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
6. Next steps

Target configuration description

A high-resolution global configuration at 1/36° (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° spatial resolution)

Tested developments

Developments from IMMERSE:

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

Outside IMMERSE:

- Mixed precision
- XIOS 2 levels servers

Plan and status

PRACE project

Porting ORCA36 reference configuration in NEMO_4.2
Computer: ECMWF/CRAY and Meteo France/Bull

Prepare ORCA36 reference configuration:
Reference code (nemo_4.0 trunk)
Namelist, xml,…
Static files

Computer: ECMWF/CRAY and Meteo France/Bull

Porting ORCA36 reference configuration in NEMO_4.2 On MNIV

Sensibility tests

Multi year simulation

Extra sensibility tests

Dec 2020 Merged party

March2021 NEMO4.2_beta

May 2021 NEMO4.2_official

April 2021

July 2021

December 2021

April 2022

Dec 2022 End of IMMERSE

Results

A first hindcast produced end 2019/early 2020

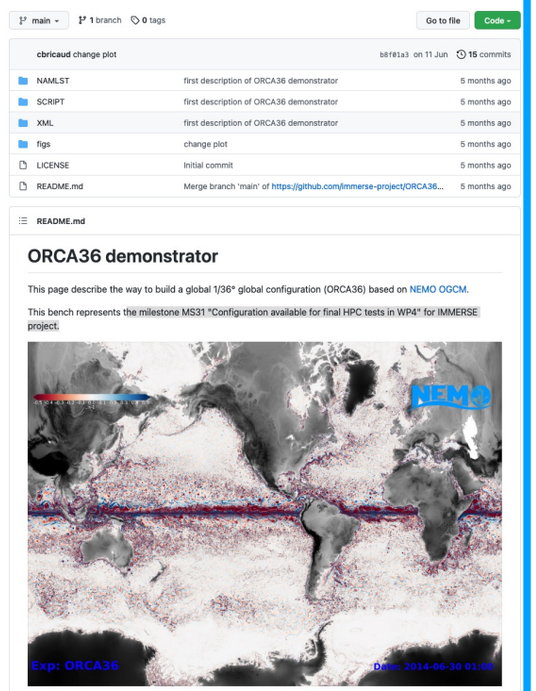
- 18 months run with ORCA36

- 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° and 3 hours resolution
- No cavities, no tidal forcing

A bench/demonstrator is available on IMMERSE github:

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



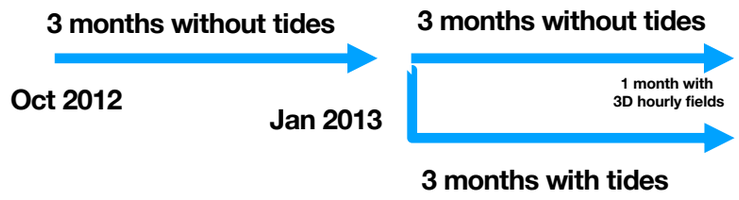
A new short experiment produced in 2021

- with <u>southern cavities</u>
- Without and with <u>tidal forcing</u>

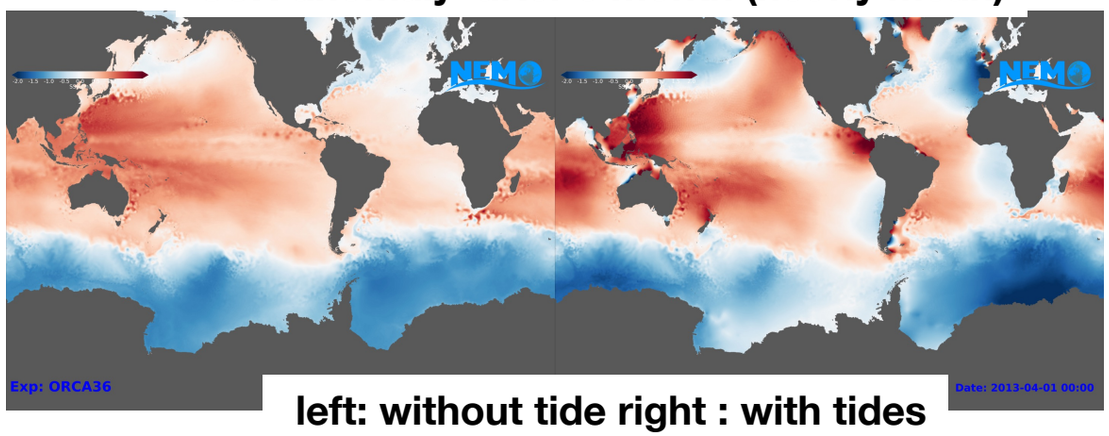
(o1, k1, m2, s2, n2 and use Self Attraction Loading)

- Bathy: based on GEBCO 2019

- Forcing dataset: improve ECMWF/IFS resolution
  - Time: <u>from 3 hours to 1 hour</u>
  - Space: <u>from 1/8° to 1/14°</u>



SSH anomaly after 3 month (hourly mean)



left: without tide right : with tides

Results

Impact of cavities on tidal solution

Compare runs at 1/12° resolution
- with tidal forcing
- Without/with cavities

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

Global 1/12° errors to FES2014

=> Adding southern cavities improve tide solution at global scale for all components

Impact of resolution on tidal solution

Compare runs at ¼°, 1/12° and 1/36° resolution
- with tidal forcing
- with cavities

N2	1/4	1/12	1/36
M2	0.072	0.052	0.031
K1	0.070	0.064	0.035
O1	0.023	0.018	0.012
S2	0.028	0.021	0.014
N2	0.014	0.014	0.006

Global ¼°,1/12° and 1/36° errors to FES2014

⇒ Resolution improve tidal solution in global configurations
⇒ Between ¼ and 1/36, errors to FES2014 are divided by 2

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; will test it soon on MF/Bull or ECMWF/Cray

Issues

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

=> Looking at processes distribution, XIOS release,…

⇒ Other computer available (Météo France / BULL, ECMWF/Cray)

⇒ MN4: Try to start with few model outputs ?

⇒ MN4: Using high memory node for XIOS ?

- 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 start soon

Mixed precision

- preliminary tests to do with ORCA12; ok for dec2021

Diagnostics on GPU

- Not started
- Others new computers in 2022 (CINES, CMCC)
- Ready to tests; see with Vineet to run it on 3 nodes of GPU on the MF/BULL
- Dorotea: CINECA

XIOS 2 levels servers

=>Memory issues for XIOS on MN4; will test it soon on MF/Bull or ECMWF/Cray

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
- Will start soon

Questions ?