IMMERSE realistic configuration: WP6_Task1

Demonstrating impact on CMEMS systems

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Outline

1. Target configuration description
2. The IMMERSE developments tested
3. Plan and status
4. First Results
5. Issues
6. Next steps

Target configuration description

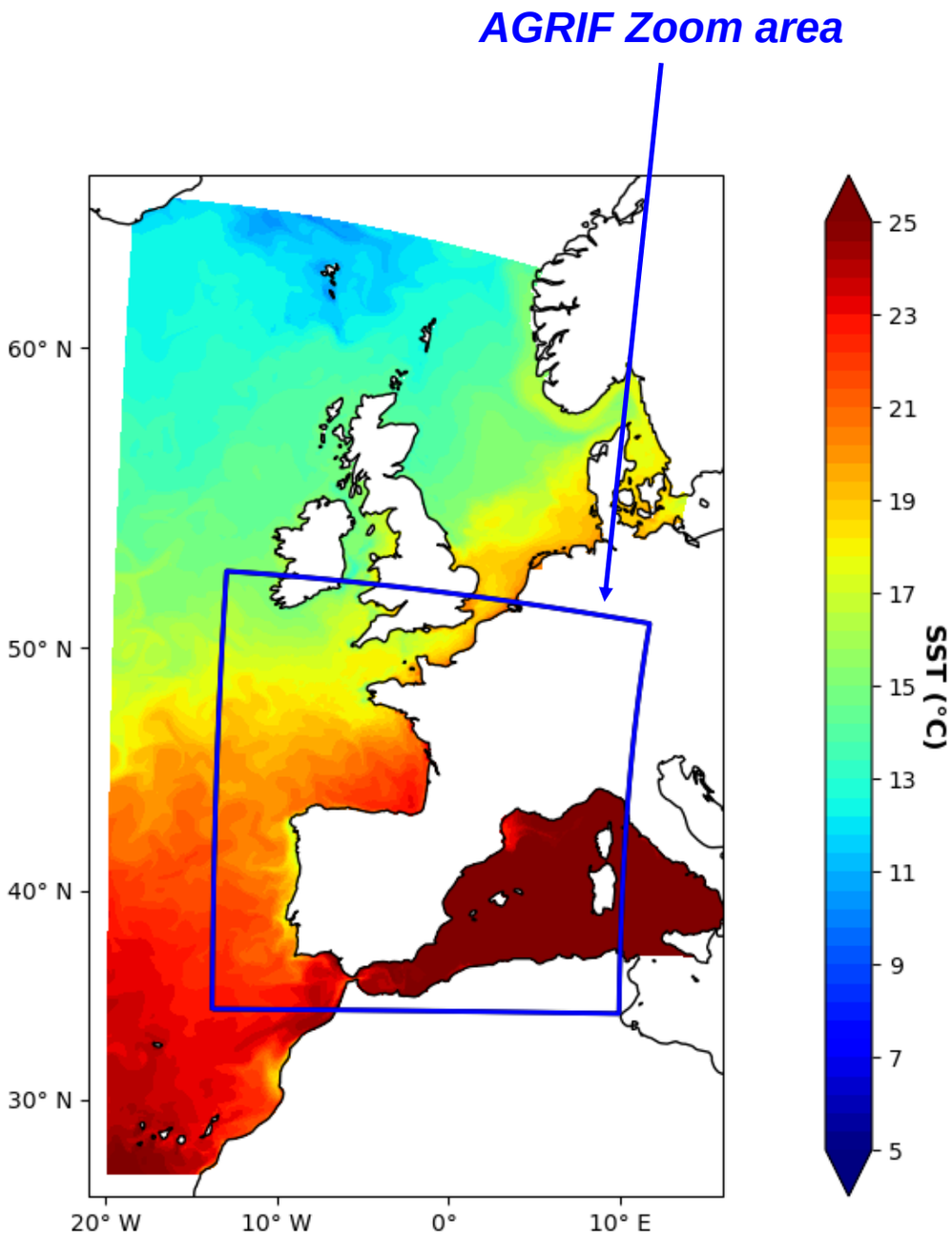
Configuration : eNEATL36 + AGRIF zoom (“IBI prototype like”)

- **Spatial resolution :**
  - eNEATL36 : 1/36° => ~2-3 km
    => 2 450 836 points
  - AGRIF zoom : 1/108° => kilometric resolution
    => 6 870 915 points

- **Temporal resolution :**
  - eNEATL36 : 150s
  - AGRIF zoom : 50s

- **Forcing :**
  - Atmospheric : IFS
  - Initial & lateral boundary condition : 1/12° CMEMS operational product
  - Tides : FES2014
  - runoffs (Several sources)

- **Period : January 2017 to mid 2018**



Averaged SST over 2018 on the eNEATL36 domain
Futur zoom is indicated with the blue squarre

Tested developments

- **AGRIF zoom**

- **HPC tests :**
  - Overall code performance improvement compared to NEMO4.0 version
  - Halos and tiling

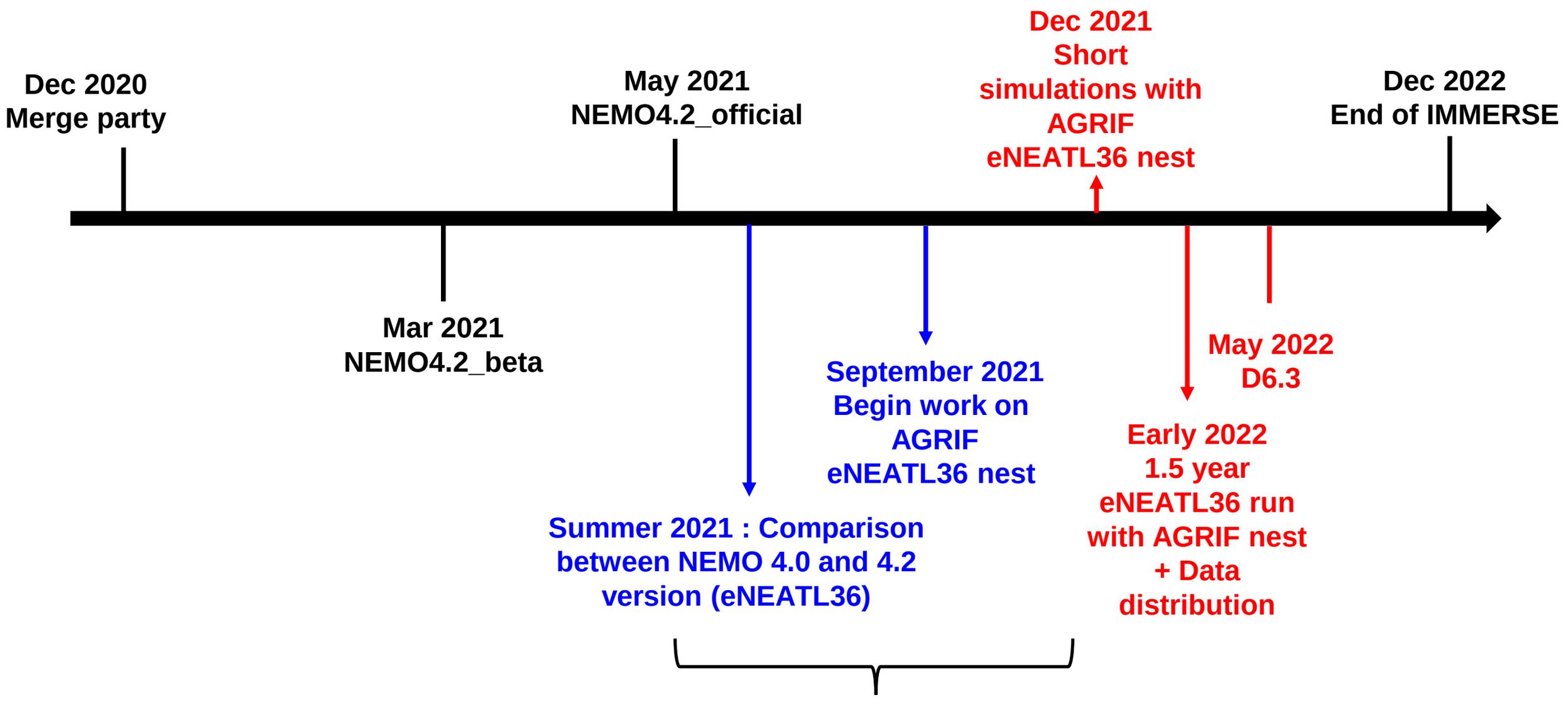
- **New IMMERSE parameterisations**
  - Renault et al. (2017) Current feedback parameterisation
  - Skin SST parameterisation

- **New IMMERSE schemes :**
  - New 4th order advection scheme
  - Vertical coordinate : QCO (Quasi – eulerian Coordinate) instead of VVL (Variable Volume Level)

- **New Emodnet bathymetry :** ~100m resolution instead of ~1km resolution (GEBCO)

- **Further tests (if time permits) :** Lemarié et al. (2021) atmospheric boundary layer parameterisation

Plan and status



Additionnal IMMERSE development tests :

- HPC : Code performance (**done**), Halos and tiling (**ongoing**)
- New IMMERSE parameterisations and schemes (**ongoing**)
- New EMODNET bathymetry (**done and validated**) (Not shown because it is not an IMMERSE development)

Results

Comparison/validation of twin NEMO 4.0 and 4.2 experiments over the 2017/08 – 2018/12 period

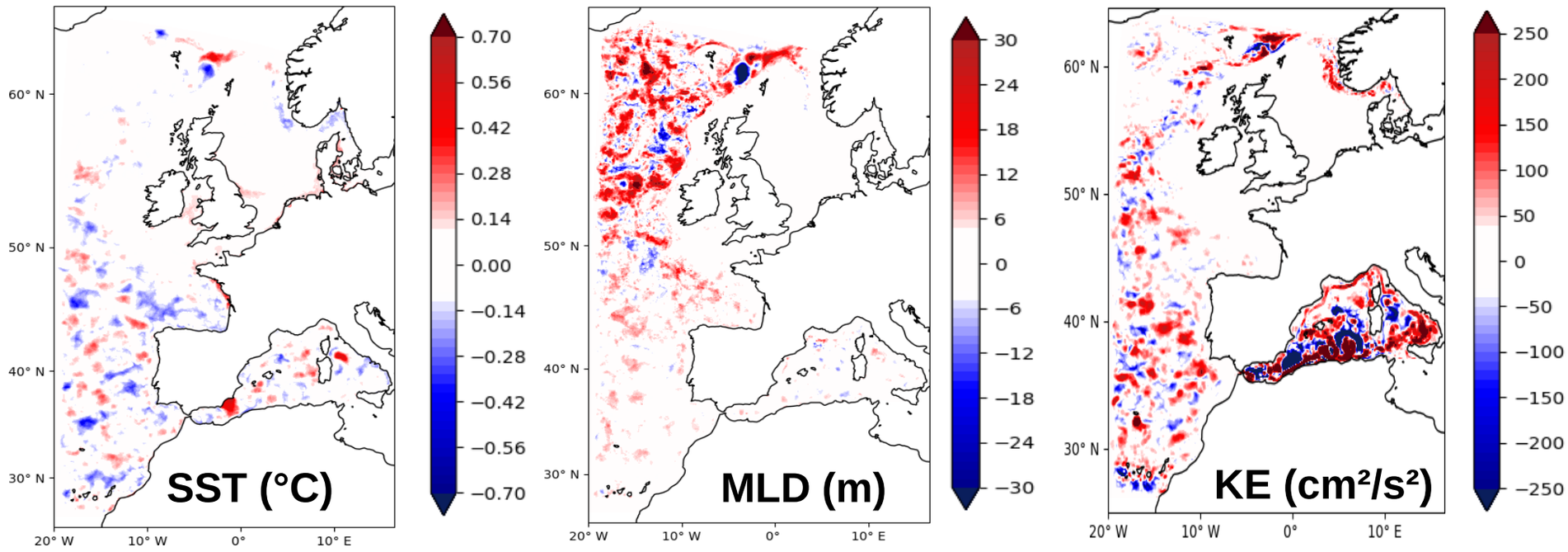
- **Objective :** **estimate the differences between NEMO4.0 and NEMO4.2**

- **Setup :** 2 simulations (with the **4.2-RC** and **4.0-HEAD** versions)

  - Same parameterisations / physical schemes and forcing (boundary and initial conditions, runoffs, tides, atmospheric forcing…)

  - Only difference: QCO in 4.2-RC and VVL in 4.0-HEAD (VVL issue in NEMO4.2-RC)

4.2-RC - 4.0-HEAD differences (averaged over 2018)



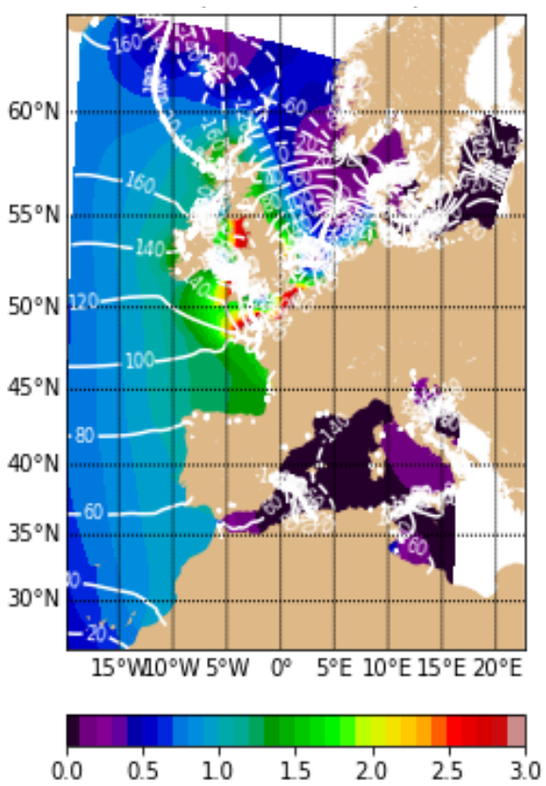
- **Results :** **No changes in mean state of KE, SST, MLD or SSS** (when the same parameterisations are used), but changes at mesoscale

Results

Comparison/validation of twin NEMO 4.0 and 4.2 experiments over the 2017/08 – 2018/12 period

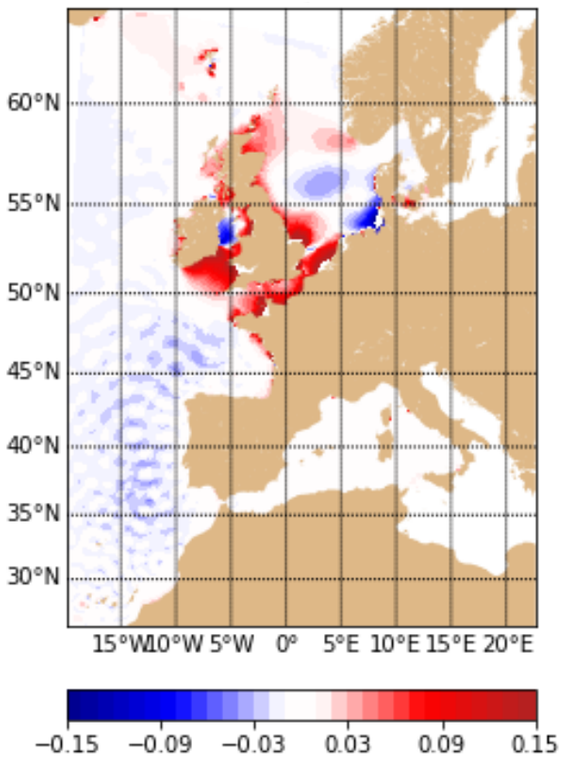
- **Tides comparison :** Harmonic analysis & comparison with FES2014

FES

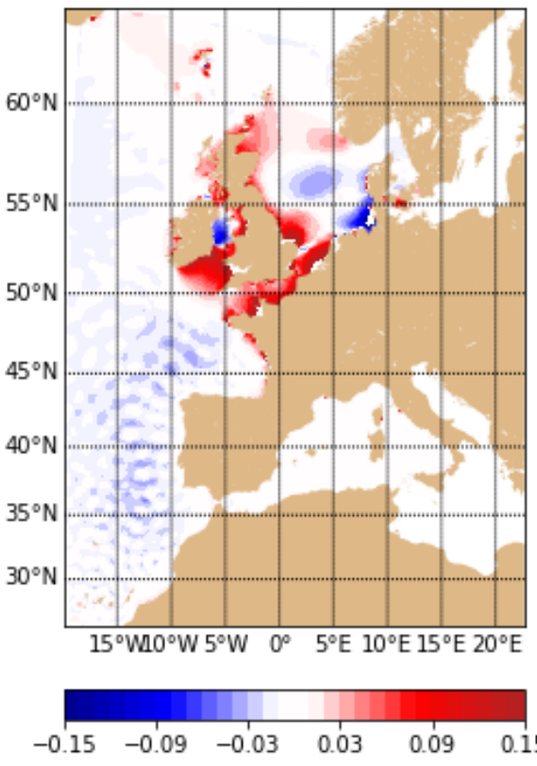


M2 Amplitude (m) and phase

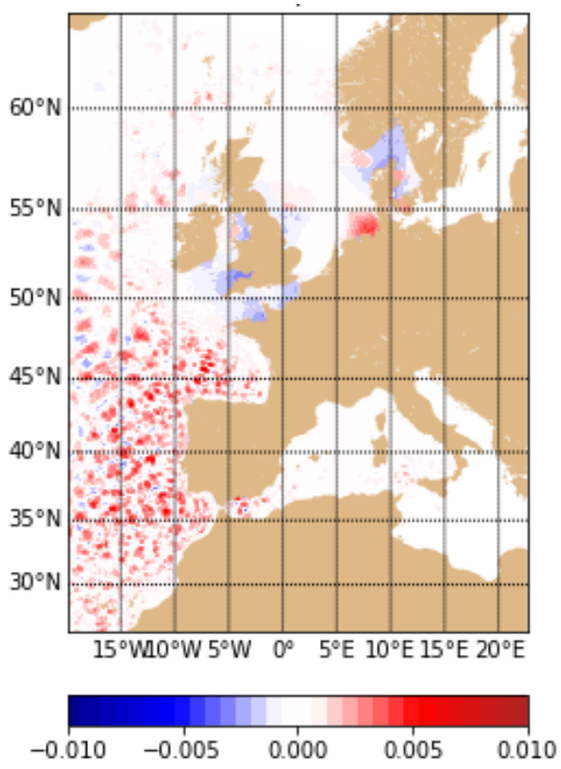
4.2-RC - FES



4.0-HEAD - FES



Diff RMSE (4.2 – 4.0)



M2 Amplitude differences (m)

- **Results :** - Small changes in mean tidal amplitude.
  - Changes in internal waves signature (QCO versus VVL ?)
  - Tide amplitude differences with FES consistent with Maraldi et al. 2013

-> NEMO4.2-RC seems OK in macroscopic point of view

Results

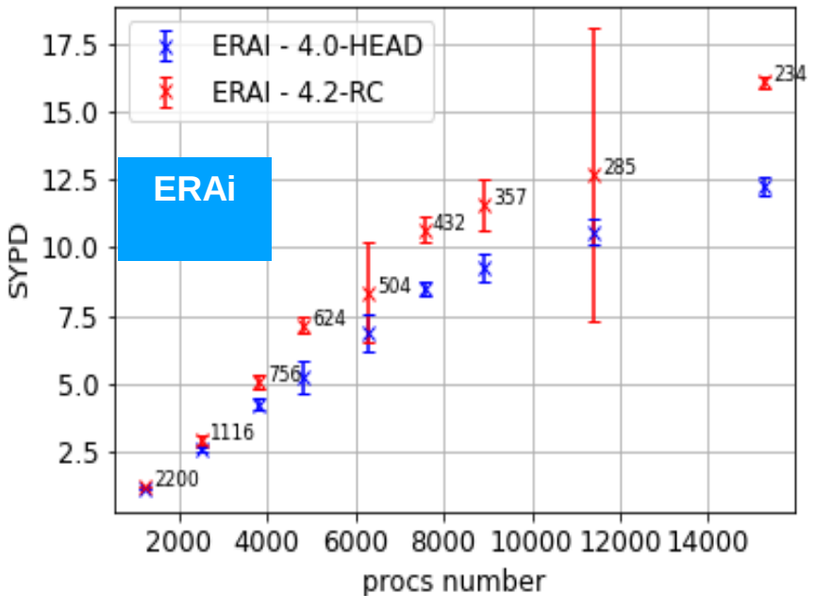
HPC tests :

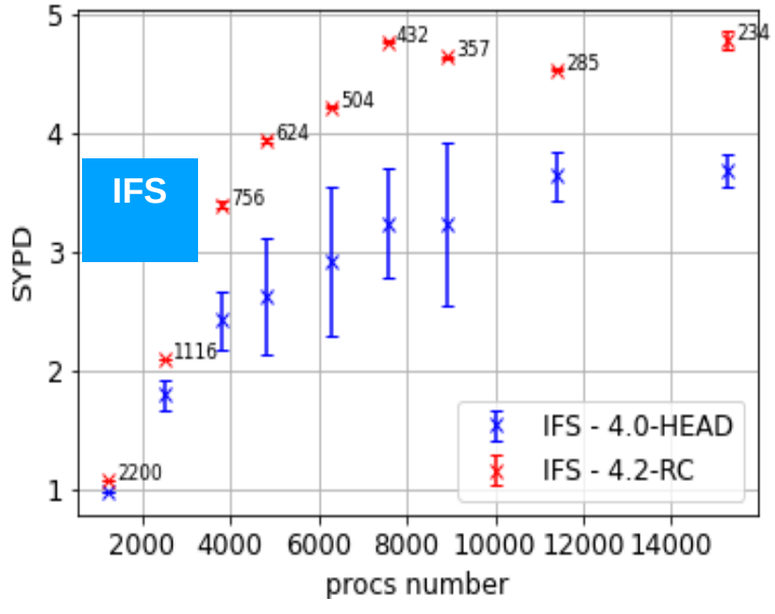
- **Objective :** show differences between HPC cost of NEMO4.2-RC versus NEMO4.0

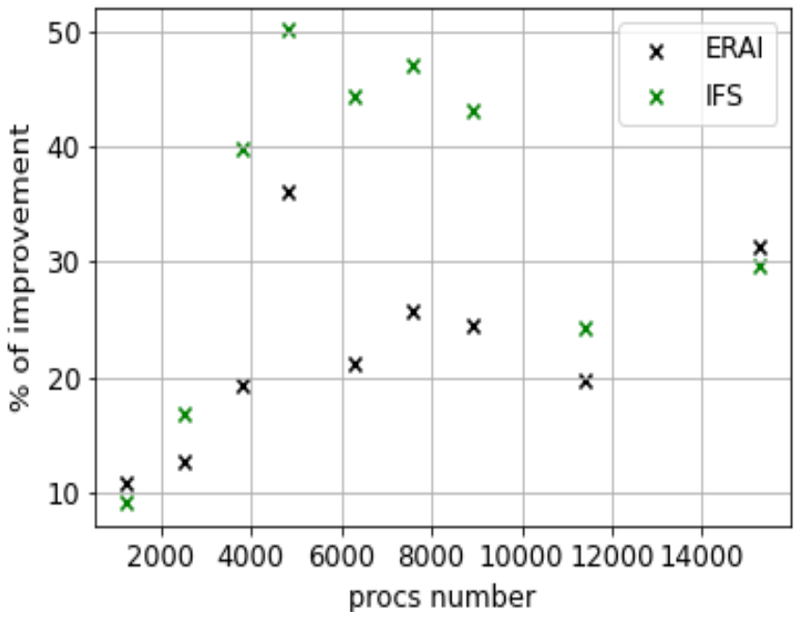
- **Setup :**
  - **NEMO4.0-HEAD** – VVL – jpni*jpnj = Nprocs (no procs suppression over land)
  - **NEMO4.2-RC** – QCO – jpni*jpnj = Nprocs (no procs suppression over land)

  → 5 simulations of 7 days per number of processors

SYPD vs number of processors ***SYPD vs number of processors*** ***% of improvement (>0 = NEMO4.2 is faster)***







- **Results :**
  - NEMO 4.2-RC (with QCO) is 1**0% to 50% faster** than 4.0-HEAD (with VVL)
  - Better improvement when using IFS (rather than Era-Interim)
  - Using ERA-Interim is 2 to 3 times faster than using IFS

Issues

AGRIF issues

- **Inconsistencies in the input mesh generated by the new domain_cfg tool**
  => Bugfix in progress (J. Chanut)

- **Inconsistencies with QCO :**
  => QCO formalism does not enable the correct feedback of volume

- **Rivers:**
  - On the current eNEATL36 configuration, rivers are prescribed as boundary conditions (BDY) but BDY not compatible with the current AGRIF version

  => 2 solutions :
  - Modify AGRIF code (strong developments required)
  - Convert BDY runoffs to 2D runoffs data (ongoing)

- **Change of coastline when using AGRIF**
  => Development of a python program to replace and redistribute runoff data near the coast (ongoing)-

HPC issues

- Find best tuning of tilling

Data distribution issues

- Find best way for Data distribution for Project and for the community

=> Test transfer from Météo-France to a THREDDS at PdE (on-going)

Next steps

- Firsts tests with AGRIF on a small zoom (over eNEATL36) => Ongoing
  - Tests with tides, runoffs

- Evaluate the impact of new NEMO4.2 parameterisations => Ongoing

- End of 2021 : short runs (1 week) on the large zoom

- End of 2021 – End of 2022 : Comparison with in-situ data (IMMEDEA)

- Early 2022 : 1.5 Year AGRIF simulation and validation

- Mid 2022 : data distribution and further tests (ABL, convection parameterisation ?)

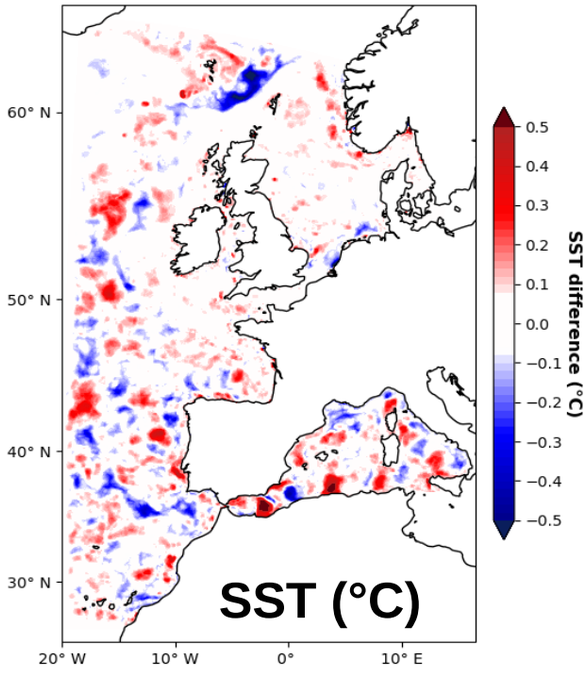
Results

Using the new EMODNET Bathymetry

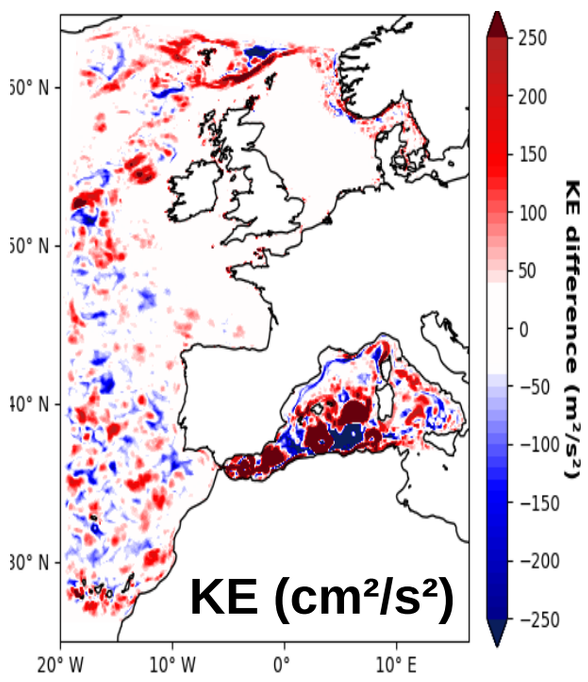
- **Comparison of twin NEMO4.2 experiments over the 2017/08 – 2018/12 period**

  - The only differences between the two runs is the bathymetry used
  - **OLD** = GEBCO (~1km), **NEW** = EMODNET (~100m)

NEW - OLD

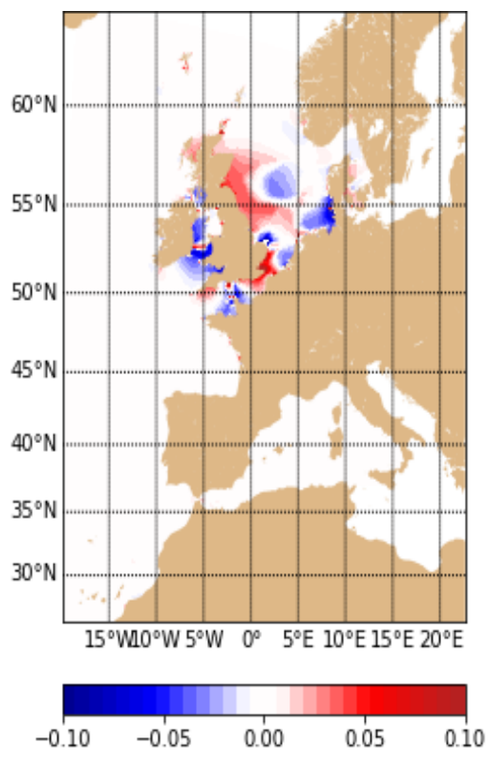


NEW - OLD



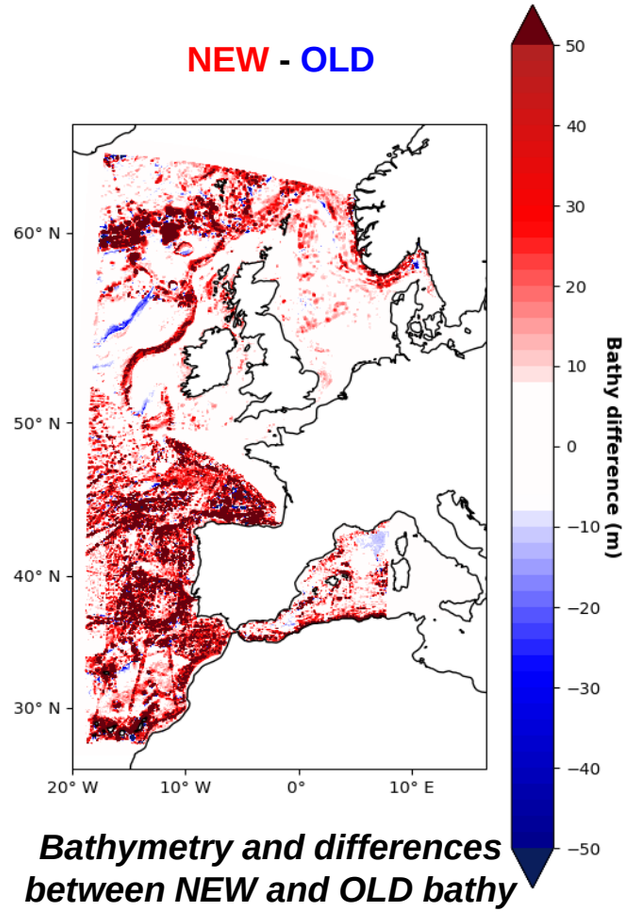
Differences averaged over 2018

NEW - OLD



RMSE (with FES) on M2 amplitude differences

NEW - OLD



Bathymetry and differences between NEW and OLD bathy (m)

- **Results :**

  - Using the new EMODNET bathymetry **does not change** the mean state of SST, SSS, KE or MLD, and **does not deteriorates** the tidal solution
  - Smaller transport in Gibraltar Strait with new Bathy