Astro-Physics Command Center (APCC) Help File

APCC Pro Version

1.9.7.x

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Special thanks to:

Ray Gralak, software author, and Howard Hedlund, technical support at Astro-Physics for persevering with this project. The many hours of collaboration, code writing and testing have now culminated in mount control software that will enhance your observing or imaging sessions for years to come.

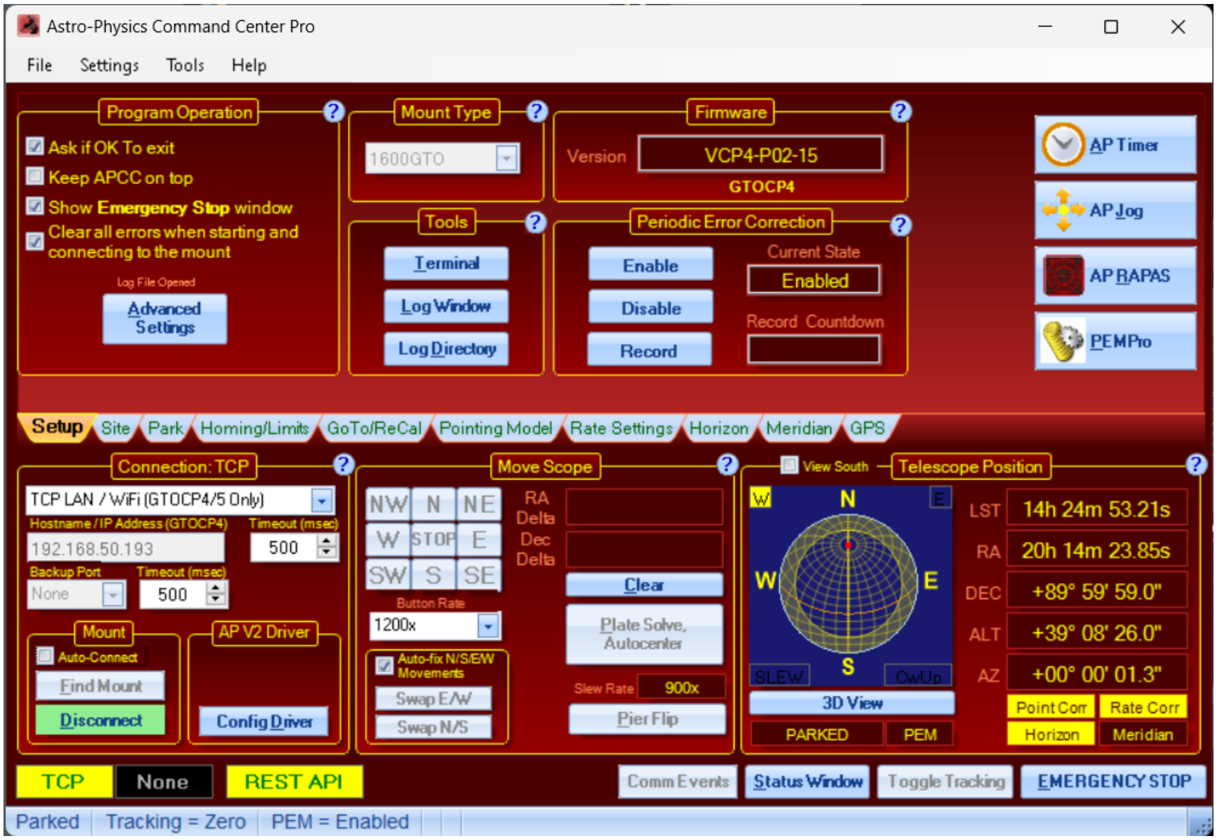
Very special thanks to our beta testers who found bugs, offered valuable suggestions and provided useful pointing data. We thank you for graciously offering your valuable time to assist with development.

Table of Contents

1 Welcome to APCC

Welcome to the instruction manual and help file for the Astro-Physics Command Center (APCC). This is a working document that will be updated frequently based on user feedback. Please check the website often to obtain the most recent version. Find the most recent documentation and updates here

The topics in this "Welcome" section provide information about the features of APCC Standard and Pro versions, version history and the license agreement. We hope you find this information useful and easy to understand.



The Astro-Physics Command Center (APCC) Main Window

1.1 Features

Astro-Physics Command Center (APCC) is available in two versions, APCC Standard and APCC Pro. Please review the feature list below regarding each version.

APCC Standard Features

- NEW in v1.9 - RA tracking rate correction for refraction(King Rate) has been added for APCC Standard and Pro.

- NEW in v1.9 - Updated drivers for Eltima virtual COM ports include bug fixes and better support for Windows 10.
- NEW in v1.9 - bug fixes for parking/unparking with counterweight up and negative altitudes.
- NEW in v1.8 - Full support for GTOCP5 and Mach 2.
- NEW in v1.8 - Safety Park has been improved. In addition to being able to park in place, it can park to home or any of the AP park positions.
- Full support for the GTOCP4 control box including Ethernet and WiFi connectivity.
- Support for increased precision in the GTOCP4.
- NEW in v1.7 -- Support for Encoder-equipped mounts, including configuration of encoder-based Home, and RA/Dec encoder limits.
- NEW in V1.7 -- Support for ASCOM ObservingConditions.
- NEW in V1.7 -- Improved support for operation with Sequence Generator Pro.
- NEW in V1.7 -- Meridian limits now has a merdian flip offset feature.
- All features of the latest GTOCP3 control box firmware are supported allowing feedback of the actual status of the mount at all times.
- Tight integration with the AP V2 ASCOM driver.
- Advanced support features for Mach2GTO, 3600GTO/3600GTOPE, 1600GTO and 1100GTO series mounts, including Home recovery. Editable 3D telescope view shows the current orientation of your telescope.
- 3D Viewer warns you if your celestial coordinates differ more than 5 degrees from the mechanical axis coordinates which could indicate trouble.
- Editable horizon tracking limits to stop tracking or park the mount once a horizon limit is reached.
- Editable meridian tracking limits to protect your telescope from pier collisions, and yet allow safe tracking past the meridian.
- Slew to counterweight-up positions with dynamic meridian delay feature (tied to meridian tracking limits).
- Safety slews for going into and out of counterweight-up positions. All declination movement occurs while counterweight is safely pointing down.
- Multiple virtual ports to allow easy connection of applications that do not require ASCOM support (like PulseGuide or TheSky6/X).
- Site management allows easily changeable setup for multiple sites.
- Display and change time zone settings
- Support for reading latitude/longitude/elevation from third-party GPS devices
- GoTo/ReCal on RA/Dec and Alt/Az coordinates
- Coordinate conversions for JNow <-> J2000 and Alt/Az <-> RA/Dec
- Access to backlash, reticle, focus (GTOCP3) and PEM settings (All mounts).
- Set custom RA/Dec tracking rates

- Can save/recall multiple RA/Dec and Alt/Az slew coordinates.
- Park to editable alt/az position.
- Available safety timer will cause the mount to park after a settable interval if a controlling computer crashes or loses COMs.
- Enables auto-park on power-down.
- Easy to read status window summarizes mount status of critical parameters.
- Logging of all commands for debugging if a problem occurs.
- Convenient log zipper function to bundle relevant log files should problems occur and you need support from AP's world-class support team!
- Can be configured to utilize a secondary serial port to prevent communication loss if a serial port to USB converter or network connection fails
- Terminal Interface tool to send commands directly to the mount.
- Includes the Horizons program for satellite, comet and asteroid tracking.
- Errant ReCal protection. Prevent outside client software from recalibrating on the wrong object
- Home and Limits for NON-Encoder mounts. Now your 400GTO, 600EGTO, Mach1GTO, 900GTO, 1200GTO or non-encoder 1100GTO, 1600GTO or 3600GTO can have Home and Limits

APCC Pro Features

- NEW in v1.9 - Platesolve, Autocenter feature for APCC Pro licenses dated 1/1/2022 and later.
- NEW in v1.9 - Ability to disable the prompt to confirm park.
- NEW in v1.9 - APPM supports ASTAP plate solving for APCC Pro licenses dated 5/1/2020 and later.
- NEW in v1.9 - APCC Pro includes Declination Arc tracking for APCC Pro licenses dated 5/1/2020 and later.
- Includes all features of the Standard version.
- Dual-model pointing and tracking rate correction even with the telescope in the counterweight-up position
- Includes a separate application to acquire Pointing/Tracking model data (APPM).
- NEW in v1.8 -- Many improvements and bug fixes to APPM.
- NEW in v1.8 -- Improvements and bug fixes that improve pointing and tracking rate accuracy.

1.2 Version History

Beginning with version 1.9, Astro-Physics implemented a one-year renewal subscription plan to provide an upgrade path for all licenses issued more than one year prior to the release date of new versions. Upgrading is optional. All licenses, regardless of age, are eligible for bug fixes and minor updates as designated in the release notes below. Please refer to our website for additional information:

https://www.astro-physics.com/apcc

Version 1.9.7.29 - 12/02/2024 (Pro version)
Version 1.9.7.28 - 12/02/2024 (Standard version)

Important: ASCOM V2 driver 5.60.17 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro and Standard - Bug Fix - Safety Park to Alt/Az position was not always working.

APCC Pro - Bug Fix - APPM would not detect ASTAP plate solve failures that had a Warning message instead of an Error message.

Version 1.9.7.27 - 11/17/24 (Pro version)
Version 1.9.7.26 - 11/17/24 (Standard version)

Important: ASCOM V2 driver 5.60.17 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro and Standard - APCC now robustly checks the mount's firmware version before allowing APCC to connect.

APCC Pro and Standard - Bug Fix - Restored logic to check and match computer's Time Zone to the mount's Time Zone (provided **Keep mount time synched to PC Time** is enabled in APCC's **Advanced Settings**).

APCC Pro - Bug Fix - **Don't display images** check box on APPM's **Camera Settings** tab was not working.

Version 1.9.7.25 - 10/08/24 (Pro version)
Version 1.9.7.24 - 10/08/24 (Standard version)

Important: ASCOM V2 driver 5.60.17 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro and Standard - BUG FIX - Now, when site latitude updates, the new site latitude will update in these windows if they are open: Meridian Limits, Horizon Limits, and 3D Scope.

Version 1.9.7.23 - 09/08/24 (Pro version)

Important: ASCOM V2 driver 5.60.17 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC - Site names containing commas are now passed correctly to the ASCOM Driver. ASCOM driver v5.60.17 or later is required to properly decode site names with these characters.

APCC - Check for and warm the user if the AP V2 ASCOM driver is running before shutting down APCC.

APCC - Check for and turn off King rate if active.

APCC - Removed "+" from commands to shorten the length of commands sending degrees, minutes, and seconds. This was causing the set longitude command to fail as the length the command exceeded the maximum length accepted by encoder mounts using the GTOCP3 and AE box.

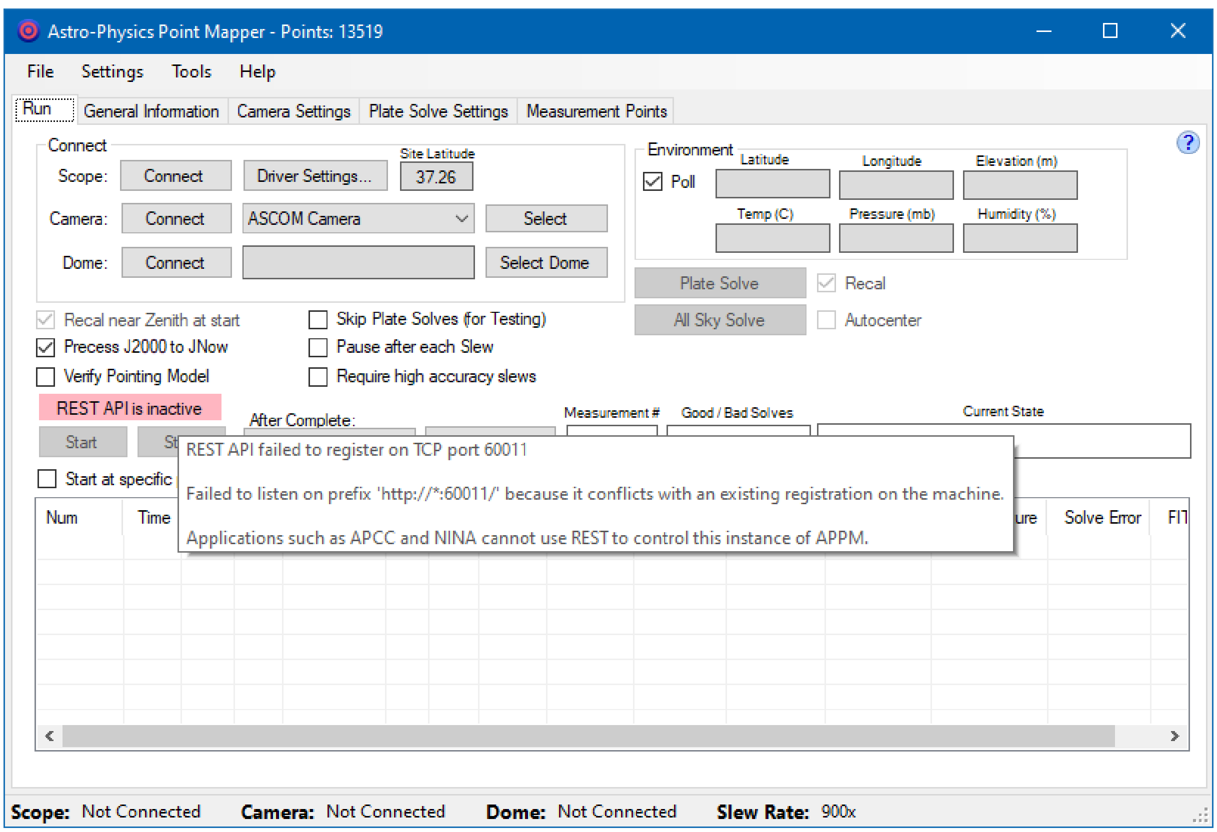
APCC Pro - APPM now has an extra digit of precision for Dec and RA spacing, allowing mapping points to be spaced closer together than 1 degree.

APCC Pro - APPM will no longer continue trying to use the ASCOM camera after switching to another camera type.

APCC Pro - Instead of using telescope focal length from the ASCOM driver when using the ASCOM camera type, APPM will now insert a calculated focal length into the FITS header calculated from the set image scale in APPM and camera pixel size (from the ASCOM Camera driver). This was done to make it easier to get plate-solving working.

APCC Pro - APPM will now reject plate solves that return results with RA=0 and Dec=0.

APCC Pro - APPM includes a indicator when the REST API was not created. This can happen if two instances are run at the same time. The first instance will be able to register the REST API to port 60011, but the second cannot because the port is already allocated. See the screen shot below, which shows that a tool tip with more details will show when hovering the mouse over the indicator.



Version 1.9.7.21 - 08/05/24 (Pro version)

Important: ASCOM V2 driver 5.60.14 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro - APPM - Improve Pause/Restart reliability.

APCC Pro - APPM - Slow down checks for Image Ready to once every 250 msecs. Previously they were happening as fast as possible.

APCC - Restore pointing and tracking correction states after Homing completes.

APCC - Increased QAC buffers to 256 from 128 to give APCC more time to recover from CPU resource scarcity.

APCC - Removed checking of Pointing Model terms that sometimes cause a model to be disabled.

Version 1.9.7.19 - 07/01/24 (Pro version)

Important: ASCOM V2 driver 5.60.14 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro - Fix Encoder status for 3600 mounts.

APCC Pro - Miscellaneous bug fixes.

Version 1.9.7.17 - 03/19/24 (Pro version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro - APPM: made improvements to settings file management and ASCOM FITS headers to prevent issues reported by users.

Version 1.9.7.15 - 03/10/24 (Pro version)
Version 1.9.7.14 - 03/10/24 (Standard version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro - Bug Fix - APPM Pause/Restart was not working.

APCC - Bug Fix - Internal Julian Date calculation was in error for some months in some years.

APCC - Bug Fix - fixed handling of G_S and G_E commands from the ASCOM Driver to the GTOCP3 controller.

APCC - Behavior change: When initializing the mount, using "Don't Unpark" in the "Unpark from" setting will no longer reset to "Last Park Position" after initialization.

Version 1.9.7.13 - 01/20/24 (Pro version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro - Bug Fix - Pointing and Tracking Rate correction may be incorrectly loaded from APPM after a point mapping run.

Version 1.9.7.11 - 01/20/24 (Pro version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro - Bug Fix - Pointing and Tracking Rate correction may be incorrectly disabled at start up of APCC.

Version 1.9.7.9 - 01/08/24 (Pro version)
Version 1.9.7.8 - 01/08/24 (Standard version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro and Standard - Bug Fix - Fixed handling of ASCOM FindHome method.

APCC Pro - Don't allow pointing or tracking rate models if RMS error exceeds 500 arc-seconds. This can be adjusted in the settings file only via this setting in Settings.apcc:

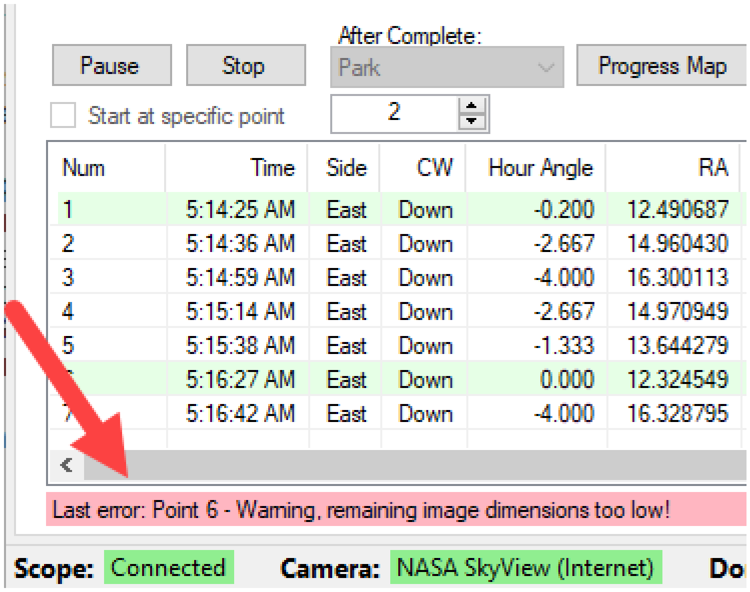
<PointingModel>

<MaximumAllowedRMS>500</MaximumAllowedRMS>

</PointingModel>

APCC Pro - APPM - If "Get Real-time RA/Dec" fails, get RightAscension and Declination via the slower, conventional ASCOM properties.

APCC Pro - APPM - To make it easier to notice errors APPM will show the last error or warning message.



Version 1.9.7.7 - 12/12/23 (Pro version)
Version 1.9.7.6 - 12/12/23 (Standard version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro - APPM enhancements:

* Added an image-scale calculator. It is available in the Common Settings group box on the Plate Solve Settings tab.

* If ASCOM camera image data fits in a 16-bit range, APPM will now save ASCOM FITS files in 16-bit integer format, otherwise it saves in the original format (32-bit integer values).

* When using ASCOM Camera option the following keywords are now included in the FITS header file:

  RA and **OBJCTRA** - Set to the decimal Right Ascension value last retrieved from the AP V2 ASCOM Driver.

  DEC and **OBJCTDEC** - Set to the decimal Declination value last retrieved from the AP V2 ASCOM Driver.

  FOCALLEN - Set to the telescope focal length in mm last retrieved from the AP V2 ASCOM driver. This value can be set using the AP V2 Driver ASCOM Setup window.

  APPMVER - Set to the APPM Version.

  ASCOMCAM - When an ASCOM camera is used this is set to the name of the ASCOM Camera driver name.

* The **SWCREATE** keyword now is set to "Astro-Physics APPM" instead of "ASCOM Camera Test".

APCC Pro and Standard - Updated to check for P02-16 firmware and display to the user. See this section for more details.

APCC Pro and Standard - Fixed firmware check in trial dialog window.

Version 1.9.7.5 - 11/18/23 (Pro version)
Version 1.9.7.4 - 11/18/23 (Standard version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro and Standard - Fixed north/south radio button when getting site coordinates from mount in Manage Sites.

APCC Pro - Updated ASCOM camera's file save orientation in APPM. Although this did not affect plate-solved position APPM was saving the image's long-edge vertically instead of horizontally

APCC Pro - Updated APPM to correctly read and append fits headers as needed, avoid unreadable fits files sent to plate solver

APCC Pro - Updated APPM to cut the size of ASCOM FITS files by saving image data as 16-bit instead of 32-bit data. The FITS files are now 1/2 the size, which improves the speed of ASCOM camera writes to disk and plate-solver reads of these images.

APCC Standard - Safety Monitor changes - added option to only log changes and errors to cut down on log writes. Also, three communications errors in a row are required before UnSafe is set to prevent shutdowns from transient conditions. NOTE:This feature is already available in APCC Pro since v1.9.7.3.

Version 1.9.7.3 - 10/05/23 (Pro version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading from 1.9.6.x or earlier. Your license key and settings will be saved automatically.

APCC Pro - Removed comments written to FITS headers as a temporary solution to FITS file corruption. .

APCC - Safety Monitor changes - added option to only log changes and errors to cut down on log writes. Also, three communications errors in a row are required before UnSafe is set to prevent shutdowns from transient conditions.

APCC Pro - added new command to enable/disable Dec Arc Tracking (requires license dated to enable Dec Arc tracking).

Version 1.9.7.1 - 09/24/23 (Pro version)

Version 1.9.7.0 - 09/24/23 (Standard version)

Important: ASCOM V2 driver 5.60.06 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading to the new versions. Your license key and settings will be saved automatically.

APCC - If a temperature below -100C is passed from an ASCOM Observing Conditions driver, APCC will fall back to the user setable temperature control on the Pointing Model tab.

APCC - Added support for driver getting site settings from APCC (AP V2 ASCOM driver 5.60.06 or later is required).

APCC - Allow processing of additional GPS message types. Supported messages: $GPGGA, $GNGGA, $GLGGA, and $GAGGA

APCC Pro - APPM has a new option to not display ASCOM images, which will speed mapping runs.

The following new features are only available with APCC licenses or renewals dated 09-01-2022 (Sept. 1, 2022) or later:

APCC - ASCOM Safety Monitor support. An action (Park, Home, stop tracking, or Warn) can be configured when an ASCOM Safety Monitor indicates outdoor conditions are unsafe (e.g. rain, wind, etc.)..

APCC Pro - Points near the zenith can be excluded in APPM with the new Max Altitude settings.

APCC Pro - Atlas sky database in DC Dreams PinPoint 7.

Version 1.9.6.7 - 02/03/23 (Pro version)

Version 1.9.6.6 - 02/03/23 (Standard version)

Important: ASCOM V2 driver 5.60.04 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading to the new versions. Your license key and settings will be saved automatically.

APCC - Query mount status immediately after a park operation completes to update park status and satisfy NINA and ASCOM desired behaviors.

Version 1.9.6.5 - 01/23/23 (Pro version)
Version 1.9.6.4 - (Standard version)

Important: ASCOM V2 driver 5.60.03 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading to the new versions. Your license key and settings will be saved automatically.

APCC - Keep slewiing status active during entire park operations to satisfy NINA and ASCOM desired behaviors.

APCC - Keep polling once a second for mount latitude/longitude until the mount responds.

APCC - Save and restore the View South checkbox between APCC runs.

APCC Pro - Restrict range of Dec Arc Tracking to within min and max declination.

Version 1.9.6.3 - 01/05/23 (Pro version)
Version 1.9.6.2 - (Standard version)

Important: ASCOM V2 driver 5.60.02 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading to the new versions. Your license key and settings will be saved automatically.

APCC - Improved handling of ASCOM SetPark command.

Version 1.9.6.1 - 01/02/23 (Pro version)
Version 1.9.6.0 - (Standard version)

Important: ASCOM V2 driver 5.60.01 or later is required. Uninstall prior versions of the V2 driver and APCC before upgrading to the new versions. Your license key and settings will be saved automatically.

APCC - Minor user interface changes.

APCC - APCC now controls park and unpark positions.

APCC Pro - renamed *recenter* to *autocenter* in APPM.

Horizons - Fixed tracking rates in the "Test Tracking" mode.

Version 1.9.5.45 - 12/09/2022 (Beta - Pro version)

APCC - Fixed auto-shutdown when the ASCOM driver uses the REST API.

Version 1.9.5.43 - 12/07/2022 (Beta - Pro version)

APCC - Changed button and menu naming for the button that plate solves and recenters.

Version 1.9.5.41 - 11/21/2022 (Beta - Pro version)

APCC - Changed units for sidereal rate value from sec/hr to sidereal.

APCC - Fixed auto-shutdown when the driver is using REST to communicate with APCC. It activates the shutdown countdown when the driver disappears from Windows process list.

Version 1.9.5.39 - 11/18/2022 (Beta - Pro version)

APCC - Changed how APCC gets the driver mode (REST or Virtual Ports).

Version 1.9.5.37 - 11/16/2022 (Beta - Pro version)

APCC Pro - Changed button name to "Plate Solve, Recal, and Center".

APCC - Fixed mount Auto-connect checkbox.

APCC - Fixed Dec encoder message not popping up.

APCC - Show "Dec Arc" instead of "Rate Corr" in the tracking correction status label when the Dec Arc Tracking algorithm is being used.

Version 1.9.5.35 - 11/12/2022 (Beta - Pro version)

APCC - Limited Virtual COM port maximum to COM99.

APCC - Fixed the refresh of controls when APCC is resized.

APCC Pro - fixed a typo in APPM message.

APCC Pro - added button to Move group box to launch APPM, plate solve, and recenter.

Version 1.9.5.33 - 11/06/2022 (Beta - Pro version)

APCC - Updated default values for controls.

APCC Pro - Changed wording of PNT files to "Active Point Map".

APCC Pro - Changed wording when prompting user to load a map at the end of a mapping run.

Version 1.9.5.31 - 10/31/2022 (Beta - Pro version)

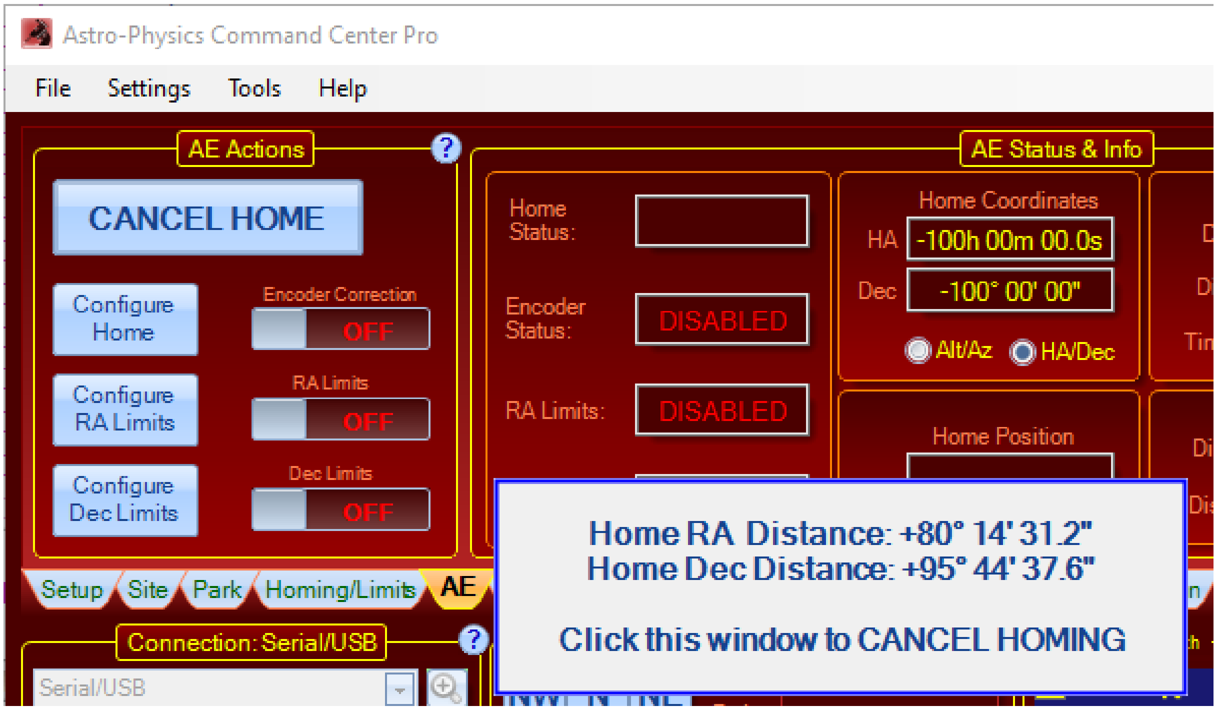
APCC - Restricted guide rates to 1.00x.

APCC - Removed Exhaustive Port Search in Advanced settings.

APCC - Removed the search for network mounts and refresh com port list buttons. Added new "Find Mount" button that can search for the mount. Also, "Connect" mount will auto-find the mount if "None" is selected.

Version 1.9.5.29 - 10/15/2022 (Beta - Pro version)

APCC Pro - AE Homing can be canceled by clicking the homing status window:



Version 1.9.5.27 - 10/09/2022 (Beta - Pro version)

APCC Pro - Fixed reversed buttons when canceling the Home operation.

APCC Pro - the APPM Test Solve folder window now allows copy/paste of its entire table.

APCC Pro - Fixed the issue when NINA connect failed, which allowed a user to continue a mapping run with NINA not connected.

APCC - Keep the "Park" button enabled even when the mount is parked. This will allow the user to park to another position without having to unpark first.

APCC - Added a new feature to disable the prompt to confirm park, **available only with licenses after the date specified at the time this feature is released.**

Version 1.9.5.25 - 09/30/2022 (Beta - Pro version)

APCC Pro - Fixed missing help link for AE tab.

APCC - Updated commands sent to reconfigure the AP V2 ASCOM driver.

Version 1.9.5.23 - 09/18/2022 (Beta - Pro version)

APCC Pro - Changed Tools menu option to say "Recal" instead of "Sync". It now says "APPM Plate Solve, Recal, and Recenter...".

APCC Pro - APPM shows a checkbox for RECAL (instead of the two buttons) even if the user does not have a subscription which includes the Recenter checkbox.

APCC - Warns the user if there is a version earlier than ASCOM Platform 6.6SP1 installed.

Version 1.9.5.21 - 09/11/2022 (Beta - Pro version)

APCC Pro - Changed Tools menu option to say "Recal" instead of "Sync". It now says "APPM Plate Solve, Recal, and Recenter...".

APCC Pro - New Feature - Removed buttons for "Plate Solve and Recal". Added checkboxes for "Recal" and "Recenter", **available only with licenses after the date specified at the time this feature is released.**

APCC Pro - Ignore command line settings file if the file is already loaded.

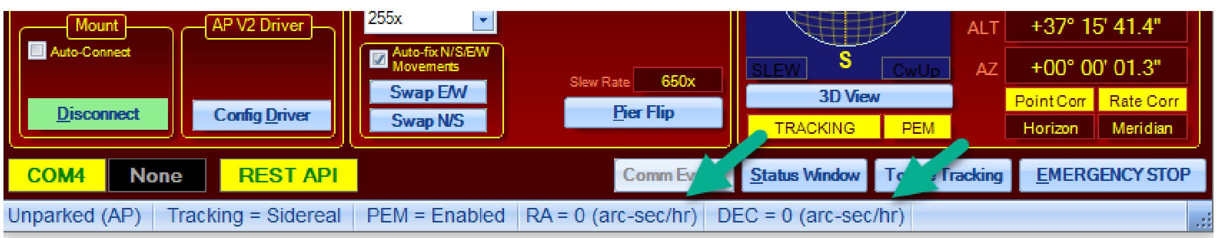
APCC - Fixed Status window's combo box for button rates to match APCC's those in main main.

Version 1.9.5.19 - 09/05/2022 (Beta - Pro version)

APCC - Added the DefaultSettings.apcc file, tested and fixed a few issues.

APCC - Removed GuideRate from status bar.

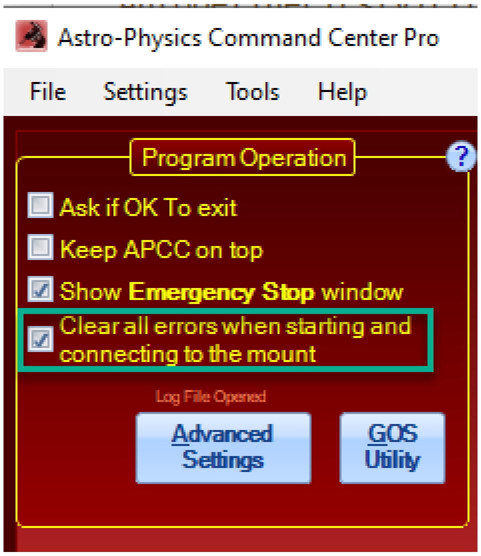
APCC - Added units to RA and Dec tracking rates in the status bar of the main window.



APCC - Fixed RA and Dec tracking rates displayed in the Status window.

APCC - Fixed - APCC did not connect to the mount with Mount Auto-connect disabled when APCC was started by the ASCOM driver.

APCC - Added new check box to clear all previous errors when APCC starts, or is connected to the mount.

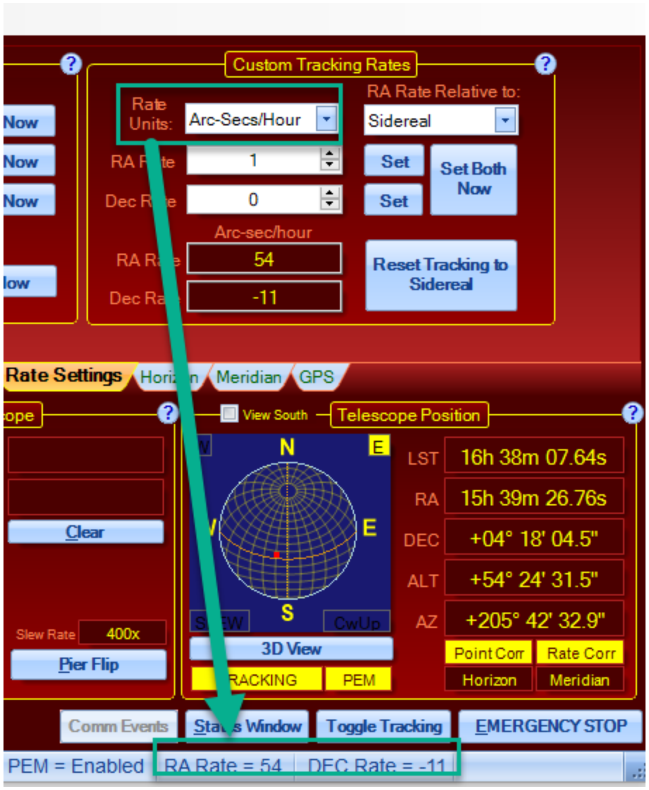


Version 1.9.5.17 - 08/28/2022 (Beta - Pro version)

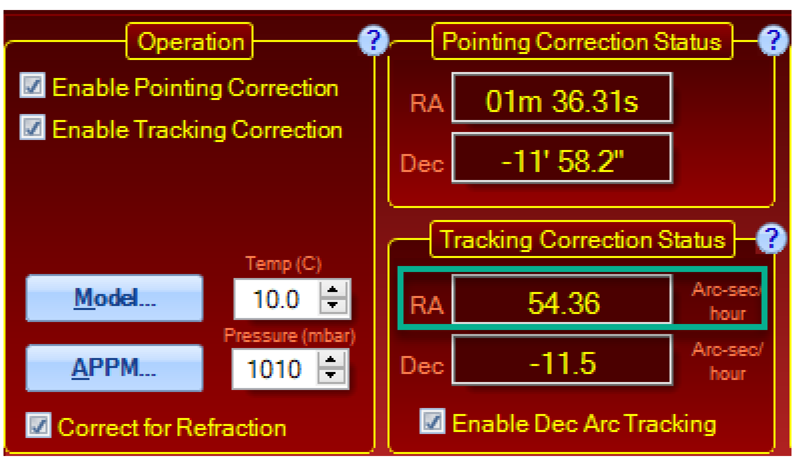
APCC - The **Metric** check box in the **Manage Sites** window, which is used to select Meters and Celsius scales (or Feet and Fahrenheit) is now linked with the **Meters** check box on the **Site** tab. Changing one will change the other. Note that now you cannot display Meters and Fahrenheit values simultaneously. That is you can select Meters and Celsius -or- Feet and Fahrenheit scales.

APCC - RA and Dec Encoder warnings are shown only once after three consecutive warnings, and will not show again unless disconnected and reconnected to the mount.Warnings are still written to the log file.

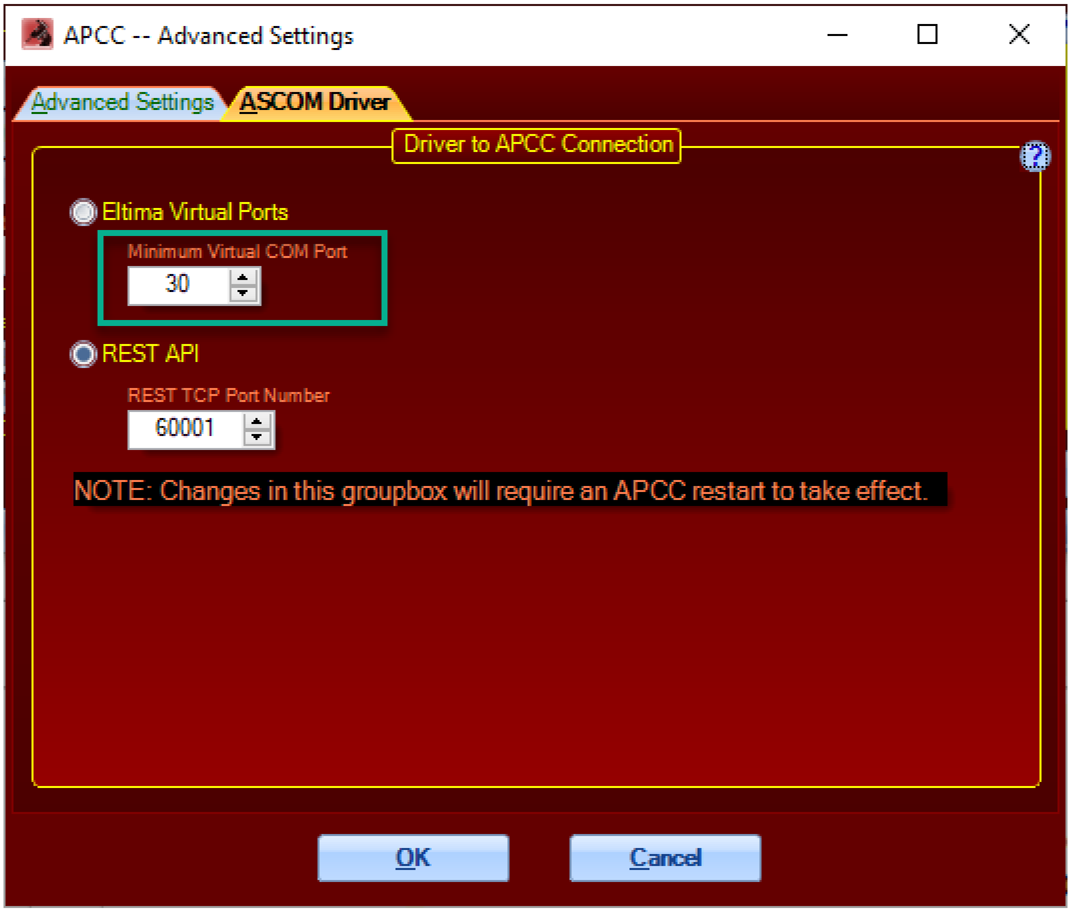
APCC - The **Rate Units** selected on APCC's **Rate Settings** tab will now be used in APCC's status bar.



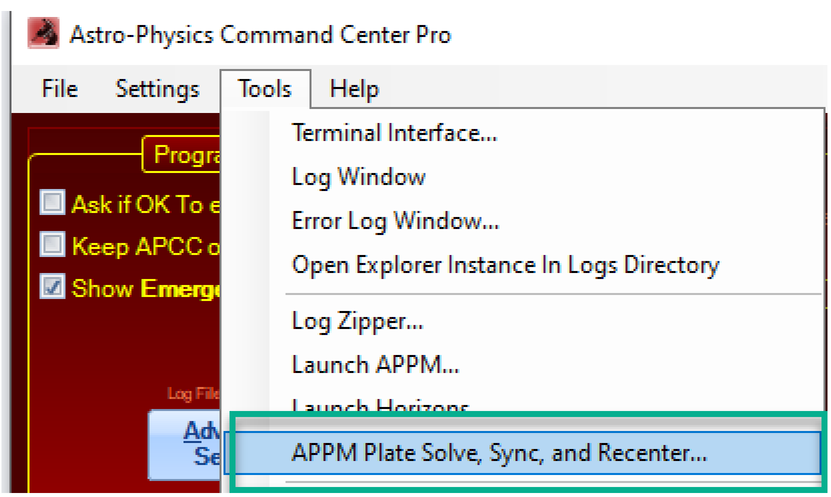
APCC Pro - The displayed RA rate units is now Arc-sec/hour in the **Tracking Correction Status** group box on the **Pointing Model** tab. Hovering the mouse over the box will show the old value (Sec/hour).



APCC - In the **ASCOM Driver** tab of **Advanced Settings**, there is a new control to specify the minimum virtual port number that APCC will use. The default is 30, which means the lowest COM port APCC will use for a virtual port is COM30.



APCC Pro - APCC will now Plate Solve, Sync (Recal), and Recenter the scope using this menu item in the **Tools** menu:



Version 1.9.5.15 - 08/26/2022 (Beta - Pro version)

APCC - Slew rate list is remembered when restarted, even when the mount is not connected.

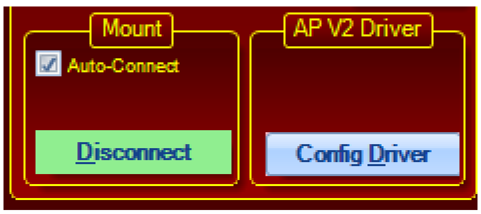
APCC - The "Refresh Ports" button now tests each COM port for a mount and will select the COM port if found.

Version 1.9.5.13 - 08/19/2022 (Beta - Pro version)

APCC - Fixed slew rates shown for the 3600GTO when GTOCP4 P02-15 or later firmware is in use.

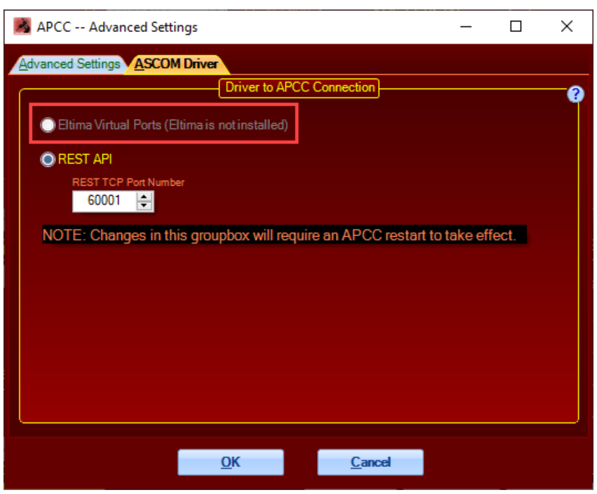
Version 1.9.5.11 - 08/14/2022 (Beta - Pro version)

APCC - Removed button to connect to the ASCOM driver and checkbox option to Auto-Connect the driver, which is no longer supported. The "Now" button is now larger and is renamed to **Config Driver**.



APCC - Installer defaults to use REST API for new users. This will not install Eltima Virtual Ports unless the user selects the option to do so.

APCC - Detects when the Eltima Virtual Ports are not installed or not working, and switches the driver to use REST API if not already selected. Also, the **Eltima Virtual Ports** option will be disabled in the **ASCOM** tab in the **Advanced Settings** window:



Version 1.9.5.9 - 08/08/2022 (Version Skipped)

Version 1.9.5.7 - 08/08/2022 (Beta - Pro version)

APCC - The installer now gives the option to not install the Eltima Virtual Ports.

APCC - Modified to work when the Eltima Virtual ports are not installed.

APCC - When the driver and APCC are mis-configured, the "Now" button in the **AP V2 Driver** group box will be red. It will turn back to blue after clicking the button and the driver is reconfigured. This should not be done when the user does not want to use APCC (i.e. driver to the mount).

APPM - Add additional information to FITS header, including when an image has been dark-subtracted.

APPM - Bug fix - values that "wrap" when dark subtracted are now handled properly.

Horizons - Change NASA Horizons link to use https instead of http.

Version 1.9.5.5 - 06/27/2022 (Beta - Pro version)

APCC Pro - On the **Pointing Model** tab, moved **Correct for Refraction** check box to the **Operation** group box.

APCC Pro - On the **Pointing Model** tab, removed check boxes and pointing terms and replaced with scatter plots of East and West pointing models.

APCC - In **Advanced Settings**, the **Reset All Defaults** button now resets the settings using the values in file c:\ProgramData\Astro-Physics\APCC\DefaultSettings.apcc. Settings not in DefaultSettings.apcc are not changes in the user's settings files.

APCC - Fixed - The **Auto-Connect** check box in the **Mount** group box was not functioning.

APCC Pro - APPM - Increased NASA Sky View image size from 1600x1200 to 2400x1600 to include more stars for plate solving.

APCC Pro - APPM - When performing a **Plate Solve Now** or **Plate Solve and Recal Now**, added a check box allowing the user to set the camera image scale from the plate solve results.

Version 1.9.5.3 - 06/12/2022 (Beta - Pro version)

APCC - Removed "Third Party Applications" tab in Advanced Settings.

APCC - Added "Purge Logs" option in Advanced Settings.

APCC - Added "Reset All Defaults" button in Advanced Settings.

APCC - Removed "Windows Priority" combo box in Advanced Settings.

APCC - Changed default to unchecked for "Clear Meridian Delay" check boxes in the GoTo/Recal tab.

APCC - Added "Set Constant Limit" to Meridian Limits Explorer window.

APCC - Removed "Stop Tracking after unparking" check box from the Park tab.

APCC - Counterweight-up parks are now allowed.

Version 1.9.5.1 - 05/02/2022 (Beta - Pro version)

APCC - Removed "Create Virtual Ports First" check box in the Mount connection group box.

APCC - Removed AP V2 Driver group box's "Auto-Config" check box.

APCC - Change Advanced setting tab's name from "API" to "ASCOM Driver".

APCC - In Advanced settings "ASCOM Driver" tab, change to use radio buttons select "Eltima Virtual Ports" or "REST API". When 'REST API' is selected, the Virtual Port tab and four status boxes at the bottom of APCC are removed and "REST API" shows in the status bar.

APCC - Added "Fixed Limit" check box and horizon Altitude settings in APCC's Horizons tab.

Version 1.9.4.3 - 02/27/2022 (Release - Pro version)

Version 1.9.4.2 - 02/27/2022 (Release - Standard version)

APCC Pro and Standard - Fixed connect to AP V2 driver from APCC.

APCC Pro and Standard - Allow upper or lower case "M" for units (meters) from MGBoxV2 ASCOM drivers.

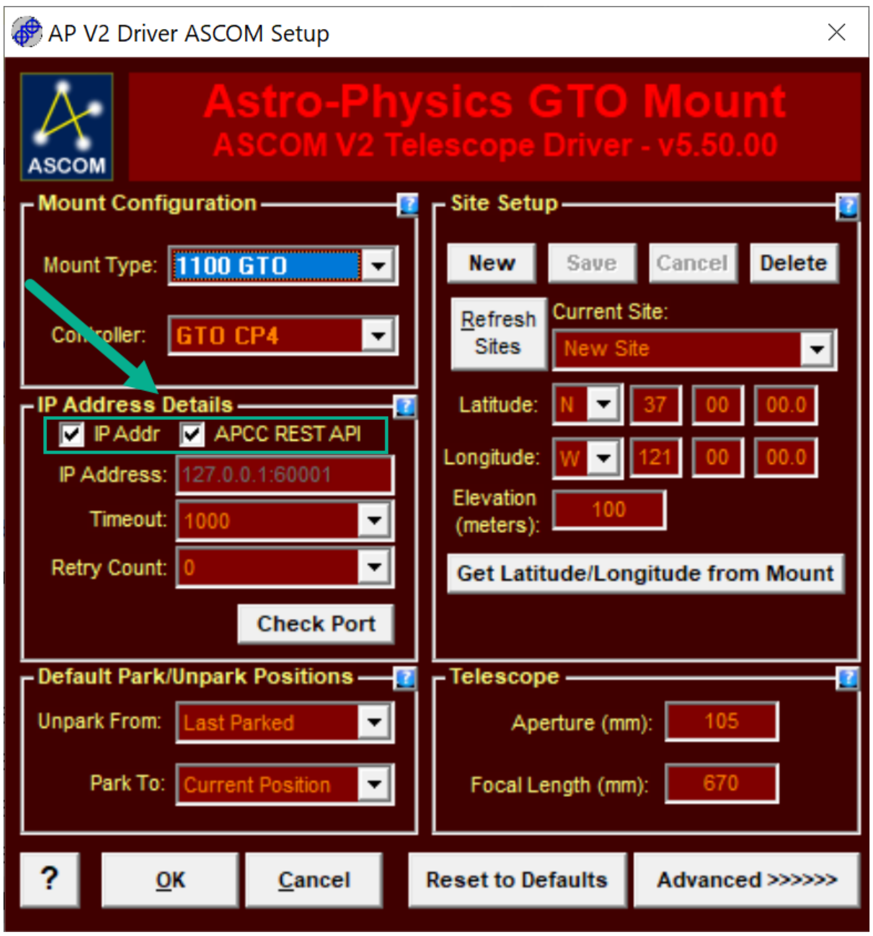
NOTE: AP V2 ASCOM Driver version 5.50.02 or later is required for proper operation.

Version 1.9.4.1 - 02/15/2022 (BETA - Pro version)

APCC Pro - for APCC's GPS tab, added internal check for new MGBoxV2 ASCOM server. Of found it will be used instead of the older driver.

APCC Pro - added REST API command that allows external applications, such as the ASCOM driver, to send native mount commands and receive responses. This is an alternative to using APCC's Virtual Ports for communication.

To setup the ASCOM Driver (version 5.50.00 or later is **required**):



Version 1.9.3.3 - 01/20/2022 (Release - Pro version)

APCC Pro - Fixed bug in APPM Trial mode that prevented use of ASTAP.

APCC Pro - Fixed bad pointing and tracking rate correction when the model's PNT file was missing.

Version 1.9.3.1 - 12/26/2021 (Release - Pro version)

Version 1.9.3.0 - 12/26/2021 (Release - Standard version)

APCC - Eltima V10 is incompatible with Windows 7, so the installer will install Eltima V9 for Windows 7.

APCC Pro - fixed a bug in the ASCOM camera view window.

Version 1.9.2.5 - 11/28/2021 (Beta - Pro version)

Version 1.9.2.4 - 11/28/2021 (Beta - Standard version)

APCC - Fixed - Horizons now accepts JPL NASA ephemeris files with refraction model set to "standard atmospheric model".

APCC Pro - Updated MappingRun/Status REST API to use numeric instead of text values for certain properties.

Version 1.9.2.3 - 11/18/2021 (Beta - Pro version)

APCC Pro - APPM - Added new REST API commands to close APPM from an external application.

Version 1.9.2.1 - 11/13/2021 (Beta - Pro version)

APCC Pro - Upgraded Eltima Virtual Serial Ports ActiveX to version 10.

APCC Pro - APPM - Added new REST API commands to start, stop, and get status of APPM mapping runs.

Version 1.9.2.0 - 11/13/2021 (Beta - Standard version)

APCC Standard - Upgraded Eltima Virtual Serial Ports ActiveX to version 10.

Version 1.9.1.5 - 11/9/2021 (Beta - Pro version)

APCC Pro - Fixed - APPM - The -M option was not parsing some values to double precision floating point.

APCC Pro - APPM - Added new REST API commands to get/set **Measurement Points** tab values.

APCC Pro - fix potential issue with Error Log window not showing when APCC is minimized.

Version 1.9.1.3 - 10/23/2021 (Beta - Pro version)

APCC Pro - Fixed - APPM - Binned full-frame images passed the wrong width and height to the ASCOM Camera driver.

APCC Pro - Fixed - When opened, the 3D Viewer no longer prompts Mach2 scopes with warning dialog boxes.

Version 1.9.1.1 - 10/18/2021 (Beta - Pro version)

Version 1.9.1.0 - 10/18/2021 (Beta - Standard version)

APCC Standard / Pro - The NASA Horizons website has been revamped so copying/pasting the website data no longer works. Horizons now accepts an ephemeris file downloaded from the new NASA Horizons web site.

APCC Standard / Pro - Report encoder error only if three or more read errors occur in a row.

APCC Standard / Pro - Provide additional time offset for meridian flip point for Sequence Generator Pro users.

APCC Pro - Any calculated pointing term that exceeds a predetermined maximum value is set to 0 to prevent huge over-corrections when using the all-sky pointing models.

APCC Pro - The 3D View now follows the Mach 2 position even when declutched.

APCC Pro - APPM - Add new command line switch (-M) to accept configuration on the Measurement Points tab.

The following change requires a license dated August 1, 2020 or later:

APCC Pro - APPM - Add check box to ASTAP plate solve configuration to use FITS header for RA, Dec, and image scale.

Version 1.9.0.13 - 09/26/2021 (Beta - Pro version)

APCC - Log user double-clicks to status bar.

The following changes require a license dated August 1, 2020 or later:

APCC Pro - Further improve performance of Real-time RA/Dec.

Version 1.9.0.11 - 09/23/2021 (Release - Pro version)

The following change require a license dated August 1, 2020 or later:

APCC Pro - Fixed - remove extra character in Real-time RADec response before converting RA to a decimal value.

Version 1.9.0.9 - 09/19/2021 (Release - Pro version)

APCC Pro - Fixed - Updated ServiceStack license to latest.

The following changes require a license dated August 1, 2020 or later:

APCC Pro - Improved Real-time RA/Dec response time.

APCC Pro - APPM now uses the Real-time RA/Dec feature, improving slew settling times.

Version 1.9.0.7 - 09/14/2021 (Release - Pro version)

APCC Pro - Fixed - Menu item **Tools->APPM Plate Solve and Sync** did not work. Also, if an error occurred, error messages were not being sent back to APCC from APPM.

APCC Pro - Fixed - External RA and Dec Tracking rates from ASCOM driver were sometimes added to the tracking rate with the wrong sign.

Version 1.9.0.5 - 09/05/2021 (Release - Pro version)

Version 1.9.0.4 - 09/05/2021 (Release - Standard version)

APCC - Fixed - APCC did not send meridian limit value to Sequence Generator Pro.

APCC - Fixed - backup COM port value did not save when set to "None".

APCC - Fixed - trial license did not enable latest subscription features.

APCC Pro - Fixed - MoveAxis commands were disabled when Dec >= 80 or Dec <= -80 degrees.

APCC Pro - Fixed - Dec-Arc check box did not save.

APCC Pro - Fixed - APPM did not allow non-standard spaces in OBJCTRA and OBJCTDEC FITS header keyword values.

APCC Pro - Fixed - ASTAP results in APPM did not work with FITS files with extensions other than ".FIT".

Version 1.9.0.3 - 08/19/2021 (Beta - Pro version)

APCC Pro - Add log file output to track command queue entries.

Version 1.9.0.1 - 08/01/2021 (Release - Pro version)

Version 1.9.0.0 - 08/01/2021 (Release - Standard version)

New Features - requires license dated August 1, 2020 or later
APCC Pro - Declination-Arc tracking algorithm. This new algorithm is an alternative to the normal all sky tracking model that APCC Pro uses.

APCC Pro - APPM can use ASTAP for plate-solving.

APCC Pro - APPM can use NINA for camera control.

APCC Pro - For third-party satellite trackers, real-time RA/Dec can be returned using the :GRGD# command.

Updates and Bug Fixes for all Licenses

APCC Pro - Added command line option to APPM to use a startup settings file.

APCC - Updated to Eltima V9.0 Drivers. Changes/fixes to the Eltima drivers include:

- Added: Windows Server 2016 support.
- Added: full Windows 10 support.

- Improved: displaying a more detailed information about the virtual serial ports in Windows Device Manager.
- Improved: drivers are digitally signed with WHQL.
- Fixed: displaying of the newly created virtual ports in the device manager.
- Fixed: timeouts processing during the read operation.

APCC - Added King rate as a new tracking rate (requires GTOCP4/CP5).

APCC - Meridian limits tab includes a title of the last meridian limits file saved or loaded.

APCC - BUG FIX - ComponentOne License dialog was coming up on a **Horizons** tracking graph window.

APCC - BUG FIX - When parking to a location "under" the celestial pole, APCC was setting an incorrect meridian delay, causing the mount to slew the wrong way.

APCC - BUG FIX - APCC was removing "X/Y/Z" characters from the response to :GOS# command.

Version 1.8.8.17 - 01/22/2021 (Release - Pro version only)

APCC Pro - Handle race condition between Horizon/Meridian Limits stop tracking and updating the modeled tracking rate.

Version 1.8.8.15 - 01/15/2021 (Release - Pro version)

Version 1.8.8.14 - 01/16/2021 (Release - Standard version)

APCC - Use an alternative method to perform "check for updates".

APCC - WiFi Mac address now displays correctly in Find GTOCP4/5.

Version 1.8.8.15 - 01/15/2021 (Release - Pro version only)

APCC Pro - Try alternative method to perform "check for updates".

APCC Pro - WiFi Mac address now displays correctly in Find GTOCP4/5.

Version 1.8.8.13 - 01/03/2021 (Release - Pro version only)

APCC Pro - Change default settings for check box options.

APCC Pro - Latitude and Longitude now display with N/S and E/W symbols, respectively, instead of positive/negative values.

Version 1.8.8.11 - 12/26/2020 (Release - Pro version only)

APCC Pro - Bug Fix - Fix the slow start up issue.

Version 1.8.8.9 - 12/19/2020 (Release - Pro version only)

APCC Pro - Bug Fix - Fix licensing issue with chart component.

Version 1.8.8.5 - 12/12/2020 (Release - Pro version only)

APCC Pro - Bug Fix - RA and Dec values in APPM log files sometimes had incorrect HH:MM:SS, and DD:MM:SS values, respectively.

Version 1.8.8.3 - 11/10/2020 (Release - Pro version only)

APCC Pro - Bug Fix - APPM was opening a new window for every ASCOM camera operation.

Version 1.8.8.1 - 11/08/2020 (Release - Pro version)

Version 1.8.8.0 - 11/08/2020 (Release - Standard version)

APCC - Bug Fix - APCC was not parking the Mach2 correctly to Home position.

APCC - Bug Fix - When comparing mount time to computer time, Date/Time was not always initialized properly, thus incorrectly reporting mount time was more than 2 seconds from computer time.

APCC - Bug Fix - Under certain conditions it was possible to set the meridian inclination value out of the valid range of 0-180 degrees. This resulted in an application exception.

APCC - Bug Fix - The command ":m#" was being sent to firmware versions that don't recognize this command. This command now is sent only to mounts with firmware P02-05 and later.

APCC - Internal mount limits are now disabled for mounts with P02-05 and later firmware.

APCC - Add new commands to set Virtual Port output RA and Dec precision from external applications.

APCC - now displays "Connected" in the pop-up window, which then will close more quickly than previous versions.

APCC Pro - APPM - Add up to 15 second delay above settle time if mount is not at the target coordinates when collecting data points for a model.

Version 1.8.7.0/1 - 10/04/2020 (Release - Standard/Pro versions)

APCC - Bug Fix - APCC was erroneously sending a command that is unrecognized by firmware versions before P02-05.

Version 1.8.6.0/1 - 08/24/2020 (Release - Standard/Pro versions)

APCC - Re-initialize encoder ranges when RA or Dec Encoder limits are enabled.

Version 1.8.5.1 - 08/23/2020 (Release - Pro version only)

APCC Pro - For Mach 2 and other encoder equipped mounts, turn off mount's internal RA and Dec limits.

APCC Pro - Initialize Encoder Limits every time APCC connects to the mount.

Version 1.8.4.1 - 07/26/2020 (Release - Pro version only)

APCC - BUG Fix - On the **Goto/Recal** tab declination values greater than 90 degrees could be entered under the right circumstances.

APCC Pro - BUG Fix - Point counts on the top of the **Pointing Model** tab were not getting set.

APPM - Improvement - Manually add DATE-OBS keyword to ASCOM FITS images.

Version 1.8.3.0/.1 - 05/31/2020 (Release - Standard/Pro versions)

APCC - BUG Fix - Because of a rare race condition a Meridian flip might not occur when it should have.

APCC - BUG Fix - Turning off Slews within West Meridian limits did not reset the meridian delay.

APCC Pro - BUG Fix - APPM Camera errors were sometimes ignored.

Version 1.8.2.0/.1 - 05/25/2020 (Release - Standard/Pro versions)

APCC - BUG Fix - Tracking rates were not working correctly for the GTOCP3 in 1.8.1.1.

APCC - BUG FIX - Prevent Mach 2 from setting HOME to be anything other than Park 3.

APCC - BUG FIX - The ASCOM driver can send values in exponential notation when the value is near zero. APCC was rejecting this exponential notation.

APCC - BUG Fix - Commands starting with "G_" were rejected.

APCC - BUG Fix - Clear flashing scope view when user clears all errors.

APCC - BUG FIX - Settings were not always being correctly saved.

APCC - BUG Fix - Prevent possible overflow in Meridian Limits Add Point dialog.

APCC - BUG FIX - Horizons - some of the menus did nothing.

APCC - BUG FIX - Horizons - Fixed a number of display bugs and made the displayed data more useful.

APCC - BUG Fix - fixed an integer overflow error that would happen occasionally.

APCC Pro - BUG FIX - APPM - Slew would sometimes fail to appear to complete thus stalling data mapping runs.

APCC Pro - BUG Fix - tracking rate correction was not always saved correctly.

APCC - Improvement - Moved virtual port handlers to their own threads to reduce latency when user interface elements are updated.

APCC - Improvement - In the Meridian Tracking Limits Explorer dialog window, add a button to update Meridian Inclination.

Version 1.8.1.0/.1 - 04/07/2020 (Release - Standard/Pro versions)

APCC - Warn user if CP4 firmware is older than VCP4-P01-13.

APCC - BUG FIX - Horizon Limit could sometimes use excessive CPU cycles.

APCC - BUG FIX - 1600 mounts with GTOCP3 and encoders would not display the AE tab.

APCC Pro - BUG FIX - ASCOM RA tracking rates were inverted.

APCC Pro - BUG FIX - Fixed math sign for all user interface RA and Dec rate values.

APCC Pro - Improved precision of tracking rates.

Version 1.8.0.8/.9 - 03/07/2020 (Release - Standard/Pro versions)

APCC - BUG FIX - Fix meridian limit flip offset value.

APCC - BUG FIX - Not all centering rates were available for earlier versions of firmware.

APCC - BUG FIX - Pressing Control-Key on start did not override saved window positions.

APCC - BUG FIX - The "*Use numerical IP address*" checkbox in the Find GTOCP4/GTOCP5 window was not saved/restored.

Version 1.8.0.7- 03/07/2020 (Beta - Pro version)

APCC Pro - Allow APPM to use camera binnings other than 1x with SGPro.

Version 1.8.0.4/.5 - 03/07/2020 (Release - Standard/Pro versions)

APCC - BUG FIX - AE tab values are not populated or updated.

APCC - BUG FIX - Custom slew rate option was missing in Rates tab and Initialization windows.

APCC - Restored Encoder Trim controls to ELS tab.

APCC - Disable Encoder enable/disable switch for Mach 2/GTOCP5.

Version 1.8.0.2/.3 - 02/29/2020 (Release - Standard/Pro versions)

APCC - BUG FIX - clicking AE tab can cause it to switch to ELS tab.

APCC - Limit Safety Park position option if the control box does not have the appropriate firmware.

APCC - Updated documentation for APPM and Virtual Port and Park tabs.

Version 1.8.0.0/.1 - 02/27/2020 (Release - Standard/Pro versions)

APCC - Added support for GTOCP5 and Mach 2.

APCC - Added Safety park to park positions.

APCC - Allow custom Alt/Az parks to negative altitudes and to counterweight up positions.

APCC - Fix various slew and park issues.

APCC Pro - Fix issues with plate solving NASA SkyView camera type.

APCC Pro - In APPM improve information presented when manual plate solving andplate solve+RECAL.

APCC Pro - Made improvements to APPM user interface.

Version 1.7.1.4/.5 - 11/29/2019 (Release - Standard/Pro versions)

APCC - BUG FIX - Mount flip does not complete when meridian limit is reached and flip mount is the selected action.

Version 1.7.1.3 - 09/29/2019 (Release - Pro version)

APCC Pro - BUG FIX - Upgrade from Standard license was not working.

APCC Pro - BUG FIX - Refraction checkbox option was not saved.

APCC Pro - BUG Fix - Final correction slew might not appear to complete if a response from the mount is not received.

APCC Pro - miscellaneous bug fixes and improvements.

Version 1.7.1.2 - 09/29/2019 (Release - Standard version)

APCC Standard - miscellaneous bug fixes and improvements.

Version 1.7.1.1 - 03/14/2019 (Release - Pro version)

Version 1.7.1.0 - 03/14/2019 (Release - Standard version)

Relabeled 1.7.0.28/29 to released status!

Version 1.7.0.29 - 03/07/2019 (Beta Release - Pro version)

Version 1.7.0.28 - 03/07/2019 (Beta Release - Standard version)

APCC Pro and Standard - Added Camera rotation parameter to 3D Telescope Editor.

APCC Pro - A couple buttons in the Pointing model window were shifting position after the window opened.

APCC Pro - Tracking rate correction commands were being overridden by a command from the ASCOM driver.

Version 1.7.0.27 - 02/22/2019 (Beta Release - Pro version)

Version 1.7.0.26 - 02/22/2019 (Beta Release - Standard version)

APCC Pro and Standard - Unsafe Slew moves were not always being honored.

APCC Pro - fixed flip flop slew to counterweight up position when using APPM with counterweight-up slews.

APCC Pro - APPM removed extra slew when settling.

APCC Pro - APPM toggling between Decimal and HH:MM:SS/DD:MM:SS formats works much better.

APCC Pro - APPM 5x Verify now only does a RECAL on the first iteration.

APCC Pro - APPM fixed several cross-threading exceptions.

APCC Pro - Improved tool tips when hovering over graphs in Pointing Model window.

Version 1.7.0.25 - 02/14/2019 (Beta Release - Pro version)

Version 1.7.0.24 - 02/14/2019 (Beta Release - Standard version)

APCC Pro and Standard - Fixes to handle edge and start up Meridian Limits conditions.

APCC Pro and Standard - State of **Limit to Meridian** check box on Meridian Limits tab was not being restored when APCC restarted.

Version 1.7.0.25 - 02/14/2019 (Beta Release - Pro version)

Version 1.7.0.24 - 02/14/2019 (Beta Release - Standard version)

APCC Pro and Standard - Fixes to handle edge and start up Meridian Limits conditions.

APCC Pro and Standard - State of **Limit to Meridian** check box on Meridian Limits tab was not being restored when APCC restarted.

Version 1.7.0.23 - 02/13/2019 (Beta Release - Pro version)

Version 1.7.0.22 - 02/13/2019 (Beta Release - Standard version)

APCC Pro only **-** Improvements to tool tips in pointing model graphs.

APCC Pro and Standard - GPS tab now supports reading GPS information from the **MGBoxV2** from Astromi.ch.

APCC Pro and Standard - Improved formatting of Latitude and Longitude

Version 1.7.0.21 - 02/07/2019 (Beta Release - Pro version only)

APCC Pro **-** BUG FIX - UDP IP Address now works without needing to provide a port number.

APCC Pro - Tracking correction now sends an updated tracking rate when the rate actually changes instead of always sending once per second.

Version 1.7.0.19 - 02/06/2019 (Beta Release - Pro version only)

APCC Pro **-** BUG FIX - Tracking rates were inverted after removing relative moves in 1.7.0.17.

Version 1.7.0.17 - 02/05/2019 (Beta Release - Pro version only)

APPM - Replaced HA/Dec slews with RA/Dec slews. The HA/Dec slews were adding a slight amount of positional error.

Version 1.7.0.15 - 02/04/2019 (Beta Release - Pro version)

Version 1.7.0.14 - 02/04/2019 (Beta Release - Standard version)

APCC Pro and Standard **-** BUG FIX - Meridian delay was getting reset under certain circumstances which sometimes prevented counterweight up slews (same as Standard).

APCC Pro and Standard - BUG FIX - Fixed cross-threading issue that might prevent the Mechanical Home position from being correctly displayed

Version 1.7.0.13 - 01/28/2019 (Beta Release - Pro version only)

APCC **-** BUG FIX - On the AE tab clicking Cancel in **Configure Home** would pop up an error and still start up APPM.

APCC - BUG Fix - The **Enable Refraction** option was not being saved.

APPM - BUG Fix - West pier side counterweight-up slews were slewing to the opposite side then back.

APPM - BUG Fix - Reset RA/Dec plate solve offsets when restarting a new run.

APPM - BUG Fix - Getting a NASA SkyView image would always fail the first time.

APCC - BUG Fix - Pier flip would not happen under certain circumstances because of the difference between the pointing model's Right Ascension value and the mount's actual Right Ascension.

APCC - Bug Fix - Fixed several bugs that sometimes would result in inaccurate pointing corrections.

Version 1.7.0.11 - 01/11/2019 (Beta Release - Pro version only)

APPM - BUG Fix - West pier side counterweight-up slews were slewing to the opposite side then back.

APPM - Reset RA/Dec plate solve offsets when restarting.

Version 1.7.0.10 - 01/11/2019 (Beta Release - Pro + Standard version)

APCC - Implemented new meridian limits operations to copy "East to West" and "West to East" data points.

APCC - Various bug fixes.

Version 1.7.0.9 - 01/09/2019 (Beta Release - Pro version only)

APCC - BUG Fix - Fixed calculation of RA/Dec error when refraction is enabled/disabled.

Version 1.7.0.7 - 01/08/2019 (Beta Release - Pro version only)

APCC - BUG Fix - Fixed sign of Southern Hemisphere RA movements.

APCC - BUG FIX - "Emergency Stop" was not stopping motions caused by RR and RD commands.

Version 1.7.0.5 - 01/07/2019 (Beta Release - Pro version only)

APCC - Totally reworked the pointing model functionality for improved pointing and tracking rate correction.

APCC - Improved accuracy of Sidereal Time calculation, which is important to the accuracy of the pointing model.

APCC - Fixed a refraction calculation bug in the model.

APCC - In the Pointing Model window, added buttons to select all mapping points.

APCC - Fixed several bugs in the pointing model window.

APPM - Fixed a bug related to the hour angle/dec slews.'

APPM - Added "automap" command line switch to start an automated APPM run.

APPM - BUG FIX - when selecting certain Point Ordering Strategy values, the appropriate controls were not always enabled.

APPM - added command line switches to load a previously saved settings file and a custom point list.

Version 1.7.0.3 - 12/2/2018 (Beta Release - Pro version only)

APPM - Changed slew to use Hour Angle/Dec commands.

APCC - Added refraction coefficient back in.

APCC - Added new Pointing model graphs to map the relationships between pointing errors and position in the sky. The graphs have features like zooming in and out to get a better view of the data in the graphs.

APCC - Added filters to remove potentially bad data points from the pointing model.

APCC - In the pointing model window hovering over a point in the graphs will automatically show and select its entry in the table. Also a popup window will show some details about the point that is being hovered over.

APCC - Selecting a row in the pointing model table will highlight the corresponding point in the pointing error graph.

Version 1.7.0.1 - 10/27/2018 (Beta Release - Pro version only)

APPM - Added Environment group box for ASCOM ObservingConditions Driver

APPM - Keep appropriate camera and plate solve settings enabled during plate solving so they can be adjusted while running.

APPM - Add new option to use last plate solve error offset to the next plate solve's hint. This usually speeds up plate solves.

APPM - Add robustness to PinPoint Remote Server setup.

APPM - Various other bug fixes.

APPM - Add "Declination (Graduated RA Density)" point ordering strategy.

APPM - Add quick "Map Type" selection.

APPM - GTOCP4 counterweight-up slews no longer slew to meridian and back to destination ("safe slews").

APCC - AE (encoder) tab added. Features include define and find Home, define fixed and variable RA limits, define fixed Dec Limits, enable/disable encoders.

Version 1.7.0.0 - 10/27/2018 (Beta Release - Pro + Standard version)

APCC - Add new **Environmental Settings** settings to select ASCOM ObservingConditions driver or THUM device.

APCC - Meridian Limits - Added **Flip Offset** and **Limit to Meridian** controls. The **Flip Offset** value allows the mount to flip during a period of time before the meridian limit is reached.

APCC - Meridian Limits - Allow a negative meridian flip point to be passed to Sequence Generator Pro.

APCC - Meridian Limit Editor - Automatically disable Meridian Limits when in the editor. This can cause unintentional meridian flips.

APCC - Site Information tab now includes the site's Time Offset from UTC, including any offset from Daylight Savings Time when

APCC - AE (encoder) tab added. Features include define and find Home, define fixed and variable RA limits, define fixed Dec Limits, enable/disable encoders.

Version 1.6.0.4 - 08/03/2017 (Public Release - Standard version only)

Note: This version must be used with the AP V2 ASCOM driver v5.10.00 or later.

APCC Standard - enable RA/Dec limits checking for Standard version.

Version 1.6.0.3 - 07/27/2017 (Public Release)

Note: This version must be used with the AP V2 ASCOM driver v5.10.00 or later.

APCC Pro - Fix formatting of extended precision response to GR commands with the pointing correction enabled.

APCC - Aborting Pier Flip would not restore original meridian delay.

APCC - Removed all "blocking" message box windows. All pop up windows will automatically close with a default action. All actions are recorded in the log file.

APCC - Status of a canceled slew was not always propagated up to the driver, so the driver would think the slew was still active.

APCC - Only send commands to Sequence Generator if it is running.

APCC - Fix UDP backup to COM port not working.

Version 1.6.0.2 - 07/17/2017 (Public Release)

Note: This version must be used with the AP V2 ASCOM driver v5.10.00 or later.

APCC - some commands were mistakenly sent to the GTOCP3 with extended precision.

Version 1.6.0.1 - 07/14/2017 (Public Release)

Note: This version must be used with the AP V2 ASCOM driver v5.10.00 or later.

APCC - Fix problem with main window scaling for high DPI monitors and laptops.

Version 1.6.0.0 - 07/12/2017 (Public Release)

Note: This version must be used with the AP V2 ASCOM driver v5.10.00 or later.

APCC - Do not use extended precision format for GTOCP3 controllers. (GTOCP4 firmware "P01-04" and later will use extended precision).

APCC - Allow RA/Dec move rates up to 999.999x for GTOCP3 firmware "V1" and all GTOCP4 controllers.

APCC - Improve performance over remote connections by decoupling many controls in the user interface from virtual port commands.

APCC - Added missing J2000/JNow conversions for Sync. Fixed a few other bugs related to J2000/JNow conversion.

APPM - Many improvements and bug fixes.

Version 1.5.1.1 - 06/06/2017 (Private Release)

Note: This version should be used with the AP V2 ASCOM driver v5.09.10 or later.

APCC - Fixed qualification of high precision formated RA/Dec/Alt/Az commands coming in through the virtual ports.

APCC - Made changes to reduce slow UI updates (e.g. over Remote desktop) from delaying responses to commands received on virtual ports.

Version 1.5.1.0 - 06/04/2017 (Private Release)

Note: This version should be used with the AP V2 ASCOM driver v5.09.10 or later.

APCC - All versions of CP3 "V" chip and CP4 "P01-04" and later now will send higher precision values to the mount for these commands:

:Sr, :Sh, :Sd, :Sz, :Sa, :St, and :SM

APCC - Increased display resolution of RA/Dec/Alt/Az/HA in various places.

APCC - Changed behavior of RA/Dec and Alt/Az Save/Restore functionality on the Goto/Recal tab.

APCC Pro - Pass point model's corrected alt/az position to the driver and other applications on the virtual ports.

APCC - Removed incorrectly displayed SGPro warning on the meridian limits tab.

APCC - Fixed popup message with incorrectly labeled buttons.

APCC - Various other bug fixes and enhancements.

APPM - Strip potential port number from network address in PinPoint platesolve settings to allow pinging to work.

APPM - Fixed ASCOM file save function.

APPM - Added Status bar on bottom to show device connection status.

APPM - Fixed ASCOM connect - ASCOM device was not saved.

APPM - When starting an APPM run a new settings summary window shows the parameters.

APPM - Fixed - incorrect interpretation of the SetSlewRate response from APCC, which was mistakenly throwing an exception.

APPM - Fixed - User defined slew rate was not being used.

Version 1.5.0.20 - 02/25/2017 (Public Release)

Note: This version should be used with the AP V2 ASCOM driver v5.09.04 or later.

APCC - Expanded allowable timezone range to -23:59:59 to +23:59:59.

Version 1.5.0.19 - 01/29/2017 (Public Beta)

Note: This version should be used with the AP V2 ASCOM driver v5.09.04 or later.

APCC - Updated documentation.

APCC - FIXED - Protect against certain out of range values in Home and Limits Configuration dialog.

APCC - IMPROVEMENT - A popup window will open to restore unpark from last parked position after unparking from one of the named park positions. If the user is not at the screen or does not select an option, the window will auto-close and change the default to unpark from last parked position.

APCC - FIXED - Status window's Connect/disconnect button wouldn't change when APCC is connected/disconnected from the mount.

APCC - FIXED - a set tracking rate command was being sent out of order during initialization.

APCC - IMPROVEMENT - On both the Horizon and Meridian Tabs, removed the Reset Limit Trigger button and the Auto-reset checkbox. Auto-reset is now always the default.

APCC - IMPROVEMENT - removed the check box option to close the Stop Window when a slew completes. The Emergency Stop window now always closed automatically when a slew completes .

APCC - BUG FIX - The Log Zipper was not working so it has been moved into its own separate application. The new log zipper application is included in the installer going forward.

APCC - NEW FEATURE - Automatically send mount flip point to Sequence Generator Pro. "Meridian Limits" and "Counterweight up slews within West limits" must both be enabled.

APCC Pro (APPM) - BUG FIX - After a point mapping run APPM offers to immediately use the data. Clicking "OK" would often result in a message saying the model was not installed correctly (but it was). model. This false error message should no longer occur.

APCC Pro (APPM) - IMPROVEMENT - when attempting to connect to Sequence Generator Pro, APPM first checks that SGPro is running. If SGPro is not running, a pop up message indicating that is displayed.

APCC Pro (APPM) - BUG FIX - Numerous improvements and bug fixes to the plate solving architecture.

APCC Pro (APPM) - BUG FIX - DSLR ISO values are now properly passed to SGPro.

APCC Pro (APPM) - BUG FIX - The command to set Slew Rate was getting ignored when starting a APPM run.

APCC Pro (APPM) - BUG FIX - Camera Binning setting was not being used to adjust the unbinned image scale.

APCC Pro (APPM) - Optional settings review dialog allows you to review the settings before starting a mapping run.

Version 1.5.0.18 - 12/09/2016 (Public Beta)

APCC - Updated documentation.

APCC - Fixed Status View Connect button text (never changed from "Disconnect").

APCC - Advanced Settings window was missing the "Help" button.

APCC - Fixed a problem that could cause the Virtual ports to not be auto-allocated.

APCC - When the mount needs to be initialized APCC will now bring up the Initialize mount window, even if auto-initialize is disabled. The user can decide to initialize or not.

APCC - Fixed issue with APCC showing the wrong button text when a connect to the driver fails.

APCC - Removed some unnecessary debug log statements.

APCC Pro (APPM) - APPM's slew rate was not getting set down in the mount.

APCC Pro (APPM) - Fixed several problems with plate solve directory function.

APCC Pro (APPM) - Fixed several bugs in the plate solving state machine.

APCC Pro (APPM) - To improve startup speed, if dark frame subtraction is selected APPM will start the dark frame in parallel with the mount settling after a move.

Version 1.5.0.17 - 11/14/2016 (Private Beta)

APCC - Updated documentation.

Version 1.5.0.16 - 11/02/2016 (Private Beta)

APCC Pro - Increased range of allowable barometric pressure from 800-1100 to 500-1300.

APCC Pro (APPM) - Minor fixes for PinPoint compatibility (Note: PinPoint 6.1d or later is required if using PinPoint's All-Sky plate solves)

Version 1.5.0.15 - 10/31/2016 (Private Beta)

APCC - Added new option in Advanced Settings to keep mount time synced to the computer. This option overrides the same feature in the ASCOM driver. If enabled, APCC will sync time even if the option in the driver is disabled (Driver v5.09.02 or later required). When disabled in APCC however, the driver can temporarily (until APCC is restarted) enable time sync in APCC. When connected to APCC the driver will delegate Time syncing to APCC and the driver will not itself perform time syncing.

APCC - **EXPERIMENTAL - Requires driver v5.09.02 or later** - APCC will now define two Virtual Ports for the ASCOM driver. Because of the way COM interop works, a separate instance of the driver will be created each for ASCOM clients running from the user account, and for ASCOM clients running "as administrator." In a hope to allow applications that need to be run "as administrator" work with applications that don't.

- The first virtual port will be used by the instance of the driver started in user mode.
- The second virtual port will be used by the driver if it started "as administrator"

APCC - Fixed range errors in some controls.

APCC Pro (APPM) - Added support for SGPro Cameras to APPM.

APCC Pro (APPM) - Removed checkbox for PinPoint All-Sky and added separate buttons to do All Sky Solve and All Sky Solve and Sync

APCC Pro (APPM) - Added new plate-solving choices to APPM: SkyX Image Linking, and Sequence Generator Pro (tested with PlateSolveX)

APCC Pro (APPM) - Added option to set explicitly set the Slew Rate for mapping runs.

APCC Pro (APPM) - Added option to open Images in the by double clicking the entry in the mapping table.

APCC Pro (APPM) - Added feature to Plate Solve files in a directory.

Version 1.5.0.14 - 09/19/2016 (Public Beta)

APCC - FIXED - do not invoke COM port fallback when disconnected.

APCC - FIXED - responses to the ASCOM driver could sometimes be delayed significantly, thus making the driver think it had lost a connection to the mount.

APCC - Adjusted position of new indicators in the "Telescope Position" group box to look better for APCC Standard.

APCC - Widened the "TRACK" indicator to allow "TRACKING" and "PARKED" to fit.

APCC - FIXED - PEM indicator was not working correctly.

APCC - Added "Auto-Reset" option to Horizon Limits and Meridian Limits. When checked these limits will automatically be reset when the mount goes back within limits.

APCC - FIXED - APCC was returning a cached value of the mount's time to the driver, which was causing the driver to sometimes think the time had gone outside the two-minute range.

APCC - Stopped using cached values on the virtual ports for the following commands: GC, GL, GG, GP, GA, and GZ. These commands now pass through to the mount.

APPM - Added "Sequence Generator Pro" as a new camera option.

APPM - Fixed the "Image Link Test" setting for TheSkyX plate solving.

APPM - BUG FIX - Even when TheSkyX plate solving was selected, PinPoint Plate solves were being used. (more work needed here).

Version 1.5.0.13 - 09/07/2016 (Private Beta)

APCC - Added COM port fallback to ethernet/wi-fi connection

APCC - Added "Pier Flip" button to "Move Scope" and "Meridian Delay" Group boxes

APCC - Added "Slew Speed" to "Move Scope" group box so that it is easy to tell the set slew speed.

APCC - Rearranged controls in "Move Scope" group box to make better use of space

APCC - Added Tracking State and PEM State labels (with Tool Tips) to "Telescope Position" group box

APCC - Meridian/Horizon labels in "Telescope Position" group box can be single-clicked to open their respective tabs. Double clicking will toggle their enabled state.

APCC Pro - Changed labels for Pointing and Tracking rate correction to "Point Corr" and "Rate Corr", respectively.

These labels can be single-clicked to open the Pointing Model tab. Double clicking will toggle their enabled state.

APCC - Added warning messages when enabling "Stop Tracking after Unparking"

APCC - Don't allow user to set or clear Meridian Delay while Meridian Limits and Slew within East/West is enabled.

APCC - Added "Exhaustive COM Port Search" option (default) to Advanced Settings

APCC - Added "Just Warn" option to Meridian and Horizon Limits

APCC - Fixed behavior of Horizon and Meridian Limits status fields

APCC Pro - Changed RA and Dec pointing error from Decimal mins/arc-mins to Mins/Secs and Degs/Secs, repectively.

APCC Pro - Changed RA and Dec tracking rate units from "secs/sec" and "arc-secs/sec" to a more understandable "secs/hour" and "arc-secs/hour", respectively.

APCC - Close "Find GTOCP4" window when "Select" is clicked.

Version 1.5.0.12 - 08/25/2016 (Public Beta)

APCC - Added check box to stop tracking after unparking.

APCC - Changed confusing custom park Alt/Az boxes to labels.

APCC - Changed look of a number of labels to be more consistent.

APCC - Added status labels for Meridian Limits, Horizon Limits, Pointing and Tracking rate correction (Tooltip info is presented when mouse hovers over them).

Version 1.5.0.11 - 08/25/2016 (Private Beta)

APCC - Fixed incorrect time zone when unparking

APCC - Fixed meridian delay getting cleared when slewing with meridian limits disabled.

Version 1.5.0.10 - 08/21/2016 (Public Beta)

APCC - Even more changes to Time Zone logic to fix issues with an European version of Windows.

APCC - Fix double moves in counterweight up positions when using the GTOCP4.

APCC - Fixed some logic errors with the Counterweight-up slews within East/West Limits.

Version 1.5.0.9 - 08/17/2016 (Private Beta)

APCC - Further changes to Time Zone logic to fix issues with an European version of Windows.

Version 1.5.0.8 - 08/14/2016 (Private Beta)

APCC - Captured Time Zone initialization errors and allow APCC to complete startup.

APCC - "Create Virtual Ports first" option will now automatically select a virtual COM port if none is defined for the first virtual port.

APCC Pro - Fixed labels for RA pointing and tracking rate corrections

APCC - when loading a settings file, put up a window indicating the operation is active.

Version 1.5.0.7 - 08/07/2016 (Private Beta)

APCC Pro (only) - Pointing model corrections were not being applied when a pier flip occurred when using a GTOCP4.

Version 1.5.0.6 - 07/17/2016 (Public Beta)

APCC - Fixed double initialization that can happen sometimes.

APCC - Added tool tips to some of the options in the connection group box.

APCC - Added a "Now" button to do a one-time configuration of the ASCOM driver (as an alternative to the "auto-config" option that re-configures every time APCC starts the ASCOM driver).

Version 1.5.0.5 - 07/13/2016 (Private Beta)

APCC - Removed unintentional residual use of Eltima 7.x.

Version 1.5.0.4 - 06/27/2016 (Private Beta)

APCC - Direct broadcasts for GTOCP4's out all network devices that support IP V4.

APCC - Allow control characters to be sent in Terminal Interface (by pressing CTRL+character)

APCC - Upgraded to the latest Eltima Virtual Port driver (v8.0.435).

IMPORTANT NOTE: This requires any previous version of APCC to be uninstalled.

Version 1.5.0.3 - 06/05/2016 (Private Beta)

APCC - Added a command line switch so APCC knows it is being started by the driver and can do certain start up actions to better ensure the driver can connect.

APCC - Before unparking force meridian delay to 0.

APCC - Auto-create the first virtual port if not defined when starting.

APCC - Improved robustness of matching the ASCOM driver's port to APCC's first virtual port (requires ASCOM driver v5.09.00 or later)

Version 1.5.0.2 - 06/03/2016 (Private Beta)

APCC - Prevent the Log Zipper window from being used while connected to the mount or driver.

APCC - Disable Log Pausing for now to capture any potential errors that might be missed when logging is paused.

APCC - Added additional log output to help debug certain scenarios.

Version 1.5.0.1 - 05/31/2016 (Private Beta)

APCC - Fixed accidental dual Virtual port threads when there should have been only one thread.

Version 1.5.0.0 - 05/31/2016 (Private Beta)

APCC - Poll site longitude/latitude from the mount when connecting to the mount.

APCC - Add more logging detail for debugging in case a network error occurs.

Version 1.0.25.0 - 05/29/2016 (Private Beta)

APCC - Moved polling to a background thread so that resizing windows and other user interface actions do not slow down polling (noticed by Chris Erickson)

APCC - Removed UDP checkbox, and the Serial/USB and the Net/WiFi radio buttons and replaced with a drop down list of connection methods. While connected the user can still switch between UDP and TCP in real-time.

APCC - Instead of "Net" the first connection status box will show "TCP" or "UDP", reflecting the protocol being used.

APCC - Added a new discovery button to locate any CP4 on the local LAN and allow it to be selected.

APCC - When connecting to the AP driver, if "Auto-config" is not selected APCC will automatically setup the driver's COM port and APCC setting if not correctly set.

APCC - When starting APCC it will create a full backup of settings in C:\ProgramData\Astro-Physics\APCC\Backups.

APCC - APCC will try up to 3 times to write a setting to a file before throwing an error. It will wait at least 50 milliseconds before retrying a save.

Version 1.0.24.0 - 05/25/2016 (Private Beta)

APCC - Add UDP as alternative to TCP/HTTP requests.

Version 1.0.23.0 - 05/22/2016 (Private Beta)

APCC - BUG FIX - disconnecting the driver did not update the button user interface state correctly.

Version 1.0.22.0 - 05/21/2016 (Private Beta)

APCC - Major internal changes to combine multiple commands for more efficient polling of the GTOCP4 when using LAN/wi-fi.

Version 1.0.21.0 - 05/14/2016 (Private Beta)

APCC - Refinements to improve Ethernet/Wifi command/response reliability.

Version 1.0.20.0 - 05/13/2016 (Private Beta)

APCC - Made mount timeout value available while connected (was formerly disabled while connected) to allow changing timeout dynamically.

APCC - Create separate timeout values for Ethernet/Wifi and for Serial/USB ports.

APCC - Lowered Ethernet minimum timeout to 10 msecs.

APCC - In "Comm Events" window add a "Clear Queues" button to allow a user to clear all command queues to hopefully allow a lost wifi connection to be res-established.

APCC - Removed "Reset Limit Triggers" button in Home/Limits tab.

Version 1.0.19.0 - 05/12/2016 (Private Beta)

APCC - BUG FIX - Fixed Primary and backup COM port boxes. They were too narrow to fit two-digit COM ports.

APCC - BUG FIX - COM ports were sometimes randomly ordered in the drop down list box. They are now sorted numerically.

APCC - BUG FIX - Emergency Stop window wasn't stopping moves for the GTOCP4.

Version 1.0.18.0 - 05/11/2016 (Private Beta)

APCC - Changed text and position of some Connection group box controls around for more clarity.

APCC - Disable Ethernet/WiFi option if GTOCP3 is being used.

APCC - Fixed bug in the Connect operation to the AP V2 Driver.

Version 1.0.17.0 - 05/10/2016 (Private Beta)

APCC - Slightly increased height and width of APCC's main window to fix additional Connection group box controls for ethernet/wi-fi connections.

APCC - Moved "COM Events" (COM Port events) button to status bar and renamed to "Comm Events" (Communications Events). It will turn light red (pink?) if there are any communications errors.

APCC - Reworked Connection group box to include radio control options for Ethernet/Wi-fi and Serial/USB

APCC - Moved Connect Driver button from Virtual Ports tab to Connection group box

APCC - When APCC is connected to the mount or driver, the corresponding button turns light green as an indication.

APCC - Moved "Close Emergency Stop window when done slewing" option from "Advanced Settings" to "Program Operation" group box

APCC - Moved "Create Virtual Ports first" option from "Advanced Settings" to "Connection" group box.

APCC - Added "Auto-Connect Driver" and "Auto-Configure" driver options to "Connection" group box.

APCC - Added "Edit Initialize Mount Settings..." to the Settings menu. This allows a user to edit initialization settings without initializing the mount.

APCC - "Initialize Mount..." option in Settings menu no longer will proceed unless mount is connected and RA=0 and Dec=90.

APCC - BUG FIX - Fixed issue with Emergency Stop window not closing after parking.

APCC - BUG FIX - the Error Log Window no longer also opens the 3D Viewer.

APCC - BUG FIX - Home and limits feature never requires reprogramming the GTCP4 personality

APCC - APCC automatically starts a new log file if the log file size exceeds about 100 MB.

Version 1.0.16.0 - 05/01/2016 (Private Beta)

APCC - BUG-FIX - fixed endless re-initialization loop when mount was first initialized

Version 1.0.15.0 - 05/01/2016 (Private Beta)

APCC - BUG FIX - Fixed exceptions when connection the driver to APCC.

Version 1.0.14.0 - 05/01/2016 (Private Beta)

APCC - Added ability to connect to the GTOCP4 via an ethernet/wi-fi connection.

Version 1.0.13.0 - 03/26/2016 (Private Beta)

APCC - Added "Update personality" button and associated functionality to enable end users to reconfigure their mount to use the Home and Limits feature. The button will only display if the personality has not already been updated.

APCC - Made Goto RA/Dec controls like Goto Alt/Az controls.

Version 1.0.12.0 - 03/16/2016 (Private Beta)

APCC - Fixed a bug in the Status window that would cause an exception if the user had configured the Status Window to be shown when APCC starts.

Version 1.0.11.0 - 03/16/2016 (Private Beta)

APCC - disable safe slews if it detects the CP4.

APPM - Add ASCOM Camera and SkyX Camera Add-on as new cameras.

APPM - Add SkyX Plate Solving as alternative to PinPoint.

APCC - Add popup window to report details of unhandled exceptions back to me (The user must ok the sending of this data).

Version 1.0.9.0 - 12/29/2015 (Private Beta)

APCC - made an user interface change for the Declination limit.

Version 1.0.8.0 - 12/23/2015 (Private Beta)

APCC - changes to match the status window and main window's move rates.

APCC - added a warning for the east/west limits

APCC - Hide the home/limits tab if AE box is detected.

Version 1.0.7.0 - 11/23/2015 (Private Beta)

APCC - Added settings save via SQLITE database.

APCC - Added new status box to the user interface for backup COM port.

APCC - Added new way of determining which COM ports are real and which are virtual ports.

Version 1.0.6.0 - 11/16/2015 (Private Beta)

APCC - improved intelligence in selecting a free virtual com port for the driver to use.

APCC - Fixed issue with backup COM port not working as designed.

APCC - Fixed syntax error in a command sent to the mount (double ":")

Horizons - Added extra debug statements.

Version 1.0.5.0 - 11/04/2015 (Private Beta)

APCC - Some semi-major reorganization of the user interface.

1) Changed look of the setup tab.

2) Placed the AutoConnect option into the Connect groupbox.

3) Moved the Virtual Ports tab to the second tab position so users can find it more easily.

4) Each of the four new application buttons (ApTimer, ApJog, ApRAPAS, PEMPro) will only be visible if the corresponding application is installed.

5) Added one extra option in the Advanced settings to close the Emergency Slew window automatically after a slew completes.

Version 1.0.4.16 - 10/25/2015 (Private Beta)

APCC - Added more debug statements to track down issues when users have COM port errors.

Version 1.0.4.15 - 10/8/2015 (Private Beta)

APCC - (now defunct) balance mount procedure.

Version 1.0.4.14 - 10/1/2015 (Private Beta)

APCC - fixed problem reported by David on Ap-gto forum concerning goto incorrectly loading the mount's RA/Dec with Pointing Correction enabled.

Version 1.0.4.13 - 9/17/2015 (Private Beta)

APCC - fixed problem reported by Joe Z. (never-ending park when the park position is under the Horizon limit).

Version 1.0.4.12 - 9/12/2015 (Private Beta)

APCC - fixed the lockup problems and the RA/Dec limits.

Version 1.0.4.11 - 9/7/2015 (Private Beta)

APCC - fixed limit bug with Park 4.

Version 1.0.4.10 - 9/5/2015 (Private Beta)

APCC - Fixed problem with the "Set" personality commands.

Version 1.0.4.9 - 9/5/2015 (Private Beta)

APCC - Fixed problem with the "Get" personality commands

APCC - Implemented the faster bounce logic.

Version 1.0.4.8 - 9/3/2015 (Private Beta)

APCC - Fixed a bug that sometimes caused an incorrect park position.

APCC - Pol mount for personality and disable Home/Limits tab if personality has not been updated.

Version 1.0.4.7 - 8/29//2015 (Private Beta)

APCC - Added read personality command.

APCC - Changed bounce back to happen only in the axis that hits a limit (and not both axes).

APCC - Added short pause before a bounce.

Version 1.0.4.6 - 8/28/2015 (Private Beta)

APCC - added an automatic clear of the limits if the mount goes back within limits.

APCC - added the bounce back option but I didn't have time to try it this morning so I'm not sure it will work as you expect. When bouncing back I start homing operations on both axes simultaneously and stop after 2 seconds.

APCC = fixed typo in the Dec Limits checking. It wasn't checking Dec limits at all like it was supposed to but was checking RA limits.

Version 1.0.4.5 - 8/27/2015 (Private Beta)

APCC - Fix an issue with the limits not being saved.

APCC - Added a check for a minimum ASCOM platform version, which was causing an issue with APCC's pointing calculations because the old ASCOM utility functions had a few bugs.

Version 1.0.4.4 - 8/13/2015 (Private Beta)

APCC - Properly handle Home configuration aborts

APCC - Limits should now work for both Southern and northern hemisphere

APCC - Added three new limit actions:

a) "Just Warn" -- does nothing but pop up an asynchronous window warning the user that a limit was breached (all actions do this also). This might be good for your testing so you won't be triggering parks and homing actions.

b) "Stop Slew" -- Stops the slew but does not stop tracking.

c) "Stop Slew, Stop Tracking" - Stops slew and tracking, but does not Park

Version 1.0.4.3 - 8/12/2015 (Private Beta)

APCC - Use the move RA/Dec fields to detect slewing done when homing (the GOS slew field is not indicating correctly).

Version 1.0.4.2 - 8/11/2015 (Private Beta)

APCC - Added missing RA home command.

APCC - Other minor fixes to homing/limits logic.

Version 1.0.4.1 - 8/10/2015 (Private Beta)

APCC - Fixes and changes to Home and Limits tab.

APCC - Added error log window

Version 1.0.4.0 - 7/9/2015 (Private Beta)

APCC - Added 3D Warning Windows.

APCC - Add Calibrate Home Warning Windows.

APCC - Started work on Environmental Graph Window.

APCC - Added Home and Limits window.

Version 1.0.3.4 - 5/27/2015 (Release)

APCC - BUG FIX - releasing any of the Status View move buttons would trigger the Emergency Stop window because the StopMove function used by the Emergency stop button was also used by the mouse up events for all of the Status View's move buttons.

Version 1.0.3.3 - 5/27/2015 (Release Candidate)

APCC - Redesigned 3D Scope syncing logic to fix potential boundary conditions where the 3D scope view might incorrectly show the mount's orientation.

APPM - Internal changes preparing for additional plate solving

Version 1.0.3.0 - 4/20/2015 (Beta)

<u>APCC</u>
* To prevent confusion on the use of the refraction checkboxes, they have been removed.
* Fixed display issues with the 3D Scope View
* Added "Create Virtual Ports First" option to Advanced settings, which when enabled will always create the

virtual ports, even if the mount is off or not connected. This will allow the ASCOM driver to attach to a virtual port
and potentially wait for the mount to be powered on.
* Fixed extra flip when scope is in a counterweight up position and the meridian limit set such that scope should slew directly to the target position.
* Fixed similar to the above when meridian limits are set up.
* Fixed rounding error in longitude/latitude
* Park 2 and Park 3 used a hour angle of exactly -6, which caused some anomalies.
* Added additional commands for external programs to use:
○ APCCVERSION returns Pro or Standard
○ LIMITREACHED returns if a limit has been reached (Meridian or Horizon)
○ SETTEMP/GETTEMP
○ SETPRESSURE/GETPRESSURE
○ SETHUMIDITY/GETHUMIDITY

APPM
Added missing DLL for AstroArt
Added new camera option to select SkyXPro Camera

Horizons
Allow "steps" to be used in calculations for fast moving satellites, like ISS
When clicking Stop tracking button tracking was completely stopped instead of returning to sidereal
Added option to display Native tracking rates.

Version 1.0.2.0 - 1/16/2015 (Release)
APCC - BUG FIX - Fixed link in Horizons to APCC's help file.

APCC - BUG FIX - Set Meridian Delay to 0 before unparking.

APCC - BUG FIX - Fix excessive CPU utilization when "Automatic Shutdown" is selected.

APCC - BUG FIX - Improve some of ELS homing functionality.

Version 1.0.1.0 - 1/1/2015 (Beta)

APCC - Allow APCC to be connected to a COM Port waiting for mount to be turned on.

APCC - BUG FIX - Fixed "arithmetic overflow" that sometimes happened when calculating CRCs

Version 1.0.0.9 - 12/20/2014 (Release)

APCC - BUG FIX - Fixed start up issue with Windows XP.

APCC - BUG FIX - Fixed homing issue with 3600 mounts Homing feature.

Version 1.0.0.8 - 11/30/2014 (Beta 8-11)

APCC - BUG FIX - Fixed extra slew that was happening sometimes when slewing from Park 1.

APCC - BUG FIX - Main window's position should now be restored if the Save windows positions option is set. Also, other window positions should be saved when closing the main window to exit APCC. Previously the windows had to be closed first to be remembered.

APCC - BUG FIX - Not all COMM timeouts were being reported in the COM Timeouts window.

APCC - Improved detection of mount disconnects and reconnects. LST/RA/Dec/Alt/Az fields will now flash when mount connection is lost.

APCC - Made improvements to logging.

Version 1.0.0.8 - 11/22/2014 (Beta 1-7)

APCC - Meridian Limits - Changed entry value precision to 2 decimal places.

APCC - Improved robustness of "Connect to Port" logic.

APCC - Improved the look and feel of the COM Port warning/error dialog. Removed pop-up warning messages (replaced by aforementioned dialog).

APCC - Changed "Administrator" to "Elevated" to more accurately describe APCC's privilege level. Implemented a different way to check for elevation.

APCC - BUG FIX - Main window's position should now be restored if the Save windows positions option is set.

APCC - BUG FIX -Port status colors were sometimes incorrect.

APCC - Tweaked Park 1, 3, and 4's positions

APCC - Added "Always on top" option to Scope 3D View window.

APCC - BUG FIX - If the THUM service is running queries to the THUM would fail after 10 seconds but would hold up APCC during that time so querying the THUM has been moved to a separate thread. WARNING: users should NOT install and/or enable the THUM service/application software because then APCC will not be able to communicate with the THUM.

APCC - BUG FIX - Added separate checks for updates for the Standard and Pro editions.

APCC - Added various information to the log files.

APPM - New Feature (Pro Only) - For dome users added new passive method for checking for dome move completion. Instead of actively moving the dome via the ASCOM dome slewing commands, APPM will assume that another program (e.g. DC3 dreams' ACP software) will issue the slew. APPM just passively waits for the slew to complete. This option is setable via a new dome settings window in APPM's settings menu.

Installer - Give permissions to "everyone" for Read/write access for logs and settings directories.

Version 1.0.0.7 (Official Release) - 10/12/2014

APCC - FEATURE - Added an option to the Log window to only show telescope move commands, which can be useful for debugging autoguider issues.

Version 1.0.0.6 - 10/06/2014

APCC - Fixed issue with reading settings file.

Version 1.0.0.5 - 8/25/2014

APCC - Declination degrees was being set to 0 after a save if the field was a negative value.

APCC - Restored "West Limits" check box and finished implementing corresponding functionality (see help section on Meridian Limits).

Version 1.0.0.4 - 8/15/2014

APCC - Now requires firmware version 'V" or later to run.

APCC - Changed out of date references to "U" firmware to save "V" firmware.

APCC/APPM - Further updates to the documentation .

Version 1.0.0.3 - 8/10/2014

APCC - BUG FIX - ASCOM driver would lock up if "Check for Valid Firmware" was clicked and the driver was already setup to talk to APCC.

Version 1.0.0.2 - 8/8/2014

APPM - BUG FIX - Changing how Image FIT files were saved in an APPM run did not change immediately (required a restart).

APCC - BUG FIX - When "start with Status View Window" was selected and the Main window brought up from the Status View, the Status View Window would minimize if the main window was minimized. Now the Main Window will (only) Minimize and optionally hide itself if the appropriate settings are enabled.

APCC - BUG FIX - Clicking a button to show a window from the Status View would not show the window if the window was previously opened but minimized.

APCC - BUG FIX - Horizon Limits check box was (purposely) cleared whenever parking or initializing the mount. Now it is not cleared but not "armed" until the scope if first slewed into an area that is within the horizon limits. Also, when clearing the Horizon limits trigger (which starts tracking) it won't actually be armed again until the mount is again within the Horizon limits.

APCC - Made visible the "Correct for refraction" check box.

Version 1.0.0.1 - 7/16/2014

APPM - fixed bug reading Horizon limits from APCC's settings file.

Version 1.0.0.0 - 7/14/2014

APCC - added a triangulator class for future use.

APCC - automatically force the ASCOM driver to enable "chkAllowConnectIfMountNotPresent".

APCC - Updated the Help file with Howard's changes.

APPM - Improved performance of APPM when adjusting Point map and connected to APCC/Driver.

Version 0.99.99.73 (Release Candidate) - 6/25/2014

Minor changes to try to fix an issue found in RC72.

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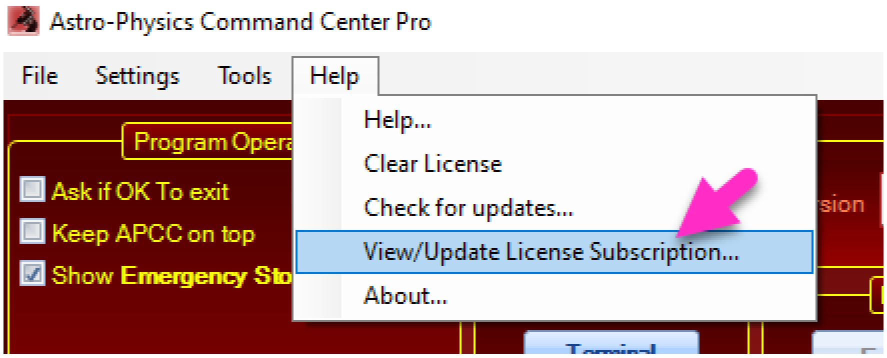
Revised: 08-16-21

2 New Features

Important: Some new features may not be available to all APCC users. Some features may require a newer license date than you have (which may require a software renewal). Where noted, certain features require an APCC Pro license, which is a paid upgrade from APCC Standard (most notable is the sky modeling and tracking enhancements). If you have any questions please contact Astro-Physics for additional assistance. Keep in mind the license you purchase for APCC is good forever for the version. Access to new features may require license renewal.

If you find a license update required to access newer features you can purchase a renewal by clicking APCC's menu Help->View/Update License subscription that will take you to the appropriate web page. The link is shown in this screen shot:



The new features include:

[NINA Support](#)

[Dec-Arc Tracking (APCC Pro only)](#)

[ASTAP Plate Solving (APCC Pro only)](#)

[Real-time RA/Dec](#)

[Platesolve, Autocenter (APCC Pro only)](#)

2.1 NINA Support

Important: The following new feature requires a license dated August 1, 2020 or later. If your license is older you can get access to these features by purchasing a license renewal. The renewal license never expires so you will always be able to use this new feature.

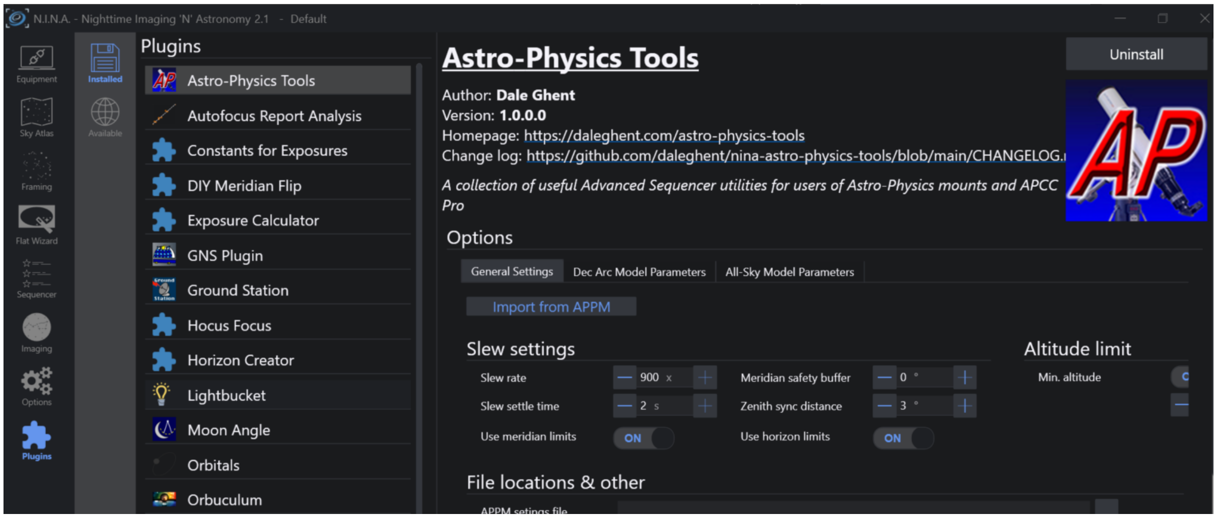
Dale Ghent (author of the Astro-Physics Tools plug-in) has graciously provided a quick how-to guide for using AP mounts with NINA. This guide applies to both APCC Standard and Pro:

https://daleghent.com/nina-and-astro-physics-mounts

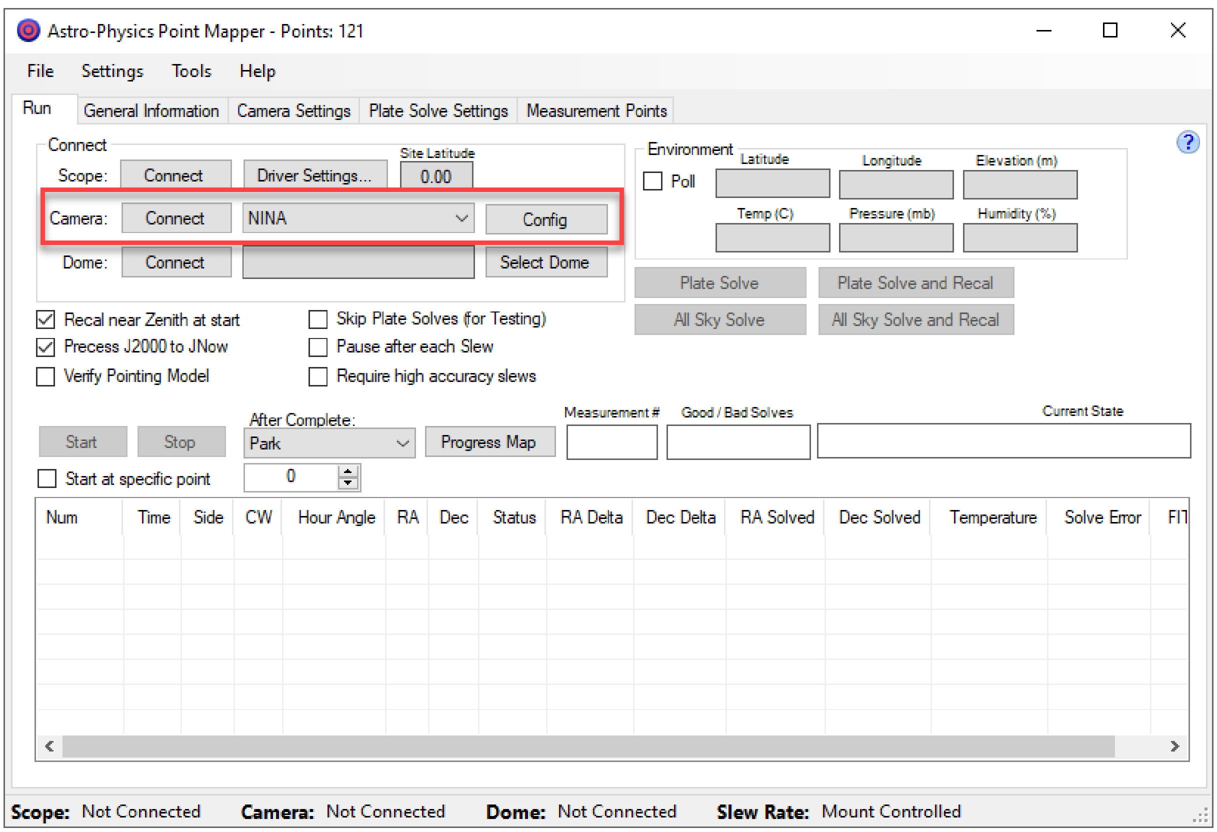
NINA can be downloaded from this link: https://nighttime-imaging.eu/download/

APCC Pro only: NINA now offers an Astro-Physics Tools plugin for automating APCC point map creation (both all sky and Dec arc maps) and enabling Dec arc tracking using NINA automation.

The Astro-Physics Tools plugin is available through NINA's standard plug-in downloads area within the NINA application



APCC Pro only: Additionally, APPM can connect to NINA 1.11 and later, allowing APPM to use a camera connection via NINA. This means any camera supported by NINA can be used as an APPM camera.



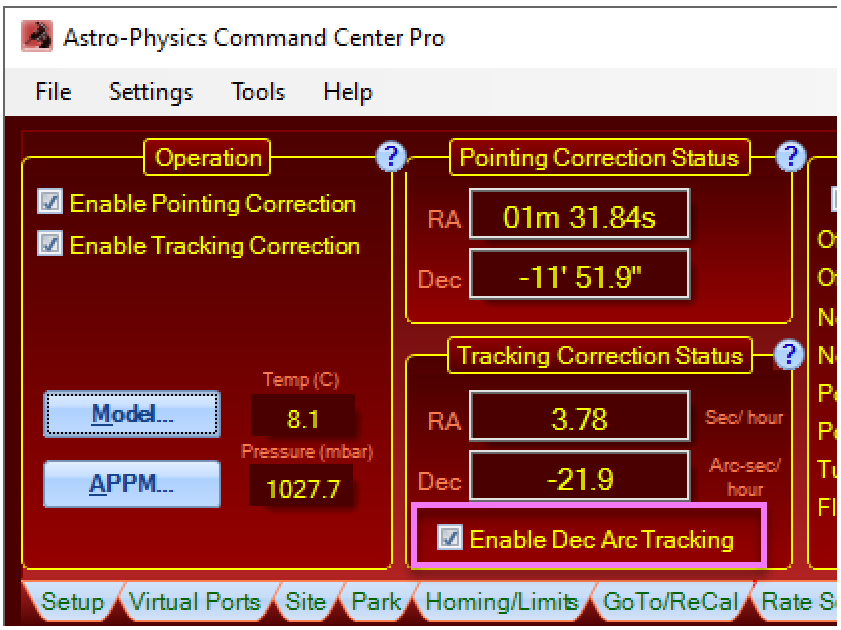
2.2 Dec-Arc Tracking

Important: The following new feature requires a license dated August 1, 2020 or later. If your license is older you can get access to these features by purchasing a license renewal. The renewal license never expires so you will always be able to use this new feature.

APCC Pro has had pointing and tracking rate correction since it was launched. The correction values are based on an pier-side model, best fitting all of the acquired data points in each pier side. This does a really good job of improving pointing and tracking rate accuracy, but sometimes localized behavior deviates from the model slightly.

The model for Dec-Arc tracking is created by optimizing and best-fitting the pointing errors along declination arcs (paths) that APPM usually follows. This improves the tracking rate accuracy in areas where there are enough data points to create a good dec-arc mode (5-7 points per declination arc is a good baseline).

Enabling Dec-Arc tracking is as simple as setting a check box in APCC Pro. It can be enabled/disabled at any time which allows you to easily compare its tracking rate quality with that of the all-sky model.

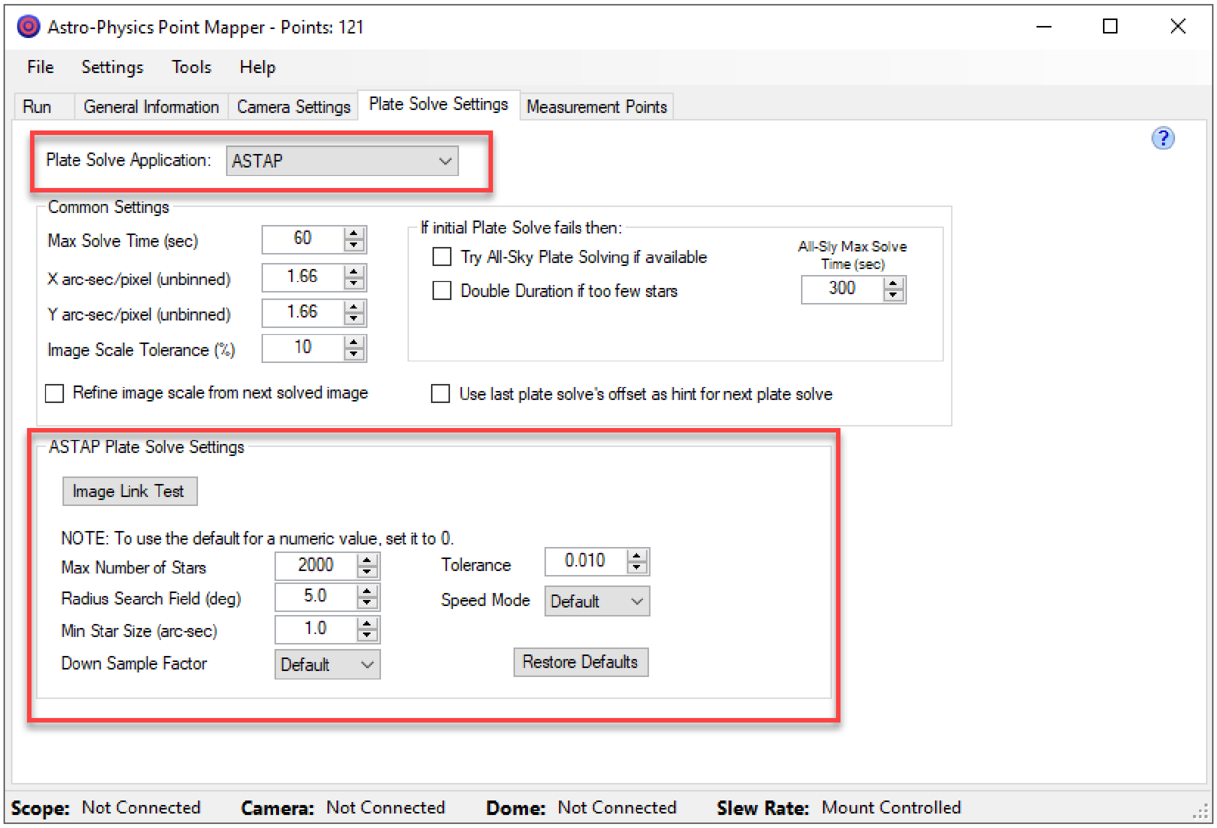


2.3 ASTAP Plate-solving

Important: The following new feature requires a license dated August 1, 2020 or later. If your license is older you can get access to these features by purchasing a license renewal. The renewal license never expires so you will always be able to use this new feature.

APPM now supports the plate solver built into ASTAP.

ASTAP and associated stellar databases can be downloaded from this link:
https://www.hnsky.org/astap.htm



2.4 Real-time RA/Dec

Important: The following new feature requires a license dated August 1, 2020 or later. If your license is older you can get access to these features by purchasing a license renewal. The renewal license never expires so you will always be able to use this new feature.

APCC V1.9 provides a new "virtual mount command" that returns the mount's RA/Dec coordinates with minimal latency.

The command's format is:

:GRGD#

This command will return both RA and Dec values. The result will have this format:

HH:MM:SS.dd|sDD*MM:SS.d#

Where:

HH = 2-digit hour,

MM = 2-digit minute,

SS = 2-digit second,

d = decimal digit,

| = ASCII pipe character, separator between RA and Dec.

s = sign (+/-),

DD = 2-digit degrees.

Here is an actual example of sending a full response:

01:47:49.33|+89*55:04.1#

Background Information and Use Case

The APCC polls and caches the mount's RA and Dec coordinates once per second. Also, the AP V2 ASCOM driver polls and caches RA and Dec from APCC once per second. The poll and caching scheme that APCC and the AP V2 driver use causes up to two seconds of latency when retrieving mount coordinates. Normally this will be fine, but there are some use cases, like satellite tracking, where a two-second latency is not acceptable.

The real-time RA/Dec command reduces the latency by directly pushing separate :GR# and :GD# commands into APCC's high-priority command queue and consolidating the responses into a single return response. The latency is most reduced when APCC is connected to the mount via ethernet (GTOCP4 and GTOCP5 only).

How to use this command

Using the AP V2 ASCOM driver via COM interop

VB.Net console example:

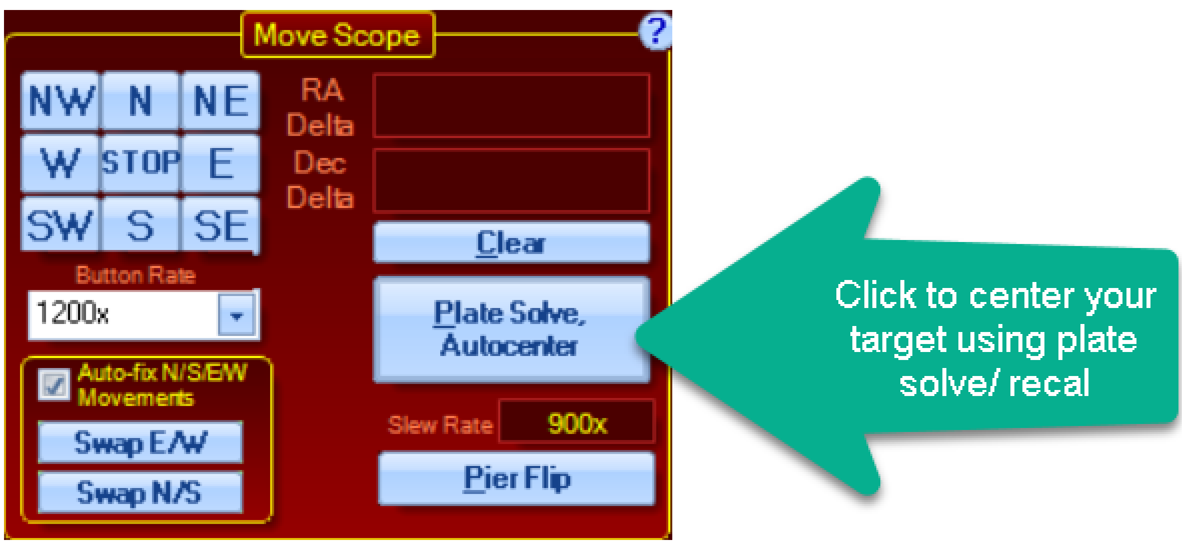
```
Module Module1

    Sub Main()
        ' Create a COM interop instance of the AP V2 ASCOM driver
        Dim mount As Object = CreateObject("AstroPhysicsV2.Telescope")
        If mount IsNot Nothing Then

            ' Connect to AP V2 Driver
            mount.Connected = True

            ' NOTE: APCC 1.9 must be connected to the mount and the APCC license date
            ' must allow for the GRGD command to be available.
            Dim realTimeRaDec As String = mount.CommandString("GRGD")

            ' Check if there was a valid response
            If String.IsNullOrEmpty(realTimeRaDec) = False Then
                Dim radec As String() = realTimeRaDec.Split("|")
                If radec.Length = 2 Then
                    Console.WriteLine($"Full response: '{realTimeRaDec}',
RA={radec(0)}, Dec={radec(1)}")
                Else
                    Console.WriteLine(realTimeRaDec)
                End If
            Else
                Console.WriteLine("No Response from APCC! APCC 1.9 must be connected
to the mount and the APCC license date must allow for the GRGD command to be
available!")
            End If

            ' Disconnect from the AP V2 ASCOM Driver
            mount.Connected = False
```

```
        End If
    End Sub
End Module
```

2.5 Plate Solve, Autocenter

Important: The following new feature requires a license dated January 1, 2022 or later. If your license is older you can get access to these features by purchasing a license renewal. The renewal license never expires so you will always be able to use this new feature.

APCC Pro only: Plate Solve/Autocenter is a new and convenient way to quickly and accurately center a target after a GoTo.After a GoTo, pushing this button will plate solve your current pointing position (via APPM), recal your mount, and send one GoTo to center the target. This feature requires the mount to be connected and tracking, and APPM must already be correctly configured according to your system and software preferences.



3 Getting Started

Some Notes on Installing and Upgrading APCC

Here are some helpful hints to assist you in installing or upgrading APCC.

- Installation Order: ASCOM Platform → AP V2 Driver → APCC
- Install the latest ASCOM Platform BEFORE installing either the driver or APCC.
- Install the latest AP-V2 driver BEFORE installing APCC.

- For major version upgrades: (i.e. 1.8.x.x to 1.9.x.x), it is a good idea to uninstall the old version first. Use the Windows Control Panel to perform the uninstalls.
- For minor version upgrades: (i.e. 1.9.4.x to 1.9.5.x), simply install as usual.
- You are always safest installing software with all other programs closed.

General Information

The information in the rest of this section will guide you through the APCC installation process and show you how to set it up with the Virtual Port for the Astro-Physics V2 ASCOM driver.

Two detailed work flow sections have been prepared:

1. The first - Getting Started Work Flow - outlines the work flow for getting the program set up for your system. The tasks in this section are performed when you first start using APCC, and are performed much less frequently afterward.
2. The second work flow section - Operational Work Flow Basics - gives you an outline of the general work flow you will use in your night to night astronomy endeavors.

To get the most from your observing session with APCC, be sure to review the Tips to Get the Most from APCC.

In addition to this manual, we encourage you to visit the Astro-Physics YouTube channel for tutorial videos and additional content

3.1 Getting Started Work Flow

There are basically two work flow descriptions that should be helpful to you as you work with APCC. First, you need to understand how to get the program set up to work with your mount, your observatory and other software. This section provides a step-by-step outline of this work flow - but it is an outline. Be sure to follow the more detailed steps in the next three sections to actually set up your system with APCC. Later in this "Getting Started" section, we will provide the second section on operational work flow. This will deal with suggested procedures and methods of operation in your normal night-to-night observing and imaging after your system is all set up.

Before You Start

1. Get familiar with your mount. If you are new to Astro-Physics mounts, spend some time simply using the mount with the keypad. Learn how your mount behaves. Become familiar with the mechanics of the mount.
2. Make sure that you are familiar with the other software programs that you plan to use with APCC. If you try to learn TheSkyX, Starry Night, MaxIm DL, NINA, Sequence Generator Pro, ACP, CCDAutoPilot and APCC all at the same time, you will probably be doomed to failure.
3. Become familiar with the AP V2 ASCOM Driver before you begin using APCC. Since most of the software you will use with APCC connects through the AP V2 ASCOM Driver, it is best to first become proficient with operations with the driver. If you have been using a program like TheSkyX with its native driver, make the switch to using it with the AP V2 ASCOM Driver before combining it with APCC.

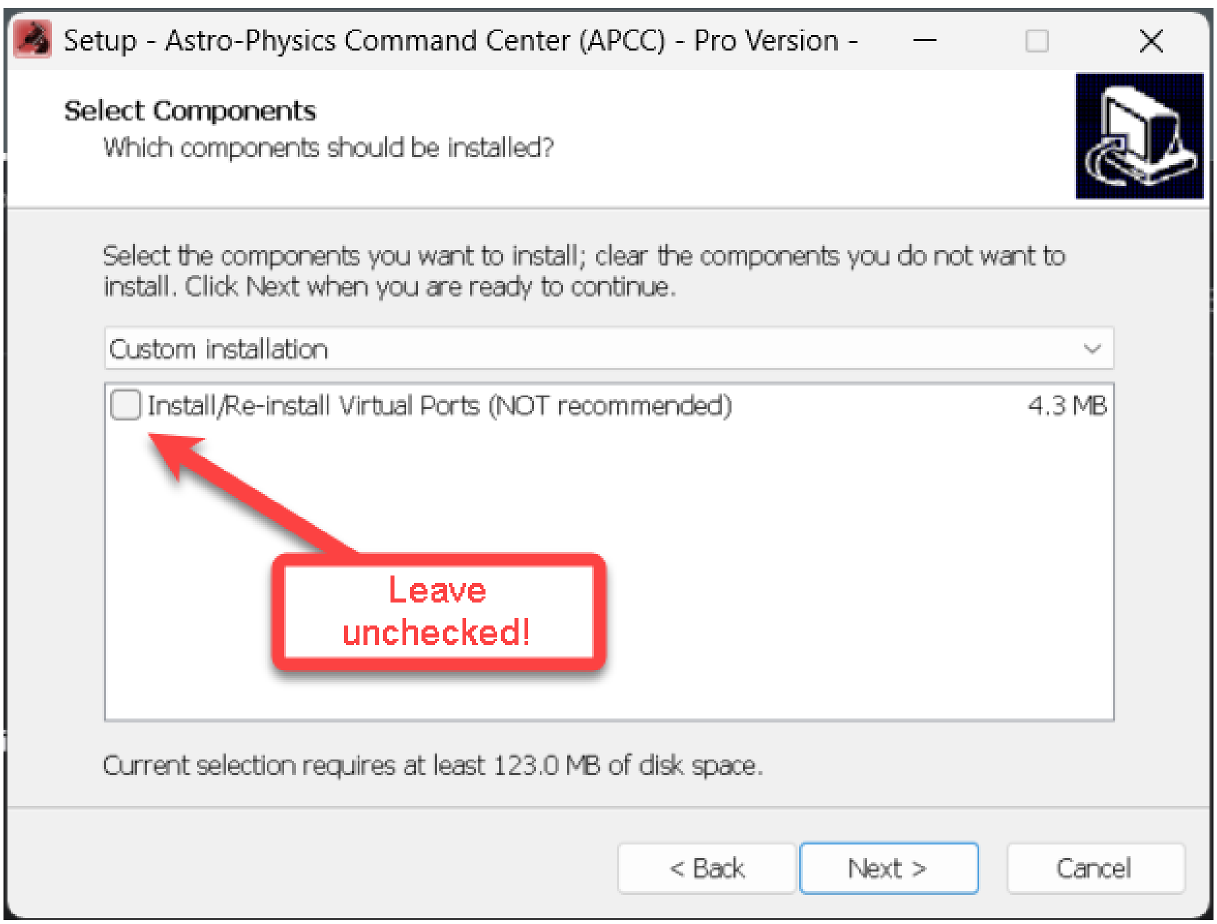
4. Confirm that you meet all of the Hardware/Software Requirements.

A Quick Primer on Virtual ports and REST API.

The original versions of APCC employed virtual serial port (VSP) drivers licensed from Eltima. The virtual ports allowed APCC to serve multiple client programs which could all access the mount at the same time through APCC. Over time, our customers taught us that they don't usually need multiple connections within APCC and therefore multiple virtual serial ports. This is because the AP V2 ASCOM driver already acts as a hub for multiple clients.

We therefore decided to offer an alternate method of connection for the AP V2 driver. It has some advantages in terms of setup and config. We now offer a REST API (an application plug-in) to facilitate the connection between the driver and APCC.

Our current recommendation is to use the REST API, and to not even install the Eltima drivers. If you are a new user, don't install the Eltima drivers unless we determine that they are necessary for your particular setup. Leave the Eltima Virtual Port option box unchecked during setup. Unless you have a specific reason to use them, you are better off not installing the VSP drivers. Windows no longer likes serial ports, so installing unneeded VSP software can be a bit probelmatic. There will, of course, still be people who will find advantages in installing the VSP drivers. That's why they are still available. They can always be added later if needed.

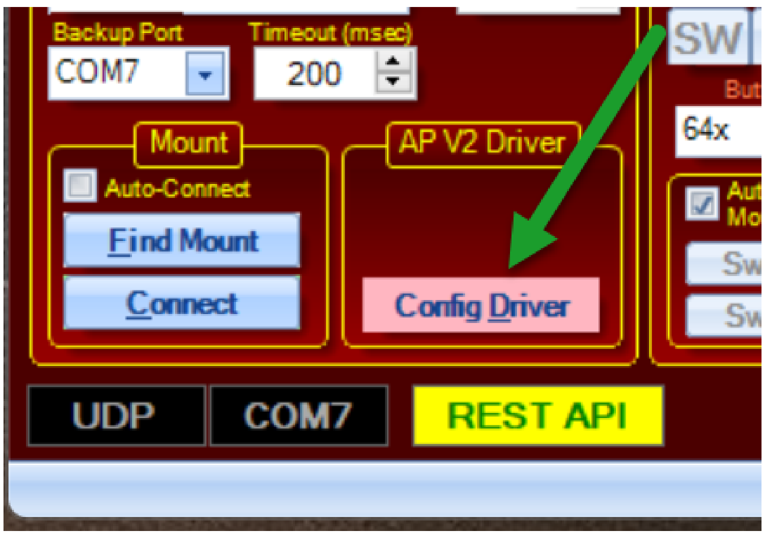


Installation Screen Capture. We no longer recommend installing the Virtual Ports.

The screenshot above shows the point in the installation where the VSP drivers could be installed.

Initial Setup - Recommended "Easy" Setup

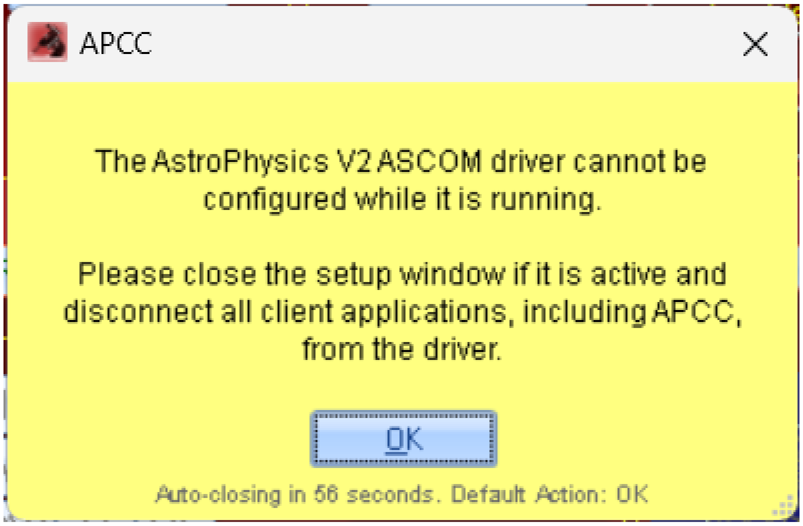
1. Prepare all of your physical connections. Have the cables ready to go.
2. Close ALL other software, especially other astronomy software (possible ASCOM client software)
3. Install in order:
    a. The Latest ASCOM Platform, if not already installed - As of this writing we require version 6.6 SP1 or later
    b. The Latest AP V2 ASCOM Driver if not already installed - v. 5.59.03 or later. **If upgrading from 5.08.x or earlier, you *MUST* uninstall older versions of the driver in Windows Control Panel first!**
4. Follow the instructions in the section that follows to: Install APCC. During the install:
    a. Be sure you leave the box to install / re-install the VSP drivers **UNCHECKED!**
    b. Check the box to: Allow to run after install.
5. NEW USERS: When APCC starts, enter your license key information when prompted to do so. This can be either the trial or full license key.
6. NEW USERS: You will be prompted to enter your site information for your primary site. You can also enter information for any other sites you wish at this time. For getting started, you only need the first site you will use, so don't worry if you don't have the information for every site you will eventually enter. You can add sites later. You can edit sties later as well, so for now, a good guess will probably work.
7. Close the driver's Setup Telescope window if it is still open from the update to the AP V2 Driver.
8. To configure the AP V2 driver for APCC, simply click the small, but mighty *Config Driver* button in the AP V2 Driver section of APCC's Connection Group box.



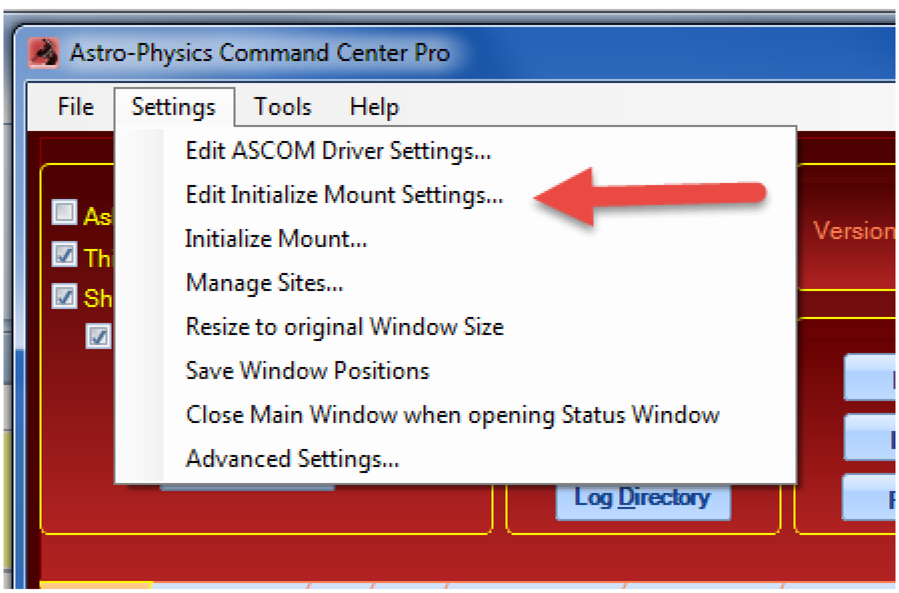
The Config Driver button will momentarily turn grey and then return to the standard blue color.

The AP V2 driver will now be configured correctly for connection through the REST API.

If for some reason you have the ASCOM driver already running, you will receive the following error. You will need to close all applications that use the ASCOM driver and ensure the ASCOM driver is not running, and then you can try the Config Driver option again



9. From the APCC Settings Menu (on the menu bar at the top), select Edit Initialize Mount Settings... This will open the Initialization Window. Enter your desired settings and then click the "Save" button.



10. In APCC's Connections Group Box, select your connection method for connecting APCC to your mount - COM port, or Network for GTOCP4/GTOCP5 owners. You MUST select the proper method from the topmost drop-down menu in the *Connection Group Box* in order to connect successfully.

11. Power up the mount.

12. If you aren't sure of the parameters and choices to make: Click the *Find Mount* button. APCC will figure it all out for you.

13. If you know the parameters and choices to make, you can manually enter them now or any time the mount is not connected.

14. Note: The backup port and its timeout setting are optional and not required for proper mount connection and operation.

15. Once parameters are entered: In APCC's *Connection* group box, click the *Connect* button. As APCC connects to the mount, it will poll the mount for relevant info, and then proceed down one of several pathways depending on the system and how you have configured it.

16. To test the driver, open up the AP Jog Utility and click the *Connect* button.

17. Start to Play!! The instructions above will get anyone started with APCC. As you become more familiar with the program, you may wish to set up additional parameters as described in the section below.

18. Final note: AFTER you have set everything up and tested through a start-up shut-down cycle or two, you will probably want to consider checking the auto-connect option in APCC's Connections group box.

Additional Things to Consider at the Getting Started Phase

1. Set your desired Park position in the Park Tab. Set the Unpark option in the dropdown list to **Last Parked**. This is the normal Unpark setting for ALL permanent setups. If you are portable, and must reestablish your position at each startup, set this to Park 4. If you just need to reestablish your position this one time in a permanent setup, select Park 4 and then switch back to Last Parked once pointing is established. To resume from Park 4, you will, of course, need to place the mount into the Park 4 position.

2. Create your Horizon Tracking Limits if you will be using them.

3. Create your Meridian Tracking Limits if you will be using them.

4. Configure your Home and Limits (NON-Encoder mounts ONLY!) after you are finished using the clutches.

5.

6. If you have APCC Pro we recommend the following:

a. Establish your Horizon and Meridian Tracking Limits BEFORE doing anything in the Pointing Model Tab.

b. If time permits, operate your mount normally for a few nights to be sure that you have everything else working the way you want it to.

c. When you feel ready (or if you simply cannot wait), open the Pointing Model Tab, and then click on the **APPM** button to get started with a pointing model.

If you follow these steps in order, you will have everything set up in a way that most users will find ideal. There are, of course, many additional options and settings in APCC that you can work with, but start with the basics and try to get a good understanding of the program before attempting to use the more advanced features.

3.2 Hardware/Software Requirements

Mount Hardware Requirements:

- Astro-Physics GTO mounts, OEM German Equatorial mounts with GTO Servo System (Parallax Instruments or Mathis Instruments).
- GTOCP4/GTOCP5 Control Box or GTOCP3 Control Box with revision "V" or later firmware. Revision V began shipping with all mounts starting at the end of July, 2014. Refer to this information from the Technical Support section of our website. (http://www.astro-physics.com/tech_support/mounts/servo/cp3-chipupgrade.htm)

Minimum Recommended Computer Hardware Requirements:

The whole idea of "minimum computer requirements" for a single application is really no longer valid in today's computer world. Any computer that can run any of the modern software packages that you will be using with APCC will be adequate to run APCC. The issue in today's environment is whether your computer can run ALL of the required software SIMULTANEOUSLY to achieve your desired goals. APCC is unlikely to ever be run as a stand-alone piece of software. When you consider your computer hardware, aim for a system that can handle all of the observing and imaging software that you plan to use, and that can handle all of it running together. That being said, here are some general tips and recommendations and a few specific requirements:

- RAM is generally more critical to adequate performance than processing power. If budgeting for a computer system, spend the money on more RAM instead of the latest and fastest processors with the most cores. 8GB of RAM is probably adequate for an imaging system, but 16GB or more is even better.
- Solid State Drives (SSDs) have recently become much more affordable. They are certainly not a requirement, but are recommended for your boot drive for their robustness, lack of moving parts, and overall speed. At least 10GB of free drive space (for logs and settings) should be available.
- APCC makes some demands for graphics capabilities, but its demands are generally less than those for either of the two most popular planetarium programs. If you can run TheSkyX or Starry Night Pro Plus, you have probably already exceeded APCC's minimum requirements. However, for clarity, please note the following:
    - 3D accelerated graphics card or integrated controller recommended if using the 3D Telescope View
    - OpenGL 1.5 or later required (Both planetarium programs mentioned above require higher Open GL.)
    - Note that having multiple graphics-intense applications open on the desktop simultaneously can cause problems if your computer doesn't have some graphics muscle!

- Native serial port, or installed PCI serial card, or USB/serial port converter required. For USB to serial converters, we recommend the following:
  - USB to Serial Adapter from FTDI (USB1PFTDI) units (sold by Astro-Physics)
  - High quality units with FTDI chipsets (i.e. Industrial units from serialgear.com like their 2-port or 4-port)
  - Industrial USB to Serial converters from Moxa
  - Converters from Digi/Edgeport
  - Keyspan converters have also been used with success. Beware: Keyspan was sold to Tripp Lite, which is now part of a bigger conglomerate. Make sure to get the real Keyspan unit and NOT the basic Tripp Lite converter.
  - We **CAN NOT** advise using **ANY** converter with a Prolific chip set!
- Network connections - Ethernet and/or WiFi (optional) for GTOCP4/GTOCP5 Control Boxes

Minimum Computer Software Requirements and Recommendations:

- Windows 7 / 8 / 8.1 / 10 / 11 32-bit or 64-bit Windows 10 Pro 64 bit is our current favorite among OS choices, but Win 11 is coming up strong. Note that since Microsoft has abandoned older versions of Windows, we can no longer recommend or support systems that are running XP or Vista.
  - Required - Run Windows Update to apply all updates.
  - Required - The .Net framework must meet the same requirements that are needed for the latest ASCOM Platform. See below

> NOTE: .Net 3.5 is also required for some of the AP V2 ASCOM Driver's features. Windows 8 and 8.1 do not ship with .Net 3.5 installed and you cannot directly download and install it. Please see this link to enable .Net 3.5 on Windows 8 and later to have full driver functionality:
>
> http://msdn.microsoft.com/en-us/library/hh506443.aspx

- Required - The latest ASCOM Platform installed (http://www.ascom-standards.org) The platform installer will ensure that the various required Windows updates like those for the .Net framework have been installed.
- Required - The latest AP V2 ASCOM Driver installed (http://www.gralak.com/apdriver)
- We recommend that you update your browser to the latest version
- We recommend that you install Adobe Acrobat Reader or another PDF reader (may be needed to read APCC and ASCOM PDF documentation)
- Please remember that we are NOT Microsoft. Whatever your hardware and Windows OS version, you should have the PC prepared and know the operational basics.
  - Know how to: use Windows Explorer to: copy and/or paste files and/or folders
  - ...navigate to Windows Device Manager

- ...navigate through your file system and make the directory **C:\ProgramData\xxx** visible in Explorer. (It's hidden by default.)

○

Additional Requirement for APCC Pro's APPM Point Mapping Program:

One of the following is required:

- The **FULL** (paid) version of DC3 Dreams PinPoint application v5 or later (v6 or later is recommended).
- Sequence Generator Pro
- TheSkyX Image Link
- ASTAP

3.3 Installation and Licensing

Preparation

In order to install and run APCC, please ensure following:

1. Make sure that you meet ALL of the requirements in the Hardware/Software Requirements section as described earlier in the Getting Started section.
2. You must register a specific e-mail address with Astro-Physics for APCC. This will be the official e-mail address that is associated with your license. **This is required to obtain a trial license key or make a purchase**. When your e-mail address has been entered into our database, you will receive an automatically generated email with the subject line: APCC Email Authorization Sent: (your e-mail address displayed).
3. Download the program from this APCC Download Link

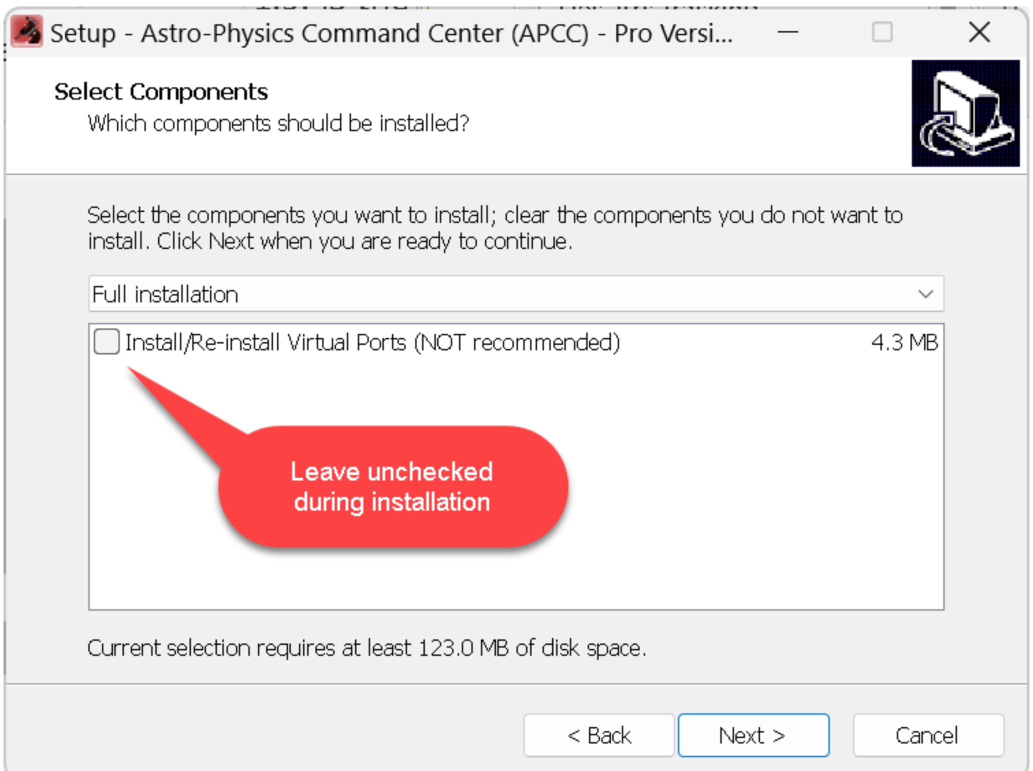
Installation

We strongly advise that you log onto your computer with FULL administrator privileges. This means that you are logged on as the primary owner / operator of the computer with full Windows permissions, as opposed to being a user on someone else's computer. Being logged on as administrator is NOT the same as running or installing a program file "as Administrator." ***DO NOT*** try to install or run this (or any other) astronomy-related software "as Administrator."

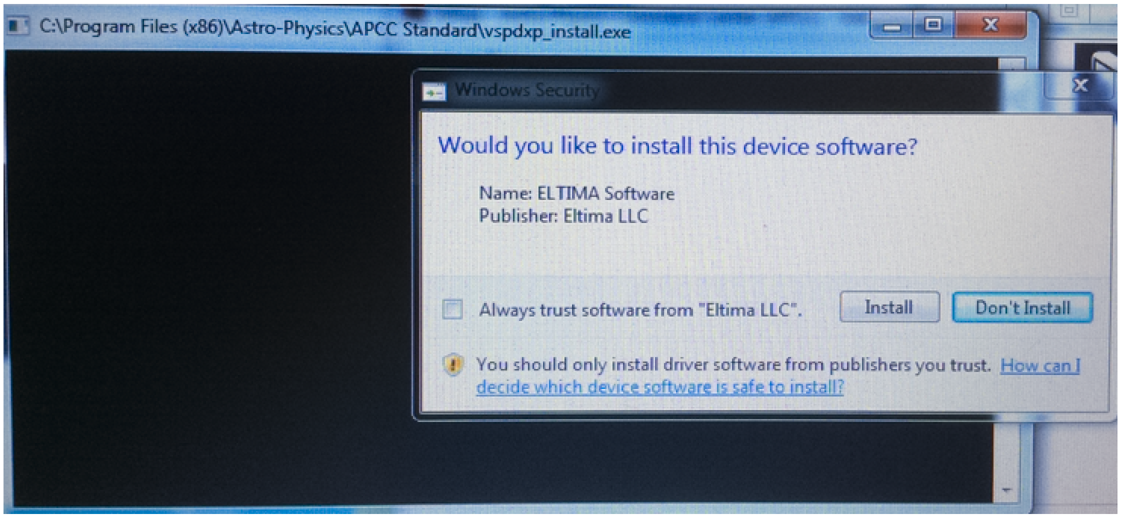
If you are updating from v1.8.8.17 or an earlier version, you must uninstall any previous version of APCC in the Windows Control Panel. This is due to the new version of the Eltima Virtual Ports Driver (V9) that will be installed.

Double-click on the installer file: **APCC_Standard_Setup_1.x.x.exe** or the **APCC_Pro_Setup_1.x.x.exe** file that you have downloaded to start the installation process. Follow the instructions on the installer. You may need to disable some anti-virus or firewall software before installing.

During the installation process, you will be prompted if you wish to install the virtual ports. **We strongly recommend you do not install or use virtual ports unless you have a specific reason to do so.** Instead, APCC now uses REST API as a robust and reliable connection mechanism instead of Virtual Ports.



IMPORTANT NOTE IF YOU INSTALL VIRTUAL PORTS: Near the end of the software installation process, a black DOS-style Command window might open. DO NOT interfere with this command window! Don't touch anything on your computer, including the mouse or keyboard while this window is up. Doing so may cause a failure of the virtual port system. Please be patient!



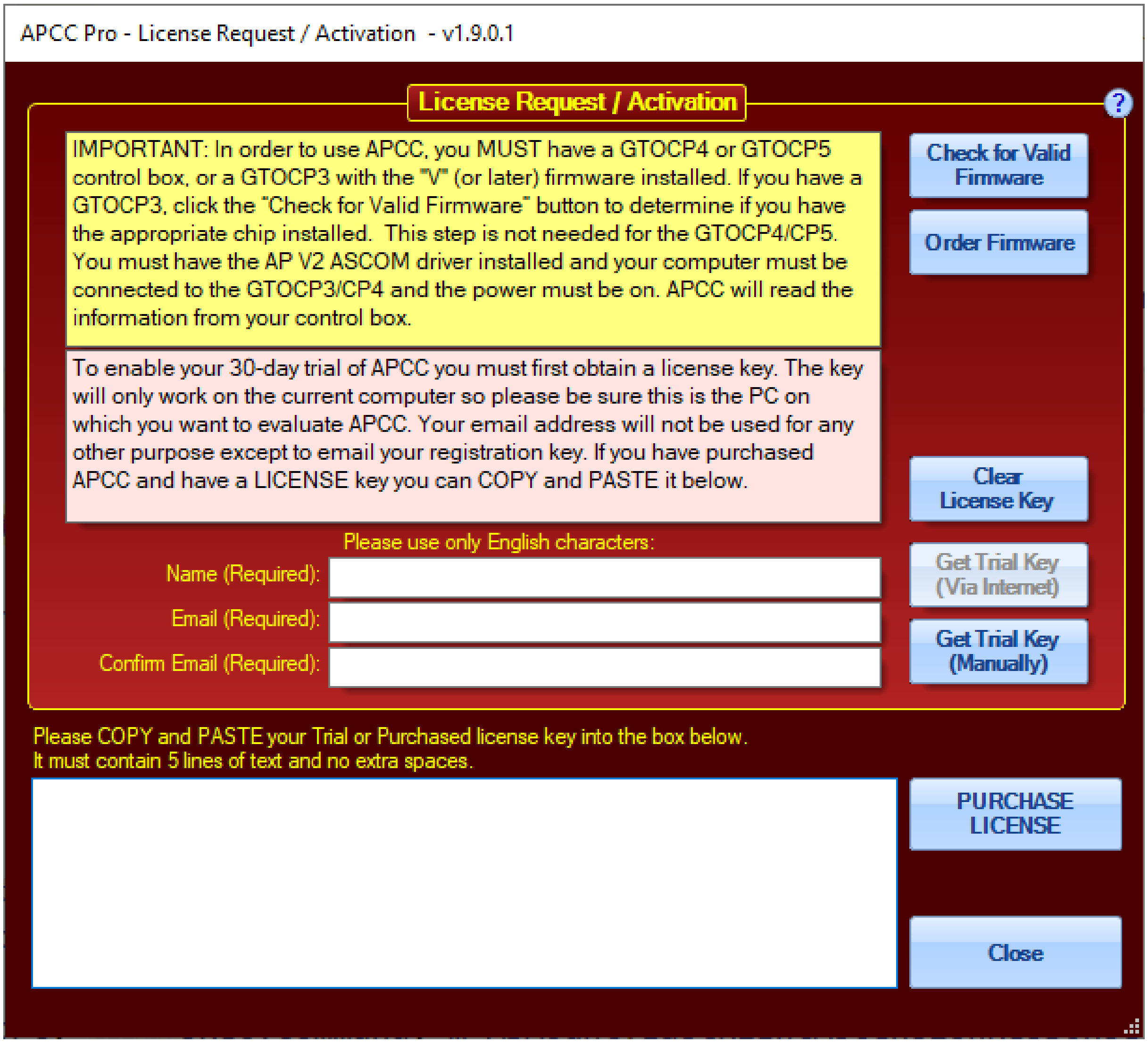
One final note on upgrades from earlier versions. This will apply to all upgrades.

IMPORTANT NOTE:

With successive versions of APCC (or any software), the various associated windows can change in terms of their content and arrangements. If the options regarding Window Size and Window Positions are selected when you install the latest version, you may need to turn the window options off, and then on again after installation to reset properly to the new appropriate window dimensions.

Obtaining a license key

When you run APCC for the first time and until you enter a license key you will be presented with the Trial Registration Information Dialog when APCC starts.



Confirming you have the proper firmware

You do not need to do this step if you have a GTOCP4 or GTOCP5.

If you have a GTOCP3 and you are not sure that your mount has the proper firmware installed then you can check it by clicking **Check for Valid Firmware**. For this to work, you must have the AP V2 ASCOM Driver installed and configured for normal (pre-APCC) operation. The serial cable must be connected from the computer to the mount, and the mount must be powered on. If you can successfully use the Check Port button in the AP V2 ASCOM Driver's Telescope Setup window, then you are set up correctly for this test.

If you don't have the correct firmware installed for this mount, you can click the **Order Firmware** button for more information on how to obtain it.

Obtaining a trial license key or permanent license key if your computer has internet access

You can try APCC for up to 30-days before purchasing. To do so you will need to make sure your e-mail is authorized to receive a trial license key. Authorization is required to ensure that you have the correct firmware and control box, which will help minimize support questions.

To get an authorized e-mail you should contact Astro-Physics via phone or e-mail (support at Astro-Physics dot com) requesting that your e-mail be authorized for the trial. In order to be authorized, you will have to purchase the upgraded firmware (revision "V" or later) if you do not already have this firmware installed in your GTOCP3. Mach1GTO, 1100GTO and 1600GTO mounts shipped beginning July 22, 2014 and later will have the upgraded firmware. Owners of these more recent mounts must still get an e-mail address authorized for the licensing process.

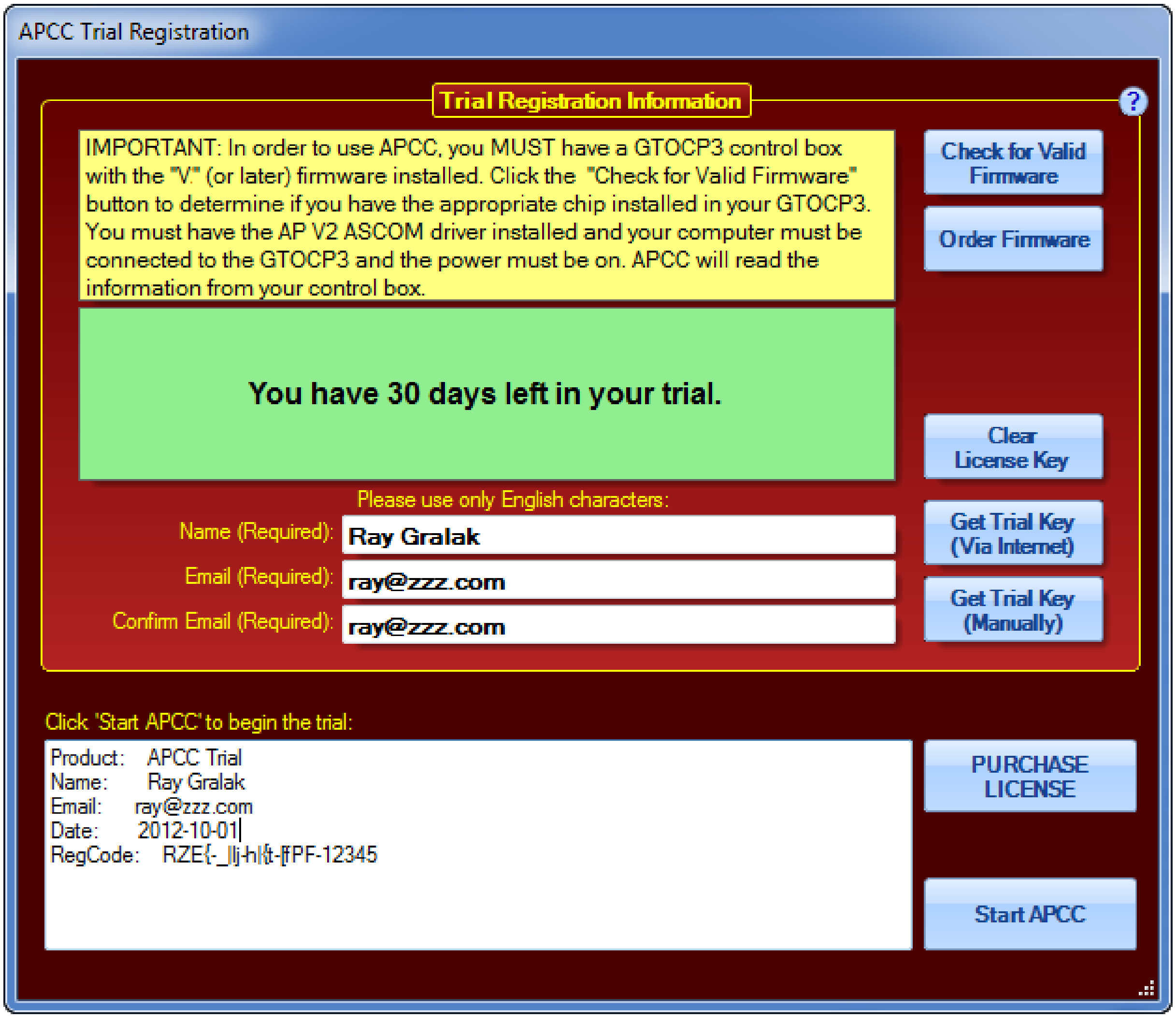
Once your e-mail address has been authorized and entered into our APCC database, you will receive an email with the subject line: APCC Email Authorization Sent: (your em-mail address displayed).

Enter your Name and E-mail address (twice) and click the **Get Trial Key (Via Internet)** button. Make sure that you run APCC on the computer you intend to run it from.

You should receive an e-mail within a few minutes with your trial license key. Just copy and paste all 5 lines of the license key into the text box at the bottom of the window. Do not copy any extra spaces or lines.

If successful, the window will now tell you that you have 30 days remaining in your trial. This window will come up every time you start APCC so you'll know how many days remaining you have.

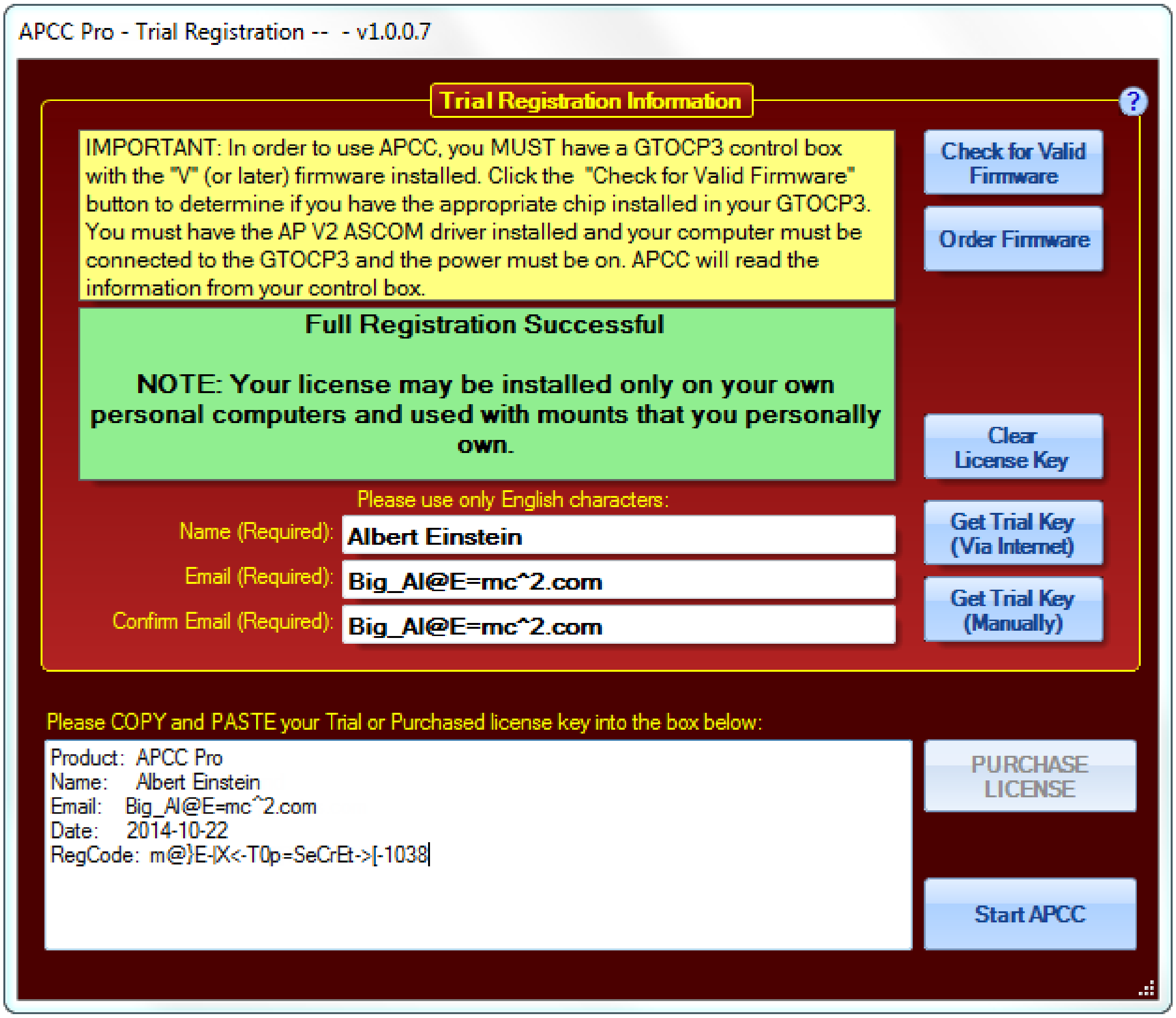
To begin using APCC click **Start APCC.**



Clicking the PURCHASE LICENSE button will take you to the Astro-Physics e-commerce page for APCC. From there, you can click the appropriate Buy now ! button for the version you wish to purchase. Follow the instructions to complete the purchase. Upon completion of the purchase, you will be sent an e-mail with your full license key.

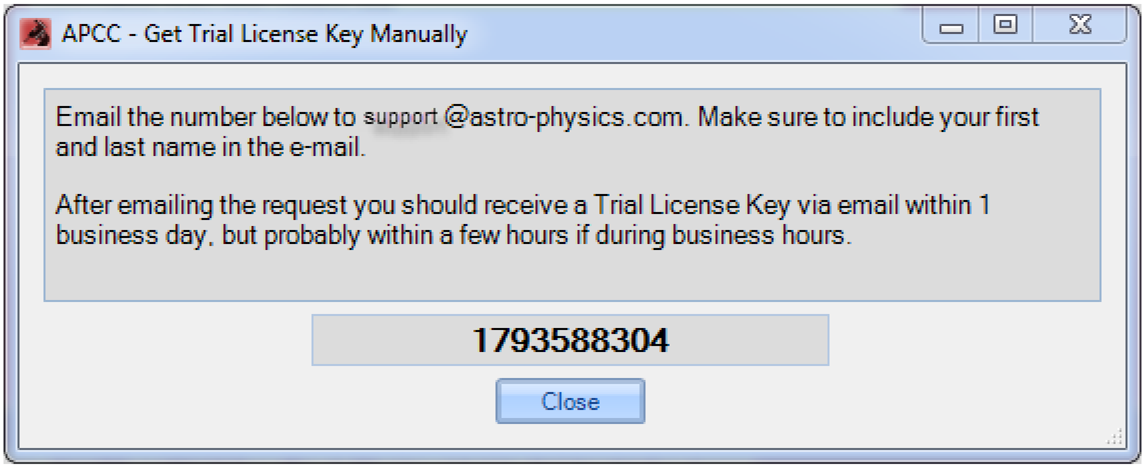
It is also possible to purchase APCC directly from Astro-Physics by contacting us. If you have made your purchase directly, you will receive a license key via email shortly after your purchase. These license keys are manually generated, so please allow a day or so.

Enter your license key in the same manner as the trial license described above. If you are really smart, a successful registration of a full license will give a message like the following:



Obtaining a trial license key if your computer does not have internet access

If the computer on which you intend to use APCC does not have internet access you can click the **Get Trial Key (Manually)** button. A window like below will appear:



Write down the number and from a computer with internet access e-mail it to Astro-Physics. The staff of Astro-Physics will manually generate the license key for you and send via a return e-mail. This could take 2-3 days since the license key won't be generated over the weekend or holidays. Remember that if you use this method, you must install the trial version of APCC on the same computer from which this number was generated.

After you have entered the license key information, select the **Start APCC** button.

Clearing the license key

If for some reason you need to reenter your license key you can click the **Clear License Key** button.

You will then be able to enter a new trial license key the next time you start APCC.

Applying a subscription renewal license

If you purchase a subscription renewal to have access to new APCC features, you must do the following:

1. Run APCC.

2. Click the menu Help->Clear License Key, and click OK.

3. Close APCC.

4. Run APCC again, and enter your new 5-line license key.

5. Close APCC again, and restart it.

3.4 Setting up your primary Virtual Port

This section is only for those using the virtual serial ports (VSP) instead of the default REST API. If you use REST API you can skip this section. Also note Virtual Ports tab is hidden when using REST API.

What is a virtual port? Real serial ports are single, unique point to point communication contacts between two, and ONLY two devices. Serial ports, by their nature cannot be shared. Virtual serial ports are software-based rather than physical. Through the Virtual port software, you can effectively create multiple ports that can all be merged into a single entity that can then communicate as a single device to your GTOCP3, CP4 or CP5 servo control box. APCC can create up to four of these virtual ports. The primary port is normally used for the AP V2 ASCOM Driver.

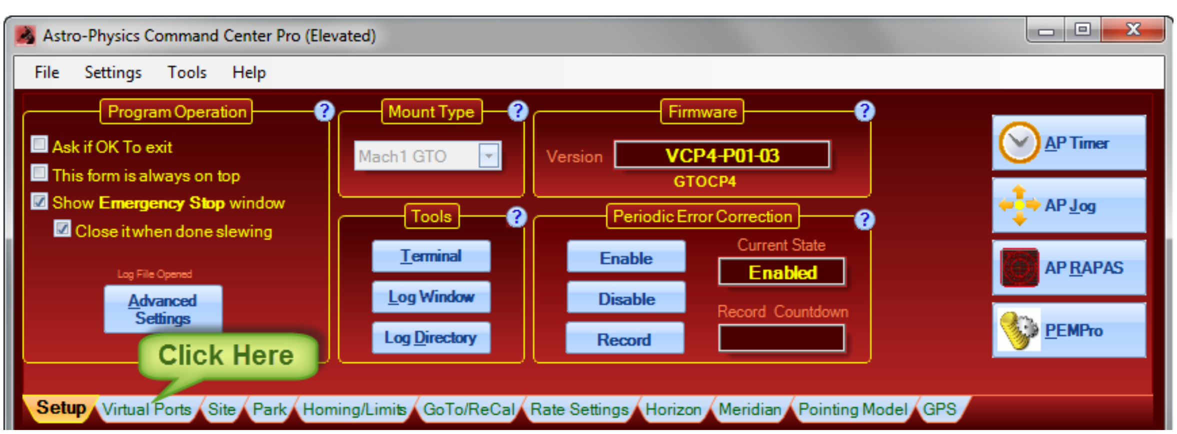
To integrate the AP V2 ASCOM Driver into APCC for seamless operation, you will need to first set up your primary Virtual Port in APCC. This only takes a few moments.

Note: You can allow APCC to simply set up and create the virtual ports for you by checking the box in the Connection Group Box to "Create Virtual Ports First." However, this may create conflicts if you have other unrelated serial devices that might not be connected or active at the moment. We have found that it is often safest to set up the primary virtual port manually to avoid these potential conflicts. Hence, the instructions below:

1. Decide on Port Numbers. In the latest release, we have limited the available ports to those between 30 and 99. Your first task is to determine which ports are already in use on your computer, and to make a good guess at which additional ports may be added. You may have a port reserved for APCC, and you may have additional ports reserved for such things as a focuser, rotator, dew heater controller, weather station, MGBox, smart UPS or other serial devices. Remember that at setup, you may not have all of these devices connected, and that they therefore may not show up on your system. Use Windows Device Manager to see your current COM Ports. If you use Keyspan USB to Serial converters, the Keyspan Serial Assistant will show you all of the currently connected converters and their assigned port numbers. Otherwise, you can find the assigned ports in Windows' Device Manager.

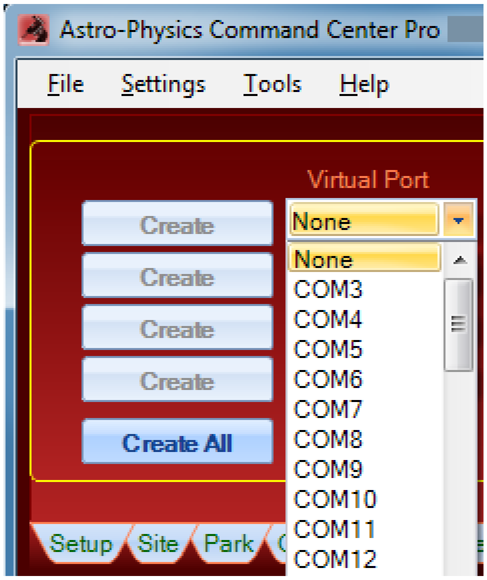
   As a general rule, most people will reserve port #s 1 through 29 for normal "real" ports, whether native or via a USB to serial converter like the FTDI or Keyspan units. COM 30 is often a good place to start with your primary virtual port. If you use a lot of serial devices, reserve ports 1 - 30 for real ports, and start your virtual ports with COM 31. You can go as high as COM 99.

2. Open APCC, if it is not still open from your installation. You do not need to be connected to the mount.



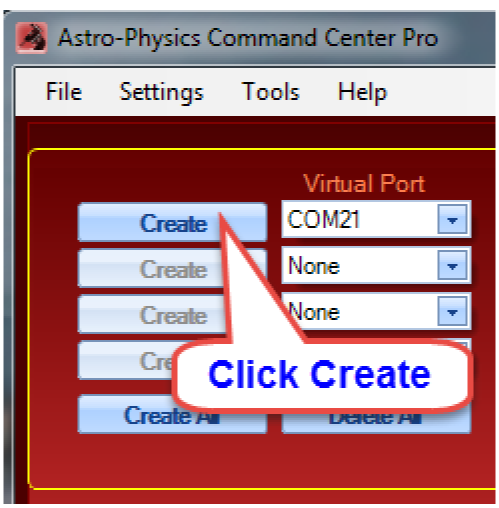
3. Click on the Virtual Ports tab in APCC.

4. Click on the Port Selection Dropdown list for the first (top) virtual port. The default is "None", but all of the available choices will be listed.



5. Select the COM Port that you decided on in step #1 from the dropdown list

6. **YOU MUST click the "Create" button to create the port in your system!** This isn't simply an APCC option, but goes to the heart of the PC's operating system.



7. Repeat this for the second COM port (i.e. COM 22) and any additional ports you may need. Defining the second port is recommended so that ASCOM client programs that must be run as administrator can have their own instance of the driver.

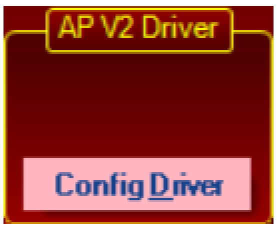
8. Remember the primary COM port number you just created, and proceed to the next step in these instructions: Setting up the AP V2 ASCOM Driver

9. More information on using the Virtual Ports can be found under the Main Window => Virtual Ports Tab.

3.5 Setting up the AP V2 ASCOM Driver with APCC

Make sure you have the most recent version of the AP V2 ASCOM driver installed. The latest software versions can always be found at Astro-Physics Software Update page

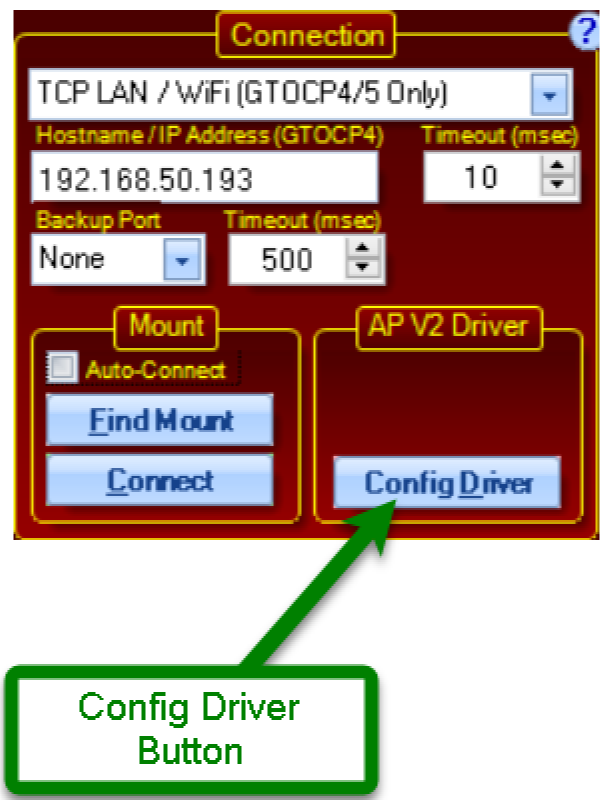
1. The ASCOM Driver and the driver's Setup Telescope window must be closed.
2. When you launch APCC, you will see the Config Driver button in the ASCOM V2 Driver Connection Group in a "Pink" status. This means the ASCOM driver is not properly configured to match APCC



A 'Pink" status means ASCOM Driver configuration does not match APCC and needs to be updated

3. From within APCC, Click the **Config Driver** button in the AP V2 Driver Connection Group box as discussed in the Getting Started Work Flow section.

Seriously! That's all that 95% of you will ever need to do!



3.6 Operational Work Flow Basics

Introduction

The earlier section on Getting Started Work Flow was designed to help you get the system up and running. This section will guide you through normal operations as you use APCC with other software to achieve your observing or imaging goals. The steps below are not hard and fast rules. They are guides that, if followed, will present the easiest and most trouble-free way of operating your system as a whole.

Use the AP V2 ASCOM Driver

First off, the question often arises: If I have a choice between using an external program's native driver (as in TheSkyX), or connecting the software through the AP V2 ASCOM Driver, which should I choose? **We strongly advise using the AP V2 ASCOM Driver.** Here are some reasons:

1. The AP V2 ASCOM Driver is a full fledged hub. It will accommodate a very large number of programs all connected at the same time, and will do so without any problems. As a single hub, the driver will minimize the serial traffic between the software and the mount by eliminating redundancy.
2. The AP V2 ASCOM Driver takes advantage of the full set of Astro-Physics servo commands, many of which were developed specifically for either the driver or for APCC. Since these new commands are not being published, the native drivers found in other software will be limited to the older set of published commands.
3. The AP V2 ASCOM Driver can create log files for troubleshooting any issues that you may have.
4. We can provide a certain amount of support if you encounter issues with a program that uses the AP V2 ASCOM Driver. We, of course, cannot fix a problem that is in someone else's software, but we may be able to figure out what is happening to cause the problem. If you use a native driver, you will be limited to the support that the software provider can give you. We are unable to support someone else's driver.

Order of Operations

While there are several ways that you can start up and run your system, we recommend the following order of operations:

1. **Power up your imaging camera(s) and software and start the cooler(s).** This is simply a time saver. The cameras might as well be cooling while the rest of the system is being activated.
2. **Power up your mount.** Since APCC automatically sets the Safety Park feature in the servo, the mount will not start default sidereal tracking, even if it was not properly shut down at the end of the previous session. The mount will quietly wait in place until it is initialized and unparked by APCC with NO loss of pointing accuracy.
3. **Start APCC.** If you checked the Auto-Connect When Started box in the Connection group box on the main page, APCC will connect automatically to the mount and initialize it. It will then create all of the virtual ports that you have defined. Finally, if the Auto-Connect Driver when APCC connects box

is checked on the Virtual Ports tab it will start up the AP V2 ASCOM Driver and connect to it through the first virtual port.

4. **Connect the imaging software to the mount** if you normally do that. This was added as a separate instruction because we advised you to start your imaging software earlier to cool the camera and we don't want you to forget.
5. **Start and connect other software.** Start up each additional piece of software that you will be using and connect that software to the mount, and to any other relevant devices. Refer to the other software and hardware documentation for advice on the order in which you power other devices like focusers and start the various other programs.
6. **DO YOUR ASTRO-THING!**

Note: Many of you with remote operations will have a scripting program like ACP or CCD Auto-Pilot that will do this for you. If this is the case, we still recommend this basic sequence except that the first thing activated will be the scripting software. Your scripts should include sufficient time (waits) for each element to be completed before proceeding to the next.

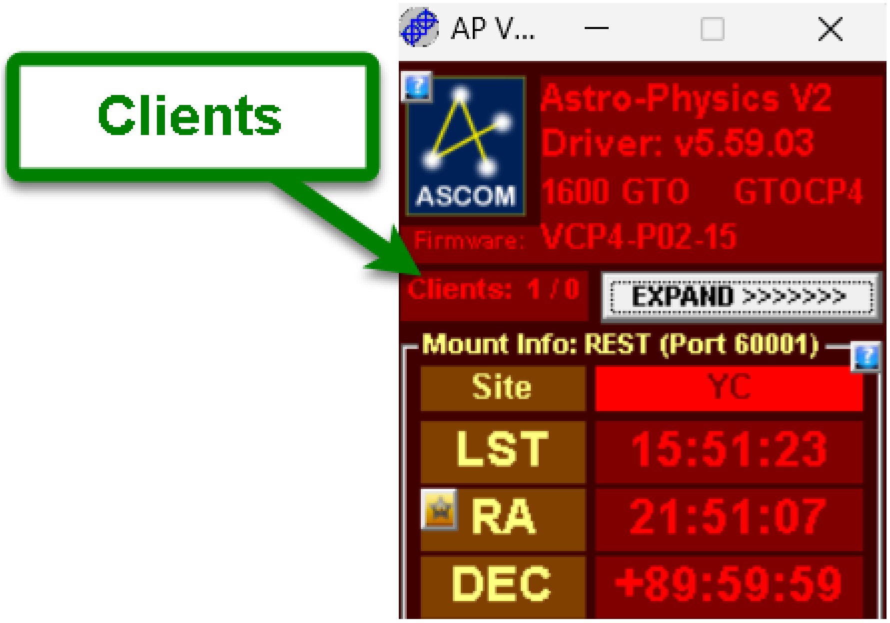
If you insist on starting everything from an ASCOM client program (not the preferred method), please note the following: The two checkboxes in the AP V2 Driver section of APCC's Connection group box (Auto-Connect and Auto-Config) must be UN-checked. Also, in APCC's Advanced Settings window: Check Auto-Initialize and set the value to zero. Check the Auto-Shutdown and set its value to 1 second.

Shutdown

The shutdown sequence is very much the reverse of the Order of Operations listed above with a couple exceptions. Here is the recommended sequence:

1. **Start the imager's cooler warm-up.** Again, this is listed first as a time saver. For cameras that require a warm-up, this might as well be going on while the rest of the shutdown is taking place.
2. **Park the mount.** Most of you will choose to park the mount to a predefined park position, even though this is not strictly necessary with an Astro-Physics mount. For many, the park position is dictated by the observatory architecture, or by the positioning of a flat screen. See the Park Tab section for more details. If you are using TheSkyX to park the mount, be sure to see the special note!
3. **Disconnect the imaging software from the mount.** Since the warm-up of the cooler can take a while, the imaging software is often the last piece of software to be closed down before shutting off the computer. You will want to disconnect the imaging software from the mount before closing APCC.
4. **Disconnect and shut down other software.** Disconnect each piece of software from the mount and any other devices that it controls, and then shut that piece of software down.
5. **Verify that everything is disconnected.** There are 2 steps to this:
   a. If you have connected to the mount with one or more **NON**-ASCOM programs, go to the Virtual Ports tab and make sure that the only active virtual port is the top one (the AP V2 ASCOM Driver's port). You do not need to delete the other ports that you may have. Just make sure that no further data is being transmitted or received over the lower three virtual ports. If you only connect to the mount through ASCOM clients, you can skip this step.

b. The AP V2 ASCOM Driver has an indicator at the top of the Handbox Window that tells you how many clients are connected. (See the AP V2 ASCOM Driver's help file.)



The first value (in the above case a 1) tells you how many client programs are still connected to the mount. The second value tells you how many DC synchronous focusers are connected. (Note: Digital focusers and focusers requiring drivers cannot use the simple AP focus controls and are NOT included in this count. For most of you, the second value will always be a zero.) When the client count gets down to 1, all the programs have been disconnected. The remaining 1 is APCC. If you have chosen the Auto-Shutdown feature in the Advanced Settings window, the shutdown timer will start when the last client apart from APCC is disconnected.

6. **Close APCC.** If you did not choose Auto-Shutdown as mentioned above, close APCC in one of the conventional ways. When APCC closes, it will also close the last instance of the AP V2 ASCOM Driver. APCC and the driver should be shut down before proceeding to the next step.

7. **Power off the mount.**

8. **Finish closing down your imager and shut down the observatory.**

3.7 Tips to Get the Most from APCC

Using the Help Files and Manual

We have tried to make this information as complete and well organized as possible. If you have suggestions for improving the documentation, please let us know!

This information is available in many formats to suit your situation. We encourage you to refer to these help files first before posting to the forum or calling for support. Please let us know how we can improve the information or presentation to make it easier for all to use.

- APCC Toolbar - The APCC toolbar includes a Help selection that will open the entire manual for your review in html format. This version includes a search function and allows you to designate sections of the manual as favorites for quick reference at a later date.
- Adobe PDF - If you plan to review the manual at times when APCC is not active, the cross-platform PDF format will be handy. Download it to your computer, print it for reference or upload it to your portable device. If you use it in conjunction with an App like iAnnotate, you can highlight information that you want to remember or make additional notes for future reference.
- Apple iBooks (ePub format) - This handy version can sit on the bookshelf on your iPad or even your iPhone! Naturally, other e-readers in ePub format can be used, as well.

We will make an effort to keep the screen shots updated as minor changes occur in upcoming releases, however you may find some outdated screen shots that look slightly different. Please bear with minor differences. However, if you find screen shots that are confusing and require immediate updating, please let us know.

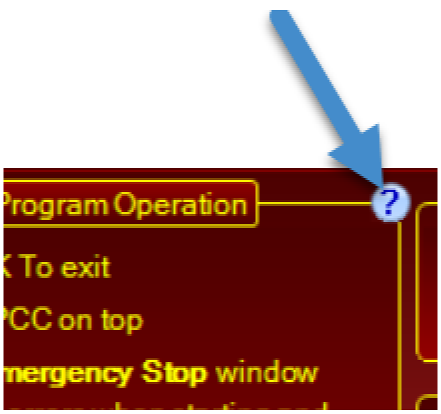
Instructional Videos on the Astro-Physics YouTube channel

We have a growing library of tutorials and instructional videos on [the official Astro-Physics YouTube channel](). Videos are continually updated and new content is created on a regular basis. We highly recommend subscribing to our YouTube channel and enabling notifications so you will be informed as new content is added.

Help ? in Corner of Group Boxes

Help icons - The Help icons available throughout APCC are likely to be the most handy method for gaining access to information when you need it. Each icon links to the specific part of help content that explains the feature or function. This puts pertinent information at your fingertips for immediate reference. There are frequent links to other information for further clarification.

Help Icons are the upper right corner of almost every group box in APCC you'll find a round button with a "?". Clicking this button will open the help for the group box.



Example of Help (?) icon, located in many group box corners for context-sensitive help

Tabs

Tabs provide a quick means to access key areas of the program. You can rearrange the order of the tabs to suit your needs by clicking and dragging the tab order, however the order will not be saved for the next session at this time.

All tabs are visible for all mounts and all versions of APCC with the following exceptions:

- Pointing Model Tab: Only visible for the APCC Pro version.
- ELS Tab: Only visible for 3600GTO
- AE Tab: Only visible for mounts with Absolute Encoders (e.g., Mach 2, 1100GTO with absolute encoders, 1600GTO with absolute encoders, etc.)

Group Boxes

Closely related items are subdivided into Group Boxes enclosed within a yellow box and given a title to describe their relationship. Some of the group boxes, like the Move Scope group box shown below are always visible on the Main Window. Others are organized within the various tabs or windows.

Resizing Windows

For your convenience, the various windows can be resized to suit your needs. Simply grab the lower right corner of the window (or the sides) and move it to fit the desired space. Note that the text and graphics will adjust proportionally to the width or length that you specify. This will allow you to optimize the monitor placement of all of the programs you typically use to enhance your work flow.

When you resize APCC, the controls will scale as well. The scaling of controls and fonts is not always perfect but is usually good enough for most purposes. For instance, you can maximize APCC so that the controls are easily visible from a distance, or shrink APCC so that other Windows are also visible.

If you wish to save the location of the windows when you exit APCC, refer to Settings Menu. Please refer to Known Issues if you are using Windows XP or Vista.

Limit Primary Control of Your Mount to One Input Device

Your mount can be controlled by a variety of input devices, including the Keypad, iPad/iPhone or computer. Although the devices can work together very well to command the movement of your mount, we recommend that you use only one in your session and that you always initialize, unpark and park with the same primary control device. We expect that for most of you, the primary control device will be your PC with APCC. Remove the primary control functions from any other device that you use. For the keypad, this means setting the auto-connect to EXT. Other devices like iPads should have the time-updating functions to the mount disabled, and should not be used during your final park and shutdown routine.

Remember these rules:

- ONLY ReCal from the same device that sent the slew command.
- NEVER perform a full SYNC from a secondary device!!!

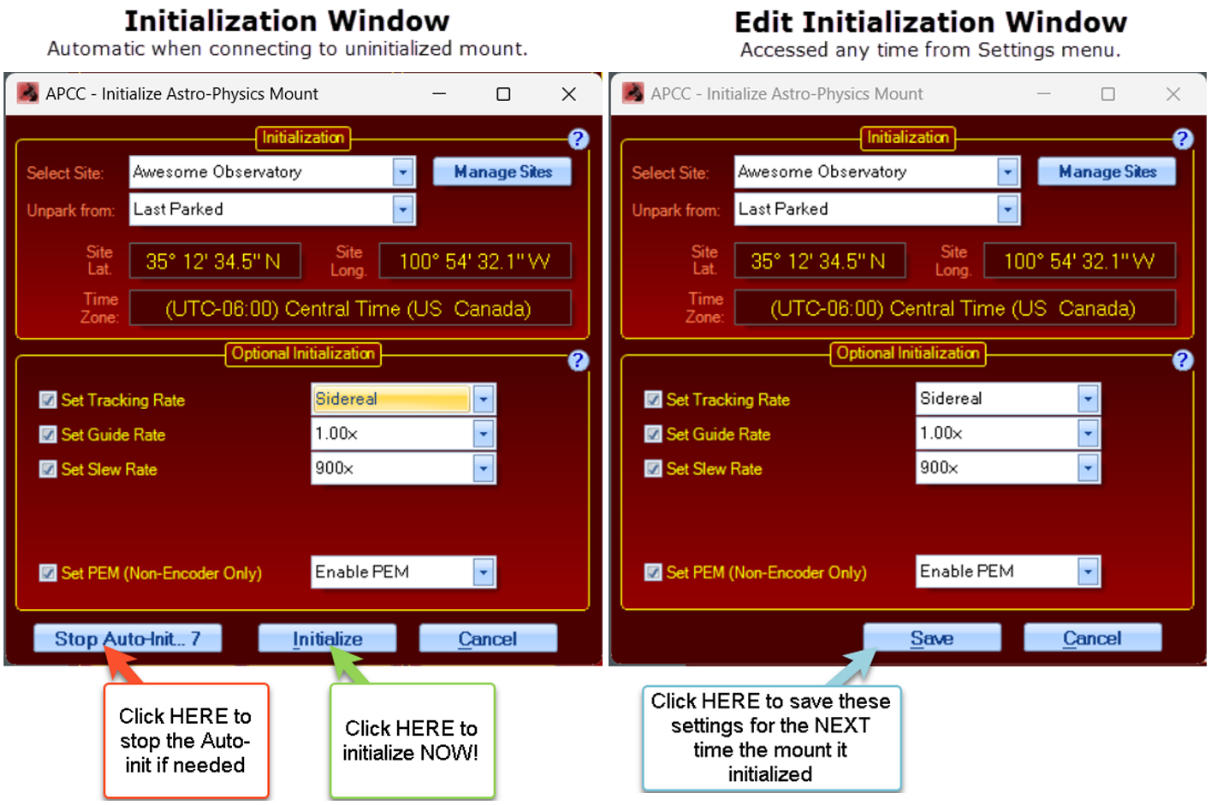
This document provides information regarding various options for controlling your mount: Control Options for Astro-Physics Mounts

4 Initialization /Edit Initialization Window

This window can take two formats: It can appear upon connection to an uninitialized mount immediately prior to initialization, or it can be opened as a savable window from the Settings menu for convenient editing.

Whenever APCC detects that the mount needs to be initialized (right ascension = 0 and declination = 90), the **Initialize Astro-Physics Mount** window will open. By default, if you do nothing, whatever parameters have been set up in this dialog window will execute in a user-defined number of seconds. (Default is 10 sec. See the Advanced Settings section under Main Window => Setup Tab) However, you can stop this auto-initialization by clicking the button **Stop Auto-Init.** This will allow you to check your settings and change them, if you wish. You will NOT normally stop the auto-init sequence.

Useful Tip: Most users will want to select Auto-Initialize from the Advanced Settings Window so that initialization by APCC is automatic. If that option is checked, the window on the left will appear every time you start APCC after power-cycling the mount. Permanent setups where the various options are not likely to change can select a very short wait time in the Advanced Settings window - 1 or 2 seconds is usually fine. Portable users will want to set longer time intervals to allow time to check settings and possibly temporarily stop the auto-init to make changes.



IMPORTANT: The window on the left above will NOT appear if you have already initialized the mount (including initializing the mount with another source, such as the keypad). Also bear in mind that the mount remains initialized until it is power cycled. Remote observatories that leave power on to the mount (not recommended in case of damaging lightening storms) will maintain an initialized state in the mount and will therefore not see this window upon startup of APCC.

At any time, you can access the editable version of this window under the Settings Menu to adjust the settings. This should be the normal way to change initialization settings. Re-initializing an already initialized mount with new information can result in changes to the mount's knowledge of where it is pointed. Therefore, the editable version DOES NOT have an initialize button.

Initialization

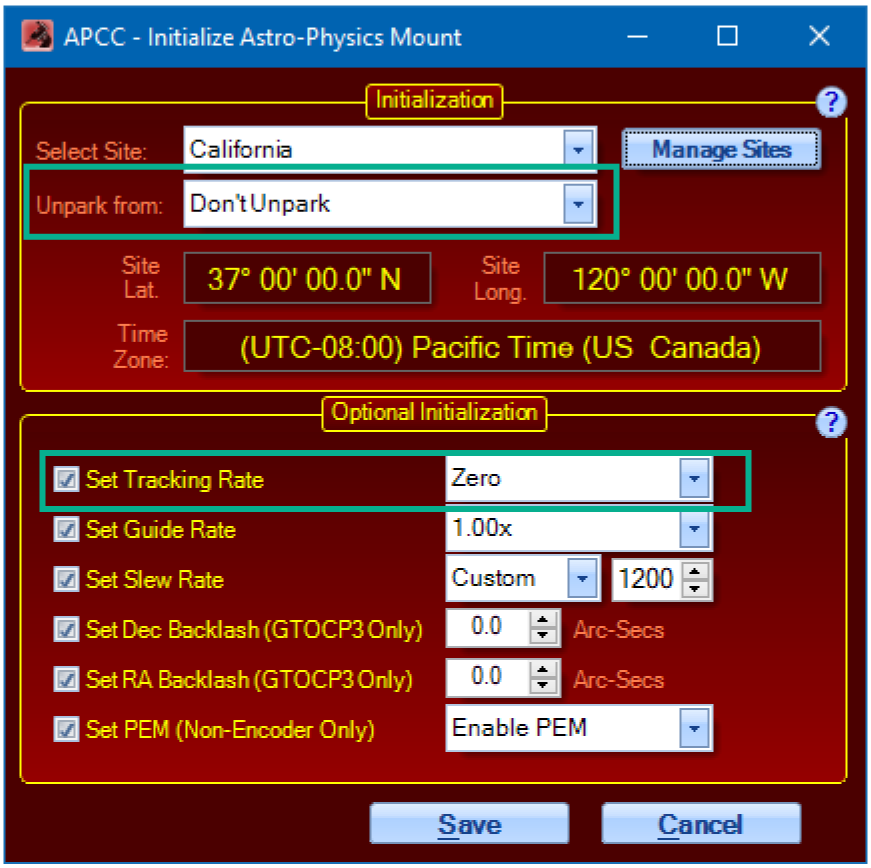
The primary initialization functions tell the mount its current location and give it the current time and date. The initialization also initiates the "unpark" calculations that re-establish the mount's pointing. For mounts that have been manually moved or set up in the field, the primary initialization functions also can include syncing the mount to a predefined Park position.

Select Site: Selects the site that will be used to initialize the mount. APCC will use the site's latitude, longitude, time zone, elevation, default temperature and pressure. To edit or create new sites, click the *Manage Sites* button.

Manage Sites: Click this button to bring up the Manage Sites Dialog.

Unpark from: This selects the park position from which APCC will unpark. **Usually you will want to select "*Last Parked*." This is true even if you park to a defined park position.** The only time you would normally unpark from a defined position is if you are setting up the mount or if you have moved the mount via the clutches. Refer to the Park Positions section if you are unsure of the various options.

NOTE: You can also set the **Unpark from:** position to **Don't Unpark** (or **Set Tracking Rate** to **Zero)** if you do not want the mount to start tracking after initialization. Both are shown as examples in this screenshot:



Unpark Now: Clicking this button will allow you to unpark the mount from one of the Park positions. You cannot use this button if you have *Last Parked* selected. You typically would use this button to unpark after you have physically moved the telescope to one of the Park positions. Refer to the Park Positions section if you are unsure of the various options.

Optional Initialization

A basic initialization will give the mount the necessary information to calculate its position (time and location data) and will unpark the mount to either its calculated pointing position, or to a user selected pre-defined Park position. You may, however, wish to set other operating parameters as part of your general start-up / initialization process. These other parameters can be set automatically at initialization by checking the boxes and selecting the values in the options listed below.

Note that the the keypad, or any other software can set its own parameters which can override the parameters you set here at initialization. The GTO Servo will always act on the last parameter that it received for any given option below.

- **Set Tracking Rate:** If this option is checked, the selected tracking rate is sent to the mount. If this option is not checked, the mount will begin tracking at the default sidereal rate.
- **Set Guide Rate:** Guide rate is no longer configurable. The guide rate of 1.0x is the recommended guide rate and the only option available.
- **Set Slew Rate:** If this option is checked, the selected slew rate will be used for slews from within APCC. If this option is not checked, the default slew rate of 1200x (600x for the 3600GTO) will be used. Note the auto-population of slew rate is only available when running P02-01 or later.
- **Set PEM:** If this option is checked, periodic error correction can be forcibly enabled or disabled during initialization. If this option is not checked, PEM will remain disabled. **Note that encoder mounts do not use PEM and will never have PEM enabled.**

Command buttons

Stop Auto-Init: Stops the auto-initialization process. This button is not present in the Initialization window accessed through Settings since it is not needed there.

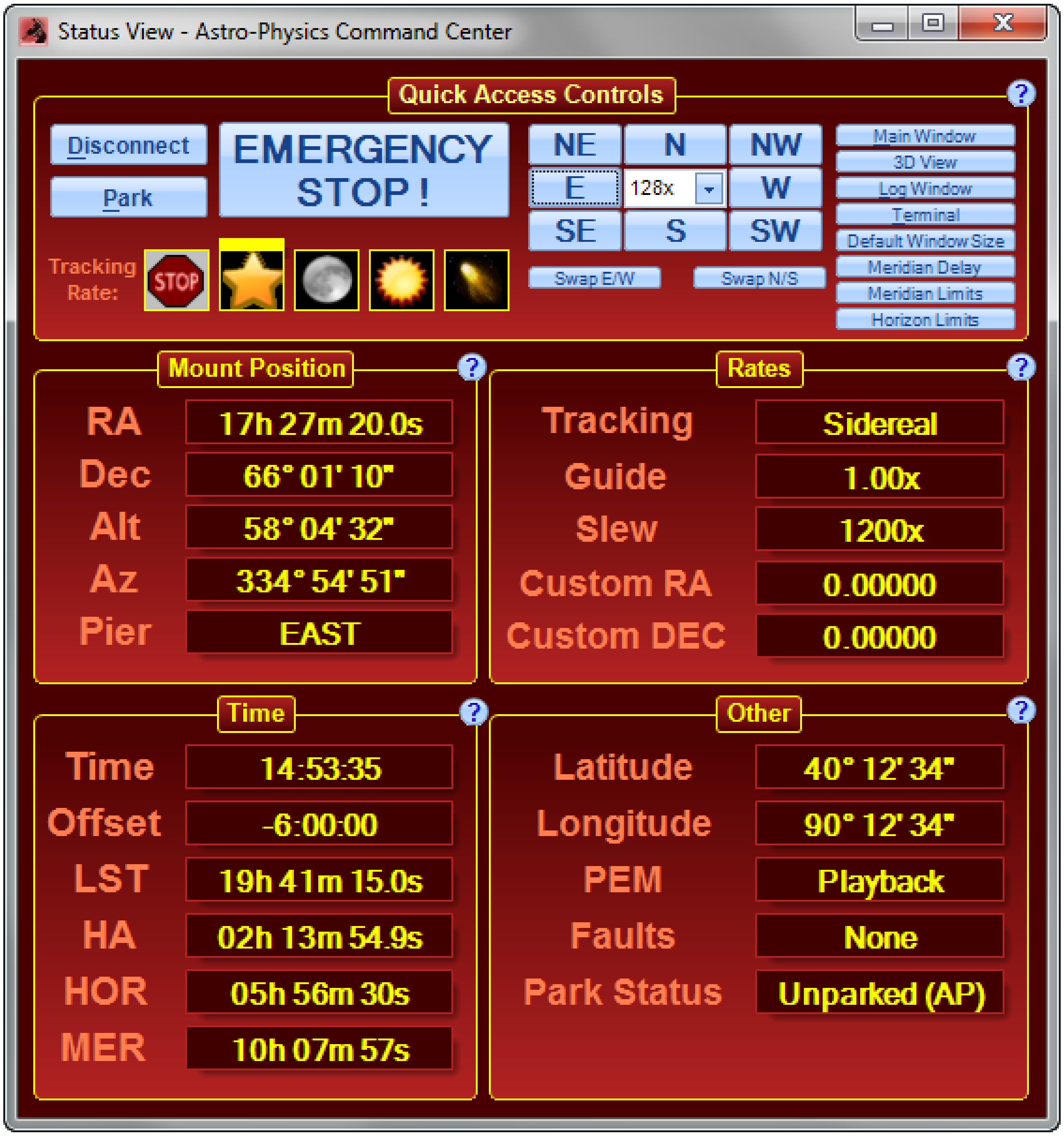
Initialize: Clicking this button will initialize the mount with whatever parameters you have defined above. If you have stopped the Auto-Initialization to make changes to your settings, this will then complete the initialization process. The rates on the Rate Settings tab will update.

Save: This is the alternate button to the "Initialize" button that is found in the editable version of the Initialization Window that is accessed from the Settings Menu.

Cancel: Clicking this button will cancel the initialization and any changes you have made to the settings will not be saved. You may wish to do this if you will be initializing later after downloading new GPS site information.

5 Status View Window

The Status View Window provides a convenient way to view information regarding your mount's position, rates, time and other information all in one window. You can initiate button rate commands to center an object in your eyepiece or initiate a "stop" command in an emergency. It also provides a quick link back to to other windows. The Status View Window can be resized to fit your screen.

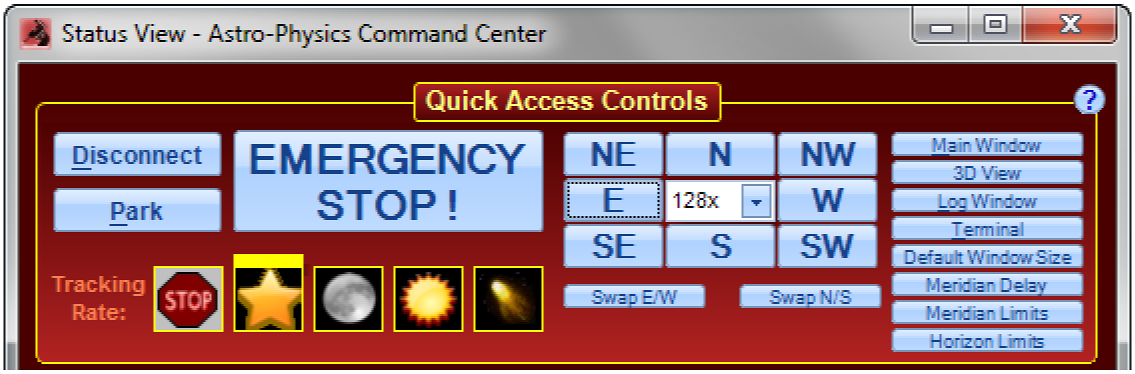


Opening the Status View Window

Show Status View Window When Starting: If you want the Status View Window to display instead of the Main Window each time you start APCC, check the appropriate box on the Setup Tab of the Main Window.

Status Window Button: Click on the button located on the Main Window under the Telescope Position group box.

Quick Access Controls



Connect / Disconnect: To connect APCC to your mount, press this button. Note that if an ASCOM application invokes the driver and the driver cannot connect to APCC on its virtual port then the driver will try to start a new instance of APCC and wait until the connection has been established. In the Connection Group box, you will want to have *"Auto-connect when started"* checked. Refer to Connection Group Box for more information.

Park: Parks the mount to the park position selected on the Park Tab.

EMERGENCY STOP!: Press this button to stop the mount. For more information check this section.

Tracking Rate: The symbols represent various tracking rates. The yellow line above the symbol indicates which rate is active. You can change the rate by selecting the appropriate symbol, with the exception of the variable rate. This rate must be set on the Rate Settings Tab.

NOTE: You can move the scope with the move buttons and the rate will still be maintained. Doing a GoTo slew usually means you want to look at a different target so tracking is reset to sidereal because almost every other target's tracking rate is sidereal!

NOTE: If you find that your mount is stopped (not tracking) and you are unable to change to any of the tracking rates, click on the Emergency Stop button and see if tracking was stopped there. If it was, click again to begin tracking.

N/S/E/W/NE/NW/SE/SW: When pressed, the mount will move in the direction that the button indicates. The rate of movement will be defined by the number in the center box, which shows the rate the mount moves in sidereal rate units when the button is pressed. This number can be changed with the arrows or simply type the value in the field.

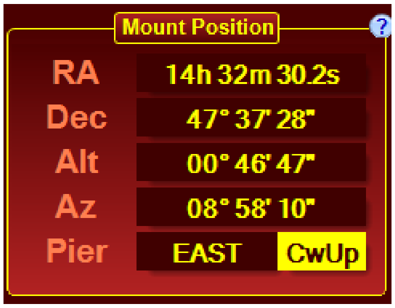
Swap N/S: Swaps the direction of North and South button commands.

Swap E/W: Swaps the direction of the East and West button commands.

Buttons for quick link to other windows: Any of the remaining eight buttons at the far right can be clicked to open the corresponding tab or window.

Mount Position

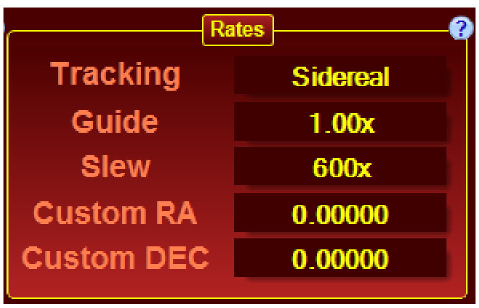
Displays information obtained from the mount control box.



Note that when the mount is in a counterweight-up position, this will be indicated in the Pier field along with the pier side.

Rates

Displays information obtained from the mount control box.

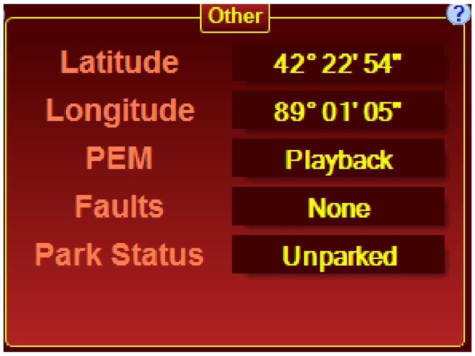


Time

Displays information obtained from the mount control box.

Other

Displays information obtained from the mount control box.



Faults: This field can display the following:

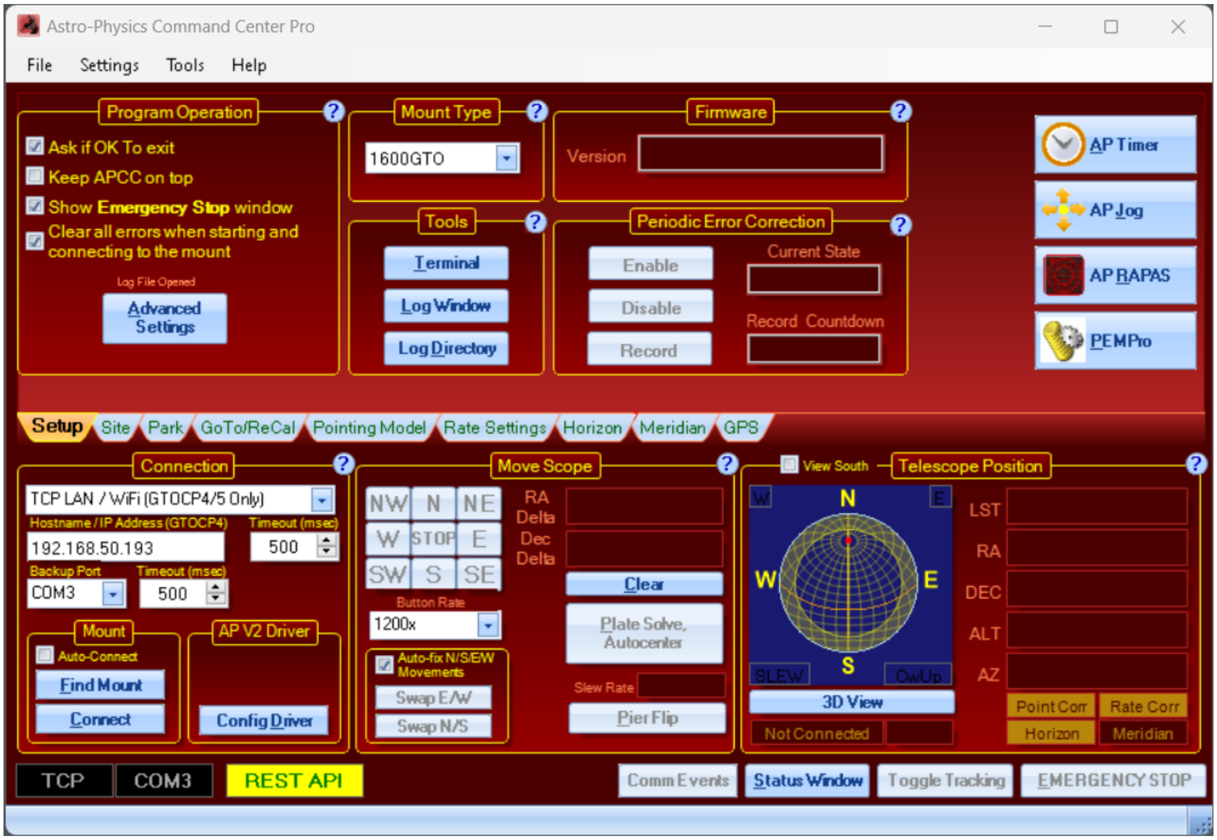
- None = No faults
- Power = Low Power fault
- Stall = Motor Stall
- Servo = Servo fault

If there are multiple items they will have a "+" sign between them. For Instance: "Power+Stall".

6 Main Window

The Main Window was designed so that you can monitor the most important connection, telescope position and status information at all times, regardless of which tab is open. The controls for moving the scope via the buttons are also handy.

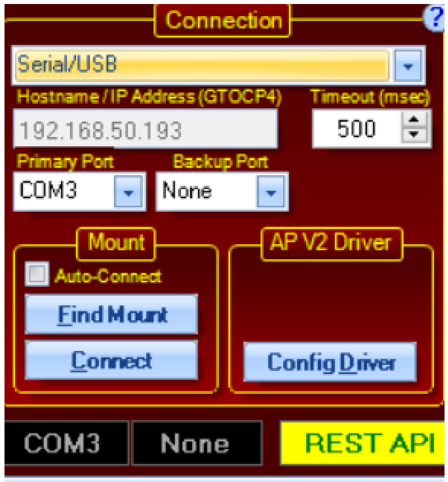
The tab format allows you to easily access all settings throughout your settings.

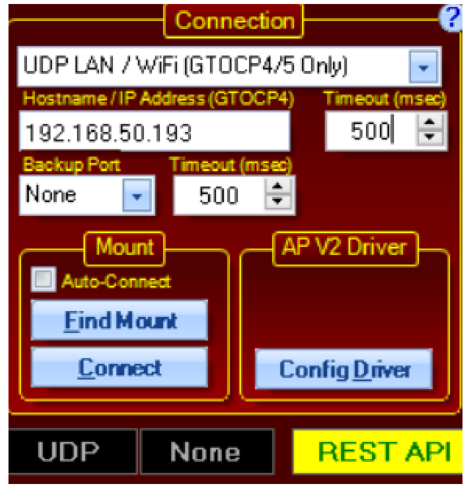


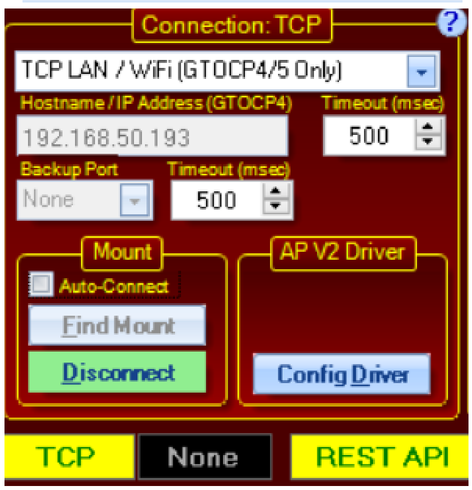
6.1 Connection Group Box

In this group box you can set up the connection to the mount via a COM port, or if you have a GTOCP4/GTOCP5, also via Ethernet or WiFi.

Below are some images showing various states of configuration and connection:







Using GTOCP4/GTOCP5 with Ethernet

Those of you with the **GTOCP4**/**GTOCP5** Servo Control Box now have the option of connecting directly with Ethernet or WiFi. Ethernet connections can either be direct peer-to-peer connections (cable direct from the computer to the **GTOCP4**/**GTOCP5**) or they can be through a local area network (LAN). In a similar manner, the **GTOCP4**/**GTOCP5** can have its WiFi configured as an Access Point for direct connection from a WiFi enabled PC, or it can join your established WiFi network in Station Mode. See IP connections below.

Connection Types:

You have two primary choices when connecting your computer to your mount: Serial (USB), UDP, and TCP. Serial requires a USB connection to the mount, while UDP and TCP require an ethernet or WiFi connection

The following sections describe how to connect APCC to your mount based on your preferred connection choice

Serial/USB

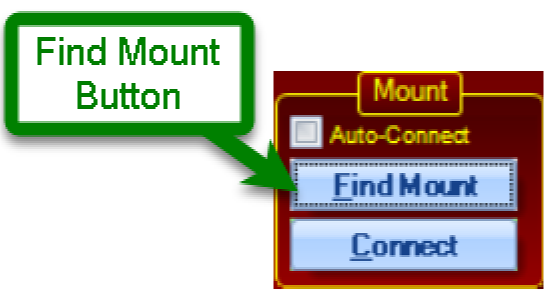
When you put APCC in serial port mode, the Primary and Backup COM Port drop down list boxes will become available and the Hostname/IP Address field will become disabled.

The USB connection on the GTOCP4/GTOCP5 is treated as a normal serial port as far as APCC or the AP V2 driver is concerned. If you are connecting with USB, simply follow the instructions for COM ports below as if it were a serial port. Please note that you MUST first install the FTDI Driver onto your computer for USB to operate properly. Note also that the FTDI USB to serial devices are all uniquely serialized. Each one will be assigned its own COM port that will be remembered through power-cycles.

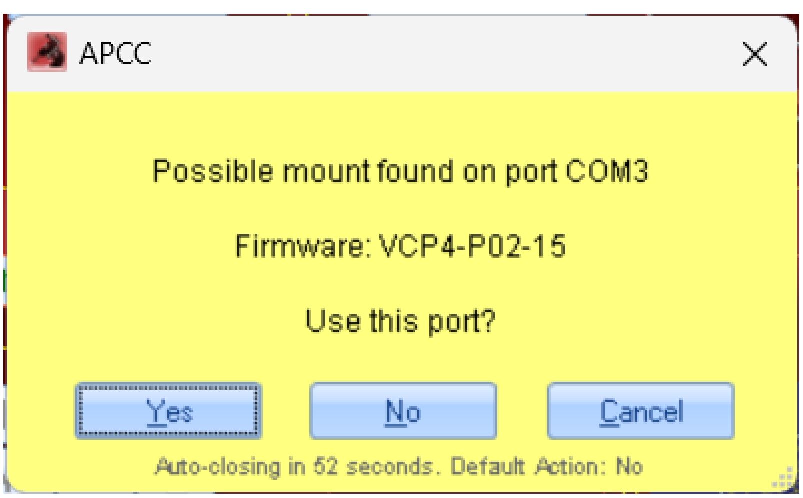
Please check the Astro-Physics Software Updates page for links to the latest FTDI drivers

Primary COM Port: The list of serial ports that were detected on the computer will be displayed in this drop down list box. Select the default COM port that APCC will use when the *Connect to Port* button is pressed.

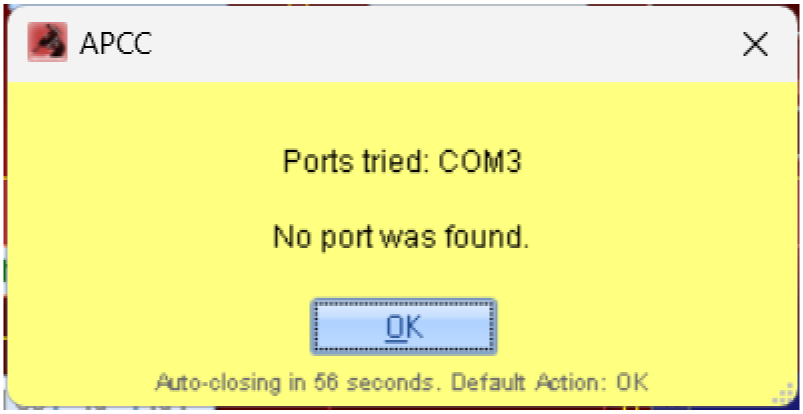
Find Mount: If you aren't sure of the mount's COM port number, you can also click the Find Mount button which will scan your serial (COM) ports.



It will scan your serial ports and if it finds a mount it will prompt if you wish to use the found COM port:



You can choose No to continue searching other ports (for example, if you have multiple mounts connected to the same computer). If it exhausts all ports and does not find a mount, it will report the COM ports it tried.



At this point you will need to investigate the physical mount connection (USB cable) and/or confirm the proper FTDI drivers are installed.

Note for GTOCP3 users: Be sure that your serial cable is connected to the *top RS-232 port on the GTOCP3 control box.*

GTOCP4/5 users: You do not need to show any preference between the top, bottom and USB ports. All should perform equally well.

Backup COM Port: If you choose to, you can select a secondary COM port for APCC to try if the primary COM port has a problem for any reason. To use this feature you will need to use both ports on the control box and will need a second USB/serial port converter. This adds an extra layer of reliability in case the primary USB/serial port converter fails. The backup port will be the bottom COM port of the GTOCP3 control box. Ideally, this should be a physically separate serial port from the primary port. If you simply use another port on a single multi-port USB to serial converter, and the converter or USB connection fails, you will lose both ports and gain nothing. If you use a second USB to serial converter that is attached to a different USB port on the computer, you are much more likely to survive a COMs problem.

Timeout: Here you can set the timeout in milliseconds for responses from the mount. In Ethernet or WiFi mode, the ideal timeout can be quite variable depending on the rest of your system. We suggest starting out at 50 ms for cabled Ethernet connections, and try 100 - 200 ms for WiFi networks. For COM ports - whether serial or USB, usually 100 or 200 ms is good enough. However, sometimes it may be necessary to increase this value to 300, 400 or even 500 ms. (Note the difference between this recommended setting and the longer recommendation for the AP V2 ASCOM Driver when it is used through APCC's Virtual Ports.)

UDP or TCP (LAN or WiFi)

UDP or TCP?

UDP LAN / WiFi (GTOCP4/GTOCP5 Only): UDP is a lightweight connectionless protocol that usually will be the best choice when connected to the CP4 with a reliable hard-wired connection. It can also be used for WiFi connections but the UDP protocol does not guarantee delivery of packets. APCC tries to resend a command one time if it gets no response, then it will report an error. To check the error count click the "Comm Events" button in APCC' status bar. You can only click this button if there are errors.

Note that when this option is selected the two COM Port's drop-down boxes will become inactive, and the Hostname/IP Address box will become active. The Hostname/IP Address box is not a drop-down box, but requires the entry of either the appropriate Hostname or IP address. It is always preferable to use the true IP address, but it is generally easier to use the Hostname. Clicking the ***Find Mount button*** will broadcast a request out to your local network. Any GTOCP4/GTOCP5 that gets the broadcast should and respond.

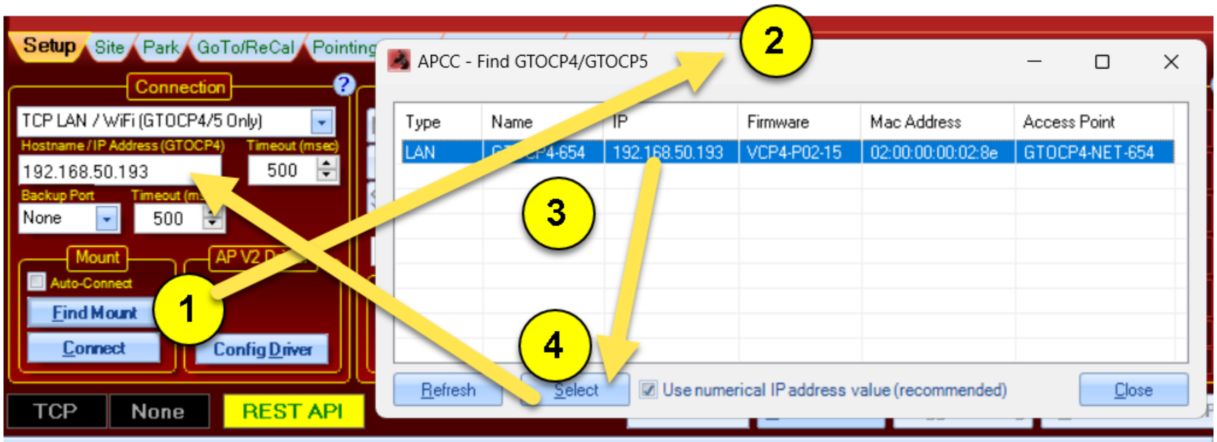
TCP LAN / WiFi (GTOCP4/GTOCP5 Only): TCP is a more robust connection-oriented protocol. It has considerably more overhead than UDP both in system and network resources but it is generally more reliable than UDP. It can be used for both wired and WiFi connections. In general it is better to use the lighter weight UDP protocol unless you start to see a considerable number of errors.

Note that when one of these options are selected the Hostname/IP Address box will become active and the two COM Port's drop-down boxes will become inactive. The Hostname/IP Address box is not a drop-down box, but requires the entry of either the appropriate Hostname or IP address. It is always preferable to use the true IP address, but the Hostname can also be used as an alternative. Clicking the ***Find Mount button*** will broadcast a request out to your local network. Any GTOCP4/GTOCP5 that gets the broadcast should and respond and be listed.

Note that a GTO controller's wired Ethernet Hostname and a wireless WiFi Hostname will be different from each other. In general, unless you have changed them the names will all end in the numeric portion of the GTOCP4/GTOCP5 serial number (without the leading zeros if there are any). For example, the control box with serial number: CP4-0456 would have a cabled Ethernet Hostname of: GTOCP4_456. The WiFi Hostname would be GTO_WIFI_456.

IP addresses can be obtained easily from your GTOCP4/5's main web page. Use the handy Find Mounts utility app (look under Utilities and download Find Mounts) to find the relevant information and open the GTOCP4/5's internal web page. Note that network-based IP addresses are subject to changes, whereas the peer-to-peer and access point IP addresses remain unchanged unless you change them.

Find GTOCP4/5 button: Clicking the Find Mount button will open a new window and send out a broadcast to find a GTOCP4/GTOCP5 on the LAN (or WiFi).



Use the following steps as indicated in the picture above:

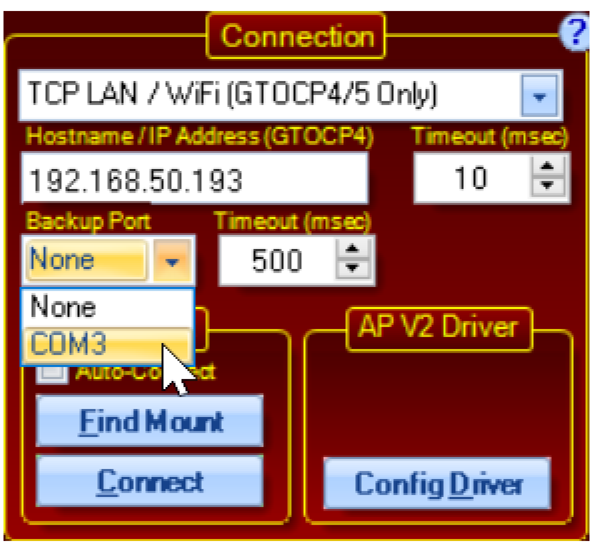
1) Click the Find Mount Button

2) The Find GTOCP4/GTOCP5 window will open and report and control boxes that are found.

3) Click the entry for the mount that you want to connect to. This will enable the ***Select*** button**.**

4) Click the ***Select*** button. This will close the Find Mount feature and will copy the mount connection information into the Hostname/IP address field

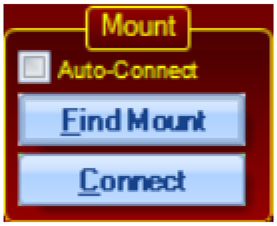
Backup COM Port: You can also optionally setup a backup COM port for APCC to try if your TCP or UDP has a problem for any reason.This adds an extra layer of reliability in case the primary ethernet connection fails. To use this feature you will need to have a USB cable connected to your mount You can specify the backup port in the same way you specify a Serial USB connection, as described above.



Mount Sub-Group Box

This group-box has options for finding mounts and controlling the connections.

"Find Mount" button is described in the context of Serial (USB) and Connection Group Box connection descriptions above



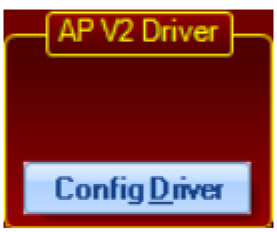
Auto-Connect - When this is checked, APCC will attempt to connect to the mount as a part of its start-up sequence. **If you have this box checked, you will want to have an overall start-up procedure that powers the mount ON before starting APCC**. This is common practice and is recommended in permanent and remote systems. Once connected, APCC will proceed through the initialization procedure you have previously defined.

When Auto-Connect option is enabled, APCC also attempts to auto re-connect to the mount if the connection is lost. It's a valuable option to enable when doing fully automated and/or remote imaging.

Connect/Disconnect Button - Click to connect APCC to the mount. The button will turn green to indicate successful connection. Click to Disconnect to disconnect from the mount, and the button will return to a blue color.

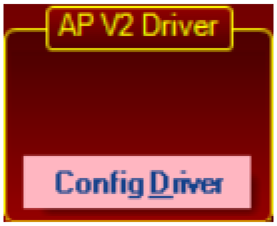
AP V2 Driver Sub-Group Box

This group box has one option: Config Driver. Pressing this button will configure the ASCOM driver with the correct settings for connecting to the mount via APCC.



Config Driver - When this is pressed, APCC will try a one-time configuration of the relevant sections of the AP V2 Driver's settings in order for the driver to connect properly.

If APCC determines the settings in the ASCOM V2 driver need to be updated, this button will display in a pink color. This indicates you should press this button and APCC will try to update the ASCOM settings. If it succeeds the button will turn back to blue, indicating it successfully updated the ASCOM driver connection settings



When the Config Driver button is Pink, this indicates the ASCOM driver and APCC settings are not consistent, and needs to be updated. Pressing this button resolves this issue.

ASCOM Connection to APCC via Client Applications

Once the ASCOM Driver connection details are finished, connection from ASCOM to APCC now is initiated by the client application (such as NINA, SGP, AP Jog Utility, etc.).

When the client application connects to the mount, it will launch the ASCOM driver, which then will connect to APCC. This process happens behind the scenes so it should just appear that the mount connects. "Pre Connecting" via ASCOM V2 driver is no longer the preferred approach and is no longer supported in this version.

6.2 Move Scope Group Box

Controls to move the mount are in this group box. You can select the move button rate and also swap North-South and East-West directions. When you press and hold a button, RA Delta will display the approximate movement of the mount. When you let go of the button, the calculations will continue to be updated as polls to the mount are completed.

N/S/E/W/NE/NW/SE/SW: When pressed, the mount will move in the direction that the button indicates. The rate of movement will be defined in the *Move Button Rate* drop-down combo box.

STOP: Stops any mount movement initiated by a button press. This might be necessary if the serial port command gets corrupted or doesn't make it to the control box. Usually tapping one of the direction buttons will also stop movement because a quit move command is always sent when a button is released.

Button Rate: Select the rate that will be applied when you press one of the directional move buttons. Note the available button rates will change based on the type of mount connected (auto-fill available button rates requires version P02-01 or later)..

Swap N/S: Reverses the direction of North and South button commands. This is useful to adjust the action of the button pushes to make them more intuitive and instinctual. For instance, if the star moves down when you push the “N” button, click on the *Swap N/S* button. Now, the star will move up when you push the "N" button, which will make subsequent adjustments easier. You can make the same adjustment with the “E” and “W” buttons. When properly set up, the direction buttons will cause the object to move according to your orientation.

Swap E/W: Reverses the direction of the East and West button commands. Refer to the *Swap N/S* section above.

IMPORTANT NOTE:

The background color of **Swap N/S** and/or **Swap E/W** will turn yellow if APCC detects that the mount has the direction reversed. When reversed this can cause autoguider calibration failures so it should **NOT** be left this way if you are attempting to do imaging.

Auto-fix N/S/E/W Movements: When checked, APCC will monitor and correct the mount direction if reversed. If you plan to autoguide through the AP V2 ASCOM Driver it is recommended that you keep this checked. It is important to understand that the direction buttons can NOT be swapped if this box is checked. This includes attempts to swap directions from the AP V2 ASCOM Driver and the keypad. If you wish to do some manual movements with the direction swaps in effect, temporarily uncheck this box, and then recheck it when you are ready to start imaging. It is important for calibration and guiding to all be done with the direction moves in their normal state.

RA Delta/Dec Delta: Shows the approximate amount of movement since the start of the last button press.

Clear: Clears the RA and DEC Delta values.

Plate Solve, Autocenter: This button is used after a GoTo when your target is not centered in the eyepiece or sensor. Clicking it starts a three-step process: APPM is launched and an image is taken where your telescope is pointed. and then plate solved. Your telescope position is then Sync/Recal to update the pointing position, and finally an additional GoTo is sent to your mount to center your telescope on the original target. A few things must happen for this feature to work correctly: The mount must be connected and unparked, a GoTo must have been previously done, your camera must be reasonably focused, and APPM must be correctly configured and be able to successfully plate solve. For more details on APPM see the section on APPM - The Astro-Physics Point Mapper

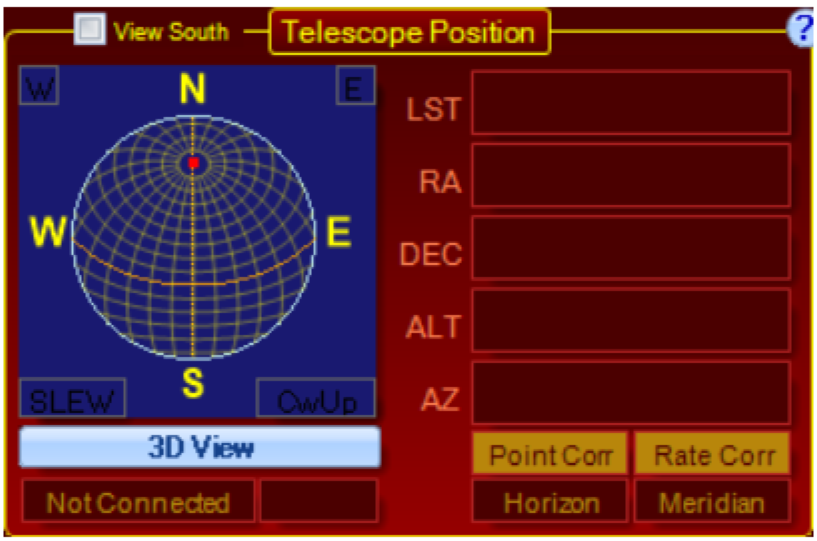
Slew Rate: Displays current Slew Rate setting

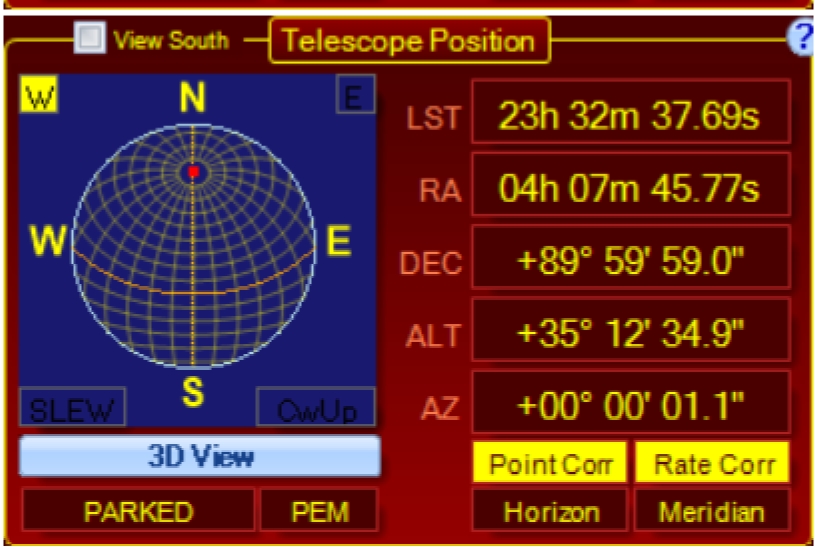
Pier Flip Button: This button will initiate a pier flip under the following conditions:

- If the scope has crossed the meridian, the button will flip it by simply issuing a GoTo slew command to the current coordinates.
- If the scope has not yet reached the meridian, but its coordinates are within the "safe zone" of the meridian limits, a meridian offset will be set to allow the flip, followed by the GoTo slew command to the current coordinates.
- If the scope has not yet reached the meridian, and it is NOT in a safe zone vis-a-vis the meridian limits, no flip slew will occur.

6.3 Telescope Position Group Box

This box shows all of the position information for the mount.





When APCC is connected to the mount, the scope's position is shown by a red square in the virtual Sky window view. The pier side is shown in the upper left and right with either an *E* or *W* within a yellow box.

View South: When enabled this option flips the orientation of the sphere so South is at the top and East is on the left. This is primarily a visual aid for customers in the Southern Hemisphere.

The 3-D telescope view can be opened by clicking the ***3D View*** button**.**

When slewing, the word ***SLEW*** will flash in the bottom left of this window.

When the mount's counterweight is "up", the word ***CWUP*** will show in the bottom right of this window.

LST: This shows the current local sidereal time. Clicking the *LST* text will swap to show the hour angle *(HA)*, which is the time distance of the scope from the Meridian. You may have noticed that there is no way to enter your clock time. APCC uses your computer time when sending time information to the mount. You may wish to utilize time server software to keep your computer time as accurate as possible, if that is important to your operation.

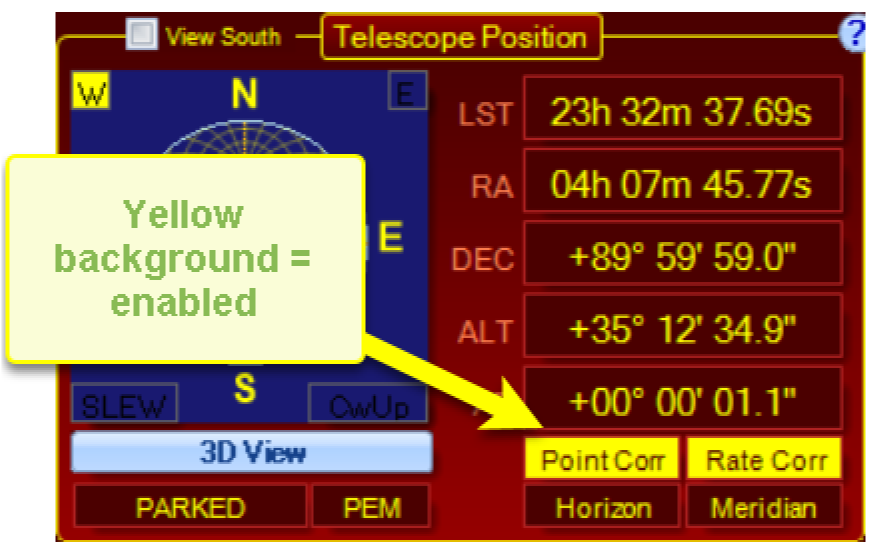
RA: This shows the right ascension position of the mount.

DEC: This shows declination position of the mount.

ALT: This shows the altitude position of the mount.

AZ: This shows the azimuth position of the mount.

The following four indicators have special features:



Point Corr: (APCC Pro only)

- This shows if pointing correction is enabled. When enabled the indicator has a yellow background and red text.
- Hovering the mouse over the indicator will show more details.
- Clicking the indicator once will switch APCC to the **Pointing Model** tab.

- Double clicking the indicator toggles Pointing correction between enabled and disabled.

Rate Corr: (APCC Pro only)

- This shows if tracking rate correction is enabled. When enabled the indicator has a yellow background and red text.
- Hovering the mouse over the indicator will show more details.
- Clicking the indicator once will switch APCC to the **Pointing Model** tab.
- Double clicking the indicator toggles Tracking Rate correction between enabled and disabled.

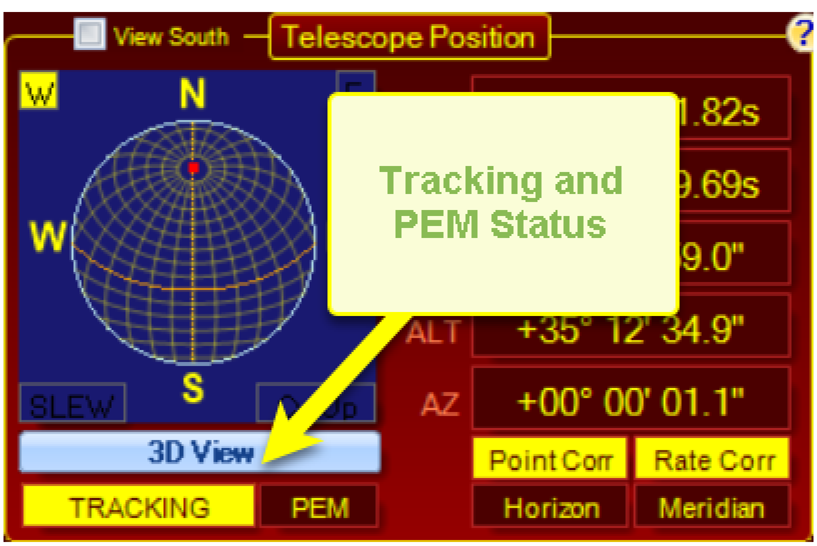
Horizon:

- This shows if horizon limits is enabled. When enabled the indicator has a yellow background and red text.
- Hovering the mouse over the indicator will show more details.
- Clicking the indicator once will switch APCC to the **Horizon Limits** tab.
- Double clicking the indicator toggles Horizon Limits between enabled and disabled.

Meridian:

- This shows if meridian limits are enabled. When enabled the indicator has a yellow background and red text.
- Hovering the mouse over the indicator will show more details.
- Clicking the indicator once will switch APCC to the **Meridian Limits** tab.
- Double clicking the indicator toggles Meridian Limits between enabled and disabled.

Tracking/PEM Indicators



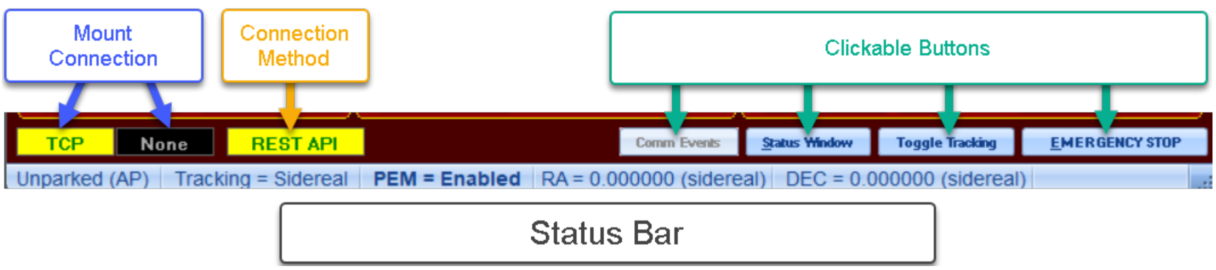
PARKED: Indicates the tracking state (e.g. Parked, Tracking, Stopped, etc.)

PEM: This shows if PEM is enabled. When enabled the indicator has a yellow background and red text.

NOTE: This box might also read "**ENC"** (encoder) if the mount has encoders and the RA encoder is enabled.

6.4 Status Bar and Button/Indicator Bar

The Status Bar, and the Button / Indicator Bar are always visible at the very bottom of the main window.



The lower portion of the Status Bar (shown in blue color above) provides the following information:

- **Park State:** Valid states include Unparked, Parked, Parking, and Unparked (AP). The last state indicates that the mount will auto-park if the mount loses connection with APCC for any reason (e.g. the computer crashes).

  Note: double-clicking the park state field will toggle the parked state of the mount. So if the mount is parked, double clicking will unpark the mount. Double clicking again will park the mount at its current position (which might not be the configured parked position on the Park tab).

- **RA Tracking State:** Valid states include Stopped, Sidereal, Lunar, Solar, and Custom.

  Note: double-clicking the RA tracking state field will toggle the tracking state of the mount.

- **PEM State:** Valid states include On, Off, Recording, Encoder

- **RA Tracking Rate State:** rate in arc seconds per second offset from sidereal rate. There will only be values here if you have set a custom rate, or are set to the Lunar or Solar rate. Otherwise, the rate will show as zeros if you are set to sidereal.

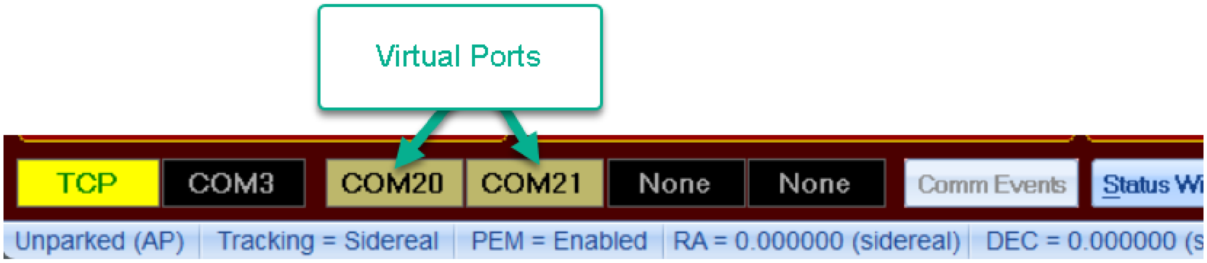
- **Dec Tracking Rate State:** The rate in arc seconds per second. There will only be values here if you have set a custom rate. Otherwise, the rate will show as zeros.

All of the above values are polled from the mount every few seconds.

The Button / Indicator Bar Shows summary connection information and provides 4 buttons with special functions.

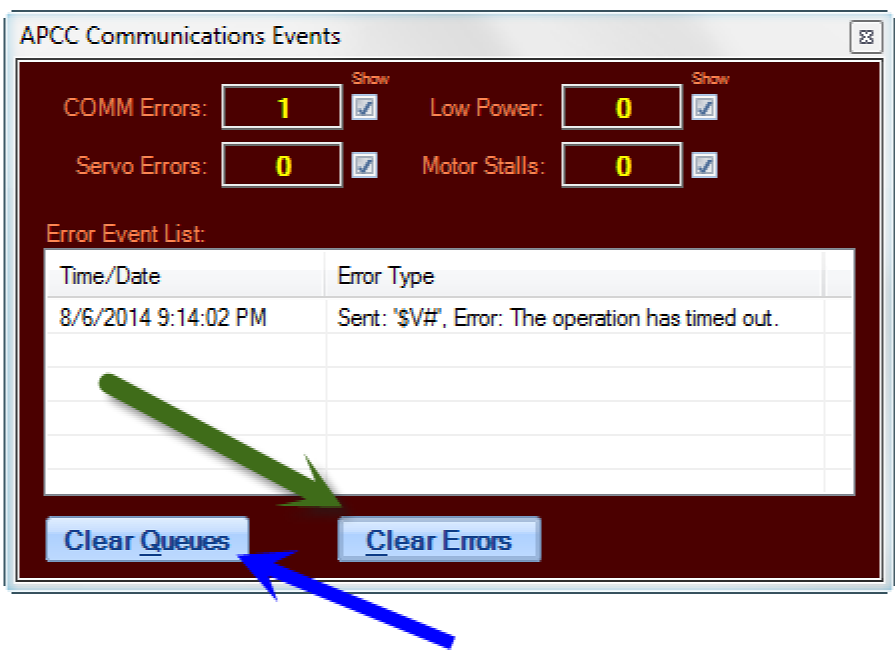
- **Mount Connection Indicators:** There are two indicators to show the current connection status. The first indicator will show one of three values depending on how APCC is connected to your mount: the COM port number (if serial), the word TCP to indicate a TCP connection through Ethernet or WiFi, or the word UDP to indicate a UDP connection through Ethernet or WiFi. The second indicator shows the number of the Backup COM port if one has been defined (it will be blank if no backup port has been defined). A Yellow indicator means a good connection. Black indicates no connection. A problem connection will be pink and may flash. Please refer to the Connection Group Box section for more information.

- **Virtual Port Indicators:** If you are using Virtual Ports instead of the REST API, the ports numbers and status are indicated here. Virtual Ports are described in detail in the Virtual Ports Tab section.



- **COMM Events Button:** This button is enabled when there have been communications errors like timeouts, or servo errors like low power or motor stall. Clicking the button will open a viewer to the list of errors. For the 1100, 1600, and 3600 mounts a $V# command timeout might get registered as a COM event. This is normal and it can be ignored. That command is simply being sent to try to determine if the AE or ELS box is present. This button is disabled if there are no communications errors.

NOTE: If timeouts regularly occur, try increasing the appropriate timeout value in the Connection group box.



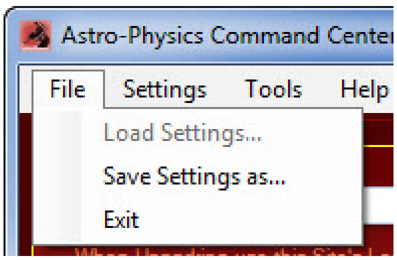
Click the **Clear Errors** button to clear the screen. When you close the window, the **COM Events** button will be grayed out again. The **Clear Queues** button may be needed if you have an Ethernet or Wifi problem that results in a large number of timeouts.

- **Status Window button:** Opens the APCC Status View Window

- **Toggle Tracking button:** Quickly toggle back and forth between sidereal tracking and stop tracking.
- **Emergency Stop:** Stops mount motion and opens the Emergency Stop Window

6.5 Menus

6.5.1 File Menu



Load Settings: This will open a dialog window from which you can select a previously saved settings file. This menu item is only available (i.e. active) when APCC is not connected to the mount.

Save Settings as: This will open a dialog window from which you can select a file name to which settings will be saved. All Initialize Mount settings will be saved. Refer to the Initialization Window for more information regarding these settings. In addition, the file names of the current set of Horizon and Meridian Limits will be saved for automatic loading into APCC. This makes it much more convenient to use APCC with several favorite locations and setups that may have different limit settings.

Exit: this will exit APCC.

6.5.2 Settings Menu

Edit ASCOM Driver Settings: This will open the ASCOM V2 Driver's Telescope Setup Window. It provides a convenient way to set the driver up to work optimally with the APCC. In particular, the COM port details. For instance, checking the APCC Virtual Port checkbox so that the ASCOM driver opens automatically when you connect to the port using APCC. Note that the location, mount type, park and initialization settings in the ASCOM V2 driver are independent of the settings in APCC. You will create and adjust these settings within APCC. Refer to the ASCOM manual for additional settings that are useful when using APCC.

Edit Initialize Mount Settings: This will allow you to edit the mount initialization settings. These are the setting that APCC will automatically apply to th emount when it detects RA=0 and Dec=90.

Initialize Mount: This will open the initialize mount dialog window, which will allow you to reinitialize the mount. **Note:** The mount can only be initialized after a power cycle when RA=0 and Dec=90.Refer to Initialization/Edit Initialization Window for additional information.

Manage Sites: This will open the Manage Sites dialog window, which will allow you to add new sites, or modify existing sites.

Environmental Settings: Allows you to select an ASCOM ObservingConditions driver, or a THUM device. Environmental values can be used for refraction calculations.

Safety Monitor Settings: Allows you to select an ASCOM Safety Monitor driver. Safety monitors can be used to report unsafe conditions, such as rain or clouds.

Advanced Settings: This will open the Advanced Settings Window. Choosing this is identical to pressing the Advanced Settings Button in the Program Operation Group Box. See Setup Tab => Advanced Settings for more information.

Resize to original Window Size: This will resize APCC main window to its default size. Please refer to Known Issues for additional information regarding Windows XP and Vista.

Save Window Positions: When this is selected, APCC's window positions will be saved when APCC exits. The next time APCC starts the Windows will open in the same position that they were last closed in. If you are using Windows XP (and possibly Vista, though this has not been tested to date) and have resized the window, the screen may not load correctly. Please refer to Known Issues for additional information.

IMPORTANT NOTE:

With successive versions of APCC (or any software), the various associated windows can change in terms of their content and arrangements. If the options regarding Window Size and Window Positions are selected when you install the latest version, you may need to turn the window options off, and then on again after installation to reset properly to the new appropriate window dimensions.

Close Main Window when opening Status Window: As the name implies, having this checked will cause the main window to close any time the Status Window is opened.

6.5.2.1 Environmental Settings

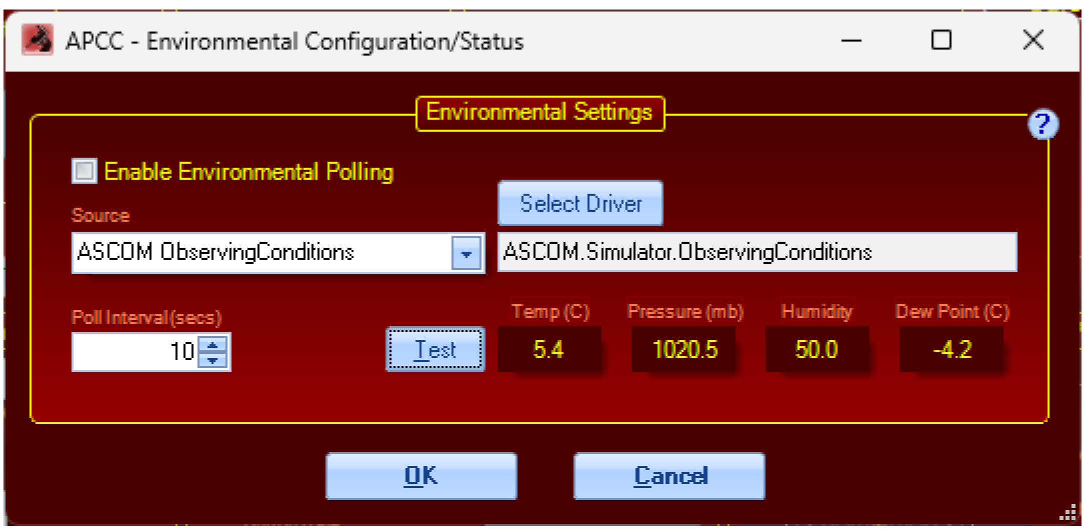
Using Environmental Settings within APCC can improve your pointing and tracking accuracy when doing things like sky modeling and refraction calculations.

APCC's Environmental polling uses the ASCOM standard ObservingConditions hub, so it can work with THUM devices, OpenWeatherMap, or any device or service that provides an ASCOM ObservingConditions driver. This includes:

- Pegasus Astro Uranus Meteo
- Pegasus Astro PowerBox (with environmental sensor)
- MGBox V2

If you are interesting in experimenting with Environmental Settings but don't want to invest in a dedicated monitor, you can try OpenWeatherMap which is a no cost source of weather data. Details on how to do this are in the following knowledgebase article: https://astro-physics.bolddesk.com/kb/article/61/how-to-set-your-location-for-environmental-variables-in-openweathermap

Open the Environmental Settings to configure the



Enable Environmental Polling - turns on/off environmental polling

Source - you can choose THUM Device or ASCOM ObservingConditions. The source will need to be properly installed and configured prior to connecting in APCC.

Poll interval (secs) - how often is the device polled for updated conditions. Generally the default value of 10 seconds is sufficient for most situations.

Select Driver - If you chose ASCOM ObservingConditions, you need to select the specific device/driver.

Test - once your device is properly configured, you can click Test button to test the connection. If it works properly, you will see values for one or more of the environmental variables (please note your device may not support all variables. For example, pressure is often omitted from some results). Also note with MGBox V2 if it returns -273c for temperature, that indicates the device is not yet initialized, or it is not working properly. Consult the product documentation for possible fixes.

Once your Environmental Settings are correctly configured, you can enable environmental polling in APPM's general information tab to further refine your sky modeling results.

6.5.2.2 Safety Monitor Settings

NOTE: This feature requires a license dated 9/1/2022 or later:

Safety Monitor enables APCC to poll an external ASCOM-compliant safety monitor . If Safety Monitor the driver returns that it is "unsafe" one of four actions will happen:

Allows APCC to poll an external ASCOM-compliant safety monitor. If Safety Monitor the driver returns that it is "unsafe" one of four actions will happen:

Allows APCC to poll an external ASCOM-compliant safety monitor. If Safety Monitor the driver returns that it is "unsafe" one of four user-configurable actions will happen:

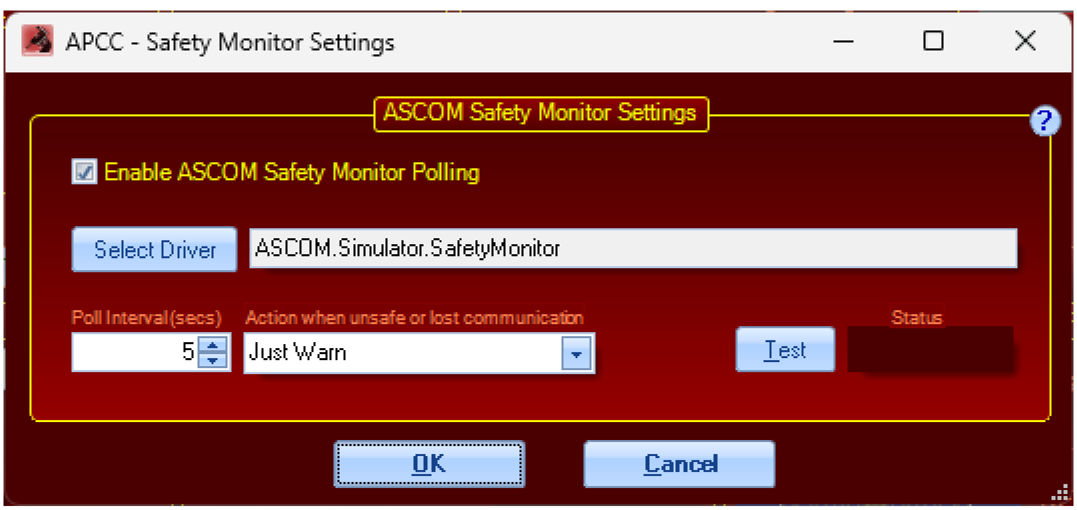
1. Park Mount to the park position defined in APCC's setup tab.

2. Send the mount to the Home position (or Park position if Home is not defined).

3. Stops mount tracking.

4. Just warn that the conditions are unsafe.

Choose Safety Monitor Settings... from the Settings Menu:



Enable ASCOM safety monitor polling - enables/disables safety monitor polling.

Select Driver - Clicking this brings up a standard ASCOM choose for selecting your desired Safety Monitor. The safety monitor must be installed and properly configured prior to selecting the option here. If your desired safety monitor is not available in the chooser pulldown menu, please consult the safety monitor documentation for installing its ASCOM driver.

Poll interval (secs) - how often is the device polled for updated conditions. Generally the default value of 5 seconds is sufficient for most situations.

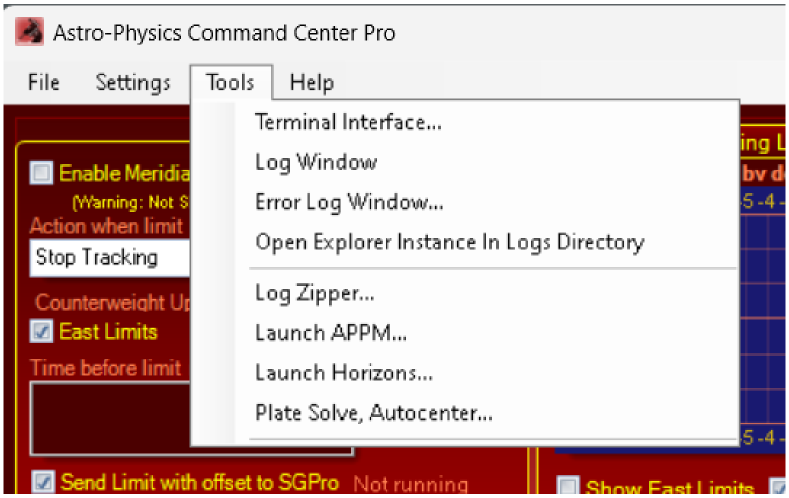
Action when unsafe or lost communication - This setting determines what happens when the safety monitor is enabled and reports unsafe conditions or communications is lost with the safety monitor. Remember the safety monitor is considered a critical point of failure to protect against events that may damage equipment (such as rain).

- Park Mount - will park the mount at the park position defined in APCC.
- Home Mount - will send the mount to its defined Home position (or park the mount if the Home position is not defined).
- Stop Tracking - will stop the mount tracking and leave it at its current position.
- Just Warn - will display a warning on the user interface but will not impact mount tracking or parking.

Which option you choose depends on what you want to happen when unsafe conditions are detected. For example, if you have a rolloff roof observatory and need to park your mount in a specific position before closing the roof, Park Mount may be a good option. If you are conducting a sky mapping session from APPM, and want to wait for clouds to pass and then continue with your mapping run, stop tracking might be a good choice.

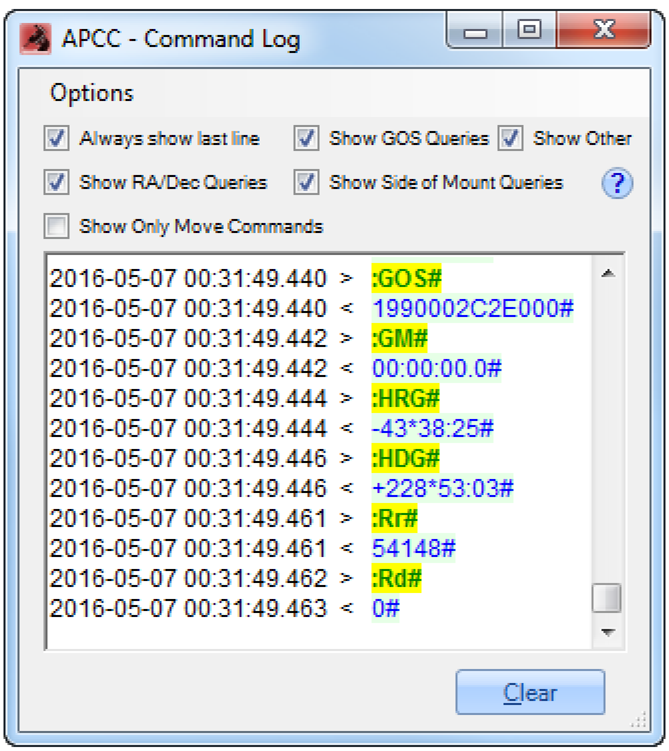
Please note if you enable safety monitor polling, it is automatically used by APPM. If you do not want safety monitor to be used by APPM, uncheck Enable in this window. **WARNING: If "Just Warn" is the selected as the action then APPM will continue even if an unsafe condition exists.**

6.5.3 Tools Menu

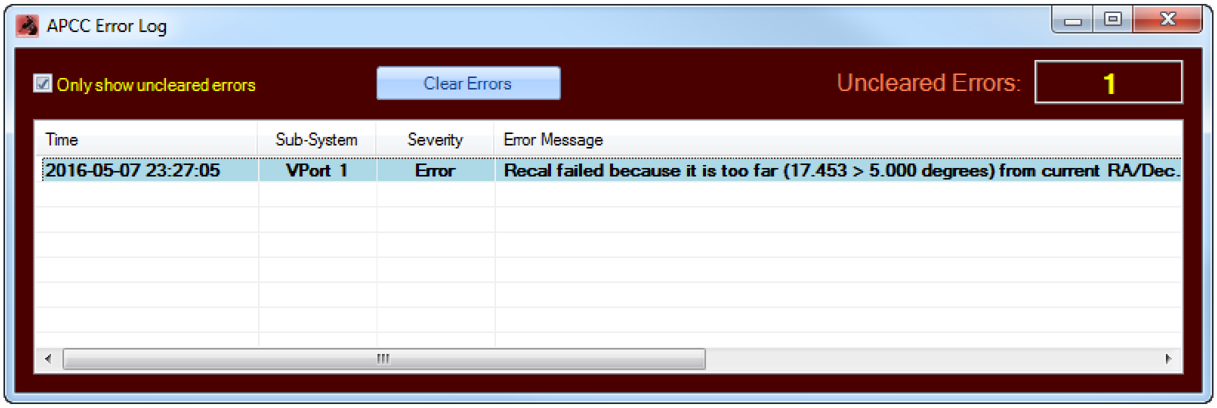


Terminal interface...: This opens the Terminal Interface window, which allows you to manually send commands directly to the mount. Please see the Terminal Interface Window section for more details. The Terminal Interface Window can also be accessed from a button on the Setup Tab.

Log window: This opens the Log window, which allows you to see the commands sent by APCC to the mount and the mount's responses. Note the following options within the window. When the mount is connected, a continual stream of commands and responses will display. Please see the Log Window section for additional information. The Log Window can also be accessed from a button on the Setup Tab.



Error Log Window...: This opens the following window: The most common error log entry will probably be from attempts at errant ReCals as shown by the log entry below. Clicking the Clear Errors button clears the window and also stops the warnings from flashing. See Advanced Settings for more.



Open Explorer Instance In Logs Directory: This opens a Windows Explorer instance with the folder set to the logs directory. This allows you to conveniently open log files should you need to. The Log Directory can also be reached from a button on the Setup Tab.

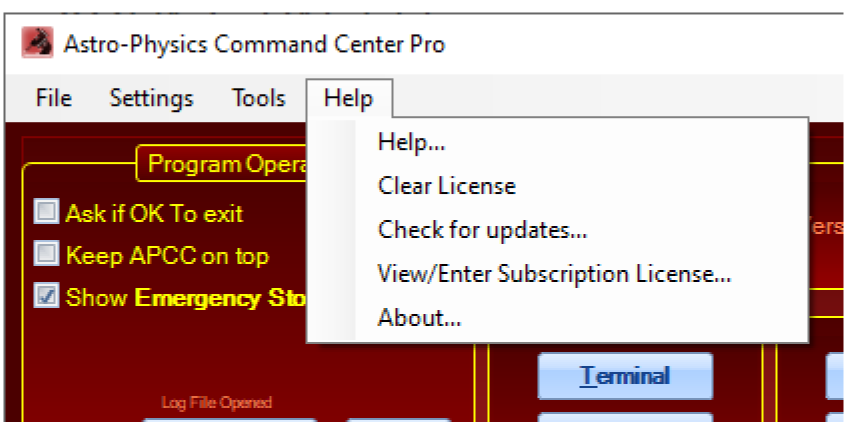
Log Zipper: This opens the Log Zipper window which allows you to package log files and configuration files in case you have a problem or software bug to report. Please see the Log Zipper Window section for more details.

Launch APPM...: If *APCC Pro* is installed this will open *APPM*, the *Astro-Physics Point Mapper* utility. If you have *APCC Standard*, an error message will appear indicating that the specified file cannot be found.

Launch Horizons...: this will open Horizons.

Platesolve, Autocenter If APCC Pro is installed this will attempt to plate solve and sync the scope/mount to its pointing position in the sky, and then issue an additional goto to center the target. Note that the option to perform a plate solve will be disabled unless the mount is unparked and tracking.

6.5.4 Help Menu



Help: This opens this Help file. You can look through the table of contents or search on a topic. Save topics that you are likely to need on a regular basis to the Favorites tab.

Clear License: Clears the license key. You might use this if you do not plan to use APCC on a particular computer again.

> Note: All of APCC's settings can be found in this folder (on Vista, Windows 7, 8 and 10):
>
> C:\ProgramData\Astro-Physics\APCC
>
> If you want to completely remove all traces of APCC you can delete the above folder and its contents.

Check for updates... If you are connected to the internet, selecting this will search for a more recent version of APCC.

View/Enter Subscription License... This opens the **APCC - Update License/Subscription** window (see here).

About: This opens the About dialog which shows the version number of APCC.

APCC - Update License/Subscription

The **APCC - Update License/Subscription** window shows features that you are entitled to with your license.

APCC's subscription policy is the following:

A) Within a major point release bug fixes and some minor improvements are free. A major point release is the starting digit. For example, 1.0 and 1.9 are part of the same major point release (1.x), but 2.0 would be a new major point release.

B) Some newly developed features will require a license date within the last year of the feature's availability. For example, if new feature X is released on August 1, 2021, then it is available to everyone with a license dated one year earlier, which would be August 1, 2020 in this example.

C) If a license date makes a feature unavailable, you can purchase a subscription renewal, which will update the license date to the current date of the purchase. This will also make available any additional features added within the next year.

In the screenshot below:

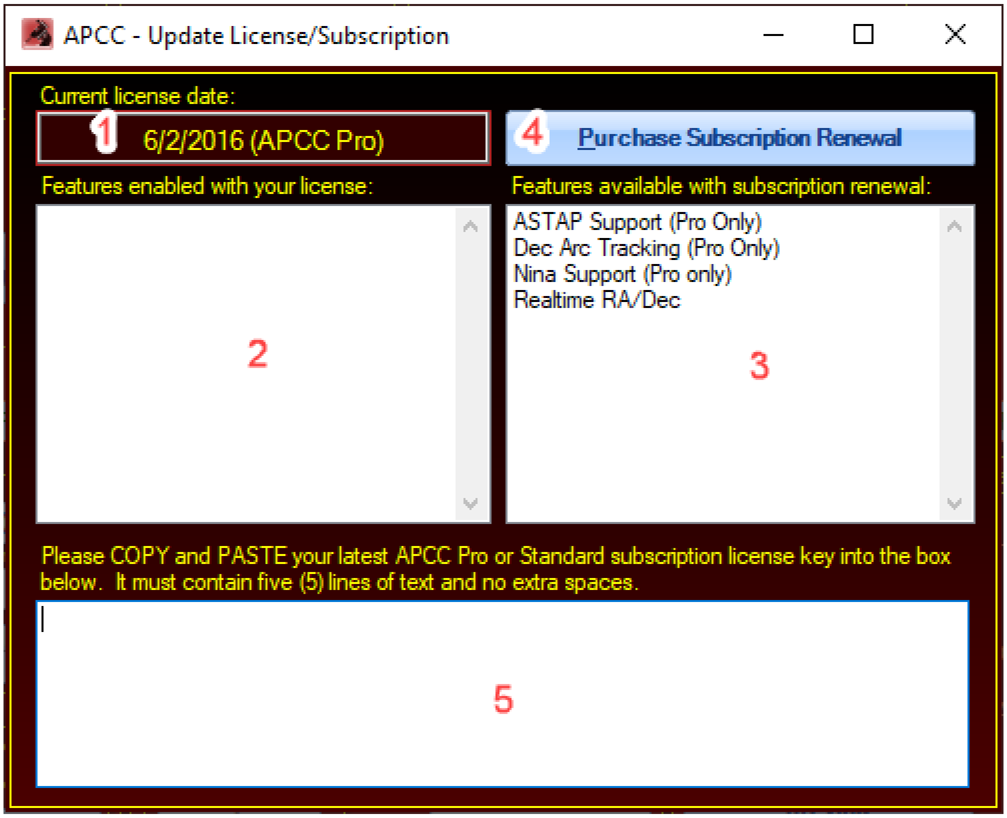
1) Shows **6/2/2016** as the current license date.

2) Shows the list of subscription features enabled in the currently installed version of APCC, which is determined by the license date. In this case, none of the features are available.

3) Shows the list of features available with a subscription renewal.

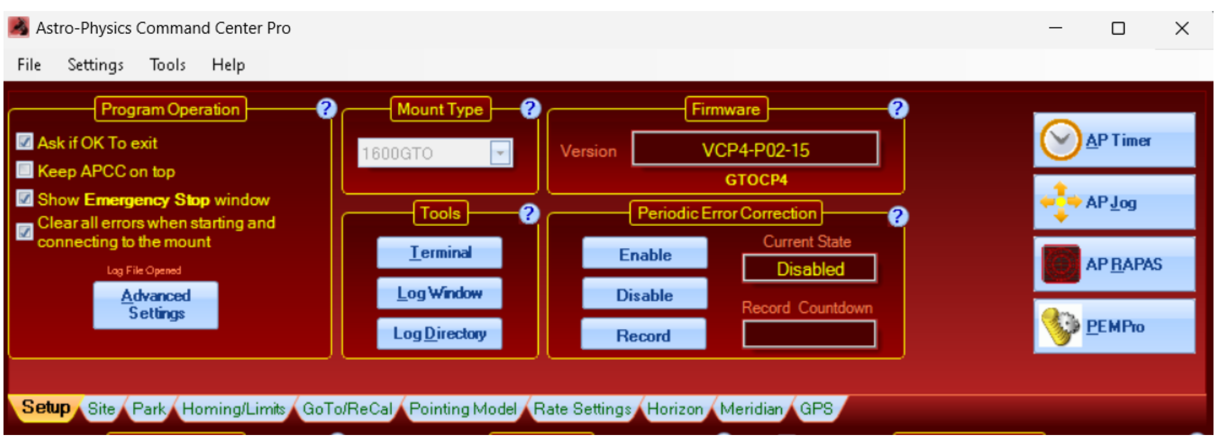
4) Brings up a browser to the page where you can purchase a subscription renewal.

5) If you have a new license, you can paste it into this box. Note that for the license to become effective, you will need to restart APCC.



6.6 Setup Tab

There are a number of group boxes on the Setup tab.: *Program Operation, Mount Type, Firmware, Tools,* and *Periodic Error Correction* or *Encoder*.



Program operation

If you change any of these settings, they are effective immediately.

Ask if OK to exit: Check this option if you want APCC to pop up a confirmation dialog before exiting. If unchecked and you exit by pressing F4 or the close window button (X), APCC will exit immediately. Note: Do NOT have this checked if you also check the Auto Shutdown box in the Advanced Setting window. Also, DO NOT check this if a script is shutting down APCC.

This form is always on top: Check this option if you always want APCC to stay on top of other windows. Note that if another window also has this property set it can be placed on top of APCC.

Show Emergency Stop Window: Check this option if you want the Emergency Stop Window to pop up when your mount is slewing. Review the Emergency Stop Window information regarding this option.

Clear all errors when starting and connecting to the mount: Check this option removes all prior Comm Events errors when you startup APCC and connect to the mount. This is helpful if you want to clear out prior errors and not have the pink reminder button.

Advanced Settings: This button: 

opens another window with some additional settings.

Mount type

Select your mount type from the drop-down box. You cannot change this setting if the mount is connected.

If you are using a mount from Parallax Instruments or Mathis Instruments with the GTOCP3 Servo Drive System, set your mount to 1200GTO. In the future, we will include a more specific setting for your mount.

Tools

The tools group box contains several buttons to quickly access a few features. You can also access these tools from the Tools Menu.

Terminal: This button opens the terminal interface window, which allows you to send commands directly to the mount. Please see the Terminal Interface Window section for more details.

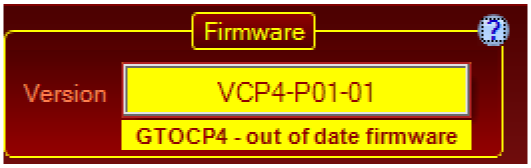
Log Window: Click this button to open the Command Log window. The log window shows commands being sent to and from the mount. Please refer to the Log Window information.

Log Directory: Clicking this button will open an instance of Windows Explorer into the directory where log files are stored. If you need to report a bug, use the Log Zipper Window.

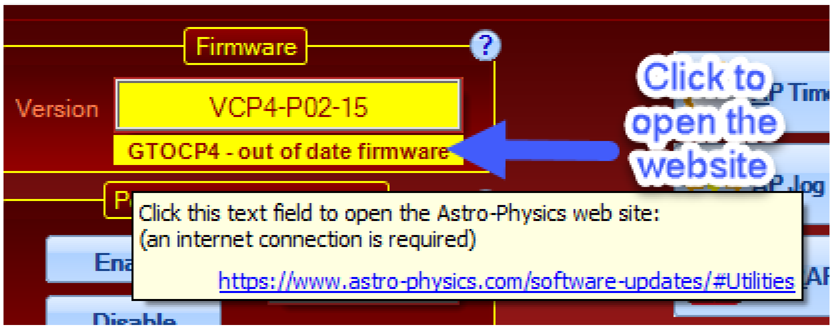
Firmware

When the mount is connected, the firmware version of the mount will display.

Occasionally APCC will require a minimum level of firmware to operate correctly with a GTOCP4 or GTOCP5. In that case the firmware version will highlight as shown in the image below. For APCC to operate best you must obtain a firmware update, which can be downloaded over the internet.



Directions can be found at this link: https://www.astro-physics.com/software-updates/#Utilities. As shown below, you can click the "out of date" field and a browser should open to the web page with instructions.



Periodic Error Correction

Astrophotography and CCD Imaging demand the highest tracking accuracy to obtain pinpoint star images throughout your photographic exposure. You do not need PEM unless you are engaged in one of these activities.

If you are not familiar with PEM (Periodic Error Memory) in the Astro-Physics GTO system, please read the PEM Recording Options section.

By default, PEM is disabled when the mount is powered on. PEM can be setup to automatically initialize each session in the Initialization Window.

Encoder

Astrophotography and CCD Imaging demand the highest tracking accuracy to obtain pinpoint star images throughout your photographic exposure. You do not need PEM unless you are engaged in one of these activities.

If you are not familiar with PEM (Periodic Error Memory) in the Astro-Physics GTO system, please read the PEM Recording Options section.

By default, PEM is disabled when the mount is powered on. PEM can be setup to automatically initialize each session in the Initialization Window.

Periodic Error Correction Group Box

Enable PEM: Enables PEM (periodic error correction). Please note that, at present, this setting does not change the status shown in the ASCOM V2 driver window. Also, the setting made in the ASCOM V2 driver does not impact APCC.

Disable PEM: Disables PEM (periodic error correction). Please note that, at present, this setting does not change the status shown in the ASCOM V2 driver window. Also, the setting made in the ASCOM V2 driver does not impact APCC.

PEM Record: Starts the mount's PEM recording feature. Please refer to this section first: *Use APCC to Record PEM*

Last Sent: The last sent command on this tab. The current PEM state is always shown in the Status Bar.

PEM Record Countdown: Shows the countdown, in seconds, after *PEM Record* is pressed. The amount of time required for the PEM cycle varies depending on the mount model and will display accordingly. Refer to the *Use APCC to Record PEM* section for instructions.

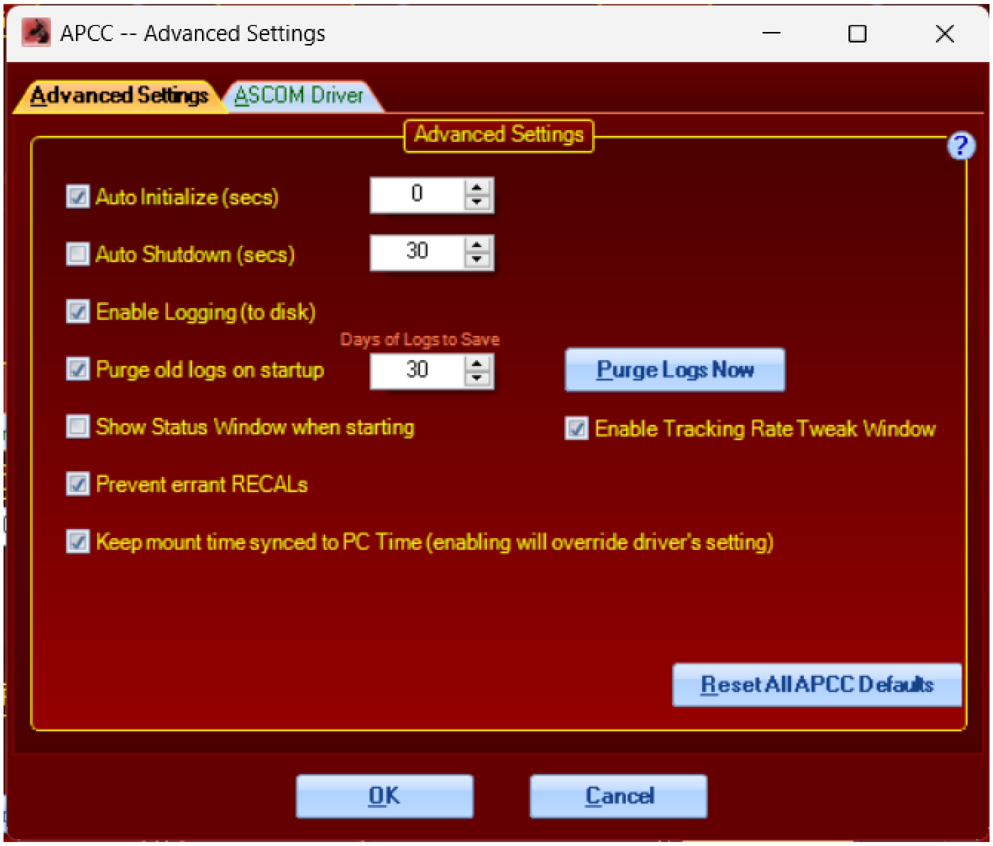
Periodic Error Correction in Mounts with Absolute Encoders

Periodic Error Correction is disabled for mounts with absolute encoders. Encoders do the job of eliminating any periodic error. Encoders are enabled by default and should never be disabled unless under the direction of Astro-Physics customer support. Encoders cannot be disabled with the Mach 2.

Buttons for Quick Access to Companion Programs

Buttons for the AP Timer, AP Jog, AP RAPAS and PEMPro (if installed on your computer) programs are located on the right-hand side of the Setup window for your convenience.

6.6.1 Advanced_Settings



Auto Initialize (secs): If you check this option and then set a value, APCC will initialize an uninitialized mount automatically. If you do not check this option, then APCC will wait for you to either tell it to commence with initialization, or else for the mount to indicate that it has already been initialized. We strongly recommend that you let APCC handle all primary control operations like initialization. In other words, we recommend that this box be checked. Some people with permanent setups will want a value of 0 or 1 second. Choose a low time value like this if you never need to change any of the initialization settings. Users who are portable or who operate hands-on may want to set the time delay higher. This gives you a chance to stop the auto-initialization to change locations or other parameters. The Initialization Window was discussed earlier in these instructions.

Remember that the mount remains initialized until it is power cycled. If you change this setting, power cycle to see your changes take effect.

Auto Shutdown: Checking this option will cause APCC to shut down after the last ASCOM driver client disconnects. It allows easier automation by removing the requirement that you manually close APCC at the end of your observing session. Hint: You may wish to consider a longer value for this feature, depending on your circumstances. For people who occasionally switch software, it is a good idea to give a time cushion so that APCC doesn't shut down before you are up and running with the next client program. Some automated remote observers, on the other hand, may want the auto-shutdown to occur immediately to facilitate full system shutdown. Be sure to coordinate this with this checkbox: Ask if OK To exit.

Enable Logging (to disk): Check this option if you want to enable logging to disk. The resulting log file will be saved to your hard drive. It is not possible to uncheck the box at this time. We want to assure that log files are created so that we can better assist you if you encounter any issues. Refer to Log Window for further information.

Purge old logs on startup/Days of Logs to Save: When this option is enabled, Log files that are older than the "days of Logs to Save" will be deleted from disk. Under normal operating conditions, this is a good option to enable to avoid large numbers of log files that can take up disk space.

Show Status Window when starting: If this option is checked, when APCC starts, the Status Window instead of the APCC's main window will display.

Prevent errant RECALs: The same basic logic that allows non-encoder mounts to have home and limits also provides a means of avoiding another common user error. We have all mistakenly clicked on the wrong object in a planetarium program and then asked for a ReCal on that object. When this box is checked, APCC will compare the requested ReCal coordinates to the mount's mechanical position and abort the ReCal. Several things then happen:

- An entry will be made in the APCC Error Log. See the Tools Menu section for more information.
- The Virtual Sky window view in the Telescope Position group box of the Main Window will start to flash between normal blue background and bright red background.
- A "View Error" button will also appear on the Virtual Sky window that will open the APCC Error Log.
- The 3D Scope Window - if open - will also flash the alternating warning red background.
- To restore normal appearance and get rid of the warning flashes, click the Clear Errors button on the APCC ERror Log.

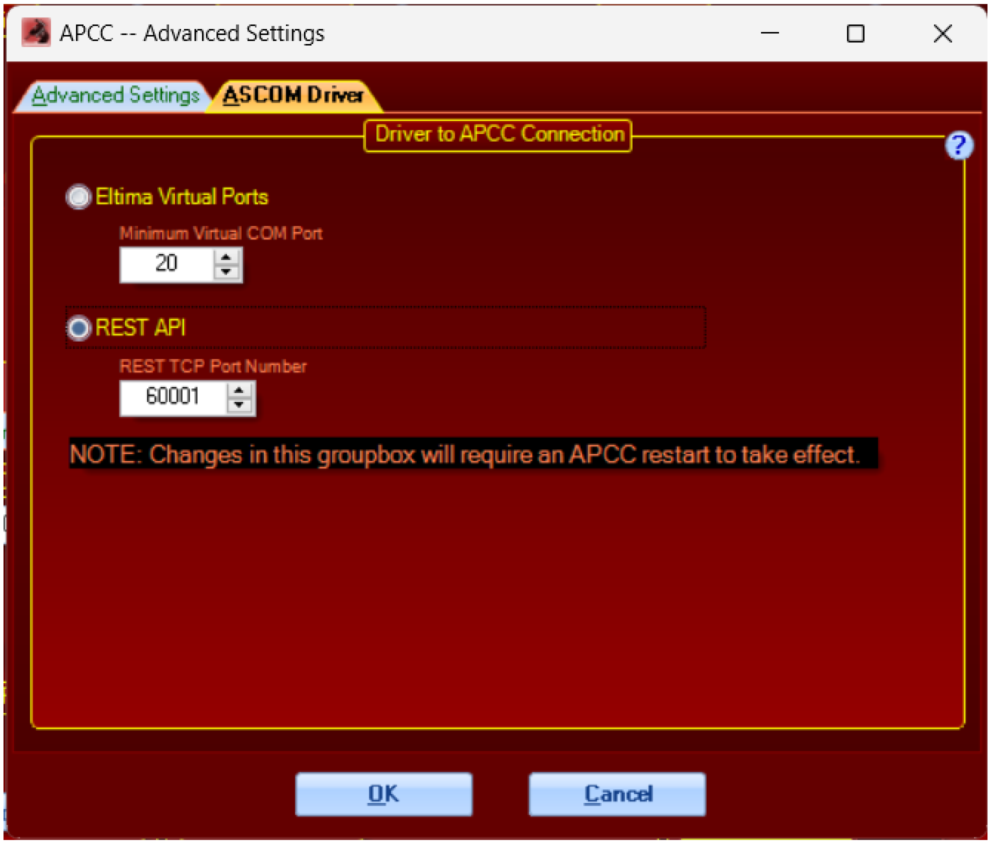
Enable Tracking Rate Tweak Window: (Pro version only) This feature allows the user to access a small window from the Pointing Model Tab that allows tweaking of the model's calculated tracking rates if minor adjustment is needed. This feature should only be used by the most advanced users.

Keep mount time synced to PC Time (enabling will override driver's settings) The default is checked. This option takes time maintenance functions away from the driver and gives them to APCC. It makes time keeping much more efficient since it is APCC that is in direct communication with the mount.

Reset All APCC Defaults Button: When this button is pressed, all APCC settings will revert to standard default application settings. This is helpful when you need to "start fresh" from a known settings, or you are troubleshooting settings and need to start over.

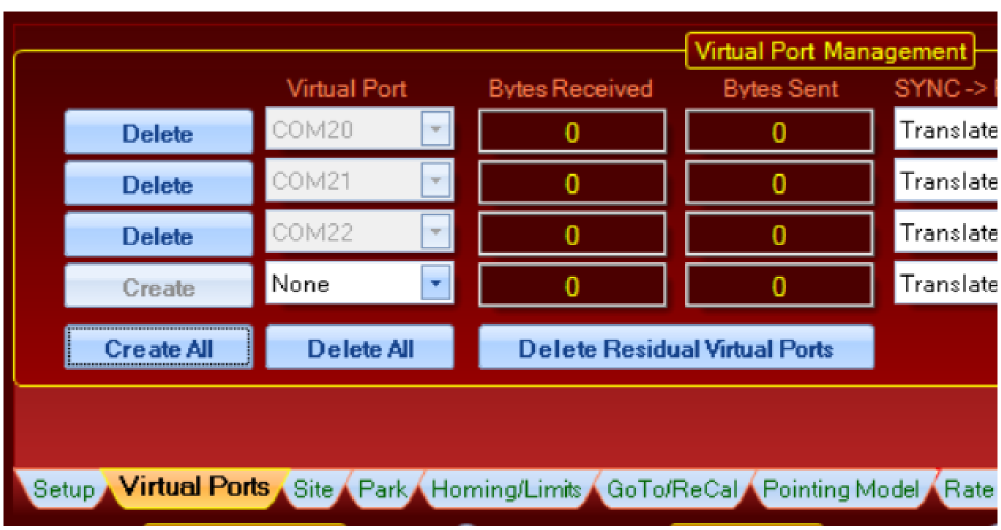
ASCOM Driver Advanced Settings Tab

NOTE: Any changes made to the ASCOM driver tab will require restarting APCC for the new settings to take effect.



Eltima Virtual Ports: When selected, Virtual Ports will be used when the ASCOM driver is connected to APCC. The default and recommended setting is to use REST API instead of Virtual Ports

Minimum Virtual COM Port: Specifies the starting COM port number Virtual Ports will be created. For example, a setting of 20 will result in Virtual Ports of COM 20, COM 21, etc. This only applies when Eltima Virtual Ports is active.



REST API: When selected, REST API will be used when the ASCOM driver is connected to APCC. This is the default and recommended setting for APCC

REST API Port Number: Specifies the port number for REST API. Default is 60001. If this is changed (for example, due to port assignment conflict), the ASCOM driver must be reconfigured using the Config Driver button on the Setup tab.

6.6.2 PEM-Recording Options

What is PEM?

PEM is the term used by Astro-Physics for periodic error correction. When it was first introduced, we chose PEM (Permanent Error Memory) rather than PEC (Periodic Error Correction), which was in common use at the time by other manufacturers. At the time, mounts with PEC had to be retrained each observing session - a real drawback. We chose PEM to indicate that our mounts retained the error correction in memory so that the process of correcting it did not have to be repeated each session. Later mounts on the market unitized the acronym PPEC (Permanent Periodic Error Correction). We have chosen to continue using PEM for consistency, although it can be confusing at first. Generally speaking, PEM and the market use of "PEC" are interchangeable terms.

The servo drive electronics contain a very sophisticated permanent periodic error compensation circuit. Because a majority of the periodic error is due to the RA drive worm and is quite predictable, it is possible to significantly reduce it by simply having the controller “memorize” the corrections you make with your button inputs and automatically play them back for each cycle of the worm. This circuit has some unique features that makes it easy to operate and almost totally foolproof.

A most valuable feature of this circuit is that it automatically compensates for any drift inadvertently introduced by the operator in the process of recording the gear error. For instance, if the mount was not properly polar aligned in altitude, the right ascension drift rate would be in error. The circuitry automatically subtracts this slow drift from the memory, so that the overall long-term drive rate remains exactly at the sidereal rate. This way, the compensated driving rate will always be correct for any other position in the sky and for any other time that the mount is set up in the field.

There are several ways to correct the residual periodic error in Astro-Physics mounts, as described below.

PEM Already Programmed at Astro-Physics

The heart of your Astro-Physics mount is a precision gearbox using custom high-quality fine-pitch gears, coupled to a highly accurate worm and worm wheel. These parts are manufactured and assembled at our facility and individually tested to meet or exceed our periodic error standards before adding any periodic error correction. The PE is smoothly variant with extremely low ripple or moment to moment error. As a final step to the mount testing process, we optimize performance even further using a special version of Ray Gralak's *PEMPro* developed specifically for our test equipment. We generate a unique PE curve for each mount that we program into the Control Box. Simply use the Keypad or your Astro-Physics software (ASCOM V2 driver or *APCC*) to turn the PE Correction "on" and you will see results significantly better than our published 5 or 7 arc second spec (depending on the mount).

NOTE: Your new Astro-Physics mount comes with a factory-installed PE curve. You should use the factory-supplied curve, do not immediately run PEMPro and replace it. Over time your mount gearing will wear in and later the PE can be updated via PEMPro. (Mounts that have encoders such as the Mach2 do not require PEM and therefore do not have PEM factory curve.)

Use PEMPro by Sirius Imaging to Record PEM

PEMPro (Periodic Error Management Professional), Version 3, by Sirius Imaging is a very powerful Windows software application that allows you to correct your mount's periodic error, polar alignment and backlash using your astro camera to dramatically improve tracking and guiding. As mentioned previously, our extensive testing procedures include several *PEMPro* runs so that your new mount will perform with optimum PE correction out of the box. Although you will not need to use *PEMPro* when you receive your mount, you may wish to do a *PEMPro* run at a later date after the worm gear has run in. Depending on usage, re-measuring error and re-loading periodic error correction from one to four times a year is a good practice, especially if you do some unguided images from time to time. The corrections have been stored in the GTOCP3 Control box and can be enabled via the Keypad, the *ASCOM* driver or *APCC* in subsequent sessions.

NOTE: Your best results will be obtained by using a PEMPro PE curve, whether it is the factory installed curve or a new one that you do yourself. The next two methods that follow can be used if there is a problem with your existing curve, but, they should NOT be used to replace a perfectly good PEMPro model. The reason is that the native recording capability in the servo only records a single worm cycle for its curve. PEMPro averages a larger number of worm cycles to create a much more statistically valid curve to represent the mount's true periodic error.

Use APCC to Record PEM

NOTE: Like the Keypad method below, using APCC to record PEM will use the GTOCP3's servo recording capabilities, and will only record a single worm cycle. DO NOT replace a good PEMPro correction model with this single cycle model. Think of this as an emergency tool for getting a quick PE curve into the mount, NOT as an ideal way to program your PEM, or as a way to improve on a PEMPro model!.

Polar align your mount so that you have minimum R.A. and Dec drift. Be sure that the night is steady enough with minimum atmospheric motion, and pick a star near the zenith (refer to the LST value in the Telescope Position group box) to minimize atmospheric refraction errors. You must use a CCD camera or webcam, which will faithfully remember each error correction that it makes. These cameras can respond quickly to changes so they are extremely accurate and will place into memory a very smooth correction of the gear error. The corrections will be stored in the GTOCP3 Control box and can be enabled via the Keypad, the *ASCOM* driver or *APCC* in subsequent sessions

1. Select 1x response rate for N-S-E-W buttons on the *Rate Settings* tab.

2. Go to Setup tab of *APCC*. Refer to [Setup Tab] for a discussion regarding the other functions on this tab.

3. Choose *PEM Record* button and click OK in the confirmation window that will appear. The *PEM Record Countdown* display box will show the amount of time remaining for the recording. The length of time may vary depending on the mount model. You cannot cancel the recording session once it begins.

4. If you are not satisfied with your results, record again using the same procedure.

Use the Keypad to Record PEM

If you plan to use a crosshair eyepiece, this is the best choice since you can use the keypad as you stand at the eyepiece. Follow instructions in the Tools Menu section of the Keypad Manual. The corrections will be stored in the GTOCP3 Control box and can be enabled via the Keypad, the *ASCOM* driver or *APCC* in subsequent sessions. Like the APCC Recording method above, this should not be used to replace a perfectly good PEMPro model.

6.7 Virtual Ports Tab

This section is only for those using the virtual serial ports (VSP) instead of the default REST API. If you use REST API you can skip this section. Also note Virtual Ports tab is hidden when using REST API.

An unfortunate aspect of serial ports is that they create unique point to point connections which exclude more than one application at a time from connecting to the mount. This limitation is more than outweighed by the robustness and dependability of serial connections, and these qualities are why serial connections are still the preferred method of control in industrial applications.

The Astro-Physics V2 ASCOM driver allows multiple ASCOM applications to connect but it does not allow multiple non-ASCOM applications to communicate to the mount using the mount's native protocol. To allow APCC to talk to multiple applications, APCC provides 4 virtual COM ports that allow (up to 4) applications to use the mount's native command protocol simultaneously. Such applications may include the AP V2 ASCOM Driver, PulseGuide, and Software Bisque's TheSky6/X or other non-ASCOM programs.

> **Note**: Be sure that you are running all of your applications (MaximDL, etc) at a regular level and not "as administrator." If you run a mixture, you will get two ASCOM driver instances (one for regular users and one for administrator) and that will cause problems. This is not caused by an issue with the driver or APCC, but the way Windows COM interop functions.

The normal configuration is to devote the first Virtual Port to the AP V2 ASCOM Driver. This was explained in the [Getting Started Section].   We highly recommend that you follow this practice.   As mentioned in the Getting Started Section, selection of COM numbers for your virtual ports should not be done without some thought and planning. We have found that it is a good idea to reserve the lower port numbers for "real" serial ports. These include actual serial ports in the computer as well as all of your USB to serial adapter ports. As a suggestion, start your virtual port numbering with COM11, or even COM21 if you have many serial devices. This prevents conflicts if you need to change a USB to serial adapter and don't want to fight with the Windows port assignments.

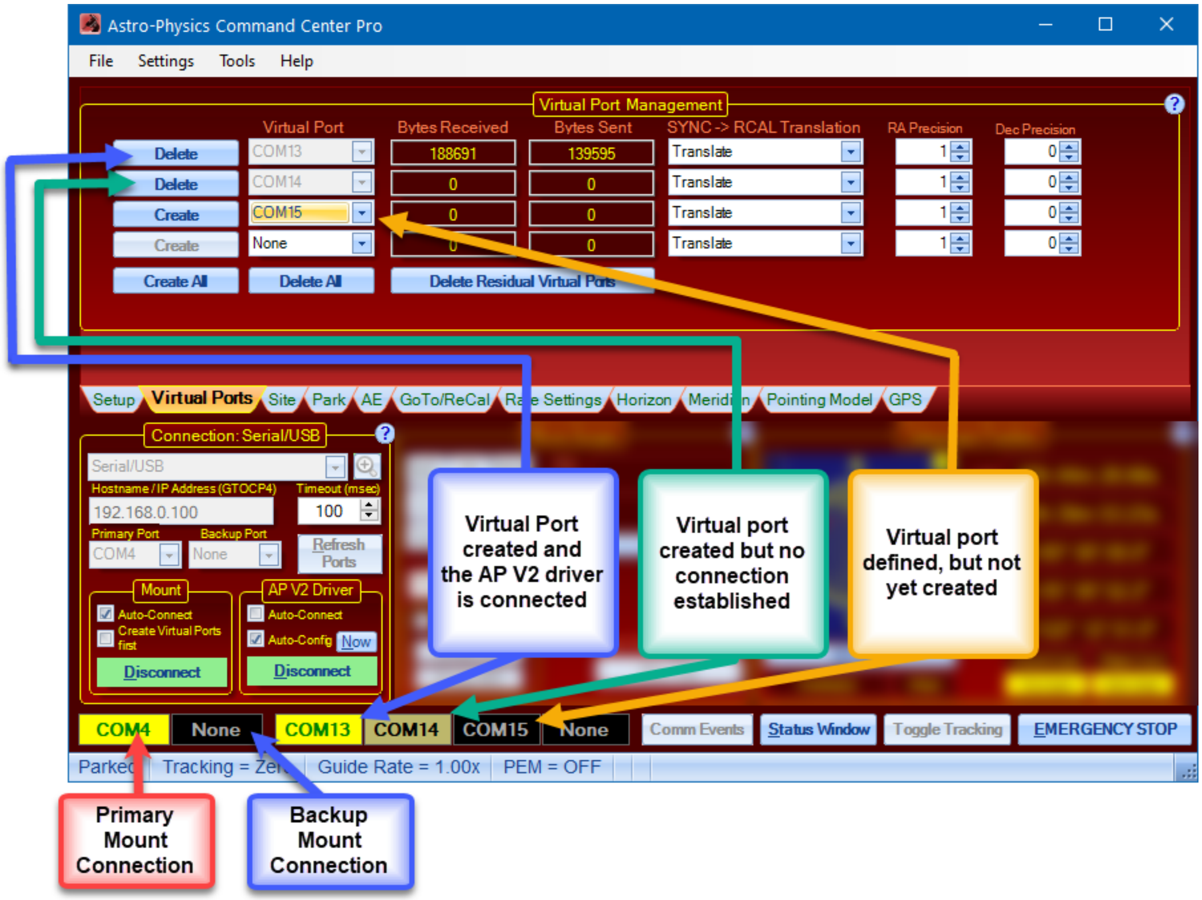
- It is fine to define all of your ports ahead of time, but only create the ports that you will actually be using during a session.
- If you plan to use PulseGuide through a virtual port, note that it only allows COM numbers up to COM 10

APCC's virtual ports communicate with the mount in an intelligent way, routing commands from each virtual COM port to the mount and back out to the originating virtual port. This prevents the commands from different virtual ports from getting mixed up.

The status of the COM port and the virtual ports is displayed near the bottom left of the main window. You can select a virtual port to be potentially created from the drop-down list next to each *Create* button. Once you define a virtual port, you will see the port name appear in gray letters on a black background. If no virtual port is defined, the *Create* button will be disabled and the label will say *None* in the virtual port status labels. Here is a table showing the different color states:

No virtual port is defined.	None
Virtual port defined but not created.	COM13
Virtual port defined and created but not opened by any application.	COM12
Virtual port defined, created, and an application is connected to it.	COM11
Communication error	Blinking

NOTE: The Connection Box shown on this screen shot is out of date, however the changes are not important to this discussion. They will not be updated at this time due to the complex labeling.



Create: Creates a virtual port when clicked. You must have an available port selected from the corresponding Virtual Port dropdown list. Once a virtual port is created, it's color changes to a dim yellow with black letters and this button changes to *Delete*. **YOU MUST click the "Create" button to create the port in your system!** This isn't simply an APCC option, but goes to the heart of the PC's operating system.

Delete: Click button to delete the virtual port.

Virtual Port: The drop down list from which to select a virtual port. Don't choose a port the same as another port or that already exists on your computer.

Create All: Click button to create all defined virtual ports.

Delete All: Click button to delete all created virtual ports.

Delete Residual Virtual Ports: You can try this option if virtual ports remain even after an attempt to delete them fails. If this does not work rebooting should remove the virtual ports.

Auto-connect Driver when APCC connects: Check this option if you plan to start APCC first before using any ASCOM client applications. This will allow ASCOM clients to connect more quickly the first time they try to access the ASCOM driver. Uncheck this option if you want to have the driver start APCC when the first ASCOM client tries connecting to the mount. Most people with permanent or remote setups will want to keep this checked. This is one of a trio of check-boxes that are normally either all checked, or all un-checked. Those are:

Auto-Connect when started - on the Main Window's Connections group box

Auto-Connect Driver when APCC connects - on the Virtual Ports tab
Create Virtual Ports first, even if not connected - on the Advanced Settings window

Bytes Received: This is the number of bytes received on the virtual port from an application. You can use this field as an indicator that an application is communicating correctly.

Bytes Sent: This is the number of bytes sent out the virtual port to an application connected on the virtual port. You can also use this and Bytes Received to verify that an application has successfully disconnected and is no longer communicating. When an application disconnects, the values will no longer be changing.

SYNC -> RCAL Translation: Use this option to convert SYNC commands to RCALs. Usually you want to set this to *Translate* to prevent SYNC commands from being issued inappropriately from other applications when the correct function is RCAL. Most programs do not employ the RCAL command and will instead send a SYNC in all circumstances, regardless of whether it is appropriate. Improper use of SYNC, particularly when the mount is in a counterweight-up position, as it might be if you are using the Meridian Delay feature, will cause the mount to become lost since SYNC defines the pier side. This translation feature will help to prevent incorrect commands.

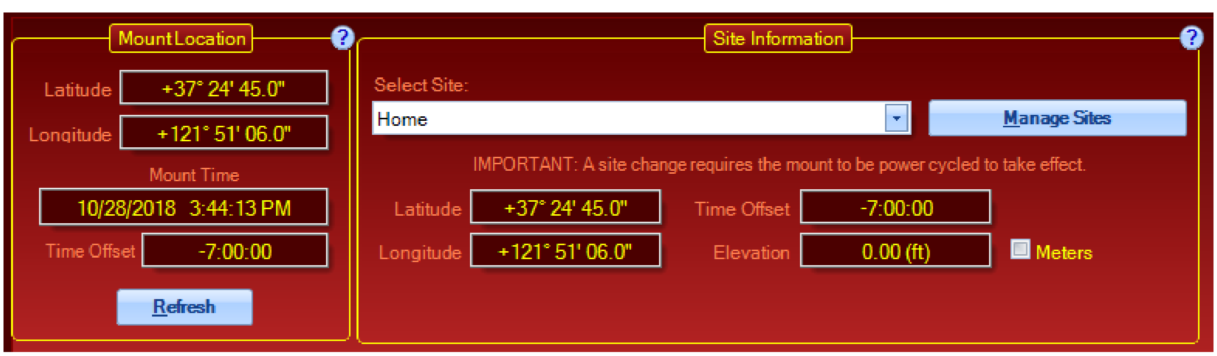
Please read the Sync Explained in Detail and Compared to Recalibrate section for a comparison of these functions.

RA Precision: The maximum number of digits precision to use on the virtual port for hour angle values. Later versions of the GTOCP4 and GTOCP5 firmware can output 2 decimal digits of precision in RA and other hour angle values, however some client applications expect only one digit and may even consider the format corrupted. Setting RA precision to 1 digit can prevent this.

Dec Precision: The maximum number of digits precision to use on the virtual port for degree values. Later versions of the GTOCP4 and GTOCP5 firmware can output 1 decimal digit of precision in Declination and other degree values, however some client applications expect no decimal digits and may even consider the format corrupted. Setting Dec precision to 0 digits can prevent this.

One last thing - Hovering the mouse over a connected virtual port will show the path of the application that is connected on that port.

6.8 Site Tab



Mount Location

The information in this group box is information that is polled from the mount.

Latitude: The current latitude value last read from the mount. This value is refreshed when you switch to the *Site* tab or click the *Refresh* button.

Longitude: The current longitude read from the mount. Note that longitudes west of the meridian will display as positive values. This value is refreshed when you switch to the *Site* tab or click the *Refresh* button.

Refresh: Clicking this button will refresh the latitude and longitude from the mount. This is a trouble-shooting aid that allows you to confirm that another device or piece of software has not sent erroneous latitude and longitude information to the mount. The latitude and longitude of the Site Information and Mount Location group boxes should match.

Mount Time: Display of date and time data from the mount control box. The time updates continuously.

Time Offset: Display of current offset. This value is refreshed when you switch to the *Site* tab or click the *Refresh* button.

Site Information

The information in this group box comes from the selected site data saved in APCC. Note that you can select a site in this group box WITHOUT sending its information to the mount. Site information is only sent to the mount during initialization.

Select Site: This drop-down list box allows you to select a site, which includes Latitude/Longitude/Elevation information. You can create or edit a site by clicking *Manage Sites*.

Latitude: The selected site's latitude value.

Longitude: The selected site's longitude value.

Elevation: The selected site's elevation value, if the data was entered.

Time Offset: The selected site's time offset, which will include an adjustment for Daylight Savings Time when appropriate.

Meters: If checked elevation is shown in meters. Otherwise, elevation is in feet.

Manage Sites: Clicking this will open the **Manage Sites Dialog**. From that dialog you can create and edit sites.

> **TIP**: If you have a GPS connected through a USB port to your computer you may be able to create a new site on the **GPS** tab.

6.8.1 Manage Sites Dialog

Site Name: Enter a name for the site. This would be the name you normally use when referring to the site.

Description: Enter an optional description of the site.

Get From Mount: Click this button to fill the Latitude and Longitude fields with the mount's current Latitude and Longitude, if that is appropriate.

Latitude: This group box contains the values for latitude in degrees, minutes, and seconds, as well as a North/South selection. Refer to the tip below to enter decimal values. Do NOT enter negative numbers. Instead, use the North or South button.

Longitude: This group box contains the values for longitude in degrees, minutes, and seconds, as well as a East/West selection. Refer to the tip below to enter decimal values. Do NOT enter negative numbers. Again, use the East or West button instead.

TIP: You can enter or paste a decimal degrees value into the degrees field for Latitude and Longitude. If you do, the appropriate minutes and second values will be calculated and displayed.

Other: In this group box you can set default values including *Time Offset* (i.e.,. Time Zone), *Elevation, Temperature and Pressure*. You may have noticed that there is no way to enter your clock time. APCC uses your computer time when sending time information to the mount. You may wish to utilize time server software to keep your computer time as accurate as possible, if that is important to your operation.

New: Click this to create a new site. Be sure to edit the *Name* field to reflect the site. When you click it a new site will be added to the Site table.

Save: Click this to make permanent the changes you have made to any of the site parameters.

Delete: This will delete the selected row in the table. To select a row click it with your mouse.

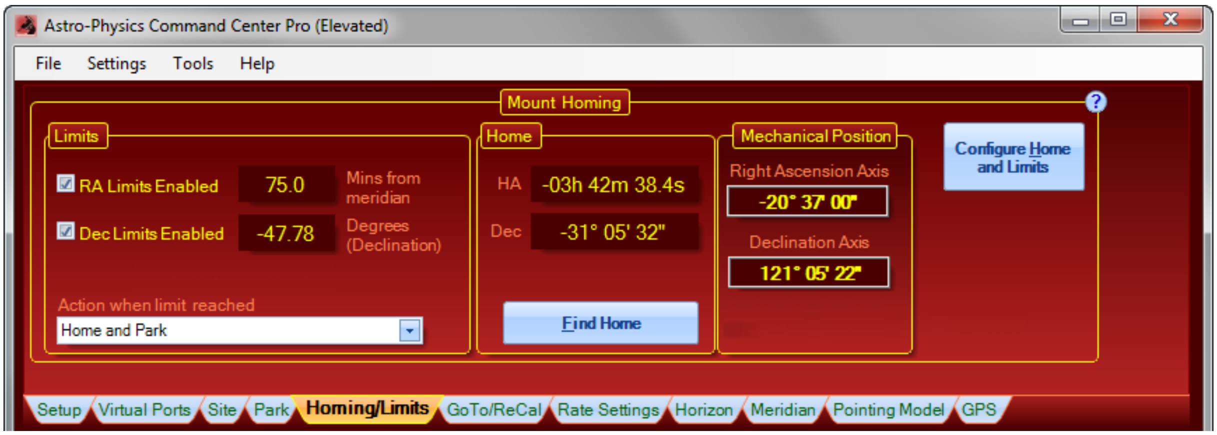
Close: This will close the window. If site information is not saved a pop-up window will give you the option to save the site, not save the site, or cancel the close window operation.

Site Table: Click a row in the table to select a site. It's values will be loaded into the Latitude, Longitude, and Other group boxes. You can then edit the values if you desire.

6.9 Homing/Limits Tab

Note: **The RA Limits that you set here will override any custom Meridian Limits you may have set on the Meridian Tab. These limits are the preferred choice for those using automation software that cannot accommodate the varied limits from the Meridian Tab anyway. Users who are more "hands on" may wish to keep these RA limits OFF and use the customizable limits from the Meridian Tab.**

Dec Limits should almost always be ON.



Note: **APCC Home and Limits will display only if you have a non-encoder mount. If you have a mount with Absolute Encoders, the AE Home and Limits Tab will be displayed instead.**

Introduction and Operation Basics

Celestial coordinates are somewhat dynamic in an astronomical mounting. We regularly tweak our celestial pointing positions following a plate-solve, or after centering a star. This ability to modify the pointing coordinates, while mostly advantageous, can lead to errors and mistakes. The result of a "bad" Sync or ReCal can be a lost mount.

The Astro-Physics GTO Servo System is smart! As long as the clutches remain fully engaged, it can determine the true mechanical position as well as knowing the celestial coordinates. Because celestial coordinates are subject to error, the mechanical position can be used for independent Home and Limits.

In brief, here are the steps to establishing Home and Limits on any mount that does NOT have Absolute Encoders:

1. ***GTOCP3 ONLY!*** If you have a GTOCP3, you will most likely need to run the ***APCC_Personality_Update.exe*** program that is incorporated into APCC. APCC will restrict all other functions of the Homing/Limits tab until this is done. The Personality Update will be your only live

option from the tab. This only needs to be done the very first time you set up with Home and Limits. It never needs to be done again, and will, in fact, not be offered as an option again on this particular GTOCP3. It will direct you as needed, and only modify settings that are needed.

a. Start APCC

b. Click on the Homing/Limits Tab.

c. Click the Update Mount Personality button at the top.

d. Follow the simple instructions.

e. Be sure that you restart APCC and power-cycle the mount (OFF - wait - ON) as instructed at the end.

2. ***ALL CONTROL BOXES*** Your mount should be fully set up and calibrated. All operations that might involve the clutches should be finished.

3. Click on the Homing/Limits Tab in APCC.

4. Click Configure Home and Limits button.

   a. Select a Home Position

   b. Set limit parameters

   c. Click Set Home Position

   d. Wait for the message saying that the configuration is finished.

5. Activate limits or not as you wish. (Dec limits should almost always be turned ON.)

That's really all there is to it. From this point forward, as long as the mount is not moved via the clutches, it will have a "Home" position that will always correctly re-establish pointing position, and it will have available limits to prevent an axis from moving into a dangerous position.

- Click Find Home to send the mount to the Home position and reestablish pointing.
- Select Limit Action
- Turn RA limits on or off as needed with the check-box.
- Turn Dec limits on or off as needed with the check-box.

> **Warning: Moving the mount via the clutches will invalidate your Home and Limit positions. You are certainly free to use the clutches if needed, but just remember that you must reconfigure Home and Limits when you are finished and properly recalibrated again.**

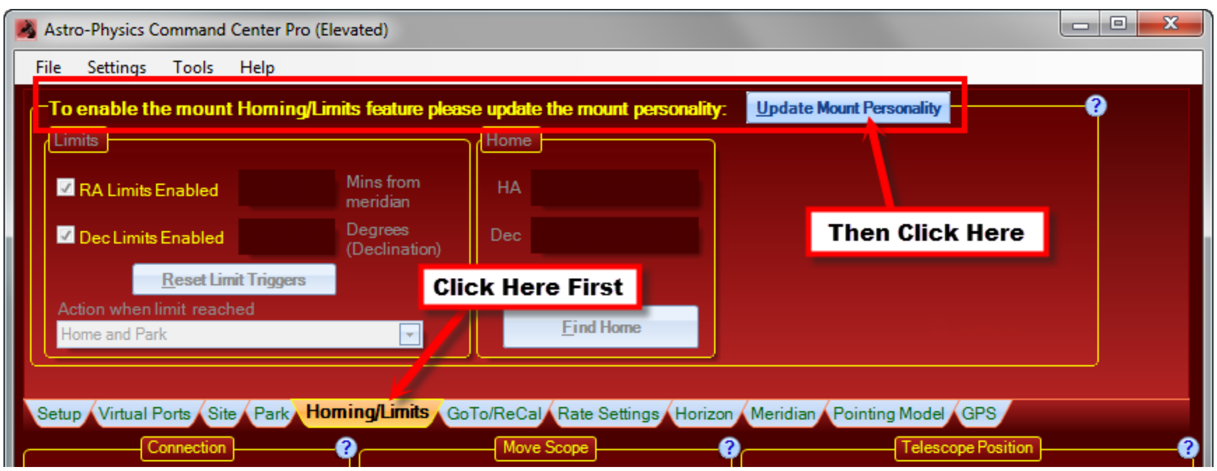
APCC Personality Update Program - GTOCP3 Control Boxes

The Home and Limits system that we have developed for APCC uses some of the features and capabilites that were originally designed for the 3600GTO's Home and Limit System and for the Absolute Encoder's Home and Limit functions. These capabilities are present in the Rev V and later chips that are required for APCC, but they are dormant in mounts that have not been configured for these advanced features. The small APCC_Personality_Update program updates the personality configuration to make these capabilities available.

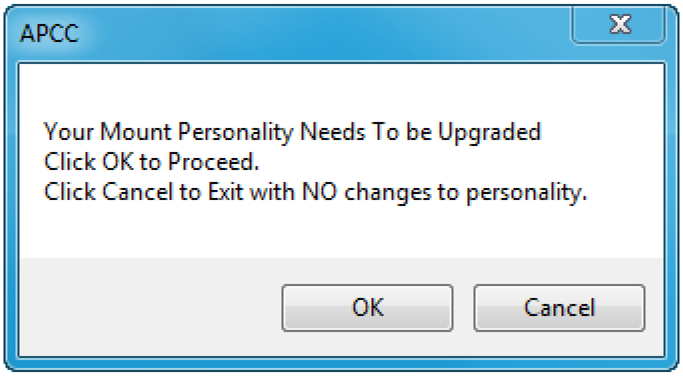
Note: The APCC_Personality_Update program is designed to be harmless to your system. It is safe to run regardless of whether the mount is already configured for the Home and Limits. (You may not know for sure!) It does not corrupt or change any of your other vital personality parameters.

This program is for GTOCP3 Control boxes ONLY. It is not needed, and will not run on GTOCP4/5 Control Boxes.

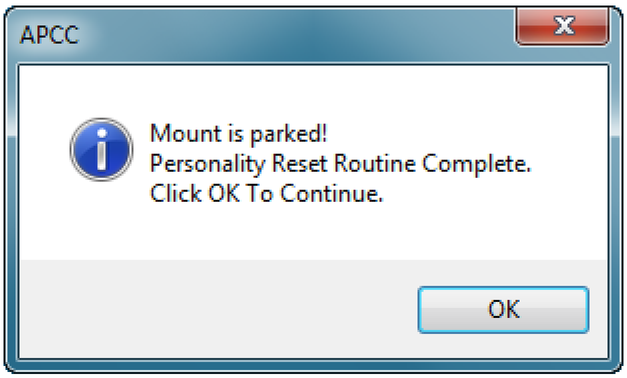
To run the program, first start APCC. APCC should be connected to the mount, and should already be configured to work with the AP V2 ASCOM Driver. You should not have other ASCOM client programs running or connected at this time. When you start APCC, it polls for the relevant personality setting. APCC therefore knows whether to allow Homing/Limits tab access, or whether the update program is required. Once you are ready to go, simply click on the Homing/Limits tab. If you need the update, the Homing/Limits tab will look like the screen below.



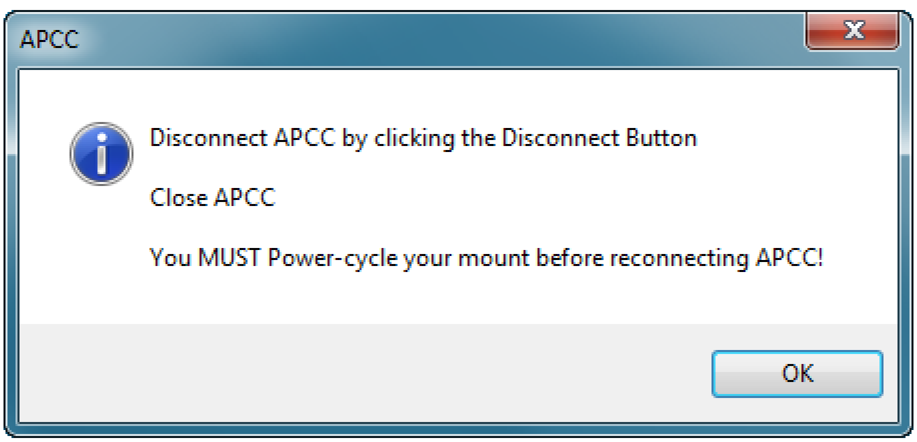
First, the program will gather all the personality data that is currently in your GTO control box. The program temporarily saves this information. The following window will appear:



Clicking Cancel will exit WITHOUT MAKING ANY CHANGES. Clicking OK will tell the program to proceed. After a few seconds, you should get the following message:

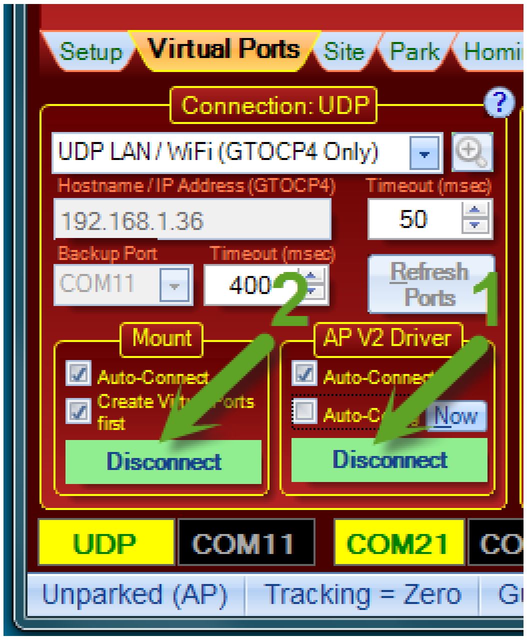


Clicking OK then opens a window with these final instructions:



It is important that you follow all three instructions in order:

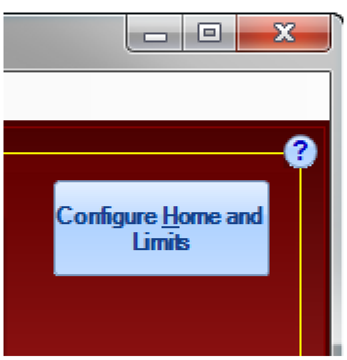
1. Disconnect the AP V2 Driver, and then APCC from the GTO Control Box by clicking the Disconnect buttons in the Connections Box.



2. Close APCC. You may need to disconnect any other ASCOM client programs that are still connected before you can close.
3. Power-cycle your mount. Allow at least 15 seconds between power-down and power-up.
4. You are now ready for all normal operations of the mount, including taking advantage of the APCC Home and Limits Feature.

Configure Home and Limits

The next step in using the Home and Limits Tab is to configure the Home positions and choose limits. This topic is presented in its own separate section.

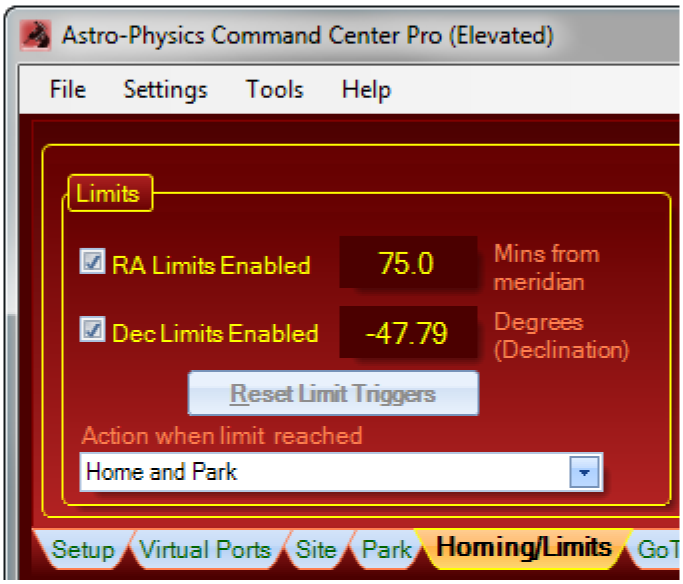


Please click on this link to go to the Configure Home and Limits page of these instructions.

Note: Be sure to return to this page for additional important information on using the Home and Limits Features after you have visited the Configure Home and Limits page!

Clutches warning

Limits Box



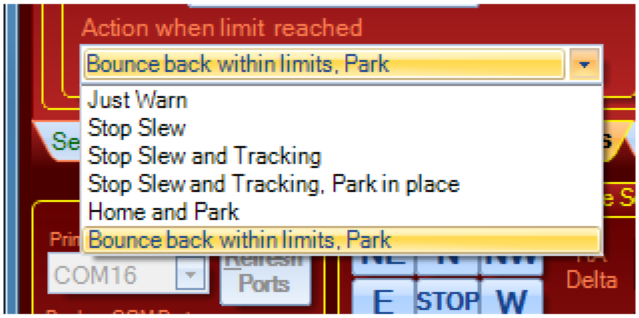
The Limits Box is where you enable or disable the limits you have configured. It is also where you set the action that will occur should you slew or track into a limit. To enable or disable the RA or Dec limits, simply check or uncheck the appropriate box.

Note: The displayed values might seem a bit confusing at first, especially in light of what you entered when you configured the Home and Limits.

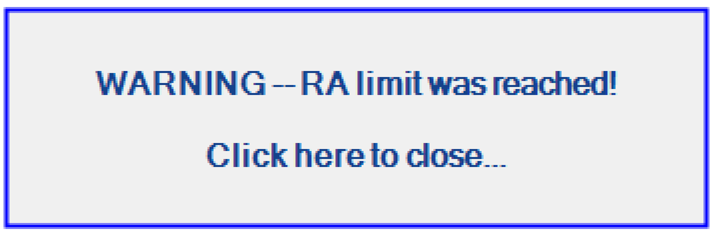
- **The RA value is the distance in RA minutes that you allow the mount to go past the meridian. It is consistent with the value you entered when you configured Home and Limits. In the example above, the mount can travel 75 minutes (1 hour 15 minutes) past the meridian in either direction before activating the RA limit.**
- **The Dec value is where most people get confused. The Dec limit is basically determined by your latitude. It will correspond somewhat to the Dec value at the Park 4**

position. However, to allow a bit of cushion, you are allowed to set a bit of additional travel before the limit is activated. The displayed value is the declination of this "cushioned" limit.

Action when limit is reached: The drop-down box at the bottom of the Limits Box gives you options for what happens when a limit is reached.



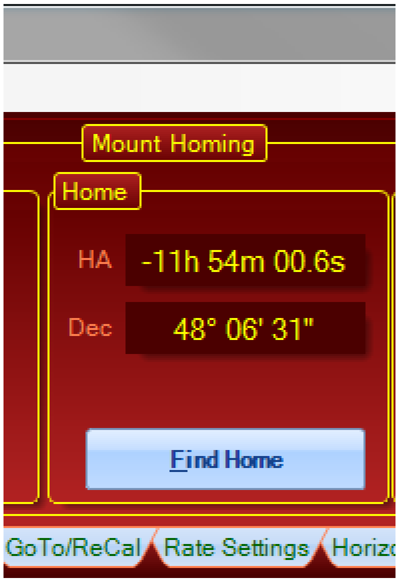
The options shown above are relatively self-explanatory, but there are a few things that we want to point out. In all cases, when a limit is reached, a warning box like the following will appear. The exact text of the warning will depend on the action-option chosen.



- **Just Warn** No action will be taken apart from the display of a warning box. This could be useful if you are present at the mount and can take action yourself as needed.
- **Stop Slew** A slew that hits the limit will be stopped, but tracking into a limit will only generate the warning box. Sidereal tracking will be allowed to continue past the limit. This may be useful for a somewhat attended mount where protection during a slew is desired, but where you also want the freedom to continue tracking with the APCC meridian limits providing the next line of defense.
- **Stop Slew and Tracking** A slew in progress will be stopped when the limit is hit. Tracking will also be stopped when the limit is hit. Motors will remain energized since the mount will NOT be put into a parked state.
- **Stop Slew and Tracking. Park in place.** A slew in progress will be stopped when the limit is hit. Tracking will also be stopped when the limit is hit. The mount will be placed into a parked state where it stopped, but will not be moved to a predefined park position.
- **Home and Park** Mount motion will be stopped, and the Find Home sequence will be initiated. The mount will end up parked and recalibrated at the home position.
- **Bounce back within limits. Park** When a limit is hit, the mount will stop, and then "bounce" back out of the limit (a short move in the opposite direction to clear the limit). It will then enter a parked state.

Most users should use the **"Home and Park"** or the **"Bounce back within limits. Park"** option. For totally remote users, the Home and Park option is probably safest, especially if there is an issue with roof closure. The bounce option can be useful in that it provides both safety and still allows you to see where you were when a problem may have occurred.

Home Box



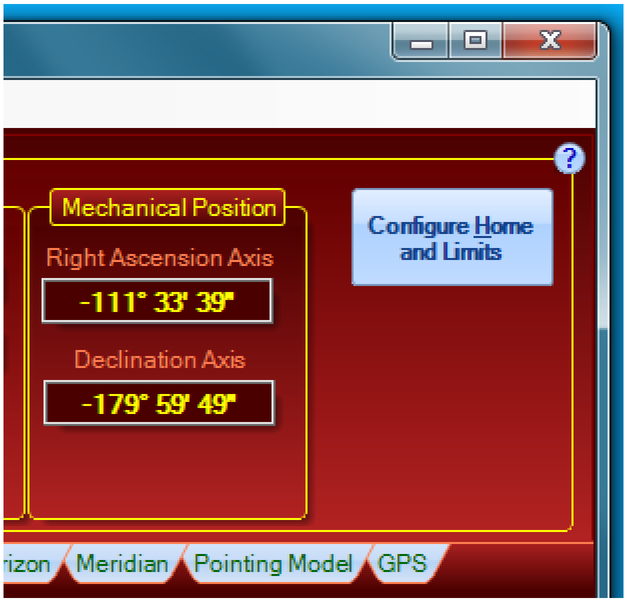
The Home box tells you the coordinates of your Home position. Coordinates are given in Hour Angle and Declination.

Find Home - What Happens?

The "Find Home" button is used if you have somehow gotten the mount lost. It starts a sequence of events that end up with the mount in its home position, and with the celestial coordinates correctly reestablished. Here is a summary of the sequence following a click of the "Find Home" button:

- Tracking is stopped.
- The RA axis is moved to the RA Home position.
- Once RA is finished, the declination moves to its Home position.
- When both axes are "Home", the Home celestial coordinates are commanded and then a full Sync is done.

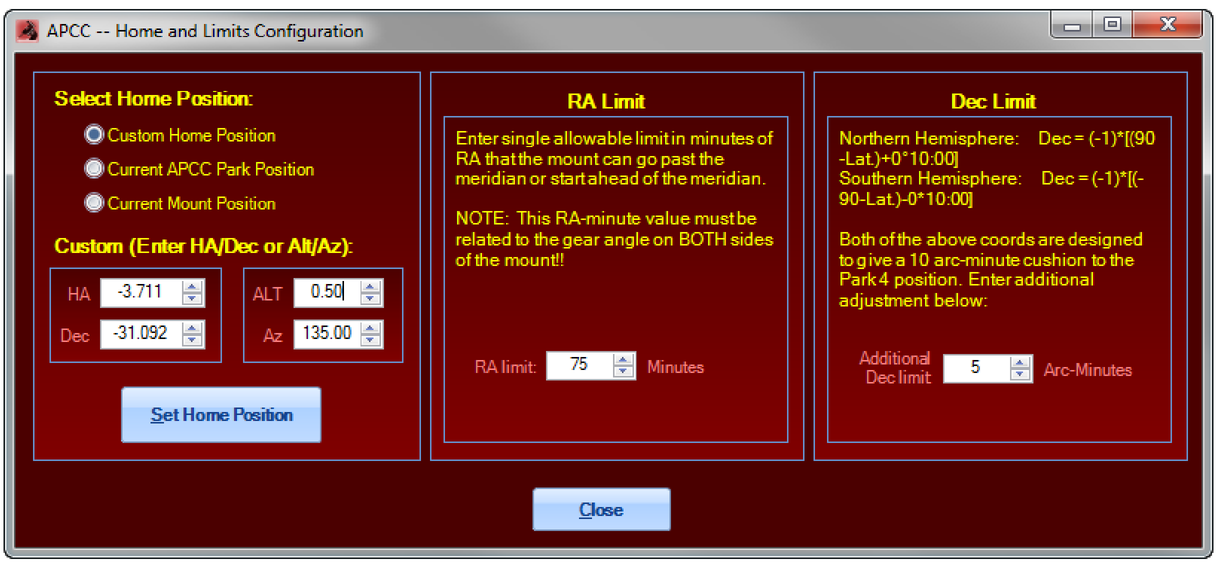
Mechanical Position Box



The Mechanical Position box tells you the current distance in degrees, minutes and seconds from the defined Home position. These values are especially useful when you define Home to be at Park 3, with the counterweight shaft pointing down and the scope pointing at the pole. For other home positions, you may need to do a bit of mental arithmetic to relate to the mechanical position.

6.9.1 Configure Home and Limits

Introduction



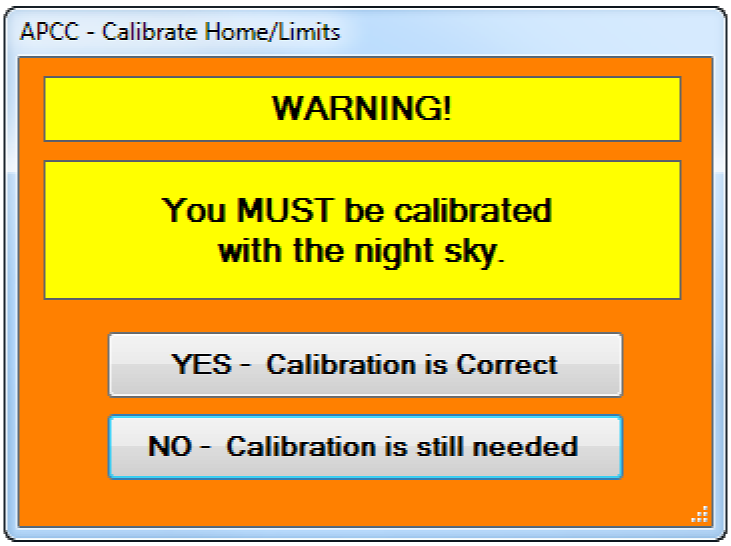
The Configuration Window is where you will set the position you wish to call "Home." It is also where you can set parameters for your limits in both RA and Dec.

- It is a good idea to think about this before you actually make the configurations, although you can always redo them. You will want to decide on the position you wish to use for "Home." Do you want

"Home" to point to a flat-field light-box? Do you have roof closure issues? Do you prefer to have "Home" point at the zenith, or the pole, or maybe a distant light on a radio tower? Or maybe you prefer to have "Home" be equivalent to an AP Park Position that you already use.

- Know ahead of time how far past the meridian you want to set your RA Limit. Since limits are easily enabled and disabled from the Homing/Limits Tab, you will probably want to set this as a "worst case" limit. ***Remember also that a 1200X slew is moving the mount at 5 degrees per second. The system needs time to react and decelerate to stop if you slew into the limit. These are, after all, software limits. They are not physical barriers.***
- One doesn't usually think of the need for a Dec Limit in a German Equatorial mount, but there is a zone at the rear of the mount, basically on either side of the opposite pole, where a properly operating Dec axis will simply never go. The size of this zone is determined by your latitude. In a nutshell, if your Dec axis crosses into this zone, then something is wrong, and corrective action needs to be taken.

When you first click on the Configure Home and Limits button at the top right of the Home/Limits Tab in APCC, you will be given the following warning:



You must be calibrated with the sky before you configure your Home position. The more accurate the calibration, the more accurate any homing recovery operation will be. For the greatest accuracy, you can do a plate-solve and ReCal on an object that is on the same side of the meridian as your chosen home position, and is also high enough in the sky to avoid too much refraction. Also, avoid doing your ReCal at a high declination (low declination in the southern hemisphere) where RA lines are compressed and lose resolution. A good practice is to choose a target on the same side of the meridian as "Home" that is between the zenith and the celestial equator (0 Dec).

Select Home Position Box

The Select Home Position box is where you set where "Home" will be. There are three approaches that can be taken to selecting your home position.

1. Use your own custom Home position. If you select this option you will need to enter either an Hour Angle (HA) / Dec set of coordinates, or else an Alt / Az set. This is done in the boxes below the

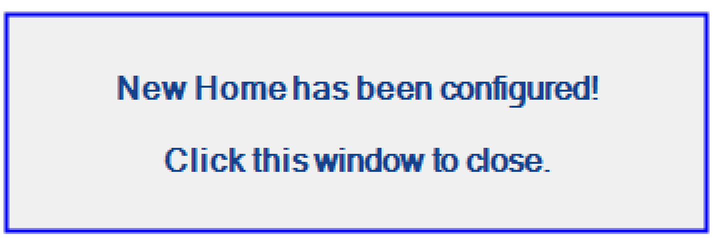
three radio selection buttons. The example above might be for a dome with a flat-field light-box located southeast of the pier.

2. Use the Current APCC Park Position. This automatically enters the coordinates for the park position you have selected in the Park Tab. You can then select Park to the Home position in the Park Tab, and all future parks will use the homing function rather than the normal park sequence. This might be especially advantageous for remote observers in that it will correct any errors that might have happened during the night's remote session. If you have chosen Park 4, for example so that your roof will close, the mount will park precisely to Park 4 even if something got the mount a bit lost while you were asleep.

3. Select the current mount position. This might be the easiest way to precisely aim the mount at a flat-field box, a laser safety switch, or a distant known terrestrial target unless you already know the exact coordinates. Simply toggle the tracking to STOP, move the mount into the exact position you want, and then proceed to set the Home position.

Once you decide on, and select your Home position, click the Set Home Position button. The following warning will appear:

If you selected #1 or 2 above, clicking OK will slew the mount to the chosen home position for verification. If you chose #3, you are already there, and no slew will take place. Once at your "Home" position, APCC will configure the position in the GTO Servo Control Box. When finished, the following will appear to indicate success.



You now have a configured Home position that will remain valid until the mount is moved via the clutches.

RA Limit Box

The RA Limit Box allows you to set how far past the meridian you want to allow your mount to travel. Only a single value is allowed. It is therefore best to consider a worst-case scenario on both sides of the mount. Set the RA Limit that you would want for UNMONITORED operation of the mount. If you will be sitting at the computer during the night's session, you can easily uncheck the RA Limits on the main Homing/Limits Tab if you wish to take advantage of the Meridian Limits you have set on the Meridian Tab.

Your limits are set in RA minutes. (Each RA minute = 15 arc-minutes. 4 RA minutes = 1 degree.) When deciding on the limit value, bear in mind that you need a safety cushion to accommodate a potential errant slew in progress. Tracking presents no problem, but when slewing at 1200X, the mount is moving at 5 degrees per second. The gear angles are polled by APCC once per second. In addition, the mount will need a small amount of time to decelerate to a stop. If you could hit the pier at 1h 40m past the meridian, you might want to set the limit at 1h 10m or 70 RA minutes to provide the safety margin. You can decrease the safety margin and thereby increase the distance past the meridian by using a slower slew speed like 600X.

You can either type in the number of RA minutes you wish to set or use the up/down arrows on the entry box to arrive at the desired value.

Dec Limit Box

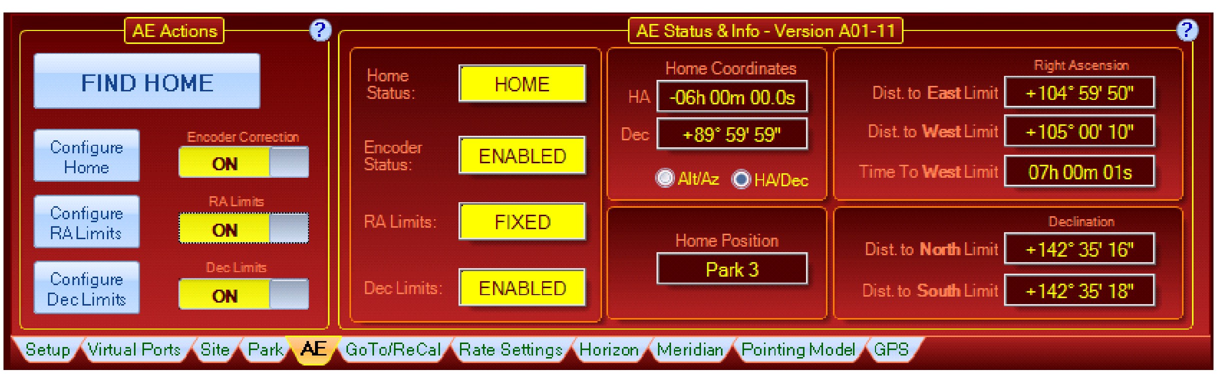
The very idea of declination limits may seem counter-intuitive. After all, the Dec. must slew all over on both sides of the pole. However, in a properly operating German Equatorial mount, there is a zone around the opposite pole from your hemisphere where the axis should never go. The size of this zone is dependent upon your latitude, and the absolute value is calculated for you by APCC.

Violation of this zone is not a sure sign of imminent disaster as it may be in right ascension. However, it **is** a sure sign that something is wrong and that you have done something to get the mount lost. We recommend that the Dec. Limit always be activated. The only valid reason we can think of for disabling the Dec limit is if you have moved the mount via the clutches, and have not yet reestablished home and limits.

The calculated value provides a 10 minute safety margin so that Park 4 will not accidentally trigger the limit. If you use Park 4, you may add an additional cushion if you wish, but it is only rarely needed, and we suggest keeping any additional limit to a minimum.

You can either type in the number of arc-minutes you wish to add to the provided cushion or use the up/down arrows on the entry box to arrive at the desired value.

6.10 AE Tab



AE Actions

Encoder Correction: Enables/disables the encoders. **NOTE: This control is not available for the Mach 2. Encoder correction is always enabled for this mount.**

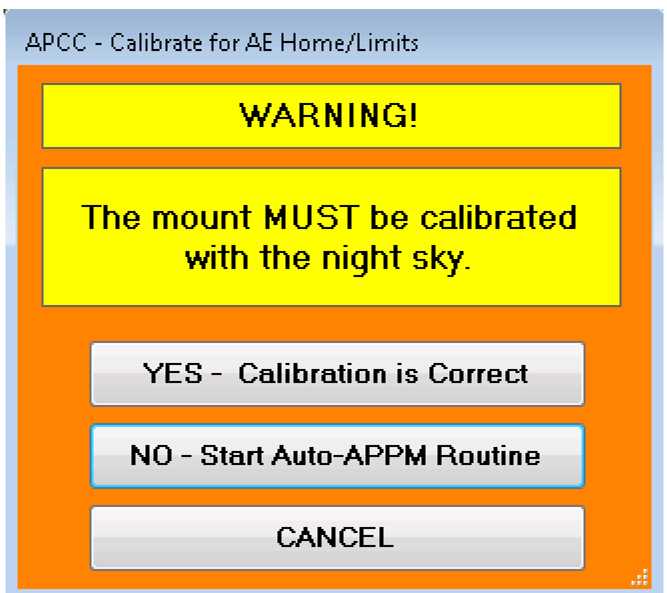
RA Limits: Enables/Disables the RA Limits. You must click the ON/OFF button to enable/disable RA limits

Dec Limits: Enables/Disables the Dec Limits.You must click the ON/OFF button to enable/disable Dec limits

Configure Home

Before **Find Home** becomes available, the home position must be configured.

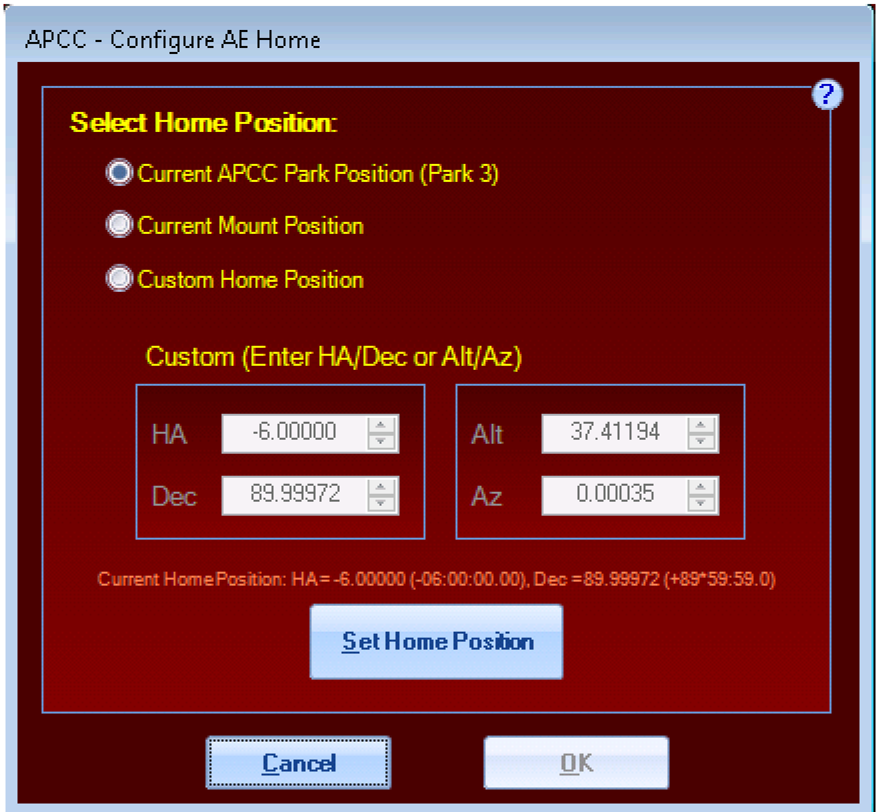
Clicking the **Configure Home** button will bring up this dialog box below if you are using APCC Pro. If you are using APCC Standard there will be no button for **No - Start Auto-APPM Routine.**



YES - Calibration is Correct: Click this button if the mount's calibration has been established, such as by doing a RECAL on plate solved coordinates.

NO - Start Auto-APPM Routine: (APCC Pro Only) Starts APPM if it is not already running, tries to connect to the mount and camera and does a plate solve and RECAL.

CANCEL: Exits the dialog box and cancels the Configure Home operation.



Select the appropriate home position and click **Set Home Position.**

NOTE: The MACH 2 mount has a fixed HOME position so it uses a simplified interface that only allows resetting HOME to the Park 3 position.

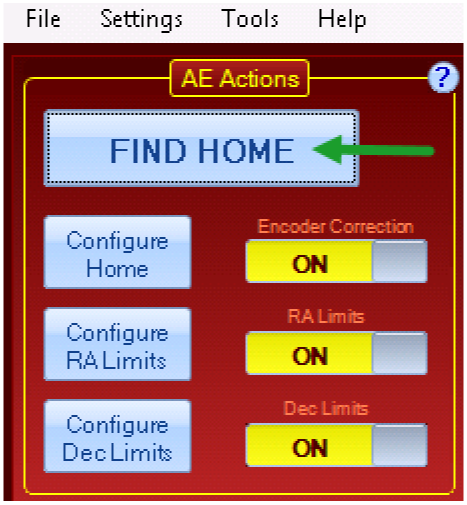
Click **OK** to exit after setting the home position.

You can click **Cancel** to abort configuring Home.

Find Home

If your mount is lost then you can use the **Find Home** feature to recover its position.

IMPORTANT: For this feature to work on non-clutch aware encoder mounts (e.g., 1600AE, 1100AE), you must never loosen the RA or Dec clutch and move the telescope after having configured home. If you must loosen one of the clutches and move the scope you will need to configure the home position again. For clutch-aware mounts like the Mach2, this step is not required: The mount remembers its home position even if the clutches are loosened and the scope moved.

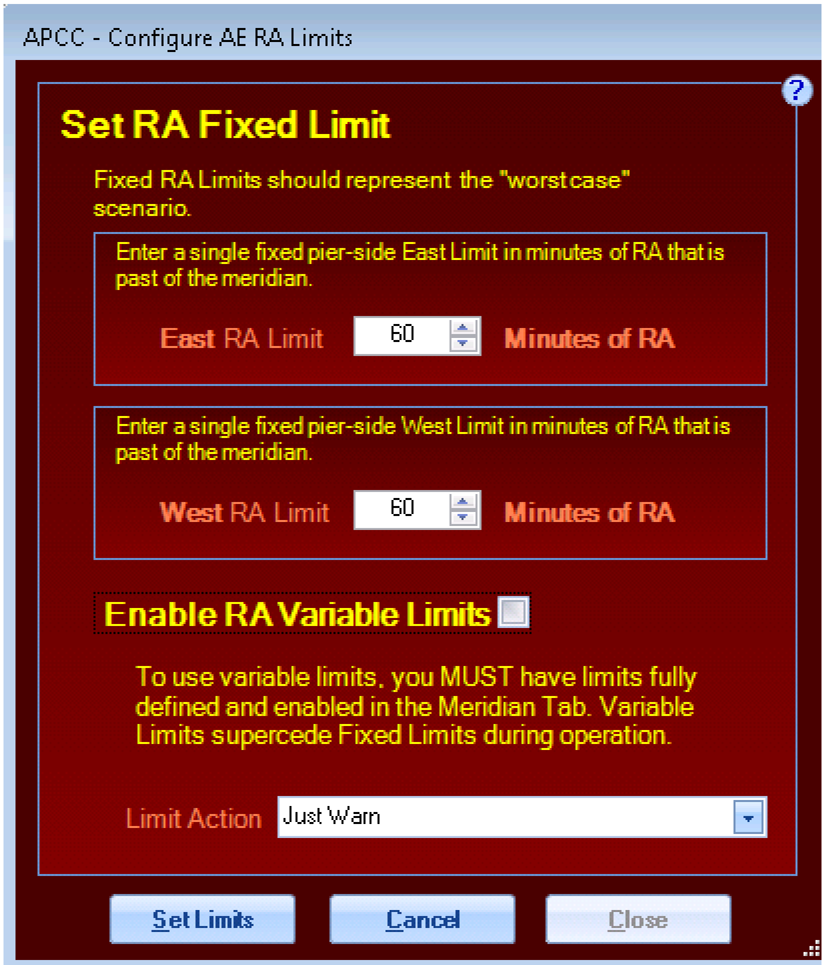


Clicking the **Find Home** button will pop up a confirmation dialog:

YES - FIND HOME: Will slew the mount to the home position and perform a sync.

NO - Cancel FIND HOME: Will cancel the find home operation.

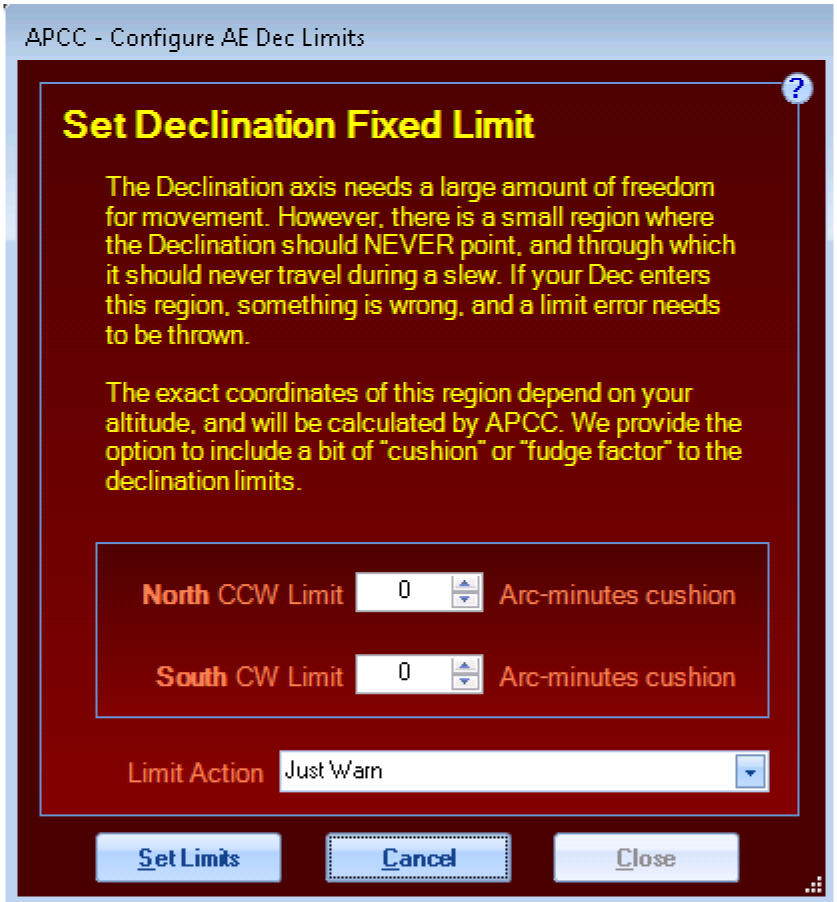
Configure RA Limits



Limit Actions: options include Just Warn, Stop Slew, Stop Slew and Tracking, Park in Place, Home and Park, Bounce back within Limits, and Park.

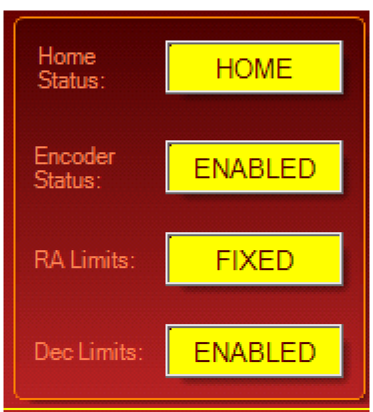
Enable RA Variable Limits: Uses the configured meridian limits for East and West sides.

Configure Dec Limits



Limit Actions: options include Just Warn, Stop Slew, Stop Slew and Tracking, Park in Place, Home and Park, Bounce back within Limits, and Park.

Status and Info Fields

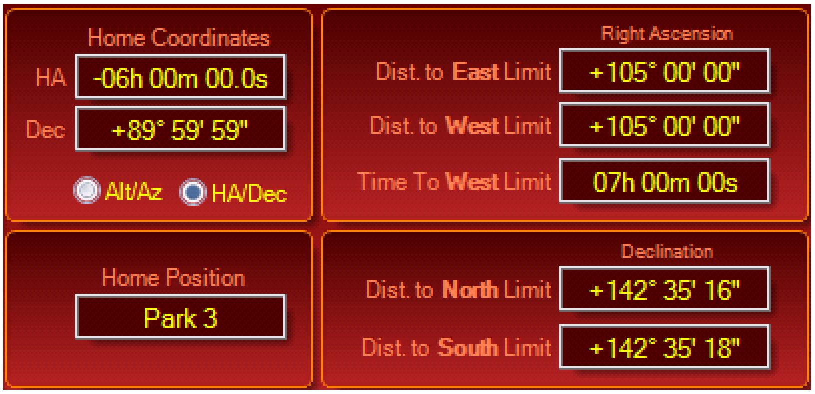


Home Status:

Encoder Status:

RA Limits:

Dec Limits:



6.11 ELS Tab

The ELS tab is only for the 3600GTO and 3600GTOPE mounts, which utilize the functions of the GTOELS secondary control box. The ELS Tab allows you to configure the limit and home switches as well as the R.A. precision encoder settings, if your mount has these features. It also has a provision for making extremely accurate home position determinations. This allows pointing recovery from the home position to be within a few arc minutes.

3600GTO and 3600GTOPE Models

Review the following information regarding these mount models and how the ELS Control Box is used for each. You may also wish to refer to this document on the Astro-Physics website for further information and ordering instructions: *Limit/Homing Switch System for the 3600GTO and 3600GTOPE*

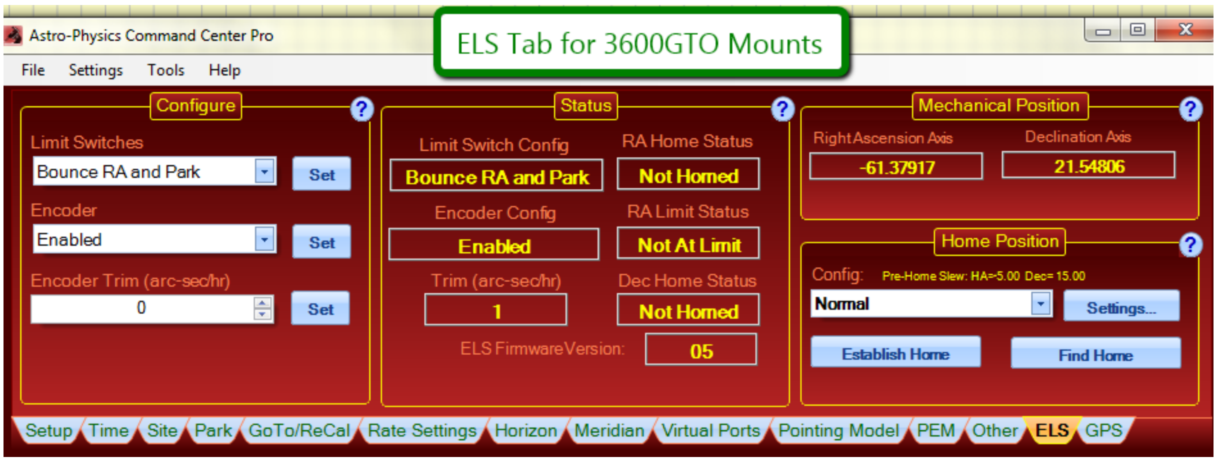
3600GTOPE without optional Limit/Homing Switch System: The ELS Control Box was included with the 3600GTOPE mounts to enable control of the R.A. precision encoder, which was installed in these mounts during initial manufacture (the R.A. precision encoder cannot be purchased as an upgrade). The Configure group box of the ELS tab allows the R.A. encoder to be enabled or disabled and allows a trim rate to be set. The remaining functions related to the Limit/Homing Switches cannot be utilized unless these components are purchased as an optional upgrade and installed by the user.

3600GTOPE with optional Limit/Homing Switch System: In addition to the control of the R.A. precision encoder described above, the ELS Tab enables full control of the limit/homing switch system, including activation of the software limits.

3600GTO with optional Limit/Homing Switch System and with GTOELS Control Box: This mount can utilize all functions related to limits and home position available on the ELS Tab. Since the mount does not have the R.A. precision encoder, the *Encoder* and *Encoder Trim* functions are not available.

3600GTO with optional Limit/Homing Switch System without GTOELS Control Box: Since this mount does not have the GTOELS Control box, it cannot take advantage of the ELS tab. Consult the user manual for the limit/homing switch system for operational instructions. The GTOELS Control Box is available as an option and can be purchased separately and installed by the user. Contact Astro-Physics for details. This mount does not have the R.A. precision encoder, so the *Encoder* and *Encoder Trim* functions are not available.

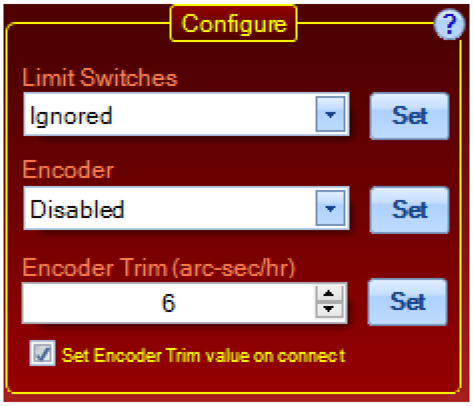
3600GTO without optional Limit/Homing Switch System: The GTOELS Tab is not useful for this mount. The limit/homing switch system and GTOELS Control Box are available as an option and can be purchased separately and installed by the user. Contact Astro-Physics for details.



TIP: Be sure to look at the General work flow for precise recovery using the Home Position section at the bottom of this page.

Configure

The Configure box is basically where you turn the ELS features on and off.



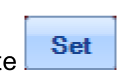
Limit switches: This drop-down list box has several options:

Ignored	The limit switches will be ignored.
Zero RA on Switch	RA tracking will stop when the switch is reached. The R.A. axis will only move in the direction of the home position.
Bounce RA and Park	The motion that caused the limit switch to activate will be stopped, and a short slew or "bounce" in the opposite direction will be made to disengage the limit switch. RA tracking will stop and the mount will be in a parked state.

Encoder: This drop-down list box configures the encoder operation. There are two options: *Enabled* and *Disabled*.

Encoder Trim: You can adjust the encoder-based trim rate with this setting. Encoder trim can be set to adjust for the apparent non-sidereal tracking rate of objects due to atmospheric refraction, polar misalignment, flexure and other causes.

Encoder trim is entered in arc-seconds per hour, and will trim the R.A. tracking rate without affecting the R.A. coordinates in the servo. ***DO NOT use any encoder trim if you are also using the APCC pointing model!*** Use the tracking correction in the Pointing Model instead. See your 3600-LSS-PE-instructions for more details.

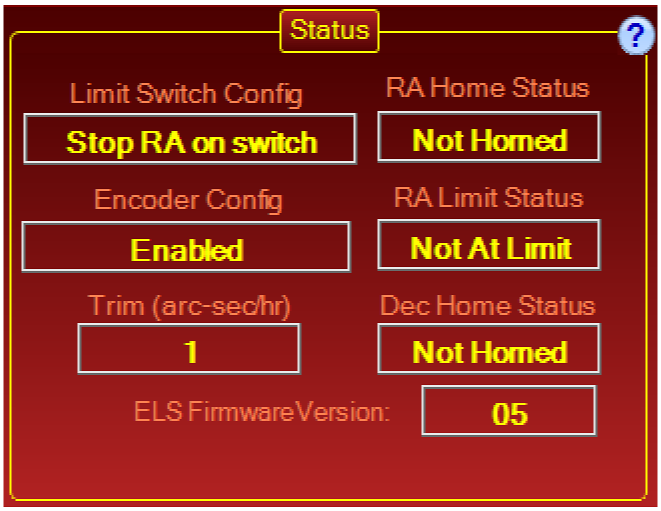
Set: For all of the above configuration settings you need to click the appropriate 

button to save the change. You *must* press the set button after selection for the changes to take place.

Set Encoder Trim value on connect: When enabled APCC will automatically set the encoder trim value when you connect to the mount.

Status

The Status box is where information is read directly from the mount.



Limit Switch Config: This is the read back of the limit switch setting.

Ignored	The limit switches will be ignored.
Zero RA on Switch	RA tracking will stop when the switch is reached. The R.A. axis will only move in the direction of the home position.
Bounce RA and Park	The motion that caused the limit switch to activate will be stopped, and a short slew or "bounce" in the opposite direction will be made to disengage the limit switch. RA tracking will stop and the mount will be in a parked state.

RA Home Status: Either *Homed* or *Not Homed*. The "Homed" response will be given whenever the home switches are activated. This does not necessarily imply that the mount is precisely at the home position that you will define below with the Establish Home routine. It simply means that the respective Home Switch has been closed.

Encoder Config: Either *Enabled* or *Disabled*.

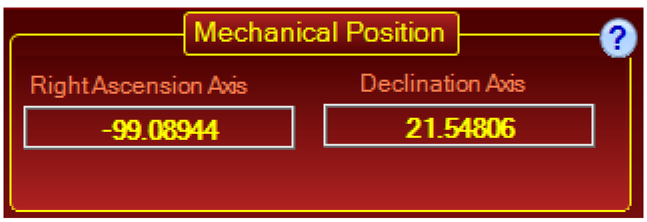
RA Limit Status: Either *Limit* or *Not at Limit*.

Trim: The currently set encoder trim value in arc-sec/hour. Please note that a returned value that is different from the entered value by one or two arc-seconds per hour is not uncommon. The value internal to the encoder system will be correct.

Dec Home Status: Either *Homed* or *Not Homed*. As with the R.A. Home Status above, the "Homed" response will be given whenever the home switches are activated. This does not necessarily imply that the mount is precisely at the home position that you will define below with the Establish Home routine.

ELS Firmware Version: The version of firmware in the GTOELS box.

Mechanical Position



Right Ascension Axis: The internal mechanical angle (degrees) of the Right Ascension Axis. The mechanical position is relative to the established home position.

Declination Axis: The internal mechanical angle (degrees) of the Declination Axis. This mechanical position is also relative to the established home position.

Home Position

Overview: The Home position is a mechanical position that roughly mimics the Astro-Physics Park 2 position for conventional scope orientations (Park 3 for side-by-side setups). Its precise position can be adjusted by a small amount via the actuators on the mount, and we have developed a routine to establish a precise mapping to celestial coordinates. The general work flow description will be provided below the information for each of the individual components in the home position box.

Config Drop-down Box: This selection tells *APCC* whether your telescope is set up in the conventional orientation (Home roughly equivalent to the AP Park 2 position) or in a side-by-side setup (Home roughly equivalent to Park 3). A third "Custom" setting is also available. This configuration then provides you with default values for the settings described immediately below.

Settings: The settings defined in this window determine how the mount will perform its Establish Home and Find Home routines.

APCC Home Settiings

Iterations: This is the number of homing slews that will be used to create the average value in the Establish Home routine. Five iterations is a good value to use with three being the minimum number of iterations that we would recommend. This setting does NOT apply to the Find Home routine.

Slew Rate: (In sidereal units) Because the homing function involves the closing of mechanical switches, precision is improved by using slower slew rates than you might for normal GoTo operation. We have found 200X to be a good compromise between accuracy and speed for this procedure. This rate will be used in BOTH the Establish Home routine and in the Find Home routine if you get the mount lost at a later time. This slower rate ONLY applies to the final short slews into the home position.

Slew Settle Time: Set a value to allow the mount to settle at its position before the next action is undertaken. For the Establish Home routine, this is the settle time before coordinates are read into memory for averaging. For the Find Home routine, it is the settle time before the saved average home coordinates are used to calibrate the GTO Servo Control Box's pointing position.

Custom Slew Coordinates before Homing: *APCC* uses these coordinates as the "jumping off point" for going home. They are used as the coordinates to which the mount slews between iterations in the Establish Home routine, and they are the coordinates used before the final approach to home in the Find Home routine. The recommended Custom Slew coordinates are in the table below.

	Northern Hemisphere - Conventional	**Northern Hemisphere - Side-by-side**	**Southern Hemisphere - Conventional**	**Southern Hemisphere - Side-by-side**
Hour Angle	-5:00	7:00	-5:00	7:00
Declination	15°	75°	-15°	-75°

Establish Home: If you have home and limit switches installed with GTOELS support, clicking this button will perform multiple same-direction slews to the home position. Before using this procedure, make sure that you are accurately polar aligned and have recently re-calibrated or synched. You only need to perform the establish home routine once unless you subsequently move the mount via the clutches or move the mount physically as in redoing the polar alignment. Changing the positions of the actuators will also necessitate redoing the Establish Home routine. However, you may repeat the procedure as often as you like - it simply isn't necessary unless the system has been moved manually.

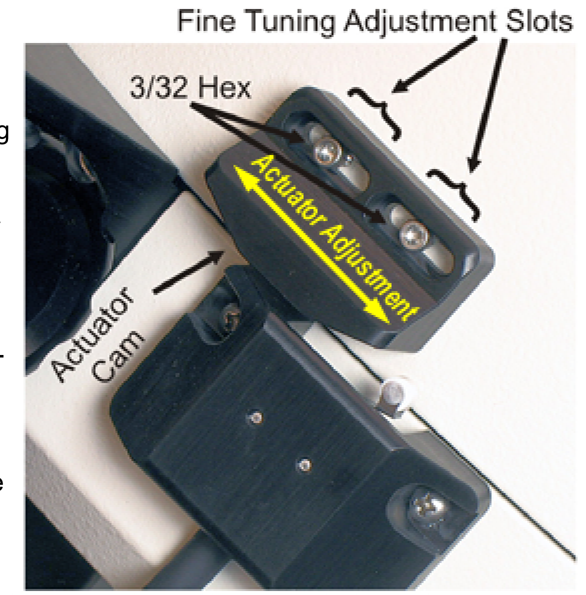
When you click the Establish Home button, the mount performs a number of pairs of slews into and out of the home position. These short slews always come from the same position and are done at the same rate to improve consistency. By having an accurate calibration before you start, and then by averaging the celestial coordinates of the home positions, an extremely accurate mapping can be made between the physical position of the mount when homed by the switches, and the sky. These averaged coordinates are stored in *APCC* for future use if you ever get your mount lost and need to use the Find Home routine.

The Establish Home routine should be considered as one of the final parts of your system setup. It is something you perform after the mount is fully polar aligned and the system is fully loaded and balanced. Once completed, it seldom needs repeating.

Find Home: If you have home and limit switches installed with GTOELS support, clicking this button will move the mount to the Home position. Before you can do this you must have previously defined the Home position by using the Establish Home routine. Clicking this button will cause the mount to slew to the home position at the normal slew rate. *APCC* will then perform a full Sync on the saved coordinates and then slew out to the Custom Slew Coordinates before Homing. Finally *APCC* will slow to the slew rate selected in the Home Settings Window and make a final slew into the home switches. The mount will be allowed to settle, and then it will be re-calibrated on the saved average home coordinates from the Establish Home routine. In testing, first GoTos after intentionally getting totally lost and then running this routine have resulted in pointing that was within a few arc-minutes.

General work flow for precise recovery using the Home Position:

Part 1 - Establishing your Home Coordinates



Declination Home Switch & Actuator

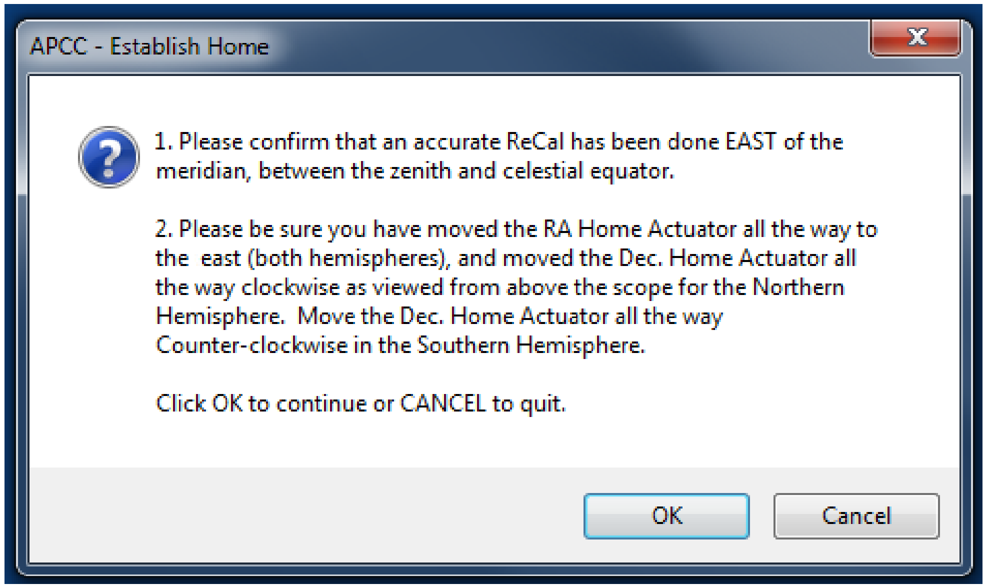
1. Adjust your Home Switch Actuators using a 3/32" hex wrench.

   For best results, adjust the R.A. actuator all the way to the east in its fine tuning adjustment slots, regardless of the hemisphere you are in. Note that the hemispheres are opposite in terms of left-right, but are consistent in terms of the cardinal direction EAST. In the northern hemisphere, adjust the Dec. actuator as far clockwise when viewed from above the axis as possible. In the southern hemisphere, move the actuator as far counter-clockwise as possible. These settings will ensure that the home position is at a positive altitude and a small distance away from a quadrant boundary.

Northern Hemisphere	Southern Hemisphere

	Move East	
	Move Counter-clockwise	

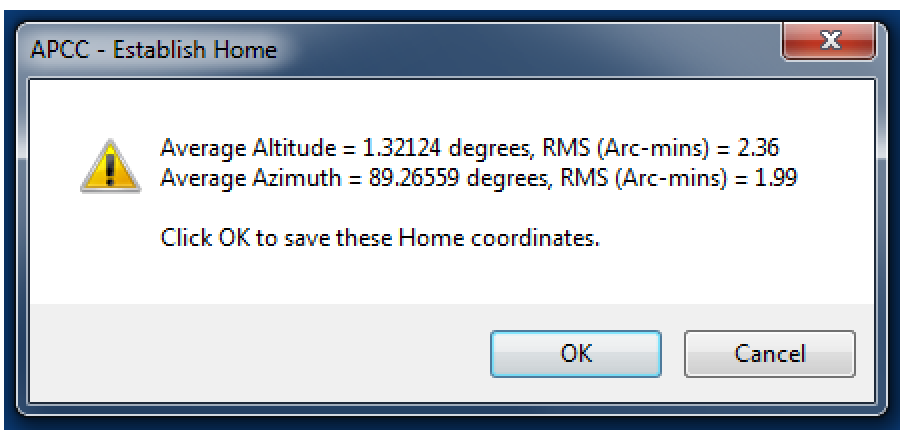
2. Make sure you are fully polar aligned. If you refine your polar alignment in the future, you may wish to repeat the Establish Home routine.
3. Your system should be completely assembled and balanced with the clutches tightened to their operational level. If you move the mount via the clutches at a later time, you will need to repeat the Establish Home routine.
4. Calibrate on a star just on the east side of the meridian and just on the celestial equator side of your zenith. For best results, use the "Plate Solve and ReCal" feature in APPM, if you are using the Pro version of APCC.
5. Select the ELS Tab.
6. Choose your scope configuration - Normal, Side-by-side, or Custom
7. Click the Settings Button.
8. Set the various parameters in the Settings window according to the instructions above. Then click OK to accept.
9. Click the Establish Home button. The following dialog box will appear:



Click OK to proceed.

10. Wait while the mount performs the number of homing slews that you chose under "Iterations" in the Settings window.

11. When APCC is finished with the routine, the following dialog box will appear (with somewhat different values):



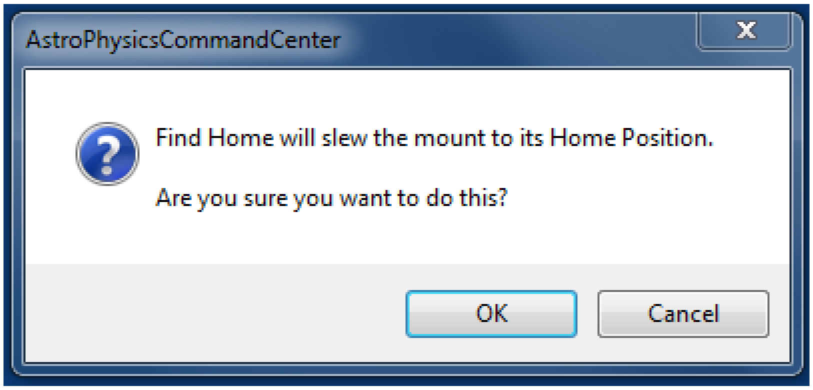
12. Click OK to save the averaged coordinates.

Part 2 - Finding Home if you get your mount lost.

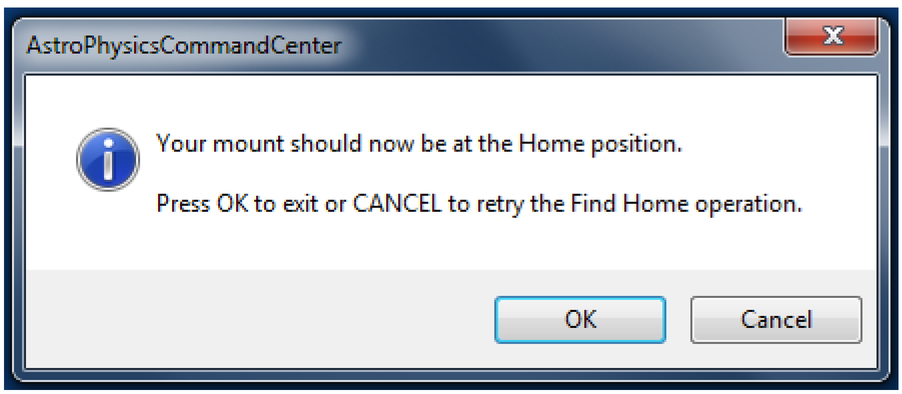
You do NOT need to use the home functions in normal operation of your mount. You only need to use the Home function if you have caused your mount to become lost. The Home function should not be thought of as an alternative method of parking the mount.

1. Select the ELS Tab.

2. Click the Find Home button. The following dialog box will appear:



3. Click OK to proceed.
4. Wait while the mount slews to the home position. IT WILL SLEW TO THE HOME POSITION TWICE! The first slew will be at your normal slew rate. Then the mount will slew the short distance to the Custom Slew Coordinates before Homing. And finally, the mount will slew back to the Home position at the slower rate that you selected in the Home Settings window. When it has settled, the following dialog box will appear:



5. Click OK to recalibrate the mount at the Home coordinates.
6. Go to any star or coordinates, center and recalibrate. Or, simply use APPM again for another "Plate Solve and ReCal."

6.12 Park Tab

> **Important: If you unpark your mount with APCC, you must park it with APCC or through the AP V2 ASCOM Driver. Do not try to park it with your Keypad or any other non-ASCOM program. DO NOT use the Keypad to unpark the mount if using APCC.**

> **Tip:** We advise you to use the same "Park to" and "Unpark" positions in both APCC and the AP V2 ASCOM Driver. **For normal operation, Unpark should always be set to Last Parked.**

Unpark

This group box allows you to unpark the mount. Clicking *Unpark* will unpark from the position specified. The park positions include *Last Parked, Park 1, Park 2, Park3*, *Park 4, Park 5* and *User Defined Alt/Az*. Refer to the illustrations and explanation of the four predefined park positions 1,2, 3, 4 and 5 below.

Note: This feature is very useful for a modified version Astro-Physics Daytime Polar Alignment Routine that is outlined in your keypad manual.

Use Unpark from *Last Parked* for all normal operations.

Park

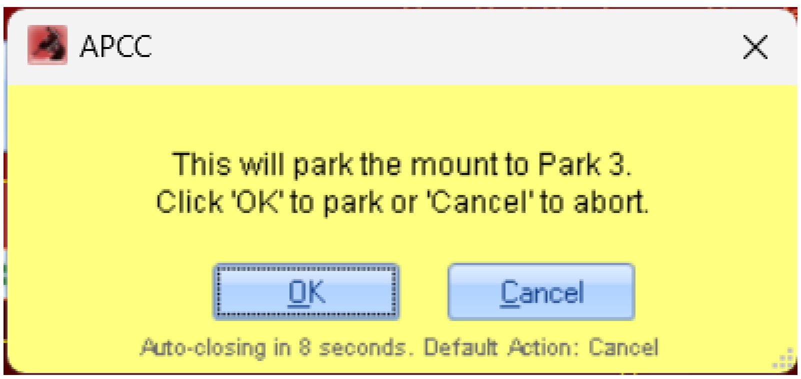
Park: Parks the mount to the park position specified. The park positions include *Current Position, Park 1, Park 2, Park3*, *Park 4, Park 5, User Defined Alt/Az and Home Position.* Park 1-5 are illustrated below.

Park to this Position: The park positions include *Current Position, Park 1, Park 2, Park3*, *Park 4, Park5, User Defined Alt/Az and Home Position* **.** The next time you initialize the mount, this selection will be remembered and automatically used. If your situation changes before your next session, you can alter your selection in the APCC Initialize Mount window at the time you initialize. Note that Park 4 is now the recommended reference park position, and that Park 1 is considered obsolete (see below).

User Park Position: You can manually set park position to a *User Defined Alt/Az* position via the *Alt* and *Az* fields. Simply click the up-down arrows or enter the number directly into the field. This is a useful feature if you must park your mount in a certain position so that your observatory roof will close without striking your telescope. It is also useful for aiming the scope at a flat-fielding box.

Set User Park as Current Alt/Az: Clicking this button will set the mount's current Alt/Az position as the *User Defined Alt/Az.* The position can be at a negative altitude (below horizon) and/or in a counterweight-up position. **However, note that the Safety Park feature cannot park to a counterweight-up position.**

Confirm before parking: When this option is checked, APCC will ask you if you are sure you want to park the mount. You must click the OK button for the park command to continue.



Unchecking this option will initiate the park command without first asking you.

Safety Park

Safety Park (mins): When checked, APCC sends a special command to the mount approximately every 10 seconds. The special command resets a "watchdog timer" internal to the mount's servo control box. The mount will be automatically parked after the time interval if the special command is not sent to the mount during that time period. This watchdog timer feature will prevent the mount from tracking your telescope into the pier should the computer freeze or crash or even if the serial connection is broken or fails.

When active, the current time countdown (before the mount is automatically parked) is shown above the numeric input box.

Safety park to this position:

In Place - The mount will park at its current position.

Home Position - The mount will park to the home position. This option is only available to mounts with P02-xx firmware and a GTOCP4 and GTOCP5 controller.

Configured park position - The mount will park to the configured park position in the **Park** group box. This option is only available to mounts with P02-xx firmware and a GTOCP4 and GTOCP5 controller.

Important: *the Safety Park feature cannot park to a counterweight-up position.*

Special Note for TheSkyX Users

If parking from TheSkyX, you will need to set up the park position in BOTH TheSkyX and the two Astro-Physics programs - APCC and the Driver.

1. In TheSkyX, first clear the park position.
2. Using APCC or the driver, park to your chosen park position.
3. In TheSkyX, set park position.

You should now be able to park from TheSkyX. Note that the mount will appear to park twice, although there should hopefully only be one slew.

Safety Park

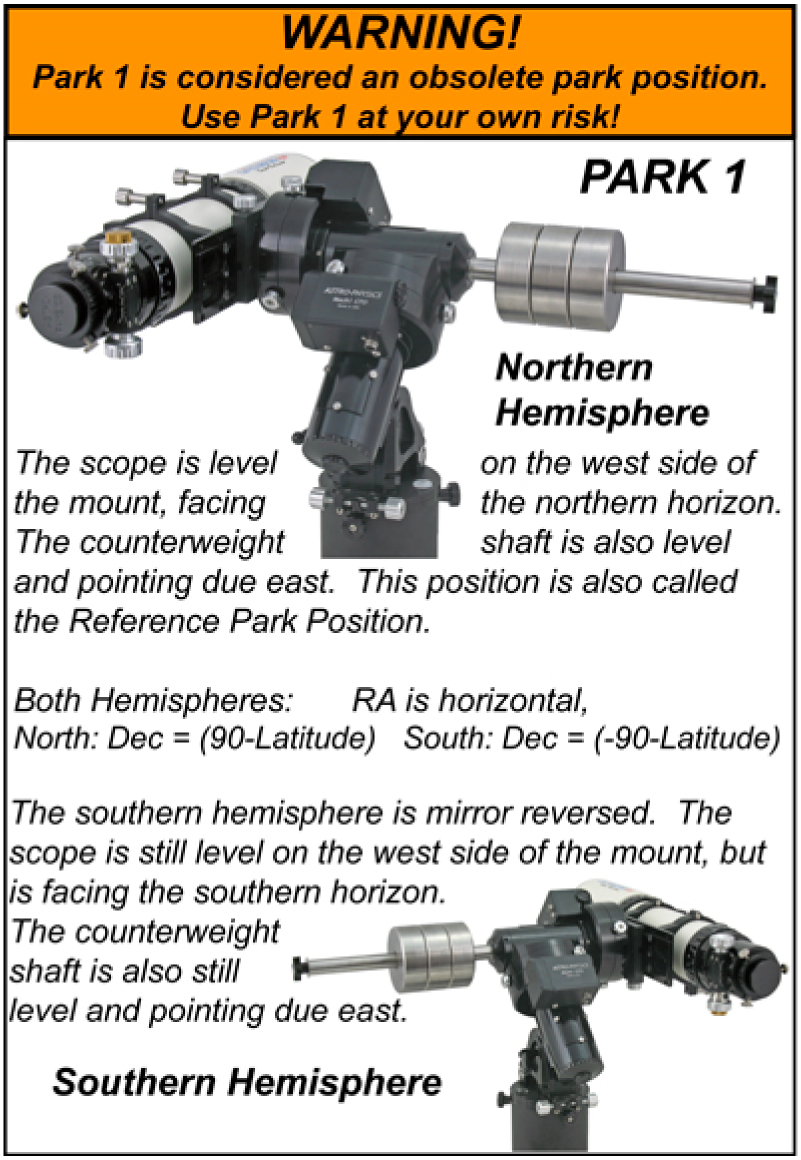
Enable Safety Park: This feature has been added to APCC as a mandatory safety feature. It will assure that if power is lost to the mount and your computer, the mount will automatically enter a parked state at its current position. If power resumes, the mount will not start tracking.

Park Positions

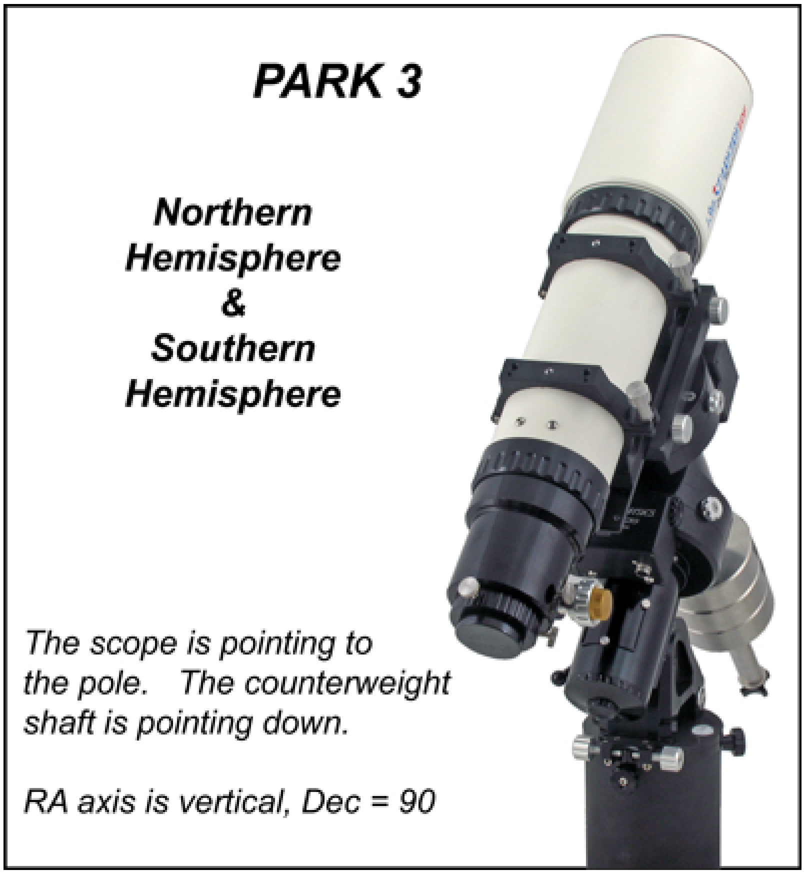
In the past, Astro-Physics always had three defined park positions, cleverly named Park 1, Park 2 and Park 3. We have now added fourth and fifth park positions. Park 4 has relegated Park 1 to "obsolete" status. It is our intent that Park 4 should replace Park 1. Park 4 is a reference park position, like Park 1 was. However, while retaining all of those benefits, it eliminates the problems that existed with Park 1. Park 4 is on the east side of the mount and the commencement of sidereal tracking will therefore not immediately put the mount into a counterweight-up position. Slews out of the Park 4 position will almost never swing the scope below the horizontal as they often would do when slewing from Park 1 to positions west of the meridian. Park 4 is safer and equally useful. If you have your heart set on still using Park 1, it can be used, but please use caution and heed our warnings.

Park 5 is like Park 4, except with the scope pointing North in Northern hemisphere, and South in the Southern hemisphere.

Park 1, 2, 3, 4, and 5 are described below:


WARNING!
Park 1 is considered an obsolete park position.
Use Park 1 at your own risk!
PARK 1
Northern Hemisphere
The scope is level on the west side of the mount, facing the northern horizon. The counterweight shaft is also level and pointing due east. This position is also called the Reference Park Position.
Both Hemispheres: RA is horizontal,
North: Dec = (90-Latitude) South: Dec = (-90-Latitude)
The southern hemisphere is mirror reversed. The scope is still level on the west side of the mount, but is facing the southern horizon.
The counterweight shaft is also still level and pointing due east.
Southern Hemisphere


PARK 2
Northern Hemisphere
The scope is level on top of the mount facing the eastern horizon. The counterweight shaft is pointing down.
Both Hemispheres: RA axis is vertical, Dec = 0
The southern hemisphere is mirror reversed. The scope still points to the eastern horizon, but east is to the left when facing the southern pole.
Southern Hemisphere


PARK 3
Northern
Hemisphere
&
Southern
Hemisphere
The scope is pointing to
the pole. The counterweight
shaft is pointing down.
RA axis is vertical, Dec = 90


PARK 4
Northern Hemisphere
The scope is level on the east side of the mount, facing the southern horizon. The counterweight shaft is also level and pointing due west. This position is the New Reference Park Position.
Both Hemispheres: RA is horizontal,
North: Dec = (-90+Latitude) South: Dec = (90+Latitude)
The southern hemisphere is mirror reversed. The scope is still level on the east side of the mount, but is facing the northern horizon. The counter-weight shaft is also still level and pointing due west.
Southern Hemisphere

6.13 GoTo/Recal Tab

GoTo/ReCal to RA/Dec

The **GoTo/ReCal to RA/Dec** group box allows you to enter your own coordinates for a slew. Coordinates can also be loaded from previously saved coordinates on the dropdown list, or the your current coordinates can be loaded directly from the mount for saving. These features are especially useful for a number of imaging tasks:

- If you have framed an object at coordinates that are not quite those that are from a catalog, simply load the current "framed coordinates" and save them. Future GoTos to the saved coordinates will place the object in your framing.
- Do you have the perfect focus star for your object? Go to the star, center it, and then load and save the star's coordinates for subsequent focus runs.

Entering Coordinates: Coordinates can be entered manually into the coordinate fields either in sexagesimal (HH:MM:SS or DD:MM:SS) form, or in decimal (HH.hhhhhh or DD.dddddd)form.

If you enter in decimal form, you might see a small warning exclamation point next to the field. The warning is simply to get your attention to be sure you intend the decimal entry. Simply press enter or click into the next field to see the decimal converted to sexagesimal. If entering in normal sexagesimal form, you can use your computer's Tab key to progress through the fields. Declination values can range from -90° to +90°. RA values can range from 0 to 23:59:59.

You can also enter a decimal value in the **Mins** fields for both RA and Dec. The decimal portion will be converted into seconds automatically when you press the enter key or leave the field.

The RA field can also be used as an hour angle field by checking the Hour Angle checkbox. The hour angle is most easily thought of as the distance from the meridian (meridian = LST) in RA. Positive hour angles are west of the meridian. Negative hour angles are east. The hour angle at any point in time is simply the meridian coordinate minus the RA coordinate (HA = LST - RA). Hour angles are especially useful if you are not tracking. If the mount is tracking, RA remains constant while the hour angle (and the meridian) keep changing with time. If you are stopped (not tracking), your hour angle remains constant, but the RA value will keep changing with time. Park positions, for example, are ideal candidates for coordinates expressed in HA and Dec. Hour angle values can range from -12:00:00 to +12:00:00. To specify an hour angle that is east of the meridian by under an hour (i.e., less than 60 arcminutes), enter -0 for hour angle.

Lastly the entered coordinates can be entered in either the **J2000** epoch or **JNow** (**local apparent)**. The **J2000** check box identifies the epoch of the coordinates.

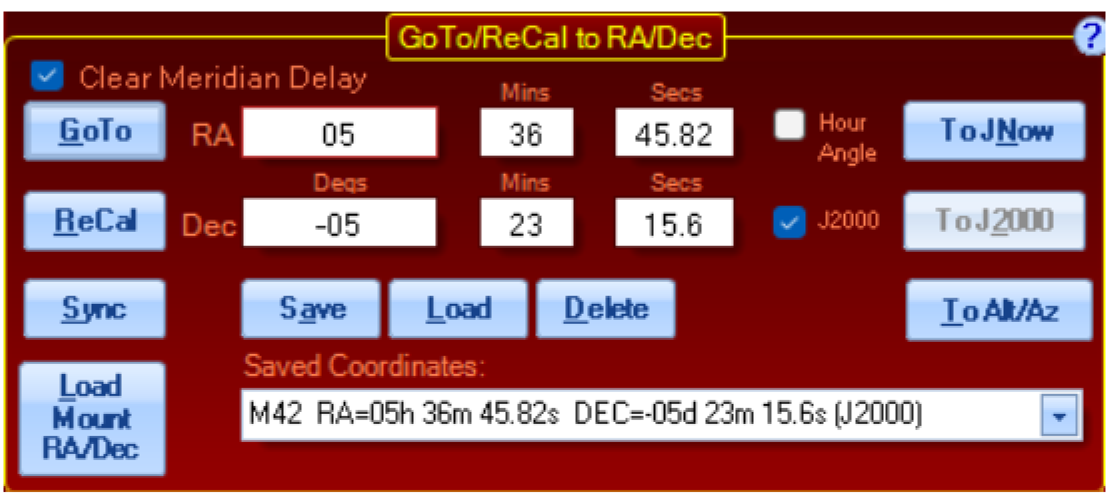
To JNow - converts coordinates from the **J2000** epoch (**J2000** check box enabled) to local apparent (**JNow**). This is extremely useful for entering catalog coordinates which are almost always in J2000.

To J2000 - converts coordinates from the **JNow (local apparent)** (**J2000** check box disabled) to the **J2000** epoch. This is normally used after loading the current Mount coordinates to compare them to a set of catalog coordinates.

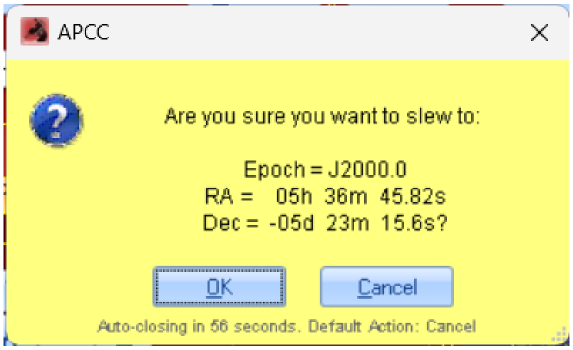
To Alt/Az - converts coordinates to Alt/Az and fills the fields in the **Goto/Recal to Alt/Az** group box. If **J2000** is checked the coordinates will be converted to local apparent first, then converted to Alt/Az.

Clear Meridian Delay: Normally you will want this check box enabled as it can prevent a pier collision. When enabled, the resulting slew position will always be with the telescope counterweight down.

However, if you want to slew to a counterweight-up position, then you may need to disable this option and set the mount's meridian delay appropriately. **Care should be taken to prevent a pier collision!**



GoTo: Clicking this will slew the mount to the RA/Dec position you have entered. A confirmation dialog box will appear. Click OK to initiate the slew.



The Emergency Stop Window will appear if you have clicked the appropriate check box on the Setup Tab. You can disable the Emergency Stop Window using the check box, if you wish.

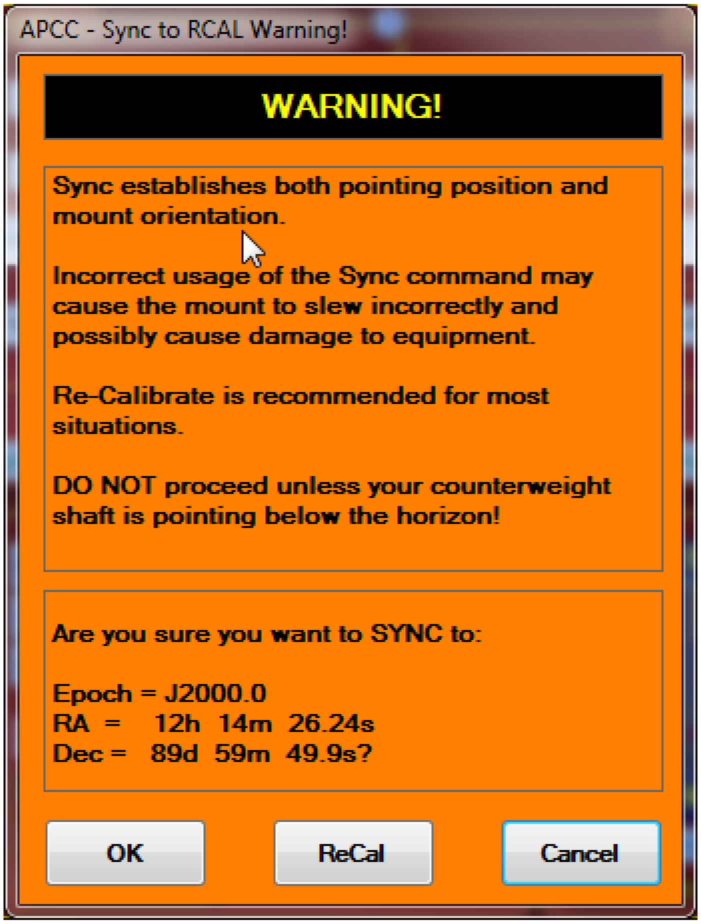
Note that when the mount is slewing, the values in the Telescope Position group box will change as the slew progresses and the word "SLEW" will flash. Note that the E and W in the upper corners of the graphic indicate the pier side. Click on 3D View to watch a representation of your telescope as it moves.

ReCal: Clicking this will Recal the mount to the RA/Dec position you have entered. In most circumstances, you will want to ReCal rather than Sync. ReCal is used to recalibrate the position of the mount if an object does not appear in the center of the field. Recalibrate can be used even when the object is past the meridian and the telescope is below the mount. ReCal recalibrates on the last object to which the telescope was sent.

NOTE: You can only use the ReCal option if APCC has the target object in its memory, i.e. you just gave a slew command and APCC already knows it should be at a particular position. You cannot use the ReCal option if you manually move the telescope to another position, since APCC has no way of knowing the position of that object. In this situation, use Sync as described below. For more detailed discussion, refer to the section below entitled: Sync Explained in Detail and Compared to Recalibrate.

Sync: Clicking this will Sync the mount to the RA/Dec position you have entered. Since misusing Sync is a common occurrence, a warning will display when you make this selection. In particular, be very careful that the mount is not in a counterweight-up position when syncing, as it might be if you are using the Meridian Delay feature. For more detailed discussion, refer to the section below entitled: Sync Explained in Detail and Compared to Recalibrate.

Please read the warning, think carefully and make the appropriate selection.

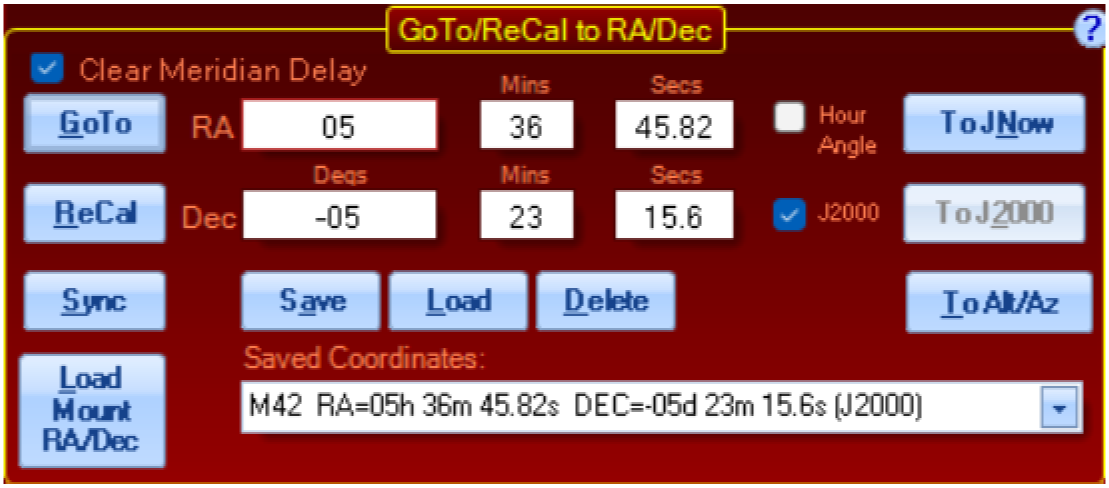


Save: This will save the RA/Dec coordinates to the drop-down list.

1. First, manually enter the coordinates or **Load Current** (see below) the coordinates that you wish to save.
2. Confirm the coordinates that populate the coordinate fields.
3. Select the **Save** button.
4. The **Saving GoTo Position** window will prompt you to enter an optional title. If you do not enter a title, one will be created for you based on the position in the drop-down box, for instance: Saved #9.

5. Click **Save** or **Save New**. **Save** will update the currently selected entry, while **Save New** will create a new entry.

6. If you decide that you want to remove any items from the list, select that item from the drop-down box and click the **Delete** button.



Load: Select the desired target from the drop-down list box. When you click the **Load** button, the RA/Dec coordinates with the selected values from your target object will populate the RA/Dec fields.

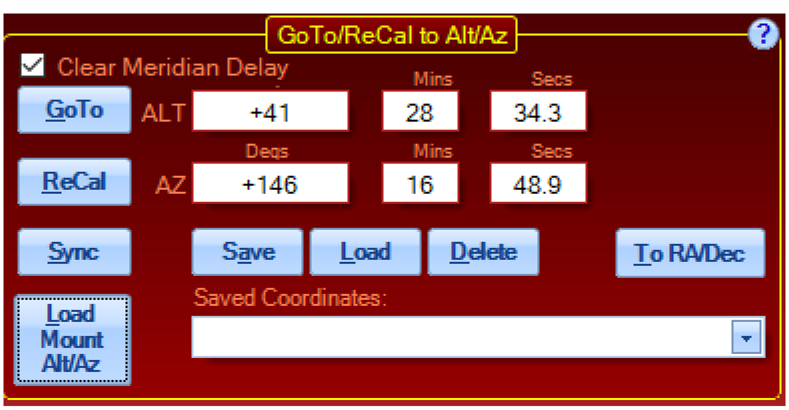
Load Mount RA/Dec: Polls the mount for its current position and then loads the RA/Dec fields with the mount's current coordinates.

GoTo/ReCal to Alt/Az

Altitude and Azimuth coordinates are entered in much the same way as the RA and Dec coordinates described above. Here too, entries can be in sexagesimal or decimal form. Valid entries for altitude are from -20 to + 90 degrees, although it is very unlikely that you will ever use negative altitude values. Azimuth values can range from 0 to 359°59'59". Az = 0 is always due north (regardless of your hemisphere). Az = 90 is due east. Az = 180 is due south. And Az = 270 is due west.

As with RA/Dec, you can enter a decimal value in the **Mins** fields. The decimal portion will be converted into seconds automatically when you press the enter key or leave the field.

All of the actions and buttons below are like the ones above where they are explained in greater detail.



Clear Meridian Delay: Normally you will want this check box enabled as it can prevent a pier collision. When enabled, the resulting slew position will always be with the telescope counterweight down.

However, if you want to slew to a counterweight-up position, then you may need to disable this option and set the mount's meridian delay appropriately. **Care should be taken to prevent a pier collision!**

GoTo: Clicking this will slew the mount to the Alt/Az position you have entered.

ReCal: Clicking this will recalibrate the mount to the Alt/Az position you have entered.

Sync: Clicking this will sync the mount to the Alt/Az position you have entered. Be very careful that the mount is not in a counterweight-up position when using this.

Save: If you want to save the position, click the **Save** button. You will be prompted to enter a title, if you wish. Click **Save** to change the selected position, or **Save New** to save as a new entry in the list. The Alt/Az coordinates will be added to the description. You may also cancel or clear, if you change your mind about saving the item.

If you decide that you want to remove any items from the list, select that item from the drop-down box and click the Save button. Then click the Clear button.

Load: Select the desired target from the drop-down box. This will load the Alt/Az coordinates for the target object into the Alt/Az fields.

Delete: If you decide that you want to remove any items from the list, select that item from the drop-down box and click the **Delete** button

To RA/Dec: Converts the displayed Alt/Az coordinates to RA/Dec and fills the fields in the RA/Dec group box with the coordinates.

Load Mount Alt/Az: Polls the mount for its current position and then loads the Alt/Az fields with the current coordinates.

Sync Explained in Detail and Compared to Recalibrate

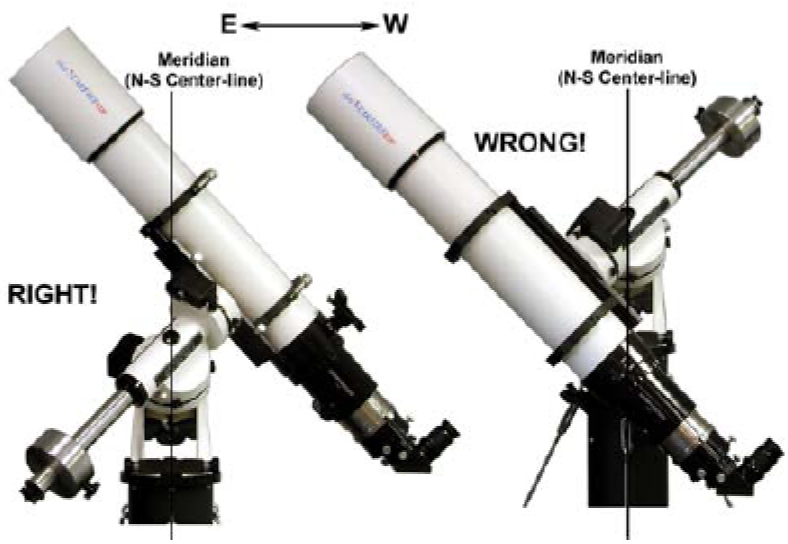
Sync and Recalibrate are often used as synonyms in everyday use, but to APCC and the GTO Control Box directing the movements of your mount, they are different and distinct. Understanding this distinction will aid you in enjoying your Astro-Physics GoTo system.

The Sync command is typically used at the beginning of an observing or imaging session. Sync tells the mount where it is pointing and defines which is the telescope side and which is the counterweight side. It is a powerful command in that it disregards earlier slewing commands and starts over. It does not take the last entered position into account, but tells the mount – “You are here,” based on the object (actually, the coordinates) displayed on the keypad or computer screen. It assumes that the telescope is correctly pointed with the sync object and the telescope on opposite sides of the meridian.

Each time you use sync, you redefine the orientation of the telescope and counterweight to the mount. If used in the wrong way, the sync command will cause the mount to slew incorrectly and possibly cause damage to equipment. It should therefore be used with caution.

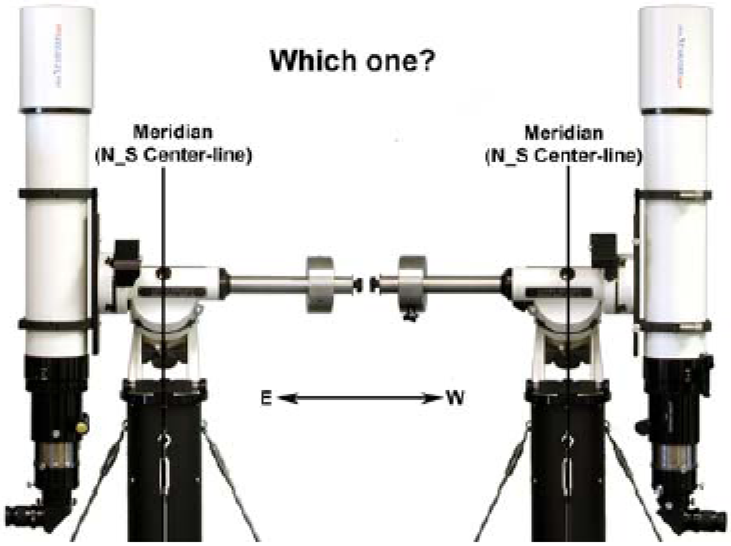
Why is the Sync command a potential problem if used incorrectly? There are two main reasons. The first reason comes from the fact that both axes of the mount are full 360° circles that are not restricted in their motion. The second comes from the fact that the mount must rely on the information it is given: in particular, the date, time, daylight savings and location data to know where the meridian is. As smart and sophisticated as these systems are, they cannot see the sky or their own orientation and must rely on the operator to give them their proper start.

Let's examine the first issue. Why would the full circular nature of the axes create a problem potential? First, if you loosen your clutches, and then remove your telescope, mounting hardware and counterweight shaft, you can simply turn both axes round and round to your heart's content. Since the clutches were disengaged, the servo drive system can not possibly have any idea where the axes are pointing before you tell it by syncing the mount. This is a critical problem because of the fact that for any location in the sky, there would be two possible ways to point at it if there were no obstructions (like a pier) in the way. See the illustration below:



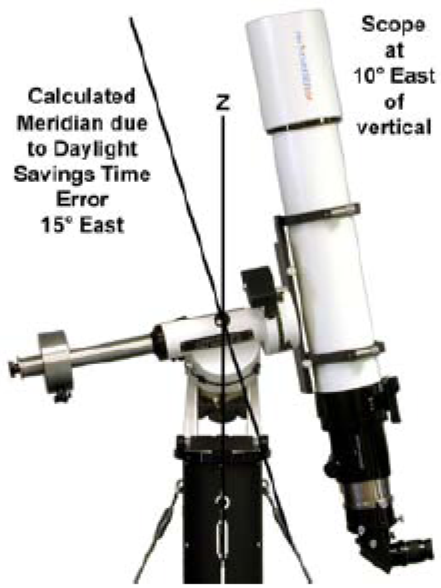
Both images show a telescope pointing at the same object. The image on the right is obviously wrong, and no experienced astronomer would position his or her mount like this, but the mount cannot know which alternative has been chosen. The software was therefore written to subsequently slew the mount assuming the sync position was correct as shown on the left. It bases its assumption of where the meridian is and where the pier is on the correct orientation of the system when it is synced.

Well, you might ask, if no one would be dumb enough to sync with their mount positioned like the one on the right in the illustration above, why even bring it up? The reason is that things aren't always as easy as the above illustration – it was designed to make the point obvious. Take a look at the next illustration. Is it OK to use sync in either of these situations? The answer is maybe, but I wouldn't really advise it.



This brings us to the second main reason that sync can be a problem if used incorrectly. The illustration above shows that it can be difficult to tell which side of the meridian you are pointing at when pointing near the meridian. This assumes that the meridian is where it's supposed to be. Now wait a minute, you say. We all know that the meridian is the north – south line that is straight up: directly overhead. It goes through the zenith. It has to be where it's supposed to be! That is true, but the mount can't see like you and I can. It can't look up and see the meridian; it has to calculate the meridian based on the data we give it. That data is the location, the date, the time and whether or not daylight savings is in effect. Errors in this data will result in errors in the calculated position of the meridian with respect to the object being synced.

Daylight savings is an easy example to understand. It changes our clocks by one hour, forward each spring, backward each fall. Each hour is equivalent to 15° of sky. Therefore, a simple mistake in the entered value (off or on) for daylight savings will throw the calculated meridian off by a whopping 15°. The next illustration shows this.



The telescope is 10° east of the true meridian. If syncing on a star with the telescope in this position, you would (and it should be on=1), the calculated meridian will be 5° too far to the east to sync! Likewise, just entering the wrong location (i.e. your back yard location number instead of your dark site location number) can throw you off by enough to make any sync close to the meridian worth reconsidering.

Sync is a very important, handy and powerful command. Don't be scared to use it, just follow these safe guidelines now that you understand how it works:

1. Your mount MUST be polar aligned. Since sync establishes the mount's orientation with respect to the telescope, counterweight shaft and pier, polar alignment is a prerequisite.

2. NEVER sync if your counterweight shaft is pointing up. Avoid syncing if your counterweight shaft is close to horizontal. Remember that the sync object and the telescope must be on opposite sides of the mount / meridian.

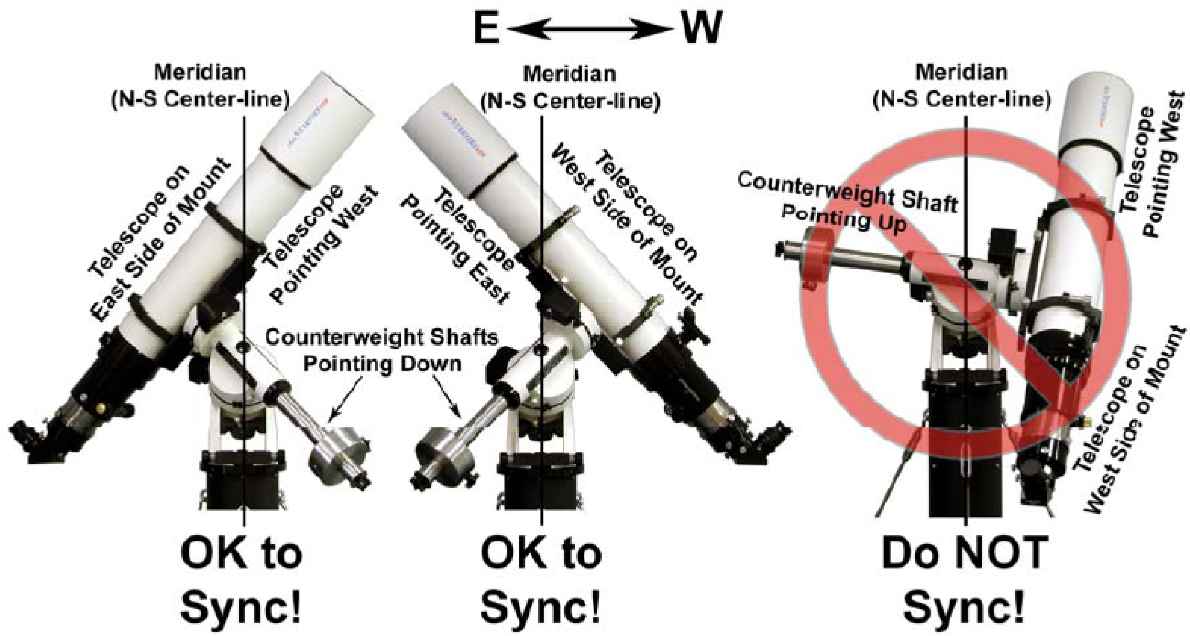
3. Do not use sync if your meridian delay feature is turned on. Meridian delay overrides the mount's orientation / clock information and can lead to the same problem as syncing when the mount is improperly oriented.

4. Compare the current LST value the R.A. value for the star you will be syncing on. Remember that the LST value changes along with time; you can't use the LST value you remember from several hours ago. If the R.A. number is larger than the LST value, the star is east of the mount's calculated meridian and the scope should be on the west side of the mount. If the R.A. value is smaller, the star is west of the calculated meridian and the scope should be on the east. This is an especially good way to check, since it uses the mount's calculated meridian and therefore bypasses any errors in time or location data.

5. To verify that everything is set correctly once you have synced, go to the RA and Dec entry screens on this GoTo/ReCal tab and enter the current LST value. For the DEC value, enter your latitude. Press GOTO. After slewing, your counterweight shaft should be perfectly horizontal. and the scope will be

pointing straight up as well. This is a good test because it also indicates whether your time and location data are correct.

6. Your sync will result in greater pointing accuracy if you sync to a single star that is close to the celestial equator, rather than close to your pole. This has nothing to do with the sync command itself, but instead is because of the geometry of the celestial sphere. Think of the longitude lines on a globe, how they are widest at the equator, but converge at the poles. A small error in centering a star near the pole would translate into a larger R.A. error than the same centering error on a star near the celestial equator.



In summary, you use the sync command once in an observing or imaging session unless the telescope gets physically moved by hand or by accident (as opposed to moved with the N-S-E-W buttons). While it can be used to tweak pointing accuracy, we prefer to use recalibrate for that. We also recommend that you Sync on objects that are at least 15 deg. (1 hour) from the meridian. This will help safeguard you from a potential clock related problem – i.e. you forgot about daylight savings time, and it makes it easier to see that the object and telescope are on opposite sides of the meridian. If you are permanently mounted and do not disturb the scope position, you do not need to use it after the very first setup.

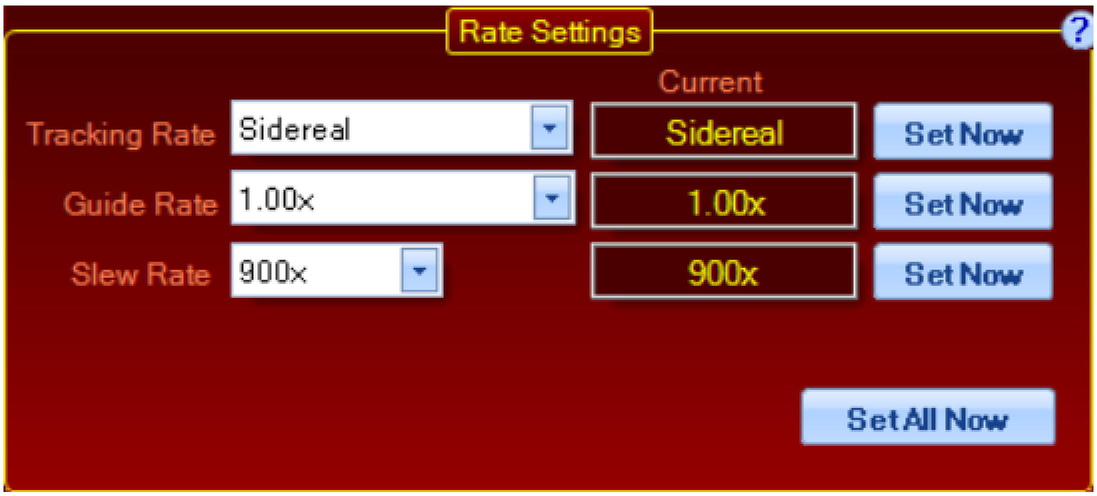
Recalibrate is the “tweak” command. It is quick and easy and is perfect for fine-tuning your pointing accuracy during your observing or imaging session. Rather than telling the mount where it is pointing, recalibrate corrects its minor pointing inaccuracies. Recalibrate works on the object in memory that the mount thinks it is already pointing at. Since it does not re-establish the mount’s position in memory, it doesn’t matter if the telescope and ReCal object are both on the same side of the meridian. It is therefore a safer command to use during your session.

Remember that for both commands, the preferred object of choice will always be a single bright star because it is a single point source. Avoid double or multiple stars if possible. Solar system objects can be useful for daylight syncing or recalibrating. In addition, remember that pointing accuracy is also dependent on the accuracy of the polar alignment and the orthogonality of the entire system.

CAUTION: It is important to note that external software programs may not make the same distinction between the 2 terms, so be careful when syncing or recalibrating (or whatever they call it) with other programs. For safety sake, we recommend that you utilize the SNYC -> RCal Translation safeguard described on the Virtual Ports tab.

6.14 Rate Settings Tab

Rate Settings



Use the drop-down menus to select from among the available rates in each category. Note that the current rate is the rate that is currently set in the mount (as read from the mount), and is not necessarily the rate displayed in the drop-down menu. Click the Set Now button to set the rate to the one you have selected. The value in the Current field will change to reflect your choice.

Tracking Rate: Sets the tracking rate to the selected value when you click the *Set Now* button.

Guide Rate: Guide rate is fixed at 1.00x for Astro-Physics mounts

Slew Rate: Sets the slew rate to the selected value when you click the *Set Now* button. Available slew rates in the pulldown menu will change based on the mount type connected (auto-fill slew settings requires version P02-01 or later).

> Note that for older 400GTO and 600EGTO mounts, the slew rates and the faster button rates may be a bit slower than what is displayed, depending on the gear heads that were used in your mount. The rates for the 3600GTO will also be slower due to slew scaling that was programmed into the control box settings for this mount.
>
> All current mounts as well as all 900GTO and 1200GTO mounts will move at the rates that are displayed.

Button Rate: Sets the move button rate to the selected value when you click the *Set Now* button.

Set All Now: Sets all of the above rates with one click.

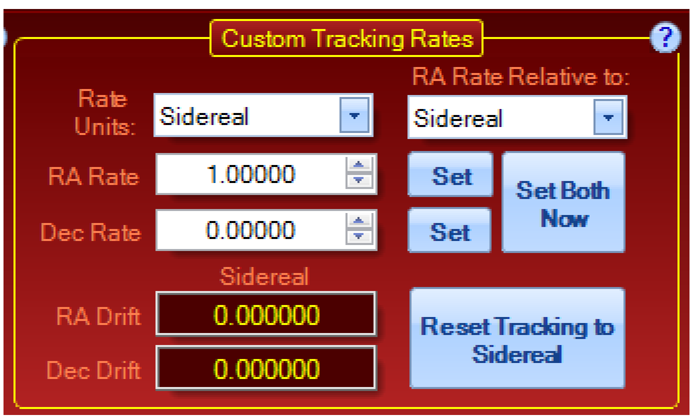
Rate Settings When Initializing APCC

When APCC is initialized at the beginning of your session, the rate settings that are set in the Initialization Window are the ones that will be sent to the mount. Please refer to the Initialization Window section for additional information.

Rate Settings in the ASCOM V2 Driver

APCC does not use these settings during the initialization routine since APCC is the program that initializes the mount, then calls the ASCOM V2 driver. The settings in both programs are independent of one another. When updates are made to one program, they do not change in the other program. We recommend that you always refer to the APCC status readings to determine the current settings that are active.

Custom Tracking Rates



Rate Units: Choices are Sidereal, Arc-Secs/Sec, and Arc-Sec/Hour.

RA Rate Relative to: Choices are Sidereal and Zero Rate. It is normal in astronomical thinking to treat sidereal as the basic default condition of a tracking mount with regard to RA. Therefore, RA tracking rates are generally relative to sidereal. As such, with sidereal being the null condition, an RA rate of zero is in fact the sidereal rate when the rates are relative to sidereal. Relative to sidereal, a stopped mount has a tracking rate of **-**1.00 x sidereal. Relative to zero is as its name implies, and relates the rate to a stopped mount.

RA Rate: Enter the RA rate and click *Set* to set the rate. You can either use the up-down arrows or enter the desired number.

Dec Rate: Enter the Dec rate and click *Set* to set the rate. You can either use the up-down arrows or enter the desired number.

Set Both Now: Sets both the RA and Dec rates simultaneously.

RA Drift: This is the current rate read back from the mount using the setting for "*RA Rate Relative To*".

Dec Drift: This is the current rate read back from the mount.

Reset Tracking to Sidereal: Resets tracking back to sidereal rate and the Dec rate back to zero.

6.15 Horizon Tab

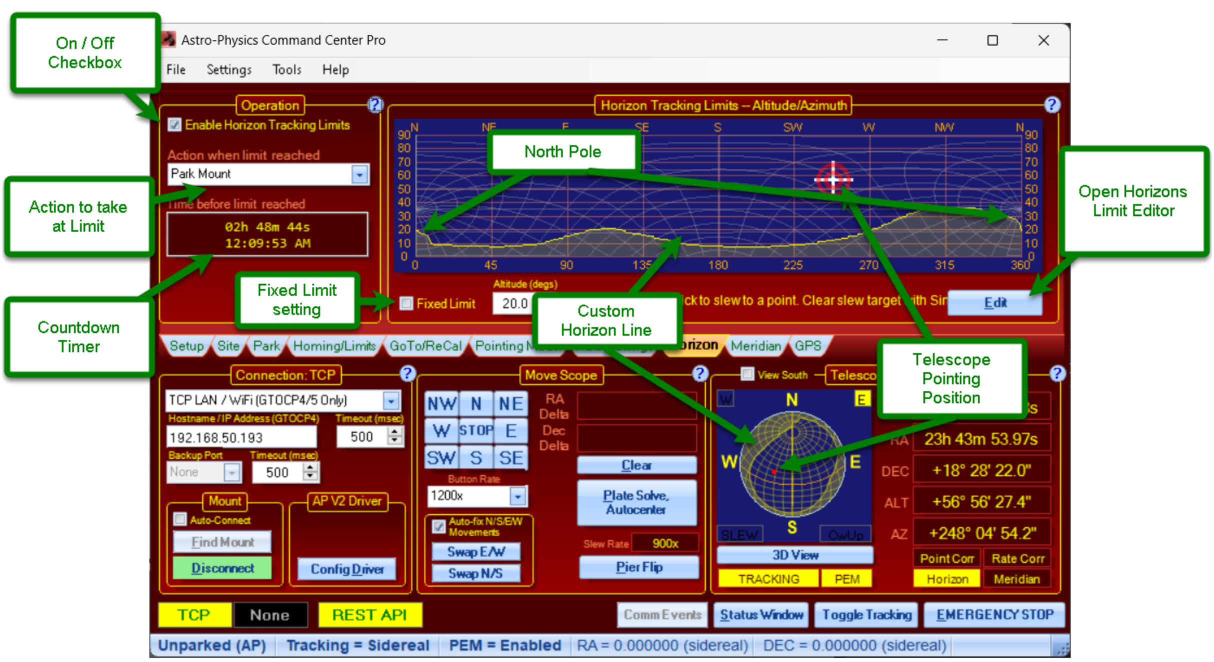
Overview

The Horizon Tab opens the Horizon Tracking Limits Window. Horizon Tracking Limits are limits that you set to represent your actual horizon at your observing location. With Horizon Limits activated, you can leave an imaging setup running unattended with the knowledge that the mount will take the action you have selected when the scope reaches your defined horizon.

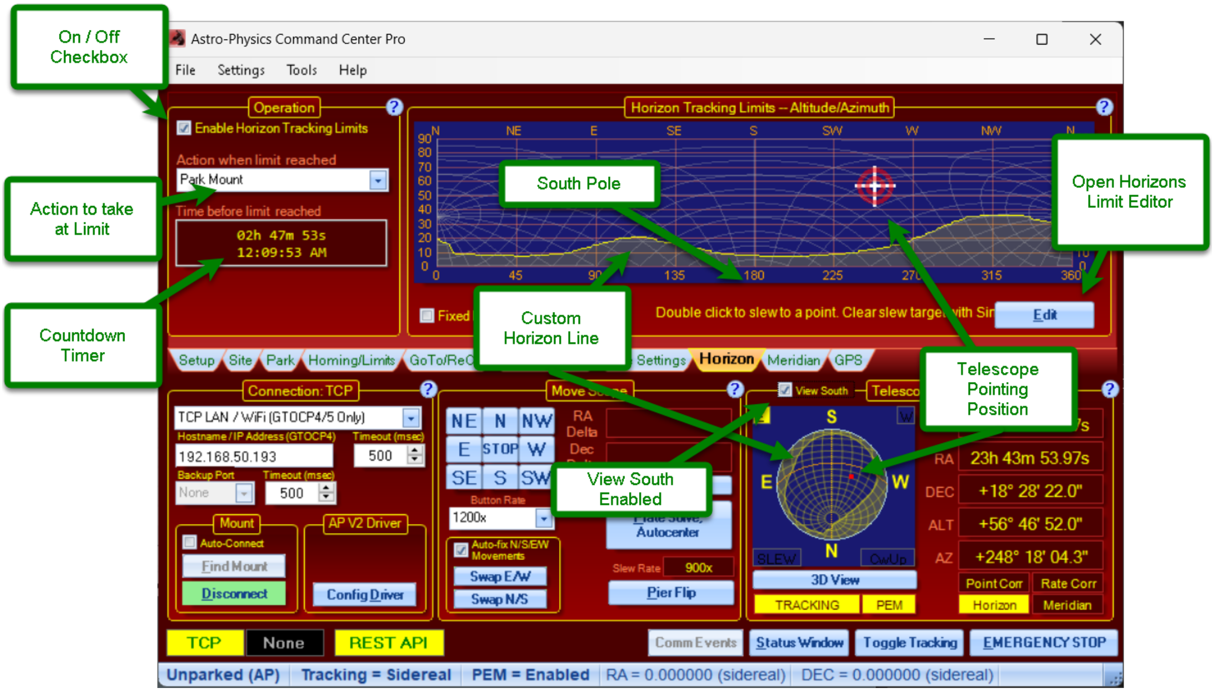
The horizon limits act upon a mount that is tracking. They do NOT prevent slews that will point the scope below your defined horizon. However, a slew into an area below the defined horizon limit will cause the mount to take your chosen action once the slew is completed and tracking commences. The horizon limits will NOT, however, save you from an errant slew command. See Notes at bottom of this page.

Use the Horizon Tracking Limits in conjunction with the Meridian Tracking Limits to define all of the allowable sky at which your scope can be pointed. Note that you should use the meridian limits to define the horizon in situations where the scope is past the meridian. Because these counterweight-up / scope-past-the-meridian positions will have higher usable horizons, you will not want the same limits as you will when the scope is in a traditional position. For users with the Pro version of APCC, the Horizon and Meridian Tracking Limits are also extremely useful in point mapping for the pointing and tracking correction functions.

Northern Hemisphere



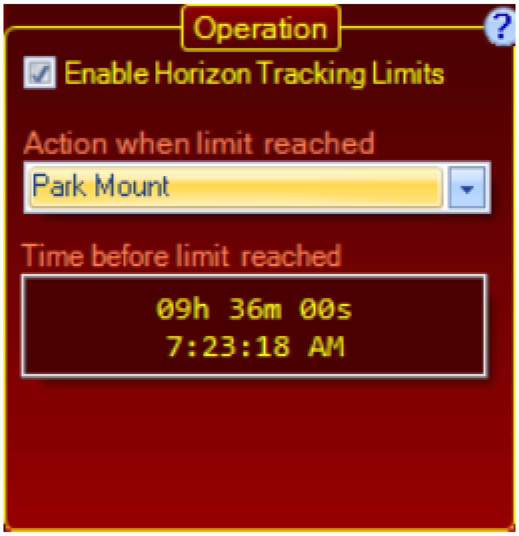
Southern Hemisphere



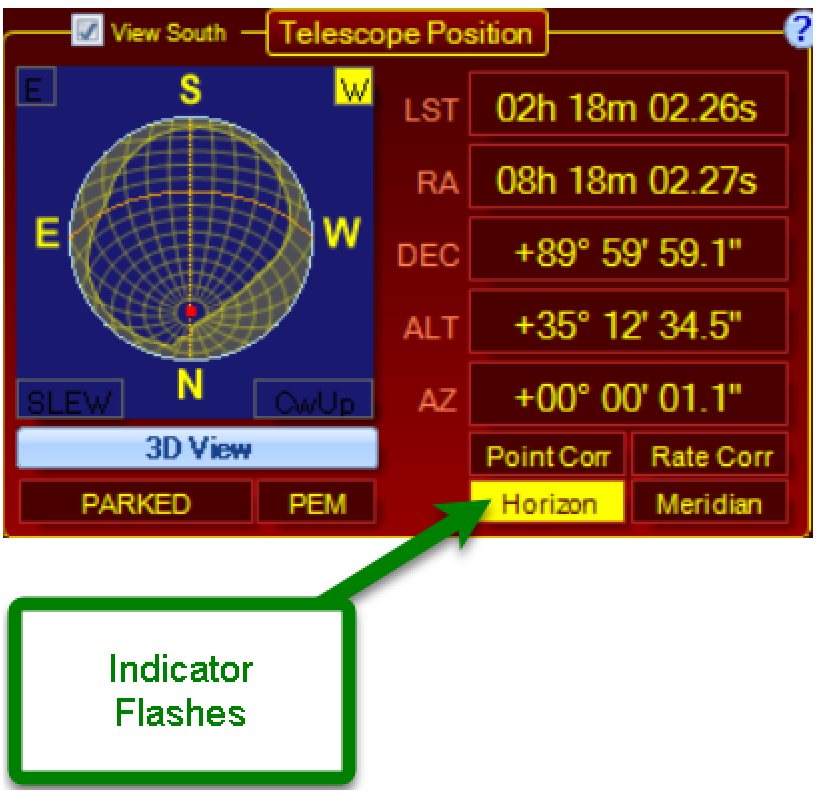
Your particular horizon can be edited and saved in the Horizon Tracking Limits Editor. Multiple horizons can be saved for different favorite locations and the particular horizon for a specific location can be associated with that location's full group of settings for ease of setup.

Operation

Enable Horizon Tracking Limits: This enables horizon tracking limits once you have a set of limits defined. Think of it as the On / Off switch for the horizon tracking limits. When a limit is reached while tracking (not slewing) the mount will do the appropriate action as described in the next paragraph. You will note that enabling the horizon limits causes the horizon to appear on the small sky map in the Telescope Position section at the lower right side of the main window. The horizon will not appear on the sky map if the limits are disabled.



Action when limit is reached: Choices are **Stop Tracking, Park Mount or Just Warn.** If Park Mount is selected, APCC will park to the park position selected on the **Park tab**. When the limit is reached, the Horizon Limits Indicator in the Telescope Position section of the main window will begin to flash alternatively between the dark red and yellow



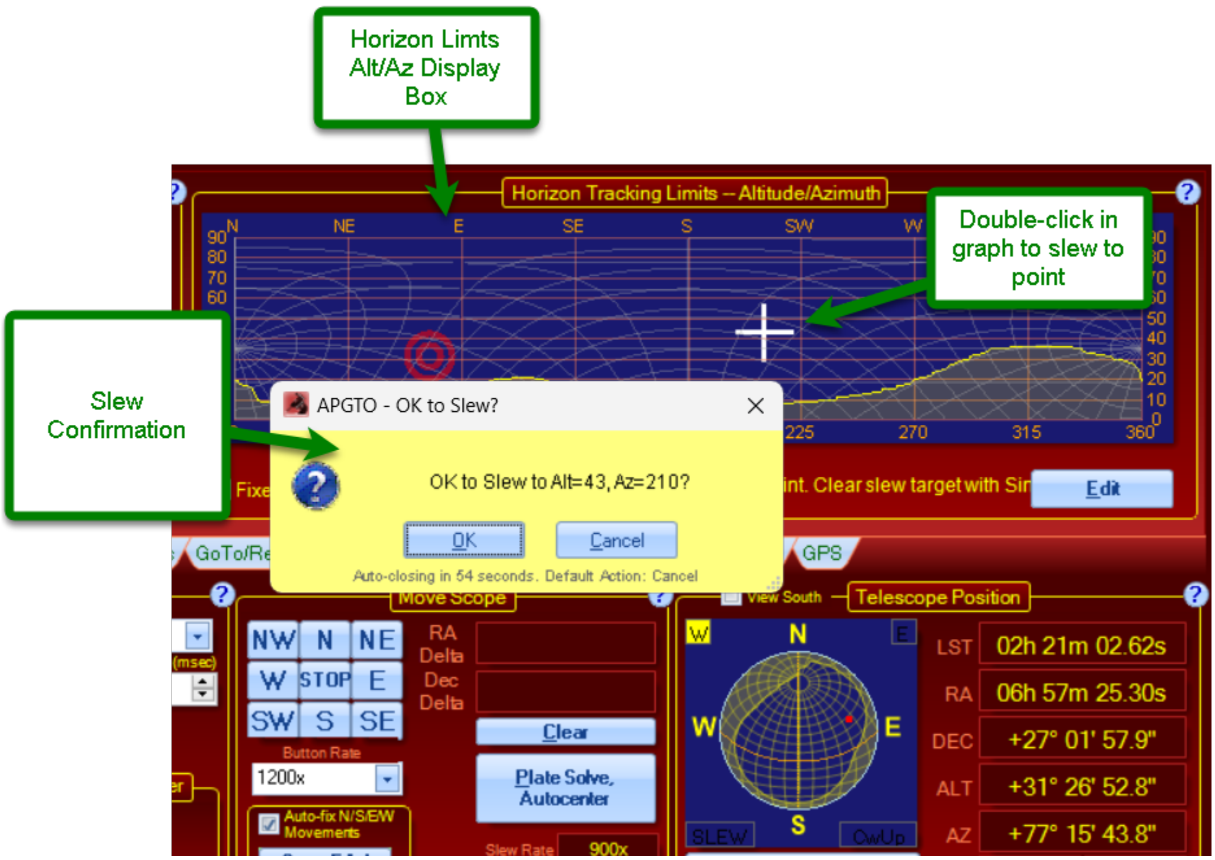
Time before limit reached: Shows the estimated time before the Horizon limit is reached. This box is only active if the limits are enabled. (See Operation Controls screen above).

Starting with version **1.5.1.0** the clock time at which the limit will be reached is also displayed.

Horizon Tracking Limits - Altitude/Azimuth

The Altitude / Azimuth box on the Horizon Tab gives you a graphical representation of the sky with your horizon limits. It shows the telescope position, a rectangular Alt / Az grid, and the corresponding R.A. and Dec. lines.

Useful Tip: A very useful feature of both the main tab graph, and the Horizon Limits Editor graph is that you can double-click on a spot on the graph to slew to that position.



Note: You can double-click a point in the graph to slew to that position as shown in the northern hemisphere view above.

6.15.1 Horizon Limits Editor

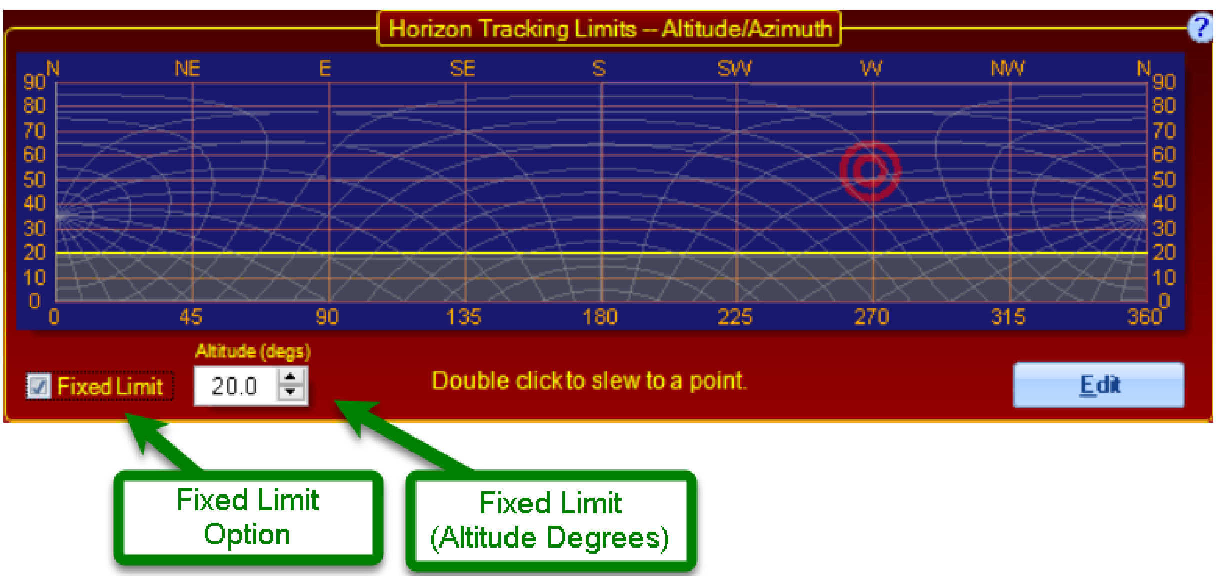
Overview

The window shown below under #3 is where you will actually describe your horizon graphically and save it for APCC to use. There are several ways to create your horizon from a simple drawing which can be done in under a minute for a one-time portable setup, to a detailed mapping with precisely accurate horizons for a permanent observatory. The detailed mapping will, of course, take a bit longer!

Shortcut for defining a fixed horizon limit

If all you need is a horizon at a fixed altitude (for example if you only want to image above a certain altitude, or you do not have any obstructions that you want to map in your horizons) using the Fixed Limit may be the easiest approach.

This is found on the Horizon tab main screen:

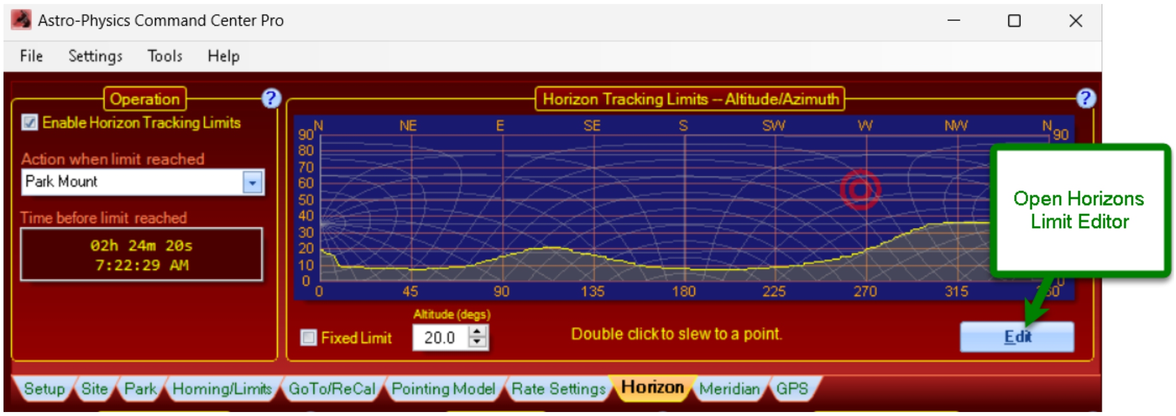


To use the Fixed Limit, simply enable the checkbox and enter a desired minimum altitude (in degrees). You will see your Horizon limit updated in the graphical representation.

To reset your horizon limit to 0, simply enter 0 for the fixed limit altitude.

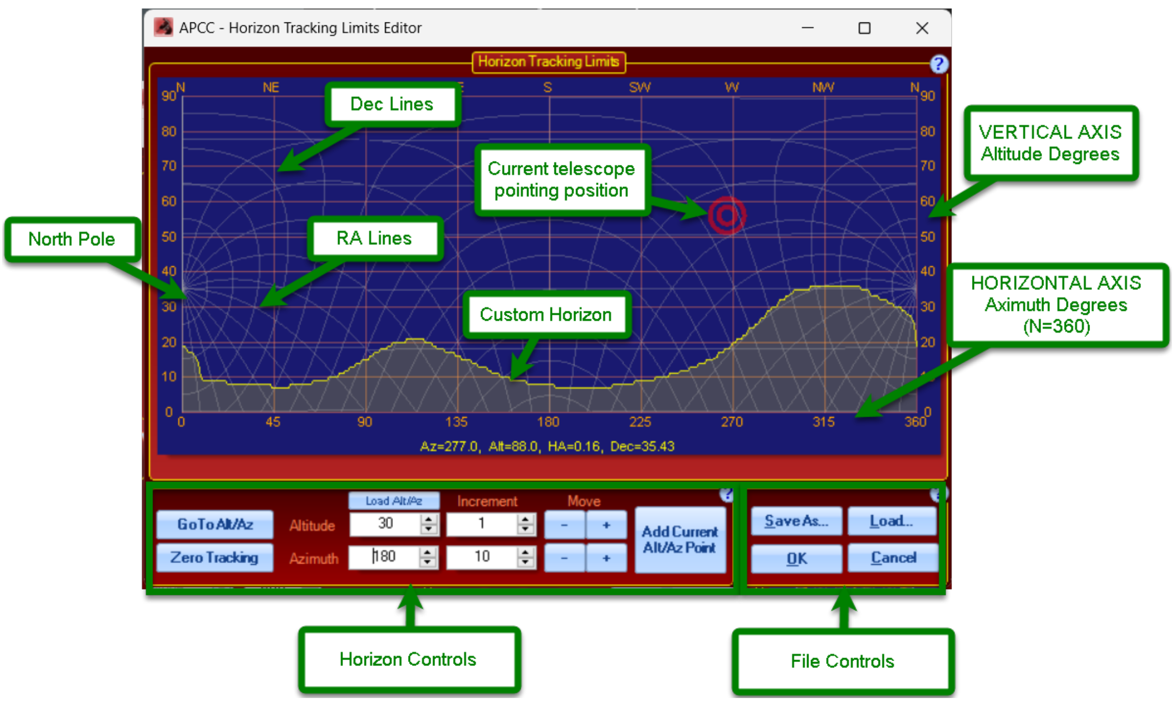
Instructions for creating and / or editing your custom horizon.

1. Click on Horizon tab in APCC main window.
2. Click on Edit button to lower right of horizon limit graphical representation. This opens the Horizon Tracking Limits Editor Window.



Note: View shown above is from a Northern Hemisphere installation.

3. The Horizon Tracking Limits Editor Window. Your custom horizon will be created and displayed in the Horizon Tracking Limits Graph. Graphs for each hemisphere are shown below.

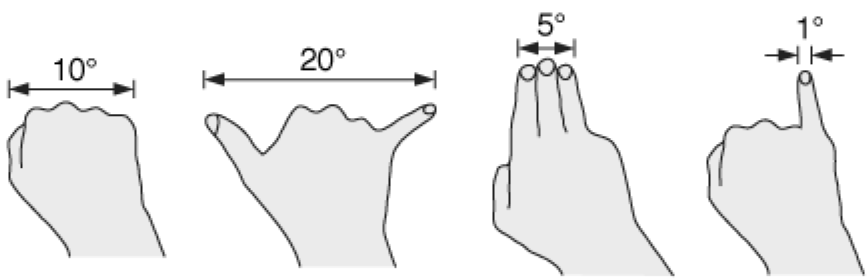


- Horizontal Axis: The horizontal axis of the Horizon Tracking Limits Editor represents the full-circle panorama of your observing location. The scale at the top of the graphic represents the compass points, and the scale at the bottom is in degrees of azimuth. It is conventional in astronomy to always set the 0/360 azimuth point as due north with the circle going around to the east, regardless of the hemisphere you are in.
- Vertical Axis: The vertical axis represents the altitude from zero to the zenith. (0=unobstructed horizon; 90=zenith)
- R.A. and Declination lines. The curvy lines are the R.A. and Declination lines as they are mapped onto the rectangular Alt/Az grid.

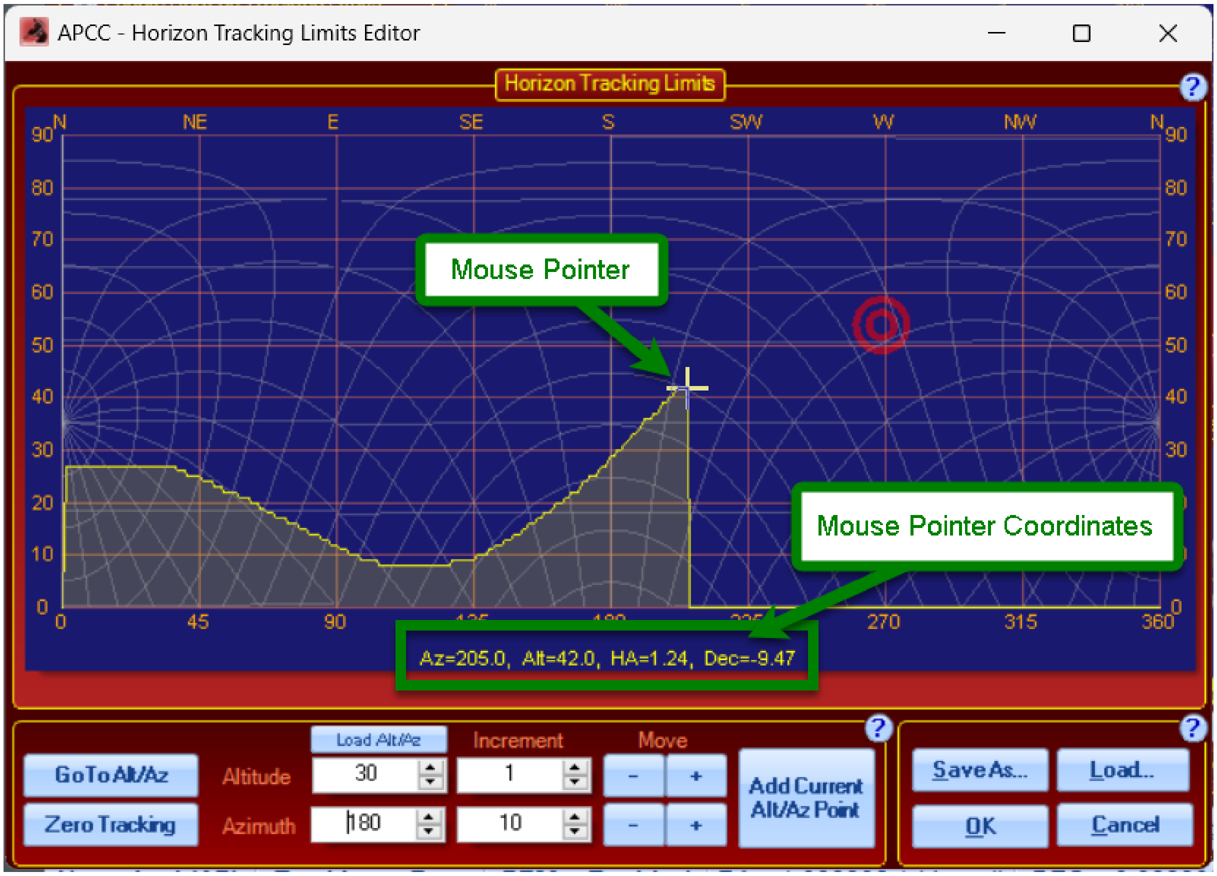
- The Horizon Controls and File Controls that are identified in the images above are explained below.

Setting up Your Limits - Simplest Method

Draw approximate horizon on Horizon Tracking Limits Editor Window of APCC. This may be the preferred method for star parties and portable setups. You can have a workable result in a minute or less. To draw your horizon, start by noting the horizon surrounding your mount. Take note of the average horizon level you will wish to use, and also the possible differences in sky glow in different directions. Use the old astronomer's trick of using fingers on an outstretched hand to estimate the height of the usable horizon.



Finally, note any obstructions like buildings or trees that will create "bumps" in your horizon. Then simply follow these steps:

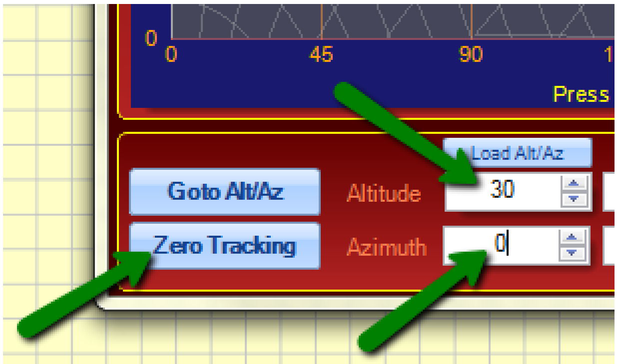


1. Place the mouse pointer at a point that will be on your horizon.
2. Click and hold down the left mouse button and drag to start drawing.
3. Edit or change what you've drawn by simply clicking on or near your drawn horizon line and redrawing. You can erase your results by dragging the mouse along the 0 line on the bottom.
4. You may find it easiest to start by draw the primary line first, and then go back and edit to deal with trees, buildings or other obstructions.
5. If you wish to save the horizon limits, click the Save As... button on the right side of the controls.
6. If you simply wish to use the limits for the one night, then just click the OK button without saving. It is probably advisable to go ahead and save anything that you have invested some time in, even as a temporary file just in case your computer crashes during the night.
7. You can always go back and edit the active horizon limits whether you have saved them or not by simply clicking the Edit button from the Horizon tab of the main APCC window.

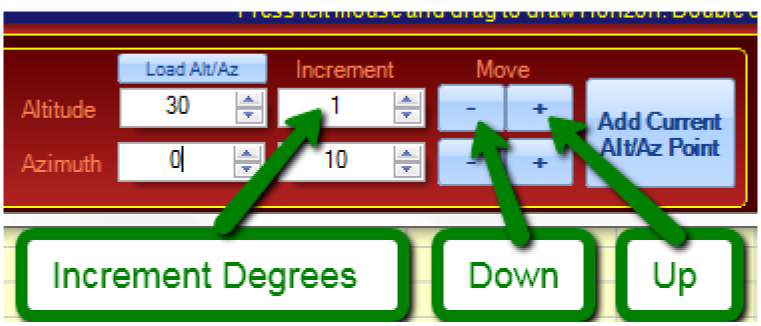
Horizon Controls - a more precise method

Use the Horizon Controls or keypad or both to move around and add points.

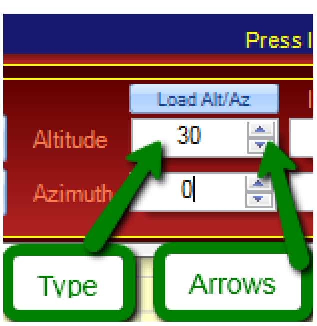
1. Temporarily turn OFF meridian limits and pointing and tracking corrections if applicable.
2. Click the Zero Tracking button in the lower left of the horizon editor screen.

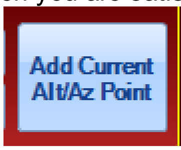


3. Start at Azimuth zero and estimate your horizon-altitude at that point.
4. Adjust altitude incrementally until you find the horizon. Since R.A. and Dec. do not move conveniently in Alt/Az, it is often easiest to use the increment feature in the horizon editor. With this feature you can simply click a single button to point the telescope up (+) or down (-) by the chosen incremental value in degrees. Your altitude increments will probably be smaller than the azimuth increments you will use (probably in the 1 - 5 degree range). Both R.A. and Dec. will move so that the azimuth will be maintained as the altitude is adjusted.



As an alternative, you can also simply enter the altitude in the box to the left of the increment box. The value can be typed in or adjusted via the up/down arrows.



5. When you are satisfied with the pointing position, add the current point to your limits. Simply click the 

button at the bottom center of the window. The Horizon Editor will draw a line connecting this new point to the previously added point (once you are past the first point at azimuth=0)

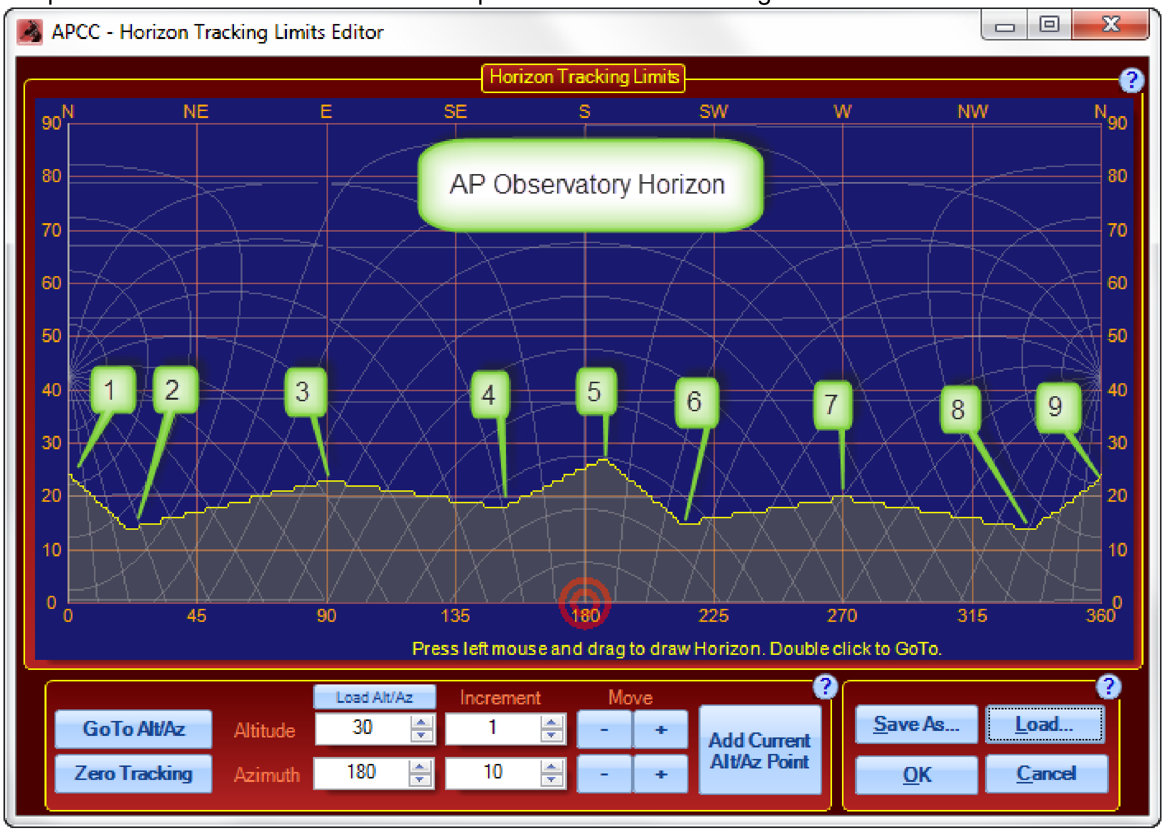
6. Increment to next azimuth and repeat. This is done in the same manner as the altitude increments described above except, of course, that you will use the lower set of Azimuth controls. Azimuth increments can be quite large, especially if there is a region of your horizon that is relatively straight. The line that the Horizon Editor will draw can slope up or down, so the important thing is that the horizon forms a straight (not necessarily flat) line without bumps or dips.

7. Continue with this process until the azimuth circle has been completed.

Hints and Tricks:

- Skip large chunks of azimuth where the horizon is flat or has a straight line (i.e. roof line) by either entering an azimuth manually followed by clicking the GoTo Az/Alt button, or by double-clicking a spot on the graph at the approximate azimuth where the horizon changes. This is especially useful for the long straight walls of roll-off-roof observatories.
- As an example: I built a very accurate horizon limit model for inside AP's roll-off-roof observatory with only 9 well placed points. The observatory is a double roll off that divides in the middle with the roof halves rolling off to the north and the south respectively. The following should be considered an example only. The exact sequence of steps will probably not be ideal for your situation.

- 1st point was at Azimuth=0 and was the peak of the north roof segment.

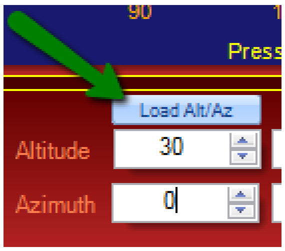


- 2nd point where roof met east wall (NNE).
- 3rd point due east.
- 4th point where east wall met southern roof segment (SSE).
- 5th point due south at peak of southern roof segment.
- 6th point where roof meets west wall (SSW).
- 7th point due west.
- 8th point where west wall meets north roof segment (NNW).
- 9th point back to peak of north roof segment.

Note that this particular test setup was not centered in the observatory.

This is the reason for the minor asymmetry in the horizon graph.

- You may find it easiest to move to a spot with the keypad's direction buttons. Then click the Load Alt/Az:



- Another really good trick is to double-click your best guess as to the next point on the graph. The mount will slew to the Alt/Az of the clicked point. Then adjust the position with your keypad. The keypad is handy because it allows you to sight along your OTA as you make the fine adjustments. When you are happy with the point location, go back to the Horizon Tracking Limits Editor and:

  a. Click the Load Alt/Az button

  b. Click the Add Current Alt/Az Point button

  c. Go to the next point.

  This can be especially useful for getting the azimuth of an obstruction right. Once the scope is pointing to the correct azimuth, load the Alt/Az coordinates and then adjust the altitude using the incremental moves described above.

- When double-clicking on the graph in the Horizon Tracking Limits Editor, be aware of the points where there would normally be a meridian flip. (0°/360° and 180°) If you try to click exactly on the line, you may or may not go to the side you wish because of the limits of your screen resolution. Instead, at 0° and 360°, click just inside the line (barely inside the graph window). For the 180° point entry, do one just to the left, and then do one just to the right of the line.

- When clicking on the graph in the Horizon Tracking Limits Editor, keep your sky glow in mind! There is no sense in outlining a detailed horizon in a direction where light pollution effectively raises the usable horizon above all the trees, buildings etc. that you so carefully outlined. This is an easy error to make if preparing the horizon limits during daylight.

File Controls - Manage your Horizon Tracking Limits

- Click the Save As button to save the newly drawn or edited limit. Multiple horizon limits can be saved for different locations. Please be sure to double check that the path for your saved horizon limit is correct. Horizon Limit files will have the suffix: .hrz. We have found it advantageous to give all settings files for a given location the same or a similar name.
- Click Load to bring up a previously saved horizon limit.
- Click OK to place the newly drawn limit into APCC for immediate use.
- Click Cancel to close the window without saving the limit or placing it into APCC.

6.16 Meridian Tab

Introduction

The Meridian Limits are one of the most powerful and useful features of Astro-Physics mounts when used in conjunction with the Astro-Physics Command Center (APCC). They open up the possibility of imaging on both sides of the meridian WITHOUT wasting time on a pier flip at declinations where the scope will not strike the pier. The limits, when properly configured, allow you to track safely past the meridian up to the limits you set based on your unique instrument package. In addition, they allow you to begin an image ahead of the meridian by safely slewing you into a counterweight-up position to start an imaging series that can then simply continue through the meridian. However, like any powerful feature, you MUST understand how the meridian limits work. It is vital that you understand what they CANNOT do as well as understanding what they can do!

Warning: Please take special note of the following:

- The Meridian Limits, are primarily tracking limits in the west, and counterweight-up slewing guides for APCC's advanced slew logic in the east. They will **NOT** prevent you from slewing into your pier with an incorrect slew, or from running into the pier with direction buttons.
- **DO NOT** use any other method for setting a meridian delay while you are using the meridian limits. When properly configured, the APCC meridian tracking limit logic will maintain the correct meridian delay in the system.
- Allow the **"Counterweight Up Slews within: East Limits"** feature (see ***Operation*** below) to safely slew your mount into a meridian advanced position east of the meridian. Do not try to "outsmart" the system and finagle this yourself.
- We suggest that you do your Horizon limits before doing your meridian limits.

Understanding East vs. West limits. People can get confused with the East and West limits. This is in part due to the conventions used in German Equatorial mounts regarding pier side. In APCC's Meridian Limits, East and West define where the scope is pointing. In both cases, the limits apply when the counterweights are up with the scope on the wrong side of the pier in a position that is not considered "normal". (Normal being with the counterweights down, but the scope on the other side of the pier.)

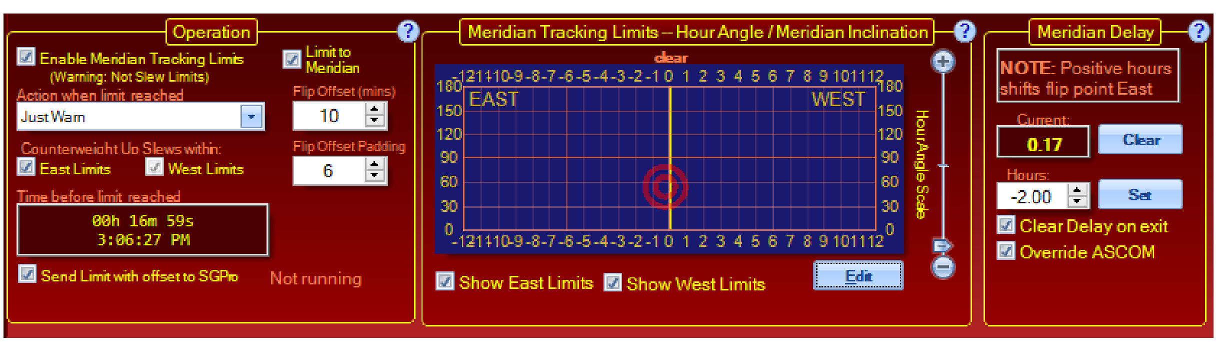
Think of West Limits as SAFETY LIMITS. These are the limits that protect you from tracking into the pier, and most people would consider them to be the most important. A normal scenario would be that you start pointing to a target in the east with the counterweight in the normal down orientation. Then, as you track the object across the sky, the telescope reaches and then crosses the meridian and the counterweight goes into an "up" orientation. These limits determine how far you can track past the meridian without getting into trouble.

Think of East Limits as OPPORTUNITY LIMITS. With an AP mount, you have the opportunity to start tracking an object that is in the east from a counterweight "up" orientation, and then tracking through the meridian into a normal counterweight "down" position to finish tracking on to your horizon. This allows you to avoid the need to flip at the meridian.

Operation

PulseGuide, the *AP V2 ASCOM* Driver, and the mount's keypad each have the ability to set a meridian delay which controls the flip point of the mount. APCC adds some powerful new capabilities. Three of these new features apply to *West Meridian Limit* points. The *West* limits come into play when a scope's counterweight is in the up position (scope under the mount) and the scope is pointing West of the meridian. This normally occurs when the scope is allowed to track past the meridian. The fourth feature below applies to east meridian limits and provides a unique and powerful tool for safely starting images in the east from the east side (counterweight up) using the meridian advance.

- Instead of just a single meridian limit for all declinations, you can configure an arbitrary number of different limits at different declinations. This is useful because at each declination there can be a different hour angle at which the telescope will touch the pier. In declination regions where the telescope can theoretically go the full 6 hours past in the west, the meridian limits can establish horizon tracking limits for the practical distance past the meridian where you can reasonably continue to work. Likewise, in the east, they can set the practical horizon ahead of the meridian where you can reasonably start an image.
- When a meridian tracking limit is reached, tracking can be automatically stopped; the scope can be "flipped"; the scope can be parked; or no action can be taken other than a warning.
- Meridian tracking limits can also be used to create a safe zone around your pier if it interferes with even reaching the zenith, similar in a way to the safe zone in the Astro-Physics GTO keypad. The keypad's safe zone, however, is a GoTo slew limit, rather than a tracking limit. Remember that an APCC Meridian Limits safe zone that does not allow the scope to reach the Meridian must be stopped or parked. It cannot be flipped.
- When east limits are properly configured and employed, slews to targets within the east limits will automatically be made using meridian advance and APCC's safety slew logic to place the system in a counterweight-up position with the scope on the east for uninterrupted imaging through the meridian. The safety slew logic ensures that all mount movement with the counterweight up is with the RA only. Using the East Limits, the scope can image through the meridian and on for another 6 hours before the telescope reaches the horizon. See: **Counterweight Up Slews within: East Limits** below.



The ability to work past the meridian into the west, or to start ahead of the meridian in the east has always been a hallmark of Astro-Physics mounts. Both the keypad and the earlier PulseGuide program provided the ability to work beyond the meridian. However, with both of these control methods, the user would want to be present at the mount for safety. APCC creates meridian limits that can allow the user to safely exceed the meridian without hovering over the mount to protect the scope and imaging equipment from a potential crash. Remotely controlled observatories can now also safely image through the meridian (where declination permits it).

Enable Meridian Tracking Limits: This check box enables the meridian tracking limit functionality allowing tracking to safely continue beyond the meridian until the west limit is reached..

Action when limit reached: This defines the action taken when the mount tracks into the West limit. The choices are to:

- **Stop tracking**. The mount simply stops where it is and waits for user input.
- **Park mount**. Parks the scope at the park position defined on the Park tab,
- **"Flip" scope**, The mount will perform a safety slew into a CW down position and then a normal slew back to the target, but in the conventional CW down position.
- **Just Warn**. APCC will place a warning on the top of your screen to inform you that the limit has been exceeded. Use this option only if you are watching the scope! It can be handy if you start an image that will last just beyond the limit, but that you think will still be within your safety margin.

In their traditional role, the meridian limits just act as a safety stop when tracking and the East limits effectively are not used. However, you can elect to use the east limits to safely slew the mount into a counterweight-up position to maximize imaging time of a single target as it tracks past the meridian. To do that you would use this:

NOTE: The following two checkboxes should ONLY be checked if you are using your mount "hands on". At the present time, automation software has not been written to fully accommodate these features in APCC. Programs like ACP and CCDAutoPilot cannot yet take full advantage of these capabilities. This will require cooperative development between the respective software developers.

DO NOT check these options if operating remotely via ACP or CCDAP! A Warning box will appear when these boxes are checked to help prevent problems.

Limit to Meridian: Limits the **Flip Offset** to be at most set to the sky's real life meridian.

Flip Offset: This defines a period of time during which the mount can be "flipped" before the actual **Meridian Limit** is reached. This may be useful when using third party applications so they can perform a meridian flip before reaching the **Meridian Limit**, which may trigger tracking to stop or parking the mount.

Flip Offset Padding: This adds or subracts time (in minutes) to the Flip Offset value sent to Sequence Generator Pro.

NOTE: **Limit to Meridian, Flip Offset,** and **Flip Offset Padding** only apply when the mount pier side is West (pointing East with counterweight "down", or West with counterweight "up").

The **Meridian Limit** usually varies with declination. The **Flip Offset** adjusts the meridian flip point a number of minutes from the configured **Meridian Limit** at the current declination. If this option is enabled and the meridian flip point would be pushed past the actual sky meridian, the meridian flip point will be instead limited to the sky meridian.

Counterweight Up Slews within:

- **East Limits:** When pier side is **East** then slews to coordinates between the meridian and East limit values will result in the mount ending up in a counterweight-up position pointing East. This will allow the target to be tracked through the meridian into a conventional counterweight-down mode without needing to be flipped. This is the automated way to start your image ahead of the meridian, and is a classic technique for many experienced Astro-Physics imagers. Short focus slews to a nearby focus star will also not result in a pier flip, but they WILL result in a safety slew in most instances. This is a necessary safety feature.
- **West Limits:** When pier side is **West** then slews to coordinates between the meridian and West limit values will result in the scope ending up in a counterweight-up position pointing West. This will avoid a meridian flip until the West limit is reached. However, if the mount is already on the East side pointing West, and within the West limits, the mount will not flip. This can be considered a "dynamic meridian delay", because the delay automatically changes based on declination. The primary use of this feature is to facilitate small slews for focusing while the mount has tracked past the meridian without instigating a pier flip.

Time before limit reached: This is a countdown timer. It gives the time remaining until the meridian tracking limit is reached at the current Declination. It is only enabled when meridian tracking limits are enabled.

Starting with version **1.5.1.0** the clock time at which the limit will be reached is also displayed.

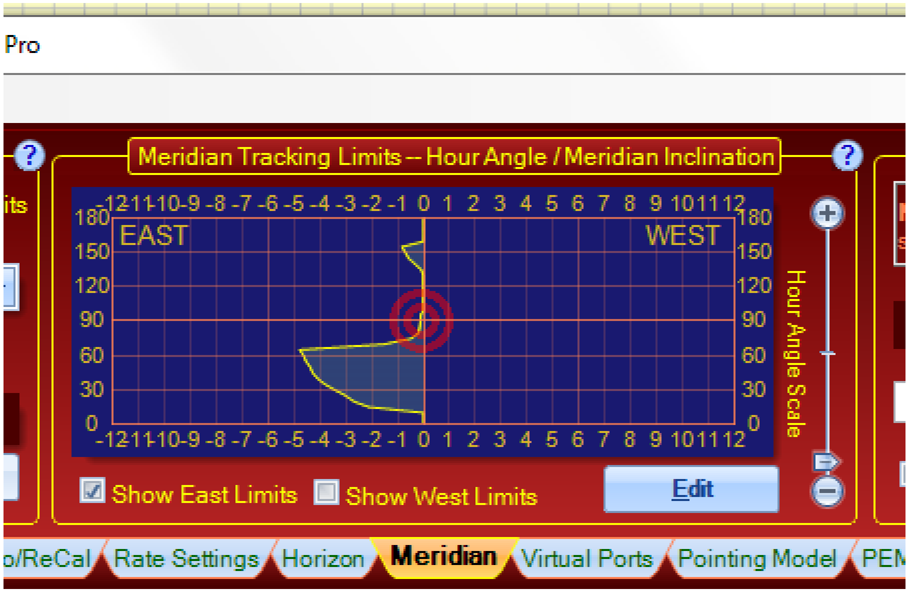
Send Limit to SGPro: If Sequence Generator Pro (SGPro) is running and declination changes, the current meridian delay value is sent to SGPro. SGPro can use that delay to determine how far before or after the meridian that a pier flip will occur. SGPro will only attempt to do the pier flip once the meridian delay value is reached.

Meridian Tracking Limits - Hour Angle/Meridian Inclination

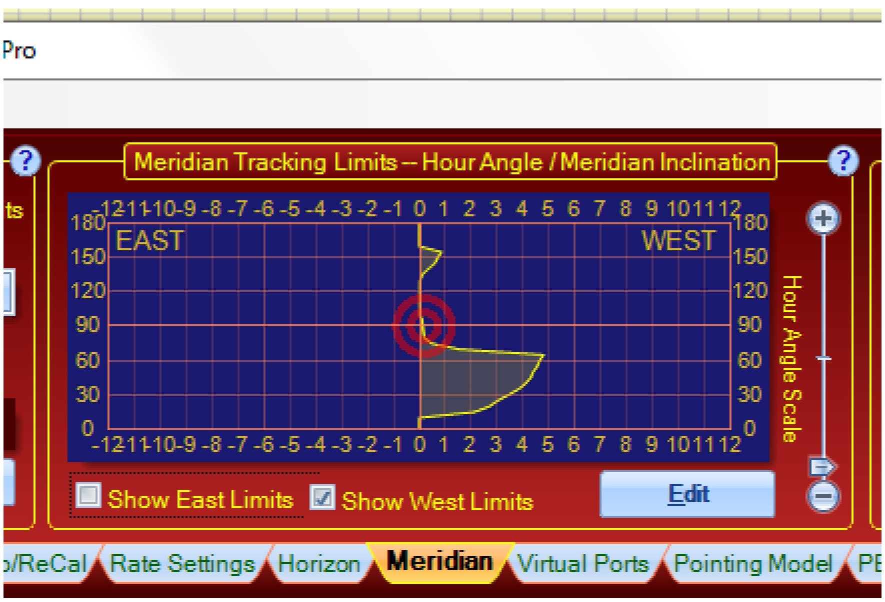
The *Meridian Inclination* is the angle measured along the meridian line from the Southern horizon to the Northern horizon in the Northern hemisphere, and from the Northern horizon to the Southern horizon in the Southern hemisphere. *Meridian Inclination = 0* at the horizon opposite your pole (ignoring the effects of refraction) and *Meridian Inclination = 180* at the horizon below your pole. Use of Meridian Inclination gets around the ambiguity of some declination values underneath the pole compared to those above the pole. For example, in the northern hemisphere at 50 degrees latitude, 85 degrees declination meets the meridian at two positions, one above the north celestial pole, and one below the north celestial pole. The Celestial pole is always at Meridian Inclination = 180 - latitude. At this 50 degree latitude, the pole is at a meridian inclination of 180 - 50 = 130. And 85 degrees declination occurs at meridian inclinations of both 125 (above pole) and 135 (below pole).

Edit: Allows you to configure the East/West Meridian limits. Clicking will bring up the Meridian Tracking Limits Explorer.

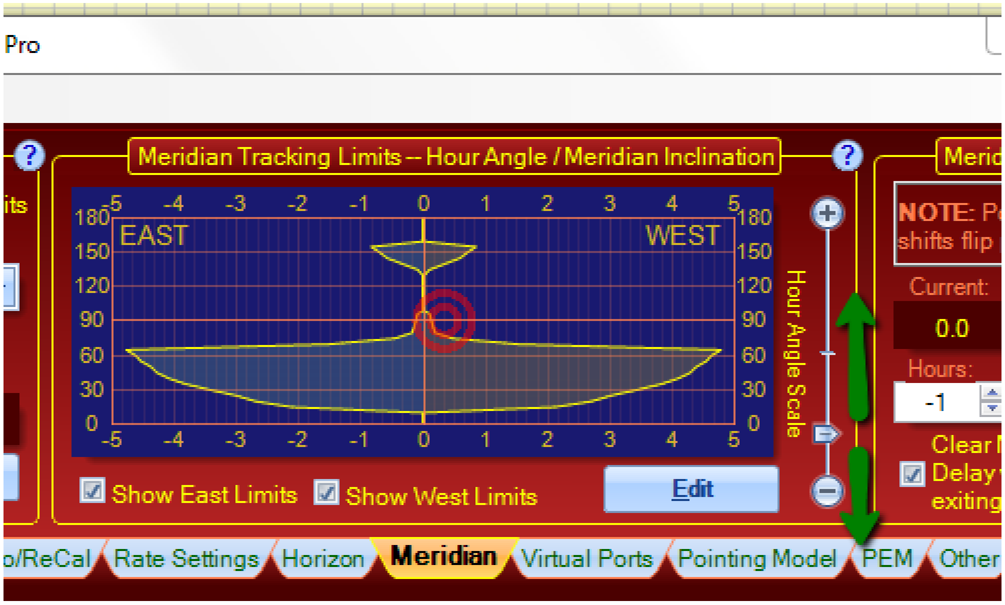
Show East Limits: When checked, shows the East Limits.



Show West Limits: When checked, shows the West Limits.



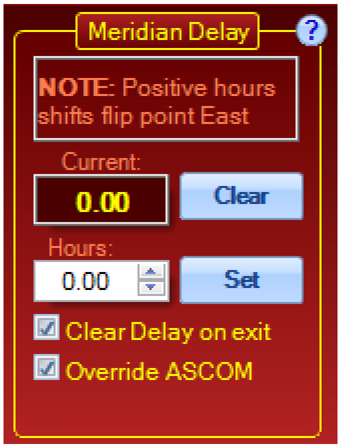
Hour Angle Scale: Allows you to magnify the hour angle values.



Meridian Delay

The ability to advance or delay the meridian to avoid a meridian flip has been a hallmark of the Astro-Physics GTO system since its initial development. Starting with APCC and the Rev. "S" firmware in 2012, the method for employing this feature has been changed in the GTO Servo Control Box. The delay is no longer accomplished by "fooling" the clock in the servo. It is now an independent function with associated commands that does not change the mount's time.

> **Note:** The earlier method employed by the keypad and PulseGuide will still work. APCC only uses the new method. The V2 ASCOM Driver can use either and will choose its method based on the firmware version it detects. ***The important thing to remember is to NOT mix methods! Do not set a meridian delay with APCC and then try to undo it with the keypad, or vice versa.***



Current: The current meridian delay as polled from the mount. Note how this value changes at different declinations if APCC's Meridian Limits are enabled. This is the manifestation of the "dynamic meridian delay" described earlier.

> **WARNING!** Do not make manual meridian delay adjustments if you have activated meridian limits. Allow APCC to set and control the meridian delay. The ***Hours*** field and the ***Clear*** and ***Set*** buttons described below are intended for manual control without active limits.

Clear: Clears the meridian delay back to zero.

Hours: The meridian delay value to use when ***Set*** is clicked. Positive values move the local meridian to the east for meridian advance. This allows you to start an image from the "wrong" side and then track through the meridian into a normal orientation without a flip. Negative values move the logical meridian to the west and allow you to "delay" the flip point of the mount.

Set: Sets the meridian delay to the value in the ***Hours*** field.

Clear Meridian Delay on Exit: This will restore the meridian delay to 0 when exiting so that the mount's flip point is not in an unexpected position. It is recommended that you keep this checked.

Override ASCOM: APCC will override the ASCOM Driver's meridian delay setting. This will allow the more precise meridian adjustments that are possible with APCC's Meridian Limits. If you have set good Meridian Limits in APCC, you should let it handle the meridian and keep this box checked so that an ASCOM client doesn't set an incorrect meridian delay value.

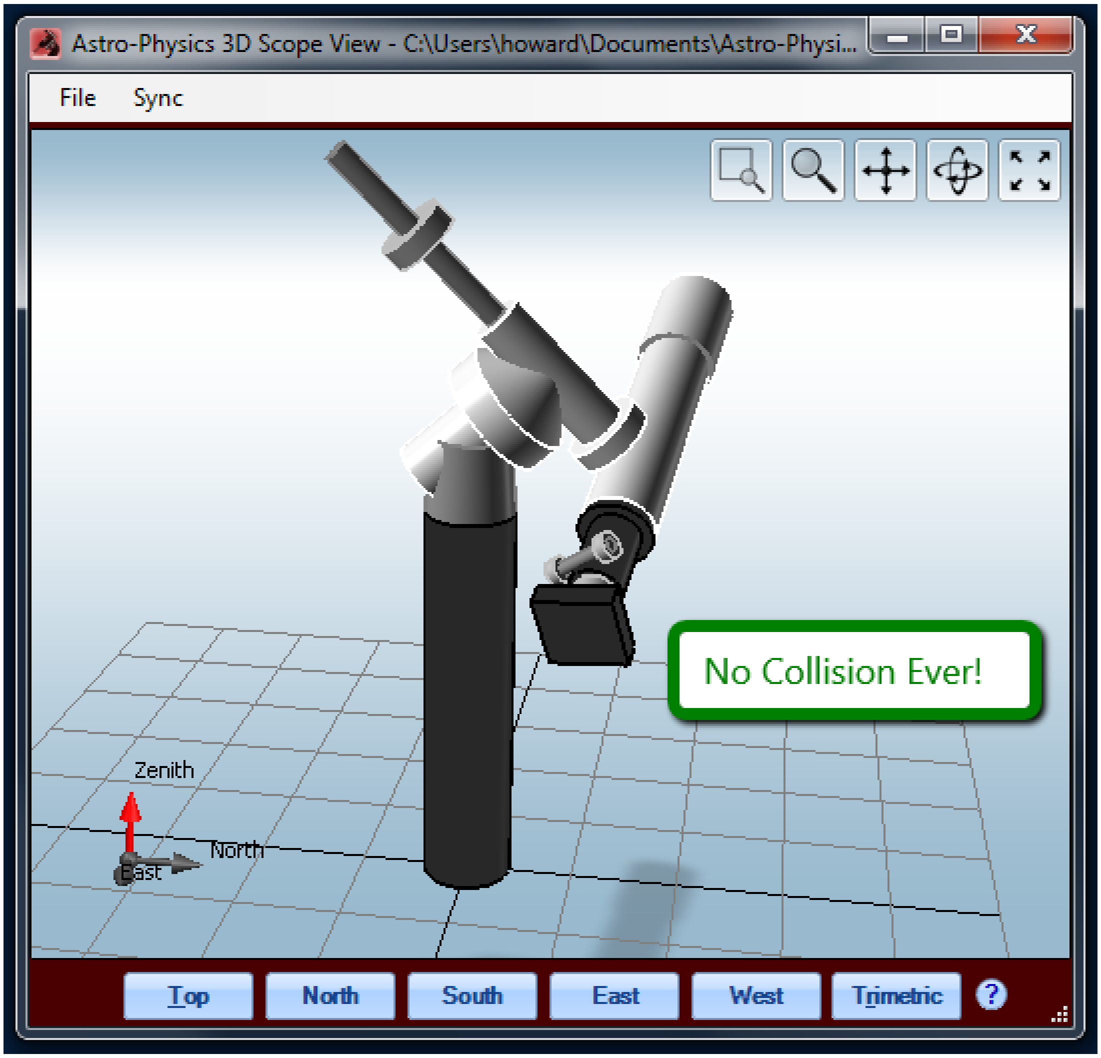
6.16.1 Meridian Limits Explorer - Introduction

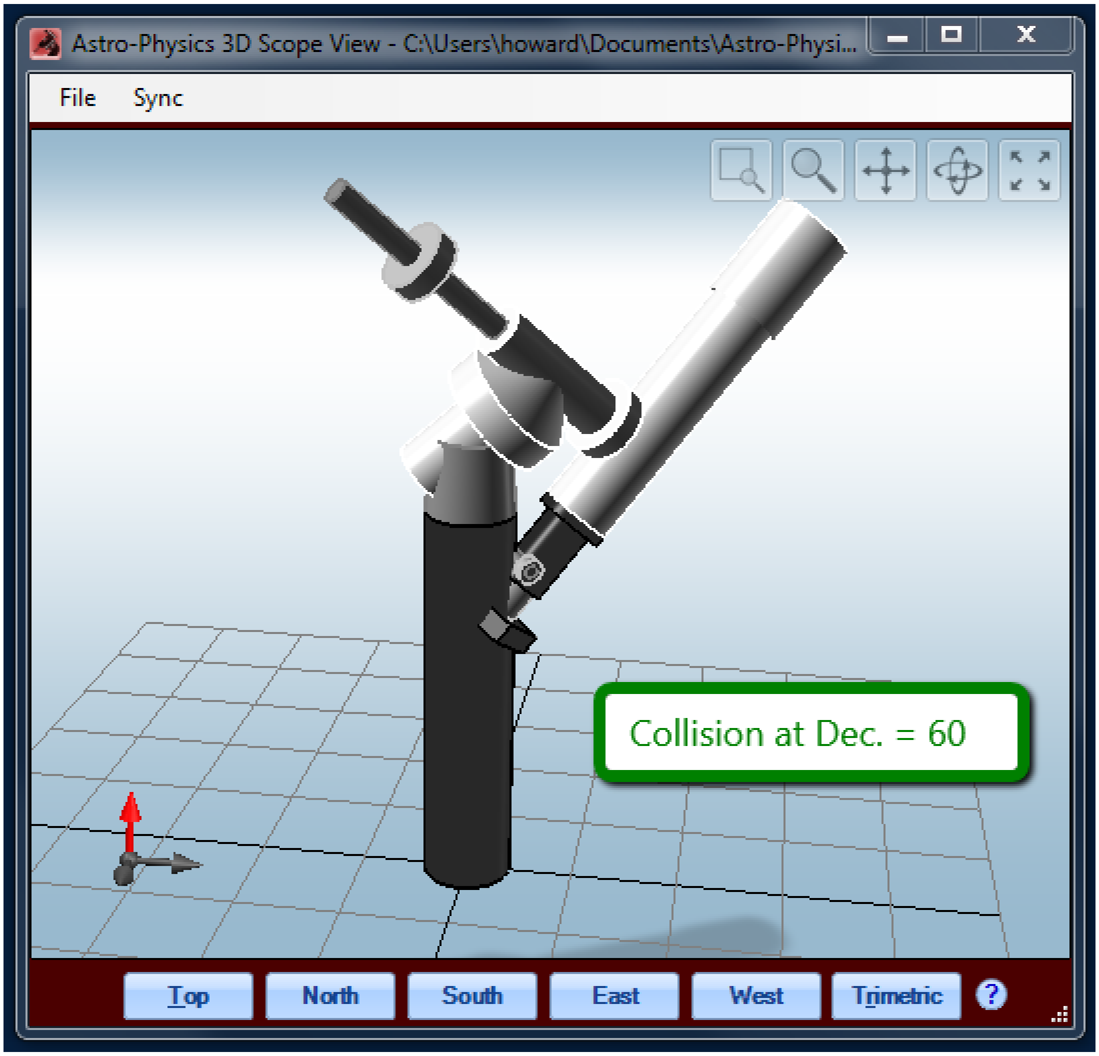
> **Warning: Please take special note of the following:**
>
> - The Meridian Limits, are primarily tracking limits in the west, and counterweight-up slewing guides for APCC's advanced slew logic in the east. They will **NOT** prevent you from

slewing into your pier with an incorrect slew, or from running into the pier with direction buttons.

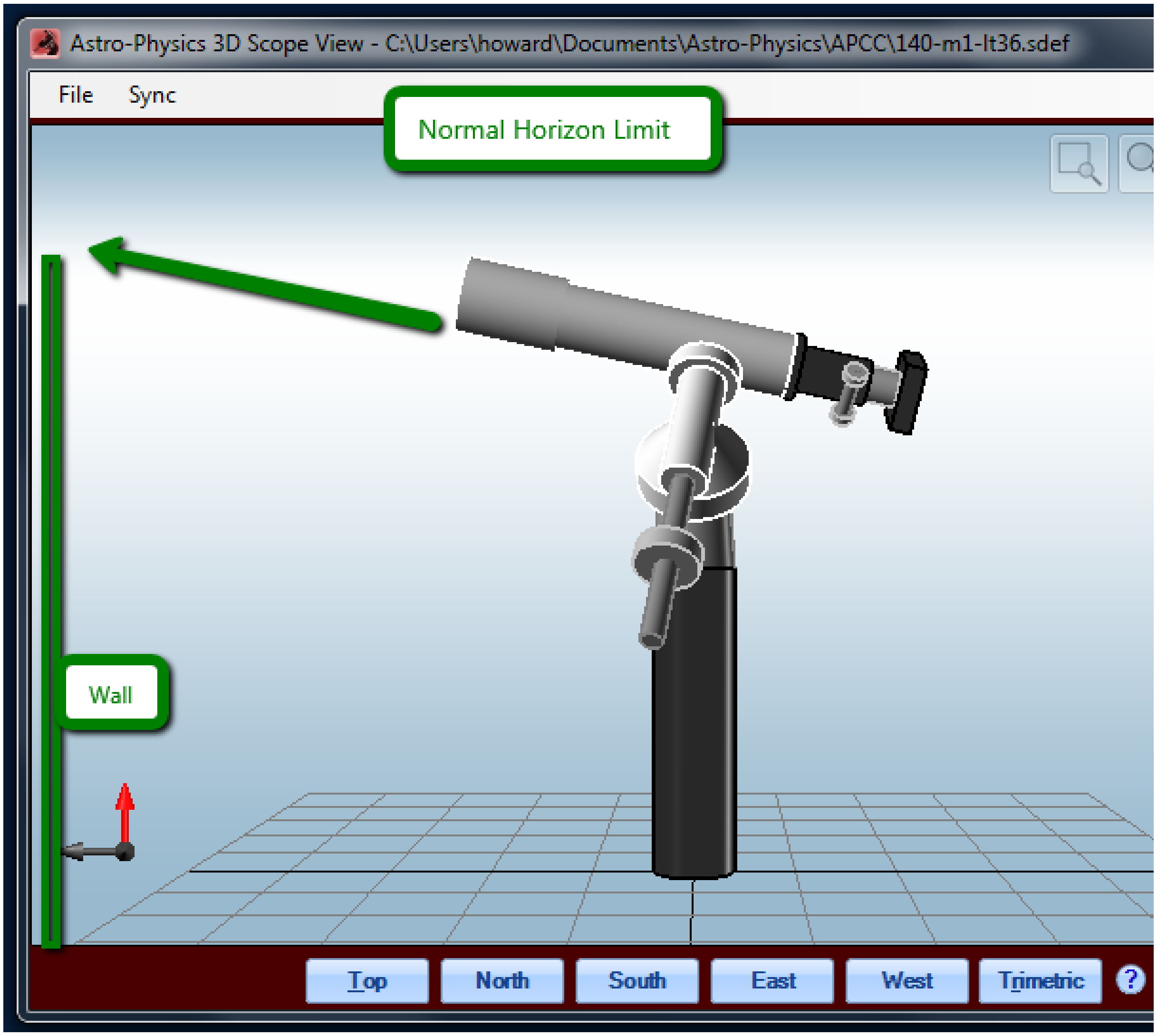
- **DO NOT** use any other method for setting a meridian delay while you are using the meridian limits. When properly configured, the APCC meridian tracking limit logic will maintain the correct meridian delay in the system.
- Allow the **"Counterweight Up Slews within: East Limits"** feature (see Meridian Limits - Operation) to safely slew your mount into a meridian advanced position east of the meridian. Do not try to "outsmart" the system and finagle this yourself.

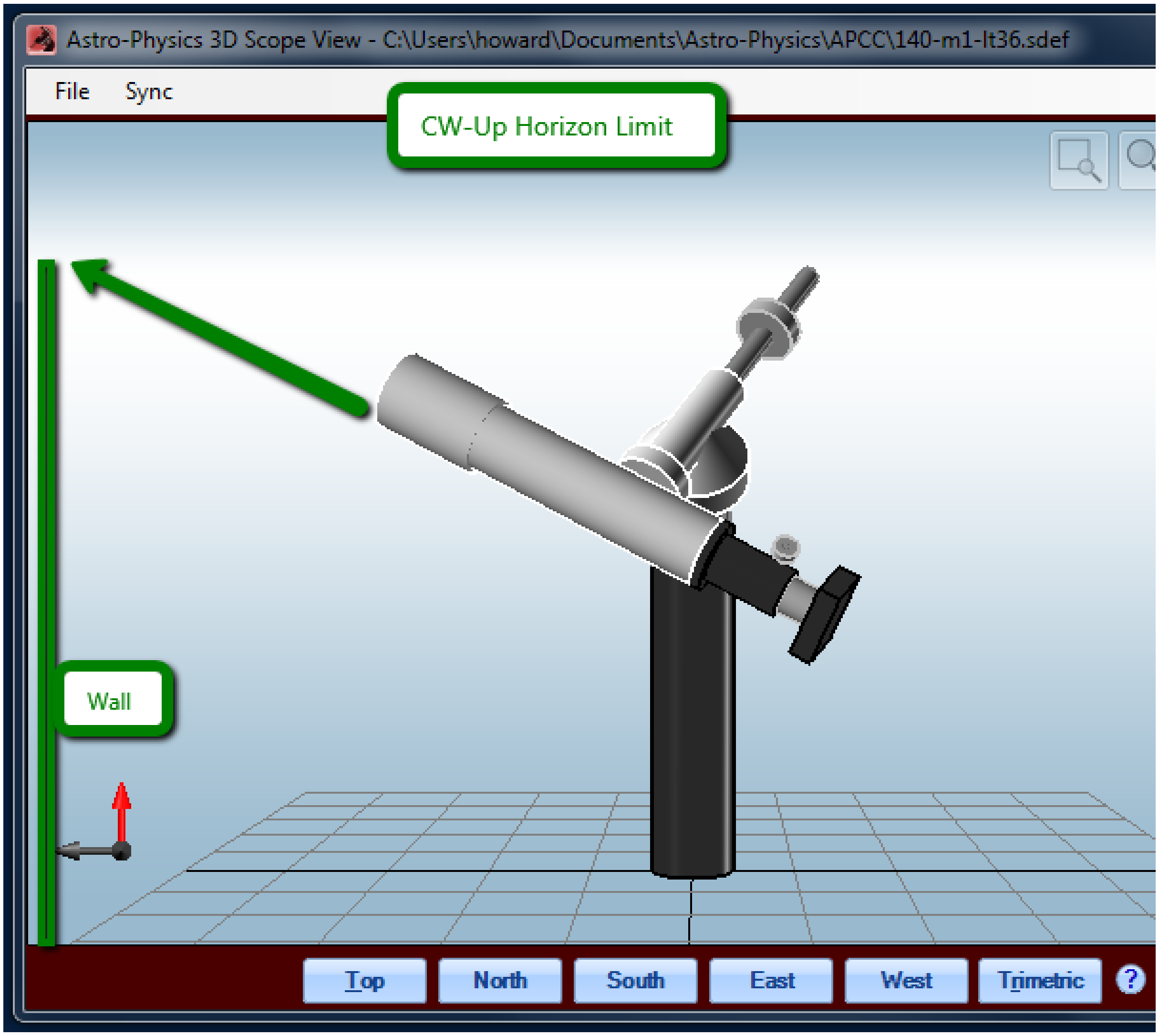
The Need for Many Limits A single fixed meridian limit is not usually optimal because while it may provide the maximum meridian travel at a single declination, it might be limited at another declination where the mount could track farther past the meridian. For example, when declination is near 0 degrees, the scope can usually pass underneath the mount without any possibility of collision. However, as the scope's declination moves further away from 0, the telescope can start to protrude enough that it can strike the pier under certain circumstances. There is a tradeoff between simplicity (setting one limit and being done with it) and optimizing how your mount handles meridian flips so it can track longer without needing to flip.


Astro-Physics 3D Scope View - C:\Users\howard\Documents\Astro-Physi...
File
Sync
No Collision Ever!
Zenith
North
East
Top
North
South
East
West
Trimetric

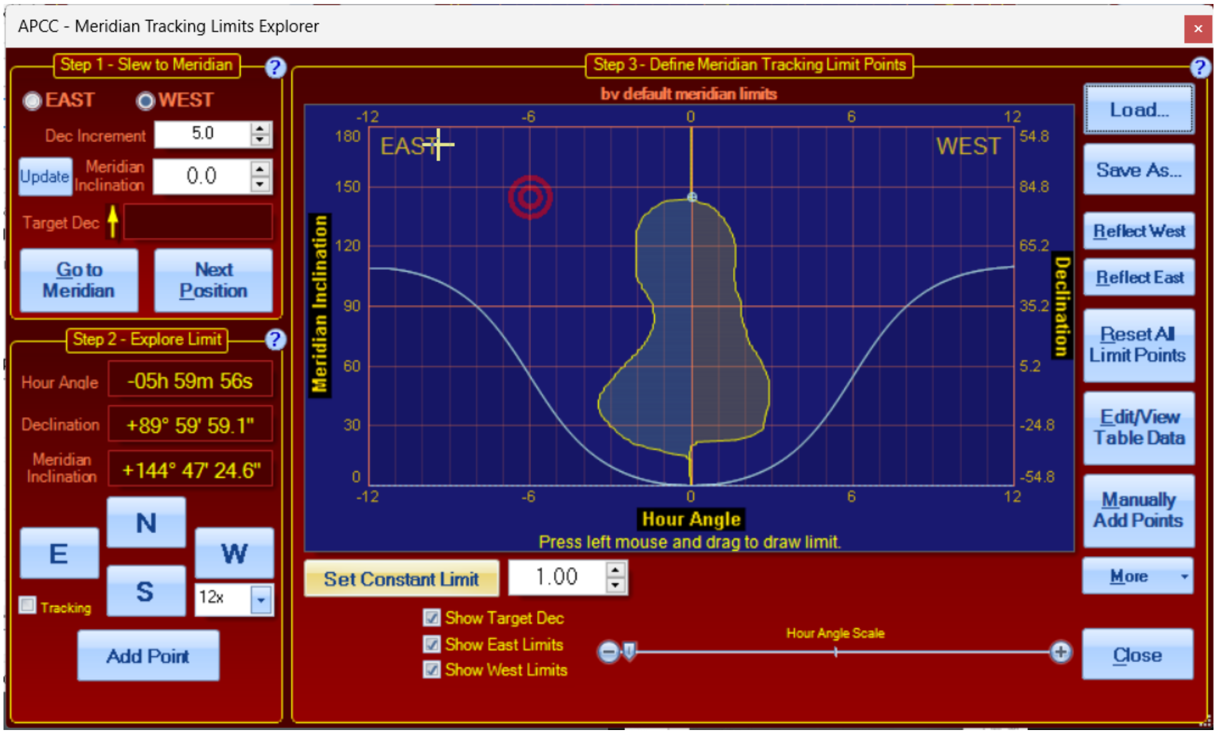


Meridian Limits and the Horizon In situations where the scope will not hit the pier, the limiting factor becomes the horizon. Take note that in observatory settings, this horizon can differ significantly in its Alt and Az values from the horizon values you established earlier with the Horizon Limits Editor. The following two screens - both identical views, and both at a declination of 10 degrees - show this difference:


Astro-Physics 3D Scope View - C:\Users\howard\Documents\Astro-Physics\APCC\140-m1-lt36.sdef
File
Sync
Normal Horizon Limit
Wall
Top
North
South
East
West
Trimetric



The **Meridian Tracking Limits Explorer** helps you setup custom meridian tracking limits for each declination. You record a series of limit values, and the Explorer interpolates a full curve from these points to give you defined limits throughout the sky. The Meridian Tracking Limits Explorer Window is shown below. To access this screen, click on Edit to the lower right of center on the Meridian Tab.



There are five ways to build your meridian limits curve with the Explorer:

1. Use the Set Constant Limit to create a fast, simple fixed limit for the entire side of pier. Constant limit value is entered in Hour Angle (e.g., a value of "1.00" is 1 hour or 15 degrees). When you press the Set Constant Limit, it will create the limit on the West side. If you wish to set a constant limit on the East, you will first need to create it on the West, then "Reflect West" to copy it over to the East, and then you can change your West limit if desired.

2. Use the Explorer's semi-automated method for drawing the limit curves. This method is detailed in the Using the Meridian Tracking Limits Explorer sub-section (next section) of this Help file and involves steps 1 through 3 as shown in the screen shot above.

3. Draw a limit. This is performed just like drawing a custom Horizon Limit - by clicking and holding the left mouse button while you trace out your limit. This is NOT recommended unless you are very familiar with meridian limits and how they should look. It is really most useful as a way to quickly modify an existing limit curve to reflect a minor change in the limit determining factors.

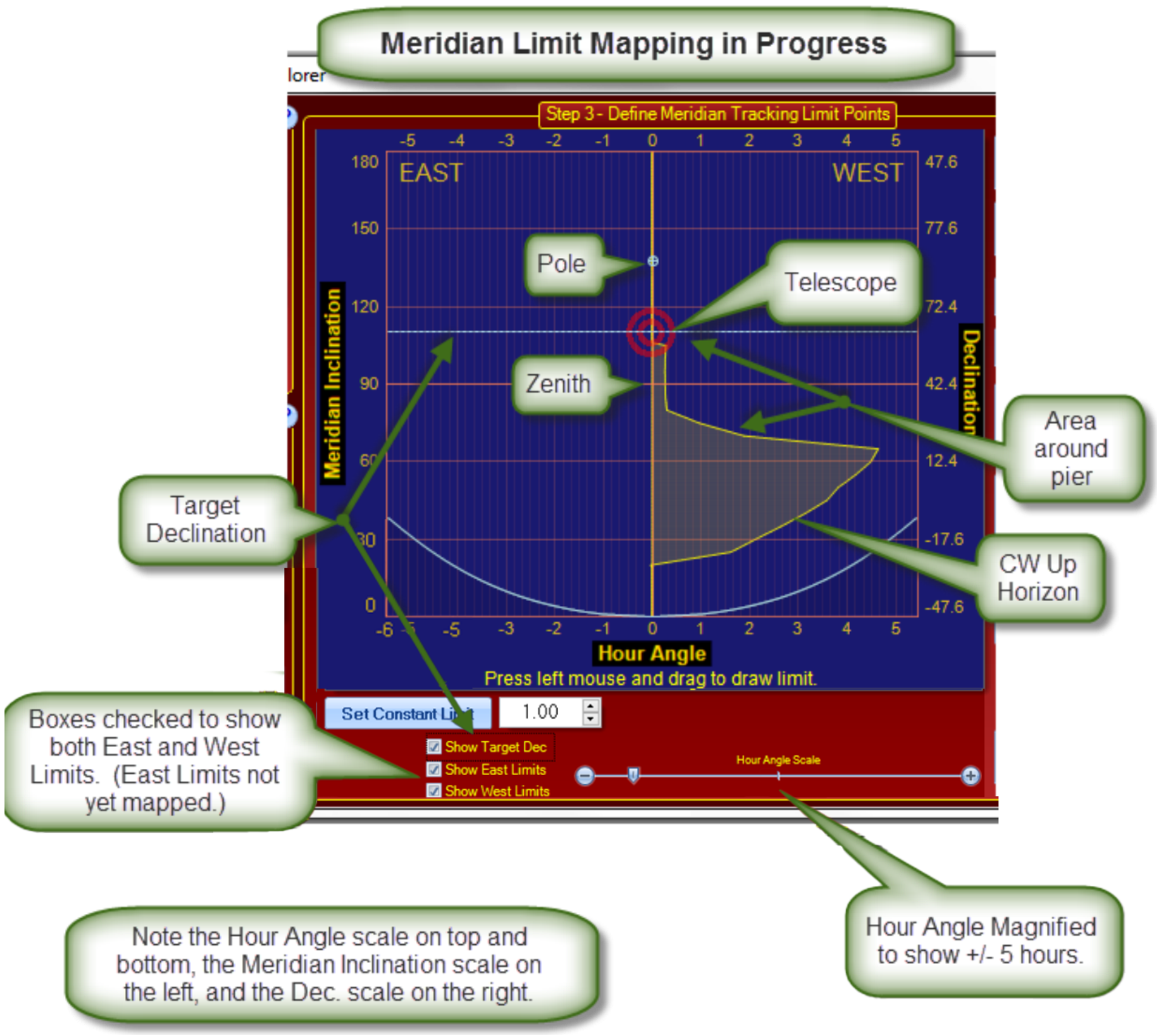
4. Manually Add Points. Clicking on the Manually Add Points button on the lower right side of the Explorer Window will open up the Add Meridian Tracking Limit window. This will be detailed in the Manually Add Meridian Tracking Limit Points sub-section below.

5. Edit the Table Manually. You can go into the actual interpolated data table of an existing Meridian Tracking Limits curve and edit the values at each meridian inclination. This is also recommended only for advanced users.

In addition, please note the following:

- There are some instances and situations where you may wish to combine the methods above. The simplest example is tweaking a mapping done with the Explorer using the "draw" feature.

- The two **Reflect** buttons can be a HUGE time saver. It "reflects" the data points on one side of the meridian to the other. This is useful when your telescope is symmetrical (single scope) instead of a side by side configuration with two different telescopes
- The **More** button allows you to **Copy East to West**, and **Copy West to East**. These are different operations than **Reflect**. These copy the values from one side to the other side of pier. This will force the mount to always flip at a declination's meridian limit at the same hour angle regardless of which side of pier the mount is on.
- The screen shot below is provided to further explain the graphical representation of the limits shown in the Meridian Tracking Limits Explorer (labeled as Step 3 - Define Meridian Tracking Limit Points). It shows the graph as it would look part way through a typical meridian limit mapping run using the Meridian Tracking Limits Explorer.



6.16.2 Using the Meridian Tracking Limits Explorer

Warning: Please take special note of the following:

- The Meridian Limits, are primarily tracking limits in the west, and counterweight-up slewing guides for APCC's advanced slew logic in the east. They will **NOT** prevent you from slewing into your pier with an incorrect slew, or from running into the pier with direction buttons.
- **DO NOT** use any other method for setting a meridian delay while you are using the meridian limits. When properly configured, the APCC meridian tracking limit logic will maintain the correct meridian delay in the system.
- Allow the **"Counterweight Up Slews within: East Limits"** feature (see Meridian Limits - Operation) to safely slew your mount into a meridian advanced position east of the meridian. Do not try to "outsmart" the system and finagle this yourself.

Getting Started

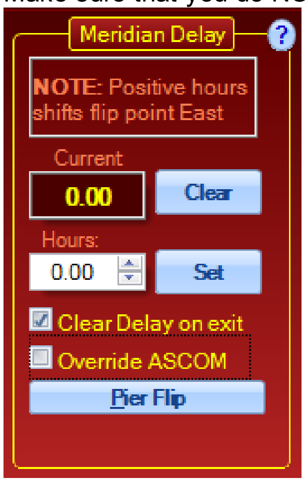
The Meridian Tracking Limits Explorer allows you to create a detailed limits curve using relatively simple steps. The idea is to slowly slew the scope while watching it at each declination value until it is about to hit the pier. The hour angle at which pier collision is about to occur is saved for each declination value that you try. The Meridian limit between sampled declination values is interpolated between measured values. If there is no measured value or a declination higher or lower than a measure declination then it is assumed to be zero (that is, the Meridian). Take note of the following:

- The Meridian Tracking Limits employ the concept of the **Meridian Inclination**. Meridian inclination is a universal concept that is not affected by a persons's latitude. Meridian inclinations, as one might expect, are measured along the meridian. With meridian inclination, the zero point is the horizon directly opposite the pole, and a meridian inclination of 180 is the horizon point directly below the pole.
  - In the north, the zero meridian angle has a declination of: –(90 – Latitude). In the south it is: –(–90 – Latitude)
  - The zenith has a meridian inclination of 90. The 90 degree meridian inclination has a declination equal to your latitude.
  - Currently, the meridian limits can only be defined up to your pole.
- It is advisable to have your horizon limits established before you try to set your meridian limits. You will want to take note of the altitude value for the horizon limit opposite your pole: Az = 180 for the northern hemisphere, Az = 0/360 for those "down under." Note that the altitude at these azimuth values will be equivalent to the meridian inclination.

- NOTE: Although you want to have set your horizon limits, be sure you have disabled them by unchecking the "Enable Horizon Tracking Limits" check box in the horizons tab before you begin your Explorer mapping.

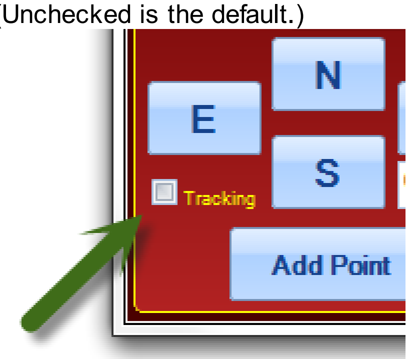
- Make sure that your equipment is fully installed and oriented as it will be for usage. If you have a rotator for imaging equipment, be aware that you will want to always rotate the imaging system into its worst case position with respect to the pier.

- Make sure that you do NOT have a meridian delay in effect!



Click the "Clear" button. "Current" should be set to "0.00."

- Uncheck the Tracking check box in the lower left corner of the Explorer window if it is checked. (Unchecked is the default.)



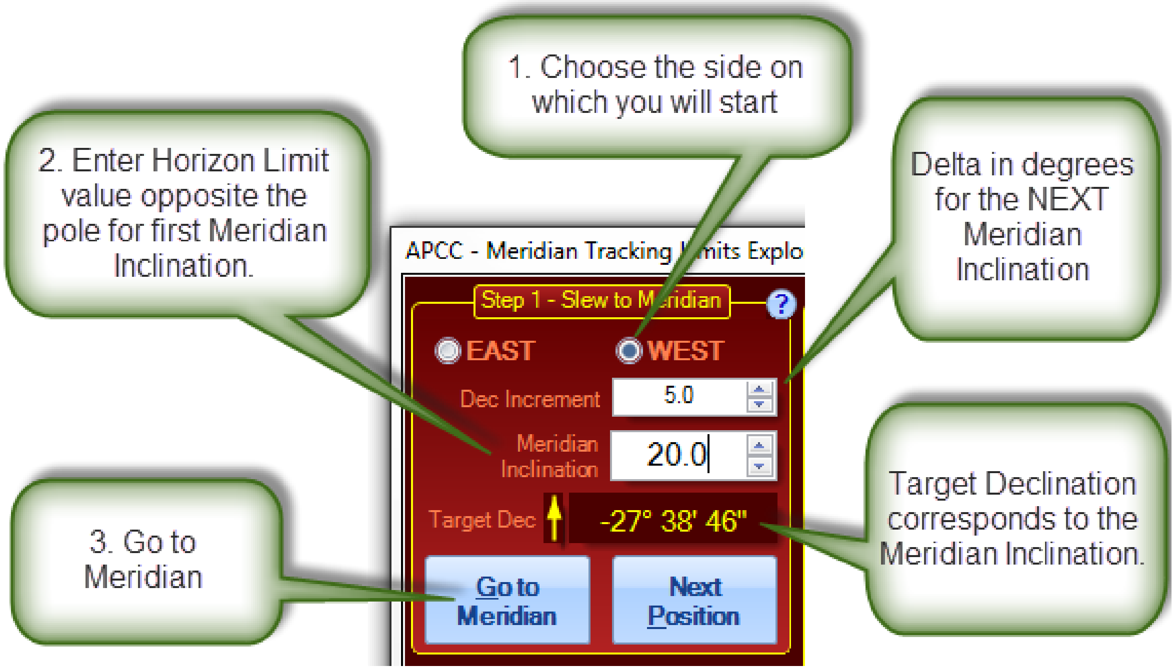
Your First Point on a Side

Your first point on each side of the mount will be handled a bit differently from the subsequent points on that side.

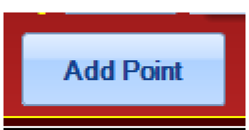
1. Begin by deciding which side of the mount you wish to map first. Click the appropriate button in the upper left of the Step 1 Box. It does not matter which side you do first. Many people will start with the West limits since the tracking direction is westward. However, don't simply forget about the East limits. As described earlier in the Meridian Tab section, you can allow the mount to automatically start in safe positions in the east with the CW up for "flip-free" imaging through the meridian!

2. Enter the altitude value from your horizon limits as described above into the Meridian Inclination field. Observe that the Target Declination will change to reflect the newly entered Meridian Inclination value. Please note that this value does NOT yet include the Dec. Increment.

3. Click the "Go to Meridian" button. The mount will slew to the meridian on the chosen pier side at the entered meridian inclination. **Important:** Before you slew to Meridian, make sure your scope is can reach the meridian without a pier crash. There are situations where the telescope may not reach the meridian if you have a very long telescope, a large filter wheel, etc.



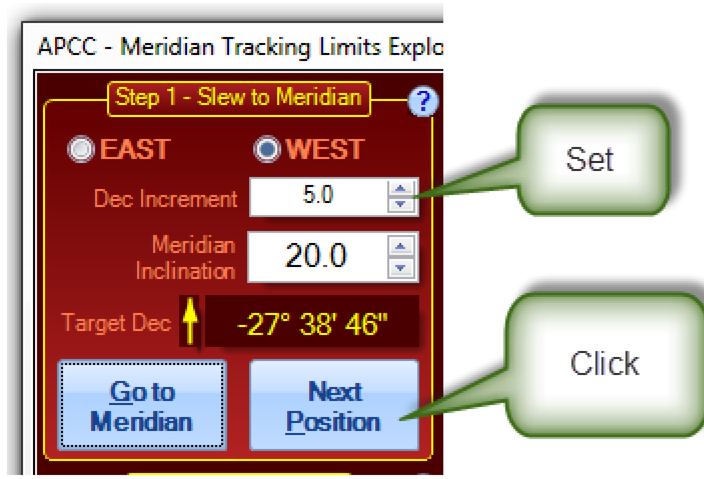
4. For this first point, DO NOT move the mount further with the E-W buttons. Instead, simply click the "Add Point" button at the bottom of the Step 2 box.



Subsequent Points on a Side

Now that you have set your starting point at the horizon opposite your pole, you are ready to map your meridian limits in earnest!

1. Select the declination increment you wish to use at the start. This is the number of degrees delta in declination to slew with each click of the *Next Position* button. For most people, the limits starting out can be rather coarse, in the 5 to 10 degree range. (The max is 20°) You may want to tighten this up as you get closer to the pier.



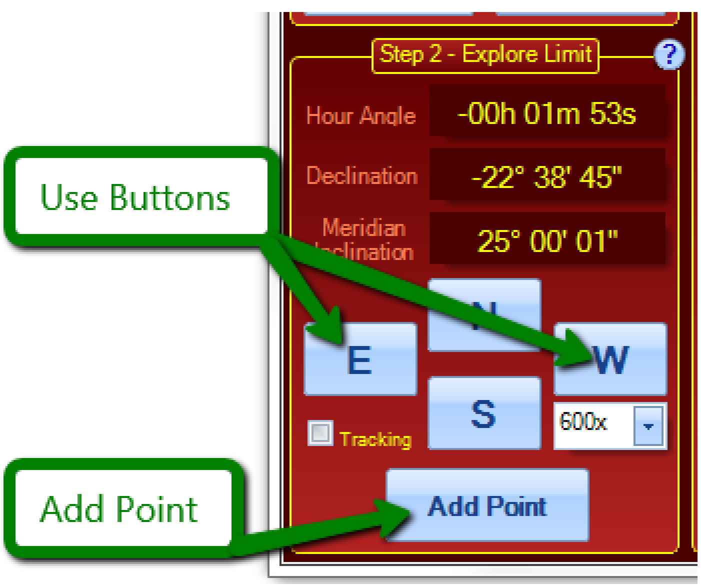
2. Click the "Next Position" button.
   Once you click the "Next Position" button:

   a. The mount will begin to slew;

   b. The Meridian Inclination will update;

   c. And the Target Dec. will also update.

3. During the slew to the "Next Position," the direction buttons will be grayed out. Once they become available, move the mount east or west, depending on the side you are mapping, until you either reach the pier, or point to the horizon. You can use any button control that you have available, but the most convenient are usually either the buttons right there in the "Step 2 - Explore Limit" box, or else the buttons on the keypad. We have found that it is often quickest and easiest to use the direction buttons in the Meridian Tracking Limits Explorer at higher speed (600x or 1200x) to get close, and then to finish with the keypad at 64x. The keypad allows you to stand where you can see the scope and pier more clearly. Allow yourself a bit of "safety margin," but since these are tracking limits, you don't need a lot.



4. Decide on next Dec Increment in the Step 1 - Slew to Meridian box. Change if necessary.

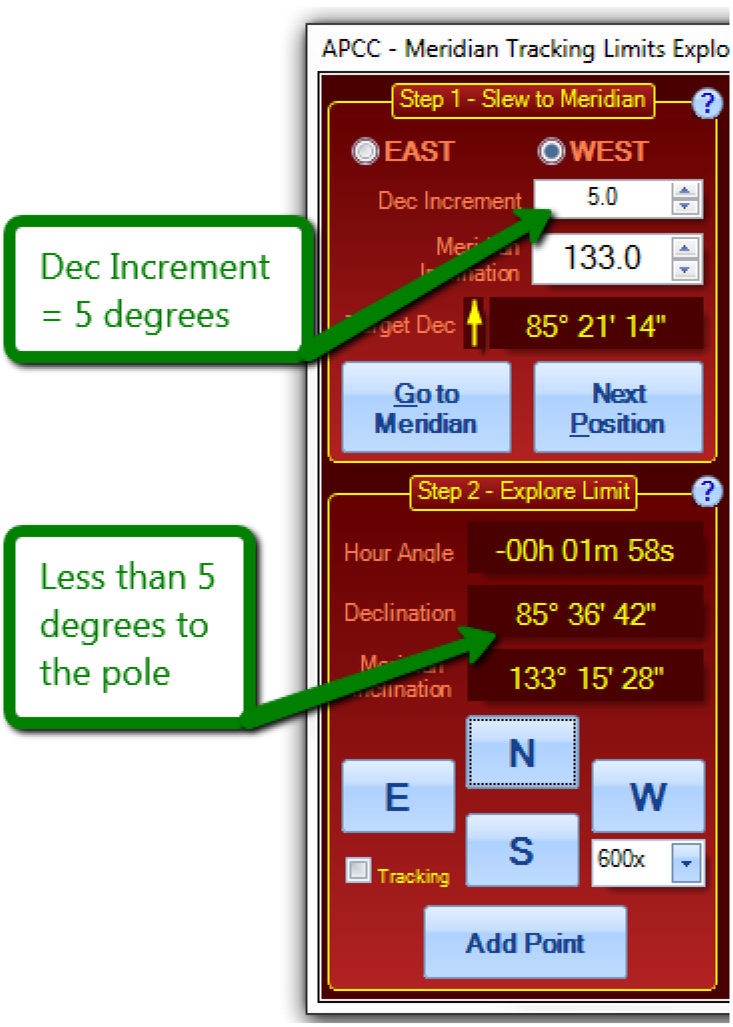
5. Return to step #2 - Next Position - above.

Some Hints:

- In general, the North and South buttons are not used, but they can come in handy if an obstruction is just narrowly missed at a given point. The subsequent Dec Increment will be calculated from the new, adjusted Dec. value, not from the original value to which the mount slewed.
- If you are taking your limit mapping all the way to the pole, be sure to compare the current declination to the declination increment. This is explained further in the next heading - Finishing at the Pole.

Finishing at the Pole

Meridian Tracking Limits are not currently defined below the pole in APCC. Future releases may add this feature if it is demanded. Because the program cannot define the limits below the pole, you must stop your mapping just before the pole. See the screen shot below:



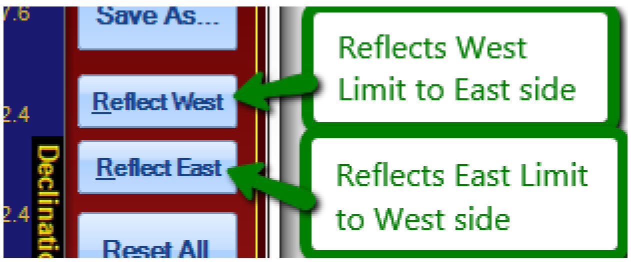
There are two options at this point.

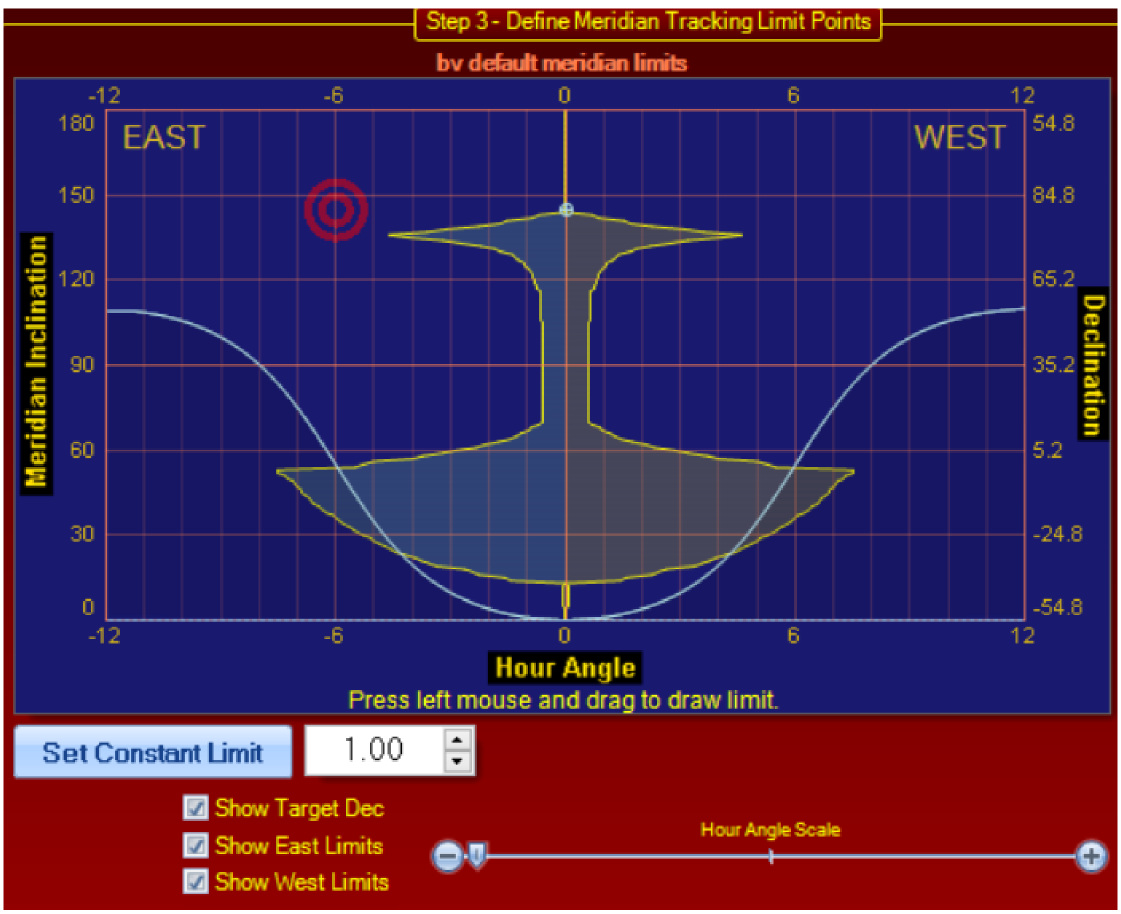
1. You can skip this last small increment and go to the other side, or finish if this is the second side already. See Below:

2. You can enter a last "adjusted" increment. In the example from the screen shot above, I would enter an increment of 4.3° (4° 18'). { Note that 4.4° (4° 24') would overshoot the pole by 42". }

After the Last Point on a Side When you have added your last point for the side, there are several options:

- If this is the first side of the mapping, return to step 1 of the "Your First Point on a Side" section.
  - At step 1, choose the other side, and then proceed with the rest of the "Your First Point on a Side" instructions. Continue as before.
- If this is the first side of the mapping, you can map the other side by "reflection." Reflecting will precisely copy the mirror image of the mapping you just completed onto the other side.



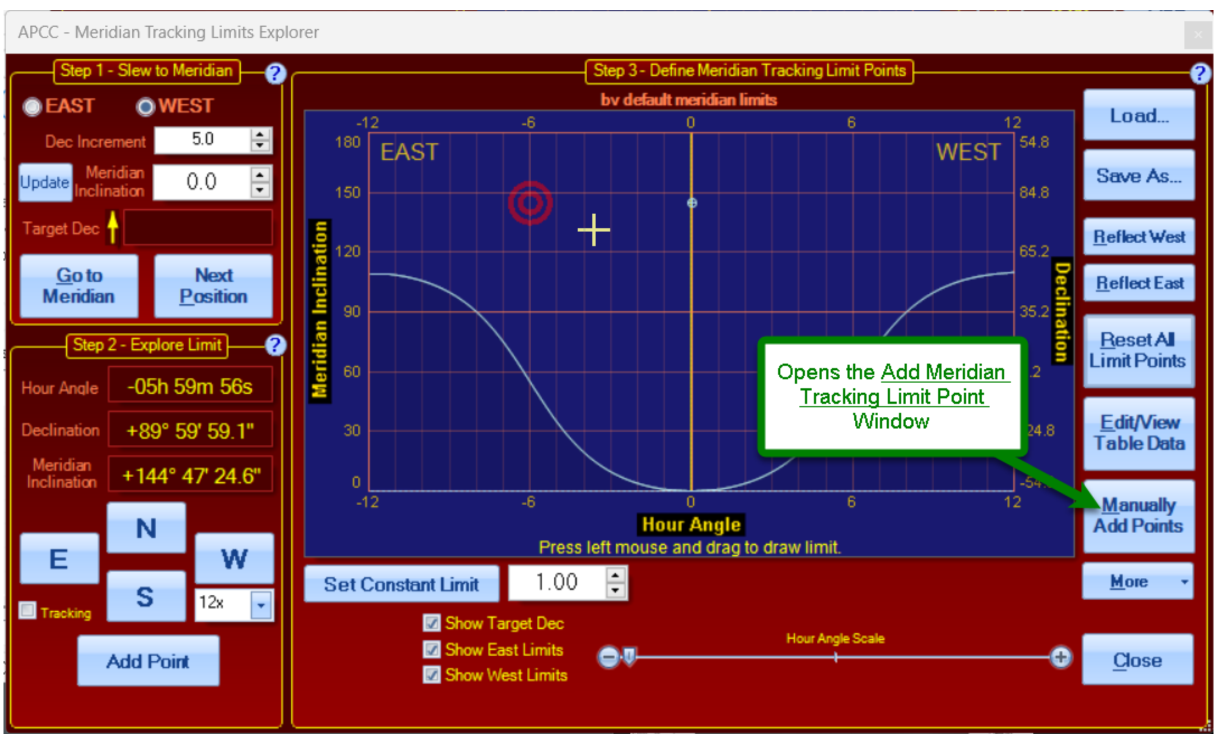


Note that the button is for the side being reflected, not the side to which you are reflecting!
Also Note: Reflected mappings can be further edited and refined using any of the methods for mapping described in these instructions.

- Save the Meridian Limits File (*.mlm) The mapping you create will automatically be kept in a file named Default.mlm. You will not lose it, but any changes you make to a limit mapping will overwrite the Default.mlm file with the changed data. Default.mlm is always the currently loaded limit file in whatever edit condition you have placed it. If you have invested the time to do a detailed mapping, take the time to save it so that you can retrieve it later. Saved files can always be loaded and edited or changed later and re-saved.
- Some additional notes:
  - There is no requirement that you start at the horizon away from your pole and then work your way poleward. You can even set negative increments to go backwards. However, we have found that after trying various methods of setting up these limits, starting at the horizon away from the pole has become the method we prefer ourselves.
  - You do not need to carry your limits all the way to the pole. Remember, however, that zero limit values will not allow you any tracking past the meridian at those declinations. An easy and quick way around this is to simply carry the "worst case" value at the pier the rest of the way poleward in one jump.

6.16.3 Manually Add Meridian Tracking Limit Points

The Manually Add Points button on the right side of the Meridian Tracking Limits Explorer opens a new window for adding points to your limit mapping.

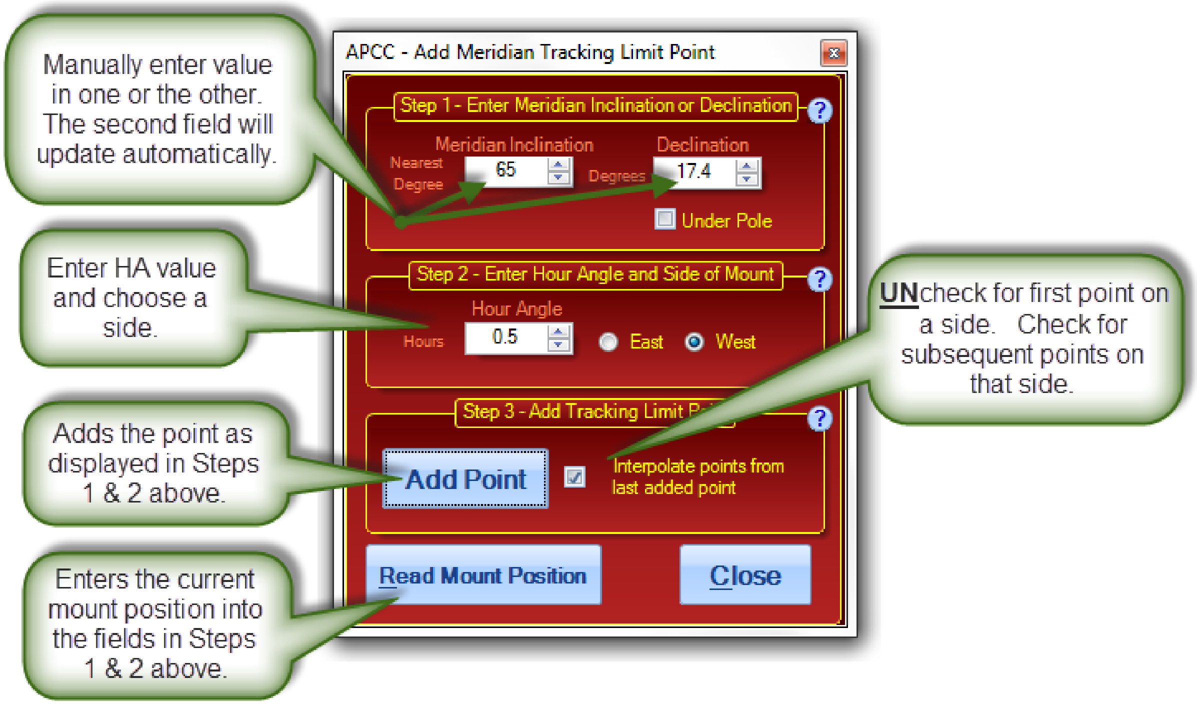


There are two primary situations where the manual method may be more appropriate:

1. You have already created a data set, perhaps on a spreadsheet, that you would like to easily transfer into the Meridian Tracking Limits Explorer.
2. You want to move the mount with the keypad to quickly put together a "rough" set of limits for a star party or portable setup.

In general, we recommend using the conventional method in the previous section: Using the Meridian Tracking Limits Explorer. This method is primarily for advanced users and for those who prefer keypad operations with their mount.

Clicking the Manually Add Points button will open the following window:



We will look at three procedures for making use of the "Add Meridian Tracking Limit Point" window:

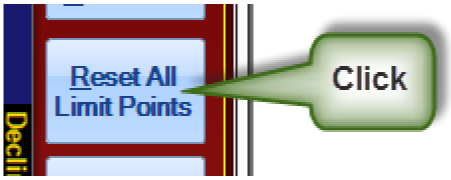
1. Making a quick set of limits with the keypad, or similar button control
2. Entering data from an existing table
3. Editing part of an existing curve to reflect a change.

Making a quick set of limits with the keypad, or similar button control

You can make a surprisingly effective set of meridian limits for a star party or other short-term setup with the keypad and this window in a very short time.

The First Point

1. Start with a cleared Meridian Tracking Limits Explorer window by pressing the "Reset All Limits" button.



2. Slew to a spot above the horizon away from your pole that you consider your "horizon limit." A very easy way to do this is to go to the Horizons Tab and double click the approximate point on the horizon graph where you wish to go.

3. As long as you are close to the meridian, and on the correct side, simply adjust the declination to your acceptable horizon height. Don't worry about RA if you are relatively close.

4. UNCHECK THE INTERPOLATE CHECKBOX IN THE STEP 3 PANE!

5. Click the "Read Mount Position" button

6. Enter 0.0 as the hour angle in the Step 2 Pane to overwrite the hour angle read from the mount.

7. Click "Add Point."

8. RE-CHECK THE INTERPOLATE CHECKBOX IN THE STEP 3 PANE!

Subsequent Points

9. Slew to the next point you wish to add. Move in both RA and Dec.

10. Click the "Read Mount Position" button

11. Click "Add Point."

12. Return to step #9, and repeat until you are done or have reached the pole.

The Last Point on a Side Remember that you cannot cross the pole!

13. Adjust the RA and Dec while watching the hour angle values in the Meridian Tracking Limits Explorer window. If you pass the pole, the hour angle value will change sign and jump 12 hours, for example from +2 to -10 hours.

    a. Adjust the Dec to be as close to 90 as you care to make it (does NOT need to be real close!) without jumping to the below-the-pole hour angle.

    b. Adjust the RA to your limit.

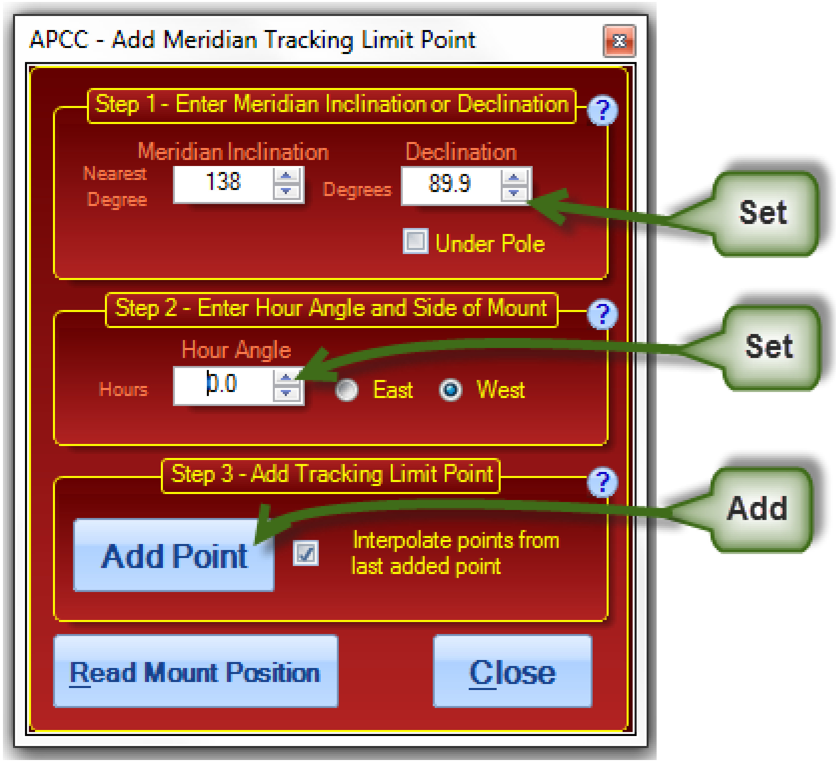
14. Click the "Read Mount Position" button

15. Click "Add Point."

16. Set the Declination value in the Step 1 pane to 89.9 (Northern Hemisphere) { –89.9 in the south }

17. Set the Hour Angle to 0.0 in the Step 2 pane.

18. Click "Add Point." This will finish the side.



Last Point

Unless you have a very lopsided camera setup or pier, you can probably simply reflect this limit for the other side. Otherwise, repeat the procedure STARTING WITH STEP #2 - NOT STEP #1!

Entering Data from an Existing Table

If you created a table or list of data that gave the "safe" and "unsafe" declinations for your system, you can copy that information into the "Add Meridian Tracking Limit Point" window.

1. UNCHECK THE INTERPOLATE CHECKBOX IN THE STEP 3 PANE!
2. Enter an hour angle of 0.0, and a Dec. or Meridian Inclination for your horizon away from the pole.
3. Click "Add Point."
4. RE-CHECK THE INTERPOLATE CHECKBOX IN THE STEP 3 PANE!
5. Enter the next values of hour angle and Dec. from your data.
6. Click "Add Point."
7. Return to step #5, and repeat until you are done or have reached the pole.
8. Set the Declination value in the Step 1 pane to 89.9 (Northern Hemisphere) { –89.9 in the south }
9. Set the Hour Angle to 0.0 in the Step 2 pane.
10. Click "Add Point." This will finish the side. (See screen shot above)

Unless you have a very lopsided camera setup or pier, you can probably simply reflect this limit for the other side. Otherwise, repeat the procedure STARTING WITH STEP #2 - NOT STEP #1!

Editing Part of an Existing Curve to Reflect a Change

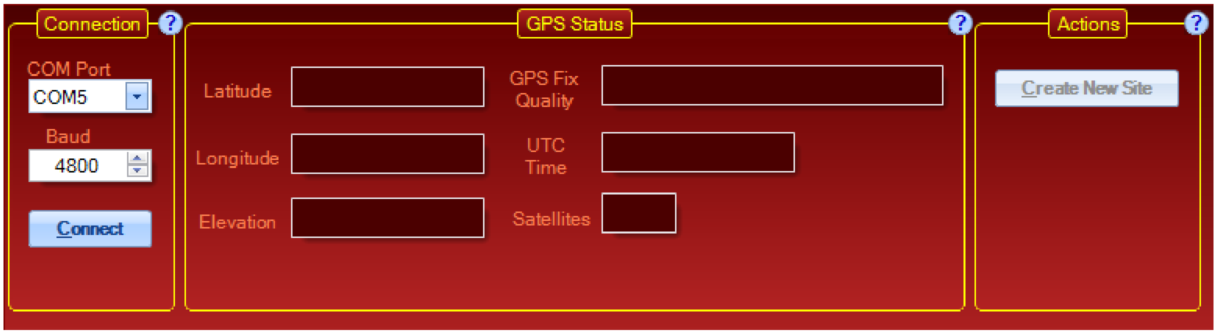
The trick to using the "Add Meridian Tracking Limit Point" window to edit an existing set of Meridian Tracking Limits is to get into the limit mapping, and then out of the mapping without creating a problem.

1. Load the Limit file that you wish to edit or modify.
2. UNCHECK THE INTERPOLATE CHECKBOX IN THE STEP 3 PANE!
3. On the graph for the limit in the Meridian Tracking Limits Explorer window, hover the mouse over the exact spot where you wish to START your edit. A white data box will appear with the coordinates for that spot.
4. Note the Hour Angle and Dec. or Meridian Inclination for the spot.
5. Enter these values in the Step 1 and Step 2 panes
6. Click "Add Point." A blinking square dot will appear on the graph to show you where you are.
7. RE-CHECK THE INTERPOLATE CHECKBOX IN THE STEP 3 PANE!
8. Make your edits and changes. After the last change proceed to Step 9 below.
9. On the graph for the limit in the Meridian Tracking Limits Explorer window, hover the mouse over the exact spot where you wish to END your edit. A white data box will appear with the coordinates for that spot.
10. Note the Hour Angle and Dec. or Meridian Inclination for the spot.
11. Enter these values in the Step 1 and Step 2 panes
12. Click "Add Point." You are done
13. Save the edited limit if you wish.

6.17 GPS Tab

APCC has the ability to read a GPS device that is connected to your computer. Most standard GPS units that create a virtual COM port on a computer should work. *APCC* also supports reading GPS information from the Astromi.ch MGBoxV2.

APCC's GPS parser looks for a specific NMEA message, GPGGA, which contains time, latitude, longitude, and altitude values. Once it finds one of these records it will fill in the information in the GPS Status group box.



GPS Connection

COM Port: For *APCC* to read a GPS device, the GPS device must have a virtual COM port assigned to it. Usually the driver for the GPS device will automatically create such a virtual COM port, so you just need to select the proper port.

If you have a Astromi.ch MGBoxV2, then select "MGBoxV2" in the COM port drop down list (it should be the first entry). For it to work you must install the MGBox V2 ASCOM Observing Conditions driver from https://www.astromi.ch/product/mgbox-v2/ and configure the proper virtual port for the driver to use. Please consult the documentation for the MGBoxV2 driver for more information.

Baud: The typical baud rate for GPS devices is 4800 baud. **(Note:** This field is ignored when configured for MGBoxV2.)

Connect: Click this button to try to connect to the virtual port of the GPS. Once connected, the button will say "Disconnect".

NOTE: If the GPS data cannot be read, ensure that your GPS device is set to NMEA mode. Your GPS device may also need time after power on to acquire and lock on to a GPS signal

GPS Status

Displays information obtained through your GPS device.

Actions

Create New Site: Click this button to create a new site with the current latitude, longitude and elevation last acquired from the GPS. This will open the Manage Sites dialog window.

7 Pointing Model Tab

Operation

Enable Pointing Correction: When checked this enables APCC's pointing correction logic.

Enable Tracking Correction: When checked this enables APCC's tracking rate correction logic.

Note: You must have a model loaded in order to enable pointing or tracking correction. See the section on APPM for further details in preparing a model.

Model..: Opens the **pointing model window**. In this window you can view and change the pointing model.

APPM: Runs the **Astro-Physics Point Mapper** (APPM) utility, which is included with APCC Pro. APPM is what is used to create pointing models used for pointing and tracking rate correction.

Temp: If no supported temperature sensor is present then in this field you can enter the temperature in Celsius. Temperature is used in the refraction calculations.

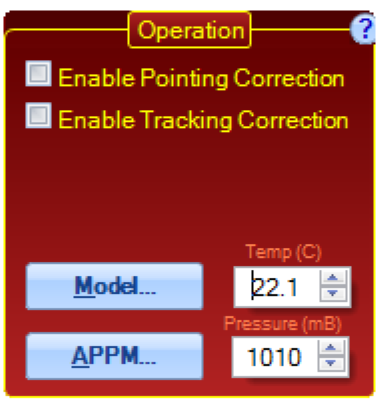
At this time, support devices include:

1) Any device with an ASCOM ObservingConditions driver.

2) Multiple ASCOM Observing Conditions devices can be mixed using the ASCOM ObservingConditions Hub

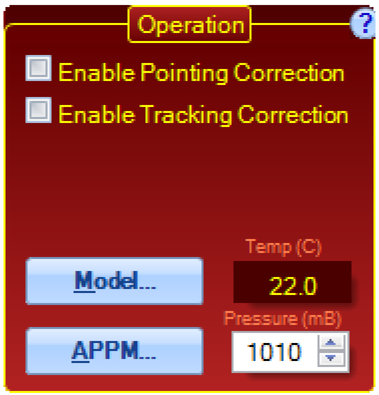
3) The THUM (Temperature Humidity USB Monitor) sensor.

Configuration of the appropriate sensor device and driver can be setup in the "Environmental settings..." menu item in APCC's Settings menu.



If a supported temperature sensor is attached to the computer then the temperature from the sensor will not be editable. The temperature field will change color to indicate this. Hovering the mouse over the temperature field will show humidity and dew point. APCC will read the device throughout your session when connected.

NOTE: When using a THUM temperature/humidity sensor do not install or run the THUM service. Only one application at a time can connect to the THUM, per the design of this device. So, if the THUM service is running APCC cannot read data from the THUM (nor can it connect to the THUM service app)..



A Note about Temperature:

Even a modest temperature change can make a measurable impact on refraction. APPM will record the temperature at each plate solve for later use. Even though there may not be a significant change in temperature on any given night, there may be a significant change from the night the Pointing Model was created. APPM and APCC can account for the difference in temperature between nights to provide the greatest pointing and tracking rate correction accuracy possible.

For the purposes of refraction the best air temp would be that measured at least 10-15 feet above the ground.

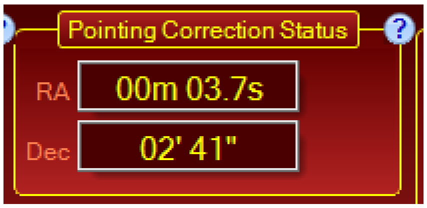
For the purpose of calculating focus point the temperature of the focuser/OTA is best used. Your focusing software will account for these temperature changes. It is not a function of APCC.

Pressure: Here you can enter the approximate atmospheric pressure. This is used for refraction calculations. The atmospheric pressure varies based on two principal factors: the weather, and your altitude above sea level. Note that this differs from typical weather forecast "barometric pressure" which is the atmospheric pressure normalized to sea level. Do not use barometric pressure values. Light is being refracted by the **actual** air mass above your telescope, not the equivalent normalized sea-level air mass. As an example: mean sea-level atmospheric pressure = average barometric pressure = 1013 mB. The Astro-Physics observatory is at an altitude of about 228 meters above sea level - none too high. The sea-level value of 1013 mB is equivalent to about 987 mB of actual atmospheric pressure here at AP. At a remote observatory in Chile at an altitude of 2295 meters, that same sea-level value is equivalent to about 770 mB.

For any given altitude, the atmospheric pressure will have a certain range of variability that can be expected. Within the range at your observing spot's altitude, you will find that higher pressure corresponds with nights where it is clear enough to actually use the telescope, and lower pressure corresponds with cloudy or even stormy weather. When manually entering a value here, enter one that corresponds with the high pressure value for your altitude that you would be likely to find on a good clear night. In a future release, APCC will add support for weather station software so that this value can be kept updated in real time.

Pointing Correction Status

If **Enable Pointing Correction** is checked this group box shows the RA and Declination adjustments that are currently applied to the mount. RA is shown in RA minutes and seconds - Declination is shown in arc-minutes and seconds. They are updated approximately once per second.

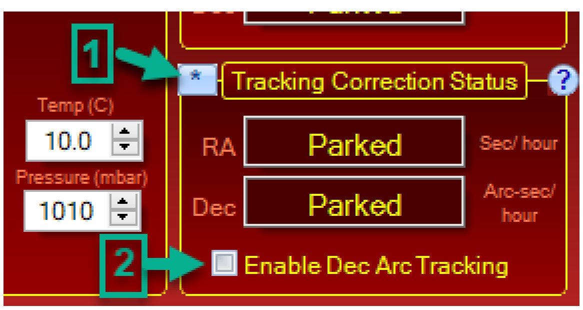


Under certain circumstances the boxes will read with other values:

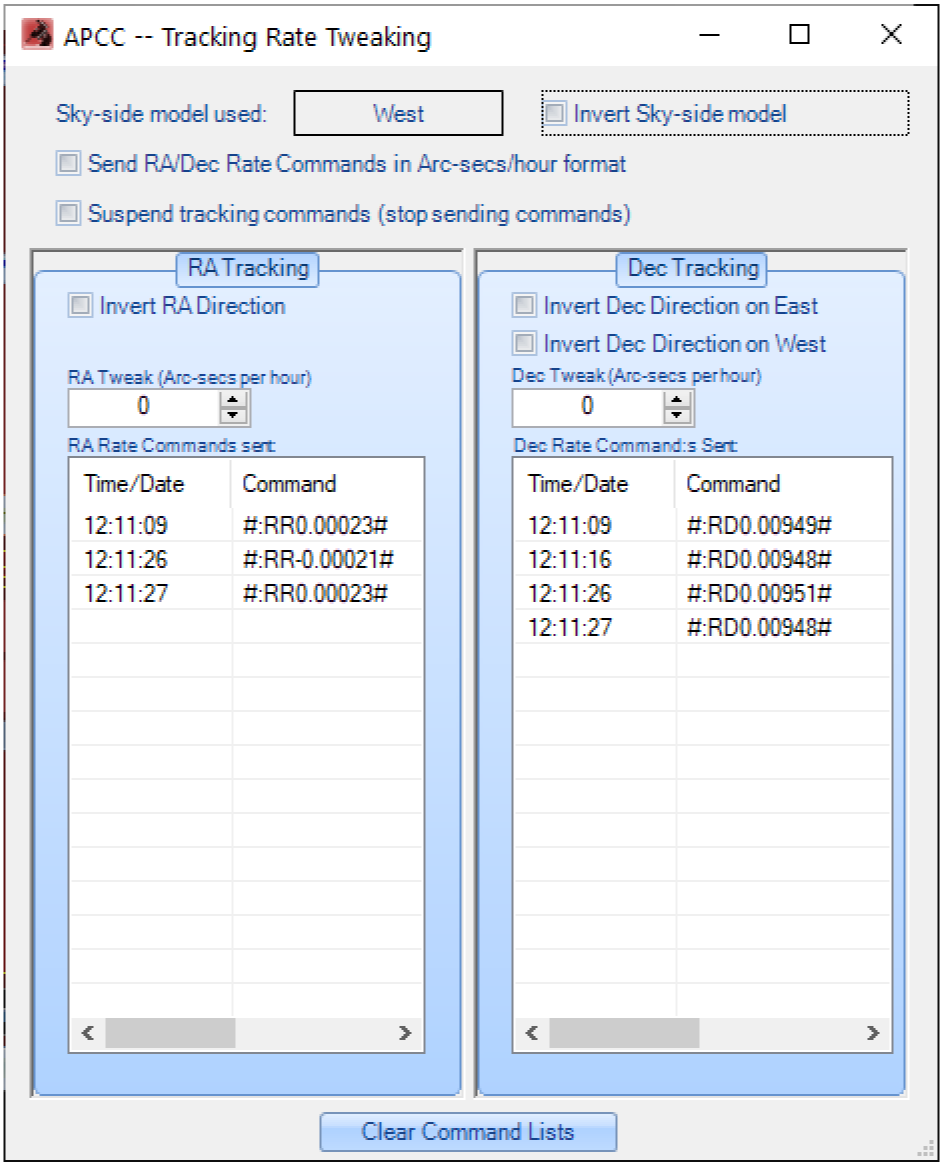
Not Tracking	The mount is not tracking.
Parked	The mount is parked.
Slewing	The mount is slewing.
Near Pole	Dec > 80 or Dec <= -80 degrees

Tracking Correction Status

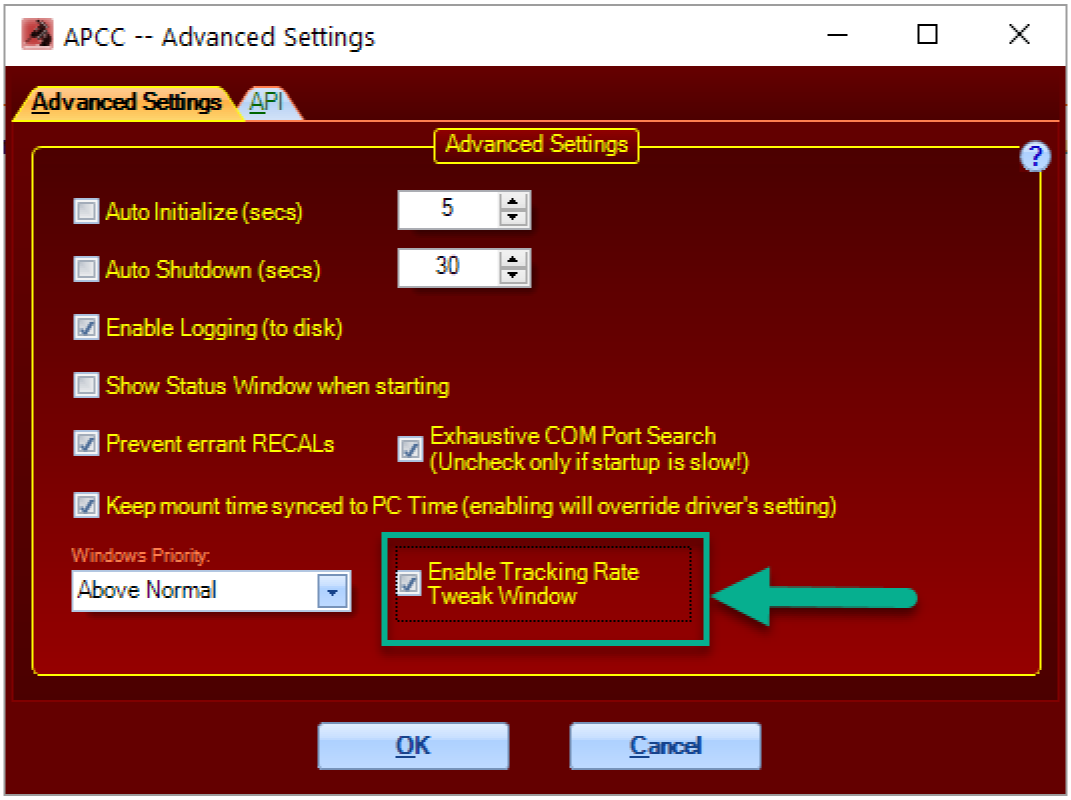
If **Enable Tracking Correction** is enabled the **Tracking Correction Status** group box shows the RA and Declination tracking rate adjustments. **RA** is in RA-seconds/hour. **Dec** is in arc-seconds/hour. These are updated approximately once per second.



1. This button opens the Tracking Rate Tweak window. This allows you to see the commands sent to the mount as well as provides the ability to adjust the rates.



To enable the Tracking Rate Tweak button (usually it is invisible) you must enable it in APCC's Advanced Settings:



2. **Enable Dec Arc Tracking** - If your license enables this feature, it will be visible.

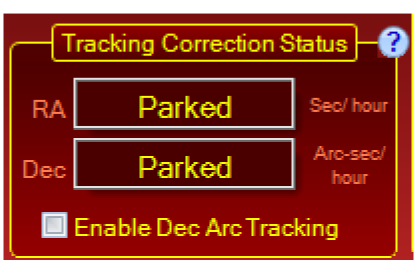
Dec Arc tracking provides an alternative and usually more accurate way to calculate tracking rates from the data points in your pointing data.

It works by doing a best-fit calculation of pointing errors at each declination accumulated in an APPM mapping run. The tracking rates are then interpolated from each declination arc providing an improved all-sky tracking rate correction compared to using the all-sky model. In particular, the Dec Arc modeling accounts for all pointing errors, even those not represented in APCC's all-sky pointing model, which may not be able to as accurately calculate tracking.

Dec Arc tracking can be enabled/disabled while APCC is running, so you can easily compare results against the rate calculated by the all-sky model.

To maintain the highest tracking accuracy the algorithm is only active within the area of sky captured by APPM. That is, APCC will use the All-Sky tracking rate algorithm when the scope points outside the mapped sky area.

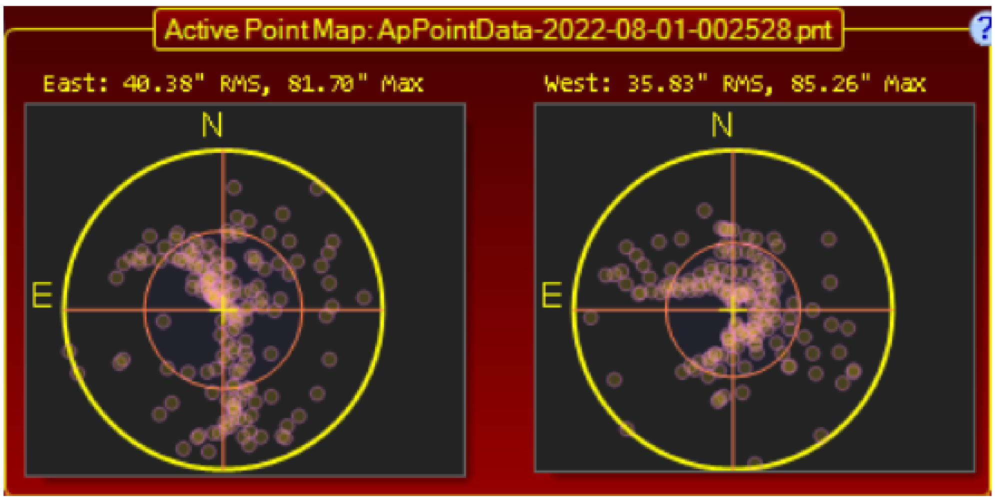
NOTE: Under certain circumstances the Tracking Rate correction boxes can have other values:



Not Tracking	The mount is not tracking.
Parked	The mount is parked.
Slewing	The mount is slewing.
Near Pole	Dec > 80 or Dec <= -80 degrees

Active PointMap

This group box shows a scatter plot for the active PointMap (the active point map filename is shown in the group box title area).



7.1 Advanced Pointing Model

The pointing model tab provides control and status of APCC's **Pointing** and **Tracking Rate** correction models. Using a pointing model can greatly improve the pointing accuracy of the mount. Using the tracking rate model can significantly increase the maximum duration that the scope can go unguided.

Pointing Model

Astro-Physics mounts are extremely accurate so one might ask why is a pointing model needed? The answer may not be obvious... because pointing errors can come from many sources other than the mount itself, including:

- Polar misalignment
- Telescope and focuser flexure
- Sagging or tilted camera to telescope interface.
- Sagging or tilting optics

- Index errors (improperly synched to the current RA/Dec coordinates)
- Refraction
- Dragging cables or moving optics.

To create a pointing model you must use APPM, the Astro-Physics Point Mapping software application. APPM will slew about the sky, taking pictures and plate solving them to extract pointing errors for many different points in the sky. Each plate-solved image is considered a measurement point for correcting pointing and tracking rates in that part of the sky. Having many measurement points allows APCC to "best-fit" a set of standard mechanical and environmental formulas to compensate for most errors.

It's very important to note that APCC's modeling can only correct repeatable errors. That is, pointing errors that reoccur with about the same magnitude every time the scope is slewed to any arbitrary position in the sky. Errors that usually do not repeat, such as dragging cables or moving optics cannot be modeled with APCC's modeling scheme because they can occur randomly and with different magnitudes. APCC cannot foretell the future! It's best to try to remove the random errors by locking optics if needed and securing cables so they cannot randomly slide around.

APCC's pointing model is different from most other pointing models because:

1) It actually consists of two separate models, one for the East side, and one for the West side of the pier. The dual model scheme is automatic. You do not need to do anything extra to get the dual models.

2) Modeling can be done for telescope positions where the counterweight is up. This is a critical feature not found in any other point modeling software that we are aware of at the time of this writing.

3) Modeling records for each measurement point the current temperature, humidity, and pressure, if they are available, at the time of the measurement. This can be very important if the temperature changes by 15 or more degrees when the scope is in use (because of changes in refraction).

It should be noted that from the AP V2 ASCOM Driver that the pointing corrections are transparent. That is the driver doesn't know that APCC is making corrections. If APCC is commanded by the driver to go to a specific RA/Dec coordinate, it will appear to the driver that the scope is at those coordinates, when in fact the mount may be at slightly different coordinates. Toggling "Enable Pointing Correction" will display the two different sets of coordinates (corrected and uncorrected).

Because APCC sits between the ASCOM driver and the mount all planetarium and other ASCOM compliant programs automatically get the benefit of the pointing model. Also, any application that connects to one of APCC's virtual ports will get the benefit of the pointing model.

Polar Alignment

To perform a quick polar alignment, you can perform a small 25-30 point model and apply the offsets shown when hovering over one of the two polar alignment terms.

	Mach 1	Mach 2	900GTO	1100GTO	1200GTO	1600GTO	3600GTO
Azimuth Knob divisions	7	7	18	18	18	18	18
Azimuth adjustment per knob turn	42.13 arc-min	42.13 arc-min	38.71 arc-min	37.99 arc-min	32.26 arc-min	22.96 arc-min	19.18 arc-min
Azimuth adjustment per knob division	6.02 arc-min	6.02 arc-min	2.15 arc-min	2.11 arc-min	1.79 arc-min	1.28 arc-min	1.07 arc-min

Here is the altitude table for the various mounts:

	Mach 1	Mach 2	900GTO	1100GTO	1200GTO	1600GTO	3600GTO
Altitude Knob divisions	16	16	30	4	30	4	-
Altitude adjustment per knob turn **(Latitude = 68)**	57.30 arc-min	57.30 arc-min	38.20 arc-min	30.16 arc-min	33.55 arc-min	20.76 arc-min	20.46 arc-min
Altitude adjustment per knob turn **(Latitude = 42)**	70.91 arc-min	70.91 arc-min	32.53 arc-min	30.16 arc-min	29.23 arc-min	20.76 arc-min	24.98 arc-min
Altitude adjustment per knob turn **(Latitude = 0)**	60.69 arc-min	60.69 arc-min	27.39 arc-min	30.16 arc-min	24.28 arc-min	20.76 arc-min	23.46 arc-min
Altitude adjustment per knob division **(Latitude = 68)**	3.58 arc-min	3.58 arc-min	1.27 arc-min	7.54 arc-min	1.12 arc-min	5.19 arc-min	-
Altitude adjustment per knob division **(Latitude = 42)**	4.43 arc-min	4.43 arc-min	1.09 arc-min	7.54 arc-min	0.97 arc-min	5.19 arc-min	-
Altitude adjustment per knob division **(Latitude = 0)**	3.79 arc-min	3.79 arc-min	0.91 arc-min	7.54 arc-min	1.12 arc-min	5.19 arc-min	-

Tracking Rate Model

Because of flexure, polar misalignment, refraction, and other effects, the apparent tracking rate of stars and deep sky objects in the sky is not exactly equal to the sidereal rate. The reason is that the magnitude of these pointing errors change slightly as the position of the telescope changes. This causes the target to drift in the telescope's view over time.

To help keep a target centered APCC Pro uses a **Tracking Rate Model.** Tracking rate correction is very important if you want to:

- Reduce required autoguider movements which will result in sharper images.
- Do long-exposure unguided images,.
- Do long-duration autoguider cycles through a narrowband filter
- Accurately track comets and/or asteroids.

The tracking rate model uses the pointing model to calculate the necessary adjustments to the tracking rate to keep a target centered. The adjustments are made to both the Right Ascension and Declination tracking rates once every second.

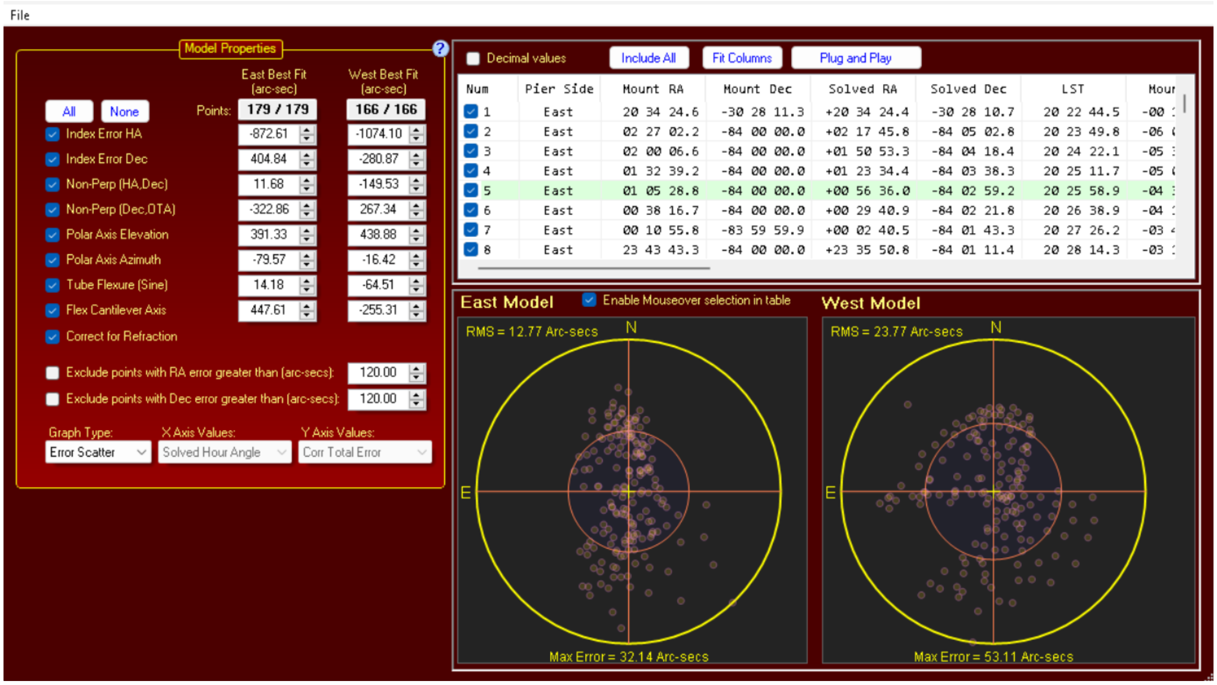
Near the Poles

Near the celestial poles, APCC will automatically turn off the pointing and tracking rate corrections to eliminate the possibility of fast RA/Dec corrections near the celestial pole. So, in this case APCC will display a message "Near Pole" in the Pointing and Tracking Rate status boxes. Pointing and tracking rate correction may not be as well corrected in these areas.

7.2 Pointing Model Window

The pointing model window shows some of the physical properties for the Astro-Physics dual model. The properties are explained below.

To open a model select the menu **File->Open** and navigate to the APPM model that you want to load.



The pointing model window is broken up into several sections. The lower right section shows the pointing errors for the East and West models as a pair of scatter diagrams. In the upper left of the graph is the overall average pointing error for the model (in arc-seconds - RMS). This is the average expected pointing error of the model using the Root Mean Square. The maximum expected error is shown at the bottom.

Note that obtaining the average error stated assumes that the mount is ReCalibrated into the model and that the effects of refraction are properly being accounted for.

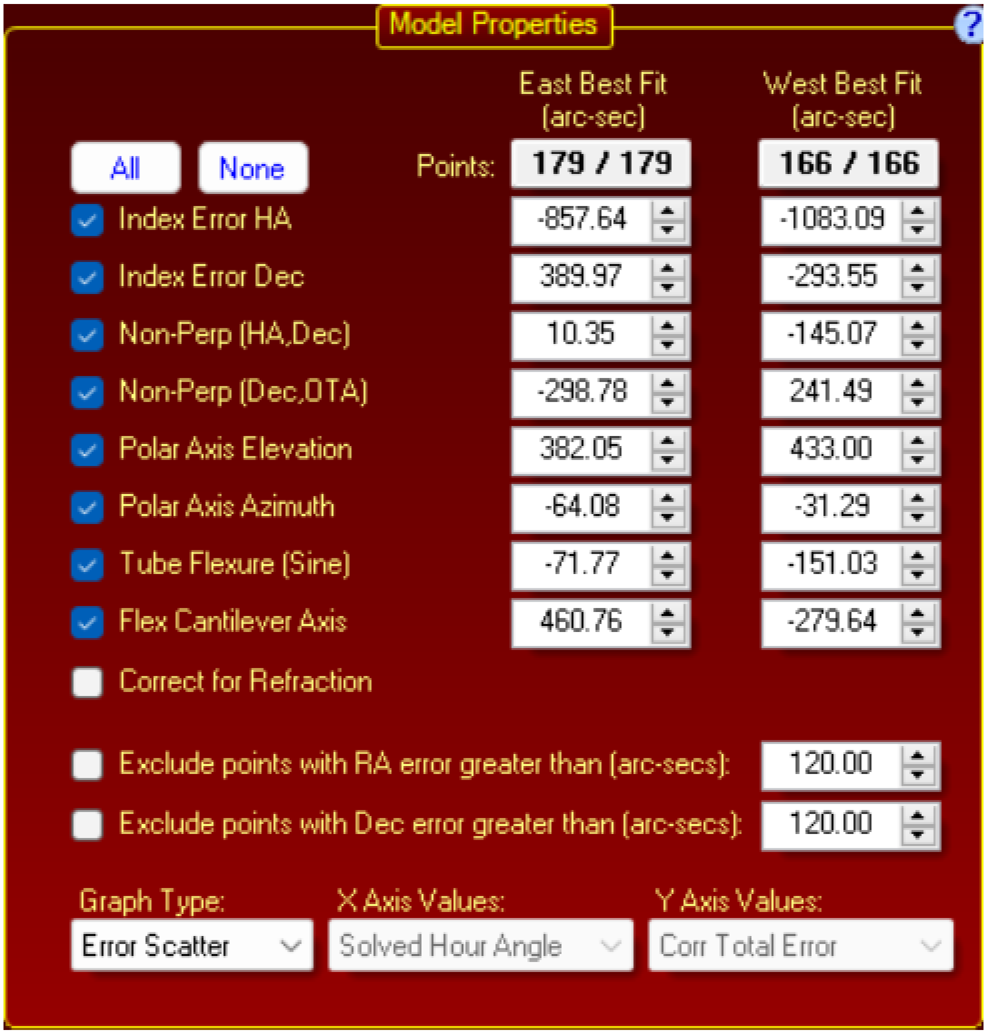
In the upper left section is the Model Properties Group Box. These are are the most important model terms. You can check/uncheck them to see how well the model fits the data by looking at how the average and maximum errors (and graph points) change. Usually you will want all terms selected.

NOTE: in the terms the **Index Dec Error, Non-perp (Dec,OTA), and Flex Cantilever Axis** usually have inverted signs between the axes. Also, the quality of the Polar alignment numbers can be judged by how well they match in each of the dual models. If they are close you can be confident that the numbers are modeled well (the Azimuth is most important).

The last large section in the upper right, the table, simple shows the raw data points collected for the model. You can uncheck specific data points if they seem to be bad data points.

Model Properties and Terms

This group box shows some of the major terms extracted from the pointing model. It is not all-inclusive of all terms and properties used in the pointing model. The pointing model will also take into account refraction and interpolation of residual pointing terms to provide greater accuracy than just these major terms. With time refinements and additional terms may be made visible.

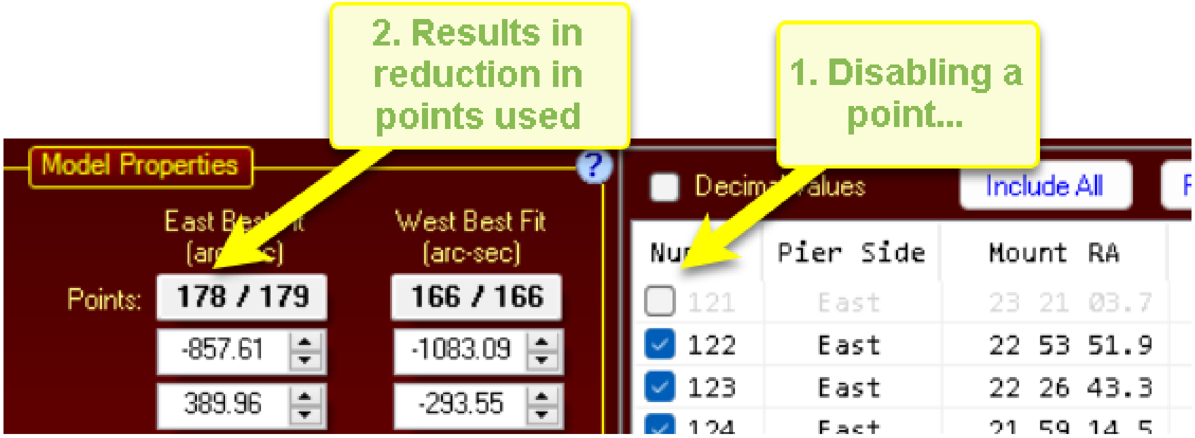


NOTE: All coordinates are in JNOW. In APPM plate solves involving catalogs with J2000.0 coordinates are precessed to JNOW for the purpose of creating pointing models.

This said, you may find these terms useful for evaluating certain mechanical aspects of your setup. There are two columns for the terms. The left column contains the East model's term values. The right column contains the West model's term values. **HOWEVER, do not treat these values as absolute.** APCC's sophisticated modeling uses a "best fit" approach. The values may tell you whether you have a problem with orthogonality or with your polar alignment, but the exact values from the model are not appropriate guides for making precise polar alignment adjustments, or for shimming an OTA.

All/None clicking these buttons will enable or disable all or none of the model terms. This is a convenient way to select all or none rather than clicking each individually. You can of course refine your choices by individually enabling the checkbox for each term.

Points Indicates the number of map points that are used/available. If you disable some model points the right number will be updated to reflect this. Here's an example of disabling one model point:



Index Error - Hour Angle

This is the index error in the Right Ascension axis. For instance in a perfect telescope system if the scope is pointing at exactly RA=10h 00m 00s but the telescope coordinates show RA=10h 02m 04s, then the error is 00h 02m 04s. This type of error can usually be fixed by syncing to a known RA/Dec coordinate (e.g. via a plate solve).

Index Error - Declination

This is an index error in declination. For instance in a perfect telescope system if the scope is pointing at exactly Dec=35d 00m 00s but the telescope coordinates show Dec=35h 04m 07s, then the error is 00h 04m 07s. This type of error can usually be fixed by syncing to a known RA/Dec coordinate (e.g. via a plate solve).

Non-perpendicularity (HA,Dec)

This is the non-perpendicularity between the Declination axis and the Right Ascension axis. There are RA and Dec components to this error but they are both combined in the value shown.

Non-perpendicularity (Dec,OTA)

This is the non-perpendicularity between the Declination axis and the OTA. There are RA and Dec components to this error but they are both combined in the value shown.

Polar Axis Elevation

This is the polar alignment error in Altitude. A positive value means the axis is pointing higher than the true pole. Refraction is not included.

Polar Axis Azimuth

This is the polar alignment error in Azimuth. A positive value means the axis is pointing to the West of the pole when facing the pole.

Tube Flexure

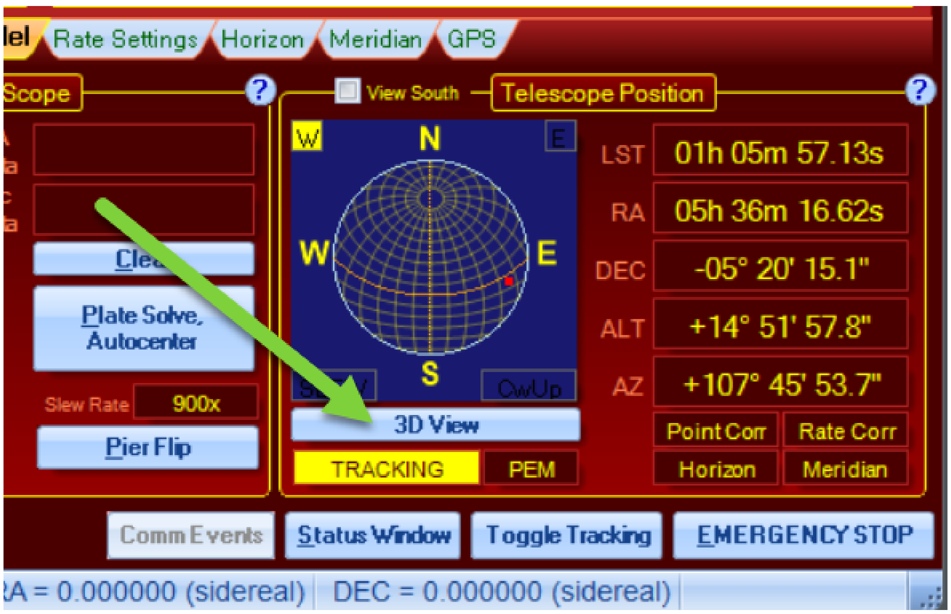
This is the amount of flexure in the tube. There are RA and Dec components to the flexure but the value shown combines both.

Flexure in Cantilever Axis

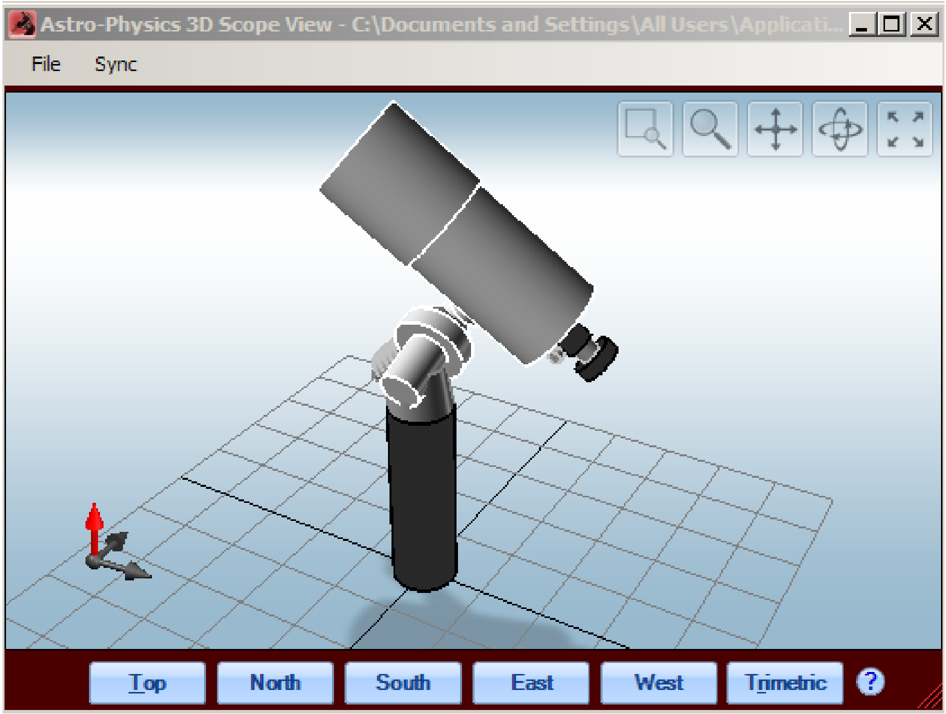
A cantilevered beam is one that is anchored at one end only. In the case of the telescope it is the flexure of the RA and Dec axes caused by gravity. There are RA and Dec components to the flexure but the value shown combines both.

8 3D Scope Window

There are several ways to monitor the position of your telescope via the Telescope Position Group Box, which is always visible on the Main Window.



- **Altitude and azimuth position values:** These values are dynamic and change as your mount moves.
- **Virtual Sky Window View:** When APCC is connected to the mount, the scope's position is shown by a red square in the Virtual Sky Window view. The pier side is shown in the upper left and right with either an *E* or *W* within a yellow box.
- **3D View:** This button will bring up a new window that provides a graphical representation of your mount and telescope based on the data that you provide in the 3D Scope Editor and position data. Note that dimensions of the mount itself cannot be edited at this time. However critical dimensions of the telescope, dewcap, focuser, camera, counterweights and pier can be specified. Refer to the 3D Scope Editor section for specific details.

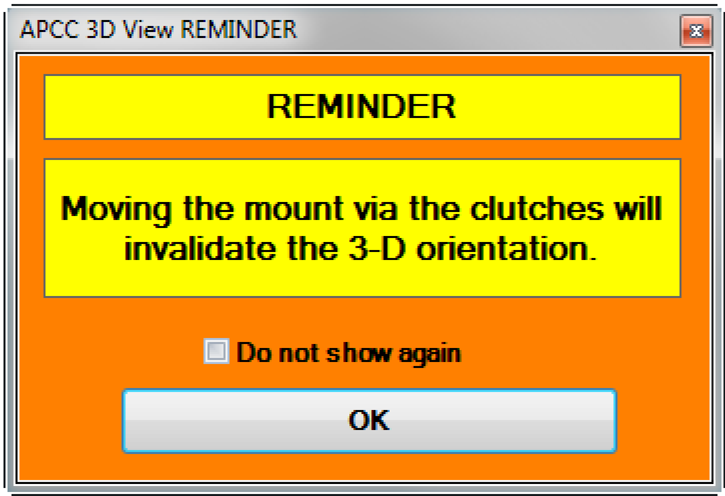


- **Opening Calibration Warning and Clutch Reminder:** When you open up the 3D View Window, a warning box will appear to ensure that the mount is correctly calibrated. In order for the 3D View's Error Warning to function, the mount must be correctly calibrated with the night sky when the window is opened. This warning and reminder are intended for portable users who must set up anew each time they go out. When you click the button to open the 3D View Window, the following box will appear:

If you have not yet re-calibrated the mount on a star, then click NO - Calibration is still needed. Both the warning and the 3D View will close, and you will be given the opportunity to get calibrated.

If your calibration is correct (...and it does NOT need to be plate-solve perfect for this!) click on the "YES - Calibration is Correct" button. If you are in a permanent setup where your mount is always properly calibrated, check the "Do not show again: check-box so you don't have to bother with this each time you open the 3D View Window.

When you click the "YES - Calibration is Correct" button, a reminder box appears. It is important that you understand, and that you remember that the validity of the calibration only remains as long as the mount is not moved via the clutches.



Again, we have provided a check-box for permanent installations so that you don't need to check this each time you open the 3D View window.

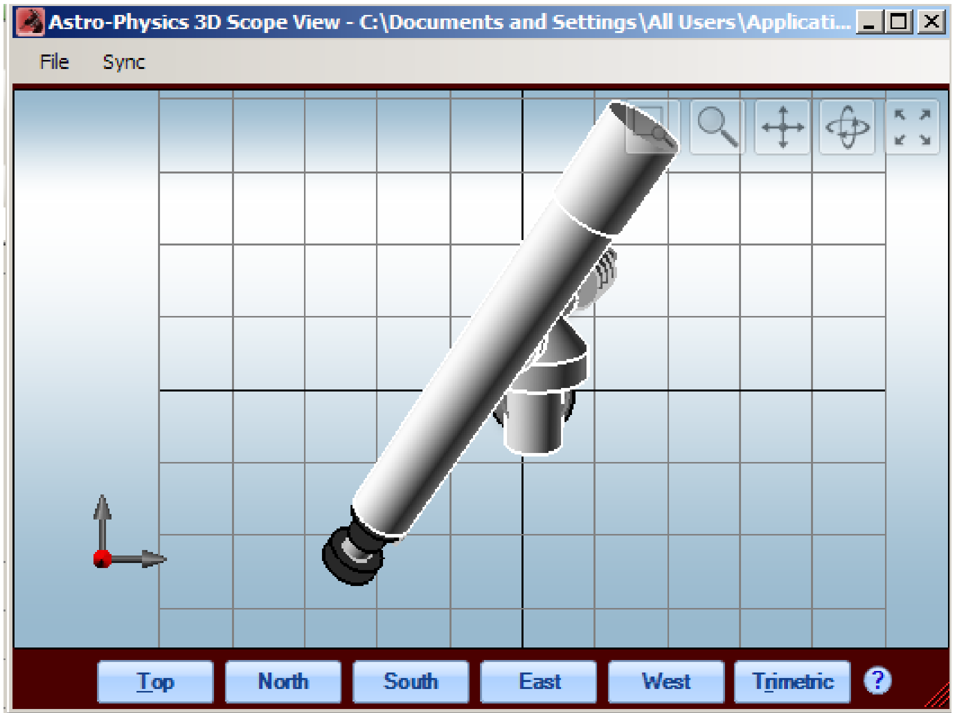
TIP: If you need to use the clutches to move the mount for re-balancing or some other purpose, simply close the 3D View window. Once you are finished with the clutches, just recalibrate in any normal fashion (i.e. reference park position or calibration on a star), and then open the 3D View window back up.

Error Warning

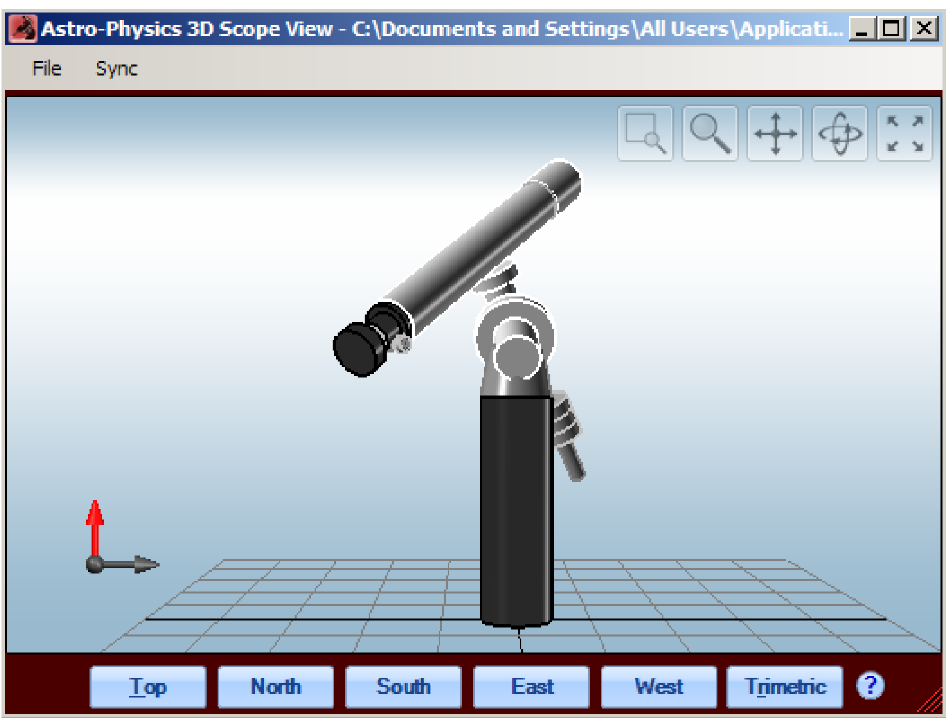
Please refer to the separate Error Warning Section for details

Perspectives

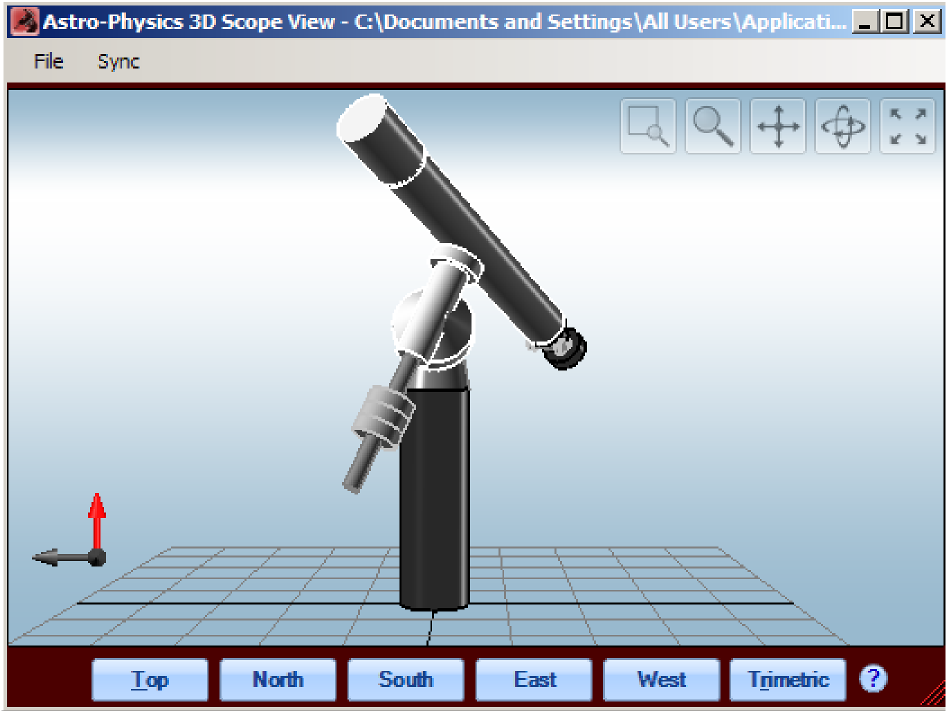
Select the perspective that you wish to view: Top, North, South, East, West or Trimetric. Examples are shown below.



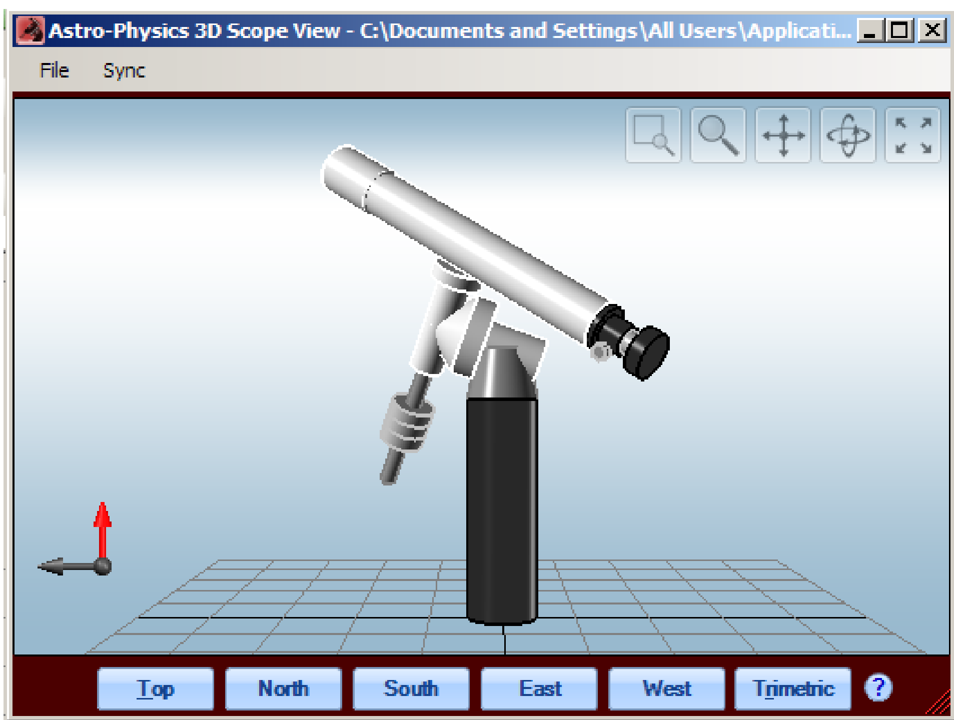
Top View



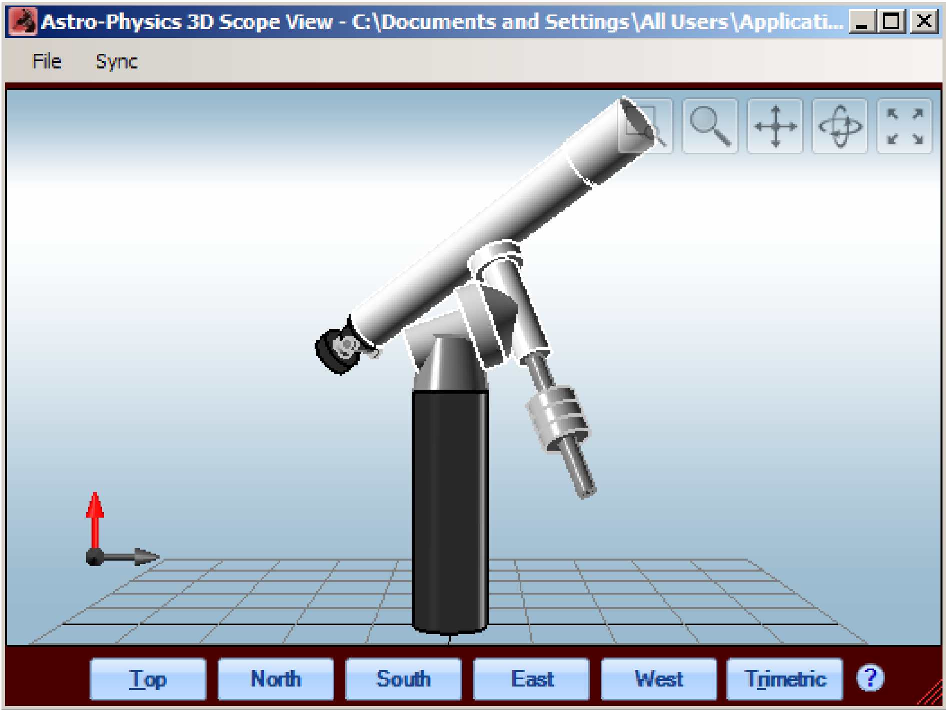
North View



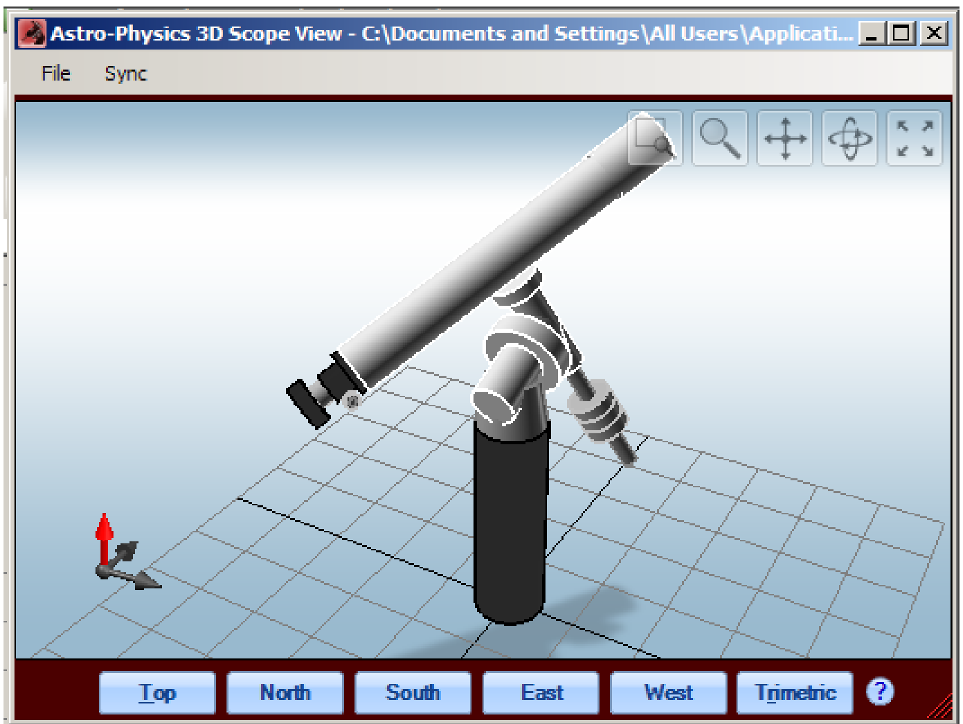
South View



East View



West View

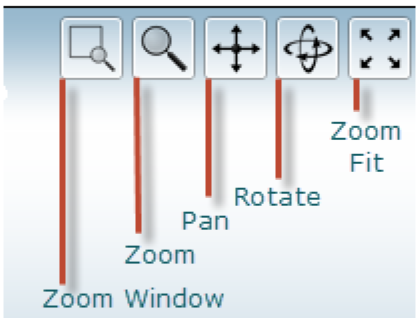


Trimetric View

In the Trimetric view, 3 axes have different angles from each other. Note that in addition to the red zenith arrow, the north and east arrows display as well.

Functional Icons

In order to fully understand how you can utilize these icons, we encourage you to experiment. When you activate each icon, the cursor will change to suit the function and the icon button will turn blue.



Zoom Window: Allows you to create an enlargement window for a specific portion of your 3D model. Left click on the icon to activate the crosshair. Scroll to move the crosshair to the desired starting position, click and draw a box, much like a crop tool in photo editing software. When you release your mouse button, the blue marked area will enlarge. To return your model to the default position, select the Zoom Fit icon.

Zoom: Allows you to zoom in gradually to the center of your 3D model. Left click on the icon to activate the magnifying glass flanked by "+" and "-" signs. Scroll across the screen to enlarge or decrease the size of the image. To return your model to the default position, select the Zoom Fit icon.

Pan: Allows you to move the 3D model to a different position within the box. This may be useful if your telescope is long or your pier is tall and you wish to fit your model within the box to its best advantage. As you move the model up and down, the perspective will shift slightly. To return your model to the default position, select the Zoom Fit icon.

Rotate: Allows you to freely rotate your 3D model to suit your needs. Note that the arrows that designate zenith, north and east will move in a corresponding manner. In this case, the Zoom Fit icon will center the mount within the frame, however does not return the position to your starting position. We suggest that you select one of the Top, North, South, East, West or Trimetric buttons to return to their default orientation.

Zoom Fit: Typically, this selection will undo the changes that were made by one of the other icon selection.

Menu Selections

Refer to the separate Menu Items section for information regarding the *File* and *Sync* drop-down selections.

8.1 Error Warning

The 3D View Error Warning is an exciting safety feature that we have added to APCC. When you opened up the 3D View, APCC tied the celestial coordinates of the mount to the mechanical coordinates (gear angles) in the servo. Celestial coordinates can be changed by user error, but the user does NOT have any way to change the mechanical coordinates, so they are very safe and stable. APCC uses this relationship to verify that the celestial coordinates in the mount are reasonable. If an error is made, and you calibrate on Vega when you are really pointing at Arcturus, APCC will detect this and warn you.

We debated how best to implement this safety feature, and the choice seemed obvious in short order. Someone who is in the middle of an imaging run probably has numerous windows open. Once a session is under way, we often minimize the APCC main window and the driver window to conserve desktop real estate. However, many of us like to use the 3D View window as our "sanity check" on where the mount is pointing since it is a small unobtrusive window and is visual rather than numeric in nature. The 3D View is often the only APCC window that we keep open all the time on our desktop. Now, there is an even better reason to follow this approach!

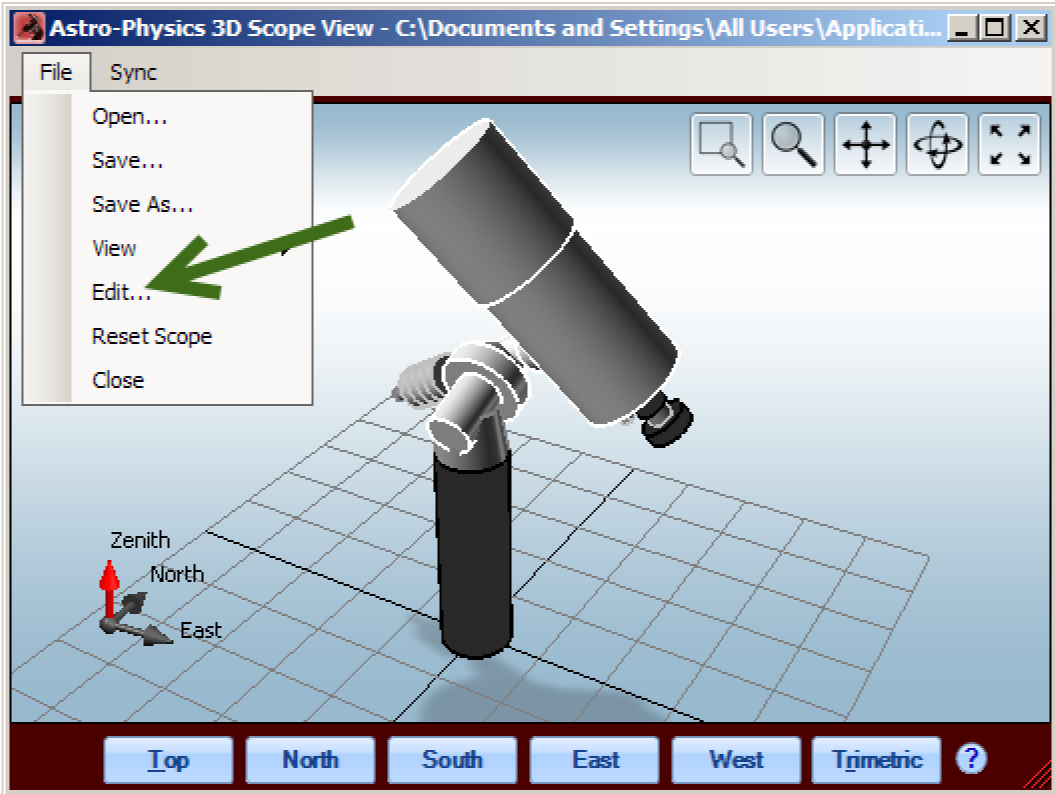
8.2 3D Scope Editor

The 3D Scope Editor allows you to create an approximate representation your telescope and imaging system on your Astro-Physics mount. It will give you a good idea of where and how the telescope is slewing and its relationship to the pier. However, DO NOT rely on the 3D model to determine how close to the pier you can slew safely. We do not provide all of the parameters, i.e. specific mount model and mounting plates, so it is not possible to create a totally accurate model.

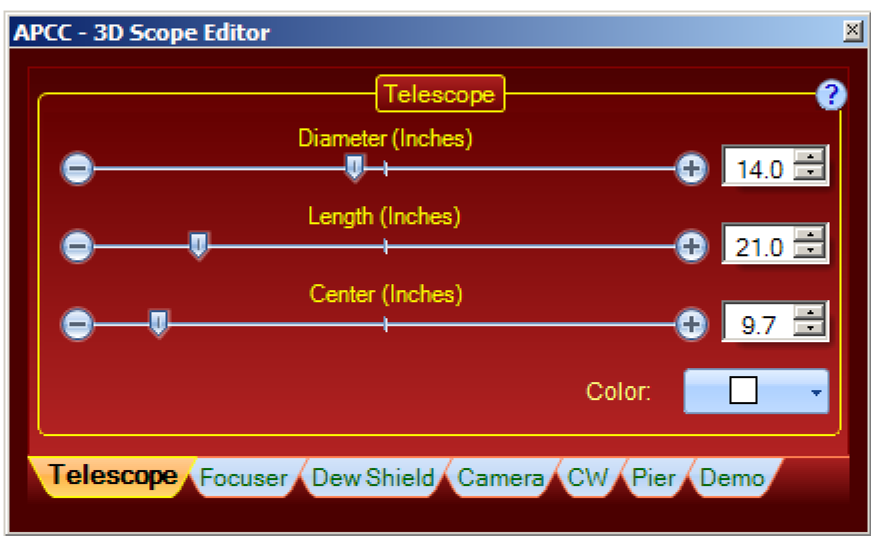
If you are operating your telescope in an observatory and you cannot see it directly from your computer, we recommend that you install a web cam to monitor your instruments.

Open the 3D Scope Editor

The 3D Scope Editor can be accessed by selecting Edit from the File drop-down menu as shown. For an explanation of other selections in the drop-down menu, refer to the Menu Items section.



Telescope Tab

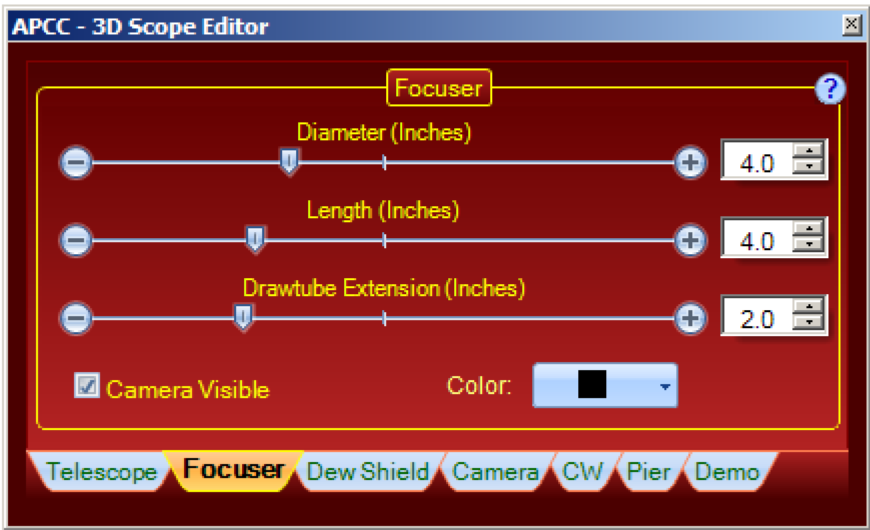


Diameter, Length: Adjust dimensions with slider, arrows or number entry.

Center: Allows you to simulate a balance point of the telescope on the mount by moving the graphical telescope forward or back in relation to the mount.

Color: The drop-down box allows you to change colors. Alas, there is no good representation of Astro-Physics cream white.

Focuser Tab

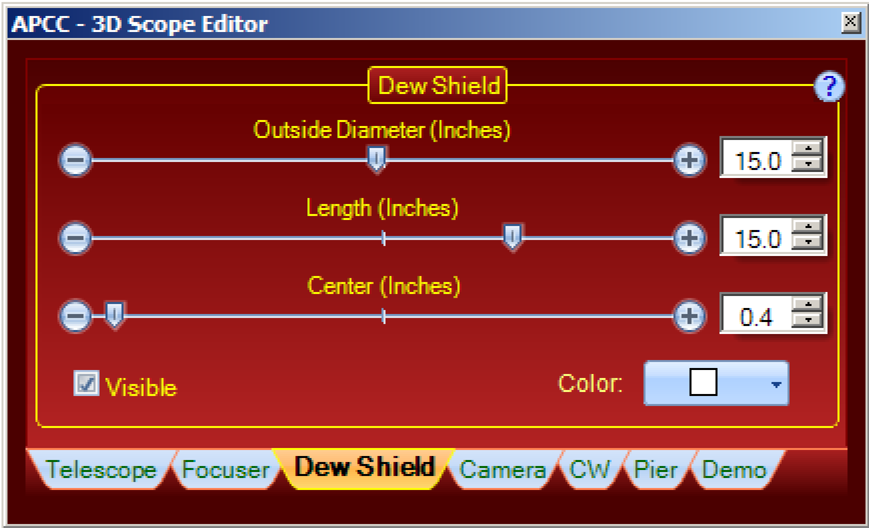


Diameter, Length, Drawtube Extension: Adjust dimensions with slider, arrows or number entry.

Camera Visible: You can specify whether or not the camera should be visible in your graphic. This will impact how your focuser displays.

Color: The drop-down box allows you to change colors.

Dew Shield Tab



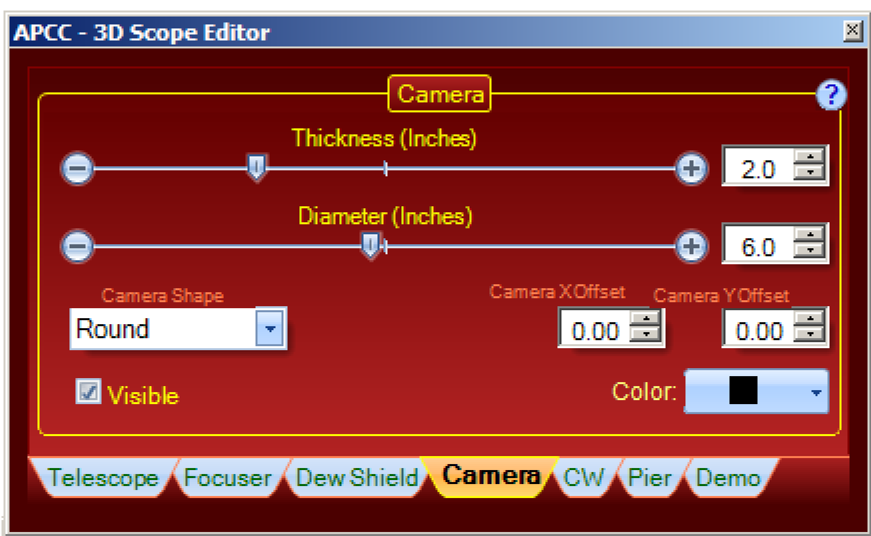
Outside Diameter, Length: Adjust dimensions with slider, arrows or number entry.

Center: Allows you to simulate the position of the dew shield relative to the tube, i.e. whether it is retracted or not.

Visible: Check the box to indicate whether or not the dew shield should be visible.

Color: The drop-down box allows you to change colors. Alas, there is no good representation of Astro-Physics cream white.

Camera Tab



Thickness, Diameter: Adjust dimensions with slider, arrows or number entry.

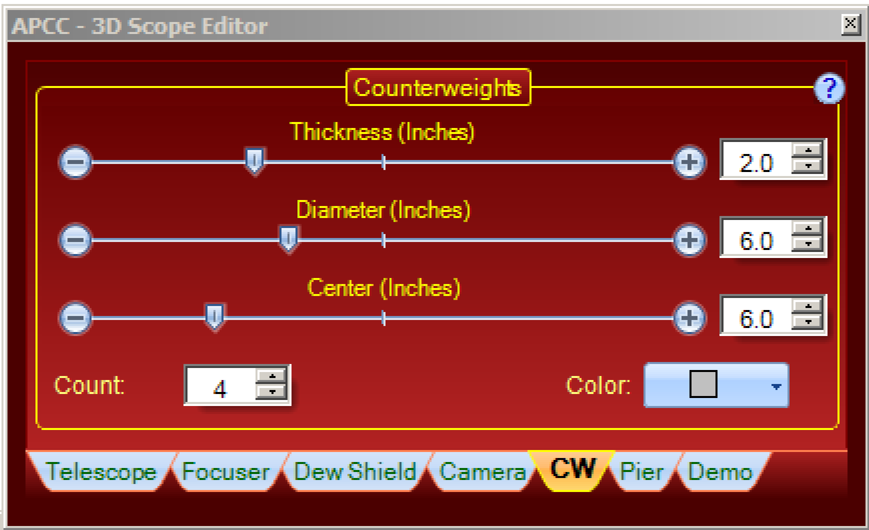
Camera Shape: Select the closest option from the drop-down list.

Camera x Offset and Camera Y Offset: Use these controls to adjust the camera position.

Visible: Check the box to indicate whether or not the camera should be visible.

Color: The drop-down box allows you to change colors.

CW - Counterweights Tab



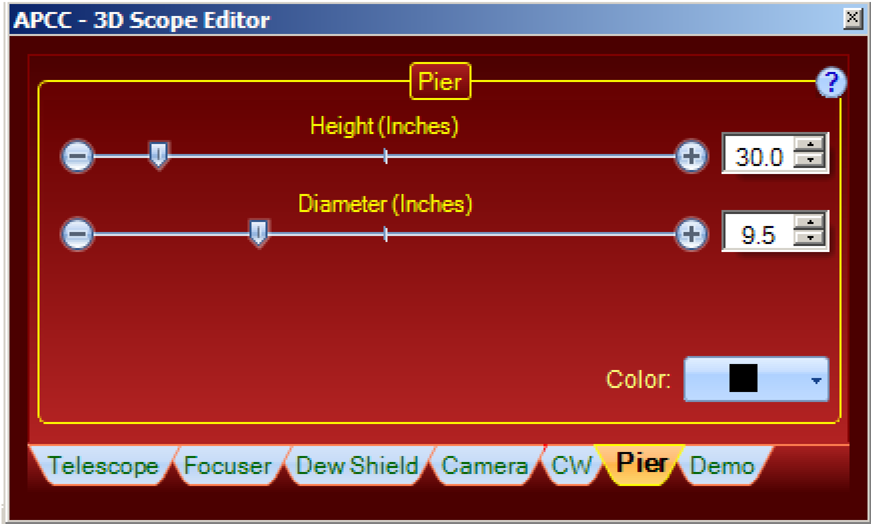
Thickness, Diameter: Adjust dimensions with slider, arrows or number entry.

Center: Adjust the position of the counterweights on the shaft.

Count: Specify the number of counterweights on the shaft.

Color: The drop-down box allows you to change colors.

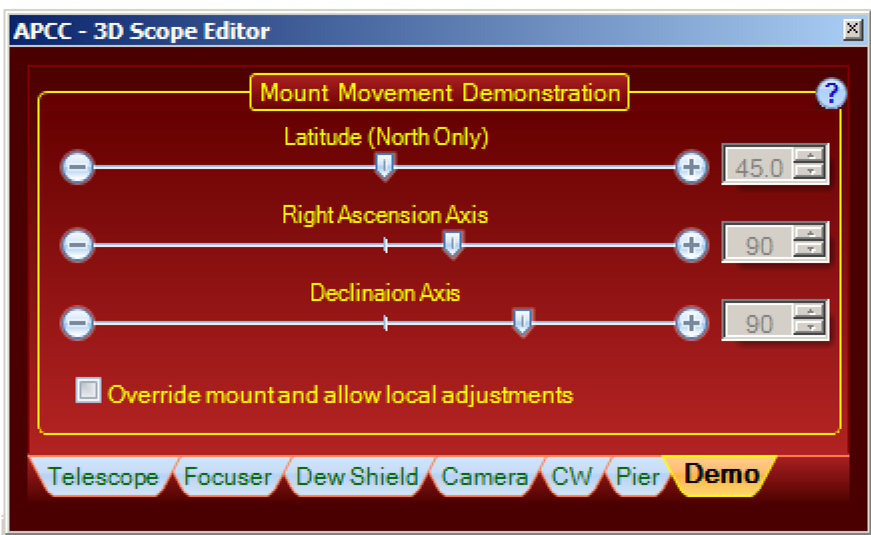
Pier Tab



Height, Diameter: Adjust dimensions with slider, arrows or number entry. Consider entering a lower pier height since entry of larger numbers may push the scope out of the view. Unless your telescope is so long it might strike the floor, this is not an important parameter of your setup.

Color: The drop-down box allows you to change colors.

Demo Tab

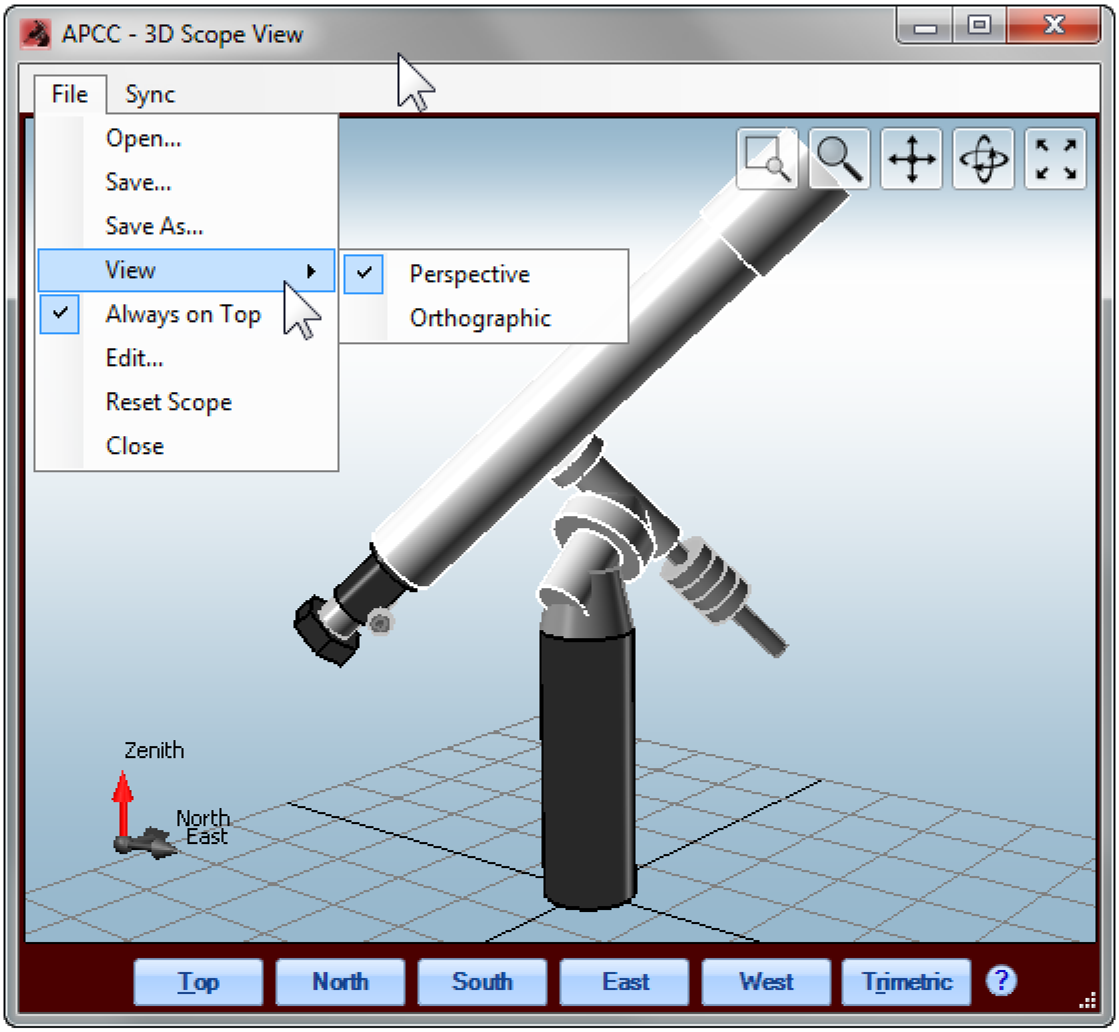


This Demo window allows you to experiment with latitude, RA and Dec values to create a graphic model without actually moving the scope to a particular position. This feature has been useful for us to create graphics.

Override mount and allow local adjustments: Check this box to ignore the input from the mount position data and activate the entry fields. When you are ready to resume your observing session, remember to uncheck this box to resume the input of actual position data.

Latitude, Right Ascension Axis, Declination Axis: Adjust values with slider, arrows or number entry.

8.3 Menu Items



File

Open: Allows you to open .sdef file that you created previously for particular telescope and camera setup.

Save: Save the parameters that you have set using the 3D Scope Editor so that you can retrieve it at a later date.

Save As: Save the parameters that you have set using the 3D Scope Editor so that you can retrieve it at a later date.

View: Two choices give you different view.

Perspective - Includes grid lines to give you a sense of your mount/scope in space.

Orthograpic - Does not include the grid lines.

Always on Top: Keeps the 3D viewer on top of your programs when you are carefully monitoring the scope position. Screenshot has not been updated to show this option.

Edit: Brings up the 3D Scope Editor

Reset Scope: Resets parameters.

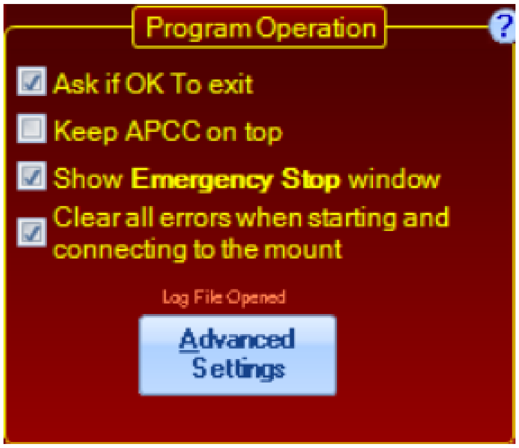
Close: Closes 3D Scope View window.

Sync

Re-Sync 3D View:

9 Emergency Stop Window

This window will be activated during slews if the Show Emergency Stop Window box is checked on the Setup Tab.



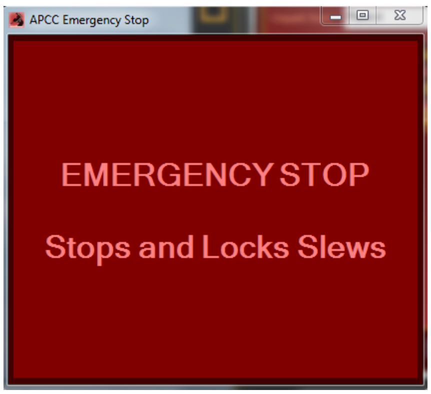
The Emergency Stop Window gives you a quick way to stop a slew in an emergency and lock out further slews. It is actually a big button that stops any GoTo or Park slews in progress and prevents any further GoTo or Park slews until the mount is unlocked. It does NOT prevent button moves, nor does it stop tracking. It differs from the normal "Slewing" stop button in that it cannot be overridden by client software, which may simply resend the slew command if it detects that a slew has been interrupted.

It was originally designed for our "extreme" beta testing, especially those tests that featured the mount going well beyond the meridian. We liked the feature well enough to leave it in as an added safety option It is of primary value when setting up the meridian limits and running the APPM point mapping with points beyond the meridian (CW - up points) included. Once you get to normal everyday (everynight) usage, you may wish to disable the feature.

The Emergency Stop Window initially flashes up large and obvious so that you won't miss it. A normal procedure, if you will be keeping it active, is then to grab a corner and shrink it to a more manageable size and drag it off into a corner of the desktop where it is out of the way, and yet immediately accessible if something goes awry. As long as you don't actually close the window, it will remain small and in the corner until that evening's session is done.

Show Emergency Stop Window: Check or uncheck as you wish.

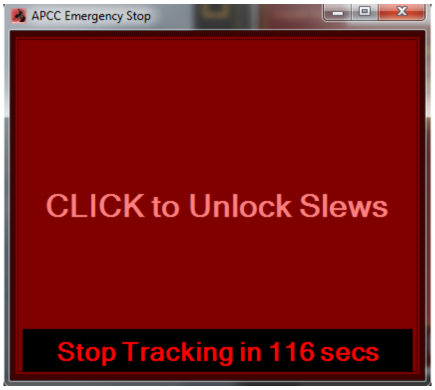
Close it when done slewing: Check if you would like the window to close once you have reached your target.



You will notice that when you mouse over the window, the color will change from red to yellow. If you click the window to stop a slew, the text inside will change, and the button will flash between red and pink.

Tracking is not stopped immediately so that any client applications connected through the ASCOM driver won't start to throw exceptions or quit. This might happen if tracking has been set to an unexpected state (turned off). However, as a safety feature, tracking will stop after about two minutes if you take no action. A countdown timer at the bottom (see picture below) will indicate how long before tracking will be stopped.

If you need to stop tracking immediately you can conveniently click the countdown text and it will toggle tracking. If you restart tracking you will have another two minutes before tracking will automatically stop. We feel this is the best compromise of safety and ASCOM client application compatibility.



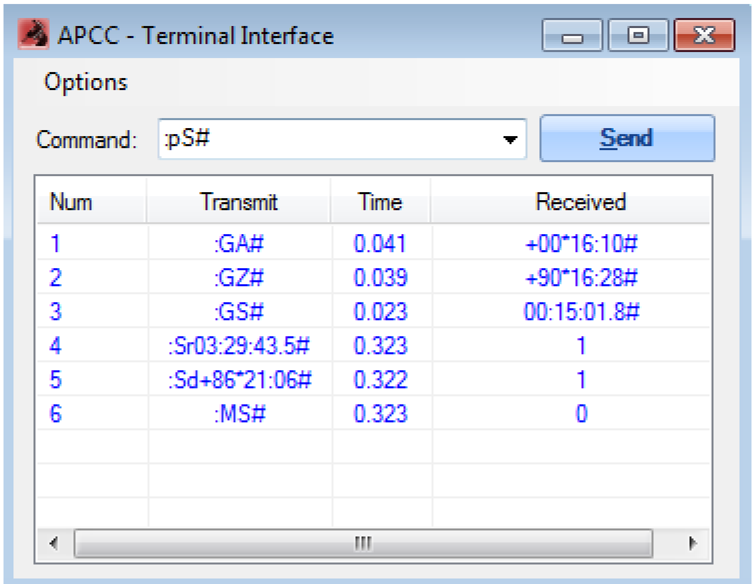
Once you click the main part of the window to unlock the slews again, you will need to restart the slew unless the client software that originally sent the command is very persistent!

10 Terminal Interface Window

Terminal Interface Window

There are times when using a direct connection to the mount is beneficial. This feature will allow you to make specific tests of the mount or to check commands when writing your own mount control software.

Terminal interface is found under the Tools drop-down menu on the main APCC window. When you select this function, you are provided with a "clean slate" on which to write your commands. It is necessary to know the Astro-Physics command language found in the Technical Support section of the Astro-Physics website.



Options: Click on *Options* to reveal the following choices:

Clear Display: Removes the commands that have been sent to the mount from the display window.

Always on Top: Provides the choice to hold the window in the foreground over other applications or to let it drop behind them. It can be toggled on and off.

Always Show Last Command: Displays the last command sent to the mount.

Command: This is the space in which one types the commands that one wishes to send to the mount. Once the command is written, click the *Send* button to send it to the mount. The command will then appear listed below. The drop-down arrow allows you to choose an entered command and resend it.

Send: Clicking the *Send* button will send the command to the mount.

Command Window:

Number: Refers chronologically to the sent commands.

Transmit: Displays the command that was sent.

Time: Displays the duration of sending and receiving the command.

Received: Displays the response from the mount.

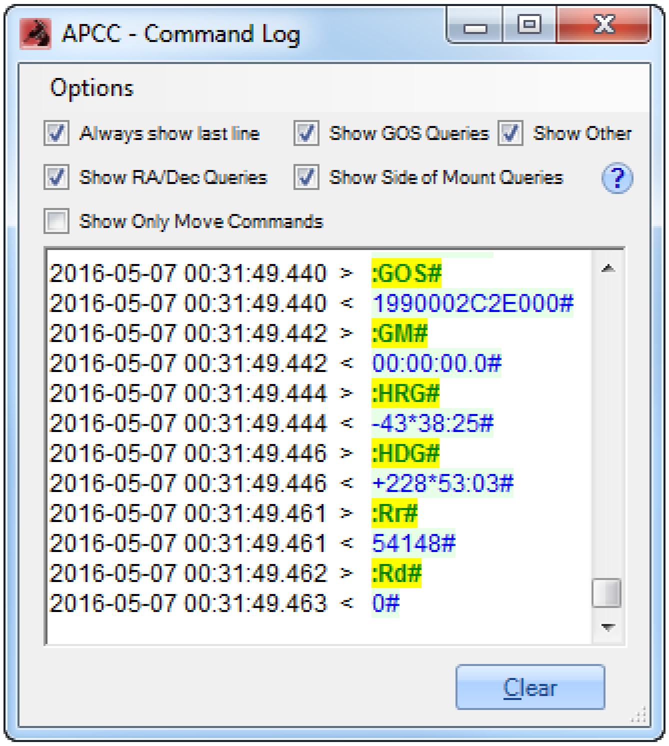
11 Log_Window

Command Log Window

This window displays a running log of the communications to and from the mount. It shows commands and inquiries issued to the mount indicated by the “>” symbol and the mount’s response indicated by the “<” symbol. Maintaining a log is vital when troubleshooting and/or providing a record of events.

The *Log Window* can be accessed from the Menu: Tools > Log Window.

The [Setup Tab](#) includes a checkbox to *Enable Logging to disk*. It is not possible to uncheck the box at this time. We want to assure that log files are created so that we can better assist you if you encounter any issues.



Options: Click on *Options* to reveal the following choices:

Clear Window: Removes the activities that have taken place from the display window.

Always on Top: Provides the choice to hold the window in the foreground over other applications or to let it drop behind them. It can be toggled on and off.

Save to File: Allows you to name and save a record of this activity in the folder of your choice. It will capture the events up to the moment of saving the file.

Always Show Last Line: If checked, automatically scrolls to show the current communications.

Show RA/Dec Queries: If checked, activates the display of RA and Dec position status.

Show GOS Queries: If checked, activates the display of the operational status of the mount.

Show Side of Mount Queries: If checked, activates the display of the mount's east or west positioning.

Show Other: If checked, activates the display of all the other mount queries.

Show Only Move Commands: Check this box is you only want to see the move commands that are sent to the mount.

Clear button: Clicking the *Clear* button will clear the record, allowing you to begin a fresh command log. This is convenient when you want to isolate specific events and mount behavior.

If you wish to zip the log file for future reference or send for analysis, refer to the Log Zipper Window section.

12 Log Zipper Window

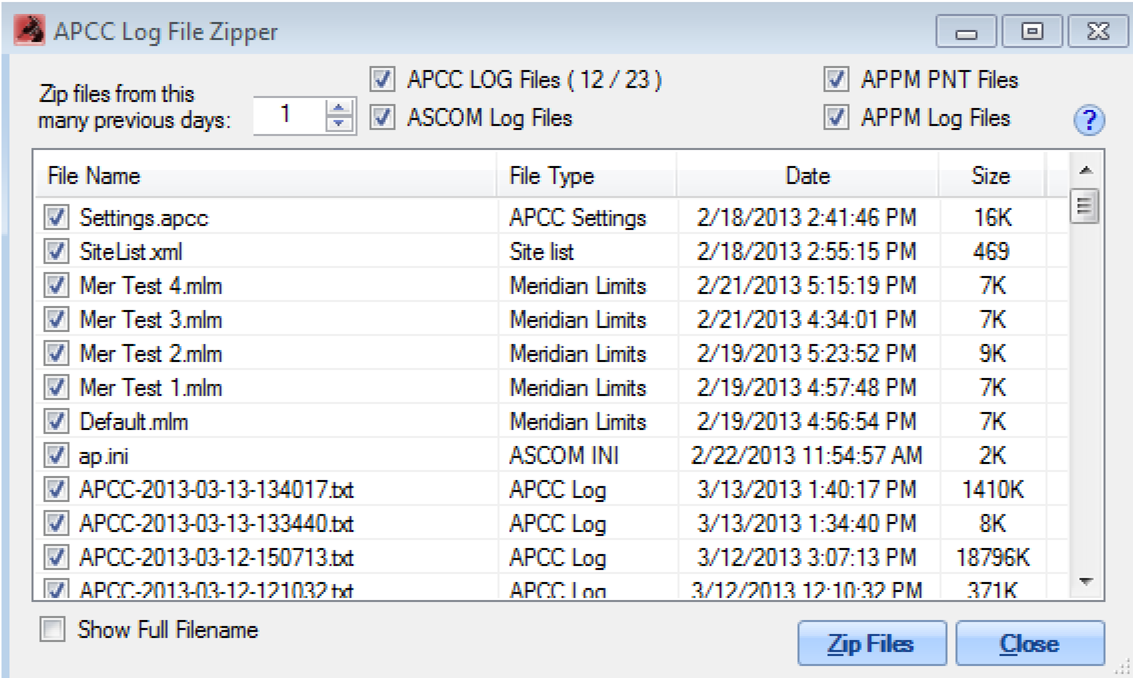
Log Zipper Window

The *APCC Log File Zipper* provides a convenient access to all related log files. It allows you to selectively zip files of specific types, if it becomes necessary to forward them for analysis.

IMPORTANT: When sending log files for analysis of a problem, you must provide specific information regarding:

- Description of the problem.
- Sequence of events leading up to the problem. Be specific!
- Approximate time when problem occurred. The logs contain megabytes of data and it is important to quickly find the code relating to the problem. Each log entry is date/time stamped.

The *Log Zipper Window* can be accessed from the Menu: Tools > Log Zipper Window.



Zip files from this many previous days: This allows you to show a range of dated files so that one day or many days of files can be selected.

APCC Log Files: Check to include these files. It is checked by default when the *Log File Zipper* window is opened.

ASCOM Log Files: Check to include these files. It is checked by default when the *Log File Zipper* window is opened.

APPM PNT Files: Check to include these files. It is checked by default when the *Log File Zipper* window is opened.

APPM Log Files: Check to include these files. It is checked by default when the *Log File Zipper* window is opened.

Show Full Filename: Checking the *Show Full Filename* box will reveal the full path to the file so that you may easily trace the location of a given file.

Zip Files: The *Zip Files* button will zip and ready the files that you have chosen for sending for review and analysis. It will allow you to save them in the location of your choice.

13 Known Issues

Saving Resized Windows

Problem: If you are using Windows XP and possibly Vista (we have not verified this issue with Vista as of this writing), you may not be able to utilize the Save Window Positions if you resize the window. We have found that windows that have been resized and saved, do not open up correctly in the next APCC session. Typically, the window will reload at the correct saved size, however the contents will not load properly. For instance, a large blank space may appear above the Status Bar or, alternatively, the lower portion of the window contents may be missing. This problem cannot be fixed using the Resize to original Window Size setting. This problem is likely due to a .net configuration issue. We will review this issue in the future to determine if it can be resolved.

Note, that if you do not resize the window, the Save Windows Positions feature can be used successfully.

Solution: Deactivate the Save Window Positions setting, exit and reopen APCC.

14 Troubleshooting

14.1 FAQ

Questions for All Versions of APCC

How can I find out if I have the OpenGL 1.5 or later version?

OpenGL support is usually determined by the graphics card in your system. There are probably many ways to find out but here is one free utility you can use:

http://www.geeks3d.com/20120927/gpu-caps-viewer-1-17-2-released/

APCC has a sophisticated meridian limits mechanism that will allow you to define the limit the mount can track past the meridian at multiple declination values. Will this also prevent slews to these positions? I will often be starting imaging east of meridian but would like reasurance that GOTOs with a negative meridian delay won't hit anything.

APCC (and also the ASCOM driver) have "safe slews" built into them to prevent slews that cause collisions in "counterweight-up" conditions. The slews occur in multiple stages. If you are starting a slew from a counterweight up position (i.e. you have tracked past the meridian), the first part of the slew will be in right ascension only. The mount will move in RA until the mount enters a normal, counterweight down orientation. It will then slew in both axes until the RA reaches the meridian, and the Dec fully completes its slew. Finally, with the Dec having arrived at its safe position, it will then complete the slew in RA only to the starting point east of the meridian with the counterweight up.

The feature that allows windows to be resized and saved does not seem to be working properly.

Please refer to the explanation Saving Resized Windows.

I am having problems when I shut down APCC or alternatively when I start up APCC with the AP V2 ASCOM Driver. The driver appears to lock up and stops responding.

Open the AP V2 ASCOM Driver's Telescope Setup Window. In the COM Port Details group box, you will find a setting to "Use ASCOM Serial Object." If this is checked, uncheck it. If it is not checked, try checking it. The driver has two low-level serial DLL drivers - one from ASCOM, and one that is native to our driver that is written in C++. Some computers and USB serial adapters seem to prefer one over the other.

APCC Pro Version Questions

Do I need the full version of PinPoint or can I use the version that comes with MaxIm DL?

To do plate solving you need the full version of PinPoint. This is only required if you plan to use APCC Pro. You do not need PinPoint for the standard version of APCC.

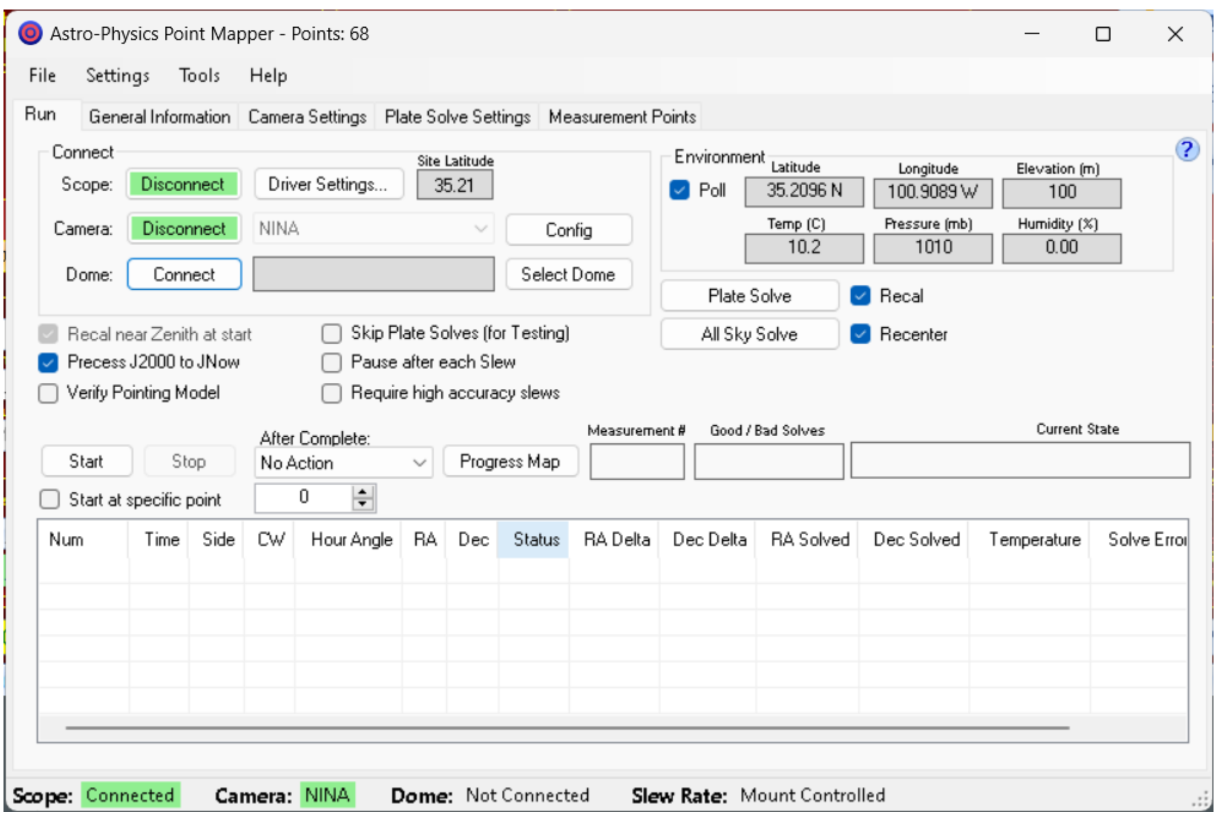
Can TheSkyX be used in place of the full PinPoint?

No, for now only PinPoint is supported.

14.2 Troubleshooting Tools

Refer to the detailed sections regarding the Log Window and Log Zipper Window .

15 APPM - The Astro-Physics Point Mapper

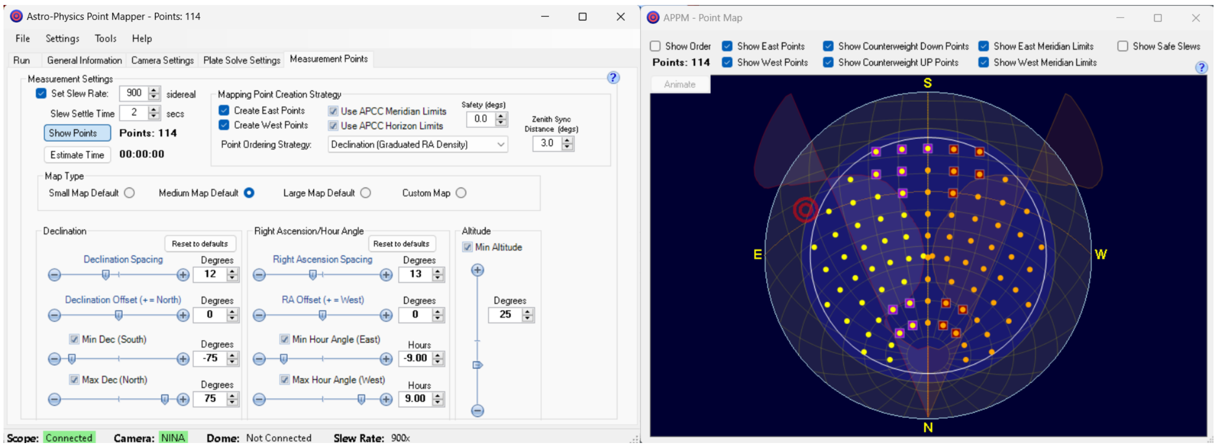


15.1 Overview

APPM, or **Astro-Physics Point Mapper**, is a tool that collects data points across the sky of the telescope's actual pointing position versus the targeted slew position. The difference between the actual and targeted positions is the pointing error. By systematically capturing the pointing errors throughout a set of points in the sky a pointing (correction) and tracking rate (correction) models can be created.APPM can map points on both hemispheres (East and West) and also in counterweight up positions.

Note that the process of mapping points does not make APPM "modeling software". The modeling software component is in APCC Pro, which uses the pointing data to create the actual pointing and tracking rate models.

At this time all of the mapping points must be done in one session.



Requirements

To use APPM with your mount you will need to have the following:

1) Camera Control Software and a camera supported by that software:

a) MaxIm DL Pro v5 or later -

b) CCDSoft V5

c) TheSkyX Pro Camera Add-on

d) AstroArt V3 or later

e) Any camera with an ASCOM Camera Driver

f) NINA

g) Sequence Generator Pro.

h) Meade DSI I-III cameras are also supported, but their sensors are usually not large enough to capture enough stars for reliable plate solves.

2) Plate Solving Software:

a) The full version of DC3 Dreams PinPoint application. Version 6 or later of Pinpoint is preferred.

b) TheSkyX Pro

c) Plate solving using Sequence Generator Pro

d) ASTAP

3) Optional - We recommend that you purchase an environmental sensor. This will allow APCC to compensate for changes in the environment, such as temperature and humidity for the purposes of calculating refraction accurately.

Supported environmental sensors:

a) THUM Temperature/Humidity sensor (http://www.practicaldesign.com/THUM/thum.html)

b) Devices with ASCOM ObservingConditions drivers.

NOTE: We do NOT recommend USB stick-type sensors that are inserted directly into a computer USB port or hub. These type of devices are often severely affected by temperatures of the electronics they are plugged into. The best solution would be a personal or commercial weather station that has an ASCOM ObservingConditions driver.

Using the Astro-Physics Point Mapper (APPM)

The APPM is a very powerful and versatile mapping tool. It's primary purpose is to create, and then run a point mapping that will provide the error-data needed for APCC to create a model which can then be used to determine corrections to both the pointing and the tracking of your mount. The point mapping can be custom tailored to your system, and even has a mapping strategy to facilitate domed observatories that may have rather narrow slits.

Before beginning an actual mapping run, make sure that your system is as mechanically sound as is possible. Models are predictive tools. They answer the question: "Based on previous results, how should I (the model) adjust the GoTo coordinates to increase pointing accuracy, and how should I adjust the tracking rate to achieve more accurate tracking?" No model can adequately predict random events. If it isn't repeatable, it can't be modeled! Flopping, shifting, cable jerks and even strong wind gusts that are not identically repeatable will spoil an otherwise good model. So make sure that everything is tight. Make sure your cables are free to follow the system throughout its entire range of motion, and make sure that they don't impose a heavy weight-burden on the end of the scope. Be sure that you have minimized mechanical backlash, but DO NOT set any backlash compensation in the software or in the keypad!

- In general, you will want to begin by running a point mapping in APPM to create a model in APCC. For your first try, we suggest that you run a smaller mapping on the order of 50 or so points. Then, run a small "verify" run of around 30 points to check how much the pointing has improved. A verify run uses the current pointing model and measures how much residual error there is.
- Begin the process by setting up each of the tabs in APPM. They are described in detail in the sections that follow. It is important to get the settings right, so invest some time in doing a good job on this.
- Make sure that you have set up your Meridian Limits and Horizon Limits in APCC if you wish them to be included in the point mapping.
- Spend some time changing the parameters in the Measurement Points Tab to see how they affect the point mapping.

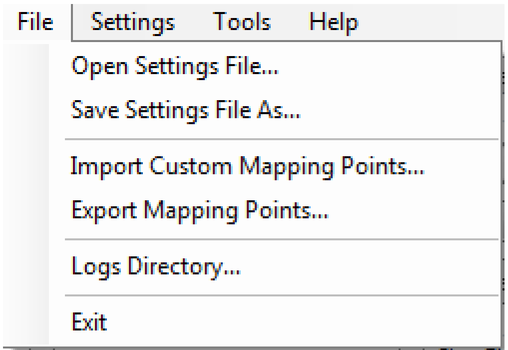
- Run your point mapping. As the mapping progresses, make a mental note of the magnitude of the errors that are being displayed. A screen shot might also be a convenient way to document the errors. These are the raw pointing errors that the model will try to correct. Note that they will vary considerably in different parts of the sky.
- When prompted, install the data file (a PNT file) into APCC, which will then internally create a pointing model.
- Go to the APCC Pointing Model Tab and open the Pointing Model Window. Verify that the correct model has been loaded by looking at the title bar of the Pointing Model Window. The file name of the loaded model will have the time and date of the mapping. That same file name should also appear at the top of the Pointing Model Group Box on the APCC Pointing Model Tab
- Perform a Verify Run on your model. Further information is found in the Run Tab section that follows. Again, as the verify run progresses, make a mental note of the magnitude of the errors that remain. If all has gone as we hope, the magnitude of the errors will have dropped significantly from the initial point mapping run.
- Live with the model you have created for a while. Try some real astronomy with it in place and with pointing and tracking corrections turned on. Are you now always placing your target on your chip, or in the field of view of your eyepiece? Try some short unguided images. Check your results all over the sky. If you have an area of the sky that is under-performing compared to the rest, you may have a mechanical issue that should be addressed. Your initial model will probably NOT be dense enough for serious unguided work, but see what kind of results you can get.

> **Tip:** Remember that larger, denser models involve a considerable investment of time. The value of doing the smaller model first is that it may help you discover and remedy mechanical issues that would otherwise spoil even the largest of point mappings.

- When you feel you are ready, go ahead and run a larger, denser point mapping.
- For additional tips and unique ways to use the Astro-Physics Point Mapper, see the Advanced Topics section.

15.2 Menus

File Menu



Open Settings File...: allows you to open a previously saved settings file. Settings files end with a ".appm" file extension. the default settings file is "Settings.appm".

Save Settings File...: saves a settings file.

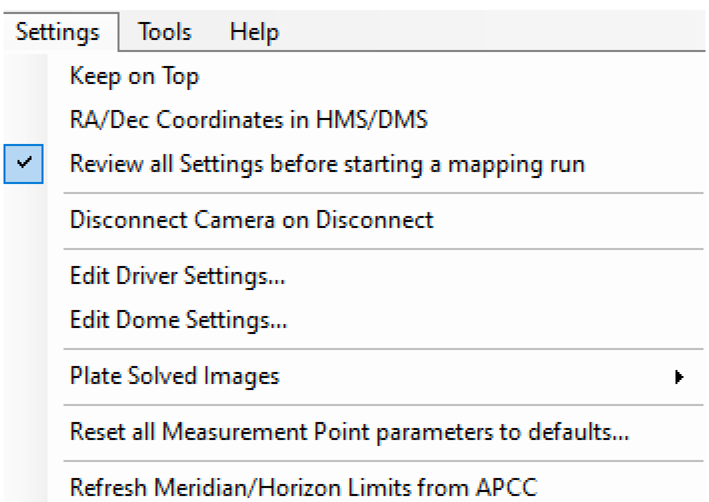
Import Custom Mapping Points...: allows you to load a custom mapping point file.

Export Mapping Points...: saves the current mapping points to a file.

Logs Directory: Opens an instance of Windows Explorer in the directory where log files are saved.

Exit: exits APPM.

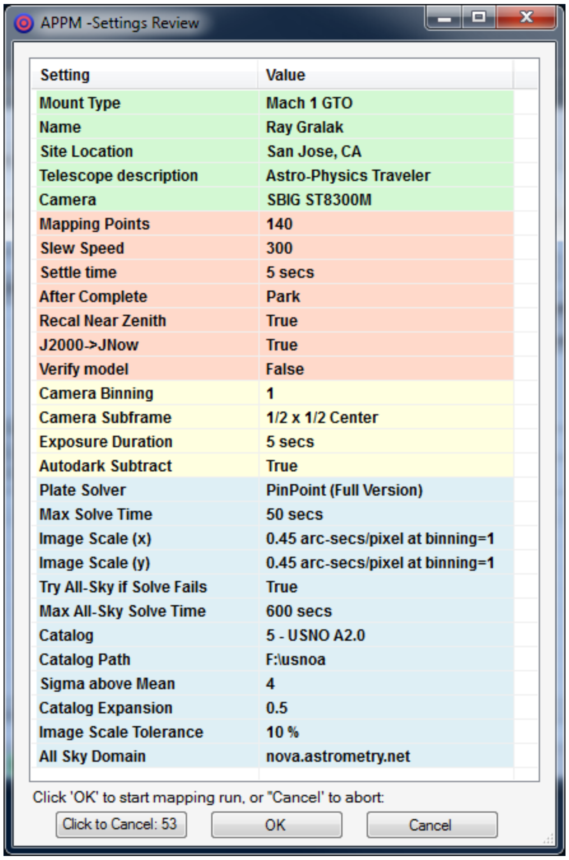
Settings Menu



Keep on Top: When checked the APPM window will stay on top of most other windows.

RA/Dec Coordinates in HMS/DMS: When checked the Right Ascension and Declination coordinates are in the format "HOURS:MINUTES:SECONDS" (RA), and "DEGREES:MINUTES :SECONDS" (Dec). If unchecked the values are in decimal Hours (RA) and Degrees (Dec).

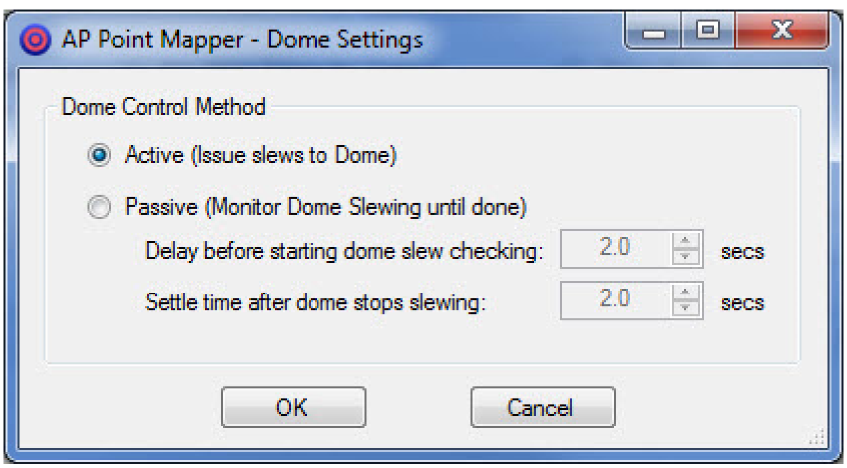
Review all Settings before starting a mapping run: When enabled, a summary of all settings is shown in color-coded areas. There is a 1-minute countdown timer, during which you can cancel or accept the mapping run.



Disconnect Camera on Disconnect: When enabled, when you disconnect the camera in APPM the camera will also be disconnected in the camera control application (e.g. MaxIm DL).

Edit Driver Settings...: This opens the AP V2 ASCOM Driver's setup window.

Edit Dome Settings...: This opens the settings options for Dome.



Active - When selected APPM will send slew commands to the dome's ASCOM driver.

Passive - When selected APPM will not issue commands to slew the dome but will wait for the dome to stop slewing. This option should be used when connected to some third-party applications that slew the dome automatically when the telescope slews. APPM periodically checks if the dome is slewing.

Delay before starting dome check slewing - the amount of time, in seconds, before APPM starts checking if the dome is slewing. The delay is used to give the telescope driver to start the dome slew in the background.

Settle Time after dome stops slewing - Extra time, in seconds, to wait after the slewing flag clears,

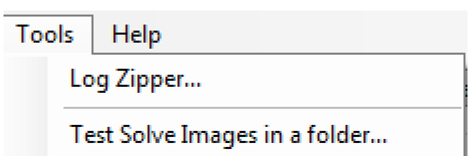
Plate Solved Images: This determines what happens to plate solved images after they are used.

- **Don't save**: after each image is used it is deleted.
- **Save Failed Solves Only**: all images except those that fail are deleted (potentially to be use for later diagnosis of why plate solves were failing).
- **Save All**: all images are saved.
- **Delete all FITS Files**: Immediately deletes all FITS images that were previously not deleted in the images directory.

Reset all Parameters to Defaults: resets all UI values in APPM to their default values.

Refresh Meridian/Horizon limits from APCC: Imports the current horizon and meridian limits from APCC's settings. If you change the horizons limits or meridian limits in APCC while APPM is active you must use this feature to pull in the updated limits.

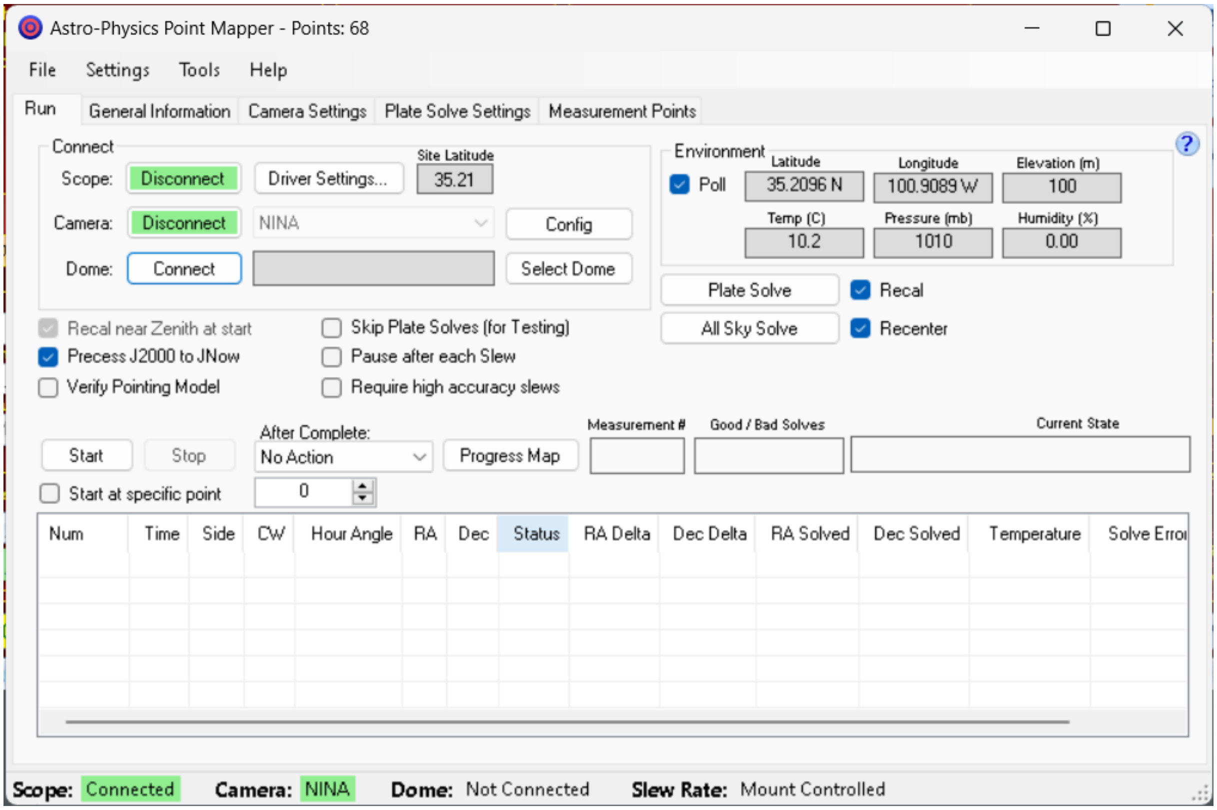
Tools Menu



Log Zipper...: Opens the logs zipper utility. You can use this to zip all of your log files into a single file if you have a support issue.

Test Solve Images in a Folder... Select a directory and APPM will try to plate solve all the files in the directory. Useful for comparing the performance of different Plate Solving applications.

15.3 Run Tab



Connect Group Box

Scope: Press the **Connect** button to connect to the AP V2 ASCOM Driver. If you need to reconfigure the ASCOM AP V2 Driver click the **Driver Settings...** button.

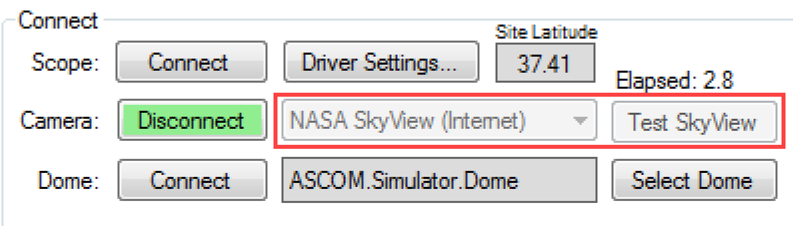
Site Latitude: Shows the site latitude last retrieved from the AP V2 ASCOM Driver. This is available even when not connected to the mount and it is used by the "Show Points" window to properly display the location of the mapping model points. You must have connected to the mount once for the latitude to show in this box.

Camera: Select the camera type if needed then press the **Connect** button.

Supported camera types supported are listed below. All of the third-party applications can support many camera types, thus providing APPM with the capability of supporting many different cameras:

- **MaxIm DL -** A great third-party commercial imaging and camera control software application. Supports many third-party cameras. https://diffractionlimited.com
- **CCDSoft -** Another third party commercial camera control program. It is no longer supported but was shipped with SBIG cameras for many years.

- **SkyX Pro Camera Add On -** The successor to CCDSoft, it is part of TheSkyX Professional platform. Supports many third-party cameras. http://www.bisque.com/sc/pages/TheSkyX-Editions.aspx
- **AstroArt -** A relatively inexpensive commercial camera control program. Supports many third-party cameras. http://www.msb-astroart.com/
- **ASCOM Camera -** Free camera drivers for some camera models. https://www.ascom-standards.org/Downloads/CameraDrivers.htm
- **NINA -** Great free image capture software. Supports many third-party cameras. - https://nighttime-imaging.eu/download/
  NINA quick-start guide: https://daleghent.com/nina-and-astro-physics-mounts
- **Sequence Generator Pro -** Great third-party image capture software. Supports many third-party cameras. - https://www.mainsequencesoftware.com/
- **Meade DSI - DSI** models 1-III are supported by APPM.



- **NASA SkyView (Internet) -** This is not a camera but a way to test the software during the day or when it is cloudy. It requires an internet connection to work. Images are taken from the DSS image If the scope/mount is not connected, clicking the **Test SkyView** button should download an image approximately centered on M33. However, when the mount is connected the image retrieved will be centered near the mount's RA/Dec coordinates.

You can collect test point data during the day by using NASA SkyView, but you don't want to load that data into APCC and use it at night because the data does not actually model the mount hardware.

More information about NASA SkyView can be found here: https://skyview.gsfc.nasa.gov

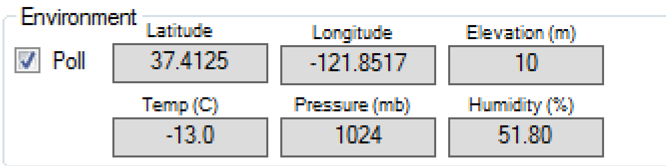
Dome: If you have a dome click the **Select Dome** button and select the ASCOM driver for your dome. Then click **Connect** to connect to the dome.

When using a dome APPM will slew both the mount and the dome to each target and wait for both to complete their slews before starting an exposure.

Please see this section in the Menus for additional dome settings.

Environment Group Box

This box shows the mount location and environmental conditions, if available.

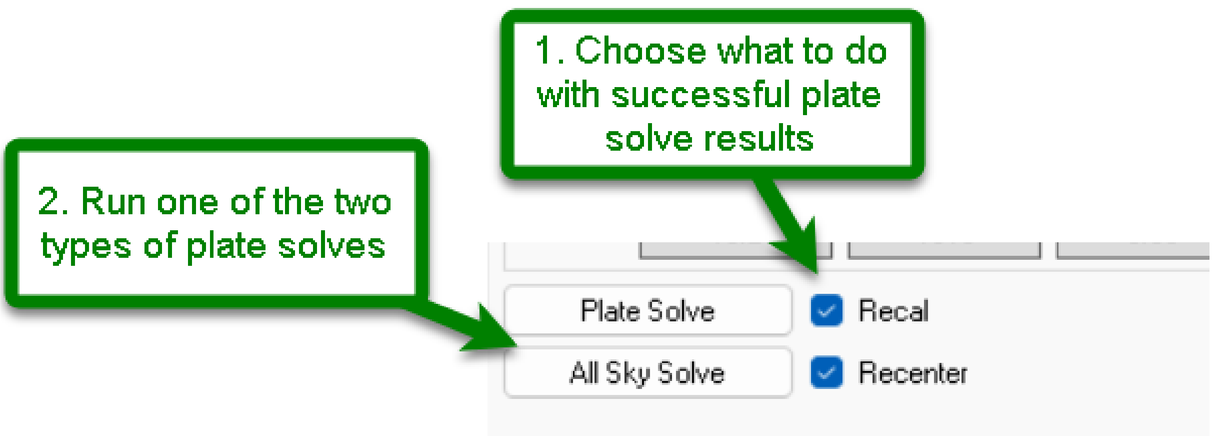


Poll: Enables polling of available properties from APCC via the ASCOM drive. The properties that are polled are Latitude, Longitude, Elevation, Temperature, Pressure, and Humidity.

If an ASCOM ObservingConditions driver or a THUM Temperature sensor is configured by APCC then environmental conditions for the device are displayed.

NOTE: If you are not using a THUM sensor or ASCOM ObservingConditions driver you can manually enter the current temperature and pressure on the Pointing Model tab in APCC.

Plate Solve, Recal, and Recenter



The options for plate solve, recal, and recenter have been revamped to offer more flexibility and capability compared to previous software releases. If you have used this feature before, we recommend you reread the following sections to familiarize yourself with the new updates:

Note: In order for the plate solve function to work, the Plate Solve Settings must be correctly configured prior to using this feature.

The workflow for plate solving and recal and/or recenter involves two steps:

1. First choose none, one or both of the optional checkboxes that determine what will happen next with successful plate solve results
2. Select and run a Plate Solve or All Sky Solve by clicking the relevant button

Recal: If the solve is successful, enabling Recal will recalibrate the mount's pointing position to the solved RA/Dec coordinates. This can be used whether APCC's Pointing and/or Tracking corrections are enabled or disabled. Recal is usually enabled so the mount's pointing position will be corrected and accurate for subsequent GoTos.

Recenter: When enabled, this option will then re-slew the mount to the original pointing position with the new updated coordinates. This works with either plate solve option, but Recal must be enabled for Recenter to work.

Plate Solve or All Sky Solve? Both options produce the same result, but does it in different ways. Both take an image and attempts to plate solve the image to find the true image center RA/Dec coordinates (The plate solved RA/Dec coordinates are converted to JNOW). Using Plate Solve option is best if you know your scope's pointing position is relatively close (roughly within 3-5 degrees). It also can solve relatively quickly, often within a few seconds. All Sky Solve is used when you are not confident in the accuracy of your scope's pointing position and may need to scan the entire sky to find the true pointing position. This can take many seconds to minutes and may require an Internet connection. All Sky Solve is typically not as accurate as Plate Solve. All Sky Solve is often used when first bringing up a new mount, or when attempting to troubleshoot a lost mount. Either Solve approach - if the solve is successful - will produce an accurate RA/Dec coordinate for your mount's pointing position

Here's an example to illustrate how these features work together: Let's say you did a GoTo to M31 Andromeda Galaxy which is at (rough) coordinates RA 0h43m Dec 41°23'. Next you used Plate Solve with Recal and Recenter options enabled. Plate Solve succeeds and determines the actual pointing position of your scope is RA 0h46m Dec 42°54'. Recal option updates the controller so now the mount correctly thinks it is pointing at the updated coordinates. Recenter issues a GoTo to M31 coordinates, which will move the scope from it's updated pointing position to M31, or approximately 3 minutes RA and 1°31' Dec.

> Tip: Use APPM's **Plate Solve and Recal** function is often the best way to correctly establish the mount's pointing position for whatever reason. It is the most accurate, and it will never conflict with any of the corrections that are in effect from a model in APCC. It is the recommended way to calibrate your position before setting Home and Limits for encoder mounts

Main Area

Recal near Zenith at Start: If checked, then when starting a new point mapping run, the scope will be slewed to near the zenith and an attempt made to recalibrate to a plate-solved image's RA/Dec coordinates. **It is recommended that you keep this checked.**

Precess J2000 to JNow: When checked the plate-solved coordinates are converted to JNow when stored in the log file, which might be useful for debugging purposes.

Verify Pointing Model: This option is used to test the quality of a model that you have already installed into APCC. If checked, a new pointing model is NOT generated. Instead, the currently loaded model is turned on in both pointing and tracking correction, and APPM will slew to the mapped points and check the pointing error at each point. This is often done on a much smaller, less dense point mapping than you would use to create a model. It is often also a good place to use the **Model 5X and Park** option in the **After Complete** drop down as described below. For example, you might want to run a 200 or 300 point mapping to create your actual model, and then test it by running 5 consecutive Verify mappings of 30 or 40 points each. Running the same verify mapping 5 times will show the repeatability of the model's corrections.

Skip Plate Solves (for Testing): If checked images will be taken but not plate solved. This option would be used to check telescope operations. **This option is not saved between invocations of APPM.**

Pause after each Slew: The purpose of this is to allow you to do some action(s) before plate solving, such as manually moving a dome into position before proceeding. After each slew the status table will show a state of "**Paused**", allowing you to do actions. To continue you must click the "**Restart**" button. This is the same button as "**Start**" but it's name will have been changed to "**Restart**" when paused. When restarted APPM will start off with a very short re-slew to the current mapping point, do the plate solve, and then slew to the next point. At that time it will pause again.

Note that if you need to use the "Pause after each Slew" option it must be checked every time you run APPM. The Pause after each Slew option is not saved.

Start: Starts a mapping run. Once clicked the button changes to **Pause**, which will allow you to pause the scope as needed.   When paused, the button will read **Restart**.

Stop: Stops a mapping run. This permanently aborts the mapping run.

After Complete: this setting determines what happens after the modeling run completes. Choices include **No Action, Stop Tracking, Park,** and **Model 5x and Park.**

- **No Action -** When the mapping run is completed, the scope remains pointed at the last RA / Dec coordinate from the mapping run. Sidereal tracking continues. **DO NOT** choose this option if you plan to leave a mapping run unattended.
- **Stop Tracking** - When the mapping run is completed, the scope remains pointed at the last Alt / Az coordinate from the mapping run. Sidereal tracking is stopped.
- **Park** - When the mapping run is completed, the mount is parked to the park position selected in the AP V2 ASCOM Driver.
- **Model 5x and Park** - This option runs 5 consecutive, individual mapping runs. It is meant to be used with the **Verify Pointing Model** option described above.

Measurement #: Indicates the current measurement point when active. If you are running Windows 7 or later the Task Bar icon will also indicate progress with a green progress overlay.

Good/Bad Solves: Indicates the number of good and bad plate solves.

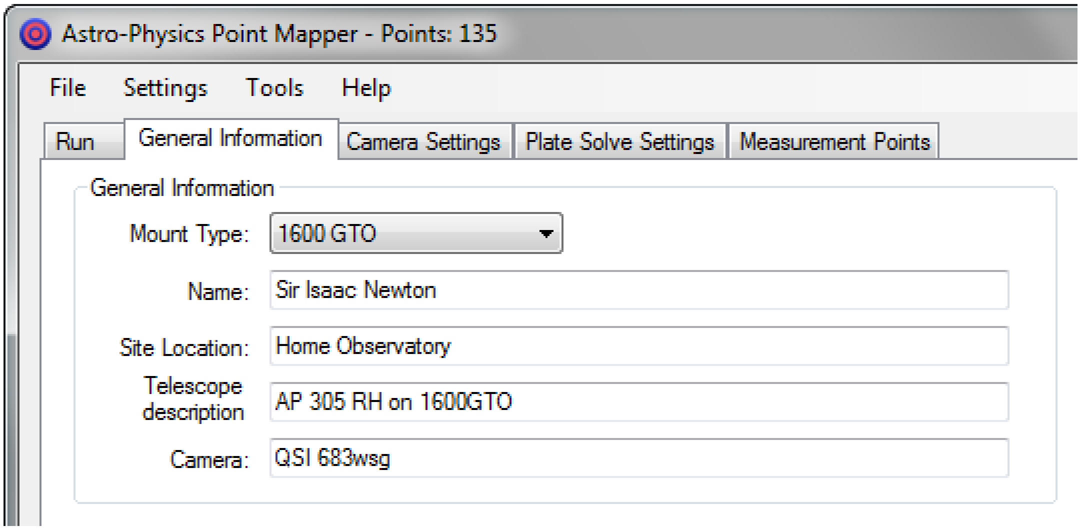
Current State: Indicates the current state machine state.

Start as specific point: generally used only for debugging. When checked and **Start** is clicked the scope will immediately skip to the entered point number.You cannot use this feature to re-do portions of a mapping run.

Table: This table provides feedback for each measured point.

15.4 General Information Tab

You can optionally enter information about your scope, camera, mount, etc. here. These values get saved with the point model raw data that is created.



Mount Type: Select your mount type from the drop down list box.

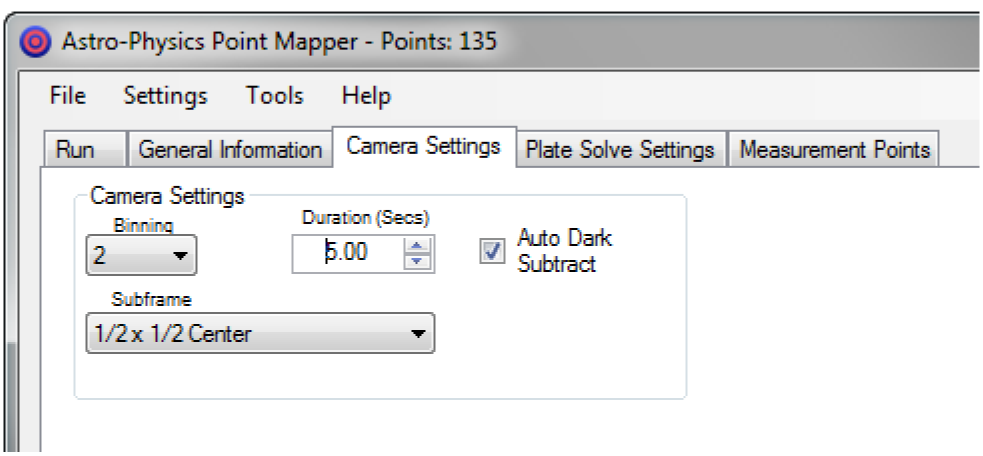
Name: Enter your name in this box.

Site Location: Enter a descriptive name of the site here.

Telescope Description: Enter a description of the telescope you are using.

Camera: Enter the model of camera that you are using.

15.5 Camera Settings Tab



Binning: Select your camera binning here. Camera binning groups pixels together to provide greater signal to noise. 1x1 binning doesn't do any grouping. 2x binning groups four pixels (2x2) into one large pixel. If your image scale when binned in less than 3 arc-seconds/binned pixel then plate solve accuracy will not be affected. For more information on binning see this link: http://www.ccd.com/ccd103.html

Duration: the exposure duration. Typically 5 seconds is enough.

Auto Dark Subtract: when checked, if your camera supports dark frames, APPM will take a dark frame and automatically subtract it from each image before plate solving. This will remove most of the noise from dark current in the images.

Subframe: this selects the fraction of the camera to use. If you have a wide field telescope or a very large sensor you might want to select 1/2x1/2 or 1/4x1/4. This will reduce the download time from the camera and the number of stars in the image. If there are too many stars a plate solve might fail.

Camera Settings Tips

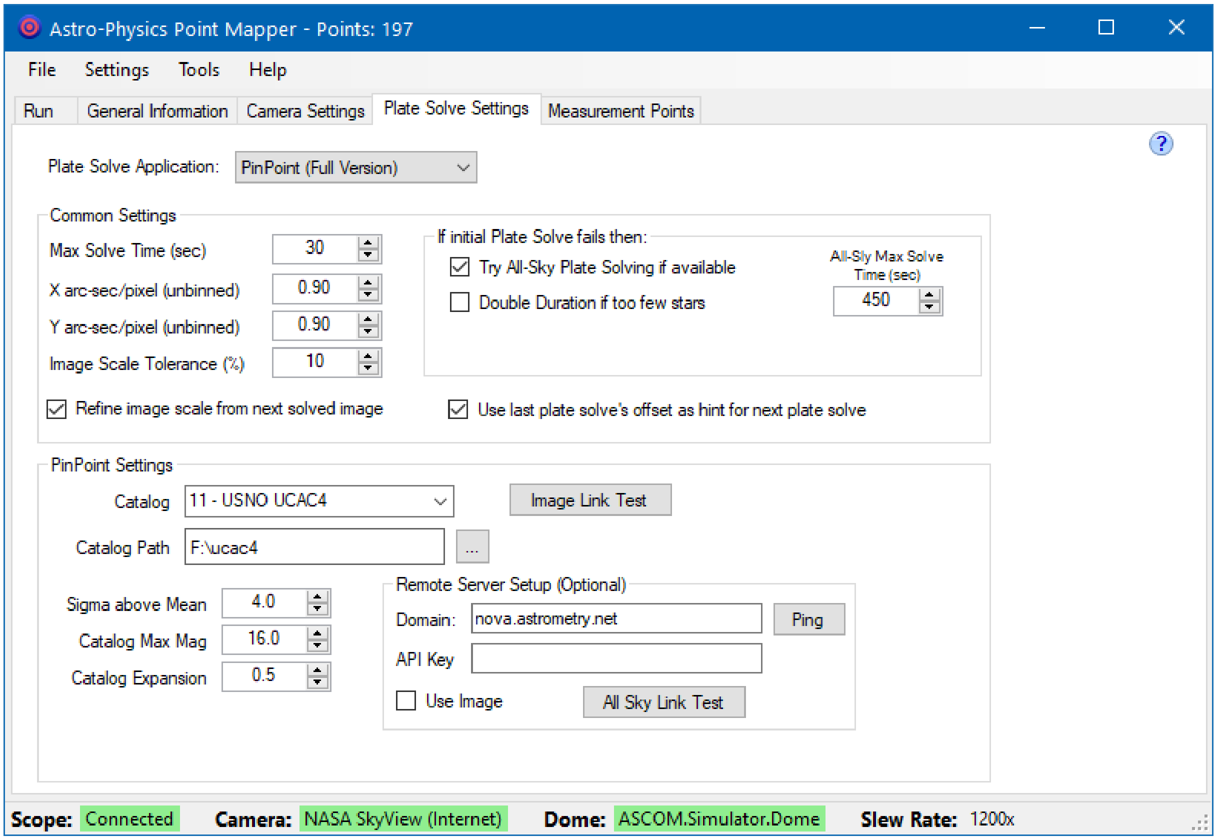
1) Use **binning** or a 1/2 or 1/4 **subframe** size to reduce image download time, unless you are using a relatively small sensor.

2) PinPoint's plate solving likes to have around 1-2 arc-sec/pixel resolution so: you can **bin** 2x or higher with impunity if your image scale is less than 1 arc-second.

3) In star-rich parts of the sky the star catalog may have too many stars for PinPoint to solve. You can reduce the chance of this error by using a a 1/2 or 1/4 **subframe**.

4) In star-sparse areas of the sky you might need to use **full frame** images even though image downloads will take longer.

15.6 Plate Solve Settings Tab



Introduction

In order to correct pointing and tracking it is necessary to exactly measure pointing errors. To do this APPM slews a telescope to a number of positions in the sky, takes pictures, and **plate solves** each image. Plate solving is the process of analyzing and comparing the positions of stars in an image to a catalog of stars. The exact center of each image is calculated in the process. The difference between where the telescope thinks it is pointing and the actual position is the pointing error for each telescope position.

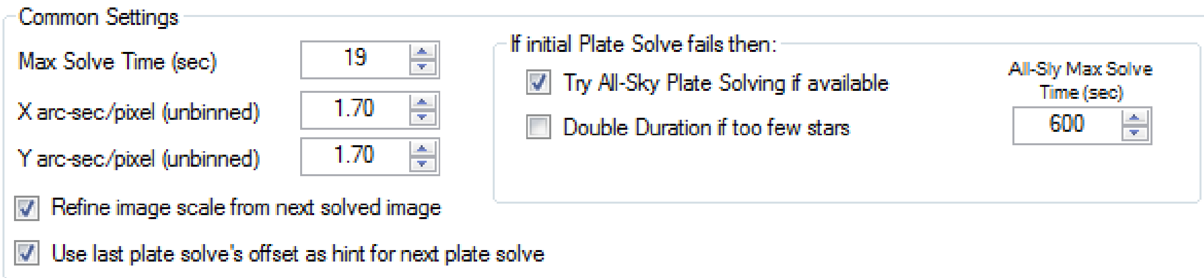
Three plate solving software packages are currently supported:

- DC-3 Dreams PinPoint V5/V6: Note that if you are using PinPoint you must purchase the full version of PinPoint if you do not already have a licensed copy. The PinPoint LE version that comes with MaxIm DL does not support third-party plate solves so APPM cannot use it.
- TheSkyX Pro Image Link. Note: To use image linking with TheSkyXPro, you must have TheSkyX connected to the mount through the AP V2 ASCOM driver.
- Sequence Generator Pro (via PlateSolve2, which is installed with SGPro). **NOTE: If you mix another camera control program with SGPro, you will still need to connect SGPro to a camera**. The ASCOM camera simulator works great for this.

- ASTAP Astrometric STAcking Program by Han Kleijn.

Plate Solve Application: select **PinPoint (Full Version), TheSkyX Image Link, Sequence Generator Pro**, or **ASTAP**.

Common Settings



Max Solve Time (sec): This is the total amount of time allowed to solve the image. If the plate solve doesn't finish in time then it will be marked as a plate solve failure.

Note: Every attempt is made to stop solving at the limit but in some cases the time limit can't be honored.

X arc-sec/pixel: This is the approximate image scale of the x-axis. If **Refine image scale from solved image** is checked then this value will be updated on the first successful plate solve.

Y arc-sec/pixel: This is the approximate image scale of the y-axis. If **Refine image scale from solved image** is checked then this value will be updated on the first successful plate solve.

Try All-Sky Plate Solving if Available: If an internet connection is available, or an all-sky database is installed locally, an attempt to do an all-sky plate solve will be issued if the initial plate solve fails.

Double Duration if too few stars: If a plate solve fails because of too few stars found this option will double the duration in an attempt to image more stars.

All-Sky Max Solve Time (secs): If all-sky plate solving is available then this will limit the maximum amount of time that will be spent attempting to solve.

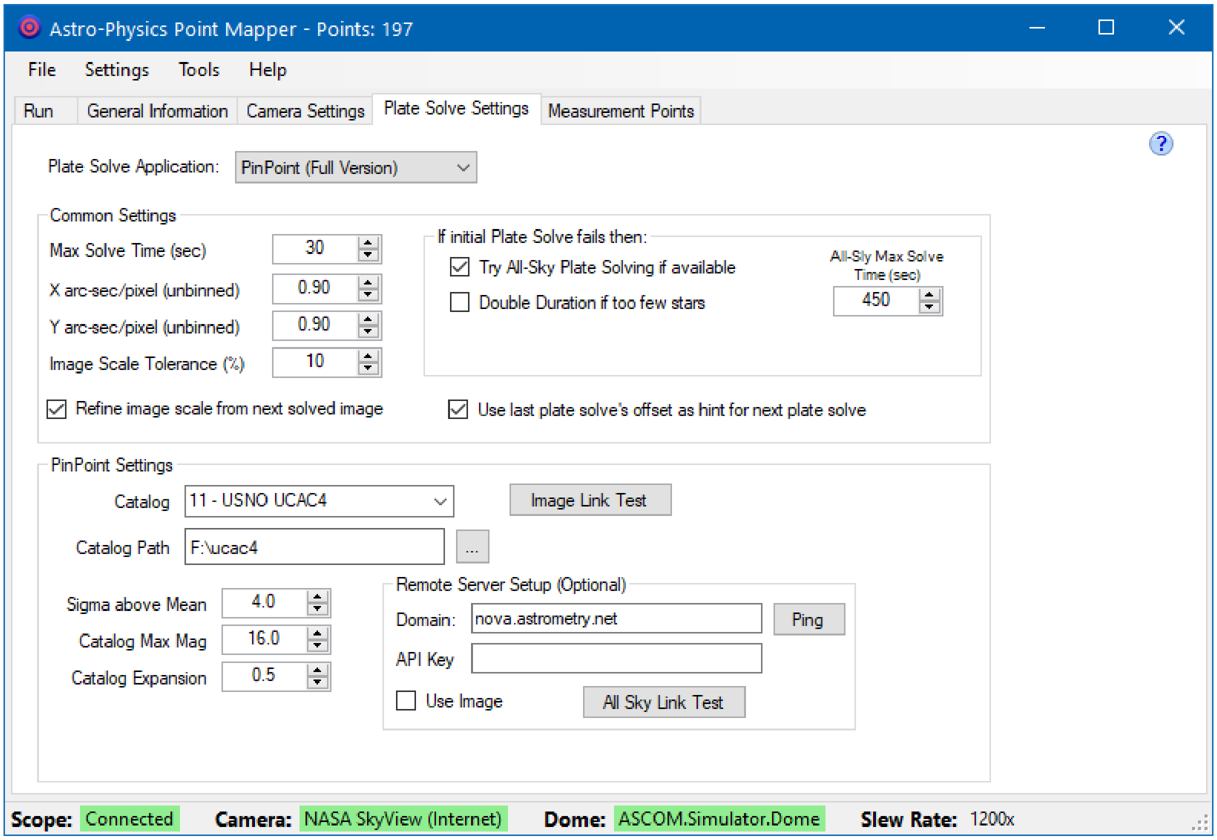
Refine image scale from solved image: When checked the X and Y image scale settings will be updated with the values in the first good plate solve. **It is HIGHLY recommended that this option be enabled so that APCC won't continuously reject images where the wrong image scale is set.**

Use last plate solve's offset as hint for next plate solve: When checked the RA and Dec error in the last plate solve coordinates is added to the next plate solve's RA/Dec "hint". This can dramatically reduce plate solve times, especially with PinPoint. If **Try All Sky Plate Solving if available** is also enabled, then the percentage of successful plate solves should be close to 100%, assuming good quality images with lots of stars.

PinPoint Plate Solve Settings

The parameters on this screen are parameters specific to PinPoint. That is they are used by functions and properties in the PinPoint library when APPM plate solves an image.

Note: Pinpoint has EXCELLENT documentation of its own. The following is NOT intended as a substitute for reading and understanding the documentation that comes with PinPoint. Please take advantage of Bob Denny's efforts on your behalf. You will save time in the long run and eliminate much frustration.



Catalog: The default value for this is the GSC 1.1 (Corrected) (=3). Use of this catalog results in excellent plate solving with modest disk space requirements (330 MB). Unless you have reasons to do otherwise (narrow field of view), this catalog is a good choice. For plate solving with a narrow field of view, you should use the USNO A2.0 catalog (6 GB). This catalog has no proper motions, however, so it is not recommended for astrometry, but for pointing, it is the best choice. To quote Bob Denny of DC3 Dreams regarding the USNO A2.0 Catalog: "...this is still the "one to use" for common plate-solved telescope pointing applications because it goes deeper than the others, and includes bright stars." For the ultimate in accuracy and coverage, use the USNO B1.0 catalog. It is really large (80+ GB) so you'll have to get it by sending a hard drive to someone who has it. Alternatively, if you can tolerate increased plate solution times, you can use B1.0 via internet access.

Bottom Line: Use either the **3 - GSC 1.1 (Corrected)** or the **5 - USNO A2.0** catalog unless you have a compelling reason not to.

Catalog Path: This is the directory in which the selected catalog is located. Click the "..." button to Navigate to the catalog directory on your computer. Most of you will have the Catalog folder(s) in the root directory of your C:\ drive.

Image Link Test: Clicking this will allow you to test that you have the PinPoint settings correctly setup. A dialog will open allowing you to navigate to a FITS image which you have previously taken and plate solve it. If the FITS image does not have embedded RA/Dec coordinates you will have to enter them yourself.

Sigma above Mean: This is considered an advanced parameter in PinPoint, and the user is cautioned to check other parameters before changing this one. Bob Denny's excellent PinPoint documentation describes it as: "The minimum brightness ratio (sigmas) above background for a star to be detected" and it lists a value of 3.0 to be the default and the best place to start. Legal values are from 1.0 to 20.0. Higher values reject dimmer stars that are not sufficiently brighter than the background. For our purposes in APPM, we have set the default at 4.0. If you are in light-polluted or hazy skies, you may need to lower this value.

Catalog Max Magnitude: The maximum (fainter) magnitude for selection of stars from the reference catalog. In certain sections of the sky with lots of stars you may need to lower the maximum magnitude so that the star limit is not reached, which would cause a plate solve failure. There is also absolutely NO reason to go deeper than what your imaging system will capture in the allotted exposure time (set in the Camera Settings Tab).

Catalog Expansion: This parameter determines the area outside the expected image area from which the catalog stars will be drawn. Again, to quote the PP documentation: "By default, PinPoint retrieves catalog stars to cover the image area plus a 30% expansion along *each border* of the image. Thus, with 30% expansion, the area over which the catalog stars are retrieved is (1 + 0.3 + 0.3) squared or 2.56 times the image area. As the catalog expansion is increased, the number of stars retrieved from the catalog increases exponentially. The effect of increasing the number of catalog stars is to slow the plate solution process." Too small a mask, however, risks missing the mark. The default in APPM is 50% which results in 4 times the image area. If your GoTos have been pretty accurate already, you can probably reduce this to the PinPoint default of 30%. If your GoTos have been off, leave it at 50%.

Image Scale Tolerance: Use this setting to prevent false-positive plate solves. The default is 10%. If you are sure of your image scale entry (see above), you can tighten this tolerance.

> Note: plate solves will be rejected even if successfully solved when the returned image scale of a plate solve differs dramatically (more than your defined %) than previously solved images.

Remote Server Setup

This allows PinPoint V6 to be configured with an alternate **Domain** and **API Key**. Please see the PinPoint documentation for more details. The domain name can have an optional port number, which is appended to the domain name with a ":" separating the domain name and port number (e.g., if the port number is "1234", the domain name might look like this: "nova.astrometry.net:1234").

Use Image: Normally PinPoint reduces internet bandwidth by sending a list of stars instead of the image. Enable this option to send the image instead of a star list from the image.

All Sky Link Test: Clicking this will allow you to test that you have the PinPoint All-Sky link settings correctly setup. A dialog will open allowing you to navigate to a FITS image which you have previously taken and plate solve it.

Ping: Sends internet ping requests to the All-Sky domain (if the domain name includes a port number, the port number will be ignored). If the domain responds, the ping button will turn green.

PinPoint Settings Tips

1) In star-rich parts of the sky the star catalog may have too many stars for PinPoint to solve. You can reduce the chance of this error by lowering the **Catalog Max Magnitude** or using a 1/2 or 1/4 camera **subframe**.

2) If plate solves are failing because you have a long focal length scope, smaller CCD sensor camera, or solving in star-sparse areas of the sky, you might need to:

a) use **full frame** images even though image downloads will take longer.

b) increase camera **exposure time** so more stars can be used.

c) increase the **Catalog Max Magnitude**

d) Use a catalog with more stars.

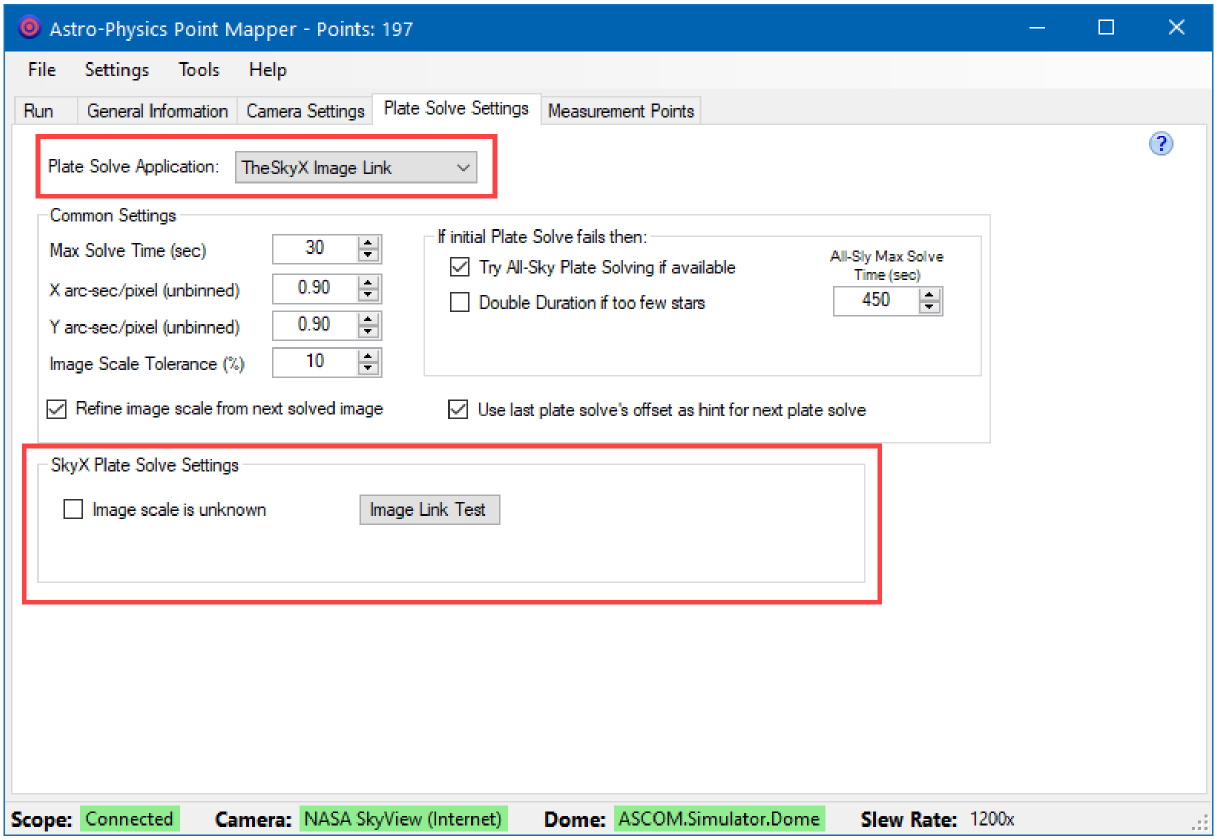
3) Enable **Use last plate solve's offset as hint for next plate solve.** When checked the RA and Dec error in the last plate solve coordinates is added to the next plate solve's RA/Dec "hint". This can dramatically reduce plate solve times, especially with PinPoint.

4) Enable **Try All Sky Plate Solving if available. T**he percentage of successful plate solves should be close to 100%, assuming good quality images with lots of stars.

TheSkyX Image Link Settings

To use TheSkyX Image link feature

IMPORTANT: When using **TheSkyX** for camera control and/or plate solving, make sure to connect **TheSkyX** to the mount via the **AP V2 ASCOM** camera driver. This allows **TheSkyX** to insert Right Ascension/Declination coordinates into FITS images as location hints for plate solving.

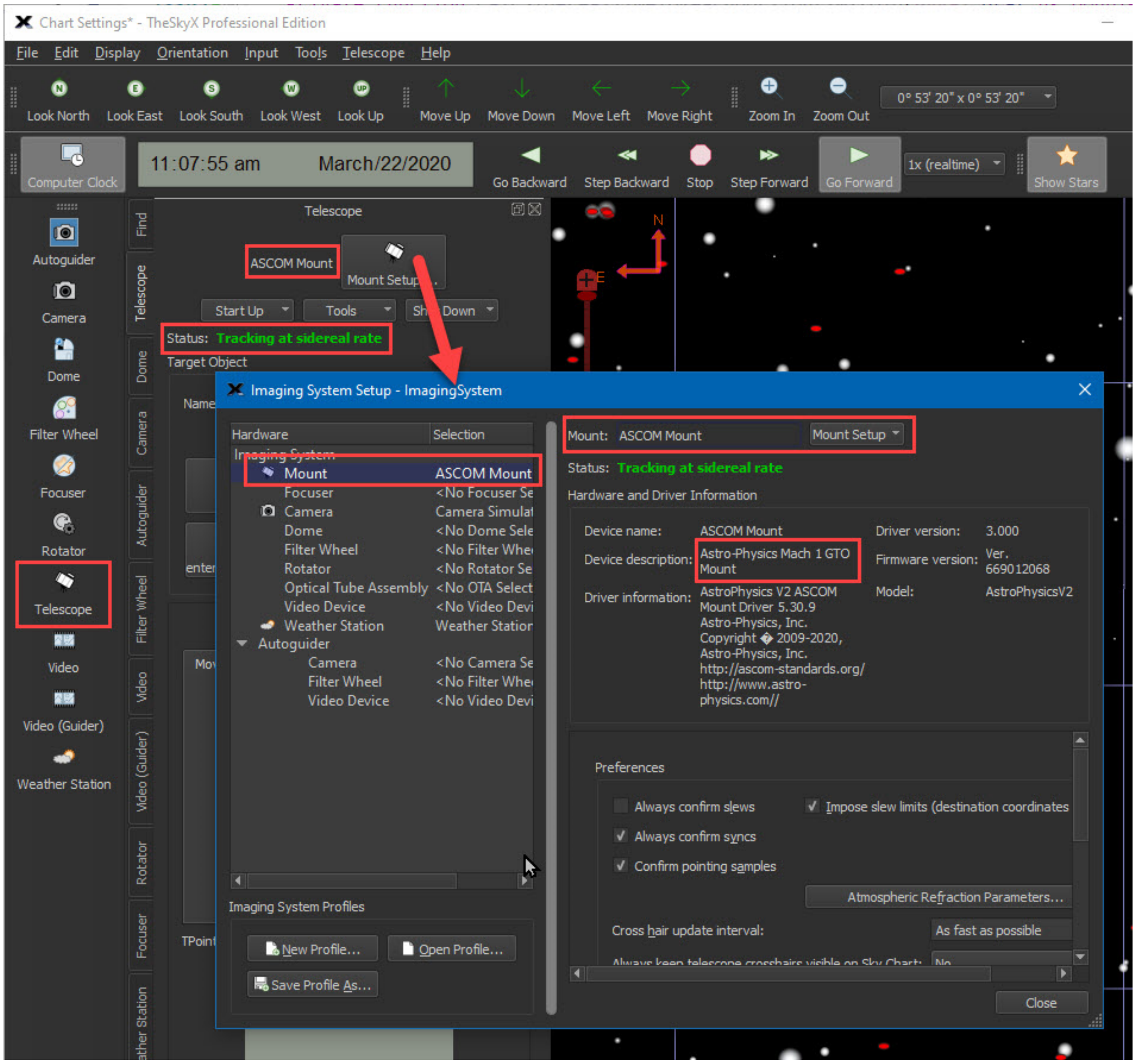


Setting up Image Link in TheSkyX.

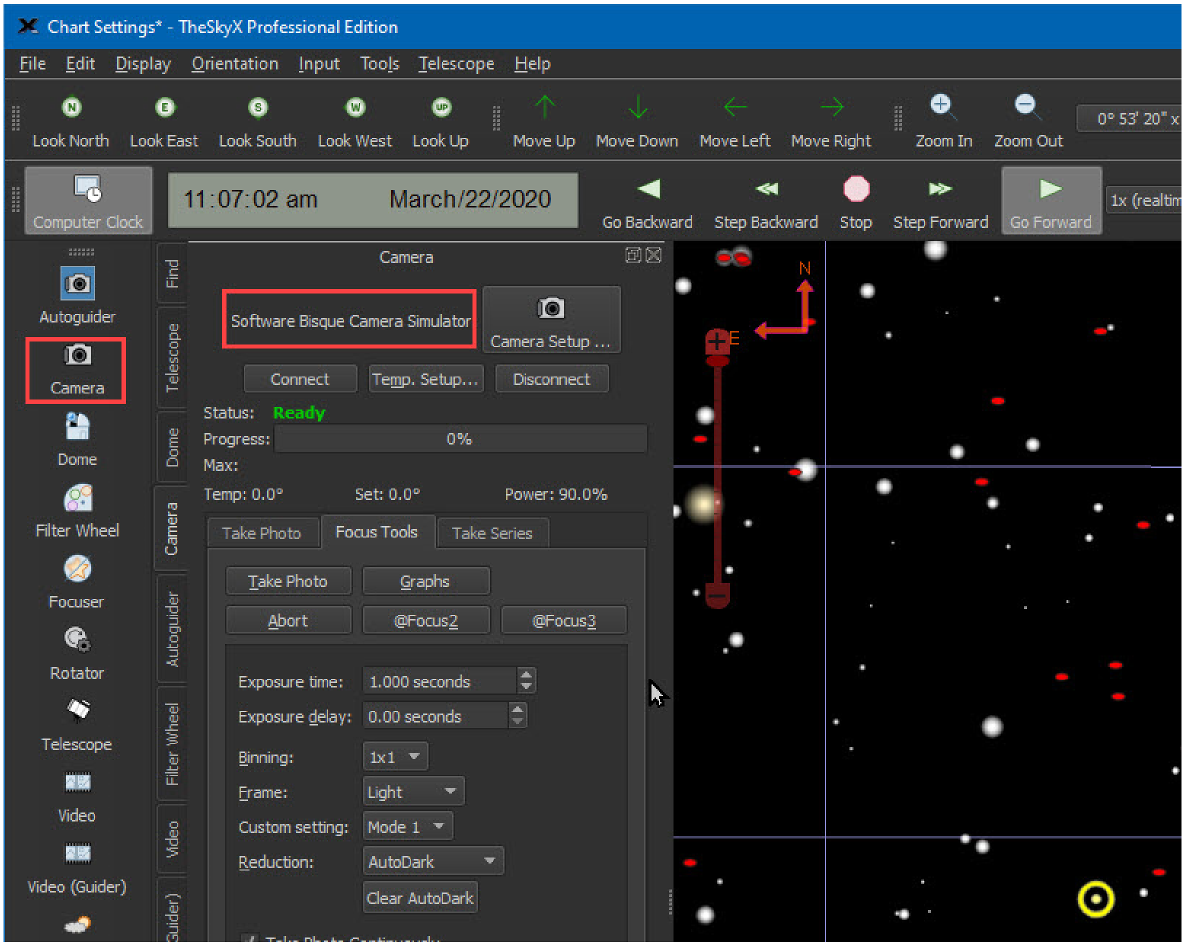
The following assumes that Software Bisque **TheSkyX Professional** has been already set up for plate solving, including the configuration star catalogs.

These instructions are to be done in **TheSkyX Professional** application:

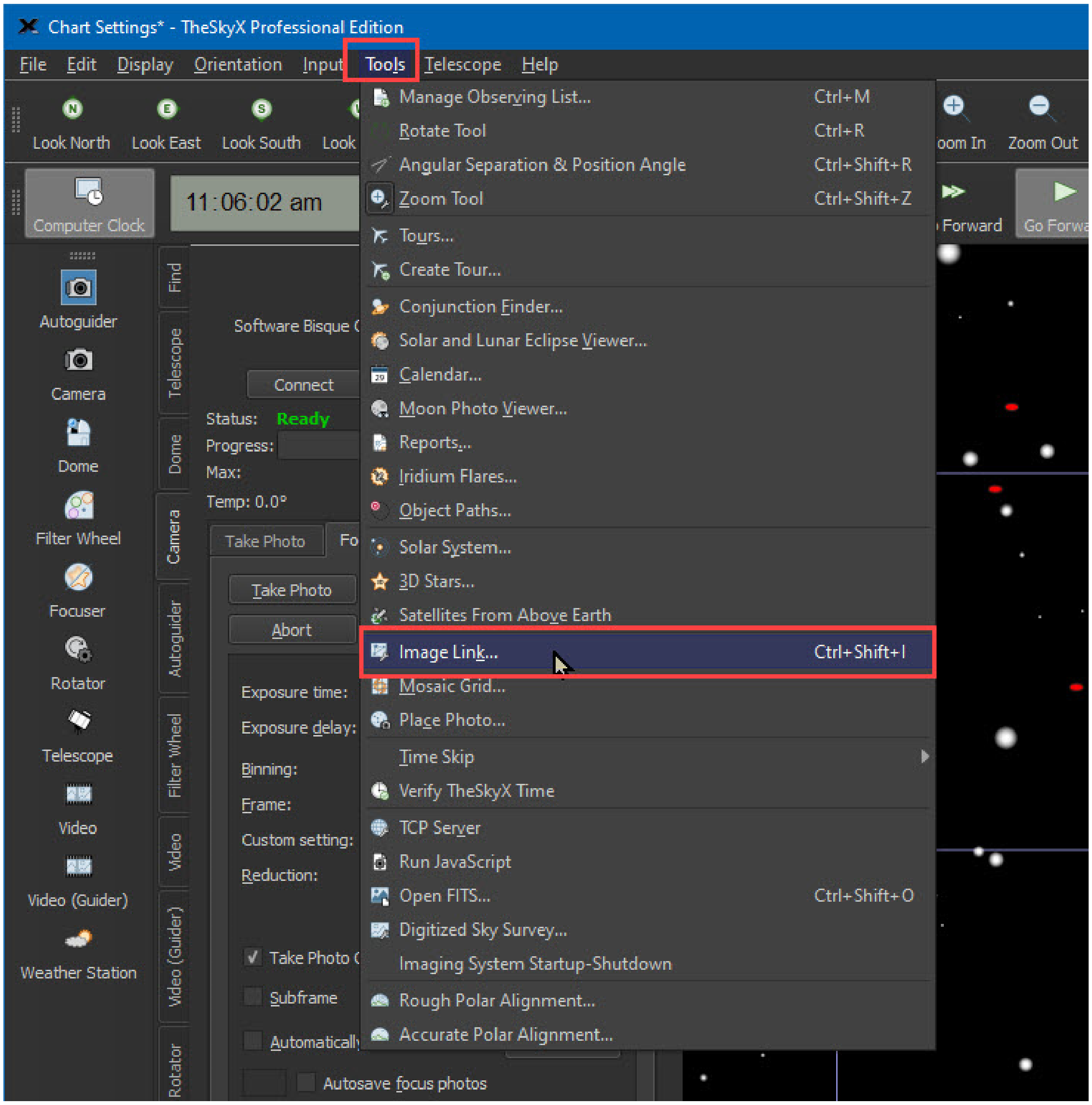
1. Make sure **TheSkyX Professional** is connected to the AP V2 ASCOM driver to the mount.



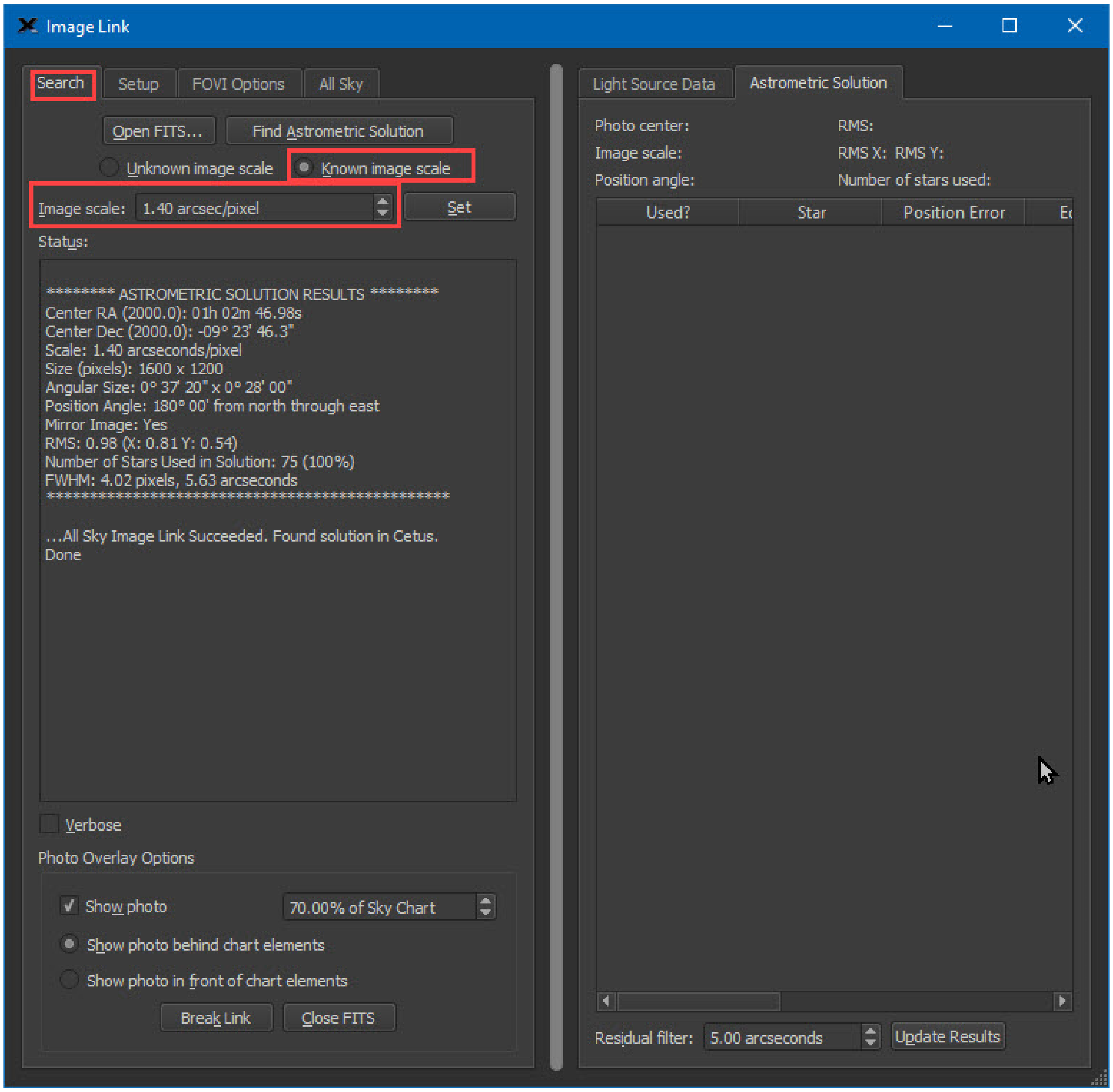
2. **ONLY if you are NOT using TheSkyX camera via APPM** then you must connect the **Software Bisque Camera Simulator** as shown in this image:



3. Click menu item **Tools**->**Image Link**.



4. For fastest plate solving on the **Search** tab, make sure Image scale matches the image scale in **APPM** and that "**Known Image scale**" is selected.

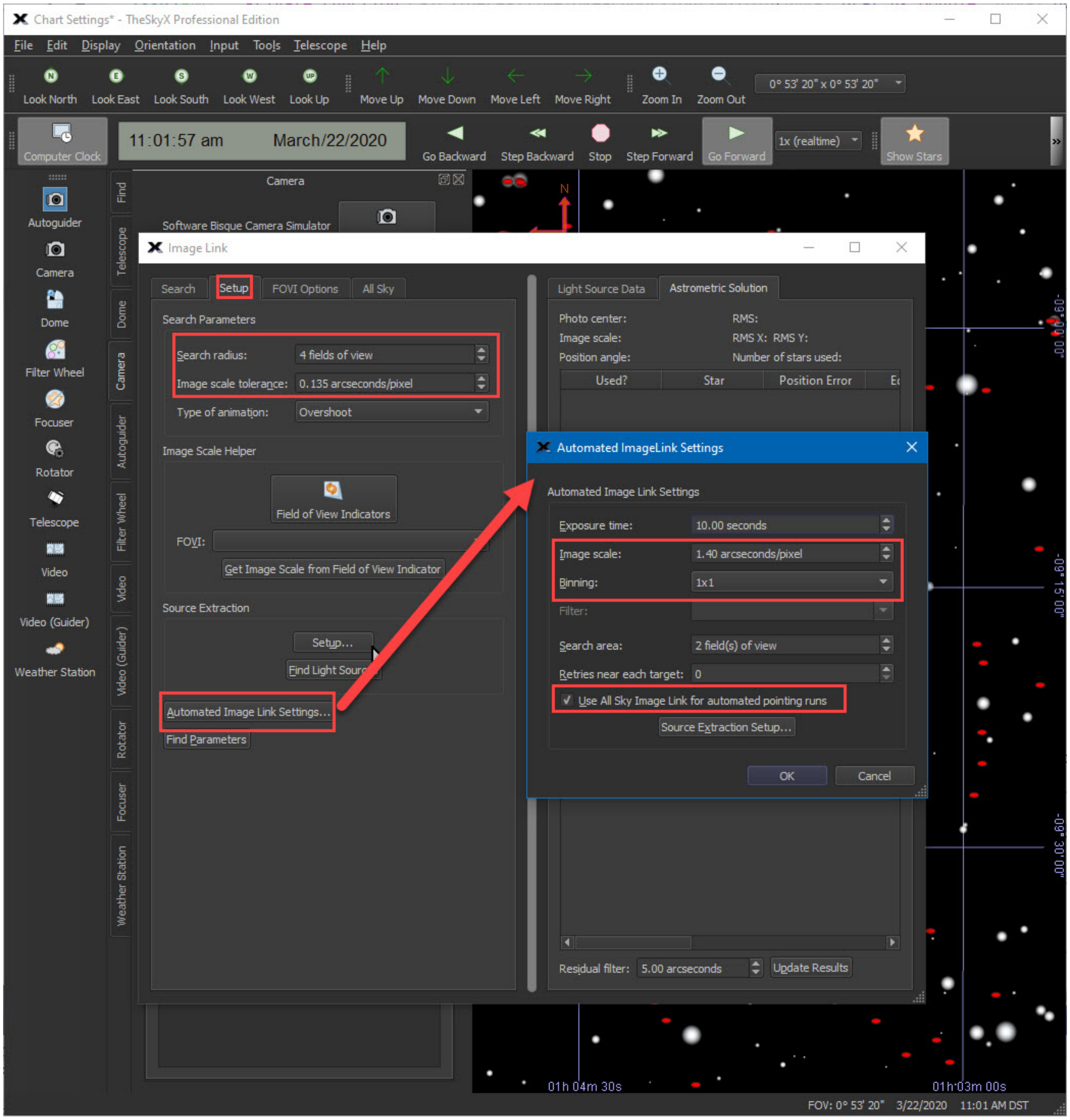


5. Click the **Setup** tab.

6. On the **Setup** tab setup an appropriate image scale tolerance. I have been using:

* **Search radius**: 4 fields of view

* **Image scale tolerance**: 0.135 arcseconds/pixel



7. Click "**Automated Image Link Settings...**"

8. In the **Automated ImageLink Settings** window make sure:

    a) The **Image scale** value matches **X arc-sec/pixel (unbinned)** set in APPM

    b) The **Binning** is **1x1** and also 1x in APPM

    c) Enable "**Use all Sky Image Link for automated pointing runs**"

9. Click **OK** and close the **Image Link** window.

Image scale is known: If image scale is known then enable this option and enter the approximate image scale. For the quickest plate solves you should enable this and make sure image scale is correct

Image Link Test: Clicking this will allow you to test that you have TheSkyX Image Link settings correctly setup. A dialog will open allowing you to navigate to a FITS image which you have previously taken and plate solve it. If the FITS image does not have embedded RA/Dec coordinates you will have to enter them yourself.

Sequence Generator Pro Plate Solve Settings

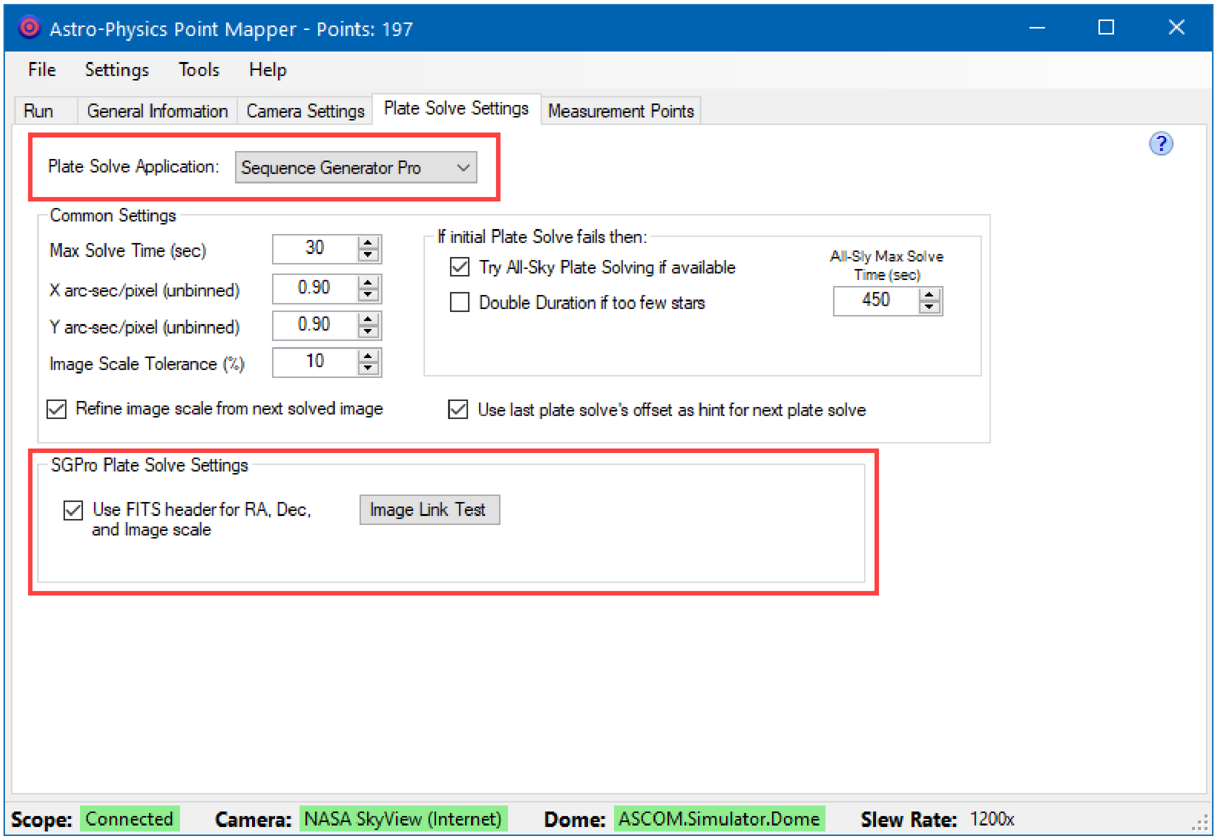
To setup plate solving in SGPro please see this link. It is highly recommended to use ASTAP or PlateSolve2. Like TheSkyX above, most of the settings will be entered in SGPro/PlateSolve2.

http://mainsequencesoftware.com/Content/SGPHelp/SequenceGeneratorPro.html?PlateSolvers.html

To setup APPM to use SGPro's plate solver do the following:

1. In SGPro 's Tool menu, select **Equipment Profile manager**.
2. In the **Equipment Profile Manager** select the **Plate Solve** tab.
3. If you have previously created a profile select it. If not create a new profile and save it.
4. On the **Plate Solve** tab:
    a. Select **PlateSolve2** as the interface.
    b. Click the **Settings** button, which should open the PlateSolve configuration window.
    c. In the File menu select **Configure Catalog Directories...**
    d. Configure the location for either the APM or UCAC3 catalog. You may need to download the catalogs if you don't have them already. You should be able download them from this link: http://pw-ecommerce.com/software/. If for some reason the link does not work please see the Sequence Generator Pro help file for an updated link.
    e. Close the catolgue configuration and PlateSolve configuration windows.
5. Configure any other equipment you are using on the other tabs (e.g. Camera, Filters, Focus, Telescope, Autoguide, etc.).
6. Click the check box to "**Use Profile as default for new sequences**" and click the "**Save**" button.
7. Close the **Equipment Tool Menu**.

IMPORTANT: When using Sequence Generator Pro for plate solving, make sure to connect SGPro to the mount via the AP V2 ASCOM camera driver. This allows SGPro to insert Right Ascension/Declination coordinates into FITS images as location hints for plate solving.



Use FITS header for RA, Dec, and Image Scale: Hints for position and image scale will be extracted from the image, if they are present.

Image Link Test: Clicking this will allow you to test that you have Sequence Generator Pro plate solve settings correctly setup. A dialog will open allowing you to navigate to a FITS image which you have previously taken and plate solve it. If the FITS image does not have embedded RA/Dec coordinates you will have to enter them yourself.

ASTAP Settings

ASTAP is a free open-source Astrometric Stacking Program, developed by Han Kleijn. To get more information about ASTAP and download it please see:

https://www.hnsky.org/astap.htm

After installing ASTAP and its latest star databases (currently H17 and H18), you will need to set up a few parameters.

ASTAP will usually solve very quickly provided image scale is set accurately. ***However, if image scale is incorrect then plate solves will likely fail.***

Max Number of Stars: Limits the number of star used for the solution. Typical value 500. APPM sets the initial value to 1000. If you have many stars in the image you may need to set this value higher to get a solution. A value "0" will result in using the default value set in ASTAP.

Radius Search Field: The program will search in a square spiral around the start position up to this radius. A value "0" will result in using the default value set in ASTAP.

Min Star Size (arc-sec): This could be used to filter out hot pixels. A value "0" will result in using the default value set in ASTAP.

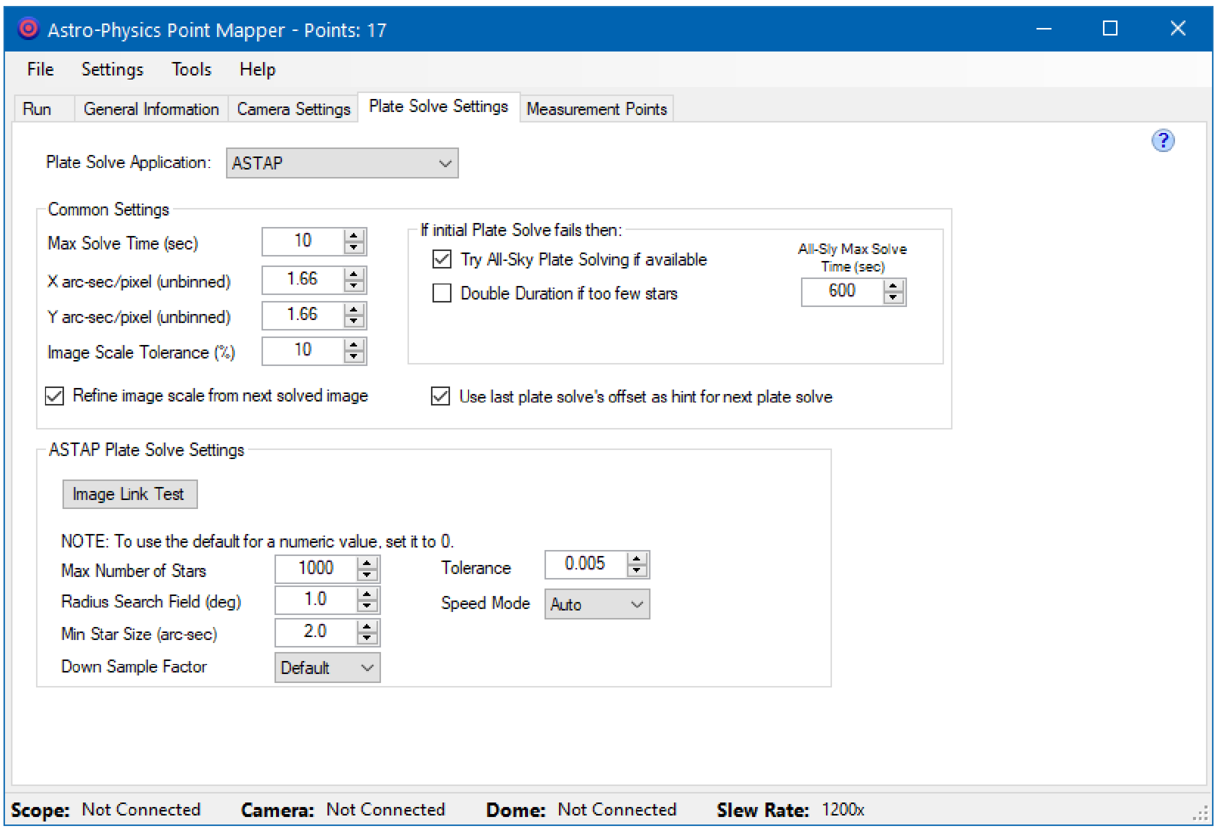
Down Sample Factor: Down sample prior to solving. Also called binning. A value "0" will result in auto selection down-sampling.

Tolerance: Tolerance used to compare quads. Typical value 0.007. A value "0" will result in using the default value set in ASTAP.

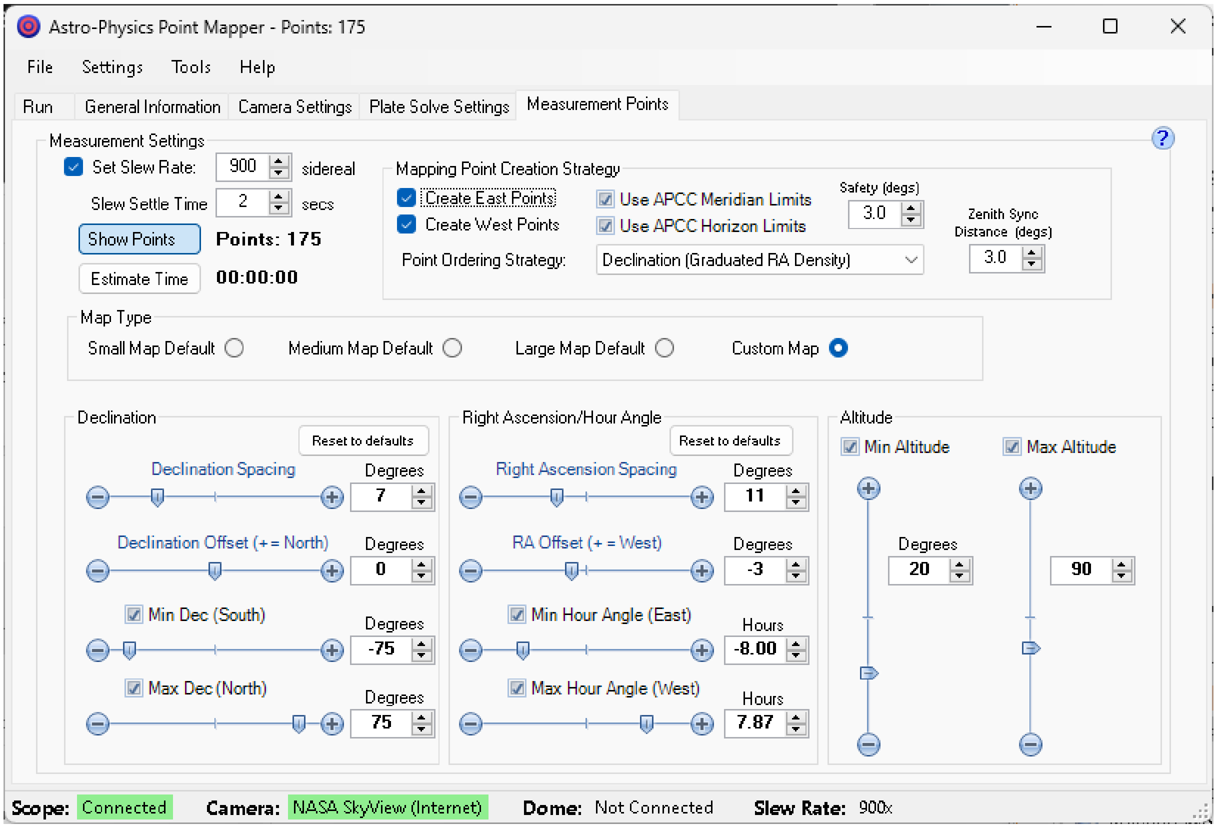
Speed Mode: "slow" is forcing of reading a larger area from the star database (more overlap) to improve detection.

If you experience problems with plate solving using ASTAP, please take a look at this link:

https://www.hnsky.org/astap.htm#conditions

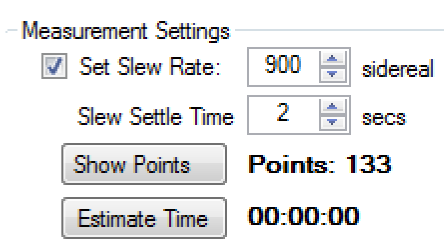


15.7 Measurement Points Tab



Tip: For best results, we recommend that you open up the Progress/Point Map by clicking the **Show Points** button (see below) before beginning to make any changes to the parameters in this tab. The Progress/Point Map will give you an immediate visual representation of the changes you are making.

Measurement Settings Group Box



Set Slew Rate: If enabled the Slew rate value is used for slewing the mount. This overrides the settings in APCC and the driver.

Hint: You may want to set a slower slew rate if your scope is setup in a residential area. This should lower the possibility that noise from your slewing mount will disturb a neighbor!

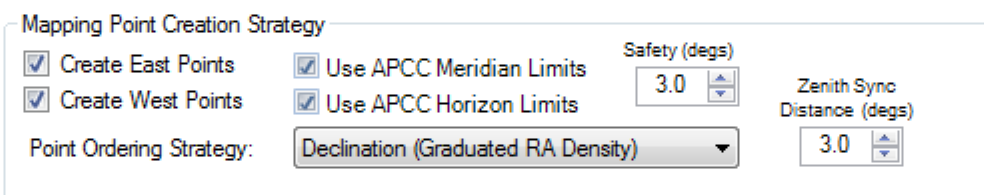
Slew Settle Time (secs): The time in seconds APPM will pause after a slew to a new point completes. This allows the system to settle at its new position after each slew. Astro-Physics mounts generally do not require more than a second or two of settle time, but you may want a longer time if your optical / imaging train needs a few extra moments to settle.

Show Points: This brings up a map of the points that will be mapped. See here for more information.

Estimate Time: This will estimate the approximate time to complete the current run. You should consider the reported time as the minimum time the run will take. If plate solves take longer than expected the actual time could be substantially longer.

Note: You must click the **Estimate Time** button any time you make a change to the point mapping in order for the time to update.

Mapping Point Creation Strategy Group Box



Create East Points: When checked East-side mapping points are generated. East side mapping points have the scope on the west side of the pier.

Create West Points: When checked West-side mapping points are generated. West side mapping points have the scope on the east side of the pier.

Use APCC Meridian Limits: When checked APPM will use the meridian limits points from APCC to create additional mapping points for "counterweight-up" telescope positions. If you make changes in APCC to the Meridian Limits while APPM is running you will need to click the **Refresh Meridian/Horizon limits from APCC** option in the Settings Menu to import the APCC Meridian Limits into APPM.

Use APCC Horizon Limits: When checked APPM will use the horizon limits points from APCC to limit mapping points to positions above the defined horizon. Points below your APCC Horizon Limits will not be included in the point mapping. If you make changes in APCC to the Horizon Limits while APPM is running you will need to click the **Refresh Meridian/Horizon limits from APCC** option in the Settings Menu to import the APCC Horizon Limits into APPM.

Safety (degs): This allows you to specify an extra number of degrees before the meridian (or the meridian limit if **Use APCC Meridian Limits** is checked) for which mapping points will not be created. In most cases you should set to 0-3 degrees.

Point Ordering Strategy: This determines the order that the mapping points will be executed. The two declination strategies reduce slew times and place priority towards a higher-accuracy RA tracking model. The options are:

- **Declination**: points are mapped at one declination at a time. As declination moves away from the celestial equator the actual sky distance between points decreases.
- **Declination (Equal RA Density)**: points are mapped at one declination at a time. RA Spacing increases inversely to Cosine of declination so that RA sky spacing remains the same at each declination.
- **Declination (Graduated RA Density)**: points are mapped at one declination at a time. For declinations of +/-45 to +/-65 degrees, RA density is increased by 1.5x over the selected spacing . Above +/-65 degrees, density is 2.0x. This should improve data at higher (lower in southern hemisphere) declinations without committing to the huge number of points required for the **Equal RA Density** spacing.
- **Hour Angle (For Dome Setups)**: points are mapped at one hour angle at a time. This reduces the amount of movement a dome slit might need to do.
- **Custom**: You can provide your own set of mapping points. For an example of the mapping points use the menu option to export points to see the latest format. This should only be attempted by advanced users.

Zenith Sync Distance (degs): When starting a run APPM will slew to near the zenith and perform a Sync (Recal). The number of degrees from the zenith is specified by this option. Usually 3.0 degrees is a good value.

Map Type

Small Map Default: Sets the Small Map Default values in the table below.

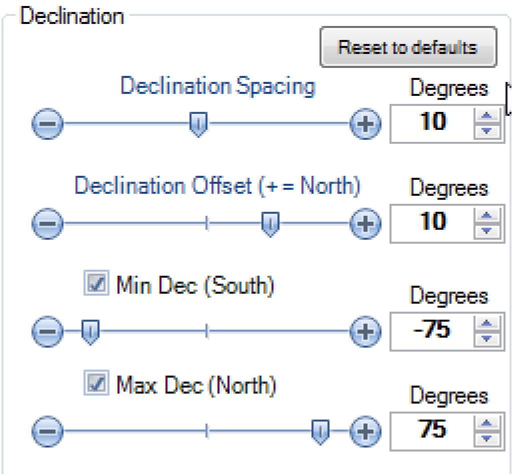
Medium Map Default: Sets the Medium Map Default values in the table below.

Large Map Default: Sets the Large Map Default values in the table below.

Custom Map: If any values are changed when using one of the default settings above, the map automatically converts to a Custom Map type.

APPM Measurement Points Tab Defaults			
	Small Map Default	**Medium Map Default**	**Large Map Default**
	25-40 points	~100 points	>200 points
Set Slew Rate	900	900	900
Slew Settle Time	2	2	2
Create East Points	X	X	X
Create West Points	X	X	X
Use APCC Meridian Limits	-	X	X
Use APCC Horizon Limits	X	X	X
Point Ordering Strategy	Declination (Graduated RA Density)	Declination (Graduated RA Density)	Declination (Graduated RA Density)
Safety Degrees	0.0	0.0	0.0
Zenith ReCal Distance (Degrees)	3.0	3.0	3.0
Declination Spacing	20	12	7
Declination Offset (+=North)	10	0	0
Min Declination (South)	-75	-75	-80
Max Declination (North)	75	75	80
Right Ascension Spacing	20	13	9
RA Offset (+=West)	0	0	0
Min Hour Angle (East)	-8.00	-9.00	-10.00
Max Hour Angle (West)	8.00	9.00	10.00
Min Altitude	30	25	20
Max Altitude	90	90	90

Declination Group Box



Reset to defaults: Resets the Declination group box settings to default values.

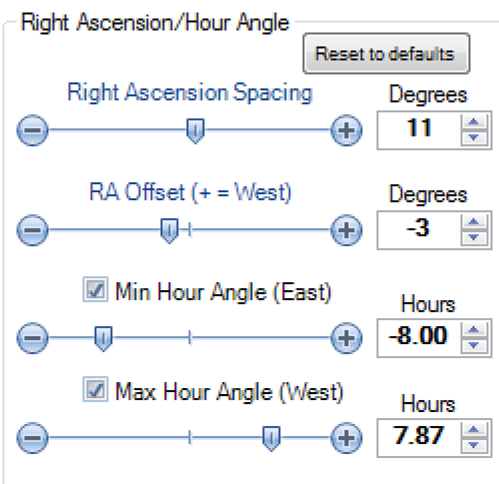
Declination Spacing: The spacing, in degrees, between Declination mapping points.

Declination Offset: The offset, in degrees, relative to the celestial equator for Declination mapping points will be created.

Min Declination: The minimum Declination at which mapping points will be created. This is primarily useful for southern hemisphere users who do not wish to map points too close to their pole. Since errors near the pole can be problematic, some people will get better overall results if they set this limit above the default of -85 degrees. The checkbox MUST be checked for this limit to take effect!

Max Declination: The maximum Declination at which mapping points will be created. This is primarily useful for northern hemisphere users who do not wish to map points too close to their pole. Since errors near the pole can be problematic, some people will get better overall results if they set this limit below the default of +85 degrees. The checkbox MUST be checked for this limit to take effect!

Right Ascension Group Box



Reset to defaults: Resets the Right Ascension group box settings to default values.

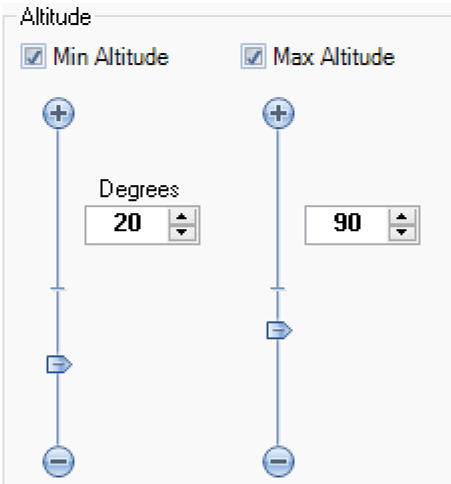
Right Ascension Spacing: The spacing, in degrees, between Right Ascension mapping points. Note that this spacing is in degrees - not in units of right ascension.

Right Ascension Offset: The offset, in degrees, relative to the meridian for which Right Ascension mapping points will be created.

Min Hour Angle: The minimum hour angle at which mapping points will be created. Remember that hour angles extend below -6 hours when below the pole. The checkbox MUST be checked for this limit to take effect!

Max Hour Angle: The maximum hour angle at which mapping points will be created Remember that hour angles extend above +6 hours when below the pole. The checkbox MUST be checked for this limit to take effect!

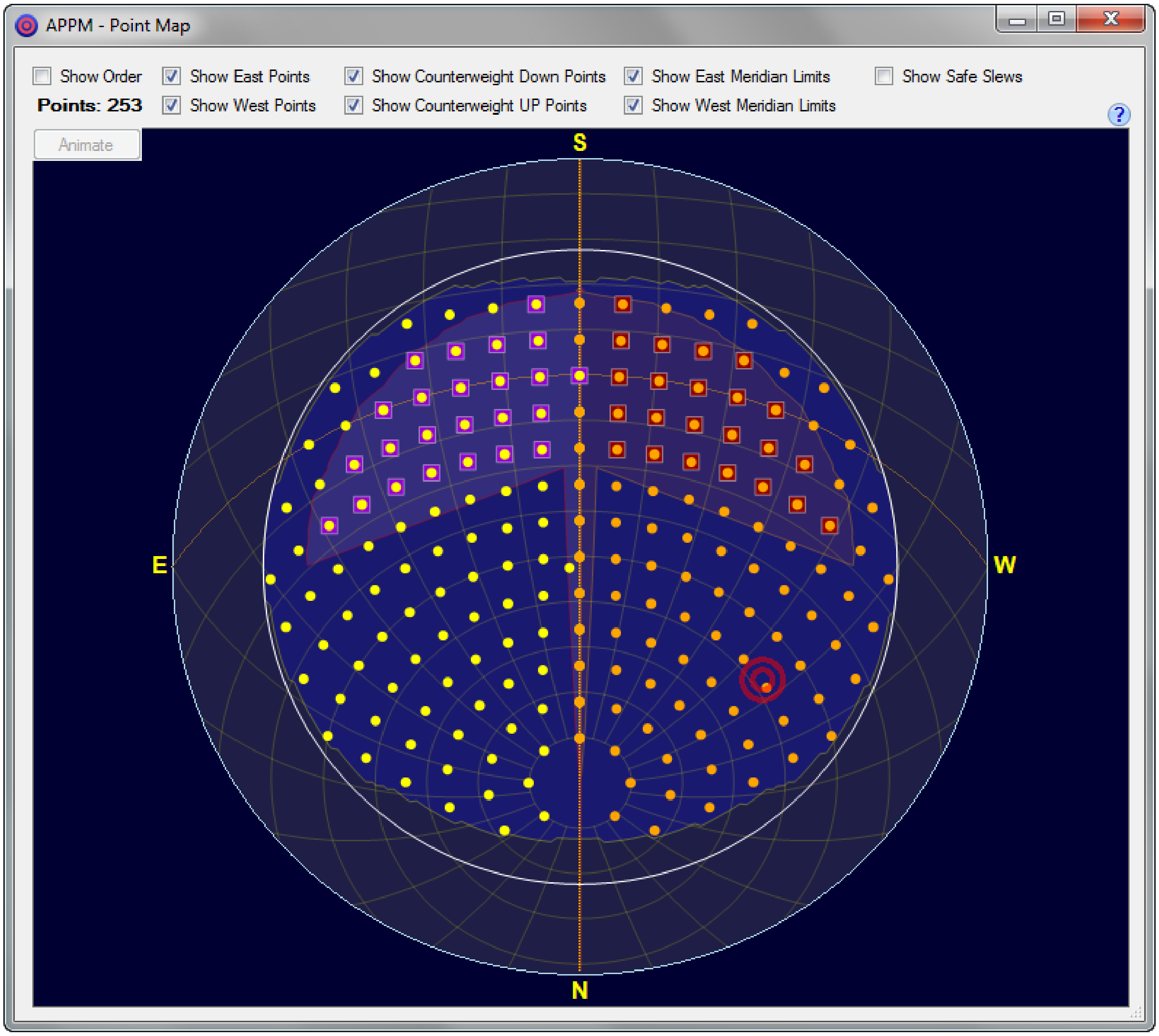
Altitude Group Box



Min Altitude: when enabled no points below the minimum altitude are created. The checkbox MUST be checked for this limit to take effect!

Max Altitude: when enabled no points above the maximum altitude are created. This can be helpful to avoid creating points near the meridian if the telescope is unable to reach that sky position. The checkbox MUST be checked for this limit to take effect! **NOTE:** The **Zenith Sync Distance** will internally be adjusted by the difference of the Max Altitude from the Zenith. For example, if the Max Altitude setting is 10 degrees and Zenith Sync Distance is 3 degrees, APPM will select the first sync point 13 degrees from the zenith (10 + 3 degrees).

15.8 Progress/Point Map



This window shows either:

1) The points to be mapped as you make adjustments on the Measurements Tab

2) The current telescope position and plate solve status of each point. Points are either yellow (East side) or orange (West side). When APPM is running a model any point that has been successfully plate solved the point will turn green. If a point failed to solve it will turn a pinkish-red.

Show Order: When checked the **Animate** button will be enabled which will allow you to "play" the order of the mapping points. Additionally a large green dot indicates the start point and the large pink dot the end point. Each point shows an arrow to the next point.

Animate: When clicked the mapping point sequence is played out at about 3 points per second. This button is only enabled when Show Order is checked. It also becomes hidden when a mapping run is in progress.

Show East Points: Shows East points.

Show West Points: Shows West points.

Show Counterweight-Down Points: Shows all counterweight-down points (normal - telescope higher than counterweights).

Show Counterweight-Up Points: Shows all counterweight-up points (telescope lower than counterweights). These points are all square in shape to differentiate them from counterweight-down points, which are all round.

Show East Meridian Limits: Shows transparent region depicting East meridian limits

Show West Meridian Limits: Shows a transparent region depicting West meridian limits.

Note: Horizon limits are always displayed if enabled on the Measurement Points tab.

Why are there two dots in the center and are slightly off the zenith?

The two "zenith points" are not actually at the zenith, but 3 degrees away by default. There is a setting in APPM to control that distance, but you should leave it at the default of 3 degrees unless you have a specific need to move it

The zenith points are used to ensure modeling for each side of the sky will have a sanity check prior to the detailed modeling. APCC creates independent models for East and West, so it is important that each of those zenith points is present on the respective side of the meridian.

15.9 Advanced Topics

Command Line Arguments

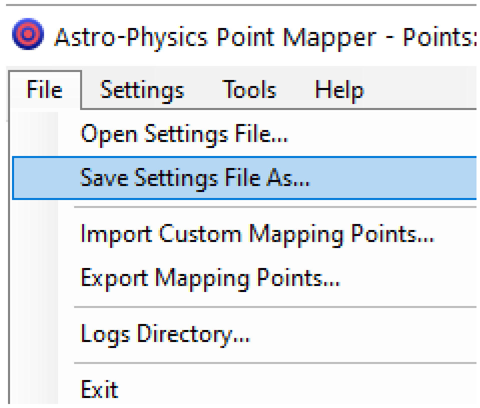
APPM can be started with command line arguments to begin an auto-mapping run. The command line format is

```
"C:\Program Files (x86)\Astro-Physics\APCC Pro\ApPointMapper.exe" [-s<settingsfile>] [-M<measurement points configuration file>] [-m<mapfile> [-auto] [-dontexit]]
```

Where,

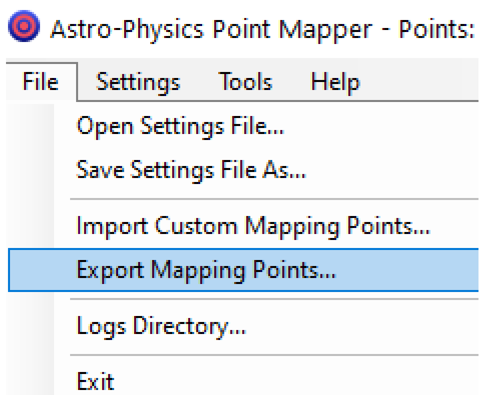
-s<settingsfile> - This loads an APPM settings file. These files have a ".appm" file extension.

You can create a settings file from APPM in its File menu:



-m<mapfile> - This loads an APPM mapping points file. This is a *.CSV* file containing the list of sky points to be mapped.

You can create a map file from APPM's File menu by "Export Mapping Points..."



-auto - When used with the **-m** option, this will automatically start a mapping run and direct APCC Pro to create a pointing model from the data points.

-dontexit - When used with **-m** and **-auto** options, APPM will not exit after completing a mapping run. By default APPM will exit if this option is not present.

-M<measurement points configuration file> - This processes a file containing measurement points configuration. The file is a simple text file with lines of the format:

<Setting> = <Value> # Comment

<Setting> is one of the keywords in the table below.

<Value> is the value of the setting.

<Comment> is any text after a "#" character.

Blank lines are allowed.

Table of allowed Settings in measurement points configuration files:

Image Item number	Setting	Description	Example
1	CreateEastPoints	Can be set to 'True' or 'False'. If 'True', include measurement points for the East hemisphere.	CreateEastPoints = True
2	CreateWestPoints	Can be set to 'True' or 'False'. If 'True', include measurement points for the West hemisphere.	CreateWestPoints = True
3	DeclinationOffset	Range: -20 to 20 degrees (integer).	DeclinationOffset = 0
4	DeclinationSpacing	Range 1 to 30 degrees (integer).	DeclinationSpacing = 20
5	MaxDeclination	Range -85 to 85 degrees (integer).	MaxDeclination = 75
6	MaxHourAngleWest	Range --12 to 12 hours (floating point). Typically a positive value.	MaxHourAngleWest = 8
7	MinAltitude	Range 0 to 85 degrees (integer).	MinAltitude = 25
8	MinDeclination	Range -85 to 85 degrees (integer).	MinDeclination = -75
9	MinHourAngleEast	Range --12 to 12 hours (floating point). Typically a negative value.	MinHourAngleEast = -8
10	PointOrderingStrategy	0 = Declination 1 = Declination (Equal RA Density) 2 - Declination (Graduated RA Density) 3 = Hour Angle (For Dome Setups) 4 = Custom	PointOrderingStrategy = 0
11	RightAscensionOffset	Range: -20 to 20 degrees (integer).	RightAscensionOffset = 0
12	RightAscensionSpacing	Range 1 to 30 degrees (integer).	RightAscensionSpacing = 3
13	SetSlewRate	Can be set to 'True' or 'False'.	SetSlewRate = False
14	SlewRate	Range 1 to Maximum mount rate (e.g. 1200 for most mounts, 1800 for Mach 2 at 24V).	SlewRate = 601

Image Item number	Setting	Description	Example
15	SlewSettleTime	Range 0 to 300 seconds (integer).	SlewSettleTime = 4
16	UseHorizonLimits	Can be set to 'True' or 'False'.	UseHorizonLimits = False
17	UseMaxDeclination	Can be set to 'True' or 'False'.	UseMaxDeclination = True
18	UseMaxHourAngleWest	Can be set to 'True' or 'False'.	UseMaxHourAngleWest = True
19	UseMeridianLimits	Can be set to 'True' or 'False'.	UseMeridianLimits = False
20	UseMinAltitude	Can be set to 'True' or 'False'.	UseMinAltitude = True
21	UseMinDeclination	Can be set to 'True' or 'False'.	UseMinDeclination = True
22	UseMinHourAngleEast	Can be set to 'True' or 'False'.	UseMinHourAngleEast = True
23	ZenithSafetyDistance	Range 0 to 15 degrees (floating point).	ZenithSafetyDistance = 0.0
24	ZenithSyncDistance	Range 0 to 15 degrees (floating point).	ZenithSyncDistance = 3.0

Checking pointing accuracy

If you run into problems with pointing or tracking rate accuracy then APPM has a method to check pointing accuracy and repeatability.The procedure is called a ***5x Verify***, because APPM will make five separate passes using the same set of sky points.

The purpose of the **5x Verify** is to determine if the telescope can repeatably point to the same location in the sky. If something is shifting in the optics, or a cable tugging somewhere, this procedure may discover it.

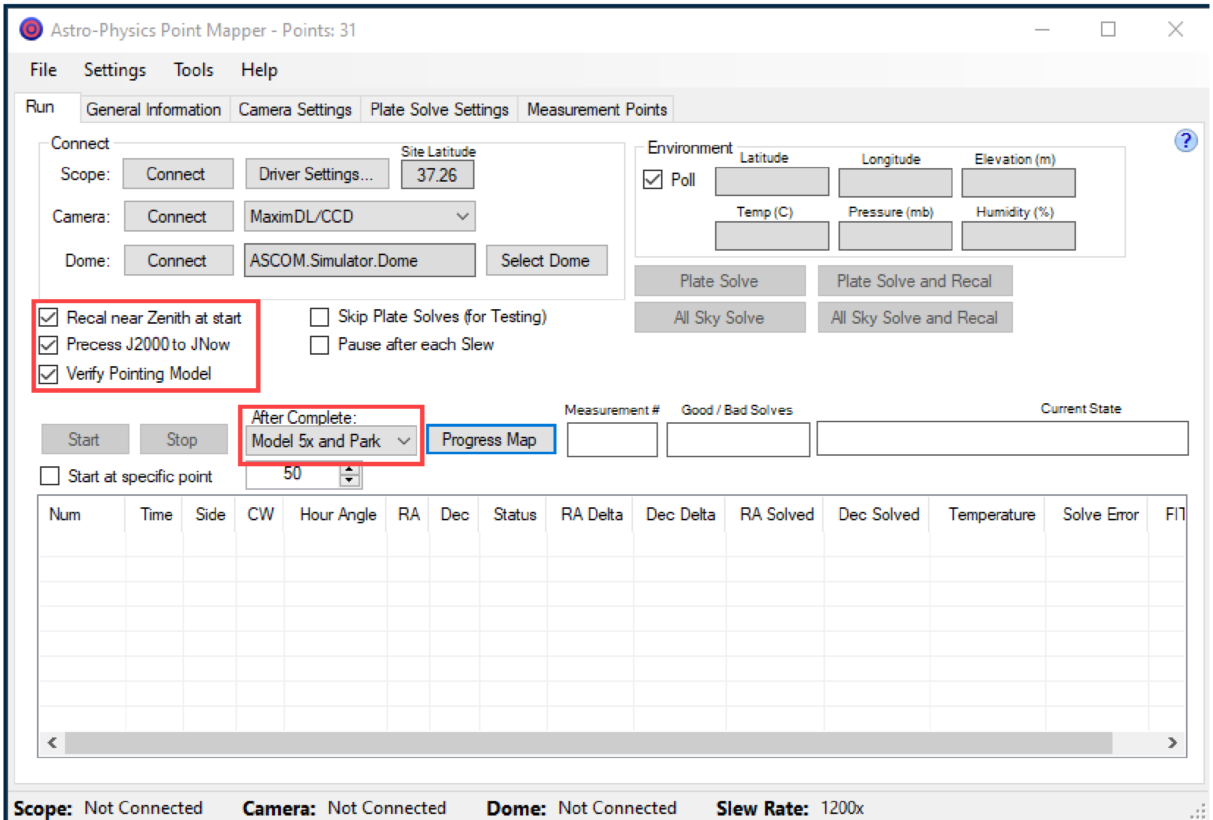
To setup for a **5x Verify**, you must enable the following options, which are also identified in the screenshot below:

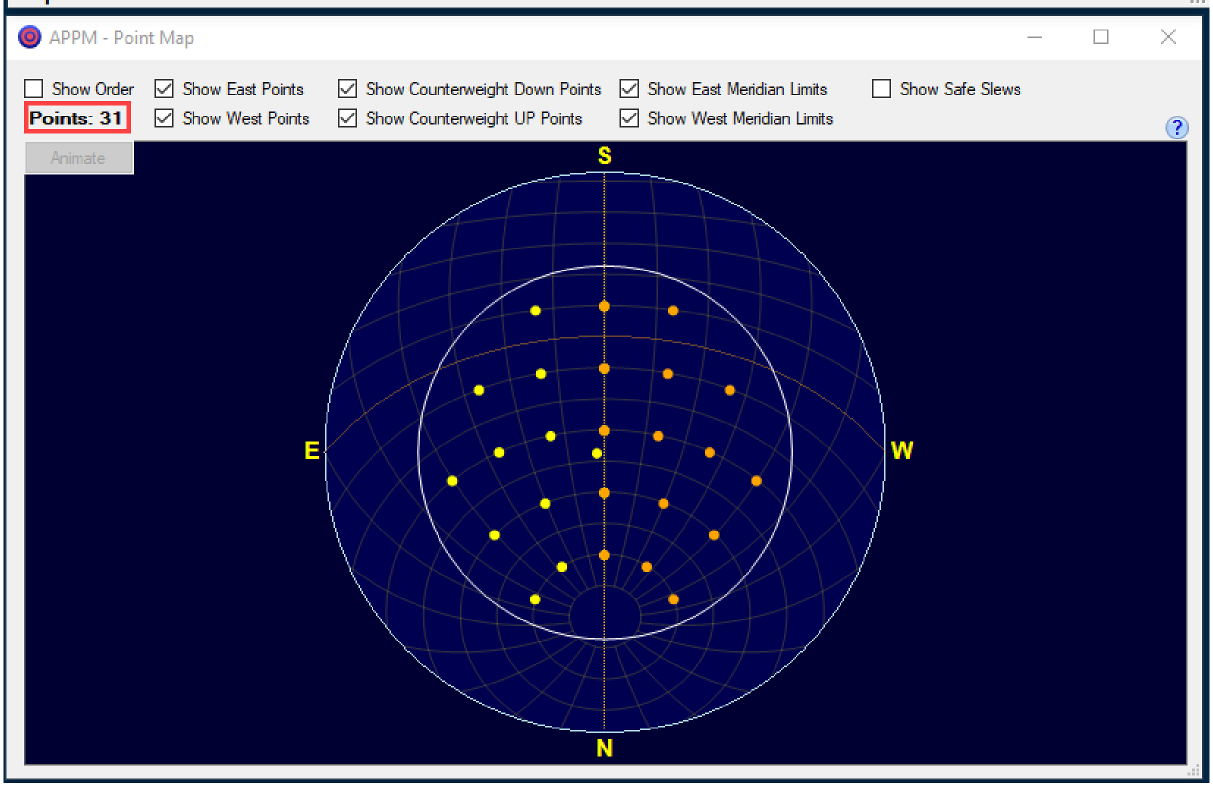
- **Recal near the Zenith at start**
- **Precess J2000 to JNow**

- **Verify Pointing Model**

Also, the ***After Complete*** option must be set to **Model 5x and Park.**

Lastly, you should reconfigure the number of data points to somewhere between 30-50 points. You don't want to use too many points because each point will get repeated a total of five times. Thus, the more points you use, the longer the procedure will take to complete.


Astro-Physics Point Mapper - Points: 31
File Settings Tools Help
Run General Information Camera Settings Plate Solve Settings Measurement Points
Connect
Scope: Connect Driver Settings...
Site Latitude 37.26
Camera: Connect MaximDL/CCD
Dome: Connect ASCOM.Simulator.Dome Select Dome
Environment
Poll
Latitude Longitude Elevation (m)
Temp (C) Pressure (mb) Humidity (%)
Plate Solve Plate Solve and Recal
All Sky Solve All Sky Solve and Recal
Recal near Zenith at start
Process J2000 to JNow
Verify Pointing Model
Skip Plate Solves (for Testing)
Pause after each Slew
After Complete:
Model 5x and Park
Progress Map
Measurement # Good / Bad Solves Current State
Start Stop
Start at specific point
50
Num Time Side CW Hour Angle RA Dec Status RA Delta Dec Delta RA Solved Dec Solved Temperature Solve Error FIT
Scope: Not Connected Camera: Not Connected Dome: Not Connected Slew Rate: 1200x


APPM - Point Map
Show Order
Show East Points
Show Counterweight Down Points
Show East Meridian Limits
Show Safe Slews
Points: 31
Show West Points
Show Counterweight UP Points
Show West Meridian Limits
Animate
S
E
W
N

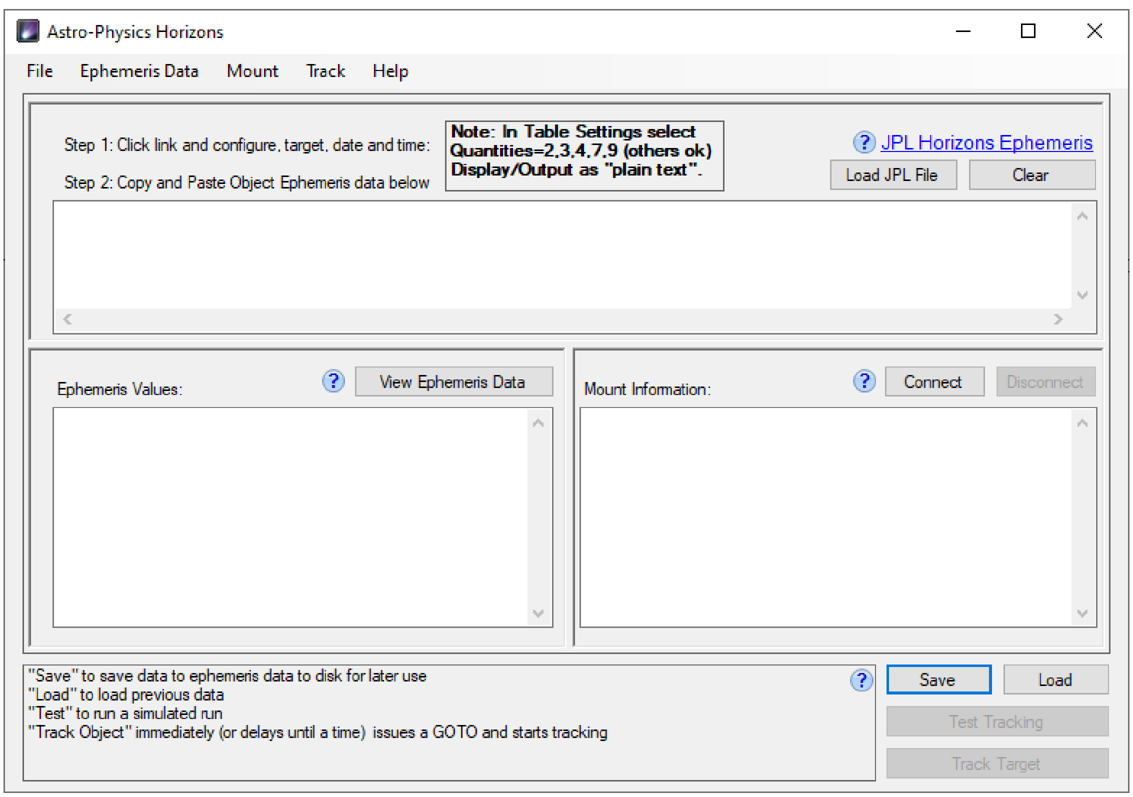
After the **5x Verify** completes, you can use the APCC Log Zipper utility to zip up the files. After zipping these can be posted to the ap-goto io groups forum or emailed to Astro-Physics support personal.

16 Horizons

Horizons allows your Astro-Physics mount to accurately follow solar system objects such as Comets, Asteroids, Planets, and even the moon and sun. It uses data that you import from the JPL Horizons Ephemerides web site to calculate the precise tracking rates needed to follow a target without any guiding. For example, this means you can do longer unguided exposures of a comet without it blurring. Or, in the case of fast moving asteroids, you don't need to worry about keeping your scope centered because Horizons will send commands to your AP GTO mount to keep the target centered.

Horizons requires APCC (Standard or Pro edition) to operate. Horizons will work best with APCC Pro because Pro includes tracking rate corrections based on the pointing model in use. Of course a pointing model must be in place for the target's tracking rate to be appropriately adjusted to compensate for things like polar misalignment, refraction, mount/scope flexures, etc.

When you open Horizons it should look something like this:

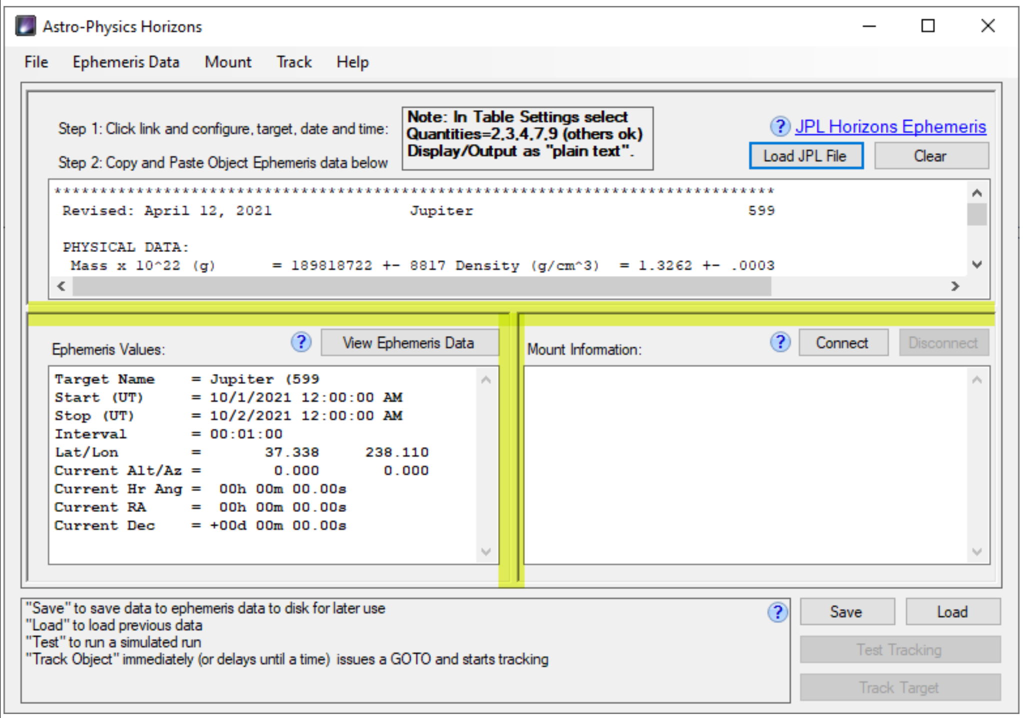


NOTE: you don't need to be online to the internet when you actually track the object as you can pre-download and save as many targets as you want.

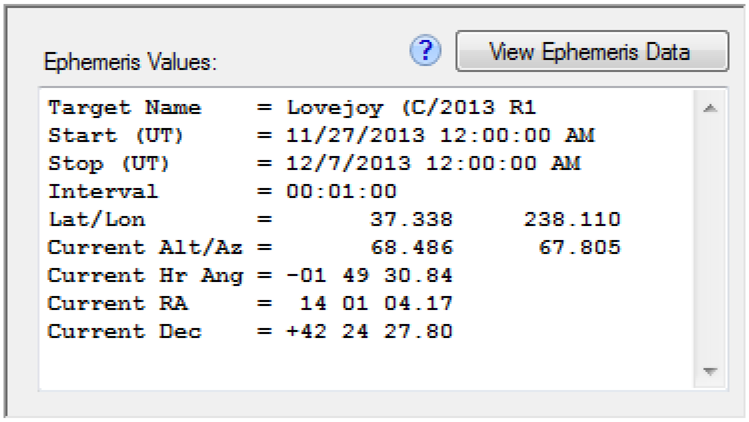
Connect to the mount to either immediately track the target or test tracking. **Test tracking** allows you to pick a time in the time span of the Ephemeris data set and the mount will slew the scope to where the target will be at that time. It is useful to confirm in advance that there are no obstructions (like trees and buildings) at the time you intend to image your target.

Track Target allows you to immediately slew to the object and start tracking, or, alternatively, start tracking at a future time.

NOTE: the three smaller windows on the main application can be resized by clicking the edge and dragging to size the windows.The edges are highlighted in yellow in this image:



Ephemeris Values



Once data has been loaded the following information is displayed about it:

Target Name - The name of the target. Double check this to be sure you have the correct target loaded.

Start (UT) - The start time and date in Universal time of the loaded Ephemeris data set.

End (UT) - The end time and date in Universal time of the loaded Ephemeris data set.

Interval - the interval between data elements in Hours: Minutes: Seconds. It is recommended that a1-minute interval (00:01:00) be used for highest accuracy.

Lat/Lon - The latitude and longitude of the site for which the ephemeris data applies. Make sure it corresponds to the location of the telescope.

Current Alt/Az - the target's current Altitude and Azimuth.

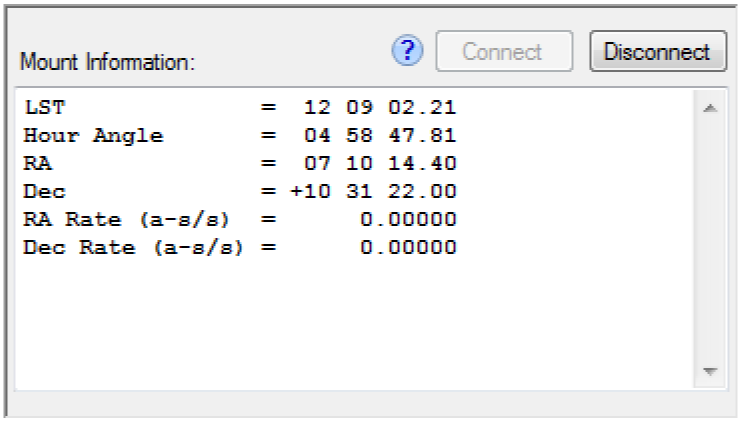
Current Hr Ang - the target's current Hour Angle. This will be negative if it is East of the meridian.

Current RA - the target's current Right Ascension.

Current Dec - the target's current Declination.

Mount Information

This section contains information retrieved from the mount.



LST - The current Local Sidereal Time. LST is defined to be the Right Ascension value currently at the meridian.

Hour Angle - The current hour angle. A negative value means the scope is pointing east of the meridian.

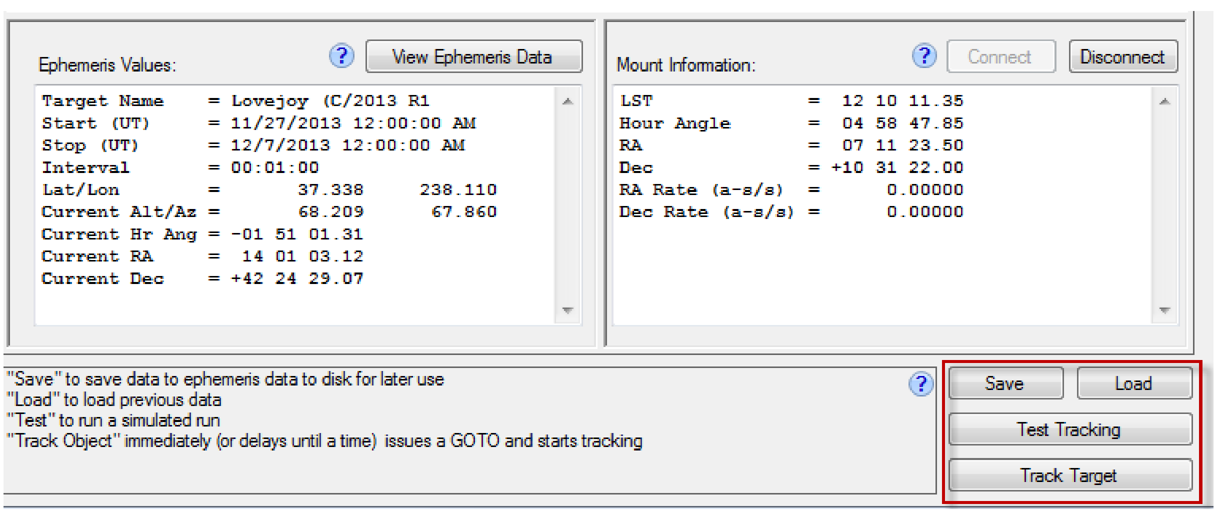
RA - The Right Ascension.coordinate that the scope is currently pointing to.

Dec - The Declination coordinate that the scope is currently pointing to.

RA Rate - the rate relative to sidereal that the mount is tracking at in Right Ascension, in arc-secs/second.

Dec Rate - the rate relative to 0 that the mount is tracking at in Declination, in arc-secs/second.

Actions



Save - Saves the currently loaded Ephemeris data to a disk file. Once saved to disk you do not need an internet connection to use Horizons. Simply load a previously saved data set and start using it.

Load - Loads a previously saved Ephemeris data set.

Test Tracking - Using the loaded Ephemeris data set you can test tracking an object of any date and time that's in the data set's time span. This allows you to check in advance that there won't be any obstructions during an actual event.

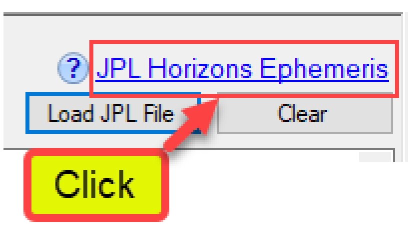
Track Target - allows you to immediately go to the targets actual position or to delay to a certain time before going to it. Once tracking has been started it will continue until stopped.

16.1 Retrieving data from the JPL Horizons Web Side

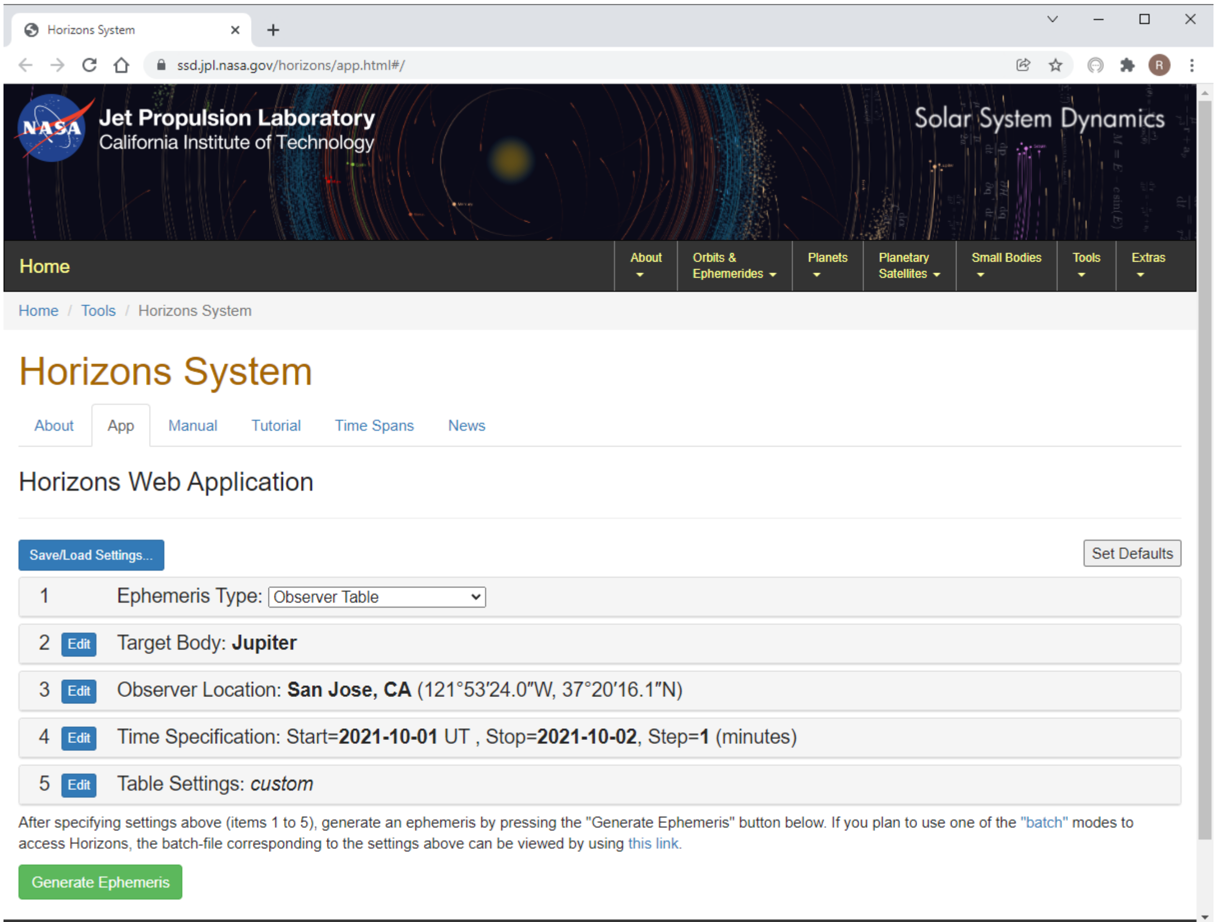
To use Horizons you just need to follow some simple steps.

Note: you will need an internet connection to download the Ephemerides data but you don't need to have an internet connection later, when tracking.

1) Click the link in the Horizons program that opens a web browser to the JPL Horizons Ephemerides site.

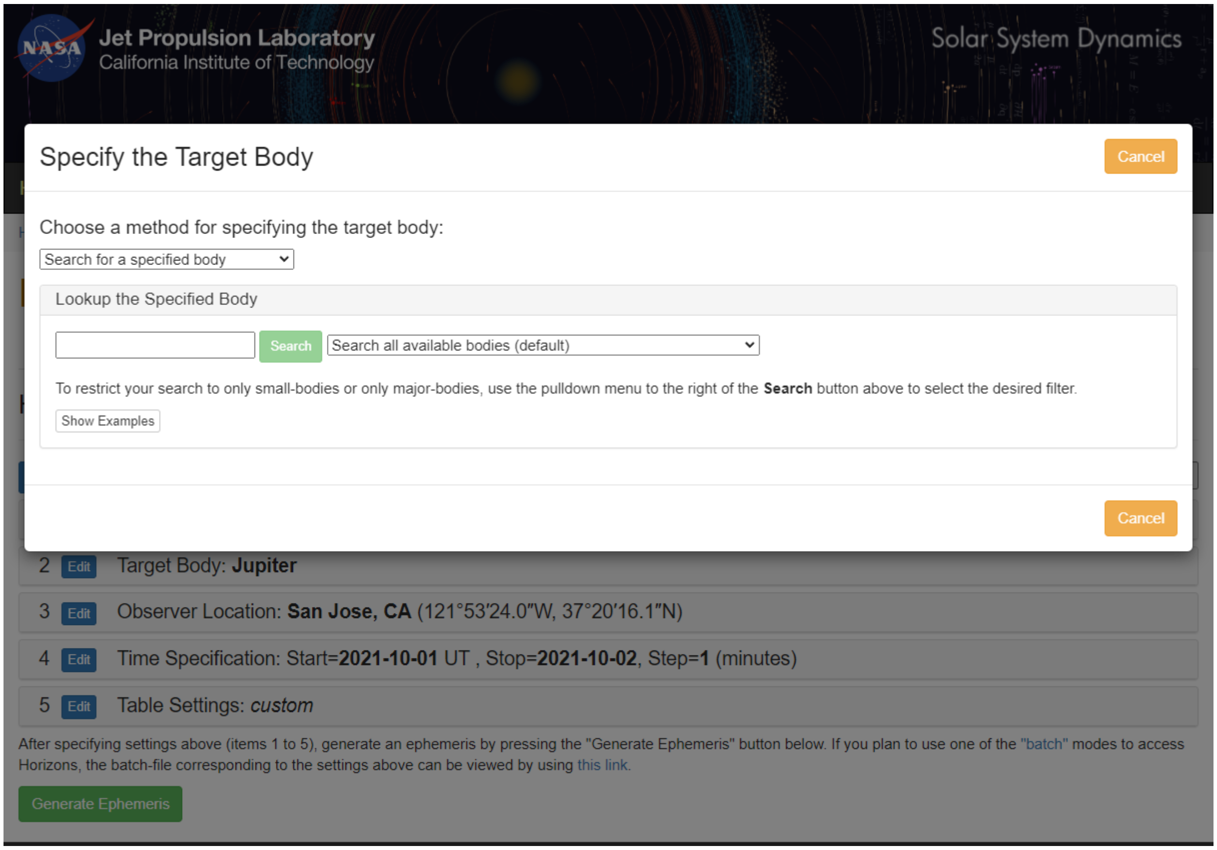


The top-level web page should look something like this:



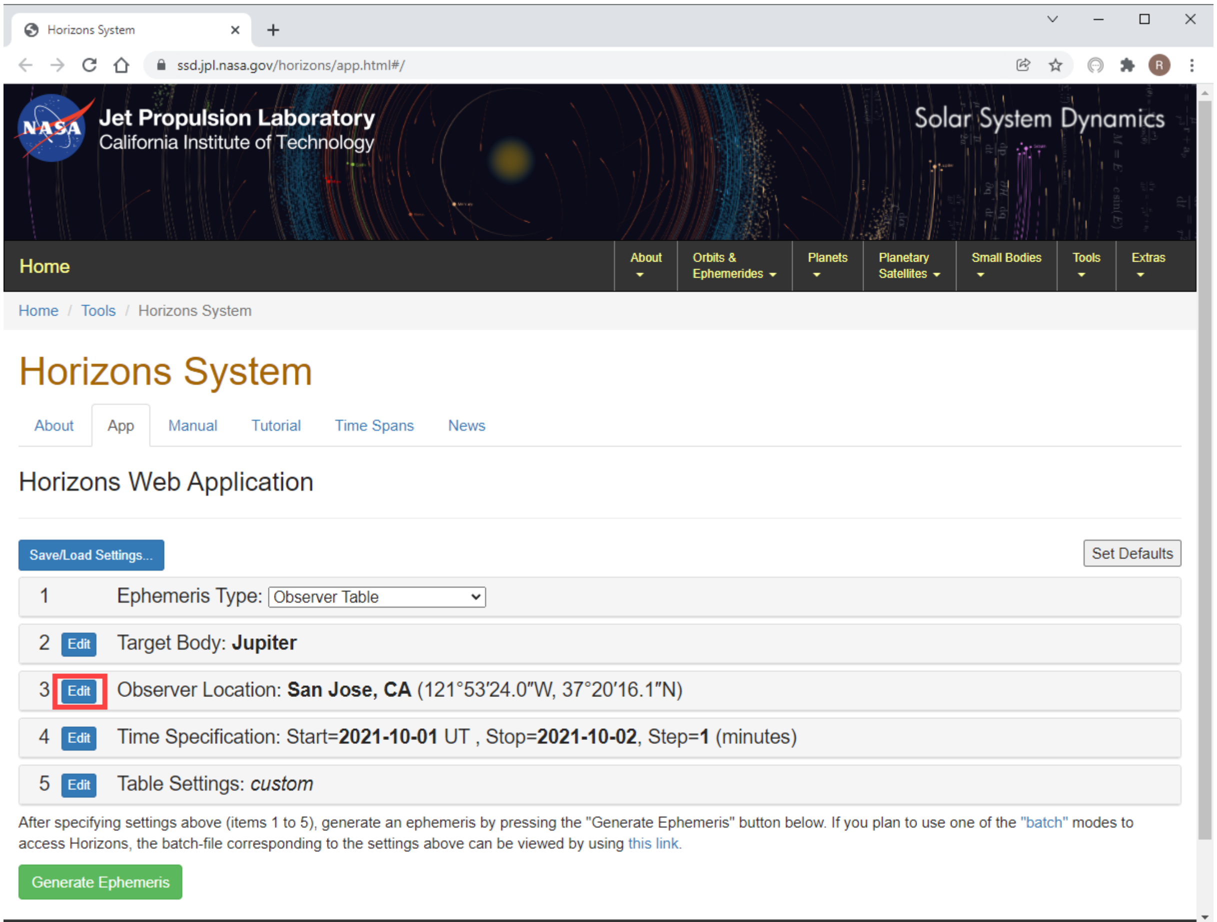
Target Body

You can select the target by clicking the **Edit** button for **Target Body.** Enter the target by its full or partial designation and click the **Search** button. If the match is exact it will automatically used. Otherwise you will have to select the target from the list and click **Select Indicted Body:**

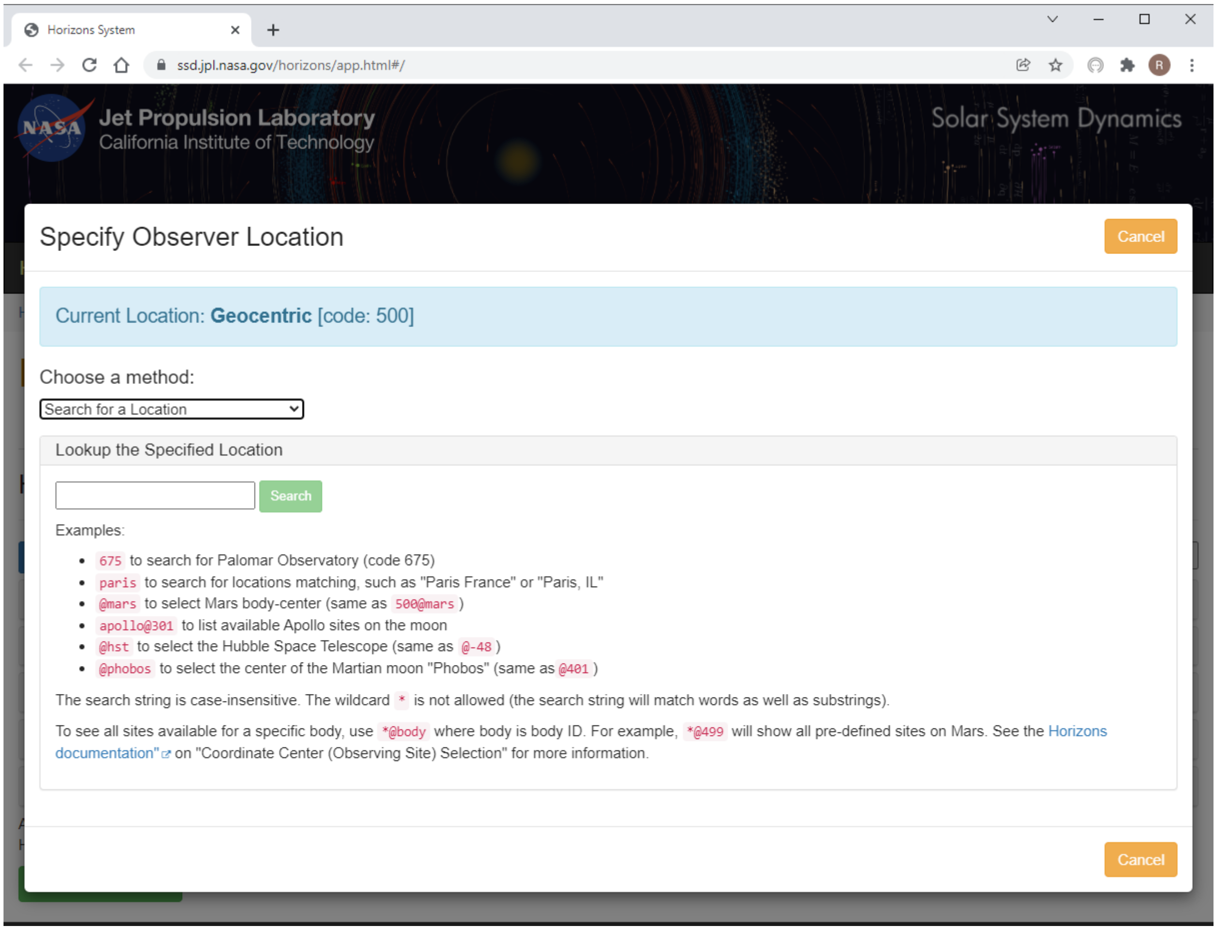


Observer Location

Once there you can configure your geographic position by clicking the **Edit** button for **Observer Location**:

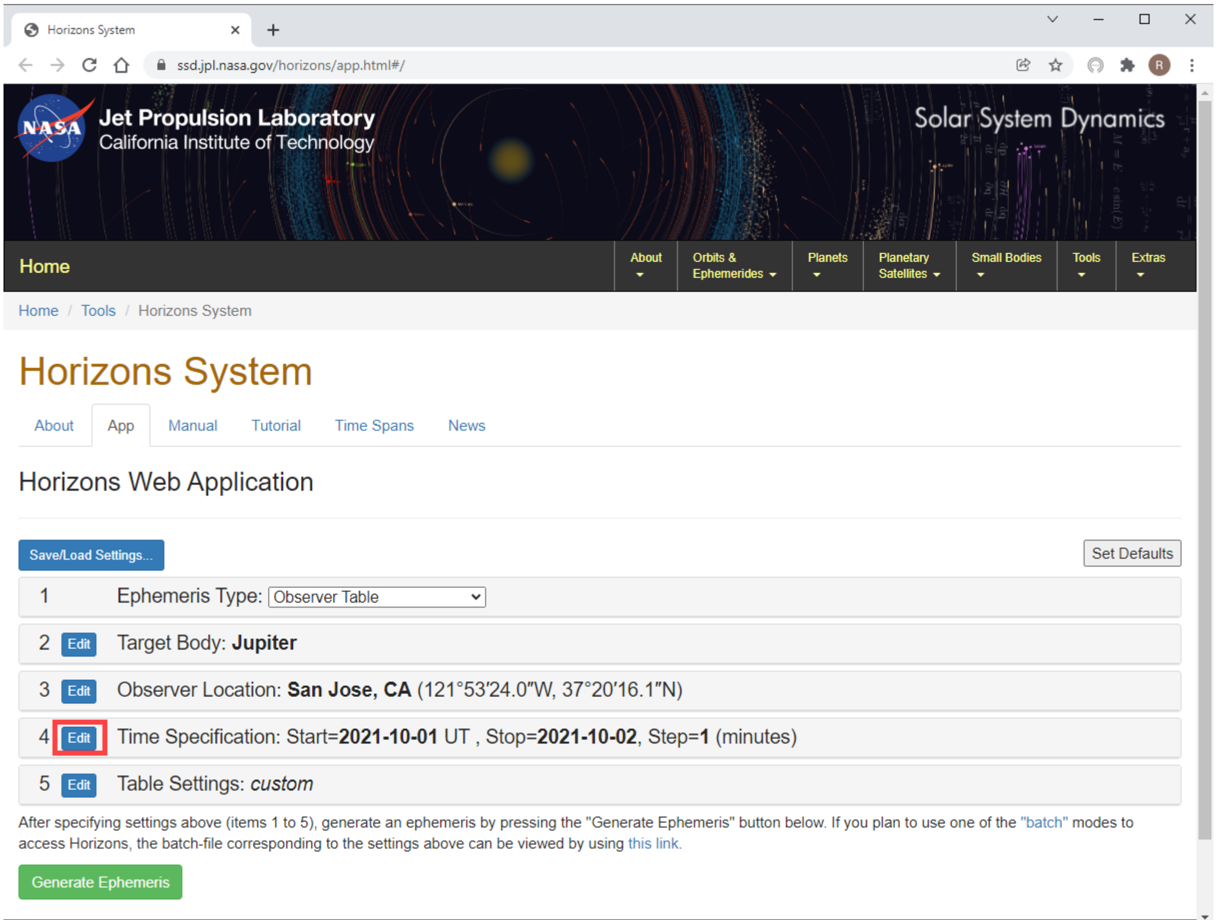


Which brings up this page where you can enter your location (e.g., City, State, or Latitude/Longitude, etc.).



Time Specification

Next, you should change the time span to the time range you are interested in. To do this click the **change** link for **Time Span.**



The fields you need to edit are marked with red boxes below:

1) Set the **Start Time** and **Stop Time** fields, or click one of the buttons: **10 day**, **30 day**, or **60 day.**
2) For the best accuracy be sure to set the **Step size** to **1 minute** so that APCC can more accurately interpolate position. In the case of a fast-moving artificial satellite you should instead select "**Equal Intervals (unitless)**" and specify enough steps to produce output positions at 1 -second intervals.
3) Be sure to click **Use Specified Times**. If you don't, the time values will NOT be used.

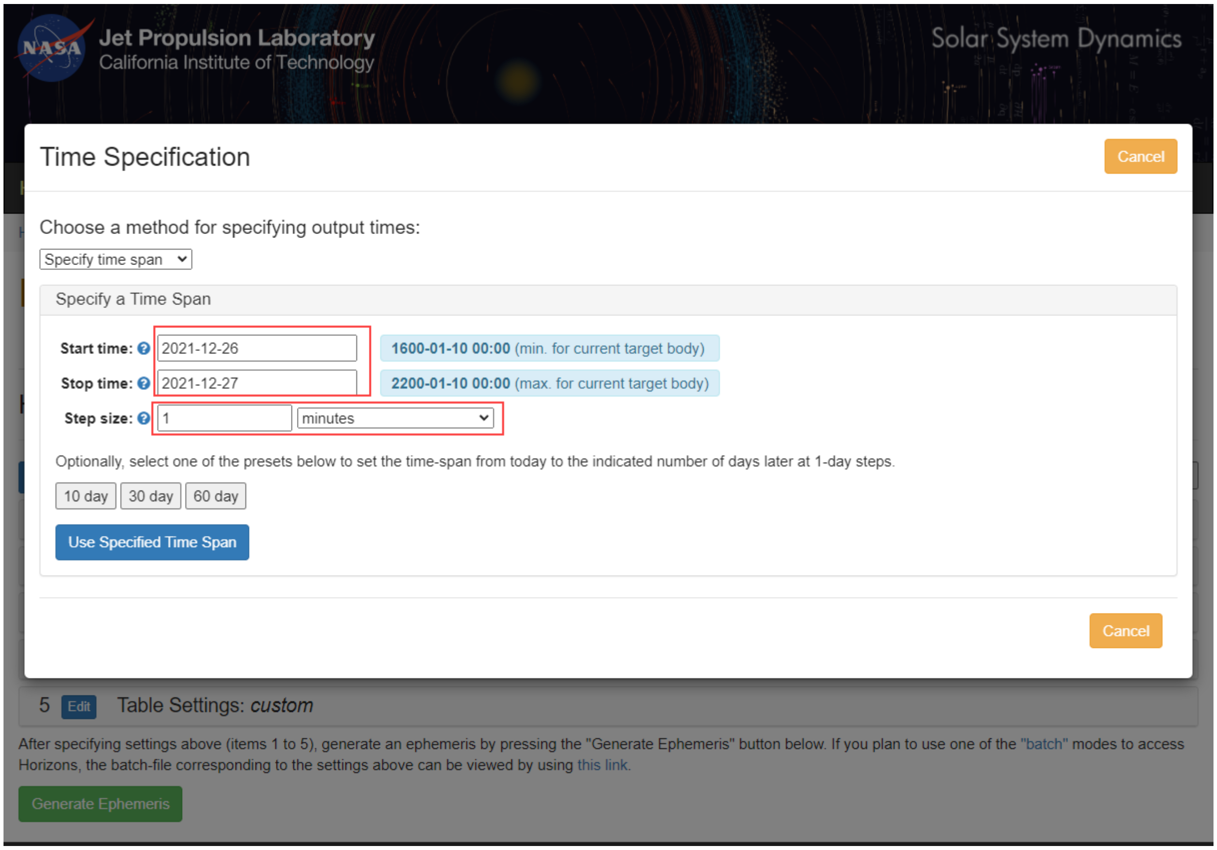
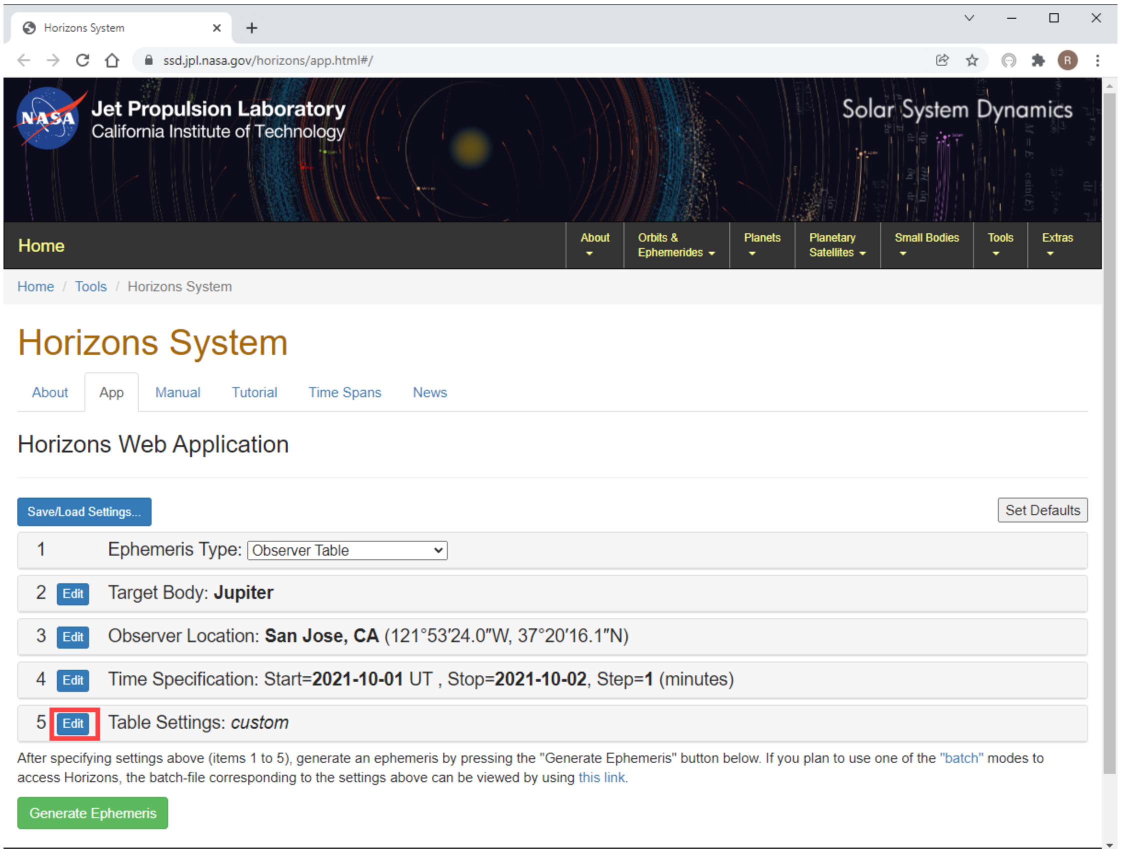


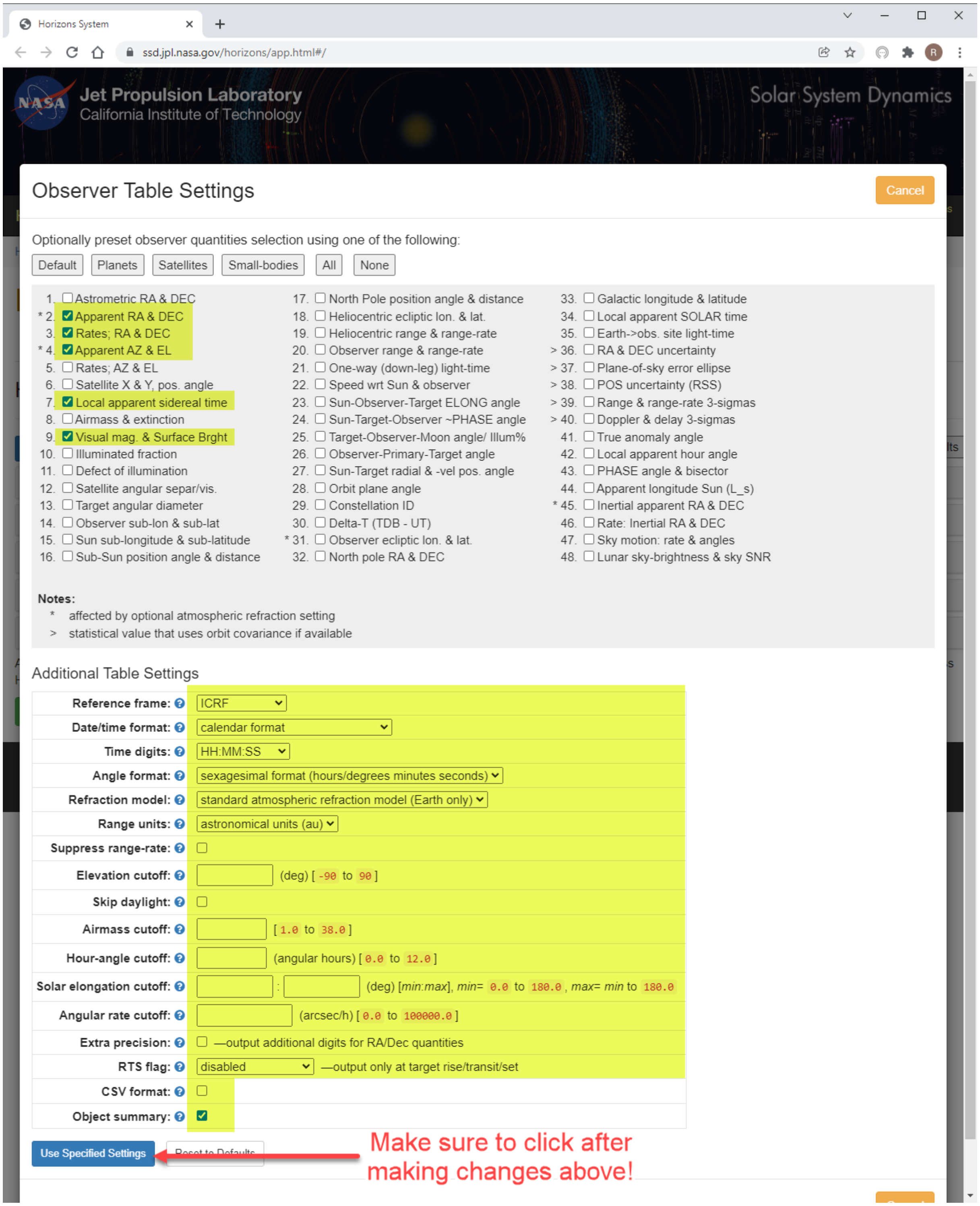
Table Settings

In order for **Horizons** to operate correctly it needs to have certain table fields selected:

The following fields MUST be checked: 2, 3, 4, 7, 9



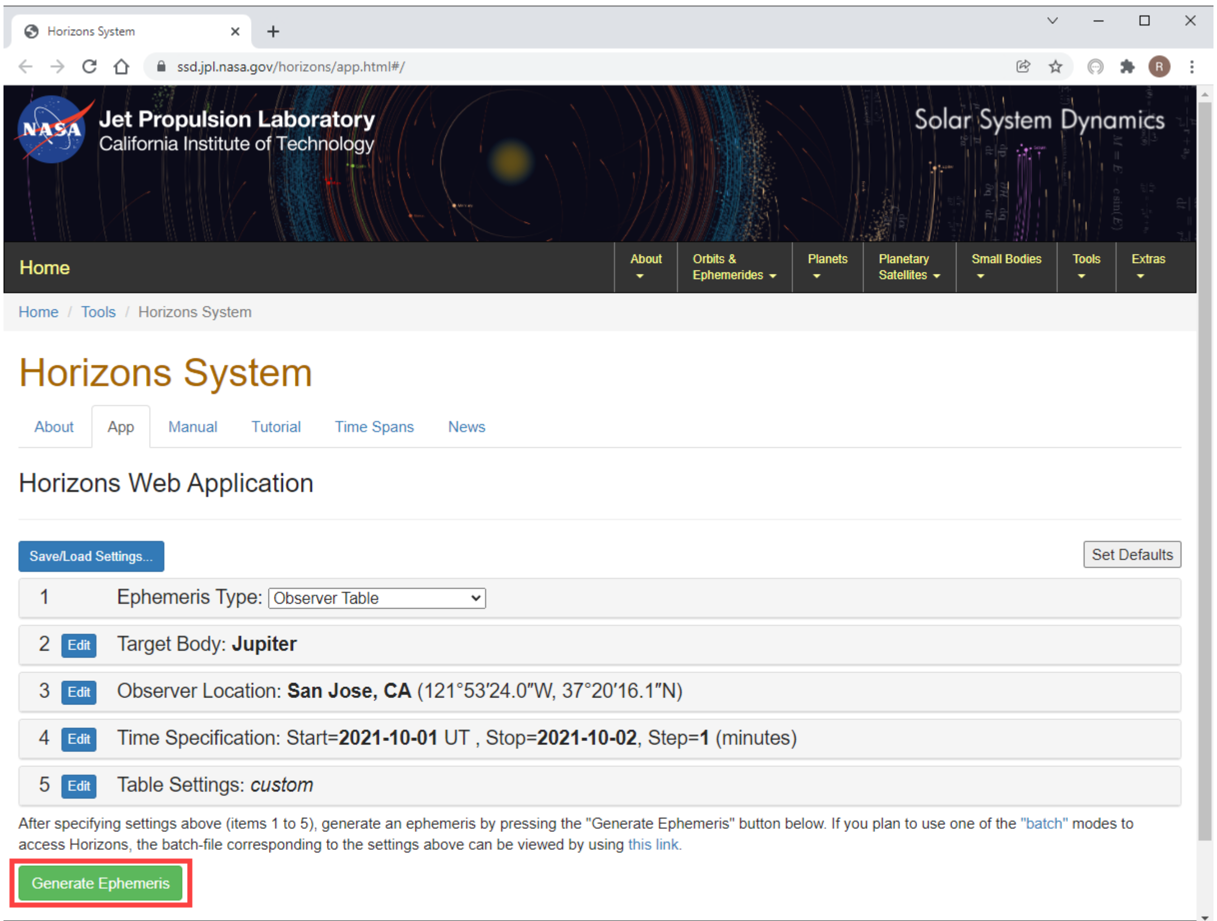
The picture below shows the options that must be selected. It is OK to include other fields. Make certain to click **Use Specified Settings** after changing any fields.



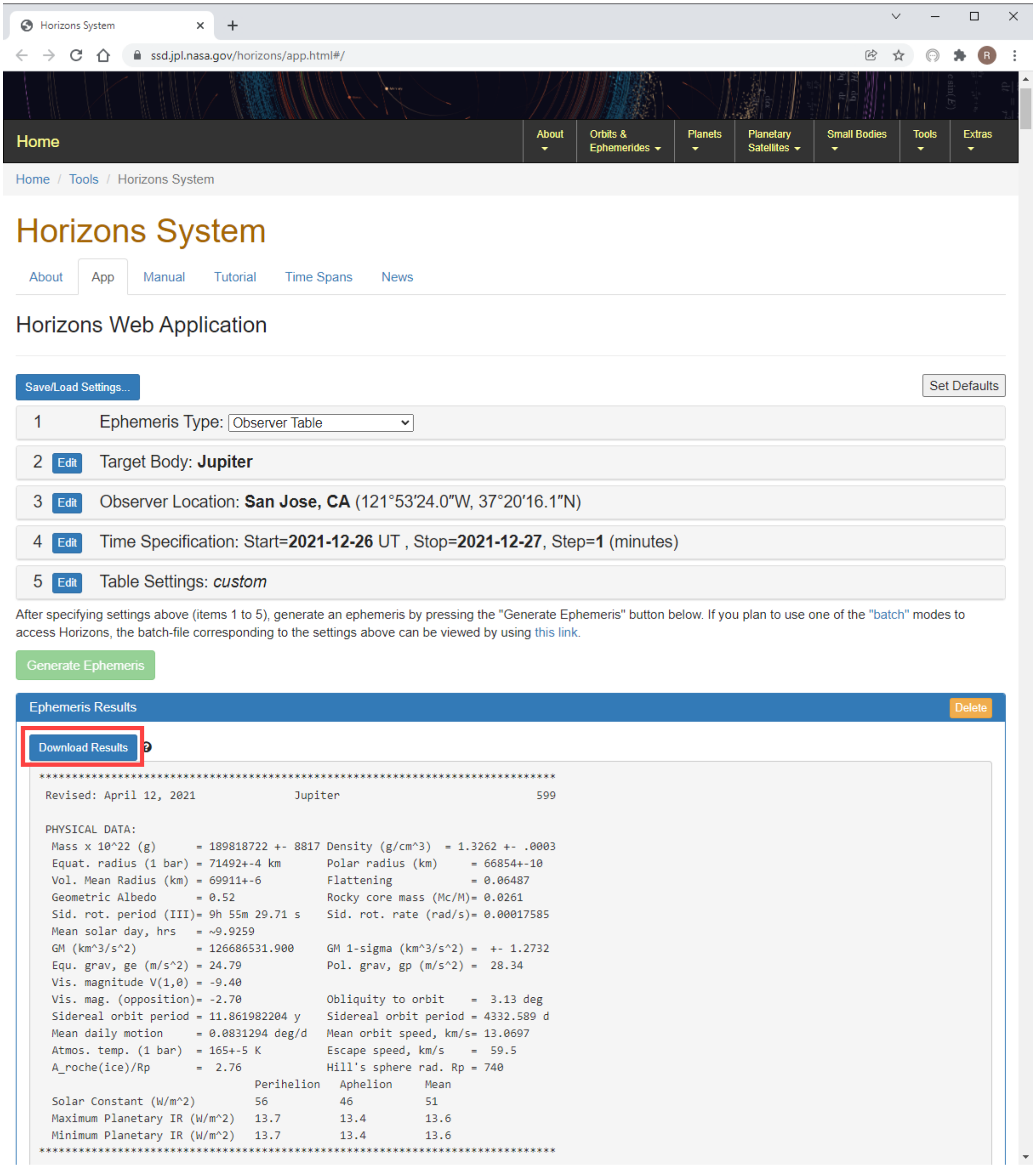
All of this information should be remembered by the JPL site the next time you return.

Generate Ephemeris

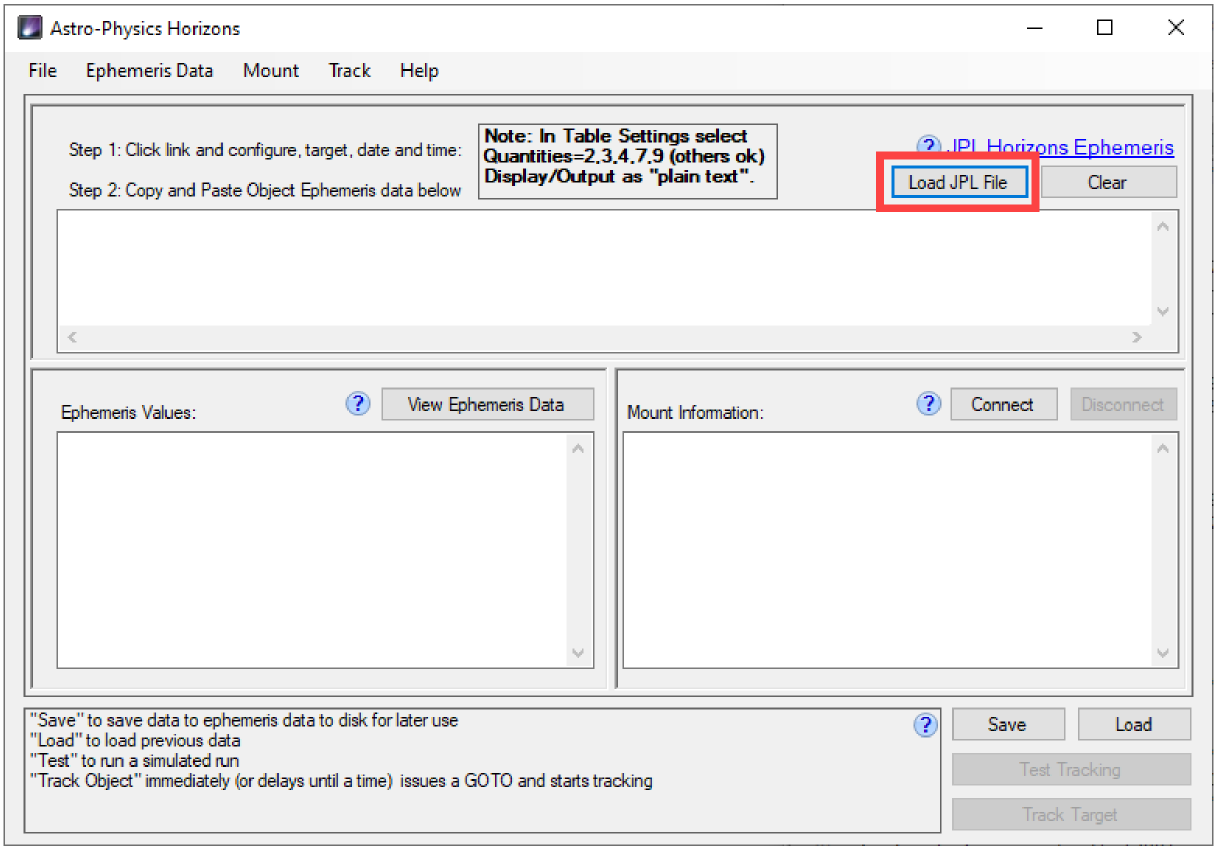
To create the ephemeris data click **Generate Ephemeris.**



The web page should look something like that below.



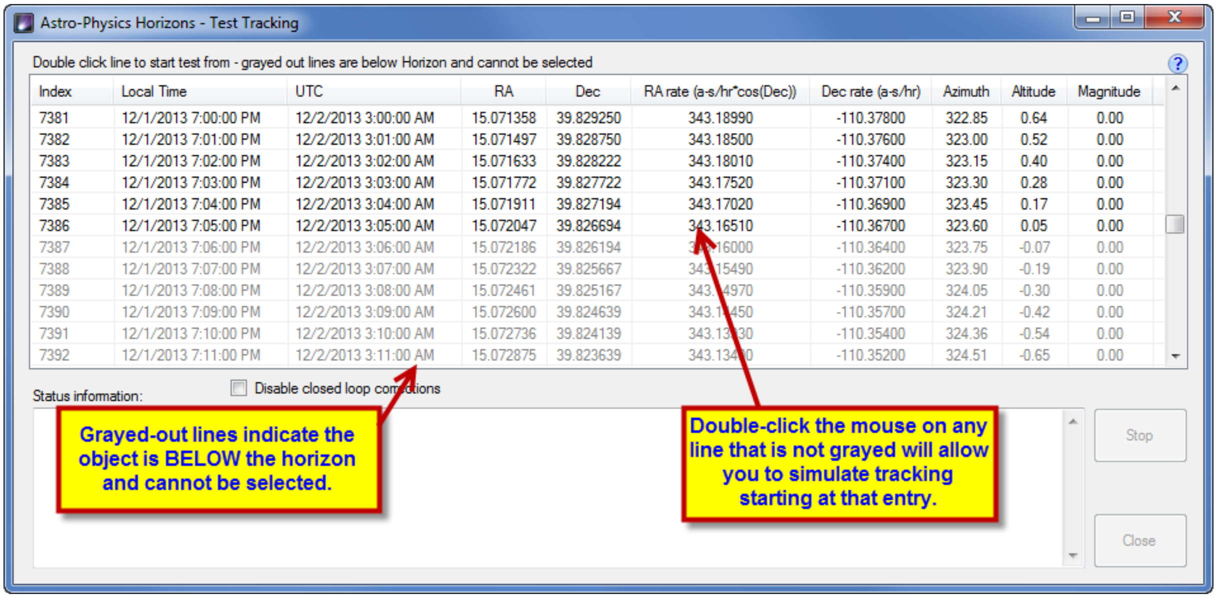
After the file has downloaded, click **Load JPL File** in the Astro-Physics Horizons application:



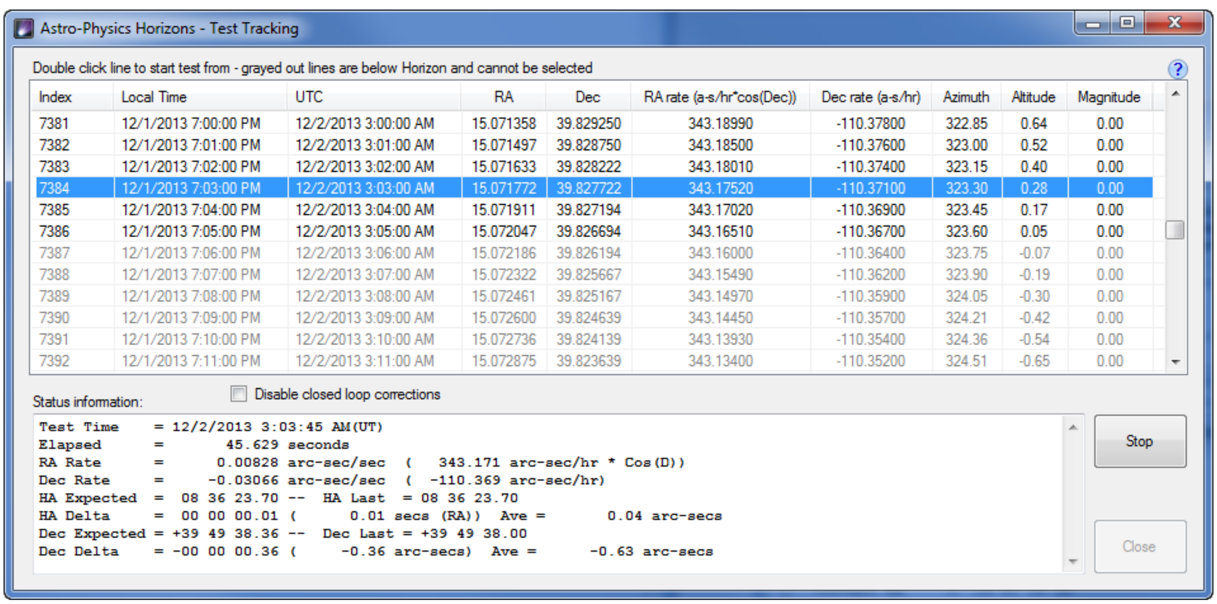
After selecting the file you should see the Ephemeris values displayed in the bottom left text box. They will be dynamically updating.

16.2 Test Tracking

The Test Tracking feature is extremely easy to use. The window has one line per each line. Lines that are grayed-out are below the horizon and cannot be used. Double click any line that is not grayed out to test out tracking of the target at that time.



When you double-click a line you will be prompted for with a confirmation dialog. If you click OK the scope will slew to the target position and start tracking. Horizons uses closed-loop tracking, which means that it checks and adjusts the RA and Dec to make sure it matches the RA/Dec coordinates of the object. You can disable this be clicking **Disable closed loop corrections.** If you do this the tracking rate will still be constantly adjusted to match the target's rate but you can then recenter the scope without Horizons interfering and recentering the target.



To stop tracking click the **Stop** button.

The **Status Information** window shows the following information:

Test Time - the simulated time at which the target will be located at the current RA/Dec scope position.

Elapsed - Elapsed time since start of the simulation.

RA Rate - the scope's current RA Rate.

Dec Rate - the scope's current Dec Rate.

HA Expected - the expected hour angle position of the target.

HA Delta - the difference between actual and expected position. This can vary slightly because the mount's position cannot be continuously and instantaneously polled.

Dec Expected - the expected declination of the target.

Dec Delta - the difference between actual and expected declination. This can vary slightly because the mount's position cannot be continuously and instantaneously polled.

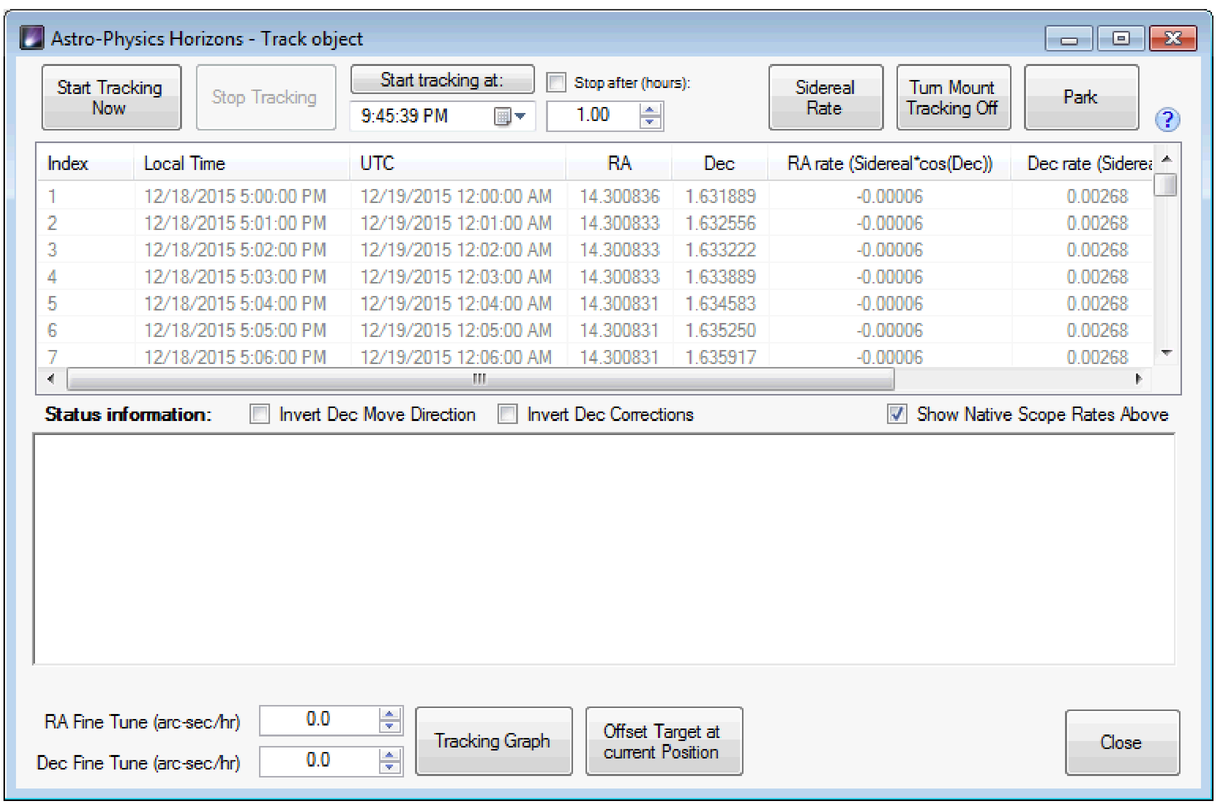
16.3 Tracking a Target

To track a target you need to:

1. Be connected to the mount by clicking the "**Connect**" button on the main window

2. Have loaded a target's ephemeris data into the main windows from the JPL Horizons web site. Alternatively you could also load a previously saved data set.

From this window you can track a target now or at a future time. In order to track an object the ephemeris data must have time entries available for the time during which you want to track it.



Start Tracking Now - Click to immediately start tracking the target. The mount will slew the telescope to the target, perform a short calibration, slew one more time, then start tracking. The **Status Information** field will indicate status as this happens.

Stop Tracking - Click to stop tracking. It is only active when tracking is active.

Start tracking at: - Click to start tracking at a specific time. The time and date can be set in the field directly under this button.

Stop after (hours) check box - if checked mount tracking will be completely stopped after the interval in hours in the field below this check box. This field applies both to the **Start Tracking Now** and **Start Tracking at** buttons. The time is measured from when tracking actually begins. This field is "live", meaning you can turn it on or off, or change the **hours** value while tracking Be careful if you lower the value while tracking as you can trigger a stop tracking event.

Sidereal Rate - click to set the mount to Sidereal tracking rate. Best used when tracking is off as **Horizons** can change the rate while tracking.

Turn Mount Tracking Off - turns tracking completely off.

Park - parks the telescope.

Tracking Table

Index	Local Time	UTC	RA	Dec	RA rate (a-s/hr*cos(Dec))	Dec rate (a-s/hr)	Azimuth	Altitude	Magnitude
1	11/26/2013 4:00:00 PM	11/27/2013 12:00:00 AM	13.830889	42.610361	476.51770	-42.12410	308.93	20.01	0.00
2	11/26/2013 4:01:00 PM	11/27/2013 12:01:00 AM	13.831089	42.610167	476.51780	-42.13840	309.04	19.85	0.00
3	11/26/2013 4:02:00 PM	11/27/2013 12:02:00 AM	13.831289	42.609972	476.51780	-42.15270	309.14	19.70	0.00
4	11/26/2013 4:03:00 PM	11/27/2013 12:03:00 AM	13.831489	42.609778	476.51780	-42.16690	309.25	19.55	0.00
5	11/26/2013 4:04:00 PM	11/27/2013 12:04:00 AM	13.831689	42.609583	476.51780	-42.18110	309.36	19.40	0.00
6	11/26/2013 4:05:00 PM	11/27/2013 12:05:00 AM	13.831889	42.609389	476.51780	-42.19520	309.46	19.24	0.00
7	11/26/2013 4:06:00 PM	11/27/2013 12:06:00 AM	13.832089	42.609194	476.51770	-42.20930	309.57	19.09	0.00
8	11/26/2013 4:07:00 PM	11/27/2013 12:07:00 AM	13.832289	42.609000	476.51770	-42.22330	309.68	18.94	0.00

This table contains relevant entries from the target's Ephemeris data. The table contains:

Index - line number in the table.

Local Time - local time for the entry in the table.

UTC - universal time for the entry in the table.

RA - the target's Right Ascension value.

Dec - the target's Declination value

RA Rate - the instantaneous RA rate of the target at the time.

Dec Rate - the instantaneous Dec rate of the target at the time.

Azimuth - azimuth of the target at the time.

Altitude - altitude of the target at the time

Magnitude - if magnitude is available, the estimated magnitude of the target at the time.

Status Information

This shows the the tracking status of the target. Values with light green backgrounds signify a positive value (greater or equal to zero). Negative values, except for **HA Expected** and **Dec Expected**, have a dark red background with white text.

```
UTC Time     = 12/1/2013 10:51:28 PM (UT)
Elapsed      =          9.13 seconds
HA Last      =  04 25 33.03 --  Dec Last     = +39 57 23.00
HA Expected  =  04 25 30.88 --  Dec Expected = +39 57 21.94
HA Delta     =  00 00 02.15 --  Dec Delta    = +00 00 01.06
RA Average   =         9.02 --  Dec Average  =          1.93 (arc-secs)
RA Rate      =      0.00831 arc-sec/sec  (   343.771 arc-sec/hr * Cos(D))
Dec Rate     =     -0.03047 arc-sec/sec  (  -109.680 arc-sec/hr)
```

Other options

Invert Dec Move Direction check box - used for debug. Will reverse declination move direction.

Invert Dec Corrections check box - also used for debug. Check this box if you experience a "Declination runaway" in the closed loop logic.

Show Native Scope Rates Above: when checked the native Astro-Physics mount tracking rates are shown (recommended).

Disable closed-loop corrections check box - **Horizons** uses closed-loop tracking, which means that it checks and adjusts the RA and Dec to make sure it matches the RA/Dec coordinates of the object. After checking this option **Horizons** will still constantly adjust tracking rate to match the target's rate but it will not recenter the target. You could then place the target anywhere in the field of view without Horizons trying to recenter the target.

RA Fine Tune (arc-sec/hr): If you are not using **APCC Pro** or not using an APPM pointing model then tracking might not be perfect because of polar misalignment, flexure, refraction, etc. You can fine-tune the RA tracking rate with this setting in units of arc-seconds per hour.

Dec Fine Tune (arc-sec/hr): If you are not using **APCC Pro** or not using an APPM pointing model then tracking might not be perfect because of polar misalignment, flexure, refraction, etc. You can fine-tune the Dec tracking rate with this setting in units of arc-seconds per hour.

Offset Target at Current Position button - This option is only available with **APCC Pro**. It allows you to offset a target for better image composition. To use it do the following:

1) Reposition your target.

2) Click the **Offset Target at Current Position** button**.**

To exit this mode you need to stop and restart tracking the target.

Tracking Graph button - available only with **APCC Pro.** This opens a graph showing the tracking delta values over time.

Index

- 3 -

- A -

- B -

- C -

- D -

- E -

- F -

- G -

- H -

- I -

- L -

- M -

- O -

- P -

- Q -

- R -

- S -

- T -

- U -

- V -

- W -