JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

FOS 93-028

5 AUGUST 1993

TO: TOM HAMILTON

FROM: BRUCE SHAPIRO

SUBJECT: TOPEX/POSEIDON REPEAT ORBIT AND REFERENCE GRID DEFINITION USING A JGM2 GRAVITY FIELD

REFERENCES: [1]*TOPEX/POSEIDON Project Mission Plan*, JPL D-6862, Rev C., August 1991.

[2]Shapiro, Bruce, *TOPEX/POSEIDON Repeat Orbit and Reference Grid Definition*, IOM No. 314.5-1642, June 22, 1992.

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The Mission Plan[1] characterizes the nature of the operational orbit and reference grid. For orbit maintenance, it was also necessary to precisely define the orbital elements and ground track grid so that maneuver targeting may be performed. This was done prior to launch with a precision orbit propagator utilizing all known physical perturbations in a 20×20 truncated GEM-T3 Earth geopotential gravity field, the model used during mission operations for orbit determination.[2] Polar motion and timing corrections were also taken into account. The earlier results have now been recalibrated utilizing a 20×20 truncated JGM2 gravity field.

Both the reference orbit (vector) and the reference grid have been recalibrated. Used together in DPTRAJ with a 20×20 truncated JGM2 geopotential gravity field, the ground track, measured at the ascending nodes, repeats to within 10 cm of equatorial longitude (after one full cycle). The JGM2 calibration was performed using all constants incorporated within the JGM2 model,

	GEM-T3 Constant	JGM2 Constant
μ_{Earth}	$3.986004\underline{360} \times 10^{14}$ m^3/s^2	$3.986004\underline{415} \times 10^{14}$ m^3/s^2
a_e	6378137.0 m	6378136.3 m
1/f	298.2570	298.2564

The ascending node crossing longitudes of the new reference grid differ from the ascending node crossing longitudes of the old reference grid by no more than 3×10^{-5}°(10^{-5}°≈1.11 meters), as

summarized in Table 1. In addition, both verification site overflights are matched to within 2 meters by both the new and the old reference orbits.

The orbital elements in true-of-date coordinates are

Epoch	State in a GEM T3 Gravity Field, 6/1/92 at 00:00:00 UTC[1]		State in a JGM2 Gravity Field, 7/1/93 at 00:00:00 UTC	
	Osculating	Mean	Osculating	Mean
a	7720.388088 km	7714.42938 km	7720.388136 km	7714.42942 km
e	0.000343	0.000095	0.000343	0.000095
i	66.05038°	66.040°	66.05037°	66.040°
ω	329.551696°	90.190°	329.55163°	90.189°
Ω	95.853364°	95.862°	125.188857°	125.197°
M	13.5615°	252.945°	13.5615°	252.945°

The reference grid is given in table 1. The osculating Keplerian elements and Cartesian state vectors in True of Date coordinates, J2000 coordinates, Greenwich non-rotating coordinates, and the corresponding mean elements were calculated with the computer program ROTV and are shown in table 2.

Effective 27 July 1993, at the transition between cycles 31 and 32, all operational orbit determination will be performed using the truncated 20×20 JGM2 gravity field. This change will be coordinated between JPL and FDF. The new model including all of its associated constants will be utilized to predict the orbit and evaluate the ground track. All subsequent bookkeeping and reporting of ground track offsets will use the new reference grid, and the recalibrated parameters defined here will be used to target the mission orbit. Maneuvers will be targeted to keep the osculating ground track within a 2-km wide swath, measured along the equator, centered on the new reference grid. This will ensure that mission ground track maintenance requirements continue to be met.

DISTRIBUTION

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Table 1. Reference Grid of Ascending Node Longitudes.

Pass	Rev	GEMT3 Longitude	JGM2 Longitude	Change $\times 10^{-5}$°	Pass	Rev	GEMT3 Longitude	JGM2 Longitude	Change $\times 10^{-5}$°	Pass	Rev	GEMT3 Longitude	JGM2 Longitude	Change $\times 10^{-5}$°
1	1	99.92489	99.92489	-	87	44	321.02736	321.02738	-2	173	87	182.12823	182.12825	-2
3	2	71.57764	71.57764	-	89	45	292.68102	292.68103	-1	175	88	153.78287	153.78289	-2
5	3	43.23054	43.23054	-	91	46	264.33357	264.33358	-1	177	89	125.43685	125.43687	-2
7	4	14.88442	14.88442	-	93	47	235.98621	235.98622	-1	179	90	97.09022	97.09023	-1
9	5	346.5387	346.5387	-	95	48	207.63949	207.63951	-2	181	91	68.74295	68.74297	-2
11	6	318.19278	318.19278	-	97	49	179.29373	179.29374	-1	183	92	40.39592	40.39594	-2
13	7	289.84632	289.84632	-	99	50	150.94837	150.94839	-2	185	93	12.04989	12.04991	-2
15	8	261.49885	261.49884	1	101	51	122.60224	122.60226	-2	187	94	343.70417	343.70418	-1
17	9	233.15154	233.15154	-	103	52	94.25557	94.25558	-1	189	95	315.35823	315.35825	-2
19	10	204.80491	204.80491	-	105	53	65.90829	65.90830	-1	191	96	287.01165	287.01167	-2
21	11	176.45923	176.45923	-	107	54	37.56135	37.56137	-2	193	97	258.66415	258.66417	-2
23	12	148.11386	148.11386	-	109	55	9.21539	9.21540	-1	195	98	230.31690	230.31692	-2
25	13	119.76763	119.76764	-1	111	56	340.86965	340.86967	-2	197	99	201.97036	201.97037	-1
27	14	91.42089	91.42089	-	113	57	312.52370	312.52372	-2	199	100	173.62475	173.62476	-1
29	15	63.0736	63.07361	-1	115	58	284.17698	284.17700	-2	201	101	145.27934	145.27936	-2
31	16	34.72676	34.72677	-1	117	59	255.82946	255.82948	-2	203	102	116.93303	116.93304	-1
33	17	6.38086	6.38087	-1	119	60	227.48227	227.48229	-2	205	103	88.58620	88.58621	-1
35	18	338.0351	338.0351	-	121	61	199.13582	199.13583	-1	207	104	60.23891	60.23892	-1
37	19	309.68912	309.68913	-1	123	62	170.79026	170.79028	-2	209	105	31.89217	31.89218	-1
39	20	281.34226	281.34227	-1	125	63	142.44480	142.44482	-2	211	106	3.54631	3.54632	-1
41	21	252.99474	252.99474	-	127	64	114.09840	114.09842	-2	213	107	335.20051	335.20053	-2
43	22*	224.64761	224.64761	-	129	65	85.75148	85.75150	-2	215	108	306.85450	306.85451	-1
45	23	196.30122	196.30 124	-2	131	66	57.40419	57.40421	-2	217	109	278.50750	278.50751	-1
47	24	167.95572	167.95573	-1	133	67	29.05756	29.05758	-2	219	110	250.15997	250.15998	-1
49	25	139.6102	139.61021	-1	135	68	0.71173	0.71175	-2	221	111†	221.81290	221.81291	-1
51	26	111.26374	111.26375	-1	137	69	332.36590	332.36592	-2	223	112	193.46660	193.46663	-3
53	27	82.91672	82.91673	-1	139	70	304.01984	304.01986	-2	225	113	165.12115	165.12116	-1
55	28	54.56944	54.56945	-1	141	71	275.67271	275.67273	-2	227	114	136.77554	136.77555	-1
57	29	26.22292	26.22293	-1	143	72	247.32520	247.32522	-2	229	115	108.42903	108.42904	-1
59	30	357.87712	357.87713	-1	145	73	218.97818	218.97820	-2	231	116	80.08192	80.08193	-1
61	31	329.53126	329.53127	-1	147	74	190.63201	190.63203	-2	233	117	51.73467	51.73467	-
63	32	301.18514	301.18515	-1	149	75	162.28657	162.28659	-2	235	118	23.38825	23.38826	-1
65	33	272.83791	272.83792	-1	151	76	133.94087	133.94089	-2	237	119	355.04248	355.04248	-
67	34	244.49041	244.49042	-1	153	77	105.59431	105.59433	-2	239	120	326.69659	326.69660	-1
69	35	216.14347	216.14348	-1	155	78	77.24714	77.24716	-2	241	121	298.35041	298.35042	-1
71	36	187.79740	187.79741	-1	157	79	48.89992	48.89994	-2	243	122	270.00309	270.00309	-
73	37	159.45199	159.45200	-1	159	80	20.55361	20.55363	-2	245	123	241.65563	241.65563	-
75	38	131.10618	131.10620	-2	161	81	352.20786	352.20788	-2	247	124	213.30875	213.30875	-
77	39	102.75960	102.75961	-1	163	82	323.86196	323.86198	-2	249	125	184.96279	184.96279	-
79	40	74.41239	74.41240	-1	165	83	295.51570	295.51572	-2	251	126	156.61741	156.61741	-
81	41	46.06522	46.06523	-1	167	84	267.16831	267.16833	-2	253	127	128.27150	128.27150	-
83	42	17.71900	17.71902	-2	169	85	238.82089	238.82091	-2	1	1	99.92489	99.92489	-
85	43	349.37327	349.37329	-2	171	86	210.47409	210.47411	-2					

* CNES Verification Site, descending pass, latitude 35.54649˚N, longitude 12.32054˚E.
† NASA Verification Site, ascending pass, latitude 34.4691˚N, longitude 120.68081˚W.

Table 2.
ROTV output showing mean elements, J2000, and GNR coordinates. A 20x20 truncation of JGM2 was used for the mean element conversion. Lunar and solar perturbations were turned off.

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-------------------------------------------------------------------------------
 State Vector              JGM2RPT9307.ROTV;2                        Page   2
-------------------------------------------------------------------------------
   UTC:  1-JUL-1993 00:00:00.0000         ET:  1-JUL-1993 00:01:00.1840 (TDT)
   ET(TDT)-UTC:   60.184000000358             UT1-UTC:   0.605650476101
   ET(TDT)-TAI:   32.184000000358 (Total)     TAI-UTC:  28.000000000000
   ET(TDT)-TAI:   32.184000000000 (DT58)      TAI-UT1:  27.394349523899
      Mean GSA:  279.057831855628            True GSA: 279.062076493490
-------------------------------------------------------------------------------
        TOD X    =  -3512.642405877243       A    =   7720.388136010975
 Osculating Y    =   6559.921459023658       E    =      0.000343000005
            Z    =  -2047.785525564620       I    =     66.050369718534
            VX   =     -3.484686090284       AOP  =    329.551633975720
            VY   =      0.096956567830       RAAN =    125.188857042277
            VZ   =      6.285824470262       M    =     13.561499859778
            U    =    343.122354244265       TA   =     13.570720268545
-------------------------------------------------------------------------------
        TOD X    =  -3511.924220927156       A    =   7714.429420024174
       Mean Y    =   6556.945986812570       E    =      0.000095192527
            Z    =  -2046.605222777231       I    =     66.039955219824
            VX   =     -3.485074047676       AOP  =     90.189183417824
            VY   =      0.094600081489       RAAN =    125.196997748712
            VZ   =      6.285848304213       M    =    252.945078084470
            U    =    343.123833307229       TA   =    252.934649889405
-------------------------------------------------------------------------------
      J2000 X    =  -3520.464416470537       A    =   7720.388136010975
 Osculating Y    =   6555.103155982931       E    =      0.000343000005
            Z    =  -2049.781619008593       I    =     66.021724931356
            VX   =     -3.488586499190       AOP  =    329.530821246961
            VY   =      0.092035517492       RAAN =    125.276392736844
            VZ   =      6.283734613747       M    =     13.561499859778
            U    =    343.101541515506       TA   =     13.570720268545
-------------------------------------------------------------------------------
      J2000 X    =  -3519.742833432471       A    =   7714.429420024175
       Mean Y    =   6552.128656986042       E    =      0.000095192527
            Z    =  -2048.600935813114       I    =     66.011313136140
            VX   =     -3.488971217893       AOP  =     90.168364536757
            VY   =      0.089678497499       RAAN =    125.284539393443
            VZ   =      6.283758175215       M    =    252.945078099421
            U    =    343.103014441122       TA   =    252.934649904365
-------------------------------------------------------------------------------
  GNR BODYP X    =  -7031.298736290623       A    =   7720.388136000000
 Osculating Y    =  -2435.579527400385       E    =      0.000343000003
            Z    =  -2047.789595042194       I    =     66.050323686797
            VX   =     -0.644601473956       AOP  =    329.551593181000
            VY   =     -3.425926432295       LAN  =    206.126797090000
            VZ   =      6.285820870422       M    =     13.561499905917
            U    =    343.122313495682       TA   =     13.570720314682
-------------------------------------------------------------------------------
  GNR BODYP X    =  -7028.067275421819       A    =   7714.429420024174
       Mean Y    =  -2435.861814565268       E    =      0.000095192527
            Z    =  -2046.605222777231       I    =     66.039955219824
            VX   =     -0.642080139128       AOP  =     90.189183417824
            VY   =     -3.426721959561       LAN  =    206.139166938165
            VZ   =      6.285848304213       M    =    252.945078084470
            U    =    343.123833307229       TA   =    252.934649889405
-------------------------------------------------------------------------------
 GTARG/OAMS X    =  -3510.686535717238       A    =   7714.427089550881
       Mean Y    =   6557.665426445692       E    =      0.000095192737
            Z    =  -2046.414811537351       I    =     66.027693272027
            VX   =     -3.486163630109       RAAN =    125.189343627200
            VY   =      0.094294898364       AOP  =     90.189056958850
            VZ   =      6.285249909805       M    =    252.945162978493
-------------------------------------------------------------------------------
 Exit ROTV 14-JUL-93 18:20:12
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