New theory aims to explain recent temperature, climate extremes

June 12 2007

Using an ocean of data, sophisticated mathematical models and supercomputing resources, researchers at the Department of Energy's Oak Ridge National Laboratory are putting climate models to the test with particular focus on weather extremes.

Ultimately, the new methodology developed by Auroop Ganguly and colleagues could help determine to what extent there is a connection between human activity and climate change. For now, however, researchers are concentrating on how climate models fare when compared to actual observations recorded between 1940 and 2005 and whether there are any connections between the extremes.

"Once we understand the nature of these connections our hope is that we will be able to determine if there is a relation between two extreme weather events - like heat waves and droughts," said Ganguly, a member of the Computational Sciences and Engineering Division. "We may then be able to determine whether there will be more intense storms, hurricanes or floods, and this information could perhaps be used as an early warning tool or to help develop policies."

While traditional climate models may not be especially useful for predicting extremes in general and rainfall extremes in particular, the statistical approach outlined in the journal Advances in Water Resources represents a big step in the direction of modeling rainfall extremes from observations and climate model simulations. Ganguly, who led the research team, believes the technique opens a world of possibilities.

"The methodology can have widespread use," Ganguly said. "In addition to water resources, hydrologic sciences, climate and ecology, the applications can include geospatial intelligence and security."

Using this new tool, researchers can relate extremes of a space and time variable like a 100-year rainfall at two locations or two time periods as well as relate the extremes of two or more variables such as 100-year precipitation extremes and heat waves. A 100-year event is one of such magnitude that over a long period of time - much longer than 100 years - the average time between such events is equal or greater to 100 years.

"For example," Ganguly said, "if 100-year events at two locations occur simultaneously, and if our measure says they are completely independent, then their simultaneous occurrence becomes a 100 times 100 -- or 10,000-year event -- and therefore can be used to predict change more confidently. If, however, our method says the events at the two locations are completely dependent, then the simultaneous occurrence remains a 100-year event overall."

In the paper, the researchers use this new approach to evaluate the performance of climate model simulations in terms of rainfall extremes, looking specifically at the dependence structure among these extremes. What they found is that while the dependence patterns appear to be visually similar and have significant commonalities, important differences do exist in terms of the magnitude, extent and directionality of the dependence.

Source: ORNL