Jets' contrails contribute to heat-trapping high-level clouds

February 22 2013, by Anne Danahy

Condensation trails that airplanes produce mean not only a white-streaked sky on some days, but an increase in the amount of high-level clouds and, by extension, warming temperatures, according to a Penn State researcher.

By comparing National Oceanic and Atmospheric Administration satellite images showing contrail occurrence with data from eastern U.S. stations that record sky-coverage for different levels in the atmosphere, Penn State Professor of Geography Andrew Carleton was able to confirm that contrails contribute to the occurrence of high-level clouds.

The results of the analysis that Carleton and several of his students completed will be published this spring in the international journal Climate Research.

To address the question of whether there is any relation between jet contrails and trends in sky coverage, the researchers plotted the spatial occurrence of contrails identified on the satellite images for two time periods: 1977-79 and 2000-02. Sky cover data on clouds occurring at different levels has been collected continuously at National Weather Service stations. The satellite contrail and surface-observed sky-cover data was overlaid and separated according to high versus low frequencies of contrails.

The researchers found that high frequencies of contrails didn't equate to an increase in total cloud amount or an increase in low-lying clouds, but

they did mean a significant increase in high-level cloudiness observed from the surface since about the mid-1960s.

"It suggests that contrails do influence the upward trend in the amount of high-level clouds over the last 50 years for the eastern one-third of the United States," said Carleton, a faculty member in Penn State's Earth and Environmental Systems Institute.

While Carleton wasn't surprised by the results, he said establishing them is an important step in looking at what might be done to address the issue. It could be particularly important in upcoming decades as the potential for contrails to go from being regionally significant to more widespread becomes likely as air traffic continues to increase.

Contrails form when jet engines emit sooty particles and moisture into cold air high in the troposphere. Water vapor already present in the atmosphere collects and freezes around those particles, which are essentially the nuclei, and form linear ice crystal clouds. Contrails are prevalent in the Midwest, Northeast and Southeast of the United States, along with Western Europe and the North Atlantic. East and Southeast Asia could see growing impacts of contrails in the upcoming 20 to 30 years, as economies and air travel there continue to grow.

Carleton's previous research found that contrails affect the climate near Earth's surface by reducing the daily range of temperatures (the warmest point during the day minus the coolest temperature at night). He and David Travis, from the University of Wisconsin-Whitewater, undertook a base study on contrails and surface temperature conditions after the Sept. 11, 2001, terrorist attacks, when there were no commercial jets in the air for three days. They found that the lack of flights led to an increase in the range of temperatures for the United States in general, and sub-regions typically seeing the highest frequencies of contrails (the Midwest and Northeast). The researchers concluded that jet contrails

contribute to reducing the near-surface air temperature range.

Persisting contrails present the greatest impact on climate because instead of dissipating relatively quickly they linger, trapping heat beneath them. While contrails do block the sun to some extent, when they persist they also spread and become thinner, which means they don't reflect as much solar energy away while still trapping heat.

"The net effect tends to be to warm the earth's surface, rather than to cool it," Carleton said.

The new research finds that in addition to shrinking the temperature range, contrails contribute to high-level cloudiness, which can contribute to warming the atmosphere.

A next step is trying to predict where and when contrails will occur so, when needed, planes could be rerouted around those areas to head off further aggravating the contrail impact on climate. Carleton noted that this is similar to the short-term rerouting of planes that already happens with severe storms.

"These contrail outbreaks are, broadly speaking, similar in size to big summer storm events," he said.

Provided by Pennsylvania State University