A hard rain's gonna fall: Analysis shows climate change to yield more extreme rainfall

August 17 2009, by David Chandler

(PhysOrg.com) -- Heavier rainstorms lie in our future. That's the clear conclusion of a new MIT and Caltech study on the impact that global climate change will have on precipitation patterns.

But the increase in extreme downpours is not uniformly spread around the world, the analysis shows. While the pattern is clear and consistent outside of the tropics, climate models give conflicting results within the tropics and more research will be needed to determine the likely outcomes in tropical regions.

Overall, previous studies have shown that average annual precipitation will increase in both the deep tropics and in temperate zones, but will decrease in the subtropics. However, it's important to know how the frequency and magnitude of extreme precipitation events will be affected, as these heavy downpours can lead to increased flooding and soil erosion.

It is the frequency of these extreme events that was the subject of this new research, which will appear online in the Proceedings of the National Academy of Sciences during the week of Aug. 17. The report was written by Paul O'Gorman, assistant professor in the Department of Earth, Atmospheric and Planetary Sciences at MIT, and Tapio Schneider, professor of environmental science and engineering at Caltech.

Model simulations used in the study suggest that precipitation in extreme events will go up by about 6 percent for every one degree Celsius increase in temperature. Separate projections published earlier this year by MIT's Joint Program on the Science and Policy of Global Change indicate that without rapid and massive policy changes, there is a median probability of global surface warming of 5.2 degrees Celsius by 2100, with a 90 percent probability range of 3.5 to 7.4 degrees.

Specialists in the field called the new report by O'Gorman and Schneider a significant advance. Richard Allan, a senior research fellow at the Environmental Systems Science Centre at Reading University in Britain, says, "O'Gorman's analysis is an important step in understanding the physical basis for future increases in the most intense rainfall projected by climate models." He adds, however, that "more work is required in reconciling these simulations with observed changes in extreme rainfall events." The basic underlying reason for the projected increase in precipitation is that warmer air can hold more water vapor. So as the climate heats up, "there will be more vapor in the atmosphere, which will lead to an increase in precipitation extremes," O'Gorman says.

However, contrary to what might be expected, extremes events do not increase at the same rate as the moisture capacity of the atmosphere. The extremes do go up, but not by as much as the total water vapor, he says. That is because water condenses out as rising air cools, but the rate of cooling for the rising air is less in a warmer climate, and this moderates the increase in precipitation, he says.

The reason the climate models are less consistent about what will happen to precipitation extremes in the tropics, O'Gorman explains, is that typical weather systems there fall below the size limitations of the models. While high and low pressure areas in temperate zones may span 1,000 kilometers, typical storm circulations in the tropics are too small for models to account for directly. To address that problem, O'Gorman and others are trying to run much smaller-scale, higher-resolution models for tropical areas.

Source: Massachusetts Institute of Technology (news : web)