



*Heliophysics
Integrated
Observatory*

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**Coordinate Transformation Service
Developers Guide**
Version 0.2

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Revision History

Version	Date	Released by	Detail
0.1	02/05/2012	P. J. Richards	Initial Draft
0.2	24/05/2012	P. J. Richards	Updates to Suggested Reading & Tests

Note: Any notes here.

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Introduction

The Coordinate Transformation Service (CTS) provides the capability to convert between the various coordinate systems used in HELIO. The CTS is built on the SPICE kernel files distributed with the SolarSoft package (Thompson, 2008). SPICE (Spacecraft, Planet, Instrument, C-matrix (pointing), and Events) is a software package developed by the Jet Propulsion Laboratory’s Navigation and Ancillary Information Facility (NAIF), and is used by many missions which navigate through the solar system.

SPICE data files are known as “kernels”, and come in a wide variety. Mission specific kernels provide information about the orbital position and orientation of the spacecraft as a function of time. On top of these are more generic kernels, such as a general solar system ephemeris, planetary constants, and so on. The SPICE system puts these various elements together into a common integrated system.

SPICE is available as both FORTRAN and C libraries. The CSPICE library can also be used from IDL as a Dynamically Loadable Module (DLM), and software has been placed in the Solar Software Library (SolarSoft, or SSW) to take advantage of that fact.

The core of the HELIO CTS is an IDL procedure which acts as a wrapper around a key SSW procedure which acts as a very straightforward interface to the SSW spice routines. This procedure is available as an IDL runtime binary which can be called by the HELIO Context Service.

Suggested Reading

<i>To build the service</i>	
IDL	http://www.exelisvis.com/ProductsServices/IDL.aspx
SolarSoft	http://www.lmsal.com/solarsoft/sswdoc/sswdoc_jtop.html
SPICE kernels	http://naif.jpl.nasa.gov/naif/
<i>To extend the service</i>	
As above	

System Requirements

As a prerequisite, the service requires the installation of the HELIO Context Service (see CXS documentation).

In order to run the IDL runtime binary, if the target system does not have an IDL development licence, then either the free IDL Virtual Machine (<http://www.exelisvis.com/ProductsServices/IDL/IDLModules/IDLVirtualMachine.aspx>) should be installed or a runtime or embedded licence should be purchased from IDL.

Service Installation

Downloading the Source

The CTS source code is part of the HELIO-vo project in sourceforge. The main page is:

<http://sourceforge.net/projects/helio-vo/>.

The helio_cts.pro together with the shell script to run the service, run_helio_cts.sh, is in the helio-cts folder of the helio-vo svn repository:

<https://helio-vo.svn.sourceforge.net/svnroot/helio-vo/>

Building the Service

The source download consists of the IDL procedure. To build the software requires an IDL development licence and the SolarSoft software package. The procedure is compiled:

```
.COMPILE helio_cts  
RESOLVE_ALL
```

and then saved as a using the command:

```
SAVE, /ROUTINES, FILENAME='helio_cts.sav'
```

The shell script, run_helio_cts.sh, runs the IDL runtime binary in the file helio_cts.sav.

Installing the CTS Service

See CXS – Admin Guide.

Structure of the Code

The code consists of a single IDL file helio_cts.pro which contains two IDL procedures:

CALL_HELIO_CTS: provides the service interface

HELIO_CTS: Main CTS backend.

HELIO_CTS calls the SPICE routine CONVERT_STEREO_COORD which does the conversion between coordinate systems.

Dependencies

SolarSoft (http://www.lmsal.com/solarsoft/sswdoc/sswdoc_jtop.html)

SPICE (<http://naif.jpl.nasa.gov/naif/>)

Tests

It is assumed that the SPICE kernel software has been fully tested before release. Tests were carried out on a subset of the coordinate system options to check that the interface between the user input and the call to the CONVERT_STEREO_COORD SPICE routine.

An example of the input and output from for a CTS run, which can be used to check installation, is given in the Appendix.

Web Service Tests

See CXS – Admin Guide.

Maintaining & Extending the Service

Maintenance will be necessary with improvements to the input interface. It is also possible that there will be future enhancements to the SPICE kernel software. This could require the addition of the new coordinate systems to the input and output parameters. The procedure helio_cts.pro would have to be modified, requiring access to an IDL development environment.

Fixing problems

The SPICE kernel and SSW libraries has been in use for some time, but if necessary the same procedure as for maintenance.

Appendix

This is an example run of the CTS which converts from the GEO coordinate system in XYZ representation to GSE in RTP representation. See the CTS - User Manual for a description of the input parameters.

The input VOTable:

```
<?xml version='1.0'?>
<VOTABLE version="1.1"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.1"
http://www.ivoa.net/xml/VOTable/v1.1"
  xmlns="http://www.ivoa.net/xml/VOTable/v1.1">
<RESOURCE>
<TABLE>
<FIELD arraysize="*" datatype="char" name="time"/> <FIELD datatype="float"
name="x"/> <FIELD datatype="float" name="y"/> <FIELD datatype="float"
name="z"/> <DATA> <TABLEDATA>
  <TR>
    <TD>2005-01-01T00:00:00Z </TD>
    <TD>-132645.54</TD>
    <TD>-93817.847</TD>
    <TD>60028.106 </TD>
  </TR>
  <TR>
    <TD>2005-01-01T00:00:00Z </TD>
    <TD>-132645.54</TD>
    <TD>-93817.847</TD>
    <TD>60028.106 </TD>
  </TR>
```

```
</TABLEDATA>
</DATA>
</TABLE>
</RESOURCE>
</VOTABLE>
```

When transformed from GEO XYZ to GSE RTP will give the following output VOTable:

```
<?xml version="1.0"?>
<!DOCTYPE VOTABLE SYSTEM "http://us-vo.org/xml/VOTable.dtd">
<VOTABLE version="1.0">
  <DESCRIPTION>
    VOTable file created by the HELIO Coordinate Transformation Service
    Created: Wed Oct 19 11:11:25 2011
  </DESCRIPTION>
  <RESOURCE>
    <DESCRIPTION>Transformed coordinate list</DESCRIPTION>
    <TABLE>
      <DESCRIPTION>Transformation from GEO/XYZ to GSE/RTP</DESCRIPTION>
      <FIELD name="TIME" datatype="char"/>
      <FIELD name="R" datatype="float"/>
      <FIELD name="THETA" datatype="float"/>
      <FIELD name="PHI" datatype="float"/>
      <DATA>
        <TABLEDATA>
          <TR><TD>2005-01-
01T00:00:00Z</TD><TD>173205.</TD><TD>54.7356</TD><TD>45.0000</TD></TR>
          <TR><TD>2005-01-
01T00:00:00Z</TD><TD>173205.</TD><TD>54.7356</TD><TD>45.0000</TD></TR>
        </TABLEDATA>
      </DATA>
    </TABLE>
  </RESOURCE>
</VOTABLE>
```