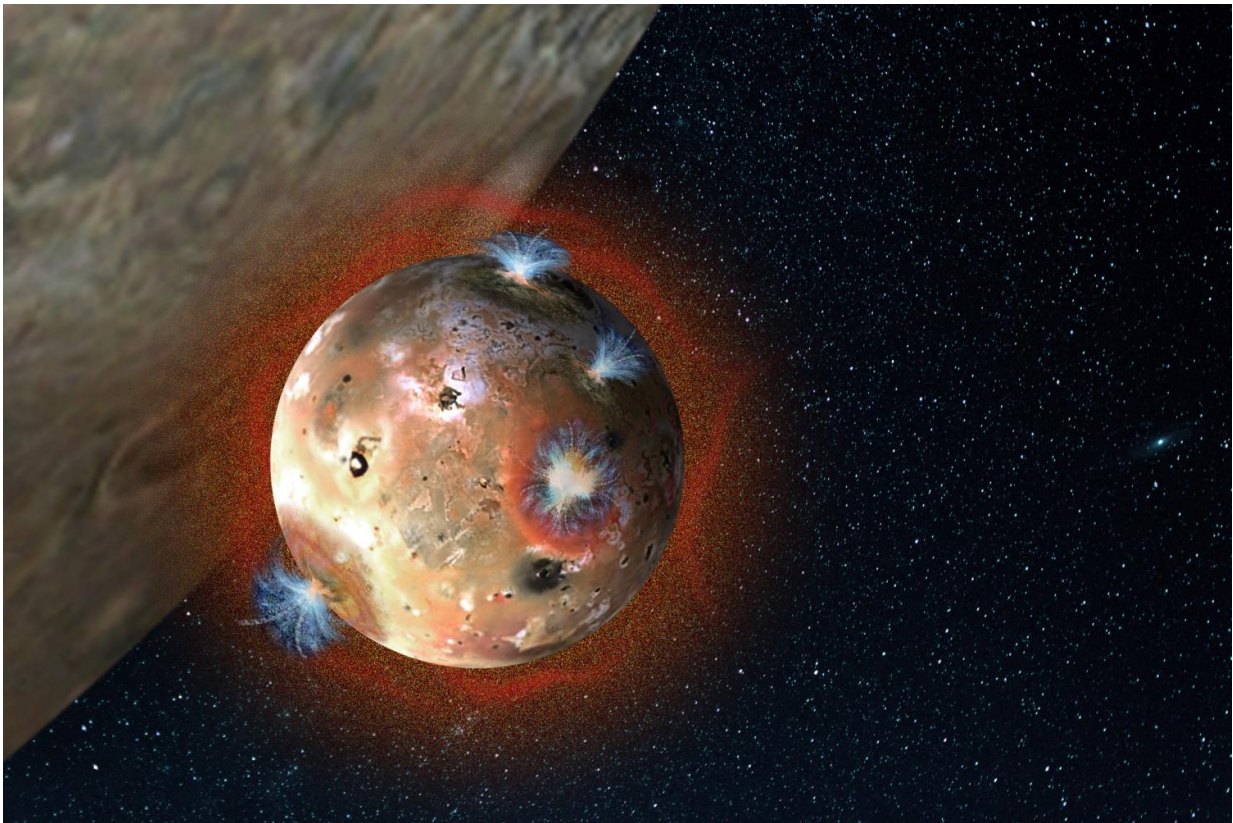


Space scientists observe Io's atmospheric collapse during eclipse

August 2 2016



An artist's rendering depicts the atmosphere on Io, Jupiter's volcanic moon, as it collapses during daily eclipses. Credit: Southwest Research Institute

A Southwest Research Institute-led team has documented atmospheric changes on Io, Jupiter's volcanically active satellite, as the giant planet

casts its shadow over the moon's surface during daily eclipses.

A study led by SwRI's Constantine Tsang concluded that Io's thin [atmosphere](#), which consists primarily of sulfur dioxide (SO₂) gas emitted from volcanoes, collapses as the SO₂ freezes onto the surface as ice when Io is shaded by Jupiter. When the moon moves out of eclipse and ice warms, the atmosphere reforms through sublimation, where ice converts directly to gas.

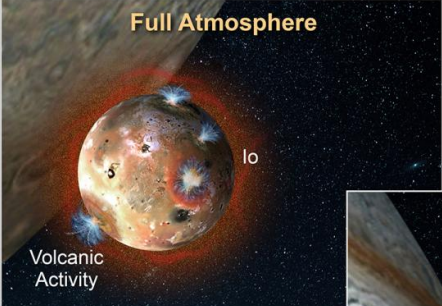
"This research is the first time scientists have observed this phenomenon directly, improving our understanding of this geologically active moon," said Tsang, a senior research scientist in SwRI's Space Science and Engineering Division.

The findings were published in a study titled "The Collapse of Io's Primary Atmosphere in Jupiter Eclipse" in the *Journal of Geophysical Research*. The team used the eight-meter Gemini North telescope in Hawaii and the Texas Echelon Cross Echelle Spectrograph (TEXES) for this research.

Data showed that Io's atmosphere begins to "deflate" when the temperatures drop from -235 degrees Fahrenheit in sunlight to -270 degrees Fahrenheit during eclipse. Eclipse occurs 2 hours of every Io day (1.7 Earth days). In full eclipse, the atmosphere effectively collapses as most of the SO₂ gas settles as frost on the moon's surface. The atmosphere redevelops as the surface warms once the moon returns to full sunlight.

Io's Atmospheric Collapse

The atmosphere on Io, Jupiter's volcanic moon, collapses during daily eclipses.




Full Atmosphere

Io


Volcanic Activity

Note: illustration is not to scale

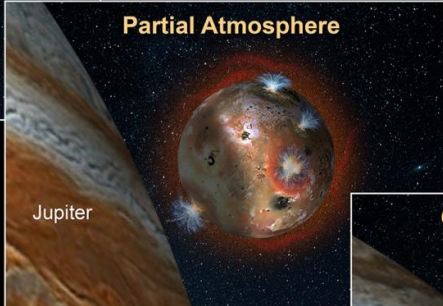
An artist's rendering depicts Io's volcanic plumes creating the atmosphere in sunlight.



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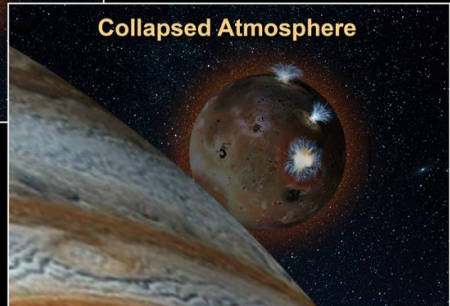
Actual Image: This image from the Cassini spacecraft captures Io's volcanoes and atmosphere in the shadow of Jupiter.



Partial Atmosphere

Jupiter

For two hours of Io's day (1.7 Earth days), it is eclipsed by Jupiter. The temperature drop freezes sulfur dioxide (SO₂) gas, causing the atmosphere to "deflate."



Collapsed Atmosphere

In full eclipse, Io's atmosphere "collapses" as SO₂ gas becomes frost on the moon's surface. The atmosphere redevelops when sunlight returns.

An artist's rendering depicts the atmosphere on Io, Jupiter's volcanic moon, as it collapses during daily eclipses. Credit: Southwest Research Institute

"This confirms that Io's atmosphere is in a constant state of collapse and repair, and shows that a large fraction of the atmosphere is supported by sublimation of SO₂ ice," said John Spencer, an SwRI scientist who also participated in the study. "Though Io's hyperactive volcanoes are the ultimate source of the SO₂, sunlight controls the atmospheric pressure on a daily basis by controlling the temperature of the ice on the surface. We've long suspected this, but can finally watch it happen."

Prior to the study, no direct observations of Io's atmosphere in eclipse had been possible because Io's atmosphere is difficult to observe in the

darkness of Jupiter's shadow. This breakthrough was possible because TEXES measures the atmosphere using heat radiation, not sunlight, and the giant Gemini telescope can sense the faint heat signature of Io's collapsing atmosphere.

Tsang and Spencer's observations occurred over two nights in November 2013, when Io was more than 420 million miles from Earth. On both occasions, Io was observed moving in and out of Jupiter's shadow, for a period about 40 minutes before and after eclipse.

Io is the most volcanically active object in the solar system. Tidal heating, the result of Io's gravitational interaction with Jupiter, drives the moon's volcanic activity. Io's volcanoes emit umbrella-like plumes of SO₂ gas extending up to 300 miles above the moon's surface and produce extensive basaltic lava fields that can flow for hundreds of miles.

This study is also timely given that NASA's Juno spacecraft entered Jupiter orbit on July 4. "Io spews out gases that eventually fill the Jupiter system, ultimately seeding some of the auroral features seen at Jupiter's poles," Tsang said. "Understanding how these emissions from Io are controlled will help paint a better picture of the Jupiter system."

More information: The collapse of Io's primary atmosphere in Jupiter eclipse, [DOI: 10.1002/2016JE005025](https://doi.org/10.1002/2016JE005025) , onlinelibrary.wiley.com/doi/10.1002/2016JE005025/abstract

Provided by Southwest Research Institute

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