Bathymetry Improvement and Tidal Modelling in the North-East Atlantic Ocean

M. Cancet, F. Toublanc, F. Lyard, G. Dibarboure, N. Picot, T. Guinle
Global tidal modelling

- Significant improvement in the last 10 years
- Large errors (> 10 cm) remain on shelves, where tides are stronger and more complex
- The global tuning of the model may not represent local specificities
Improvement of the hydrodynamic models (no data assimilation)

Vector differences between hydrodynamic solution and TP/J1/J2 crossover points (M2)
Global tidal modelling

- Significant improvement in the last 10 years
- Large errors (> 10 cm) remain on shelves, where tides are stronger and more complex
- The global tuning of the model may not represent local specificities
- Future developments, including increased resolution, are limited by computing capabilities
Increase in the global mesh resolution

FES2004
247 354 vertices

FES2012
389 737 vertices

FES2014
757 755 vertices
Global tidal modelling

- Significant improvement in the last 10 years
- Large errors (> 10 cm) remain on shelves, where tides are stronger and more complex
- The global tuning of the model may not represent local specificities
- Future developments, including increased resolution, are limited by computing capabilities

Regional tidal modelling

- Smaller domain allows higher resolution
- Regional tuning easier to implement
- Needed for current and future satellite altimetry missions (SAR alti, SWOT)
- But still limited by the quality of the ocean bathymetry that plays a key role in tidal dynamics, especially in shallow coastal waters and estuaries
A number of macro-tidal regions with bathymetry improvement potential have been identified.
Selection of two regions, to start (CNES project)

Assess and validate the new bathymetry through HR tidal modelling
Methodology

- **Inventory** of existing / freely available bathymetry datasets
  - Raw data from single-beam or multi-beam soundings
  - Digital Elevation Models (DEM)

- **Integration** of these bathymetry datasets in the global database and visual assessment

- Implementation of a **regional tidal model** (hydrodynamic modelling) in the region of interest

- **Validation** of the tidal model with altimetry and tide gauge observations

⇒ The resulting regional tidal model is consistent with FES2014 at the boundaries (possible patch)
Bathymetry datasets identified in the North East Atlantic (NEA) for the integration in the global database.
Merge of bathymetry datasets into the global LEGOS bathymetry (FES2014 basis)

- Vertical reference identification, editing, sub-sampling, seamless boundaries…
- More small scale features, more “realistic” isobaths lines

**South of Taiwan - Luzon Strait**

**LEGOS bathymetry**

**LEGOS bathymetry + MGL0905 dataset**
Merge of bathymetry datasets into the global LEGOS bathymetry (FES2014 basis)

- Vertical reference identification, editing, sub-sampling, seamless boundaries...
- More small scale features, more “realistic” isobaths lines
- Visual assessment to remove unrealistic patterns / erroneous datasets

**Java Sea**

**Malacca Strait**
Regional tidal modelling

- T-UGOm tidal model: hydrodynamic modelling without assimilation
- Regional configuration: increased resolution
- Designed to be compatible with the FES2014 global model/mesh

Resolution of the hydrodynamic model unstructured grid in the NEA

![Resolution of the hydrodynamic model unstructured grid in the NEA](image-url)
Validation results

North-East Atlantic Ocean

Comparison to the tide gauges - Vector differences for M2

FES2014 hydro

Regional model
Validation results

North-East Atlantic Ocean

Comparison to the tide gauges
Vector differences for M2

Zoom in the Skattegat, between the North Sea and the Baltic Sea

FES2014 hydro

Regional model
→ Reduction of error for all the tidal waves, compared to the non-assimilated FES2014 hydrodynamic solution.

→ Strongest reduction of error for M2 (1 cm for altimetry (27%), 7.5 cm for tidal gauges (43%)), K1 and S2.

→ Major improvements of tidal solution in the German Bight, the Bristol Bay and along the French Atlantic coast.

→ Very good performance of the regional model compared to the assimilated global tidal models.
Conclusions and Perspectives

- Improvement of the bathymetry in the North East Atlantic Ocean, using existing in situ datasets
- Implementation of a high-resolution regional tidal model to assess the new bathymetry

Main results in the NEA region:
- Very good performance and dramatic reduction of the errors, especially wrt tide gauges
- This new configuration includes the German Bight (not available in global models) and the Baltic Sea
- Increasing the mesh resolution does not necessarily imply better tidal solutions, especially when the bathymetry is of poor quality.

- This new NEA tidal atlas could benefit from data assimilation (altimetry and tide gauges) for ever better performance
- Other macro-tidal regions could benefit from this methodology.
- New methods for bathymetry detection using satellite data (optic and/or SAR) could also help improve bathymetry and tidal modelling in areas poorly covered by traditional in situ data.
Global tidal models still lack accuracy in other regions in the Atlantic and regional models should be considered in:

- North-West Atlantic Ocean
- Patagonian Shelf
- Amazonian Shelf

Access to high resolution bathymetry data should be easier and more open
Thank you for your attention!