

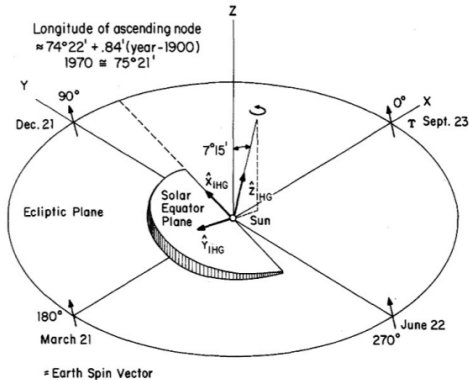
Data from the ULYSSES FINAL ARCHIVE

ulysses_daily_heliocentric_data_1990-2009.txt													
~/PUF-Fun/Ulysses/Trajectory/trajectory_data													
lat: Sun Mean Equator and Equinox of 1950													
RA and DEC: Earth Mean Orbit and Equinox of 1950													
Long: long of Ulysses wrt Earth in Sun Mean Equator and Equinox of 1950													
YYYY MM DD	YYYY DOY JD	HH MM SS	ESP [deg]	SPE [deg]	SEP [deg]	R [AU]	R [km]	dR [km/s]	V [km/s]	lat [deg]	RA [deg]	DEC [deg]	long [deg]
1990 10 07	1990 280 2448171.5	00 00 00	0.08	97.86	82.06	0.999	149497071.034	-2.512	41.092	6.35	12.98	0.01	0.08
1990 10 08	1990 281 2448172.5	00 00 00	0.45	98.57	80.97	0.998	149301115.851	-2.035	40.987	6.32	14.34	0.06	0.46
1990 10 09	1990 282 2448173.5	00 00 00	0.83	97.43	81.74	0.997	149145073.980	-1.577	40.996	6.28	15.70	0.10	0.83
1990 10 10	1990 283 2448174.5	00 00 00	1.20	96.17	82.63	0.996	149028578.950	-1.119	41.008	6.24	17.06	0.15	1.21
1990 10 11	1990 284 2448175.5	00 00 00	1.58	94.86	83.56	0.996	148951687.780	-0.661	41.017	6.20	18.42	0.20	1.59
1990 10 12	1990 285 2448176.5	00 00 00	1.96	93.54	84.50	0.995	148914448.678	-0.201	41.020	6.15	19.78	0.24	1.96
1990 10 13	1990 286 2448177.5	00 00 00	2.33	92.21	85.46	0.995	148916887.222	0.258	41.019	6.10	21.14	0.29	2.34
1990 10 14	1990 287 2448178.5	00 00 00	2.71	90.88	86.42	0.996	148958991.852	0.717	41.012	6.05	22.51	0.34	2.72
1990 10 15	1990 288 2448179.5	00 00 00	3.08	89.54	87.38	0.997	148914448.678	1.178	41.008	6.00	23.87	0.39	3.10
helioc.dat													
~/PUF-Fun/Ulysses/Trajectory/trajectory_data													
Year	DOY	HR MN SC	Earth Sun S/C	Sun S/C Earth	Sun Earth S/C	Helioc. Range	Heliograph. Latitude	Helioc. Rt. Asc.	Helioc. Ecliptic Lat.	Solar Longitude wrt Earth			
1990 10 16													
1990 10 17													
1990 10 18													
1990 10 19													
1990 10 20													
1990 10 21													
1990 10 22													
1990 10 23													
1990 10 24	1990 296 00 00 00		5.93	78.96	95.11	1.0100	5.42	-999.	0.75	-999.			
1990 10 25	1990 297 00 00 00		6.25	77.64	96.11	1.0127	5.34	-999.	0.79	-999.			
1990 10 26	1990 298 00 00 00		6.58	76.31	97.11	1.0154	5.25	-999.	0.83	-999.			
1990 10 27	1990 299 00 00 00		6.89	74.99	98.12	1.0187	5.16	-999.	0.87	-999.			
1990 10 28	1990 300 00 00 00		7.19	73.67	99.14	1.0227	5.07	-999.	0.91	-999.			
1990 10 29	1990 301 00 00 00		7.48	72.35	100.20	1.0261	4.98	-999.	0.95	-999.			
1990 10 30	1990 302 00 00 00		7.76	71.03	101.20	1.0301	4.89	-999.	0.99	-999.			
1990 10 31	1990 303 00 00 00		8.04	69.72	102.20	1.0348	4.79	-999.	1.03	-999.			
1990 11 01	1990 304 00 00 00		8.30	68.41	103.30	1.0394	4.69	-999.	1.07	-999.			
1990 11 02	1990 305 00 00 00		8.54	67.10	104.40	1.0441	4.60	-999.	1.10	-999.			
1990 11 03	1990 306 00 00 00		8.78	65.79	105.40	1.0488	4.50	-999.	1.14	-999.			
1990 11 04	1990 307 00 00 00		9.01	64.49	106.50	1.0542	4.40	-999.	1.17	-999.			
1990 11 05	1990 308 00 00 00		9.22	63.19	107.59	1.0593	4.29	155.19	1.20	9.240			
1990 11 06	1990 309 00 00 00		9.42	61.90	108.69	1.0648	4.19	156.38	1.24	9.440			
1990 11 07	1990 310 00 00 00		9.60	60.60	109.79	1.0706	4.09	157.57	1.27	9.620			

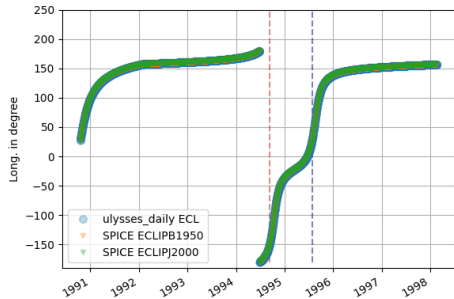
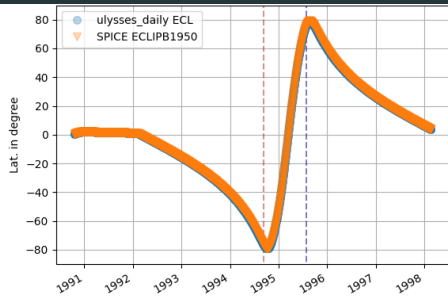
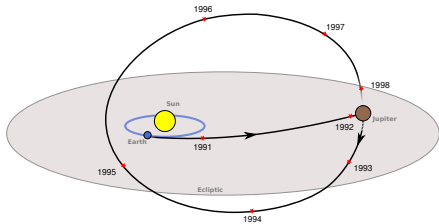
Coordinate Systems

There seem to be two options for coordinate systems:

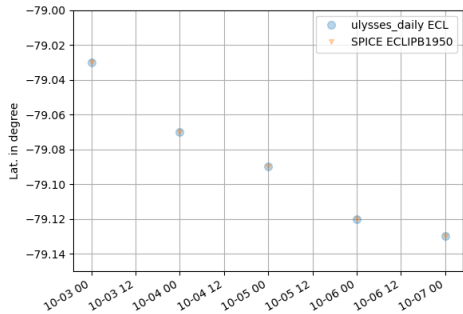
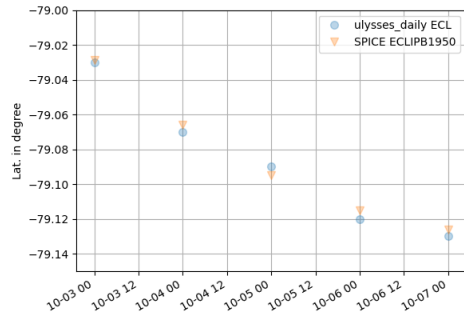
- **Heliocentric Inertial (HCI)** system
- **Heliocentric Aries Ecciptic (HAE)** system



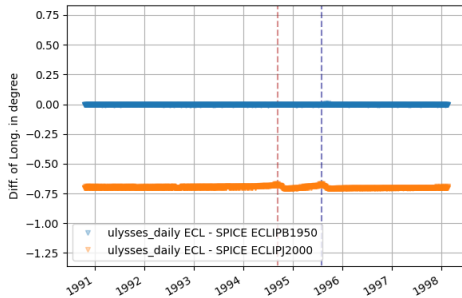
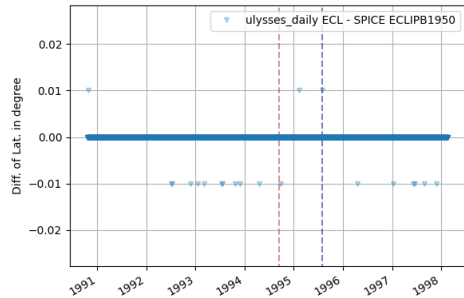
Ulysses' 1st Orbit



Ecliptic System – Latitude



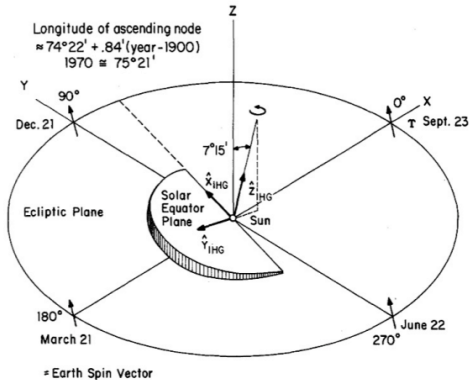
Ecliptic System – Differences



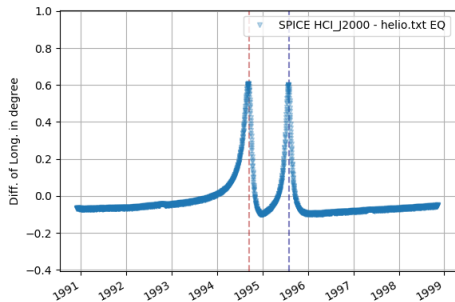
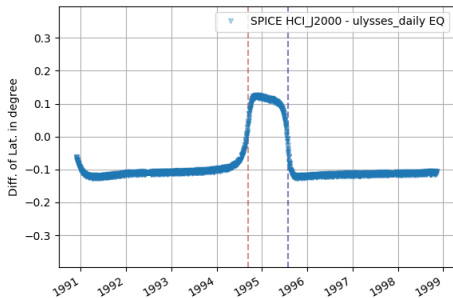
Equatorial System

There seem to be two options for coordinate systems:

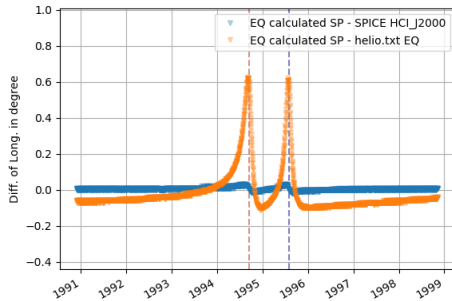
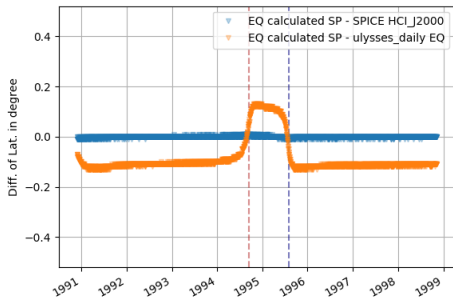
- **Heliocentric Inertial (HCI)** system
- **Heliocentric Aries Ecciptic (HAE)** system



Equatorial System



Equatorial System – calculated



Equatorial System

628-53, Rev. G Controlled Document

Ulysses

Reference Trajectory Characteristics

Krystyna Kiedron

March 15, 1993



JPL-D-243

Earth - Sun - S/C Angle	deg
Sun - S/C - Earth Angle	deg
Sun - Earth - S/C Angle	deg
Heliocentric Range of S/C	AU
Heliocentric Range Rate	km/sec
Heliocentric Velocity Magnitude	km/sec
Heliographic Latitude of S/C (SMEQ) ^a	deg
Heliocentric Sun Equator Right Ascension ^b	deg
Ecliptic Latitude of S/C Relative to Sun (EMEC) ^c	deg
Solar Longitude With Respect to Earth ^d	deg

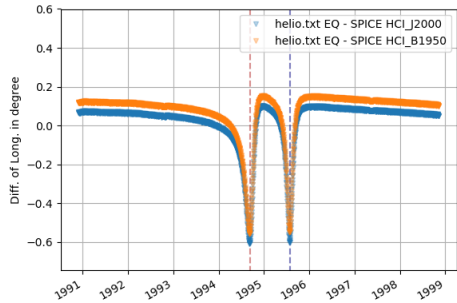
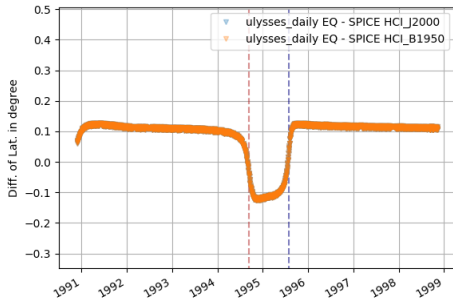
^aSMEQ - Sun mean equator and equinox of 1950

^bThe right ascension of the S/C in the Sun's equatorial plane measured from the ascending node of Earth's orbit plane of 1950

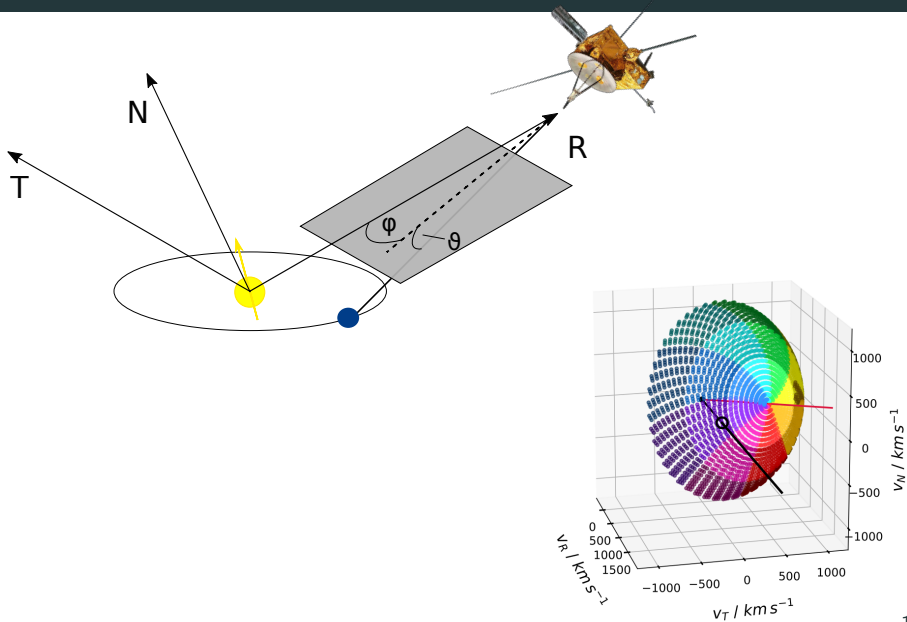
^cEarth mean ecliptic and equinox of 1950

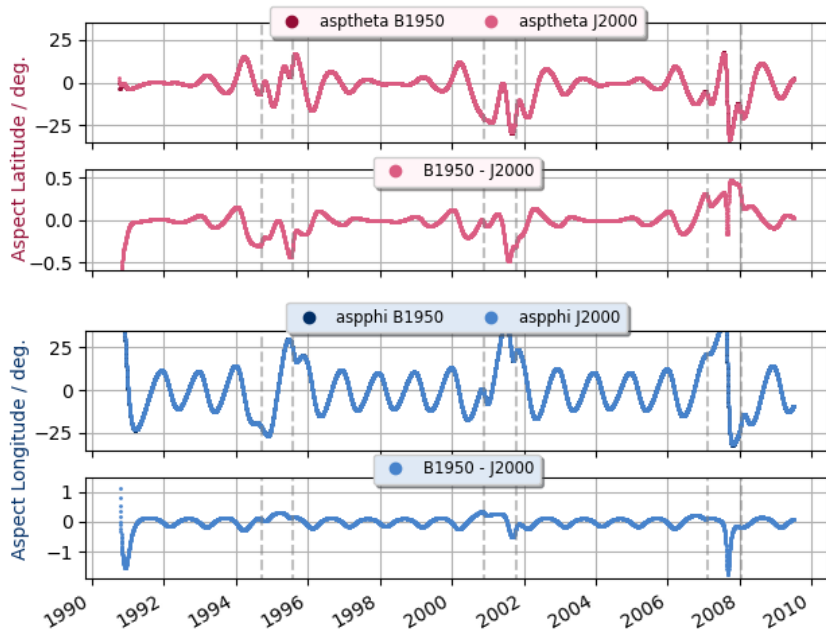
^dThe Earth-Sun-S/C angle projected on the sun's equatorial plane where the current Earth-Sun line is always longitude = 0.0°

Equatorial System – B1950 vs. J2000



Aspect Angle





SPICE Reference Frame Kernel



Two-Vector Frame Concepts - 3

Navigation and Ancillary Information Facility

• Secondary Vector

- A specified positive or negative axis of the two-vector frame is aligned with the component of the secondary vector orthogonal to the primary vector.
 - » The frame kernel creator associates with this vector one of the axis designations { +X, -X, +Y, -Y, +Z, -Z }, where the axis is orthogonal to that associated with the primary vector.

Heliocentric Inertial (HCI) Frame

Definition of the Heliocentric Inertial frame:

All vectors are geometric: no aberration corrections are used.

The solar rotation axis is the primary vector: the Z axis points in the solar north direction (IAU_SUN frozen at J2000 epoch).

The ascending node on the ecliptic of J2000 of the IAU SUN equator forms the X axis. *** N.B this is accomplished by using the +Z axis of the ecliptic of J2000 as the secondary vector and HCI +Y as the secondary axis

The Y axis is Z cross X, completing the right-handed reference frame.

\beginindata

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FRAME_1810420_CLASS = 5
FRAME_1810420_CLASS_ID = 1810420
FRAME_1810420_CENTER = 10
FRAME_1810420_RELATIVE = 'J2000'
FRAME_1810420_DEF_STYLE = 'PARAMETERIZED'
FRAME_1810420_FAMILY = 'TWO-VECTOR'
FRAME_1810420_FREEZE_EPOCH = 2000-JAN-01/12:00:00
FRAME_1810420_PRI_AXIS = 'Z'
FRAME_1810420_PRI_VECTOR_DEF = 'CONSTANT'
FRAME_1810420_PRI_FRAME = 'IAU SUN'
FRAME_1810420_PRI_SPEC = 'RECTANGULAR'
FRAME_1810420_PRI_VECTOR = ( 0, 0, 1 )
FRAME_1810420_SEC_AXIS = 'Y'
FRAME_1810420_SEC_VECTOR_DEF = 'CONSTANT'
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FRAME_1810420_SEC_SPEC = 'RECTANGULAR'
FRAME_1810420_SEC_VECTOR = ( 0, 0, 1 )
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