Research flights probe particulate impact on climate

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Researchers will use a specially outfitted Department of Energy aircraft to carry out aerosol analysis missions over California for the next five weeks. Credit: Scripps Institution of Oceanography, UC San Diego

In a winter of unpredicted weather, a multiyear project to investigate the possible effects of air pollution on California's precipitation launches a new phase with a series of research flights that begin today featuring Scripps Institution of Oceanography, UC San Diego scientists.

Professor Kim Prather, distinguished chair of atmospheric chemistry at UCSD and director of the National Science Foundation Center for Aerosol Impacts on Climate and the Environment, will document cloud microphysics and aerosol impacts on clouds and precipitation from the research aircraft equipped with an aerosol particle analyzer developed in her lab along with a suite of other state-of-the-art cloud probes and instruments.

"It is an exciting and timely study," said Prather, who holds a joint

faculty appointment at Scripps as well as the UCSD Department of Chemistry and Biochemistry. "The overall understanding of the impacts of aerosols on clouds represents the largest single uncertainty in climate change. A major challenge involves sorting out how different air pollution sources impact clouds and precipitation. We have established a unique way to identify and study the sources of the aerosols that actually 'seed' the clouds and will now combine this method with an unprecedented package of other aircraft and ground-based air pollution, meteorological measurements, as well as satellite data and climate models."

Five weeks of airborne measurements will be coordinated with ground-based observations in the Sierra Nevada and Central Valley as part of CalWater, a project funded by the California Energy Commission Public Interest Energy Research (PIER) project and NOAA's Physical Sciences Division that began in 2008.

"The data collected and the analysis gleaned from these flights will contribute to better climate projections, leading to better planning for California's water and energy resources," said California Energy Commissioner Jeff Byron. "About 15 percent of the state's electricity is generated by hydroelectric sources, so improving the estimate of impacts is crucial for our state."

The winter of 2010-2011 has already produced extremely heavy downpours in much of California. Ironically, this year is one having a moderately strong La Niña pattern that typically brings cool dry weather to the southern half of the state. The scientists are hoping for another one or two more significant precipitation events during the aircraft sampling campaign. The goal of CalWater is to improve projections of water supply and flood risks to the state as air pollution and climate change begin to alter traditional weather patterns. Prather and her research group are investigating the effects that aerosols - particles

ranging from dust to soot created by vehicle exhaust - have on clouds and precipitation.

Particulates in air pollution affect precipitation by changing the number and composition of cloud condensation and ice nuclei. Tiny naturally produced particles of dust, sea salt, organic materials combine with human-produced pollutants such as diesel soot and act as "seeds" around which cloud droplets and ice crystals form. The moist droplets must grow large enough to fall from the sky as rain or snow, so changes in the quantity of seed particles in the air can influence how much rain or snow a cloud is capable of producing. It is hypothesized that air pollution may be shifting the locations where precipitation is occurring, quite possibly away from regions designed to capture and store it.

A key question that will be addressed is whether the additional pollution "seeds" produced by humans are reducing the amount of precipitation occurring over the Sierra mountain range. Aircraft studies in 2005 and 2006 by Daniel Rosenfeld, another CalWater scientist from Hebrew University of Jerusalem, suggest a reduction in precipitation associated with pollution may be occurring. The work provided much of the motivation for CalWater.

"There is no question that by adding new measurements on aerosol sources and chemistry we will learn a great deal about aerosol-cloud interactions during CalWater," Prather said. "This information will be put into climate models to improve future projections."

Making analysis of these influences possible is an instrument developed by Prather known as an aerosol time-of-flight mass spectrometer (ATOFMS). Continuously pulling in air samples, the instrument can chemically characterize the individual particles that form the cloud seeds and link them back to their original source. This will be the first time this instrument is used for in-cloud measurements in California.

Scientists from other institutions including the Pacific Northwest National Lab, Colorado State University, NOAA, the Hebrew University of Jerusalem, Lawrence Berkeley National Lab, and UC Davis will participate in ground- and aircraft-based studies during CalWater.

Other CalWater researchers are trying to improve understanding of "atmospheric rivers," including a special subset of atmospheric rivers known as "Pineapple Express", which deliver fast flowing air currents and long pipelines of moisture from the Pacific Ocean that are responsible for many of California's major precipitation events. In addition to research flights, CalWater investigators have also made ground measurements and developed computer models to analyze and interpret these unprecedented effects since 2009.

NOAA researcher Marty Ralph, a CalWater principal investigator, said that the project has already yielded valuable data on the role the Sierra Nevada plays in determining the paths and water yield of atmospheric rivers, as well as providing insight into the transport of Asian dust that finds its way into rain and ice particles that constitute rain and snow in California and elsewhere in the western United States.

"Analysis of climate models in terms of atmospheric river frequency and intensity in a changing climate has determined that in the future there are still likely to be atmospheric river events, some of which will contain enriched moisture and strong winds that could increase chances of major flooding," Ralph said.

Provided by University of California - San Diego