Supercomputers may help predict climate changes locally

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Even a century ago, scientists working out equations on paper understood that gases in the atmosphere absorbed and emitted energy, keeping Earth from being a ball of ice. Today they use supercomputers to make increasingly refined predictions about how the Earth's climate will change.

The new efforts take the question from global to local scale. Nations, states and communities have lots of climate-related questions: Should they divert water from one area to another? Build higher sea walls? Store and manage water the way Israel does today? Plan for many more 100-degree days in future summers?

"We can't answer those questions with the capabilities we have today. That's why we're using supercomputers to push the limits of what we understand and how well we can predict," said James Kinter. He's a professor in the climate dynamics Ph.D. program at George Mason University in Virginia and the director of the Center for Ocean-Land-Atmosphere Studies.

"We know with a high degree of certainty that the planet is warming up, and so just on average every place is going to be warmer," Kinter said. "But nobody lives on the average."

Scientists have used computer-generated models for decades to understand the past, present and future climate by studying the interaction of the oceans, atmosphere, land and ice. Kinter said climate

models today showed changes on a continental scale, but that faster computers would be able to make better predictions at regional and local scales.

Better computers should help with the difficult climate problem of clouds. Clouds interfere with the flow of energy between the Earth and the sun in two ways, Kinter said. They reflect some of the sun's energy back to space, a cooling effect. But they also absorb and send back some of the energy that the Earth emits, just as gases such as carbon dioxide in the atmosphere do. That's a warming effect.

Recent models looked at the Earth as if it were covered by a grid of 2 degrees by 2 degrees, or boxes that were more than 19,000 square miles each, which is roughly half the size of Kentucky. The computer model sees everything within the box as being the same, but of course no clouds are that big.

Today's models are better. And scientists hope to have a computer that's 1,000 times as powerful as those today by the end of this decade. That still won't be robust enough to deliver models as precise as desired, but they'll be closer than today's, Kinter said.

Computers also are used to simulate how different types of particles, known as aerosols, scatter or absorb heat in different ways, and how the particles interact with clouds.

"When people say clouds and aerosols, that's shorthand for tough problem," Kinter said. "And representing all that quantitatively in the models is a real challenge."

Thousands of scientists around the world are working on better climate models. Kinter and his group focus on how predictable extreme events such as floods, droughts and heat waves will be as the climate changes.

Lawrence Buja, the director of the Climate Science and Application Program at the National Center for Atmospheric Research in Boulder, Colo., said climate models had moved quickly from "Climate 1.0" to "Climate 2.0."

In Climate 1.0, the main issue was to prove that human-caused climate change was happening. "For that we needed models developed over 40 years to understand and address this question," he said.

The last review of international climate science by the Intergovernmental Panel on Climate Change in 2007 concluded that warming was "unequivocal" and primarily the result of human activities, mostly the burning of coal, oil and gas.

With that, Climate 2.0 began.

"Almost overnight, the question changed to 'What is the impact of this climate change on our human and natural systems?' " Buja said.

As computers improve, climate scientists can make increasingly better models, Buja said.

"We can do finer-scale modeling with more powerful computers and address these Climate 2.0 questions," he said.

The National Center for Atmospheric Research today hosts one of the world's top computers for climate models, used by Kinter's group and many other scientists. Next year a better computer will open in a new facility in Cheyenne, Wyo. The current site couldn't house the next generation of computing, Buja said.

National Center for Atmospheric Research and Department of Energy scientists' models were major contributions to the 2007 report by the

Intergovernmental Panel on Climate Change. Buja said they now were finishing models for the next international review of climate science, due in 2014.

"There's a huge economic cost of responding to this," Buja said. "We need to make sure we're presenting as convincing a case as we can."

It hasn't been easy. In the latest signal of distrust of computer models, Republicans in the GOP-controlled House of Representatives have put a provision in the foreign aid spending bill that would eliminate U.S. funding for the Intergovernmental Panel on Climate Change.

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