

What makes Saturn's atmosphere so hot

April 7 2020, by Mikayla MacE



Saturn and it's aurora. Credit: NASA

The upper layers in the atmospheres of gas giants—Saturn, Jupiter, Uranus and Neptune—are hot, just like Earth's. But unlike Earth, the Sun is too far from these outer planets to account for the high temperatures. Their heat source has been one of the great mysteries of planetary science.

New analysis of data from NASA's Cassini spacecraft finds a viable

explanation for what's keeping the upper layers of Saturn, and possibly the other gas giants, so hot: auroras at the planet's north and south poles. Electric currents, triggered by interactions between solar winds and charged particles from Saturn's moons, spark the auroras and heat the [upper atmosphere](#). (As with Earth's northern lights, studying auroras tells scientists what's going on in the planet's atmosphere.)

The work, published today in *Nature Astronomy*, is the most complete mapping yet of both [temperature](#) and density of a gas giant's upper atmosphere—a region that has been poorly understood.

"Understanding the dynamics really requires a global view. This dataset is the first time we've been able to look at the upper atmosphere from pole to pole while also seeing how temperature changes with depth," said Zarah Brown, lead author of the study and a graduate student in the University of Arizona Lunar and Planetary Laboratory.

By building a complete picture of how heat circulates in the atmosphere, scientists are better able to understand how auroral electric currents heat the upper layers of Saturn's atmosphere and drive winds. The global wind system can distribute this energy, which is initially deposited near the poles toward the equatorial regions, heating them to twice the temperatures expected from the sun's heating alone.

"The results are vital to our general understanding of planetary upper atmospheres and are an important part of Cassini's legacy," said study co-author Tommi Koskinen, a member of Cassini's Ultraviolet Imaging Spectrograph team. "They help address the question of why the uppermost part of the atmosphere is so hot, while the rest of the atmosphere—due to the large distance from the Sun—is cold."

Managed by NASA's Jet Propulsion Laboratory in Southern California, Cassini was an orbiter that observed Saturn for more than 13 years

before exhausting its fuel supply. The mission plunged it into the planet's atmosphere in September 2017, in part to protect its moon Enceladus, which Cassini discovered might hold conditions suitable for life. But before its plunge, Cassini performed 22 ultra-close orbits of Saturn, a final tour called the Grand Finale.

It was during the Grand Finale that the key data was collected for the new temperature map of Saturn's atmosphere. For six weeks, Cassini targeted several bright stars in the constellations of Orion and Canis Major as they passed behind Saturn. As the spacecraft observed the stars rise and set behind the giant planet, scientists analyzed how the starlight changed as it passed through the atmosphere.

Measuring how dense the atmosphere is gave scientists the information they needed to find the temperatures. Density decreases with altitude, and the rate of decrease depends on temperature. They found that temperatures peak near the auroras, indicating that auroral [electric currents](#) heat the upper atmosphere.

Density and temperature measurements together helped scientists figure out wind speeds. Understanding Saturn's upper atmosphere, where planet meets space, is key to understanding space weather and its impact on other planets in our solar system and exoplanets around other stars.

"Even though thousands of exoplanets have been found, only the planets in our solar system can be studied in this kind of detail. Thanks to Cassini, we have a more detailed picture of Saturn's upper [atmosphere](#) right now than any other giant planet in the universe," Brown said.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. NASA's Jet Propulsion Laboratory, or JPL, a division of Caltech in Pasadena, manages the mission for NASA's Science Mission Directorate in

Washington. JPL designed, developed and assembled the Cassini orbiter.

More information: Z. Brown et al, A pole-to-pole pressure–temperature map of Saturn's thermosphere from Cassini Grand Finale data, *Nature Astronomy* (2020). [DOI: 10.1038/s41550-020-1060-0](#)

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