Saturn - From Pole to Pole

Saturn, the second-largest planet in our Solar System, is easily the most visually spectacular. The gas giant puts on a magnificent display with its immense rings, but, unlike its larger sibling Jupiter, hides the details of its complex atmospheric structures with layers of haze.

Sometimes intriguing glimpses of Saturn's inner dynamism erupt to the outer layers of its atmosphere and can be captured by the Cassini-Huygens Orbiter, which has been observing the planet and its moons for years.

Principal Investigator Kevin Baines (joint appointment at UW-Madison Space Science and Engineering Center and the Jet Propulsion Laboratory in Pasadena, CA) has been studying several recent storm systems on the planet.

"Saturn's year is the equivalent of nearly 30 Earth years, "Baines says. "We have previous records of storm activity breaking through the haze, but usually these eruptions happen toward the end of Saturn's summer. We're only two years into the planet's spring season and the features that are appearing are fascinating."

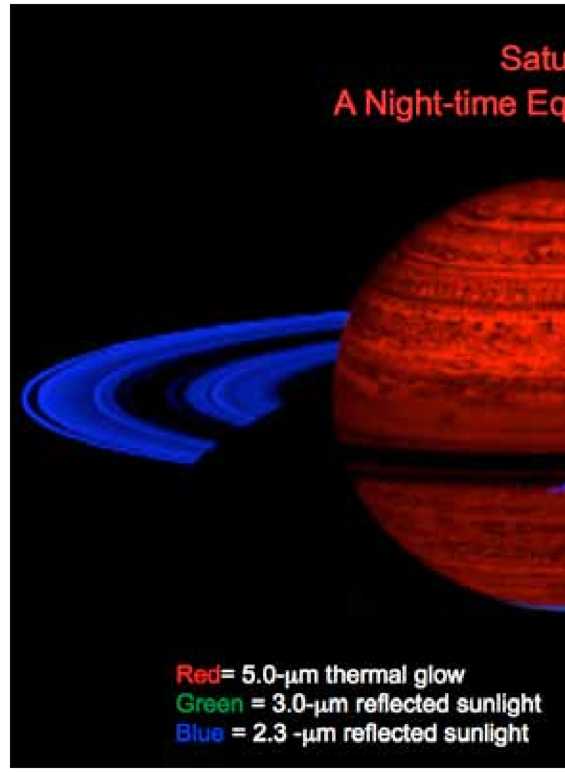
The Southern Hemisphere Storm

The first storm was observed near 30° south latitude in February 2008. Two new types of clouds were discovered, each with its own distinctive composition: ammonia condensate clouds (likely formed from upwelling ammonia gas) and exceptionally dark clouds from carbon-soot-impregnated condensates.

The carbon was likely created by lightning flashes – averaging 2 per minute but more than 10 per second at times – blasting through atmospheric methane near the 10-bar level, some 100 km underneath the cloudtops observed from Earth. Water vapor and water clouds can exist this deep in the atmosphere and can form thunderstorms. We do not see these water clouds themselves, but instead detect other thunderstorm-related clouds created by convective upwelling.

These clouds give rise to the "Double Bubble Model." Ammonia gas lying just under the upper clouds (themselves likely ammonia) is pushed up in convective upwellings, forming fresh ammonia clouds comprised of exceptionally large particles that are readily identifiable spectroscopically.

Within a few days, dark clouds containing an optically-significant component of lightning-produced carbon soot, reach higher altitudes and become visible.



String of Pearls Nea

Kevin Baines is also examining a bizarre train o longitude discovered by VIMS in 2005.

"They appear as a bright string of lights," he says level that allows 5-mm thermal light from the d 100 km across, and they are separated from each

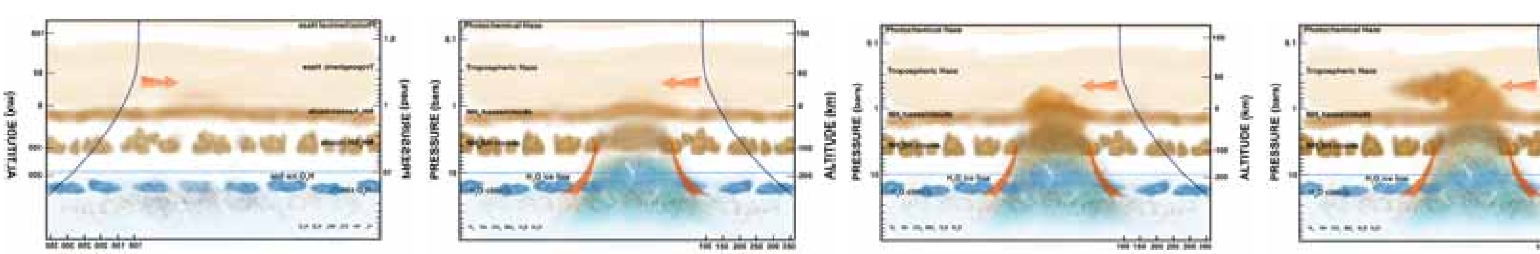
The "necklace," stretching a quarter of the way a observed for five years and was remarkable for i

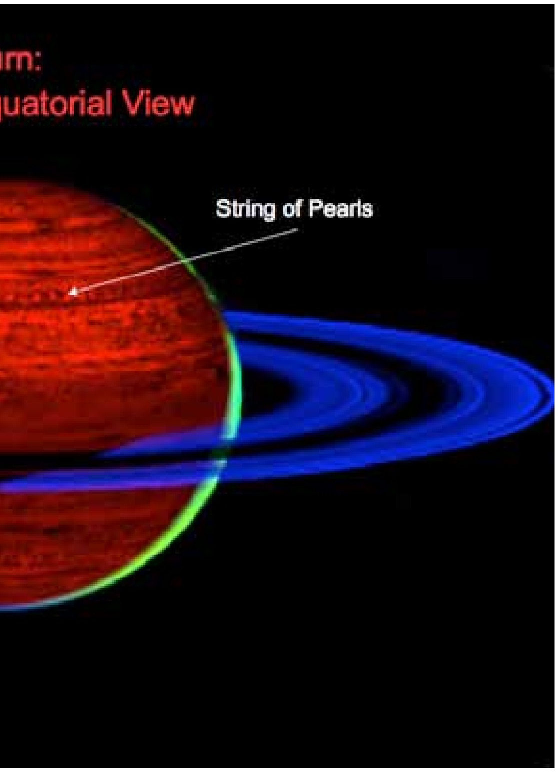
The necklace disappeared when the Northern St the past year and obliterated it.

"We wonder if there may be a common dynami and the storm," Baines said. "Both may be mani prevalent near 35° north latitude. This is the lati retrograde speed at non-polar latitudes."

It seems possible that the pearls are clearings in vortex streets. Such features are typically formed an obstacle such as convectively-forced updrafts and anvil-type storm clouds covered the pearl r

The "Double Bubble Model"





r 35° North Latitude

f cloud clearings spanning about 90° of

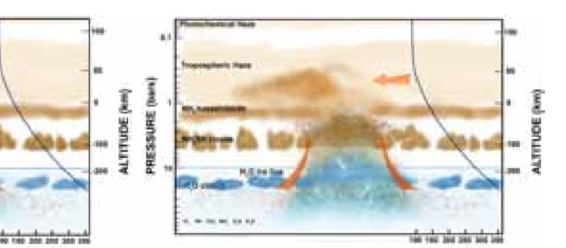
s. "Each 'light' is a cloud clearing near the 3-bar
epths to shine through. Each clearing is about
h other about 4000 kilometers."

across a Saturn's northern hemisphere, was
ts uniform spacing.

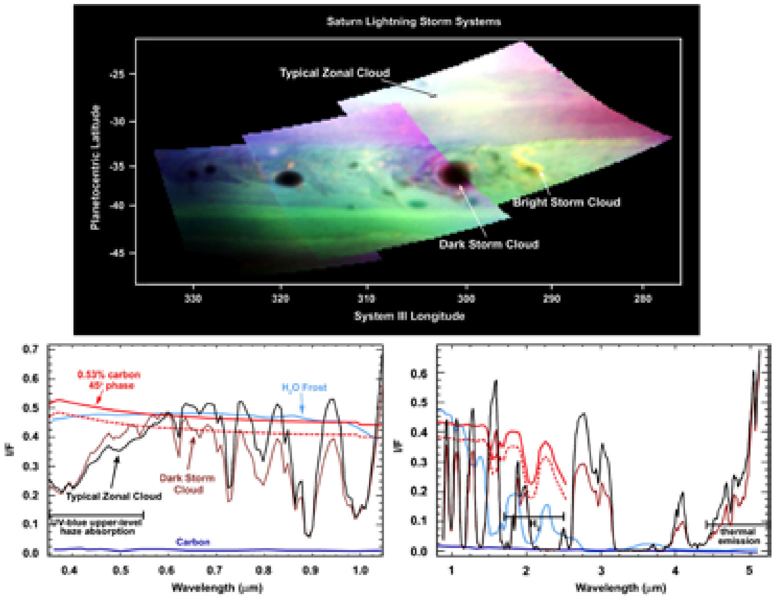
torm expanded into the midst of the "pearls" in

cal mechanism responsible for both the pearls
festations of the exceptional vertical dynamics
tude where zonal motions have the maximum

clouds, likely vortices found in von Kármán
d by winds disrupted by an obstacle, in this case
s. The storm appeared as convection increased
egion.



Images and Spectra of Clouds on Saturn Associated with Thunderstorm Activity

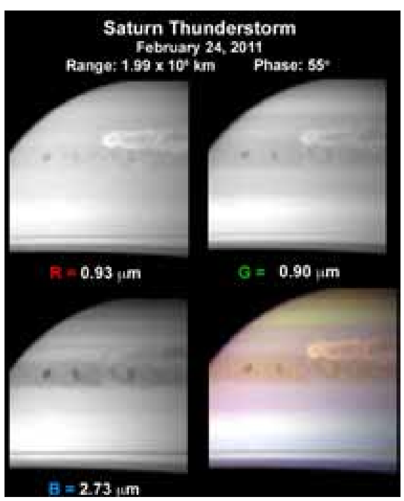


Upper panel: False color image depicts the 0.93 μm atmospheric continuum (red), the 0.90 μm atmospheric methane absorption (green), and the 2.73 μm atmospheric continuum (blue). Dark storm clouds (e.g., arrow pointing to dark region) are unusually dark at both continuum wavelengths.

Lower panels: VIMS spectra of a dark storm cloud (brown) and a more typical cloud (black) are shown in I/F units, as acquired by the instrument's visual channel (left panel) and near-infrared channel (right panel).

Northern Storm near 35° North Latitude

First detected by Cassini's Visual and Infrared Mapping Spectrometer (VIMS) on 5 December 2010, the immense (500 times larger than any other storm detected by Cassini) storm has been studied in detail since February 2011.



"Storms of this magnitude seem to occur at about the same time every Saturnian year," Baines said, "and only six have been detected since 1876. This is the first one to be examined by infrared imagery."

Thermal imaging showed that the rising gases generated by the storm cooled a 5,000 km wide swath of the atmosphere by 7° to 9° Kelvin.

*Above figure: **Red:** 0.93 mm Continuum -- **Green:** 0.90 mm High Alt. Clouds -- **Blue:** 2.73 mm Ammonia absorption -- **Yellow clouds:** NH_3 ice (yellow is the lack of blue. Blue is gone because the material is absorbing the ammonia ice) Absorption at 2.73 mm indicates ammonia ice. A combination of ammonia ice comprised of large particles indicates extremely powerful convective storm.*

Mark Hobson