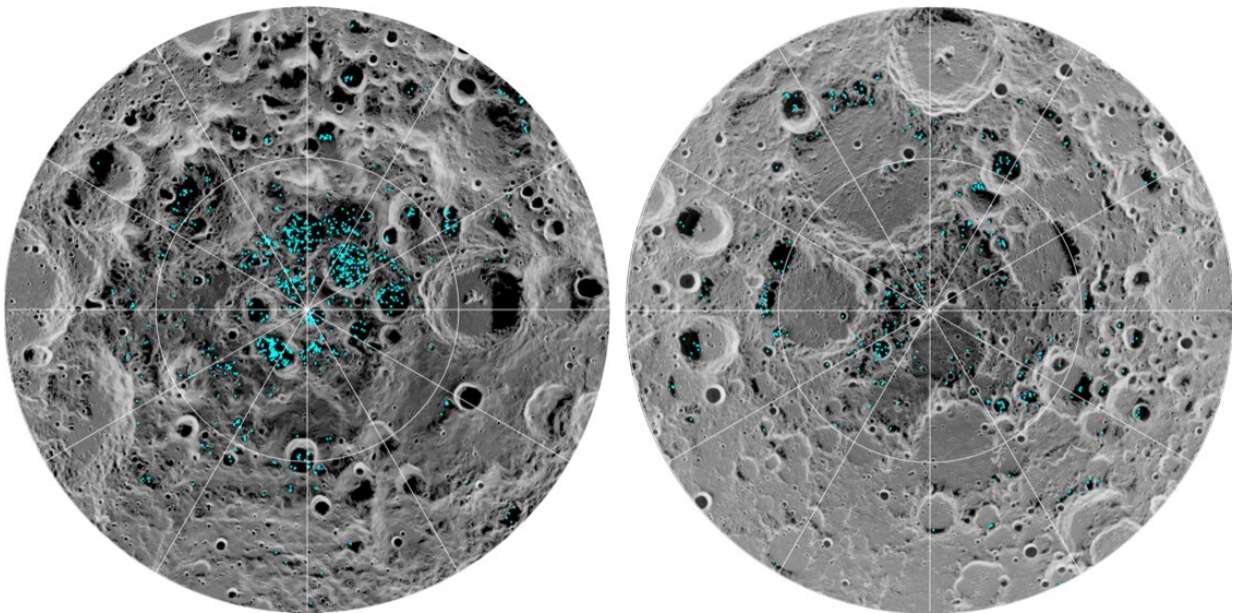


# Earth's atmosphere may be source of some lunar water

April 28 2022, by Rod Boyce

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The image shows the distribution of surface ice at the moon's south pole (left) and north pole (right), detected by NASA's Moon Mineralogy Mapper instrument in 2009. Blue represents the ice locations, and the gray scale corresponds to surface temperature. Credit: NASA

Hydrogen and oxygen ions escaping from Earth's upper atmosphere and combining on the moon could be one of the sources of the known lunar water and ice, according to new research by University of Alaska Fairbanks Geophysical Institute scientists.

The work led by UAF Geophysical Institute associate research professor Gunther Kletetschka adds to a growing body of research about water at the [moon](#)'s north and south poles.

Finding water is key to NASA's Artemis project, the planned long-term [human presence](#) on the moon. NASA plans to send humans back to the moon this decade.

"As NASA's Artemis team plans to build a [base camp](#) on the moon's south pole, the water ions that originated many eons ago on Earth can be used in the astronauts' life support system," Kletetschka said.

The new research estimates the moon's [polar regions](#) could hold up to 3,500 cubic kilometers—840 cubic miles—or more of surface permafrost or subsurface liquid water created from ions that escaped Earth's atmosphere. That's a volume comparable to North America's Lake Huron, the world's eighth-largest lake.

Researchers based that total on the lowest volume model calculation—1% of Earth's atmospheric escape reaching the moon.

A majority of the [lunar water](#) is generally believed to have been deposited by asteroids and comets that collided with the moon. Most was during a period known as the Late Heavy Bombardment. In that period, about 3.5 billion years ago when the [solar system](#) was about 1 billion years old, it is argued that the early inner planets and Earth's moon sustained unusually heavy impact from asteroids.

Scientists also hypothesize that the solar wind is a source. The [solar wind](#) carries oxygen and [hydrogen ions](#), which may have combined and been deposited on the moon as water molecules.

Now there's an additional way to explain how water accumulates on the

moon.

The research was published March 16 in the journal *Scientific Reports* in a paper authored by Kletetschka and co-authored by Ph.D. student Nicholas Hasson of the Geophysical Institute and UAF Water and Environmental Research Center at the Institute for Northern Engineering. Several colleagues from the Czech Republic are also among the co-authors.



the moon approaching Earth's magnetotail. Credit: Gunther Kletetschka

Kletetschka and his colleagues suggest hydrogen and [oxygen ions](#) are driven into the moon when it passes through the tail of the Earth's magnetosphere, which it does on five days of the moon's monthly trip around the planet. The magnetosphere is the teardrop-shaped bubble created by Earth's [magnetic field](#) that shields the planet from much of the continual stream of charged solar particles.

Recent measurements from multiple space agencies—NASA, European Space Agency, Japan Aerospace Exploration Agency and Indian Space Research Organization—revealed significant numbers of water-forming ions present during the moon's transit through this part of the magnetosphere.

These ions have slowly accumulated since the Late Heavy Bombardment.

The presence of the moon in the magnetosphere's tail, called the magnetotail, temporarily affects some of Earth's [magnetic field lines](#)—those that are broken and which simply trail off into space for many thousands of miles. Not all of Earth's field lines are attached to the planet at both ends; some have only one attachment point. Think of each of these as a thread tethered to a pole on a windy day.

The moon's presence in the magnetotail causes some of these broken field lines to reconnect with their opposing broken counterpart. When that happens, hydrogen and oxygen ions that had escaped Earth rush to those reconnected field lines and are accelerated back toward Earth.

The paper's authors suggest many of those returning ions hit the passing

moon, which has no magnetosphere of its own to repel them.

"It is like the moon is in the shower—a shower of water ions coming back to Earth, falling on the moon's surface," Kletetschka said.

The ions then combine to form the lunar permafrost. Some of that, through geologic and other processes such as asteroid impacts, is driven below the surface, where it can become liquid water.

The research team used gravitational data from NASA's Lunar Reconnaissance Orbiter to study polar regions along with several major lunar craters. Anomalies in underground measurements at impact craters indicate locations of fractured rock conducive to containing liquid water or ice. Gravity measurements at those subsurface locations suggest the presence of ice or [liquid water](#), the research paper reads.

The latest research builds on work published in December 2020 by four of the new paper's authors, including Kletetschka.

**More information:** Gunther Kletetschka et al, Distribution of water phase near the poles of the Moon from gravity aspects, *Scientific Reports* (2022). [DOI: 10.1038/s41598-022-08305-x](https://doi.org/10.1038/s41598-022-08305-x)

Provided by University of Alaska Fairbanks

Citation: Earth's atmosphere may be source of some lunar water (2022, April 28) retrieved 4 June 2024 from <https://phys.org/news/2022-04-earth-atmosphere-source-lunar.html>

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