Report of the DRAKKAR meeting
Grenoble, 28-30 January 2013

1. Overview

The meeting was organized in six sessions:

- Focus on the global 1/12° model ORCA12
- Advances and challenges for ocean models;
- Drakkar hierarchy of global models from low resolution to ORCA025
- Regional model simulations and AGRIF
- Surface forcing
- Plans of the participating groups for 2013.

The "advances and challenges for ocean models" session started with an invited talk by Steve Griffies (GFDL) who discussed the challenges of eddy-resolving ocean components for climate models, and described the current evolutions in the U.S.: at GFDL, MOM6 will be a merge of GOLD and MOM, a structured C-Grid model with ALE vertical coordinate. NCAR and Los Alamos LANL are developing MPAS (Model for Prediction Across Scales, http://mpas.sourceforge.net/) which is so well advanced that it may be used for the next IPCC scenarios (AR6).

The present report summarizes only the discussions and modeling issues regarding the DRAKKAR global configurations. The agenda and the talks are available through the Drakkar web site, www.drakkar-ocean.eu ; direct link:
http://www-meom.hmg.inpg.fr/Web/Events/Drakkar2013

2. ORCA12 results and discussions

Sensitivities from the Kiel global experiments (Markus Scheinert)

The new run K003 uses the new bathymetry (v3.3). The forcing is modified (reduction of rain by 7.5% north of 65N). The restoring of sea surface salinity (SSS) is much weaker, 8 years for 50m depth (rn_deds=-16.44).
There is a strong increase in AMOC compared with the previous run (20.1Sv vs. 13.5Sv in the K001 run). The use of free slip instead of partial slip seems to make the Gulf Stream separation better. However the eddy variability is surprisingly lower in K003 some regions. A sensitivity experiment demonstrates that it is due to the lower biharmonic coefficient (0.5×10^{10} $m^4 s^{-1}$ instead of 1.25×10^{10} $m^4 s^{-1}$).

Global results from the Mercator experiments (Romain Bourdalle-Badie).

For both ORCA025 and ORCA12 a free and an assimilated experiment are compared. The eddy kinetic energy is low in the free ORCA025, higher (and similar) in both the free ORCA12 and assimilated ORCA025 run, and even higher in the assimilated ORCA12 run. The free ORCA12 run has more energy compared with AVISO (the time/space sampling of AVISO is too low to sample the variability simulated in ORCA12).

Group	Duration	Vertical grid	Forcing	Other parameters
Kiel ORCA12-K001	1978-2007	46 levels	CORE v2 relative wind	ice Lim2 VP. No SSS restoring under sea ice. partial slip (shlat=0.5)
Kiel ORCA12-K003	1978-2007	46 levels bathy v3.3	CORE v2 rain reduction	ice Lim2 VP. Very weak SSS restoring. No SSS restoring under sea ice. free slip. Reduced biharmonic
Grenoble ORCA12.L46-MAL95	1989-2007 restart fm K001	46 levels	ERA-I relative wind	ice Lim2 VP. partial slip (shlat=0.5)
Grenoble ORCA12.L46-MAL85	1978-1992	46 levels	DFS4.1 relative wind	Flux form momentum advection, free slip (shlat=0)
Grenoble ORCA12.L46-MAL105b	1989-2011	46 levels bathy v3.3	ERA-I absolute wind	SSS restoring 30days/50mEEN momentum . advection, free slip (shlat=0) par no-slip in special places.
Grenoble ORCA12.L46-GJM02	84 years	46 levs. bathy v3.3	as 105b+3D relaxation Weddell sea	Ice EVP first, then VP from year 12 on.
Mercator ORCA12.L50-T321	1999-**2010**	50 levels	ERA-I absolute wind	free slip (shlat=0)
NOCS ORCA12.L75-N0083	1978-**2010**	75 levels	DFS4.1	VVL option

Table 1: summary of ORCA12 long experiments. The new experiments run in 2012 or the updates of runs started in 2011 are indicated in bold characters. All runs use the filtered free surface (excepted NOCS) and the vector form EEN of the momentum advection (excepted MAL85).

Global results from the Grenoble experiments (Bernard Barnier).

Two new experiments have been performed in 2012, with the parameters decided at last year DRAKKAR meeting. One simulation (MAL105b) uses the new ERA-Interim forcing and the other, which is 84-years long, is forced by a seasonal climatology ("grand challenge" on the new computer ADA at the Idris centre). By looking at all the simulations, sensitivities are revealed: Side wall friction (slip, no-slip, partial slip); Momentum advection (EEN, FLX); Bathymetric details (Strait of Gibraltar); Bering strait customisation; Atmospheric forcing (DFS4, ERAi); Absolute wind vs Relative Wind. Two paths of the Agulhas eddies are identified in 11 ORCA025 runs and the ORCA12 runs: the unrealistic path seems to occur with absolute wind or momentum advection scheme other than EEN. Plots of the mean SS difference between model and Rio MSSH are provided for 6 different ORCA12 runs. Biases in different regions suggest different origin

(wind, numerical parameters...). Twin runs show many improvements going from 1.4° to 1/12°.

Ongoing scientific studies with ORCA12 presented at the meeting:

- Analysis of the Arctic circulation (Y. Aksenov et al). The analyses use the NOC runs (ORCA025 and ORCA12). There is a large improvement of some circulation features with ORCA12 comapred to the lower resolution.
- Study of the eddy contribution to the meridional transport of salt (A.M. Treguier et al.). The analysis uses the Grenoble runs (ORCA025 and ORCA12).
- Effect of winds on the variability of the AMOC at the eastern boundary at 26°N (A. Duchez et al.): a study based on RAPID data and the NOC ORCA12 run.
- Coherence of western boundary current variability in models and observations, (J. Hirshi et al). Analysis of NOC run+ intercomparison with Grenoble runs (F. Fransner).

Discussion

The new bathymetry v3.3

All groups excepted NOC are now using the new v3.3 bathymetry. Bering Strait is OK, so is the correction at Gibraltar. No minimum level is set in the file available on the MERCATOR ftp site: do all groups use the same minimum water depth (set in the code)?

The lateral boundary condition has been discussed again. Runs have been performed with a free slip boundary condition almost everywhere but no-slip locally in some places where it improves the solution (like Cape Desolation in the Labrador sea). It seems that everybody has the same shlat mask. Participants do not agree on the physical justification of this mask. Some argue that "no slip" is justified when bottom roughness is high, others say the stability properties of boundary current depend on the topographic slope, and on the orientation of the boundary (Western boundary or Eastern boundary).

Bering strait and bottom friction: it should not be increased further at Bering Straits. New observations suggest that the transport is larger than previously thought (1.2 Sv instead of 0.8Sv).

Viscosity: The sensitivity to the biharmonic coefficient is discussed. The fact that a too low biharmonic viscosity enhances noise and can lead to less eddy kinetic energy (see Markus's results) has been noted before in other simulations (NATL12 for example, Anne Marie, or simulations in the Indian Ocean, Gurvan). There is no agreement on the use of closures other than biharmonic (Smagorinsly? UBS scheme, where the viscosity is done entirely by the numerics?).

The calculation of wind stress had been discussed last year: no progress made since last year.

Conclusions, actions points

More research is needed on lateral boundary conditions

More research is needed on the viscosity and the momentum advection schemes (parameterization/vs use of the numerics to provide viscosity).

For Bering Strait, Yevgenei proposes to look at the Grenoble runs to evaluate the transport at Bering (can we say it is too large or too low from T/S comparison with data?)

Plans for ORCA12 joint papers:

Deshayes et al, South Atlantic overturning freshwater transport in high resolution hindcast simulations, bistability of the MOC: Geophysical Research Letters, in press.

Bourdalle-Badie et al, ORCA12: A global ocean model at 1/12° resolution for ocean prediction systems and long term variability studies. In preparation.

NOC: Establishement of the subpolar gyre circulation, paper to be resubmitted this spring.

NOC-Grenoble: two joint papers in preparation on WBC (Hirshi, Fransner et al); Zika et al: Vertical heat and buoyancy fluxes.

Plans for ORCA12 simulations in 2013

- We need to verify we all use the same minimum water depth for the bathymetry;
- The shlat mask should be part of the distributed input files (with a version number)

- LGGE Grenoble: one 50-years experiment planned, with DFS4.3 forcing. This simulation will use the same settings as the 84-years long climatological experiment carried out within the "Grand Challenge" project. This way combined analysis of the two experiments (climatological and interannual forcing) will be possible. There is computer time for a few sensitivity experiments.
- NOCS: Another hindcast, O(1 year) short term study with resolved tides. With/without z tilde. Embedded sea ice: open at the moment.
- GEOMAR: and hindcast of 30 years with CORE will be run with the new setting decided at the meeting. The aim is to comapre with simulations at other resolutions. In 2014 more computer time will be available to GEOMAR.
- Met Office : perhaps at some point a coupled ocean-atmosphere configuration with ORCA12?
- LOCEAN: We run a coupled 1/12 atmosphere, 1/12° ocean but it is not global (without the polar oceans). The aim is the coupled ocean-atmosphere processes in the tropics.

3. Evolution of NEMO

In 2013 there will be a special meeting of the developers' committee to discuss future plans for NEMO (10 years outlook).

The new equation of state (TEOS10) will be implemented in NEMO shortly (Fabien Roquet, Gurvan Madec).

The Fox-Kemper parameterization has been tested in ORCA2 in the framework of the OSMOSIS U.K. project (A New). The standard implementation of Fox-Kemper creates numerical noise, a different implementation may be coded by G. Madec (S. Griffies proposes to share experience).

4. ORCA2, ORCA1 and ORCA025 results and discussion

4.1 Presentations from NOCS and MetOffice

With ORCA025 in coupled mode with the atmosphere, a strong warm bias develops in the Southern Ocean. The possible sources of this bias have been thoroughly investigated (presentation by Pat Hyder) but there is no single simple origin of the bias. It may result from added errors (atmospheric errors and oceanic errors). Note that the bias is lower in ORCA1 but possibly for the wrong reasons (compensating errors).

The MetOffice and NOCS have now a common ORCA025 configuration, with version control and a new release each year (presentation by Dave Storkey). This configuration is used at ECMWF, in the FOAM operational system, the GloSea seasonal forecasting, for the decadal prediction system DePreSys, for Hadgem3 and for the UK Earth system model.

The 2012 version, G05, has the following settings:
- NEMO 3.4
- vertical mixing changes (esp. change to nn_etau length scale).
- latest DRAKKAR bathymetry.
- double-diffusive mixing included.
- geothermal heat flux included.
- "calving runoff" spread out around Antarctica.
- salinity-dependent freezing temperature.

Possible science changes for GO6.0 in 2013 include:
nonlinear free surface
embedded sea-ice
iceberg tracking
Griffies version of isopycnal rotation operator
Fox-Kemper parametrisation

4.2 Discussion items

- Two different ORCA025 configurations are made available to the community: one in the U.K. and one at LGGE (Jean-Marc). Proposition: keep the two, but document the differences.
- The bathymetry files should have version numbers.
- The coordinate file should include the changes of scale factor in straits (it should not be done in the NEMO code) and also have version numbers.
- Other files to distribute: patches for bottom friction and lateral boundary condition.
- Do not test the Neptune effect (it has been used by G. Nurser in NOCS for the CORE experiments with ORCA1, and it led to a large decrease of the MOC at 26°N).
- We need to improve the overflows but none of the sensitivity tests so far really improves the overflows (use GM or not, Griffies formulation of the isopycnal mixing, etc).

- We need to clarify when to use the 3-band light penetration scheme. Tests done at MERCATOR (Presentation, G. Garric) show that it is wrong to use it unless one has an online biogeochemistry. It is best to use 2 bands, until a suitable climatology of sea colour (with depth information) can be provided.
- Vertical mixing schemes: work has been done to test GLS at MERCATOR (the K-epsilon scheme had good performance), and compare different parameters of TKE at the MetOffice. What are the recommendations for ORCA025 and ORCA12?
- How to make use of all the ORCA025 simulations? Could we document the sensitivities in a more systematic fashion through collaborative work?

5. Evolution of the Drakkar forcing sets

Forcing for the Glorys reanalysis (Gilles Garric):

- Bulk formulation : CORE (chosen after comparison with ECUME),
- 3H sampling + 24H for downward fluxes with diurnal cycle applied to the SW flux.
- Correction of daily SW, LW and rainfalls towards satellite data. Detrend the rainfall flux.
- High latitudes / Arctic Ocean: Northward of 80°N : -2°C and -15% humidity only during summertime and over sea ice cover. No correction of rainfall, SW or LW fluxes northward of 75°N.
- High latitudes / Southern Ocean: Keep correction towards GEWEX for SW & LW and with -20% SW southward 60°S. No correction of rainfall southward 60°S.
- No damping.

Presentation of the DFS5.1 forcing set (Raphael Dussin)

- Correction of wind speed toward Quickscat (Like Large and Yeager)
- Correction of radiative fluxes toward ISCCP satellite estimates
- Correction of precipitation towards PMWC+ detrending
- Correction of air temperature in the Arctic toward the POLES climatology (like DFS4, Brodeau et al).

The discussions show that there is no consensus on the corrections that need to be applied to ERA-Interim. A strategy needs to be decided in order to go forward. *To quote Keith Haines: "Is there a strategy that can provide forcings that people will use and won't want to change in the next week or so?".*

Drakkar/MyOcean Workshop 2013, list of participants

Registrered Participants (69)

LGGE - Grenoble (12): Bernard Barnier, Jean Marc Molines, Thierry Penduff, Sandy Gregorio, Nathan Grivault, Raphael Dussin, Gildas Mainsant, Pierre Brasseur, Guillaume Serazin, Aurélie Albert, Nicolas Ducousso, Alice Barthel
LJK - Grenoble (2): Laurent Debreu, Florian Lemarié
GEOMAR - Kiel (10): Claus Böning, Eric Behrens, Arne Biastoch, Markus Scheinert, Wonsun Park, Franziska Schwarzkopf, Christina Roth, Olaf Duteil, Lavinia Patara, Jonathan Durgadoo
LPO - Brest (4): Claude Talandier, Anne Marie Treguier, Xavier Couvelard, Matthew Thomas
LEMAR - Brest (2): Laurent Memery, Christoph Stegert
LOCEAN/IPSL - Paris (6): Gurvan Madec, Julien Jouanno, Sébastien Masson, François Colas, Claire Levy, Martin Vancoppenolle
Environnement Canada (2): François Roy, Greg Smith
University of Alberta (1): Paul Myers
LSCE - Orsay (3) : James Orr, Olivier Marti, Jérôme Servonnat
NOC - Southampton (5): Adrian New, Joel Hirschi, Yevgeny Aksenov, Aurélie Duchez, Jan Zika
ESSC - Reading (2): Keith Haines, Maria Valdivieso
University of Reading (1): Remy Tailleux
ECMWF (1): Magdalena Balmaseda
BAS Cambridge (1): Pierre Mathiot
Univ. Oxford (1): Camille Lique
UKMO (2): Dave Storkey, Pat Hyder
MERCATOR-Ocean - Toulouse (5): Jérôme Chanut, Romain Bourdallé Badie, Laurent Parent, Gilles Garric, Clément Bricaud
UNSW/CCRC Sydney (1): Paul Spence
CMCC Bologna (1): Dorotea Iovino
University of Stockholm (1): Fabien Roquet
CICESE - Ensenada (1): Julio Sheinbaum
NOAA/GFDL - Princeton (1): Stephen Griffies
KNMI – De Bilt (1): Elodie Burrillon
ENSTA-ParisTech (1): Karine Béranger
METEO FRANCE (1): Aurore Voldoire
University of CapeTown (1): Mathieu Rouault