HQ Space Operations Command (SpOC)
DCG-T/S9I
Astrodynamics Standards Engineering Group

Astrodynamics Standards

Release Notes

Version 9.4

May 2024

1. Background

Version 9.4 (v9.4) is a minor release of the U.S. Space Force, Space Operations Command, Astrodynamics Standards software library. The Astro Standards are delivered as a collection of shared libraries (DLL/so/dylibs for Windows, Linux, and Mac respectively). The libraries can be run on 64-bit, x86/x64 platforms, and version releases include wrappers and drivers to support a variety of customer/user preferred languages. Starting with v9.0, MacOS is supported for the M1 architecture. Within this document, the term "Library" is used to refer to either a Windows DLL, Linux so, or a Mac dylib. The Library algorithms are designed to be compatible with systems and astrodynamics algorithms implemented into space operations and used by Warfighters and Analysts, including those of 18 Space Defense Squadron (18 SDS). The Astro Standards are also used to Verify and Validate (V&V) equivalent algorithms of these operational space- domain systems such as those that run at the 18 SDS at Vandenberg AFB, and other operational locations critical to the National defense.

2. Highlights

The BatchDc had a bug introduced in v5.4 of Astro Standards that affected the Time subset correction. This has been fixed, so BatchDc is much more robust now.

Ada2012 is now a supported language in Astro Standards. The SampleCode folder has driver examples and wrappers for Ada.

Many APIs in all libraries have been made more thread safe.

For the SGP4/SGP4-XP Propagator:

1. The fastest way to obtain SGP4/SGP4-XP is by creating an account on https://www.space-track.org, and downloading it directly from there. No approval is required, but permissions will need to be granted by the administrators of space-track.org.
2. SGP4 is one unique Astro Standards library in the suite of Astro Standards libraries available in that it is U.S. Space Force, Space Operations Command-approved to "share with the world."

Other Applications within the Astro Standards Library (including SGP4/SGP4-XP):

1. For the balance of the Astro Standard Applications, use https://halfway.peterson.af.mil/SARP. The requestor must have a U.S. Government-issued CAC card and be logged into *NIPRnet*. This website cannot be accessed from the Internet.
2. Once logged-in to https://halfway.peterson.af.mil/SARP obtain additional details by referring to the document, "***Instructions for Requesting Astrodynamics Standards Software.pdf,"*** available upon logging into the SARP website.

Figure 1. Astrodynamics Standards Distribution

3. Tally of Bug Fixes / Improvements for Releases

Item	Current Release	Previous Release
Bug Fixes	*12*	*10*
New Features /Improvements	*67*	*55*
Target / Final Release Date	*May 2024*	*Jan 2024*

See AstroJiras_v9.4.html for full list of changes.

AOF

AOF added thread-safety to APIs

- AofLoadFile – Mod. Added thread safety
- AofLoadFileAll – Mod. Added thread safety
- AofLoadCard – Mod. Added thread safety
- AofGetDataFrInputFiles – Mod. Added thread safety

AstroFunc

- CompSunMoonPos – Mod. moonVecMag was using a hardcoded for earth radii when calculating distance. Changed this to use environment variable for consistency.
- CompMoonPos – Mod. moonVecMag was using a hardcoded for earth radii when calculating distance. Changed this to use environment variable for consistency.

Bam

- No Changes

BatchDC

Found bugs in BatchDC that were introduced in v5.4. These mostly affected BatchDC when using the time correction. BatchDC should be much more robust. Also added thread safety to some APIs

- BatchDCInitSat – Mod. Added thread safety
- BatchDCSolveSelObs – Mod. Added thread safety

Combo

Added thread safety to some APIs

- ComboLoadFile – Mod. Added thread safety
- ComboLoadFileAll – Mod. Added thread safety
- ComboLoadCard – Mod. Added thread safety
- ComboSaveFile – Mod. Added thread safety
- ComboGetNumOfPriSecSats – Mod. Added thread safety
- ComboGetPriSatNums – Mod. Added thread safety
- ComboGetSecSatNums – Mod. Added thread safety
- ComboGet7pCard – Mod. Added thread safety
- ComboGet7pAll – Mod. Added thread safety

- ComboGet7pField – Mod. Added thread safety

DllMain
- No Changes

ElComp
Added new multi thread APIs and made some APIs more thread safe
- ElCompGetResults – Mod. Added some thread safety
- ElCompGetResults_MT – New. Thread safe version of ElCompGetResults
- ElCompFrElData – Mod. Added some thread safety
- ElCompFrElData_MT – New. Thread safe version of ElCompFrElData
- CocoGetResults – Mod. Added some thread safety
- CocoGetResults_MT – New. Thread safe version of CocoGetResults
- CocoGetResultsWOA – Mod. Added some thread safety
- CocoFrElData – Mod. Added some thread safety
- CocoFrElData_MT – New. Thread safe version of CocoFrElData
- CocoFrElDataWOA – Mod. Added some thread safety

ElOps
- No Changes

EnvConst
- No Changes

ExtEphem
- No Changes

Fov
Added thread safety to some APIs
- FovLoadFile – Mod. Added thread safety
- FovLoadFileAll – Mod. Added thread safety
- FovLoadCard – Mod. Added thread safety
- FovSaveFile – Mod. Added thread safety
- FovGetDataFrInputFiles – Mod. Added thread safety

Lamod
Added thread safety to some APIs
- LamodLoadFile – Mod. Added thread safety
- LamodLoadFileAll – Mod. Added thread safety
- LamodLoadCard – Mod. Added thread safety
- LamodSaveFile – Mod. Added thread safety
- LamodGetNumOfSensSats – Mod. Added thread safety
- LamodGetSenNums – Mod. Added thread safety
- LamodGetSatNums – Mod. Added thread safety

- LamodGet1pCard – Mod. Added thread safety
- LamodGet1pAll – Mod. Added thread safety
- LamodGet1pField – Mod. Added thread safety
- LamodGet3pAll – Mod. Added thread safety
- LamodGetObsFileName – Mod. Added thread safety
- LamodInitSenSat – Mod. Added thread safety

Obs

- No Changes

ObsOps

Added thread safety to some APIs

- IomodLoadFile – Mod. Added thread safety.
- IomodLoadFileAll – Mod. Added thread safety.
- IomodSaveFile – Mod. Added thread safety.
- IomodGetIpCard – Mod. Added thread safety.
- IomodGetIpAll – Mod. Added thread safety.
- IomodGetIpField – Mod. Added thread safety.
- IomodSetIpField – Mod. Added thread safety.

Rotas

Added thread safety to some APIs and added new thread safe APIs

- RotasLoadFile – Mod. Added thread safety.
- RotasLoadFileAll – Mod. Added thread safety.
- RotasLoadCard – Mod. Added thread safety.
- RotasSaveFile – Mod. Added thread safety.
- RotasGetPCard – Mod. Added thread safety.
- RotasGetPAll – Mod. Added thread safety.
- RotasGetPField – Mod. Added thread safety.
- RotasGetAssocMultipliers – Mod. Added thread safety.
- RotasSetAssocMultipliers – Mod. Added thread safety.
- RotasResetAll – Mod. Added thread safety.
- RotasHasASTAT – Mod. Added thread safety.
- RotasHasASTAT_MT – Mod. Added thread safety.
- RotasHasASTATMultp_MT – New. Determines if observation/sat pair can have association using provided multipliers.
- RotasComputeObsResiduals – Mod. Added thread safety.
- RotasComputeObsResiduals_MT – Mod. Added thread safety.
- RotasComputeObsResidualsMultp_MT – New. Does obs association using provided multipliers
- RotasComputeTrackResiduals – Mod. Added thread safety.
- RotasComputeTrackResiduals_MT – New. Same as RotasComputeTrackResiduals but uses user provided parameters.
- RotasCompObResDirect -- Mod. Added thread safety.
- RotasGetRetagObsFile -- Mod. Added thread safety.

SpVec
- No Changes

Saas
- No Changes

SatState
Added Gobs functionality for comparison of geosynchronous satellites
- GetGobsParams – New. Get satellites Gobs Parameters (SGP4/XP only)
- GobsGom – New. Does Gobs comparison on two sats (SGP4/XP only)
- GobsGomArr – New. Does Gobs comparison on two sats (SGP4/XP only)

Sensor
- No Changes

Sgp4Prop
Added APIs to return XP native equinoctial elements and their rates at a specified time. This will enable some analysis
- XPGetNativeElts – New. Get XP equinoctial elements and rates at specified time
- XPReepochGetNativeElts – New. Get XP equinoctial elements and rates at specified time and reepoch the element set

SpProp
Added thread safety to some APIs
- SpGetPredCtrl – Mod. Added some thread safety
- SpSetPredCtrl – Mod. Added some thread safety

Tle
- No Changes

TimeFunc
Added thread safety to some APIs
- Get6P – Mod. Added some thread safety
- Set6P – Mod. Added some thread safety
- Get6PCardLine – Mod. Added some thread safety

Vcm
- No Changes

4. Future Capabilities and Changes

- Add Position, Partials, and Time Version 3 (PPT3) Navy propagator to Sgp4Prop in a future Release. This will allow Astro Standards to be compatible with the Navy theory. This will also allow creation of PPT3 elements. These will be distinguished by *element set type "3"*.
- Ability to use Right Ascension and Declination Rates in ROTAS and BatchDC.
- Replace analytical theory of Sun and Moon position with JPL ephemeris for SGP4-XP for very deep space satellites
- Add capability to use TDOA/FDOA observations

5. Contact Astro Standards

For reporting issues, contact the Astro Standards development team at:

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