Coordinate Transform Standards

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IHDEA Meeting
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Background

Space Time Coordinate Transform (STCT) Standards Working Group

- ○ See Meeting Notes
- ○ Email list: https://groups.io/g/hdrl-stct/
- ○ Contact rweigel@gmu.edu for bi-weekly (Thursday @ noon) telecon invite

Small NASA-sponsored HDRL-related project; started this year. Result of HDRL Conclave break-out discussion in January, 2023.

Participants
- Rebecca Ringuette
- Lan Jian
- Steven M Petrinec
- Brian A Thomas
- Scott Turner
- Albert Y. Shih
- Robert M. Candey
- … Baptiste Cecconi

Motivation

Experience with 1. HAPI and 2. Research Analysis

1. HAPI metadata is minimal - it relies on pointing to existing standards for interpretation of unit and coordinate system strings in HAPI metadata. SPASE is a standard that has coordinate transform definitions, but is lacking is several respects. The SPASE working group has been included in discussions.
2. In projects over past 5 years, my students and I have used 6 different libraries for coordinate transforms.
   - Not one library worked as-needed for all projects due to speed, compilation/interfacing issues, up-to-date IGRF, needed transforms, bugs, etc.
   - Libraries usually give similar results (< 0.1% difference). This is usually "good enough", until it isn't and one tries to figure out why.
   - I often see questions in community forums related to numerical differences, primarily due to implementation assumptions.
   - There are also issues with differences due to definitions.
   - Our experience is not unique.

Objective

1. The development of a comprehensive standard for acronyms and definitions

and, at some level,

2. the facilitation and/or implementation of comprehensive software, services, and unit tests for coordinate transforms; and
3. understanding the uncertainty of transforms due to implementation choices.

Objective 1

The development of a comprehensive standard for acronyms and definitions

Considered extending SPASE and IVOA. SPASE has coordinate system name/definition pairs. Definitions don't have enough details for reproducibility.

In IVOA, one can also provide enough metadata that will allow for reproducibility (for example, what model was used for Earth position and orbit)

We are in the process of researching if IVOA is what we should build on. Many challenges in this regard.

Note that SPICE kernels also provide metadata that will allow for reproducibility.

Objective 2a

The facilitation and/or implementation of comprehensive (a) software, (b) services, and (c) unit tests for coordinate transforms.

Software was discussed at DASH. My takeaways about software:

1. No single package should attempt to be comprehensive. (don't want AstroPy to have field line tracing magnetic field model dependencies.)
2. Packages have very different interface syntax. Convergence on syntax would be helpful to users.
3. Interoperability attempts have been ad-hoc.
4. Perhaps there should be a top-level Python package that wraps existing transform libraries. Very useful, but lots of maintenance would be required. Will continue to probe this question.

Objective 2b

The facilitation and/or implementation of comprehensive (a) software, **(b) services**, and (c) unit tests for coordinate transforms.

Services exist for transforms, e.g., SPDF, WebGeoCalc, BGS, NGDC. All very limited.

1. A comprehensive web service would be useful.
2. Have had early discussions with Baptiste and Bobby on WebGeoCalc.
3. This working group will likely provide a report on what exists, what can be built on, and what features users want.

Objective 2c

The facilitation and/or implementation of comprehensive (a) software, (b) services, and **(c) unit tests for coordinate transforms.**

Expect to give this priority.

Tests help reveal flaws in definitions.

Can be used by new library developers.

Need central place where tests are discussed and documented.

Objective 3

Understanding the uncertainty of transforms due to implementation choices.

This will likely be a result that follows from other efforts.

Expect to have student prepare report and code for comparing results from different libraries.