Pre-GRACE era recovery of time-varying DORIS-based mass concentration parameters for TOPEX/Poseidon precise orbit determination

J. Moyard, F. Mercier, A. Couhert from CNES POD Team

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CONTEXT OF THE STUDY

CNES will reprocess TOPEX/Poseidon (T/P) orbits in the POE-F standards this summer.
The POE-F standards include the last RL04 version of CNES/GRGS mean TVG model, based on GRACE data:

Could the use of concentrated mass (mascons) improve T/P orbits POE-F DORIS-only performance?
Improvements are assessed on the radial orbit component, not a ‘geodetic’ approach.
MASCONS TOPOLOGY

MASCONS LEGOS/GRGS

MASCONS ZOOM

7 regions with strong annual signals and/or linear trends
MASCONS CONSTRUCTION

MESH with latitude step 10° points $m_j$

$\min(\text{distance}(p_i, m_j))$ defines set of $d_k$ points $\rightarrow$ barycenters with associated surfaces

MASCONS LEGOS/GRGS points $p_i$
METHODOLOGY

POE-E ORBIT DETERMINATION with static GRGS gravity field

Mascons introduction using POE-E dynamic at convergence (one more iteration)

Stack normal equations on all available missions (period 3 months)

Stack mascons by region
Constant surfacic mass

FILTERING STEP

7 MASCONS models ready to be used!
The orbit determination process uses only DORIS measurements
Several missions → different altitudes, repeat periods, number of revolutions within a cycle, …
TOPEX period: stacking process starts with only 2 missions and uses 5 missions at the end
Equivalent covariance for all:

Greenland, Golf of Alaska, West Antarctica tend to ‘loose mass’
East Antarctica tend to ‘gain mass’
Amazonas has a significant annual amplitude

Some periods with strange observations, need to be improved
ADJUSTED MASCONS, FILTERING STEP

Filtering step, possible to:
- constrain drift/amplitude signal
- remove outliers

Need to constraint the drift for Greenland and Arctic Islands?
ORBITS PERFORMANCE
GEOGRAPHICALLY CORRELATED ERRORS

Patchs East – West
drift 0.5mm/year  annual amplitude 2.5mm
Sub-millimetric improvement for SLR RMS all stations / Core network
A bit more significative improvement for Core Network + high elevation (e>70°)

Core Network specific for T/P and period 1992 → 2002:
7090 7105 7110 7124 7210 7836 7838 7839 7849 7918
Patch East, improvement 3mm for 7090 (core network)
Patch West, improvement for 7124 (core network) and 7097 but degradation for 7403
Mean difference of crossover variances, improvement of 4.75mm²
And for period before march 2002, improvement of 7.9mm²
CONCLUSION

The adjusted mascons improve slightly the orbit performance. Submillimetric improvements in global SLR RMS and mean improvement of 4.75mm² on crossover variances.

The adjusted mascons still show some ‘too noisy’ periods. Need to improve SPOT orbits performance or to introduce complementary SLR missions like LAGEOS. The filtering process helps to workaround

The orbit determination process was based here on the GDR-E standards with a static gravity field: effects should be less important when using a mean gravity field model including TVG?

Next evaluation with up to date GRGS mean gravity field arriving soon for the POE-F reprocessing