CESM Ocean Component Beyond CESM2

Disruptions Anticipated Ahead

Background

- Our current ocean component, POP, and our partnership with LANL in its development, have served the CESM community well for 15 years.
- Aspects of the current dynamical formulation of POP are an impediment to improving the model skill and addressing cutting-edge climate research questions.
- Development of the POP dynamical core at LANL has ended and subsequent efforts in CESM to advance the POP dynamical core have stagnated.
- The landscape of the US ocean and climate modeling enterprise has evolved significantly since we last switched ocean models in CESM:
  - More diversity in ocean models
  - CESM ocean model used in broader scope of Earth system modeling applications (Paleo, BGC, Ecosystems, Data Assimilation and Prediction, etc)
  - Coordinated community activities (CPT's, EaSM's, CORE's)
  - Changes in organizational structures and partnerships

Objectives of This Discussion

- Assess community requirements for next generation CESM ocean component
- Identify viable options and non-viable options, both technical and organizational
- Help define the process to guide the transition to a new ocean component

What attributes of the POP model should be retained in the next generation CESM ocean component model?

- Tuned global configurations at a range of resolutions, both coupled and uncoupled
- Simulation skill/computational cost ratio met or exceeded
- Good documentation, support, training opportunities
- Open source approach to model development
- The current output/diagnostic options (multiple streams at different frequencies)
- Backwards compatibility with diagnostic tools
- Key physics parameterizations from POP modularized and extracted
- Modular support for diverse tracers
- Written in Fortran

What capabilities or application areas not currently supported by POP should the next generation CESM ocean component model address?

- Natural boundary conditions
- Generalized/ALE vertical coordinates
- Modern advection algorithms
- Refinement and/or two-way nesting in global model
  - especially for continental shelf regions
  - Relocatable, user configurable, variable meshes/nesting refinement
- Regional (one-way nested) configurations
- Straightforward grid generation tools
- Conservative wetting/drying, moving lateral boundaries
- Iceberg and ice shelf interface
- Efficient treatment of large (>100) tracer counts
- Lagrangian tracking
- Mass or volume conserving (non-Boussinesq/Boussinesq)
- Non-hydrostatic (?)

Should the CESM ocean model development activity strive to provide a model that meets the needs of the ocean modeling community generally, or remain focused on a model suited primarily to climate science applications?

Should the CESM ocean component model (or at least the code base) be suitable for both process modeling and climate modeling applications? For educational and training activities?

- Yes to the extent that process modeling capability does not compromise the fidelity of the climate simulation (e.g. strict conservation of mass, heat, salt)
- Caution that the resource requirements to support multiple communities would spread us too thin
- Building/Expanding community important to reinvigorate participation in the CESM ocean modeling development

Should the CESM Ocean Model Working Group join efforts with an existing ocean model development activity or begin a new design from scratch?

What level of collaborative development is considered essential? Through what process should CESM Ocean Model Working Group work to become integral part of the design and development team for the next base model code?

- Must distinguish between an ocean model (a runnable configuration) with ocean model base code to be configured to meet CESM needs
- Do not reduce the diversity and vitality of the US ocean modeling community
- Developing a model from scratch is a 10 year (20-40 man-year) effort
- Not clear what value would be added by pursuing a new model from scratch

- CESM must take the lead in developing its own ocean model configuration
- Whatever model code is adopted by whatever route, OMWG should be integral to the design and development process
- There should be a dependable and agile/versatile user/developer at NCAR devoted to interface with dycore developers
- Relationship between CESM and dycore developers must be regularly nurtured to ensure ongoing trust and mutual recognition of each other's value and integrity

Alternative Pathways Proposed by Respondents

1. Take a snapshot of an existing mature dycore and rebrand it and fully support further development of the CESM version (*CSM-1*)
2. Choose an dynamical core that suits CESM's needs and leave further development of the dycore to the expert developers and invest in parameterization (*CCSM-2 to CESM-1*)
3. Collaborate on dycore development with a trusted group with the following attributes:
   - an active and sustainable development process
   - Institutional long-term commitment to support ongoing development
   - Joining with one of the less mature efforts may provide for the potential to shape and contribute to their near term evolution and longer viable lifetime
   - Note example of NEMO council as an example of collaborative governance
4. Consider deeper collaboration on dycores with AMWG (e.g. an SE ocean dycore)

Next Steps ?

- Define the process to guide the transition to a new ocean component
  - What options should be eliminated?
  - What development groups should we approach to discuss collaboration?
  - What organizational structure/joint governance options should we propose?