SATELLITE LASER RANGING

EARTH ROTATION FROM LAGEOS LASER RANGING CSR 89 L 02

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A single, continuous Lageos ephemeris was fit to Lageos laser range data for the interval from May 1976 to February 1989. The data base contained about 360 000 three-minute normal points formed from over 37 000 passes collected from more than 100 sites.

The force and measurement models were the MERIT Standards with some exceptions. A preliminary Topex gravity field. PTGF-3 (Tapley, et al., 1987). was used with an adopted value of GM equal to 398600.4404 km**3/s**2. Some ocean tide parameters were adjusted in the solution. The laser range residual weighted RMS was 28 cm for the 12.8 year span; however, the postprocessing weighted RMS was 8.5 cm. The postprocessing allowed further adjustment of the orbit elements and Earth orientation within time-dependent intervals. For 1976-1979. 15-day intervals were used, whereas 6-day and 3-day intervals were used in the periods 1980-1983 and 1983-1989, respectively. In the later time intervals, the weighted RMS was 4 to 5 cm. A further adjustment for time-dependent station coordinates was accomplished using 60-day intervals, however, only the mean coordinates are reported here.

The stations were assumed to be attached to the tectonic plates noted in the following table with rates defined by the AM1-2 model. The epoch of the derived station coordinates is 1988 January 1 00:00 UTC.

The estimated UT1 values contain Lageos node model errors which were filtered to remove periods greater than about 80 days. As a consequence, the long period (greater than 80 days) represents the reference UT1 series, but for periods below about 40 days, the Lageos UT1 estimates are independent of the reference series.

References

Tapley, B.D., B.E.Schutz, C.K.Shum, J.C.Ries and D.N.Yuan, An improved model for the Earth's gravity field, Proc. IUGG 19th General Assembly, Vancouver, August 1987.

SSC(CSR) 89 L 02

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	SX m	SY m	SZ m	PLATE	EPOCH MJD
1181S001	POTSDAM	14106S001	3800621.487	882005.127	5028859.474	.036	.035	.023	EURA	47161
1884S001	RIGA	12302S002	3183895.971	1421496.199	5322803.882	.237	.270	.186	EURA	47161
1953S001	SANTIAGO DE CUBA	40701S001	1474548.287	-5811242.476	2168945.067	.100	.071	.100	NOAM	47161
7035M001	SAN DIEGO	40436M003	-2428826.870	-4799754.092	3417267.173	.021	.019	.017	PCFC	47161
7051M001	QUINCY	40433M001	-2516893.342	-4198844.913	4076411.485	.022	.020	.017	NOAM	47161
7061S001	EASTER ISLAND	41703S002	-1884985.186	-5357609.287	-2892853.992	.045	.035	.033	NAZC	47161
7062M001	SAN DIEGO	40436M002	-2428826.170	-4799750.277	3417272.876	.020	.017	.019	PCFC	47161
7063M001	WASHINGTON	40451M112	1130714.500	-4831367.773	3994087.399	.018	.013	.014	NOAM	47161
7067M001	BERMUDA	42501M001	2308538.269	-4874080.101	3393628.585	.070	.047	.073	NOAM	47161
7069M001	PATRICK AFB	40417M002	917958.601	-5548370.248	2998776.658	.118	.066	.094	NOAM	47161
7080M001	FORT DAVIS	40442M006	-1330021.272	-5328401.732	3236480.936	.016	.010	.014	NOAM	47161
7082M001	BEAR LAKE	40438M001	-1735997.376	-4425047.955	4241430.476	.030	.026	.021	NOAM	47161
7084M001	OWENS VALLEY	40439M003	-2410590.303	-4477745.094	3838648.485	.100	.093	.058	NOAM	47161
7085M001	GOLDSTONE	40405M001	-2353394.104	-4641529.082	3676898.986	.088	.100	.065	NOAM	47161
7086M001	FORT DAVIS	40442M001	-1330125.610	-5328526.465	3236150.379	.015	.009	.013	NOAM	47161
7090M001	YARRAGADEE	50107M001	-2389006.200	5043329.408	-3078525.391	.014	.009	.013	INDI	47161
7091M001	HAYSTACK	40440M001	1492453.556	-4457278.790	4296815.914	.026	.023	.017	NOAM	47161
7092M001	KWAJALEIN ATOLL	50505M001	-6143447.139	1364700.628	1034163.170	.017	.028	.028	PCFC	47161
7096M001	AMERICAN SAMOA	50503M001	-6100045.972	-996202.697	-1568976.180	.014	.024	.023	PCFC	47161
7097M001	EASTER ISLAND	41703M002	-1884984.827	-5357608.038	-2892853.296	.023	.018	.020	NAZC	47161
7100M001	WASHINGTON	40451M106	1131355.465	-4831169.112	3994131.978	.162	.132	.145	NOAM	47161
7101M001	WASHINGTON	40451M101	1131240.195	-4831179.869	3994148.466	.079	.053	.078	NOAM	47161
7102M001	WASHINGTON	40451M102	1130686.378	-4831353.065	3994110.933	.019	.014	.015	NOAM	47161
7103M001	WASHINGTON	40451M103	1130685.374	-4831348.750	3994116.371	.025	.023	.018	NOAM	47161
7104M001	WASHINGTON	40451M104	1131095.589	-4831196.954	3994170.733	.061	.051	.051	NOAM	47161
7105M001	WASHINGTON	40451M105	1130719.505	-4831350.588	3994106.528	.015	.010	.012	NOAM	47161
7109M001	QUINCY	40433M002	-2517234.916	-4198555.981	4076569.782	.014	.011	.012	NOAM	47161
7110M001	MONUMENT PEAK	40497M001	-2386278.203	-4802354.091	3444881.569	.014	.010	.013	PCFC	47161
7112M001	PLATTEVILLE	40496M001	-1240678.439	-4720463.245	4094480.700	.016	.011	.012	NOAM	47161
7114M001	OWENS VALLEY	40439M001	-2410422.629	-4477802.494	3838686.769	.017	.014	.014	NOAM	47161

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	SX m	SY m	SZ m	PLATE	EPOCH MJD
7115M001	GOLDSTONE	40405M002	-2350861.871	-4655546.116	3660997.971	.017	.014	.015	NOAM	47161
7120M001	MAUI	40445M002	-5465998.548	-2404408.075	2242228.603	.010	.017	.017	PCFC	47161
7121M001	MOTU HIUMOO	92202M002	-5345865.530	-2958246.263	-1824623.628	.011	.016	.017	PCFC	47161
7122M001	MAZATLAN	40504M001	-1660089.656	-5619100.229	2511637.978	.015	.008	.014	NOAM	47161
7123M001	MOTU HIUMOO	92202M003	-5345865.500	-2958246.241	-1824623.680	.018	.023	.023	PCFC	47161
7125M001	WASHINGTON	40451M114	1130745.563	-4831368.074	3994077.101	.132	.109	.086	NOAM	47161
7130M001	WASHINGTON	40451M116	1130735.056	-4831324.653	3994132.359	.128	.109	.087	NOAM	47161
7210M001	MAUI	40445M001	-5466006.615	-2404427.458	2242187.634	.008	.014	.015	PCFC	47161
7220M001	MONUMENT PEAK	40497M002	-2386292.537	-4802347.259	3444881.046	.021	.019	.019	PCFC	47161
7265M001	GOLDSTONE	40405M006	-2356475.920	-4646618.088	3668424.857	.024	.024	.020	NOAM	47161
7274M001	MONUMENT PEAK	40497M003	-2386289.602	-4802346.258	3444884.119	.023	.021	.019	PCFC	47161
7288M001	GOLDSTONE	40405M013	-2356494.289	-4646607.440	3668426.760	.022	.017	.019	NOAM	47161
7295M001	RICHMOND	40499M002	961318.671	-5674090.990	2740489.606	.029	.018	.026	NOAM	47161
7400M001	SANTIAGO	41705M001	1769699.322	-5044613.130	-3468260.020	.031	.021	.028	SOAM	47161
7401M001	CERRO TOLOLO	41706M001	1815516.674	-5213465.076	-3187999.363	.023	.016	.021	SOAM	47161
7510M001	ASKITES	12612M001	4353445.203	2082666.049	4156506.518	.016	.020	.016	EURA	47161
7512M001	KATAVIA	12615M001	4573400.331	2409321.949	3723881.634	.017	.022	.018	EURA	47161
7515M001	DIONYSOS	12602M002	4595216.711	2039435.067	3912629.377	.015	.019	.016	EURA	47161
7517M001	ROUMELLI	12613M001	4728694.960	2174373.104	3674572.828	.014	.018	.016	EURA	47161
7520M001	KARITSA	12614M001	4596042.867	1733476.563	4055720.710	.023	.025	.019	EURA	47161
7525M001	XRISOKALARIA	12616M001	4745949.798	1905705.678	3799168.918	.019	.022	.019	EURA	47161
7530S001	BAR GIYYORA	20702S001	4443968.770	3121946.609	3334695.318	.023	.025	.023	AFRC	47161
7540M001	MATERA	12734M005	4641984.815	1393057.458	4133233.320	.030	.030	.023	EURA	47161
7541M001	MATERA	12734M004	4641990.532	1393042.024	4133231.711	.020	.023	.017	EURA	47161
7544M001	LAMPEDUSA	12706M001	5072832.196	1130885.945	3684836.831	.022	.028	.021	EURA	47161
7545M001	CAGLIARI	12725M002	4893398.243	772673.039	4004140.851	.018	.025	.019	EURA	47161
7546M001	BOLOGNE	12711M002	4461399.890	919566.627	4449510.393	.064	.090	.052	EURA	47161
7550M001	TRIESTE	12718M002	4336738.800	1071271.253	4537910.910	.033	.043	.028	EURA	47161
7575M001	DIYARBAKIR	20801M001	3848636.370	3251760.706	3898909.088	.037	.037	.029	EURA	47161
7580M001	MELENGICLICK	20803M001	4247620.849	2778638.741	3851607.372	.026	.032	.020	EURA	47161

SSC(CSR) 89 L 02

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	SX m	SY m	SZ m	PLATE	EPOCH MJD
7585M001	YOZGAT	20802M001	4029731.026	2802093.086	4062067.868	.042	.053	.026	EURA	47161
7587M001	YIGILCA	20804M001	4117362.328	2517076.601	4157678.902	.030	.026	.020	EURA	47161
7596S001	WETTZELL	14201S010	4075585.489	931837.518	4801559.135	.027	.034	.021	EURA	47161
7599S001	WETTZELL	14201S007	4075517.624	931753.856	4801630.192	.060	.064	.040	EURA	47161
7805S001	METSAHOVI	10503S001	2892595.358	1311808.207	5512609.884	.138	.118	.078	EURA	47161
7810S001	ZIMMERWALD	14001S001	4331283.783	567549.298	4633139.826	.016	.019	.013	EURA	47161
7831S001	HELWAN	30101S001	4728283.844	2879670.408	3156894.110	.203	.162	.130	AFRC	47161
7833S001	KOOTWIJK	13504S001	3899224.257	396742.657	5015073.770	.035	.036	.023	EURA	47161
8833M001	KOOTWIJK	13504M002	3899238.047	396768.985	5015055.124	.022	.026	.017	EURA	47161
7834S001	WETTZELL	14201S002	4075530.300	931781.077	4801618.122	.015	.018	.012	EURA	47161
7835S001	GRASSE	10002S001	4581691.978	556159.125	4389359.262	.012	.016	.012	EURA	47161
7837S001	SHANGHAI	21605S001	-2831087.321	4676203.715	3275172.835	.094	.081	.070	EURA	47161
7838S001	SIMOSATO	21726S001	-3822388.009	3699363.804	3507573.109	.013	.013	.013	EURA	47161
7839S001	GRAZ	11001S002	4194426.927	1162693.666	4647246.415	.012	.015	.011	EURA	47161
7840S001	HERSTMONCEUX	13212S001	4033463.987	23662.125	4924304.934	.012	.015	.010	EURA	47161
7843S001	ORRORAL	50103S008	-4446476.618	2678127.296	-3696251.606	.013	.015	.014	INDI	47161
7853M001	OWENS VALLEY	40439M004	-2410421.373	-4477800.120	3838690.462	.022	.018	.018	NOAM	47161
7882M001	CABO SAN LUCAS	40505M001	-1997242.102	-5528041.060	2468355.372	.022	.017	.021	PCFC	47161
7885M001	FORT DAVIS	40442M005	-1330125.655	-5328526.418	3236150.337	.033	.033	.027	NOAM	47161
7886M001	QUINCY	40433M005	-2517242.527	-4198550.726	4076570.416	.021	.017	.014	NOAM	47161
7888M001	MOUNT HOPKINS	40434M002	-1936744.587	-5077638.883	3331993.985	.035	.026	.032	NOAM	47161
7891M001	FLAGSTAFF	40491M002	-1923976.911	-4850871.510	3658574.816	.034	.033	.027	NOAM	47161
7892M001	VERNAL	40492M001	-1631484.916	-4589133.656	4106749.611	.027	.027	.019	NOAM	47161
7894M001	YUMA	40493M001	-2196778.096	-4887336.858	3448425.358	.030	.027	.028	NOAM	47161
7896M001	PASADENA	40400M001	-2493212.210	-4655229.217	3565574.763	.027	.026	.023	PCFC	47161
7899M001	WASHINGTON	40451M111	1131364.469	-4831168.794	3994129.010	.039	.037	.033	NOAM	47161
7907S001	AREQUIPA	42202S001	1942791.455	-5804077.903	-1796919.266	.015	.007	.015	SOAM	47161
7921S001	MOUNT HOPKINS	40434S001	-1936760.473	-5077706.972	3331922.545	.022	.017	.021	NOAM	47161
7929S001	NATAL	41604S001	5186467.551	-3653856.422	-654321.812	.039	.053	.056	SOAM	47161
7939S001	MATERA	12734S001	4641965.325	1393069.672	4133262.106	.012	.015	.012	EURA	47161
7943S001	ORRORAL	50103S003	-4447548.581	2677134.298	-3694996.587	.013	.015	.014	INDI	47161

EOP(CSR) 89 L 02 Available from 1976 to 1988

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

YEAR	X		Y		UT1	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1976	16	7.53	16	7.24	16	4.16
1977	24	4.31	24	3.40	24	2.55
1978	18	4.04	18	3.27	18	2.39
1979	38	2.64	38	2.28	38	1.66
1980	61	2.04	61	1.49	61	1.21
1981	62	2.55	62	1.74	62	1.24
1982	60	2.14	60	1.44	60	1.30
1983	81	1.64	81	1.84	81	1.10
1984	122	1.36	122	1.43	122	1.13
1985	121	1.37	121	1.40	121	0.98
1986	122	1.30	122	1.22	122	1.00
1987	122	1.28	122	1.25	122	1.02
1988	122	1.68	122	1.82	122	1.35

EARTH ROTATION AND STATION COORDINATES FROM 1986 AND 1987 LAGEOS DATA. DUT 89 L 01

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A continuous series of 5-day solutions for polar motion and the A1-UT1 time difference has been computed for 1986 and 1987 from global full-rate laser ranging measurements on the LAGEOS satellite.

In the analysis the observations were processed in batches of multiple contiguous 1-week data arcs, in which the orbit parameters and the earth rotation parameters are estimated simultaneously. This approach was used since the analyses were also aimed at the determination of crustal deformations. Therefore, for each of these batches which covered data periods ranging from 8 to 16 weeks, also all the station coordinates were adjusted, simultaneously with the other parameters. This resulted in a total of 9 different global station coordinates solutions, together with solutions for polar motion and the A1-UT1 time difference.

The reference frame was defined using the following constraints. The longitude of Greenbelt (station 7105) was held fixed at the value according to the University of Texas UT/CSR 84.02 coordinates solution. During the time-span covered by each batch of 1-week data arcs, the stations were supposed to exhibit no motion. Further constraints imposed upon each of the 9 parameter solutions were equivalent to a zero mean shift with respect to the a priori values for the X and Y position of the pole and for the A1-UT1 time difference.
A priori values for the earth rotation parameters were taken from the IERS Bulletin B.

A summary of the computation model that was used is given in Table 1. Main elements are the NASA/GSFC GEM-T1 gravity field, the Wahr harmonic expansion model for the solid earth tides and a subset of the NASA/GSFC GEM-T1 solution for ocean tides (only the constituents that are also included in the Schwiderski model were used). Table 2 lists an averaged solution for the monument coordinates of the laser stations from which measurements were processed. These results represent the best estimate for the epoch January 1, 1987, and were obtained from the 9 individual global network solutions after corrections for tectonic motions and for systematic differences between these solutions. For the averaging, the effects of tectonics were either modeled using the Minster & Jordan AM1-2 geologic model or estimated, for stations with uncertain tectonic characteristics (sites in the Mediterranean area, Monument Peak and Simosato). The solution presented here may be designated as the SSC(DUT) 89 L 01 global coordinates solution. Table 3, finally, gives the raw, unsmoothed solutions for polar motion and UT1-UTC. The solution is designated ERP(DUT) 89 L 01.

Table 1 Models and constants.

Dynamic model.

Gravity field	-	NASA/GSFC GEM-T1. truncated at 20 x 20
GM	-	398600.4359 km**3/s**2
c	-	299792.458 km/s
ae	-	6378.1370 km
1/f	-	298.257
Solar and lunar attraction	-	JPL DE-118 ephemeris
Solid earth tides	-	Wahr model
Ocean tides	-	NASA/GSFC GEM-T1 model (constituents of 55 elements also in Schwiderski model only)
Solar radiation	-	CR adjusted occultation by earth and moon umbra and penumbra
Along-track acceleration	-	AT adjusted

Reference frame.

Station coordinates	-	adjusted, except for longitude of Greenbelt (7105)
Earth rotation	-	adjusted. a priori values from IERS Bulletin B
CIS	-	mean equator and equinox of J1950.0
Precession	-	J1950 precession (JPL DE-118 ephemeris)
Nutation	-	Wahr series

Measurement model.

Tropospheric refraction	-	Marini-Murray model
Tidal uplift	-	h2 = 0.6000. 12 = 0.0750

EOP(DUT) 89 L 01 **Available from 1986 to 1987**

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

YEAR	X		Y		UT1	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1986	71	0.90	71	0.90	71	6.76
1987	72	0.82	72	0.82	72	6.14

Table 2.

SSC(DUT) 89 L 01

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	SX m	SY m	SZ m	PLATE	EPOCH MJD
7086M001	FORT DAVIS	40442M001	-1330125.341	-5328526.590	3236150.191	.005	.008	.012	NOAM	46796
7090M001	YARRAGADEE	50107M001	-2389006.359	5043329.278	-3078525.396	.005	.008	.014	INDI	46796
7105M001	WASHINGTON	40451M105	1130719.727	-4831350.550	3994106.352	.010	.009	.011	NOAM	46796
7109M001	QUINCY	40433M002	-2517234.727	-4198556.160	4076569.578	.004	.011	.011	NOAM	46796
7110M001	MONUMENT PEAK	40497M001	-2386277.938	-4802354.300	3444881.308	.004	.010	.012	PCFC	46796
7121M001	MOTU HIUMOO	92202M002	-5345865.317	-2958246.515	-1824623.915	.016	.017	.024	PCFC	46796
7122M001	MAZATLAN	40504M001	-1660089.358	-5619100.329	2511637.774	.006	.007	.013	NOAM	46796
7123M001	MOTU HIUMOO	92202M003	-5345865.312	-2958246.482	-1824623.940	.016	.017	.024	PCFC	47796
7210M001	MAUI	40445M001	-5466006.438	-2404427.878	2242187.374	.003	.013	.015	PCFC	46796
7510M001	ASKITES	12612M001	4353444.980	2082666.147	4156506.527	.021	.018	.018	EURA	46796
7512M001	KATAVIA	12615M001	4573400.081	2409322.091	3723881.670	.025	.021	.023	EURA	46796
7515M001	DIONYSOS	12602M002	4595216.486	2039435.183	3912629.396	.019	.017	.018	EURA	46796
7517M001	ROUMELLI	12613M001	4728694.726	2174373.212	3674572.851	.019	.016	.018	EURA	46796
7525M001	XRISOKALARIA	12616M001	4745949.571	1905705.821	3799168.986	.027	.024	.026	EURA	46796
7530M001	BAR GIYYORA	20702M001	4443966.060	3121945.007	3334693.513	.019	.015	.018	AFRC	46796
7810S001	ZIMMERWALD	14001S001	4331283.659	567549.451	4633139.809	.014	.014	.012	EURA	46796
7834S001	WETTZELL	14201S002	4075530.088	931781.148	4801618.061	.014	.013	.011	EURA	46796
7835S001	GRASSE	10002S001	4581691.773	556159.253	4389359.204	.015	.016	.015	EURA	46796
7838M001	SIMOSATO	21726M002	-3822386.990	3699362.311	3507571.918	.020	.016	.018	EURA	46796
7839S001	GRAZ	11001S002	4194426.740	1162693.763	4647246.407	.014	.013	.011	EURA	46796
7840S001	HERSTMONCEUX	13212S001	4033463.846	23662.221	4924304.909	.012	.012	.010	EURA	46796
7843S001	ORRORAL	50103S008	-4446476.534	2678127.021	-3696251.587	.009	.019	.022	INDI	46796
7907S001	AREQUIPA	42202S001	1942791.877	-5804077.594	-1796919.374	.018	.008	.017	SOAM	46796
7939S001	MATERA	12734S001	4641965.105	1393069.786	4133262.085	.012	.011	.012	EURA	46796

EARTH ORIENTATION FROM LASER RANGING TO LAGEOS
STATION COORDINATES FROM LASER RANGING TO LAGEOS GAOUA 89 L 01

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Computer program · Kiev - Geodynamics - 3

Models · MERIT Standards with following exceptions :
Dynamical model :
- cylindrical model for the Earth's shadow,
- occultation by Moon,
- Earth's rotational deformation,
- relativistic perigee advance.

Reference frame :
- relativistic effects in Earth's rotation.

Measurement model :
- body pole tide,
- tectonic plate motion (AM0-2).

Reflectance coefficient CR = 1.14 and the empirical along-track acceleration coefficient ĊT = -2.9 are not adjusted parameters.

Data : normal points for LAGEOS at interval January 1986 - December 1987.

Estimated parameters · 6 orbital elements (5-day intervals), 2 pole coordinates and excess of length of the day DR = (5-day interval), station coordinates X, Y, Z.

Orbital fit : standard deviation +/- 6-10cm.

Station positions : station coordinates have been solved together with arc-dependent orbital elements (5-day arcs) from two-year normal equation system.

At this stage BIH combined solution for Earth rotation parameters (Circular D) and fixing of longitude and latitude of Arequipa station (7907) have been used. The positions for stations are for the reference points of the laser ranging system and include the permanent tidal deformation.

Note added by the editor : the results arrived late and they cannot be printed in this document. The series of EOP and the SSC will be available in the same conditions as the other ones.

A 12.2 YEAR SLR EOP SERIES FROM LAGEOS SATELLITE LASER RANGING
SL7.1 (G44) GSFC 89 L 01

D.E.Smith, R Kolenkiewicz and B.H.Putney - the Geodynamics Branch, GSFC. Greenbelt. Maryland
P.J.Dunn, S.M.Klosko, E.C.Pavlis, J.R.Robbins, M.H.Torrence and R.G.Williamson Washington Analytical Services Center, Inc., Lanham, Maryland 20706
S.M.Fricke - Republic Management System, Inc., Lanham. Maryland 20706.

This solution was done by fitting 30 day (and occasionaly 35 day) day arcs of LAGEOS laser ranging normal point data from May 1976 through June 1988. There were 414.025 normal points used to form the solution, which were constructed from approximately 50 million full rate laser range observations. In each of the monthly arcs the initial state vector and two coefficients of solar radiation pressure and two coefficients of along track acceleration were estimated. The monthly arcs were combined to form a solution for earth orientation parameters and station positions. The following is a summary of the kinematic and dynamic models used for these solutions:

FORCE MODEL

- GEM-T1 Gravity model complete to degree and order 20.
- Third body perturbations: Sun, Moon, Venus, Mars, Jupiter, and Saturn (positioned with the JPL DE200 ephemeris)
- GM = 398600.4408 km3/sec2
- Tidal perturbations: Solid earth from Wahr, ocean tidal coeficients from with the 18.6 year coefficients adjusted to 2.3 cm, 278 deg.
- Direct effect of solar radiation pressure adjusted twice in each monthly
- Along track acceleration adjusted twice in each monthly arc

MEASUREMENT MODEL

- Marini-Muray wavelength dependent refraction model with site meteorologic
- Velocity of light = 299792.458 km/sec
- Vertical and horizontal tide displacements: h2=0.6272, 12=0.0986
- 2 minute normal points following the Herstmonceux recommendations

REFERENCE FRAME

- Wahr nutation series
- J2000 precession (JPL DE200 ephemeris)
- Ae = 6378137. m
- Flattening = 1/298.257
- A priori Earth orientation (Xp, Yp. and A1-UT1) obtained from a weakly Vo Earth orientation from SL7. These input values are adjusted at 5-day in (Xp, Yp, and A1-UT1) except that the first 5 day value of A1-UT1 in each arc is fixed at the input value.
- The station positions were constrained to move according to the Minster/tectonic motion model AM0-2. The positions have an epoch of January 15, 1983.

The Xp and Yp positions for the pole and the LOD values are in ERP(GSFC)SL7.1(G44).

The sigmas given are scaled formal errors from the least squares adjustment.

The station positions are presented in cartesian coordinates in SCC(GSFC)SL7.1(G44).

The positions are for an epoch of January 15, 1983, and, as for the EOP, the sigma given are scaled formal errors from the least squares adjustment.

The positions for stations 7051,7061,7062,7063,7069,7082,7086,7090,7091, 7092,7096,7100,7101,7102,7103,7104,7105,7109,7110,7112,7114,7115, 7120,7121,7122,7210,7220,7265,7517,7520,7525,7530,7541,7545,7550, 7590,7838,7882,7885,7887,7888,7890,7891,7892,7896, and 7899 are for the pad marker at the site.

The positions for stations 1181,7400,7401,7805,7810,7831,7833,7834,7835, 7837,7839,7840,7843,7886,7894,7907,7921,7929,7939, and 7943 are for the optical axis of the laser ranging system.

Notes ·
The latitude and longitude of 7105 and the latitude of 7210 were the fixed coordinates in the solution.
The gravity model is GEM-T1 with the GEM-T1 tides the MERIT Standards have been followed.

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	SX m	SY m	SZ m	PLATE	EPOCH MJD
1181S001	POTSDAM	14106S001	3800621.581	882005.142	5028859.433	.075	.072	.070	EURA	45349
7051M001	QUINCY	40433M001	-2516893.065	-4198845.049	4076411.554	.016	.015	.020	NOAM	45349
7061M001	EASTER ISLAND	41703M001	-1884984.534	-5357606.613	-2892852.522	.108	.083	.100	NAZC	45349
7062M001	SAN DIEGO	40436M002	-2428825.743	-4799750.541	3417272.720	.014	.012	.010	PCFC	45349
7063M001	WASHINGTON	40451M112	1130714.847	-4831367.732	3994087.356	.001	.005	.010	NOAM	45349
7064M001	WASHINGTON	40451M107	1130689.803	-4831342.691	3994123.447	2.819	1.652	1.000	NOAM	45349
7067M001	BERMUDA	42501M001	2308538.602	-4874079.890	3393628.491	.146	.092	.100	NOAM	45349
7068M001	GRAND TURK	43602M002	1920482.763	-5619478.311	2318914.303	.472	.260	.300	NOAM	45349
7069M001	PATRICK AFB	40417M002	917958.943	-5548370.459	2998776.607	.256	.168	.300	NOAM	45349
7080M001	FORT DAVIS	40442M006	-1330022.617	-5328401.924	3236480.057	.076	.059	.070	NOAM	45349
7082M001	BEAR LAKE	40438M001	-1735997.059	-4425048.160	4241430.596	.019	.019	.020	NOAM	45349
7084M001	OWENS VALLEY	40439M003	-2410590.154	-4477745.802	3838648.314	.228	.579	.500	NOAM	45349
7085M001	GOLDSTONE	40405M001	-2353394.103	-4641529.886	3676898.730	.204	.553	.500	NOAM	45349
7086M001	FORT DAVIS	40442M001	-1330125.320	-5328526.571	3236150.399	.003	.002	.010	NOAM	45349
7090M001	YARRAGADEE	50107M001	-2389006.174	5043329.309	-3078525.544	.002	.002	.010	INDI	45349
7091M001	HAYSTACK	40440M001	1492453.733	-4457278.721	4296815.811	.013	.011	.010	NOAM	45349
7092M001	KWAJALEIN ATOLL	50505M001	-6143447.309	1364699.984	1034163.069	.017	.023	.020	PCFC	45349
7096M001	AMERICAN SAMOA	50503M001	-6100045.851	-996203.268	-1568976.335	.014	.019	.020	PCFC	45349
7097M001	EASTER ISLAND	41703M002	-1884985.096	-5357607.971	-2892853.294	.010	.009	.010	NAZC	45349
7100M001	WASHINGTON	40451M106	1131355.725	-4831168.689	3994132.099	.228	.181	.200	NOAM	45349
7101M001	WASHINGTON	40451M101	1131240.525	-4831179.808	3994148.465	.085	.051	.070	NOAM	45349
7102M001	WASHINGTON	40451M102	1130686.662	-4831353.085	3994110.883	.011	.009	.010	NOAM	45349
7103M001	WASHINGTON	40451M103	1130685.722	-4831348.731	3994116.302	.018	.018	.020	NOAM	45349
7104M001	WASHINGTON	40451M104	1131095.967	-4831196.839	3994170.806	.065	.055	.060	NOAM	45349
7105M001	WASHINGTON	40451M105	1130719.794	-4831350.569	3994106.480	.001	.001	.010	NOAM	45349
7109M001	QUINCY	40433M002	-2517234.646	-4198556.122	4076569.837	.002	.002	.010	NOAM	45349
7110M001	MONUMENT PEAK	40497M001	-2386277.817	-4802354.394	3444881.433	.002	.002	.010	PCFC	45349
7112M001	PLATTEVILLE	40496M001	-1240678.159	-4720463.314	4094480.706	.005	.005	.010	NOAM	45349

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	SX m	SY m	SZ m	PLATE	EPOCH MJD
7114M001	OWENS VALLEY	40439M001	-2410422.342	-4477802.663	3838686.814	.010	.009	.010	NOAM	45349
7115M001	GOLDSTONE	40405M002	-2350861.580	-4655546.275	3660998.006	.010	.010	.010	NOAM	45349
7120M001	MAUI	40445M002	-5465998.367	-2404408.684	2242228.421	.007	.009	.010	PCFC	45349
7121M001	MOTU HIUMOO	92202M002	-5345865.217	-2958246.722	-1824623.804	.004	.005	.010	PCFC	45349
7122M001	MAZATLAN	40504M001	-1660089.359	-5619100.325	2511637.995	.003	.002	.010	NOAM	45349
7123M001	MOTU HIUMOO	92202M003	-5345866.657	-2958247.515	-1824624.371	.012	.013	.010	PCFC	45349
7125M001	WASHINGTON	40451M114	1130745.856	-4831368.072	3994077.096	.016	.012	.010	NOAM	45349
7210M001	MAUI	40445M001	-5466006.421	-2404428.051	2242187.491	.002	.002	.010	PCFC	45349
7220M001	MONUMENT PEAK	40497M002	-2386292.132	-4802347.487	3444880.898	.012	.010	.010	PCFC	45349
7265M001	GOLDSTONE	40405M006	-2356475.634	-4646618.187	3668424.884	.011	.011	.010	NOAM	45349
7288M001	GOLDSTONE	40405M013	-2356494.018	-4646607.566	3668426.816	.009	.006	.010	NOAM	45349
7400S001	SANTIAGO	41705S003	1769700.165	-5044614.808	-3468263.229	.015	.010	.010	SOAM	45349
7401S001	CERRO TOLOLO	41706S001	1815517.690	-5213466.839	-3188002.490	.009	.007	.010	SOAM	45349
7510M001	ASKITES	12612M001	4353445.190	2082666.029	4156506.499	.052	.058	.050	EURA	45349
7512M001	KATAVIA	12615M001	4573400.353	2409321.948	3723881.595	.056	.068	.060	EURA	45349
7515M001	DIONYSOS	12602M002	4595216.695	2039435.084	3912629.347	.045	.052	.050	EURA	45349
7517M001	ROUMELLI	12613M001	4728694.943	2174373.100	3674572.779	.040	.047	.050	EURA	45349
7520M001	KARITSA	12614M001	4596042.893	1733476.585	4055720.667	.018	.015	.020	EURA	45349
7525M001	XRISOKALARIA	12616M001	4745949.795	1905705.658	3799168.867	.055	.059	.060	EURA	45349
7530M001	BAR GIYYORA	20702M001	4443967.678	3121945.149	3334694.197	.006	.006	.010	AFRC	45349
7541M001	MATERA	12734M004	4641990.570	1393042.045	4133231.674	.013	.015	.010	EURA	45349
7544M001	LAMPEDUSA	12706M001	5072832.233	1130885.917	3684836.756	.069	.081	.080	EURA	45349
7545M001	CAGLIARI	12725M002	4893398.280	772673.061	4004140.805	.013	.018	.020	EURA	45349
7550M001	TRIESTE	12718M002	4336738.766	1071271.267	4537910.927	.055	.077	.070	EURA	45349
7575M001	DIYARBAKIR	20801M001	3848636.432	3251760.761	3898908.998	.117	.126	.120	EURA	45349
7580M001	MELENGICLICK	20803M001	4247620.855	2778638.740	3851607.359	.085	.097	.090	EURA	45349
7585M001	YOZGAT	20802M001	4029731.047	2802093.115	4062067.855	.122	.163	.140	EURA	45349
7587M001	YIGILCA	20804M001	4117362.322	2517076.619	4157678.905	.098	.075	.100	EURA	45349
7590M001	MONTE GENEROSO	14005M002	4390310.123	696751.790	4560835.765	.011	.012	.010	EURA	45349

SSC(GSFC) 89 L 01

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	SX m	SY m	SZ m	PLATE	EPOCH MJD
7596M001	WETTZELL	14201M004	4075580.179	931836.253	4801560.335	.168	.235	.200	EURA	45349
7805S001	METSAHOVI	10503S001	2892595.635	1311808.025	5512610.798	.154	.147	.150	EURA	45349
7810S001	ZIMMERWALD	14001S001	4331283.816	567549.263	4633139.813	.005	.005	.010	EURA	45349
7831S001	HELWAN	30101S001	4728283.993	2879669.959	3156893.986	.082	.134	.100	AFRC	45349
7833S001	KOOTWIJK	13504S001	3899224.428	396742.611	5015073.808	.107	.090	.100	EURA	45349
7834S001	WETTZELL	14201S002	4075530.303	931781.041	4801618.046	.004	.003	.010	EURA	45349
7835S001	GRASSE	10002S001	4581692.013	556159.120	4389359.236	.005	.005	.010	EURA	45349
7837S001	SHANGHAI	21605S001	-2831087.478	4676203.760	3275173.026	.487	.233	.500	EURA	45349
7838M001	SIMOSATO	21726M002	-3822386.774	3699362.431	3507572.109	.003	.003	.010	EURA	45349
7839S001	GRAZ	11001S002	4194426.968	1162693.641	4647246.381	.004	.003	.010	EURA	45349
7840S001	HERSTMONCEUX	13212S001	4033464.040	23662.115	4924304.892	.003	.003	.010	EURA	45349
7843S001	ORRORAL	50103S008	-4446476.605	2678127.229	-3696251.785	.007	.005	.010	INDI	45349
7882M001	CABO SAN LUCAS	40505M001	-1997241.598	-5528041.087	2468355.189	.021	.021	.020	PCFC	45349
7885M001	FORT DAVIS	40442M005	-1330125.339	-5328526.420	3236150.356	.024	.026	.030	NOAM	45349
7886S001	QUINCY	40433S010	-2517242.374	-4198554.028	4076572.330	.038	.033	.040	NOAM	45349
7887M001	VANDENBERG AFB	40420M004	-2668868.165	-4530743.797	3598685.126	.128	.540	.500	NOAM	45349
7888M001	MOUNT HOPKINS	40434M002	-1936744.310	-5077639.010	3331994.001	.025	.019	.020	NOAM	45349
7890M001	AUSTIN	40412M001	-754162.110	-5459061.190	3200744.117	.271	.240	.300	NOAM	45349
7891M001	FLAGSTAFF	40491M002	-1923976.587	-4850871.542	3658574.900	.030	.029	.030	NOAM	45349
7892M001	VERNAL	40492M001	-1631484.640	-4589133.829	4106749.704	.020	.022	.020	NOAM	45349
7894S001	YUMA	40493S001	-2196777.863	-4887339.190	3448428.341	.020	.018	.020	NOAM	45349
7896M001	PASADENA	40400M001	-2493211.830	-4655229.621	3565574.604	.023	.024	.020	PCFC	45349
7907S001	AREQUIPA	42202S001	1942791.743	-5804077.749	-1796919.370	.001	.002	.010	SOAM	45349
7921S001	MOUNT HOPKINS	40434S001	-1936760.101	-5077707.071	3331922.681	.021	.017	.020	NOAM	45349
7929S001	NATAL	41604S001	5186467.882	-3653856.333	-654322.066	.013	.018	.020	SOAM	45349
7939S001	MATERA	12734S001	4641965.326	1393069.669	4133262.052	.002	.002	.010	EURA	45349
7943S001	ORRORAL	50103S003	-4447548.620	2677134.262	-3694996.848	.008	.007	.010	INDI	45349
8833S001	KOOTWIJK	13504S007	3899238.066	396768.943	5015055.126	.027	.025	.030	EURA	45349

EOP(GSFC) 89 L 01 Available from 1976 to 1988

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

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1976	47	96.70	47	47.15	35	0.412
1977	73	17.17	73	17.55	58	0.256
1978	72	23.78	72	12.95	55	0.332
1979	73	6.51	73	7.45	59	0.145
1980	74	1.79	74	1.21	61	0.043
1981	73	2.05	73	1.32	61	0.039
1982	73	1.51	73	0.95	61	0.034
1983	73	0.91	73	0.74	61	0.020
1984	73	0.37	73	0.33	61	0.013
1985	73	0.45	73	0.39	61	0.015
1986	73	0.53	73	0.44	61	0.018
1987	73	0.28	73	0.24	61	0.011
1988	36	0.48	36	0.38	30	0.014

EARTH ORIENTATION FROM LAGEOS LASER RANGING SHA 88 L 01

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To determine a series of the Earth Orientation Parameters EOP(SHA) 88 L 01, the 1988 Lageos quick-look normal points data obtained from 24 stations, kindly provided by CSR of Texas University at Austin, have been processed with a program system named SHORDE I. In the solution we have designed a software package embodying a "multistage-multiarc" procedure to estimate simultaneously satellite states, EOPs and some station coordinates. These adjustable parameters are devided into three groups. The first group, the global parameters, such as some station coordinates, are adjusted in the whole of the long arc (several months) in order to obtain stable and reliable results. The second group, the first-stage local parameters, such as satellite orbit states, are independently adjusted in the different subarcs (10 days) so as to reduce the effect of some unmodeled perturbations and obtain stable solutions. The third group, the second-stage local parameters, such as EOPs, are independently adjusted from one sub-subarcs (5 days) to the next so as to model properly their variation. The adjustment for whole long arc is to be accomplished step by step from one sub-subarc 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 Xp, Yp. The ability to detect the rate of polar motion with 5-day arc solution has been investigated and found to be better than 0.001"/day. In our solution the overall RMS fit of the laser observations to the orbits in 10-day arcs is generally about 10cm.

The station coordinates used in our solution is from SSC(SHA) 88 L 01. In which most of station coordinates is derived from SSC(SHA) 87 L 01 to be attached to respective tectonic plates with motion defined by the AM1-2 model of Minster and Jordan 1978, the coordinates of a few stations are re-estimated simultaneously with the satellite orbit states and EOPs. The epoch of the derived SSC(SHA) 88 L 01 is January 1.0 1988 (MJD 47161.0). Modeling of AM1-2 tectonic plate motion is expected to enable improved maintenance of the system accuracy.

The force model and constants used in the solution adhere closely to the MERIT Standards. Some exceptions are following :

1. $GM=398600.4404 km^3/sec^2$, $Re=6378145.0m$
2. Earth radiation pressure and general relativistic perturbation have been considered.
3. The drag-like coefficient Cd and reflectivity of LAGEOS'surface Cr have been estimated in each 10-day arc along with the satellite states.

References

Minster,J.B. and T.H.Jordan, Present-day plate motions, JGR 83, No B11, 5331-5354, 1978.

He Miaofu et al., A series of ERP from LAGEOS during the MERIT Campaign, Proceedings of the International Conference on Earth Rotation and the Terrestrial Reference Frame, I.I.Mueller (convenor), 205-212.

IERS(1989) : Technical Note no 2.

SSC(SHA) 88 L 01

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	PLATE
1181S001	POTSDAM	14106S001	3800621.334	882005.320	5028859.745	EURA
7086M001	FORT DAVIS	40442M001	-1330125.462	-5328526.621	3236150.412	NOAM
7090M001	YARRAGADEE	50107M001	-2389006.464	5043329.442	-3078525.292	INDI
7091M001	HAYSTACK	40440M001	1492453.403	-4457278.786	4296815.818	NOAM
7105M001	WASHINGTON	40451M105	1130719.658	-4831350.680	3994106.618	NOAM
7109M001	QUINCY	40433M002	-2517234.855	-4198556.253	4076569.794	NOAM
7110M001	MONUMENT PEAK	40497M001	-2386278.116	-4802354.286	3444881.601	PCFC
7112M001	PLATTEVILLE	40496M001	-1240678.331	-4720463.336	4094480.682	NOAM
7122M001	MAZATLAN	40504M001	-1660089.494	-5619100.410	2511637.908	NOAM
7210M001	MAUI	40445M001	-5466006.622	-2404427.729	2242187.606	PCFC
7805S001	METSAHOVI	10503S001	2892595.172	1311808.161	5512609.943	EURA
7831S001	HELWAN	30101S001	4728282.998	2879669.620	3156894.238	AFRC
7834S001	WETTZELL	14201S002	4075530.183	931781.218	4801618.399	EURA
7835S001	GRASSE	10002S001	4581691.905	556159.287	4389359.452	EURA
7837S001	SHANGHAI	21605S001	-2831087.574	4676203.643	3275172.751	EURA
7838S001	SIMOSATO	21726S001	-3822388.302	3699363.521	3507573.153	EURA
7839S001	GRAZ	11001S002	4194426.787	1162693.817	4647246.663	EURA
7840S001	HERSTMONCEUX	13212S001	4033463.862	23662.227	4924305.145	EURA
7810S001	ZIMMERWALD	14001S001	4331283.520	567549.241	4633140.237	EURA
7843S001	ORRORAL	50103S008	-4446476.946	2678127.384	-3696252.111	INDI
7882M001	CABO SAN LUCAS	40505M001	-1997241.683	-5528041.124	2468355.203	PCFC
7907S001	AREQUIPA	42202S001	1942791.809	-5804077.858	-1796919.280	SOAM
7939S001	MATERA	12734S001	4641965.180	1393069.837	4133262.355	EURA
8833S001	KOOTWIJK	13504S007	3899237.883	396769.131	5015055.387	EURA

SX, SY, SZ = 0.100m. EPOCH-MJD = 47161.

EOP(SHA) 88 L 01 Available from 1988 to 1988

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

YEAR	X Nb	X Sigma	Y Nb	Y Sigma	D Nb	D Sigma
1988	72	1.02	72	1.12	72	0.548

EARTH ROTATION PARAMETERS IN 1987 AND STATION COORDINANTES FROM LASER RANGING TO LAGEOS

ZIPE 87 L 01
ZIPE 87 L 02
ZIPE 87 L 03

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Using the Satellite Laser Ranging (SLR) data to LAGEOS in 1987 a Set of Station Coordinates (SSC) and several series of Earth Orientation Parameters (EOP) were determined by the program package TOTSDAM-5. The SLR data were introduced as normal points delivered by Ch.Reigber, SLR Data Collection Center for Europe at the DGFI. All constants and model parameters were taken from the MERIT Standards and its updating - the International Earth Rotation Service Standards, Draft of December 1988. The only deviations from the latter document are :

- the GEM-T1 was used instead of GEM-L2 ; the coefficients C_{21} and S_{21} were reduced to the average pole position ;
- the effect of penumbra for the radiation pressure was not included ;
- no relativistic corrections ;
- the tidal variations in UT1 caused by zonal tide terms with periods greater than 35 days were not considered:
- the variation of station coordinates caused by polar tide was not taken into account.

The SSC results were referred to the epoch 1984.0 applying the AM0-2 tectonic plate model. The origin of the reference system was defined by $C_{10} = C_{11} = S_{11} = 0$, and the orientation was constrained by fixation of φ and λ for station 7210 and of φ for station 7105. The precision (formal error) of the station coordinates is in the order of +/- 5mm. The accuracy obtained by comparison with other solutions via a Helmert transformation with 7 free parameters was estimated to be about +/- 2cm.

For the EOP (pole coordinates and length of day (LOD)) several sets were determined : the set EOP(ZIPE) 87 L 01 with a time resolution of 5 days and the two sets EOP(ZIPE) 87 L 02 and L 03 with a resolution of 3 days. The 5-days resolutions (EOP(ZIPE) 87 L 01) were simultaneously computed with the station coordinates and the orbit dependent parameters (6 orbital elements, empirical acceleration). The average orbital fit amounts to about +/- 6cm. For both the other sets of EOP with a time resolution of 3 days the station coordinates were fixed to the values obtained from the 5-days solutions. The set EOP(ZIPE) 87 L 02 was obtained by simultaneous adjustment of the pole coordinates and the length of day together with the orbit dependent parameters for every 3-days interval. On the contrary, the set EOP(ZIPE) 87 L 03 differs from the latter in two points : the orbital improvement were performed for 6-days intervals, and instead of the pole coordinates and LOD the pole coordinates and LOD, the pole coordinates and UT1 values were estimated in a 3-days interval symmetrical situated inside of each converted into LOD. That means that the time scale has to be transferred by -1.5d for the LOD values of the set EOP(ZIPE) 87 L 03.

For The determination of EOP results the measurements were weighted according to their estimated accuracy. But, in addition, several non permanent stations (e.g. WEGENER project) were provided with a smaller weight in order to reduce the influence of the change of the station distribution. No post-adjustment smoothing or filtering procedure was applied to the EOP series. Generally, the accuracy of both the 5-days and 3-days solutions is very similar. Only in a few cases with only a small number of stations and passes the 3-days solutions are worse. The number of such worse solutions is of course smaller for the EOP(ZIPE) 87 L 03 set.

The average precision of all EOP sets is in the order of +/-0.0001" to 0.0002" (3 to 6mm) for the pole coordinates and +/- 0.003ms for LOD. The accuracy was estimated to be about +/- 3cm for the pole coordinates and less than +/- 0.1ms for LOD.

SSC(ZIPE) 89 L 01

NETWORK NUMBER	SITE	DOMES NUMBER	X m	Y m	Z m	SX m	SY m	SZ m	PLATE	EPOCH MJD
7090S001	YARRAGADEE	50107S001	-2389007.470	5043331.776	-3078527.262	.001	.002	.003	INDI	45700
7105S002	WASHINGTON	40451S101	1130720.343	-4831352.970	3994108.249	.001	.002	.003	NOAM	45700
7109S002	QUINCY	40433S006	-2517235.902	-4198558.283	4076571.481	.002	.002	.001	NOAM	45700
7110S001	MONUMENT PEAK	40497S001	-2386279.043	-4802356.873	3444882.822	.001	.002	.001	PCFC	45700
7122S001	MAZATLAN	40504S001	-1660090.135	-5619103.205	2511638.940	.001	.002	.002	NOAM	45700
7210S001	MAUI	40445S001	-5466006.898	-2404428.355	2242188.123	.001	.002	.002	PCFC	45700
7838S001	SIMOSATO	21726S001	-3822388.212	3699363.578	3507572.913	.002	.003	.003	EURA	45700
7840S001	HERSTMONCEUX	13212S001	4033463.921	23662.205	4924304.766	.002	.002	.003	EURA	45700
7907S001	AREQUIPA	42202S001	1942791.969	-5804077.630	-1796919.555	.001	.002	.001	SOAM	45700
7939S001	MATERA	12734S001	4641965.167	1393069.803	4133261.958	.003	.002	.002	EURA	45700
7834S001	WETTZELL	14201S002	4075530.142	931781.150	4801617.913	.002	.003	.003	EURA	45700
7839S001	GRAZ	11001S002	4194426.830	1162693.755	4647246.258	.002	.002	.003	EURA	45700
7810S001	ZIMMERWALD	14001S001	4331283.712	567549.429	4633139.671	.002	.003	.003	EURA	45700
7835S001	GRASSE	10002S001	4581691.855	556159.264	4389359.050	.002	.002	.003	EURA	45700
7086S001	FORT DAVIS	40442S00	-1330120.924	-5328532.282	3236146.546	.001	.002	.001	NOAM	45700
7530S001	BAR GIYYORA	20702S001	4443968.585	3121946.739	3334695.138	.002	.004	.004	AFRC	45700
7512S001	KATAVIA	12615S001	4573402.475	2409323.345	3723880.192	.002	.004	.003	EURA	45700
7510S001	ASKITES	12612S001	4353447.548	2082667.266	4156505.303	.002	.003	.002	EURA	45700
7585S001	YOZGAT	20802S001	4029733.125	2802094.618	4062066.633	.005	.006	.006	EURA	45700
7515S001	DIONYSOS	12602S008	4595219.006	2039436.256	3912627.976	.001	.002	.002	EURA	45700
7517S002	ROUMELLI	12613S002	4728698.086	2174374.702	3674573.331	.002	.003	.003	EURA	45700
7517S003	ROUMELLI	12613S003	4728697.184	2174374.288	3674571.328	.002	.003	.003	EURA	45700
7544S001	LAMPEDUSA	12706S001	5072834.680	1130886.651	3684835.287	.002	.004	.003	EURA	45700
7525S004	XRISOKALARIA	12616S004	4745952.915	1905707.193	3799169.460	.002	.003	.003	EURA	45700
7575S001	DIYARBAKIR	20801S001	3848638.290	3251762.497	3898907.659	.003	.006	.006	EURA	45700
7580S001	MELENGICLICK	20803S001	4247623.732	2778640.762	3851608.016	.003	.004	.003	EURA	45700
7587S001	YIGILCA	20804S001	4117365.139	2517078.541	4157679.779	.003	.004	.004	EURA	45700
1884S001	RIGA	12302S002	3183895.028	1421495.804	5322800.743	.004	.009	.010	EURA	45700
7097S001	EASTER ISLAND	41703S004	-1884985.161	-5357609.245	-2892854.247	.004	.005	.005	NAZC	45700
1181S001	POTSDAM	14106S001	3800621.453	882005.240	5028859.299	.002	.003	.003	EURA	45700
7831S001	HELWAN	30101S001	4728283.735	2879670.382	3156893.992	.002	.003	.003	AFRC	45700

EOP(ZIPE) 89 L 01 Available from 1986 to 1987

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

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1986	4	0.16	4	0.16	4	0.032
1987	73	0.16	73	0.14	73	0.036

EOP(ZIPE) 89 L 02 Available from 1986 to 1987

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

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1986	6	0.18	6	0.19	6	0.039
1987	122	0.19	122	0.21	122	0.055

EOP(ZIPE) 89 L 03 Available from 1986 to 1987

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

YEAR	X		Y		D	
	Nb	Sigma	Nb	Sigma	Nb	Sigma
1986	6	0.21	6	0.22	6	0.176
1987	122	0.21	122	0.31	122	0.230