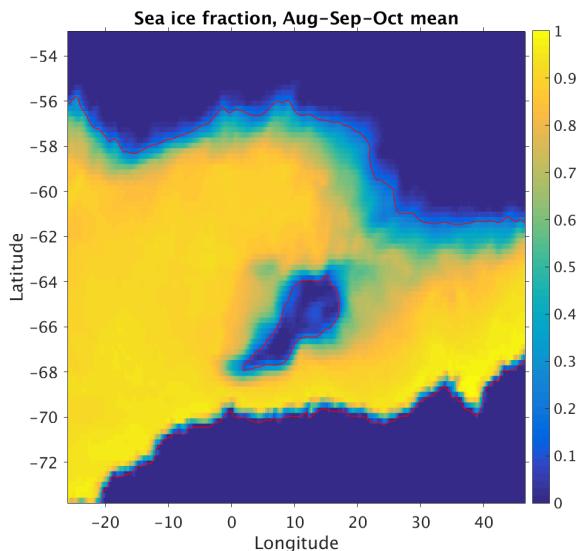


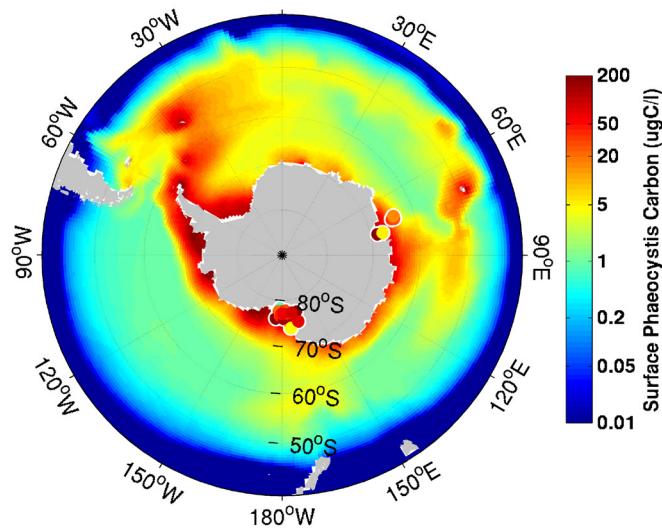
## HIGH LATITUDE APPLICATION AND TESTING OF CLIMATE MODELS (HiLAT)

The climate of polar regions is changing faster than anywhere else on Earth. Permafrost degradation, collapsing ice shelves, and retreating sea ice all made headlines in recent years, with consequences for coastal and Arctic energy infrastructures. Even more challenging are the feedbacks that these high-latitude changes have on the polar and global climate system in general, like the global carbon cycle and mid-latitude weather. A thorough understanding of the high-latitude climate system is critical for researchers to better understand the challenges and opportunities the polar regions provide.

The High Latitude Application and Testing of Climate Models (HiLAT) project was created to answer Arctic and Antarctic climate change questions through targeted application of global modeling and analysis capabilities to evolving polar processes and their impacts. Researchers will apply high-performance multi-scale models and analyze the results to better understand how changes in the high-latitude climate system respond and contribute to global climate change.



High-resolution climate model simulation of a polynya (i.e., area of open water enclosed by pack ice) shown in the Weddell Sea, Southern Ocean. Polynyas are important for the formation of the densest water masses in the World's Ocean.



Simulated distribution of the plankton species *Phaeocystis* Antarctica displayed in the Southern Ocean (observations in dots). This high-latitude specialist is an important source of cloud-brightening aerosols.

### LOCAL AND GLOBAL CLIMATE CHANGES

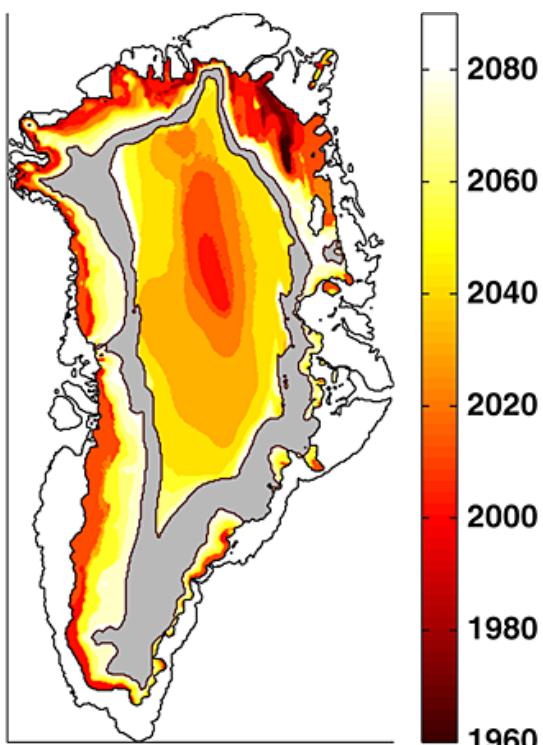
Polar climate is highly complex due to the strong interactions between ocean, atmosphere, land, sea ice, land ice, and associated ecosystems. The multidisciplinary HiLAT team is taking an integrative approach to tackling some of the toughest climate problems. Researchers will use climate model simulations to quantify feedbacks between the cryosphere and the Earth's heat and water budgets to improve projections of high-latitude climate change and the resulting regional and global impacts.

Several component studies will be performed to address sea ice predictability in the Arctic, Arctic delta evolution, and Greenland Ice Sheet behavior in a warming climate. These studies will address the regional and global impacts of these cryospheric changes, including atmospheric, oceanic and ecosystem responses.

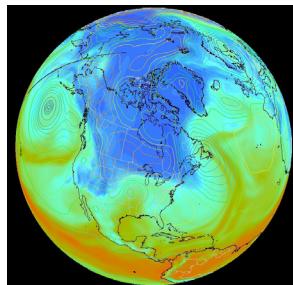


Science questions include:

- Are changes in Arctic sea ice cover influencing mid-latitude weather extremes?
- How do recent changes in Arctic and Antarctic sea ice impact marine ecosystems, aerosol production, and the brightness of polar clouds?
- How do freshwater and nutrient inputs from ice sheets (e.g., Greenland and Antarctica) and Arctic rivers affect marine ecosystems and carbon sequestration?
- Does enhanced freshwater input from the Antarctic ice sheet play a role in the recent Southern Hemisphere sea-ice expansion?
- Will changes in Arctic Ocean circulation impact the Atlantic Meridional Overturning Circulation (AMOC), and affect decadal variability of the climate system?
- How will the Southern Ocean overturning and Antarctic Bottom Water formation respond to competing changes in atmospheric wind forcing, upwelling, sea ice changes, and fresh water inputs from ice sheets?
- Is polar amplification weaker in the Antarctic due to water vapor transport and lapse rate feedbacks resulting from changes in land mass and sea-ice distribution?



Year in which an anthropogenic signal can be detected from the surface mass balance of the Greenland Ice Sheet.



*Water vapor and sea level pressure (contours) show the strong connectivity between the high and mid latitudes.*

## FUTURE DIRECTION

The HiLAT project will contribute to a better understanding of the complex interactions between the high latitude climate system components and how they will shape the evolution of climate system under continued anthropogenic forcing. The development of a new generation of climate models under DOE's Accelerated Climate Modeling for Energy (ACME) project will allow the team to address these issues with increasing level of detail and complexity. At the same time, continuing developments in uncertainty quantification will allow researchers to interpret model results in a more rigorous way.

HiLAT is a collaboration between scientists at the Los Alamos National Laboratory and the Pacific Northwest National Laboratory. This work is supported by the Regional and Global Climate Modeling program of the U.S. Department of Energy's Office of Science.

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