Scientists Want to Solve Puzzle of Excess Water Vapor Near Cirrus Clouds

A number of researchers in recent years have reported perplexing findings of water vapor at concentrations as much as twice what they should be in and around cirrus clouds high in the atmosphere, a finding that could alter some conclusions about climate change.

Now a group of European and U.S. scientists is advocating a broad research effort to solve the puzzle and understand just what is occurring in cirrus clouds, wispy sheets of ice crystals 6 to 10 miles above the Earth's surface.

"Based on our current knowledge, it shouldn't exist," said Marcia Baker, a University of Washington professor of Earth and space sciences. She is one of six climate researchers who authored a Perspectives article in the Nov. 30 edition of the journal *Science* promoting an extensive effort to investigate the dilemma.

Part of the problem is that many atmospheric scientists have dismissed the findings as erroneous because the current understanding of atmospheric conditions and cirrus clouds would make the water vapor anomaly impossible, Baker said. Yet a number of pieces of evidence published in peer-reviewed journals and presented at scientific meetings during the last six years have supported the finding.

Clouds and particles in the atmosphere play a significant role in regulating the Earth's temperature because they help determine how much of the sun's heat and energy is reflected back into space and they trap outgoing radiation from the Earth's surface. Cirrus clouds also are important in regulating the distribution of water vapor, the most important greenhouse gas, in the upper troposphere.

"We have thought our models of the formation and evolution of cirrus clouds are generally adequate in how they portray the role of cirrus clouds in regulating water vapor, but if the recent findings are accurate and high humidities are widespread, our assumptions could need significant adjustment," Baker said.

"The point is to bring this to the more general science audience as a broad puzzle, but also to lay the groundwork for research to solve the puzzle," she said.

Cirrus clouds form in the upper troposphere and modulate the exchange of water between the troposphere and the stratosphere. Vapor in the upper troposphere can rise into the stratosphere but tiny ice crystals can fall back toward the surface.

Outside the clouds, there are water vapor and minute atmospheric particles called aerosols, but no ice crystals. Scientists have come to expect that new ice crystals will begin to form in aerosols when vapor levels rise to the point at which they are 60 percent above equilibrium with the surrounding air. Yet measurements have shown that vapor levels can reach 90 percent to 100 percent above equilibrium without forming new ice particles.

Inside the clouds, it is expected that vapor levels above equilibrium cannot be maintained, yet evidence shows that often vapor levels are as much as 30 percent above equilibrium in large areas of clouds.

Scientists have speculated about what causes these anomalies. It is possible the aerosols might have as-yet undiscovered properties that prevent crystals from forming in some conditions, or there could be some kind of coating on the aerosols that prevents ice from forming, Baker said. There also could be some undiscovered property of ice crystals that prevents them from growing in certain conditions.

"There could be a different phase of ice at the temperatures and pressures in cirrus clouds that has a higher equilibrium for vapor," Baker said. "These are the kinds of questions for which we are trying to find answers."

The lead author of the *Science* article is Thomas Peter of the Institute for Atmospheric and Climate Science at Eidgenössische Technische Hochschule of Switzerland. Other co-authors are Claudia Marcolli, Peter Spichtinger and Thierry Corti, also of the climate institute, and Thomas Koop of Bielefeld University in Germany.

Source: University of Washington