

IMMERSE realistic configuration: WP6-Task3

“Impact of NEMO developments on the global forecasts”



Demonstrating impact on
CMEMS systems

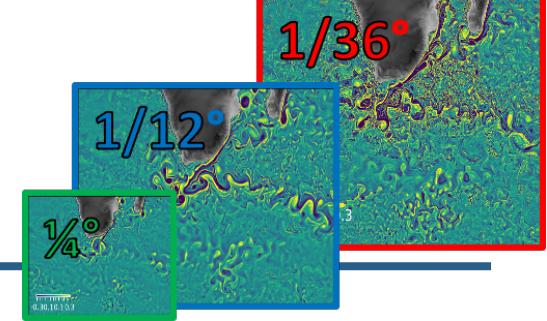
Clément Bricaud (Mercator Ocean)
Dorotea Iovino (CMCC)
Jean-Marc Molines (CNRS/IGE)
Miguel Castrillo (BSC)



Outline

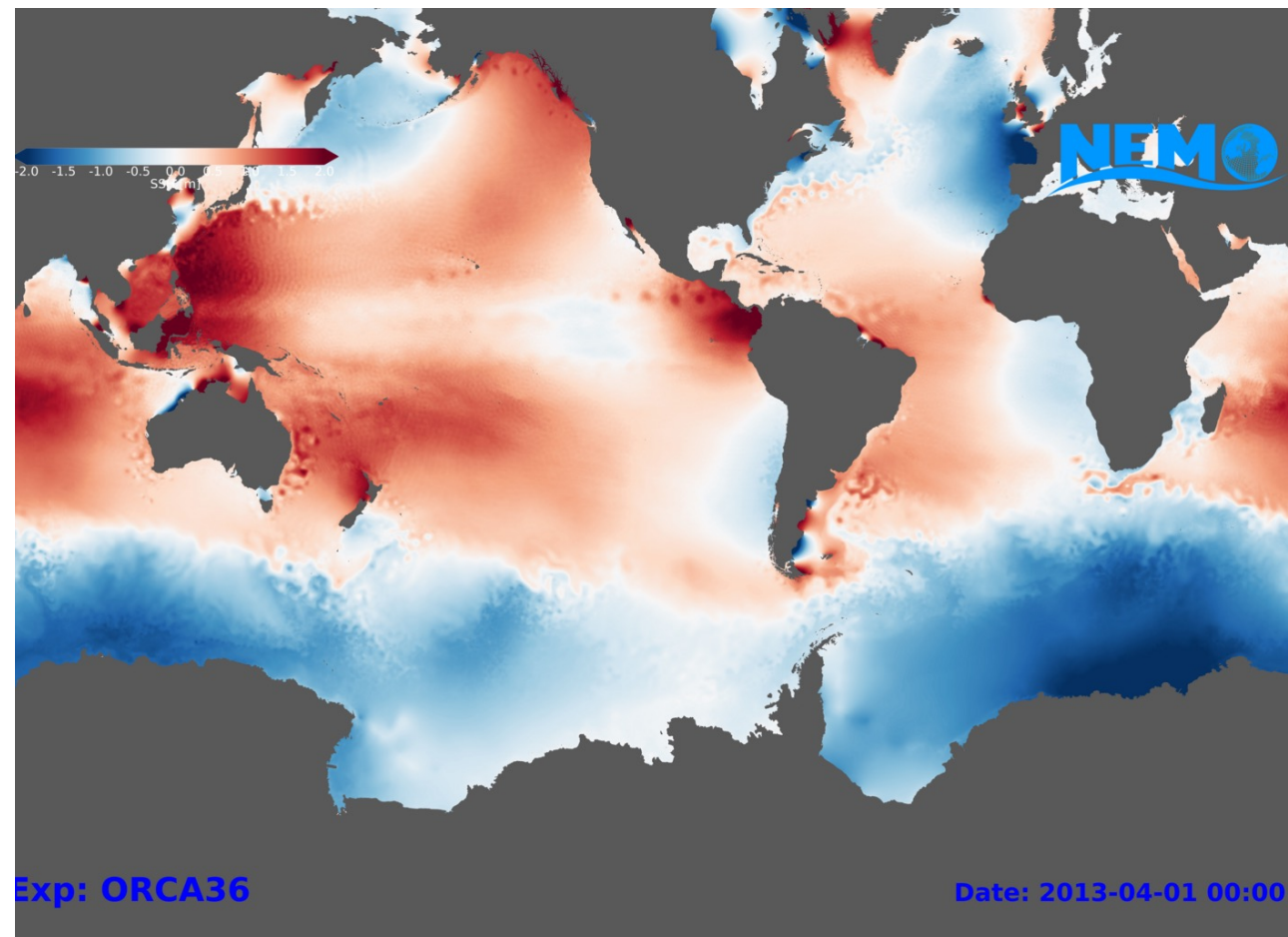
1. Target configuration description
2. The IMMERSE developments tested
3. Plan and status
4. First Results
5. Issues
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Target configuration description



A high-resolution global configuration at $1/36^\circ$ (2-3 km) horizontal resolution

- Horizontal grid : ORCA tripolar grid, 12960 * 10850 points
- Vertical grid: 75 Z-levels, 1 meter at surface
- with southern cavities (under ice shelf seas)
- with tidal forcing (o1, k1, m2, s2, n2 and use Self Attraction Loading)
- Forcing dataset: based on ECMWF/IFS system (1 hour time frequency and $1/14^\circ$ spatial resolution)





Tested developments

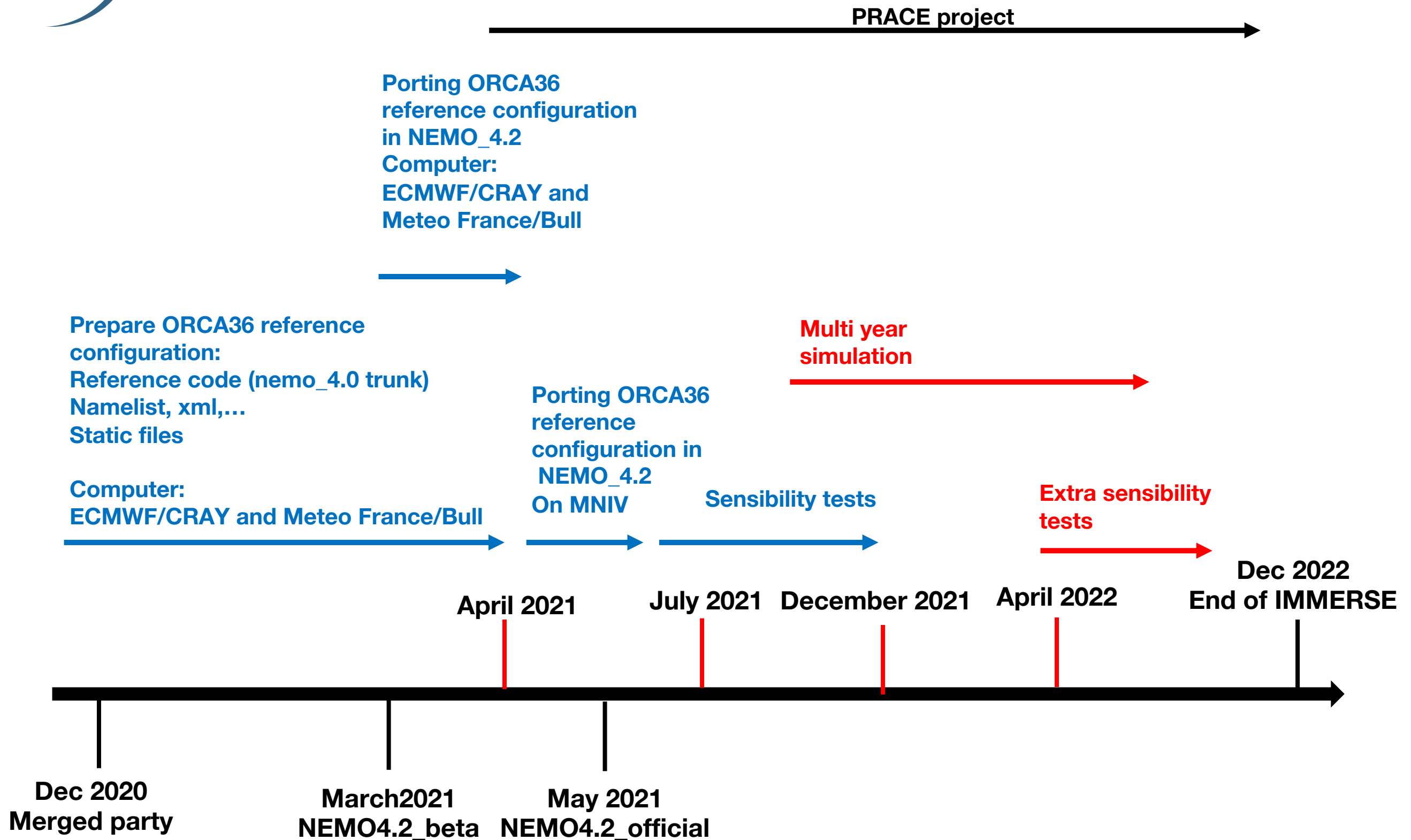
Developments from IMMERSE:

- XIOS read/write restarts
- Tiling
- Loop fusion
- Wider halo
- Diagnostics on GPU
- Collective neighborhood communications (mpi3 optimization)
- New time-stepping scheme (based on RK3)

Outside IMMERSE (H2020 ESIWACE2 project):

- Mixed precision
- XIOS 2 levels servers

Plan and status



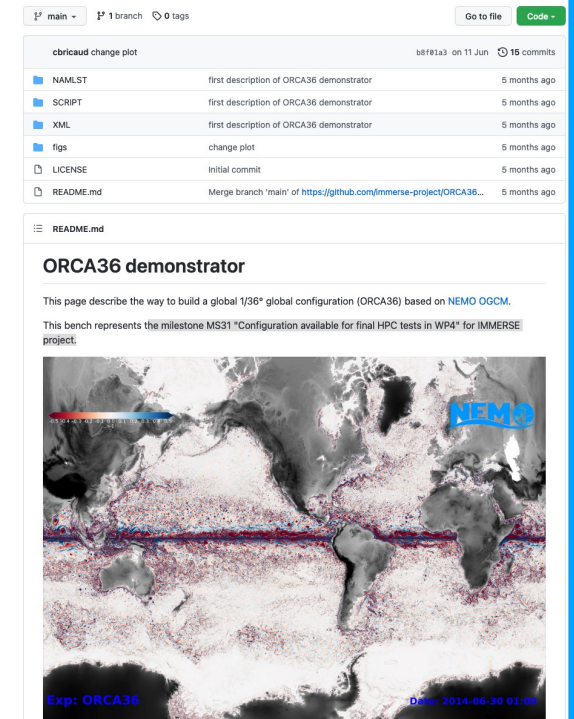
Results

A first hindcast produced end 2019/early 2020

- 18 months run with ORCA36
- new Meteo France Bull computer
- 30.000 cores for NEMO
- 2 to 3 months can be simulated per days
- 3D daily and 2D hourly outputs with XIOS
- Forced by IFS at $1/8^\circ$ and 3 hours resolution
- No cavities, no tidal forcing

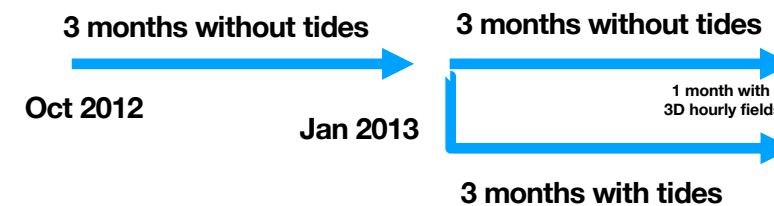
A bench/demonstrator is available on
IMMERSE github:

<https://github.com/immerse-project/ORCA36-demonstrator/>

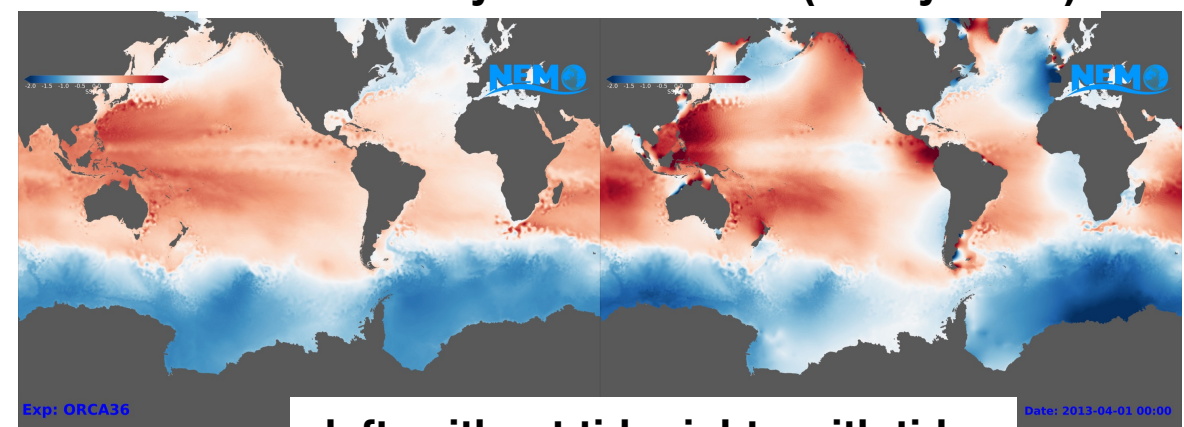


A new short experiment produced in 2021

- with southern cavities
- Without and with tidal forcing (o1, k1, m2, s2, n2 and use Self Attraction Loading)
- Bathy: based on GEBCO 2019
- Forcing dataset: improve ECMWF/IFS resolution
 - Time: from 3 hours to 1 hour
 - Space: from $1/8^\circ$ to $1/14^\circ$



SSH anomaly after 3 month (hourly mean)



left: without tide right : with tides



Results: HPC tests

XIOS read/write restarts

nn_wxios		0=NO			1=mono			2=multi		
		test1	test2	test3	test1	test2	test3	test1	test2	test3
ln_xios_read	F	03:41:47	01:08:47	01:08:07	03:13:03	01:29:03	02:27:04	01:15:28	01:10:55	01:11:09
	T	01:54:24	01:50:22	01:54:35	01:56:27	04:24:45	01:55:08			

Using XIOS to write restart files:

- Multiple file mode: no increase in elapsed time
- One file mode : increase in elapsed time

Using XIOS to read restart files:

- Multiple file mode: not possible
- One file mode: increase in elapsed time

Collective neighbor communications (MPI3)

=> Tested on MN4, no change in elapsed time

XIOS 2 levels servers

=>Memory issues for XIOS on MN4 for ORCA36; Preliminary tests with ORCA12 configuration in progress

Results

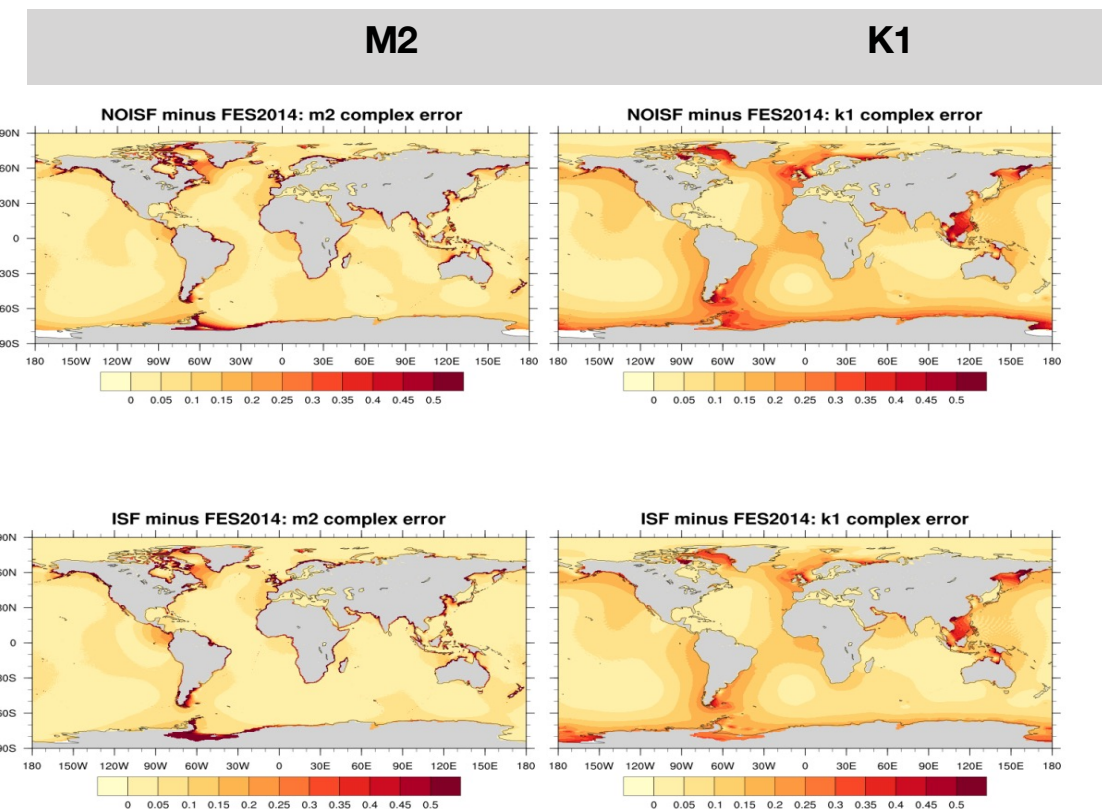
- At lower resolution, we test the impact of southern cavities on tidal solution
- Adding southern cavities improve tidal solution at global scale for all components

Error (cm)	M2	K1	O1	N2	S2
no cavity	8,50	6,17	2,37	1,24	2,66
cavities	6,49	2,20	1,77	1,07	2,03
gain	2	4	0,5	0,17	0,63

Tidal solution errors to FES2014
for the global 1/12° (ORCA12) configuration

ORCA12
without cavity

ORCA12
with cavities



Tidal solution errors to FES2014
for the global 1/12° (ORCA12) configuration

Results

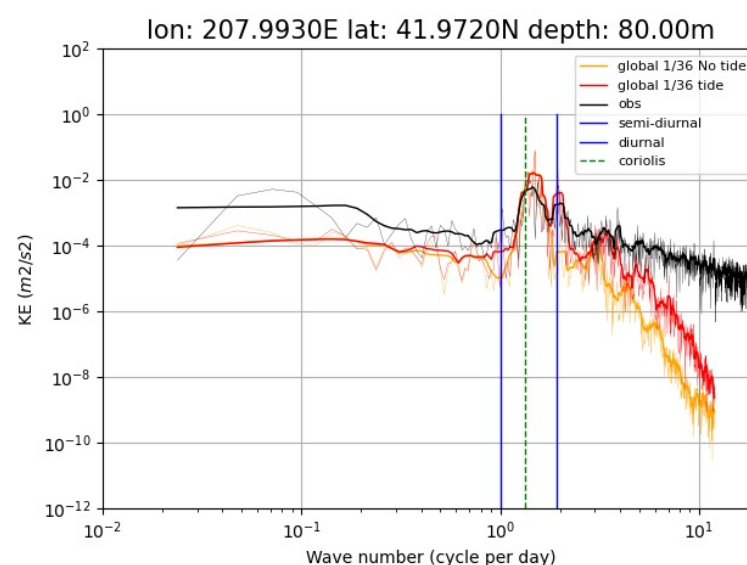
Before performing a multi-year hindcast, short runs without/with tidal forcing (at $1/4^\circ$, $1/12^\circ$ and $1/36^\circ$) are performed, forced by ECMWF/IFS 1h-resolution

Tidal solution error compared to FES2014 are divided by 2 with $1/36^\circ$ resolution, compared with global $1/4^\circ$

	1/4	1/12	1/36	Error(1/4)/error(1/36)
M2	7.2	5.2	3.1	2.31
K1	7.0	6.4	3.5	2.
O1	2.3	1.8	1.2	1.9
S2	2.8	2.1	1.4	2.
N2	1.4	1.4	0.6	2.33

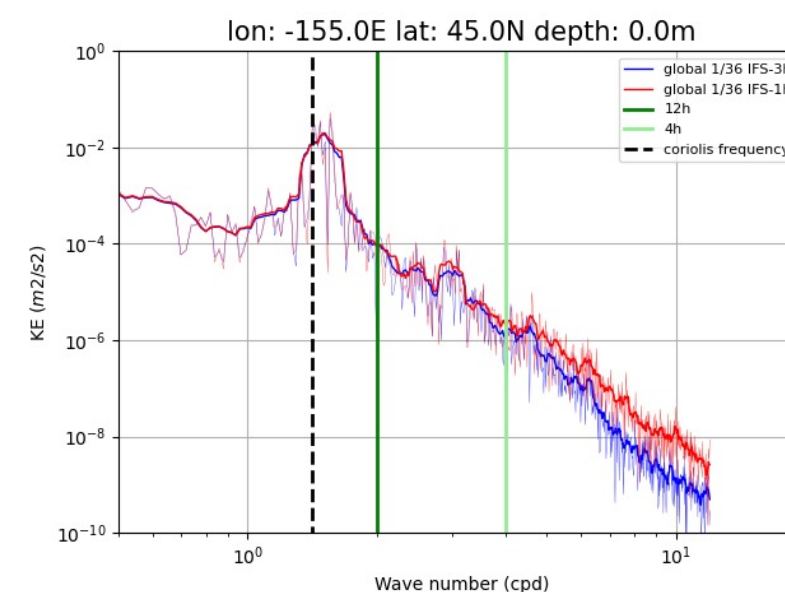
Tidal solution errors to FES2014 for the global $1/4^\circ$, $1/12^\circ$ and $1/36^\circ$ configurations

Tidal forcing improve finer time-scales energy



spectrum decomposition of KE in time domain, from ORCA36 and current meter velocities

Hourly atmospheric forcing increases energy at finer time-scales



spectrum decomposition of KE in time domain, from ORCA36



Issues

- XIOS: Memory issues for model outputs on BSC/Mare Nostrum 4

=> Looking at processes distribution, XIOS release,...

⇒ Switch to ECMWF/CRAY computer to produce a first ORCA36 multi-year hindcast

⇒ 2.5 years already produced.

- NEMO/interpolation on the fly: memory issues with big input files (2D or 3D)

=> interpolation of field on eORCA36 grid is done in pre-processing



Next steps

HPC tests:

Wider halo/Tilling/Loop fusion

- Will be done in 2022

Mixed precision

- preliminary tests to do with ORCA12

Diagnostics on GPU

- Will be done on computer with GPUs: CINES, CINECA, Météo France/BULL

XIOS 2 levels servers

=>test with ORCA36 configuration will be done on ECMWF/Cray or new ECMWF/Bull

New time-stepping scheme (based on RK3)

- Will be done when the development will be ready

Multi annual run:

- The code is running, the configuration exists and it has been tested over 6 months
- 2.5 years produced
- Continue the production on ECMWF/CRAY computer. Will switch on their new BULL computer.