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

# Astrodynamics Standards

## Release Notes

Version 9.3

January 2024

# 1. Background

Version 9.3 (v9.3) 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

Many new features were added to BatchDC. There are new functions to speed up initialization of BatchDC by observation selection and a new function to do an initial orbit determination followed immediately by a BatchDC in one step.

Matlab has a new way of interfacing with the libraries via an intermediate library, similar to JNI for Java. The new method is at least an order of magnitude faster than the old method. The new libraries are included for Windows. Users on other systems will have to build them. This can be done with scripts in the SampleCode/Matlab/DriverExamples/CreateProtoFiles.

**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** | *10* | *22* |
| **New Features /Improvements** | *55* | *58* |
| **Target / Final Release Date** | *Jan 2024* | *Sept 2023* |

See AstroJiras_v9.3.html for full list of changes.

AOF
- No Changes

AstroFunc
- TemeEpochToDate – New. Rotates position and velocity vectors from TEME of Epoch to TEME of Date

Bam
- No Changes

BatchDC
BatchDC has been made slightly more robust and increase thread safety. eGP controls allow user to change the max number of iterations. Many new functions were added to increase performance and user friendliness.
- BatchDCLoadCard – Mod. Added some thread safety
- BatchDCGetPCard – Mod. Added some thread safety
- BatchDCSaveFile – Mod. Added some thread safety
- BatchDCGetCtrlArr – New. Returns DC control parameters using array format
- BatchDCSetCtrlArr – New. Sets DC control parameters using array format
- BatchDCInitSatObsKey – New. Initialize DC for satellite using only preselected obsKeys
- BatchDCInitSatObsSel – New. Initialize DC using only obs that meet selection criteria.
- BatchDCSolveSelObs – Mod. Added some thread safety
- BatchDCGetSpVOut – Mod. Added some thread safety
- BatchDCSetSpVOut – Mod. Added some thread safety
- BatchDCResetAll – Mod. Added some thread safety
- IomodDC – New. Performs Initial Orbit then BatchDC on the input observations. Thread Safe

Combo
- No Changes

DllMain

A new key mode was added for changing the behavior of when duplicate sats/obs/etc. are found in memory. The new mode will return the key instead of zero.

- ResetAllKeyMode – Mod. Now resets Duplication key mode to default value
- SetDupKeyMode – New. Change behavior when duplicate key is found.
- GetDupKeyMode – New. Gets current duplication key mode

ElComp

- No Changes

ElOps

- No Changes

EnvConst

- No Changes

ExtEphem

- No Changes

Fov

- No Changes

Lamod

- LamodSenSatDirect_OS – New. Computes all look and view data using input directly

Obs

- ObsGetSelected – New. Allows the user to retrieve only obs that match the obs selection criteria

ObsOps

- AnglesOnlyToPosVel – Mod. Fix bug for Type 8 and 9 observations.
- FindTrack – Mod. Make a huge improvement in performance

Rotas

- No New APIs

SpVec

- No Changes

Saas

- No Changes

SatState

- No Changes

Sensor

Sensor adds a new parameter, off-boresight angle, to the newly added constant azimuth fan which allows the user to specify the shape of the fan. Since the fan can be tilted, the minimum elevation is no longer applicable and therefore removed from this sensor type. Refer to documentation for details.

Sgp4Prop

Fixed bug in SGP4-XP introduced in v9.2. Introduced error handling for cases that return NAN.

- No New APIs

SpProp

- No Changes

Tle

- No Changes

TimeFunc

- TConTimeSpan – New. Returns the time span of the loaded timing constants

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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