US Southwest water availability reductions ahead according to research that reveals spring drying trends

May 21 2014

A dry irrigation canal illustrates one challenge presented by large shifts in spring wet and dry periods across the U.S. Southwest—reductions in water availability. Authors of this study found that the intensity of the water cycle, due to more atmospheric moisture held captive in a warming climate, leads to changes in water availability with regional impacts and implications for society's resilience to climate change.

New research from scientists at Pacific Northwest National Laboratory identified a trajectory of spring drying that will alter water availability across the U.S. Southwest. To describe the net change in water, they calculated the water gained through precipitation and subtracted the water lost through evaporation and transpiration in an ensemble of regional and global simulations. Their findings indicate future challenges for regional water resource managers and agricultural production.

"Our research identified a prominent spring drying trend over the U.S. Southwest and a seasonal migration of the wet and dry patterns," said Dr. Yang Gao, post-doctoral researcher and atmospheric scientist at PNNL. "These signals are strong and consistent across regional and global climate projections."

Water in the soil, streams, and groundwater is critical for Earth ecosystems and food and energy production, so understanding and projecting how water availability is going to change in the future is a major science challenge with important societal implications. While global precipitation is projected to increase in a warmer climate, water availability is a measure determined by regional precipitation and the amount of moisture that either evaporates or is taken up by plants, called transpiration. Together, precipitation and evapotranspiration vary greatly over a region, and their changes are due to complex alterations in atmospheric circulation, soil moisture, and many other processes. The new research underscores the importance of evaluating changes in regional North American water availability and propels efforts to evaluate their implications for climate impacts and adaptation.

"Increasing greenhouse gases cause the atmosphere to hold more moisture in a warmer climate, intensifying Earth's water cycle," said Dr. Ruby Leung, PNNL Laboratory Fellow, atmospheric scientist and corresponding author on the study. "Changes in the water cycle have significant implications for water availability that challenge regional

resilience to climate change."

The PNNL research team calculated changes in water availability from a multi-model ensemble of climate simulations for the present (1975-2004) and the future (2070-2099) produced by a single regional climate model and 20 global climate models used in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5). Through both model agreement and statistical significance they identified robust changes across the models. They investigated the relationships between seasonal large-scale circulation and water availability changes using regression analysis to evaluate the contributions of dynamical changes, in addition to increased moisture availability, to changes in precipitation minus evapotranspiration (P-E). Lastly, they depicted seasonal P-E changes by the seasonal timing of the dominant wet/dry trends derived from the regional and global model projections to highlight their robust features over North America.

Their research shows that seasonal changes in the large-scale circulation and increased atmospheric moisture due to warmer temperatures lead to wet/dry trends that are dominated by two distinct and opposite north-south and east-west patterns.

The multi-model ensemble of regional and global climate simulations will be further analyzed to evaluate changes in extreme events such as heat waves and cold air outbreaks, heavy precipitation, and other climatic features important for understanding societal vulnerability to climate change in the United States.

More information: Gao Y, LR Leung, J Lu, Y Liu, M Huang, and Y Qian. 2014. "Robust Spring Drying in the Southwestern U.S. and Seasonal Migration of Wet/Dry Patterns in a Warmer Climate." *Geophysical Research Letters* 41(5):1745-1751. DOI: 10.1002/2014GL059562

Provided by Pacific Northwest National Laboratory