A COMBINATION OF EOP MEASUREMENTS: SPACE96 EOP(JPL) 97 C 01

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A combination of Earth orientation measurements has been generated from space-geodetic observations spanning 1976-1996. The approach taken is the same as that used in generating previous such combinations (e.g., Gross, "Combinations of Earth Orientation Measurements: SPACE94, COMB94, and POLE94", J. Geophys. Res., 101, 8729-8740, 1996) and will be only briefly described here. Since it was desirable to combine only independent measurements, only those series listed in Table 1 were used. Note that only measurements from the Scripps GPS series through May 31, 1992 were used, with measurements from the JPL GPS series EOP(JPL) 95 P 02 used from June 1, 1992 through December 31, 1994, measurements from the IGS combined series EOP(IGS) 95 P 01 used from January 1, 1995 through June 29, 1996, and measurements from the IGS combined series EOP(IGS) 96 P 02 used thereafter. Similarly, only the USNO IRIS Intensive UT1 determinations made after January 1, 1995 were used, with the NOAA IRIS Intensive series being used before then.

Prior to their combination, the bias and rate of each series was iteratively adjusted so as to be in agreement with the bias and rate exhibited by a combination of all other series; the stated uncertainty of each series was adjusted by applying a multiplicative scale factor making the residual of that data, when differenced with a combination of all other data, have a reduced chi-square of one; and those data points whose residual values were greater than three times their adjusted uncertainties were deleted. In order for the final combination, SPACE96, to be given within a well-defined terrestrial reference frame, an additional common bias-rate correction was applied to each series so that their combination, SPACE96, would be aligned with the IERS Earth orientation series EOP(IERS) 97 C 04 during 1987-1996. The UT1 values of the entire SPACE96 series have also had the new 9.3- and 18.6-year terms included by adding the correction:

UT1_new - UT1_old = -0.176 sin(Omega) - 0.0042 sin(2.*Omega) (ms)

which is consistent with the new GST definition (see IERS Conventions (1996), pp. 21-22), but is of opposite sign to the correction given in IERS Gazette No. 8. The total bias-rate corrections and uncertainty scale factors that have been applied to the individual series prior to their combination into SPACE96 are given in Table 1 in the natural reference frame for each data type: the transverse (T), vertical (V) frame for single baseline VLBI measurements; the variation-of-latitude (VOL), UT0 frame for single station LLR measurements; and the usual UTPM (PMX, PMY, UT1) frame for all other measurements. The uncertainties in the bias-rate corrections (given in parentheses in Table 1) are the formal errors in determining the incremental bias-rate corrections during the last iteration.

ACKNOWLEDGMENTS. The work described here was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

TABLE 1. ADJUSTMENTS TO DATA SETS PRIOR TO COMBINATION

DATA SET NAME	BIAS (mas)		RATE (mas/yr)		UNCERTAINTY SCALE FACTOR	
LLR (JPL; 04FEB97)	VOL	UT0	VOL	UT0	VOL	UT0
McDonald Cluster	0.209	-0.336	-0.028	-0.112	1.458	1.209
	(0.121)	(0.107)	(0.041)	(0.035)		
CERGA	0.258	-0.008	0.132	-0.003	1.828	1.349
	(0.057)	(0.038)	(0.021)	(0.014)		
Haleakala	0.942	-1.518	-0.126	-0.121	2.015	1.703
	(1.146)	(0.715)	(0.231)	(0.152)		
DSN (JPL; 96R01)	T	V	T	V	T	V
CA-Spain Cluster	-0.452	0.490	0.117	0.165	1.348	1.102
	(0.027)	(0.063)	(0.012)	(0.028)		
CA-Australia Cluster	1.153	-0.117	0.047	0.037	1.392	1.115
	(0.021)	(0.059)	(0.008)	(0.024)		
NASA SGP (GLB1057c)	T	V	T	V	T	V
Westford-Ft. Davis	8.370	4.775	0.830	0.477	1.304	0.837
	(3.758)	(6.301)	(0.378)	(0.630)		
Westford-Mojave	0.432	-0.077	0.121	-0.050	2.564	0.858
	(0.232)	(0.428)				
NASASGP(1057c) PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
Multi- -1.024	-1.331	0.008	-0.073	0.026	-0.063	1.586	1.428	1.687
baseline (0.013)	(0.011)	(0.018)	(0.005)	(0.004)	(0.007)			
NOAA (95R02) PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
IRIS Inten. ---	---	0.296	---	---	-0.013	---	---	0.934
		(0.021)			(0.006)			
USNO (19FEB97) PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
IRIS Inten. ---	---	-1.004	---	---	0.084	---	---	1.048
		(0.044)			(0.018)			
UTCSR (96L01) PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
LAGEOS SLR -0.047	0.792	---	0.053	0.109	---	0.982	0.835	---
(0.014)	(0.011)		(0.004)	(0.004)				
GPS (SIO93P01) PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
Scripps -0.968	-0.716	---	0.129	0.100	---	1.879	1.932	---
(0.034)	(0.039)							
GPS (JPL95P02) PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
JPL -0.100	0.512	---	0.110	-0.067	---	3.007	2.677	---
(0.024)	(0.022)		(0.020)	(0.018)				
GPS (IGS95P01) PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
IGS 0.175	0.412	---	0.145	0.241	---	2.578	1.424	---
(0.086)	(0.068)		(0.031)	(0.025)				
GPS (IGS96P02) PMX	PMY	UT1	PMX	PMY	UT1	PMX	PMY	UT1
IGS -0.887	-0.477	---	0.129	0.100	---	3.591	1.060	---
(0.025)	(0.016)							

REFERENCE DATE FOR BIAS-RATE ADJUSTMENT IS 1993.0

Technical description of solution JPL 97 C 01

1 - Technique: Combined

2 - Analysis Center: Jet Propulsion Laboratory

3 - Software used: Kalman Earth Orientation Filter (KEOF) OP-B

4 - Data span: Oct 76 - Feb 97 at 1-day intervals

5 - Celestial Reference Frame: Not Applicable

a - Nature:

b - Definition of the orientation:

6 - Terrestrial Reference Frame: Not Applicable

a - Relativity scale:

b - Velocity of light:

c - Geogravitational constant:

d - Permanent tidal correction:

e - Definition of the origin:

f - Definition of the orientation:

g - Reference epoch:

h - Tectonic plate model:

i - Constraint for time evolution:

7 - Earth orientation: EOP(JPL) 97 C 01

a - A priori precession model: Not Applicable

b - A priori nutation model: Not Applicable

c - Short-period tidal variations in x, y, UT1:

When necessary, diurnal and semidiurnal tidal variations have been removed from the individual EOP series prior to their combination into EOP(JPL) 97 C 01. Diurnal and semidiurnal tidal terms have not been added back and are therefore not included in the values reported in EOP(JPL) 97 C 01.

8 - Estimated Parameters:

a - Celestial Frame:

b - Terrestrial Frame:

c - Earth Orientation: PMX, PMY, UT1-UTC

d - Others:

JPL Kalman Earth Orientation Series : SPACE96 19-MAR-97 17:42:14 IERS Series Designator : EOP(JPL) 97 C 01

MJD	PMX (arc sec)	PMY (arc sec)	UT1-UTC (sec)			SIG X (arc sec)	SIG Y (arc sec)	SIG U (sec)				COR XY	COR XU	COR YU			
43049.000	0.1882687	0.1619289	-0.0435872	0	0	0.0044677	0.0030681	0.0006662	0	0	0	-0.0063	0.2081	0.1070	0	0	0
43050.000	0.1877425	0.1598036	-0.0467965	0	0	0.0041895	0.0029587	0.0006283	0	0	0	-0.0209	0.1969	0.1261	0	0	0
43051.000	0.1872142	0.1576080	-0.0499560	0	0	0.0039636	0.0028638	0.0005842	0	0	0	-0.0309	0.1917	0.1490	0	0	0
43052.000	0.1866756	0.1553541	-0.0531267	0	0	0.0037853	0.0027808	0.0005352	0	0	0	-0.0365	0.1934	0.1753	0	0	0
43053.000	0.1861189	0.1530543	-0.0563531	0	0	0.0036490	0.0027079	0.0004828	0	0	0	-0.0381	0.2034	0.2042	0	0	0
43054.000	0.1855346	0.1507246	-0.0596580	0	0	0.0035484	0.0026442	0.0004293	0	0	0	-0.0370	0.2231	0.2343	0	0	0
43055.000	0.1849101	0.1483876	-0.0630439	0	0	0.0034760	0.0025894	0.0003774	0	0	0	-0.0345	0.2536	0.2623	0	0	0
43056.000	0.1842329	0.1460667	-0.0664959	0	0	0.0034252	0.0025448	0.0003311	0	0	0	-0.0322	0.2945	0.2817	0	0	0
43057.000	0.1834909	0.1437831	-0.0699840	0	0	0.0033907	0.0025130	0.0002942	0	0	0	-0.0312	0.3423	0.2836	0	0	0
43058.000	0.1826700	0.1415423	-0.0734610	0	0	0.0033687	0.0024966	0.0002670	0	0	0	-0.0324	0.3927	0.2646	0	0	0
43059.000	0.1817593	0.1393406	-0.0768810	0	0	0.0033565	0.0024980	0.0002484	0	0	0	-0.0360	0.4409	0.2273	0	0	0
43060.000	0.1807553	0.1371720	-0.0802118	0	0	0.0033510	0.0025163	0.0002378	0	0	0	-0.0418	0.4809	0.1786	0	0	0
43061.000	0.1796575	0.1350323	-0.0834358	0	0	0.0033490	0.0025487	0.0002374	0	0	0	-0.0493	0.5005	0.1268	0	0	0
43062.000	0.1784682	0.1329134	-0.0865518	0	0	0.0033486	0.0025926	0.0002510	0	0	0	-0.0577	0.4876	0.0795	0	0	0
43063.000	0.1771951	0.1308046	-0.0895799	0	0	0.0033488	0.0026456	0.0002808	0	0	0	-0.0659	0.4442	0.0422	0	0	0
43064.000	0.1758467	0.1287028	-0.0925541	0	0	0.0033485	0.0027039	0.0003251	0	0	0	-0.0734	0.3867	0.0164	0	0	0
43065.000	0.1744284	0.1266138	-0.0955133	0	0	0.0033460	0.0027622	0.0003787	0	0	0	-0.0800	0.3306	0.0001	0	0	0
43066.000	0.1729436	0.1245436	-0.0985009	0	0	0.0033404	0.0028164	0.0004363	0	0	0	-0.0858	0.2828	-0.0099	0	0	0
43067.000	0.1713957	0.1224979	-0.1015650	0	0	0.0033318	0.0028638	0.0004938	0	0	0	-0.0907	0.2439	-0.0162	0	0	0
43068.000	0.1697869	0.1204830	-0.1047530	0	0	0.0033204	0.0029025	0.0005486	0	0	0	-0.0949	0.2127	-0.0204	0	0	0
43069.000	0.1681156	0.1185069	-0.1081043	0	0	0.0033054	0.0029312	0.0005988	0	0	0	-0.0983	0.1878	-0.0236	0	0	0
43070.000	0.1663795	0.1165781	-0.1116393	0	0	0.0032864	0.0029493	0.0006427	0	0	0	-0.1008	0.1681	-0.0262	0	0	0
43071.000	0.1645764	0.1147050	-0.1153476	0	0	0.0032638	0.0029574	0.0006795	0	0	0	-0.1022	0.1528	-0.0286	0	0	0
43072.000	0.1627046	0.1128956	-0.1191803	0	0	0.0032385	0.0029566	0.0007083	0	0	0	-0.1022	0.1412	-0.0311	0	0	0
43073.000	0.1607635	0.1111526	-0.1230545	0	0	0.0032105	0.0029468	0.0007284	0	0	0	-0.1009	0.1329	-0.0338	0	0	0
43074.000	0.1587531	0.1094744	-0.1268742	0	0	0.0031796	0.0029271	0.0007396	0	0	0	-0.0984	0.1276	-0.0367	0	0	0
43075.000	0.1566734	0.1078589	-0.1305606	0	0	0.0031459	0.0028974	0.0007415	0	0	0	-0.0946	0.1251	-0.0400	0	0	0
43076.000	0.1545232	0.1062997	-0.1340786	0	0	0.0031091	0.0028576	0.0007340	0	0	0	-0.0902	0.1255	-0.0437	0	0	0
43077.000	0.1523005	0.1047886	-0.1374445	0	0	0.0030691	0.0028081	0.0007173	0	0	0	-0.0856	0.1288	-0.0479	0	0	0
43078.000	0.1500035	0.1033173	-0.1407123	0	0	0.0030262	0.0027501	0.0006916	0	0	0	-0.0815	0.1350	-0.0524	0	0	0

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7379 records not shown

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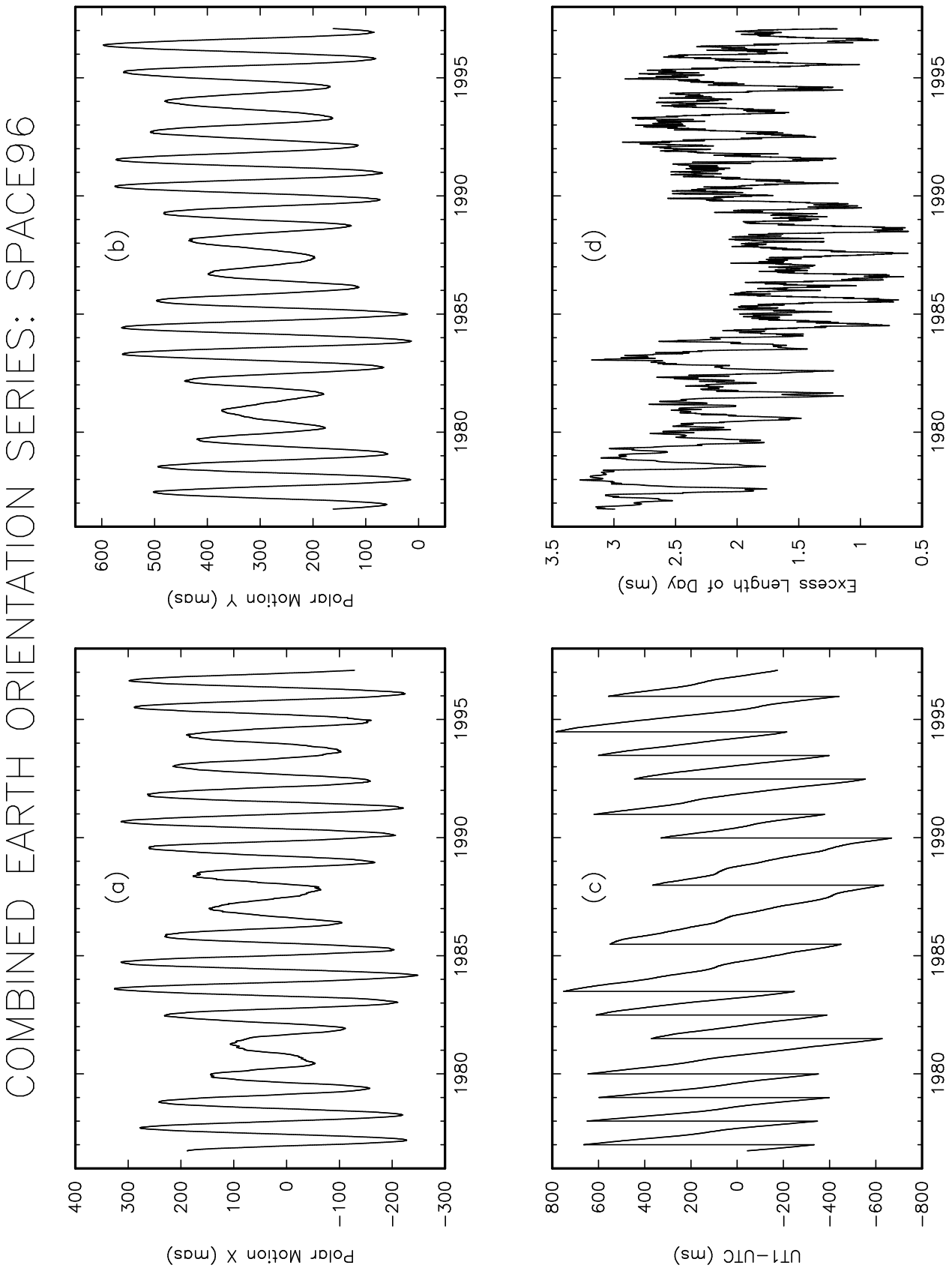
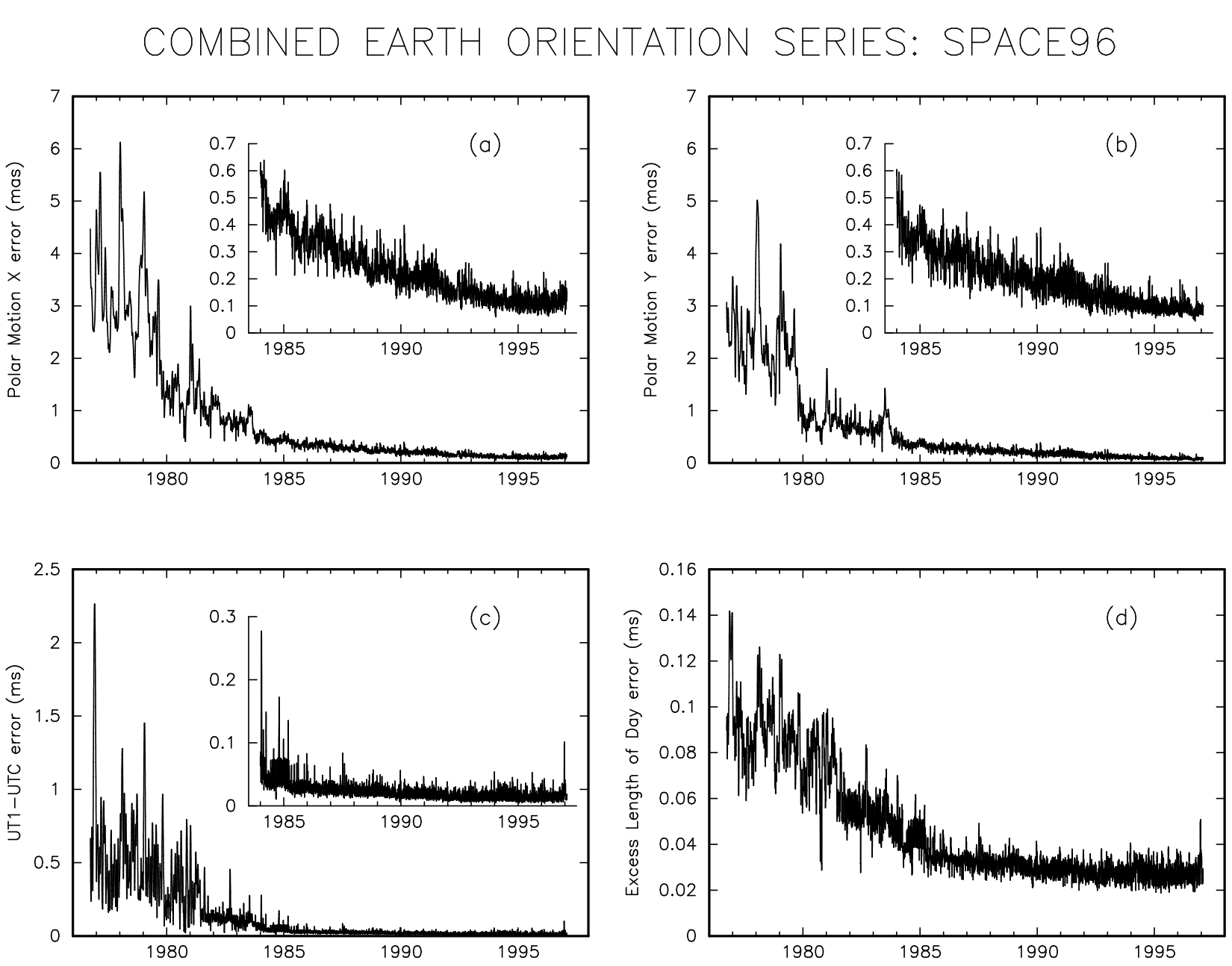
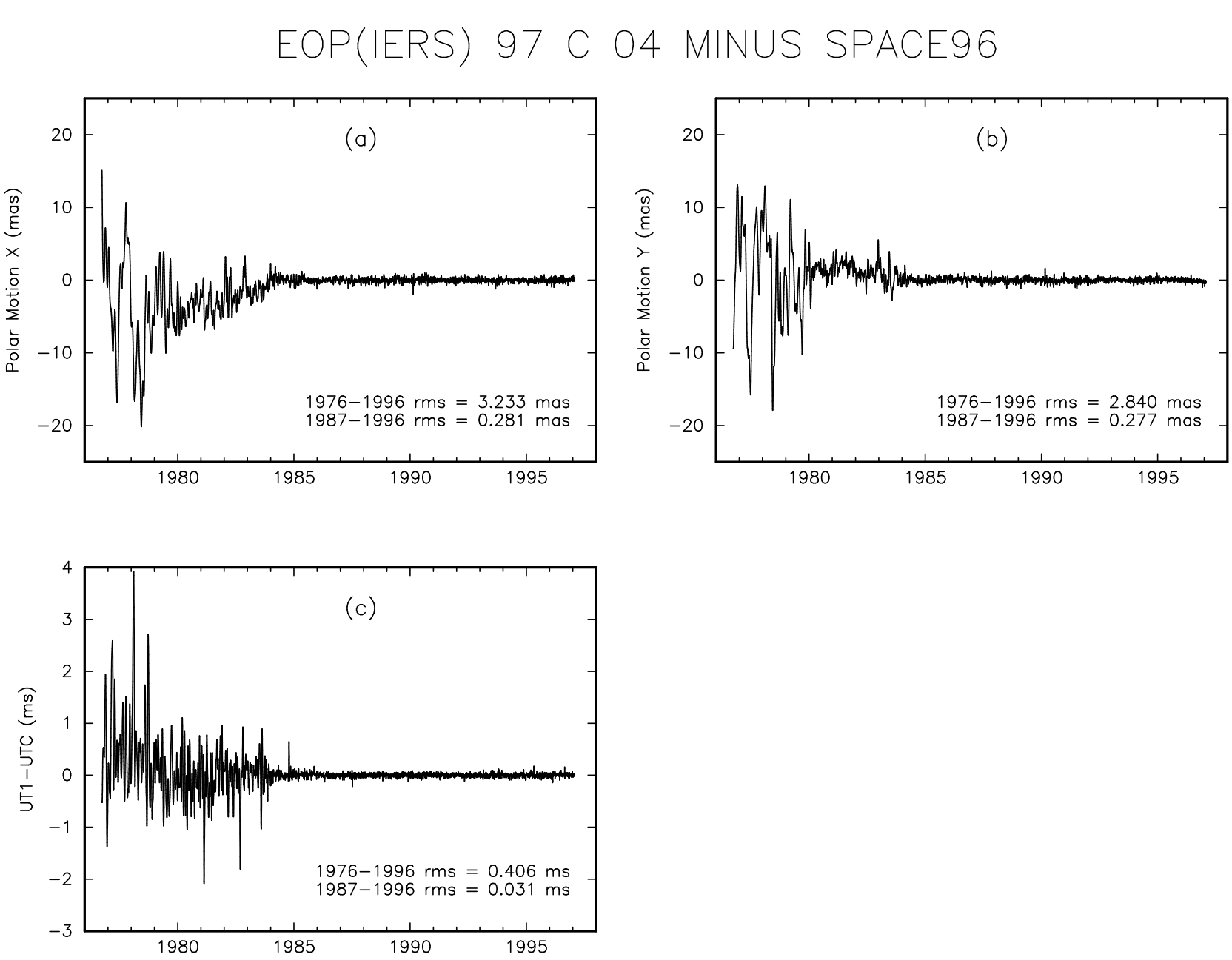
50458.000	-0.0533266	0.1059693	-0.1283603	0	0	0.0000746	0.0000967	0.0000287	0	0	0	0.0027	-0.0002	-0.0002	0	0	0
50459.000	-0.0562117	0.1071397	-0.1304272	0	0	0.0000743	0.0000796	0.0000253	0	0	0	0.0003	-0.0023	0.0017	0	0	0
50460.000	-0.0590361	0.1083565	-0.1326017	0	0	0.0000904	0.0000761	0.0000177	0	0	0	0.0097	-0.0809	0.0282	0	0	0
50461.000	-0.0616546	0.1096634	-0.1348062	0	0	0.0001495	0.0000891	0.0000236	0	0	0	0.0066	-0.0496	0.0151	0	0	0
50462.000	-0.0639989	0.1111015	-0.1370169	0	0	0.0001834	0.0000916	0.0000274	0	0	0	0.0013	-0.0058	0.0002	0	0	0
50463.000	-0.0661122	0.1127617	-0.1392110	0	0	0.0001925	0.0000963	0.0000352	0	0	0	-0.0039	0.0047	-0.0049	0	0	0
50464.000	-0.0680877	0.1146437	-0.1413328	0	0	0.0001783	0.0000866	0.0000237	0	0	0	-0.0040	0.0064	-0.0070	0	0	0
50465.000	-0.0700256	0.1166575	-0.1433385	0	0	0.0001676	0.0000695	0.0000099	0	0	0	0.0007	-0.0024	0.0002	0	0	0
50466.000	-0.0720566	0.1186733	-0.1451684	0	0	0.0001532	0.0000717	0.0000103	0	0	0	0.0043	-0.0348	0.0080	0	0	0
50467.000	-0.0743312	0.1206826	-0.1468194	0	0	0.0001346	0.0000829	0.0000099	0	0	0	0.0021	-0.0018	0.0004	0	0	0
50468.000	-0.0769295	0.1227532	-0.1483547	0	0	0.0001231	0.0000810	0.0000175	0	0	0	0.0001	0.0019	-0.0002	0	0	0
50469.000	-0.0797434	0.1248415	-0.1498013	0	0	0.0000996	0.0000890	0.0000105	0	0	0	-0.0043	-0.0001	-0.0002	0	0	0
50470.000	-0.0825169	0.1268696	-0.1512187	0	0	0.0000991	0.0001102	0.0000120	0	0	0	-0.0069	0.0038	0.0022	0	0	0
50471.000	-0.0851783	0.1287574	-0.1526687	0	0	0.0000985	0.0001100	0.0000183	0	0	0	-0.0084	0.0041	0.0023	0	0	0
50472.000	-0.0878441	0.1305560	-0.1541367	0	0	0.0000881	0.0001028	0.0000109	0	0	0	-0.0003	0.0001	0.0001	0	0	0
50473.000	-0.0906574	0.1323220	-0.1556223	0	0	0.0000970	0.0001016	0.0000102	0	0	0	0.0009	0.0000	0.0000	0	0	0
50474.000	-0.0936832	0.1340412	-0.1571365	0	0	0.0001153	0.0000937	0.0000094	0	0	0	0.0029	0.0000	0.0000	0	0	0
50475.000	-0.0967840	0.1358116	-0.1586943	0	0	0.0001475	0.0000850	0.0000168	0	0	0	0.0024	0.0000	0.0000	0	0	0
50476.000	-0.0998306	0.1376938	-0.1603377	0	0	0.0001653	0.0000756	0.0000105	0	0	0	0.0013	0.0000	0.0000	0	0	0
50477.000	-0.1028078	0.1395880	-0.1620104	0	0	0.0001660	0.0000746	0.0000148	0	0	0	-0.0006	0.0000	0.0000	0	0	0
50478.000	-0.1057231	0.1414381	-0.1636029	0	0	0.0001637	0.0000744	0.0000177	0	0	0	0.0007	0.0000	0.0000	0	0	0
50479.000	-0.1086139	0.1434542	-0.1651593	0	0	0.0001484	0.0000662	0.0000102	0	0	0	-0.0010	0.0000	0.0000	0	0	0
50480.000	-0.1115322	0.1456679	-0.1666617	0	0	0.0001258	0.0000716	0.0000116	0	0	0	-0.0017	0.0000	0.0000	0	0	0
50481.000	-0.1144556	0.1478780	-0.1680372	0	0	0.0001174	0.0000816	0.0000098	0	0	0	-0.0001	0.0000	0.0000	0	0	0
50482.000	-0.1172880	0.1500344	-0.1693282	0	0	0.0001268	0.0000684	0.0000168	0	0	0	0.0026	0.0000	0.0000	0	0	0
50483.000	-0.1199702	0.1522912	-0.1705886	0	0	0.0001399	0.0000731	0.0000109	0	0	0	-0.0018	0.0000	0.0000	0	0	0
50484.000	-0.1224708	0.1546974	-0.1718991	0	0	0.0001551	0.0000916	0.0000166	0	0	0	0.0010	0.0000	0.0000	0	0	0
50485.000	-0.1247500	0.1571103	-0.1733433	0	0	0.0001559	0.0000924	0.0000187	0	0	0	-0.0016	0.0000	0.0000	0	0	0
50486.000	-0.1267743	0.1594872	-0.1749582	0	0	0.0001384	0.0001016	0.0000115	0	0	0	-0.0018	0.0000	0.0000	0	0	0
50487.000	-0.1285962	0.1618867	-0.1767785	0	0	0.0001323	0.0000993	0.0000123	0	0	0	0.0003	0.0000	0.0000	0	0	0


COMBINED EARTH ORIENTATION SERIES: SPACE96
(a)
Polar Motion X (mas)
400
300
200
100
0
−100
−200
−300
1980
1985
1990
1995
(b)
Polar Motion Y (mas)
600
500
400
300
200
100
0
(c)
UT1−UTC (ms)
800
600
400
200
0
−200
−400
−600
−800
(d)
Excess Length of Day (ms)
3.5
3
2.5
2
1.5
1
0.5


COMBINED EARTH ORIENTATION SERIES: SPACE96
Polar Motion X error (mas)
(a)
Polar Motion Y error (mas)
(b)
UT1−UTC error (ms)
(c)
Excess Length of Day error (ms)
(d)
1980
1985
1990
1995


EOP(IERS) 97 C 04 MINUS SPACE96
(a)
Polar Motion X (mas)
1976–1996 rms = 3.233 mas
1987–1996 rms = 0.281 mas
(b)
Polar Motion Y (mas)
1976–1996 rms = 2.840 mas
1987–1996 rms = 0.277 mas
(c)
UT1–UTC (ms)
1976–1996 rms = 0.406 ms
1987–1996 rms = 0.031 ms
1980
1985
1990
1995