SATELLITE LASER RANGING

EARTH ORIENTATION AND SITE COORDINATES FROM THE CENTER FOR SPACE RESEARCH CSR 91 L 02

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Earth orientation parameters were derived from a combination of Lageos full rate and quick look data. Full rate data was used from 1976 until the end of July, 1990, and quicklook data used for August 1990 through February 1991. A summary of the 1990 data used in the solution is provided in Table 1. The column titled RBTB RMS refers to the root mean square of the residuals after removing an estimated range bias and time bias. The column titled PREC EST refers to the residual rms after removing a second order polynomial, yielding an estimate of the internal precision of the data.

The site coordinates for sites which observed in 1990 were adjusted using data only from that year, for sites which did not observe, the coordinates were fixed to the values determined in the solution SSC(CSR) 89 L 02, after three rigid rotations to an origin close to that of the IERS combined system for the period 1984-1989. The velocities of all sites were held to that predicted by the Minster and Jordan AM0-2 model. The site positions were mapped to epoch 1988.0 for all sites using those velocities. This set of coordinates, referred to as SSC(CSR) 91 L 02, should yield the best results for 1990, as opposed to fitting in a mean sense over the entire 14.8 year span of the data.

The force and measurement models used for this solution conform generally to the IERS Standards, with the following exceptions:

1) The mean gravity field was PTGF-4A, a state of the art gravity field computed at the University of Texas Center for Space Research. PTGF-4A incorporates data from 15 satellites, plus altimetric data from 2 satellites, and surface gravimetry. The field was a preliminary version of the now released TEG-2 model.

2) The ocean tide model was an enhanced version of the Schwiderski model extrapolated to include 80 consituents complete through degree and order 20, assuming admittances which vary linearly with frequency. Preliminary documentation is found in Casotto, [1989].

3) The solid tide model has been expanded to include third degree terms.

4) The geogravitational constant, GM, is 398600.4415 km3/s2, derived from Ries et al. [1989], adjusted for an 11 mm lengthening of the Lageos center of mass correction after recent recalculation.

The data was weighted in a piecewise continuous, linearly interpolated model to reflect the increase in laser hardware over the data span. The weighting curve had the following node points:

MJD 42905.0: 700 mm
MJD 44162.0: 400 mm
MJD 45578.0: 200 mm
MJD 47000.0: 100 mm

The weights are larger than the true random component of the laser ranges in order to reflect unmodelled systematic errors, and are thus scaled so that the formal uncertainties on the Earth orientation parameters are consistent with their internal precision.

The solutions for orbit elements and Earth orientation parameters were computed using residuals from a long arc fit spanning the period from 7 May 1976 through 21 February 1991, a period of 14.8 years.The short arc adjustments were made at the following intervals, to allow for the change in data quantity over time:

MJD 42904.5-44164.5: 15 days
MJD 44164.5-45580.5: 6 days
MJD 45580.5 - present: 3 days

For each interval, whether 15, 6, or 3 days in length, 6 Keplerian mean elements and xp and yp were solved. The UT1 estimates are obtained from the Lageos node residuals, with the constraint that they follow the JPL SPACE90 series at periods longer than about 60 days [Gross and Steppe, 1991].

REFERENCES

Casotto, S., 1989: Ocean Tide Models for TOPEX Precision Orbit Determination, *Ph.D. Diss.*, The University of Texas at Austin, 1989.

Gross, R.S. and J.A. Steppe, 1991: A Combination of Earth Orientation Data: SPACE90 description submitted to IERS.

Ries, J.C., R.J. Eanes, C. Huang, B.E. Schutz, C.K. Shum, B.D. Tapley, M.M. Watkins, and D.N. Yuan, 1989: Determination of the Gravitational Coefficient of the Earth from Near Earth Satellites, *Geophysical Research Letters*, **16(4)**, 271-274.

Table 1. Summary of 1990 Lageos Residual Analysis, FR np Jan-Jul, QL np Aug-Dec

Station	# of Passes	# of 2-min np	number edited	percent edited	number kept	RAW RMS (cm)	RBTB RMS (cm)	PREC EST (cm)
1181 POTSDM	121	1308	250	19.1	1058	15.2	11.2	9.9
1873 SIMEIZ	77	693	133	19.2	560	14.4	9.3	8.2
1884 RIGA	64	737	387	52.5	350	18.6	12.0	8.8
1893 CRIMEA	26	190	25	13.2	165	7.5	5.5	4.8
1953 SANCUB	13	82	33	40.2	49	16.3	10.9	9.2
7046 BRLAK2	45	651	1	0.2	650	6.3	3.8	3.6
7080 MCDON4	214	2122	56	2.6	2066	3.8	1.1	1.0
7090 YARAG	250	4417	35	0.8	4382	3.3	0.6	0.4
7091 HAYSTK	40	430	0	0.0	430	3.4	1.1	1.0
7097 EASTR2	69	767	7	0.9	760	6.3	1.2	1.1
7105 GRF105	50	747	4	0.5	743	1.7	0.7	0.6
7109 QUINC2	186	2858	19	0.7	2839	3.6	0.5	0.3
7110 MNPEAK	394	6239	31	0.5	6208	2.9	0.6	0.4
7112 PLATVL	40	565	0	0.0	565	5.3	4.2	3.9
7122 MAZTLN	137	1922	14	0.7	1908	2.7	0.6	0.4
7123 HUAHI2	54	698	33	4.7	665	4.3	0.8	0.7
7210 HOLLAS	147	1715	9	0.5	1706	3.3	1.1	0.9
7236 WUHAN	33	524	33	6.3	491	9.7	3.0	2.5
7288 MOJAV2	34	519	2	0.4	517	4.4	0.7	0.5
7401 CERTOL	93	1432	10	0.7	1422	2.5	0.7	0.6
7403 ARELA2	86	1377	5	0.4	1372	2.0	0.8	0.7
7515 DIONS2	45	624	14	2.2	610	6.4	2.9	2.6
7525 XRISOK	31	434	8	1.8	426	6.1	0.6	0.4
7530 BARGIY	8	73	1	1.4	72	15.0	4.4	4.3
7543 NOTO	49	529	0	0.0	529	5.0	1.6	1.4
7545 CAGLIA	40	514	6	1.2	508	4.6	0.8	0.5
7602 TROMSO	45	405	4	1.0	401	5.8	2.9	2.7
7805 METFIN	8	55	46	83.6	9	17.0	12.0	12.0
7810 ZIMMER	240	3290	35	1.1	3255	4.3	2.9	2.6
7811 BOROWC	70	667	119	17.8	548	13.9	9.9	8.2
7831 HELWAN	65	639	12	1.9	627	3.6	2.0	1.7
7834 WETZEL	179	1887	13	0.7	1874	3.7	2.0	1.8
7835 GRASSE	624	10192	186	1.8	10006	3.2	1.6	1.2
7837 SHAHAI	132	1406	82	5.8	1324	9.4	4.6	4.1
7838 SHO	84	1095	34	3.1	1061	5.3	3.8	3.2
7839 GRAZ	150	2029	8	0.4	2021	2.7	0.8	0.7
7840 RGO	493	5660	68	1.2	5592	3.5	1.8	1.5
7843 ORRLLR	281	3624	44	1.2	3580	3.1	1.1	0.8
7853 OWNSV3	46	697	109	15.6	588	6.3	2.6	2.2
7907 ARELAS	145	2074	53	2.6	2021	10.3	8.9	8.5
7918 GRF918	53	715	96	13.4	619	6.2	0.5	0.3
7920 GRF920	14	103	11	10.7	92	7.1	0.8	0.7
7939 MATERA	404	6448	172	2.7	6276	8.0	6.3	5.7
8833 KOTWK2	35	383	3	0.8	380	3.9	2.4	2.1
TOTALS	5414	73536	2211	3.0	71325	5.6	3.5	3.1

SUMMARY SHEET

1 - Technique:		SLR
2 - Analysis Center:		CSR
3 - Solution Identifier:		SSC(CSR) 91 L 02
4 - Software Used:		UTOPIA
5 - Relativity Scale:		Geocentric (LE)
6 - Permananent Tidal Correction on station:		Yes
7 - Tectonic Plate model:		AM0-2
8 - Velocity of light (C) =		299792458 m/sec
9 - Geogravitational constant (GM) =		398600.4415 km3/s2
10 - Reference Epoch =		1988.0
11 - Adjusted Parameters:	Coordinates:	Epoch 1988.0 position for all sites in cartesian coordinates solved one time for entire data span. Data weighted so that for sites which observed in 1990 had positions adjusted using only that data. For sites which did not observe, positions were held to their SSC(CSR) 89 L 01 positions.
	Orbit:	6 Keplerian mean elements solved every: 15 days from MJD 42904.5 - 44180.5 6 days from MJD 44180.5 - 45580.5 3 days from MJD 45580.5 - 48000.5
	EOP:	x, y and UT1 (UT1 constrained by JPL SPACE 90) solved at same intervals as orbit
12 - Definition of the origin:		Geocentric, C10 = C11 = S11 = 0.0
13 - Definition of the orientation:		System oriented to agree with IERS combined in a mean sense over period 1984-1988, maintained through a priori covariance on estimated Earth orientation and station coordinates.
14 - Constraint for time evolution:		All sites fixed to AM0-2 velocities

Station name	X (m)	Y (m)	Z (m)	Mean MJD	Data Span Days	X Err	Y Err	Z Err	Plate name
						meters			
X S POTSDM1181	3800621.265	882005.386	5028859.542	47129.7	3971.0	0.015	0.015	0.010	EURASA
X S SIMEIZ1873	3783902.598	2551404.900	4441257.582	48074.6	495.9	0.100	0.100	0.100	EURASA
X S RIGA 1884	3183896.035	1421496.880	5322803.338	47773.3	812.8	0.082	0.075	0.051	EURASA
X S CRIMEA1893	3785944.896	2550780.647	4439461.505	47905.0	693.1	0.162	0.123	0.088	EURASA
X S SANCUB1953	1474548.738	-5811242.320	2168944.947	47721.2	1072.6	0.099	0.067	0.088	NAMRCA
X M OTAY2 7035	-2428826.501	-4799754.378	3417267.033	47404.6	38.9	0.014	0.013	0.011	PACIFC
X M BRLAK27046	-1736002.827	-4425049.597	4241427.118	48125.2	24.0	0.034	0.033	0.021	NAMRCA
X M QUINCY7051	-2516893.045	-4198845.220	4076411.352	44580.4	1761.3	0.027	0.025	0.020	NAMRCA
X M OTAY 7062	-2428825.801	-4799750.564	3417272.735	43899.5	2677.0	0.021	0.020	0.019	PACIFC
X M STALAS7063	1130714.858	-4831367.735	3994087.344	44186.0	1935.9	0.018	0.015	0.014	NAMRCA
X M GRF0657065	1130692.170	-4831351.790	3994111.892	42939.1	2.0	1.000	1.000	1.000	NAMRCA
X M BERMDA7067	2308538.647	-4874079.942	3393628.558	43685.3	809.1	0.097	0.065	0.100	NAMRCA
X M GNDTRK7068	1920482.970	-5619478.275	2318914.393	43762.4	24.0	1.000	1.000	1.000	NAMRCA
X M MCDON47080	-1330020.832	-5328401.834	3236480.827	47651.6	1098.5	0.010	0.006	0.009	NAMRCA
X M BERLAK7082	-1735997.061	-4425048.192	4241430.359	44007.8	2652.3	0.040	0.038	0.026	NAMRCA
X M OWENSV7084	-2410589.974	-4477745.386	3838648.350	43581.2	43.3	0.133	0.126	0.083	NAMRCA
X M GOLDST7085	-2353393.756	-4641529.366	3676898.850	43588.2	24.1	0.116	0.130	0.088	NAMRCA
X M MCDON 7086	-1330125.186	-5328526.645	3236150.255	46248.9	3045.2	0.010	0.006	0.008	NAMRCA
X M YARAG 7090	-2389006.601	5043329.236	-3078525.362	46237.7	4144.2	0.009	0.006	0.008	INDAUS
X M HAYSTK7091	1492453.844	-4457278.751	4296815.942	45228.2	4679.3	0.012	0.010	0.009	NAMRCA
X M KWAJLN7092	-6143447.292	1364700.032	1034163.045	44445.6	292.9	0.026	0.037	0.038	PACIFC
X M SAMOA 7096	-6100045.841	-996203.244	-1568976.344	44367.1	446.7	0.021	0.031	0.029	PACIFC
X M EASTR27097	-1884984.252	-5357608.166	-2892853.433	47677.4	1177.9	0.017	0.014	0.014	NAZCA
X M GRF1007100	1131355.823	-4831169.074	3994131.923	43440.3	13.0	1.000	1.000	1.000	NAMRCA
X M GRF1017101	1131240.553	-4831179.831	3994148.411	44129.6	1187.9	0.128	0.081	0.119	NAMRCA
X M GRF1027102	1130686.736	-4831353.027	3994110.878	44721.2	1556.8	0.019	0.016	0.014	NAMRCA
X M GRF1037103	1130685.732	-4831348.712	3994116.316	44970.4	1362.0	0.028	0.028	0.020	NAMRCA
X M GRF1047104	1131095.947	-4831196.916	3994170.678	43975.9	96.3	0.101	0.086	0.085	NAMRCA
X M GRF1057105	1130719.863	-4831350.550	3994106.473	46575.3	3612.1	0.009	0.006	0.008	NAMRCA
X M QUINC27109	-2517234.633	-4198556.245	4076569.728	46714.0	3422.8	0.009	0.007	0.007	NAMRCA
X M MNPEAK7110	-2386277.834	-4802354.374	3444881.429	46908.2	3502.5	0.009	0.006	0.008	PACIFC
X M PLATVL7112	-1240678.093	-4720463.432	4094480.589	45900.4	3522.0	0.011	0.008	0.008	NAMRCA
X M OWNSV27114	-2410422.301	-4477802.786	3838686.634	44464.1	1228.1	0.017	0.016	0.013	NAMRCA
X M GLDST27115	-2350861.522	-4655546.399	3660997.834	44399.4	562.2	0.018	0.017	0.015	NAMRCA
X M HAWXAA7120	-5465998.376	-2404408.627	2242228.430	44727.1	530.1	0.012	0.016	0.016	PACIFC
X M HUAHIN7121	-5345865.208	-2958246.735	-1824623.807	45997.1	993.3	0.009	0.012	0.012	PACIFC

Center for Space Research Lageos Station Coordinates (Cont.) SSC (CSR) 91 L 02

Station name	X (m)	Y (m)	Z (m)	Mean MJD	Data Span Days	X Err	Y Err	Z Err	Plate name
						meters			
X M MAZTLN7122	-1660089.218	-5619100.446	2511637.901	46866.5	2832.6	0.009	0.005	0.009	NAMRCA
X M HUAHI27123	-5345865.695	-2958247.553	- 1824624.381	47650.1	1122.1	0.007	0.011	0.011	PACIFC
X S GRF1257125	1130746.034	-4831367.993	3994077.066	46233.3	97.9	0.025	0.020	0.017	EURASA
X M GRF1307130	1130735.527	-4831324.572	3994132.324	46760.8	180.3	1.000	1.000	1.000	EURASA
X M HOLLAS7210	-5466006.456	-2404428.083	2242187.498	46494.4	4286.8	0.005	0.009	0.009	PACIFC
X M MONPK27220	-2386292.168	-4802347.542	3444880.906	45962.9	554.0	0.019	0.018	0.017	PACIFC
X S WUHAN 7236	-2266555.525	5009079.420	3222266.108	48133.4	478.7	0.084	0.078	0.070	EURASA
X M MOJAVE7265	-2356475.572	-4646618.372	3668424.721	45734.7	44.0	0.023	0.025	0.018	NAMRCA
X M MONPK37274	-2386289.233	-4802346.542	3444883.979	46240.4	37.9	0.019	0.019	0.016	PACIFC
X M MOJAV27288	-2356493.941	-4646607.724	3668426.623	47745.8	1077.6	0.016	0.013	0.013	NAMRCA
X M RICHMO7295	961319.139	-5674090.946	2740489.532	47527.1	1047.7	0.100	0.100	0.100	NAMRCA
X M SNTAGO7400	1769699.881	-5044612.905	- 3468260.063	45804.7	60.9	0.031	0.021	0.027	SAMRCA
X M CERTOL7401	1815517.382	-5213464.803	- 3187999.293	47671.5	2467.9	0.016	0.013	0.014	SAMRCA
X M ARELA27403	1942808.157	-5804069.682	- 1796915.584	48128.1	105.7	0.020	0.015	0.019	SAMRCA
X M ASKITS7510	4353444.907	2082666.388	4156506.659	47255.4	1285.6	0.015	0.018	0.013	EURASA
X M RHODES7512	4573400.014	2409322.316	3723881.786	47236.8	1133.0	0.010	0.013	0.011	EURASA
X M DIONS27515	4595216.424	2039435.432	3912629.523	47178.0	1278.5	0.009	0.012	0.009	EURASA
X M ROUMEL7517	4728694.667	2174373.487	3674572.979	47129.9	1117.0	0.009	0.012	0.010	EURASA
X M KARITS7520	4596042.605	1733476.927	4055720.851	47202.7	1223.9	0.013	0.016	0.012	EURASA
X M XRISOK7525	4745949.527	1905706.060	3799169.065	47319.6	1229.3	0.011	0.013	0.011	EURASA
X S BARGIY7530	4443968.516	3121946.961	3334695.587	46927.1	1815.3	0.023	0.024	0.021	AFRICA
X M MAT5407540	4641984.583	1393057.824	4133233.455	46472.5	57.3	0.031	0.029	0.020	EURASA
X M MAT5417541	4641990.300	1393042.390	4133231.846	46459.0	60.9	0.019	0.021	0.015	EURASA
X S NOTO 7543	4934531.621	1321133.802	3806521.322	48228.2	25.2	0.029	0.034	0.025	EURASA
X M LAMPED7544	5072832.000	1130886.359	3684836.973	47365.9	622.9	0.011	0.014	0.011	AFRICA
X M CAGLIA7545	4893398.073	772673.431	4004140.983	47304.5	1626.1	0.011	0.015	0.011	EURASA
X M MEDICI7546	4461399.696	919566.972	4449510.517	47306.2	40.1	0.035	0.058	0.035	EURASA
X M BASOVI7550	4336738.589	1071271.583	4537911.033	46928.6	1190.2	0.026	0.034	0.023	EURASA
X M DIYARB7575	3848635.969	3251761.001	3898909.236	47569.2	887.4	0.014	0.015	0.013	EURASA
X M MELENG7580	4247620.515	2778639.089	3851607.489	47406.3	951.3	0.021	0.022	0.016	EURASA
X M YOZGAT7585	4029730.663	2802093.396	4062068.013	47543.9	823.7	0.016	0.017	0.013	EURASA
X M YIGILC7587	4117361.991	2517076.918	4157679.045	47345.4	857.9	0.014	0.014	0.011	EURASA
X S WET5967596	4075585.285	931837.819	4801559.250	46306.5	198.7	0.024	0.030	0.018	EURASA
X S WET5977597	4075604.836	931827.101	4801547.012	46145.7	21.0	1.000	1.000	1.000	EURASA
X S WET5997599	4075517.421	931754.158	4801630.307	46026.4	28.0	0.061	0.065	0.040	EURASA
X M TROMSO7602	2102904.325	721602.498	5958201.171	48134.2	39.0	0.058	0.038	0.030	EURASA

Station name	X (m)	Y (m)	Z (m)	Mean MJD	Data Span Days	X Err	Y Err	Z Err	Plate name
						meters			
X S METFIN7805	2892595.102	1311808.386	5512609.976	45755.1	3500.8	1.000	1.000	1.000	EURASA
X S ZIMMER7810	4331283.659	567549.669	4633139.976	47490.6	2460.7	0.008	0.010	0.007	EURASA
X S BOROWC7811	3738332.715	1148246.439	5021815.738	47981.2	990.7	0.090	0.087	0.055	EURASA
X S HELWAN7831	4728283.545	2879670.374	3156894.567	47558.9	1177.9	0.048	0.050	0.042	AFRICA
X S KOOTWK7833	3899224.098	396742.939	5015073.871	44725.2	2964.0	0.037	0.037	0.023	EURASA
X S WETZEL7834	4075530.042	931781.372	4801618.215	46627.4	4582.8	0.008	0.010	0.007	EURASA
X S GRASSE7835	4581691.783	556159.472	4389359.354	47437.8	3816.7	0.007	0.009	0.007	EURASA
X S SHAHAI7837	-2831087.892	4676203.319	3275172.843	47714.4	2401.8	0.100	0.100	0.100	EURASA
X S SHO 7838	-3822388.330	3699363.459	3507573.134	46766.1	3232.4	0.008	0.008	0.008	EURASA
X S GRAZ 7839	4194426.705	1162693.982	4647246.536	47120.2	3041.8	0.008	0.009	0.007	EURASA
X S RGO 7840	4033463.866	23662.421	4924305.031	47130.5	2865.9	0.007	0.009	0.006	EURASA
X S ORRLLR7843	-4446476.781	2678126.941	-3696251.668	47096.8	2264.0	0.007	0.009	0.008	INDAUS
X M OWNSV37853	-2410421.067	-4477800.396	3838690.286	47671.2	651.0	0.012	0.010	0.010	NAMRCA
X M CABO 7882	-1997241.331	-5528041.458	2468355.103	47215.5	1584.2	0.014	0.010	0.014	EURASA
X M ENSENA7883	-2406126.586	-4898368.493	3290336.622	47708.1	138.3	0.020	0.018	0.019	PACIFC
X M MCDON37885	-1330125.232	-5328526.599	3236150.214	45206.1	67.0	0.039	0.042	0.031	NAMRCA
X M QUINC37886	-2517242.230	-4198551.032	4076570.284	45911.3	507.5	0.019	0.015	0.011	NAMRCA
X M MTHOP27888	-1936744.189	-5077639.121	3331993.852	45034.8	77.0	0.046	0.034	0.042	NAMRCA
X M FLGSTF7891	-1923976.543	-4850871.754	3658574.687	44791.9	39.1	0.047	0.046	0.036	NAMRCA
X M VERNAL7892	-1631484.584	-4589133.879	4106749.493	44915.2	434.2	0.033	0.035	0.023	NAMRCA
X M YUMA 7894	-2196777.719	-4887337.124	3448425.221	45474.2	96.8	0.032	0.030	0.031	NAMRCA
X M PASDNA7896	-2493211.858	-4655229.512	3565574.623	44568.6	56.2	0.036	0.037	0.029	PACIFC
X M GRF8997899	1131364.827	-4831168.756	3994128.955	44499.9	41.0	0.057	0.056	0.048	NAMRCA
X S ARELAS7907	1942792.151	-5804077.610	-1796919.235	45631.2	5389.0	0.010	0.005	0.010	SAMRCA
X M GRF9187918	1130705.479	-4831345.413	3994115.907	48044.7	119.1	1.000	1.000	1.000	NAMRCA
X S GRF9197919	1130705.889	-4831347.444	3994117.511	46554.7	52.0	1.000	1.000	1.000	NAMRCA
X M GRF9207920	1130742.124	-4831369.823	3994076.046	47955.1	397.3	1.000	1.000	1.000	NAMRCA
X S HOPLAS7921	-1936760.075	-5077707.211	3331922.412	43384.6	2127.3	0.037	0.033	0.031	NAMRCA
X S NATLAS7929	5186467.911	-3653855.923	-654321.750	43624.8	1965.9	0.043	0.057	0.061	SAMRCA
X S MATERA7939	4641965.093	1393070.038	4133262.242	46980.5	2707.8	0.007	0.009	0.007	EURASA
X S DIONYS7940	4595216.352	2039464.721	3912613.410	45865.6	6.0	1.000	1.000	1.000	EURASA
X S ORRLAS7943	-4447548.744	2677133.943	-3694996.649	43906.9	3624.0	0.012	0.013	0.013	INDAUS
X M KOTWK28833	3899237.888	396769.266	5015055.225	47389.8	2292.2	0.066	0.072	0.044	EURASA

EOP(CSR) 91 L 02 Available from 1976 to 1991

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for UT1

YEAR	X		Y		UT1	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1976	16	6.54	16	7.00	16	7.96
1977	24	4.70	24	3.83	24	3.36
1978	25	4.35	25	3.90	25	3.84
1979	30	3.70	30	3.27	30	2.45
1980	60	2.83	60	2.08	60	1.72
1981	62	3.49	62	2.36	62	1.75
1982	61	2.51	61	1.64	61	1.52
1983	80	1.70	80	1.89	80	1.19
1984	122	1.37	122	1.35	122	1.16
1985	121	1.11	121	1.00	121	0.82
1986	122	1.09	122	1.06	122	0.88
1987	122	0.76	122	0.74	122	0.68
1988	122	0.72	122	0.88	122	0.92
1989	121	0.66	121	0.72	121	0.60
1990	122	0.79	122	1.10	122	0.65
1991	17	0.93	17	0.85	17	0.68

EARTH ORIENTATION AND SITE COORDINATES FROM THE CENTER FOR SPACE RESEARCH

CSR 91 L 03

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Earth orientation parameters were derived from a combination of Lageos full rate and quick look data. Full rate data was used from 1976 until the end of July, 1990, and quicklook data used for August 1990 through February 1991. A summary of the 1990 data used in the solution is provided in Table 1. The column titled RBTB RMS refers to the root mean square of the residuals after removing an estimated range bias and time bias. The column titled PREC EST refers to the residual rms after removing a second order polynomial, yielding an estimate of the internal precision of the data.

The site coordinates for all sites were adjusted using data from the entire span, and velocities were adjusted for 7 sites in deformation zones, and hence known anomalous velocities with regard to rigid plate models. The sites with adjusted velcoties were Quincy, USA (7109), Monument Peak, USA (7110), Arequipa, Peru (7907), Easter Island, Chile (7097), Huahine, Fr. Polynesia (7123), Matera, Italy (7939), and Simosato, Japan (7838). The velocities of all other sites were held fixed to that predicted by the Minster and Jordan AM0-2 model.The nominal positions were the essentially given by a previous Center for Space Research solution, SSC(CSR) 89 L 02 after three rigid rotations to an origin close to that of the IERS combined system for the period 1984-1989. The site positions were mapped to epoch 1988.0 for all sites using either the AM0-2 or estimated velocities as appropriate. This set of coordinates, referred to as SSC(CSR) 91 L 03, should yield good results in a mean sense over the entire 14.8 year span of the data.

The force and measurement models used for this solution conform generally to the IERS Standards, with the following exceptions:

1) The mean gravity field was PTGF-4A, a state of the art gravity field computed at the University of Texas Center for Space Research. PTGF-4A incorporates data from 15 satellites, plus altimetric data from 2 satellites, and surface gravimetry. The field was a preliminary version of the now released TEG-2 model.

2) The ocean tide model was an enhanced version of the Schwiderski model extrapolated to include 80 consituents complete through degree and order 20, assuming admittances which vary linearly with frequency. Preliminary documentation is found in Casotto, [1989].

3) The solid tide model has been expanded to include third degree terms.

4) The geogravitational constant, GM, is 398600.4415 km3/s2, derived from Ries et al. [1989], adjusted for an 11 mm lengthening of the Lageos center of mass correction after recent recalculation.

The data was weighted in a piecewise continuous, linearly interpolated model to reflect the increase in laser hardware over the data span. The weighting curve had the following node points:

MJD 42905.0 : 700 mm
MJD 44162.0 : 400 mm
MJD 45578.0 : 200 mm
MJD 47000.0 : 100 mm

The weights are larger than the true random component of the laser ranges in order to reflect unmodelled systematic errors, and are thus scaled so that the formal uncertainties on the Earth orientation parameters are consistent with their internal precision.

The solutions for orbit elements and Earth orientation parameters were computed using residuals from a long arc fit spanning the period from 7 May 1976 through 21 February 1991, a period of 14.8 years.The short arc adjustments were made at the following intervals, to allow for the change in data quantity over time:

MJD 42904.5 - 44164.5 : 15 days
MJD 44164.5 - 45580.5 : 6 days
MJD 45580.5 - present : 3 days

For each interval, whether 15, 6, or 3 days in length, 6 Keplerian mean elements and xp and yp were solved. The UT1 estimates are obtained from the Lageos node residuals, with the constraint that they follow the JPL SPACE90 series at periods longer than about 60 days [Gross and Steppe, 1991].

REFERENCES

Casotto, S., 1989: Ocean Tide Models for TOPEX Precision Orbit Determination, *Ph.D. Diss.*, The University of Texas at Austin.

Gross, R.S. and J.A. Steppe., 1991: A Combination of Earth Orientation Data: SPACE90 description submitted to IERS.

Ries, J.C.,R.J. Eanes, C. Huang, B.E. Schutz, C.K. Shum, B.D. Tapley, M.M. Watkins, and D.N. Yuan., 1989: Determination of the Gravitational Coefficient of the Earth from Near Earth Satellites, *Geophysical Research Letters,* **16(4)**,271-274.

Table 1. Summary of 1990 Lageos Residual Analysis, FR np Jan-Jul, QL np Aug-Dec

Station	# of Passes	# of 2-min np	number edited	percent edited	number kept	RAW RMS (cm)	RBTB RMS (cm)	PREC EST (cm)
1181 POTSDM	121	1308	250	19.1	1058	15.2	11.2	9.9
1873 SIMEIZ	77	693	133	19.2	560	14.4	9.3	8.2
1884 RIGA	64	737	387	52.5	350	18.6	12.0	8.8
1893 CRIMEA	26	190	25	13.2	165	7.5	5.5	4.8
1953 SANCUB	13	82	33	40.2	49	16.3	10.9	9.2
7046 BRLAK2	45	651	1	0.2	650	6.3	3.8	3.6
7080 MCDON4	214	2122	56	2.6	2066	3.8	1.1	1.0
7090 YARAG	250	4417	35	0.8	4382	3.3	0.6	0.4
7091 HAYSTK	40	430	0	0.0	430	3.4	1.1	1.0
7097 EASTR2	69	767	7	0.9	760	6.3	1.2	1.1
7105 GRF105	50	747	4	0.5	743	1.7	0.7	0.6
7109 QUINC2	186	2858	19	0.7	2839	3.6	0.5	0.3
7110 MNPEAK	394	6239	31	0.5	6208	2.9	0.6	0.4
7112 PLATVL	40	565	0	0.0	565	5.3	4.2	3.9
7122 MAZTLN	137	1922	14	0.7	1908	2.7	0.6	0.4
7123 HUAHI2	54	698	33	4.7	665	4.3	0.8	0.7
7210 HOLLAS	147	1715	9	0.5	1706	3.3	1.1	0.9
7236 WUHAN	33	524	33	6.3	491	9.7	3.0	2.5
7288 MOJAV2	34	519	2	0.4	517	4.4	0.7	0.5
7401 CERTOL	93	1432	10	0.7	1422	2.5	0.7	0.6
7403 ARELA2	86	1377	5	0.4	1372	2.0	0.8	0.7
7515 DIONS2	45	624	14	2.2	610	6.4	2.9	2.6
7525 XRISOK	31	434	8	1.8	426	6.1	0.6	0.4
7530 BARGIY	8	73	1	1.4	72	15.0	4.4	4.3
7543 NOTO	49	529	0	0.0	529	5.0	1.6	1.4
7545 CAGLIA	40	514	6	1.2	508	4.6	0.8	0.5
7602 TROMSO	45	405	4	1.0	401	5.8	2.9	2.7
7805 METFIN	8	55	46	83.6	9	17.0	12.0	12.0
7810 ZIMMER	240	3290	35	1.1	3255	4.3	2.9	2.6
7811 BOROWC	70	667	119	17.8	548	13.9	9.9	8.2
7831 HELWAN	65	639	12	1.9	627	3.6	2.0	1.7
7834 WETZEL	179	1887	13	0.7	1874	3.7	2.0	1.8
7835 GRASSE	624	10192	186	1.8	10006	3.2	1.6	1.2
7837 SHAHAI	132	1406	82	5.8	1324	9.4	4.6	4.1
7838 SHO	84	1095	34	3.1	1061	5.3	3.8	3.2
7839 GRAZ	150	2029	8	0.4	2021	2.7	0.8	0.7
7840 RGO	493	5660	68	1.2	5592	3.5	1.8	1.5
7843 ORRLLR	281	3624	44	1.2	3580	3.1	1.1	0.8
7853 OWNSV3	46	697	109	15.6	588	6.3	2.6	2.2
7907 ARELAS	145	2074	53	2.6	2021	10.3	8.9	8.5
7918 GRF918	53	715	96	13.4	619	6.2	0.5	0.3
7920 GRF920	14	103	11	10.7	92	7.1	0.8	0.7
7939 MATERA	404	6448	172	2.7	6276	8.0	6.3	5.7
8833 KOTWK2	35	383	3	0.8	380	3.9	2.4	2.1
TOTALS	5414	73536	2211	3.0	71325	5.6	3.5	3.1

SUMMARY SHEET

1 - Technique:		SLR
2 - Analysis Center:		CSR
3 - Solution Identifier:		SSC(CSR) 91 L 03
4 - Software Used:		UTOPIA
5 - Relativity Scale:		Geocentric (LE)
6 - Permananent Tidal Correction on station:		Yes
7 - Tectonic Plate model:		AM0-2
8 - Velocity of light (C) =		299792458 m/sec
9 - Geogravitational constant (GM) =		398600.4415 km3/s2
10 - Reference Epoch =		1988.0
11 - Adjusted Parameters	Coordinates:	Epoch 1988.0 position for all sites in cartesian coordinates, plus mean velocities in each of the coordinates for selected sites, all solved one time for entire data span.
	Orbit:	6 Keplerian mean elements Solved every: 15 days from MJD 42904.5 - 44180.5 6 days from MJD 44180.5 - 45580.5 3 days from MJD 45580.5 - 48000.5
	EOP:	x, y and UT1 (UT1 constrained by JPL SPACE90) Solved at same intervals as orbit
12 - Definition of the origin:		Geocentric, C10 = C11 = S11 = 0.0
13 - Definition of the orientation:		System oriented to agree with IERS combined in a mean sense over period 1984-1988, maintained through a priori covariance on estimated Earth orientation and station coordinates and velocities.
14 - Constraint for time evolution:		Most sites fixed to AM0-2 velocities, sites in deformation zones adjusted with a priori covariance of 100 mm/yr.

Note: * after plate name indicates that the velocity was adjusted

Station name	X (m)	Y (m)	Z (m)	Mean MJD	Data Span Days	X Err	Y Err	Z Err	Plate name
						meters			
X S POTSDM1181	3800621.254	882005.379	5028859.576	47129.7	3971.0	0.015	0.015	0.010	EURASA
X S SIMEIZ1873	3783902.598	2551404.900	4441257.582	48074.6	495.9	0.100	0.100	0.100	EURASA
X S RIGA 1884	3183896.001	1421496.913	5322803.454	47773.3	812.8	0.082	0.075	0.051	EURASA
X S CRIMEA1893	3785944.873	2550780.603	4439461.504	47905.0	693.1	0.162	0.123	0.088	EURASA
X S SANCUB1953	1474548.660	-5811242.318	2168944.972	47721.2	1072.6	0.099	0.067	0.088	NAMRCA
X M OTAY2 7035	-2428826.478	-4799754.400	3417267.042	47404.6	38.9	0.014	0.013	0.011	PACIFC
X M BRLAK27046	-1736002.870	-4425049.674	4241427.115	48125.2	24.0	0.034	0.033	0.021	NAMRCA
X M QUINCY7051	-2516893.027	-4198845.211	4076411.375	44580.4	1761.3	0.027	0.025	0.020	NAMRCA
X M OTAY 7062	-2428825.768	-4799750.536	3417272.786	43899.5	2677.0	0.021	0.020	0.020	PACIFC
X M STALAS7063	1130714.871	-4831367.737	3994087.360	44186.0	1935.9	0.018	0.015	0.014	NAMRCA
X M GRF0657065	1130692.276	-4831351.379	3994111.765	42939.1	2.0	1.000	1.000	1.000	NAMRCA
X M BERMDA7067	2308538.641	-4874079.907	3393628.509	43685.3	809.1	0.097	0.065	0.101	NAMRCA
X M GNDTRK7068	1920482.936	-5619478.250	2318914.369	43762.4	24.0	1.000	1.000	1.000	NAMRCA
X M MCDON47080	-1330020.824	-5328401.902	3236480.824	47651.6	1098.5	0.010	0.006	0.009	NAMRCA
X M BERLAK7082	-1735997.023	-4425048.263	4241430.390	44007.8	2652.3	0.040	0.038	0.026	NAMRCA
X M WENSV7084	-2410590.014	-4477745.306	3838648.407	43581.2	43.3	0.133	0.126	0.083	NAMRCA
X M GOLDST7085	-2353393.790	-4641529.316	3676898.848	43588.2	24.1	0.116	0.130	0.088	NAMRCA
X M MCDON 7086	-1330125.169	-5328526.667	3236150.291	46248.9	3045.2	0.010	0.006	0.008	NAMRCA
X M YARAG 7090	-2389006.608	5043329.214	-3078525.329	46237.7	4144.2	0.009	0.006	0.008	INDAUS
X M HAYSTK7091	1492453.850	-4457278.726	4296815.894	45228.2	4679.3	0.012	0.010	0.009	NAMRCA
X M KWAJLN7092	-6143447.295	1364700.040	1034163.086	44445.6	292.9	0.026	0.038	0.038	PACIFC
X M SAMOA 7096	-6100045.864	-996203.234	-1568976.285	44367.1	446.7	0.021	0.031	0.029	PACIFC
X M EASTR27097	-1884984.260	-5357608.193	-2892853.360	47677.4	1177.9	0.020	0.018	0.017	NAZCA *
X M GRF1007100	1131355.899	-4831168.977	3994131.917	43440.3	13.0	1.000	1.000	1.000	NAMRCA
X M GRF1017101	1131240.561	-4831179.840	3994148.412	44129.6	1187.9	0.128	0.081	0.119	NAMRCA
X M GRF1027102	1130686.759	-4831353.028	3994110.902	44721.2	1556.8	0.019	0.016	0.014	NAMRCA
X M GRF1037103	1130685.773	-4831348.685	3994116.324	44970.4	1362.0	0.028	0.028	0.020	NAMRCA
X M GRF1047104	1131095.919	-4831196.916	3994170.669	43975.9	96.3	0.101	0.086	0.085	NAMRCA
X M GRF1057105	1130719.886	-4831350.547	3994106.490	46575.3	3612.1	0.009	0.006	0.008	NAMRCA
X M QUINC27109	-2517234.599	-4198556.292	4076569.679	46714.0	3422.8	0.009	0.007	0.007	NAMRCA *
X M MNPEAK7110	-2386277.802	-4802354.408	3444881.424	46908.2	3502.5	0.009	0.006	0.008	PACIFC *
X M PLATVL7112	-1240678.055	-4720463.422	4094480.600	45900.4	3522.0	0.011	0.008	0.008	NAMRCA
X M OWNSV27114	-2410422.277	-4477802.776	3838686.660	44464.1	1228.1	0.017	0.016	0.013	NAMRCA
X M GLDST27115	-2350861.521	-4655546.392	3660997.865	44399.4	562.2	0.018	0.017	0.015	NAMRCA

Station name	X (m)	Y (m)	Z (m)	Mean MJD	Data Span Days	X Err	Y Err	Z Err	Plate name
						meters			
X M HAWXAA7120	-5465998.359	-2404408.652	2242228.467	44727.1	530.1	0.012	0.016	0.016	PACIFC
X M HUAHIN7121	-5345865.202	-2958246.770	-1824623.783	45997.1	993.3	0.009	0.012	0.012	PACIFC
X M MAZTLN7122	-1660089.166	-5619100.451	2511637.870	46866.5	2832.6	0.009	0.005	0.009	NAMRCA
X M HUAHI27123	-5345865.706	-2958247.569	-1824624.347	47650.1	1122.1	0.010	0.013	0.013	PACIFC *
X S GRF1257125	1130745.995	-4831368.012	3994077.069	46233.3	97.9	0.025	0.020	0.017	EURASA
X M GRF1307130	1130735.527	-4831324.572	3994132.324	46760.8	180.3	1.000	1.000	1.000	EURASA
X M HOLLAS7210	-5466006.426	-2404428.069	2242187.483	46494.4	4286.8	0.005	0.009	0.009	PACIFC
X M MONPK27220	-2386292.141	-4802347.550	3444880.920	45962.9	554.0	0.019	0.018	0.017	PACIFC
X S WUHAN 7236	-2266555.576	5009079.352	3222266.138	48133.4	478.7	0.084	0.078	0.070	EURASA
X M MOJAVE7265	-2356475.555	-4646618.376	3668424.735	45734.7	44.0	0.023	0.025	0.018	NAMRCA
X M MONPK37274	-2386289.216	-4802346.564	3444883.991	46240.4	37.9	0.019	0.019	0.016	PACIFC
X M MOJAV27288	-2356493.919	-4646607.736	3668426.650	47745.8	1077.6	0.016	0.013	0.014	NAMRCA
X M RICHMO7295	961319.139	-5674090.946	2740489.532	47527.1	1047.7	0.100	0.100	0.100	NAMRCA
X M SNTAGO7400	1769699.918	-5044612.890	-3468260.061	45804.7	60.9	0.031	0.021	0.027	SAMRCA
X M CERTOL7401	1815517.404	-5213464.782	-3187999.303	47671.5	2467.9	0.016	0.013	0.014	SAMRCA
X M ARELA27403	1942808.191	-5804069.632	-1796915.602	48128.1	105.7	0.020	0.015	0.019	SAMRCA
X M ASKITS7510	4353444.864	2082666.386	4156506.671	47255.4	1285.6	0.015	0.018	0.013	EURASA
X M RHODES7512	4573400.006	2409322.325	3723881.781	47236.8	1133.0	0.010	0.013	0.011	EURASA
X M DIONS27515	4595216.408	2039435.427	3912629.517	47178.0	1278.5	0.009	0.012	0.009	EURASA
X M ROUMEL7517	4728694.645	2174373.480	3674572.970	47129.9	1117.0	0.009	0.012	0.010	EURASA
X M KARITS7520	4596042.605	1733476.860	4055720.873	47202.7	1223.9	0.013	0.016	0.012	EURASA
X M XRISOK7525	4745949.532	1905706.038	3799169.057	47319.6	1229.3	0.011	0.013	0.011	EURASA
X S BARGIY7530	4443968.365	3121946.978	3334695.486	46927.1	1815.3	0.023	0.024	0.021	AFRICA
X M MAT5407540	4641984.562	1393057.851	4133233.459	46472.5	57.3	0.031	0.029	0.020	EURASA
X M MAT5417541	4641990.275	1393042.414	4133231.857	46459.0	60.9	0.019	0.021	0.015	EURASA
X S NOTO 7543	4934531.630	1321133.731	3806521.366	48228.2	25.2	0.029	0.034	0.025	EURASA
X M LAMPED7544	5072831.987	1130886.354	3684836.979	47365.9	622.9	0.011	0.014	0.011	AFRICA
X M CAGLIA7545	4893398.080	772673.410	4004140.994	47304.5	1626.1	0.011	0.015	0.011	EURASA
X M MEDICI7546	4461399.644	919566.961	4449510.547	47306.2	40.1	0.035	0.058	0.035	EURASA
X M BASOVI7550	4336738.579	1071271.576	4537911.052	46928.6	1190.2	0.026	0.034	0.023	EURASA
X M DIYARB7575	3848635.886	3251760.980	3898909.273	47569.2	887.4	0.014	0.015	0.013	EURASA
X M MELENG7580	4247620.446	2778639.052	3851607.533	47406.3	951.3	0.021	0.022	0.016	EURASA
X M YOZGAT7585	4029730.612	2802093.327	4062068.024	47543.9	823.7	0.016	0.017	0.013	EURASA
X M YIGILC7587	4117361.951	2517076.916	4157679.068	47345.4	857.9	0.014	0.014	0.011	EURASA
X S WET5967596	4075585.254	931837.802	4801559.254	46306.5	198.7	0.024	0.030	0.018	EURASA
X S WET5977597	4075604.799	931827.100	4801547.004	46145.7	21.0	1.000	1.000	1.000	EURASA

Station name	X (m)	Y (m)	Z (m)	Mean MJD	Data Span Days	X Err	Y Err	Z Err	Plate name	
						meters				
X S WET5997599	4075517.403	931754.163	4801630.316	46026.4	28.0	0.061	0.065	0.040	EURASA	
X M TROMSO7602	2102904.205	721602.449	5958201.271	48134.2	39.0	0.058	0.038	0.030	EURASA	
X S METFIN7805	2892595.102	1311808.386	5512609.976	45755.1	3500.8	1.000	1.000	1.000	EURASA	
X S ZIMMER7810	4331283.617	567549.650	4633139.965	47490.6	2460.7	0.008	0.010	0.007	EURASA	
X S BOROWC7811	3738332.734	1148246.408	5021815.733	47981.2	990.7	0.090	0.087	0.055	EURASA	
X S HELWAN7831	4728283.527	2879670.476	3156894.466	47558.9	1177.9	0.048	0.050	0.042	AFRICA	
X S KOOTWK7833	3899224.112	396742.926	5015073.866	44725.2	2964.0	0.038	0.037	0.023	EURASA	
X S WETZEL7834	4075530.059	931781.366	4801618.234	46627.4	4582.8	0.008	0.010	0.007	EURASA	
X S GRASSE7835	4581691.775	556159.474	4389359.384	47437.8	3816.7	0.007	0.009	0.007	EURASA	
X S SHAHAI7837	-2831087.892	4676203.319	3275172.843	47714.4	2401.8	0.100	0.100	0.100	EURASA	
X S SHO 7838	-3822388.413	3699363.375	3507573.118	46766.1	3232.4	0.008	0.008	0.008	EURASA	*
X S GRAZ 7839	4194426.685	1162693.969	4647246.552	47120.2	3041.8	0.008	0.009	0.007	EURASA	
X S RGO 7840	4033463.840	23662.416	4924305.046	47130.5	2865.9	0.007	0.009	0.006	EURASA	
X S ORRLLR7843	-4446476.775	2678126.902	-3696251.610	47096.8	2264.0	0.007	0.009	0.008	INDAUS	
X M OWNSV37853	-2410421.022	-4477800.415	3838690.341	47671.2	651.0	0.012	0.010	0.010	NAMRCA	
X M CABO 7882	-1997241.646	-5528041.330	2468355.271	47215.5	1584.2	0.014	0.010	0.014	EURASA	
X M ENSENA7883	-2406126.625	-4898368.477	3290336.583	47708.1	138.3	0.020	0.018	0.019	PACIFC	
X M MCDON37885	-1330125.230	-5328526.602	3236150.245	45206.1	67.0	0.039	0.042	0.031	NAMRCA	
X M QUINC37886	-2517242.204	-4198551.047	4076570.295	45911.3	507.5	0.019	0.015	0.011	NAMRCA	
X M MTHOP27888	-1936744.142	-5077639.130	3331993.893	45034.8	77.0	0.046	0.034	0.042	NAMRCA	
X M FLGSTF7891	-1923976.546	-4850871.757	3658574.717	44791.9	39.1	0.047	0.046	0.036	NAMRCA	
X M VERNAL7892	-1631484.568	-4589133.876	4106749.510	44915.2	434.2	0.033	0.035	0.023	NAMRCA	
X M YUMA 7894	-2196777.674	-4887337.146	3448425.257	45474.2	96.8	0.032	0.030	0.031	NAMRCA	
X M PASDNA7896	-2493211.867	-4655229.522	3565574.652	44568.6	56.2	0.036	0.037	0.029	PACIFC	
X M GRF8997899	1131364.826	-4831168.759	3994129.018	44499.9	41.0	0.057	0.056	0.048	NAMRCA	
X S ARELAS7907	1942792.134	-5804077.617	-1796919.274	45631.2	5389.0	0.010	0.005	0.010	SAMRCA	*
X M GRF9187918	1130705.479	-4831345.413	3994115.907	48044.7	119.1	1.000	1.000	1.000	NAMRCA	
X S GRF9197919	1130705.889	-4831347.444	3994117.511	46554.7	52.0	1.000	1.000	1.000	NAMRCA	
X M GRF9207920	1130742.124	-4831369.823	3994076.046	47955.1	397.3	1.000	1.000	1.000	NAMRCA	
X S HOPLAS7921	-1936759.928	-5077707.110	3331922.358	43384.6	2127.3	0.038	0.033	0.032	NAMRCA	
X S NATLAS7929	5186467.935	-3653855.821	-654321.864	43624.8	1965.9	0.043	0.057	0.061	SAMRCA	
X S MATERA7939	4641965.056	1393070.030	4133262.259	46980.5	2707.8	0.007	0.009	0.007	EURASA	*
X S DIONYS7940	4595217.267	2039464.537	3912613.152	45865.6	6.0	1.000	1.000	1.000	EURASA	
X S ORRLAS7943	-4447548.777	2677133.925	-3694996.613	43906.9	3624.0	0.012	0.013	0.013	INDAUS	
X M KOTWK28833	3899237.858	396769.257	5015055.235	47389.8	2292.2	0.066	0.072	0.044	EURASA	

SSV (CSR) 91 L 03

Station		Velocity Change From AM0-2 X	Y	Z	Total Velocity X	Y	Z	Velocity Sigma X	Y	Z
		(mm/yr)			(mm/yr)			(mm/yr)		
EASTR2	7097	-4.9	2.6	3.6	81.0	-22.8	-5.4	7.9	7.8	7.2
QUINC2	7109	-1.4	4.5	9.2	-18.7	2.8	-3.2	1.0	1.0	0.8
MNPEAK	7110	3.1	-10.4	-8.9	-33.2	24.4	14.4	0.9	0.8	0.7
HUAHI2	7123	10.6	-5.7	5.1	-33.2	51.6	40.5	4.8	5.7	5.5
SHO	7838	23.5	13.4	17.3	1.1	2.2	4.7	1.7	1.8	1.5
ARELAS	7907	17.2	13.9	4.4	11.7	9.2	13.7	1.4	1.0	1.3
MATERA	7939	-3.7	-3.8	7.9	-20.0	14.3	20.0	1.2	1.2	0.9

EOP(CSR) 91 L 03 Available from 1976 to 1991

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for UT1

YEAR	X		Y		UT1	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1976	16	6.54	16	7.00	16	7.96
1977	24	4.70	24	3.83	24	3.36
1978	25	4.35	25	3.90	25	3.84
1979	30	3.70	30	3.27	30	2.45
1980	61	2.84	61	2.11	61	1.72
1981	61	3.49	61	2.34	61	1.75
1982	61	2.51	61	1.64	61	1.52
1983	80	1.70	80	1.89	80	1.19
1984	122	1.37	122	1.35	122	1.16
1985	121	1.11	121	1.00	121	0.82
1986	122	1.09	122	1.06	122	0.88
1987	122	0.76	122	0.74	122	0.68
1988	122	0.72	122	0.88	122	0.92
1989	121	0.66	121	0.72	121	0.60
1990	122	0.79	122	1.10	122	0.65
1991	17	0.93	17	0.85	17	0.68

EARTH ORIENTATION AND STATION COORDINATES COMPUTED FROM 10.3 YEARS OF LAGEOS OBSERVATIONS

DGFII 91 L 01

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The solution (DGFII) 91 L 01 is an Earth orientation, station position and station velocity solution derived by DGFI from all laser tracking data acquired in the period January 1980 to April 1990 from LAGEOS by fixed and mobile SLR systems of the international SLR network. The differences to previous DGFI Earth orientation and station position solutions are: (1) the considered analysis interval of 10.3 years, (2) recomputation of 2 minute normal points through the whole period and very careful screening of all data, and (3) use of a recently derived new gravity field model by DGFI and GRGS, GRIM4-S1.

The derivated pole positions are referred to the position of the mean pole averaged over the period 1/1980 to 10/1986. This DGFI fixed origin of the pole departs from the CIO position by .045" in x and .286" in y.

Most of the station coordinates are given for the reference epoch 1984.0.

1) THE COMPUTATION MODEL:

The models and constants underlying the (DGFII) 91 L 01 solution and used for parameter estimation within the DGFI Orbit and Geodetic Parameter Estimation System (DOGS) are given in the following:

Reference Frame

CIS	:	mean equator and equinox of J2000.0
Precession	:	IAU 1976
Nutation	:	IAU 1980 + DGFI correction(*) (Zhu, Reigber 1991)
Planetary Ephemerides	:	JPL DE200/LE200 ephemerides
Initial Earth Rotation	:	BIH87C02S homog. series, IERS Bulletin B (pole position transf. to zero mean pole: 1/1980 - 10/1986)(*)
Initial Station Coordinates	:	GRIM4-S1 (Schwintzer *et al.* 1991)
Initial Station Velocities	:	zero
Orientation of CTS	:	stations 7086, 7090, 7105, 7109, 7122,7210, 7834, 7835, 7840, 7907 (c.f. Bender, Goad 1979)
Time Evolution of Orientation	:	common rotation with respect to AM0-2 plate motion model fixed to zero (same stations as above)

Dynamical Model

GM	:	3.98600440 E+14 m^3 s^{-2}, C(0,0) solved
Semi Major Axis of Earth	:	6378136 m
Flattening 1/f	:	298.257810
Angular Velocity of Earth	:	0.7292115 E-4 rad/s
Gravity Model of Earth	:	GRIM4-S1 (truncated at l,m=25) (*) (Schwintzer *et al.* 1991)
C(2,1), S(2,1)	:	applied, computed with respect to zero mean pole
Gravity Model of Moon	:	Ferrari 77 (4*4)

Third Body	:	Sun, Moon, Jupiter, Venus, Saturn, Mars, Mercury
Along Track Acceleration	:	empirical (adjusted)
Albedo and Infrared	:	Stephens model
Ocean Tides	:	Schwiderski + GRIM4-S1(*)
Solid Earth Tides	:	Wahr (2,2) model, k2=0.3, d=0, with permanent tide not removed
Relativistic Motion Equation	:	harmonic isotropic

Measurement Model

Marini-Murray Refraction Model	:	IERS standards
Solid Earth Tides Displacement	:	IERS standards (Wahr model)
Ocean Loading Site Displacement	:	based on Schwiderski model
Pole Tide	:	IERS 1989
Normal point elimin. criterion	:	eliminated when created by 3 or less single ranges

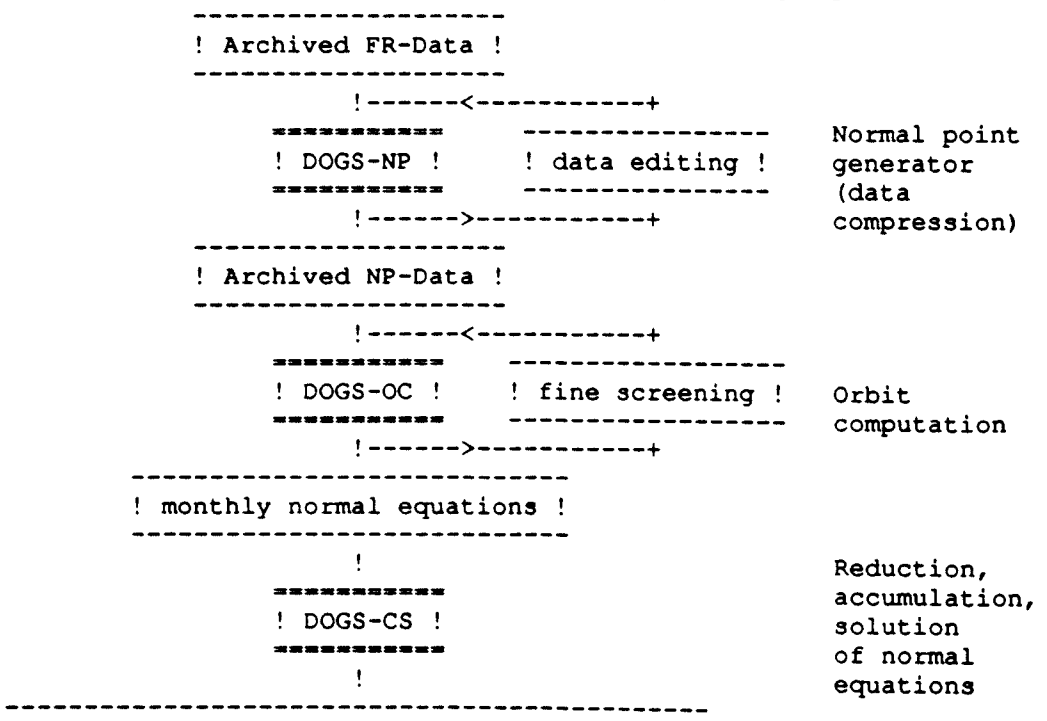
* - departures of IERS-Standards

2) THE DATA

For the solution (DGFII) 91 L 01 two minute normal points were generated using the module DOGS-NP. For the 10.3 years period considered here 469333 normal points were generated out of a total of 60 million LAGEOS full-rate data points collected from 92 globally distributed fixed and mobile sites

3) THE ANALYSIS PROCESS

The analysis was performed with the DGFI Orbit and Geodetic Parameter Estimation System (DOGS). DOGS consists of several macro modules. Those being used for the described analysis are: the normal point generator (DOGS-NP), the orbit computation module (DOGS-OC), and the reduction, accumulation and solution module (DOGS-CS). The processing sequence is as follows:



DOGS-OC is used for orbit computation, fine screening of data, and for the creation of monthly arc normal equations. DOGS-CS is firstly providing the reduced normal equations, secondly accumulating several reduced normal equations including datum contraints and eccentricity conditions, and thirdly solving the 10.3 years combined normal equation system for station positions (epoch values), station velocities and C(0,0).

4) THE GEODETIC DATUM

The solution is minimum constrained. Since the origin of the reference system is the geocentre by setting the first degree and order terms of the gravity model to zero and the scale being defined by the velocity of light, the orientation remains to be defined. This is done by forcing the common rotation between the initial and the adjusted coordinates of a selected set of stations to become zero (Bender, Goad 1979).

In the same way the drift in orientation about the three coordinate axes is forced to be the same as derived from a given set of horizontal station velocities inferred by a geophysical plate motion model, presently being the AM0-2 model (Minster, Jordan 1978).

5) ECCENTRICITY CONDITIONS

In order to achieve reasonable drift rates on stations successively occupied by different systems some conditions have to be applied. First all station coordinate rates of the same site are set equal. Then eccentricity vectors between two occupations have been applied as observations only where the constraint on the solution remains reasonable small. In contrary, some occupations had to be divided into separate occupations, because a discontinuity appeared somewhere in the data.

6) ADJUSTED PARAMETERS

The adjusted parameters are listed in the following table:

Gravity Field Parameters	: C(0,0)
Direct Solar Radiation Pressure	: CR (per 15 days)
Along Track Acceleration	: CA (per 15 days)
Orbital State Vector	: 6 parameters per 30 days
Polar Motion	: one x and y parameter per 5 days
LOD	: one parameter per 5 days
Station Coordinates	: geocentric coordinates X, Y, Z
Velocity of Stations	: north and east direction (phidot, lambdadot*cos(phi))

Some of these parameters have been reduced in the monthly normal equations before combining the equations to a multi-year system in order to reduce the size of the system. The solution has 147 sets of x-, y- , z- station coordinate parameters. Only horizontal station velocities were solved for. For stations with a time span of the observations shorter than one year no station velocities were solved for. Some of the station velocity parameters are set to the same value. That's why there are only 47 independent sets of N-, E- velocity parameters. All velocity parameters are solved for regardless of their significance. Nevertheless, good coordinate results can only be achieved for stations having observed for a longer period of time.

7) THE RESULTS

Earth orientation parameters for the 10.3 years interval are given in Appendix 1. They are given in the format proposed by the IERS Central Bureau. The only exception is in field no. 4, in which instead of UT1-UTC the values of LODR are given. Only these values can be estimated in an SLR solution. So the actual format is as follows: MJD of the measurement, x of the pole ["], y of

the pole ["], LODR [s], 2 fields unused, uncertainty in x ["], uncertainty in y ["], uncertainty in LODR [s], 2 fields unused, rms residual of the least squares solution, correlation coefficient of x and y, correlation coefficient of x and LODR, correlation coefficient of y and LODR, 3 fields unused.

Station coordinates are given in Appendix 2. Since horizontal station movements are also solved for, a reference epoch for the coordinates is given. The format is following the IERS guidelines, so column 2 to 10 contains the DOMES numbers (with the exception of seven stations with unknown DOMES numbers), column 10 to 20 the CDP station number and site occupation designator, followed by x, y, z coordinates in m, the MJD of the reference epoch of the coordinates, the time span and the uncertainties of x, y, z in m.

In Appendix 3 the velocity parameters are given as follows: DOMES number (with the exception of two stations with unknown DOMES numbers), CDP station number, station motion in latitude in m/year, station motion in longitude*cos(PHI) in m/year, uncertainties in latitude and longitude in the same dimensions. The station motions of different occupations of the same site are forced to be the same, so only one line is to be found for each site.

REFERENCES

Bender, P.; Goad, C., 1979: Probable LAGEOS Contributions to a Worldwide Geodynamics Control Network. In: *The Use of Artificial Satellites for Geodesy and Geodynamics*. Ed. by G. Veis and E. Livieratos. Athens (Greece): Publication of the National Technical University. Vol. II, pp 145-161

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Schwintzer, P., Reigber, Ch., Massmann, F.H., Barth, W.,Raimondo, J.C., Gerstl, M., Li, H., Biancale, R., Balmino, G., Lemoine, J.M., Moynot, B., Boudon, J., Barlier, F. 1991: A New Earth Gravity Field Model in Support of ERS-1 and SPOT2: GRIM4-S1/C1. *Technical Report to the German Space Agency (DARA) and the French Space Agency (CNES)*, DGFI, Munich. (in preparation)

Zhu, S.Y., Reigber, Ch., 1991: The German PAF for ERS-1: ERS-1 Standards used at D-PAF, D-PAF Document ERS-D-STD-31101, Muenchen.

SUMMARY SHEET FOR THE DESCRIPTION OF THE TERRESTRIAL SYSTEM ATTACHED TO A SET OF STATION COORDINATES

1 - Technique:	SLR
2 - Analysis Center:	DGFI, Dept.I, Munich
3 - Solution identifier:	SSC(DGFII) 91 L 01
4 - Software used:	DGFI Orbit and Geod. Parameter Estimation System (DOGS)
5 - Relativity scale:	LE
6 - Permanent tidal correction on station:	not included
7 - Tectonic plate model:	no a priori model
8 - Velocity of light (c) =	299792458 m/sec
9 - Gravit. const. * Earth mass (GM):	398600.4394 km3/s2 (adjusted)

10 - Reference epoch:	station dependent, c.f. column 61 to 67 in the coordinate table
11 - Adjusted parameters:	C00, X,Y,Z, LAMBDA*COS(PHI),PHI (for 10.3 years) LAGEOS state vector at epoch (at monthly intervals) CR, CA (at 15 day intervals) PX, PY, LODR (at 5 day intervals)
12 - Definition of origin:	geocentre
13 - Definition of the orientation:	common rotation angle between initial and adjusted coordinates of 10 stations forced to be zero
14 - Constraint for time evolution:	drift in orientation around the three coordinate axes is forced to be the same as derived from a given set of AM0-2 horizontal station position velocities.

Appendix A:

EOP(DGFII) 91 L 01 Available from 1980 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for D

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1980	73	1.46	73	0.90	73	0.125
1981	73	1.10	73	0.66	73	0.110
1982	73	0.83	73	0.47	73	0.085
1983	73	0.75	73	0.59	73	0.095
1984	73	0.34	73	0.29	73	0.056
1985	73	0.34	73	0.27	73	0.053
1986	73	0.32	73	0.28	73	0.054
1987	73	0.29	73	0.26	73	0.053
1988	73	0.28	73	0.28	73	0.051
1989	73	0.30	73	0.30	73	0.055
1990	24	0.32	24	0.38	24	0.068

Appendix 2: SSC(DGFII) 91 L 01

Domes Number	Network Number	X (meters)	Y (meters)	Z (meters)	Epoch MJD	Data Span Days	X Err	Y Err	Z Err
							------- meters -------		
14106S	1181 3901	3800620.236	882012.338	5028859.051	45704.5	1920.0	.010	.012	.008
12337S	1873 4901	3783901.528	2551411.202	4441254.933	47744.5	300.0	.011	.011	.009
12302S	1884 4401	3183894.710	1421504.304	5322802.084	47100.0	210.0	.009	.008	.006
12337S	1893 1801	3785943.893	2550786.751	4439458.676	47744.5	240.0	.012	.011	.007
40701S	1953 2001	1474547.042	-5811239.677	2168952.723	45704.5	300.0	.098	.050	.115
40436S	7035TL1301	-2428828.011	-4799751.681	3417274.618	45704.5	60.0	.006	.006	.006
40433S	7051ML0804	-2516895.017	-4198841.751	4076418.873	44792.0	120.0	.006	.005	.004
41703S	7061TL1201	-1884985.802	-5357613.028	-2892844.043	47139.0	120.0	.011	.008	.008
41703S	7061TL1202	-1884979.796	-5357610.774	-2892851.152	47139.0	90.0	.024	.020	.016
40436S	7062TL1104	-2428829.033	-4799747.775	3417280.743	45704.5	120.0	.005	.005	.005
40436S	7062TL1205	-2428826.996	-4799747.278	3417279.796	45704.5	120.0	.007	.006	.006
40451S	7063 2101	1130714.762	-4831364.475	3994096.158	45704.5	480.0	.004	.004	.004
40417S	7069 2201	917958.771	-5548369.276	2998785.910	43770.0	60.0	.092	.066	.079
40442S	7080ML2401	-1330021.808	-5328398.906	3236488.825	45704.5	750.0	.005	.003	.004
40438S	7082TL1103	-1735998.004	-4425046.098	4241437.863	44792.0	60.0	.009	.009	.006
40438S	7082TL1104	-1735997.890	-4425046.069	4241437.921	44792.0	90.0	.011	.010	.008
40442S	7086ML0101	-1330126.541	-5328525.319	3236159.310	45704.5	120.0	.004	.004	.004
40442S	7086TL1102	-1330126.830	-5328525.932	3236157.836	45704.5	60.0	.006	.006	.006
40442S	7086ML2403	-1330121.433	-5328527.818	3236153.862	45704.5	840.0	.003	.003	.002
40442S	7086ML2404	-1330121.423	-5328527.824	3236153.827	45704.5	1050.0	.002	.002	.002
50107S	7090ML0501	-2389006.971	5043327.428	-3078534.531	45704.5	2490.0	.001	.001	.002
50107S	7090ML0506	-2389006.992	5043327.433	-3078534.543	45704.5	930.0	.003	.002	.003
40440S	7091ML0702	1492453.814	-4457275.113	4296824.526	44427.0	270.0	.005	.004	.004
40440S	7091TL1103	1492453.667	-4457274.176	4296825.794	44427.0	90.0	.008	.006	.007
50505S	7092ML0801	-6143450.714	1364701.484	1034160.233	44421.0	180.0	.006	.009	.009
50503S	7096ML0601	-6100048.467	-996206.468	-1568977.188	44421.0	240.0	.005	.007	.008
41703S	7097TL1201	-1884984.048	-5357613.457	-2892847.080	47139.0	120.0	.006	.005	.005
41703S	7097TL1202	-1884984.074	-5357613.428	-2892847.088	47139.0	120.0	.007	.006	.007
41709S	7097TL1203	-1884984.032	-5357613.465	-2892847.074	47139.0	120.0	.009	.007	.008
40451S	7102ML0402	1130686.607	-4831349.961	3994119.810	45704.5	720.0	.010	.007	.007
40451S	7102ML0404	1130686.656	-4831349.985	3994119.828	45704.5	60.0	.011	.008	.008
40451S	7103ML0602	1130685.625	-4831345.588	3994125.210	45704.5	90.0	.007	.007	.005
40451S	7105ML0207	1130719.613	-4831347.396	3994115.400	45704.5	90.0	.005	.005	.004
40451S	7105ML0701	1130719.687	-4831347.356	3994115.360	45704.5	60.0	.005	.005	.004
40451S	7105ML0702	1130719.666	-4831347.379	3994115.405	45704.5	690.0	.003	.002	.002
40451S	7105ML0704	1130719.648	-4831347.393	3994115.410	45704.5	690.0	.002	.002	.002
40451S	7105ML0709	1130719.653	-4831347.393	3994115.407	45704.5	1230.0	.003	.002	.002

Domes Number	Network Number	X (meters)	Y (meters)	Z (meters)	Epoch MJD	Data Span Days	X Err	Y Err	Z Err
							------- meters -------		
40451S	7105ML0716	1130719.647	-4831347.401	3994115.419	45704.5	360.0	.005	.005	.005
40433S	7109ML0801	-2517236.613	-4198552.772	4076577.009	45704.5	210.0	.003	.003	.003
40433S	7109ML0802	-2517236.613	-4198552.756	4076576.952	45704.5	1500.0	.001	.001	.001
40433S	7109ML0805	-2517236.599	-4198552.767	4076576.941	45704.5	1320.0	.003	.002	.002
40497S	7110ML0301	-2386279.711	-4802352.381	3444889.423	45704.5	750.0	.003	.002	.002
40497S	7110ML0402	-2386279.605	-4802352.160	3444889.221	45704.5	1650.0	.002	.002	.002
40497S	7110ML0404	-2386279.607	-4802352.169	3444889.241	45704.5	780.0	.003	.002	.003
40496S	7112ML0201	-1240679.550	-4720460.369	4094489.171	45704.5	1260.0	.003	.002	.002
40496S	7112MT1502	-1240679.533	-4720460.427	4094485.721	45704.5	30.0	.006	.005	.005
40439S	7114ML0201	-2410424.452	-4477799.991	3838694.574	47466.0	300.0	.010	.008	.008
40439S	7114TL1102	-2410424.351	-4477798.870	3838695.702	47466.0	60.0	.011	.009	.009
40439S	7114TL1103	-2410424.284	-4477798.922	3838695.688	47466.0	90.0	.008	.006	.006
40405S	7115ML0301	-2350863.472	-4655543.983	3661005.976	44421.0	420.0	.004	.003	.004
40445S	7120ML0101	-5466001.840	-2404407.197	2242231.742	45704.5	570.0	.002	.003	.004
92202S	7121ML0101	-5345867.674	-2958251.255	-1824621.996	45704.5	870.0	.003	.004	.004
40405S	7122ML0601	-1660090.469	-5619099.754	2511646.560	45704.5	1860.0	.002	.001	.002
40504S	7122ML0605	-1660090.473	-5619099.785	2511646.574	45704.5	540.0	.004	.003	.004
92202S	7123TL1201	-5345867.492	-2958250.829	-1824621.817	45704.5	90.0	.016	.019	.019
92202S	7123TL1202	-5345867.331	-2958251.098	-1824621.769	45704.5	150.0	.012	.018	.018
92202S	7123TL1203	-5345867.364	-2958251.128	-1824621.785	45704.5	150.0	.012	.019	.019
92202S	7123TL1204	-5345867.661	-2958250.711	-1824621.675	45704.5	30.0	.011	.011	.012
40451S	7125MT1501	1130743.389	-4831364.221	3994084.586	46252.0	90.0	.012	.009	.008
40445S	7210 2301	-5466007.298	-2404425.479	2242190.500	45704.5	2730.0	.001	.001	.002
40445S	7210 2304	-5466007.332	-2404425.549	2242190.554	45704.5	300.0	.003	.004	.004
40497S	7220TL1101	-2386292.966	-4802344.897	3444889.906	45704.5	60.0	.005	.004	.004
	7265TL1101	-2356478.746	-4646614.911	3668433.102	45887.0	90.0	.005	.006	.004
	7288TL1301	-2356495.581	-4646604.547	3668434.087	45887.0	120.0	.007	.006	.006
	7288TL1402	-2356495.611	-4646604.568	3668434.122	45887.0	90.0	.009	.008	.008
	7288TL1403	-2356495.583	-4646604.572	3668434.121	45887.0	90.0	.009	.007	.008
40499S	7295MT1501	961319.180	-5674089.419	2740495.832	47313.0	120.0	.007	.005	.006
41705S	7400TL1101	1769701.360	-5044619.453	-3468255.839	45887.0	90.0	.009	.006	.007
41706S	7401TL1101	1815518.770	-5213471.124	-3187994.829	45887.0	60.0	.006	.004	.005
41706S	7401TL1302	1815518.730	-5213471.397	-3187993.117	45887.0	60.0	.008	.006	.008
12612S	7510MT1501	4353446.380	2082673.263	4156503.670	46617.0	90.0	.005	.006	.005
12612S	7510MT1504	4353446.455	2082673.268	4156503.594	46617.0	60.0	.007	.009	.007
12612S	7510MT1602	4353446.483	2082673.187	4156503.634	46617.0	90.0	.005	.006	.004
12612S	7510MT1603	4353446.478	2082673.216	4156503.619	46617.0	60.0	.008	.009	.007

Domes Number	Network Number	X (meters)	Y (meters)	Z (meters)	Epoch MJD	Data Span Days	X Err	Y Err	Z Err
							------- meters -------		
12615S	7512MT1501	4573401.397	2409328.697	3723878.184	46617.0	60.0	.005	.006	.005
12615S	7512MT1503	4573401.475	2409328.743	3723878.097	46617.0	30.0	.007	.009	.008
40496S	7512MT1602	4573401.416	2409328.686	3723878.183	46617.0	90.0	.005	.007	.005
12602S	7515MT1501	4595217.930	2039441.859	3912626.494	46617.0	60.0	.005	.007	.005
12602S	7515MT1502	4595217.947	2039441.876	3912626.467	46617.0	120.0	.005	.006	.005
12602S	7515MT1503	4595217.934	2039441.910	3912626.461	46617.0	60.0	.007	.009	.008
12613S	7517TL1102	4728697.117	2174379.971	3674571.650	46617.0	60.0	.006	.006	.005
12613S	7517TL1104	4728697.073	2174379.938	3674571.619	46617.0	60.0	.007	.009	.008
12613S	7517MT1503	4728696.168	2174379.584	3674569.673	46617.0	90.0	.006	.007	.006
12613S	7517MT1601	4728696.164	2174379.662	3674569.683	46617.0	120.0	.005	.006	.006
12614S	7520MT1501	4596044.135	1733483.364	4055718.427	46617.0	90.0	.006	.006	.004
12614S	7520MT1502	4596044.289	1733483.517	4055718.210	46617.0	90.0	.007	.009	.007
12616S	7525TL1104	4745951.922	1905712.671	3799168.151	46617.0	120.0	.006	.008	.007
12616S	7525TL1105	4745951.944	1905712.628	3799168.165	46617.0	90.0	.009	.012	.010
12616S	7525MT1601	4745951.143	1905712.172	3799166.227	46617.0	60.0	.007	.010	.008
20702S	7530ML0201	4443967.574	3121951.555	3334692.125	46617.0	450.0	.009	.011	.011
12734S	7540MT1501	4641986.314	1393064.252	4133231.379	45704.5	90.0	.009	.008	.006
12734S	7541MT1601	4641992.057	1393048.735	4133229.777	45704.5	90.0	.006	.006	.005
12706S	7544MT1502	5072833.758	1130892.050	3684835.119	47100.0	90.0	.007	.010	.008
12706S	7544MT1601	5072833.741	1130891.990	3684835.139	47100.0	120.0	.007	.008	.006
12725S	7545TL1103	4893399.450	772680.794	4004143.020	46252.0	90.0	.008	.012	.008
12725S	7545MT1601	4893399.881	772679.370	4004139.768	46252.0	60.0	.006	.009	.006
12725S	7545MT1602	4893399.916	772679.324	4004139.742	46252.0	90.0	.006	.010	.007
	7546MT1601	4461401.437	919573.531	4449509.303	47313.0	60.0	.015	.025	.014
12718S	7550MT1601	4336739.836	1071278.894	4537909.999	46617.0	90.0	.009	.011	.007
12718S	7550MT1602	4336740.359	1071278.501	4537909.607	46617.0	60.0	.010	.013	.009
20801S	7575MT1501	3848637.140	3251768.002	3898904.343	46916.0	60.0	.009	.011	.008
20801S	7575MT1502	3848637.220	3251767.966	3898904.309	46916.0	30.0	.010	.012	.010
20803S	7580TL1101	4247622.636	2778646.215	3851605.369	46905.0	60.0	.006	.007	.004
20803S	7580TL1102	4247622.646	2778646.071	3851605.340	46905.0	60.0	.007	.009	.007
20802S	7585MT1501	4029731.991	2802100.365	4062063.896	46961.0	60.0	.010	.013	.007
20802S	7585MT1502	4029731.994	2802100.384	4062063.879	46961.0	60.0	.010	.013	.010
20804S	7587TL1101	4117364.081	2517084.449	4157677.443	46961.0	30.0	.008	.007	.005
20804S	7587TL1102	4117364.133	2517084.292	4157677.433	46961.0	150.0	.009	.009	.007
14005S	7590MT1601	4390311.405	696758.220	4560835.069	46252.0	60.0	.005	.006	.004
14201S	7596MT1502	4075584.362	931844.472	4801558.933	45704.5	60.0	.009	.010	.006
14201S	7596MT1601	4075584.226	931844.363	4801558.890	45704.5	60.0	.019	.067	.051

Domes Number	Network Number	X (meters)	Y (meters)	Z (meters)	Epoch MJD	Data Span Days	X Err	Y Err	Z Err
							------- meters -------		
14001S	7810 4801	4331282.619	567555.936	4633140.072	45704.5	1560.0	.004	.006	.004
12205S	7811 3801	3738331.749	1148253.379	5021814.950	45704.5	360.0	.011	.012	.008
30101S	7831 4601	4728282.800	2879674.880	3156891.283	45522.0	150.0	.007	.007	.006
14201S	7834 3001	4075529.054	931787.898	4801617.777	45704.5	2880.0	.002	.002	.002
10002S	7835 3101	4581690.850	556165.441	4389359.559	45704.5	1890.0	.002	.003	.002
21726S	7838 3601	-3822389.148	3699368.181	3507567.189	45704.5	2040.0	.003	.003	.003
11001S	7839 3401	4194425.710	1162700.301	4647245.797	45704.5	2220.0	.003	.003	.002
13212S	7840 3501	4033462.809	23669.143	4924305.844	45704.5	2340.0	.002	.002	.002
	7843 2501	-4446475.934	2678121.618	-3696256.589	45704.5	90.0	.031	.040	.036
40439S	7853MT1501	-2410423.133	-4477797.522	3838694.649	47466.0	60.0	.005	.004	.004
40505S	7882TL1102	-1997241.527	-5528041.470	2468363.296	45704.5	60.0	.014	.009	.013
40505S	7882TL1201	-1997242.413	-5528039.434	2468362.997	45704.5	60.0	.013	.010	.011
40506S	7883TL1401	-2406128.430	-4898365.894	3290344.208	47684.0	180.0	.008	.006	.007
40442S	7885TL1101	-1330125.846	-5328524.459	3236160.457	45704.5	90.0	.009	.009	.007
40433S	7886TL1101	-2517243.076	-4198548.578	4076577.525	45887.0	30.0	.007	.006	.005
40433S	7886TL1102	-2517243.156	-4198548.624	4076577.387	45887.0	30.0	.009	.008	.007
40433S	7886TL1103	-2517243.163	-4198548.626	4076577.392	45887.0	30.0	.007	.005	.004
40433S	7886TL1104	-2517245.485	-4198546.576	4076578.084	45887.0	30.0	.007	.006	.005
40434S	7888TL1101	-1936745.673	-5077638.130	3332001.095	43770.0	120.0	.011	.008	.009
40412S	7890TL1102	-754164.168	-5459059.362	3200753.390	44678.0	30.0	.076	.069	.033
40491S	7891TL1101	-1923979.613	-4850868.535	3658583.149	44678.0	60.0	.009	.008	.007
40492S	7892TL1101	-1631484.666	-4589131.259	4106757.798	44678.0	60.0	.013	.011	.009
40492S	7892TL1102	-1631484.628	-4589131.175	4106757.817	44678.0	60.0	.015	.012	.011
40493S	7894TL1101	-2196778.340	-4887334.610	3448434.617	45522.0	120.0	.018	.010	.012
40400S	7896TL1101	-2493212.763	-4655226.750	3565583.491	44421.0	90.0	.006	.007	.006
40451S	7899TL1102	1131364.830	-4831164.799	3994139.120	45704.5	60.0	.010	.010	.009
42202S	7907 4001	1942792.496	-5804080.096	-1796910.886	45704.5	3550.5	.002	.001	.002
40451S	7920TL1306	1130742.329	-4831365.160	3994085.898	45704.5	30.0	.029	.026	.017
40451S	7920TL1308	1130742.332	-4831365.131	3994085.933	45704.5	30.0	.012	.013	.015
40434S	7921 4301	-1936760.724	-5077702.547	3331929.669	43770.0	120.0	.022	.015	.028
41604S	7929 4101	5186468.143	-3653856.973	-654316.105	44609.5	420.0	.013	.017	.016
12734S	7939 4101	4641964.203	1393075.660	4133261.259	45704.5	2370.0	.002	.002	.002
	7943 4201	-4447547.866	2677128.928	-3695001.291	45704.5	750.0	.016	.021	.019
13504S	8833MT1501	3899236.778	396776.087	5015055.519	45887.0	60.0	.010	.010	.006
13504S	8833MT1602	3899237.006	396776.124	5015055.452	45887.0	120.0	.009	.010	.006
13504S	8833MT1604	3899236.998	396776.125	5015055.448	45887.0	120.0	.010	.012	.008

Appendix 3: SSV(DGFII)91L01

Domes Number	Network Number		Station velocity North m/y	Station velocity East m/y	Errors North m/y	Errors East m/y
14106S	1181	3901	.010	-.002	.003	.003
40701S	1953	2001	.106	.196	.024	.019
40436S	7062		-.015	-.040	.002	.002
40438S	7082		-.003	-.024	.006	.007
40442S	7086		-.011	-.016	.001	.001
50107S	7090		.060	.038	.001	.001
40440S	7091		.012	-.011	.001	.001
41709S	7097		.004	.059	.005	.006
40451S	7102		-.022	-.005	.004	.004
40451S	7105		-.001	-.017	.001	.001
40433S	7109		-.009	-.022	.001	.001
40497S	7110		.007	-.042	.001	.001
40496S	7112		-.030	-.015	.001	.002
40439S	7114		-.009	-.019	.001	.001
40504S	7122		-.010	-.011	.001	.001
92202S	7123		.002	-.077	.004	.004
40445S	7210		.024	-.074	.001	.000
	7288		-.017	-.017	.002	.002
41706S	7401		.003	.025	.002	.002
12612S	7510		.010	.023	.003	.003
12615S	7512		-.025	.004	.003	.004
12602S	7515		-.008	.007	.003	.004
12613S	7517		-.025	.008	.004	.004
12614S	7520		.020	-.013	.004	.004
12616S	7525		-.011	.001	.004	.004
20702S	7530	ML0201	.001	.027	.020	.020
12706S	7544		.004	.014	.008	.008
12725S	7545		.011	.023	.003	.003
12718S	7550		.024	.018	.009	.009
20801S	7575		.024	.026	.006	.006
20803S	7580		-.003	.029	.004	.005
20802S	7585		.012	-.008	.007	.007
20804S	7587		.016	.034	.005	.005
14001S	7810	4801	.004	.024	.001	.001
14201S	7834	3001	.008	.019	.001	.001
10002S	7835	3101	.010	.020	.001	.001
21726S	7838	3601	-.000	-.002	.001	.001
11001S	7839	3401	.012	.019	.001	.001
13212S	7840	3501	.009	.013	.001	.001
	7843		.082	-.008	.007	.007
40505S	7882		.030	-.056	.003	.004
40433S	7886		.068	.010	.013	.017
40492S	7892		-.029	-.037	.013	.014
42202S	7907	4001	.011	.015	.000	.000
41604S	7929	4101	.173	-.104	.033	.041
12734S	7939	4101	.019	.018	.001	.001
13504S	8833		-.002	.017	.003	.004

EARTH ROTATION AND STATION COORDINATES COMPUTED FROM SLR OBSERVATIONS ON LAGEOS.

DUT 91 L 01

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This contribution to the 1990 Annual Report describes in brief a series of Earth Rotation Parameters (ERPs) at 5-day intervals. The solutions for the pole position and the A1-UT1 time difference have been computed from laser range observations on the geodetic satellite LAGEOS, and cover the period January 1986 - April 1990.

For the processing of the measurements, the entire data interval was divided in sub-intervals, or data arcs, with a length of 7 days. The parameter estimation was based on a least-squares fitting of the computed satellite orbit through the observations, for each individual data arc. In addition to the ERPs, the estimated parameters also included the coordinates of all global laser stations and, for each data arc, the satellite state-vector at epoch, the satellite's solar reflectivity and an along-track acceleration parameter. In order to strengthen the laser station coordinates solutions, the observations were processed in batches of about 13 weeks.

The computation model that was used is summarized in Table 1. The model closely follows the IERS Standards, with only few exceptions. The IERS models for the earth gravity field and the ocean tides are replaced by the very recent NASA/GSFC GEM-T2 solutions, and the effect of ocean loading was not applied. Since a co-objective of the investigations is the determination of crustal deformations from successive laser station coordinates solutions, no plate motion model was incorporated in the computations. Details of the terrestrial system are given in Table 2.

To eliminate the computational singularities that are introduced by the large correlations between some of the solve-for parameters, the fact that the overall analysis program is based on a Bayesian estimation scheme was exploited. The a priori standard deviation of the pole position and the UT time difference were assigned values of 0.1 arcsec and 0.01 s, respectively; the initial laser station coordinates were given an a priori uncertainty of 1 m.

The resulting series of ERP solutions is given in Table 3. The effect of short-term perturbations in the UT time difference, caused by zonal tides, has been removed. Table 4 lists the station coordinates at the epoch January 1, 1988. For each station, the cartesian monument coordinates are followed by the corresponding standard deviations, the correlations between these coordinates (in the order x-y, x-z and y-z) and solved-for values for the time-derivatives of these coordinates. The latter may be used to correct the ERP solutions for unmodeled trends in the overall reference system. The motion estimates are relative to a reference frame rigidly attached to the Eurasian tectonic plate. The individual apparent motions are in m/yr, the position components and the standard deviations are in m.

Table 1. : Models and constants.

DYNAMIC MODEL:

Gravity field	NASA/GSFC GEM-T2 model, truncated at 20x20; C(2,1) and S(2,1) according to IERS Standards (1989)
GM	398600.4360 km^3/s^2
c	299792.458 km/s
ae	6378.1370 km
1/f	298.257
Solar and lunar attraction	JPL DE-200 ephemeris
Solid earth tides	Wahr model
Ocean tides	NASA/GSFC GEM-T2 model
Solar radiation	CR adjusted; occultation by earth and moon; umbra and penumbra
Along-track acceleration	AT adjusted
Third body attraction	Sun, Moon, Venus, Mars, Jupiter, Saturn
Pole tide (dynamic part)	applied

REFERENCE FRAME:

Station coordinates	adjusted
Earth rotation	adjusted at 5-day intervals; a priori values from IERS Bulletin B
CIS	mean equator and equinox of J2000.0
Precession	IAU 1976
Nutation	IAU 1980 (Wahr series) plus Herring correction (offsets applied)
Plate motion	not applied
Tidal uplift	h2 = 0.609, l2 = 0.0852
Pole tide (geometric part)	applied
Ocean loading	not applied

MEASUREMENT MODEL:

Observations	Release B normal points, computed at DGFI (January - October 1986, 1987), DUT (November, December 1986) and Bendix (1988 - 1990)
Data weighting	determined from overall model accuracy and system characteristics
Tropospheric refraction	Marini-Murray model

Table 2 : SUMMARY SHEET FOR THE DESCRIPTION OF THE TERRESTRIAL SYSTEM ATTACHED TO A SET OF STATION COORDINATES

1.	Technique :	SLR
2.	Analysis center:	Delft University of Technology, Faculty of Aerospace Engineering
3.	Solution identifier :	SSC(DUT) 91 L 01
4.	Software used :	GEODYN-II
5.	Relativity scale :	local Earth
6.	Tidal uplift :	permanent correction applied (h2 = 0.609, l2 = 0.0852); periodic tidal correction not applied
7.	Tectonic plate model :	not applied
8.	Velocity of light :	299792.458 km/s
9.	Gravitational constant :	398600.4360 km^3/s^2
10.	Reference epoch :	January 1, 1988
11.	Adjusted parameters :	X(0), Y(0), Z(0)
12.	Origin definition :	C(1,0) = 0, Cbar(2,1) = -1.3 x (XP), Sbar(2,1) = -1.3 x (-YP)
13.	Orientation definition:	*a priori* standard deviation of 1 m for all coordinates (*a priori* coordinates from preliminary analysis)
14.	Evolution constraint :	fixed for each "quarterly" solution

Table 3:

EOP(DUT) 91 L 01 Available from 1986 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for UT1

YEAR	X		Y		UT1	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1986	73	1.41	73	1.46	73	1.31
1987	72	0.79	72	0.82	72	0.60
1988	73	0.80	73	0.77	73	0.57
1989	73	0.75	73	0.74	73	0.52
1990	23	0.70	23	0.80	23	0.50

Table 4: Global laser station coordinates solution. SSC(DUT) 91 L 01

Network Number	X m	Y m	Z m	
7080	-1330021.0252	-5328401.8285	3236480.7747	
	0.0295	0.0244	0.0319	<= σx,σy,σz (m)
	-0.3366	-0.1194	0.1291	<= ρ(x,y), ρ(x,z), ρ(y,z)
	-0.0055	-0.0160	-0.0044	<= Vx,Vy,Vz (m/y)
7086	-1330125.3629	-5328526.5994	3236150.2441	
	0.0291	0.0239	0.0316	
	-0.3492	-0.1228	0.1343	
	-0.0055	-0.0160	-0.0044	
7090	-2389006.3803	5043329.2697	-3078525.2921	
	0.0426	0.0352	0.0427	
	-0.0854	-0.5756	0.5784	
	0.0809	0.0205	0.0112	
7097	-1884984.4626	-5357608.0357	-2892853.3745	
	0.0373	0.0359	0.0330	
	-0.2375	-0.1996	-0.4242	
	-0.0039	0.0464	0.0083	
7105	1130719.7057	-4831350.5707	3994106.4213	
	0.0274	0.0201	0.0296	
	-0.1308	-0.2079	0.2301	
	-0.0083	-0.0170	0.0006	
7109	-2517234.7370	-4198556.1530	4076569.6257	
	0.0258	0.0268	0.0285	
	-0.4460	0.0169	0.1598	
	-0.0052	-0.0180	-0.0031	
7110	-2386277.9694	-4802354.2815	3444881.3815	
	0.0266	0.0252	0.0298	
	-0.4534	-0.0631	0.1413	
	0.0157	-0.0460	-0.0066	
7121	-5345865.2845	-2958246.4459	-1824623.7920	
	0.0367	0.0423	0.0413	
	-0.2061	-0.4034	-0.0428	
	0.0438	-0.0765	-0.0452	
7122	-1660089.3735	-5619100.3479	2511637.8284	
	0.0283	0.0226	0.0316	
	-0.3930	-0.1499	0.0457	
	-0.0109	-0.0139	0.0090	
7123	-5345866.8180	-2958247.3138	-1824624.3272	
	0.0310	0.0371	0.0361	
	-0.2632	-0.5060	-0.0534	
	0.0438	-0.0765	-0.0452	
7210	-5466006.4683	-2404427.8263	2242187.4739	
	0.0209	0.0330	0.0353	
	-0.3047	-0.0845	-0.0582	
	0.0491	-0.0743	0.0144	
7288	-2356494.1239	-4646607.6214	3668426.5978	
	0.0301	0.0294	0.0326	
	-0.3392	-0.0356	0.1204	
	0.0008	0.0071	-0.0246	
7510	4353444.9482	2082666.1746	4156506.5901	
	0.0240	0.0244	0.0261	
	-0.1761	-0.1095	-0.0494	
	-0.0007	0.0090	-0.0018	
7512	4573400.0999	2409322.0971	3723881.6918	
	0.0248	0.0252	0.0275	
	-0.2058	-0.0841	-0.0218	
	-0.0145	-0.0034	0.0155	

Table 4. (cont.) Global laser station coordinates solution. SSC(DUT) 91 L 01

Network Number	X m	Y m	Z m	
7515	4595216.4852	2039435.1987	3912629.4363	
	0.0235	0.0245	0.0263	<= σx,σy,σz (m)
	-0.1917	-0.0984	-0.0328	<= ρ(x,y), ρ(x,z), ρ(y,z)
	-0.0277	-0.0190	0.0020	<= Vx,Vy,Vz (m/y)
7517	4728694.7246	2174373.2539	3674572.8932	
	0.0237	0.0248	0.0267	
	-0.2124	-0.0827	-0.0195	
	-0.0347	-0.0019	0.0113	
7520	4596042.6814	1733476.6470	4055720.7729	
	0.0255	0.0268	0.0281	
	-0.1480	-0.0948	-0.0315	
	-0.0116	-0.0418	0.0051	
7525	4745949.5934	1905705.8022	3799168.9858	
	0.0240	0.0255	0.0271	
	-0.1793	-0.0860	-0.0244	
	-0.0273	-0.0260	0.0069	
7530	4443967.3809	3121945.3173	3334694.2953	
	0.0389	0.0379	0.0411	
	-0.1326	-0.0448	0.0058	
	-0.0245	0.0628	0.0069	
7544	5072832.0230	1130886.1046	3684836.8891	
	0.0270	0.0297	0.0308	
	-0.1049	-0.0617	-0.0189	
	0.0073	0.0199	0.0206	
7545	4893398.1187	772673.1931	4004140.8887	
	0.0281	0.0301	0.0307	
	-0.0483	-0.0664	-0.0122	
	0.0100	-0.0033	0.0077	
7550	4336738.6448	1071271.3619	4537910.9650	
	0.0253	0.0267	0.0272	
	-0.1023	-0.1267	-0.0306	
	-0.0054	-0.0028	0.0099	
7575	3848636.0645	3251760.8075	3898909.1816	
	0.0285	0.0262	0.0304	
	-0.1700	-0.0886	-0.0493	
	0.0353	0.0039	-0.0103	
7580	4247620.5768	2778638.8500	3851607.4566	
	0.0276	0.0267	0.0297	
	-0.1778	-0.0821	-0.0329	
	0.0079	-0.0148	0.0003	
7585	4029730.7556	2802093.1743	4062067.9517	
	0.0283	0.0271	0.0301	
	-0.1556	-0.0845	-0.0517	
	0.0287	-0.0305	-0.0157	
7587	4117362.0808	2517076.7141	4157678.9896	
	0.0279	0.0273	0.0296	
	-0.1481	-0.0858	-0.0520	
	0.0056	0.0010	-0.0004	
7810	4331283.6660	567549.4515	4633139.8621	
	0.0213	0.0230	0.0233	
	-0.0952	-0.1858	-0.0140	
	0.0092	-0.0042	0.0081	
7811	3738333.3452	1148246.1869	5021815.9089	
	0.0725	0.0730	0.0731	
	-0.0326	-0.0399	-0.0196	
	0.1249	0.1051	-0.2340	

Table 4. (cont.) Global laser station coordinates solution. SSC(DUT) 91 L 01

Network Number	X m	Y m	Z m	
7831	4728283.6711	2879670.3717	3156894.2225	
	0.0259	0.0258	0.0288	<= σx,σy,σz (m)
	-0.2564	-0.0588	0.0221	<= ρ(x,y), ρ(x,z), ρ(y,z)
	0.0036	-0.0493	-0.0009	<= Vx,Vy,Vz (m/y)
7834	4075530.0976	931781.1630	4801618.1207	
	0.0213	0.0225	0.0224	
	-0.1181	-0.1777	-0.0391	
	0.0015	-0.0046	0.0066	
7835	4581691.8025	556159.2666	4389359.2874	
	0.0208	0.0231	0.0237	
	-0.0890	-0.1702	-0.0139	
	0.0095	-0.0009	0.0028	
7838	-3822386.9384	3699362.2947	3507571.9336	
	0.0249	0.0294	0.0423	
	0.4651	-0.0828	-0.2675	
	0.0169	-0.0323	-0.0087	
7839	4194426.7466	1162693.7626	4647246.4588	
	0.0212	0.0224	0.0226	
	-0.1335	-0.1667	-0.0476	
	0.0053	0.0073	0.0054	
7840	4033463.8508	23662.2305	4924304.9650	
	0.0212	0.0226	0.0223	
	-0.0697	-0.2211	0.0241	
	-0.0008	-0.0011	-0.0051	
7843	-4446476.5985	2678127.0472	-3696251.5298	
	0.0410	0.0407	0.0422	
	-0.0646	-0.6675	0.3825	
	0.0804	-0.0135	0.0585	
7883	-2406126.8754	-4898368.3381	3290336.3941	
	0.1475	0.1466	0.1486	
	-0.0286	-0.0021	0.0134	
	0.1191	-0.0254	0.0200	
7907	1942791.8636	-5804077.6366	-1796919.2857	
	0.0337	0.0312	0.0348	
	-0.0028	0.0691	-0.6562	
	-0.0035	0.0028	-0.0299	
7939	4641965.1147	1393069.8005	4133262.1575	
	0.0208	0.0227	0.0237	
	-0.1646	-0.1337	-0.0361	
	0.0096	0.0011	0.0136	
8833	3899237.9360	396769.1391	5015055.1351	
	0.0623	0.0631	0.0630	
	-0.0245	-0.0427	-0.0068	
	0.0665	-0.1184	-0.0282	

EARTH ORIENTATION PARAMETERS AND SET OF STATION COORDINATES

GAOUA 91 L 01

V. K. Tarady, K. Kh. Nurutdinov, V. N. Salyamov, M. L. Tsesis

Earth orientation Parameters and station coordinates were derived from the June 1989 - July 1990 Lageos normal points data using Kiev-Geodynamics-3 computer program. The models underlying the GAOUA 91 L 01 solution are IERS standard models with exceptions indicated [V. K. Tarady et al, 1990] and -NASA/GSFC GEM-T2 gravity field model, truncated at 20 X 20; - a subset of NASA/GSFC GEM-T1 solution for ocean tides.

Adjusted parameters are cartesian coordinates X,Y,Z of 44 stations, 6 orbital elements, 2 pole coordinates, universal time UT1R and rates of EOP changes.

The analysis process.

1. The Lageos normal points from June 1989 till July 1990 were processed in batches of multiple continuous 15-days data arcs to estimate 6 orbital elements and set of station coordinates. In this procedure the Minster-Jordan plate motion model AM1-2 was used. The connection with ITRF-88 frame is defined by fixing the longitude of Grasse (7835) station. A priori EOP values were taken from IERS Bulletin B. Reference epoch is MJD 47161.

2. At the second stage of analysis new Lageos orbital elements were determined on the basis of the 5-days arcs. Finally the Lageos node longitudes were kept fixed and others five orbit parameters were estimated simultaneously with pole coordinates, UT1R and rates of EOP changes. Mean value of post-fit orbital is 0.047 m. Mean formal uncertainties for the EOP values in January - July 1990 are 0.17 mas, 0.11 mas, 0.015 ms for the pole coordinates x, y and UT1R accordingly.

SUMMARY SHEET :

1 -	Technique :	SLR
2 -	Analysis Center :	GAOUA
3 -	Solution identifier :	SSC(GAOUA) 91 L 02
4 -	Software used :	KIEV-GEODYNAMICS - 3
5 -	Relativity scale :	LE
6 -	Permanent tidal correction on station :	NO
7 -	Tectonic plate model :	AM1-2
8 -	Velocity of light (C) =	299 792 458
9 -	Geogravitational constant (GM) =	3.9860 0440*10**14
10 -	Reference epoch =	MJD 47161
11 -	Adjusted parameters :	X,Y,Z
12 -	Definition of the origin :	C10=0, C11=0, S11=0
13 -	Definition of the orientation :	ERP values from IERS Bulletin B
14 -	Constraint for time evolution :	fixed plate motion model

References : IERS Technical Note 5, June 1990, Paris, France.

Domes Number	Network Number	X m	Y m	Z m	Mean MJD	Data Span Days	Y Err meters	Y Err meters	Z Err meters
X14106S001	1181S001	3800621.356	882005.319	5028859.308	47794.9	597.2	0.011	0.009	0.007
X12337S000	1873S001	3783902.816	2551404.893	4441257.461	48037.1	360.2	0.019	0.016	0.012
X12302S002	1884S001	3183896.245	1421496.893	5322803.352	47894.1	584.1	0.013	0.011	0.008
X12337S001	1893S001	3785944.988	2550780.515	4439461.294	47801.1	599.1	0.025	0.024	0.015
X40701S001	1953S001	1474548.348	-5811242.351	2168944.917	47790.9	591.0	0.015	0.014	0.016
X40438S001	7046S001	-1736001.162	-4425050.089	4241429.248	48124.7	28.7	0.012	0.011	0.008
X40442M006	7080M001	-1330021.009	-5328401.846	3236480.783	47777.7	599.0	0.005	0.004	0.006
X50107M001	7090M001	-2389006.458	5043329.319	-3078525.314	47813.2	596.7	0.005	0.004	0.005
X41703M002	7097M001	-1884984.481	-5357608.101	-2892853.348	47773.0	396.8	0.010	0.009	0.009
X40451M005	7105M001	1130719.765	-4831350.562	3994106.398	47749.0	598.8	0.007	0.006	0.006
X40433M006	7109M001	-2517234.709	-4198556.162	4076569.641	47805.6	598.2	0.005	0.005	0.005
X40497M001	7110M001	-2386277.948	-4802354.307	3444881.363	47844.5	589.2	0.004	0.004	0.005
X40496M001	7112M001	-1240678.125	-4720463.334	4094480.626	48145.7	1.0	0.034	0.032	0.022
X40504M001	7122M001	-1660089.364	-5619100.404	2511637.842	47873.8	598.0	0.007	0.005	0.008
X92202M003	7123M001	-5345866.975	-2958247.228	-1824624.207	47948.4	434.4	0.012	0.013	0.013
X40445M001	7210M001	-5466006.546	-2404427.875	2242187.534	47981.8	314.5	0.006	0.008	0.009
X40405M013	7288M001	-2356494.033	-4646607.650	3668426.631	47788.5	334.2	0.010	0.008	0.009
X41706M001	7401M001	1815517.175	-5213465.102	-3187997.651	47990.2	68.0	0.012	0.010	0.010
X42202M003	7403S001	1942808.759	-5804072.132	-1796916.360	48108.0	71.9	0.011	0.009	0.011
X12612M001	7510M001	4353444.920	2082666.342	4156506.491	47852.9	31.3	0.010	0.012	0.009
X12615M001	7512M001	4573400.184	2409322.251	3723881.555	47819.4	14.0	0.010	0.012	0.010
X12602M002	7515M001	4595216.481	2039435.283	3912629.320	47909.7	44.7	0.012	0.015	0.010
X12613M001	7517M001	4728695.659	2174373.774	3674574.743	47662.5	26.0	0.016	0.017	0.013
X12614M001	7520M001	4596042.895	1733476.810	4055720.468	47728.0	34.0	0.013	0.017	0.013
X12616M001	7525M001	4745949.715	1905705.825	3799168.891	47896.1	53.7	0.013	0.014	0.011
X12706M001	7544M001	5072832.334	1130885.981	3684836.740	47614.9	3.0	0.475	0.416	0.155
X12725M002	7545M001	4893397.675	772674.730	4004144.105	47968.9	63.0	0.014	0.015	0.011
X20801M001	7575M001	3848636.117	3251760.814	3898909.124	47787.7	15.1	0.010	0.011	0.010
X20803M001	7580M001	4247620.568	2778638.794	3851607.431	47834.9	10.2	0.017	0.017	0.016
X20802M001	7585M001	4029730.723	2802093.286	4062067.861	47767.4	16.1	0.014	0.013	0.011
X20804M001	7587M001	4117362.192	2517076.613	4157678.876	47787.3	53.4	0.012	0.013	0.013
X10302S001	7602S001	2102904.775	721604.619	5958202.103	48130.7	31.5	0.025	0.015	0.012
X10503S001	7805S001	2892595.479	1311807.020	5512611.110	47867.2	358.0	0.033	0.036	0.029
X14001S001	7810S001	4331283.671	567549.545	4633139.846	47857.6	599.3	0.005	0.006	0.006
X12205S001	7811S001	3738332.933	1148246.188	5021815.532	47945.2	485.9	0.016	0.014	0.010
X30101S001	7831S001	4728283.598	2879670.318	3156894.416	47962.5	449.1	0.009	0.009	0.009

Domes Number	Network Number	X m	Y m	Z m	Mean MJD	Data Span Days	Y Err meters	Y Err meters	Z Err meters
X14201S002	7834S001	4075530.110	931781.212	4801618.075	47878.9	589.1	0.007	0.008	0.006
X10002S001	7835S001	4581691.806	556159.352	4389359.244	47779.5	600.1	0.003	0.000	0.005
X21605S001	7837S001	-2831087.709	4676203.457	3275172.792	48045.4	303.9	0.014	0.014	0.011
X21726M001	7838M001	-3822386.961	3699362.233	3507571.945	47864.1	598.0	0.009	0.011	0.009
X11001S002	7839S001	4194426.751	1162693.842	4647246.414	47856.5	585.2	0.006	0.006	0.006
X13212S001	7840S001	4033463.859	23662.266	4924304.908	47828.6	598.0	0.004	0.004	0.005
X50103S007	7843S001	-4446476.751	2678127.067	-3696251.573	47960.0	314.3	0.008	0.009	0.007
X40506S001	7883S001	-2406127.779	-4898370.309	3290338.052	47697.1	91.0	0.026	0.019	0.020
X42202S001	7907S001	1942791.945	-5804077.604	-1796919.311	47835.2	594.9	0.006	0.005	0.007
X40451M120	7918M001	1130705.435	-4831345.502	3994115.962	48082.1	139.2	0.016	0.014	0.011
X40451M117	7920M001	1130742.635	-4831369.035	3994075.786	47841.6	341.2	0.022	0.020	0.023
X12734S001	7939S001	4641965.137	1393069.874	4133262.130	47892.6	599.0	0.004	0.005	0.005
X13504M002	8833M001	3899237.876	396769.125	5015055.061	48088.9	26.3	0.022	0.019	0.011

EOP(GAOUA) 91 L 01 Available from 1990 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for UT1

YEAR	X		Y		UT1	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1990	42	0.19	42	0.12	42	0.20

A 14 YEAR SLR EOP SERIES FROM LAGEOS SATELLITE LASER RANGING SL7.1 (G72)

GSFC 91 L 01

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This solution was obtained by fitting the orbit of LAGEOS for 30 day (or 35 day) arcs using normal points from May 1976 through June 1990. There were more than 50 million full rate data points used to form the 532,050 normal points used in the solution. The monthly arcs were combined to form the solution for earth orientation parameters and a set of station positions. The following summarizes the models used in the solution.

GEM-T1 Geopotential model
Earth and ocean tides from GEM-T1
Luni-solar and planetary gravitational perturbations for Mercury through Neptune
GM= 398600.4408 km^3/s^2
Velocity of light 299792.458 m/s
Along track acceleration estimated two times per arc
Solar radiation coefficient estimated two times per arc
Data extends from May 1976 to June 1990
532,050 two minute normal points formed following the Herstmonceux recommendations
Stations positions estimated at epoch Jan 15, 1983, (the latitude and longitude of 7105, the latitude of 7210, and the longitude of 7907 were the fixed coordinates)
Time evolution of the stations was done with the AM0-2 tectonic model
Wahr nutation series
J2000 Reference system implemented with the JPL DE-200 planetary ephemeris
Earth orientation (Xp, Yp and A1-UT1) were adjusted at 5 day intervals fixing the first 5 day value of A1-UT1 in each arc. The LOD was formed by doing a forward difference of the piecewise continuous A1-UT1 series.

The Xp, Yp and LOD values are in ERP(GSFC)SL7.1(G72). The sigmas are the formal errors from the least squares adjustment.

The station locations in cartesian coordinates are in SSC(GSFC)SL7.1(G72). The locations are for an epoch of January 15, 1983. As for the EOP, the sigmas are formal errors from the least squares adjustment. The position for station numbers 7035, 7051, 7061, 7062, 7063, 7067, 7069, 7080, 7082, 7086, 7090, 7091, 7092, 7096, 7097, 7105, 7109, 7110, 7112, 7114, 7115, 7120, 7121, 7122, 7123, 7125, 7210, 7220, 7265, 7288, 7295, 7510, 7512, 7515, 7517, 7520, 7525, 7530, 7541, 7544, 7545, 7546, 7550, 7575, 7580, 7585, 7587, 7590, 7838, 7853, 7882, 7883, 7885, 7888, 7890, 7891, 7892, 7896, and 7899 are for the padmarker at the site. The position for stations 1181, 1184, 1953, 7307, 7400, 7401, 7805, 7810, 7811, 7831, 7833, 7834, 7835, 7837, 7839, 7840, 7843, 7844, 7086, 7894, 7907, 7921, 7929, 7939, 7943, and 8833 are for the optical axis for the laser ranging system.

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H SSC( GSFC)SL7.1(G72)
C STATION COORDINATES MAY 76 - JUN 90
C THE FIXED STATION COORDINATES IN THE SOLUTION ARE
C THE LATITUDE AND LONGITUDE OF 7063 AND 7105, THE
C LONGITUDE OF 7907, AND THE LATITUDE OF 7210
C THE GRAVITY MODEL IS GEM-T1 WITH THE GEMT-1 TIDES
C THE MERIT STANDARDS HAVE BEEN FOLLOWED EXCEPT THE VALUE
C OF GM WAS ESTIMATED TO BE = 398600.4408 (NONRELATIVISTIC)
C BASED UPON A LAGEOS COM CORRECTION OF 24.0 CM
C AND SPEED OF LIGHT OF 299792458 M/SEC
C FI HDR: 2  LAGEOS SL7.1  MAY76-JUN90 (11-29-90)   STA(7105PL7210P) GM GEMT1
```

Station coordinates — SSC(GSFC) 91 L 01

Station Name	Station Number	X (m)	Y (m)	Z (m)	X Err	Y Err	Z Err
					meters		
POTSDA	1181	3800621.587	882005.127	5028859.308	0.045	0.039	0.027
RIGA	1884	3183896.107	1421496.632	5322803.079	0.051	0.050	0.032
SANTIA	1953	1474548.213	-5811242.446	2168944.953	0.057	0.049	0.058
OTAY M	7035	-2428826.513	-4799754.370	3417267.031	0.065	0.066	0.044
QUINCY	7051	-2516893.079	-4198845.036	4076411.551	0.018	0.017	0.013
EASTER	7061	-1884984.547	-5357606.612	-2892852.513	0.117	0.091	0.091
OTAY M	7062	-2428825.756	-4799750.529	3417272.719	0.015	0.013	0.014
GREENB	7063	1130714.846	-4831367.729	3994087.353	0.001	0.006	0.005
BERMUD	7067	2308538.593	-4874079.889	3393628.488	0.160	0.102	0.149
PATRIC	7069	917959.113	-5548370.282	2998776.626	0.156	0.091	0.120
MCDONA	7080	-1330021.009	-5328401.812	3236480.937	0.009	0.008	0.004
BEAR L	7082	-1735997.072	-4425048.148	4241430.594	0.021	0.021	0.015
MCDONA	7086	-1330125.332	-5328526.565	3236150.400	0.003	0.003	0.002
YARAGA	7090	-2389006.159	5043329.325	-3078525.559	0.003	0.002	0.003
WESTFO	7091	1492453.724	-4457278.719	4296815.813	0.014	0.012	0.010
KWAJAL	7092	-6143447.305	1364700.000	1034163.058	0.018	0.026	0.026
AMERIC	7096	-6100045.852	-996203.255	-1568976.343	0.015	0.021	0.020
EASTER	7097	-1884985.129	-5357607.962	-2892853.255	0.009	0.009	0.007
GREENB	7105	1130719.794	-4831350.569	3994106.480	0.000	0.002	0.001
QUINCY	7109	-2517234.660	-4198556.101	4076569.848	0.002	0.003	0.002
MONUME	7110	-2386277.834	-4802354.396	3444881.424	0.002	0.003	0.002
PLATTE	7112	-1240678.170	-4720463.306	4094480.706	0.012	0.011	0.022
OWENS	7114	-2410422.353	-4477802.653	3838686.813	0.011	0.010	0.008
GOLDST	7115	-2350861.592	-4655546.265	3660998.004	0.011	0.011	0.009
HALEAK	7120	-5465998.375	-2404408.668	2242228.413	0.008	0.010	0.010
HUAHIN	7121	-5345865.230	-2958246.706	-1824623.796	0.005	0.006	0.006
MAZATL	7122	-1660089.384	-5619100.321	2511638.002	0.003	0.003	0.002
HUAHIN	7123	-5345866.745	-2958247.468	-1824624.340	0.012	0.016	0.014
GREENB	7125	1130745.845	-4831368.072	3994077.093	0.017	0.014	0.012
HALEAK	7210	-5466006.440	-2404428.045	2242187.496	0.002	0.004	0.001
MONUME	7220	-2386292.144	-4802347.479	3444880.902	0.013	0.011	0.010
MOJAVE	7265	-2356475.650	-4646618.176	3668424.886	0.012	0.013	0.009
MOJAVE	7288	-2356494.038	-4646607.550	3668426.821	0.040	0.031	0.031
RICHMO	7295	961318.956	-5674090.958	2740489.572	0.079	0.050	0.064
ISIGAK	7307	-3265753.892	4810000.831	2614265.565	0.212	0.137	0.153
SANTIA	7400	1769700.144	-5044614.820	-3468263.227	0.017	0.011	0.014
CERRO	7401	1815517.669	-5213466.849	-3188002.490	0.011	0.008	0.009
ASKITE	7510	4353445.212	2082666.032	4156506.453	0.037	0.042	0.028
KATAVI	7512	4573400.383	2409321.970	3723881.573	0.041	0.048	0.032
DIONYS	7515	4595216.718	2039435.072	3912629.320	0.048	0.057	0.035
ROUMEL	7517	4728695.020	2174373.114	3674572.718	0.036	0.041	0.030
KARITS	7520	4596042.917	1733476.567	4055720.646	0.018	0.016	0.012

Station coordinates (cont.) SSC(GSFC) 91 L 01

Station Name	Station Number	X (m)	Y (m)	Z (m)	X Err	Y Err	Z Err
					meters		
XRISOK	7525	4745949.843	1905705.647	3799168.840	0.055	0.059	0.042
BAR GI	7530	4443967.704	3121945.145	3334694.185	0.016	0.017	0.033
MATERA	7541	4641990.590	1393042.034	4133231.651	0.015	0.017	0.011
LAMPED	7544	5072832.254	1130885.942	3684836.724	0.054	0.062	0.042
PUNTA	7545	4893398.330	772673.004	4004140.745	0.014	0.019	0.013
MEDICI	7546	4461399.926	919566.616	4449510.322	0.170	0.270	0.171
BASOVI	7550	4336738.798	1071271.253	4537910.900	0.057	0.080	0.042
DIYARB	7575	3848636.419	3251760.708	3898908.967	0.048	0.050	0.036
MELENG	7580	4247620.887	2778638.686	3851607.346	0.048	0.050	0.037
YOZGAT	7585	4029731.084	2802092.860	4062067.968	0.065	0.063	0.042
YIGILC	7587	4117362.407	2517076.531	4157678.857	0.052	0.049	0.039
MONTE	7590	4390310.139	696751.785	4560835.741	0.023	0.028	0.055
METSAH	7805	2892595.777	1311807.773	5512610.200	0.112	0.111	0.081
ZIMMER	7810	4331283.836	567549.299	4633139.747	0.007	0.007	0.015
BOROWI	7811	3738333.295	1148246.112	5021815.543	0.073	0.075	0.048
HELWAN	7831	4728283.931	2879670.127	3156894.144	0.048	0.063	0.055
KOOTWI	7833	3899224.443	396742.627	5015073.792	0.110	0.096	0.057
WETTZE	7834	4075530.326	931781.038	4801618.026	0.004	0.003	0.004
GRASSE	7835	4581692.025	556159.112	4389359.203	0.010	0.010	0.021
SHANGH	7837	-2831087.379	4676203.611	3275172.998	0.085	0.071	0.070
SIMOSA	7838	-3822386.732	3699362.471	3507572.100	0.004	0.004	0.004
GRAZ	7839	4194426.976	1162693.637	4647246.363	0.003	0.003	0.004
HERSTM	7840	4033464.049	23662.101	4924304.867	0.003	0.003	0.004
ORRORA	7843	-4446476.606	2678127.243	-3696251.798	0.008	0.007	0.009
TITISI	7844	-4491072.526	3481527.749	2887391.806	0.308	0.284	0.274
OWENS	7853	-2410421.111	-4477800.248	3838690.498	0.069	0.062	0.050
CABO S	7882	-1997241.611	-5528041.117	2468355.194	0.021	0.021	0.019
ENSENA	7883	-2406126.753	-4898368.539	3290336.484	0.102	0.078	0.074
MCDONA	7885	-1330125.348	-5328526.414	3236150.359	0.027	0.028	0.022
QUINCY	7886	-2517242.385	-4198554.008	4076572.340	0.042	0.037	0.023
MOUNT	7888	-1936744.329	-5077638.998	3331994.002	0.028	0.021	0.025
AUSTIN	7890	-754162.120	-5459061.186	3200744.116	0.294	0.260	0.127
FLAGST	7891	-1923976.599	-4850871.531	3658574.897	0.032	0.032	0.025
VERNAL	7892	-1631484.652	-4589133.820	4106749.704	0.022	0.024	0.015
YUMA	7894	-2196777.874	-4887339.185	3448428.346	0.022	0.021	0.020
PASADE	7896	-2493211.841	-4655229.610	3565574.602	0.025	0.027	0.020
GREENB	7899	1131364.769	-4831168.808	3994128.940	0.040	0.041	0.034
AREQUI	7907	1942791.728	-5804077.741	-1796919.364	0.008	0.004	0.009
MOUNT	7921	-1936760.121	-5077707.061	3331922.683	0.023	0.019	0.022
NATAL	7929	5186467.873	-3653856.347	-654322.065	0.015	0.020	0.023
MATERA	7939	4641965.351	1393069.656	4133262.036	0.003	0.003	0.004
ORRORA	7943	-4447548.607	2677134.262	-3694996.852	0.008	0.008	0.008
KOOTWI	8833	3899238.080	396768.936	5015055.109	0.029	0.027	0.016

EOP(GSFC) 91 L 01 Available from 1976 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y;0.0001s for D

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1976	46	109.92	46	53.70	35	4.630
1977	72	16.99	72	18.34	58	2.777
1978	71	25.87	71	13.99	55	3.651
1979	72	7.07	72	8.13	59	1.566
1980	73	1.95	73	1.31	61	0.457
1981	72	2.24	72	1.43	61	0.424
1982	72	1.65	72	1.04	61	0.362
1983	72	0.99	72	0.80	61	0.209
1984	72	0.41	72	0.36	61	0.128
1985	72	0.50	72	0.41	61	0.155
1986	72	0.58	72	0.48	61	0.188
1987	72	0.33	72	0.26	61	0.115
1988	72	0.36	72	0.33	62	0.139
1989	72	0.45	72	0.36	61	0.193
1990	35	0.50	35	0.46	30	0.161

EARTH ROTATION FROM LAGEOS LASER RANGING NAL 91 L 01

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Station coordinates (SSC) and earth orientation parameters (EOP) were determined by the program package COSMOS ver.91. They are based on the Satellite Laser Ranging (SLR) normal points for all Lageos data covering the period of 1983 September to 1990 August. Models and constants adopted adhere to the IERS Standards.

The station coordinate SSC(NAL) 91 L 01 includes solutions for the selected 20 stations which tracked Lageos with longer data coverage over the 7-year interval, and it has the reference epoch on 1988 January 10h UTC, assuming the Minster-Jordan plate motion model AM0-2. The origin of the reference system was defined by C10=C11=S11=0. The origin was constrained by fixation of longitude and latitude for the station 7105 (Greenbelt) and of latitude for the station 7909 (Arequipa). Corrections due to the permanent tidal deformation fo the earth were applied.

For the EOP (pole coordinates and UT1-TAI), a 5-day resolution series, designated as EOP(NAL) 91 L 01, was simultaneously determined with the station coordinates (for the whole data interval), the six orbital elements, an empirical drag-like acceleration, and a solar radiation coefficient. The overall post RMS fit of the laser observations to the orbits in 30-day arcs ranges 7 to 13cm.

A summary of the computational model used in the solution is given in Table 1. Table 2 provides station coordinates at the reference epoch (January 1, 1988) and the corresponding formal standard deviations. The coordinates refer to the optical axis of the laser ranging system. Table 3, finally, gives a statistics of the raw, unsmoothed solutions for earth rotation parameters for a 7-year interval.

Table 1 : Models

Force Model

- GEM-T1 gravity model (20*20) with C21 and S21 of IERS Standards
- Third body perturbation: Sun, Moon, Venus, Mars, Jupiter, and Saturn (positioned with the JPL DE200/LE200 ephemeris)
- GM = 398600.44089 km3/sec2 (estimated)
- Tidal perturbations: solid earth from Wahr, ocean tidal coefficients (Schwiderski model only)
- Solar radiation pressure (direct) adjusted once in each of 30 day arcs (occultation by earth and moon with conical shadow model)
- Along track acceleration adjusted once in each 30 day arcs
- Relativistic correction to equations of motion, not applied

Measurement Model

- Martini-Muray refraction model
- Velocity of light = 299792.458 km/sec
- Vertical and horizontal tide displacements: h2 = 0.6090, l2 = 0.0852
- Ocean loading site displacement not activated
- Relativistic propagation correction
- Normal points of NAL (3minutes) following the Herstmonceux recommendations

Reference Frame

- CIS Mean equator and equinox of J2000.0
- Wahr nutation series
- J2000 precession (JPL DE200 ephemeris)
- ae = 6378137 m
- Flattening = 1/298.257

- A priori values for the earth orientation parameters (Xp, Yp, and UT1R-TAI) were taken from the IERS Bulletin B. These input values are adjusted at 5-day interval except that the epochal value of UT1R-TAI in each arc is fixed at the input value.

- The station position were constrained to move according to the Minster/Jordan tectonic motion model AM0-2. The positions have an epoch of January 1, 1988; All the position are for the optical axis of the laser ranging system.

- The latitude and longitude of Greenbelt (station 7105) and the latitude of Arequipa (station 7907) were held fixed at the values according to the ITRF88 for epoch 1988.0 (IERS Annual Report for 1988).

Table 2: Global Station Coordinates SSC(NAL) 91 L 01

Site Number	X (m)	Sigma	Y (m)	Sigma	Z (m)	Sigma
1181	3800621.282	0.021	882005.294	0.008	5028859.586	0.015
7086	-1330120.919	0.005	-5328532.305	0.008	3236146.670	0.011
7090	-2389007.721	0.005	5043331.810	0.005	-3078526.856	0.005
7105	1130720.327	0.000	-4831352.981	0.002	3994108.461	0.001
7109	-2517235.924	0.003	-4198558.357	0.012	4076571.613	0.014
7110	-2386279.128	0.003	-4802356.799	0.011	3444883.101	0.014
7112	-1240678.845	0.007	-4720465.939	0.010	4094482.762	0.011
7121	-5345868.328	0.016	-2958248.346	0.015	-1824624.849	0.023
7122	-1660090.110	0.008	-5619103.225	0.008	2511639.074	0.012
7210	-5466006.954	0.002	-2404428.178	0.019	2242188.460	0.023
7805	2892595.185	0.028	1311808.293	0.014	5512609.997	0.015
7810	4331283.621	0.019	567549.531	0.009	4633139.992	0.016
7833	3899224.255	0.023	396742.863	0.012	5015073.910	0.016
7834	4075530.070	0 020	931781.266	0.008	4801618.269	0.016
7835	4581691.793	0.018	556159.356	0.010	4389359.399	0.017
7838	-3822388.402	0.024	3699363.378	0.015	3507573.118	0.011
7839	4194426.642	0.021	1162693.849	0.009	4647246.487	0.016
7840	4033463.831	0.018	23662.310	0.008	4924305.062	0.015
7907	1942792.045	0.024	-5804077.654	0.008	-1796919.329	0.001
7939	4641965.075	0.019	1393069.931	0.010	4133262.270	0.018

Note: Sigma denotes unscaled formal standard deviations associated with NP weight of 10 cm for all stations.

Epoch is 1988 January 1 00:00 UTC (MJD 47161).

EOP(NAL) 91 L 01 Available from 1983 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for D

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1983	25	0.85	25	0.47	25	0.220
1984	73	0.84	73	0.42	73	0.205
1985	73	0.85	73	0.40	73	0.185
1986	73	0.86	73	0.42	73	0.188
1987	73	0.83	73	0.41	73	0.181
1988	73	0.83	73	0.45	73	0.180
1989	73	0.87	73	0.49	73	0.256
1990	47	0.84	47	0.54	47	0.246

EARTH ORIENTATION FROM LAGEOS LASER RANGING SHA 91 L 01

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The solution EOP(SHA) 91 L 01 has been made at Shanghai Observatory with the use of the SHORDE I program system. The Lageos Laser Ranging normal point data from January 1990 to September 1990 generated at the GSFC NASA were used to form this solution. A "multistage-multiarc" procedure was used to estimate simultaneously satellite states , EOPs and some station coordinates. The station coordinates , as the global parameters , are adjusted in the whole long arc ; the satellite states , as the first-stage local parameters , are independently adjusted in the different subarc (10 days) ; the EOPs , as the second stage local parameters , are independently adjusted from the one sub-subarc (5 days) to the next.

Each set of EOP solution includes three Earth Rotation Parameters Xp, Yp, DR as well as the rate of the polar motion $\dot{X}p, \dot{Y}p$. The ability to detect the rate of the polar motion with 5 day arc solution has been investigated and found to be better than 0.7 mas/day. In our solution the overall RMS fit of the laser observations to the orbits is generally about 10 cm.

The most station coordinates of SSC(SHA) 91 L 01 are from SSC(SHA) 90 L 01. The coordinates of a few stations are re-estimated simultaneously with the satellite orbit states and EOPs , and are constrained to move according to the Minster/Jordan (1978) tectonic motion model AM0-2. The epoch of the derived SSC(SHA) 91 L 01 is MJD 47527.0. The positions of all stations refer to the optical axis of the laser ranging system.

The force model and constants used in the solution adhere closely to the IERS standards. The following is a summary of the kinematic and dynamical models used in our solution.

Reference frame

-- Mean equinox and equator of J 2000.0
-- Station coordinates SSC(SHA) 91 L 01
-- IAU 1976 precession
-- IAU 1980 nutation
-- DE200/LE200 planetary ephemerides
-- TAI as the coordinate time scale of the earth-centered frame

Force model

-- GEM T1 earth gravity field with C(2,1) and S(2,1) of IERS standards,
GM=398600.436 km^3/sec^2
-- Luni-Solar and planetary gravity perturbation
-- Wahr solid earth tides
-- Schwiderski ocean tides

-- Solar radiation pressure (Cr adjusted)
-- Drag-like perturbation (Cd adjusted)
-- Atmospheric tide
-- Earth's radiation pressure
-- General relativistic perturbation (earth-centered frame)

Measurement model

-- Marini Murray refraction model
-- Solid earth tides displacement
-- Ocean loading site displacement
-- Relativistic correction

DOMES NUMBER	NETWORK NUMBER	X (m)	Y (m)	Z (m)	SX (m)	SY (m)	SZ (m)	EPOCH MJD
14106S001	1181S001	3800621.459	882005.092	5028859.473	0.066	0.056	0.034	47527.0
12302S002	1884S001	3183896.075	1421496.336	5322803.453	0.387	0.320	0.243	47527.0
40701S001	1953S001	1474548.138	-5811242.442	2168945.055	0.154	0.132	0.142	47527.0
40436S003	7035S001	-2428827.804	-4799755.994	3417268.574	0.032	0.024	0.028	47527.0
40442S006	7080S001	-1330021.544	-5328403.077	3236481.787	0.021	0.018	0.020	47527.0
40442S001	7086S001	-1330121.226	-5328532.137	3236146.821	0.024	0.021	0.028	47527.0
50107S001	7090S001	-2389007.499	5043331.918	-3078526.885	0.020	0.014	0.018	47527.0
40440S001	7091S001	1492454.186	-4457280.111	4296819.414	0.052	0.034	0.038	47527.0
40451S105	7105S001	1130720.051	-4831352.958	3994108.530	0.018	0.016	0.014	47527.0
40433S002	7109S001	-2517236.130	-4198558.076	4076571.757	0.019	0.016	0.017	47527.0
40497S002	7110S001	-2386279.421	-4802356.512	3444883.310	0.019	0.015	0.017	47527.0
40496S001	7112S001	-1240679.096	-4720465.850	4094479.526	0.023	0.019	0.021	47527.0
40504S001	7122S001	-1660090.454	-5619103.051	2511639.238	0.020	0.015	0.018	47527.0
92202S003	7123S001	-5345868.171	-2958247.730	-1824624.438	0.041	0.036	0.031	47527.0
40445S001	7210S001	-5466007.102	-2404427.654	2242188.674	0.023	0.021	0.024	47527.0
40405S013	7288S001	-2356495.242	-4646609.235	3668428.191	0.036	0.028	0.031	47527.0
40499S002	7295S001	961319.314	-5674093.183	2740487.791	0.039	0.027	0.036	47527.0
12612S001	7510S001	4353447.586	2082667.218	4156505.383	0.031	0.033	0.026	47527.0
12615S001	7512S001	4573402.589	2409323.281	3723880.234	0.042	0.031	0.031	47527.0
12602S002	7515S001	4595219.060	2039436.237	3912628.068	0.038	0.040	0.041	47527.0
12613S001	7517S001	4728698.058	2174374.470	3674573.295	0.027	0.029	0.024	47527.0
12616S001	7525S001	4745953.072	1905707.016	3799169.558	0.030	0.026	0.034	47527.0
12706S001	7544S001	5072834.726	1130886.578	3684835.442	0.024	0.034	0.026	47527.0
12725S002	7545S001	4893400.836	772673.504	4004139.557	0.026	0.036	0.031	47527.0
12711S002	7546S001	4461402.566	919567.244	4449509.356	0.124	0.086	0.110	47527.0
12718S002	7550S001	4336741.476	1071272.005	4537909.934	0.113	0.126	0.093	47527.0
20801S001	7575S001	3848638.377	3251762.297	3898907.822	0.042	0.036	0.028	47527.0
20803S001	7580S001	4247623.699	2778640.423	3851608.058	0.053	0.061	0.043	47527.0
20802S001	7585S001	4029733.158	2802094.459	4062066.758	0.051	0.038	0.036	47527.0
14001S001	7810S001	4331283.767	567549.354	4633139.848	0.023	0.016	0.017	47527.0
	7811S001	3738333.111	1148246.182	5021815.476	0.054	0.107	0.097	47527.0
30301S001	7831S001	4728283.808	2879670.478	3156894.142	0.243	0.168	0.180	47527.0

SSC(SHA) 91 L 01

DOMES NUMBER	NETWORK NUMBER	X (m)	Y (m)	Z (m)	SX (m)	SY (m)	SZ (m)	EPOCH MJD
14201S002	7834S001	4075530.280	931781.131	4801618.143	0.028	0.031	0.020	47527.0
10002S001	7835S001	4581691.943	556159.159	4389359.249	0.023	0.016	0.018	47527.0
21605S001	7837S001	-2831087.393	4676203.686	3275172.833	0.132	0.104	0.096	47527.0
21726S001	7838S001	-3822388.017	3699363.783	3507573.085	0.020	0.024	0.019	47527.0
11001S002	7839S001	4194426.907	1162693.723	4647246.432	0.026	0.020	0.023	47527.0
13212S001	7840S001	4033463.980	23662.173	4924304.952	0.024	0.018	0.017	47527.0
50103S008	7843S001	-4446476.684	2678127.259	-3696251.570	0.021	0.024	0.020	47527.0
40439S004	7853S001	-2410422.575	-4477802.436	3838689.092	0.036	0.042	0.034	47527.0
40505S001	7882S001	-1997241.667	-5528044.442	2468356.293	0.043	0.032	0.040	47527.0
42202S001	7907S001	1942791.502	-5804077.899	-1796919.262	0.021	0.015	0.024	47527.0
12734S001	7939S001	4641965.306	1393069.730	4133262.123	0.020	0.023	0.018	47527.0

EOP(SHA) 91 L 01 available from 1990 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for DR

YEAR	X		Y		DR	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1990	54	0.97	54	1.11	54	0.515

EARTH ROTATION PARAMETERS AND STATION COORDINATES FROM LAGEOS LASER RANGING DATA FOR 1989/1990

ZIPE 91 L 01
ZIPE 91 L 02
ZIPE 91 L 03

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The Set of Station Coordinates (SSC) and three sets of Earth Rotation Parameters (ERP) were determined by the program package POTSDAM-5. They are based on Satellite Laser Ranging (SLR) normal points of the IERS stations for 1989 and partly 1990 (up to August). Generally, all constants and model parameters were taken from the IERS standards (McCarthy *et al.* 1989). As exceptions from this IERS publication the following effects were not considered:

- penumbra for the radiation pressure,
- relativistic corrections,
- tidal variations in UT1 caused by zonal tides with periods bigger than 35 days.

In a multistage-multiarc procedure the different solve-for parameters were derived. Details on the adopted model for the terrestrial system are given in appendix 1. The station coordinates (SSC(ZIPE) 91 L 01) were refered to the epoch 1988.0 applying the AM0-2 model for the tectonic plate motions. The origin of the reference system was defined by $C_{10}=C_{11}=S_{11}=0$. The orientation was constrained by fixation of latitude and longitude for the station 7105 and of latitude for the station 7840. Additionally, no common net rotations were permitted in relation to the reference coordinate set ITRF 88. Corrections due to the permanent tidal deformation of the Earth were applied. The standard deviations of the station coordinates are in the order of several millimeters for the third generation laser stations and of one to several centimeters for the second generation stations. The accuracy obtained by comparison with other solutions via a 7-parameter Helmert transformation was estimated to be about or better than ± 3 cm. The station coordinates are given in appendix 2.

For the ERP (pole coordinates and length of day-LOD) three sets with different time resolutions were determined. The results are a continuation of the previously reported series of ZIPE. The 5-days resolution set ERP(ZIPE) 91 L 01 was simultaneously estimated with the station coordinates (for the whole data interval), and the 6 orbital elements (every 5-day interval). The average orbital fit amounts between ± 3 cm and ± 5 cm. The time resolution for the two other sets is higher, namely three days for the set ERP(ZIPE) 91 L 02, and two days for the set ERP(ZIPE) 91 L 03. In the solutions of these two sets the station coordinates were fixed to the values obtained from the processing of the mentioned 5-day values. Further, for the solutions L 02 and L 03 the 6 orbit dependent parameters were estimated for 6-days intervals covering the 3-days and 2-days intervals, respectively. This way a better stability could be obtained for the intervals with a sparse data distribution.

Whereas in the 5-days solutions the LOD values were directly estimated in the L02 and L03 solutions UT1 values were solved for instead of LOD. These UT1 results were converted into LOD. That means that the time scales (col.1) for the ERP(ZIPE)91 L 02 and L 03 have to be transfered for the LOD values by -1.5 d and -1.0 d, respectively.

Generally, the SLR data were weighted according to their estimated accuracy. In addition, several no-permanent stations were provided with a smaller weight in order to reduce the influence of the change of the station distribution. In the data processing no post-adjustment smoothing or filtering procedure was applied to the ERP series. The standard deviations of the ERP(ZIPE) 91 L 01 solution

are about ±0.1 to ±0.2 mas for the pole coordinates and ±0.001 to ±0.004 ms for LOD; the y-component of the pole is somewhat more precise than the x-component. The accuracy was estimated to be about ±0.001" (3cm) for the pole and ±0.1 ms for LOD. The 3-days solutions L 02 show nearly the same precision as the 5-days solution if there are submitted at least data from 10 stations. For solutions with data from 6 to 9 stations (col.17) the precision is between ± 0;1 and ± 0.3 mas and up to 0.03 ms, respectively. There are also several solutions on the basis of data from less than 6 stations. Here the uncertainty can rise several times. Naturally, the number of results being based on data of less than 6 stations is still higher for the ERP(ZIPE) 91 L 03 series with a time resolution of 2 days. These individual results can be at least partly worse depending on the relevance of the station positions for the single ERP components (stations with longitude from 315° to 45° and 135° to 225° more relevant for the x-component, all others for the y-component). Therefore, these individual results (5 for the L 02 and 23 for the L 03 series) were omitted. If there are measurements from at least 10 stations the precision for the L 03 series is about ±0.2 mas and ±0.2 ms, respectively. In the case of using data from 6 to 10 stations the precision of the L 03 results can be smaller by a factor up to about 2. Comparing with the EOP series of ZIPE reported last year the precision of the new series was slightly improved.

Appendix 1:

SUMMARY SHEET FOR THE DESCRIPTION OF THE TERRESTRIAL SYSTEM ATTACHED TO A SET OF STATION COORDINATES

1 -	Technique:	SLR
2 -	Analysis Center:	ZIPE
3 -	Solution Identifier:	SSC(ZIPE) 91 L 01
4 -	Software used:	POTSDAM-5
5 -	Relativity scale:	LE
6 -	Permanent tidal correction on station:	yes
7 -	Tectonic Plate model:	AM0-2
8 -	Velocity of light (C) =	299 792 458
9 -	Geogravitational constant (GM) =	3.9860 0440 $10^{14}m^3s^{-2}$
10 -	Reference epoch =	47160. (1988.0)
11 -	Adjusted parameters:	longitude, latitude and station radius; orbital elements in intervals of 5 days
12 -	Definition of the origin:	geocentre through $C_{10}=C_{11}=S_{11}=0$
13 -	Definition of the orientation:	fixed latitude for 7105, 7840, fixed longitude for 7105
14 -	Constraint for time evolution:	fixed plate motion model AM0-2

Domes Number	Station Number	X (meters)	Y (meters)	Z (meters)	Mean MJD	Data Span Days	X Err	Y Err	Z Err
							meters		
X14106s001	1181s001	3800621.291	882005.346	5028859.415	47827.0	584.0	0.016	0.024	0.025
X12337s001	1873s001	3783902.784	2551404.845	4441257.639	47891.5	235.0	0.048	0.064	0.080
X12302s002	1884s001	3183896.028	1421496.930	5322803.512	47769.0	524.0	0.015	0.025	0.028
X	1893s001	3785944.951	2550780.501	4439461.364	47756.0	420.0	0.039	0.060	0.061
X40701s001	1953s001	1474548.415	-5811242.261	2168944.963	47720.0	446.0	0.028	0.035	0.036
X40442m006	7080m001	-1330020.916	-5328401.872	3236480.821	47790.5	587.0	0.001	0.002	0.002
X50107m001	7090m001	-2389006.530	5043329.263	-3078525.339	47811.0	628.0	0.001	0.002	0.003
X41703m002	7097m001	-1884984.406	-5357608.143	-2892853.383	47721.5	447.0	0.002	0.003	0.003
X40451m105	7105m001	1130719.819	-4831350.544	3994106.479	47689.0	384.0	0.001	0.000	0.000
X40433m002	7109m001	-2517234.684	-4198556.220	4076569.689	47808.5	623.0	0.001	0.002	0.002
X40497m001	7110m001	-2386277.892	-4802354.362	3444881.398	47809.0	624.0	0.001	0.002	0.002
X40504m001	7122m001	-1660089.280	-5619100.417	2511637.880	47815.0	612.0	0.001	0.003	0.002
X92202m003	7123m001	-5345866.711	-2958247.449	-1824624.323	47877.5	469.0	0.002	0.003	0.003
X40445m001	7210m001	-5466006.497	-2404427.993	2242187.469	47806.0	618.0	0.001	0.003	0.003
X40405m013	7288m001	-2356494.010	-4646607.671	3668426.628	47735.0	334.0	0.002	0.003	0.003
X41706m001	7401m001	1815517.323	-5213464.797	-3187999.317	47991.0	104.0	0.002	0.003	0.003
X42202s001	7403s001	1942808.877	-5804072.084	-1796916.348	48098.5	49.0	0.003	0.004	0.003
X12612m001	7510m001	4353444.878	2082666.305	4156506.621	47834.5	59.0	0.002	0.004	0.003
X12615m001	7512m001	4573400.073	2409322.238	3723881.707	47818.0	14.0	0.002	0.005	0.004
X12602m002	7515m001	4595216.480	2039435.320	3912629.417	47897.5	45.0	0.003	0.005	0.004
X12613	7517s004	4728697.794	2174374.578	3674573.693	47674.5	45.0	0.003	0.005	0.004
X12614m001	7520m001	4596042.641	1733476.686	4055720.831	47722.0	40.0	0.003	0.006	0.005
X12616m001	7525m001	4745949.599	1905705.910	3799168.986	47884.5	51.0	0.003	0.005	0.004
X12706	7544s002	5072829.411	1130885.675	3684838.320	47645.0	64.0	0.003	0.004	0.004
X12725m002	7545m001	4893398.105	772673.310	4004140.956	47973.0	58.0	0.003	0.006	0.004
X12718m002	7550m001	4336738.575	1071271.446	4537911.031	47695.5	23.0	0.007	0.019	0.018
X20801m001	7575m001	3848635.950	3251760.902	3898909.202	47787.5	15.0	0.003	0.005	0.004
X20803m001	7580m001	4247620.517	2778638.935	3851607.487	47830.5	21.0	0.002	0.005	0.004
X20802m001	7585m001	4029730.670	2802093.236	4062067.961	47766.0	16.0	0.003	0.006	0.006
X20804m001	7587m001	4117362.002	2517076.827	4157679.035	47782.5	53.0	0.003	0.005	0.005
X10503s001	7805s001	2892595.557	1311807.571	5512610.973	47922.5	109.0	0.120	0.168	0.216
X14001s001	7810s001	4331283.621	567549.584	4633139.934	47814.5	623.0	0.001	0.003	0.001
X12205	7811s002	3738332.924	1148246.308	5021815.636	47873.5	467.0	0.018	0.030	0.036
X30101s001	7831s001	4728283.533	2879670.362	3156894.499	47897.5	409.0	0.005	0.006	0.006
X14201	7834m001	4075530.052	931781.275	4801618.189	47827.0	584.0	0.001	0.003	0.002

Appendix 2: (cont.) SSC(ZIPE) 91 L 01

Domes Number	Station Number	X (meters)	Y (meters)	Z (meters)	Mean MJD	Data Span Days	X Err	Y Err	Z Err
							meters		
X10002s002	7835s002	4581691.756	556159.384	4389359.341	47811.5	629.0	0.001	0.002	0.001
X21605	7837s005	-2831087.772	4676203.426	3275172.863	47685.0	368.0	0.005	0.011	0.010
X21726m001	7838m001	-3822387.048	3699362.223	3507571.942	47731.0	436.0	0.002	0.003	0.004
X11001	7839m001	4194426.688	1162693.892	4647246.523	47812.5	623.0	0.001	0.003	0.002
X13212s001	7840s001	4033463.814	23662.332	4924305.009	47812.0	626.0	0.001	0.002	0.000
X50103	7843s002	-4446476.736	2678127.023	-3696251.637	47974.5	287.0	0.001	0.003	0.003
X40506	7883m001	-2406126.717	-4898368.387	3290336.499	47713.0	112.0	0.003	0.006	0.006
X42202	7907s002	1942792.037	-5804077.592	-1796919.275	47812.5	621.0	0.006	0.008	0.007
X40451	7918m001	1130705.383	-4831345.393	3994115.945	48070.0	102.0	0.003	0.005	0.004
X40451	7920m001	1130741.976	-4831369.771	3994076.067	47806.0	8.0	0.007	0.008	0.010
X12734	7939m001	4641965.053	1393069.923	4133262.229	47822.0	574.0	0.005	0.007	0.006
X13504	8833s005	3899238.095	396769.240	5015055.154	48088.5	27.0	0.005	0.006	0.007

EOP(ZIPE) 91 L 01 Available from 1988 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for D

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1988	6	0.11	6	0.15	6	0.019
1989	73	0.13	73	0.12	73	0.022
1990	47	0.11	47	0.14	47	0.021

EOP(ZIPE) 91 L 02 Available from 1988 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for D

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1988	9	0.14	9	0.23	9	0.179
1989	120	0.19	120	0.18	120	0.152
1990	77	0.16	77	0.19	77	0.155

EOP(ZIPE) 91 L 03 Available from 1988 to 1990

Number of measurements and RMS uncertainty per year
Units : 0.001" for X,Y; 0.0001s for D

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1988	12	0.16	12	0.21	12	0.168
1989	168	0.22	168	0.23	168	0.190
1990	114	0.19	114	0.26	114	0.212