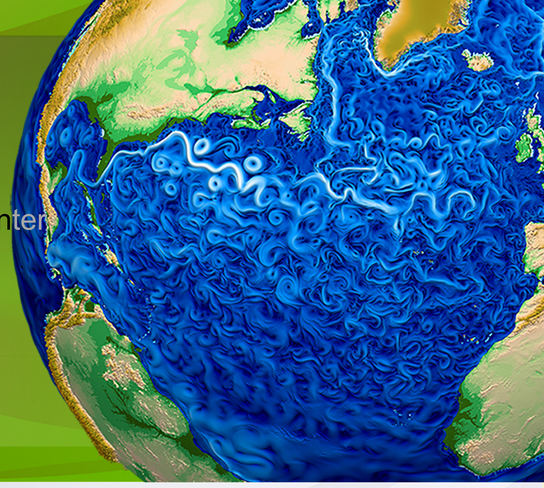
P: CICE Consortium

Accelerating sea ice model research, development and transfer to operations

Members:
Los Alamos National Laboratory
National Center for Atmospheric Research
Naval Research Laboratory, Stennis Space Center
Naval Postgraduate School
NOAA National Weather Service
NOAA Geophysical Fluid Dynamics Laboratory
Environment and Climate Change Canada



Open collaboration

The primary developers and stakeholders of the Los Alamos sea ice model, CICE, are forming a sea-ice modeling consortium to formalize and enhance the collaborative alliance that has fostered the model's development over the past two decades. The CICE Consortium will incorporate and maintain new research and development in collaboration with the larger sea ice modeling community, in order to accelerate the transfer of scientific sea ice model development into operational use and for the wider research community, including ACME.

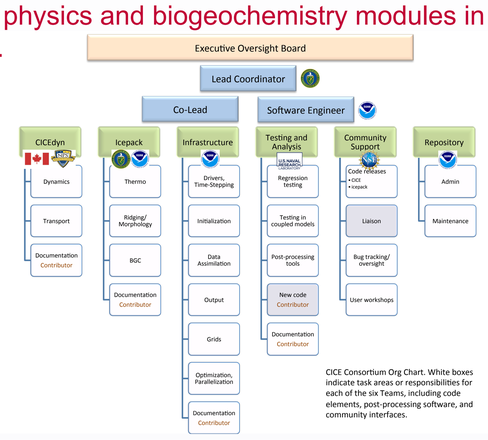
This multi-agency, international Consortium represents a microcosm of larger R&D/ operational alliances now developing within the U.S. climate and weather prediction community, for which our experience may provide guidance, including a governance model, intellectual property protection within an open software development environment, and innovative solutions for code confidence and acceptance testing as it advances from research into operations.

Structure and Governance

The organizational structure below shows the Executive Oversight Board (EOB) in tan, Executive in blue, and the six Teams with Team Leads in green. A committee consisting of the Executive and Team Leads acts as a science oversight/advisory board and as a change control board for the code. In addition, a group of **Sponsors** takes responsibility for agency-level oversight, policy authority on behalf of their organizations, and coordination of resources. The **EOB** advocates for Sponsors' financial support to maintain the Consortium and oversees Consortium management to ensure continuity of Consortium functions for the benefit of the CICE user community. The **Executive** is responsible for overall coordination and management of the Teams and broad oversight of the code. **Team members** plan and implement tasks needed to maintain and distribute the model software and documentation in a manner that promotes the ease of future model development. Team members are not responsible for support of scientific R&D, parameter tuning or emergency responses following operational failures. Teams are led or co-led by institutions having the most experience or interest in the team topic.

DOE is participating in the CICE Consortium through support of the Lead Coordinator and co-leading the Icepack Team. Icepack contains all column physics and biogeochemistry modules in CICE, and is used in ACME's MPAS-seaice component.

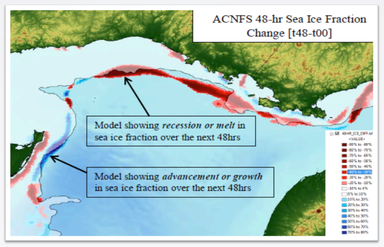
The CICE code is available through a set of public repositories on github. The code is governed by a 3-clause BSD license and copyright. A distribution policy, which applies to privately held forks and branches of the public repositories, protects individual authorship and intellectual property rights for both Consortium Members and the broader CICE user community, while encouraging open, collaborative software development.



CICE Consortium Org Chart. White boxes indicate task areas or responsibilities for each of the six Teams, including code elements, post-processing software, and community interfaces.

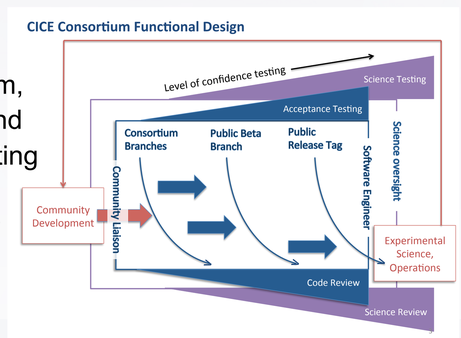
Use and Functional Design

The CICE sea ice model is currently used in operational settings by the UK Met Office and the U.S. Navy, which pushes daily sea ice forecast products to NOAA and the National Ice Center. For example, the National Ice Center uses the change in sea ice concentration (left) to prepare daily ice charts for marine traffic. The Navy also uses the model to support NASA Operation IceBridge flights and for special missions, such as a narrowly averted disaster when the town of Nome, Alaska nearly ran out of heating oil, after an early winter storm prevented their final fuel delivery. The CICE sea ice model was used to guide the joint US-Russian convoy (above) through 300 miles of sea ice, to resupply the town.



The Consortium's role within the broader community

The Consortium is represented by the blue box (right). Research and development occurs outside the Consortium, in the community. The Consortium provides a pathway and support for contributions from the community by coordinating code improvements and confidence testing on which agencies can base decisions for code acceptance in their models. Scientific review is done by the community in publicly accessible code, leading to further development.



Status and Plans

https://github.com/CICE-Consortium

Status

- Consortium governance and code distribution policies have been developed
- Github repository structure has been designed and implementation is underway
- Detailed guides for working with CICE and the Icepack submodule are being tested
- Icepack is becoming a fully independent code package
- Test suites and confidence scoring (sidebar) are being developed for both Icepack and CICE
- Online model documentation has been piloted and existing documentation is being reorganized and updated in this new format

Examples of community contributed improvements for upcoming 2017 release:

- Normalization pressure for principal stresses
- Time-level consistency in transport code
- Anisotropic rheology performance
- Freezing temperature option for coupled consistency
- Simplify CICE-Icepack interfaces and warning system

Icepack v1.0 – Oct 2017, CICE v6.0 – Dec 2017

Expected follow-on contributions to Icepack:

- Floe size distribution
- First-principles ridging and morphology
- Snow on sea ice redistribution, metamorphosis
- Biogeochemistry improvements
- Thermodynamically consistent melt ponds
- Under-ice ponds

Code acceptance testing — M=Mandatory, P=Preferred, O=Optional

OUTCOME	Smoke test	Restart test	10-Day Regression test	Annual Cycle Regression test
	✗ / ✔	✗ / ✔	✗ / ✔ / ⚠	✗ / ✔ / ⚠
Namelist 1	M	M	M	M
⋮	↓	↓	↓	↓
Namelist 5	O	O	O	O
PE Count 2	P	P	P	P
Threading	O	O	O	O
Machine 2	P	P	P	P
Resolution 2	P	P	P	P

A code contribution must pass mandatory tests and accumulate a minimum confidence score to be merged into the Consortium's repository. The score increases with additional positive tests and is tracked in the repository. This allows confidence to accumulate for each code version without requiring all Consortium member institutions to test each version before it is released.

ACME Accelerated Climate Modeling for Energy

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