A new kilometric resolution zoom over the North-East Atlantic based on NEMO 4.2 (IMMERSE) version

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Why do we need further increase of the resolution?

- Currently, the highest resolution of Mercator configurations (used for ocean reanalysis or forecasts) is 1/36° (2-3km)(e.g : IBI36, Sotillo et al., 2015)
- Mediterranean sea : mesoscale structures are poorly resolved at a 1/36° (only 2 to 3 points per eddy) (Fig. 1)
- Continental shelf: eddies are not resolved.
- Kilometric resolution :
  - Mesoscale resolving in the Mediterranean sea, and mesoscale permitting over the shelf
  - Better representation of ITW spectrum (higher modes)
  - Better representation of geometric constraints (e.g : Gibraltar strait)

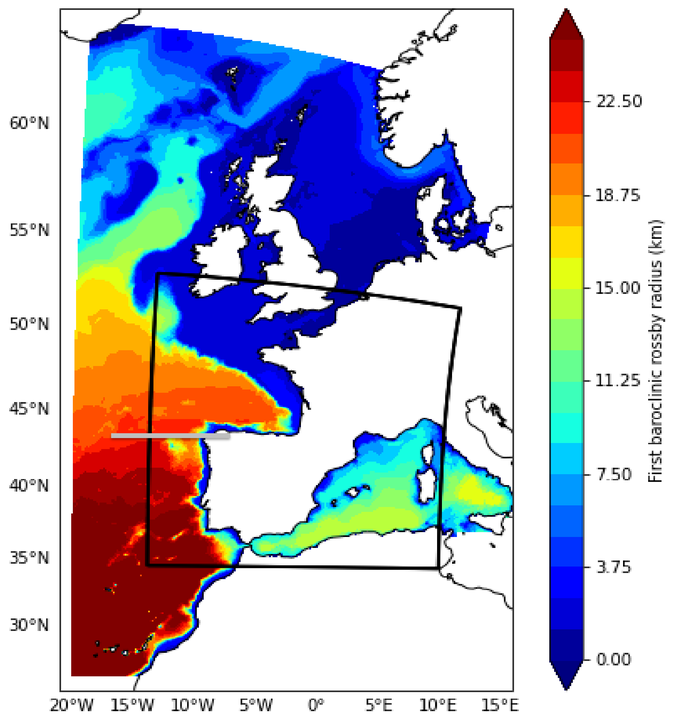

Figure 1 : First baroclinic rossby radius on the eNEATL36 domain. Nest area is indicated in black,. The Galician bank section is indicated in grey

The eNEATL36 + BIzoo (BIscay zoom) configuration

- **Parent configuration: eNEATL36**
  - 1/36° resolution (~2-3km)
  - 150s time step
- **High resolution nest: BIzoo**
  - based on AGRIF code (Debreu and Blayo, 2008)
  - 1/108° resolution (~1km)
  - 50s time-step
- **Forcing :**
  - Atmospheric : IFS
  - Initial & lateral boundary condition : 1/12° CMEMS operational product
  - Tides : FES2014
  - runoffs (Several sources)
- **Bathymetry** : Emodnet 2018
- **2 way nesting between the parent and the child configuration**

Simulations

- **NEST**:
  - eNEATL36 + BIzoo
  - Drag boost x2 (for stability issues) in the bay of Bristol and of the mt saint Michel
- **TWIN**:
  - eNEATL36 only
  - Same parameterisations / schemes as NEST, but no drag boost
  - Slightly different topography

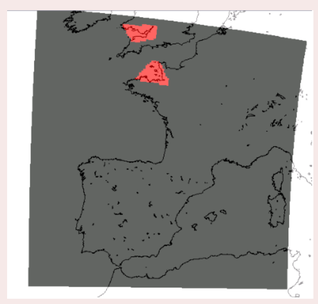

Figure 2: Areas (in red) where a X2 Cd boost is applied

Two-way nesting

- **Internal waves (ITW) crossing the nest boundaries:**
  - Galician Bank (see Fig. 1)= ITW created by the interaction with a sea mount at ~11.5°W
  - Ubiquity of ITW in the area => Two-way nesting is challenging
  - ITW information is well transmitted across the nest

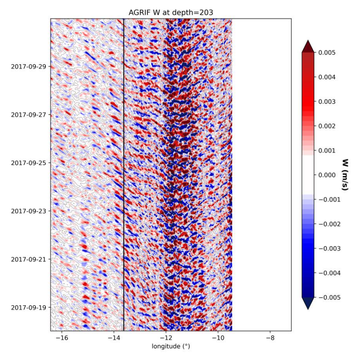

Figure 5: Hoevmoeller diagram (time vs longitude) of the vertical velocities (m/s) at 200m at 42.7°N

Macroscopic validation

- **SLA along satellite tracks (Jason 3):**
  - SLA data unfiltered from tides
  - Good agreement with satellite SLA for scales >100km (=satellite effective resolution)
  - Small scales filtered by on-track interpolations

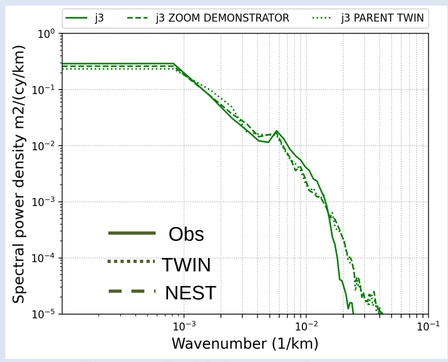

Figure 3: SLA spectrums

- **Tides : Validation with FES2014:**
  - NEST : Good agreement with FES (differences < 15cm)
  - Underestimation in NEST, overestimation in TWIN = Drag boost and bathymetry change
  - Continuous tidal solution across the nest boundaries

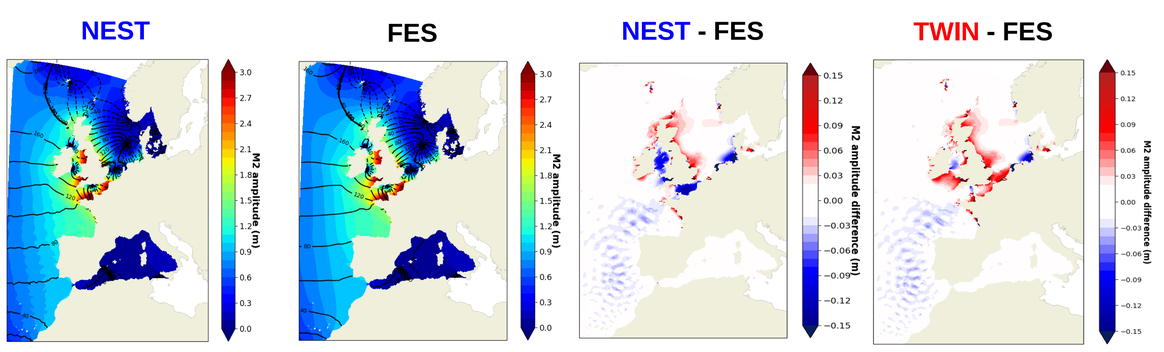

Figure 4: M2 amplitude, comparison with FES2014

- **The two-way nesting enables a realistic and continuous large scale solution across the nest boundaries**

Resolution impact on energetic levels

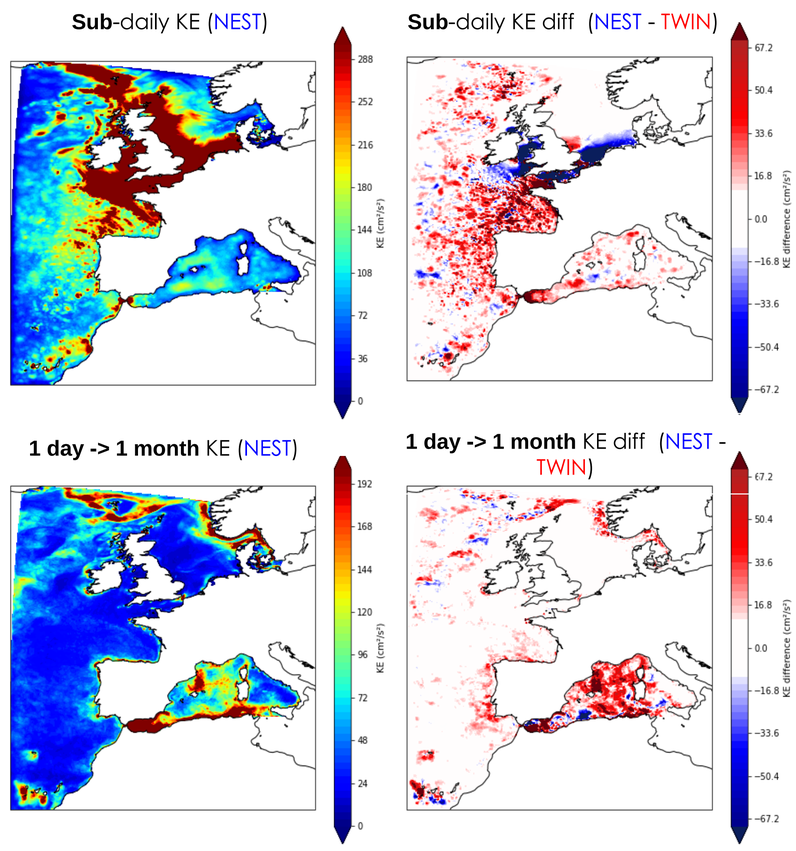

Figure 6: KE (left) and KE differences (right, NEST – TWIN) averaged over 2017

- **Comparison with TWIN**
- **Subdaily KE:**
  - Strong KE induced by tides over the continental shelf
  - Internal waves (ITW) signature in KE over in the bay of Biscay and north-west of the Iberian peninsula
  - Changes in KE over the shelf = changes in tidal amplitude
  - Increase of the ITW signature in KE in NEST
- **KE for scales between 1 day and 1 month:**
  - Small Rossby radius of the Mediterranean sea = better resolved structures in NEST

Conclusion & perspectives

- eNEATL36 + BIzoo = test case for NEMO 4.2
- The high resolution nested configuration eNEATL36 + BIzoo was successfully implemented
- Two-way nesting : realistic & continuous solution across the nest boundaries
- The nest increase the KE signature of ITW, and of the mesoscale structures in the Mediterranean sea
- **Next steps:**
  - Validation of currents at small scales with observations
  - Modal analysis: nest impact on small scales
  - Additional tests: Increase of vertical resolution, wetting & drying

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