NEMO Perspectives in 2013

Contribution from the EC-Earth consortium

Background: Current developments in EC-Earth

- V3: IFSc36r4 and NEMOV3.3/LIM3 (with 1 ice category)
- high resolution coupled model: T511 atmosphere, ORCA025
- seasonal to decadal forecasts (initialization)
- ESM – relatively low resolution (T159/T255 [T255 will be the default resolution in V3] atmosphere and ORCA1 globally), but with additional components (bio-geochemistry, vegetation, land ice, atm. Chemistry, etc.)

Required developments in NEMO

Bio-geochemical model

- **cost-effective BGC model**. Typical run length for EC-Earth is 100 yrs, typical resolution 1 degree or even 0.25 degrees. Possible ways to come to cost-effectiveness (investigation needed)
    - BGC model on lower resolution than ocean model
    - "basic" BGC model with less tracers than current PISCES
    - numerical improvements
    - coupling interface to atmosphere?
- Sediment model as part of the BGC model

Sea-ice model

- coupling to LIM3: coupling interface for LIM3 (for all ice categories)
- improved redistribution of incoming atmospheric fluxes on ice category
- include LIM3-variables in XIOS-output server
- improved albedo scheme: sophisticated melt ponds, improved snow albedo on ice (ice aging). (Albedo of the ice-snow system is much to uniformly distributed in EC-Earth compared to satellite data, which show substantially higher summer ice/snow albedos in the Central Arctic than along the ice edges.)
- Ice calving/ ice berg model

Technical aspects

- include LIM3-variables in XIOS-output server
- Possibility to compute in the ocean model easily numerical/artificial tracers for diagnostic purposes. These tracers are dye tracers, where I might describe by an analytic function the temporal evolution at the ocean-atmosphere interface or along given transects, age tracer, where the time is risen by the time step width and an analytic function at the ocean interfaces.
- Rising and falling sea level should allow to (partly) emptying or flood grid cells at least during the restart. For example a mask, where the sea level has fallen under the required minimal

depth, should be considered as land in NEMO or before as land considered points should be considered as ocean. This scheme would require, that the salt mass is conserved, and that flooded areas should start from rest.

Drying/Wetting together with providing a temporal diving depth, at least during the restart period, would allow to couple in a simple fashion ocean-ice sheets/shelves. In addition new studies of paleo applications would be in our reach.

- Configuration of large scale caves, where the ocean's surface layer follows a given diving depth. This is a necessary step to integrate large scale shelf ice caverns, which have the size of the Iberian Peninsula or Texas. The diving depths reach more than 1000 m at the grounding line, where ice that flows from the central ice sheet towards the coasts, loses its contact with the ground and starts to float on the water. The required parameterization of ice shelf-ocean interaction could follow budget considerations of turbulent controlled fluxes of heat and fresh water fluxes between ice and ocean.

- Introduce Mixed Layer heat budget diagnostics as an option (with a precompilation key)

- Developments should be done in agreement with OASIS developments, so that no additional features are required from either component

- Need for benchmarks in each version/configuration.

Configurations

- need for unique configurations (bathymetry, namelists, etc) to ease comparisons between different modelling groups and to exchange (initial) fields

- Modification of an existing or creation of a new NEMO reference configuration that takes up the specific needs of ESM's. Particularly, this reference version should include

    - a global grid finer than ORCA2

    - the LIM3 ice model

    - the NEMO coupling interface

    - biogeochemical model (PISCES) - cost effective (see above)

- AGRIF over Arctic with coupling interface to atmosphere

- Need for benchmarks in each version/configuration (repeated from above)