

CLIMATE, OCEAN AND SEA ICE MODELING

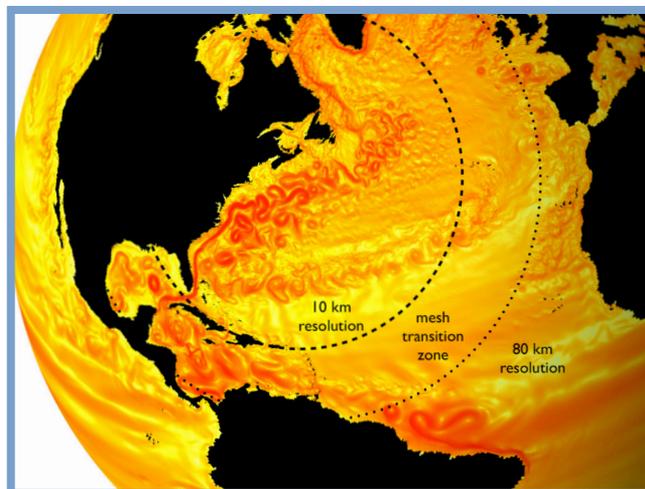
The Climate, Ocean and Sea Ice Modeling (COSIM) project at Los Alamos National Laboratory is responsible for developing advanced computer models of the ocean, sea ice, and ice sheets for climate change research. COSIM researchers apply these high-performance multi-scale models as part of coupled climate models, analyzing the results to understand the role of ocean and ice systems in high-latitude climate change and its impacts throughout the globe.

CRITICAL CLIMATE CHANGE ELEMENTS

The oceans, sea ice, and land ice are critical elements of the climate system. Melting of glaciers and ice sheets contributes to significant sea-level changes. Understanding their role in the rate of sea level rise will be important as we respond to climate change. Sea ice provides strong feedback to the climate system through albedo changes. Rapid decreases in Arctic ice could significantly impact human activities in the Arctic and beyond. The ocean transports heat, water, and other quantities around the globe and contributes to longer timescales of climate variability, which could last decades, centuries, or longer. Models used to understand and predict climate change must include ocean and ice processes.

OCEAN AND ICE IN ACTION

COSIM researchers include their models in full climate system models to study how they interact as part of the system. This analysis provides a better test of how well they reproduce past and current climate, while increasing confidence in their capability for projecting future climate. All three component models are used as part of the Community Earth System Model (CESM) contributions to national and international climate assessments and intercomparisons, including scientific assessments of the Intergovernmental Panel on Climate Change (IPCC).



A variable-resolution MPAS ocean simulation, focused on the North Atlantic.

OCEAN AND ICE MODELS

COSIM is responsible for developing ocean and ice component models for the Department of Energy and other climate centers throughout the world. Our current models include:

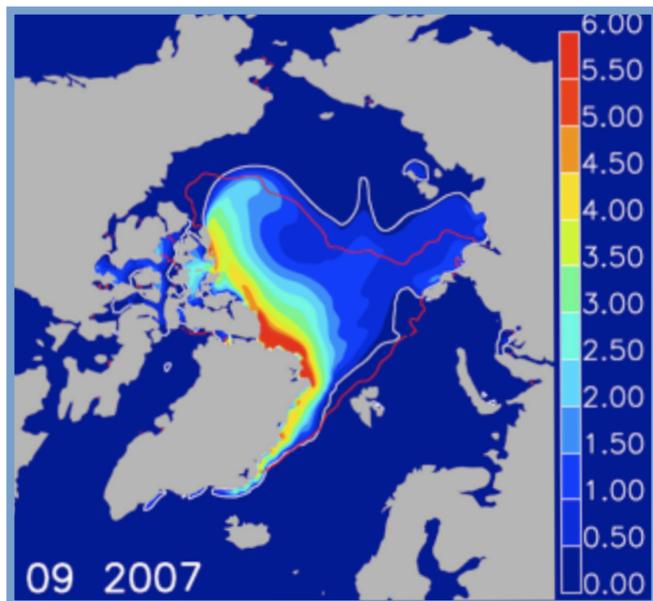
POP – Parallel Ocean Program

CICE – Los Alamos Sea Ice Model

CISM – Community Ice Sheet Model

These are publicly available and form the ocean and ice components of the **Community Earth System Model (CESM)**, a coupled climate model jointly supported by the Department of Energy and National Science Foundation.

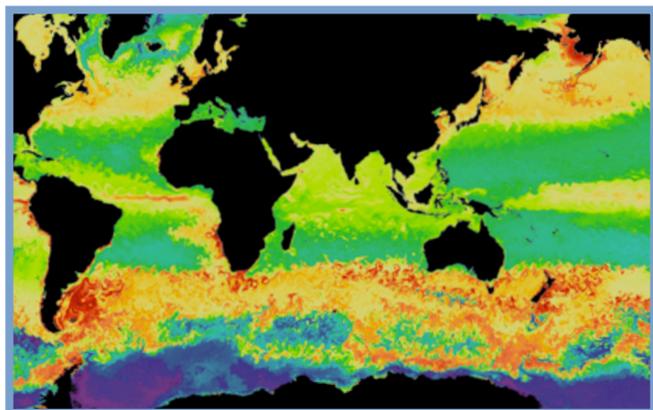
Our next generation ocean and ice models are built on a new **Model for Prediction Across Scales (MPAS)** framework that permits spatial resolution to vary widely around the globe, in order to focus on regional or local changes and to efficiently resolve finer scale processes.



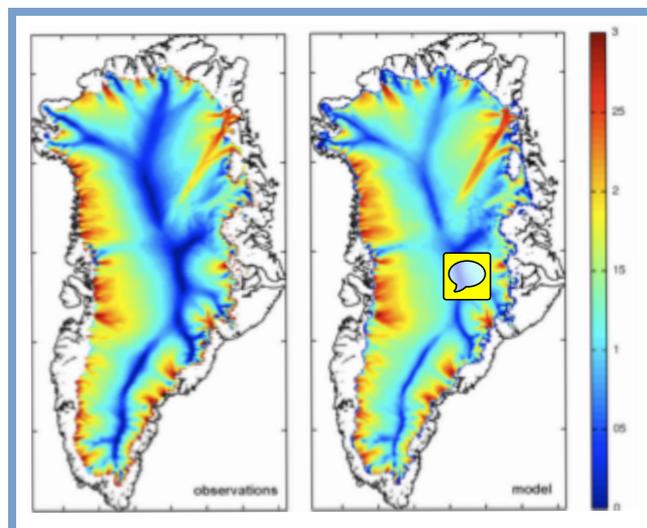
Sea ice thickness (m) in September 2007 from a simulation of Los Alamos' CICE model, compared to observations (red line).

As shown above, the Los Alamos Sea Ice Model (CICE) performs well when forced by observed atmospheric conditions and reproduces the historical sea-ice extent, including the rapid decrease in 2007.

Ice-sheet models are the most recent COSIM contribution to the climate modeling community. Simulations from the Community Ice Sheet Model (CISM) have been performed for both the Greenland and Antarctic ice sheets and evaluated through comparison with observed ice velocities. This model is now coupled within CESM and will soon provide improved estimates of future sea-level rise.



Surface chlorophyll concentration from an eddy-resolving simulation of the POP model, with an embedded model of marine ecosystems and biogeochemistry.



Ice speeds (log of m/yr) from a CISM simulation of the Greenland ice sheet (right), compared to observationally based ice speeds (left).

The Parallel Ocean Program (POP) model is used to perform simulations at the highest spatial resolution possible in order to study the impact of ocean eddies (typically 50-100 km in size) on the global circulation of the ocean. The figure above shows one such eddy-resolving study that included a representation of the North Atlantic Ocean.

FUTURE DIRECTIONS

COSIM is providing future generation computer models, simulations and analysis needed to understand how the ocean, sea level, sea ice, and ice sheets are changing and interacting with the climate system.

This work is supported by the Climate and Earth System Modeling programs of the Department of Energy's Office of Science.

CONTACTS

Dorothy Koch, Ph.D.

DOE Program Manager
 Earth System Modeling
dorothy.koch@science.doe.gov

Renu Joseph, Ph.D.

DOE Program Manager
 Regional and Global
 Climate Modeling
renu.joseph@science.doe.gov

Philip Jones, Ph.D.

Principal Investigator
 Los Alamos National Laboratory
pwjones@lanl.gov

Project Website:

<http://climate.lanl.gov>