ACME Collaboration Agreement
CICE Community of Users/Developers

1. **Briefly describe the research objectives of your project**

   CICE has strongly benefitted from community development efforts, and this agreement allows us to continue integrating, testing and rapidly adopting these new developments into ACME's new MPAS-based sea-ice model (MPAS-CICE).

   A very large community, including many climate modeling and forecast centers, uses the CICE model. Several of these centers and collaborators have been active in the development of CICE, particularly in the column physics. As part of the ACME proposal, we specifically outlined an approach for continued support of this CICE community during the transition to MPAS-CICE. In the proposal, we describe the development of a standalone CICE column physics package as a set of modules that are completely independent of grid and other infrastructural CICE elements (e.g. MPI tasks, calendar). It also includes an interface of subroutine calls that translate from model-specific arrays and other variables to the model-independent column physics calculations. As such, the column package consists primarily of existing physics parameterizations that have been publicly released (CICE v5), but the code has been refactored so that the column physics is callable by both the older CICE model and the new MPAS-CICE model, to enable continued development of the CICE column physics during the transition.

   This collaboration agreement addresses all use and development of the column package in the context of the CICE model, as well as new CICE developments outside of the column package, by ACME personnel and community developers. It does not address potential collaborations using the new ACME sea ice model, MPAS-CICE. This collaboration agreement specifically requests an initial, limited release of the column physics package to the CICE developers group, including physics that was already released as part of CICE v5. This release is necessary to support existing collaborations and speed integration into the ACME model. The release will also include the full 3-D sea-ice biogeochemistry that has been published (N. Jeffery and E. C. Hunke, 2014. JGR, DOI: 10.1002/2013JC009634), but was not quite ready for the v5 release due to inadequate documentation and final testing that were continued under the ACME project.

2. **Describe any proposed ACME code changes and expected timeline of effort.**

   As new developments are incorporated into the column package, associated changes to the interface routines in MPAS-CICE will be required for adoption into the ACME model. These changes will follow the standard ACME protocol for adoption of new capabilities into the code and will be done as time allows, based on ACME priorities. To enable easier adoption into both CICE and MPAS-CICE, community-contributed code must be accompanied with a complete description of the changes necessary to

the column package interface. A form detailing the information needed will be provided to developers (see https://acme-climate.atlassian.net/wiki/display/OCNICE/Sea+Ice+-+Documentation+Required+for+Changes+to+the+Column+Package).

In the short term, we have created the column physics package and are manually synchronizing the CICE and MPAS-CICE models while we test the interfaces. We plan to distribute an early version of the column physics package from the existing CICE repository, to be used with CICE. In the longer term, we will work toward an independent repository from which we can distribute the column physics as a standalone package and where community developments will continue to be merged.

3. **Describe any simulations to be used or proposed and their timeline.**

   All simulations will be done using the CICE model, which is not an ACME component but contains the ACME-funded column package software. Simulations will serve to test and document new CICE model developments, as they arise in the community, prior to their integration in MPAS-CICE.

4. **List publications expected from the collaborative effort, expected authors, and approximate dates of submission.**

   Publications will be determined based on collaborators' interests as outlined below.

   Developers of the column package (E. Hunke, A. Turner, and for BGC, N. Jeffery and S. Elliott) will be invited as co-authors on all publications utilizing the column package software until such time as it is publicly released, and publications will acknowledge support from DOE as the funding source of the column package refactorization.

5. **If any exceptions to the ACME code policy are requested, describe and justify the request.**

   We expect to abide by the (30 June 2015) ACME policy, reproduced below, with modifications noted in italics.

   1. Development code or simulations from development code may not be redistributed. Anyone with access to the code or simulations will take reasonable precautions to ensure the code or simulations are not accessed by unauthorized persons. *Column package development code and data from CICE simulations performed by ACME developers (E. Hunke, N. Jeffery, S. Elliott, A. Turner) may be distributed to CICE collaborators at the discretion of E. Hunke, pursuant to the ACME policy conditions below.*

   2. All proposed research using development code and associated simulations must

be coordinated with the related developers and subsequently approved by the Council or its designee prior to starting the research. The research plan should include an upfront discussion of publications and authorship. All developers must be given an offer to participate in both the design and performance of the research.

3. Development code and associated simulation output can only be used for the agreed upon research and may not be used for other purposes or in other models, until such time as the development code is publicly released. *The CICE model and/or the column package may be adopted into other models and used, pursuant to the ACME policy conditions reproduced here, at the discretion of E. Hunke.*

4. New code developed that relies on ACME development code must be made available to ACME under the ACME policies.

5. ACME, at its discretion, may release code into a separate repository for use by others provided that the governance of that repository requires users of that code to adhere to the ACME collaboration policy.

6. Access to the ACME-Confluence software is generally restricted to ACME project members and those who are active ACME code developers.

6. **Provide the names and emails of individuals involved in this agreement and specify those that will require ACME code and Confluence access and their roles in the collaborative project. Each project member seeking code and/or Confluence access should also send an email request to David Bader (bader2@llnl.gov) and Project Engineer Renata McCoy (mccoy20@llnl.gov), subject "ACME code/confluence access request for project XX and developer YY".**

Collaborators will not require access to Confluence or to ACME repositories.

As described above, the CICE user community is very large. The most important collaborations are with significant users and with those involved in joint development of the CICE model. This "CICE developers group" includes, but is not limited to, the following research groups and institutions:

- The US Navy uses CICE in its operational Arctic forecast model. The current operational version is CICE v4.0. They are currently testing CICE v5.1 as part of their plans to upgrade the forecast model for future operational use.
- The UK Met Office uses CICE in its forecasting suite at all time scales (numerical weather prediction to climate projection). Like the Navy, they currently use an older version operationally while testing CICE v5.1 as part of a lengthy validation and evaluation cycle.
- Daniel Feltham's group at the University of Reading is responsible for a number

of CICE developments and is funded to supply new developments to the UK Met Office. Feltham's group has made sustained contributions to CICE, most notably contributing new form drag, melt pond and anisotropic rheology parameterizations for CICE v5. They have a number of other developments in the pipeline, including refreezing of melt water on top of and underneath the ice, frazil ice physics, and inclusion of ocean stability effects on ice-ocean drag. Their funding hinges on the contingency that their parameterizations be adopted in CICE and used by UK Met Office.

- GFDL has requested the column package to test in their modeling framework, for evaluation purposes. They would not adopt it into GFDL-released code until after their CMIP6 code is frozen, which likely would be after the column package has been released by us. (They do not adopt the entire CICE model).
- The Regional Arctic System Model (RASM) based at the Naval Postgraduate School, funded by DOE (RGCM), the Office of Naval Research and NSF, has been a long-term user and developer of CICE capabilities. Recently, they were responsible for diagnosing and fixing high-frequency ocean-ice coupling instabilities and for incorporating CICE v5 into the CESM model. Current collaborative research includes developing a more physically defensible, unified sea ice form-drag and ridging parameterization. In addition, RASM is conditionally accepted for DOE funding to implement a satellite emulator for the NASA ICESat-2 mission to be launched in 2017 for evaluating sea ice volume in CICE, which will directly benefit ACME. This work addresses issues with the sea ice thickness distribution that are not scheduled for improvement as part of ACME development. All of this work needs to be done in the column physics package to enable its timely adoption into MPAS-CICE. The RASM project is required by DOE to collaborate closely with the HiLAT project below.
- The undeniable success of CICE is a direct result of our decades-long collaboration with CESM researchers. This collaboration continues through RASM, with a particular focus on biogeochemical cycles.
- The DOE High-Latitude Application and Testing of Regional and Global Climate Models (HiLAT) project plans to use CICE v5 in coupled simulations and specific studies exploring model sensitivity to new CICE physics (HiLAT will be the subject of its own collaboration agreement).

CICE is accessible to these collaborators through its own repository, located at LANL, with development by each group occurring on password-protected branches within that repository. Further ACME development will occur on a private branch with ACME developers (Hunke, Jeffery, Turner) responsible for ensuring all ACME collaboration policies are followed for any release from that private branch into public or collaborative spaces in the repository.

Dr. Elizabeth Hunke of Los Alamos National Laboratory (LANL) will maintain sole authority over the CICE column physics repository. Should Dr. Hunke relinquish this authority, or should she no longer work more than 50% under ACME support at LANL, this agreement will no longer be valid. Further, Dr. Hunke will report to the

Executive Committee by email within 30 days when significant ACME-funded developments at any DOE-laboratory are released into the shared non-ACME CICE column physics repository under her control. It is her responsibility to assure that the spirit of the ACME publication policy is maintained in the use of the code by any non-ACME collaborator (proper attribution to developers and the project through publications and the release of simulations.)