ACCESS-OM2 Namelist discussion April/2018

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1. Introduction

We hold a meeting on 6^{th} of April, 2018, to discuss the ocean setup for the Modular Ocean Model v5 (MOM5) in the Australian Community Climate and Earth System Simulator (ACCESS). Research groups in Australia run ACCESS with different goals, which includes the CMIP6 and AMIP runs using the Coupled Model v2 (CM2) by a CSIRO team, Ocean-Sea Ice model v2 (OM2) for ocean studies across Australian Universities (UNSW, ANU, UTAS) with COSIMA (Consortium for Ocean-Sea Ice Modelling in Australia) support, and the Earth System Model (ESM) used for biogeochemistry studies. The main goal is to achieve the most similar ocean configuration across models as possible, salving exceptions where OGCM (OM2) and AOGCM (CM2 and ESM) specifically require different setups.

List of participants:

1. Kial Stewart
2. Stephen Griffies
3. Matt Chamberlain
4. Catia Domingues
5. Simon Marsland
6. Andy Hogg
7. Abhishek Savita
8. Andrew Kiss

9. Ryan Holmes

10. Paul Spence

a. Background diffusivity

The background diffusivity has been usually implemented as a global-wide value ranging from zero to 10^{-5} m^2 s^{-1}. Studies from Jochum (2009) using theory and observations showed that are different latitudinal bands of distinct background diffusivities. Past implementations of the ACCESS-OM and CM v1 have used a tropical band (20°S - 20°N) with 10^{-6} m^2 s^{-1}, while the rest of the global ocean has 10^{-5} m^2 s^{-1}. This setup helps improves tropical thermocline and ENSO representation (Bi et al. 2013b,a).

In practice, there is a three different ways of implement a lower background diffusivity in the MOM5:

1. Through hwf diffusivity on ocean_vert_mix.F90

2. Through tidal mixing scheme on ocean_vert_tidal.F90, set by bg_diff_lat_dependence_nml;

3. Through K-Profile Parametrisation as done by Ryan Holmes

In previous ACCESS-OM/CM and current ACCESS-CM2, it is done through tidal mixing scheme. Stephen Griffies suggested that MOM5 already includes an option to reduce the background diffusivity in a latitudinal band in the vert_mix.F90 (hwf option) and it's well documented and published, so Aidan may hard code this option when porting the CM2 implementation to the MOM5 main branch. A third option is to follow Ryan Holmes implementation through KPP. While there is some progress towards a zero diffusivity match between KPP and background diffusivity in the boundary layer, no testing between different implementations of background diffusivity reduction was performed until now.

Following the discussion, it sounds plausible to use in the same way ACCESS-CM2 does (through ocean_vert_tidal.F90) in other ACCESS models. Aidam Heerdegen (ANU) made a pull request with several changes coming from ACCESS-CM2 (https://github.com/mom-ocean/MOM5/pull/214), which includes the implementation of the option 2 in the above list by adding ‘bg_diff_lat_dependence_nml‘ namelist section:

```
&bg_diff_lat_dependence_nml
lat_low_bgdiff=20.
bg_diff_eq=1.0e-6
/
```

b. Horizontal friction

Past versions of ACCESS-OM in coarse (nominal 1°) horizontal resolution have made use of a highly-engineering approach for horizontal friction. A implementation of a NCAR 2007 scheme included six coefficients specifically design to improve North Atlantic simulations. This approach are not interchangeable between model resolution. The consensus is that coarse models should use both biharmonic and laplacian horizontal friction, with NCAR scheme set as false. Models with horizontal resolution equal or higher than 1/4 degree should use only biharmonic option.

c. Neutral Physics

The Coupled Model have been tuning GM and isopycnal diffusion parametrisations. Previous ACCESS-OM from CORE-II papers uses minimum and maximum agm_closure (_min and _max) as 50 and 600, while current CM2 is using 100 and 1200. The isopycnal diffusion 'aredi' was also changed from 600 (OM) to 300 in CM2. For Stephen Griffies, the maximum of 600 is arguably small, as more recent studies showing that this value can be larger (values from 800 to 1200). It also does not seem to have a physical meaning to reduce 'aredi' to 300, other than just tuning.

It still not clear the rationality behind the changes in neutral physical parameters in ACCESS-CM2. Only with further tests we should be able to changes these coefficients. By now, we will keep using the same values as for ACCESS-OM v1:

1. agm_closure_min = 50
2. agm_closure_max = 600
3. aredi = 600

Future tests should try to use ACCESS-CM2 values:

1. agm_closure_min = 100
2. agm_closure_max = 1200
3. aredi = 300

Richard Matear's group (ACCESS-ESM) have only performed tests comparing simulations with neutral physics on and off. Matthew Chamberlain reported that the neutral physics helps with bottom water and ENSO variability simulations. Their values was get from GFDL (Stephen Griffies/Paul Spence models).

d. Submesoscale

The submesoscale scheme is using values of smooth_advect_transport_num (4) and smooth_psi_num (3), different from default where both are equal 2. No one could explain where these values came from so we are switching to the default values.

e. Conservative temperature

Conservative temperature is consider more modern to diagnose ocean temperature. However, it requires potential temperature to be saved as an additional diagnostic, adding the *pot_temp* variable in the diag_table. With respect to salinity, it sounds that the community is not ready yet for a migration to absolute salinity so we should continue to use practical salinity for a while.

f. Frazil

Ocean frazil namelist has different choices between ACCESS versions. Previously, ACCESS-OM only uses frazil in the surface layer, but Simon suggested that, mainly with higher vertical resolution near surface, ocean frazil should use multilayer option. ACCESS-OM2 is using the 3D frazil. In addition, freezing_temp used the simple approach on previous ACCESS-OM and preteos10 approach in ACCESS-OM2. It was not clear in the discussion which we should use.

On 19^{th} of April, during the MOM meeting, Simon Marsland stated that previous tests (with help of Peter Uotila) have improved sea-ice extension using multilayers frazil. Aspendale team will use the multilayer until future tests comparing those two are performed.

g. Rivermix

The ocean rivermix is set as true in the ACCESS-OM2 models and as false in previous ACCESS-OM and ACCESS-CM2. However, the river_diffusivity is set to zero anyway so it will have no effect.

h. Thickness

The ocean_thickness_nml also has different options between ACCESS OM1, OM2 and CM2. However, with the enforce_positive_dzt set as false (default), the thickness_dzt_min_init is not being used.

i. Sigma transport

The sigma horizontal advection and diffusion is an overflow parametrisation of dense waters moving through the bottom cells. Suggestions are that coarse models should have this option on in parallel with the mixdownslope parametrisation. High-resolution models should not use this module.

j. Barotropic smooth of eta_t

For the smooth operator of the eta_t, Stephen Griffies suggested to use the default Laplacian operator instead of the biharmonic used in the previous ACCESS-OM/CM.

k. Ocean sbc

The flag ‘do_bitwise_exact_sum‘ is required be on to maintain the reproducibility of model experiments across different processors. If off, it will not do bitwise exact global sum, which will increase efficiency. ACCESS-OM2 and ACCESS-CM2 should turn this on. However, the ACCESS-CM2 is already being run for the CMIP6 which is not viable to restart. ACCESS team at CSIRO will consider inclusion of any of the modifications include in this document for future simulation of ACCESS-CM2 with the CABLE instead of JULES land model.

In addition, the flag ‘max_ice_thickness‘ should be set to zero. Stephen suggested it will likely have less instability problems. For models with higher vertical resolution (as Kial Stewart is running), it seems justifiable to use other values; he is using -5. ACCESS-CM2 should change from 8 to zero in future simulations.

l. Ocean bbc

The ACCESS-OM2 is using a roughness map which can improve the bottom drag. Stephen Griffies suggested that GFDL have not perform enough tests with this, but there is other groups (e.g. MIAMI group doing Labrador Sea simulations) which does have regions with higher bottom drag and it can improve simulations in terms of bottom water flow. We should keep using the roughness spatially dependent in ACCESS-OM2 and port it to next ACCESS-CM2 if it is not being used currently.

2. Field Table

Another issue that was raised in this meeting regards the 'field_table' input file for MOM5 runs. In summary, the current ACCESS-OM2 runs were not considerer the Indonesia Through Flow Rayleigh damp values. For 1-degree ACCESS (360 x 300), it should includes the follow values:

"rayleigh_damp","ocean_mod","rayleigh_damp"

"rayleigh","Ombai","itable=44,jtable=111,ktable_1=1,ktable_2=29,rayleigh_damp=5400"

"rayleigh","Lombok","itable=36,jtable=112,ktable_1=1,ktable_2=19,rayleigh_damp=3600"

"rayleigh","Torres","itable=62,jtable=105,ktable_1=1,ktable_2=50,rayleigh_damp=3600"

"rayleigh","Torres","itable=62,jtable=106,ktable_1=1,ktable_2=50,rayleigh_damp=3600"

"rayleigh","Torres","itable=62,jtable=107,ktable_1=1,ktable_2=50,rayleigh_damp=3600"

"rayleigh","Torres","itable=62,jtable=108,ktable_1=1,ktable_2=50,rayleigh_damp=3600"/

The 'Inverse Rayleigh damping time from table' is given in '$1/s$'. Simon Marsland suggested to not use a damping time below the model timestep.

References

Bi, D., and Coauthors, 2013a: ACCESS-OM: the ocean and sea-ice core of the ACCESS coupled model. *Australian Meteorological and Oceanographic Journal*, **63 (January)**, 213–232.

Bi, D., and Coauthors, 2013b: The ACCESS coupled model: description, control climate and evaluation. *Australian Meteorological and Oceanographic Journal*, **63**, 41–64.

Jochum, M., 2009: Impact of latitudinal variations in vertical diffusivity on climate simulations. *Journal of Geophysical Research: Oceans*, **114 (1)**, doi:10.1029/2008JC005030.