

Simulating the Earth's Climate

Introduction

Atmospheric scientists from the Lawrence Livermore National Laboratory have produced the highest resolution global climate simulations to date. They will be used to study the effects of global changes in specific geographical regions and the societal impacts of climate change.

Typical global climate simulations use spatial resolution of about 300 kilometers (186 miles across), which limits their ability to simulate climate and climate change on a regional scale. For example, with these coarse-resolution models it is difficult to assess climate changes in climatically varying regions within California.

Using super-computers at the Laboratory and other Department of Energy facilities, Livermore scientists increased their model resolution to roughly 50 km (30 miles) so that they have 32 times more grid cells and require about 200 times more computer processing time than comparable simulations at 300-km resolution.

Higher resolutions have been used in weather forecasts, which typically only span for a few days. The Livermore climate simulations are global and span roughly 10 simulated years.

Results

The Livermore high-resolution climate simulations have been extensively compared to observed climate data. The 50-km resolution simulations more closely mirror the present climate than do comparable coarse-resolution simulations. Researchers from Livermore's Program for Climate Model Diagnosis and Intercomparison compared the high-resolution present climate

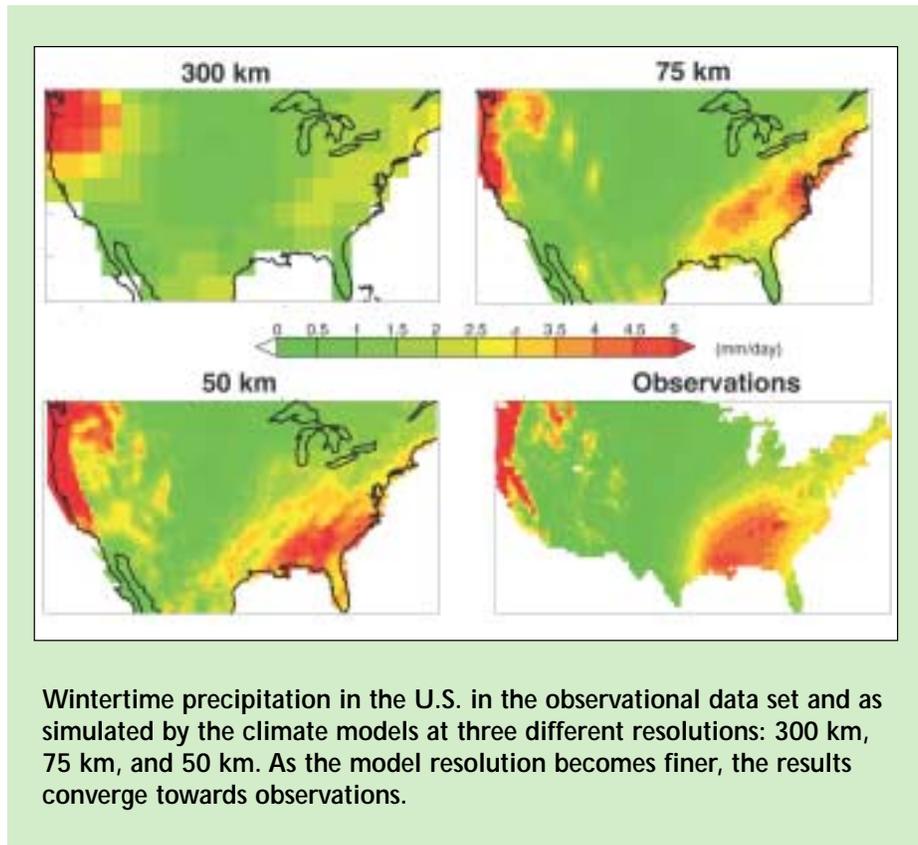
simulations to observations and to models at coarse resolution (300 km). They determined that increasing the resolution brings very significant improvements in the model's ability to simulate large-scale features of climate.

Future Climate Simulations

To show the possible effects of increased atmospheric greenhouse gases on future climate, Livermore researchers ran models at 300-km and 75-km resolutions. Because they represent a possible future climate, the model results cannot be evaluated by comparing them to observations. The predicted globally averaged climate changes are very similar at 75-km versus 300-km resolution. However, predicted climate changes in specific geographical regions can be very different in the high-resolution simulations.

Significance

Although simulations of 300 km can provide useful information on continental and larger scales, they cannot provide meaningful information on regional scales. Thus, coarse-resolution global climate simulations cannot provide information on many of the most important societal impacts of climate change, such as impacts on water resource management, agriculture or human health. By using much finer spatial resolution, Livermore scientists hope to improve the realism of the models and produce better predictions of future climate, specifically the effects of humans on climate, on both global and regional scales.



Wintertime precipitation in the U.S. in the observational data set and as simulated by the climate models at three different resolutions: 300 km, 75 km, and 50 km. As the model resolution becomes finer, the results converge towards observations.

