Public release date: 7-Aug-2002
[Print Article | E-mail Article | Close Window]

Back To EurekAlert!

Contact: A'ndrea Elyse Messer
aem1@psu.edu
814-865-9481
Penn State

Jet contrails alter average daily temperature range

For three days after September 11, the Federal Aviation Administration grounded commercial aircraft in the U.S., stranding travelers, hindering mail delivery and interrupting courier service, but for scientists at Penn State and the University of Wisconsin–Whitewater, the three-day shutdown provided a rare glimpse of the climate effects of jet contrails.

"In the past, some studies have compared the climate of areas with little overhead air traffic with those under heavily used flight paths," says Dr. Andrew M. Carleton, professor of geography. "Other studies looked at cloud cover before the advent of heavy jet traffic in the 1960s and afterwards, but these studies really provide circumstantial evidence."

Carleton, and Dr. David Travis, climatologist at University of Wisconsin-Whitewater and Ryan Lauritsen, then an undergraduate at UW-W, looked at high and low temperatures recorded throughout the country during the three days of commercial air shutdown and at satellite photos taken during that time. The satellite photos show where contrails were occurring, mostly absent over the U.S. between Sept 11-14, but still occurring in Canada and northern Mexico.

"We show that there was an anomalous increase in the average diurnal temperature range for the period Sept. 11-14, 2001," the researchers reported in today's (Aug. 8) issue of the journal Nature. "Because persisting contrails can reduce the transfer of both incoming solar and outgoing infrared radiation and so reduce the daily temperature range, we attribute at least a portion of this anomaly to the absence of contrails."

The diurnal temperature range is the difference between the nighttime low temperature and the daytime high temperature, usually for a given day.

"Because the shutdown occurred before noon on Sept. 11, the low temperature had already been reached, so we looked at 24-hour periods beginning with the high on Sept. 11 to the low on Sept. 14," said Carleton.

The change in the temperature difference was plus 1.1 degree Celsius, equal to plus 2 degrees Fahrenheit, above the 30-year long-term mean diurnal temperature range. The researchers compared the temperature ranges on these three days to those of the three days directly before Sept. 11 and the three days after Sept. 14, finding that the days before and after were similar, but that the three days in question differed by 1.8 degrees Celsius or 3.2 degrees Fahrenheit.

"Sept. 11-14, 2001, had the biggest diurnal temperature range of any three-day period in the past 30 years," said Carleton. Contrails form when water vapor and particles from jet engine exhaust enter the atmosphere. If the atmospheric temperature is cool enough, and the humidity high enough, the exhaust forms ice crystals that create the contrail. Contrails generally last one to two hours, but can last as long as six.

All jet exhausts do not create contrails. In warmer areas, contrails are rare, while in temperate areas, especially in the Midwest and Great Plains, contrails are common, especially in the winter and spring. Sometimes, the added moisture of a series of jets will increase the atmospheric humidity enough so that subsequent aircraft will form contrails even though earlier ones did not.

"The fact that the three jetless days were in the late summer should suggest that there was less of an effect than would have occurred during a cooler time of the year when more contrails occur," said Carleton.

Contrails alter temperature the same way that natural high clouds do. During the day, the layer of ice crystals shields the ground from some of the sun's energy. At night, the layer of ice crystals prevents some of Earth's heat from dissipating into the vacuum. Without the contrails, the daytime temperature would be slightly higher and the nighttime temperature would be slightly lower, creating the increased range between lowest and highest temperatures.

The researchers note that the greater range reported was an average and that some areas had an even larger range increase. They also investigated whether those three days were unusually dry, which would account for an absence of natural cloud cover and a greater temperature range.

"Satellite images showed that cloud cover on Sept. 11 was light, but that cloud cover and humidity increased on the 12th, 13th and 14th," says Carleton. "These clouds and greater humidity should have suppressed the range, but the temperature range was still the largest in 30 years."

###

Carleton and Travis are collaborating on a general study of contrails and climate change funded by the National Science Foundation that also funded this work.

[Print Article | E-mail Article | Close Window]

Back To EurekAlert!