Desert dust intensifies summer rainfall in U.S. southwest

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This rainstorm in Eastern New Mexico, as part of the North American Monsoon, gets moisture from the Gulf of Mexico and Gulf of California during the late summer. Scientists have found that desert dust increases the monsoon effect in this region. Credit: Wikimedia Commons

(Phys.org) -- Dust is more than something to be brushed off the furniture. Scientists at Pacific Northwest National Laboratory found that dust kicked up from the desert floor acts like a heat pump in the atmosphere, fueling the annual climate system called the North American Monsoon. The dust increases precipitation by up to 40 percent during the summer rainy season in Arizona, New Mexico, and Texas. Their study, the first on the U.S. Southwest summer monsoon, found that the heat pump effect is consistent with how dust acts on West African and Asian monsoon regions.

As the climate warms, more regions of the world will be affected by drought. Increased desert regions and dry land produce more dust that

gets lofted into the atmosphere. These dust particles absorb sunlight and act as a heat pump, attracting moisture from nearby oceans and increasing seasonal rainfall. PNNL researchers are the first to investigate this effect in a dry region of the United States where water resources are limited. Understanding how dust contributes to atmospheric heating is important for predicting drought and rainfall patterns in this region and others in the world with rising populations.

During June, July, and August each year, the U.S. Southwest and northern Mexico experience a climate system known as the North American Monsoon, characterized by surface heat and episodes of heavy rainfall. This region receives over 70 percent of its annual precipitation in just 3 months. PNNL researchers, using sophisticated simulation techniques, investigated the effect on the atmosphere of dust emitted from the U.S. Southwest deserts to fuel the intensity of the monsoon system.

The research team studied both solar heat and thermal heat from the Earth and other effects of dust. Model-simulated dust mass concentration was evaluated using surface measurements over Arizona from the IMPROVE network, 100 sites in the United States that measure the chemical make-up of aerosols. They evaluated aerosol optical depth simulations using data from AERONET and satellite measurements from MODIS and MISR near the dust source region.

Researchers simulated 15 years with dust emissions and 15 years without dust emissions, from 1995-2009, using the Weather Research and Forecasting model coupled with chemistry, known as WRF-Chem, and compared the results with observations. The 15-year simulations were used to average out natural interannual climate variability. The simulations showed that the dust effect prompts a 45 percent increase in aerosol optical depth near the deserts, causing the increased precipitation. These findings show a similar effect of dust on the North

American Monsoon as found with the Asian and West African monsoon systems.

"We found that dust heated the lower atmosphere by 0.3 Kelvin/day, which strengthened low-level north-south winds," said Dr. Chun Zhao, lead author and climate scientist at PNNL. "Strengthening the winds leads to a 10-40 percent increase in precipitation in the monsoon. This is a significant effect that has not been well understood."

The current study looked at the effect of dust on strengthening the Southwestern monsoon season. Next, researchers will investigate the dust effect on clouds and cloud microphysical interactions and processes in the region, and how those processes affect the area monsoon system.

More information: Zhao C, X Liu, and LR Leung. 2012. "Impact of the Desert Dust on the Summer Monsoon System Over Southwestern North America." *Atmospheric Chemistry and Physics*,12:3717-3731, DOI:10.5194/acp-12-3717-2012

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