## Researchers calculate size of particles in Martian clouds of CO2 snow

June 19 2012, by Jennifer Chu


Researchers have determined the size of CO2 snow particles on Mars, depicted in this artist's rendering as a mist or fog that eventually settles to the surface as carbon dioxide snow. Image: NASA, Christine Daniloff/MIT News

In the dead of a Martian winter, clouds of snow blanket the Red Planet's poles - but unlike our water-based snow, the particles on Mars are frozen crystals of carbon dioxide. Most of the Martian atmosphere is composed of carbon dioxide, and in the winter, the poles get so cold cold enough to freeze alcohol - that the gas condenses, forming tiny particles of snow.

Now researchers at MIT have calculated the size of snow particles in clouds at both Martian poles from data gathered by orbiting spacecraft. From their calculations, the group found snow particles in the south are slightly smaller than snow in the north - but particles at both poles are about the size of a red blood cell.

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"These are very fine particles, not big flakes," says Kerri Cahoy, the Boeing Career Development Assistant Professor of Aeronautics and Astronautics at MIT. If the carbon dioxide particles were eventually to fall and settle on the Martian surface, "you would probably see it as a fog, because they're so small."

Cahoy and graduate student Renyu Hu worked with Maria Zuber, the E.A. Griswold Professor of Geophysics at MIT, to analyze vast libraries of data gathered from instruments onboard the Mars Global Surveyor (MGS) and Mars Reconnaissance Orbiter (MRO). From the data, they determined the size of carbon dioxide snow particles in clouds, using measurements of the maximum buildup of surface snow at both poles. The buildup is about 50 percent larger at Mars' south pole than its north pole.

Over the course of a Martian year (a protracted 687 days, versus Earth's 365), the researchers observed that as it gets colder and darker from fall to winter, snow clouds expand from the planet's poles toward its equator. The snow reaches halfway to the equator before shrinking back toward the poles as winter turns to spring, much like on Earth.
"For the first time, using only spacecraft data, we really revealed this phenomenon on Mars," says Hu, lead author of a paper published in the Journal of Geophysical Research, which details the group's results.

## Diving through data

To get an accurate picture of carbon dioxide condensation on Mars, Hu analyzed an immense amount of data, including temperature and pressure profiles taken by the MRO every 30 seconds over the course of five Martian years (more than nine years on Earth). The researchers looked through the data to see where and when conditions would allow carbon dioxide cloud particles to form.

The team also sifted through measurements from the MGS' laser altimeter, which measured the topography of the planet by sending laser pulses to the surface, then timing how long it took for the beams to bounce back. Every once in a while, the instrument picked up a strange signal when the beam bounced back faster than anticipated, reflecting off an anomalously high point above the planet's surface. Scientists figured these laser beams had encountered clouds in the atmosphere.

Hu analyzed these cloud returns, looking for additional evidence to confirm carbon dioxide condensation. He looked at every case where a cloud was detected, then tried to match the laser altimeter data with concurrent data on local temperature and pressure. In 11 instances, the laser altimeter detected clouds when temperature and pressure conditions were ripe for carbon dioxide to condense. Hu then analyzed the opacity of each cloud - the amount of light reflected - and through calculations, determined the density of carbon dioxide in each cloud.

To estimate the total mass of carbon dioxide snow deposited at both poles, Hu used earlier measurements of seasonal variations in the Martian gravitational field done by Zuber's group: As snow piles up at Mars' poles each winter, the planet's gravitational field changes by a tiny amount. By analyzing the gravitational difference through the seasons, the researchers determined the total mass of snow at the north and south poles. Using the total mass, Hu figured out the number of snow particles in a given volume of snow cover, and from that, determined the size of the particles. In the north, molecules of condensed carbon dioxide ranged from 8 to 22 microns, while particles in the south were a smaller 4 to 13 microns.
"It's neat to think that we've had spacecraft on or around Mars for over 10 years, and we have all these great datasets," Cahoy says. "If you put different pieces of them together, you can learn something new just from the data."

## What can the size of snow tell us?

Hu says knowing the size of carbon dioxide snow cloud particles on Mars may help researchers understand the properties and behavior of dust in the planet's atmosphere. For snow to form, carbon dioxide requires something around which to condense - for instance, a small silicate or dust particle. "What kinds of dust do you need to have this kind of condensation?" Hu asks. "Do you need tiny dust particles? Do you need a water coating around that dust to facilitate cloud formation?"

Just as snow on Earth affects the way heat is distributed around the planet, Hu says snow particles on Mars may have a similar effect, reflecting sunlight in various ways, depending on the size of each particle. "They could be completely different in their contribution to the energy budget of the planet," Hu says. "These datasets could be used to study many problems."

This research was funded by the Radio Science Gravity investigation of the NASA Mars Reconnaissance Orbiter mission.

## More information:

www.agu.org/pubs/crossref/pip/2012JE004087.shtml

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https://phys.org/news/2012-06-size-particles-martian-clouds-co2.html

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