Stock-take for NEMO kernel WG

NEMO Developers Committee January 2019

Content

- Meetings of kernel working group and of COMMODORE

- Topics discussed in strategy – which ones will be covered in more detail

- Progress on main issues

- Note: what will be covered by IMMERSE will not be discussed in detail

Kernel WG meetings

- First year of Kernel WG meetings: presentations made
  - Gurvan Madec – two on design of time-stepping
  - Mike Bell – on approaches to calculation of HPG
  - Alex Megann – summary of position on diapycnal mixing
  - Andrew Shao – on a scheme for isopycnal mixing
  - Jerome Chanut –on improved representation of projection of bottom friction on the barotropic mode

COMMODORE group

- Major 3-day international meeting Sep 2018 in Paris organised by Burchard, Debreu, Klingbeil, Lemarie and Sainte-Marie
- Intention to meet biennially
- About numerical solution techniques for ocean circulation

Objectives

- share experience on model development
- share common test-cases to evaluate numerical models and emphasize merits and flaws
- share perspectives on future model evolutions on all aspects of dynamical core formulation
- establish a more systematic bridge between methods used and developed by the applied maths community and the ones used in realistic oceanic models

Topics discussed in strategy

- Vertical grid – ALE coordinate

- Horizontal grid – a watching brief (Chris Eldred has expertise here)

- Time-stepping schemes
  - Vertical advection schemes (partially implicit or compact & implicit)
  - Two-level schemes

- Additional issues
  - Non-hydrostatic – no clear consortium need; CROCO is exploring
  - Shaved cells at lateral or bottom boundaries
  - Representation of advection of momentum (Dave Storkey poster)
  - Wetting & drying
  - Weaknesses of Lorenz grid (some work in Bell & White (2017); no clear need for any action)

Vertical grid

- Investigate performance of $\tilde{z}$ scheme in climate model integrations
    - Jerome & Alex are doing this within Renumerate project
    - A first implementation of $\tilde{z}$ is working in ORCA025 & ORCA0083
    - Initial analysis of 20 year simulation shows small reduction in diapycnal mix
- Design of target coordinate options – no progress ?
- Choice of remapping scheme – no progress ?
- Design of pressure forces – analysis & proposal by Mike
- Staged adaptation of other schemes – no progress ?
- Clarify approach to vanishingly thin layers – (w&d & vertical advection schemes)
- Clarify likely costs and benefits

- There appear to be a lot of gaps here

Time-stepping schemes

- Gurvan and Andrew Coward are coding up ROMS vertical advection scheme (vertical advection surplus to CFL limit is implicit)

- Not sure what position is on compact, implicit vertical advection scheme (think there is a draft version in NEMO already)

- WP3 of IMMERSE will implement a 2-level time-step scheme
  - Plan to append a time-dimension to all time-dependent fields (Gurvan, Andrew, Dave) in 1st year of IMMERSE
  - Details of algorithm for 2-level schemes to be clarified in 1st year of IMMERSE
  - Analysis made of coupling between barotropic & baroclinic steps: Florian, Jerome, Gurvan

- This area is in relatively good shape

Advection of momentum

- Issue is should we discontinue the vector invariant form of the momentum equations
- Dave Storkey is exploring impact on bathymetric steering
- Impact on representation of moderately resolved mesoscale motions alread investigated by Bernard and others ?

Wetting & drying

- A version of the ROMS scheme has been introduced at version 4.0 (Enda O'Dea)

Summary

- Kernel working group and COMMODORE group were spun up in 2018

- Most issues identified in strategy are making progress

- ALE coordinates is the area with the largest gaps