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CU-BOULDER STUDY TRACES DELAY IN NORTH AMERICAN MONSOON TO PACIFIC OCEAN WARMING

The southwestern United States has experienced a significant delay in its annual summer monsoon rains in recent decades due to warmer sea-surface temperatures in the Pacific Ocean, according to a new study at the University of Colorado at Boulder.

The study is scheduled for publication May 1 in a special issue of the American Meteorological Society's *Journal of Climate* focusing on the North American monsoon system. The study's principal author, Katrina Grantz, is a water resources engineer at the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) in CU-Boulder's department of civil, environmental and architectural engineering.

Grantz studied trends in the timing and amount of monsoon rainfall in New Mexico and Arizona from 1948 to 2004 and discovered a delay of 10 days to 20 days depending on specific location in the beginning, peak and closing stages of the monsoon in recent years. The study also showed a decrease in rainfall during July and a corresponding increase in rainfall during August and September, while the total annual rainfall stayed approximately the same.

"This is primarily because of the greater number of warming events in the Pacific Ocean -- especially El Niños -- that have occurred since the 1970s," Grantz said.

It is well known that such warming events in the Pacific result in wetter than average winter and spring conditions in the Southwest and drier than normal conditions in the Pacific Northwest, Grantz said. She and co-authors Balaji Rajagopalan, Martyn Clark and Edith Zagona believe the shift in the timing of the Southwestern monsoon is a result of wetter land conditions during the winter and spring seasons, which delays the seasonal heating of the land mass necessary to set up the conditions for the monsoon.

Rajagopalan, an associate professor of civil, environmental and architectural engineering and Fellow of the Cooperative Institute for Research in Environmental Sciences, said North American monsoon conditions are created when winds shift from the west to the south and start to bring moist air in off the cool ocean to meet warmer temperatures on land.

"The monsoon is not as strong a phenomenon in Colorado," Grantz said, "but in New Mexico and Arizona where I focused the study, the role of land and ocean conditions in modulating the summer monsoon appears to be quite significant. Drier winters are typically followed by earlier and stronger monsoons, while wetter winters are followed by later and weaker monsoons."

The findings are important because they enhance the prospects for longer lead time of forecasts of rain and stream flows in the southwestern United States, which could have significant implications for water resources planning and management, Grantz said.

Grantz, who also plans to publish companion papers on stream flow and water resources management in the Pecos River, performed the research for her doctorate in civil engineering, which she received in December. The application to Pecos River management was demonstrated using RiverWare, a water management tool

developed by CADSWES that is used by as many as 75 agencies, consultants, universities and research institutions and plays a key role in the management of several river basins.

The American Meteorological Society is the nation's leading professional society for professionals in the atmospheric and related sciences. The society publishes nine peer-reviewed journals, hosts scientific conferences, promotes science education and conducts policy outreach.