

Report of the Drakkar Meeting Grenoble, February 11-13, 2009

March 24, 2009

1. Summary of presentations

The meeting started with presentations of scientific results by the various groups (material is available through the Drakkar web site¹). A few questions about Drakkar simulations were raised.

- Importance of the relaxation to sea surface salinity (again and again) and our desire to lower it.
- The Grenoble/Brest ORCA025 runs shows that MOC is maintained with both DFS3 (run G70) and DFS4 (run B83) with "strong" SSS relaxation.
- Recent NOCS ORCA025 runs seem to suggest that the MOC is maintained with "weak" SSS relaxation everywhere excepted under sea ice with forcing DFS3, but that the MOC collapses with DFS4 (Bervery de Cuevas).
- Keith Haines finds that DFS4 performs better than DFS3 for his experiments with data assimilation. Specifically the resulting surface freshwater fluxes are more in balance with assimilated salinity data thus reducing sea level trends in the assimilated run.
- LIM3 seems to work with ORCA2 but there are problems in all other configurations.
- The use of ocean currents in the wind stress calculation has been questioned, especially because of its damping effect of the EKE noticed in all eddy resolving simulations, including in 1/15° AGRIF zoom (a short note from Grenoble is in preparation). Removing ocean currents from the wind stress enhances surface EKE at high-resolution both in ORCA and in FLAME (Eden 2009). However, doing so might not be the best solution, both intrinsically (stress should decrease when wind and currents go in the same direction) and in terms of consequences (reaching higher EKE for possibly wrong reasons is risky). See Eden 2009 about this issue.

Presentations of ongoing work were made by the different groups.

- **LSCE (Jennifer Simeon, James Orr):** study of CO₂ fluxes, first using ORCA2-PISCES but also higher resolution configurations (ORCA025 in the longer term).
- **NOCS (Adrian New):** A number of ORCA025 runs have been performed (results are available). Few people have analyzed them so far. NOCS will run a global 1/12 model. There are higher resolution regional configurations using AGRIF (for example, for the DIMES project in the Drake Passage, 1/16 zoom embedded in 1/4 region in ORCA1 model). A similar strategy will be considered in the North Atlantic, perhaps in the Arctic. A short experiment will be run with a global 1/36 model to study internal tides. NOCS participates in NEMO developments (GM parameterization, on the fly interpolation...). It will be necessary to collaborate with UK Met Office (perhaps to use Cice as an ice model. Comparison between CICE and LIM3 might be carried out). The biogeochemical model *Medusa* is likely to be used in the NOCS configurations.
- **EC-earth (KNMI, Andreas Sterl):** The EC-earth model is based on IFS (ECMWF atmospheric model), NEMO (ORCA1-LIM), Orchidee, and other modules. The coupled model is running, the aim is to take part in IPCC AR5. Transfer to NEMO3 and LIM3 is planned soon (Swedish met office).
- **UK MetO (Malcolm Roberts):** The long-term plan is "seamless prediction" (from weather to climate forecasting), using the unified model (UM). The model will have NEMO as an ocean

¹ <http://meolipc.hmg.inpg.fr/Web/Events/Drakkar2009/February-2009-Agenda.html>. If your presentation is not on line, it means that I do not have it (please send it). If you do not want your presentation to be available on-line, let me know, I shall remove the link. Note that you will need the login (drakkar) and password (nemo00) to access the presentations.

component, and Cice for the ice model. There will be a ORCA1 ocean with 90-150km atmosphere, and ORCA025 with 60km atmosphere (seasonal, then decadal prediction). There are plans for super-high resolution.

- **University of Reading (Keith Haines)** : Various projects using NEMO and data assimilation (Arctic Ocean, RAPID project, etc). Reanalysis have been performed with ORCA025, DFS3 and DFS4. There are plans to use Era Interim as a forcing.
- **University of Alberta (Paul Myers)**: Studies are under way with $\frac{1}{4}$ configurations (NATL4), which will investigate technical "subpolar" modelling issues. A high resolution zoom model of the Canadian archipelago is being developed. One study will consider the effect of Greenland ice melt at different resolutions (ORCA2, ORCA05, ORCA025).
- **National lab for Marine and coastal meteorology (Youyu Lu, Environment Canada)**: The CONCEPTS project focuses on prediction at time scale from hours to months. It uses ORCA1 (UK MetO configuration) and ORCA025, with data assimilation. Long term experiment have been made with ORCA1 with CORE-V1 and CORE-V2 as forcing. The coupling of NEMO with the GEM (Global Environnemental Multiscale) Model is in progress.
- **LPO, Brest (Anne Marie Treguier)**: Various studies have been done or are under way using ORCA025. One long experiment (1980-2007) has been run with NATL12 and DFS4 forcing, but results are not fully satisfying in the subpolar gyre. A second experiment will be run this year (last year of the DRAKKAR/North Atlantic French project).
- **Geomar Kiel (Arne Biastoch)**: Besides the studies about the Agulhas region, there are ongoing projects using ORCA05 or ORCA025 to study the variability at low latitudes (Indonesian throughflow, Benguela ninos...), and there are plans of using AGRIF to study the circulation in the minimum oxygene zones in equatorial regions. There is a study of the relationship between the SSH and MOC. In the framework of Thor, the plan is to use a 1/10 zoom around Greenland in ORCA05. There will be studies using coupled models in collaboration with M. Latif et al.
- **MERCATOR- MyOcean (Eric Dombrowski)**: MERCATOR is the coordinator of MyOcean, a European project starting in 2009 for 3 years, with 61 partners (20 core partners committed to providing services). Mercator will use the global $\frac{1}{4}$ model, move to a global 1/12 model operated weekly, and perform $\frac{1}{4}$ reanalysis (in relation with the "Glorys" French project). There is a regional 1/36° model developed at Mercator and in Spain. Question: what will be the collaboration with the Drakkar group after 2012?
- **LEGI Grenoble (Thierry Penduff)**: Various projects use ORCA025, also NATL12 and a strategy of AGRIF zooms in NATL025. A new project is starting for the Southern Ocean (Southern cross, Julien le Sommer); a 1/8° peri-antarctic configuration will be developed. Model-data comparisons with dedicated tools are part of a CNES project (Melanie Juza, Thierry Penduff et al).
- **LOCEAN Paris (Gurvan Madec)**: The main task is to set up the model of IPCC AR5: ORCA2-Lim, Pisces... the atmospheric resolution will be 2°. There is also work on regional higher resolution configurations (1/4° in the Indian Ocean) as well as model development (improvement of time-stepping, arbitrary lagrangian/eulerian vertical coordinate (Matthieu Leclair).
- **NEMO system Team (Claude Talandier)**. In 2008 many new features have been added (BDY, LIM3..). Version 3.1 is coming soon, with on-the-fly interpolation, new TKE, etc. It is possible to have ice/ocean fluxes in the AGRIF zoom in that version (development by Steve Alderson). Main developments in 2009 are a better configuration manager (to be developed in the Myocean project) and IOM for output. There are plans to simplify the system: suppress the rigid lid option, merge trp and tra for tracers, rewrite mpp libray and timing tools, generic coupling interface for lim3, etc.

2. General discussion: the future of Drakkar

Drakkar is not a single scientific project. We should not use the word “consortium” either because it evokes a formal agreement. Perhaps say “the Drakkar coordination” or the “Drakkar group” (we used Drakkar group in the Clivar exchange newsletter). Nobody suggested to change the name. The group has become wider with time, activities are more diverse. Drakkar is unique because we are trying to create a very large base of model experiments (hindcasts/reanalyses of the last decades, and perhaps coupled O/A model runs in a near future), spanning a wide parameter space. It is not usually the case with modelling studies.

The discussions concerned the short term perspective (2009-2010) and the longer term.

Some actions are proposed for the short term:

- Continue to hold an annual workshop;
- coordinate and document ORCA025 experiments in the various groups, and have (as much as possible) a common ORCA025 configuration (see section 3).
- Improve the visibility of Drakkar activities, re-design the web site (B. Barnier, A.M. Treguier, JM Molines). All groups should point to that web site. It should have a welcome page with a short message, and it should make clear the availability of a number of coordinated experiments.
- Suggestion not mentioned at the meeting. We propose that in addition to citing NEMO, we cite Drakkar in the abstracts and/or introductions (if not in the titles) of our articles, and in EGU/AGU-like communications. Drakkar should be cited either about the configurations that are used, or as the group that developed the hierarchy of configurations, or that constructed the set of hindcast simulations. Projects like Clipper, CME, Dynamo, FLAME, FRAM, etc are well known since many papers directly named the project names.
- We need to choose a short list of experiments that would be made available (ORCA025-G70, KAB001, ...) . For those experiments a small number of plots should appear on the web site with explanations. The aim is for an outsider to evaluate quickly if the Drakkar experiments may be of use to him/her.
- Ideally, some of the results should be available via *dods* servers that the central web site would point to (we propose to have on-line annual means and monthly means in 16-bit format)
- Should we install Keith Haines' viewer (Godiva) on all the sites? It is certainly worth to try. Grenoble will test it.
- Write a new letter (for Clivar exchanges? or EOS?) to publicize the project (suggestion of C. Böning).

For the longer term, various possibilities are discussed.

- Drakkar helps coordinate model developments in NEMO. In the next three years, the MyOcean project will perhaps be the place where many numerical developments will be discussed (participants to MyOcean: LEGI, LOCEAN, NOCS, IFM-Geomar, Mercator, NCOF/UKMO). But MyOcean does not cover the coupled Ocean/Atmosphere issues, which are also discussed in Drakkar.
- Drakkar has been set up to coordinate ambitious experiments with ORCA025, that were too big to be run by a single group. Five years later, with the increase of available computer power, ORCA025 is easy to use by all the groups. Are there new ambitious configurations that are needed by the scientific projects of the various groups and would require coordination? NOCS proposes to move to the global 1/12° model, that will be used at MERCATOR. Other groups are not enthusiastic about it.
- Are coupled physics-biogeochemistry runs the next frontier? Various groups will be running them, at different resolutions, with different biogeochemical models and for different scientific objectives: it is not clear that a coordination is possible or beneficial at this stage.
- Should Drakkar put more emphasis on coupled ocean-atmosphere experiments? Most groups

agree that it is important to have both forced model runs and coupled model runs. Coupled model runs could be made available to the same community as the forced runs? The perspective of guided coupled runs (assimilated atmosphere above some level) will help bridge between forced and coupled runs, and bring coupled runs toward observed trajectories.

- Should we coordinate our strategy of grid refinement using AGRIF? Should we use Agrif zooms to move to ultra-high resolution?
- AM Treguier mentions the possibility of proposing a Marie Curie Initial Training network to support the Drakkar coordination (next call will be probably in spring 2010).

No conclusion emerges for a long-term plan for the whole group. Some kind of strategic document is needed for the French group (by September): it is necessary to think about it.

There are convergent scientific interests of many members of the group to define a strategy to fix (or at least significantly improve) resisting model flaws in the subpolar gyre and the GIN seas. There are plans to implement several AGRIF zoom on this regions in ORCA05 (1/10° in Kiel) and in NATL025 (1/20°, Grenoble), that would help making progresses on these issues. A workshop will be organized in Brest (early July) about this topic (A.M. Treguier and J. Deshayes). The overestimated mixing in overflows remains an important problem (for local water masses, for the subpolar gyre, possibly for the MOC), that requires more efforts to be solved in NATL025 (similar problem around Antarctica). Two directions were mentioned: [1] enhance horizontal AND vertical resolution (AGRIF between Greenland and Scotland). Or [2] introduce 2- or n-level BBL.

3. Coordination of ORCA025 experiments in 2009

3.1. Common ORCA025 model configuration

It will be based on NEMO 3.1 Recommended options are:

1. Sea-ice model will be LIM2+ (EVP rheology).
2. Usual implicit free surface.
3. Corrected bottom friction. The tuning of the friction at the strait of Torres will have to be redone (Grenoble).
4. The internal tide mixing parameterisation will be included
5. TKE options should be tke2.
6. The impact of water turbidity on Light penetration should be included, based on monthly mean climatology of ocean colour. Two actions are required:
 - Include the parameterisation in the code (who volunteers?)
 - Test is in ORCA05 before implementing in ORCA025 (who volunteers?).
7. Updated bathymetry: modifications made in the Canadian Archipelago should be included (Youyu Lu) maybe revisit Denmark Strait and Faroe Bank channel to improve Atlantic/Nordic sea exchanges.
8. Add some relaxation at depth around Antarctica to fix the Antarctic bottom water deficit and prevent decline of the ACC (awaiting for a more satisfying solution that should come in about one year from the southern Cross project).
9. Use weak SSS restoring except under sea-ice? We need to consider the results of NOCS (is the MOC stable in that case with DFS4?).
10. Free slip boundary condition.
11. BBL. The problem of the overflows of dense waters remain. Could comparisons with other

models provide some guidance (OCCAM 1/12, and MPI-OM which also has a C-grid like NEMO)? First we need to assess the impact of correcting the bottom friction bug. The use of a no-slip boundary condition locally may help. This issue will be revisited during the workshop in Brest.

12. Vertical levels. Three different vertical grids are used at the moment (Original Drakkar grid uses 46 levels, MERCATOR has 50 levels with 1m layer near the surface and 450 in abyssal plains, and NOCS uses 64 levels. NOCS will provide some information on the comparison between 64 and 46 levels. Is there a report comparing the MERCATOR grid with the 46 levels grid?
 - Could Mercator and NOCS provide a short note discussing the effects of the higher resolution compared to the standard one? A short list of precise (possibly simple) and identical criteria is needed to assess this sensitivity. Email discussions will help identify them.
13. Subgridscale parameterisation.
 - Laplacian isopycnal diffusion will be used for tracers. Diffusivity of 300 m²/s has been used, but no tests of sensitivity to that parameter have been made. Smaller values (150 to 200 m²/s) will be tested (Grenoble).
 - What about the too deep mixed layer in winter? No easy fix is suggested. (except Fox-Kemper parameterization, not that easy).
 - Other tests regarding parameterizations (use of GM) can be made through coordinated experiments (C. Böning, P. Myers). The Fox-Kemper submesoscale parameterization should be implemented and tested.
14. Initialisation fields: The initialization is discussed: some would like to use recent analysis (Coriolis) or reanalysis (ESSC, GLORYS) rather than Levitus. However, none of these products accurately represents the year 1958. Suggestion: Since resolution barely affects long-term trends (Southern, Arctic Oceans in particular), and since the “memory” of the initial state is unknown (geography, duration, etc), model sensitivities to the initial state might be investigated (i) at 2° and (ii) over O(300 years).
15. Forcing. A new “reference” experiment from 1958 to 2008 will be run at LEGI this spring, with this updated model configuration. Forcing will be DFS4.1 (AM Treguier notes that the adjustment made in 1979 has in fact taken out trends from the forcing compared with DFS3. The increase of the Southern oscillation from 1970 to 2000 is not apparent in DFS4.1. This is not considered a priori a problem by the group. Comparing both forcings in the Southern Ocean is needed to conclude.
 - Bernard will provide a note on the effect of the correction applied to the winds in DFS4.1.
16. Forcing. CORE2 will be used in Kiel.
17. A decision will have to be made regarding the use of ocean currents in the wind stress calculation. Rfer to Eden (2009).

Grenoble will publish a document describing the NEMO3.1 based customised ORCA025 configuration.

3.2. Coordinated work plan in 2009

One objective of coordinated work plan is to define experiments and sensitivity studies dedicated to improve the hierarchy of model configurations (with a particular focus on ORCA025), to improve the atmospheric forcing, and to continue the construction of the set of hindcast simulations describing the state of the ocean and its variability on the period 1958 to present.

Regarding sensitivity tests, we should work to reduce the initial model drift. The long MJM01 experiment shows that the model biases that can be identified after 15 years, and that they persist after 150 years (B. Barnier). Therefore, most sensitivity experiments do not require 50 years and it would be useful to define a common test period and initial state.

- Definition of the common test period and initial state (for CFC too).

3.2.1. Development/improvement of ORCA025

Investigate the Salinity Forcing

- work out and test a flux correction (from diagnosed FWF). IFM

Investigate ERAinterim and other forcings fields

- Precipitation (Sergei Gulev)
- Grenoble and Mercator will evaluate ERAinterim
- Grenoble will continue to improve DFS4.1 (G90) in coordination with IFM (exact same model configuration).
- ESSC will carry out a Reanalysis in the lines of the above runs.

Ice-Model

- NOCS will continue testing and comparing LIM2/LIM2+/LIM3

Spin-up and initial conditions

- IFM will investigate robust diagnostic spin-up with ORCA05
- Grenoble will test initialisation with T,S fields from ESSC/GLORYS reanalysis products

Vertical resolution

- We need reports from Mercator and NOCS regarding the effect of the vertical resolution they tested (versions 46, 50 and levels). Short list of common criteria needed.
- GLORYS Stream1-V2 might be performed with 70 levels or have two runs, a 50 level and a DRAKKAR-46 level

Improving the use of the Drakkar data base

- We need to find a way to make Drakkar data available via a centralised or distributed data centre. Could Mercator or My Ocean help?

Parameterisation strategy to improve the overflows

- BBL on several levels
- The stream-tube parameterisation (Malcom, MOHC)

AGRIF strategy to solve the resisting flaws in the subpolar gyre and the GIN Seas.

- Kiel: ORCA05 and AGRIF 1/10°
- Grenoble/Brest: NATL025 and AGRIF 1/20°
- NOCS: ORCA025 +AGRIF at (1/12° or better).

- Organisation of a dedicated meeting in Brest next July (Julie Deshayé).
- Note that this will require to implement AGRIF on LIM2, following what was done at DFO by Frederic Dupont.

3.2.2. Other targets for sensitivity studies

- Testing new bathymetry
- Testing the effect of the corrected bottom friction on BBL in overflow regions (Grenoble will use NATL025 for that).
- Implementing and testing the new parameterisation for penetration of light.
- Testing lower isopycnal diffusivity in a run with CFC (Grenoble)
- Compare LIM3 and LIM2+

3.2.3. Targets for new hindcasts are:

- DFS4.1 (Grenoble)
- CORE2 (Kiel)
- ERAinterim (ESSC, Grenoble)

We do not need to run a new experiment with climatological forcing. The MJM01 run (300 years with repeated seasonal cycle) must be analyzed first.

The tests of the new version of the ice model (LIM3) will continue at NOCS.

50-years experiments with ORCA05 using freshwater flux correction will be performed in Kiel (first run the model to diagnose the flux correction, then re-run the model and apply it instead of using SSS relaxation).

3.2.4. Publications to be submitted and in 2009:

Suggestion: Is it useful to provide a tentative title and author list for studies planned or ongoing in various groups? Possible titles for common papers?

Collaborations between people from various labs for certain papers should help take advantage of complementary viewpoints, exploit the growing database, and help reach interesting science results.

4. Coordination of model developments (MyOcean)

The DRAKKAR meeting was an opportunity for the teams also participating to MyOcean to meet for the first time before the Kick-off meeting in Toulouse in April. MyOcean will carry out cross-cutting R&D work, aimed at improving ocean models codes, assimilation, forcing, biogeochemistry.

Relevant to Drakkar are :

- The work planned in WP3 on new physical parameterisations and numerics.
- The model developments planned in WP4 on Ice modelling (LIM3/CICE), PISCES and the downscaling toolbox.
- The production of the global eddy permitting (ORCA025) reanalyses (1992-2011) with ORCA025 driven by ERAinterim. Drakkar could help to define the protocol of the analysis (model design, parameters, forcing, ...).

Regarding WP3, It will be necessary to provide in an updated list of planned activities at the kick-off meeting. MyOcean appears as a very favourable framework to coordinate ORCA025 developments.