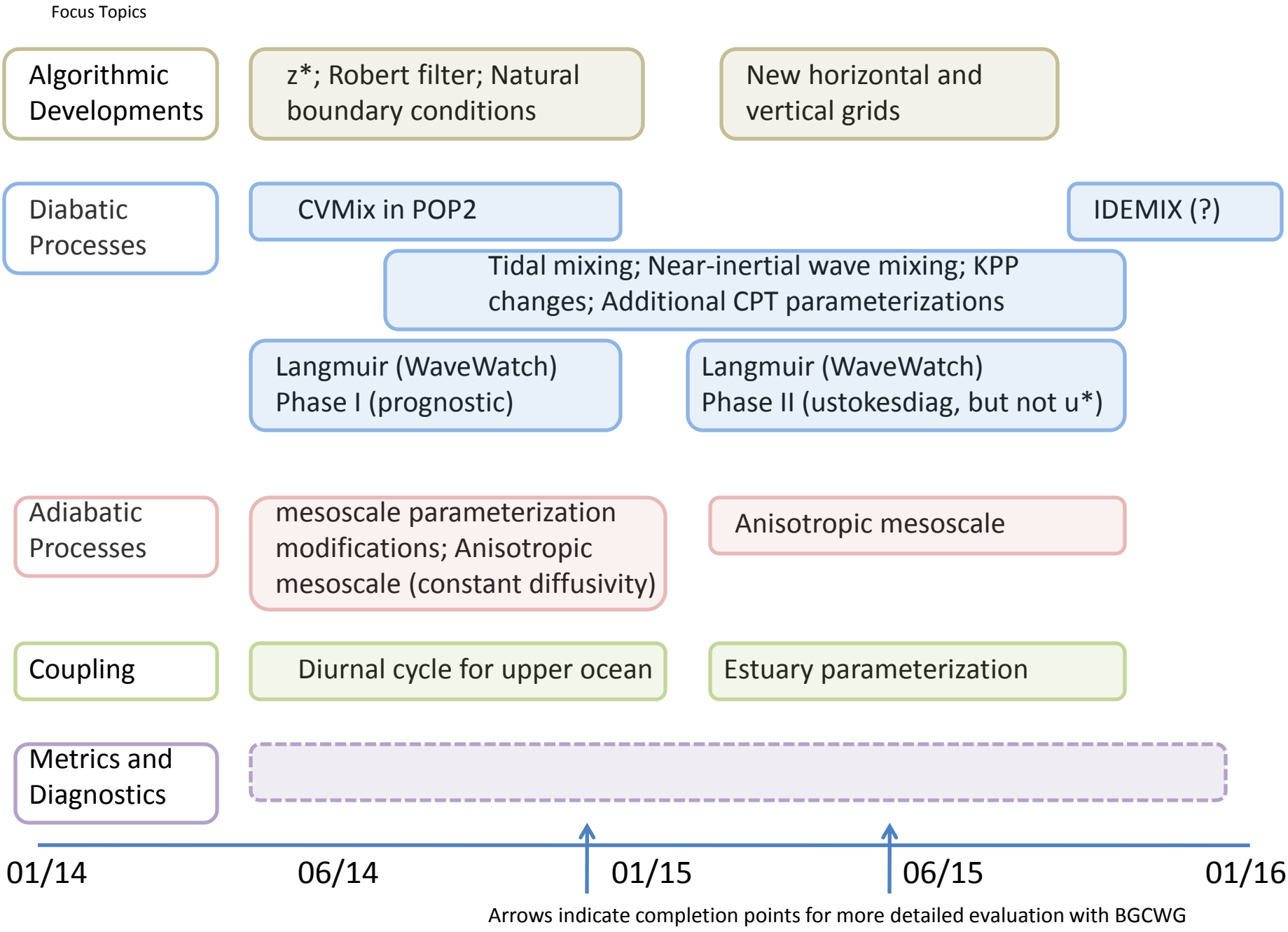
CESM OMWG Development Timeline – Path Towards CESM2



CESM proposal for CSL resources will be submitted in early Fall.

Please send me your allocation requests for CESM OMWG related work by August 1st, 2014.

Algorithmic Developments [Participants: Bryan (lead), Danabasoglu, Hecht, Lindsay, Maltrud, Tseng, Yeager]:

i) Elimination of virtual salt fluxes in favor of true freshwater surface fluxes;

ii) Implementation of a new vertical coordinate system, z*;

iii) Introduction of a conservative Robert time filter to replace the time-averaging time step;

iv) Making partial bottom cell treatment fully operational;

v) Considering both slightly finer horizontal resolution than currently used and increased vertical resolution.

Diabatic Processes [Jayne (lead), Bryan, Danabasoglu, Fox-Kemper, Gent, Jochum, Large, Levy, Long]:

i) New and modified tidal mixing and near-inertial wave mixing parameterizations;

ii) Langmuir mixing parameterization; ii) development and incorporation of the CVMix (Community ocean Vertical Mixing) modules into POP2;

iii) Revisiting and modifying some parts of the K-Profile Parameterization (KPP);

iv) Considering incorporation of additional (and new) parameterizations emerging from the Climate Process Team (CPT) activities on internal mixing or from the general OMWG community, e.g., Internal Wave Dissipation, Energy, and Mixing (IDEMIX).

Adiabatic Processes [Gent (lead), Danabasoglu, Fox-Kemper, Long, Moore]:

i) changes in the prescriptions for both the isopycnal and thickness diffusivity coefficients used in the Gent and McWilliams mesoscale mixing parameterization;

ii) implementation of an anisotropic version of this parameterization.

Coupling and Boundary Conditions [Large (lead), Bailey, Bryan, Tseng]:

i) evaluation and use of a newly developed coupler scheme for diurnal cycling of the near-surface ocean temperature;

ii) incorporation of an estuary parameterization.

Metrics and Diagnostics [Danabasoglu (lead), Levy]: In response to an earlier request from the CESM SSC, the OMWG had prepared and submitted (to the SSC) a short document summarizing our current practice of model evaluation along with a list of desired redesign and improvements of the OMWG metrics and diagnostics. The goal here is to start making some progress.

Numerics Team

- Z^* and Robert Filter
  - Previous Robert and z* versions merged and validated in idealized channel, gx1v3, 0.3v1 (eddying, PBCs) using control and 4 configurations of new version (avgfit,robert_fit),(varthick,z*)
  - Exact restart verified
  - Pressure gradient correction for z* grid slope
  - Nominal thicknesses used for d/dz (parameterizations unchanged)
  - Works with centered, upwind3, lw_lim advection
  - 3 time level pressure averaging works (additional assessment required)
  - Simpler version of ice formation logic (top level only-current standard)
  - Works with Ideal Age and CFCs
  - Still To Do:
    - BEC
    - Overflows, marginal sea balancing
    - Explore higher order RF (Williams, Tseng)
    - Port to more recent version, merge w/ T. Craig implementation in RASM

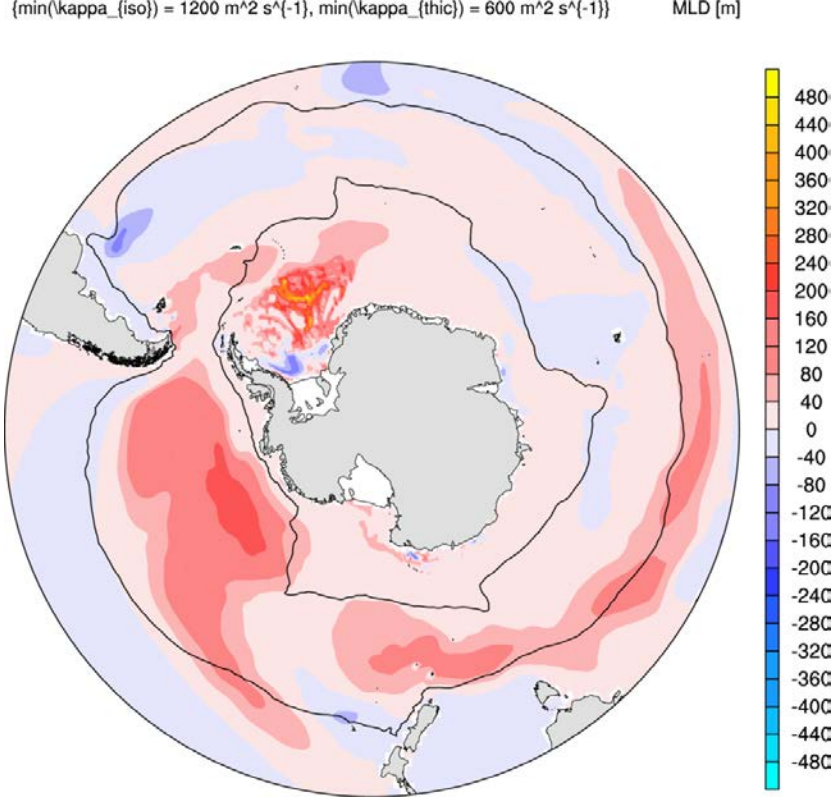
- Natural B.C.s
  - Modifications to current land mask required (isolated bays)
  - Short test (~5 year) runs produce plausible results
  - Potential bugs identified
  - Further work pending Z^* and RF completion
- Grids
  - Reviewing Steve Yeager's work on vertical grids leading to CCSM3.5 (see presentations in CCSM archives)
    - Clear additional benefits at 80 and 100 levels
    - Recent case with 550 levels as a benchmark
  - Discussions about potential new "workhorse" grid
    - Slightly higher (~0.75°) zonal resolution (more isotropic) ?
    - Tripole?
    - Revisit horizontal viscosity closure (Munk layer resolution necessary?)
- Barotropic solver
  - Looking at Hu et al (2013): Stiefel iteration based solver
    - No global sums
  - See poster OMWG-7

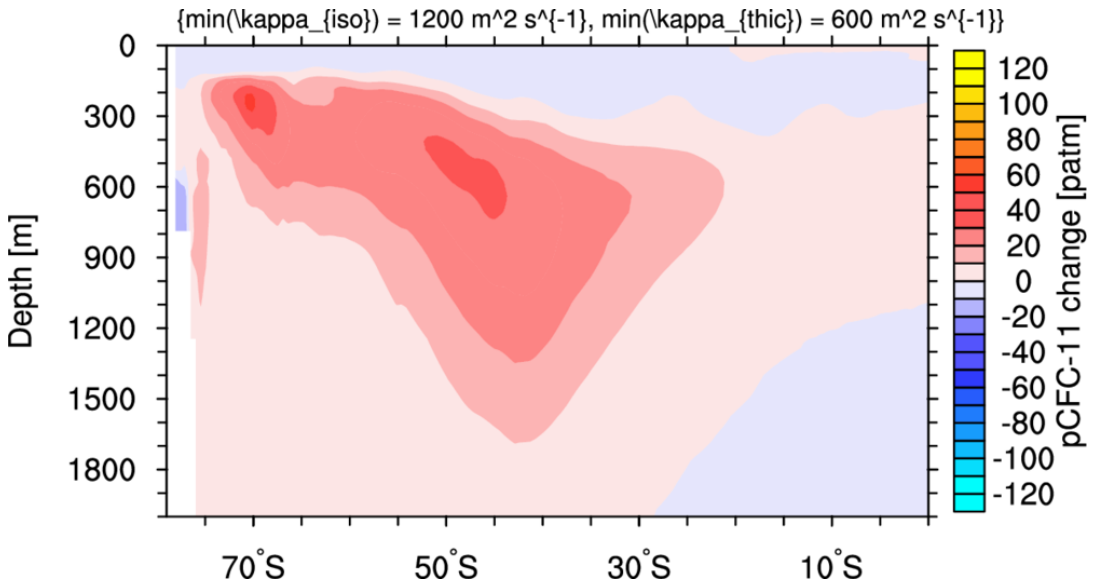
Changes to GM

Minimum value increased to 0.2 of the surface value

and Redi diffusion

Minimum value increased to 0.4 of the surface value





A/S/O ML depth increased where it is too shallow, and annual CFC11 uptake increased where it is too little compared to observations

A request from J.-F. Lamarque: A couple of science questions that OMWG could target either under CSL and/or CMIP6 planning. A motivation for the latter is that the CMIP panel wants to know the plans of different modeling groups.

In OMWG discussions during some recent meetings, we identified a few science opportunities that also guide our development efforts:

- Sea level change and land-ice – ocean interaction,
- Role of ocean in near-term (seasonal-to-decadal) climate variability,
- Model biases (possibly) impacting science to be done, e.g., Southern Ocean ventilation, drift, ….
- ….

Update on Robert Filter and z*

- Implemented in stand-alone CESM1.1beta08
  - Previous Robert and z* versions merged
  - Validated idealized channel, gx1v3, 0.3v1 (eddying, PBCs) using control (unmodified 1.1beta08) and 4 configurations of new version (avgfit,robert_fit),(varthick,z*)
  - Pressure gradient correction for z* grid slope
  - Nominal thicknesses used for vertical derivatives
    - Parameterizations unchanged
  - Works with centered, upwind3, lw_lim advection
  - 3 time level pressure averaging works
    - Need to assess magnitude of error estimating n+1 thickness
  - Simpler version of ice formation logic
    - Only works for ice in top layer and formation just prior to coupling steps (current standard)
  - Works with Ideal Age and CFCs
  - Exact restart verified

What's Left?

- BEC module
  - Extra 3D array for each prognostic variable
    - Also in restart file
  - Do we need Robert Filter for this?
    - Source/sink terms use average of n, n-1 levels
- No compatibility with Overflow parameterization and Marginal Sea balancing (yet)
- Explore higher order variants of Robert Filter (Williams, Tseng)
- Port to recent version of CESM
  - which version?
  - Leverage Tony's RF implementation in RACM
- Validation runs
  - Multi-century fully coupled control
  - Others?
- Documentation