

Friday, May 27, 2016

Re: Email Request for information for the next ocean component of the CESM

Dear Gokhan, Baylor and Frank,

Thanks for reaching out to the MITgcm ocean modeling group. A core group actively involved in the MITgcm modeling effort had some (fairly short) preliminary discussion on your RFI when we were together last week. A summary of our discussion points, organized around *technical possibilities* and *organizational resource concerns*, is provided below. Broadly we all see, to varying degrees, possible ways in which we would like to try and help the CESM effort. However, we also noted some organizational resource concerns around the NCAR involvement that we believe may need to be addressed more convincingly. These concerns do appear to several of us to present a reasonable obstacle to our being able to help to the extent we might hope or like. We hope to have some participation in the Breckenridge meeting to discuss the topics further.

We hope that you find the comments below helpful in formulating your plans.

Sincerely,

Chris Hill,
John Marshall,
Jean-Michel Campin,
Dimitris Menemenlis

Technical Possibilities

1. We discussed that there are some interesting aspects to the MITgcm work that could certainly be valuable as you move forward on CESM and CMIP6 commitments. Many of the technical requirements you outlined have already been developed and implemented within MITgcm.
2. Our discussions also touched on a number of MITgcm aspects that are not mentioned in the RFI, but that seem likely to be relevant in coming years. These could be technical considerations that you may also want to factor in your planning.
 - 2.1. Tides and internal waves. MITgcm is used in research that explores large-scale and small-scale internal wave/tide processes. A seamless connection to these scales could be useful to efforts to move climate prediction skill toward improved accuracy.
 - 2.2. Ice sheet boundary conditions. MITgcm has several innovative capabilities around interacting with dynamic ice sheets. These include recent parameterizations of buoyant melt plumes and recent work on wetting and drying and moving ocean boundaries. These aspects should be relevant to removing sources of possible systematic bias in sea-level change monitoring and prediction.
 - 2.3. Non-hydrostatic dynamics. MITgcm has proved useful for understanding non-hydrostatic processes, including dense overflows and deep convection dynamics, and also in detailed understanding of wave breaking. Again a relatively seamless link to the ability to represent processes down to some of these scales could be relevant within the next 5-10 years.
 - 2.4. Formal data assimilation. The RFI mentions CESM data assimilation capabilities. The MITgcm has been interfaced with the NCAR DART ensemble Kalman filter system, but it also has well known budget preserving adjoint capabilities. Together these aspects could provide valuable new directions for initialization, for guiding observational programs, for highlighting structural inconsistencies between models and data, and for incorporating measurement types that are

starting to increase in coverage such as chemical tracer data and ambient acoustics data. Again these are factors that seem likely to grow in relevance over the next decade.

- 2.5. Kilometer scale modeling capabilities. MITgcm has the ability to model horizontal resolutions of around a kilometer in global scale numerical experiments. The capability has been linked with highly scalable I/O tools to allow high spatial and temporal recording of simulation trajectories. Although computationally highly demanding at present, such computations have the potential to bridge to emerging highly resolved observational datasets and to provide frameworks for understanding parameterization formulation and limitations. Our expectation is that this direction will prove relevant to seasonal and decadal modeling in coming years.

Organizational resource concerns

Overall the technical items suggest that some engagement with CESM could be helpful and worthwhile all around. However, several of us were more than a little wary of the impression given in the RFI that NCAR itself might bring relatively little engagement into the activity. Much of the innovation in MITgcm centers on collaborations where co-ownership of the work resides with engaged researchers who actively contribute to the model development process. The work feeds back into the modeling effort synergistically. We were unclear reading the RFI whether NCAR itself would be truly committed to "owning/co-owning" much of the modeling activities that it cares about, or whether there was an expectation that many laborious, but important, tasks would be outsourced to a "partner".

This RFI could be a great opportunity for NCAR to strategize and set the stage for its next big push in ocean modeling. It makes sense to us that NCAR should partner with other groups, but it should not cede model development - including that of the dynamical core - to outside parties. Given the tradition of community modeling at NCAR, one can envisage a devolved development strategy engaging the brightest and best ideas out in the community.

The development of the MITgcm has been centered at MIT but with a devolved group of developers out in the field. This has led to algorithmic innovation, a sense of ownership and wide adoption of the model. In this regard we are concerned that our mode of working may be different from what NCAR currently envisions. The RFI seemed to indicate that NCAR might not be envisioning putting adequate resources itself into any CESM ocean activity. This could present a challenge to any plans to work with an academic group such as MITgcm, which by construction and necessity is distributed and relatively thinly spread. Without plans for a more viable the center of gravity for the ocean component of CESM at NCAR it is hard for us to envision a collaborative effort, under the terms outlined, living up to everyones aspirations.

We certainly stand ready to collaborate and exchange ideas in the development of a next-generation community ocean model at NCAR. The MITgcm itself is openly available of course. We welcome contributions of all sorts and have a robust process for informal and semi-formal collaboration. Our strong feeling, however, is that CESM would be better off establishing a larger commitment to core ocean model development activities at NCAR, before making any firm decisions on what partnerships and numerical models to leverage and how.