FES 2014 : a new global tidal model

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Project website : http://www.legos.obs-mip.fr/recherches/equipes/ecola/projets/fes2014

Introduction

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

•In 2012, we have developed a new high resolution tidal model on global ocean taking advantage of:
- •19 years altimeters time series
- •Improved bathymetry & coastline, modelling/assimilation techniques

•FES2012 results are very good particularly in shallow waters and coastal regions although no TG has been assimilated (cf Stammer et al. 2014)
•But altimeter crossover variance is raised in some places when using FES2012, which was not entirely satisfying

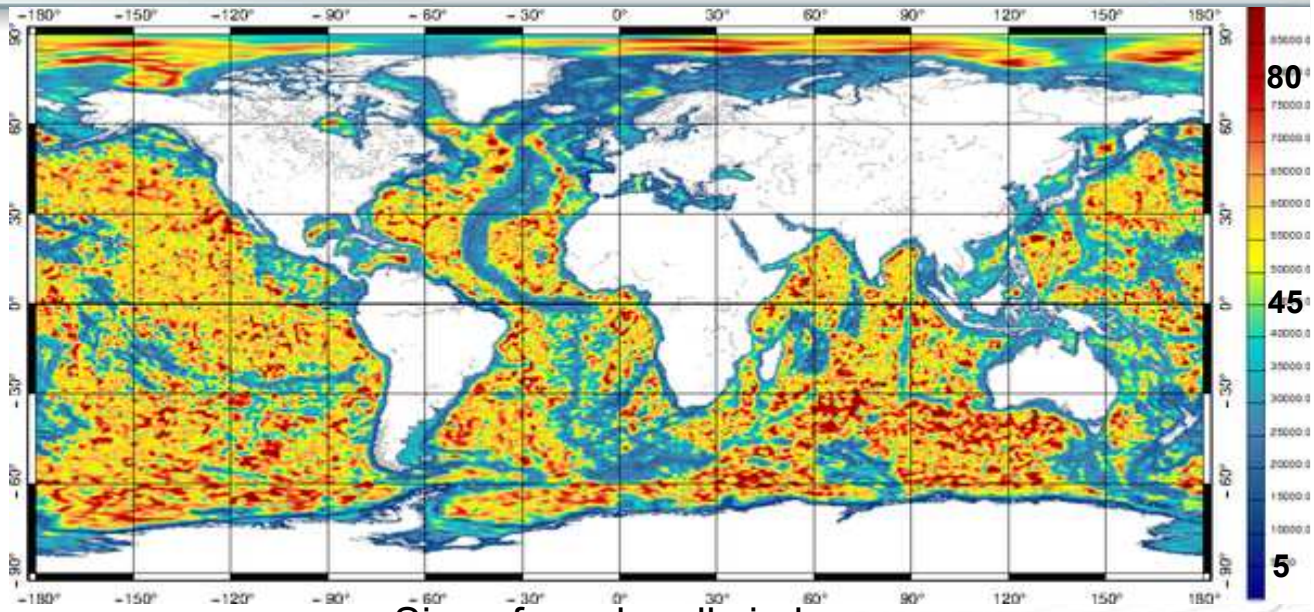
•New release FES2014 is being performed in order to improve FES2012 results in deep ocean, at high latitudes and in shallow/coastal seas.
- •=> intermediate FES2014 results are presented here

FES2014 : hydrodynamic configuration

FES2014 Mesh

FES2012

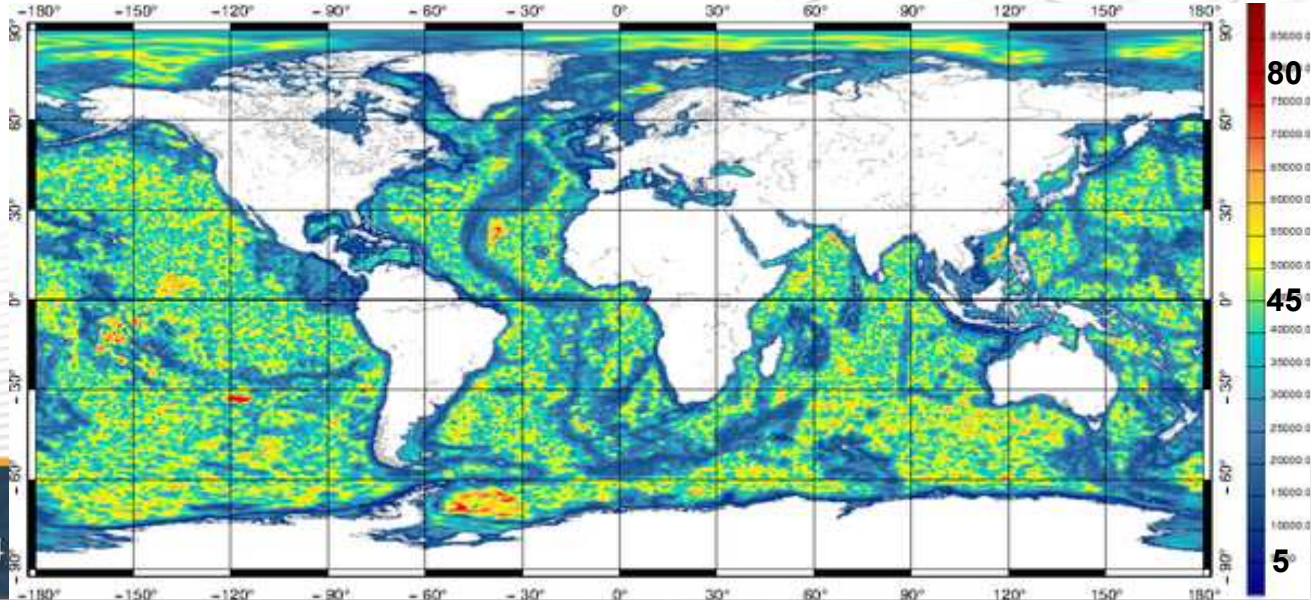
- 730 000 triangles
- 1 500 000 elevation nodes
- 2 200 000 velocity nodes



Size of mesh cells in km

FES2014

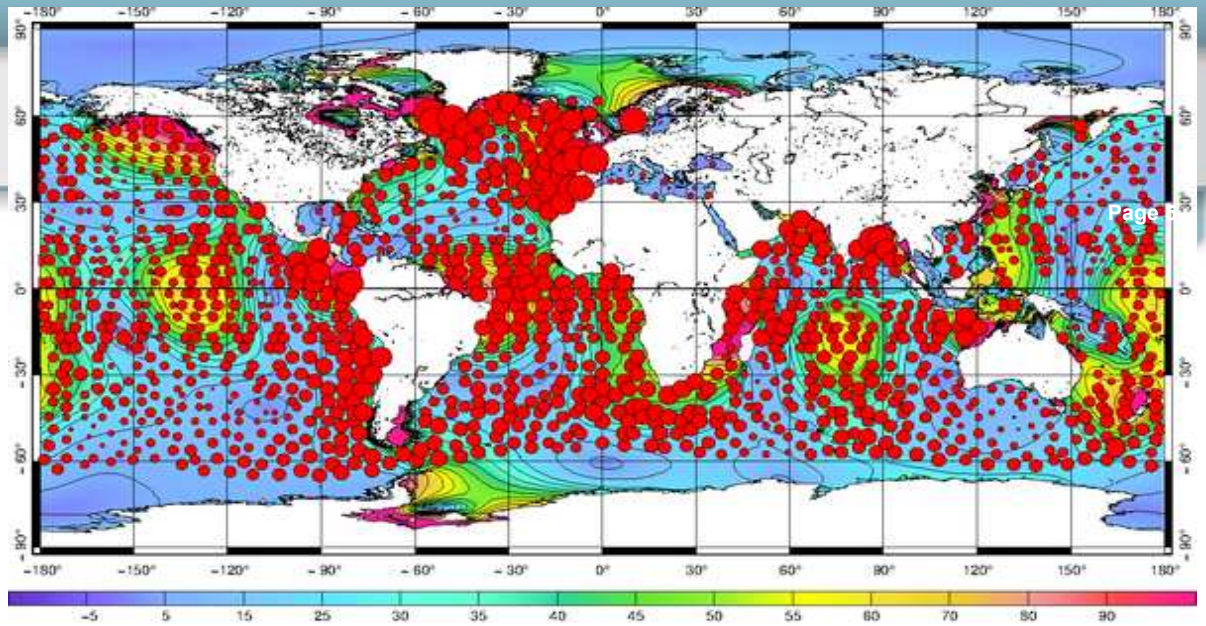
- 1 464 500 triangles
- 2 981 213 elevation nodes
- 4 393 500 velocity nodes



FES2012 hydro

M2 RMS (TP/J1/J2 xovers)

Deep ocean	2,5 cm
Shelf seas	9,3 cm

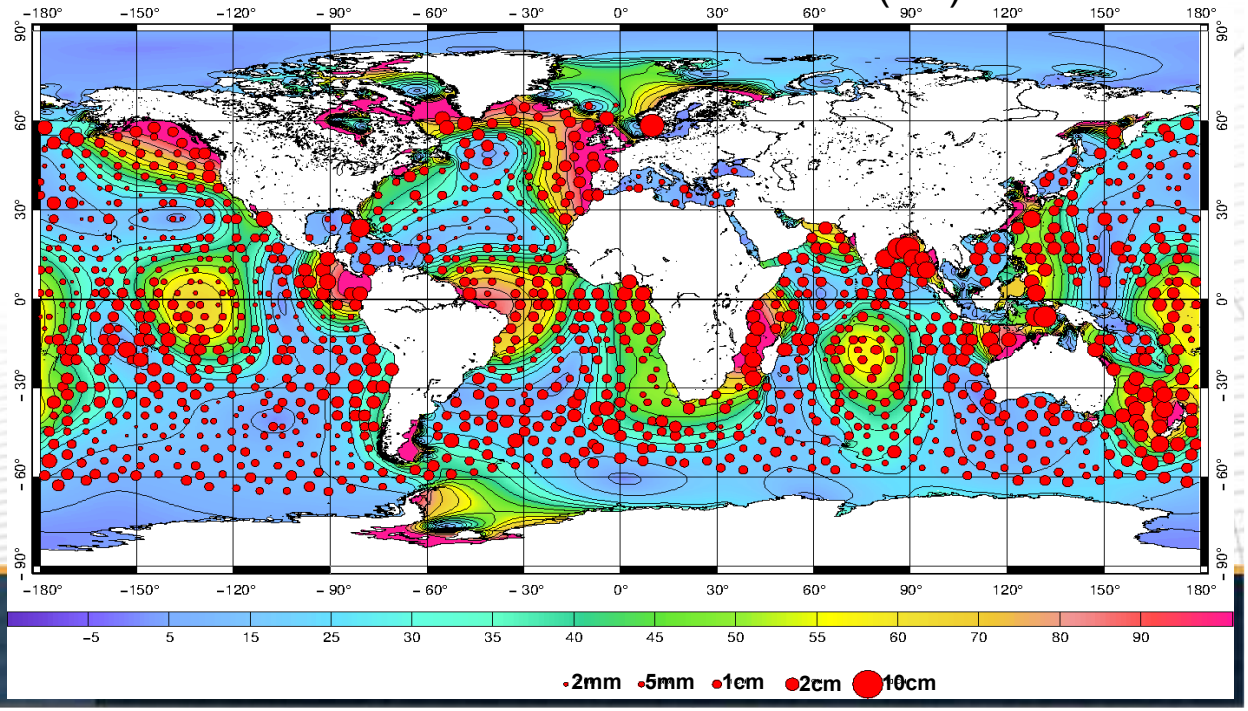


RMS between model and TPJ1J2 crossovers estimations for M2 (cm)

FES2014 hydro

M2 RMS (TP/J1/J2 xovers)

Deep ocean	1,20 cm
Shelf seas	5,37 cm



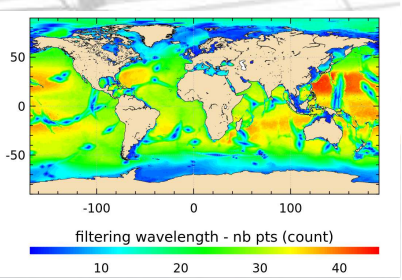
Assimilation

Assimilation database

• Main issue in altimeter data harmonic analysis = aliased frequencies and subsequent separation periods (depends on the considered mission)

• 20 years time series for TP/J1/J2 nominal track => most of the alias issues have vanished
•Still aliasing issues for the T/P interleaved mission and for ERS/EN missions (6y and 17y resp.)
• Reprocessed DUACS DT multimissions datasets have been used (cf poster 59, Pujol et al.)
- •Most recent L2 standards have been used (DAC based on ERA-interim)
- •Revisited L3 standards have been used (editing, multimissions cross-calibration correction for ERS-EN missions)
- •GOT4.8 tidal loading effects are used (tidal loading error correction to GOT4.8 applied)

•Harmonic analysis has been improved
- •to take into account the effect of seasonal ice cover
- •Use GLORYS2-V1 to remove non tidal annual & semi-annual contaminations (TPNJ1N, ERSEN)
- •Improved along-track filtering to remove internal tide signatures

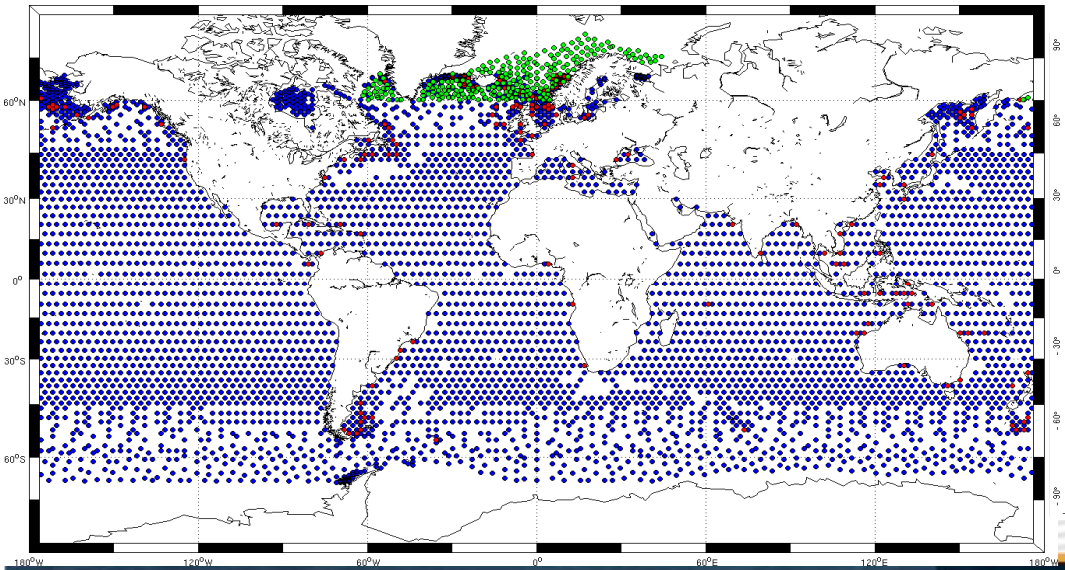


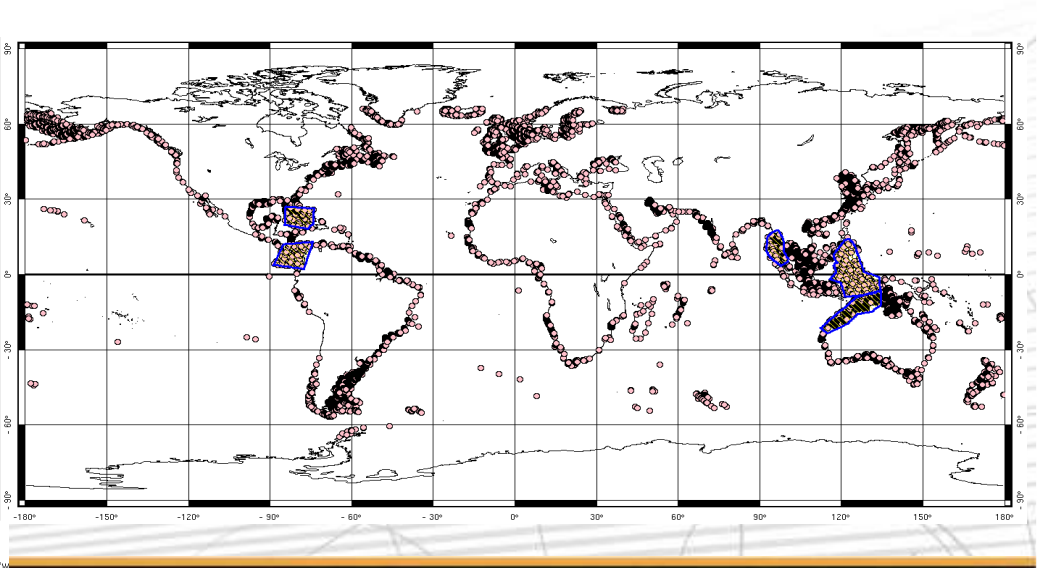
FES2014 – Assimilation

- **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)
- **Assimilation process is still on-going**
- **we present data used for the FES2014 intermediate atlas**

Assimilated data

- **4858 Crossover points:**
  - 4427 TPJ1J2: open ocean + shelves
  - 186 TPNJ1N: shelves
  - 245 E1E2EN: Arctic Ocean (no S2)
- **Along track data:**
  - 6258 TPJ1J2: shelves + patches
- **Only 1 TG**
  - in the Bristol Channel (UK)

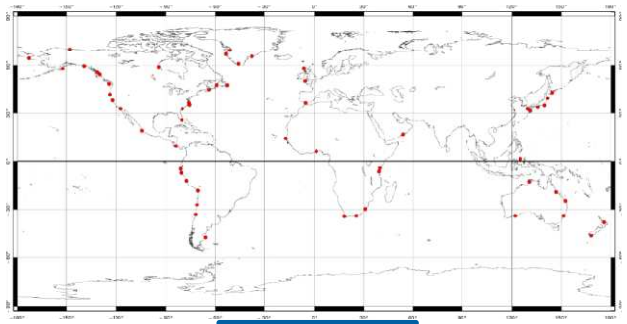




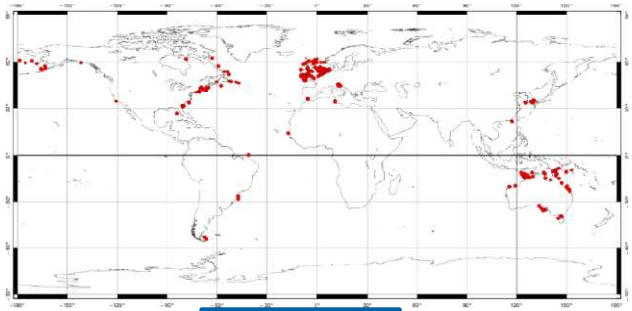
Results

Validation in spectral domain

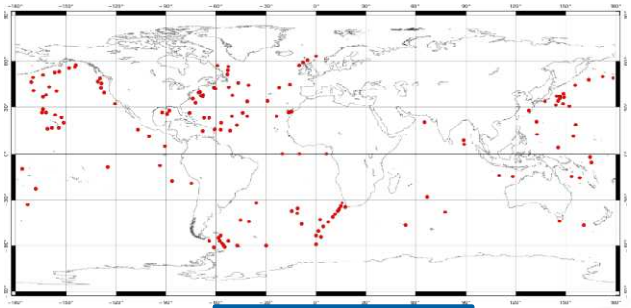
- **Performances vs tide gauge databases**
  - **Deep, Shallow, Coastal databases used in Stammer et al. paper (2014)**



Coastal



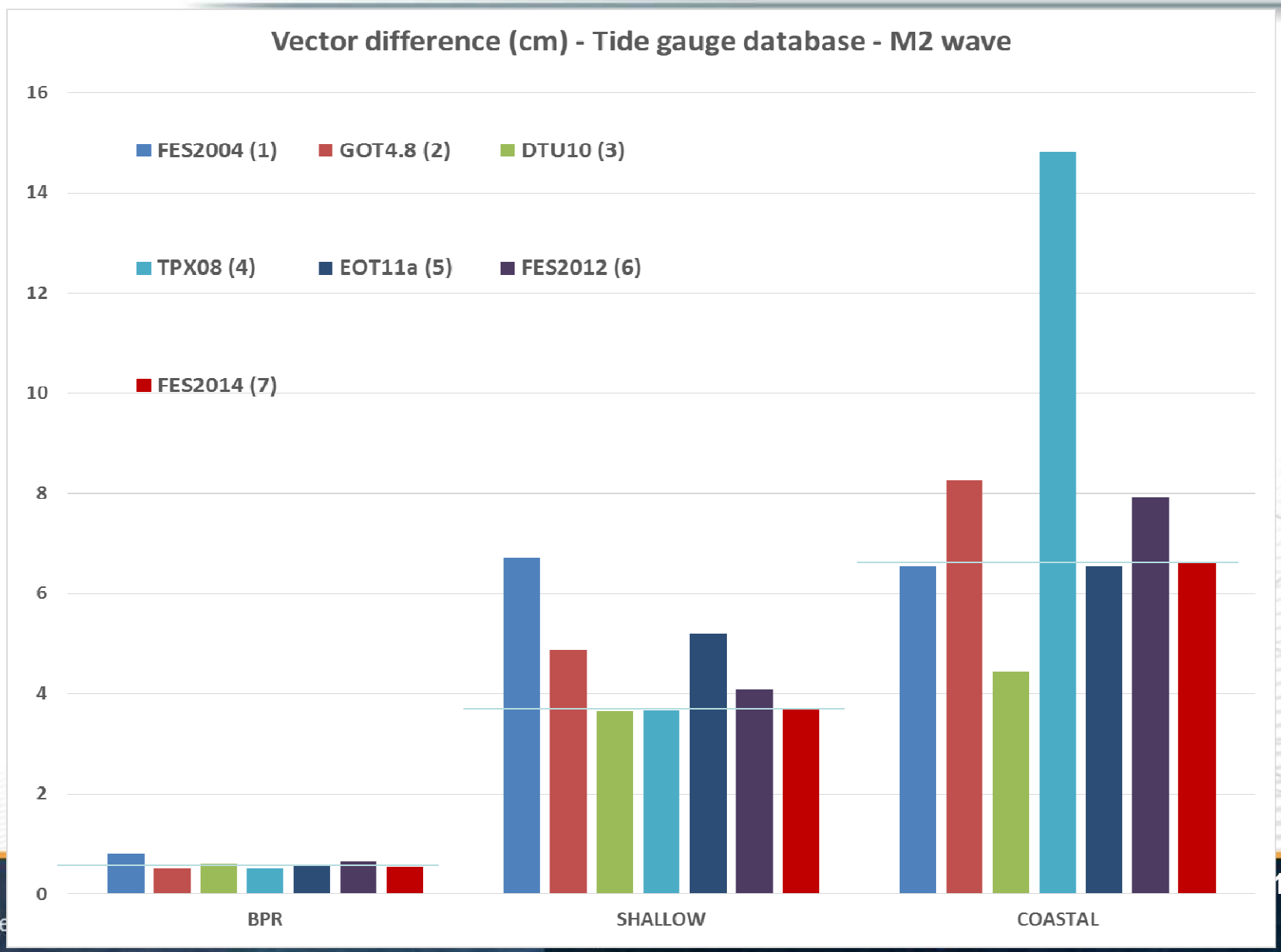
Shallow



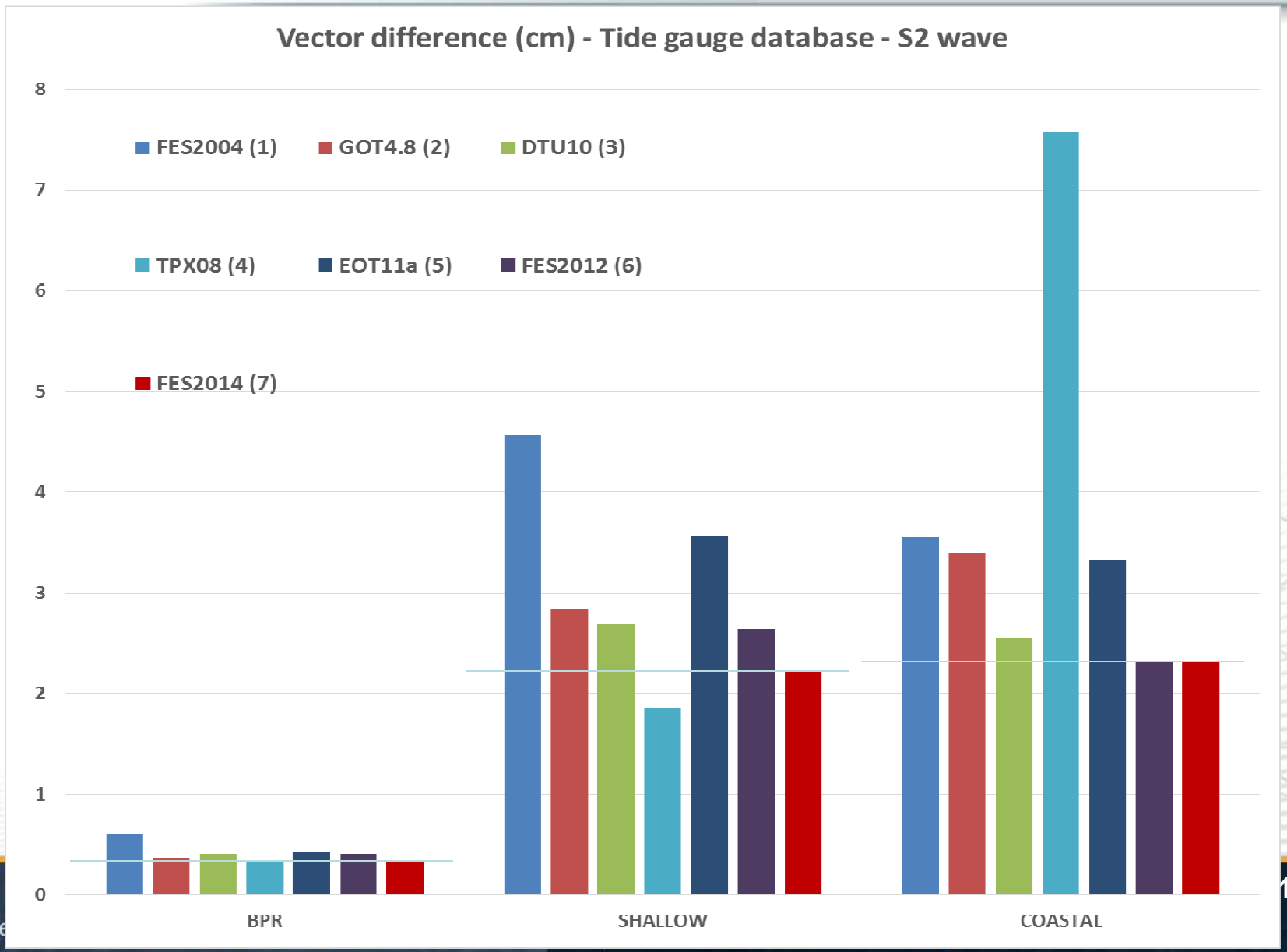
Deep BPR

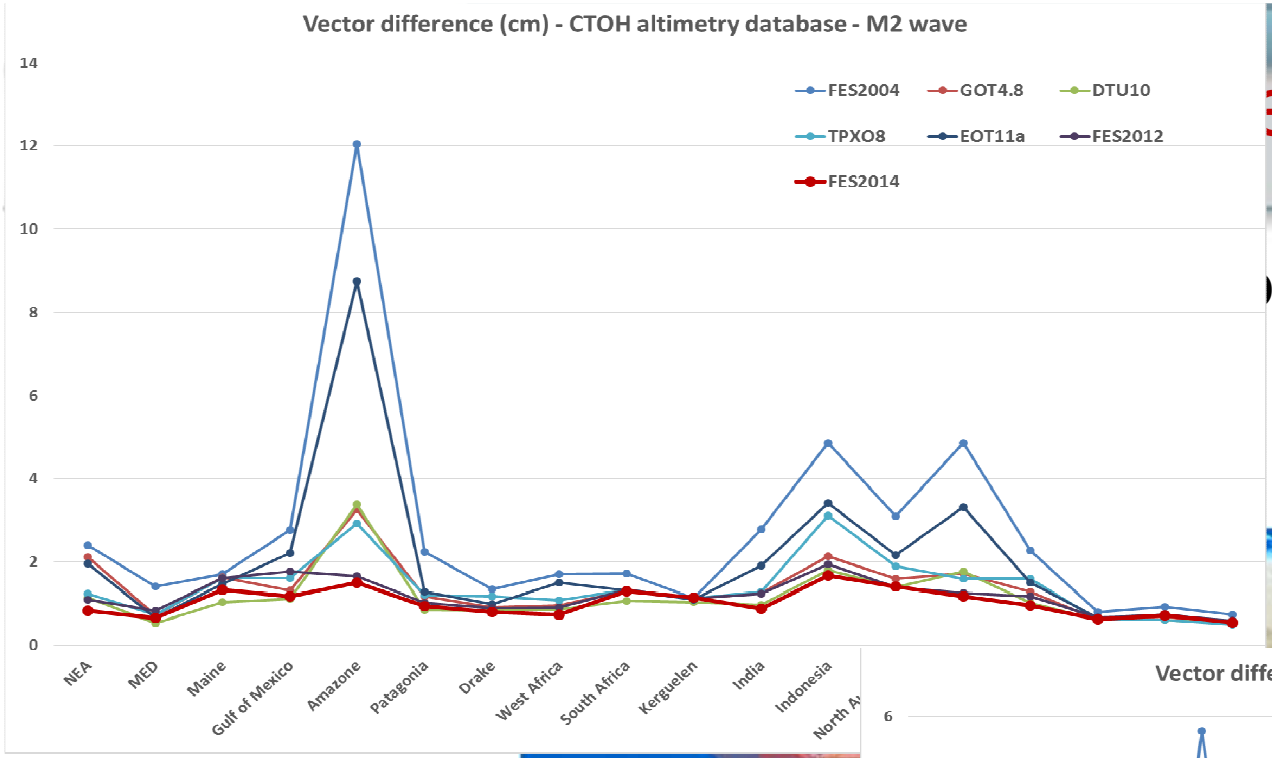
  - **Models listed in Stammer et al. paper have been used for comparison**
  - **Comparisons with DTU10, GOT4.8, TPXO8, EOT11a, FES2004 and FES2012 are presented**

Validation in spectral domain



Validation in spectral domain





ectral domain

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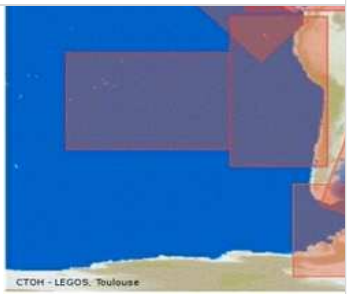
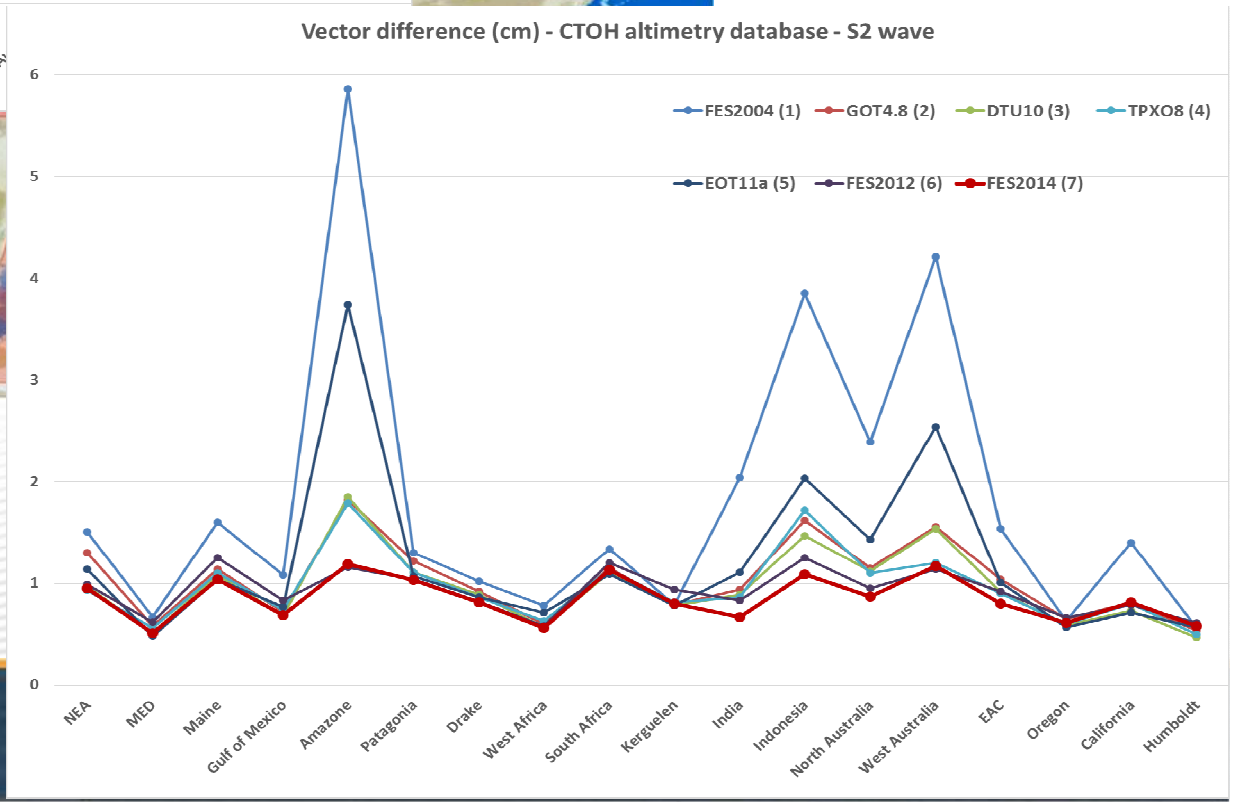




New frontiers of Altimetry –
Lake Constance, Germany - October 2014

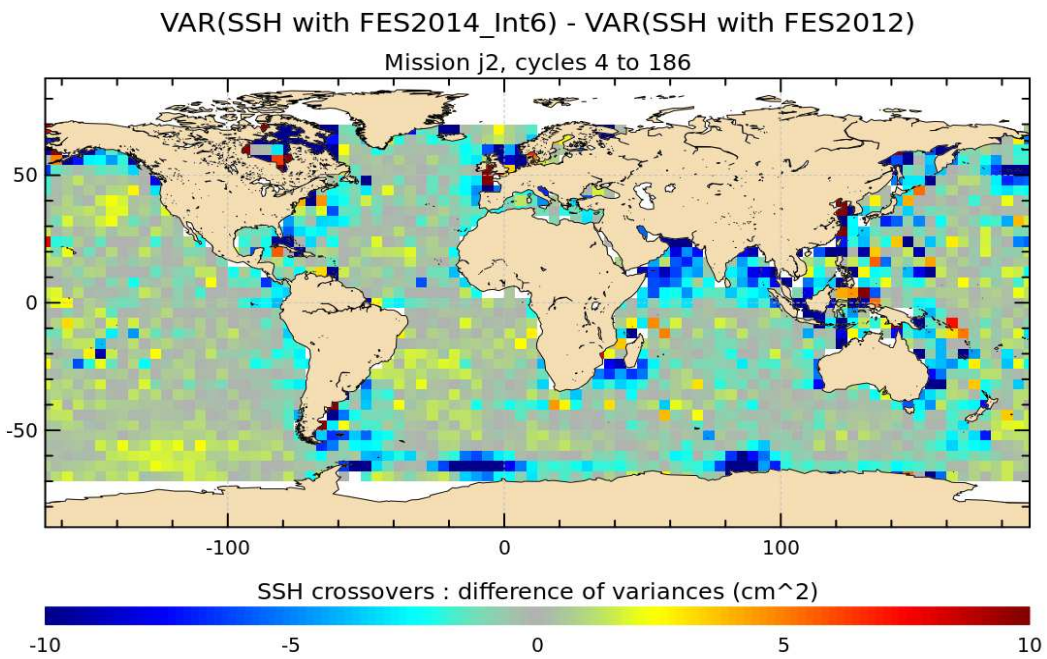
Validation in temporal domain

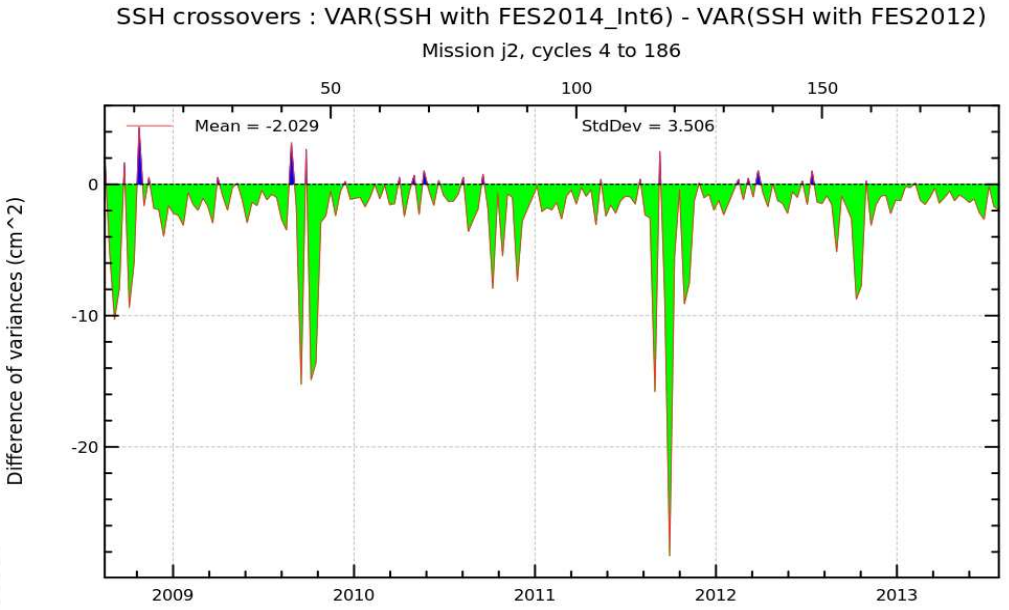
- **Modeling and omission errors**

- **FES2014 intermediate atlas assimilating data presented previously:**
  - 10 waves available: M2, M4, S2, 2N2, K2, N2, K1, O1, P1, Q1
  - completed **by DTU10 (S1)**

- **Performances vs global altimetry databases (CLS/CALVAL)**
  - Global ocean
  - 5 years of Jason-2 (2008-2013)
  - Variance reduction analysis at crossovers compared to DTU10 and FES2012 tide models

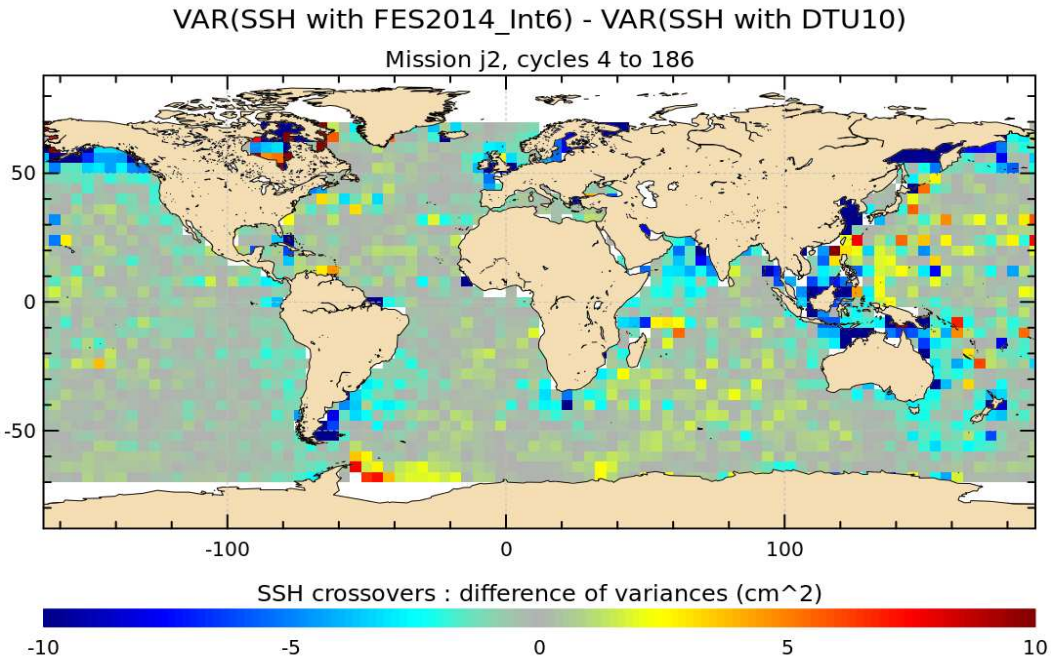
Variance reduction for J2 crossovers when using FES2014 instead of FES2012

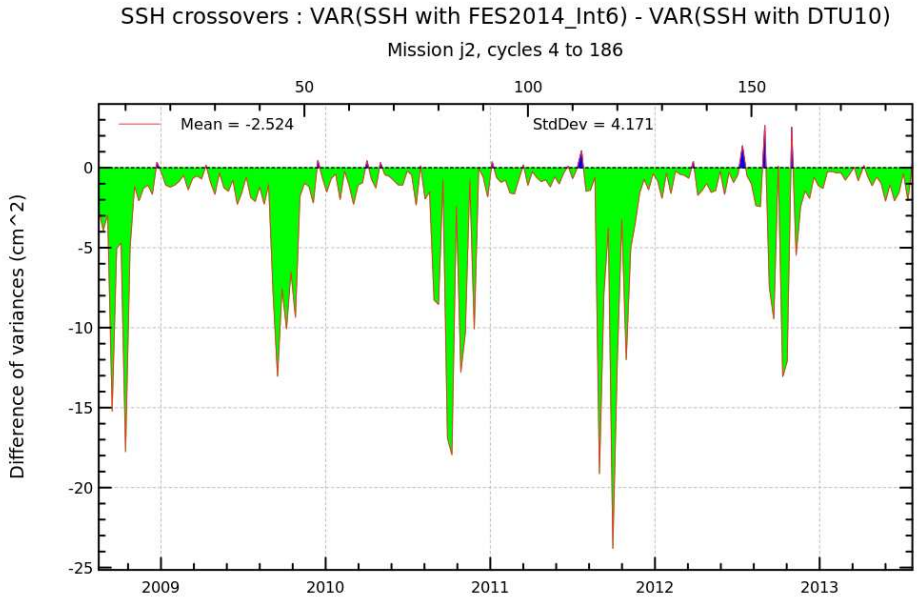




- Significant improvement in many areas: coastal regions and many deep ocean areas
- Improvement in Southern Ocean, north of Indian & south Aleutian islands

Variance reduction for J2 crossovers when using FES2014 instead of DTU10





- Significant improvement on global ocean and particularly: around Australia, in Indonesian and China seas, northern Indian Ocean, north Pacific, south Brazil/Argentine, NEA …
- narrow regions with variance raise are still noted north of Weddell sea, east of Philippines, around Seychelles=> those areas will be improved in the final FES2014

Conclusions

- FES2014 int. atlas results show a strong improvement compared to previous version FES2012
- FES2014 is ~/better than other models for all waves except TPXO8 in shallow waters and DTU10 in coastal region, but no TG have been assimilated yet
- Improvement noted on most deep ocean regions for M2 + S2
- Global temporal validation vs DTU10 & FES2012:
  - Improvement in coastal/shelf regions, in deep ocean areas and at high latitudes
  - A few regions can still be improved
- Good results obtained in shelf/coastal regions and at high latitudes are explained by:
  - The more accurate bathymetry + finer native resolution of the grid
  - The better quality of the assimilation database
  - A specific selection of assimilated data according to each region

Perspectives

- Assimilation process is on-going …
- Final FES2014 atlas will be ready by the end of November 2014
- A specific task is devoted to the analysis of the 58.77 days MSL signals:
  - FES2014 model (hydro+assim) will be tested in this context
  - => cf Poster °22 on this subjet from **Zawadzki et al.**