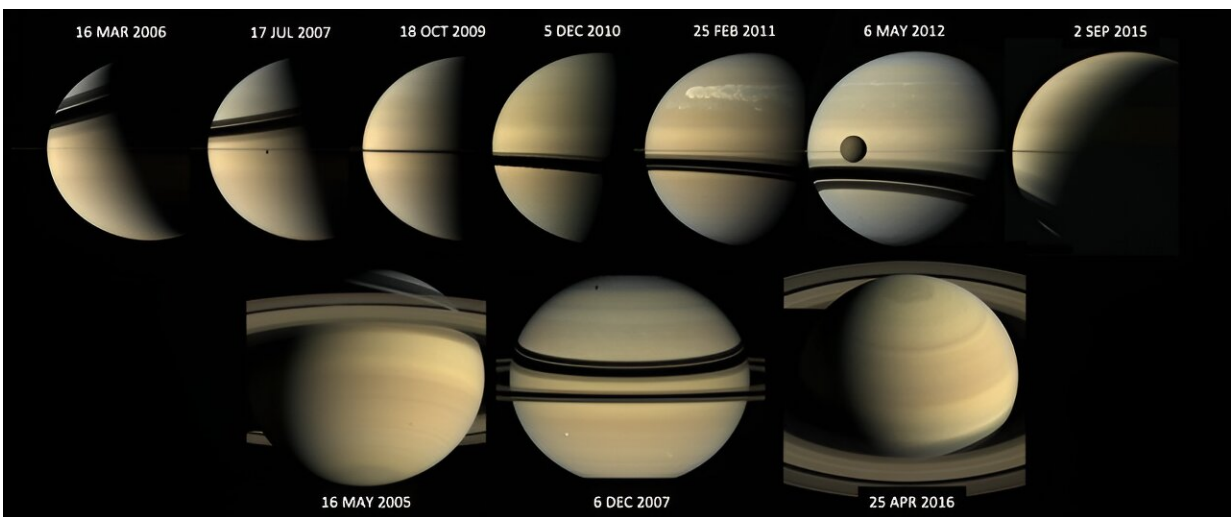


New Saturn images show a change of seasons and a last glimpse of its huge, warm polar vortex

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Saturn's changing insolation from 2004 to 2016 as seen by Cassini's Imaging Science Subsystem (ISS). The top row shows Saturn from an equatorial vantage point (the rings appear edge-on), and attempts to show the location of the terminator in each image to indicate how it changed over time. The bottom row shows images from outside of the equatorial plane, showing the transition from southern summer to northern summer. Compiled from Cassini/ISS images courtesy of NASA/JPL-Caltech. Credit: *Journal of Geophysical Research: Planets* (2023). DOI: 10.1029/2023JE007924

While the UK has been experiencing warm autumnal weather, a team of

planetary scientists has found that Saturn's late northern summer is experiencing a cooling trend, as huge planetary-scale flows of air have reversed direction as autumn approaches.

The new observations have also provided a last glimpse of Saturn's north pole, with its enormous warm vortex filled with hydrocarbon gases, before the pole begins to recede into the darkness of polar winter.

This interplanetary weather report is thanks to new images analyzed by a team led by the University of Leicester from the JWST and published in *Journal of Geophysical Research: Planets*. They have provided new insights into the changing seasons on the massive outer planet, famous for its icy rings.

Like Earth, Saturn has an axial tilt and experiences seasons in the same way. However, Saturn takes 30 years to orbit the sun, so the seasons last for 7.5 Earth-years. Northern-hemisphere summer on both worlds is now coming to an end. While Earth is heading for northern autumn equinox in September, Saturn is heading for northern autumn equinox in 2025, which means the north poles of both planets are heading for extended periods of polar winter.

The Leicester team used the MIRI instrument on JWST to study Saturn's atmosphere in infrared light, which allows them to measure the temperatures, gaseous abundances, and clouds from the churning cloud tops to regions high in the atmosphere known as the stratosphere. The MIRI instrument splits the [infrared light](#) into its component wavelengths allowing scientists to see the fingerprints of the rich variety of chemicals within a planet's atmosphere.

In the image, created by combining just a few of the wavelengths observed by MIRI, the bright thermal emission from the north pole stands out in blue. The warm 1500-km wide north polar cyclone (NPC),

which was first observed by the Cassini mission, can be seen at the north pole. This is surrounded by a broader region of warm gases called the north-polar stratospheric vortex (NPSV), which formed in Saturnian spring and has persisted throughout its northern summer.

These are warm vortices high in the stratosphere, heated by the sun's warmth during Saturn's long summer season. As autumn equinox approaches in 2025, the north polar stratospheric vortex will begin cooling down and will disappear as the northern hemisphere recedes into the darkness of autumn.

By modeling the mid-infrared spectra, the scientists noticed that the distributions of stratospheric temperatures and gases at this particular point in Saturn's seasonal cycle were rather different to those observed by the Cassini mission during northern winter and spring.

Saturn has a large-scale stratospheric circulation pattern with warmer temperatures and excess hydrocarbons, like ethane and acetylene, in the northern midlatitudes in winter, signifying sinking of hydrocarbon-rich air from above. Air was thought to rise in the southern summer midlatitudes, cross the equator, and sink into the northern winter midlatitudes.

The MIRI Medium-Resolution Spectrometer results taken in November 2022 revealed that this stratospheric circulation has now reversed and cool stratospheric temperatures and low hydrocarbon abundances are seen in the north between 10°N and 40°N , suggesting upwelling of hydrocarbon-poor air in the summer, which will then be flowing towards the south.

Professor Leigh Fletcher, from the University of Leicester School of Physics and Astronomy, said, "The quality of the new data from JWST is simply breath-taking—in one short set of observations, we've been

able to continue the legacy of the Cassini mission into a completely new Saturnian season, watching how the weather patterns and atmospheric circulation respond to the changing sunlight."

"JWST can see in wavelengths of light that were inaccessible to any previous spacecraft, producing an exquisite dataset that whets the appetite for the years to come. This work on Saturn is just the first of a program of observations of all four giant planets, and JWST is providing a capability beyond anything we've had in the past—if we can get so many new findings from a single observation of a single world, imagine what discoveries await?"

Saturn was chosen as an early target for JWST as a test of its capabilities. Dr. Oliver King, a postdoctoral researcher in Leicester's School of Physics and Astronomy, explained, "Because it is big, bright, rotating, and moving across the sky, it provides a challenge for the small fields-of-view of the MIRI instrument—MIRI can only see a small area of Saturn at any one time, and we're at risk of saturating the detectors because the planet is so bright compared to JWST's usual targets."

"The observations were taken as three tiles, stepping from the equator to the [north pole](#), and then out to the rings for a final tile."

Professor Fletcher adds, "We started designing these Saturn observations more than 8 years ago, so when that first data landed in late 2022, it was certainly a career highlight: the Leicester team of planetary scientists crammed around a computer screen, astonished by the quality of the new data, and maybe sipping some sparkling wine to celebrate."

"It would not have been possible without the wider team of experts that contributed to the Saturn program, especially the folks at Space Telescope who put up with our endless questions and problems as we dealt with all the challenges of a brand-new telescope."

"No spacecraft has ever been present to explore Saturn's late northern summer and autumn before, so we hope that this is just the starting point, and that JWST can continue the legacy of Cassini into the coming decade."

More information: Leigh N. Fletcher et al, Saturn's Atmosphere in Northern Summer Revealed by JWST/MIRI, *Journal of Geophysical Research: Planets* (2023). [DOI: 10.1029/2023JE007924](https://doi.org/10.1029/2023JE007924)

Provided by University of Leicester

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