Expect a warmer, wetter world this century, computer models agree

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Recent episodes of deadly heat in the United States and Europe, long dry spells across the U.S. West, and heavy bursts of rain and snow across much of North America and Eurasia hint at longer-term changes to come, according to a new study based on several of the world's most advanced climate models. Much of the world will face an enhanced risk of heat waves, intense precipitation, and other weather extremes, conclude scientists from the National Center for Atmospheric Research (NCAR), Texas Tech University, and Australia's Bureau of Meteorology Research Centre.

The new study, "Going to the Extremes," will appear in the December issue of the journal *Climatic Change*.

Many previous studies have looked at how average temperature or rainfall might change in the next century as greenhouse gases increase. However, the new research looks more specifically at how weather extremes could change.

"It's the extremes, not the averages, that cause the most damage to society and to many ecosystems," says NCAR scientist Claudia Tebaldi, lead author for the report. "We now have the first model-based consensus on how the risk of dangerous heat waves, intense rains, and other kinds of extreme weather will change in the next century."

The study is one of the first analyses to draw on extensive and sophisticated computer modeling recently carried out for the

Intergovernmental Panel on Climate Change. The IPCC's next assessment report will be released early in 2007.

Tebaldi and colleagues based their work on simulations from nine different climate models for the periods 1980–1999 and 2080–2099. The simulations were created on supercomputers at research centers in France, Japan, Russia, and the United States. Each model simulated the 2080-2099 interval three times, varying the extent to which greenhouse gases accumulate in the atmosphere. These three scenarios were used to account for uncertainty over how fast society may act to reduce emissions of carbon dioxide and other greenhouse gases over coming decades.

From the model output, the scientists computed 10 different indices of climate extremes, with 5 related to temperature and 5 to moisture. For instance, a frost days index measures how many days per year temperatures dip below 32 degrees Fahrenheit, while a dry days index measures the length of each year's longest consecutive string of days without rain or snow. Because the impact of a given index can be stronger in one climatic zone than another, the authors expressed the results in terms of statistical significance at each location.

For all three greenhouse-gas scenarios, the models agree that by 2080-2099:

-- The number of extremely warm nights and the length of heat waves will increase significantly over nearly all land areas across the globe. During heat waves, very warm nights are often associated with fatalities because people and buildings have less chance to cool down overnight.

-- Most areas above about 40 degrees north will see a significant jump in the number of days with heavy precipitation (days with more than 0.40 inches). This includes the northern tier of U.S. states, Canada, and most

of Europe.

-- Dry spells could lengthen significantly across the western United States, southern Europe, eastern Brazil, and several other areas. Dry spells are one of several factors in producing and intensifying droughts.

-- The average growing season could increase significantly across most of North America and Eurasia.

Most of these trends are significantly weaker for the lowest-emission scenario than for the moderate and high-emission scenarios. Thus, the authors add, lowering the output of greenhouse gases over the next century should reduce the risk that the most severe changes will occur.

Citation: Going to the Extremes: An intercomparison of model-simulated historical and future changes in extreme events, Claudia Tebaldi, Katharine Hayhoe, Julie M. Arblaster, and Gerald A. Meehl, *Climatic Change*, December 2006

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