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

Astrodynamics Standards

Release Notes

Version 9.1

May 2023

1. Background

Version 9.1 (v9.1) 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

V9.1 is a "spring cleaning" release. The biggest advantage of this is a 10-15 percent speed up of the SP propagator. The most breaking change occurs in SGP4-XP, which was using truncated precision in the resonance functions' geopotential terms. Using an older version of the propagator with TLEs built with the newer version of the propagator will sometimes give very inaccurate results.

The Swift language is fully supported in v9.1.

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	*20*	*50*
New Features /Improvements	*53*	*102*
Target / Final Release Date	*May 2023*	*Jan 2023*

See AstroJiras_v9.1.html for full list of changes.

AOF
- No Changes

AstroFunc
- Mtx9x9ToLTA45 – New. Converts 9x9 Matrix to a Lower Triangular Array
- LTA45ToMtx9x9 – New. Converts a Lower Triangular Array to a 9x9 Matrix
- PropCovFrState – New. Given the State Transition Matrix and Epoch Covariance, get Covariance at a requested time
- CovMtxECIToEqnx – New. Convert ECI of Date Covariance to Equinoctial
- CovMtxEqnxToECI9x9 – New. Convert Equinoctial Covariance to ECI of Date
- CovMtxEqnxToUVW9x9 – New. Convert Equinoctial Covariance to UVW
- AberrationAnnual – New. Apply Annual Aberration to Ra and Dec
- AberrationDiurnal – New. Apply Diurnal Aberration to Ra and Dec
- CovMtxUpdate – New. Given State Transition and Covariance, propagate covariance.

Bam
- No Changes

BatchDC
- No Changes

Combo
- No Changes

DllMain
- SetAllKeyMode – New. Sets the Key Mode for all keys
- GetAllKeyMode – New. Gets the Key Mode for all keys
- ResetAllKeyMode – New. Resets Key Mode to default values

ElComp
- No Changes

ElOps
- No Changes

EnvConst
- No Changes

ExtEphem
- ExtEphAddSatFrFile – New. Loads satellite data from an external ephemeris file

Fov
- No Changes

Lamod
- No Changes

Obs
- No Changes

ObsOps
- No Changes

Rotas
The synthesized range from ASW was updated. It should handle special cases much better
- No New APIs

SpVec
- No Changes

Saas
- No Changes

SatState
- No Changes

Sensor
- No Changes

Sgp4Prop
Sgp4-XP wasn't using full precision tesserals in the resonance calculation. This has been updated to full precision. This will cause incompatibility with older versions of the propagator. It is recommended to always use the latest version available.
- No New APIs

SpProp

A few bugs were found when using JPL ephemeris for the Sun and Moon Position. The propagator will now use the GM values of the Sun and Moon from the JPL ephemeris file.

- SpPropAllExt – New. Generates a State, Covariance, and State Transition Matrix at time.

Tle

- No Changes

TimeFunc

- No Changes

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.
- Release of unit tests along with the new Release.
- Fully replace the AVL tree with the new DMA mode. This may deprecate some functions.

5. Contact Astro Standards

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

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