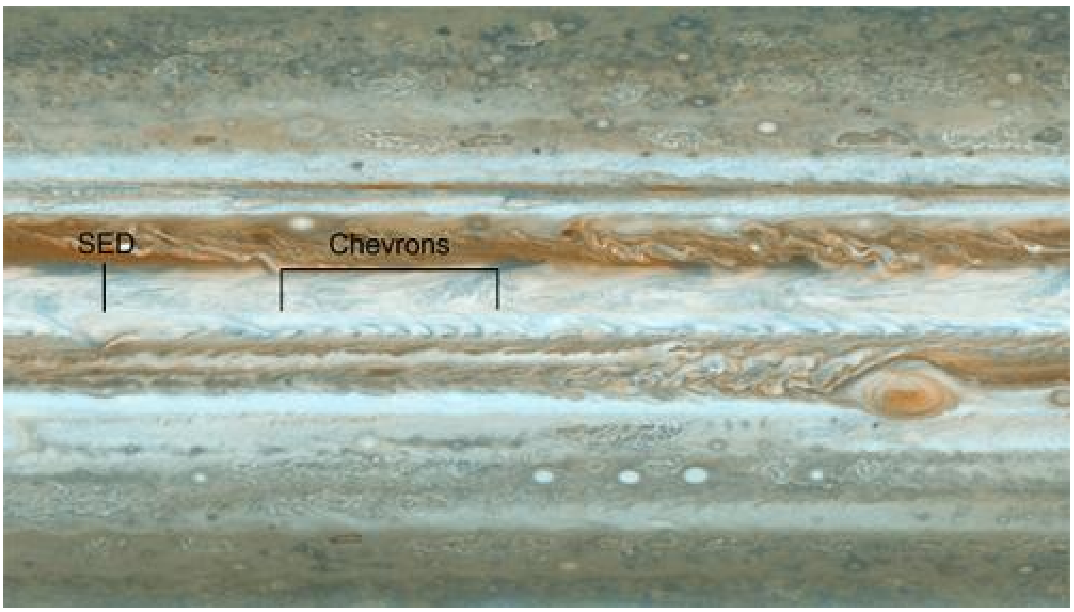
Cassini spies wave rattling jet stream on Jupiter

March 13 2012



Following the path of one of Jupiter's jet streams, a line of V-shaped chevrons travels west to east just above Jupiter's Great Red Spot. Most of the planet is unfolded here in a single, flat map made on December 11 and 12, 2000, when NASA's Cassini spacecraft flew past Jupiter. At the left, the chevrons run into another storm called the South Equatorial Disturbance (SED). Credit: NASA/JPL/Space Science Institute

(PhysOrg.com) -- New movies of Jupiter are the first to catch an invisible wave shaking up one of the giant planet's jet streams, an interaction that also takes place in Earth's atmosphere and influences the weather. The movies, made from images taken by NASA's Cassini spacecraft when it flew by Jupiter in 2000, are part of an in-depth study conducted by a team of scientists and amateur astronomers led by Amy Simon-Miller at NASA's Goddard Space Flight Center in Greenbelt, Md., and published in the April 2012 issue of *Icarus*.

"This is the first time anyone has actually seen direct wave motion in one of Jupiter's jet streams," says Simon-Miller, the paper's lead author. "And by comparing this type of interaction in Earth's atmosphere to what happens on a planet as radically different as Jupiter, we can learn a lot about both planets."

Like Earth, Jupiter has several fast-moving jet streams that circle the globe. Earth's strongest and best known jet streams are those near the north and south poles; as these winds blow west to east, they take the scenic route, wandering north and south. What sets these jet streams on their meandering paths -- and sometimes makes them blast Florida and other warm places with frigid air -- are their encounters with slow-moving waves in Earth's atmosphere, called Rossby waves.

In contrast, Jupiter's jet streams "have always appeared to be straight and narrow," says co-author John Rogers, who is the Jupiter Section Director of the British Astronomical Association, London, U.K., and one of the amateur astronomers involved in this study.

Rossby waves were identified on Jupiter about 20 years ago, in the northern hemisphere. Even so, the expected meandering winds could not be traced directly, and no evidence of them had been found in the southern hemisphere, which puzzled planetary scientists.

To get a more complete view, the team analyzed images taken by NASA's Voyager spacecraft, NASA's Hubble Space Telescope, and Cassini, as well as a decade's worth of observations made by amateur astronomers and compiled by the JUPOS project.

The movies zoom in on a single jet stream in Jupiter's southern hemisphere. A line of small, dark, V-shaped "chevrons" has formed along one edge of the jet stream and zips along west to east with the wind. Later, the well-ordered line starts to ripple, with each chevron moving up and down (north and south) in turn. And for the first time, it's clear that Jupiter's jet streams, like Earth's, wander off course.

"That's the signature of the Rossby wave," says David Choi, the postdoctoral fellow at NASA Goddard who strung together about a hundred Cassini images to make each time-lapse movie. "The chevrons in the fast-moving jet stream interact with the slower-moving Rossby wave, and that's when we see the chevrons oscillate."

The team's analysis also reveals that the chevrons are tied to a different type of wave in Jupiter's atmosphere, called a gravity inertia wave. Earth also has gravity inertia waves, and under proper conditions, these can be seen in repeating cloud patterns.

"A planet's atmosphere is a lot like the string of an instrument," says co-author Michael D. Allison of the NASA Goddard Institute for Space Studies in New York. "If you pluck the string, it can resonate at different frequencies, which we hear as different notes. In the same way, an atmosphere can resonate with different modes, which is why we find different kinds of waves."

Characterizing these waves should offer important clues to the layering of the deep atmosphere of Jupiter, which has so far been inaccessible to remote sensing, Allison adds.

Crucial to the study was the complementary information that the team was able to retrieve from the detailed spacecraft images and the more complete visual record provided by amateur astronomers. For example, the high resolution of the spacecraft images made it possible to establish the top speed of the jet stream's wind, and then the amateur astronomers involved in the study looked through the ground-based images to find variations in the wind speed.

The team also relied on images that amateur astronomers had been gathering of a large, transient storm called the South Equatorial Disturbance. This visual record dates back to 1999, when members of the community spotted the most recent recurrence of the storm just south of Jupiter's equator. Analysis of these images revealed the dynamics of this storm and its impact on the chevrons. The team now thinks this storm, together with the Great Red Spot, accounts for many of the differences noted between the jet streams and Rossby waves on the two sides of Jupiter's equator.

"We are just starting to investigate the long-term behavior of this alien atmosphere," says co-author Gianluigi Adamoli, an amateur astronomer in Italy. "Understanding the emerging analogies between Earth and Jupiter, as well as the obviously profound differences, helps us learn fundamentally what an atmosphere is and how it can behave."

Provided by NASA's Goddard Space Flight Center

Citation: Cassini spies wave rattling jet stream on Jupiter (2012, March 13) retrieved 23 April 2024 from https://phys.org/news/2012-03-cassini-spies-rattling-jet-stream.html