

# Report of the DRAKKAR meeting Grenoble, February 2010

This short report summarizes the conclusions of the group regarding the common strategy of simulations. The scientific discussions following the talks are not reported here (the talks are available on the Drakkar web site).

## 1 Reports of activity from the different teams

**In Kiel**, the modelling work is organized in projects, each addressing different scientific questions.

- Southern ocean Agulhas: there is a new DFG project about the response of the ACC to recent climate change. The ITN (Marie Curie Initial Training Network) Gateway has just started (J. Durgadoo PhD student, will develop an embedded zoom in the Kiel climate model).
- North Atlantic MOC: Eric Behrens works in the THOR project (study freshwater input from Greenland at various resolutions, develop AGRIF zoom in the subpolar gyre)
- New project on gas hydrates: can we use sigma coordinates to improve the representation of the ocean bottom temperatures?
- A DFG ongoing project on equatorial dynamics and oxygen minimum zones.

### **NOCS Southampton**

The project OCEAN 2025 funds about 8 people working on modelling with NEMO. Part of the work is also done within the MyOcean project. The configurations are ORCA1, ORCA025, development of ORCA12. A few are (non exhaustive list)

- projects on global tides and internal waves
- sill flows, statistical modelling of overflows (Smeed, Challenor);
- projects on sea ice: compare CICE and lim, develop embedded ice, study the effect of surface waves on the lateral melting...
- Biogeochemistry: compare different biogeochemical models, MEDUSA and HADDOCC (in ORCA1).

### **UK Met Office**

There is a convergence of model configurations in the U.K., and collaborative work. The MetO develops a model hierarchy for seamless seasonal, centennial time scales, earth system modelling on longer time scales.

The configurations are ORCA2, ORCA1 and ORCA025 coupled with HADGEM (and CICE for ice model).

We have several 30 years runs. Some parameters of the namelist have a large effect on SST (nn\_etau: penetration of wind-induced EKE). We need to understand this better. Preliminary results at high resolution are encouraging (ITCZ, path of the NAC).

### **French DRAKKAR project**

The DRAKKAR project is funded for 3 years (2010-2012) in the form of a coordination of model developments, used for a number of scientific projects funded by various agencies

(for example Southern Cross for the Southern Ocean (J. Le Sommer), joint use of model and altimetry to study ocean variability (T. Penduff et al), new projects of J. Deshayes (variability of the Irminger and Labrador sea) and X. Capet (submesoscale modelling and parameterizations). The main themes are:

- Global configurations: improvement of ORCA025, development of ORCA12.
- Continuous validation and development of forcing data;
- Development of the code: parameterizations, input/output, database management, CDFTOOLS...
- Enhancing capability and tools or regional configurations (AGRIF, boundary conditions)

**Reanalysis projects** (Reading, MERCATOR). K. Haines (Reading) has plans for assimilation using NEMOVAR and ORCA1 75 levels with CICE. Reanalysis work is coordinated with U.K MetO. There are plans to assimilate RAPID data. Interests: study of oceanic circulation and transport, arctic strait transports, etc. Regarding the Glorys reanalysis(MERCATOR, DRAKKAR), preliminary results are presented by L Parent, N. Jourdain, and C. Lique (see talks). The biases in the deep ocean and equatorial oceans are discussed (but no suggestion of an easy way to fix them...)

**Parameterizations** . Julien Le Sommer plans to implement a new anisotropic parameterization in the momentum equation. Georges Nurser (NOCS) may work on the BBL parameterisation (Killworth and Edwards).

### **NEMO system team (Rachid Benschila)**

NEMO is used in 40 countries by about 450 users (50 projects). Among them DRAKKAR, Myocean, IPCC-AR5, VODA (ANR, data assimilation)...

We have upgraded the code in version 3.2: the light penetration with 3 wavebands and ocean colour data, tidal mixing, new ice model Lim3, an update of the TKE parameterization. The nonlinear free surface is now updated (many bugs have been fixed). We have suppressed the rigid lid option and cleaned the mpp code. There will be no new version in 2010 (the aim is to consolidate version 3.2).

In 2011 we will focus on the coastal ocean with improved time splitting, implement the observation vector (for data assimilation) as an online diagnostic tool. NOCS has revisited the air/sea flux forcings, to take into account the temperature and salinity of all water exchange between ocean and other compartments (ice, atmosphere, runoffs). We have suppressed emp and emps (one single field for salinity and volume equations?). We plan to implement a new vertical coordinate (PhD M. Leclair, LOCEAN) and a new pressure gradient computation from POL. There are two versions for managing the runoff (MERCATOR and MetO), perhaps the Exeter version will be put in the reference in the end.

Andrew Coward mentions a bug in trc iso (the bug did not appear in the vopt version of the routine, so that it had an impact only on scalar machines and took time to find out). We should avoid to have two versions of the same routine.

## **2 The ORCA025 configuration**

Bernard Barnier presents results of the most recent experiment, ORCA025.L75-G85, run

with the new vertical grid (75 levels, 1m near the surface). There is a new bathymetry, the new EVP rheology form LIM2, and the diurnal cycle (calculated analytically, with earth rotation). The sensitivity to light penetration (now controlled by a climatology of sea colour) is being investigated. The model has been run with weaker salinity restoring (6 times less). This caused a larger drift of the sea level (correction made during the run) and there is more salinity drift.

Can we agree on the main challenges we face with ORCA025?

- overflows
- salinity restoring. Julien Le Sommer and Carolina Dufour have added a restoring in the deep water masses in the southern Ocean to maintain these water masses and avoid the decline of the ACC transport. Julien proposes also to investigate the method of Hallberg et al (2006) for surface restoring. Others propose to use the spectral nudging (coded in Canada). The discussion is inconclusive: we need to try different methods.
- Level of diapycnal mixing: this is always a challenge in a z-coordinate model (due to the advection operator). Adrian New mentions that there is less diapycnal mixing in CHIME.
- Under-ice shelf seas
- Iceberg advection, parameterize it perhaps like in the low resolution version of Goosse et al, use a seasonal cycle (remark by Julien when we spread the run off over 200km instead of just the grid point next to land, we improve the summer ice around Antarctica).

A few other problems are discussed: transport too high in Bering Strait, for example.

We need a strategy to always have an up-to-date simulation of ORCA025 (remark: excepted for the Glorys reanalysis, we don't have a simulation of the 2007 ice minimum, for example).

Regarding coordination of ORCA025, everybody doesn't agree yet to use 75 levels (Kiel keeps 46 levels, so does LSCE for biogeochemical tracers). It does not seem practical to run coordinated sensitivity studies this year. The possibility of building ensembles of simulations is mentioned (no conclusion).

### **3 High resolution modelling (1/12°): ORCA12 and NATL12**

We have encountered various problems with **NATL12** (Raphael Dussin, A.M. Treguier; see reports). There is some progress in the representation of the Med Water (by fiddling with the bathymetry- and with no relaxation to salinity in the Gulf of Cadiz) but not enough progress with the Nordic sea overflows, the salinization of the Labrador Sea or the Irminger sea (problem with the path of the NAC after 1995).

Romain Bourdalle Badie (Mercator) presents the **development of ORCA12**. A first simulation was run in 2008 (8 years). Then in 2009 the model was upgraded to NEMO3.1, the new rheology evp for LIM2, etc. 2 years of run were made with ERA Interim. A new bathymetry has been prepared (BASE 10 along the European coast, ETOPO1 without smoothing elsewhere. No hand modifications have been done). Tests on the advection schemes and parametrizations have been made in the Med sea

configuration MED12: comparison of TVD+ isopycnal mixing of 100m<sup>2</sup>/s, Quickest ultimate and ppm (the last two with no explicit lateral mixing). Quickest ultimate gives better TS properties and EKE?

Andrew Coward: **ORCA12 at NOCS**. We have used the MERCATOR version of ORCA12 to study the tides. We use the tidal forcing of Jerome Chanut. We run with nonlinear free surface and netcdf 4 on 925 processors. We will do a 75 level run, probably with CICE. V3.2 to study arctic ocean processes.

Marcus Schneider: **ORCA12 in Kiel**. For our ORCA12 runs, the focus is the Arctic (note that AGRIF does not work with the north fold boundary). One month runs in 6.5 h elapsed on 512 processors. . The plan is to run a 20 years spin up (before the end of june) and then 30-40 years of run. The first simulation has been difficult: need to reduce the time step to 72s, crank up the Asselin parameter to 0.2... Discussion: the constraint on the time step comes from the large (1.4m/s) velocities around Antarctica. The current is not restricted to the surface, so it is not sure the sensitivity is larger with the 50 mevel grid compared with the 46 levels. Romain has increased the viscosity over a few grid points around Antarctica to be able to run at 480s time step. Gurvan suggests to initialize with a ssh from ORCA025 instead of starting with a flat SSH.

### **Coordination of the development of ORCA12**

- Everybody should try to switch to NEMO 3.2 before doing long runs;
- Markus will compile a common list of options (cpp keys, namelists, etc). Kiel will keep 46 levels for the moment (for comparison with previous lower resolution models), the other groups use 75 levels.
- We agree to keep LIM2 EVP for the sea ice model at the moment. LIM3 needs to be validated at intermedaite resolutions first.
- We agree to continue using TVD/isopycnal mixing. Quickest/ultimate has not been tested for in large basins and long time scales. There may be an unacceptable level of diapycnal mixing associated with it.
- Mercator will be responsible for the bathymetry and runoffs (we need a documentation). The bathymetry needs to be improved (hand modifications). Perhaps ask Ariane to check the Indonesian throughflow? The minimum depth will be set to 20m. *(Remark by Andrew and Jean Marc : it is necessary to verify the mask so there are no ocean points inside land that are not connected to the ocean. Jean Marc found a lot of them around Antarctica).*
- Lateral boundary conditions: some want to modify them in places. For the Med sea the free slip condition does not work well. Romain will provide the file of "shlat" variations MERCATOR is using.
- Initial conditions: All use Levitus+PHC. The interpolation weights take forever to compute when using SOSIE for the interpolation. Markus will provide the weights. Mercator uses the on the fly interpolation to be able to initialize with a lower resolution version, but the implementation is complex (the number of arguments to fld read changes and so the code has to be changed in many places).

## 4 DRAKKAR web site, tools, AGRIF

We still don't have a standard version of AGRIF+ice. Julie will work on it using the version developed by Fred Dupont. The vertical refinement in AGRIF is under development (Henrick Berger, PhD student in Brest, will test it).

We need to renew the DRAKKAR web site (ongoing work). The LEGI will provide easy access to the forcing fields (DFS3 and DFS4).

The cdftools are under svn in a private machine. The first step is to make them available using a public machine.

There is no process to get back the bug reports and improvements of cdftools, excepted send an email to Jean Marc (we discuss the possibility of a cdftools mailing list but it may be unnecessary if the public repository has a trac server). How to recover the developments made by others (like the calculations of all the components of the MOC made by Keith Haines and collaborators at NOCS)?

I/O for large simulations and database management.

A discussion group was set up after the Brest in June 2009, not much has been going on. Solutions to decrease the size of the output: netcdf4, degradation, mix of monthly and 5 day output...