TOPEX/POSEIDON PROJECT SATELLITE/SENSORS PERFORMANCE CHARACTERISTICS WORKSHOP #11

ORBIT MAINTENANCE STATUS AND MANEUVER PERFORMANCE

Sara Schoenbaechler

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JPL

Raytheon

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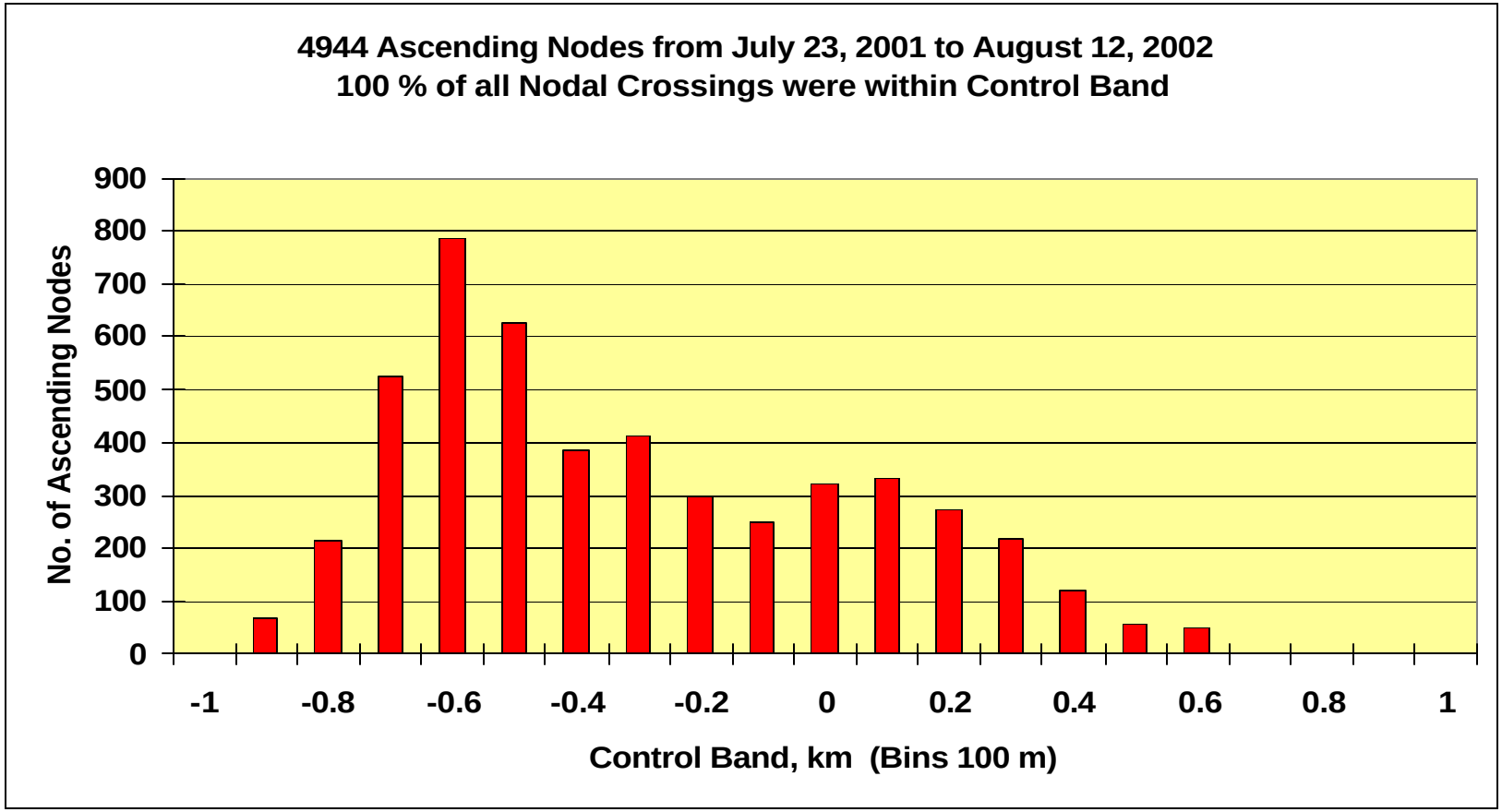
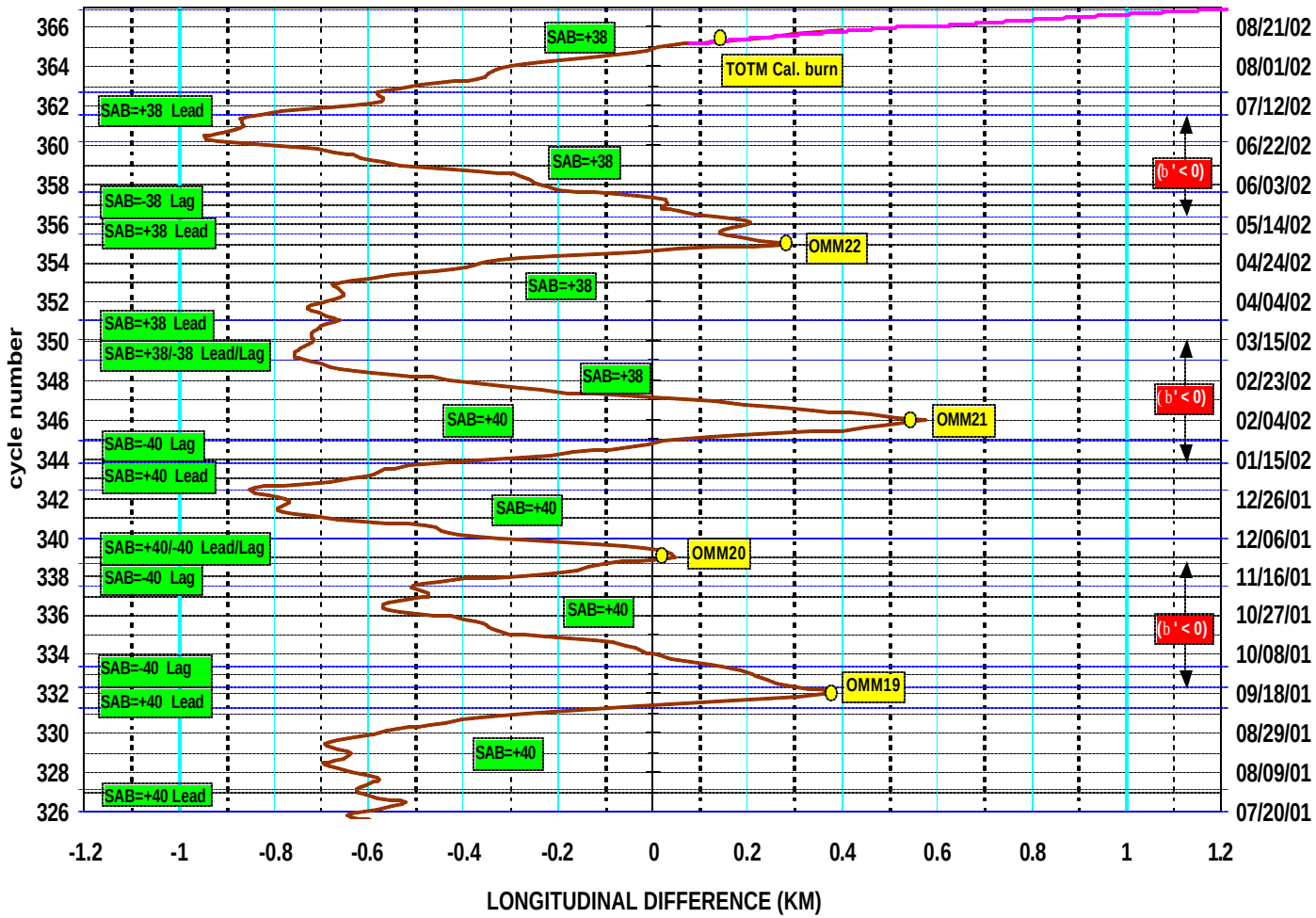
Ground Track Maintenance Requirements

- **95% of all equatorial crossings are contained within a 2-km longitude band at each orbit node**
- **95% of all verification site overflights are within 1-km about the site during initial verification phase**
- **Mean value of eccentricity is contained within .001**
- **Maneuver spacing be consistent with POD requirements**
- **Maintenance maneuvers executed over land**

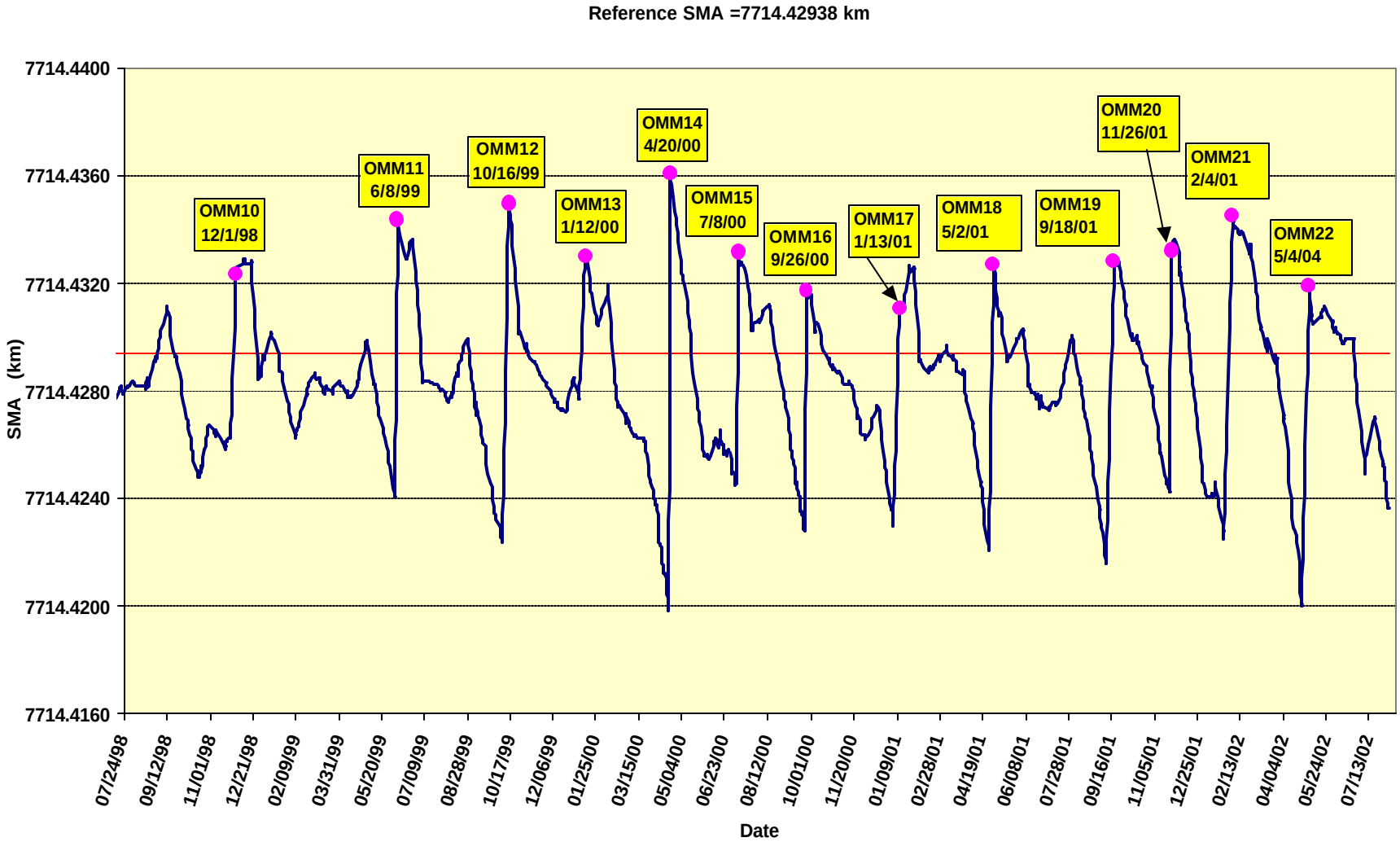
Ground Track Maintenance Statistics



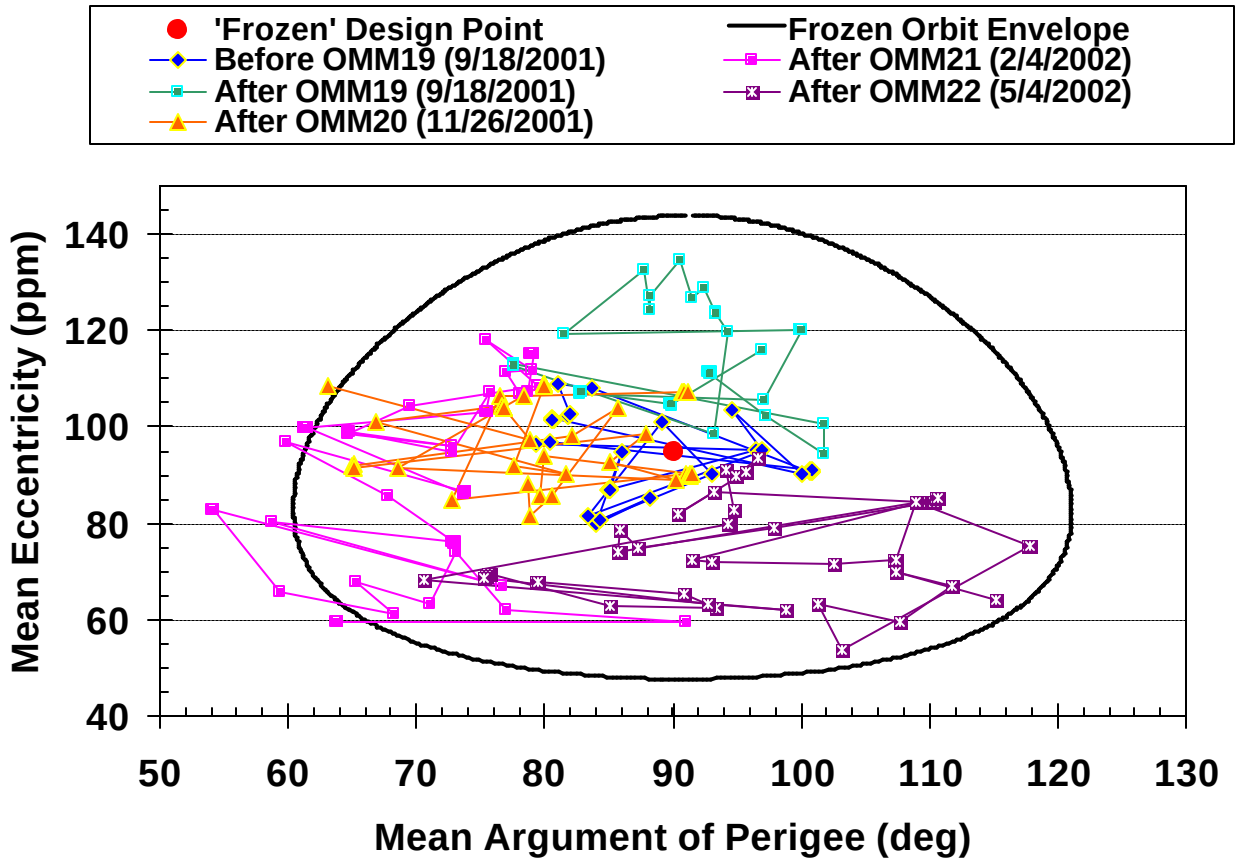
Ground Track Variations at Ascending Equator Crossings



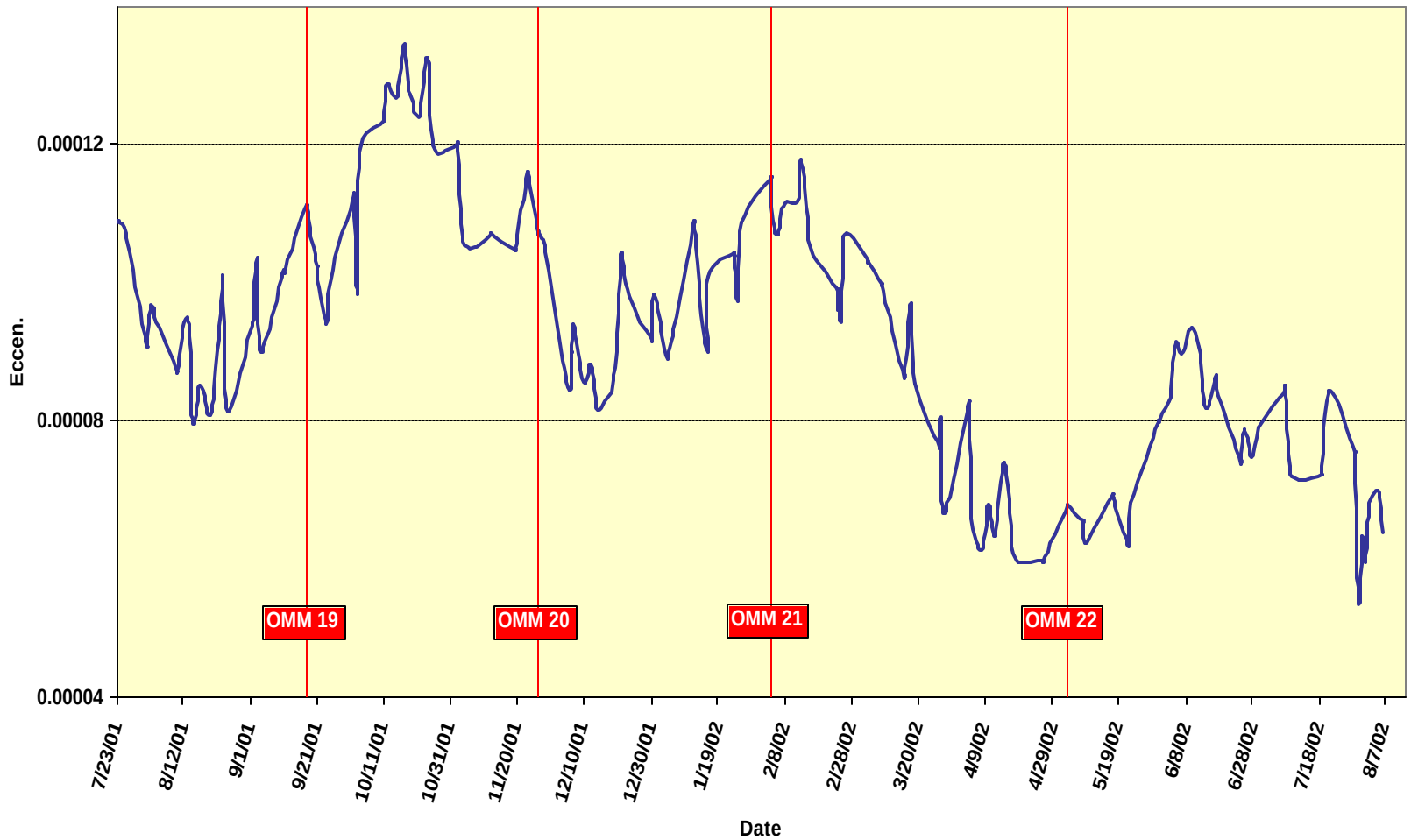
Mean Semi-major Axis History



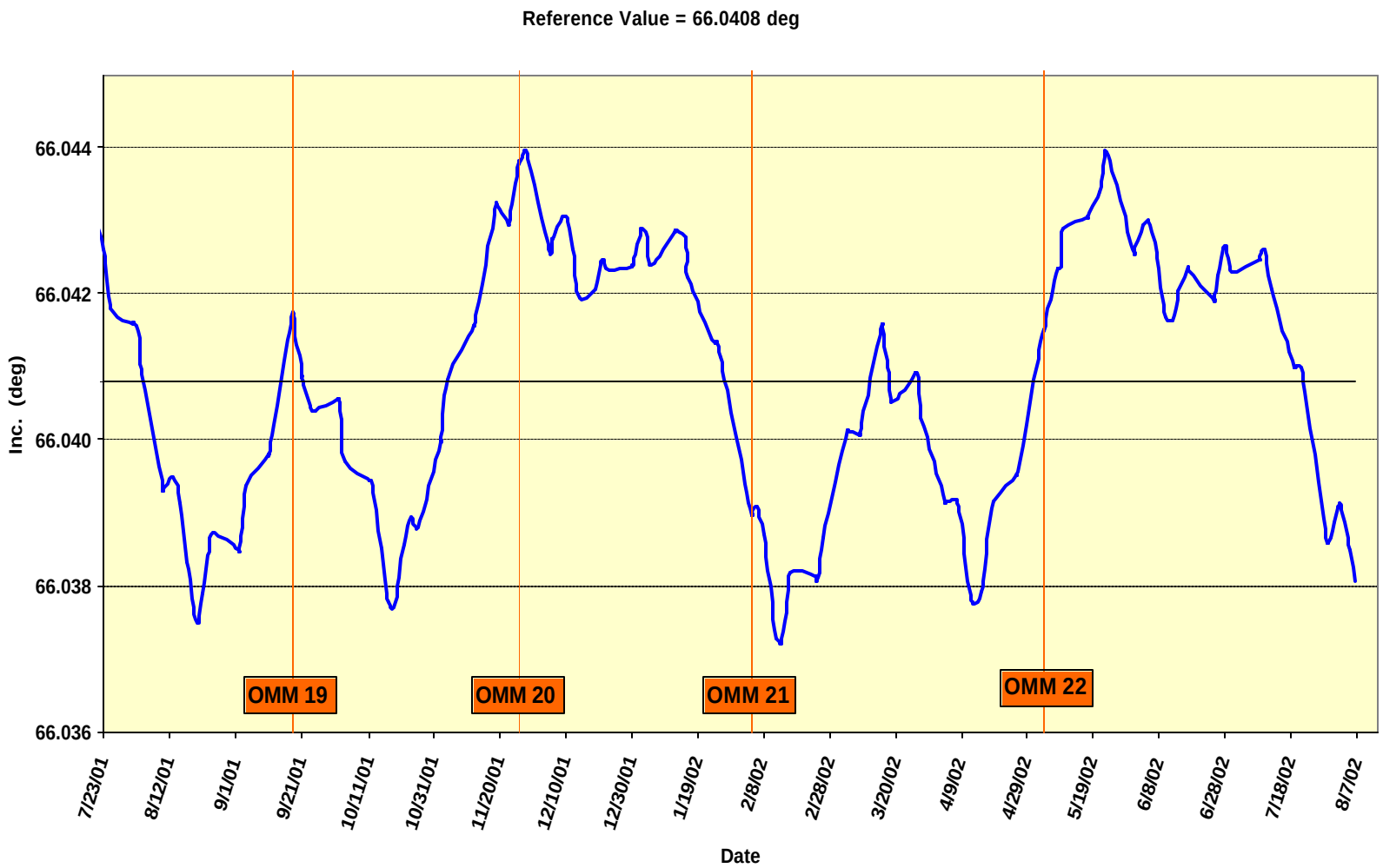
Mean Eccentricity Vector



Mean Orbit Eccentricity



Mean Orbit Inclination



Verification Site Overflight Maintenance

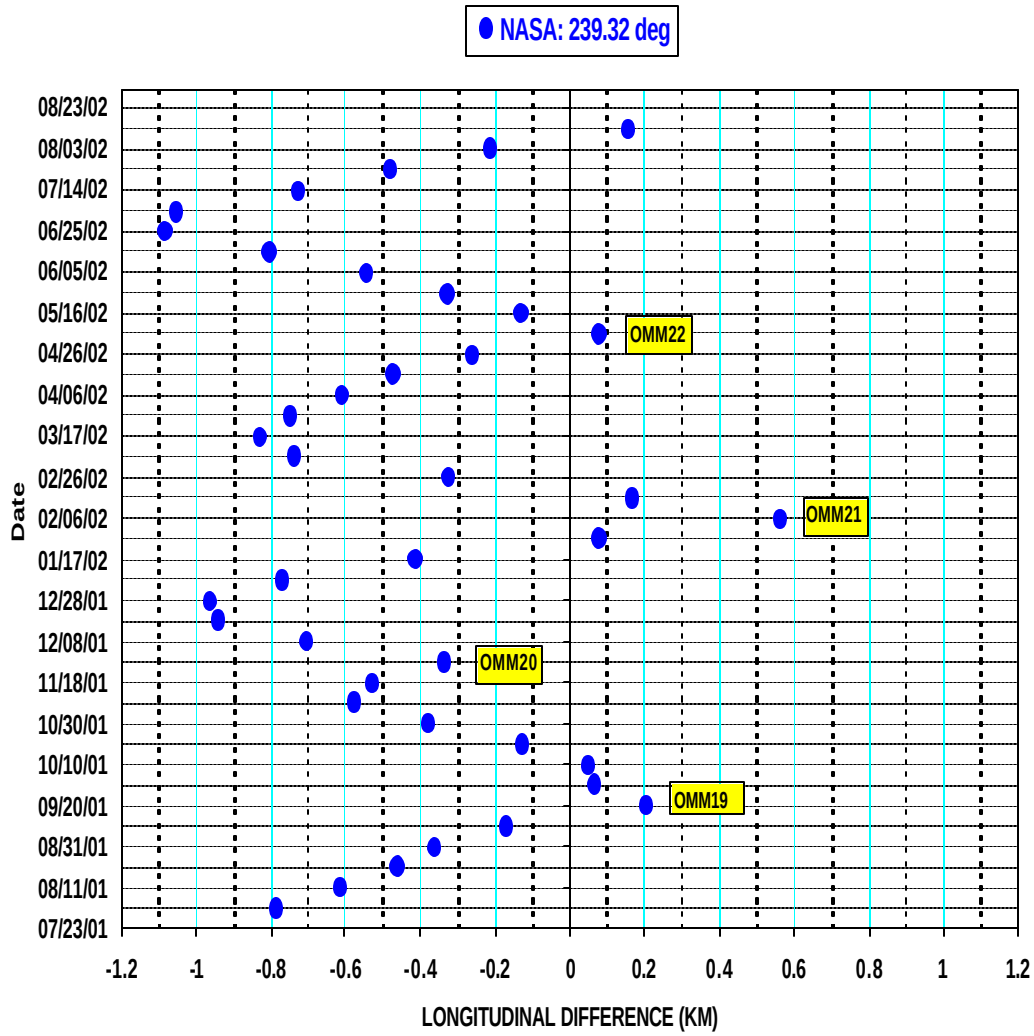
- **Aimed to maintain verification site overflights within the control band of +/- 1 km about the NASA site at 239.32^{o} longitude**

- **There were two violations of the control band during site overflights:**

  - June 24, 2002, 80 meters west of the control band

  - July 4, 2002, 49 meters west of the control band

Verification Site Overflights



Lead/Lag Strategy

- **Full and partial lead/lag strategies during fixed yaw periods continue to be used to maintain ground track within control boundaries and to maximize maneuver spacing**
- **Fixed yaw periods: $-30^o < \beta' < 0^o$ (flying backward, $\gamma = 180^o$)**

  $0^o < \beta' < 30^o$ (flying forward, $\gamma = 0^o$)
- **Continue dual solar array pitch bias (SAB) strategy to accommodate battery management concerns**

  SAB = +40º changed to +38º from February 23, 2002 (SA in lead position)

  SAB = -40º changed to -38º from February 23, 2002 (SA in lag position)
- **Creating boost strategy:**

  SA lead + $\gamma = 0^o$ ($0^o < \beta' < 30^o$)

  SA lag + $\gamma = 180^o$ ($-30^o < \beta' < 0^o$)
- **Creating decay strategy:**

  SA lead + $\gamma = 180^o$ ($-30^o < \beta' < 0^o$)

  SA lag + $\gamma = 0^o$ ($0^o < \beta' < 30^o$) First implemented December 5-6, 2001

Other Factors

- **Solar activity has increased since last year and has been in the moderate to active level, resulting a "double peaked" solar maximum cycle. Solar activity is now beginning to subside and return to low levels.**
- **Drag forces are the dominant forces reducing the influence of lead/lag strategies.**
- **OMM19 and OMM20 were executed during periods of fixed yaw, flying forward to simplify maneuver design and to eliminate large yaw turns. OMM21 and OMM22 were executed during yaw steering.**

Summary of Orbit Maintenance Maneuvers

MANEUVER	DATE	CENTROID TIME (UTC)	ORBIT NUMBER	CYCLE BOUNDARY	MANEUVER SPACING (days)	ACHIEVED DELTA-V (mm/s)
OMM 1	10/12/1992	23:12:00	807	2/3		9.431
OMM 2	12/21/1992	9:03:00	1696	9/10	70	3.153
OMM 3	3/30/1993	12:44:00	2966	19/20	99	4.617
OMM 4	8/6/1993	10:01:00	4617	32/33	129	4.611
OMM 5	1/31/1994	20:50:30	6902	50/51	178	4.116
OMM 6	5/20/1994	23:52:00	8300	61/62	109	3.123
OMM 7	10/6/1994	18:13:00	10077	75/76	139	3.146
OMM 8	5/22/1995	22:03:00	13000	98/99	226	3.832
OMM 9	1/15/1996	19:10:41	16046	122/123	238	3.652
OMM 10	12/1/1998	20:36:40	29508	228/229	1051	2.877
OMM 11	6/8/1999	07:11:00	31922	247/248	189	5.021
OMM 12	10/16/1999	19:18:00	33594	260/261	130	5.878
OMM 13	1/12/2000	10:39:00	34716	269/270	88	3.054
OMM 14	4/20/2000	15:56:00	35987	279/280	99	6.600
OMM 15	7/08/2000	23:09:00	37003	287/288	79	3.389
OMM 16	9/26/2000	06:00:00	38018	295/296	80	4.633
OMM 17	1/13/2001	07:44:00	39415	306/307	109	4.558
OMM 18	5/02/2001	10:38:00	40813	317/318	109	5.661
OMM 19	9/18/2001	05:07:00	42590	331/332	139	5.000
OMM 20	11/26/2001	14:57:00	43479	338/339	69	4.460
OMM 21	2/4/2002	00:43:00	44368	345/346	70	6.100
OMM 22	5/4/2002	06:55:00	45511	354/355	89	6.400

Maneuver Performance

MANEUVER	DATE	IDEAL DELTA-V (mm/s)	ACHIEVED DELTA-V NAVT	ACHIEVED DELTA-V FDF	% DIFFERENCE (Achieved-Ideal)
OMM 1	10/12/1992	9.10	9.431	9.425	+3.64
OMM 2	12/21/1992	3.20	3.153	3.151	-1.47
OMM 3	3/30/1993	4.676	4.617	4.610	-1.26
OMM 4	8/6/1993	4.62	4.611	4.611	-0.20
OMM 5	1/31/1994	4.00	4.116	4.102	+2.90
OMM 6	5/20/1994	3.15	3.123	3.123	-0.78
OMM 7	10/6/1994	3.15	3.146	3.162	-0.21
OMM 8	5/22/1995	3.86	3.832	3.832	-0.78
OMM 9	1/15/1996	2.50	3.652	N.A.	+46.0
OMM 10	12/1/1998	3.10	2.877	2.935	-7.19
OMM 11	6/8/1999	5.20	5.021	5.014	-3.50
OMM 12	10/16/1999	5.70	5.878	6.063	+3.12
OMM 13	1/12/2000	3.20	3.054	3.036	-4.56
OMM 14	4/20/2000	6.80	6.600	6.740	-2.90
OMM 15	07/08/2000	3.40	3.389	3.506	-0.32
OMM 16	09/26/2000	4.50	4.633	4.552	+2.89
OMM 17	01/13/2001	4.50	4.558	4.479	+1.11
OMM 18	05/02/2001	5.80	5.661	5.389	-2.40
OMM 19	9/18/2001	5.30	5.000	5.400	-5.66
OMM 20	11/26/2001	4.20	4.460	4.380	+6.19
OMM 21	2/4/2002	6.10	6.100	6.250	0.00
OMM 22	5/4/2002	6.40	6.400	6.250	0.00

Conclusions

- **Ground track and orbit maintenance status within mission requirements.**
- **Verification site overflight requirements continue to be met.**
- **Lead/lag strategies continue to be used to maintain ground track within required control band.**
- **OMM19, OMM20, OMM21 and OMM22 have been successfully executed since Workshop #10. The average maneuver spacing is two and a half to three months due to higher solar activity.**
- **TOPEX Orbit Transfer Maneuvers (TOTM) are currently underway and TOPEX should achieve its new orbit in mid September 2002.**
- **Next OMM expected in November 2002.**