Cassini CHARM Presentation: Saturn Science

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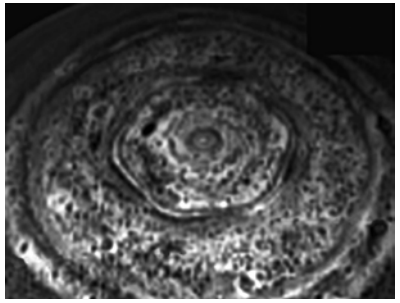
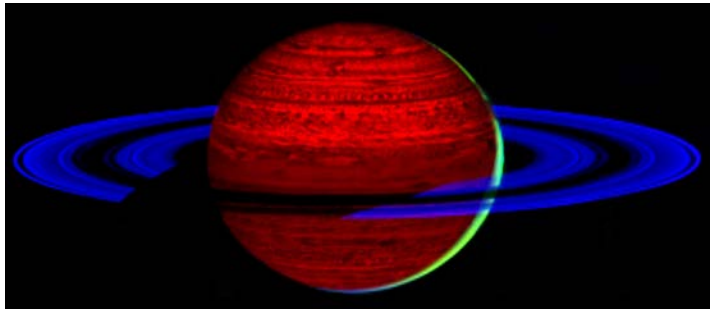
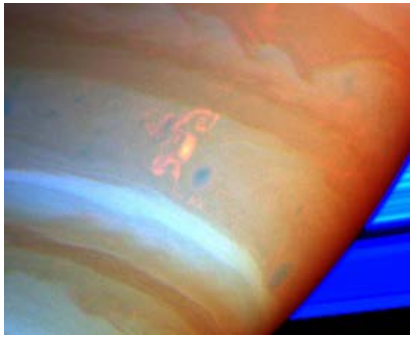
Saturn Discipline Group

Equinox Mission Science Objectives: Saturn

- Search for non-zonal components of the magnetic field and the internal rotation of Saturn;
- Use IR and microwave to image the deep atmosphere below the visible clouds;
- Study changes in the clouds, temperatures, composition, and winds during the transition to northern spring;
- Measure the evolution and life cycles of newly discovered atmospheric features;
- Follow seasonal and solar cycle-induced changes in the auroras;
- Increase coverage of the northern hemisphere as it emerges from behind the rings;
- Monitor lightning storms, which are rare occurrences, when and if they appear.

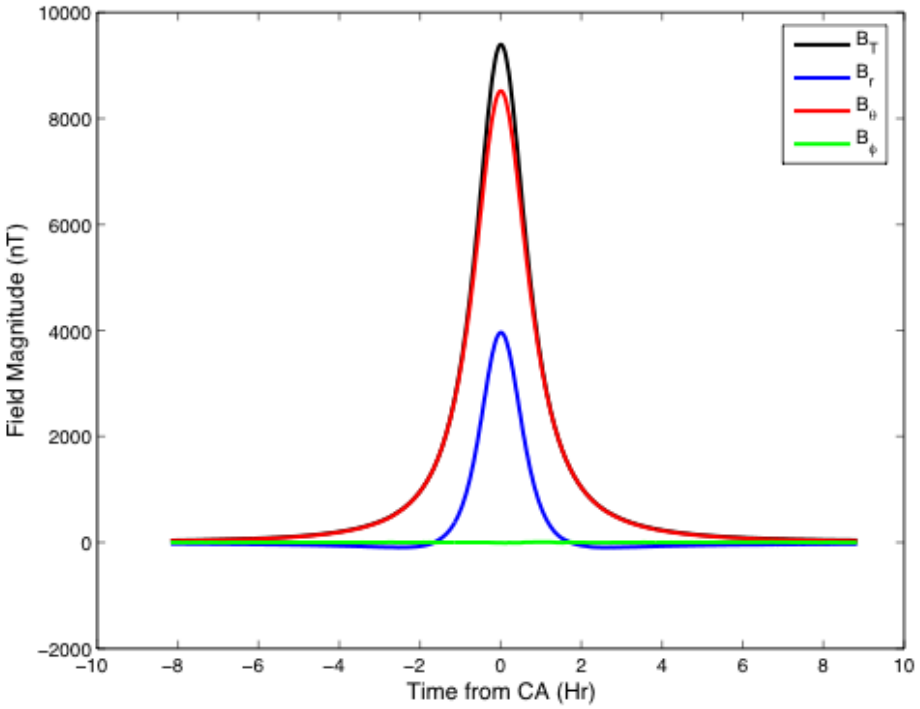


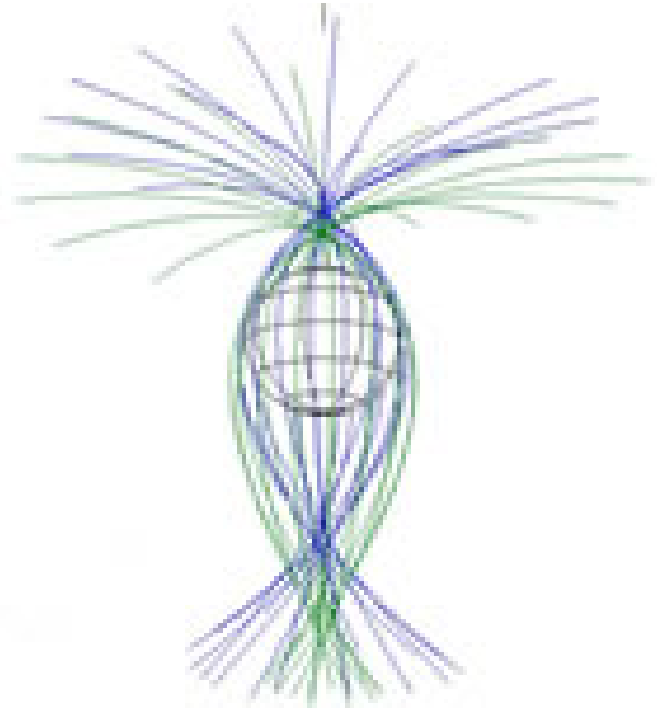




Magnetic Field and Rotation

- Search for non-zonal components of the magnetic field and the internal rotation of Saturn

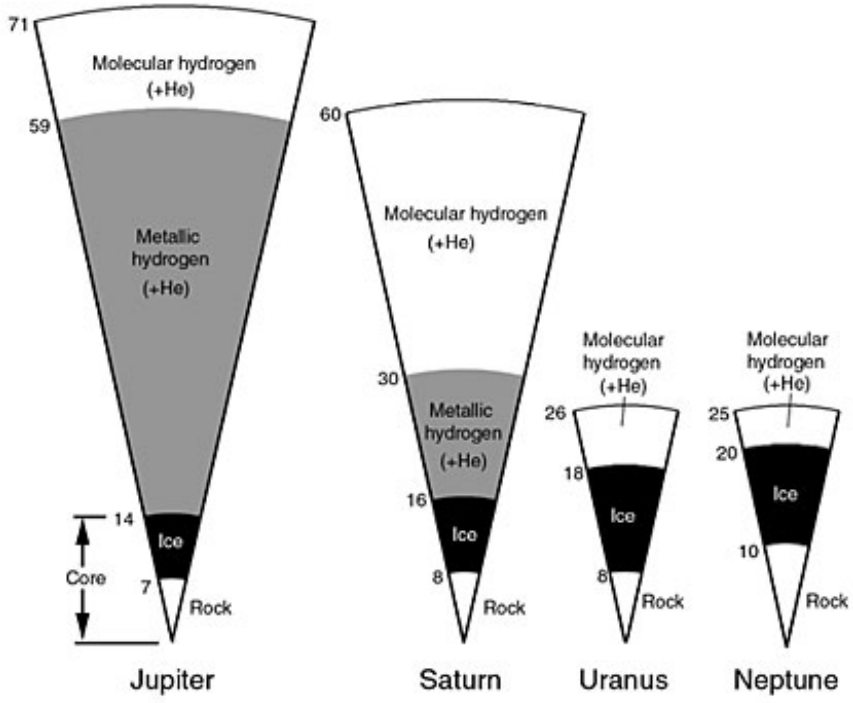


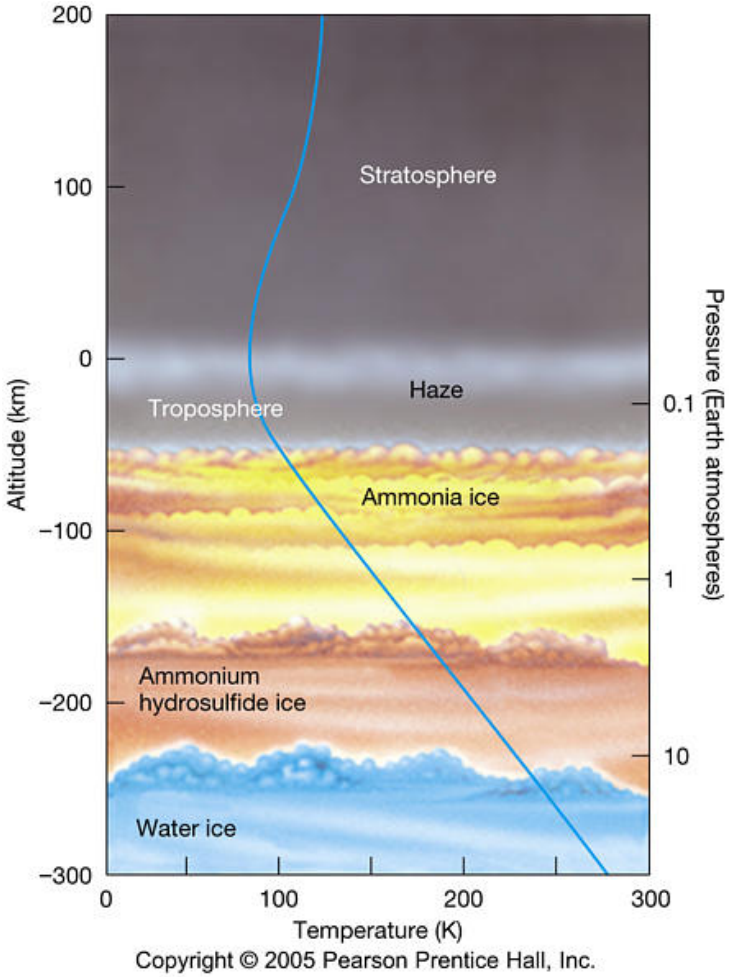


- **Left:** Symmetric field in 2004. **Right:** Juno-type orbits in 2017

Saturn's Bulk Composition

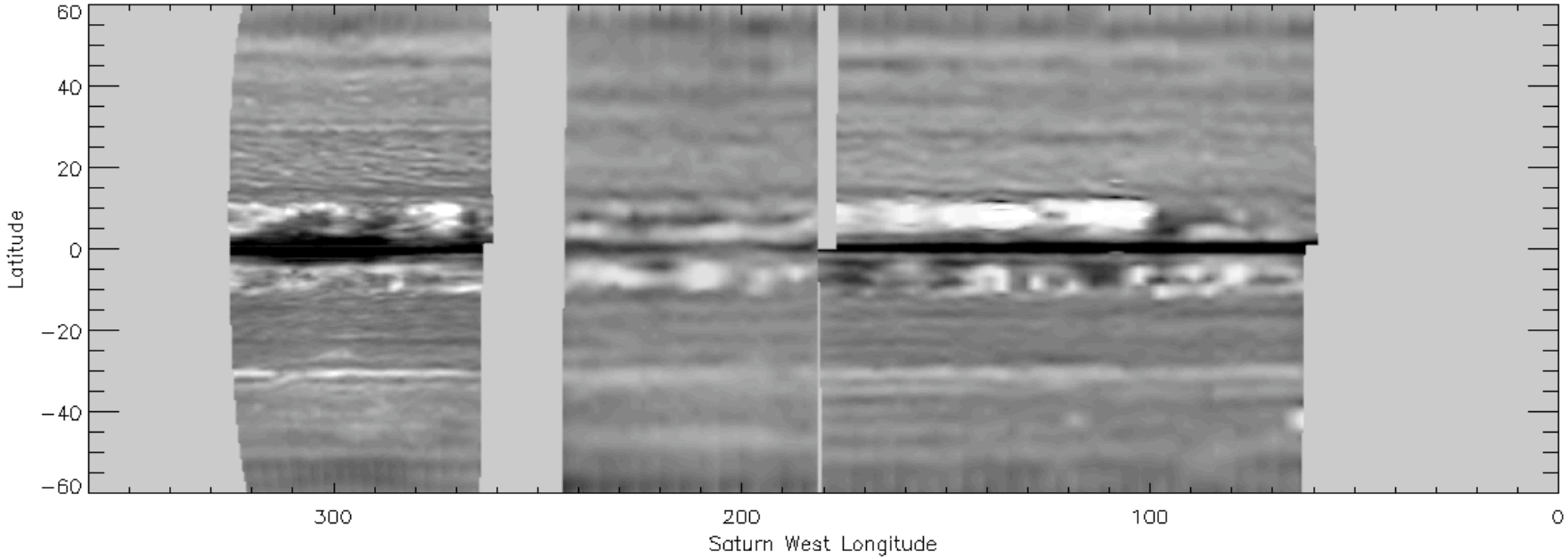
Determine He/H_2 from molecular mass m:
T/m from ray bending, T from IR sounding





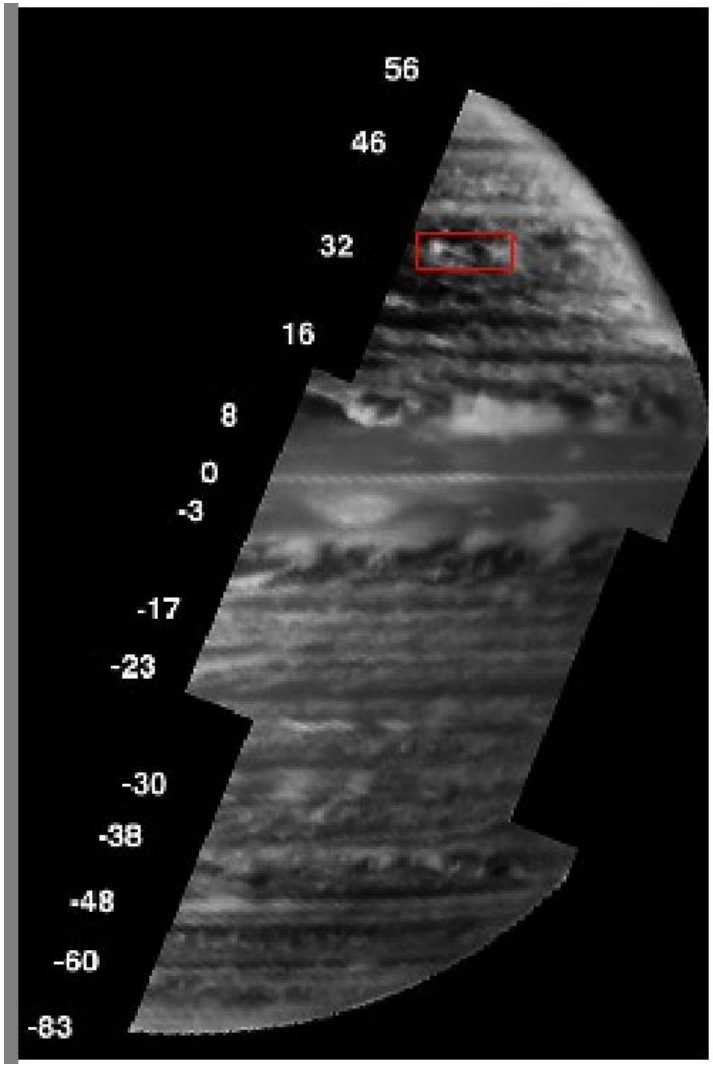
Deep Atmosphere

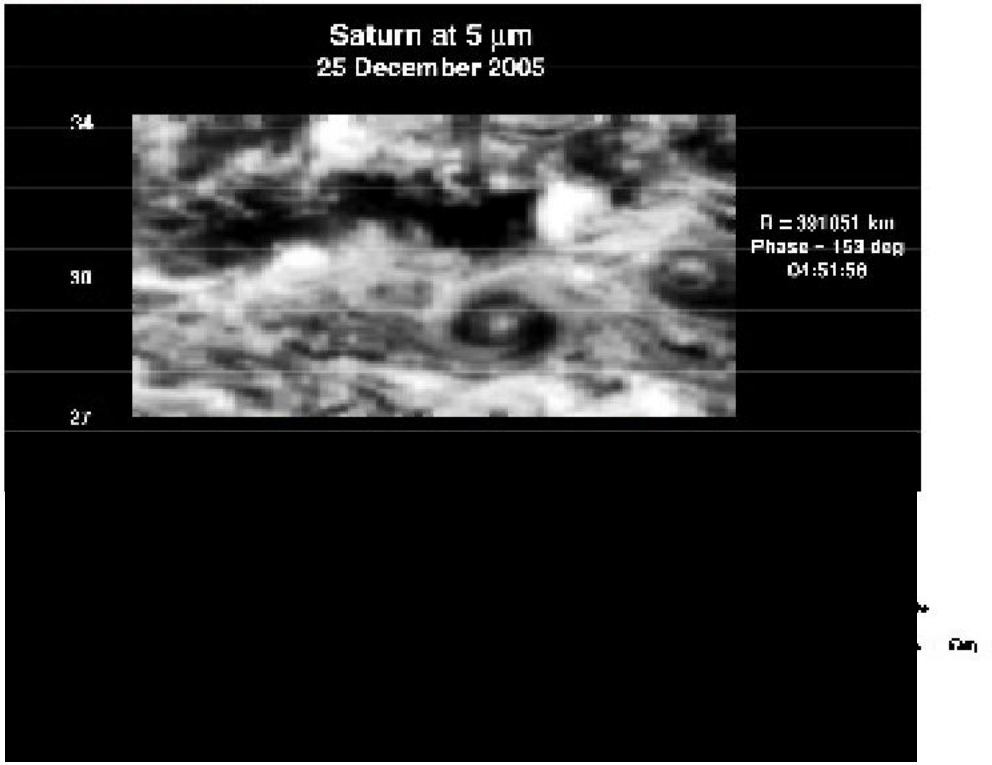
- Use IR and microwave to image the deep atmosphere below the visible clouds



Thermal emission at 2 cm – a new view of Saturn. Bright areas are regions of low ammonia abundance ($\Delta T_b \approx 15$ K), possibly a sign of downwelling. Dark band at equator is due to the rings

Peering below the Clouds





5-micron imaging in thermal emission reveals deep clouds below the visible layers

Transition to Northern Spring

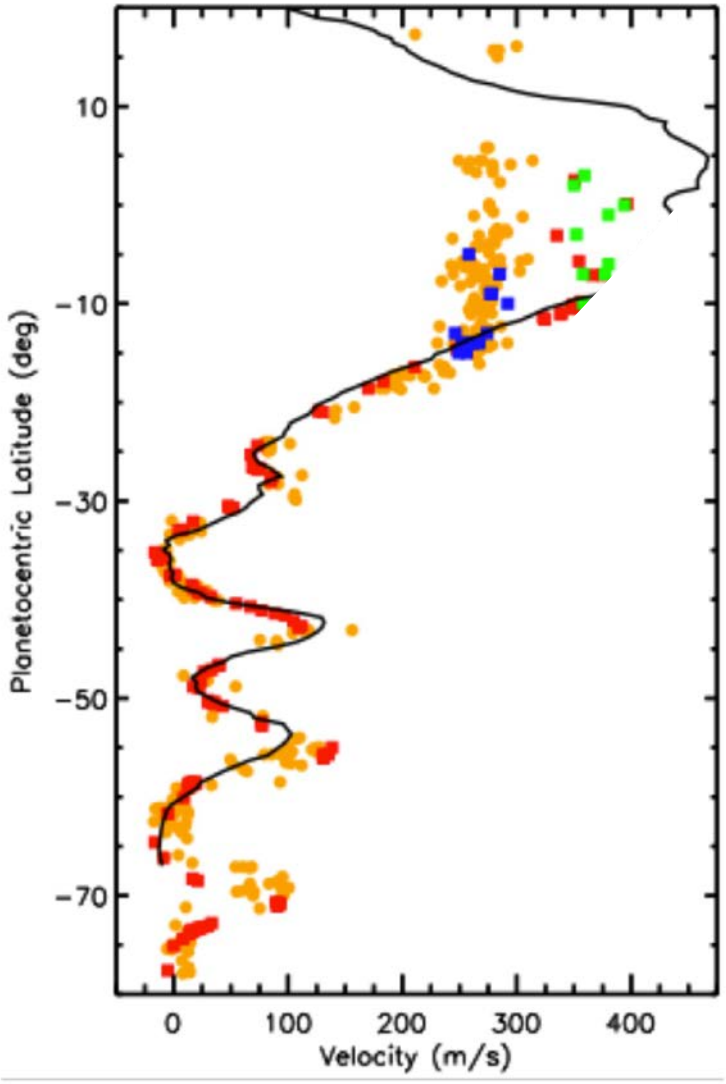
- Study changes in the clouds, temperatures, composition, and winds during the transition to northern spring

Winds are measured relative to the internal rate of rotation

Are the winds changing, or are we seeing wind shear?

Black line: Voyager. Yellow: HST

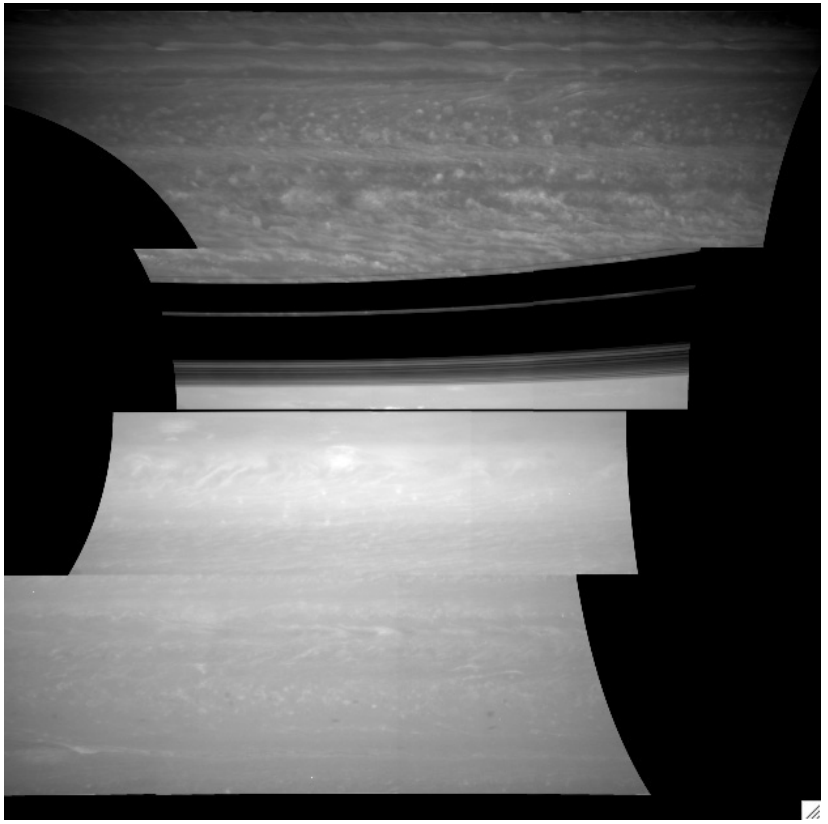
Red & Green: ISS Cassini continuum
Blue: ISS Cassini methane



North vs South near Equinox

Cloud texture, a measure of dynamic activity, in north is different from that in south as equinox approaches

Tilted structures (north in this image) and tilted velocity vectors are evidence of momentum transfer between eddies and jets

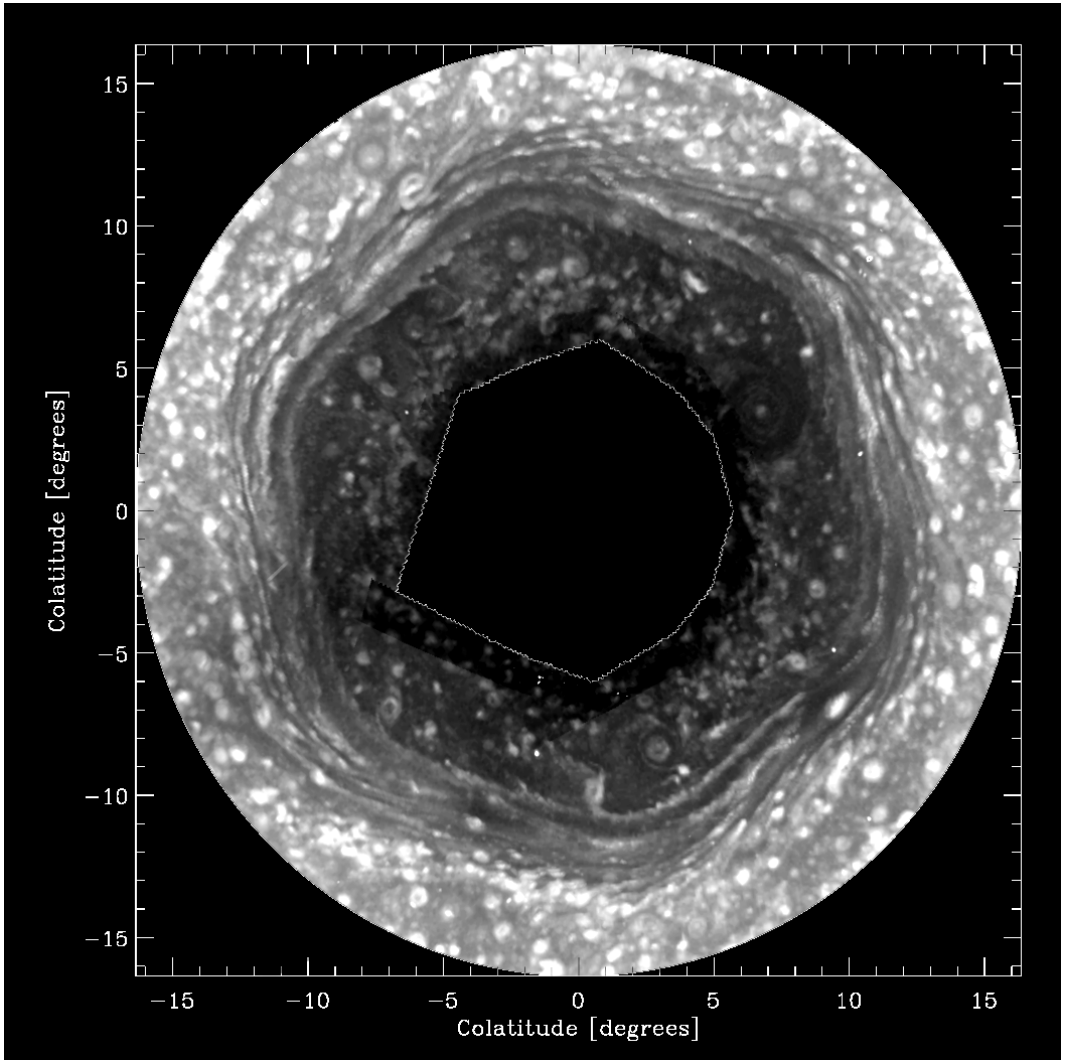


Hexagon Re-discovered after 30 yrs

- Measure the evolution and life cycles of newly discovered atmospheric features

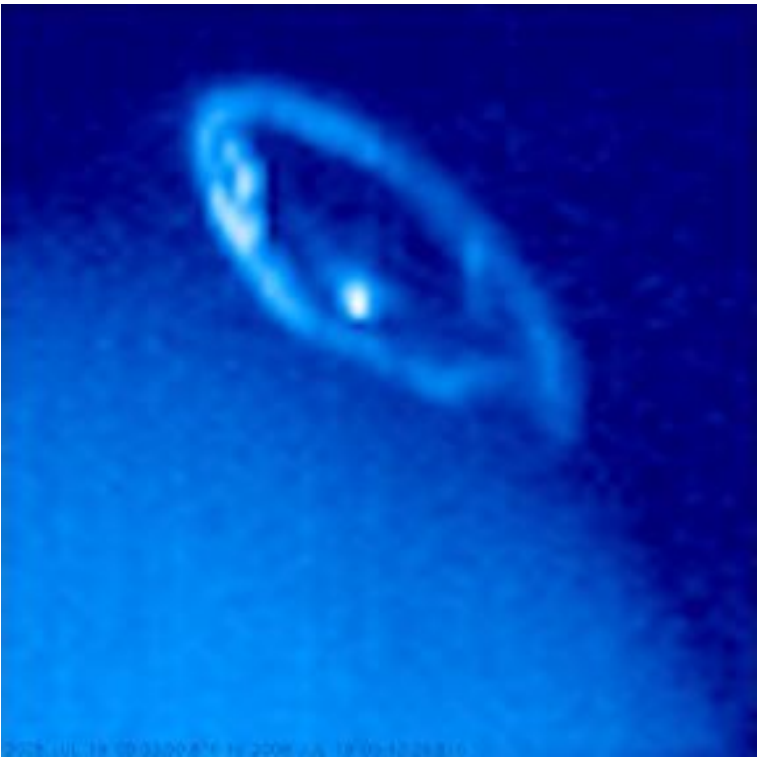
Pattern is stationary in Voyager reference frame

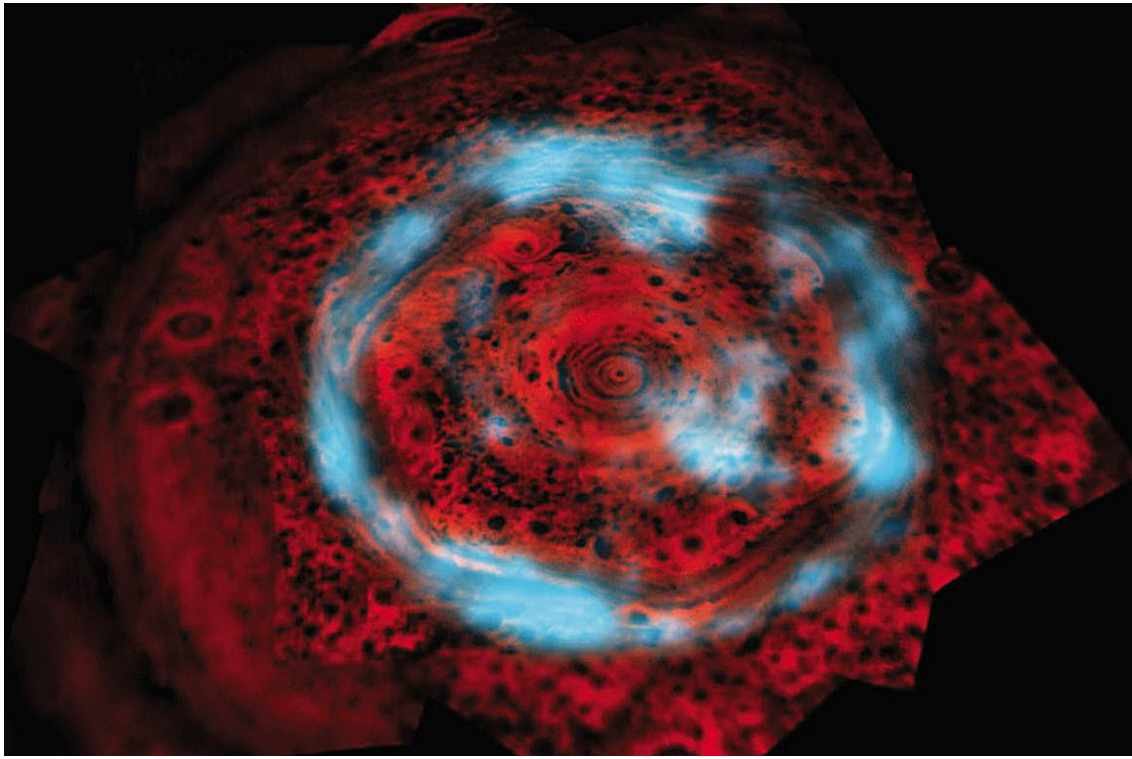
Flow is 100 m/s to east relative to the pattern



Changes in the Auroras

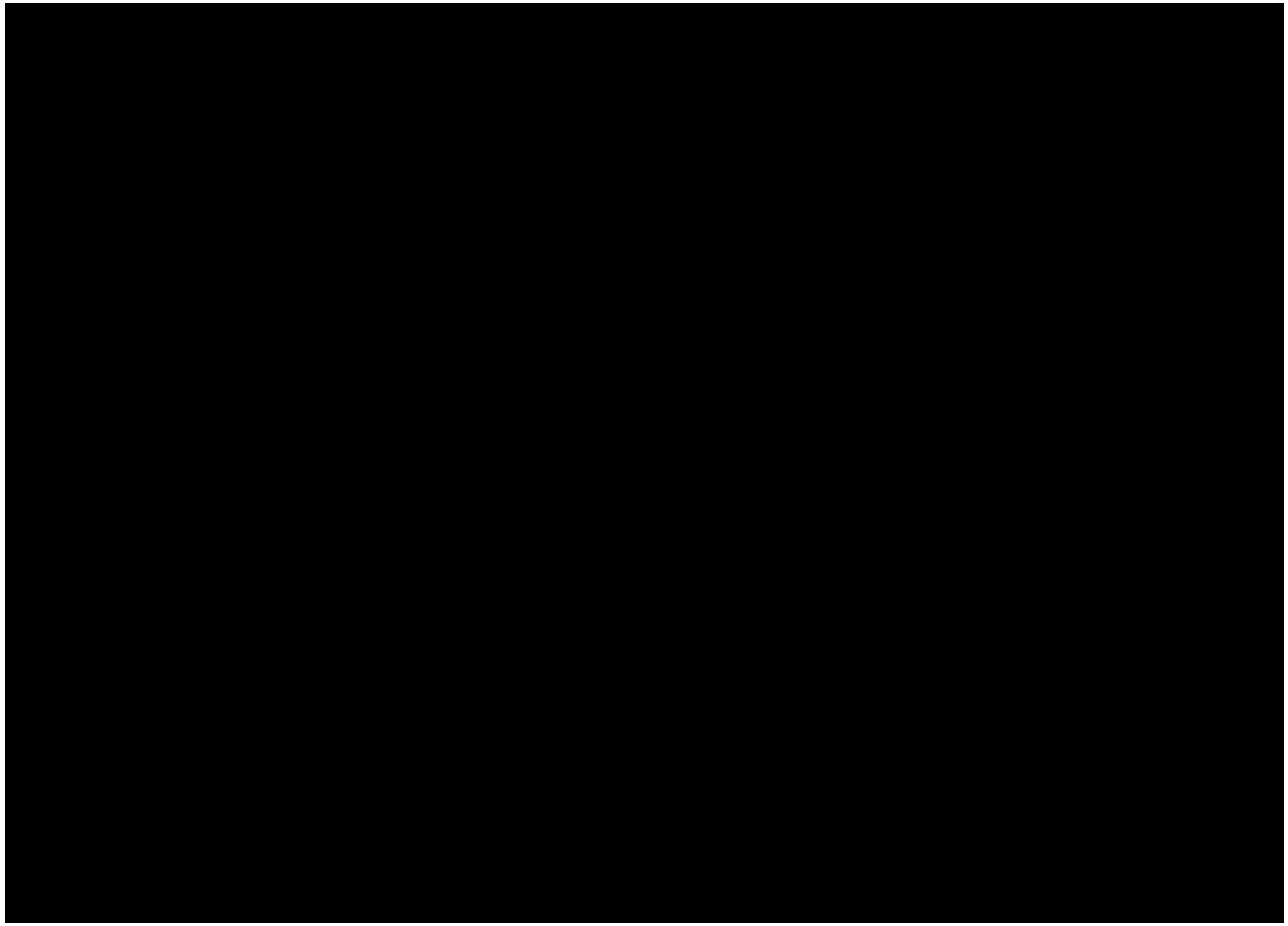
- Follow seasonal and solar cycle-induced changes in the auroras





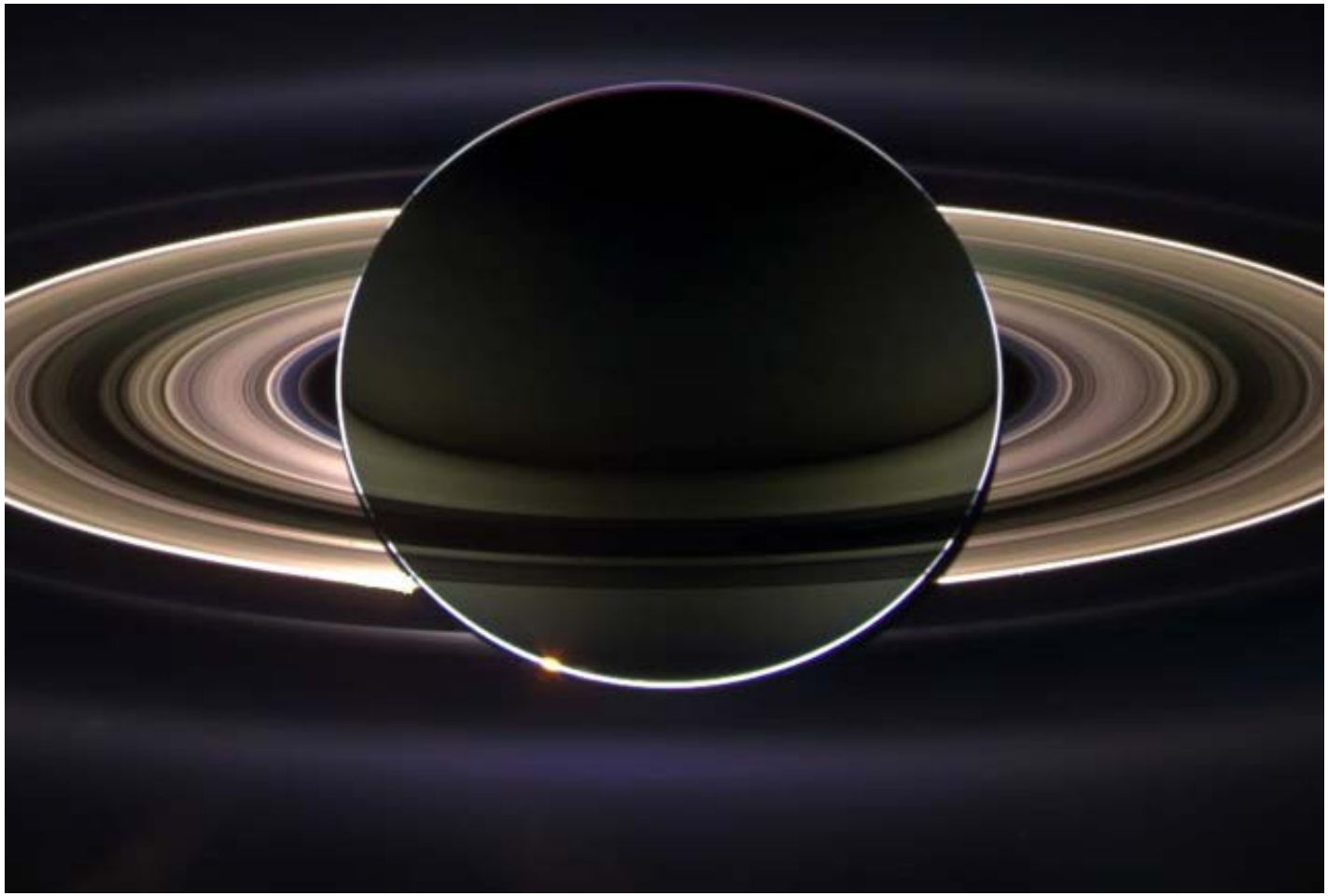
- **Left**: UV aurora. **Right**: IR aurora (blue) above hexagon (red)

Aurora Movie in Visible Light



Aurora going over the limb (80 hours), stars in background

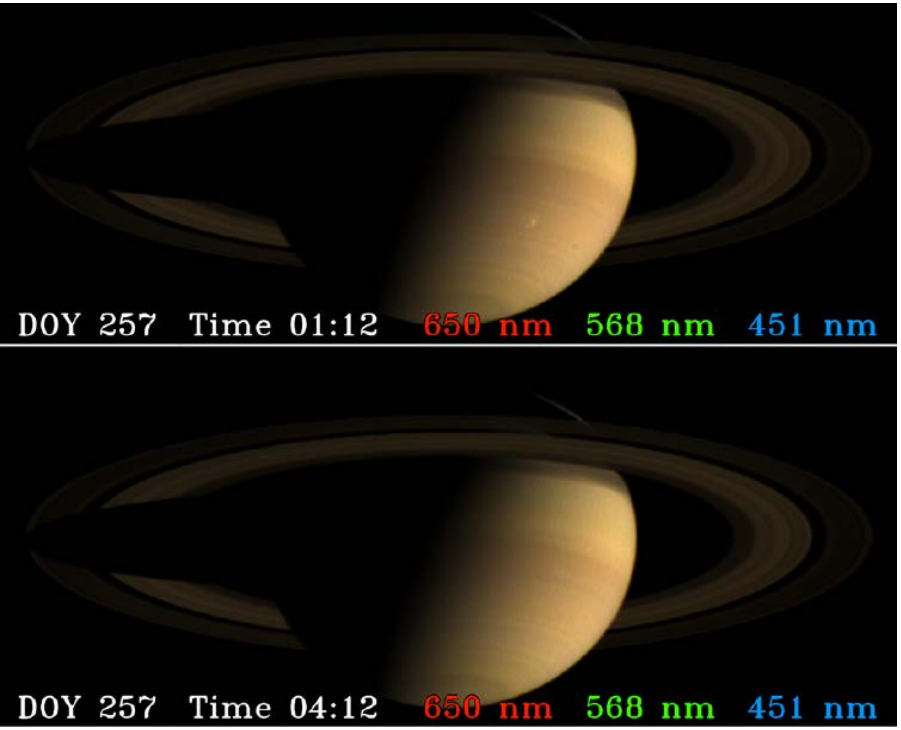
Ring Shine on the Night Side

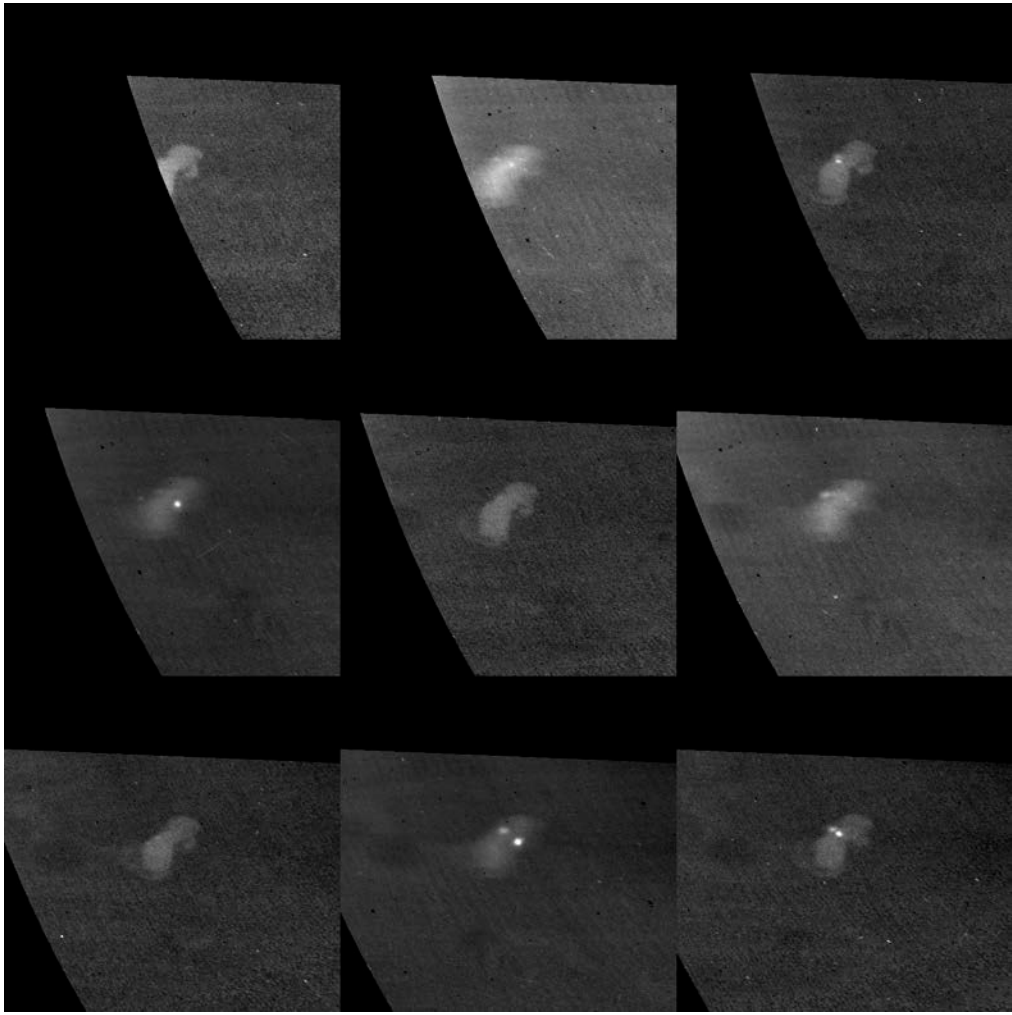


It never gets dark at night, except during equinox, which is the best time to look for lightning

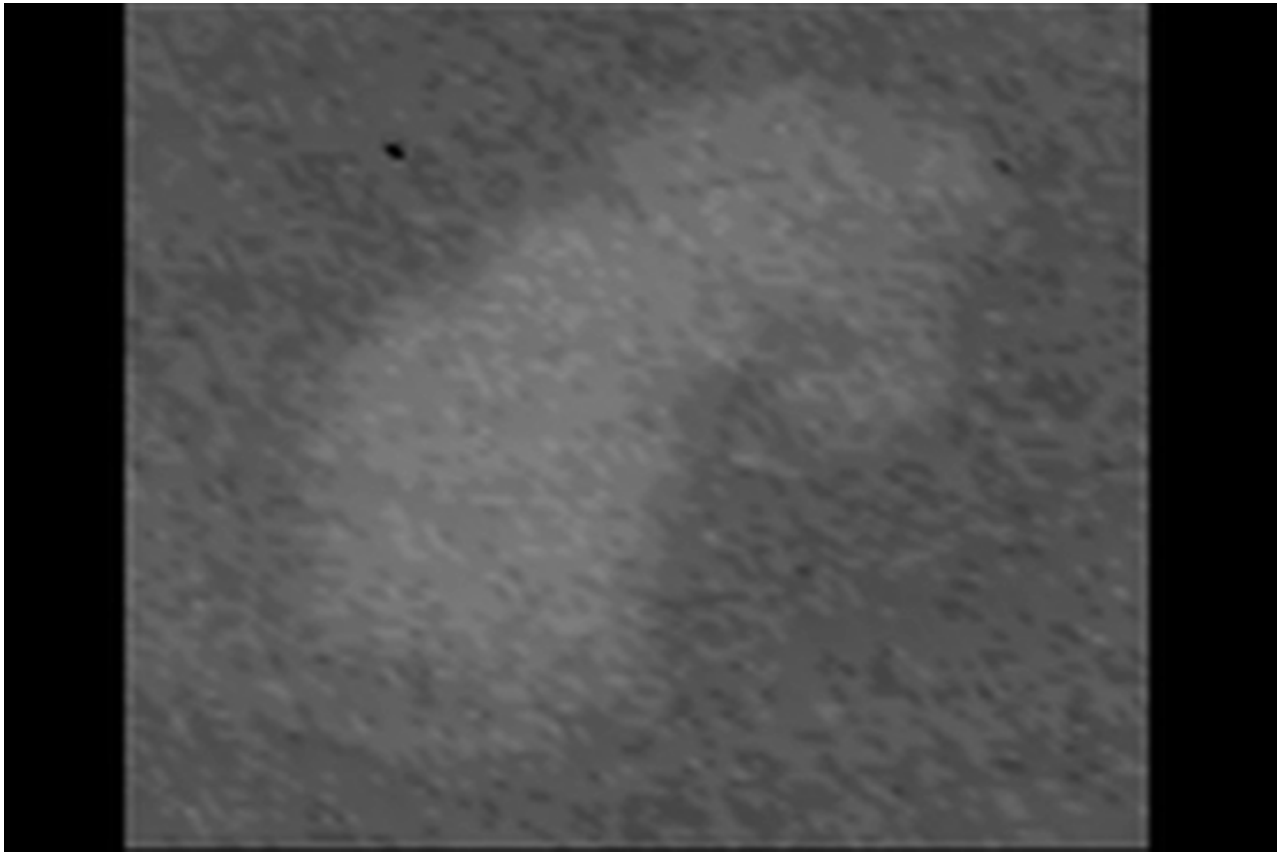
Seeing the Lightning

- Monitor lightning storms, which are rare occurrences, when and if they appear



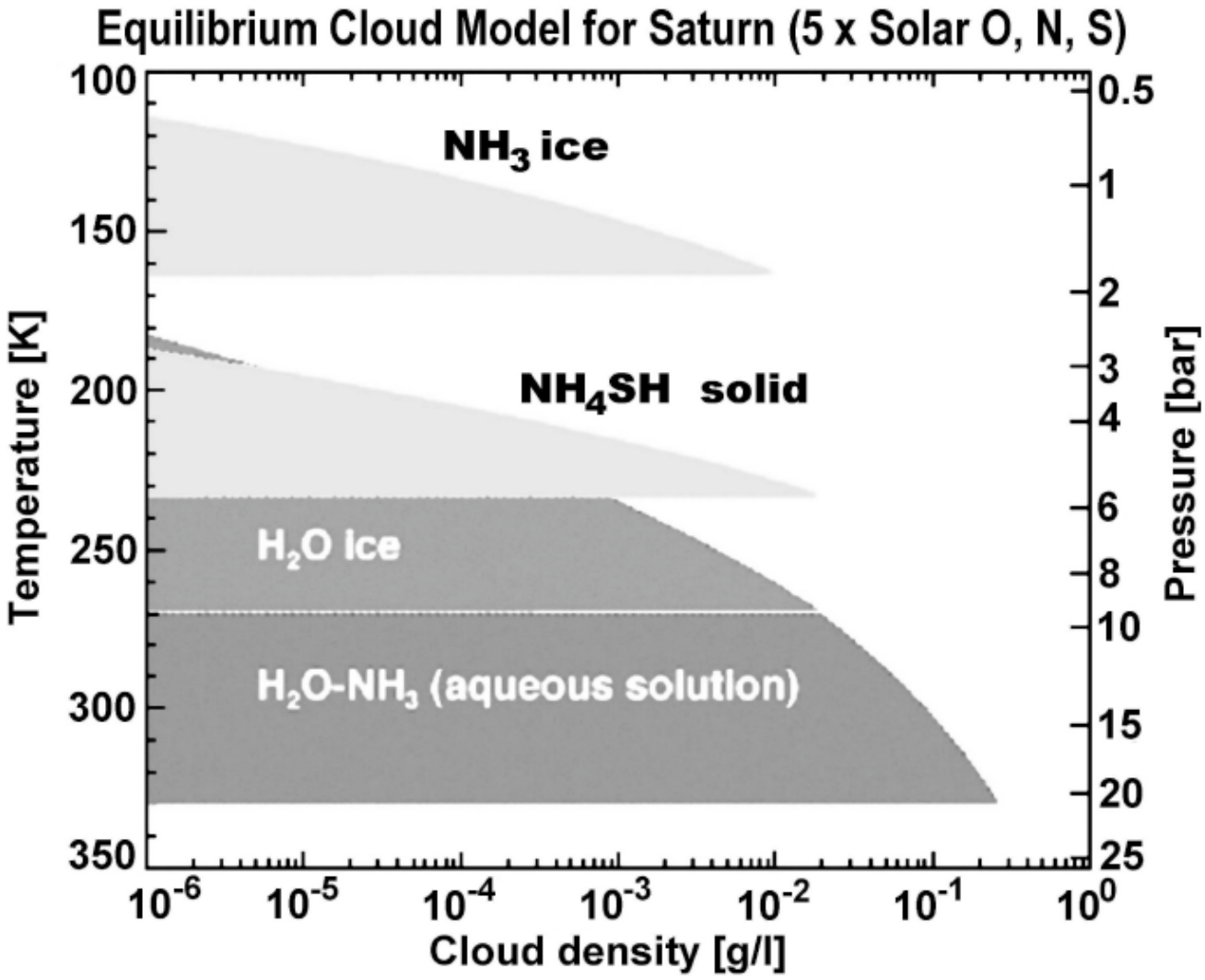


Light and Sound Synchronization



Flashes recorded by camera have exposure times up to 2 minutes
Radio signals are used to determine the exact times of the flashes

Lightning Depth from Width



Depth (km)

0

100

200

300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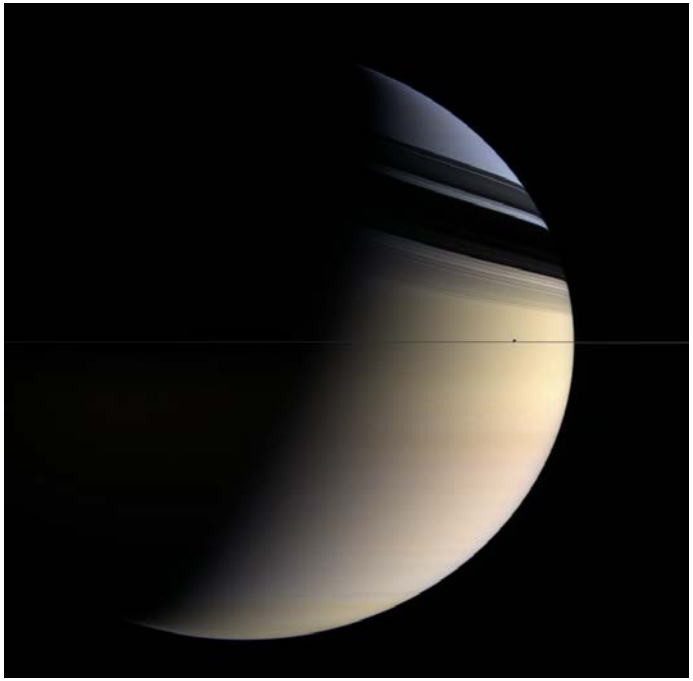
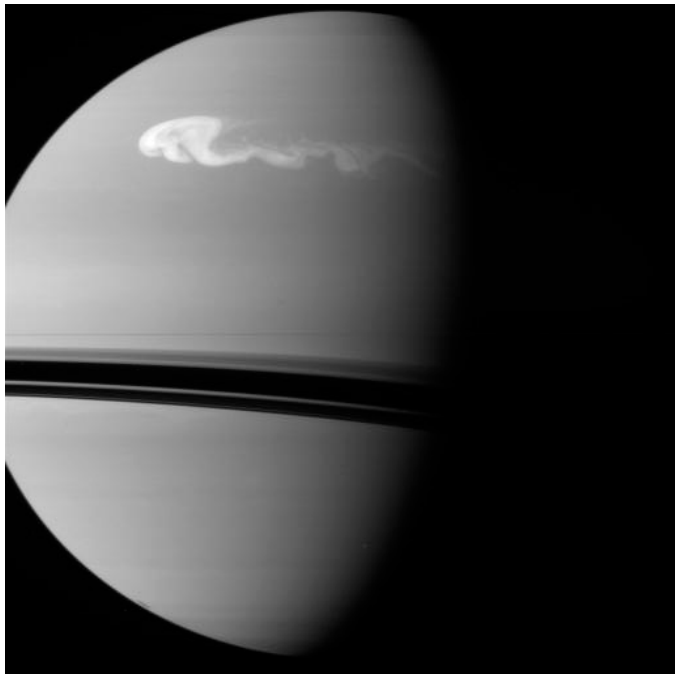
Northern Hemisphere in Sunlight

- Increase coverage of the northern hemisphere as it emerges from behind the rings

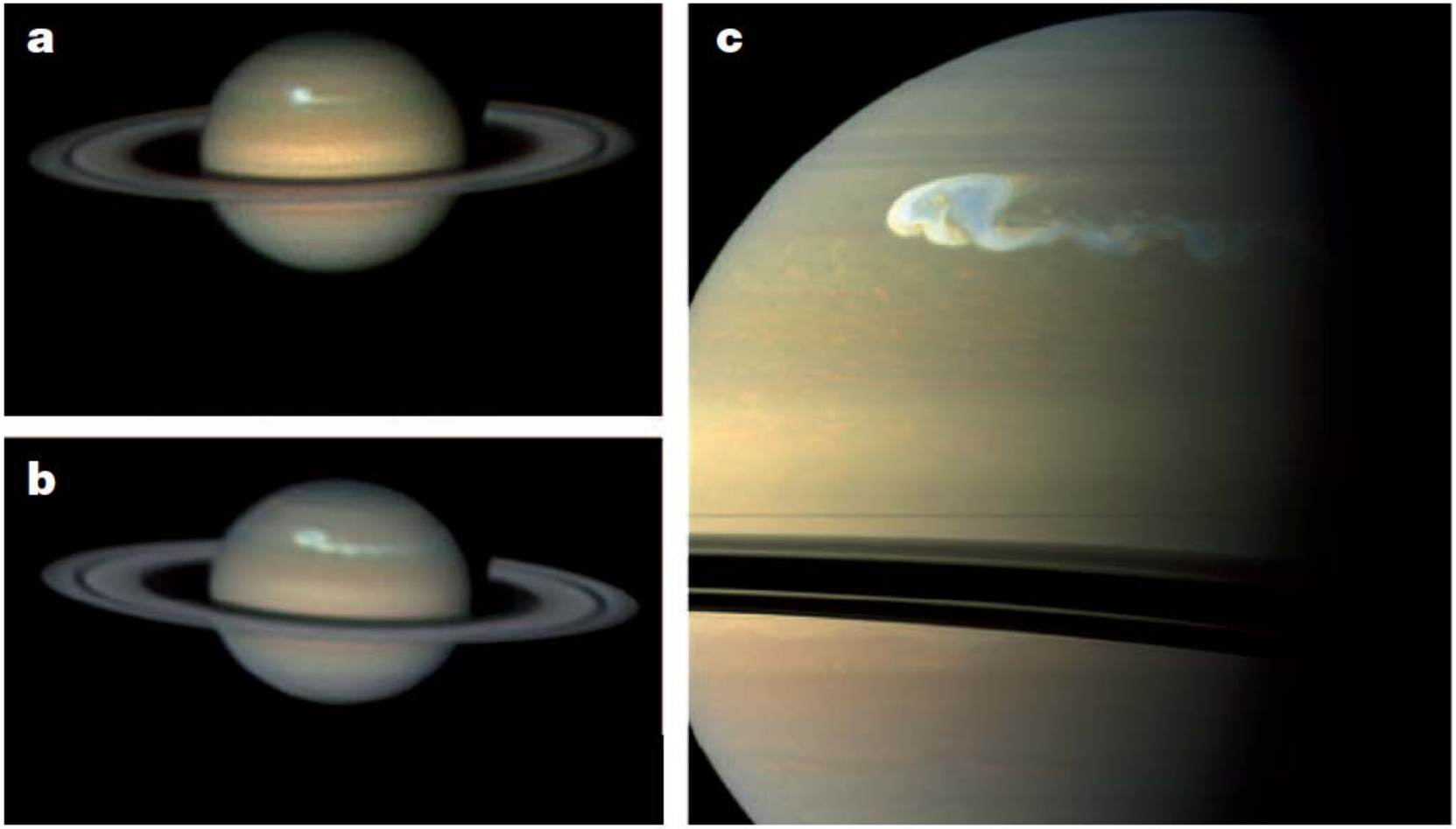




- **Left:** Blue skies in winter. **Right:** Giant lightning storm in spring

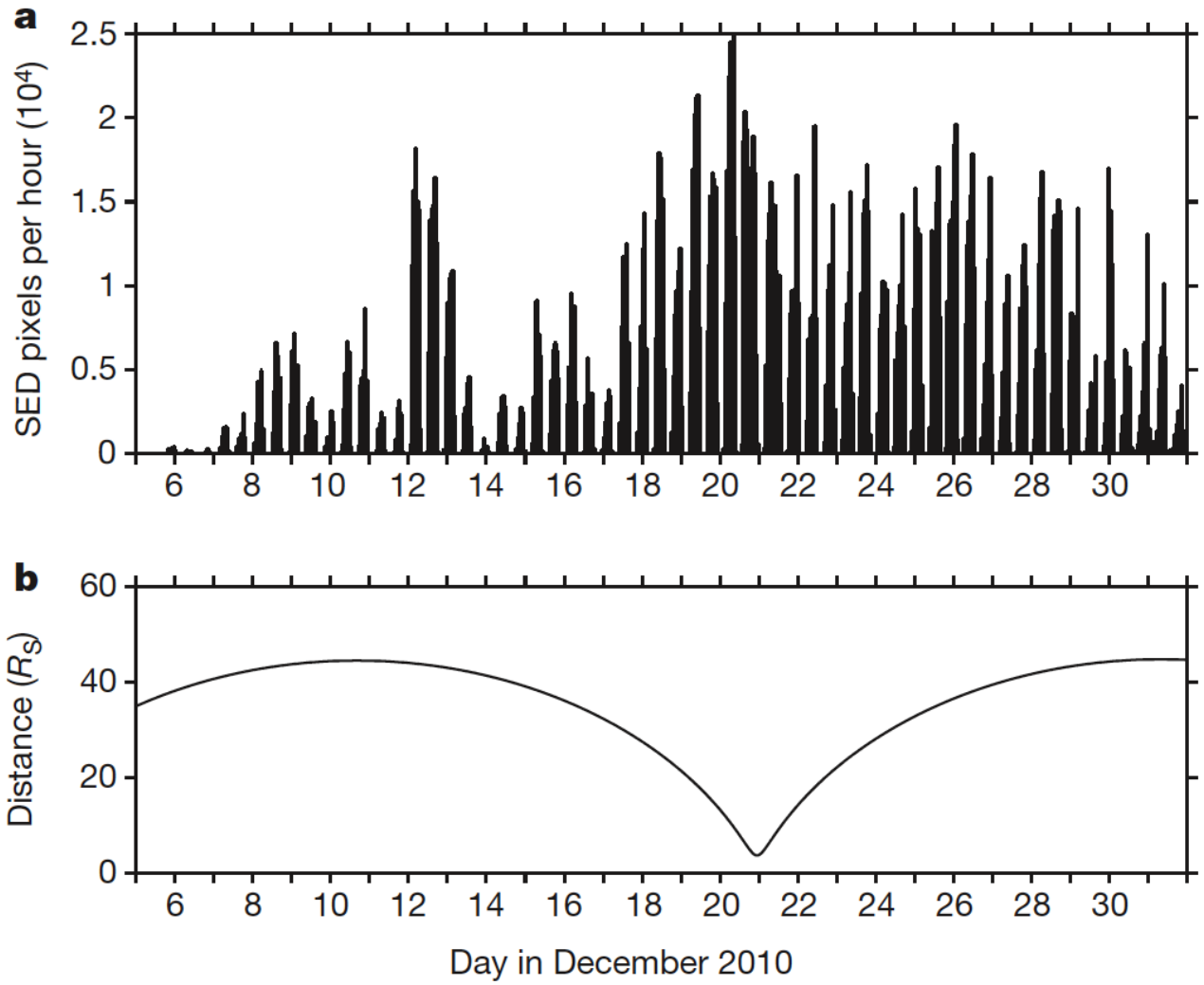
  Once in 20-30 year eruptions, unlike weather on Jupiter or Earth

Going Strong since Dec 5, 2010

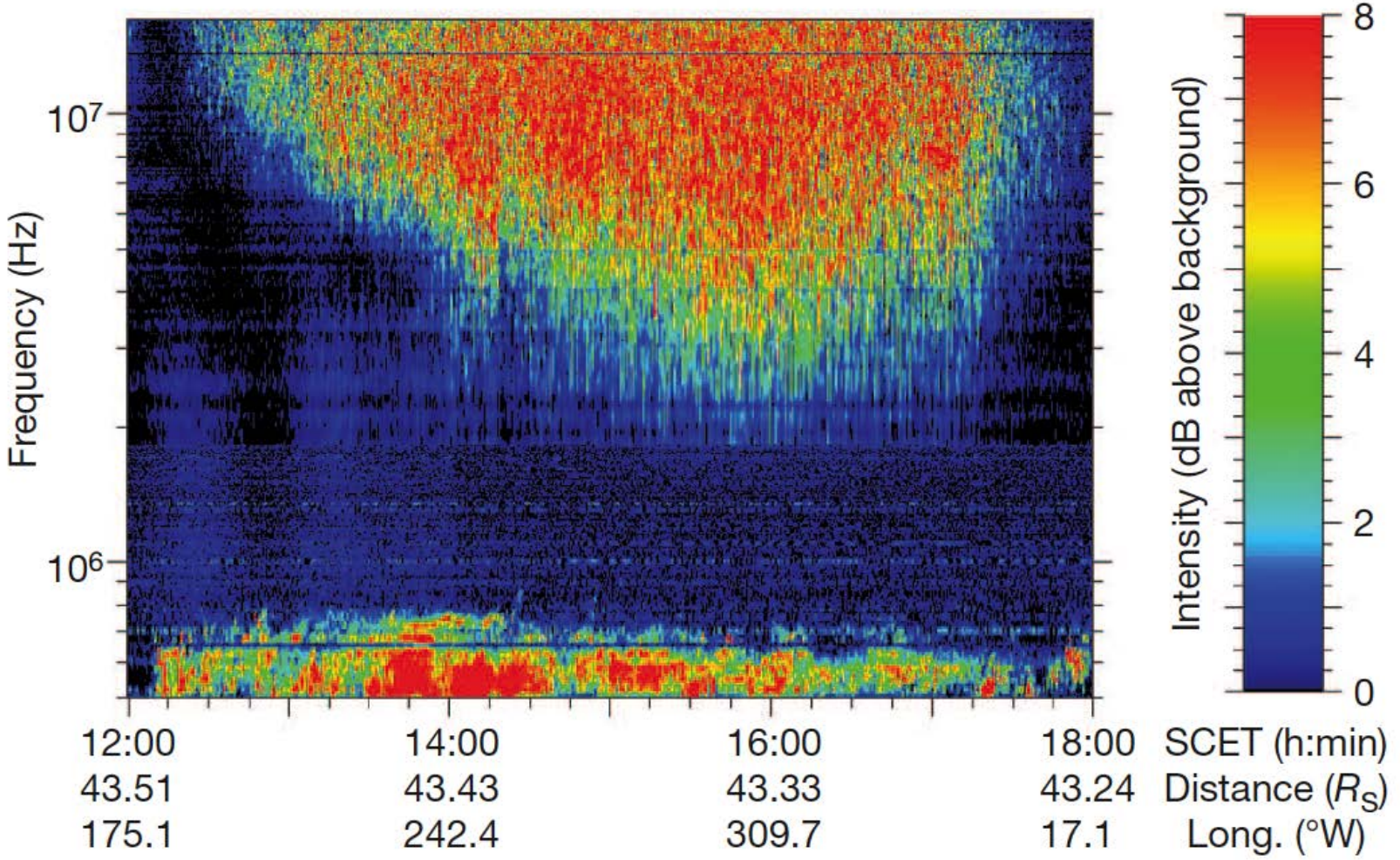


Earth-based images (a) Dec 13, (b) Dec 22; Cassini image (c) Dec 24

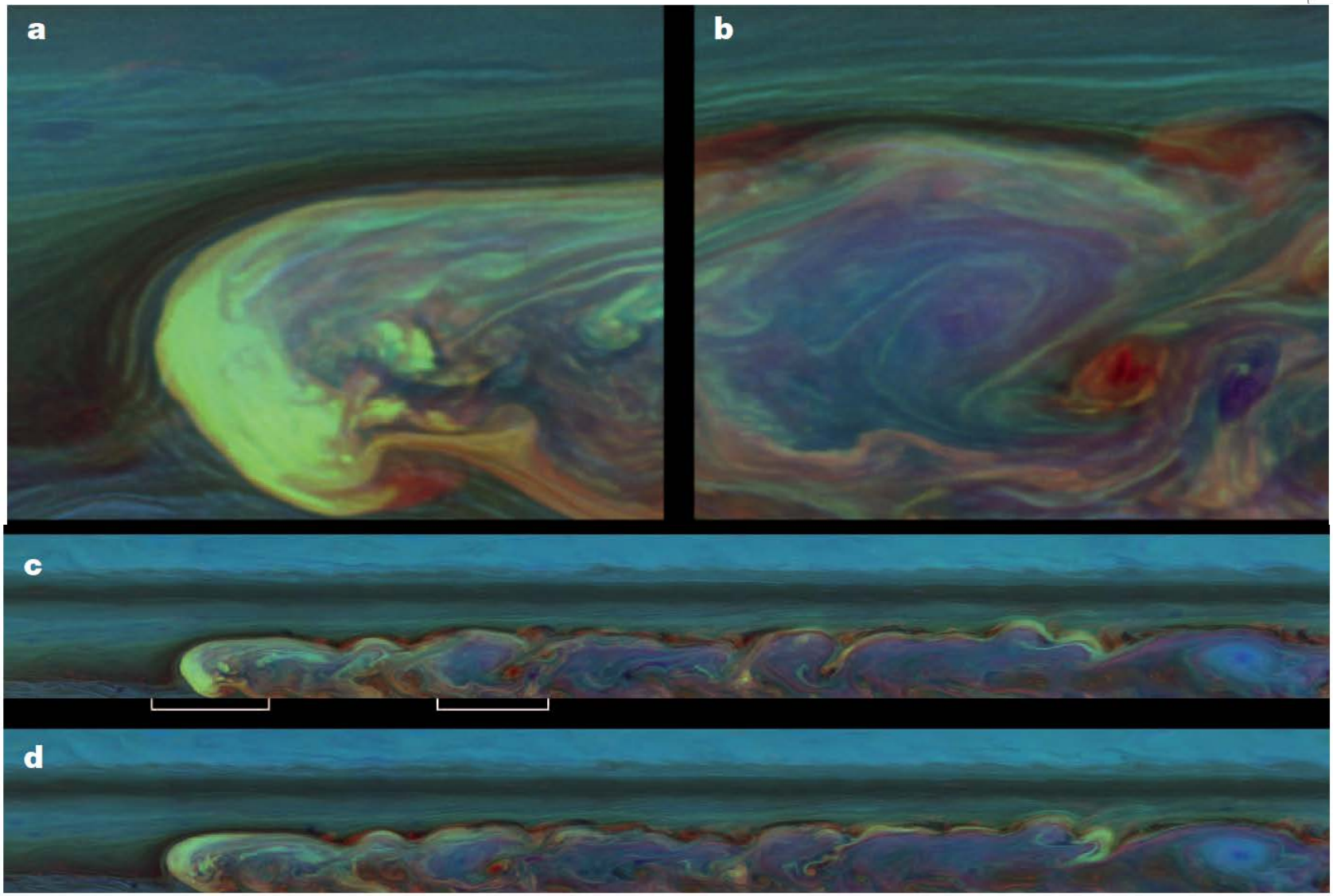
Radio Episodes last for ½ Rotation



Six Hours as the Storm Passes By



False Color Reveals Cloud Heights



Stratospheric Temperature Change