EOT08a – Empirical Ocean Tide Analysis for Improving GRACE de-aliasing

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Introduction

• In open ocean global tide models are accurate up to a few cm, exhibit, however significant errors in shallow water.
• EOT08a (Empirical Ocean Tide Model obtained from altimeter data) is a new global ocean tide model, developed by empirical analysis of altimetry data. Correlation problems, due to alias effects, are minimized by combining data of different altimeter missions.
• EOT08a was validated by altimetric time series at crossover points, by comparison with tide gauge data, and by analyzing GRACE data.

Development and Validation of EOT08a

1. Preprocessing of multi-mission-altimeter data
   - Homogenisierung (ellipsoid, time scale, FES2004, DAC)
   - updates (e.g. satellite orbits, radiometer correction)
   - relative cross-calibration by crossover analysis

2. Least squares harmonic analysis (w.r.t. FES2004) on a 15°×15° grid
   - mean, trend, and annual semi-annual variations
   - diurnal tides: O1, K1, P1 und K1
   - semi-diurnal tides: M2, S2, N2, K2 und 2N2
   - non-linear tide: M4

3. Interpolation to FES2004 grid (7.5°×7.5°) and addition of the reference model FES2004
   - at high latitudes (|φ| > 62°) transition from EOT08a to FES2004

4. Validation by
   - time series of bottom pressure gages
   - time series of sea surface heights at crossover points
   - tidal constants from external sources
   - analysis of GRACE data and monthly GRACE solutions

Results:

- The global ocean tide model EOT08a was derived by empirical analysis of multi-mission altimeter data
- In shallow-water and shelf areas the improvements against the reference model exceed 10-15 cm.
- In deep ocean large scale pattern with residual amplitudes of 1-2 cm were identified.
- ftp://ftp.dgfi.badw.de/pub/EOT08a

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Fig. 1: Residual amplitudes for M2, S2 and O1 constituents

Fig. 2: Residual amplitudes for the North-West-European shelf and in the Yellow Sea

Fig. 3: Residual amplitudes of S2 from altimetry (left) and harmonic analysis of GRACE monthly solutions (right) show high affinity. Note, GRACE senses also hydrological mass variations over land.

Fig. 4: Correlation between S2 and the mean. In general, correlation at high latitude are larger (no T/P and Jason data). The mean correlation between all parameters (tides, mean, etc.) remain < 0.3.

Fig. 5: Percentage reduction in RMS of equivalent water heights (ocean areas only) if FES2004 is replaced by EOT08a for the monthly GRACE solutions, generated by IGG, Bonn (Mayer-Gürr).

Fig. 6: Tide gauges with tidal constants

Fig. 7: Reduction of variances (%) for time series at ERS-2 crossover points (left) and bottom pressure gages (right) for the North-West-European shelf.