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

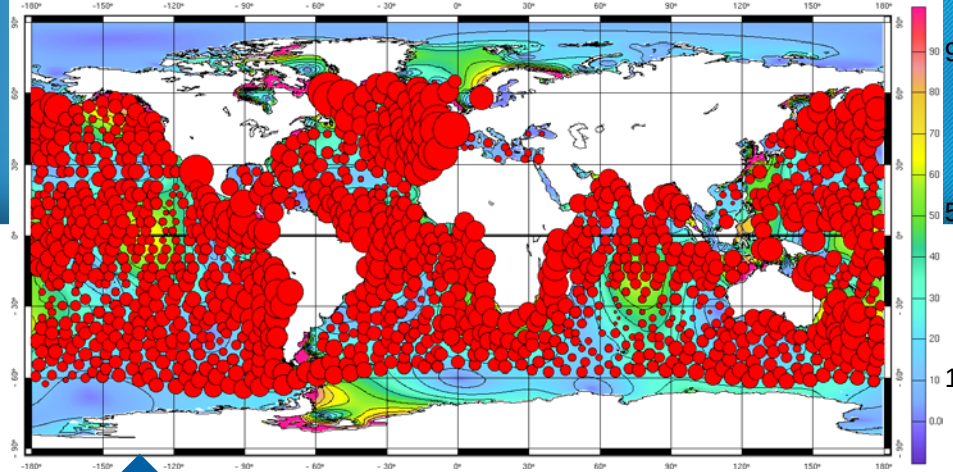
M. Cancet, F. Toublanc, F. Lyard, G. Dibarboure, N. Picot, T. Guinle

Context

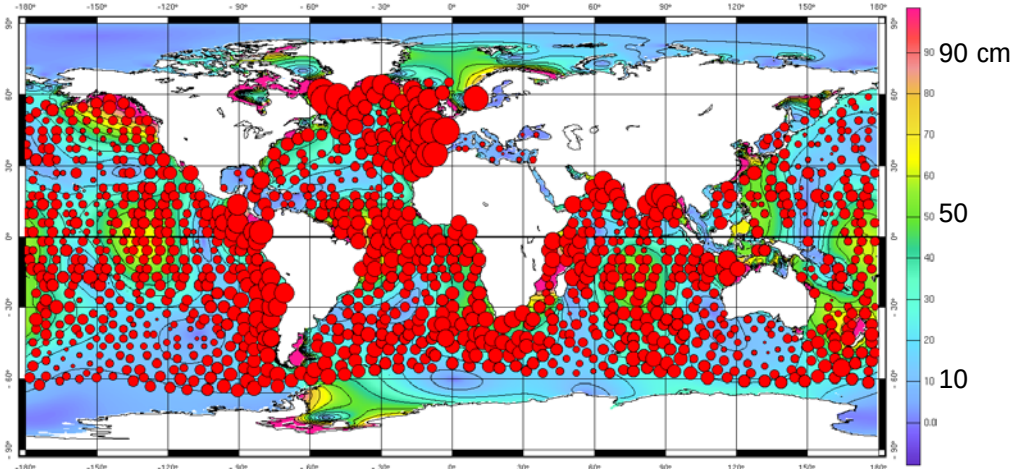
- Global tidal modelling
  - Significant improvement in the last 10 years
  - Large errors (> 10 cm) remain on shelves, where tides are stronger and more complex
  - The global tuning of the model may not represent local specificities

Context

Improvement of the hydrodynamic models (no data assimilation)



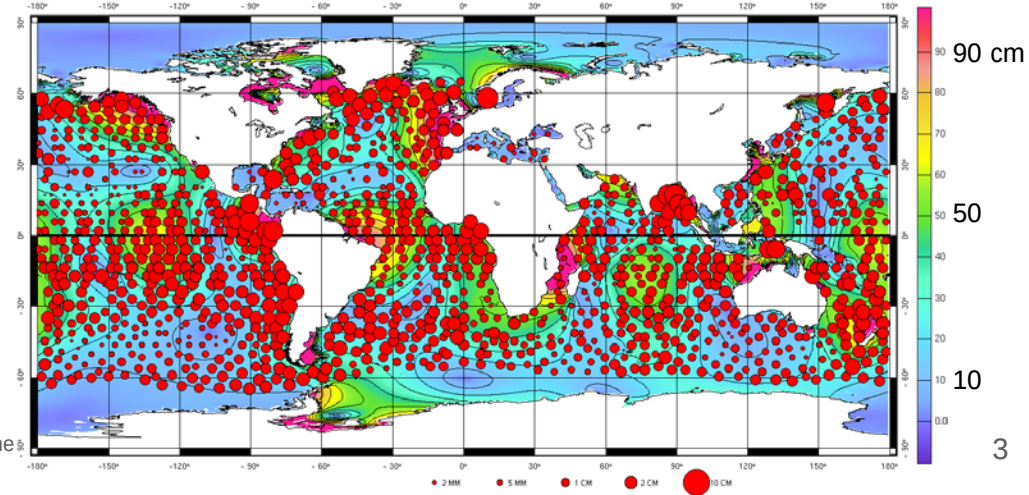
FES2004



FES2012

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

FES2014



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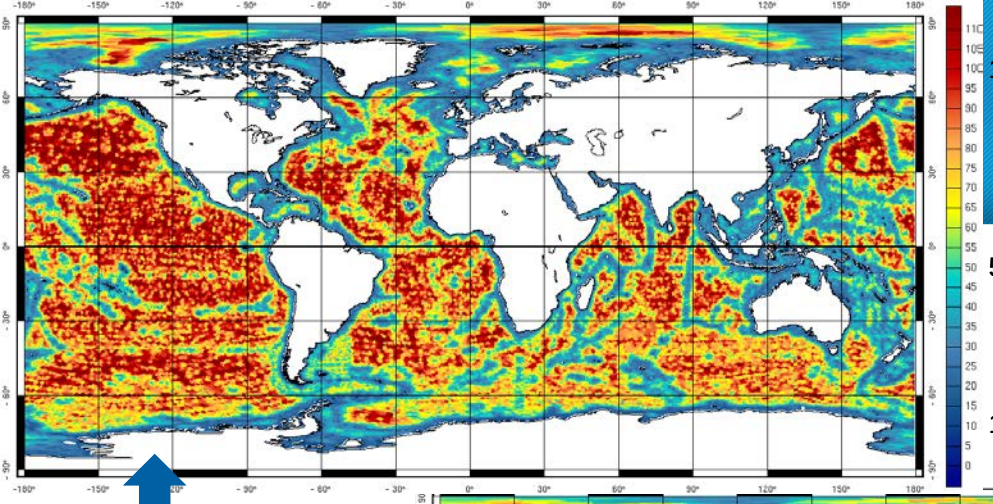
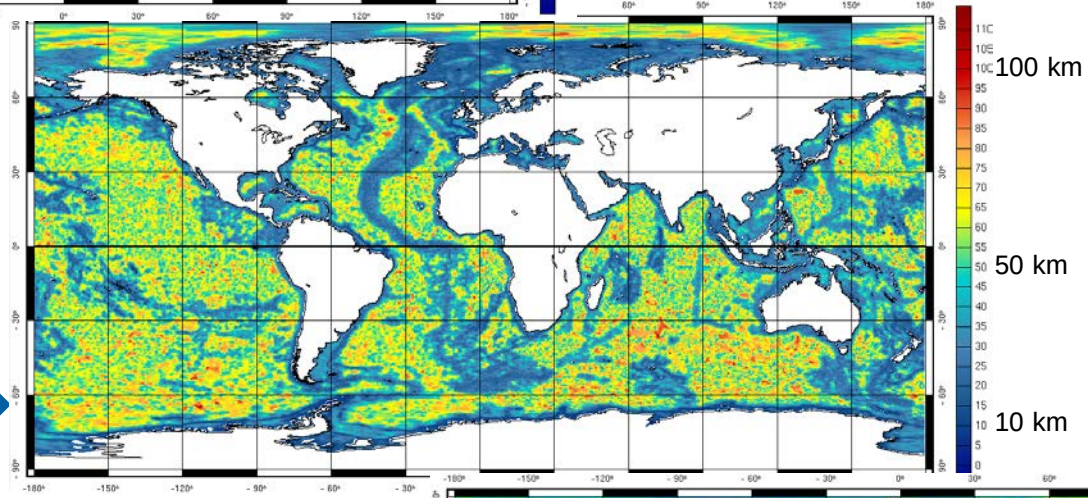
  - Future developments, including increased resolution, are limited by computing capabilities

Context

Increase in the global mesh resolution



FES2004
247 354 vertices



FES2012
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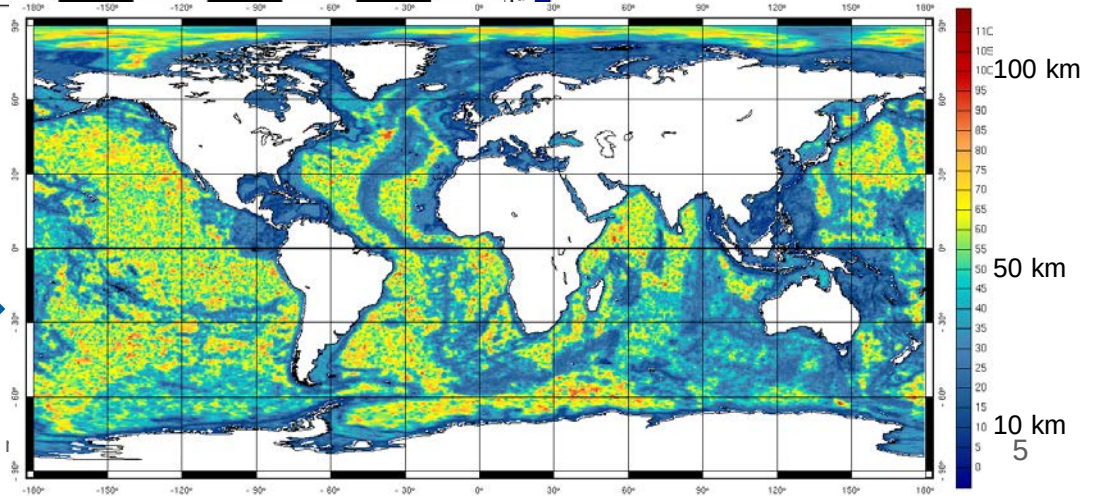

FES2014
757 755 vertices

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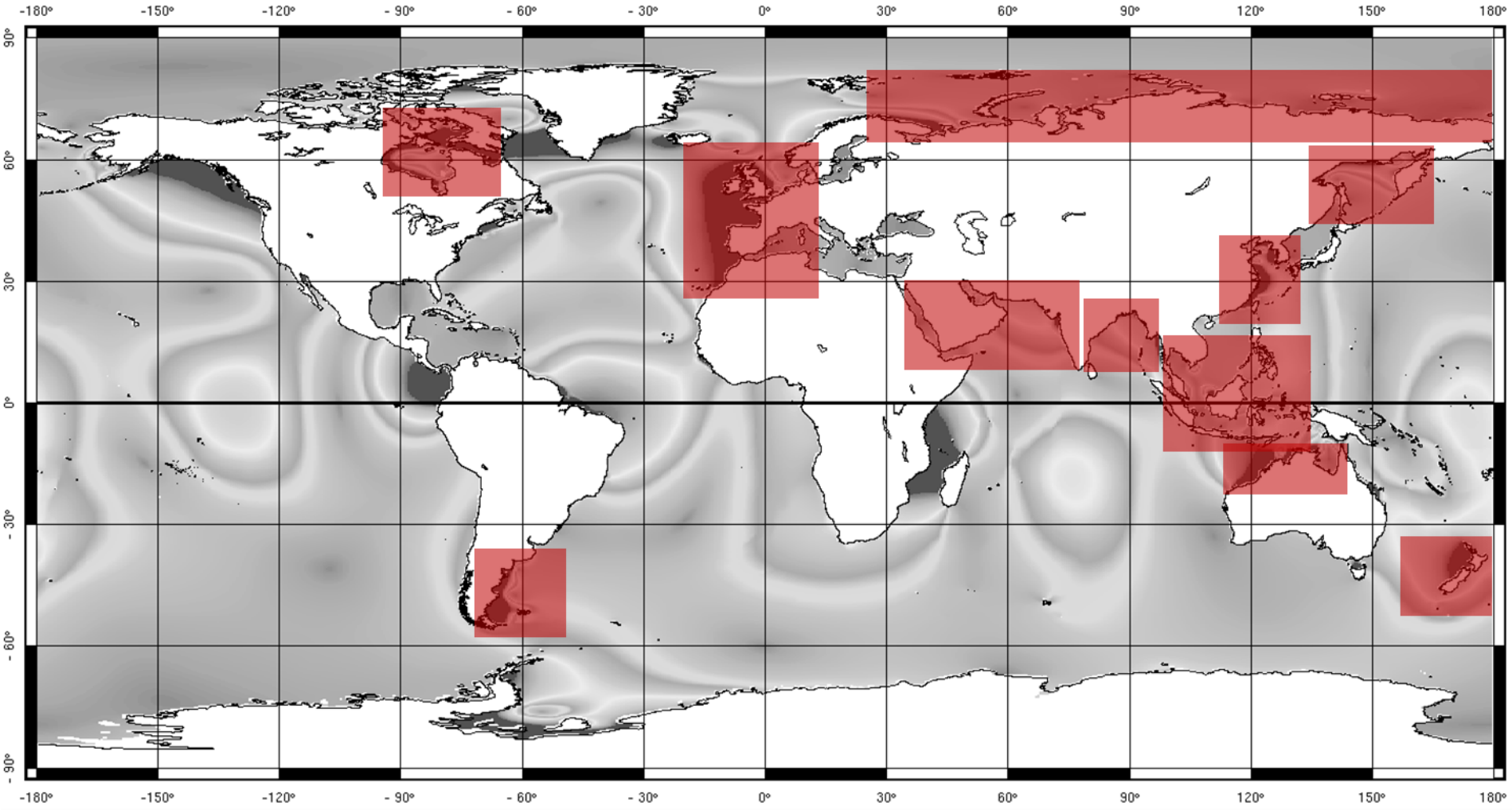
- Regional tidal modelling
  - Smaller domain allows higher resolution
  - Regional tuning easier to implement
  - Needed for current and future satellite altimetry missions (SAR alti, SWOT)
  - But **still limited by the quality of the ocean bathymetry** that plays a key role in tidal dynamics, especially in shallow coastal waters and estuaries

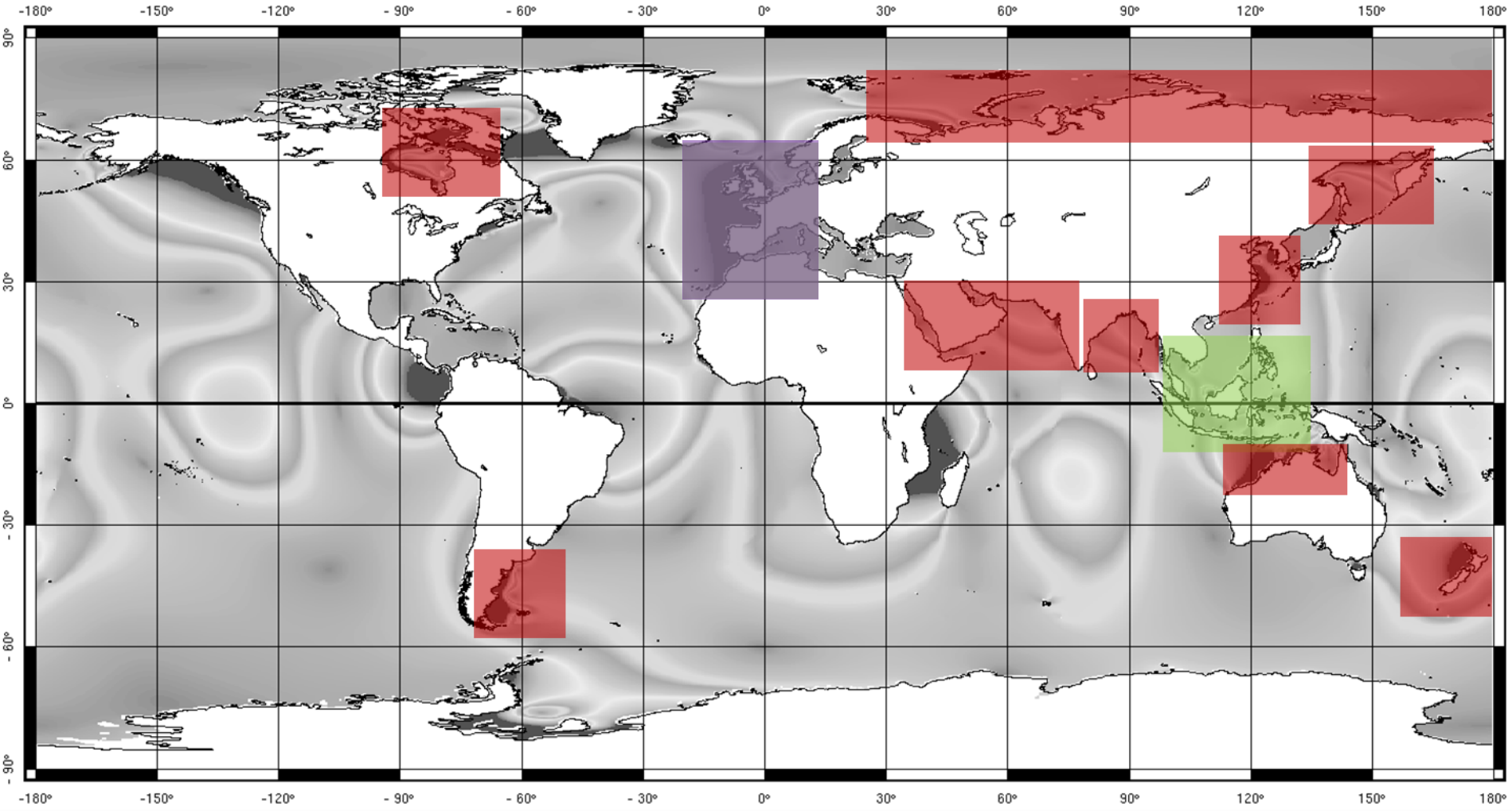
Context

- A number of macro-tidal regions with bathymetry improvement potential have been identified



Context

- Selection of two regions, to start (CNES project)
- Assess and validate the new bathymetry through HR tidal modelling



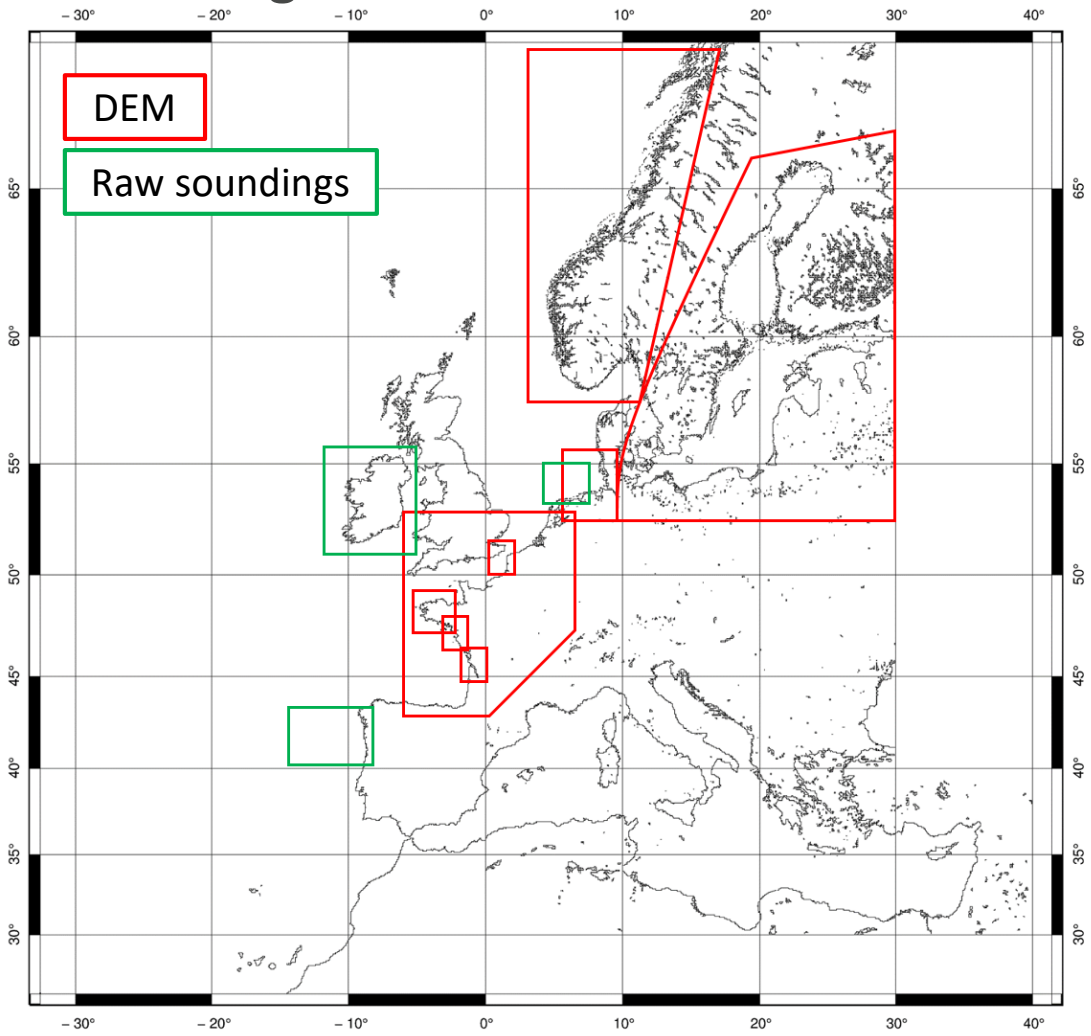
Methodology

- 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 data inventory

- Bathymetry datasets identified in the North East Atlantic (NEA) for the integration in the global database.

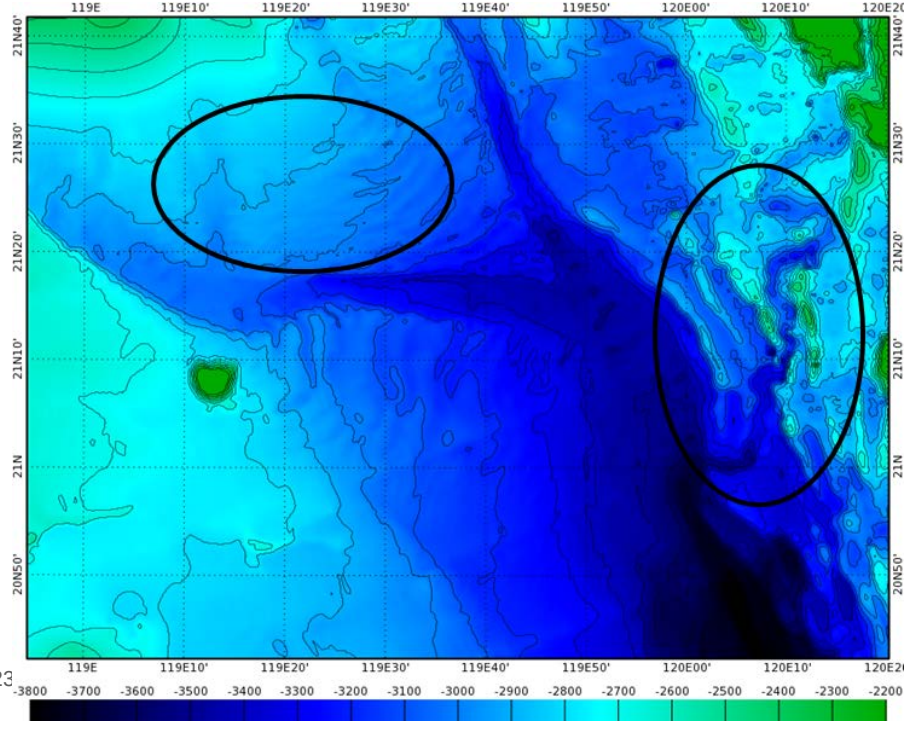


Bathymetry data integration

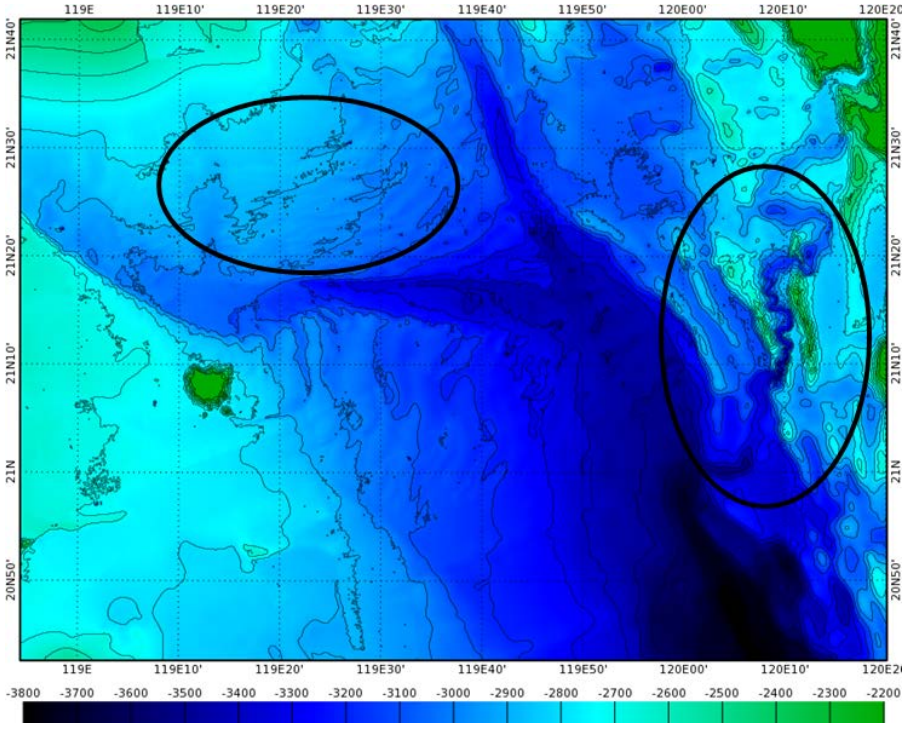
- Merge of bathymetry datasets into the global LEGOS bathymetry (FES2014 basis)
  - Vertical reference identification, editing, sub-sampling, seamless boundaries...
  - More small scale features, more “realistic” isobaths lines

South of Taiwan – Luzon Strait

LEGOS bathymetry



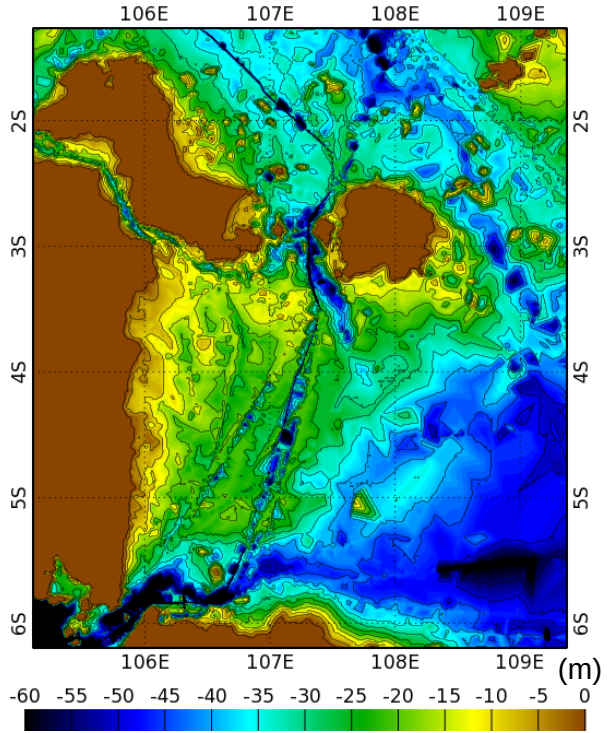
LEGOS bathymetry + MGL0905 dataset



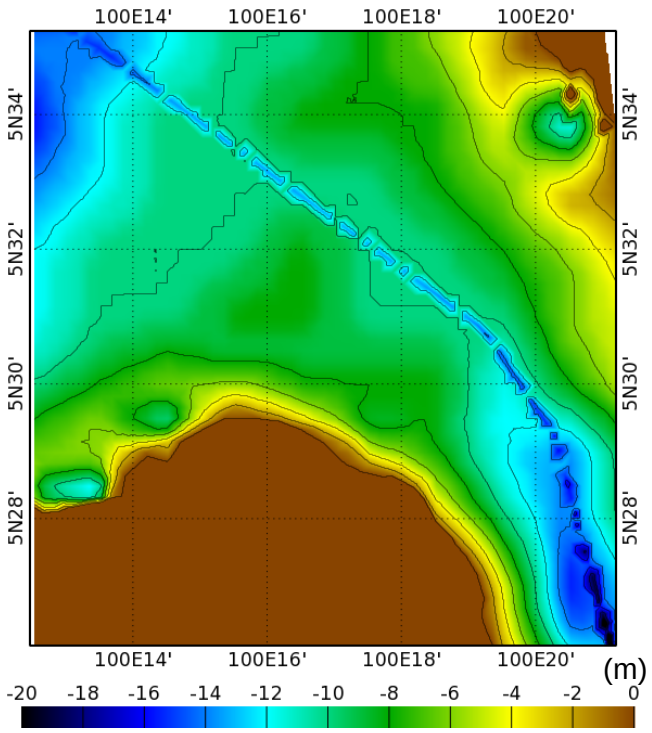
Bathymetry data integration

- 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



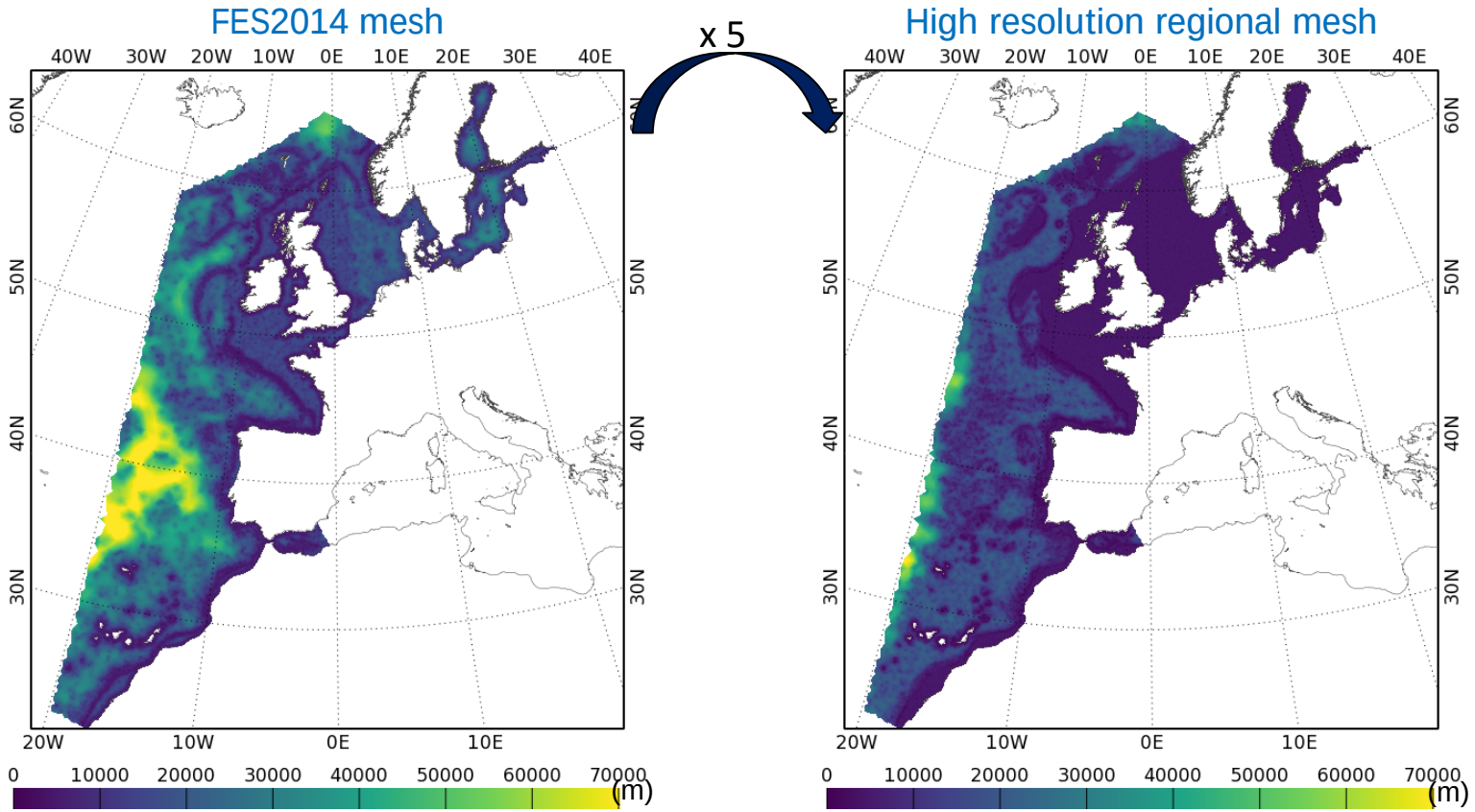
Malacca Strait



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

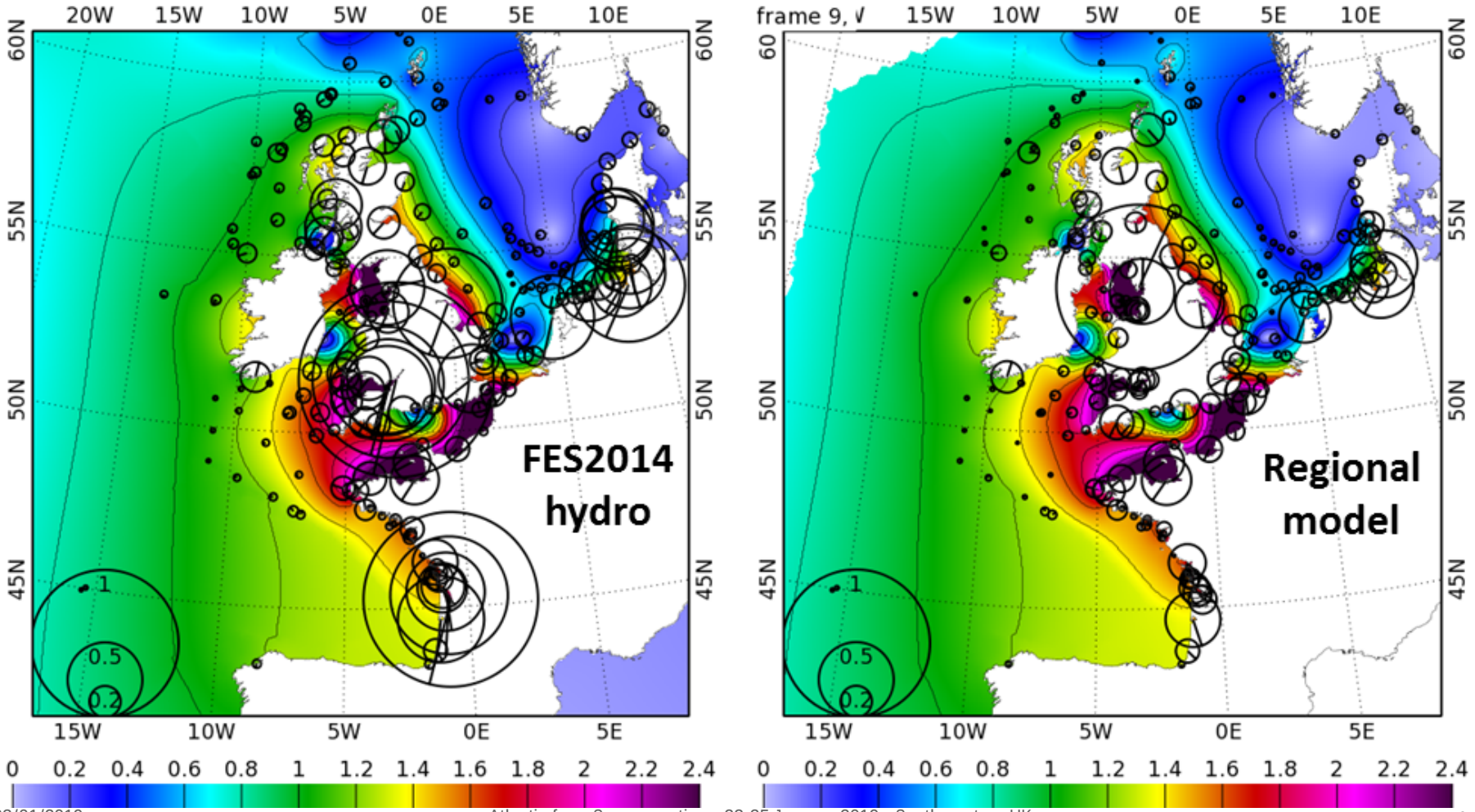
Resolution of the hydrodynamic model unstructured grid in the NEA



Validation results

- North-East Atlantic Ocean

Comparison to the tide gauges – Vector differences for M2

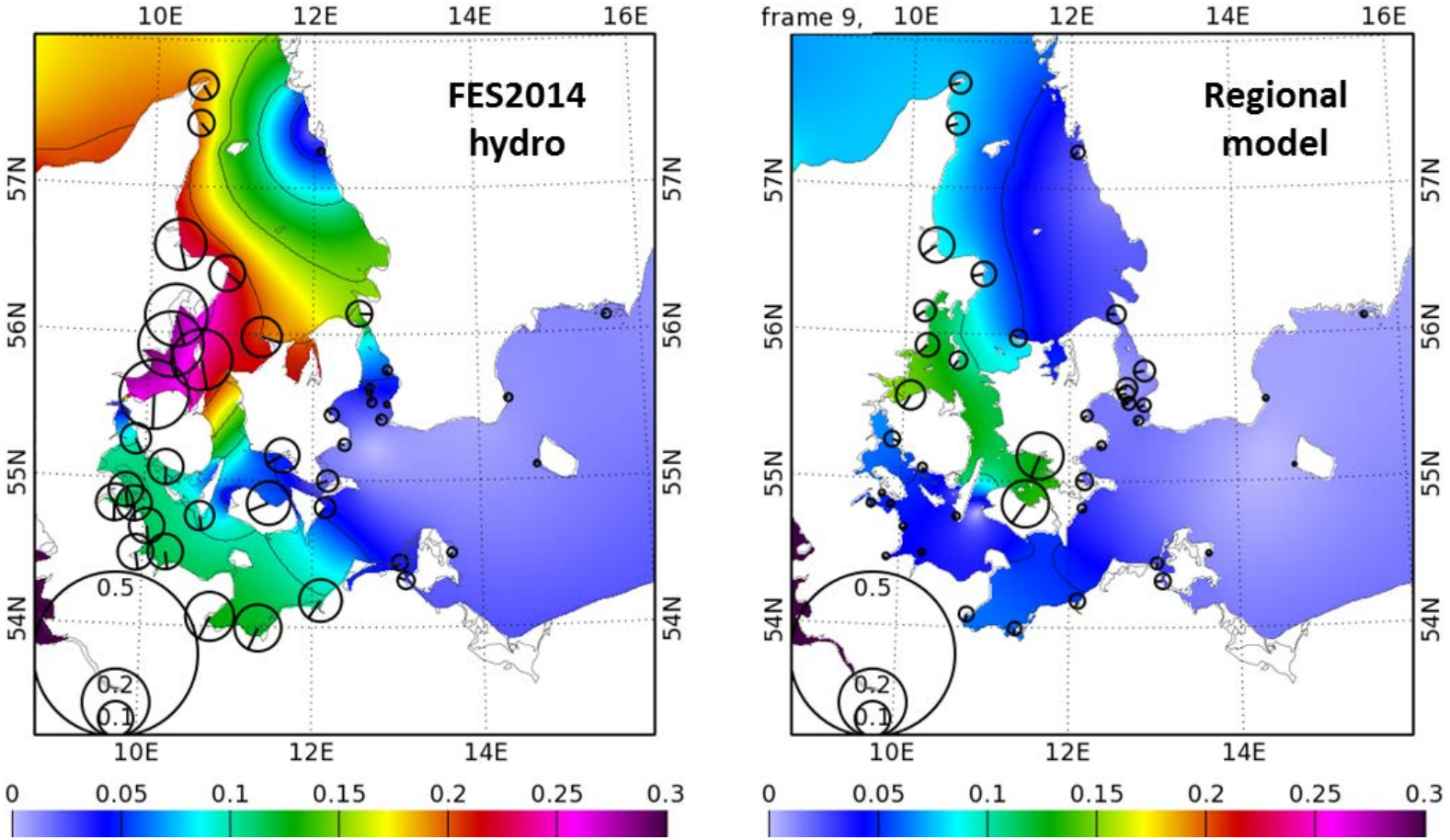


Validation results

- North-East Atlantic Ocean

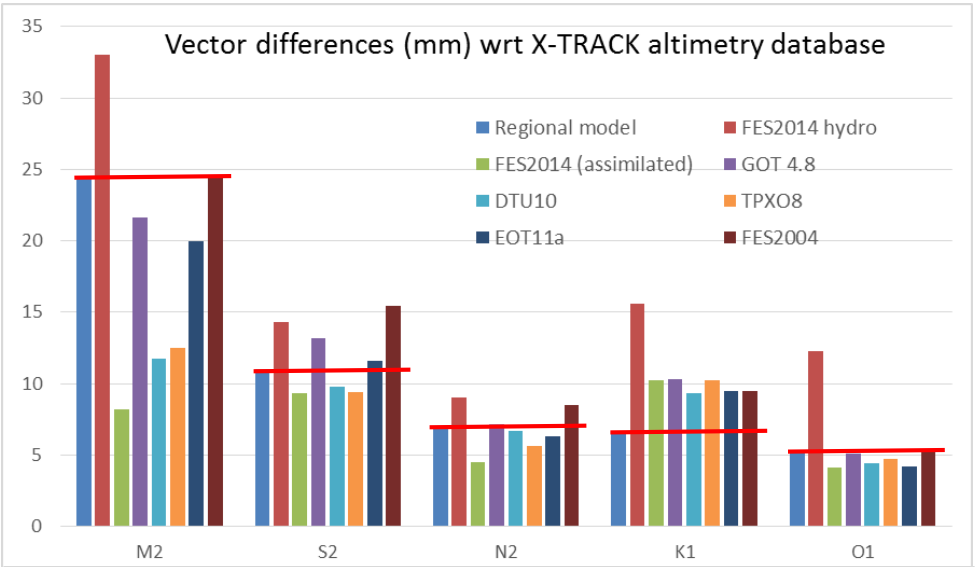
Comparison to the tide gauges
Vector differences for M2

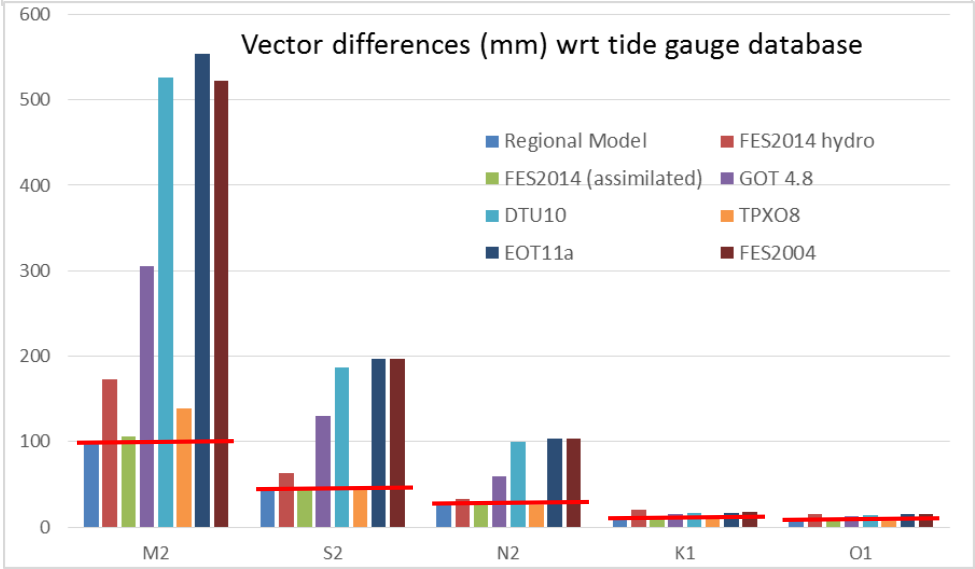
Zoom in the Skattegat, between the North Sea and the Baltic Sea



Validation results

North-East Atlantic Ocean





→ 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.

Recommendations

- 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 !