FES 2014: a new global tidal model

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Introduction

• Accuracy of tidal models has been much improved these last 20 years, but errors remain in shallow waters and high latitudes
• Still need to improve tide correction for all altimeter missions, particularly for future SWOT mission and HR altimeters

• In 2012, we have developed a new high resolution tidal model on global ocean
  – FES2012 results are good in shallow waters + coastal regions although TG has been assimilated (cf Stammer et al. 2014)

  – But altimeter crossover variance is raised in some places

• => New release FES2014 has been performed in order to improve FES2012 results in deep ocean, at high latitudes and in shallow/coastal regions
• FES2014 benefits from:
  – Better hydrodynamic modeling including better bathymetry and refined mesh

FES2014
• 1 464 500 triangles
• 2 981 213 elevation nodes
• 4 393 500 velocity nodes

• In situ data, nautical charts, adding SRTM elevation
• Merging with global database
FES2014 hydrodynamic configuration

**FES2012 hydro**
M2 RMS (TP/J1/J2 xovers)
Deep ocean 2,5 cm
Shelf seas 9,3 cm

**FES2014 hydro**
M2 RMS (TP/J1/J2 xovers)
Deep ocean 1,2 cm
Shelf seas 5,37 cm
Assimilation: altimetry database

- 20 years time series for TP/J1/J2 nominal track => most of the alias issues have vanished
- 6y of T/P-J1 interleaved mission and 17y of ERS-EN missions => still some aliasing issues
- Reprocessed DUACS DT multimissions datasets have been used
  - Most recent L2 standards (DAC based on ERA-interim, GDR-D orbits)
  - Revisited L3 standards (editing, multimissions cross-calibration correction for ERS-EN missions)
    - **GOT4.8ac** tidal loading effects are used (including tidal geocenter correction, R. Ray)
- Harmonic analysis has been improved
  - **To take into account the effect of seasonal ice cover** => strong improvement at HL
  - Use GLORYS2-V1 to remove non tidal annual & semi-annual contaminations (TPNJ1N, ERSEN)
  - Improved along-track filtering to remove internal tide signatures
Assimilation

• Spectral data assimilation code (SpEnOI)
  • Ensemble method within representers approach: perturbations on bathymetry, friction coefficient, wave drag coefficient, minimum bathymetry value, loading effects (=> ~900 members)

• Altimetry and TG data
  • 12,622 assimilated points for M2, included 600 TG
Spectral validation

- Deep, Shallow, Coastal TG databases used in Stammer et al. paper (2014)

Spectral validation - TG

Vector difference (cm) - Tide gauge database - M2 wave

- FES2004 (1)
- GOT4.8 (2)
- DTU10 (3)
- TPX08 (4)
- EOT11a (5)
- FES2012 (6)
- FES2014 (7)
- FES2014 hydro (8)
Spectral validation - altimetry

Vector difference (cm) - CTOH altimetry database - M2 wave

- FES2004
- GOT4.8
- DTU10
- TPXO8
- EOT11a
- FES2012
- FES2014

Regions: NEA, MED, Maine, Gulf of Mexico, Amazone, Patagonia, Drake, West Africa, South Africa, Kerguelen, India, Indonesia, North Australia, West Australia, EAC, Oregon, California, Humboldt.
Temporal validation

• Modeling and omission errors
• **FES2014 final atlas**
  • 34 waves available
  • 15 assimilated: M2, M4, S2, 2N2, K2, N2, K1, O1, P1, Q1, Mu2, Nu2, E2, La2, M4
  • 9 non-linear + 6 long-period
• Performances estimated versus TG databases + global altimetry databases (CLS/CALVAL)
  – Several years of Jason-1, ENVISAT, ALTIKA, CRYOSAT-2
  – Variance reduction analysis at crossovers compared to FES2012, DTU10, TPXO8 and GOT4v8-v10 tide models
Variance of SSH crossover differences
FES2014 vs FES2012
FES2014 vs GOT4v10c
Variance of SSH crossover differences
FES2014 vs TPXO8
Variance of SSH crossover differences
Arctic

Mission en, cycles 9 to 93

Mission en, cycles 9 to 93

Mission en, cycles 9 to 93

Mission en, cycles 9 to 93

M2 K1 N2

FES2014 11.9 1.9 8

DTU10 16.4 2.6 8.6

GOT4v8 14.6 3.3 8.3

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Conclusions

• FES2014 atlas shows a strong improvement compared to previous version FES2012
• FES2014 has better/~ performances than other models for all main waves
• Global temporal validation vs FES2012, DTU10, GOT4.8, TPXO8
  •=> Improvement in coastal/shelf regions, in deep ocean areas and at high latitudes + Arctic

• Some more validation diagnostics are still being computed by independent teams also
• A specific task has been devoted to the analysis of the 58.77 days MSL signals:
  •=> Cf. next presentation from Zawadzki et al.

• Tidal currents are being computed and will be available at the same resolution of 1/16°
• Specific validation of the tidal currents is planned in 2016 around Australia
• Specific FES2014 loading tide will be computed within next months
• Scientific paper on FES2014 atlas should be submitted within next months
• More slides ...
FES2014 vs DTU10
SSH

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