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Modeling of Arctic Storms with a Variable High-Resolution General Circulation Model

Mark A. Taylor, PI
Erika L. Roesler
Peter Bosler

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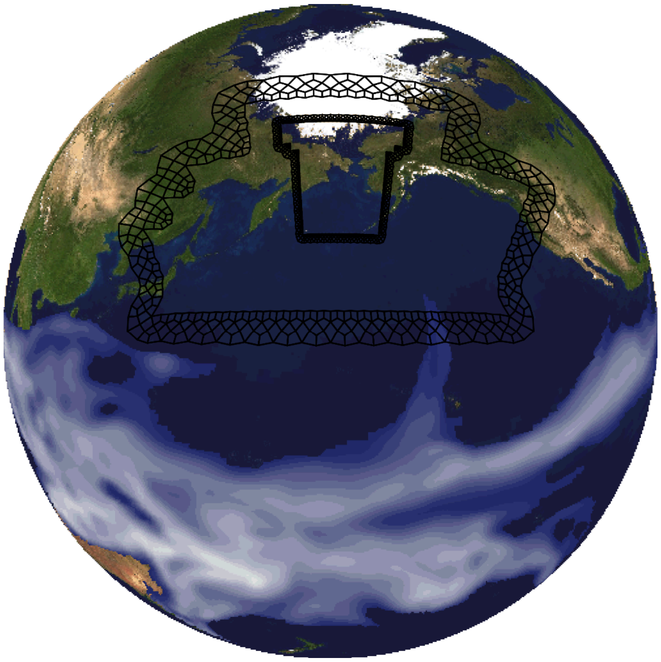
The Department of Energy's (DOE) Biological and Environmental Research project, "Water Cycle and Climate Extremes Modeling" is improving our understanding and modeling of regional details of the Earth's water cycle. Large uncertainties exist in the ability of today's climate models to simulate regional water cycle extremes such as storms, droughts and floods. Increased model resolution is a key tool for improved modeling of extremes. However, global high-resolution simulations are computationally expensive and usually performed at leadership computing facilities. Work at Sandia has led to dramatic improvements in scalability of DOE's atmosphere component model, making these high-resolution simulations possible, and at the same time also supporting a variable resolution capability where high resolution is used over fixed locations on the globe. This new capability allows scientists to gain insight into high-resolution model behavior over a smaller domain at a fraction of the computational cost.

Our team is using variable resolution to investigate storms in the Arctic. Strong storms in the Arctic are believed to further break-up sea ice. The sea ice extent affects storm tracks, and accurate predictions of the sea ice extent is desired by many agencies.

Currently, it is unknown if or how powerful storms will change in the future climate. To help answer this question, our team developed a variable resolution region in the Arctic to compare the number of storms and their properties in the low, high, and variable resolution simulations, using Red Sky and Sky Bridge for the simulations, data processing, and analysis. We developed a new storm-detection tool used to identify and track storms. As the resolution of the model is increased, it can capture small-scale storms that are not possible to resolve at low resolution, establishing our new variable resolution capability is an effective tool that will allow the climate modeling community achieve a better understanding of Arctic storms.

"Our team is composed of atmospheric scientists with backgrounds in physics, math, and computer science. We are driven by the need to develop the best climate model for predicting the future climate of this country. " –Erika Roesler



This figure shows a projection of the northern Pacific Ocean basin. The colored contours represent the total amount of water vapor in the atmosphere at a given time and location as simulated by the atmospheric component of the ACME model. The lighter, whiter color indicates the presence of a higher water vapor concentration, which also indicates where precipitation is likely to occur. The model was run in a variable resolution configuration using the spectral element atmospheric dynamical core. Areas of higher-resolution in atmospheric models develop more realistic storms. This grid is used to study Arctic storms, polar lows, and the energetics of storms hitting the Alaskan coast. The resolution in the smallest area outlined over the Bering Sea has an effective resolution of about 13 kilometers (1/8-degree). The area outlined in the northern Pacific Ocean basin stretching from the west's Sea of Okhotsk to the east's Gulf of Alaska has an effective resolution of about 27 kilometers (1/4-dgree). For the remainder of the globe, the effective resolution is about 110 kilometers (1-degree).