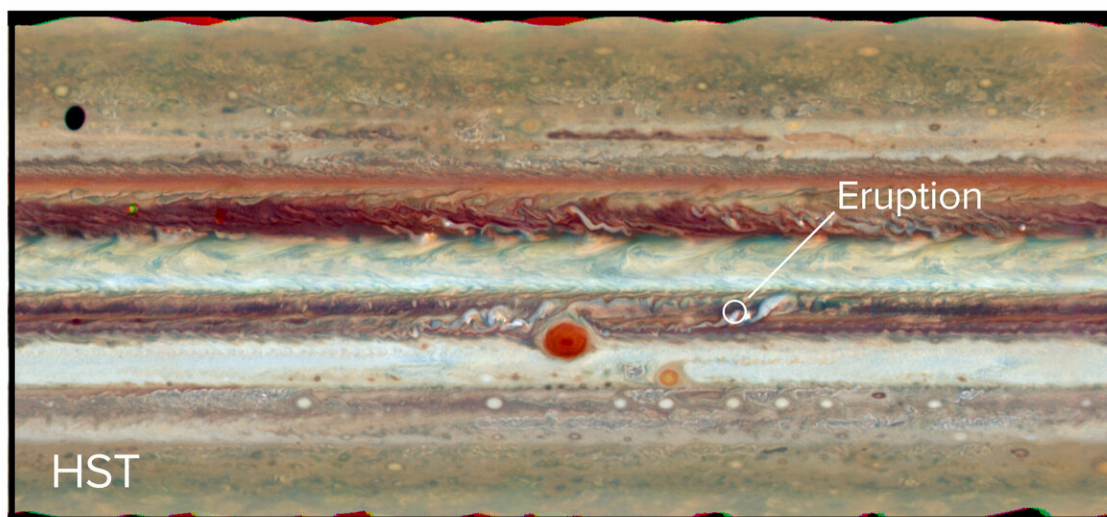
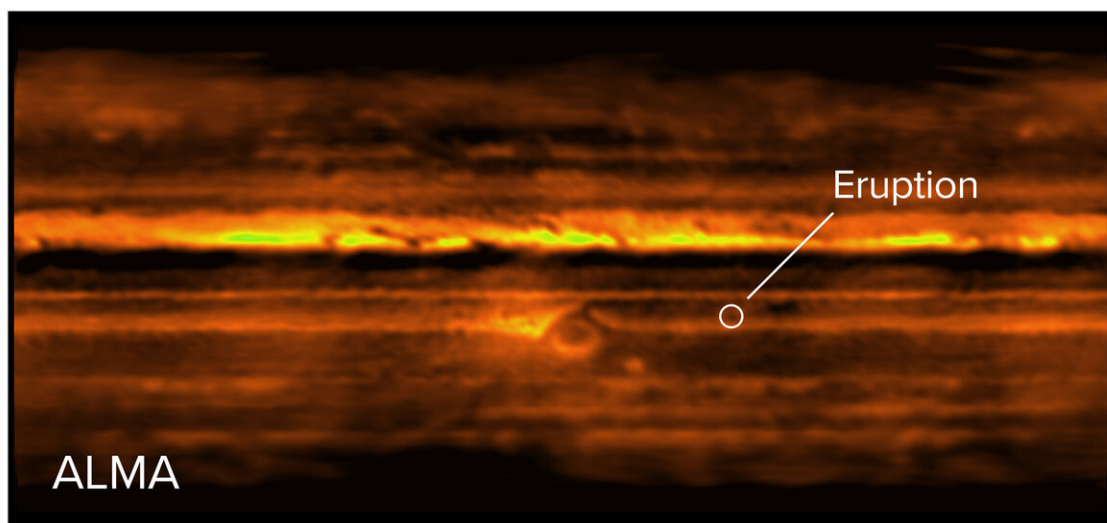


Storms on Jupiter are disturbing the planet's colorful belts

August 22 2019



Jupiter in radio waves with ALMA (top) and visible light with the Hubble Space

Telescope (bottom). The eruption in the South Equatorial Belt is visible in both images. Credit: ALMA (ESO/NAOJ/NRAO), I de Pater et al.; NRAO/AUI NSF, S. Dagnello; NASA/Hubble

Storm clouds rooted deep in Jupiter's atmosphere are affecting the planet's white zones and colorful belts, creating disturbances in their flow and even changing their color.

Thanks to coordinated observations of the planet in January 2017 by six ground-based optical and radio telescopes and NASA's Hubble Space Telescope, a University of California, Berkeley, astronomer and her colleagues have been able to track the effects of these storms—visible as bright plumes above the planet's ammonia ice clouds—on the belts in which they appear.

The observations will ultimately help planetary scientists understand the complex atmospheric dynamics on Jupiter, which, with its Great Red Spot and colorful, layer cake-like bands, make it one of the most beautiful and changeable of the giant gas planets in the solar system.

One such plume was noticed by amateur astronomer Phil Miles in Australia a few days before the first observations by the Atacama Large Millimeter/Submillimeter Array (ALMA) in Chile, and photos captured a week later by Hubble showed that the plume had spawned a second plume and left a downstream disturbance in the band of clouds, the South Equatorial Belt. The rising plumes then interacted with Jupiter's powerful winds, which stretched the clouds east and west from their point of origin.

Three months earlier, four bright spots were seen slightly north of the North Equatorial Belt. Though those plumes had disappeared by 2017,

the belt had since widened northward, and its northern edge had changed color from white to orangish brown.

"If these plumes are vigorous and continue to have convective events, they may disturb one of these entire bands over time, though it may take a few months," said study leader Imke de Pater, a UC Berkeley professor emerita of astronomy. "With these observations, we see one plume in progress and the aftereffects of the others."

The analysis of the plumes supports the theory that they originate about 80 kilometers below the cloud tops at a place dominated by clouds of liquid water. A paper describing the results has been accepted for publication in the *Astronomical Journal* and is now [online](#).

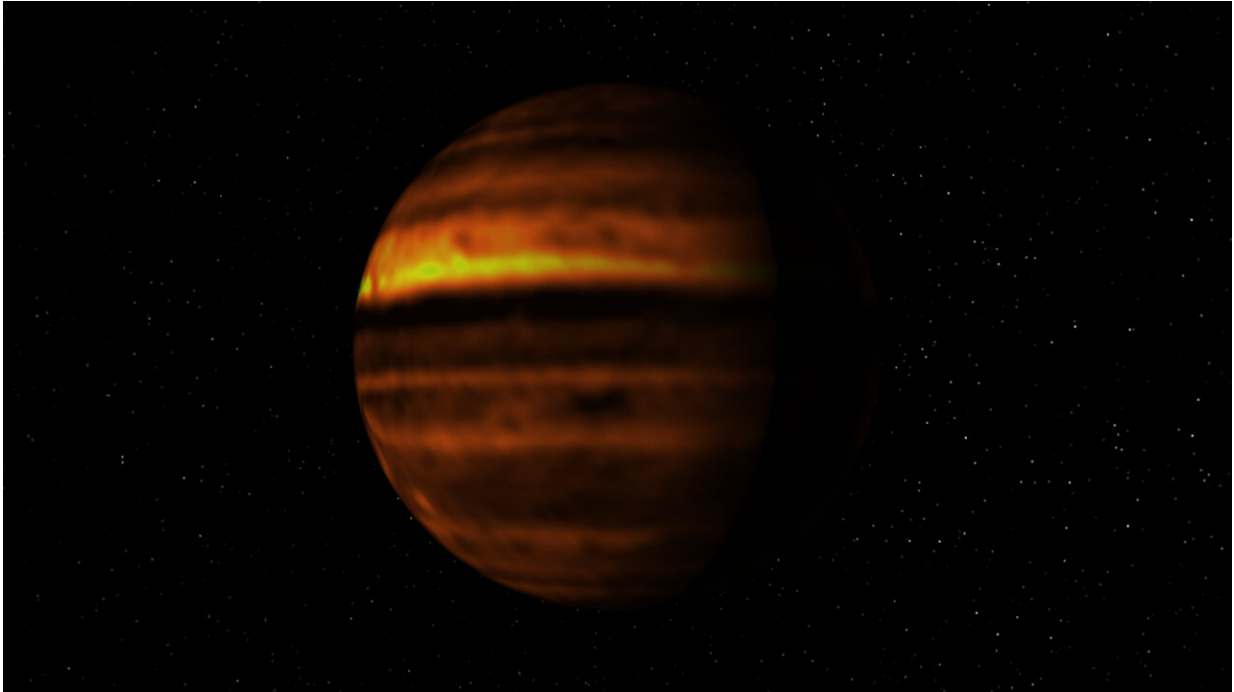
Into the stratosphere

Jupiter's atmosphere is mostly hydrogen and helium, with trace amounts of methane, ammonia, hydrogen sulfide and water. The top-most cloud layer is made up of ammonia ice and comprises the brown belts and white zones we see with the naked eye. Below this outer cloud layer sits a layer of solid ammonium hydrosulfide particles. Deeper still, at around 80 kilometers below the upper cloud deck, is a layer of liquid water droplets.

The storm clouds de Pater and her team studied appear in the belts and zones as bright plumes and behave much like the cumulonimbus clouds that precede thunderstorms on Earth. Jupiter's storm clouds, like those on Earth, are often accompanied by lightning.

Optical observations cannot see below the ammonia clouds, however, so de Pater and her team have been probing deeper with [radio telescopes](#), including ALMA and also the Very Large Array (VLA) in New Mexico, which is operated by the National Science Foundation-funded National

Radio Astronomy Observatory.



ALMA image showing the distribution of ammonia gas below Jupiter's cloud deck. Credit: ALMA (ESO/NAOJ/NRAO), I de Pater/UC Berkeley et al.; NRAO/AUI NSF, S. Dagnello

ALMA array's first observations of Jupiter were between Jan. 3 and 5 of 2017, a few days after one of these bright plumes was seen by amateur astronomers in the planet's South Equatorial Belt. A week later, Hubble, the VLA, the Gemini, Keck and Subaru observatories in Hawaii and the Very Large Telescope (VLT) in Chile captured images in the visible, radio and mid-infrared ranges.

De Pater combined the ALMA radio observations with the other data, focused specifically on the newly brewed storm as it punched through

the upper deck clouds of ammonia ice.

The data showed that these [storm clouds](#) reached as high as the tropopause—the coldest part of the atmosphere—where they spread out much like the anvil-shaped cumulonimbus clouds that generate lightning and thunder on Earth.

"Our ALMA observations are the first to show that high concentrations of ammonia gas are brought up during an energetic eruption," de Pater said.

The observations are consistent with one theory, called moist convection, about how these plumes form. According to this theory, convection brings a mix of ammonia and water vapor high enough—about 80 kilometers below the cloud tops—for the water to condense into liquid droplets. The condensing water releases heat that expands the cloud and buoys it quickly upward through other cloud layers, ultimately breaking through the ammonia ice clouds at the top of the atmosphere.

The plume's momentum carries the supercooled ammonia cloud above the existing ammonia-ice clouds until the ammonia freezes, creating a bright, white plume that stands out against the colorful bands encircling Jupiter.

"We were really lucky with these data, because they were taken just a few days after amateur astronomers found a bright plume in the South Equatorial Belt," said de Pater. "With ALMA, we observed the whole planet and saw that [plume](#), and since ALMA probes below the cloud layers, we could actually see what was going on below the ammonia [clouds](#)."

Hubble took images a week after ALMA and captured two separate bright spots, which suggests that the plumes originate from the same

source and are carried eastward by the high altitude jet stream, leading to the large disturbances seen in the belt.

Coincidentally, three months before, bright plumes had been observed north of the Northern Equatorial Belt. The January 2017 observations showed that that belt had expanded in width, and the band where the plumes had first been seen turned from white to orange. De Pater suspects that the northward expansion of the North Equatorial Belt is a result of gas from the [ammonia](#)-depleted plumes falling back into the deeper atmosphere.

De Pater's colleague and co-author Robert Sault of the University of Melbourne in Australia used special computer software to analyze the ALMA data to obtain radio maps of the surface that are comparable to visible-light photos taken by Hubble.

"Jupiter's rotation once every 10 hours usually blurs radio maps, because these maps take many hours to observe," Sault said. "In addition, because of Jupiter's large size, we had to 'scan' the planet, so we could make a large mosaic in the end. We developed a technique to construct a full map of the planet."

More information: First ALMA Millimeter Wavelength Maps of Jupiter, with a Multi-Wavelength Study of Convection, arXiv:1907.11820 [astro-ph.EP] arxiv.org/abs/1907.11820

Provided by University of California - Berkeley

Citation: Storms on Jupiter are disturbing the planet's colorful belts (2019, August 22) retrieved 19 April 2024 from <https://phys.org/news/2019-08-storms-jupiter-disturbing-planet-belts.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.