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For Immediate Release
May 2, 2002

THUNDERSTORMS ARE AFFECTED BY POLLUTION

A NASA-funded researcher has discovered that tiny airborne particles of pollution may modify developing thunderclouds by increasing the quantity and reducing the size of ice crystals within them. These modifications may affect the cloud's impact on the "radiation budget," the amount of radiation that enters and leaves the Earth.

"I've found that aerosols depress the size of ice crystals in thunderclouds over land and oceans – and as a result may reduce precipitation," said Steven Sherwood of Yale University. Because smaller ice crystals are lighter, they don't fall out of the cloud as easily and evaporate instead of falling as rain.

Using several satellites and instruments including NASA's Total Ozone Mapping Spectrometer (TOMS), Sherwood looked at how airborne pollution particles (aerosols) affect large thunderstorms, or cumulonimbus clouds, in the tropics.

Common aerosols include mineral dust, smoke, and sulfates. An increased number of these particles increase the number of ice crystals in a cumulonimbus cloud, but they're just smaller in size. As a result of their smaller size, the ice crystals evaporate from a solid state directly into a gas, instead of falling as rain. Sherwood noted that this effect is more prevalent over land than open ocean areas.

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Previous research by Daniel Rosenfeld of Hebrew University revealed that aerosols and pollution reduced rainfall in shallow cumulus clouds of liquid water, which do not have the capability to produce as much rainfall. Sherwood expanded on that research by looking at cumulonimbus clouds, which contain ice particles.

Previous studies have proven that ice particles are smaller in the upper reaches of thunderclouds when there is more pollution, and when the rising air in the clouds (convection) is stronger. Aerosols seem to have the most influence on seasonal and longer timescales, such as during the warmer months when plants and undergrowth are burned to clear fields.

Over areas where biomass burning occurs, such as South America, aerosols have been found to reduce the diameter of ice crystals in the clouds by as much as 20 percent. Areas over deserts, such as Africa's Sahel Region where dust is a primary aerosol, there was a 10 percent decrease in the diameter of ice crystals in cumulonimbus clouds.

Aerosol particles are necessary for clouds to form, and it has been suspected that clouds might be altered by large concentrations of them, from a fire for example. "I was able to show by looking at 10 years of aerosol data and statistically analyzing many thunderclouds in the tropics that they are definitely affected," Sherwood said.

Clouds play an important role in regulating heat in the atmosphere by reflecting the Sun's rays back to space.

Sherwood found that ice crystals are smaller in clouds over continents than oceans, which could be attributed to the amount of pollution generated over land. The highest values occur widely over Northern Africa, where desert dust and smoke from agricultural burning occur. Intermediate values prevail over much of Asia, through the Indonesia region and into the south Pacific. The largest ice crystal sizes were found over the eastern Pacific and southern Indian Oceans.

Sherwood used aerosol data from TOMS to verify pollution levels. He also used cloud reflectivity data from NASA's Tropical Rainfall Measuring Mission (TRMM) satellite, and radiance (reflected light generated from aerosols) data from the Advanced Very High Resolution Radiometer (AVHRR) aboard a NOAA satellite.

Sherwood's article "Aerosols and Ice Particle Size in Tropical Cumulonimbus" appears in the May 1, 2002 issue of the American Meteorological Society *Journal of Climate*.

This work was performed under the NASA Earth Observing System/Interdisciplinary Science (IDS) program under the Earth Science Enterprise (ESE). The mission of NASA's ESE is to develop a scientific understanding of the Earth System and its response to natural or human-induced changes to enable improved prediction capability for climate, weather and natural hazards.

For images and more information:

http://www.gsfc.nasa.gov/topstory/20020501thunder.html

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