628-53, Rev. G Controlled Document

Ulysses

ReferenceTrajectory Characteristics

Krystyna Kiedron

March 15, 1993

Jet Propulsion Laboratory
California Institute of Technology

JPL-D-243

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Krystyna Kiedron

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ACRONYMS

AU	Astronomical Unit (1 AU = 149597893 km)
EMEC	Earth mean ecliptic and equinox of 1950 reference system
EMEQ	Earth mean equator and equinox of 1950 reference system
SMEQ	Sun mean equator and equinox of 1950 reference system
S/C	Spacecraft
SPE	Sun-S/C-Earth angle
SEP	Sun-Earth-S/C angle
ESP	Earth-Sun-S/C angle
ULS	Ulysses Spacecraft/Mission
wrt	With respect to
sec	Second
km	Kilometer
R_p	Radius at periapsis
YYMMDD	Fields, reserved for year, month and day
HHMMSS	Fields, reserved for hour, minute and second

SECTION 1

INTRODUCTION

The Ulysses mission, designed to explore the polar regions of the Sun, has successfully completed its encounter with Jupiter on February 8, 1992. The spacecraft is now traveling south, out of the ecliptic plane. It will reach 70 degrees south solar latitude in June 1994, and begin its pass over the Sun's south pole.

The purpose of this document is to update the primary mission reference trajectory based on post-Jupiter knowledge. Several errors in the Jupiter encounter conditions caused minor changes in mission characteristics and resulted in the need for this update. This version replaces Rev. F of the document.

For reference later in the document, mission performance criteria are the number of days above 70° heliographic latitude (total for two passes of the Sun's poles) and the maximum heliographic latitude.

The primary mission was designed to maximize the total trajectory time at heliographic latitudes greater than 70° during the two polar passes, with a minimum of 150 days total time above 70° on the two passes. To accomplish this, the following constraints were placed on the trajectory:

(1) Perihelion distance (Rp) shall be > 1.3 AU.
(2) Heliocentric radius at maximum latitude shall be < 2.3 AU.

SECTION 2

REFERENCE TRAJECTORY

The reference trajectory for the primary mission is uniquely defined by classical orbital elements derived from the Ulysses ephemeris file labelled 92169_NOMSRP. They are listed in Table 2-1 and shown in Table 2-2.

Table 2-1. Listing of Classical Orbital Elements

Symbol	Definition	Units
a	Semi-major axis of ellipse or hyperbola	km
e	Eccentricity	nondimensional
i	Inclination to Earth ecliptic of 1950	deg
Ω	Longitude of ascending node in Earth ecliptic	deg
ω	Argument of Periapsis (from node)	deg
TA	True anomaly: angle from periapsis to S/C	deg

Table 2-2. Classical Orbital Elements of the Reference Trajectory

(Earth Mean Ecliptic of 1950)

EPOCH (GMT)	CENTRAL BODY	a (KM)	e	i (DEG)	Ω (DEG)	ω (DEG)	TA (DEG)	VALID DATES
June 30, 1992 23:59:01.816	Sun	504835174.6	0.60116	79.36440	-22.46215	-1.14084	-172.71074	June 30, 1992 to Oct 1, 1995

SECTION 3

REFERENCE TRAJECTORY CHARACTERISTICS AND SUMMARY

The reference trajectory characteristics for the Ulysses primary mission are described in this section. Included are both mission plots and tabular data for geocentric and sun-related parameters.

All quantities plotted are based on data points with 10-day granularity; hence, minima and maxima are only approximated by values tabulated within 5 days of the true value. Figures 3-1 to 3-8 are plots of geocentric quantities (see Table 3-1 for listing). Figures 3-9 to 3-18 provide angles related to the Sun-spacecraft geometry and heliocentric data (see Table 3-2 for listing). Curves of all plots are marked every 60 days with a "+" sign. Tables 3-5 and 3-6 contain the geocentric and sun-centered quantities in tabular form.

Table 3-1. Geocentric Data (Quantities Plotted)

Quantity	Unit
Geocentric Right Ascension (EMEQ)[a]	deg
Geocentric Declination (EMEQ)	deg
Geocentric Range	AU
Range Rate with respect to Earth	km/sec
Range Acceleration with respect to Earth	km/sec^2
Declination Rate of S/C with respect to Earth	deg/day
Right Ascension Rate of S/C with respect to Earth	deg/day
Vector Rate of S/C with respect to Earth	deg/day

[a]EMEQ - Earth mean equator and equinox of 1950 reference system

Table 3-2. Sun-Related Data (Quantities Plotted)

Quantity	Unit
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

[a]SMEQ - Sun mean equator and equinox of 1950

[b]The right ascension of the S/C in the Sun's equatorial plane measured from the ascending node of Earth's orbit plane of 1950

[c]Earth mean ecliptic and equinox of 1950

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

Table 3-3 contains a summary of the post-Jupiter Ulysses primary mission. The following definitions are to clarify the quantities whose titles are not self-explanatory:

Maximum latitude	Maximum heliographic latitude achieved by spacecraft (deg)
Radius at Max Lat 1, 2	Distance from Sun's center when reaching maximum latitude on passes 1 and 2 near the solar poles (AU)
SPE Max	Maximum value of Sun-S/C-Earth angle during the primary mission (deg)

Table 3-3. Post-Jupiter Mission Summary

Parameter:	YYMMDD	HHMMSS
Injection Date	901006	193721
Jupiter Encounter	920208	120056
Perihelion Date	950312	114000
End of Mission Date	951001	000000

Days Above 70°:	
Pass 1	132.29
Pass 2	102.38
Total	234.67

Maximum Latitude (deg)	80.22
Perihelion Radius (AU)	1.3388
Radius at Max Lat 1 (AU)	2.2924
Radius at Max Lat 2 (AU)	2.0178

		YYMMDD	HHMMSS
Pass 1	Begin	940626	130000
	Max Lat	940913	120000
	End	941105	200000
Pass 2	Begin	950619	080000
	Max Lat	950731	150000
	End	950929	090000
SPE Max (deg)	30.19	950613	120000

Note: All values are taken from a DPTRAJ integrated trajectory

Table 3-4 provides a summary of oppositions and conjunctions. The spacecraft is in opposition with Earth when SEP approaches 180 degrees. The spacecraft is in conjunction with Earth if SEP and SPE approach 0 degrees. The numbering of oppositions and conjunctions follows the original numbering of these events in previous editions of this document.

Table 3-4. Summary of Oppositions and Conjunctions for the Ulysses Post-Jupiter Primary Mission

EVENT	DATE	SPE ANG (deg)	SEP ANG (deg)
2nd Conjunction	September 01, 1992	1.48	7.74
3rd Opposition	March 01, 1993	4.62	156.36
3rd Conjunction	September 08, 1993	5.79	25.69
4th Conjunction	March 04, 1995	4.25	5.76

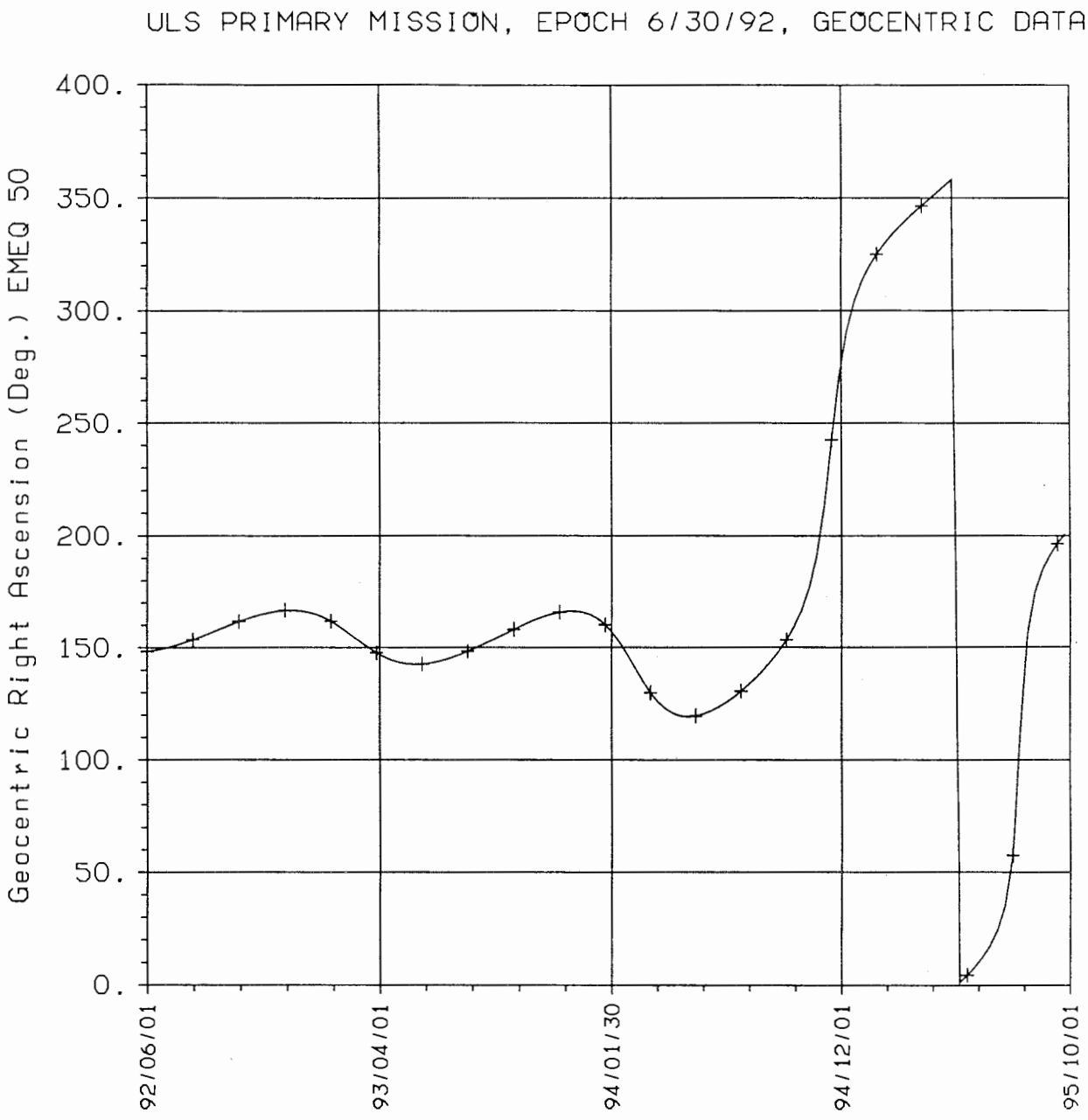


Figure 3-1. Geocentric Right Ascension (EMEQ 50)

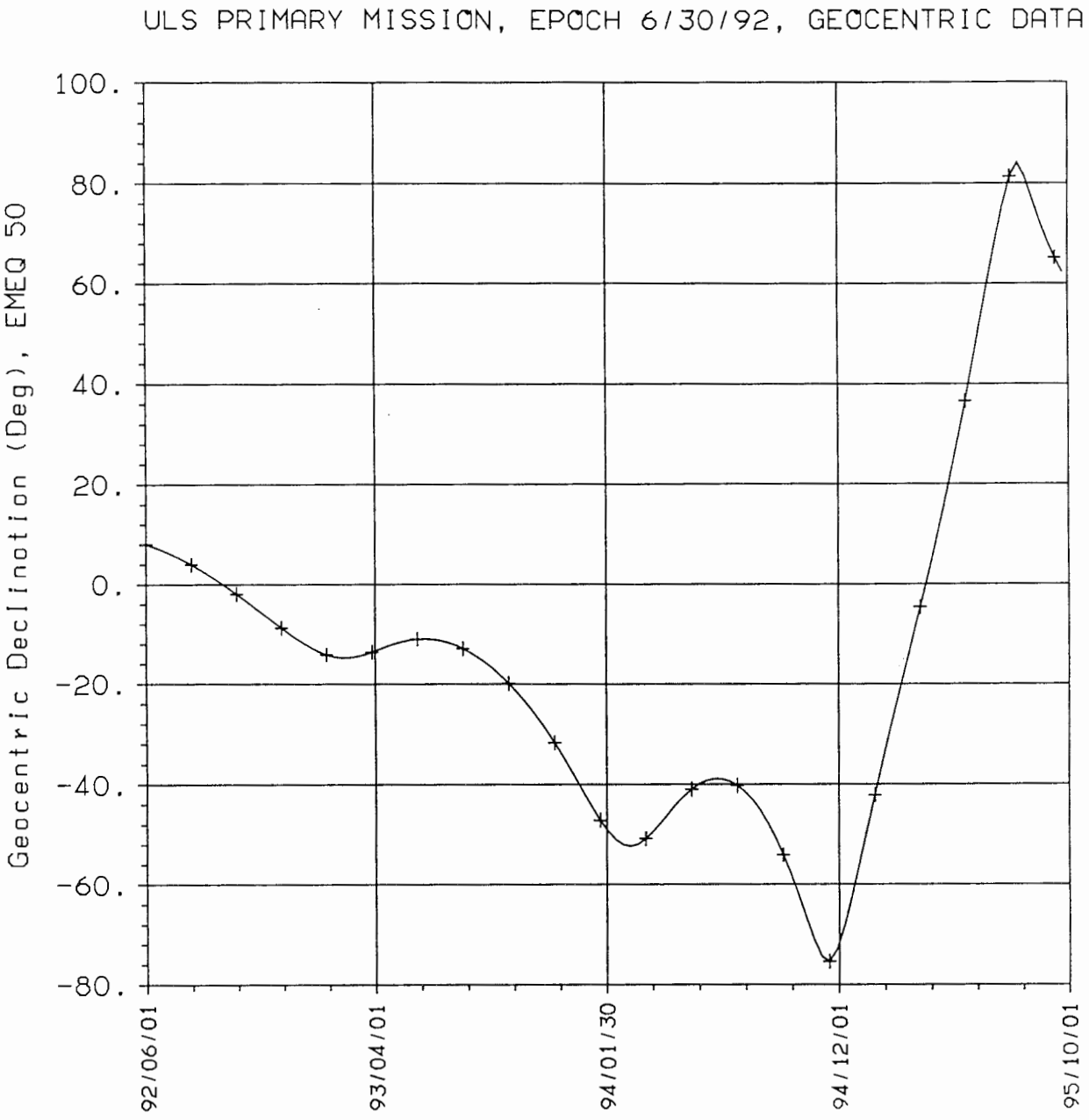


Figure 3-2. Geocentric Declination (EMEQ 50)

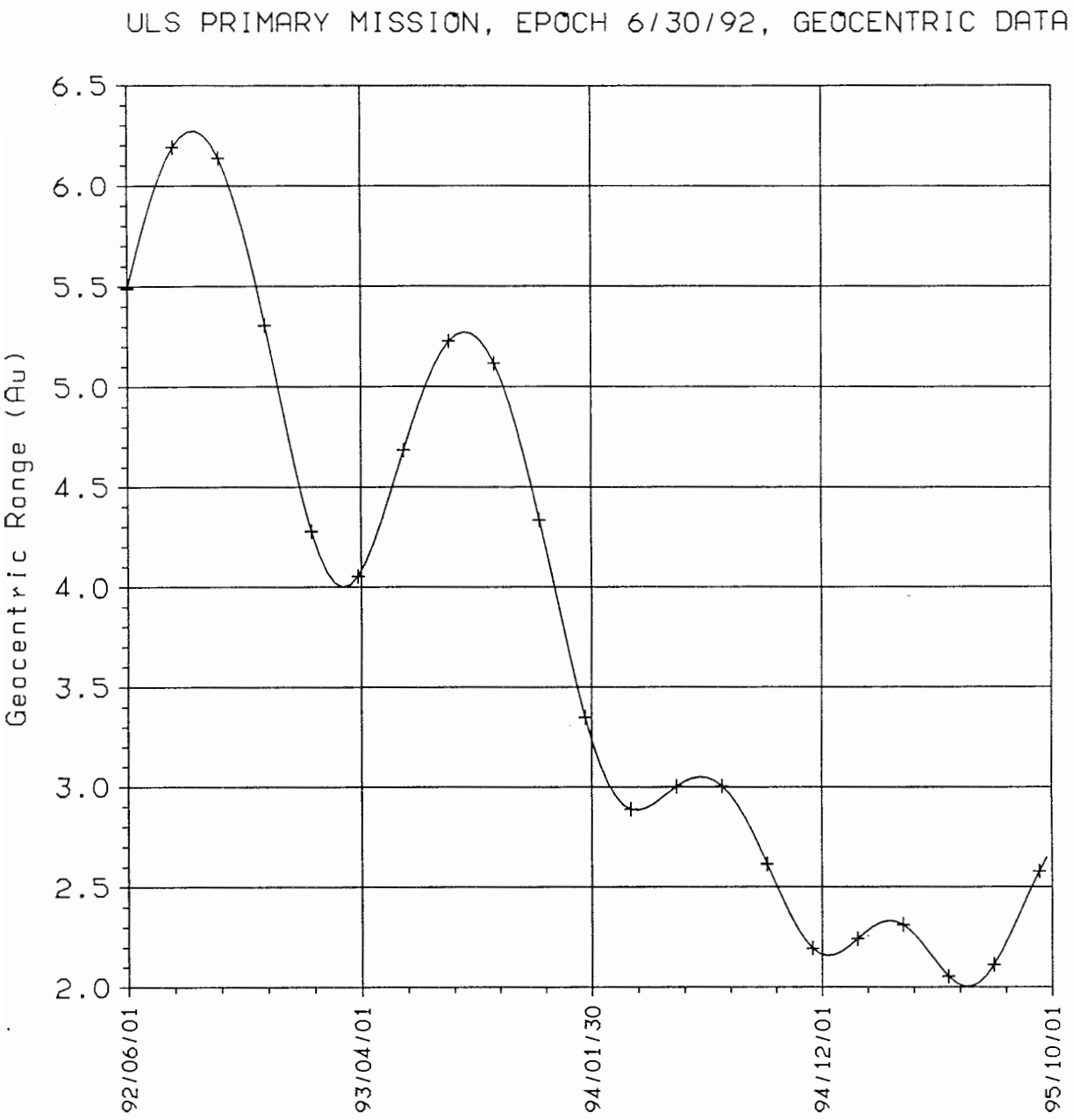


Figure 3-3. Geocentric Range

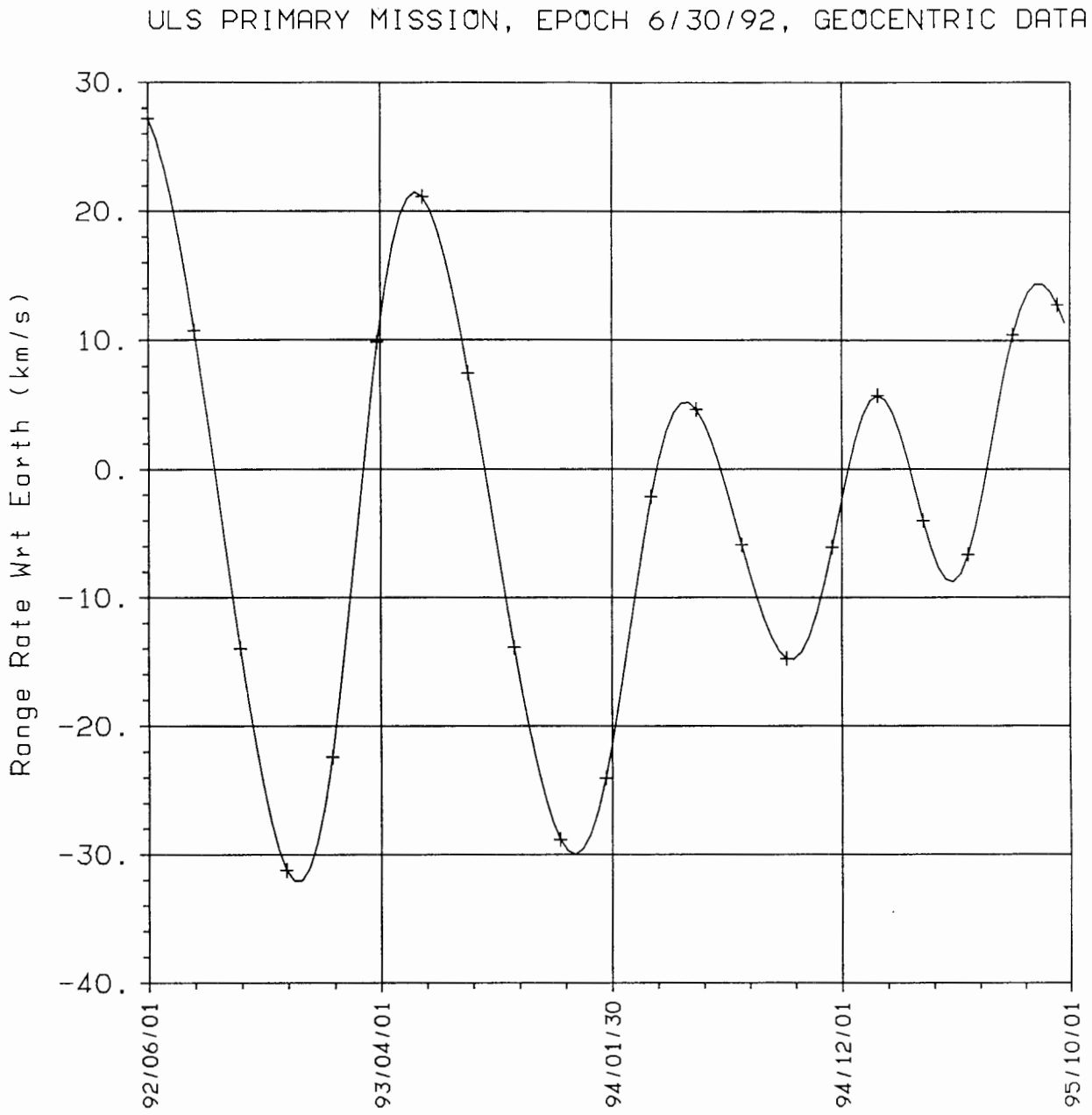
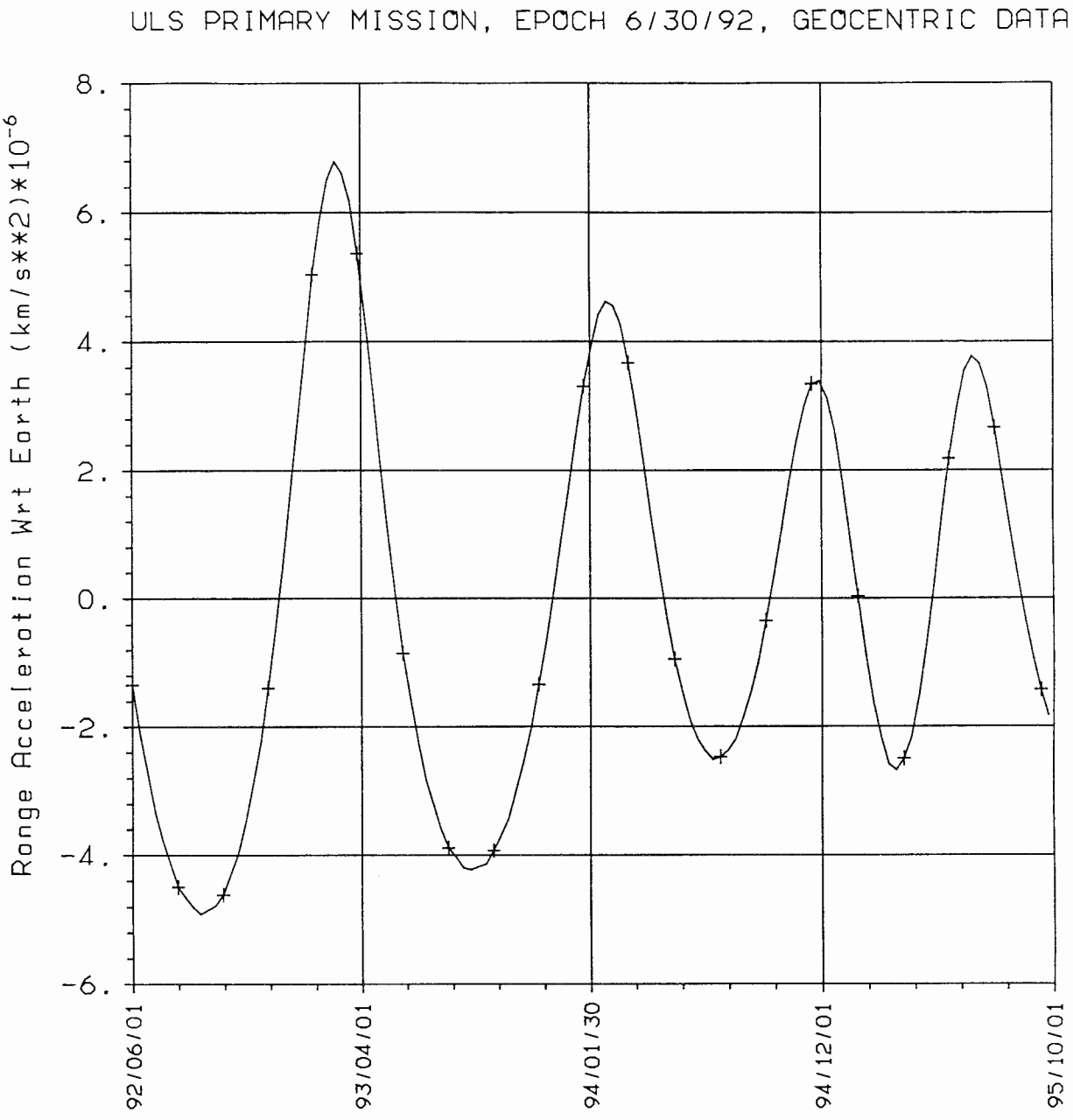


Figure 3-4. Range Rate with respect to Earth



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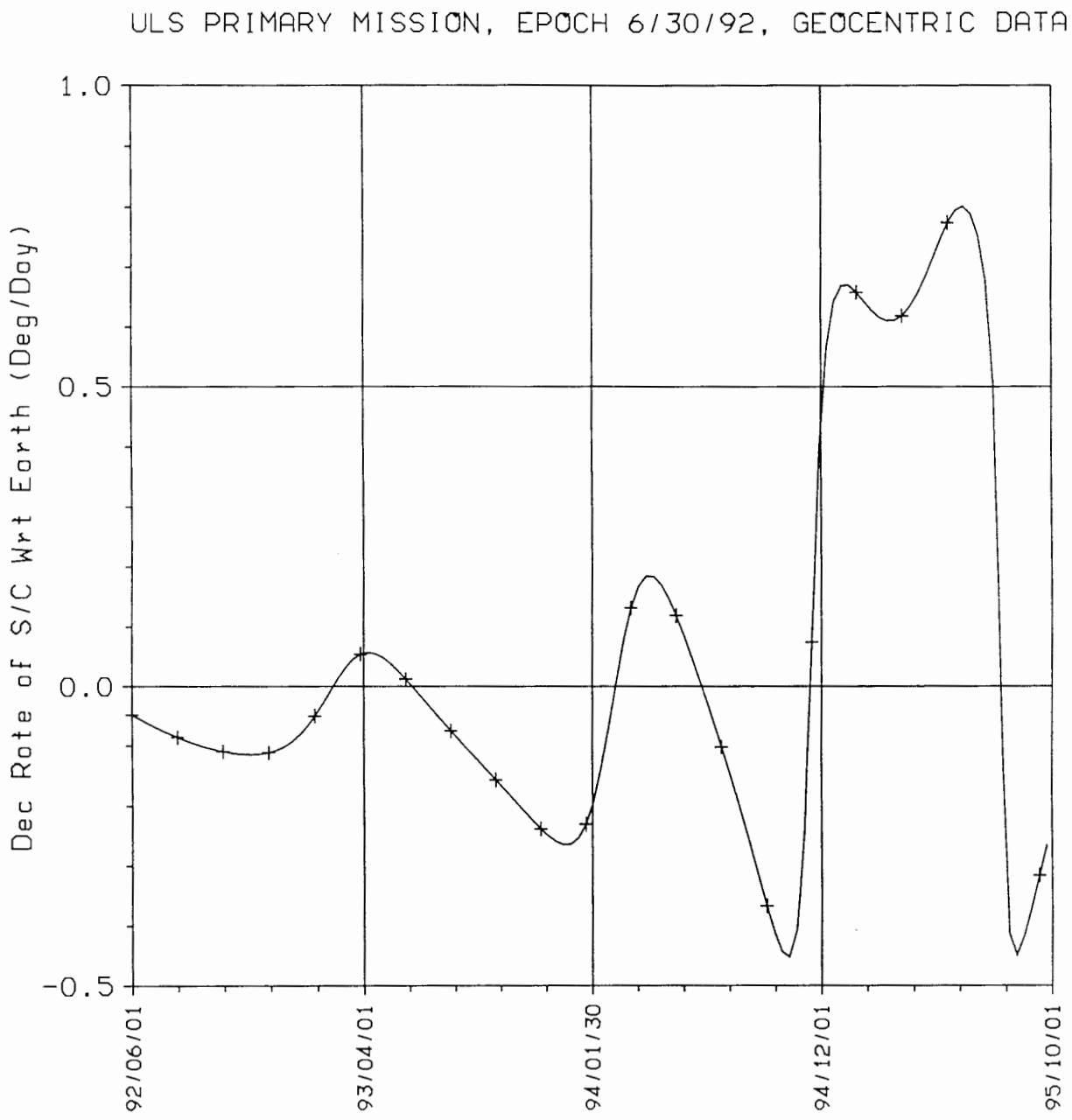

Figure 3-6. Declination Rate of S/C with respect to Earth

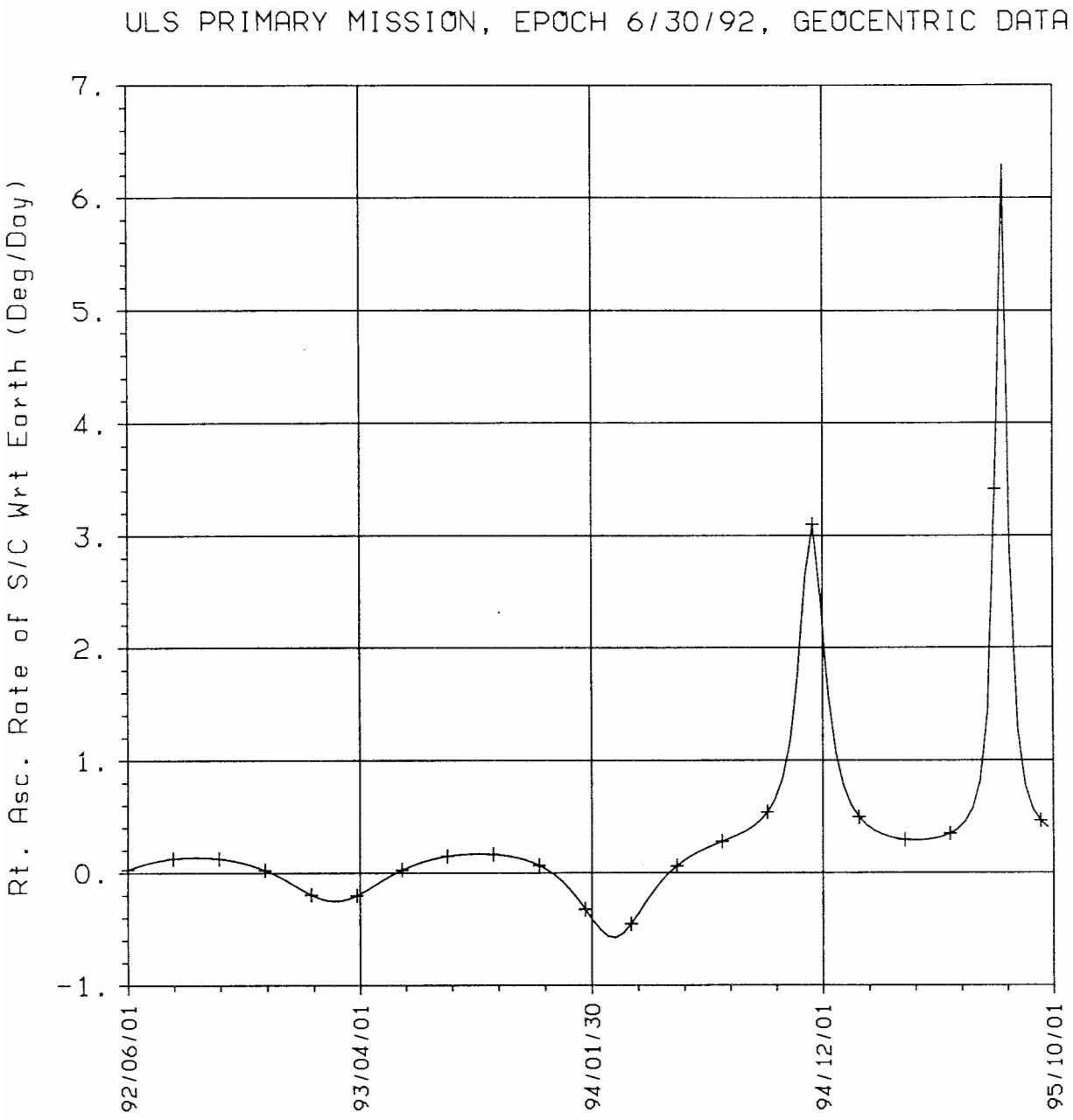

Figure 3-7. Right Ascention Rate of S/C with respect to Earth

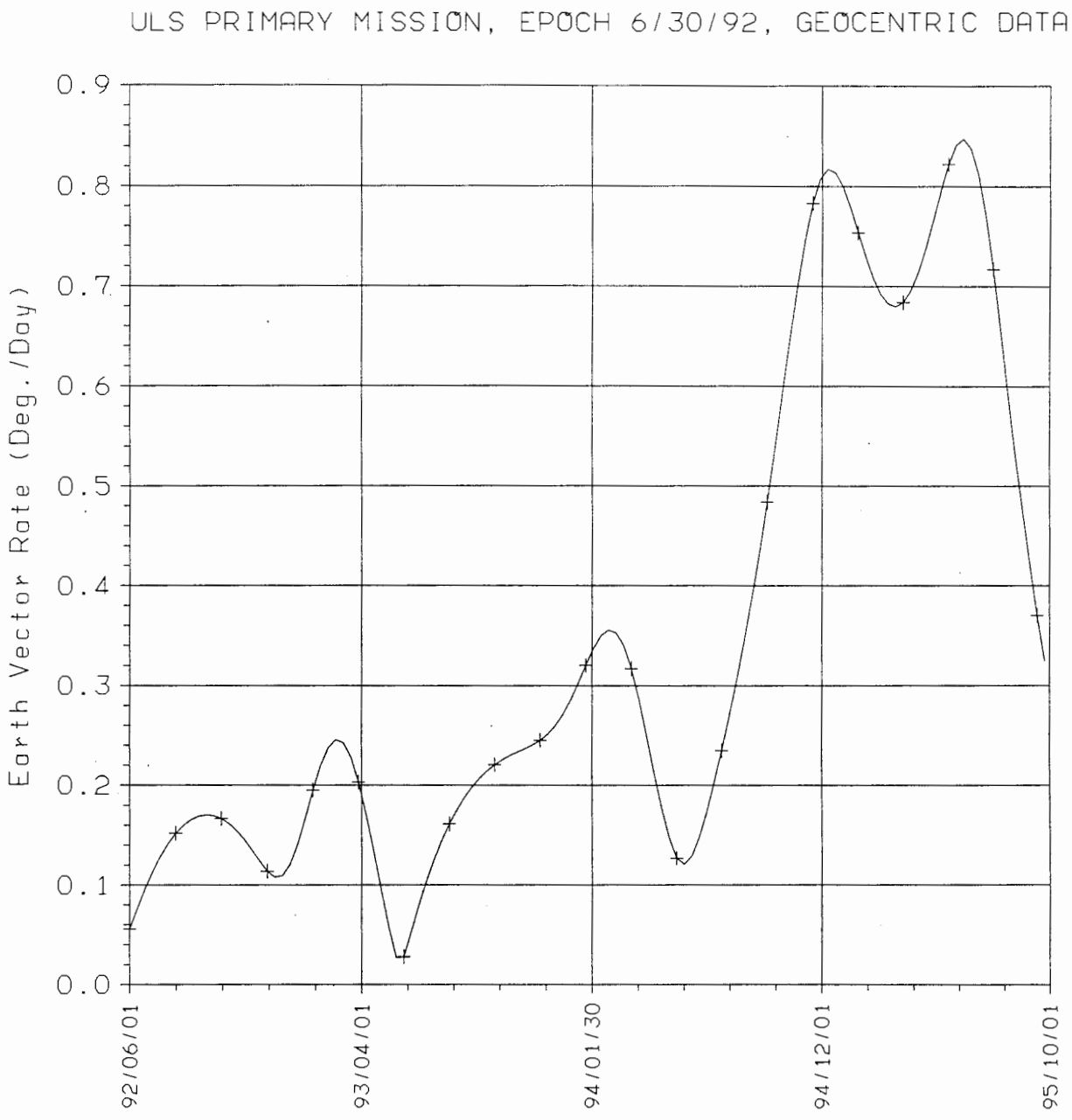

Figure 3-8. Vector Rate of S/C with respect to Earth

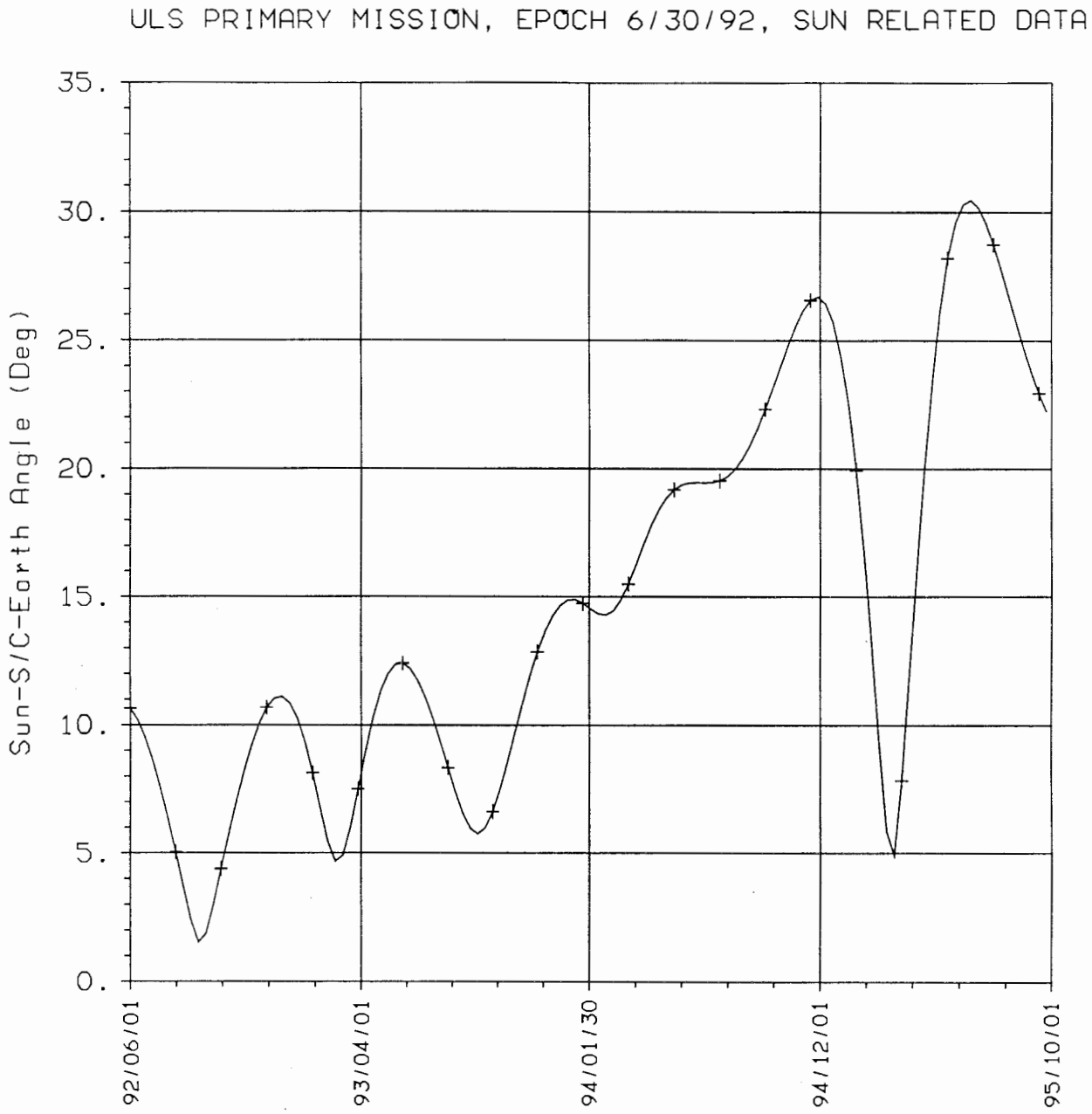

Figure 3-9. Sun-S/C-Earth Angle

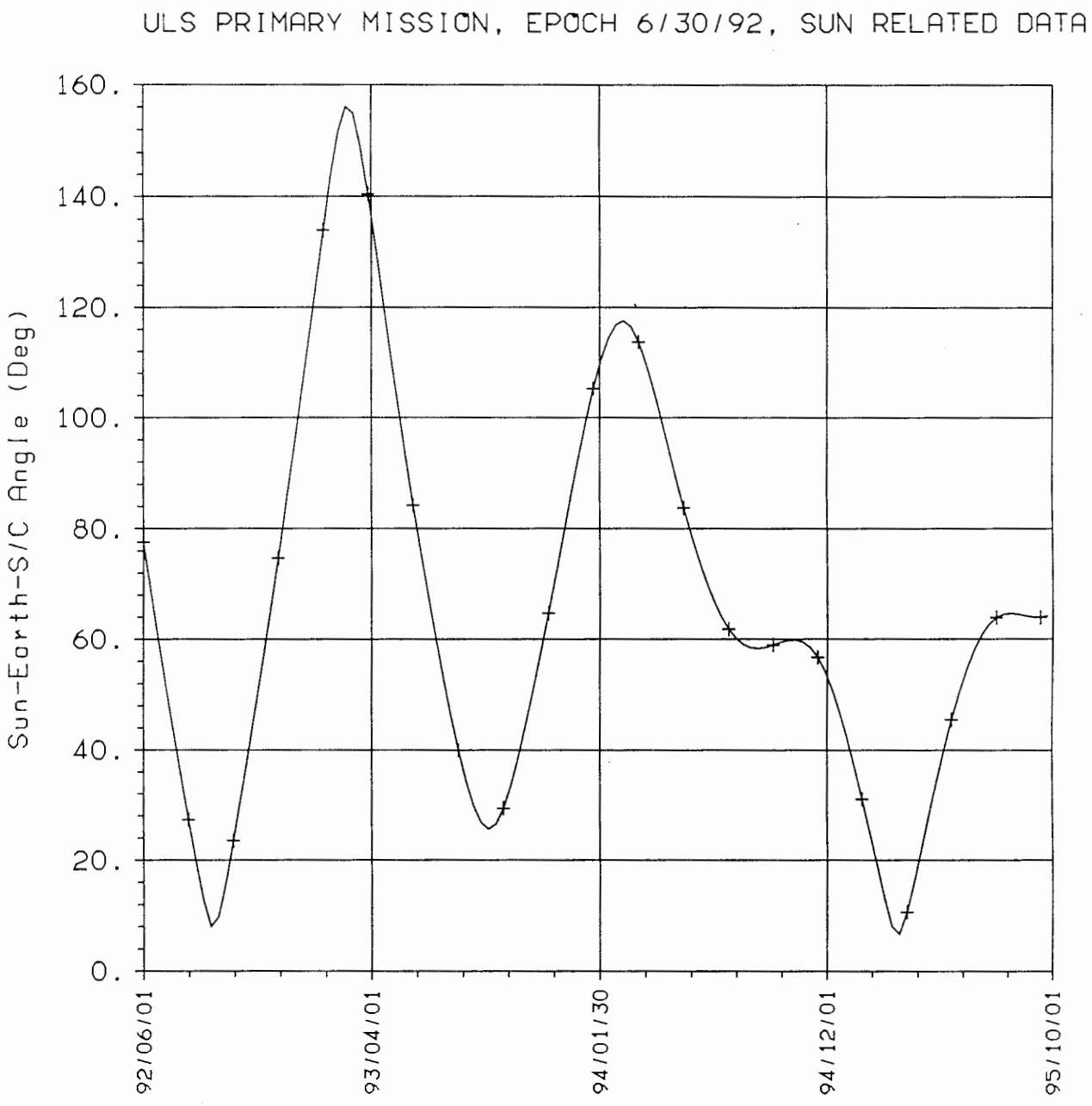

Figure 3-10. Sun-Earth-S/C Angle

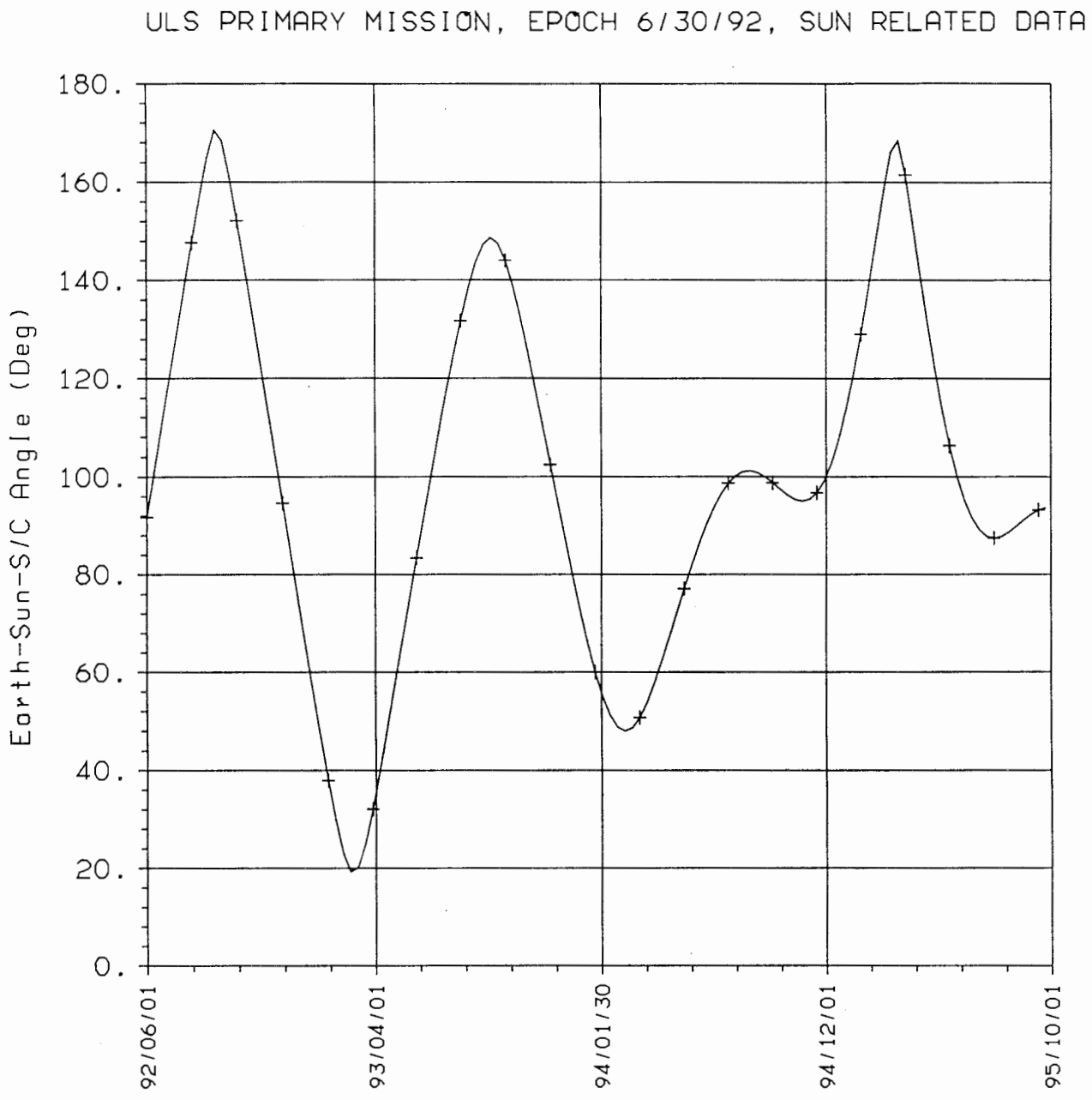

Figure 3-11. Earth-Sun-S/C Angle

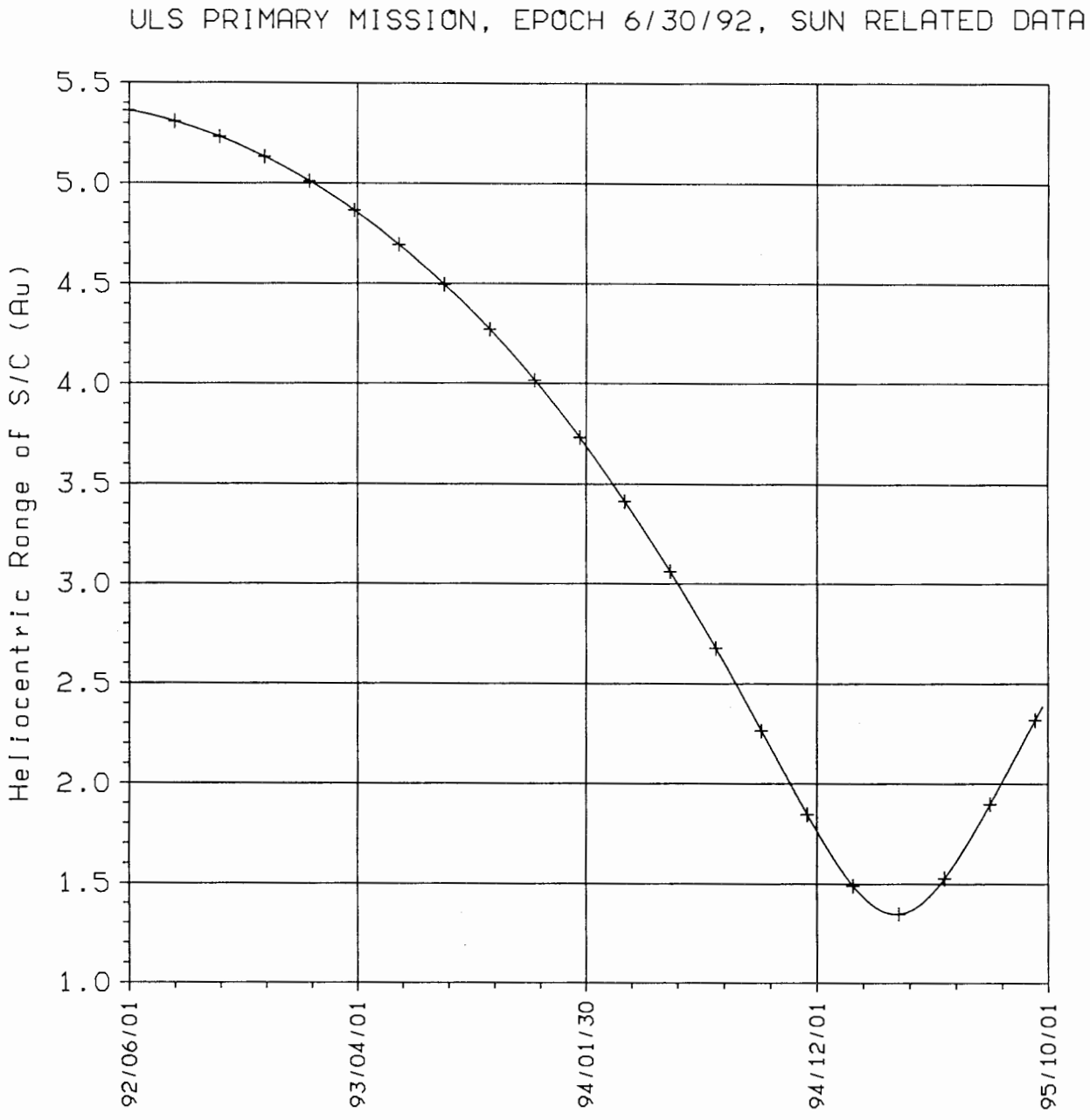

Figure 3-12. Heliocentric Range of Spacecraft

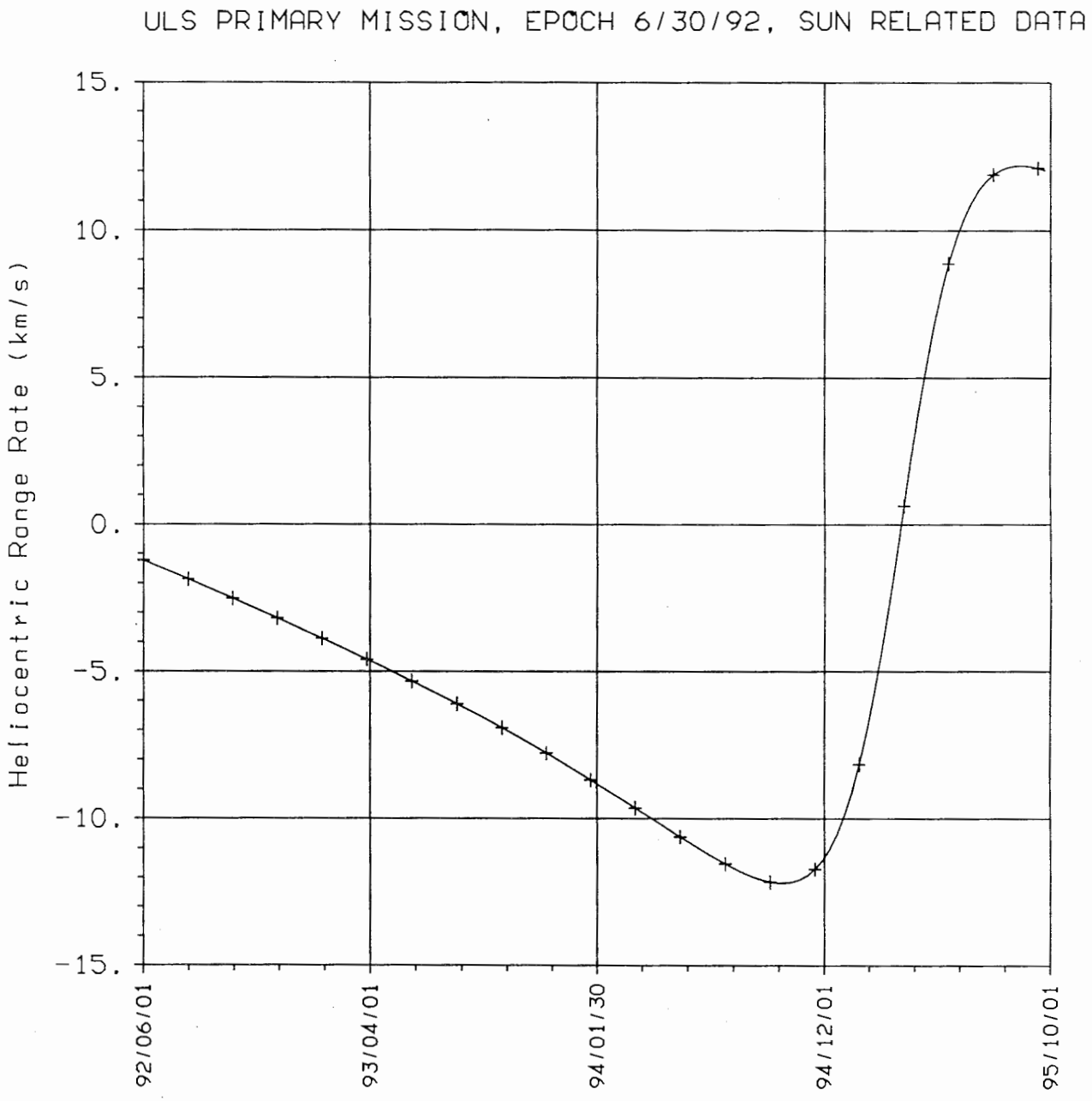

Figure 3-13. Heliocentric Range Rate

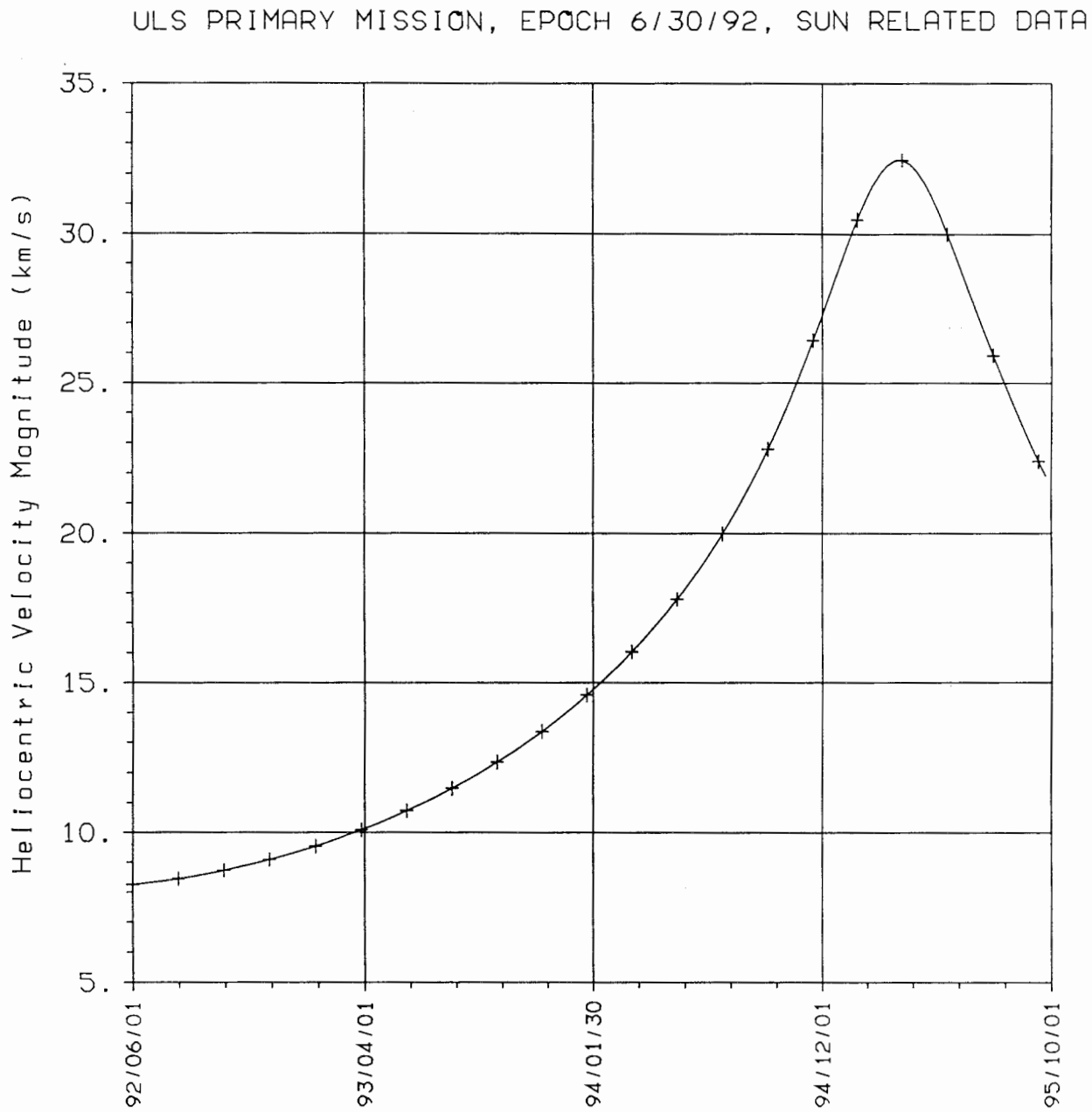

Figure 3-14. Heliocentric Velocity Magnitude

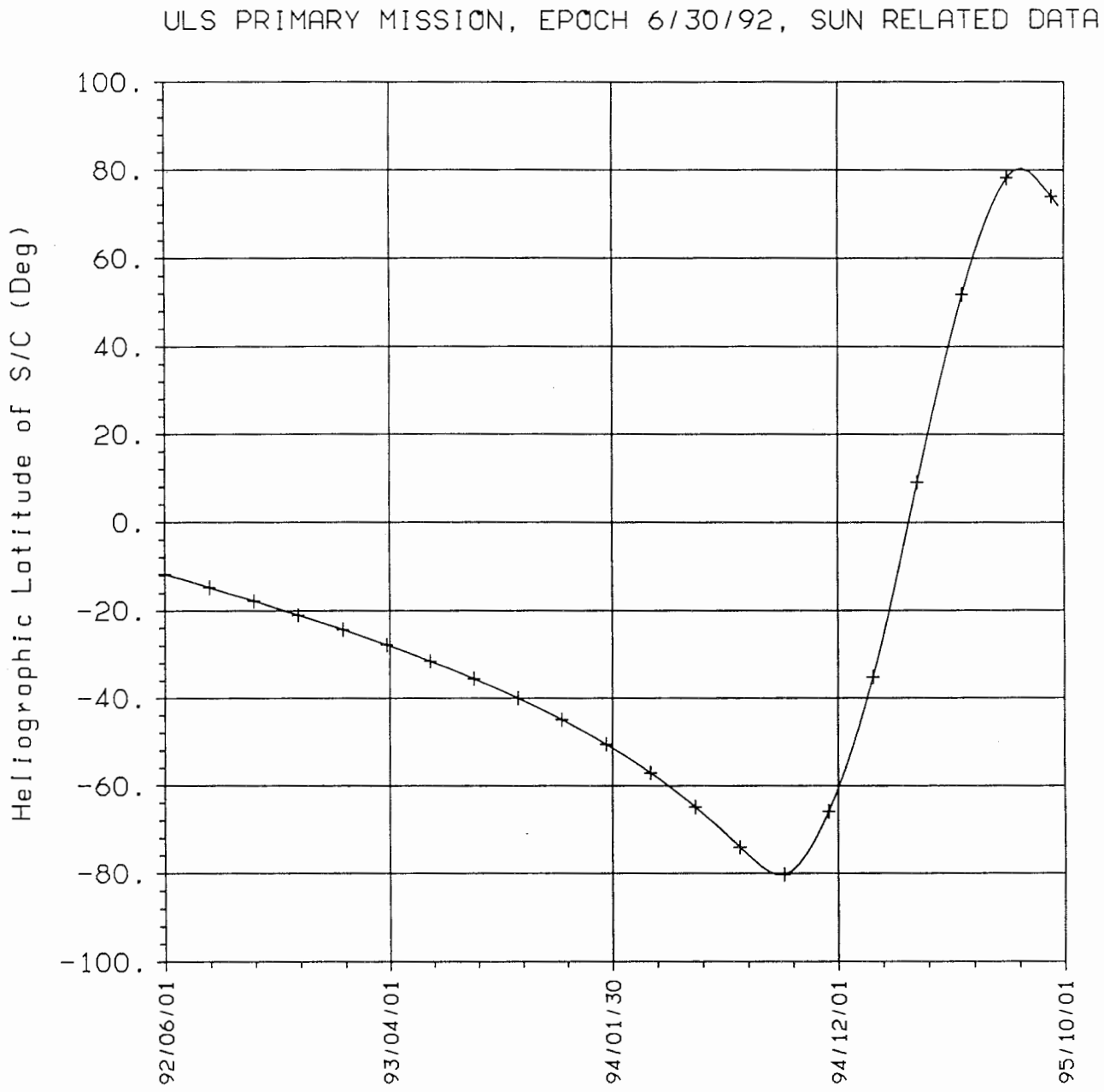

Figure 3-15. Heliographic Latitude of Spacecraft

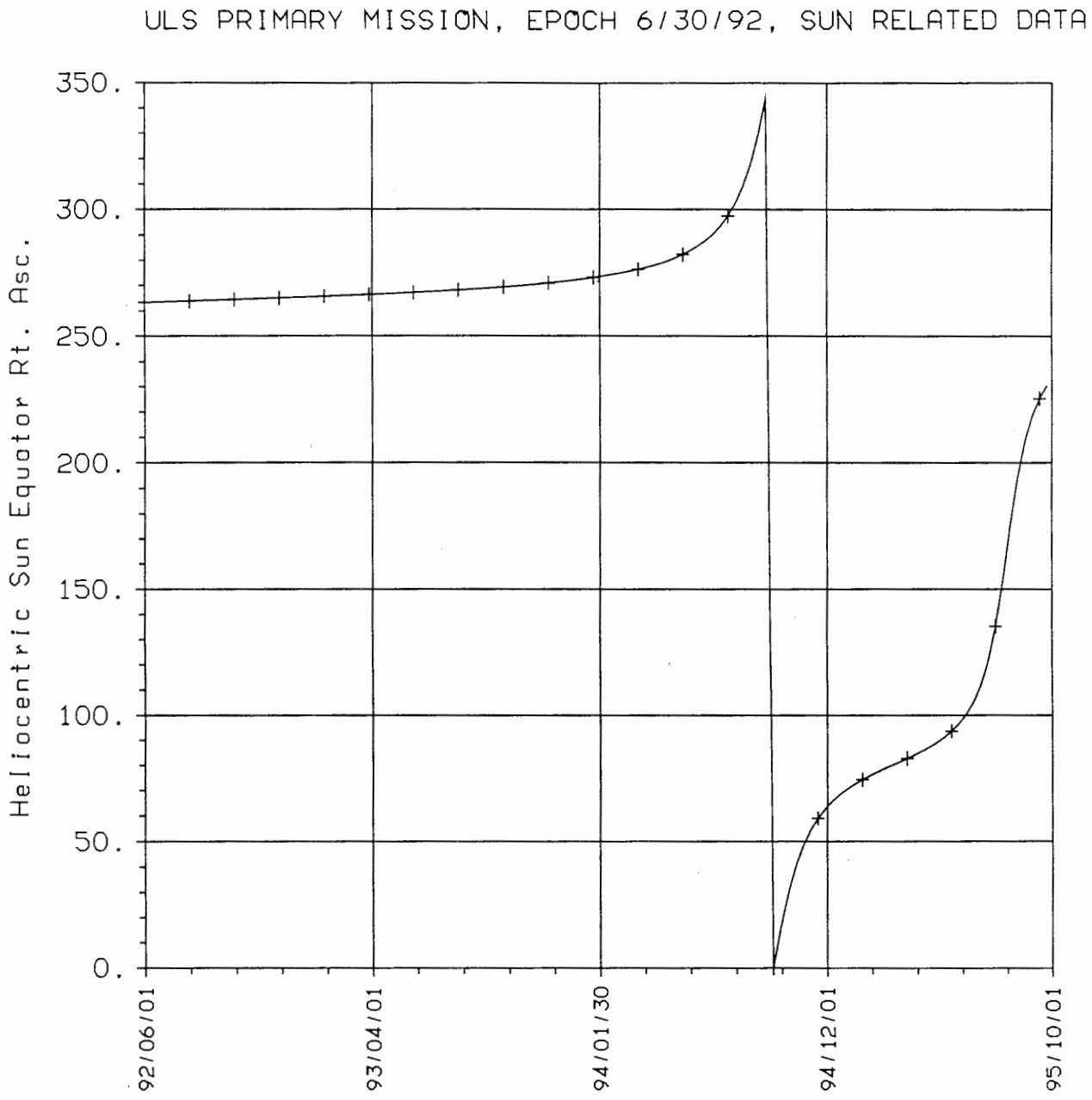

Figure 3-16. Heliocentric Sun Equator Right Ascension

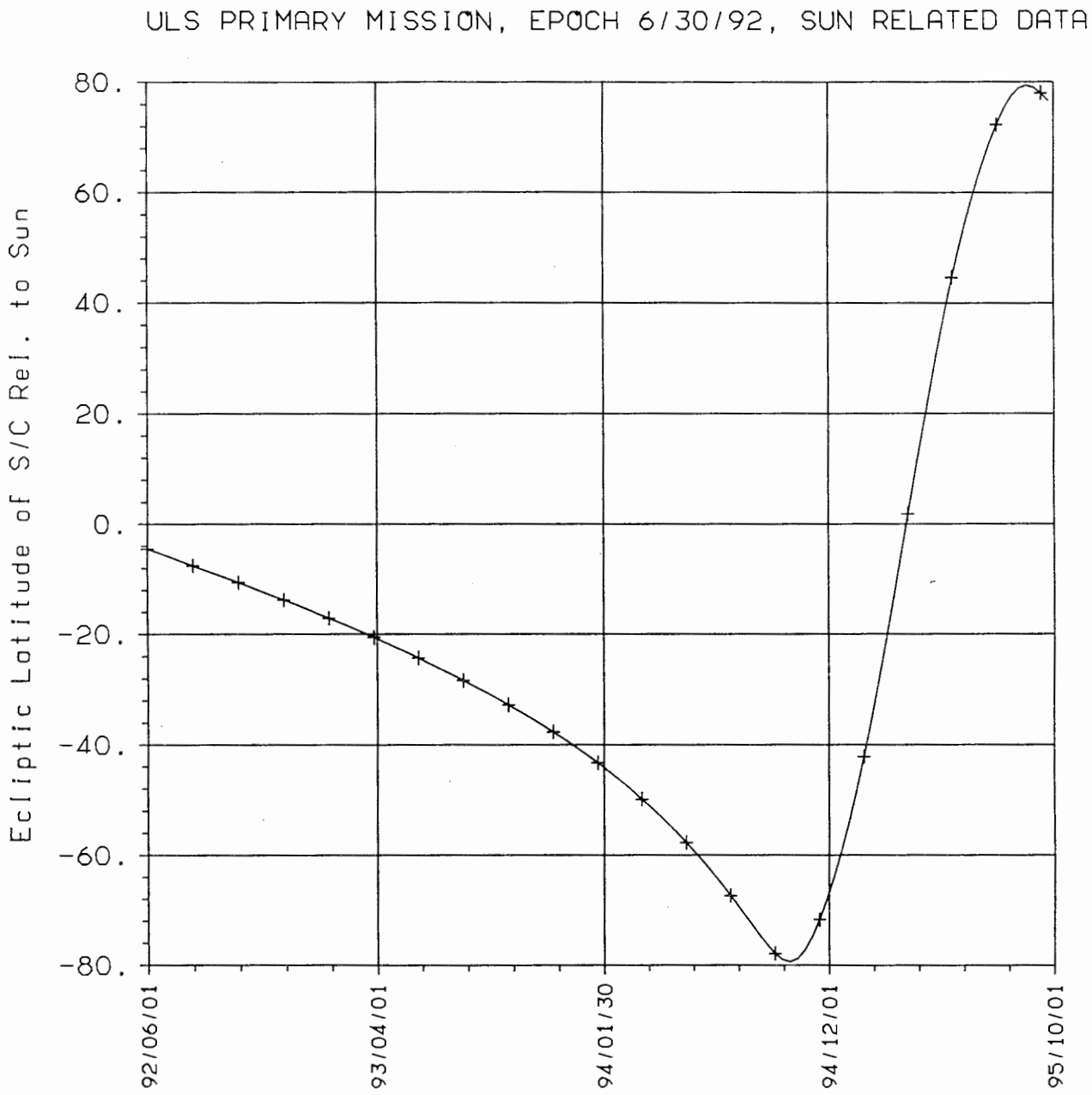

Figure 3-17. Ecliptic Latitude of Spacecraft relative to Sun

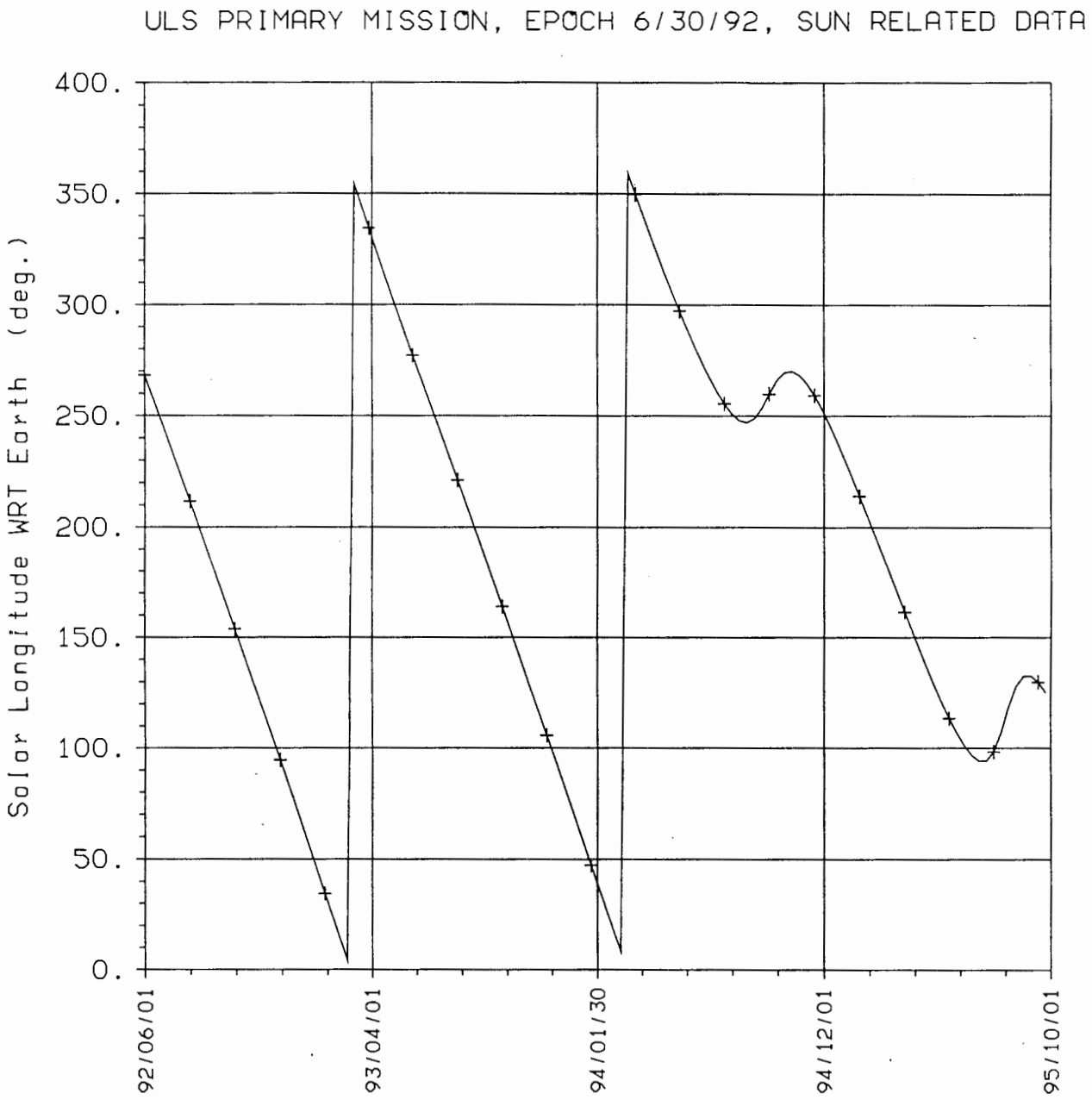

Figure 3-18. Solar Longitude of Spacecraft relative to Earth

TABLE 3-5 GEOCENTRIC CHARACTERISTCS FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Rt Asc wrt Earth	Geoc Rt Asc Rate	Decl wrt Earth	Geoc Decl Rate	Range wrt Earth	Range Rate wrt Earth	Range Acc wrt Earth	Earth Vector Rate
	deg	deg/day	deg	deg/day	AU	km/sec	km/sec^2	deg/day
25-JUN-1992	149.725	0.0812	6.734	-0.0647	5.8365	22.5800	-0.00000297	0.1034
5-JUL-1992	150.620	0.0974	6.054	-0.0712	5.9590	19.7527	-0.00000354	0.1202
15-JUL-1992	151.661	0.1103	5.312	-0.0771	6.0639	16.5237	-0.00000392	0.1342
25-JUL-1992	152.818	0.1206	4.513	-0.0827	6.1492	12.9845	-0.00000428	0.1459
4-AUG-1992	154.064	0.1282	3.659	-0.0880	6.2133	9.1404	-0.00000457	0.1553
14-AUG-1992	155.374	0.1332	2.755	-0.0928	6.2545	5.1284	-0.00000471	0.1622
24-AUG-1992	156.722	0.1360	1.805	-0.0973	6.2723	0.9928	-0.00000487	0.1671
3-SEP-1992	158.086	0.1363	0.812	-0.1013	6.2658	-3.2421	-0.00000489	0.1698
13-SEP-1992	159.440	0.1341	-0.220	-0.1049	6.2349	-7.4339	-0.00000481	0.1703
23-SEP-1992	160.761	0.1297	-1.285	-0.1081	6.1800	-11.5647	-0.00000474	0.1688
3-OCT-1992	162.024	0.1224	-2.380	-0.1107	6.1016	-15.5677	-0.00000449	0.1650
13-OCT-1992	163.201	0.1124	-3.498	-0.1128	6.0007	-19.3062	-0.00000417	0.1591
23-OCT-1992	164.263	0.0995	-4.634	-0.1143	5.8791	-22.7663	-0.00000382	0.1513
2-NOV-1992	165.180	0.0831	-5.780	-0.1148	5.7385	-25.8269	-0.00000325	0.1415
12-NOV-1992	165.914	0.0632	-6.927	-0.1145	5.5818	-28.3694	-0.00000264	0.1306
22-NOV-1992	166.432	0.0395	-8.067	-0.1131	5.4119	-30.3650	-0.00000194	0.1197
2-DEC-1992	166.690	0.0116	-9.184	-0.1102	5.2324	-31.6498	-0.00000103	0.1107
12-DEC-1992	166.650	-0.0202	-10.264	-0.1055	5.0478	-32.1411	-0.00000011	0.1074
22-DEC-1992	166.274	-0.0557	-11.287	-0.0987	4.8627	-31.7961	0.00000095	0.1128
1-JAN-1993	165.527	-0.0941	-12.228	-0.0891	4.6825	-30.4647	0.00000212	0.1281
11-JAN-1993	164.388	-0.1337	-13.059	-0.0766	4.5127	-28.1545	0.00000322	0.1511
21-JAN-1993	162.856	-0.1724	-13.750	-0.0609	4.3591	-24.8726	0.00000438	0.1782
31-JAN-1993	160.953	-0.2070	-14.268	-0.0422	4.2273	-20.6272	0.00000540	0.2050
10-FEB-1993	158.742	-0.2338	-14.588	-0.0215	4.1223	-15.6340	0.00000613	0.2273
20-FEB-1993	156.311	-0.2501	-14.695	0.0001	4.0478	-10.0749	0.00000668	0.2420
2-MAR-1993	153.784	-0.2530	-14.591	0.0203	4.0065	-4.2348	0.00000676	0.2457
12-MAR-1993	151.296	-0.2425	-14.300	0.0372	3.9987	1.4953	0.00000647	0.2379
22-MAR-1993	148.975	-0.2198	-13.862	0.0494	4.0231	6.8694	0.00000590	0.2190

TABLE 3-5 GEOCENTRIC CHARACTERISTCS FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Rt Asc wrt Earth	Geoc Rt Asc Rate	Decl wrt Earth	Geoc Decl Rate	Range wrt Earth	Range Rate wrt Earth	Range Acc wrt Earth	Earth Vector Rate
	deg	deg/day	deg	deg/day	AU	km/sec	km/sec^2	deg/day
1-APR-1993	146.933	-0.1874	-13.330	0.0558	4.0767	11.5776	0.00000496	0.1907
11-APR-1993	145.246	-0.1493	-12.764	0.0566	4.1551	15.4134	0.00000393	0.1562
21-APR-1993	143.956	-0.1085	-12.214	0.0525	4.2530	18.3418	0.00000282	0.1183
1-MAY-1993	143.077	-0.0677	-11.728	0.0443	4.3650	20.2711	0.00000166	0.0797
11-MAY-1993	142.595	-0.0292	-11.338	0.0334	4.4854	21.2670	0.00000067	0.0440
21-MAY-1993	142.483	0.0063	-11.067	0.0205	4.6091	21.4268	-0.00000030	0.0214
31-MAY-1993	142.708	0.0380	-10.932	0.0064	4.7313	20.7771	-0.00000116	0.0378
10-JUN-1993	143.229	0.0655	-10.940	-0.0081	4.8478	19.4803	-0.00000183	0.0648
20-JUN-1993	144.006	0.0894	-11.095	-0.0229	4.9552	17.6147	-0.00000248	0.0907
30-JUN-1993	145.004	0.1095	-11.399	-0.0377	5.0503	15.2334	-0.00000298	0.1138
10-JUL-1993	146.185	0.1262	-11.849	-0.0523	5.1305	12.4941	-0.00000336	0.1341
20-JUL-1993	147.519	0.1400	-12.444	-0.0667	5.1940	9.4246	-0.00000374	0.1521
30-JUL-1993	148.975	0.1507	-13.182	-0.0808	5.2389	6.0936	-0.00000394	0.1675
9-AUG-1993	150.525	0.1589	-14.060	-0.0947	5.2641	2.6249	-0.00000410	0.1809
19-AUG-1993	152.145	0.1647	-15.076	-0.1085	5.2689	-0.9819	-0.00000424	0.1925
29-AUG-1993	153.809	0.1678	-16.228	-0.1220	5.2527	-4.6340	-0.00000420	0.2021
8-SEP-1993	155.494	0.1687	-17.516	-0.1355	5.2155	-8.2463	-0.00000416	0.2104
18-SEP-1993	157.175	0.1671	-18.940	-0.1491	5.1575	-11.8196	-0.00000408	0.2173
28-SEP-1993	158.826	0.1626	-20.498	-0.1626	5.0793	-15.2351	-0.00000383	0.2228
8-OCT-1993	160.419	0.1555	-22.193	-0.1763	4.9819	-18.4417	-0.00000359	0.2276
18-OCT-1993	161.923	0.1448	-24.025	-0.1901	4.8667	-21.4196	-0.00000326	0.2316
28-OCT-1993	163.301	0.1300	-25.995	-0.2038	4.7352	-24.0348	-0.00000280	0.2349
7-NOV-1993	164.509	0.1108	-28.102	-0.2176	4.5898	-26.2616	-0.00000235	0.2385
17-NOV-1993	165.496	0.0855	-30.345	-0.2310	4.4327	-28.0492	-0.00000175	0.2425
27-NOV-1993	166.196	0.0533	-32.718	-0.2434	4.2669	-29.2719	-0.00000109	0.2475
7-DEC-1993	166.535	0.0129	-35.209	-0.2544	4.0957	-29.9253	-0.00000042	0.2546
17-DEC-1993	166.417	-0.0383	-37.797	-0.2624	3.9225	-29.9378	0.00000041	0.2642
27-DEC-1993	165.730	-0.1012	-40.442	-0.2656	3.7512	-29.2331	0.00000121	0.2766

TABLE 3-5 GEOCENTRIC CHARACTERISTCS FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Rt Asc wrt Earth	Geoc Rt Asc Rate	Decl wrt Earth	Geoc Decl Rate	Range wrt Earth	Range Rate wrt Earth	Range Acc wrt Earth	Earth Vector Rate
	deg	deg/day	deg	deg/day	AU	km/sec	km/sec^2	deg/day
6-JAN-1994	164.351	-0.1771	-43.086	-0.2618	3.5861	-27.8463	0.00000201	0.2920
16-JAN-1994	162.144	-0.2660	-45.641	-0.2471	3.4310	-25.7393	0.00000285	0.3093
26-JAN-1994	159.003	-0.3628	-47.982	-0.2186	3.2901	-22.9609	0.00000355	0.3268
5-FEB-1994	154.891	-0.4584	-49.959	-0.1740	3.1668	-19.6451	0.00000412	0.3424
15-FEB-1994	149.896	-0.5359	-51.406	-0.1129	3.0640	-15.8883	0.00000452	0.3528
25-FEB-1994	144.299	-0.5759	-52.180	-0.0408	2.9837	-11.9234	0.00000461	0.3555
7-MAR-1994	138.542	-0.5670	-52.215	0.0333	2.9262	-7.9847	0.00000448	0.3490
17-MAR-1994	133.122	-0.5098	-51.541	0.0990	2.8910	-4.2742	0.00000406	0.3322
27-MAR-1994	128.455	-0.4199	-50.292	0.1475	2.8759	-1.0432	0.00000340	0.3062
6-APR-1994	124.766	-0.3168	-48.657	0.1763	2.8778	1.5823	0.00000266	0.2736
16-APR-1994	122.117	-0.2142	-46.831	0.1859	2.8928	3.5072	0.00000179	0.2367
26-APR-1994	120.447	-0.1218	-44.993	0.1796	2.9168	4.6772	0.00000094	0.1992
6-MAY-1994	119.638	-0.0419	-43.275	0.1623	2.9456	5.1599	0.00000017	0.1651
16-MAY-1994	119.568	0.0257	-41.775	0.1367	2.9752	4.9823	-0.00000057	0.1380
26-MAY-1994	120.114	0.0818	-40.559	0.1060	3.0020	4.2296	-0.00000114	0.1229
5-JUN-1994	121.174	0.1291	-39.665	0.0723	3.0232	3.0289	-0.00000163	0.1229
15-JUN-1994	122.671	0.1692	-39.120	0.0363	3.0362	1.4335	-0.00000204	0.1362
25-JUN-1994	124.538	0.2034	-38.941	-0.0007	3.0392	-0.4332	-0.00000226	0.1582
5-JUL-1994	126.728	0.2342	-39.138	-0.0388	3.0309	-2.4678	-0.00000244	0.1858
15-JUL-1994	129.213	0.2625	-39.721	-0.0781	3.0105	-4.6181	-0.00000251	0.2165
25-JUL-1994	131.973	0.2896	-40.702	-0.1182	2.9776	-6.7548	-0.00000243	0.2493
4-AUG-1994	135.010	0.3180	-42.090	-0.1597	2.9326	-8.8051	-0.00000231	0.2850
14-AUG-1994	138.342	0.3488	-43.902	-0.2029	2.8762	-10.7073	-0.00000206	0.3230
24-AUG-1994	142.005	0.3852	-46.152	-0.2472	2.8095	-12.3315	-0.00000169	0.3638
3-SEP-1994	146.081	0.4320	-48.852	-0.2932	2.7344	-13.6196	-0.00000128	0.4084
13-SEP-1994	150.698	0.4950	-52.017	-0.3397	2.6529	-14.4961	-0.00000072	0.4563
23-SEP-1994	156.077	0.5872	-55.640	-0.3844	2.5679	-14.8433	-0.00000008	0.5075

TABLE 3-5 GEOCENTRIC CHARACTERISTCS FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Rt Asc wrt Earth	Geoc Rt Asc Rate	Decl wrt Earth	Geoc Decl Rate	Range wrt Earth	Range Rate wrt Earth	Range Acc wrt Earth	Earth Vector Rate
	deg	deg/day	deg	deg/day	AU	km/sec	km/sec^2	deg/day
3-OCT-1994	162.614	0.7318	-59.687	-0.4237	2.4826	-14.6233	0.00000059	0.5621
13-OCT-1994	171.027	0.9723	-64.066	-0.4482	2.4002	-13.7895	0.00000135	0.6178
23-OCT-1994	182.667	1.3965	-68.536	-0.4375	2.3246	-12.3015	0.00000208	0.6727
2-NOV-1994	199.970	2.1179	-72.559	-0.3484	2.2592	-10.2274	0.00000270	0.7241
12-NOV-1994	225.480	2.9336	-75.010	-0.1140	2.2073	-7.6775	0.00000318	0.7673
22-NOV-1994	255.511	2.8611	-74.457	0.2261	2.1712	-4.8038	0.00000342	0.7993
2-DEC-1994	280.011	2.0117	-70.800	0.4812	2.1520	-1.8682	0.00000332	0.8180
12-DEC-1994	296.407	1.3222	-65.270	0.6080	2.1492	0.8554	0.00000295	0.8220
22-DEC-1994	307.428	0.9204	-58.887	0.6599	2.1610	3.1526	0.00000232	0.8134
1-JAN-1995	315.383	0.6909	-52.196	0.6738	2.1844	4.7953	0.00000145	0.7958
11-JAN-1995	321.543	0.5518	-45.475	0.6683	2.2149	5.6556	0.00000055	0.7723
21-JAN-1995	326.584	0.4628	-38.856	0.6548	2.2482	5.7417	-0.00000035	0.7474
31-JAN-1995	330.897	0.4035	-32.385	0.6393	2.2797	5.0460	-0.00000124	0.7245
10-FEB-1995	334.712	0.3619	-26.063	0.6257	2.3052	3.6807	-0.00000188	0.7051
20-FEB-1995	338.176	0.3328	-19.854	0.6169	2.3213	1.8423	-0.00000235	0.6917
2-MAR-1995	341.400	0.3132	-13.706	0.6139	2.3258	-0.3406	-0.00000264	0.6852
12-MAR-1995	344.461	0.3000	-7.554	0.6176	2.3172	-2.6194	-0.00000258	0.6855
22-MAR-1995	347.421	0.2931	-1.329	0.6285	2.2958	-4.7436	-0.00000232	0.6934
1-APR-1995	350.341	0.2916	5.039	0.6462	2.2630	-6.5636	-0.00000184	0.7085
11-APR-1995	353.268	0.2947	11.615	0.6699	2.2211	-7.8301	-0.00000106	0.7295
21-APR-1995	356.254	0.3035	18.453	0.6984	2.1739	-8.3833	-0.00000022	0.7554
1-MAY-1995	359.359	0.3185	25.591	0.7293	2.1257	-8.1740	0.00000073	0.7838
11-MAY-1995	2.649	0.3412	33.035	0.7587	2.0812	-7.1015	0.00000174	0.8108
21-MAY-1995	6.227	0.3770	40.745	0.7821	2.0453	-5.2252	0.00000256	0.8326
31-MAY-1995	10.255	0.4331	48.639	0.7943	2.0221	-2.7059	0.00000324	0.8443

TABLE 3-5 GEOCENTRIC CHARACTERISTCS FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Rt Asc wrt Earth	Geoc Rt Asc Rate	Decl wrt Earth	Geoc Decl Rate	Range wrt Earth	Range Rate wrt Earth	Range Acc wrt Earth	Earth Vector Rate
	deg	deg/day	deg	deg/day	AU	km/sec	km/sec^2	deg/day
10-JUN-1995	15.015	0.5281	56.574	0.7896	2.0149	0.2971	0.00000366	0.8414
20-JUN-1995	21.097	0.7093	64.359	0.7634	2.0259	3.4889	0.00000368	0.8228
30-JUN-1995	29.898	1.1088	71.746	0.7078	2.0550	6.5753	0.00000343	0.7884
10-JUL-1995	45.464	2.2017	78.323	0.5915	2.1012	9.3384	0.00000293	0.7406
20-JUL-1995	80.498	5.1114	82.912	0.2662	2.1619	11.5727	0.00000222	0.6846
30-JUL-1995	134.690	4.4096	82.697	-0.2745	2.2336	13.1654	0.00000146	0.6241
9-AUG-1995	164.184	1.8772	78.910	-0.4314	2.3127	14.1029	0.00000071	0.5626
19-AUG-1995	177.844	1.0073	74.568	-0.4263	2.3953	14.3934	-0.00000003	0.5036
29-AUG-1995	186.038	0.6775	70.491	-0.3864	2.4778	14.0810	-0.00000067	0.4478
8-SEP-1995	191.955	0.5232	66.866	-0.3383	2.5570	13.2640	-0.00000120	0.3958
18-SEP-1995	196.735	0.4405	63.729	-0.2889	2.6302	12.0193	-0.00000166	0.3486
28-SEP-1995	200.872	0.3904	61.087	-0.2396	2.6951	10.4262	-0.00000200	0.3050
1-OCT-1995	202.026	0.3788	60.390	-0.2249	2.7127	9.8991	-0.00000207	0.2926

TABLE 3-6 SUN-RELATED-DATA FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Earth Sun S/P Angle	Sun S/C Earth Angle	Sun Earth S/C Angle	Helioc Range	Helioc Range Rate	Helioc Vel Magnitude	Heliog Lat S/C	Helioc Rt Asc S/C	Helioc Eclip Lat	Solar Long wrt Earth
	deg	deg	deg	AU	km/sec	km/sec	deg	deg	deg	deg
25-JUN-1992	114.34	9.13	56.53	5.3435	-1.4831	8.3169	-12.84	263.47	-5.74	245.510
5-JUL-1992	123.69	8.16	48.15	5.3347	-1.5906	8.3486	-13.34	263.56	-6.24	236.114
15-JUL-1992	132.98	7.04	39.97	5.3252	-1.6983	8.3827	-13.84	263.65	-6.74	226.703
25-JUL-1992	142.20	5.81	31.99	5.3150	-1.8064	8.4193	-14.34	263.74	-7.24	217.261
4-AUG-1992	151.29	4.50	24.21	5.3043	-1.9147	8.4584	-14.85	263.83	-7.75	207.771
14-AUG-1992	160.04	3.17	16.79	5.2929	-2.0233	8.4999	-15.35	263.93	-8.25	198.238
24-AUG-1992	167.67	1.97	10.36	5.2809	-2.1323	8.5438	-15.86	264.02	-8.76	188.653
3-SEP-1992	170.69	1.49	7.82	5.2683	-2.2416	8.5901	-16.37	264.11	-9.27	179.009
13-SEP-1992	165.71	2.28	12.00	5.2550	-2.3513	8.6388	-16.89	264.21	-9.79	169.320
23-SEP-1992	157.49	3.56	18.94	5.2411	-2.4613	8.6899	-17.41	264.31	-10.30	159.584
3-OCT-1992	148.43	4.92	26.64	5.2266	-2.5718	8.7434	-17.92	264.40	-10.82	149.801
13-OCT-1992	139.06	6.25	34.69	5.2114	-2.6826	8.7993	-18.45	264.50	-11.34	139.988
23-OCT-1992	129.53	7.50	42.97	5.1956	-2.7939	8.8575	-18.97	264.60	-11.86	130.143
2-NOV-1992	119.90	8.62	51.48	5.1791	-2.9056	8.9182	-19.50	264.70	-12.39	120.267
12-NOV-1992	110.21	9.58	60.21	5.1620	-3.0178	8.9813	-20.03	264.81	-12.92	110.372
22-NOV-1992	100.49	10.34	69.18	5.1443	-3.1305	9.0468	-20.57	264.91	-13.45	100.452
2-DEC-1992	90.75	10.86	78.40	5.1259	-3.2437	9.1147	-21.11	265.02	-13.99	90.506
12-DEC-1992	81.03	11.11	87.87	5.1068	-3.3574	9.1850	-21.65	265.12	-14.53	80.540
22-DEC-1992	71.35	11.05	97.60	5.0871	-3.4717	9.2579	-22.20	265.23	-15.08	70.547
1-JAN-1993	61.77	10.66	107.57	5.0667	-3.5866	9.3331	-22.75	265.34	-15.63	60.528
11-JAN-1993	52.36	9.94	117.71	5.0457	-3.7021	9.4109	-23.30	265.46	-16.18	50.493
21-JAN-1993	43.21	8.89	127.89	5.0240	-3.8182	9.4912	-23.86	265.57	-16.74	40.439
31-JAN-1993	34.56	7.60	137.84	5.0016	-3.9350	9.5740	-24.43	265.69	-17.31	30.376
10-FEB-1993	26.85	6.21	146.94	4.9785	-4.0524	9.6593	-25.00	265.81	-17.87	20.322
20-FEB-1993	21.09	5.04	153.87	4.9548	-4.1705	9.7473	-25.57	265.93	-18.45	10.282
2-MAR-1993	19.03	4.63	156.34	4.9303	-4.2894	9.8378	-26.15	266.05	-19.03	0.273
12-MAR-1993	21.67	5.27	153.06	4.9052	-4.4090	9.9310	-26.74	266.18	-19.61	350.318
22-MAR-1993	27.62	6.59	145.79	4.8794	-4.5294	10.0268	-27.33	266.31	-20.20	340.420

TABLE 3-6 SUN-RELATED-DATA FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Earth Sun S/P Angle	Sun S/C Earth Angle	Sun Earth S/C Angle	Helioc Range	Helioc Range Rate	Helioc Vel Magnitude	Heliog Lat S/C	Helioc Rt Asc S/C	Helioc Eclip Lat	Solar Long wrt Earth
	deg	deg	deg	AU	km/sec	km/sec	deg	deg	deg	deg
1-APR-1993	35.16	8.11	136.73	4.8529	-4.6505	10.1253	-27.93	266.44	-20.80	330.594
11-APR-1993	43.41	9.54	127.05	4.8257	-4.7724	10.2266	-28.54	266.57	-21.41	320.853
21-APR-1993	51.98	10.73	117.30	4.7978	-4.8952	10.3307	-29.15	266.71	-22.02	311.191
1-MAY-1993	60.68	11.61	107.71	4.7691	-5.0188	10.4375	-29.77	266.85	-22.64	301.611
11-MAY-1993	69.41	12.17	98.42	4.7398	-5.1433	10.5473	-30.39	267.00	-23.26	292.111
21-MAY-1993	78.12	12.41	89.47	4.7097	-5.2687	10.6599	-31.03	267.14	-23.89	282.674
31-MAY-1993	86.77	12.35	80.88	4.6789	-5.3950	10.7755	-31.67	267.30	-24.54	273.291
10-JUN-1993	95.30	12.04	72.66	4.6474	-5.5223	10.8942	-32.32	267.45	-25.18	263.951
20-JUN-1993	103.70	11.49	64.80	4.6151	-5.6506	11.0160	-32.98	267.61	-25.84	254.630
30-JUN-1993	111.91	10.76	57.33	4.5821	-5.7799	11.1410	-33.65	267.78	-26.51	245.318
10-JUL-1993	119.84	9.90	50.27	4.5484	-5.9103	11.2692	-34.33	267.95	-27.19	236.001
20-JUL-1993	127.38	8.94	43.67	4.5139	-6.0418	11.4008	-35.02	268.13	-27.88	226.660
30-JUL-1993	134.36	7.96	37.68	4.4786	-6.1744	11.5358	-35.72	268.31	-28.57	217.286
9-AUG-1993	140.46	7.04	32.49	4.4425	-6.3081	11.6742	-36.42	268.50	-29.28	207.877
19-AUG-1993	145.25	6.29	28.47	4.4057	-6.4430	11.8164	-37.15	268.69	-30.00	198.418
29-AUG-1993	148.11	5.83	26.06	4.3681	-6.5791	11.9622	-37.88	268.90	-30.73	188.913
8-SEP-1993	148.52	5.79	25.69	4.3297	-6.7165	12.1119	-38.62	269.11	-31.48	179.366
18-SEP-1993	146.40	6.19	27.41	4.2905	-6.8551	12.2654	-39.38	269.32	-32.24	169.772
28-SEP-1993	142.17	6.95	30.88	4.2505	-6.9950	12.4231	-40.16	269.55	-33.01	160.144
8-OCT-1993	136.47	7.94	35.59	4.2097	-7.1362	12.5850	-40.94	269.79	-33.80	150.489
18-OCT-1993	129.82	9.05	41.13	4.1681	-7.2788	12.7512	-41.74	270.04	-34.60	140.804
28-OCT-1993	122.58	10.18	47.24	4.1256	-7.4227	12.9218	-42.56	270.30	-35.41	131.103
7-NOV-1993	114.99	11.29	53.72	4.0823	-7.5679	13.0972	-43.39	270.57	-36.25	121.391
17-NOV-1993	107.22	12.30	60.48	4.0382	-7.7146	13.2774	-44.25	270.85	-37.10	111.662
27-NOV-1993	99.40	13.19	67.41	3.9932	-7.8627	13.4625	-45.12	271.15	-37.97	101.927
7-DEC-1993	91.64	13.91	74.45	3.9474	-8.0122	13.6529	-46.00	271.47	-38.86	92.185
17-DEC-1993	84.03	14.45	81.52	3.9007	-8.1631	13.8487	-46.91	271.81	-39.77	82.430
27-DEC-1993	76.71	14.78	88.50	3.8531	-8.3154	14.0501	-47.84	272.16	-40.70	72.673

TABLE 3-6 SUN-RELATED-DATA FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Earth Sun S/P Angle	Sun S/C Earth Angle	Sun Earth S/C Angle	Helioc Range	Helioc Range Rate	Helioc Vel Magnitude	Heliog Lat S/C	Helioc Rt Asc S/C	Helioc Eclip Lat	Solar Long wrt Earth
	deg	deg	deg	AU	km/sec	km/sec	deg	deg	deg	deg
6-JAN-1994	69.81	14.91	95.27	3.8046	-8.4691	14.2574	-48.80	272.54	-41.65	62.915
16-JAN-1994	63.49	14.87	101.65	3.7553	-8.6243	14.4708	-49.77	272.94	-42.63	53.156
26-JAN-1994	57.95	14.69	107.36	3.7050	-8.7808	14.6907	-50.77	273.38	-43.63	43.415
5-FEB-1994	53.42	14.48	112.10	3.6538	-8.9386	14.9172	-51.80	273.84	-44.66	33.702
15-FEB-1994	50.14	14.33	115.53	3.6018	-9.0977	15.1508	-52.85	274.34	-45.72	24.028
25-FEB-1994	48.33	14.35	117.33	3.5488	-9.2581	15.3918	-53.94	274.88	-46.80	14.421
7-MAR-1994	48.06	14.61	117.33	3.4948	-9.4196	15.6405	-55.05	275.46	-47.92	4.899
17-MAR-1994	49.28	15.12	115.59	3.4399	-9.5821	15.8973	-56.19	276.10	-49.07	355.478
27-MAR-1994	51.79	15.82	112.39	3.3841	-9.7455	16.1627	-57.37	276.81	-50.26	346.187
6-APR-1994	55.30	16.61	108.09	3.3274	-9.9096	16.4372	-58.59	277.58	-51.48	337.044
16-APR-1994	59.51	17.39	103.09	3.2697	-10.0742	16.7211	-59.84	278.44	-52.75	328.061
26-APR-1994	64.17	18.09	97.74	3.2110	-10.2391	17.0150	-61.13	279.40	-54.05	319.264
6-MAY-1994	69.06	18.65	92.29	3.1514	-10.4039	17.3195	-62.46	280.49	-55.40	310.666
16-MAY-1994	73.99	19.07	86.95	3.0908	-10.5683	17.6352	-63.84	281.72	-56.80	302.282
26-MAY-1994	78.81	19.33	81.86	3.0293	-10.7318	17.9627	-65.25	283.14	-58.24	294.144
5-JUN-1994	83.40	19.47	77.13	2.9669	-10.8939	18.3027	-66.71	284.79	-59.73	286.277
15-JUN-1994	87.64	19.53	72.84	2.9035	-11.0538	18.6560	-68.21	286.73	-61.28	278.726
25-JUN-1994	91.42	19.53	69.05	2.8392	-11.2108	19.0234	-69.76	289.05	-62.89	271.567
5-JUL-1994	94.65	19.53	65.81	2.7740	-11.3639	19.4056	-71.33	291.86	-64.54	264.899
15-JUL-1994	97.27	19.57	63.16	2.7079	-11.5119	19.8036	-72.93	295.34	-66.26	258.871
25-JUL-1994	99.22	19.68	61.11	2.6410	-11.6534	20.2184	-74.54	299.72	-68.02	253.725
4-AUG-1994	100.47	19.89	59.64	2.5733	-11.7867	20.6508	-76.11	305.36	-69.83	249.795
14-AUG-1994	101.04	20.22	58.74	2.5049	-11.9097	21.1020	-77.59	312.76	-71.67	247.562
24-AUG-1994	100.98	20.69	58.34	2.4358	-12.0198	21.5730	-78.89	322.51	-73.50	247.636
3-SEP-1994	100.39	21.28	58.34	2.3661	-12.1141	22.0648	-79.83	335.11	-75.28	250.507
13-SEP-1994	99.40	21.97	58.63	2.2959	-12.1888	22.5784	-80.22	350.34	-76.92	255.950
23-SEP-1994	98.18	22.76	59.07	2.2254	-12.2394	23.1146	-79.87	6.61	-78.25	262.392

TABLE 3-6 SUN-RELATED-DATA FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Earth Sun S/P Angle	Sun S/C Earth Angle	Sun Earth S/C Angle	Helioc Range	Helioc Range Rate	Helioc Vel Magnitude	Heliog Lat S/C	Helioc Rt Asc S/C	Helioc Eclip Lat	Solar Long wrt Earth
	deg	deg	deg	AU	km/sec	km/sec	deg	deg	deg	deg
3-OCT-1994	96.92	23.59	59.49	2.1546	-12.2606	23.6744	-78.70	21.61	-79.03	267.513
13-OCT-1994	95.84	24.43	59.73	2.0838	-12.2458	24.2580	-76.80	33.90	-78.99	269.894
23-OCT-1994	95.16	25.23	59.60	2.0132	-12.1872	24.8657	-74.29	43.40	-77.97	269.448
2-NOV-1994	95.11	25.94	58.94	1.9431	-12.0756	25.4971	-71.28	50.63	-76.01	266.704
12-NOV-1994	95.90	26.49	57.61	1.8739	-11.8998	26.1506	-67.82	56.19	-73.24	262.266
22-NOV-1994	97.69	26.80	55.51	1.8058	-11.6470	26.8241	-63.94	60.56	-69.83	256.615
2-DEC-1994	100.63	26.76	52.60	1.7395	-11.3024	27.5136	-59.65	64.08	-65.85	250.082
12-DEC-1994	104.79	26.29	48.92	1.6755	-10.8496	28.2131	-54.95	66.97	-61.37	242.903
22-DEC-1994	110.19	25.29	44.52	1.6144	-10.2709	28.9142	-49.82	69.42	-56.40	235.250
1-JAN-1995	116.78	23.70	39.52	1.5571	-9.5488	29.6054	-44.26	71.53	-50.95	227.231
11-JAN-1995	124.49	21.47	34.05	1.5044	-8.6672	30.2718	-38.25	73.38	-45.04	218.937
21-JAN-1995	133.17	18.62	28.21	1.4573	-7.6145	30.8950	-31.80	75.06	-38.66	210.446
31-JAN-1995	142.65	15.20	22.15	1.4168	-6.3866	31.4534	-24.93	76.60	-31.85	201.805
10-FEB-1995	152.63	11.35	16.02	1.3839	-4.9909	31.9237	-17.69	78.04	-24.65	193.072
20-FEB-1995	162.46	7.38	10.17	1.3595	-3.4486	32.2826	-10.12	79.43	-17.13	184.300
2-MAR-1995	169.55	4.43	6.02	1.3443	-1.7963	32.5102	-2.33	80.79	-9.37	175.528
12-MAR-1995	166.80	5.62	7.58	1.3388	-0.0837	32.5926	5.59	82.16	-1.48	166.806
22-MAR-1995	157.56	9.54	12.91	1.3433	1.6318	32.5247	13.51	83.56	6.41	158.186
1-APR-1995	147.18	13.85	18.97	1.3576	3.2923	32.3107	21.31	85.05	14.19	149.706
11-APR-1995	136.93	17.94	25.13	1.3811	4.8470	31.9638	28.88	86.65	21.75	141.422
21-APR-1995	127.25	21.59	31.16	1.4133	6.2581	31.5034	36.13	88.42	28.99	133.396
1-MAY-1995	118.39	24.64	36.97	1.4531	7.5028	30.9525	43.00	90.44	35.85	125.689
11-MAY-1995	110.54	27.03	42.43	1.4996	8.5725	30.3347	49.42	92.80	42.28	118.400
21-MAY-1995	103.83	28.72	47.45	1.5518	9.4703	29.6716	55.39	95.65	48.26	111.665
31-MAY-1995	98.34	29.74	51.92	1.6087	10.2073	28.9821	60.86	99.20	53.78	105.676

TABLE 3-6 SUN-RELATED-DATA FOR THE ULYSSES POST-JUPITER PRIMARY MISSION

Date	Earth Sun S/P Angle	Sun S/C Earth Angle	Sun Earth S/C Angle	Helioc Range	Helioc Range Rate	Helioc Vel Magnitude	Heliog Lat S/C	Helioc Rt Asc S/C	Helioc Eclip Lat	Solar Long wrt Earth
	deg	deg	deg	AU	km/sec	km/sec	deg	deg	deg	deg
10-JUN-1995	94.10	30.17	55.73	1.6694	10.7991	28.2814	65.84	103.78	58.84	100.756
20-JUN-1995	91.10	30.10	58.80	1.7332	11.2634	27.5814	70.28	109.92	63.43	97.419
30-JUN-1995	89.25	29.65	61.10	1.7993	11.6178	26.8907	74.11	118.46	67.55	96.475
10-JUL-1995	88.42	28.93	62.66	1.8672	11.8788	26.2154	77.21	130.58	71.17	99.112
20-JUL-1995	88.42	28.03	63.55	1.9364	12.0616	25.5597	79.33	147.36	74.25	106.377
30-JUL-1995	89.05	27.03	63.91	2.0064	12.1790	24.9262	80.21	167.82	76.67	117.283
9-AUG-1995	90.09	26.00	63.90	2.0769	12.2423	24.3161	79.81	187.76	78.32	127.624
19-AUG-1995	91.32	24.99	63.69	2.1477	12.2610	23.7301	78.48	203.50	79.08	133.718
29-AUG-1995	92.52	24.03	63.44	2.2185	12.2430	23.1680	76.63	214.71	78.95	135.223
8-SEP-1995	93.52	23.16	63.32	2.2891	12.1950	22.6295	74.56	222.57	78.12	133.336
18-SEP-1995	94.13	22.40	63.47	2.3593	12.1225	22.1137	72.43	228.23	76.82	129.189
28-SEP-1995	94.23	21.77	64.00	2.4291	12.0300	21.6199	70.29	232.44	75.26	123.538
1-OCT-1995	94.14	21.60	64.26	2.4499	11.9990	21.4759	69.66	233.49	74.76	121.629