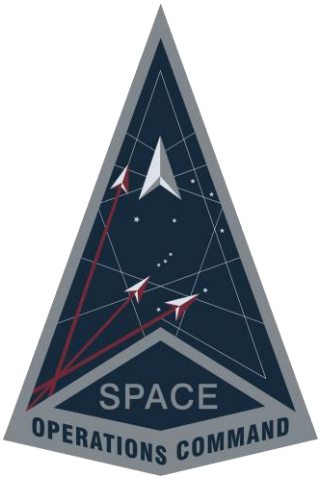
HQ Space Operations Command (SpOC)
DCG-T/S9I
Astrodynamics Standards Engineering Group

Astrodynamics Standards



Release Notes

Version 9.0

Jan 2023

1. Background

Version 9.0 (v9.0) is a major 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 most notable change in v9.0 is the addition of 64 bit MacOS dylibs built natively for the M1 architecture. To accomplish this, the source code needed to be reformatted to be compatible with GNU Fortran (gfortran) while keeping compatibility with the Intel Fortran. This comes with a few side effects:

1. Users are no longer required to initialize the libraries to use the functions. These functions and others are now deprecated.
2. SGP4 and SGP4-XP have sped up significantly
3. The Linux folder now has IFORT and gfortran libraries. The gfortran libraries will be slower than the IFORT libraries but will be significantly smaller in size.

The Swift language is partially supported in v9.0. Special thanks to Gavin Eadie for putting the rule set for the wrappers together. The Swift wrappers will be distributed alongside the SGP4 package on space-track.org a few days after the release of the SGP4 package.

Astro Standards no longer supports 32-bit distributions.

Sensor keys are now int64 instead of int. This is expected to break existing code that uses sensor keys.

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	*50*	*36*
New Features /Improvements	*102*	*42*
Target / Final Release Date	*Jan 2023*	*Aug 24, 2022*

See AstroJiras_v9.0.html for full list of changes.

AOF
- AofInit – Deprecated

AstroFunc
Used a more accurate lunar position calculation from Astronomical Almanac. Will affect XP
- AstroFuncInit – Deprecated
- CovMtxECIToEFG – New. Converts ECI of Date covariance to EFG
- CovMtxEFGToECI – New. Converts EFG covariance to ECI of Date

Bam
- BamInit – Deprecated

BatchDC
Batch DC now maintains international designator for DC functions and eGP functions. BatchDC has also been modified to be more robust. It should converge in less iterations for some cases.
- BatchDCInit – Deprecated
- SpToTle2 – New. Same as SpToTle, but adds DC arrays
- SpToCsv2 – New. Same as SpToCsv, but adds Dc arrays
- SpToEGP – Modification. SpToEGP and derivative functions now have a different automatic fit span for XP extrapolations based off of a SPOC study.

Combo
- ComboInit – Deprecated

DllMain
- DllMainInit – Deprecated
- GetInitDllNames – Deprecated
- TestInterface2 – strInOut now returns correct input

ElComp
- ElCompInit – Deprecated

ElOps

- ElOpsInit – Deprecated

EnvConst

EGM-96 had an incorrect flattening coefficient. This was corrected which affected the results of SGP4-XP. SP will use the older flattening coefficient to be consistent with operations.

- EnvInit – Deprecated

ExtEphem

- ExtEphInit – Deprecated

Fov

- FovInit – Deprecated

Lamod

Lamod now uses sensor view type exclusively to determine if sensor is an optical. It previously depended on observation type and visibility flag.

- LamodInit – Deprecated

Obs

- ObsInit -- Deprecated

ObsOps

- ObsOpsInit – Deprecated

Rotas

- RotasInit – Deprecated

SpVec

- SpVecInit – Deprecated

Saas

- SaasInit – Deprecated

SatState

- SatStateInit – Deprecated
- TimeAtNodalCrossing – New. Get the time of nodal crossing prior to input time for a satellite

Sensor

Sensor keys are now 64-bit integers. This will allow sensors to be used in DMA mode. TDOA/FDOA sensor type now supported.

- SensorInit – Deprecated
- SetSenKeyMode – New. Allows sensors to be read directly from memory.
- GetSenKeyMode – New.
- SenNumOf – New. Get sensor number of SenKey
- SensorGetSenKey – New. Get SenKey of Sensor Number

- SensorGetSenKeyML – New. Same as SensorGetSenKey for Matlab
- SensorAddFrArray – New. Add a sensor using data stored in an array
- SensorDataToArray – New. Get sensor's data and put in array

Sgp4Prop

Sgp4-XP had a bug in the resonance calculation of the geosynchronous regime. Geosynchronous satellites should be more accurate now.

- Sgp4Init – Deprecated

SpProp

- SpInit – Deprecated
- SpGenEphemsCov – New. Same as SpGenEphems but adds covariance
- SpGenEphemsVcmCov_OS – New. Same as SpGenEphemsVcm_OS but adds covariance

Tle

- TleInit – Deprecated
- GetCheckSums – New. Get the check sums for both lines of a TLE

TimeFunc

- TimeFuncInit – Deprecated

Vcm

- VcmInit -- Deprecated

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.
- More covariance transformations in AstroFunc library
- The v9.0 architecture should allow the Astro Standards to be ported to non-x86 machines such as the M1 Mac. Options such as the gfortran cross-compiler will be explored.

5. Contact Astro Standards

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

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