EVALUATION OF GEOSAT FOLLOW-ON PRECISE ORBIT EPHEMERIS

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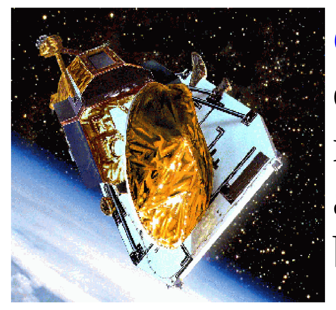
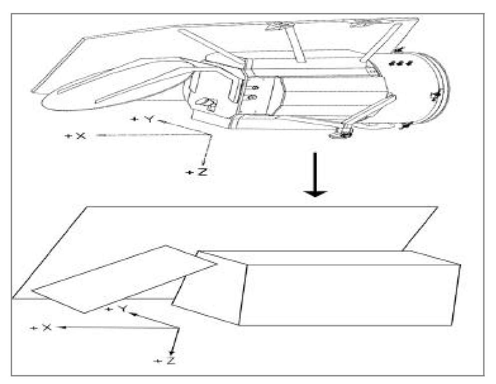


GFO data promises Poseidon-level accuracy with orbit the dominant error source. Given the sparse nature of SLR tracking and lower (800 km) altitude, achieving 5-cm SLR-based orbits are challenging, but possible.

Gravity and Macromodel tuned using SLR, Doppler, and altimeter crossover data

Macromodel surface force approximation



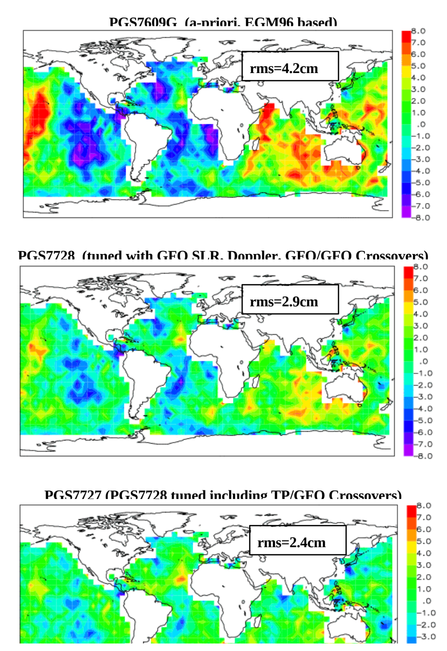
Acceleration due to radiation pressure on a flat plate:

$$\Gamma = -\frac{\Phi A \cos q}{Mc}\left[2(d/3 + r\cos q)\mathbf{n} + (1-r)\mathbf{s}\right]$$

where
- Γ = acceleration (m/s²)
- Φ = radiation flux from source
- *A* = surface area of flat plate (m²) *
- θ = incidence angle (surface normal to source)
- M = satellite mass (m)
- *c* = speed of light (m/s)
- *d* = diffuse reflectivity *
- *r* = specular reflectivity *
- **n** = surface normal unit vector
- **s** = source incidence unit vector

* are the adjustable macro model parameters

TP-GFO crossovers show geographically correlated GFO orbit error



Gravity Field Tests

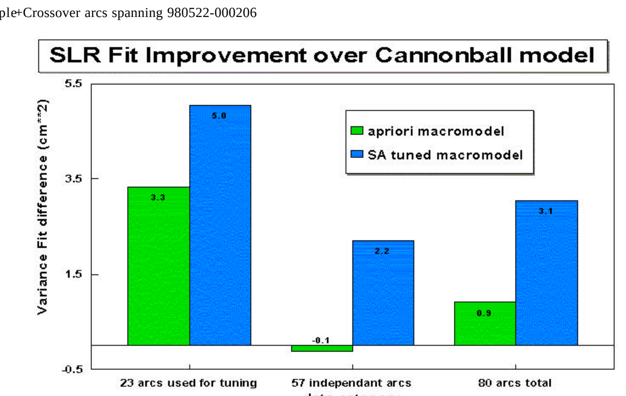
gravity field	radial orbit error projected from 70x70 gravity covariance (cm)	data RMS (cm) combined results over five 10-day arcs: TP crossover	TP/GFO crossover	GFO crossover	GFO SLR
JGM3	4.97	6.17	8.45	8.51	7.42
EGM96	2.61	6.14	7.71	8.27	6.97
PGS7609G [1]	2.61	6.16	7.74	8.26	6.75
PGS7728 [2]	1.66	6.14	7.17	7.68	5.64
PGS7727 [3]	1.31	6.13	7.02	7.59	5.53

1 PGS7609G = EGM96 + TDRSS tracking of GRO, XTE, TRMM, ERBS
2 PGS7727 = PGS7609G + GFO SLR/Doppler, GFO/GFO crossover
3 PGS7727 = PGS7609G + GFO SLR/Doppler, GFO/GFO crossover, TOPEX/GFO crosso

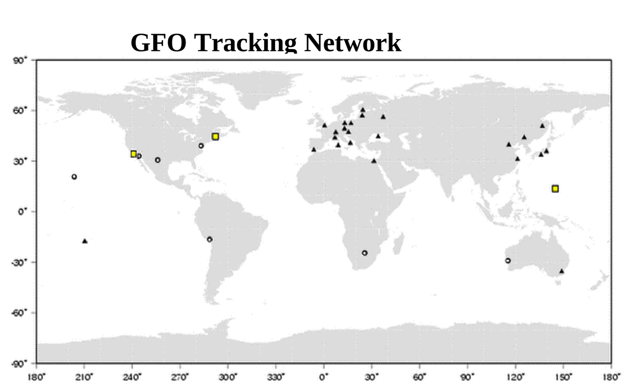
GFO Macro model Tuning

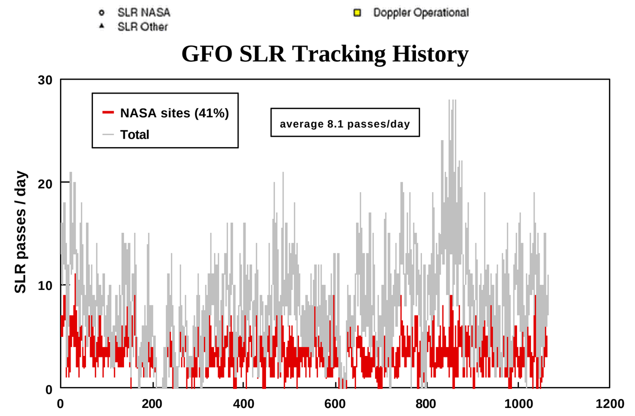
Spacecraft Surface Model	Solar Array (SA) Reflectivity Coefficient	SLR Fits Over 32 Dependant Arcs (cm)	SLR Fits Over 57 Independent Arcs (cm)	SLR Fits Over 80 Arcs Total[2] (cm)
Cannonball	----	13.23	12.88	12.99
A-priori macro model	.160	13.11	12.89	12.95
Tuned SA macro model [1]	.144	13.04	12.80	12.87

[1] Tuned using 23 SLR+Doppler and 8 SLR+Dopple+Crossover arcs spanning 980522-000206
[2] 80 consecutive arcs spanning 980422-990603

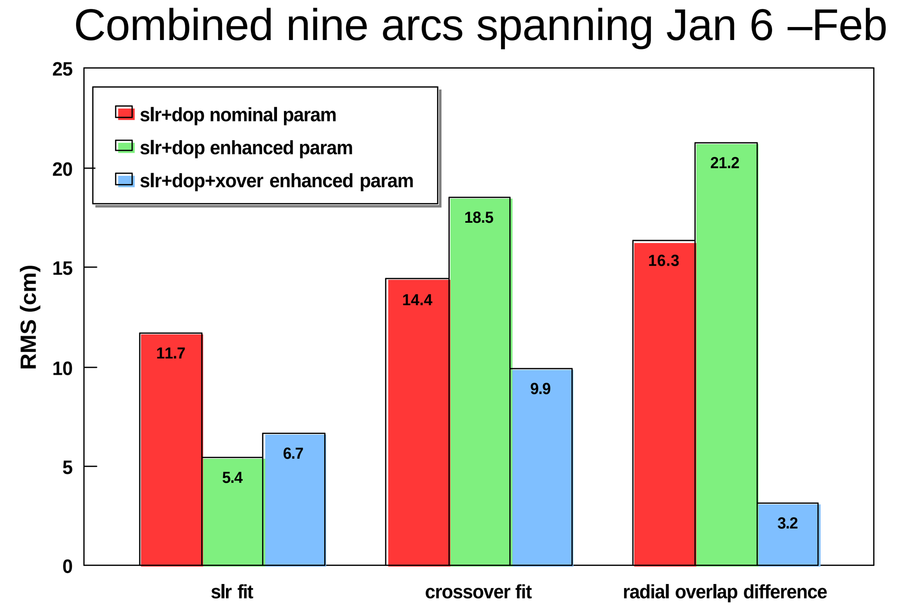


SLR and Altimeter crossover data are vital for GFO POD Accuracy





GFO Orbit Solution Strategies
nominal: 1drag/day, 1cpr/5day; enhanced: 3drag/day, 1cpr/1day
Combined nine arcs spanning Jan 6 –Feb 13 2000

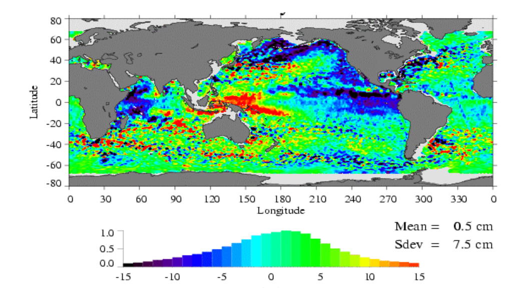


GFO POE orbit solutions use enhanced parameterization

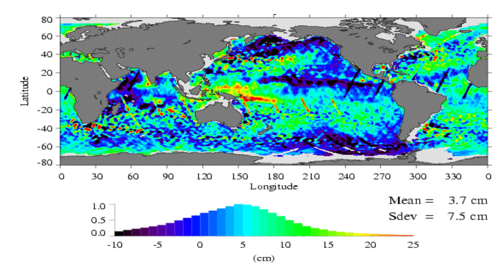
Adjust GFO data to TOPEX frame

T/P-GFO altimeter crossover data is used to adjust GFO to the T/P frame removing GFO instrumental and POE orbit effects

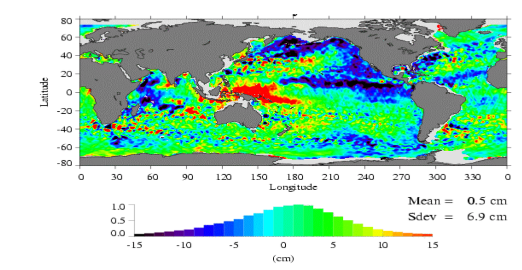
TOPEX SSH anomaly wrt GSFC MSS
January 2001



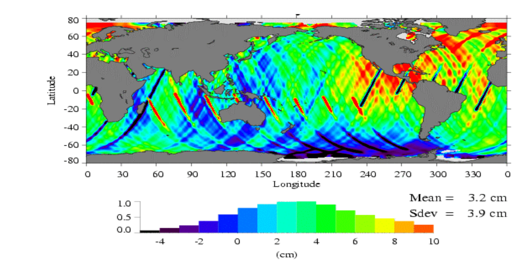
GFO SSH anomaly wrt GSFC MSS
January 2001



GFO SSH anomaly wrt GSFC MSS adjusted using TP-GFO crossovers
January 2001

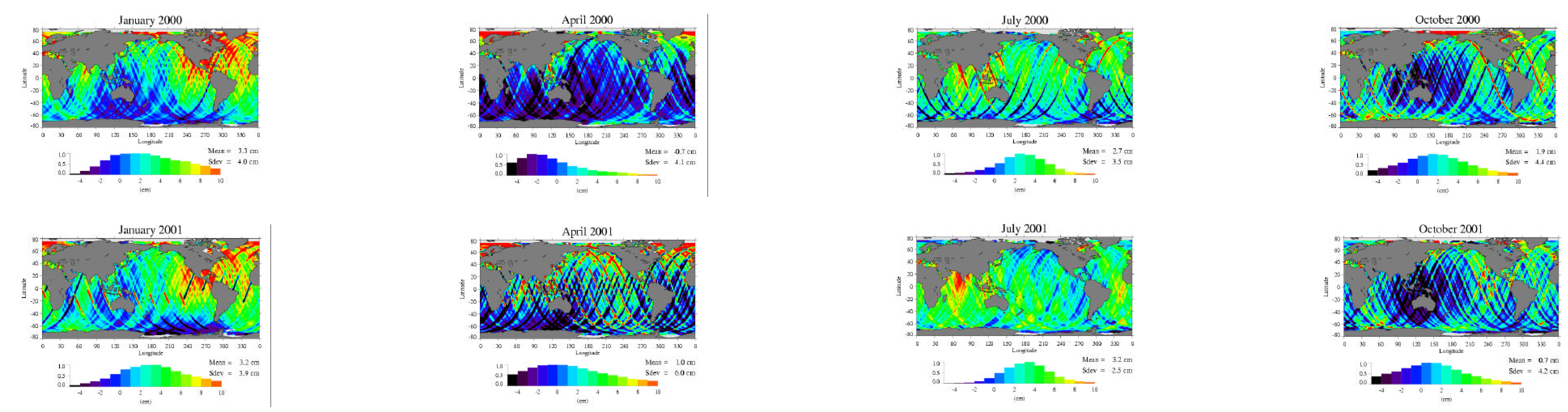


GFO Correction
January 2001



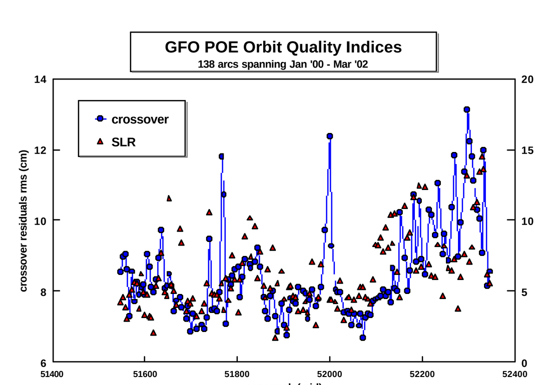
4-5 cm orbit error relative to T/P

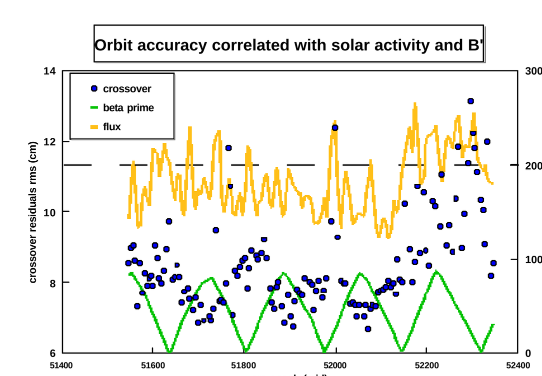
Standard deviation of the "GFO Correction"is largely GFO orbit error wrt T/P, showing 4-5 cm over two years. Seasonal variation suggest GFO environmentally-related corrections, such as sea state, may be in error.



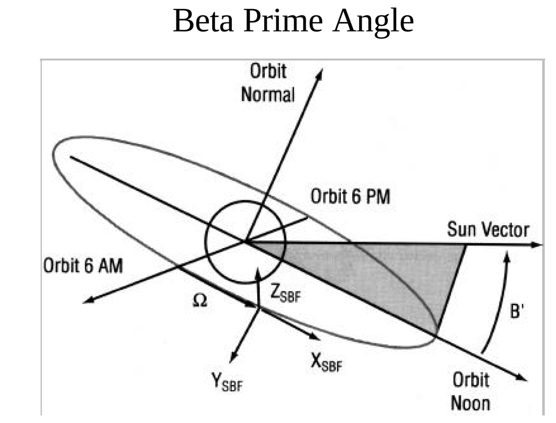
Recent orbit accuracy has degraded but can be improved using Reduced-Dynamic

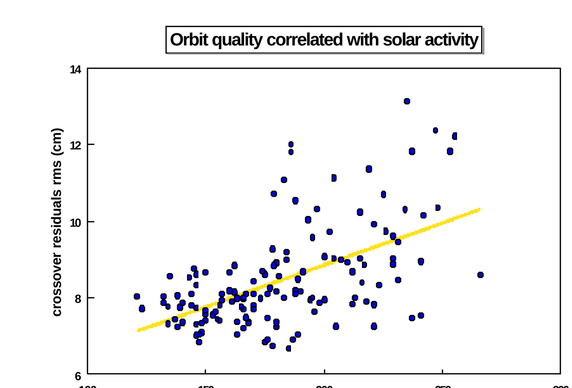
GFO radial orbit error, estimated at 5-cm, has been increasing due to the recent, extremely high solar activity affecting atmospheric drag. The correlation with B' is due to non-conservative force model error including drag.





Beta Prime Angle





Reduced-Dynamic approach can keep orbit error to 5-cm or better

Reduced-Dynamic exponential adjustment constraint between acceleration parameters of a time series

$$W_{jk} = \left(e/s^2\right)e^{-\left(\left|T_j - T_k\right|/t\right)}$$

where
- W_{jk} = weight for constraint equation between two parameters, one at time T_j and the other at T_k
- σ = parameter sigma or process noise (user input)
- τ = correlation time (user input)
- *e* = Euler's number