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NCAR Scientists, Aircraft, Instruments Head to Indian Ocean for Climate Change Experiment; UCAR Directs Operations

BOULDER -- How much do sulfate aerosols--a form of pollution--cool the climate? That's one of the most pressing questions for understanding global climate change. To help find the answer, the National Center for Atmospheric Research (NCAR) has sent researchers, instruments, and a C-130 research aircraft owned by the National Science Foundation (NSF) to the \$25-million Indian Ocean Experiment (INDOEX). NSF is NCAR's primary sponsor and a partial sponsor of INDOEX.

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INDOEX is based in the Republic of the Maldives, an archipelago southwest of India's southern tip. There, NCAR scientists are working alongside more than 70 researchers from a dozen nations to observe the tropical oceans and atmosphere from January to April. The University Corporation for Atmospheric Research, NCAR's parent organization, is overseeing operations from the INDOEX support office for logistics and data management, headed by Richard Dirks of the UCAR Office of Programs. The highly instrumented C-130 aircraft will be based through March 27 at Male' airport, which occupies its own island in the archipelago.

According to NCAR's Jeffrey Kiehl, a principal investigator for INDOEX, "In the future, pollution in the tropics will increase, so we'd better understand it now. The chemistry in the tropics is severely undersampled." The Indian subcontinent and surrounding nations are rich sources for many kinds of aerosols, including those produced from industrial and auto emissions, biomass burning, and soil dust. With Asia's population rising at a dramatic rate, the amount of sulfur dioxide released into the atmosphere is expected to increase. Sulfur dioxide is converted into sulfate aerosol in the atmosphere.

The ability of sulfate aerosols to reflect the sun's radiation may be one reason that increasing greenhouse gases have not warmed the earth as much as some climate models have predicted. Sulfates also contribute to local pollution and acid rain.

Kiehl helped design INDOEX to ensure that the project collects the data needed to advance global climate modeling. Some physical and chemical processes in the earth system are so complicated that modelers cannot simulate each detailed step. "With INDOEX data, we can actually test the way we treat aerosols in computer models against observations."

The observation region is downwind of the Indian subcontinent during the spring and extends into the pristine Southern Hemisphere. With a forecast of pleasant weather--calm, with little rain--the investigators should be able to sample both polluted and clean air in clouds and clear sky.

"It's a natural laboratory for studying direct and indirect effects of aerosols," says NCAR's Andrew Heymsfield, another INDOEX researcher. The direct effect of aerosols is the scattering that occurs when solar radiation bounces off particles in clear air. The indirect effects have to do with sulfates' interactions with clouds.

Globally, aerosols are an important source of nuclei around which cloud droplets can condense, and in the tropics they are the chief source. The more cloud condensation nuclei, the brighter the cloud, that is, the more solar radiation reflected back into space before it reaches the earth's surface. This radiative effect is what makes clouds, and the indirect effects of aerosols, so important in climate change research. However, indirect effects are now so little understood that estimates in global climate models vary from almost no effect to more than enough cooling to offset global warming resulting from greenhouse gas increases.

"A host of changes in cloud physical and microphysical properties are lumped under the term 'indirect effects,' " says NCAR scientist William Collins. Collins is using satellite measurements to estimate optical depths in clouds and the sizes of aerosol droplets.

The Maldives archipelago runs in a north-south line from about 500 miles southwest of the tip of the Indian subcontinent to the equator. The personnel and observing systems are spread across several islands, with all transport by boat. Resources include five aircraft, two research ships, and a host of ground-based systems. Satellite data will be used for real-time weather forecasting, monitoring the motion of pollutants, and measuring radiation at different altitudes. This combination of ground, airborne, and satellite data is expected to vastly increase scientists' understanding of the nature and scope of aerosols' indirect effects.

Heymsfield and NCAR colleague Gregory McFarquhar are studying some of the cloud microphysical changes using a scanning aerosol backscatter lidar, developed at NCAR and mounted on the C-130. From the aircraft the lidar can characterize cloud top and bottom. The scientists will observe the optical depth of clouds in both clear and cloudy aerosol-laden skies.

"The government of the Maldives has been extraordinarily cooperative and accommodating," says Dirks. "They're deeply concerned with climate change research." The Maldives islands are vulnerable to rising sea levels due to climate change.

INDOEX is coordinated by the Center for Clouds, Chemistry and Climate (C4), an NSF Science and Technology Center at the Scripps Institution of Oceanography. Paul J. Crutzen, director of the Max Planck Institute for Chemistry and a 1995 Nobel Laureate in

Chemistry, and C4 director V. Ramanathan will serve as INDOEX chief scientists.

-The End-

Note to Editors: Please contact David Hosansky (information above) to interview INDOEX participants or to fly on the C-130 aircraft. For more information, see the INDOEX Web site: <http://www-indoex.ucsd.edu/>

See also:

[INDOEX - The Indian Ocean Experiment](#)

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