Cassini CHARM :

Saturn's 2010 Storm

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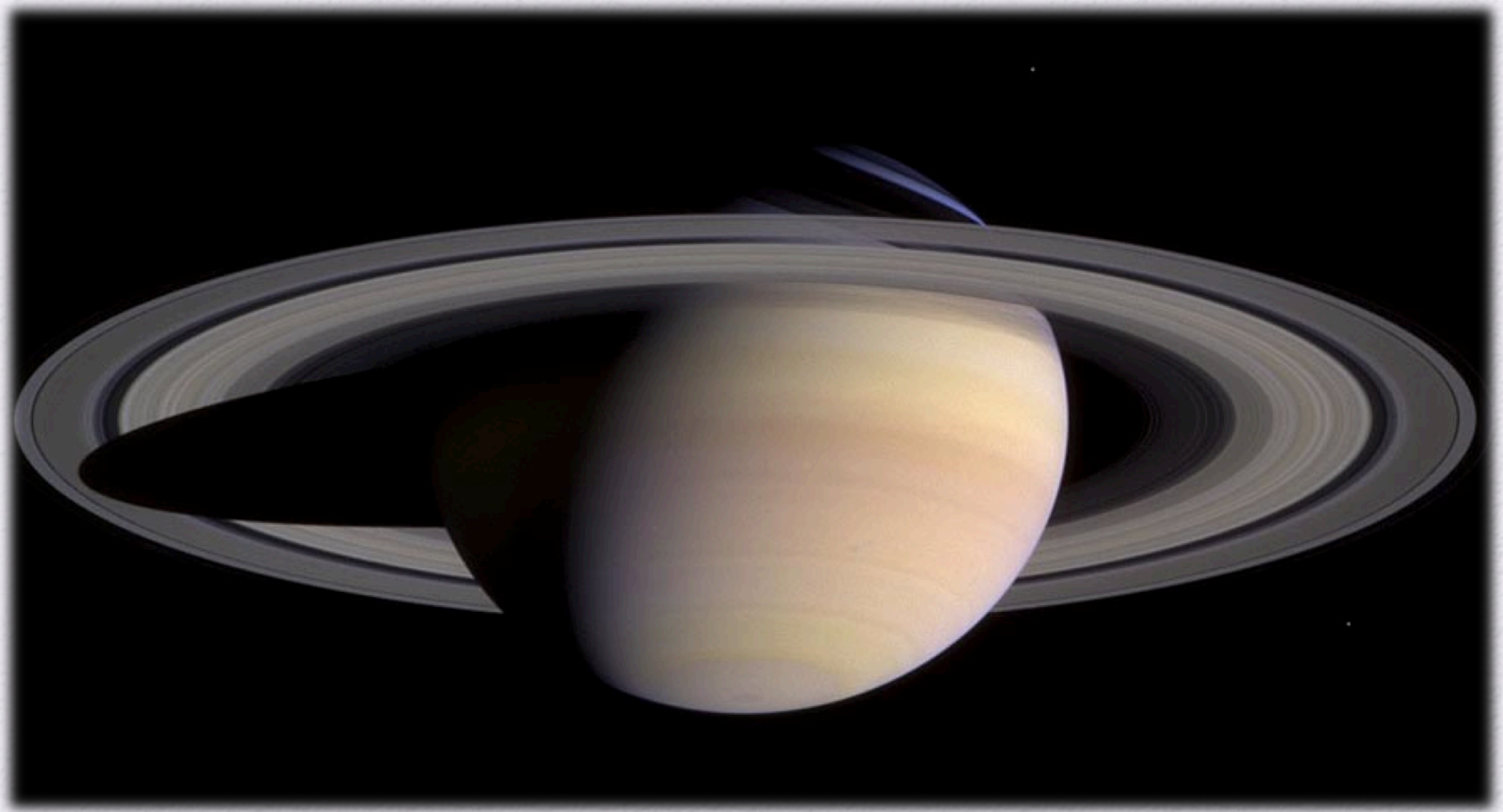
Image credit: ISS, SSI, JPL, ESA, NASA; Color Composite: Jean-Luc Dauvergne

Saturn – A Solar System Beauty

- Haze in the upper troposphere gives Saturn a more muted appearance compared with Jupiter's swirling clouds and massive storms
- A serene beauty in the solar system



History of Great White Spots

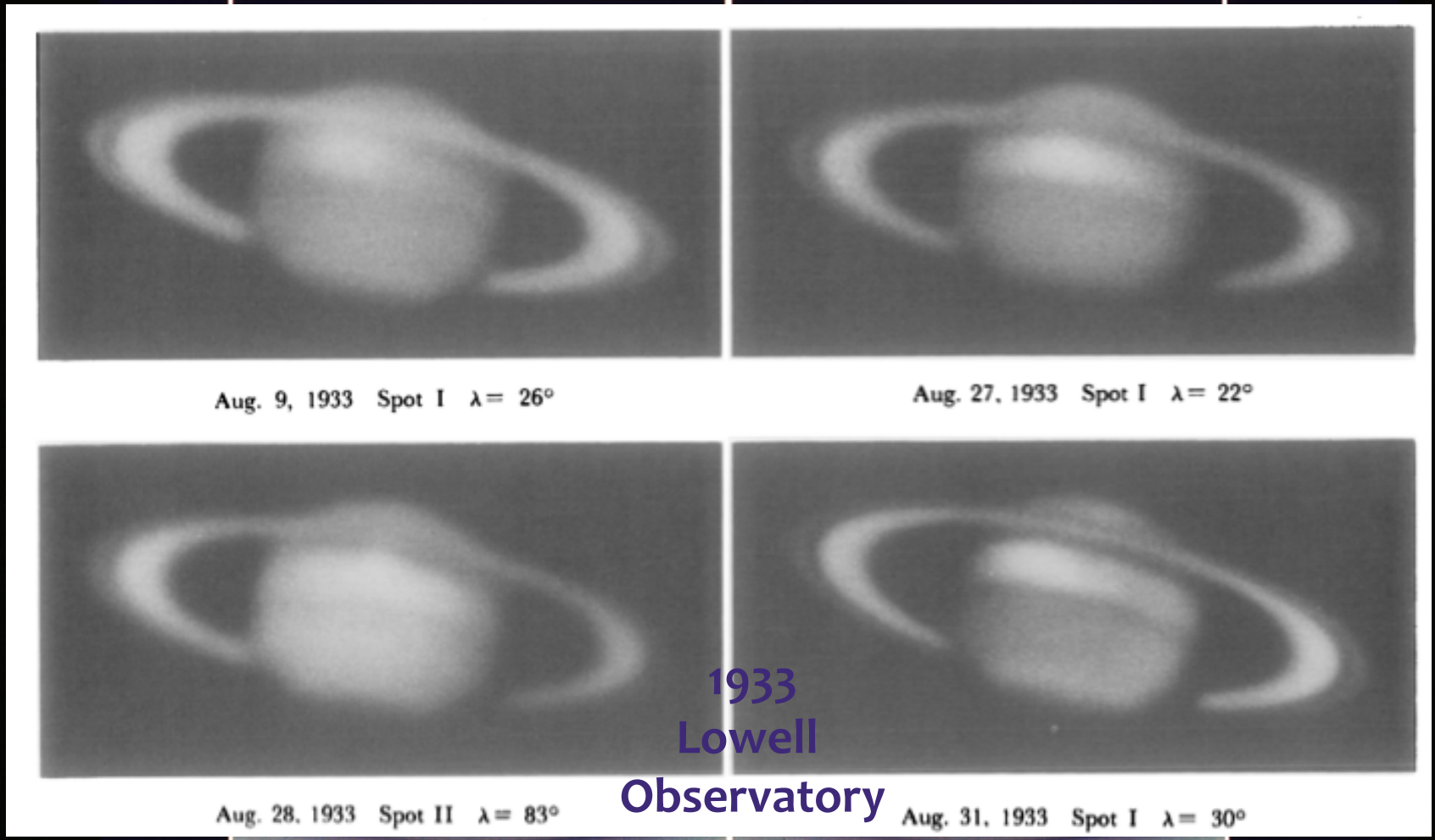
- Great White Spots (GWS) are a spectacular phenomenon unique to Saturn's atmosphere

  - Large bright white spot that quickly expands from its edges E and W until it wraps around the planet at the latitude at which it appeared

  - 1876 – Observed at 5°N by Asaph Hall
  - 1903 – Observed at 36°N by Edward Barnard
  - 1933 – Observed at 5°N by Will Hay (amateur astronomer)
  - 1960 – Observed at 58°N by JH Botham
  - 1990 – Observed at 12°N by Stuart Wiber

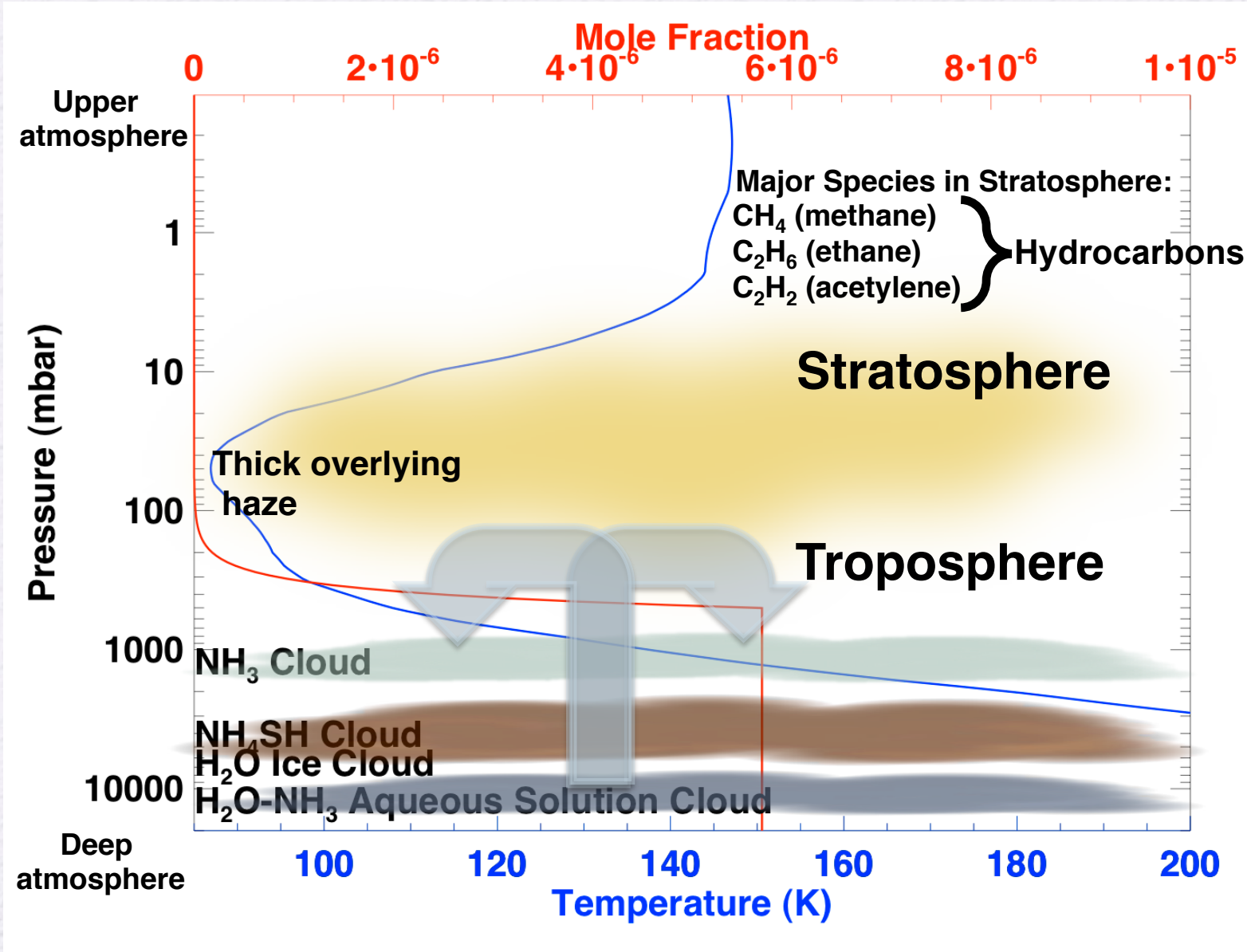
Large Storms on Saturn

once every ~30 years

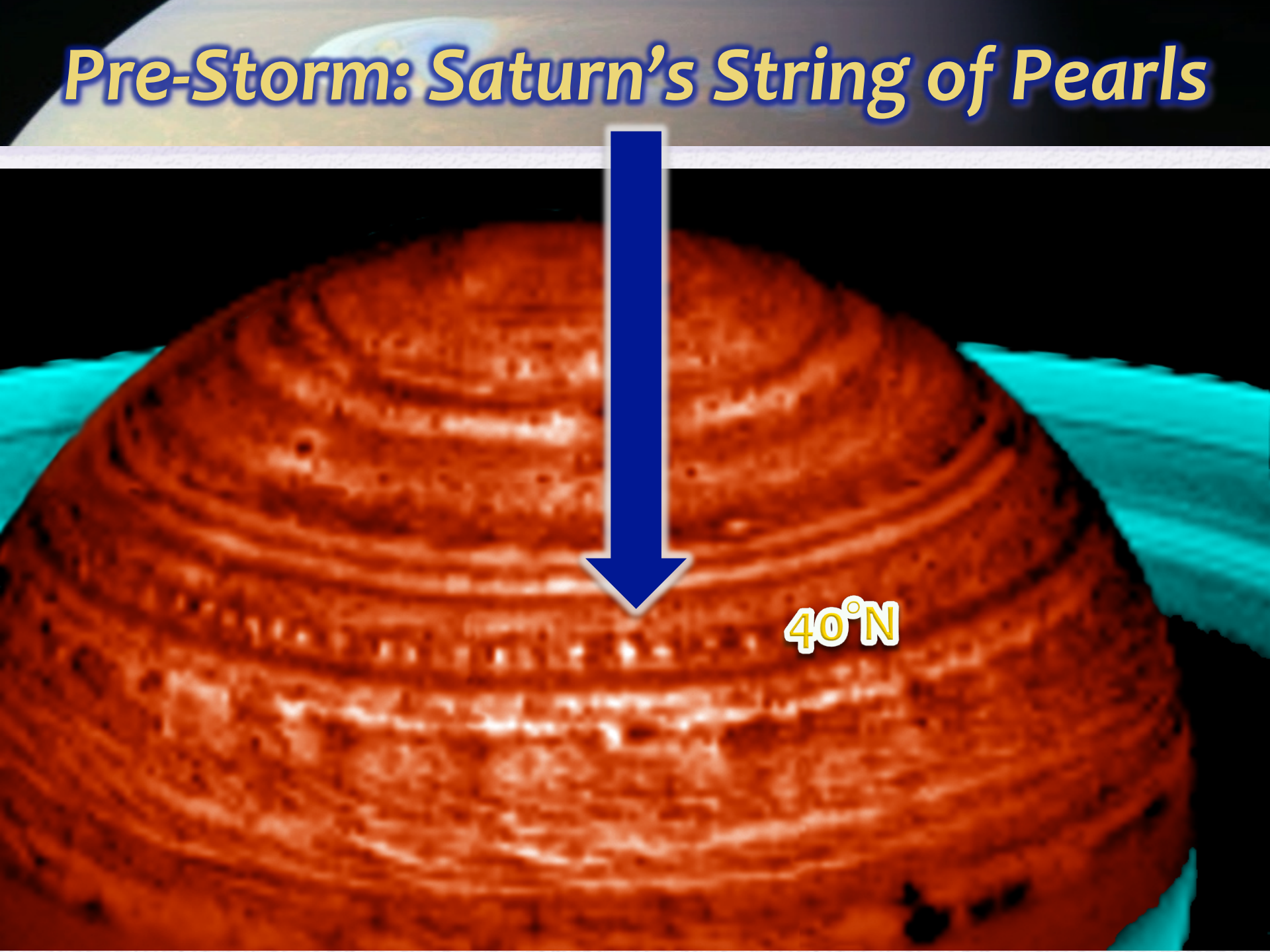


1933
Lowell
Observatory

Saturn's Atmosphere



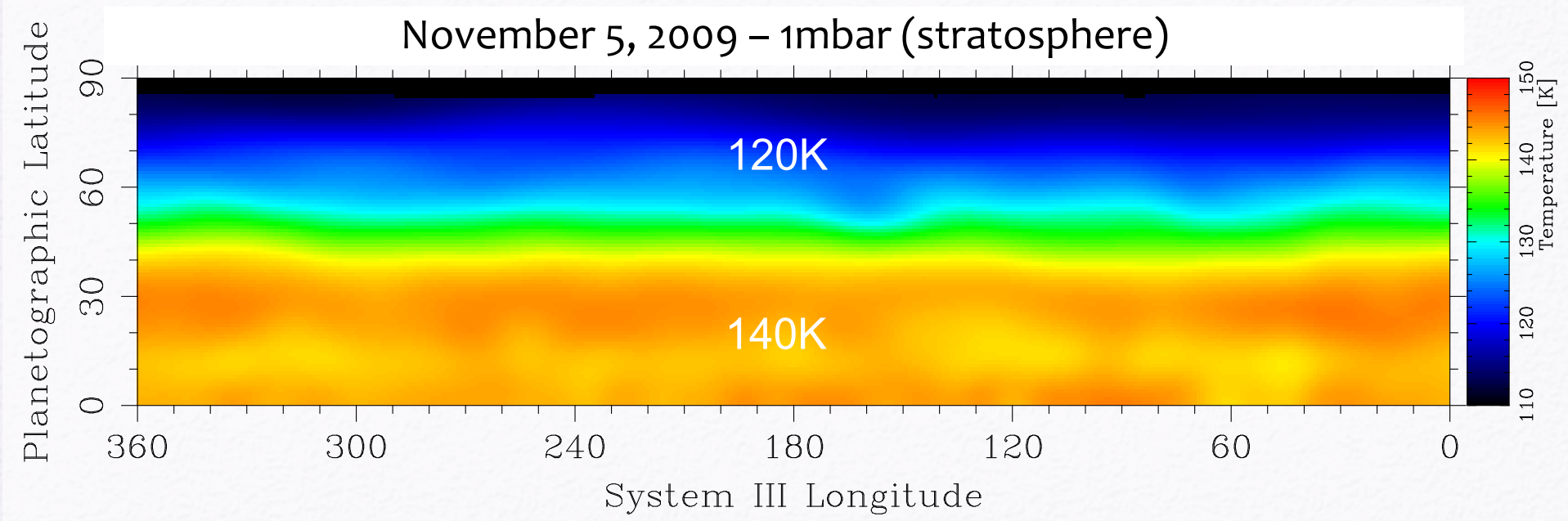
Pre-Storm: Saturn's String of Pearls



Pre-storm: Above the Clouds

Pre-storm stratosphere:

- northern hemisphere's stratosphere slowly warming after 2009 equinox
- temperatures vary from 140K near equator to as low as 110K at the northern pole
- temperature variation with longitude was VERY minimal (on the order of 2K)



Temperature map from Rich Achterberg

Saturn's Northern Explosion

Amateurs and the Pro's Work Together!

Cassini's Radio and Plasma Wave Science Instrument (RPWS) monitored the "sounds" of static in December 2010 -- indicating a storm was looming. Amateur astronomers took the first images of the initial outbreak of the storm before the sequencing for Cassini's Imaging Science Subsystem (ISS) was able to take the first images from space.

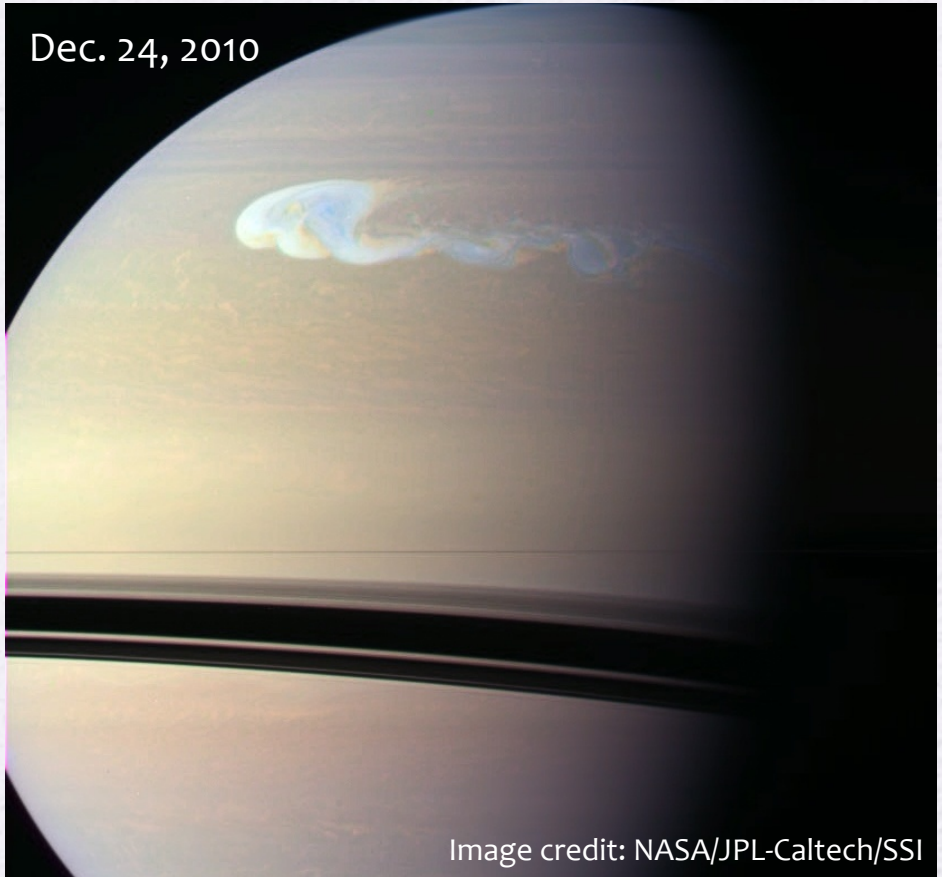
Saturn's Northern Outburst

Cassini Gets Its Turn

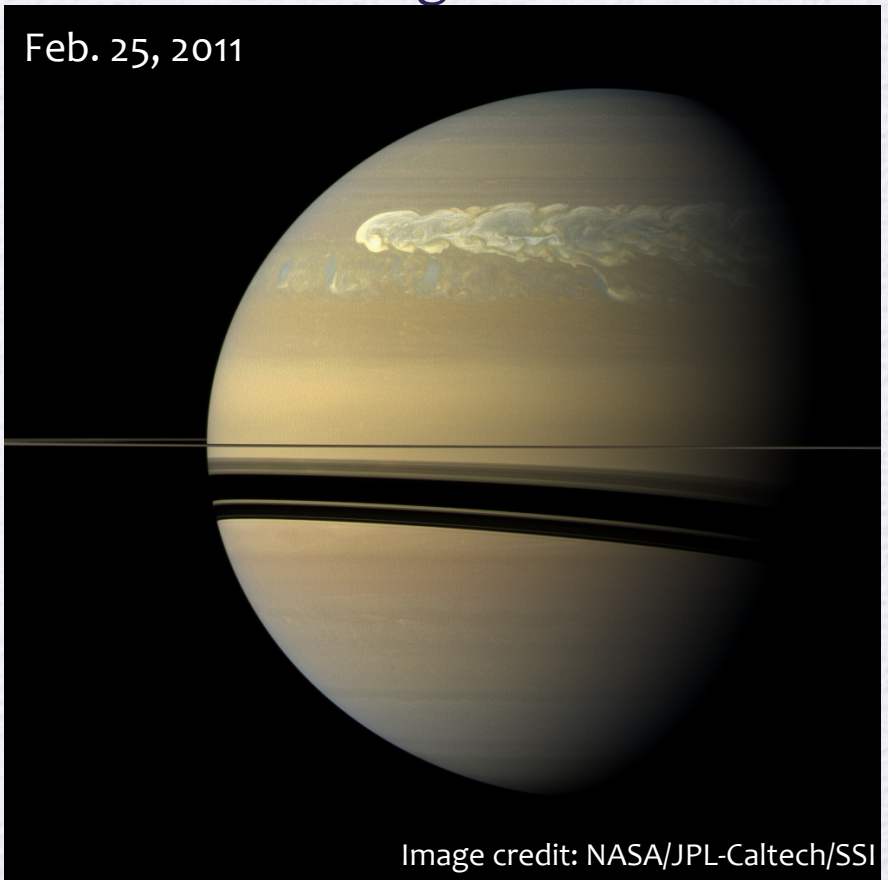
- Massive Eruption at 40N in December 2010 produced lasting effects in Saturn's northern hemisphere

Cassini ISS Images

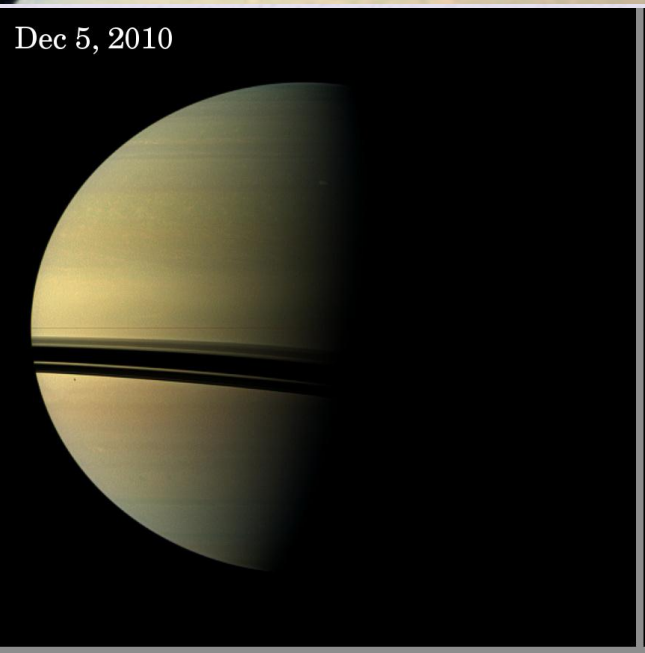
Initial Outbreak

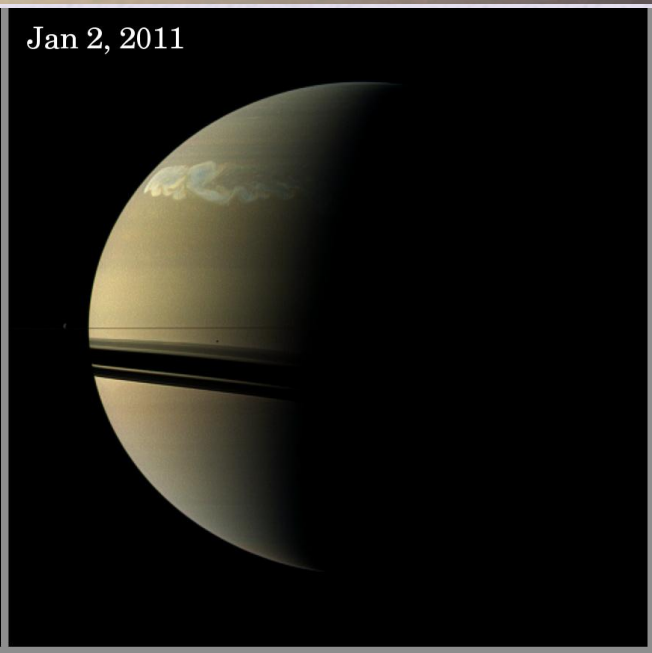


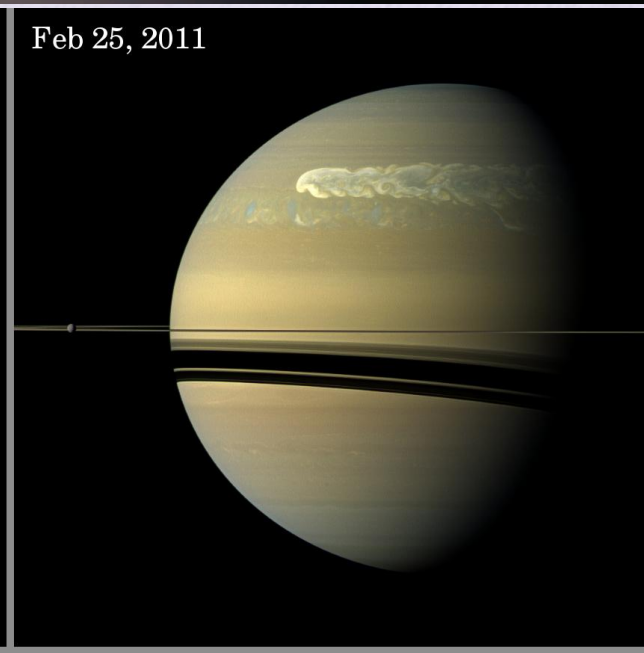
Catching Its Tail

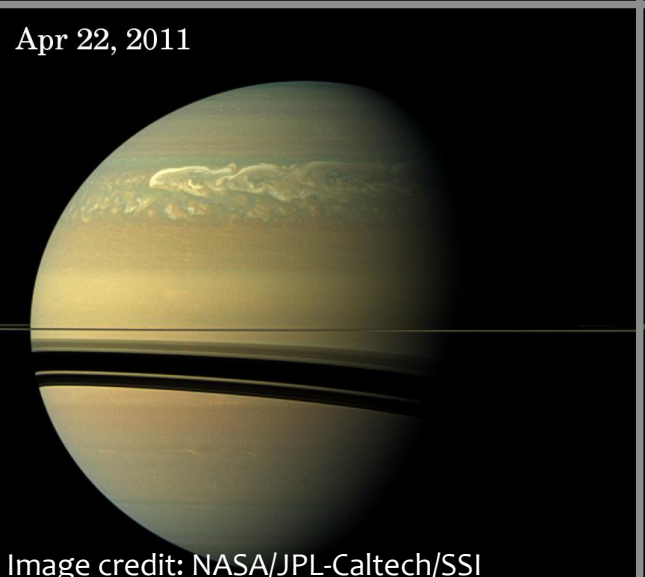


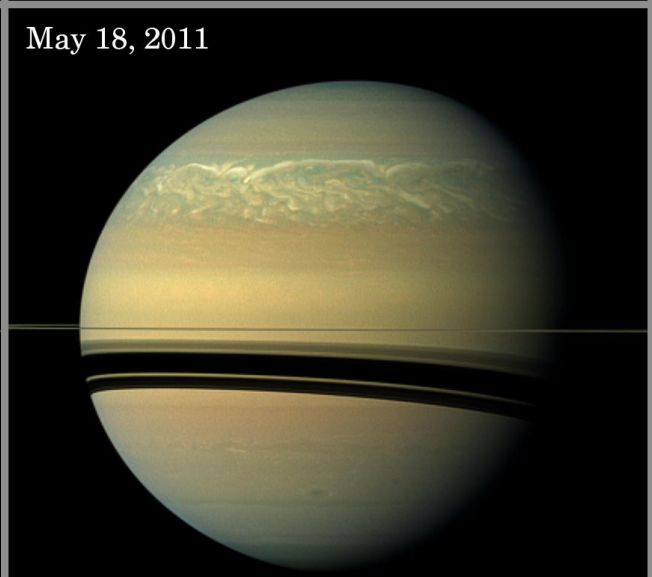
The Visible Storm Record











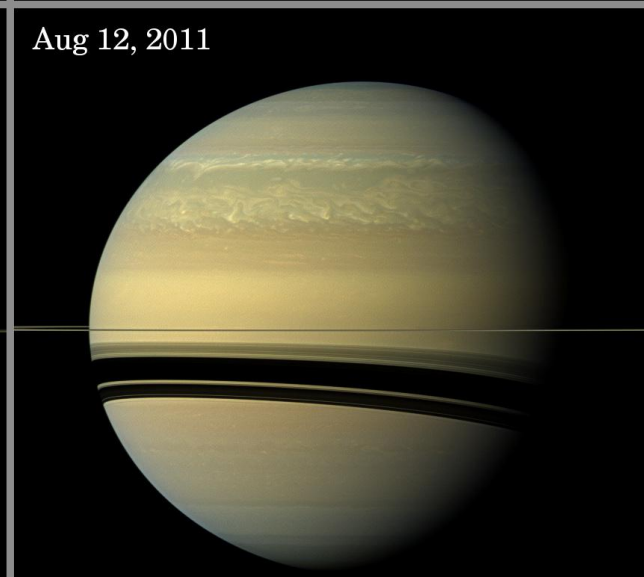
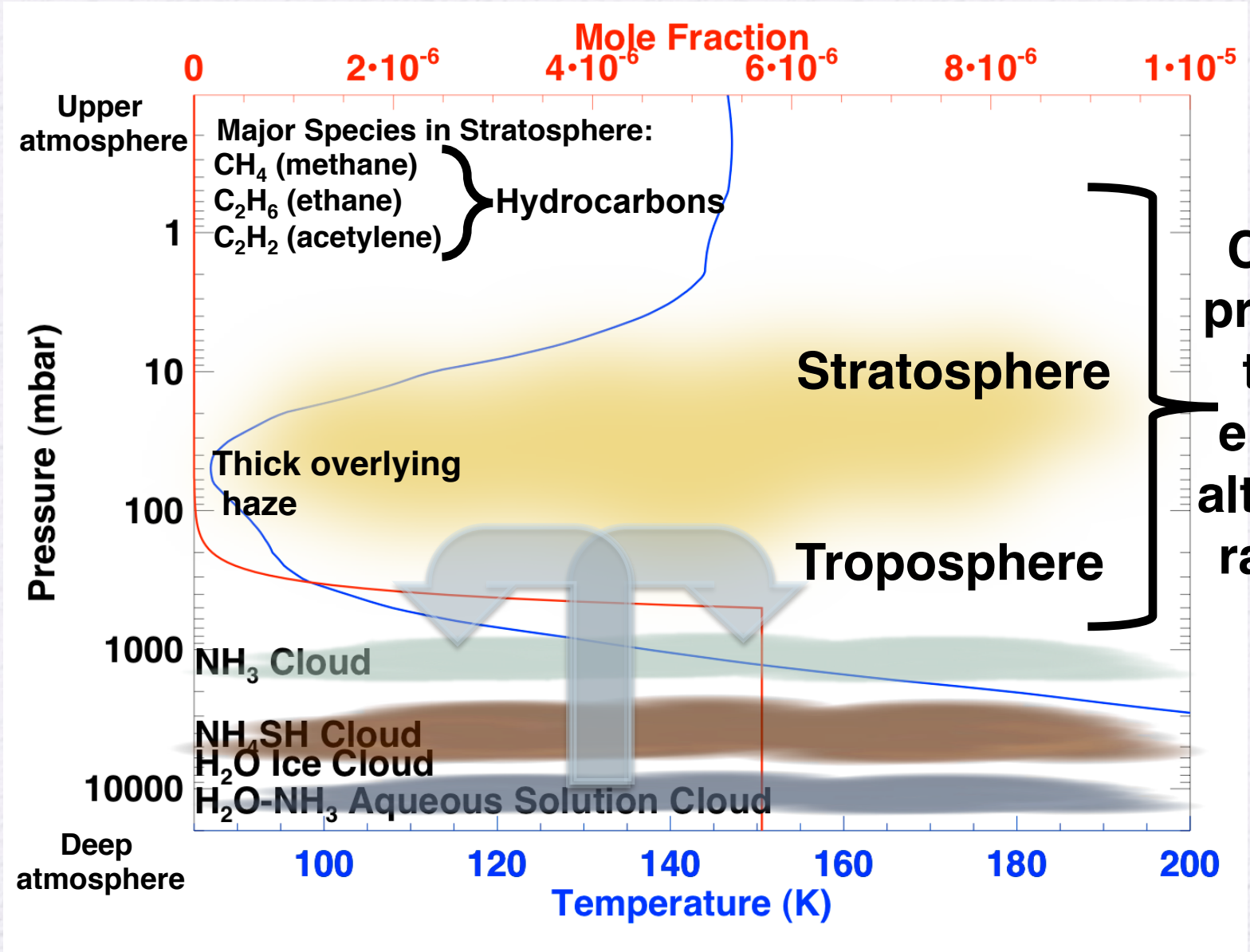


Image credit: NASA/JPL-Caltech/SSI

Why Use CIRS to Study Storms?



Saturn's Northern Outburst

The Infrared Surprises Us All

Infrared Observations by Fletcher et al. (2011)

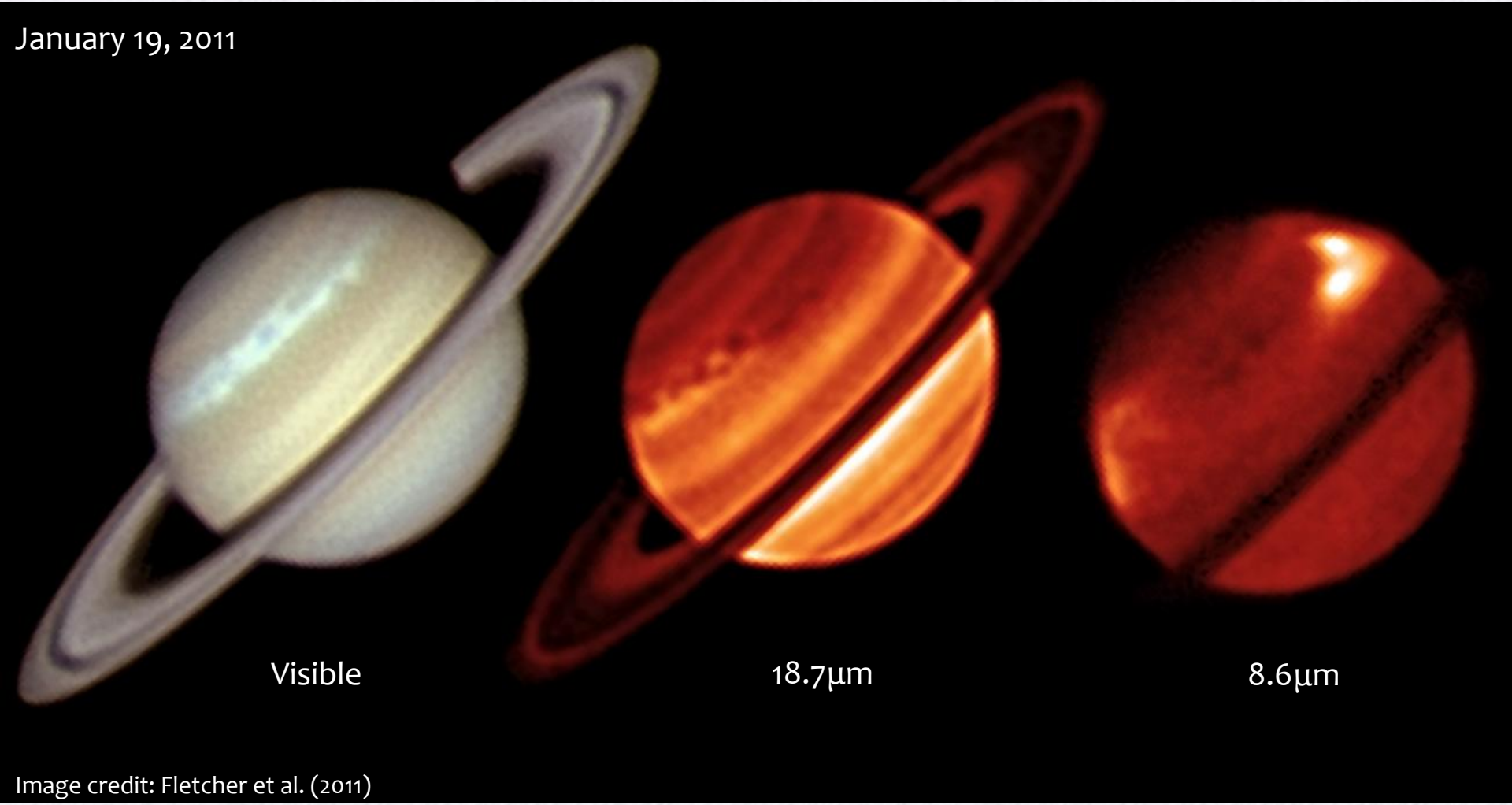


Image credit: Fletcher et al. (2011)

Above the Storm Clouds

Phase 1:

- two "hot" beacons
- temperatures increasing from January to May
- hydrocarbon emission strengthening
- stratospheric wind speeds accelerating above tropospheric speeds

Phase 2:

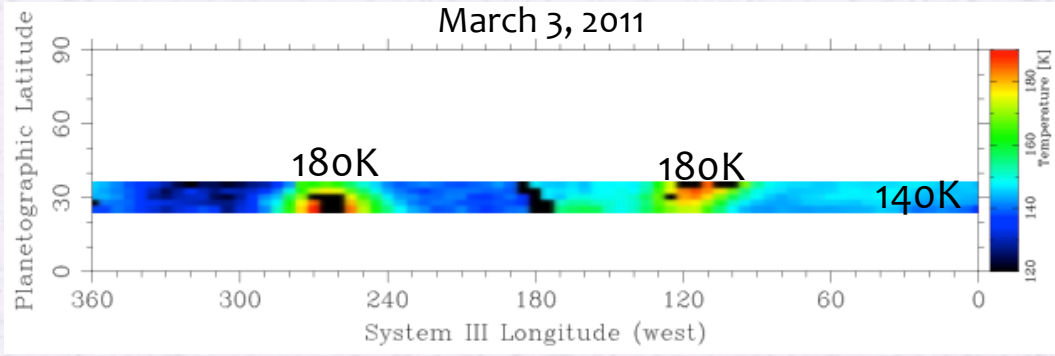
- two beacons merge to one
- temperature [illegible]
- stratospheric wind speeds equivalent to tropospheric

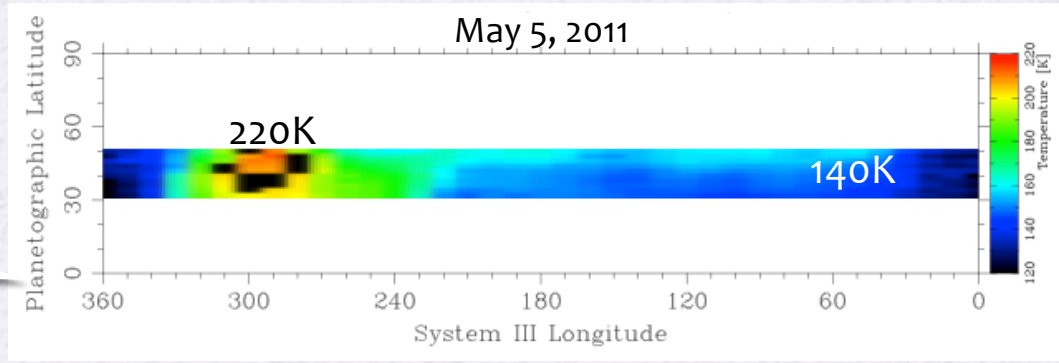
Largest temperature difference (80K) ever seen in a storm!!!

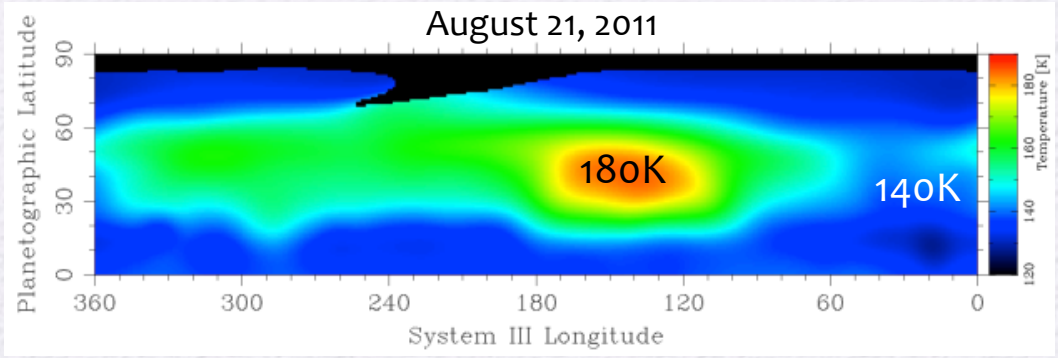
Phase 3:

- two beacons still merged
- temperatures are slowly relaxing
- stratospheric wind speeds increase again

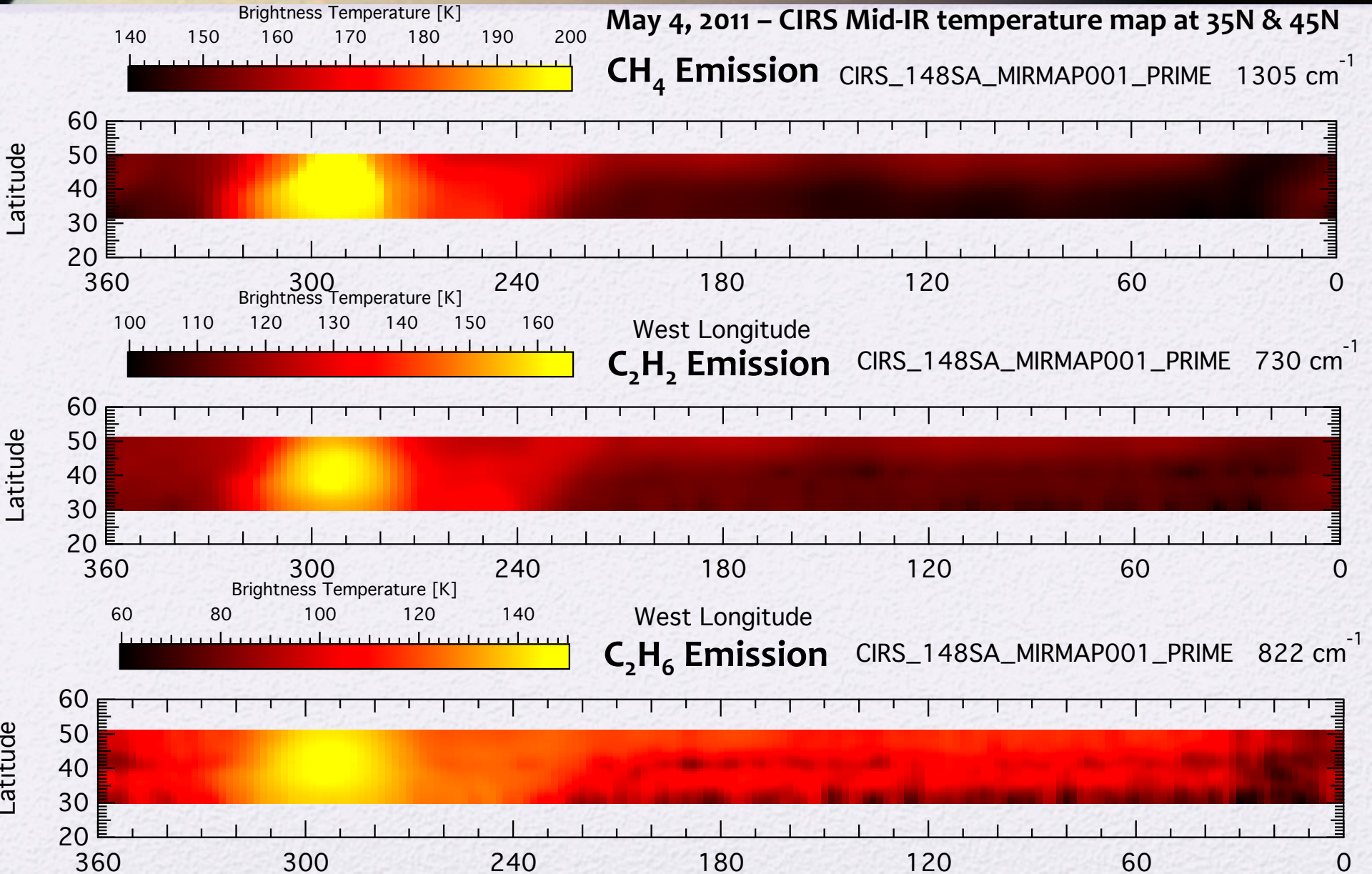
Temperature maps from Rich Achterberg





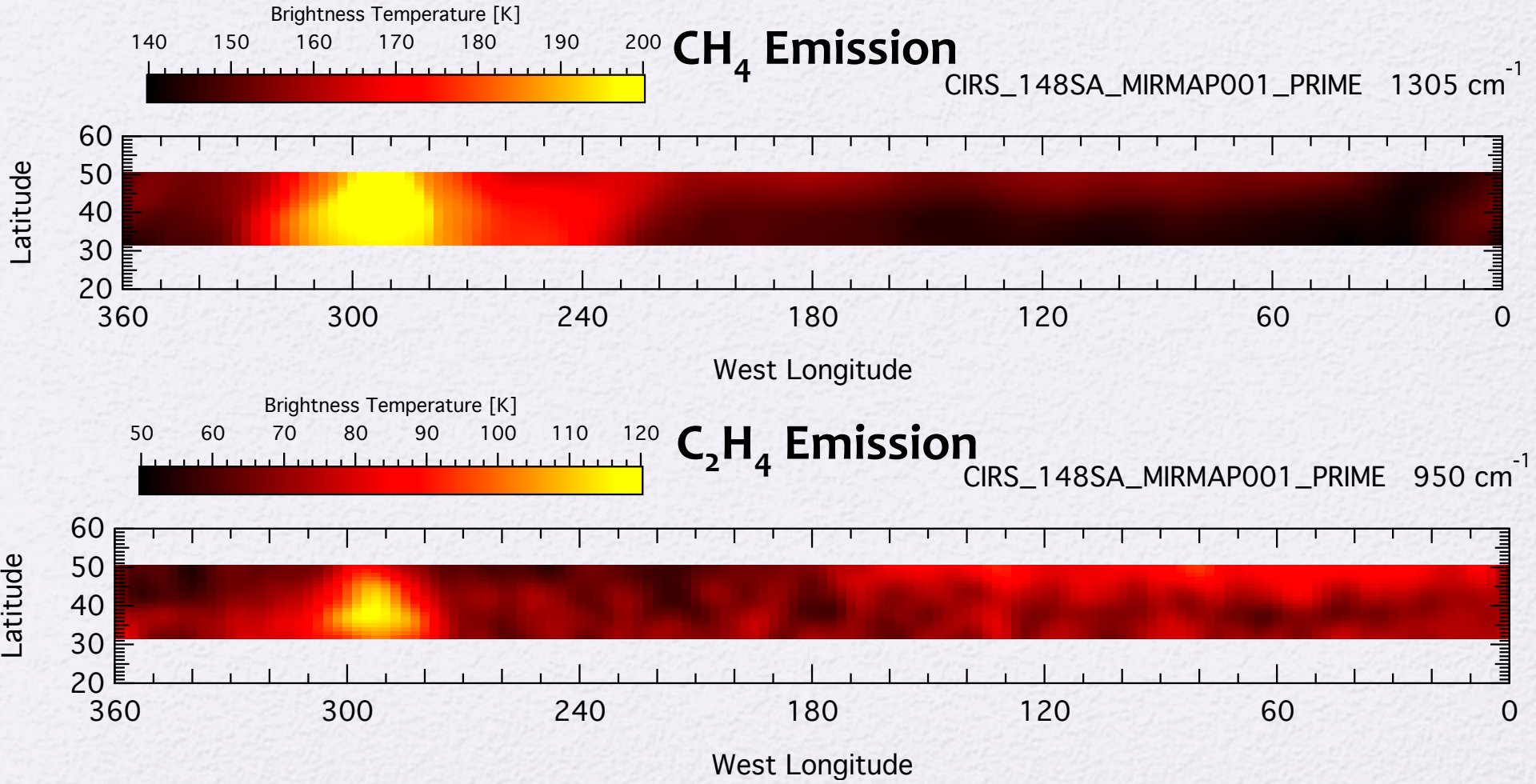


CIRS Mapping Hydrocarbons

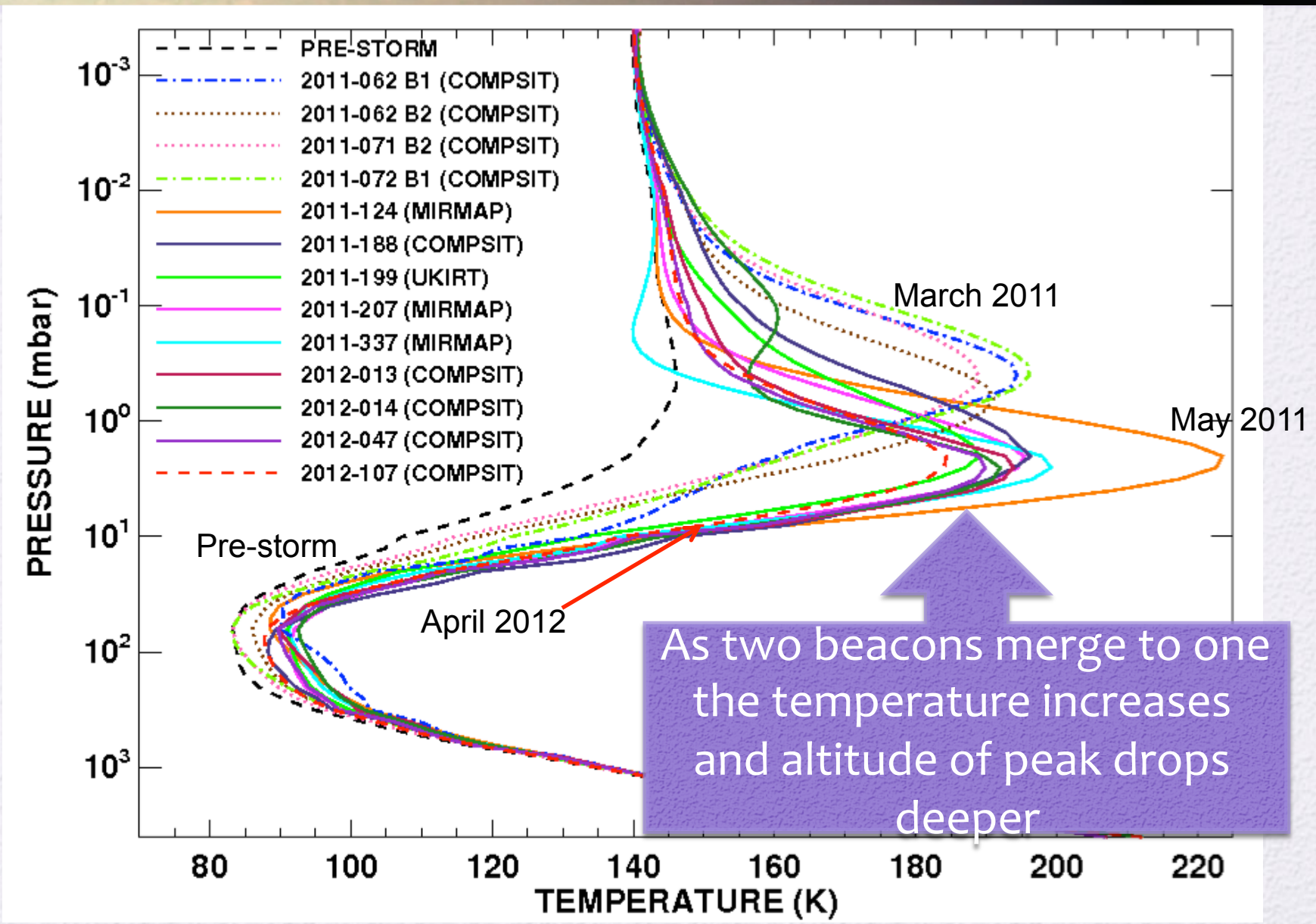


CIRS Detection of Ethylene

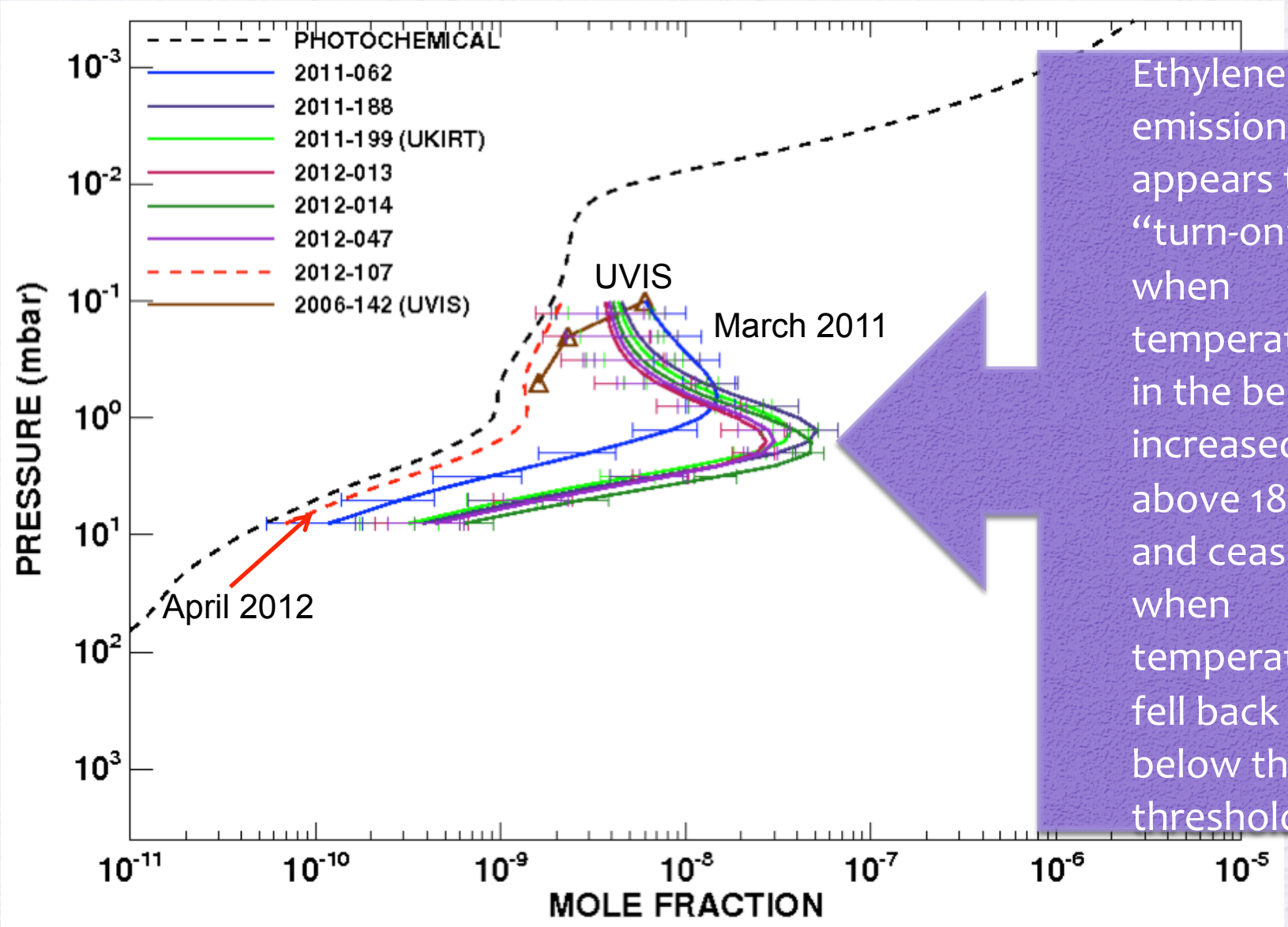
May 4, 2011 – CIRS Mid-infrared temperature map at 35N and 45N



Retrieved Temperatures

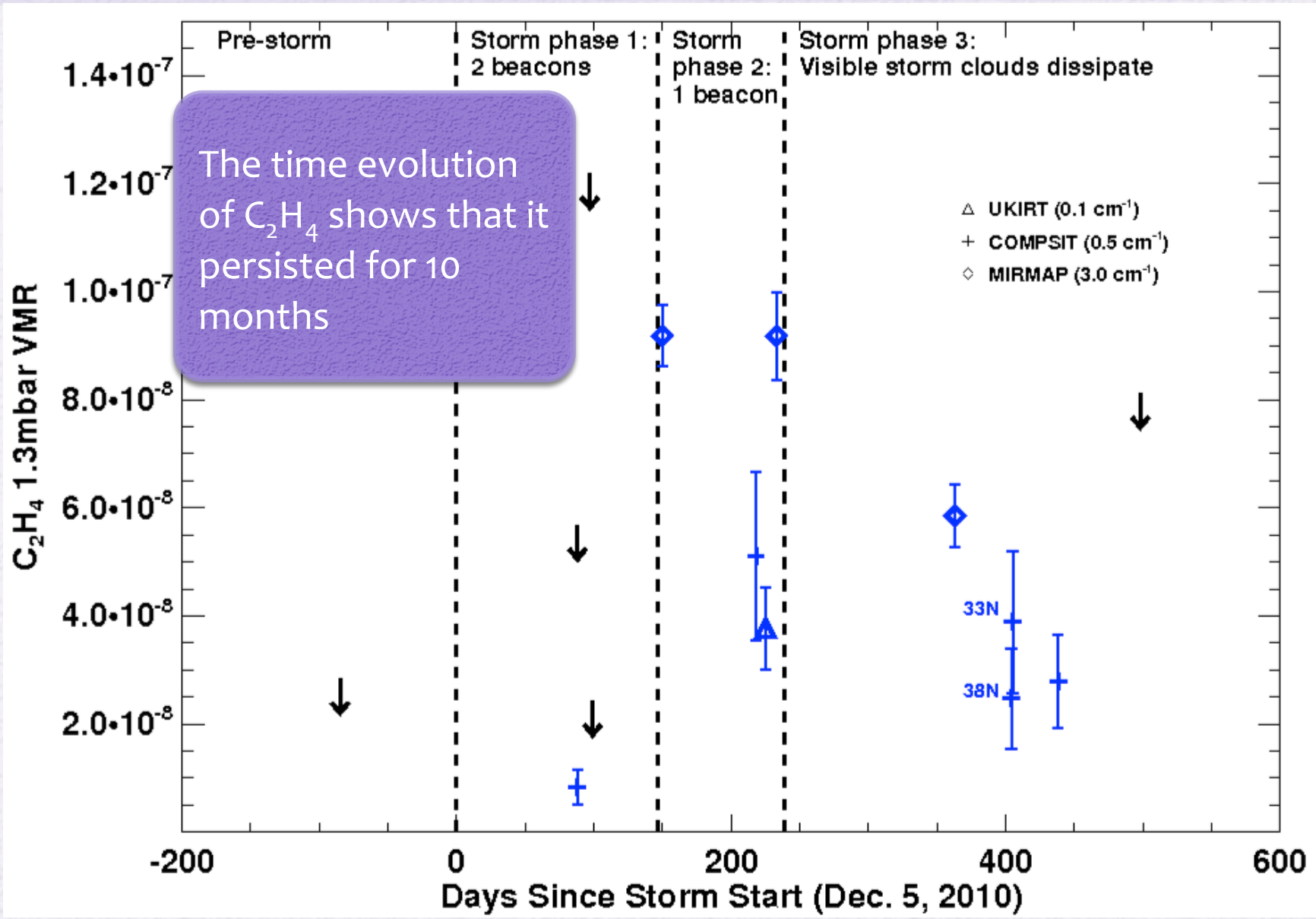


Retrieved Ethylene Profiles

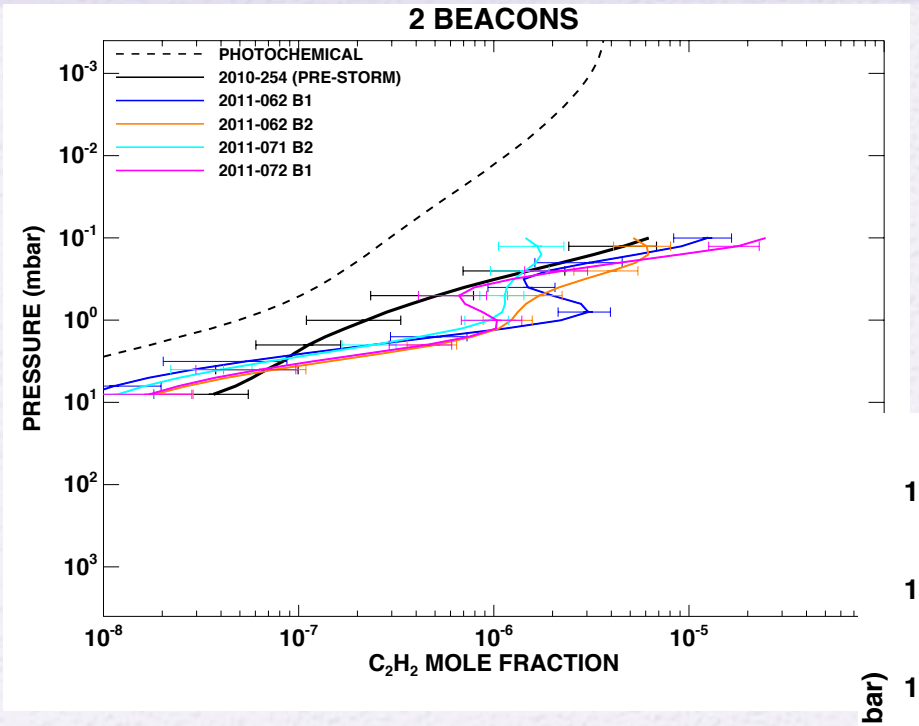


Ethylene emission appears to "turn-on" when temperatures in the beacon increased above 180K and ceased when temperatures fell back below that threshold.

Time Evolution of C_2H_4

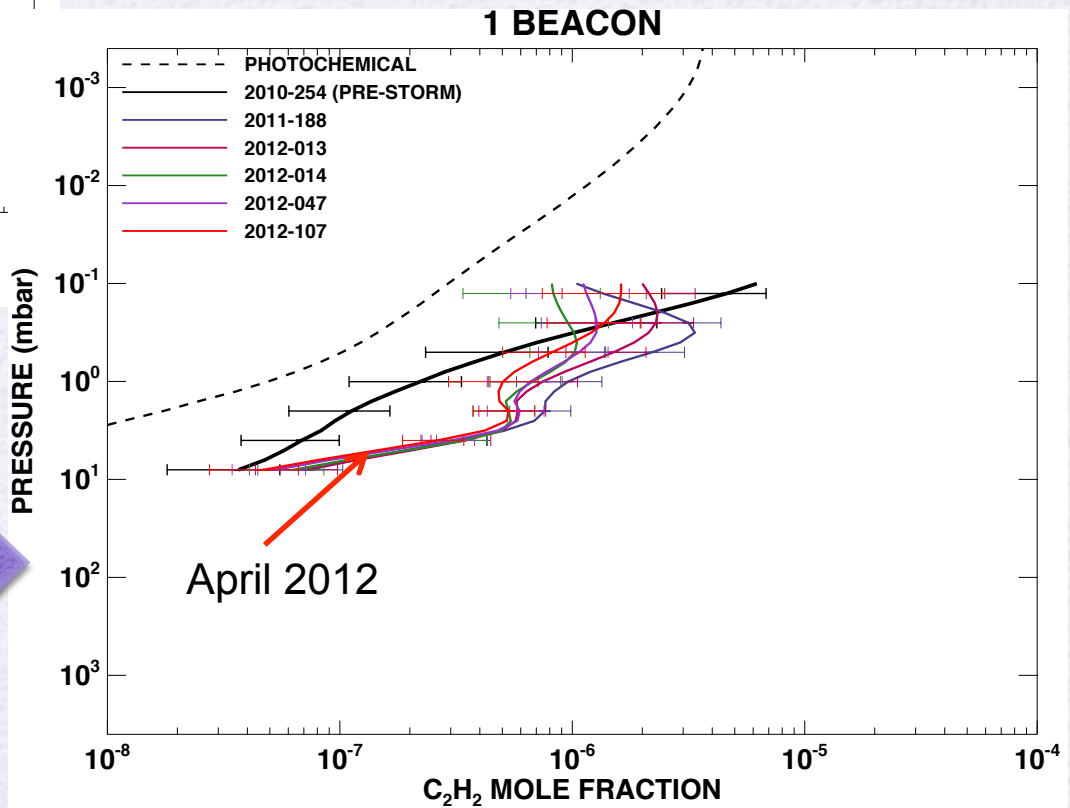


Retrieved Acetylene Profiles

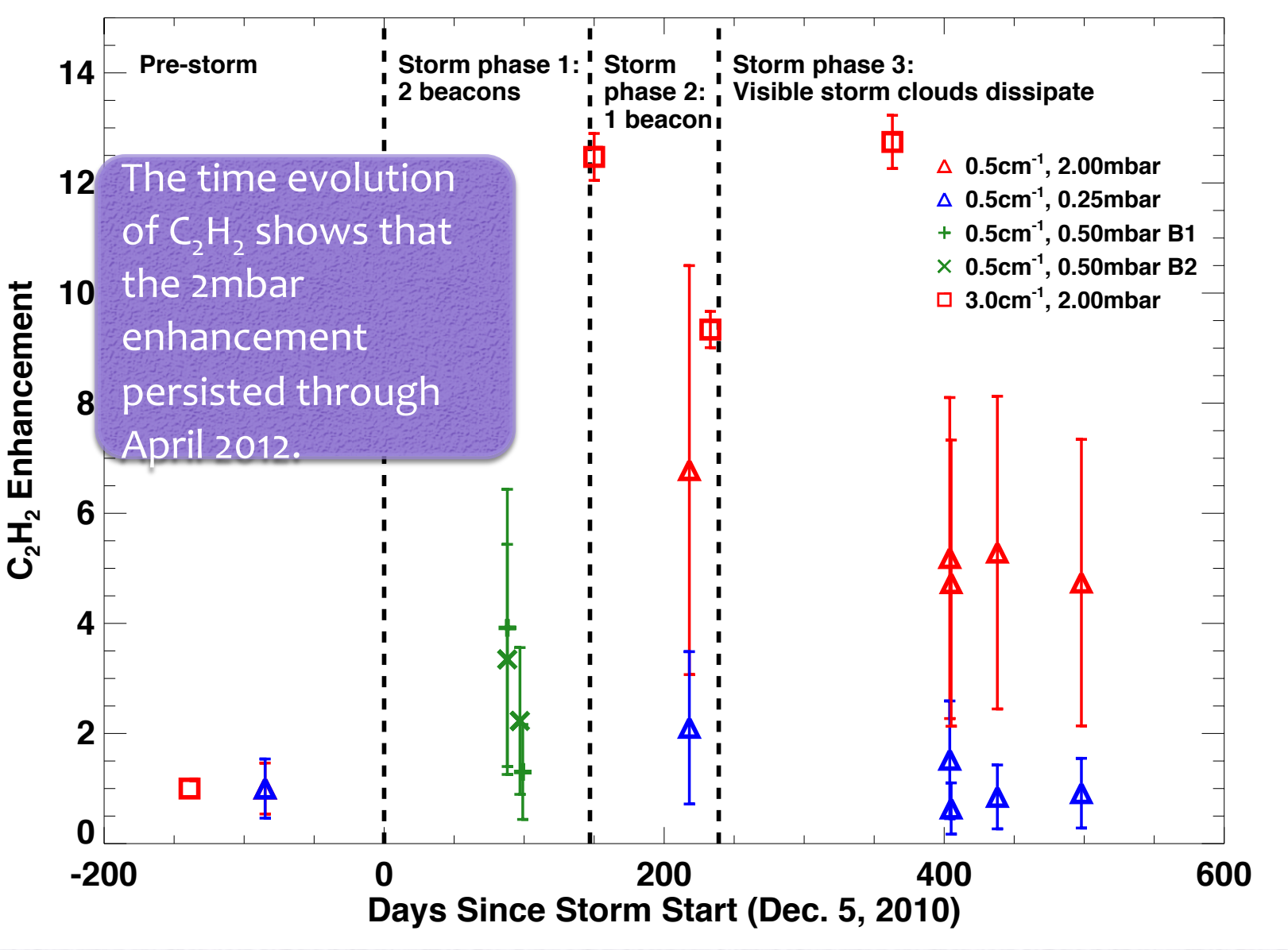


Marginal enhancement during 2 beacon phase

Two altitude regimes in 1 beacon phase: 2mbar and 0.25mbar

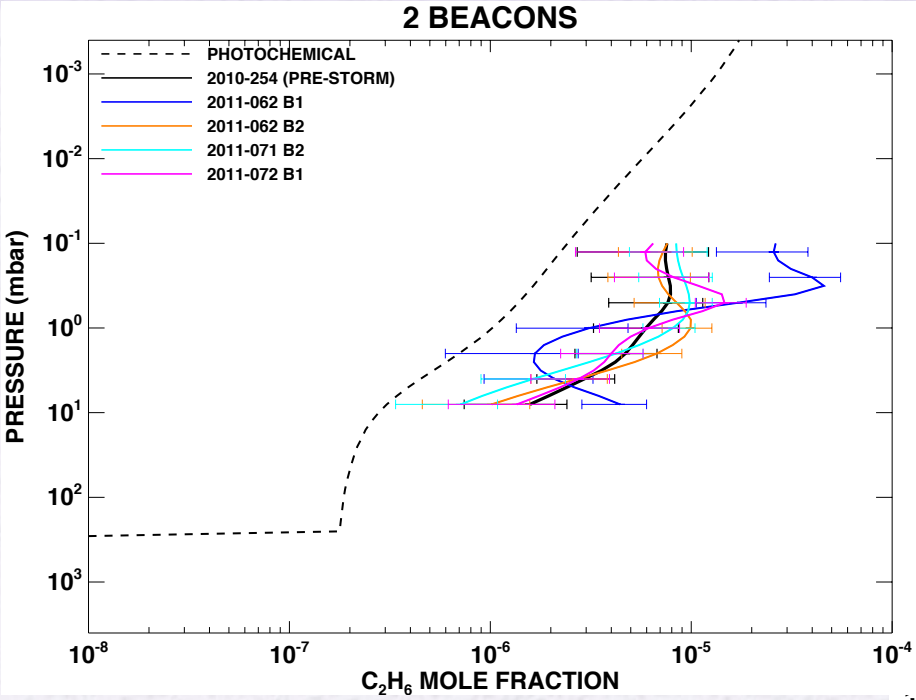


Time Evolution of C_2H_2



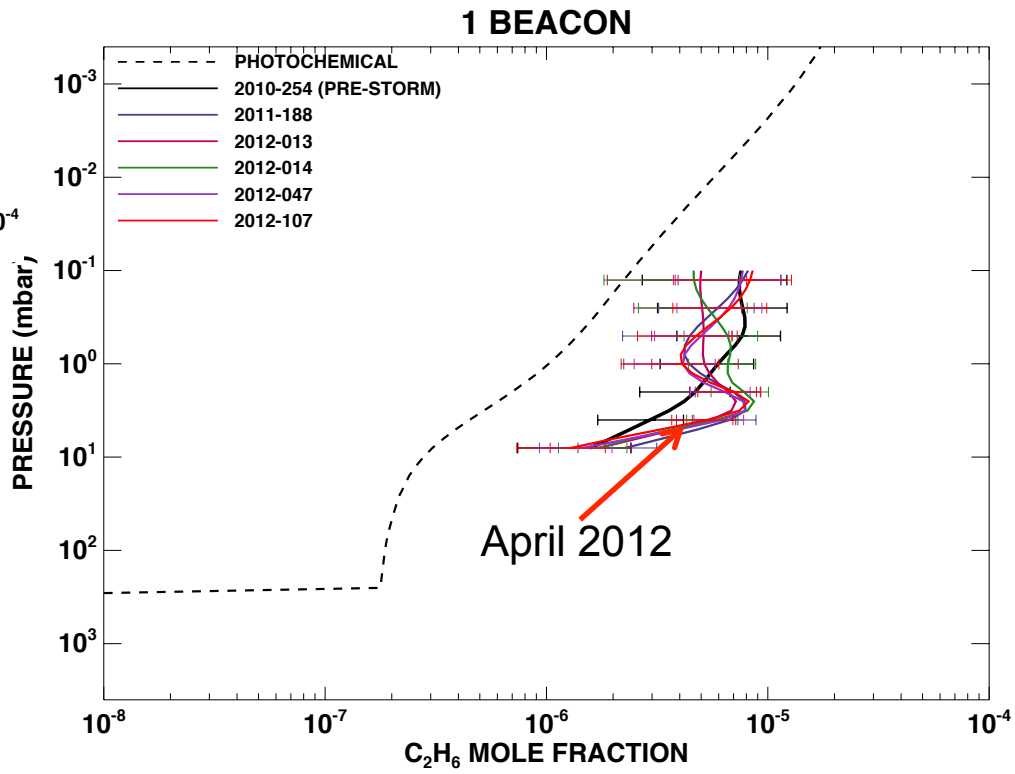
The time evolution of C_2H_2 shows that the 2mbar enhancement persisted through April 2012.

Retrieved Ethane Profiles

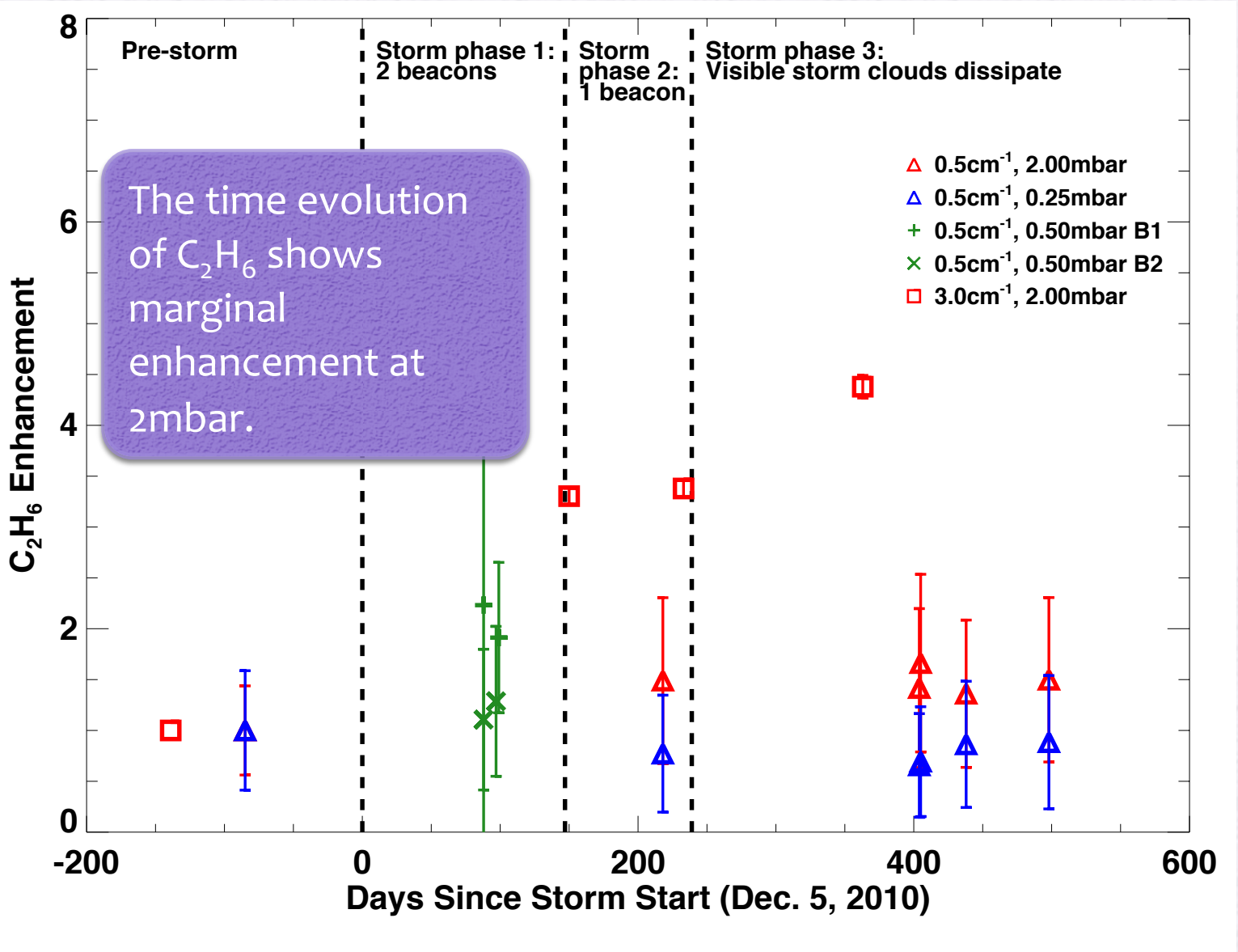


In two beacon situation ethane shows no enhancement within error bars

Two altitude regimes in 1 beacon phase: 2mbar and 0.25mbar



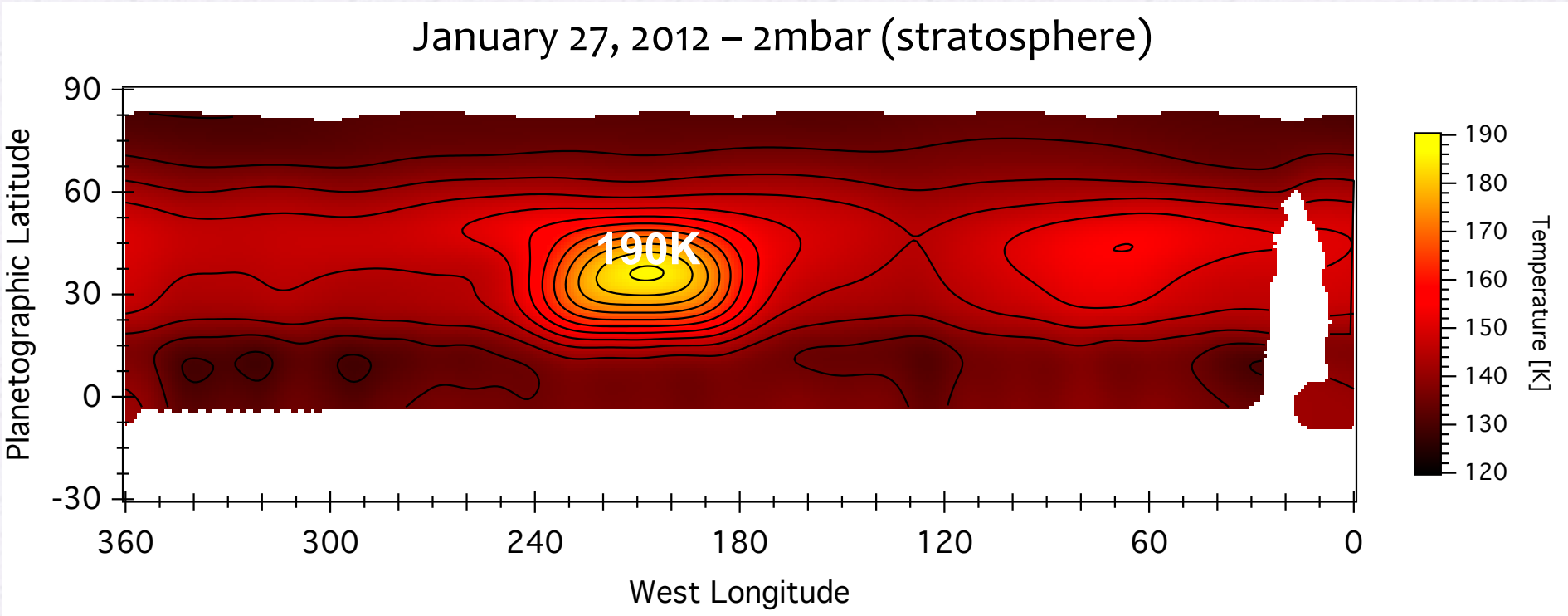
Time Evolution of C_2H_6



The time evolution of C_2H_6 shows marginal enhancement at 2mbar.

"Post" Storm

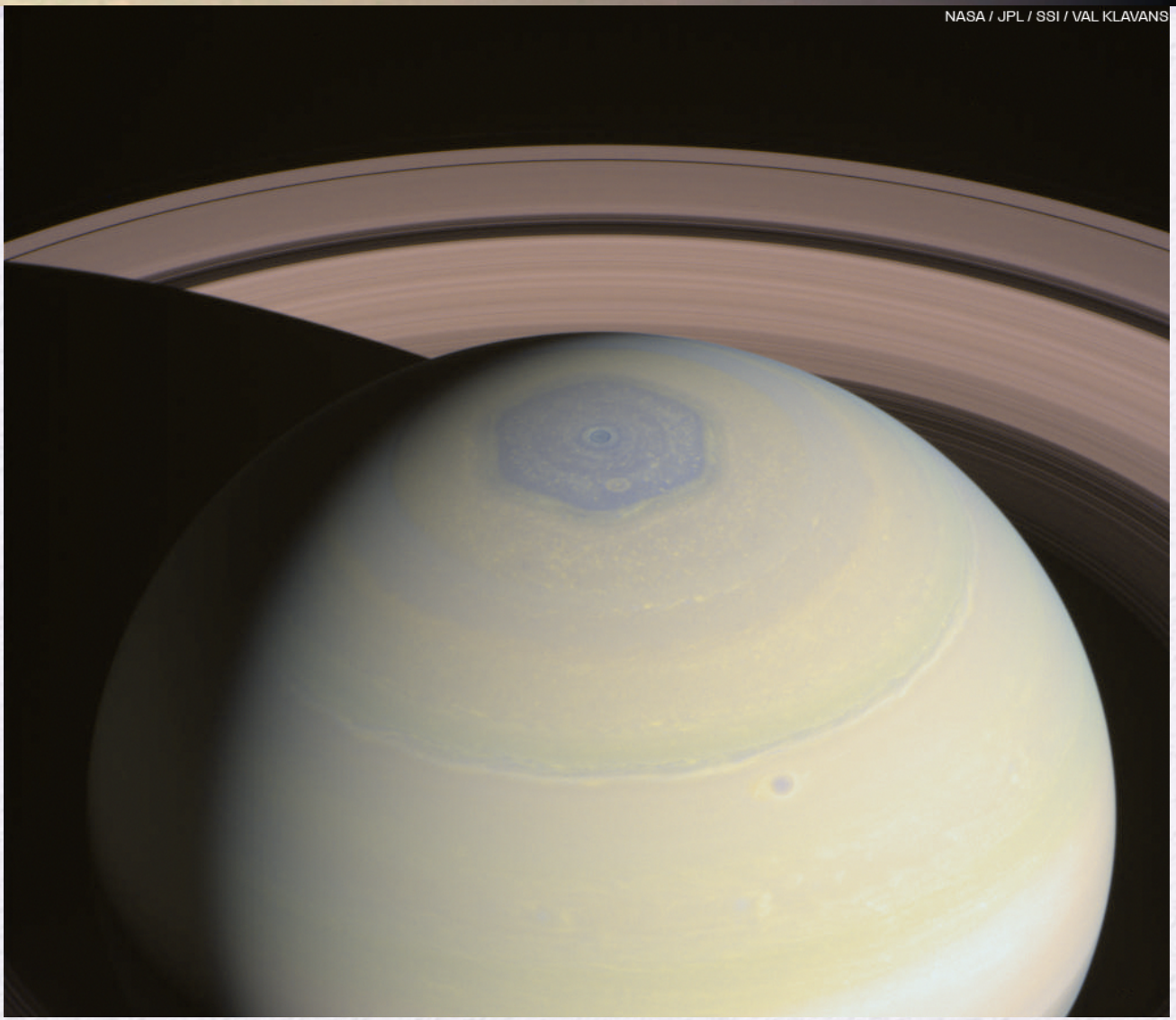
- The storm clouds dissipated in 2011 but the bright beacon in the stratosphere continued to glow



- How long will we see the effects? Well … as of March 2014 we still saw a 4K variation in longitude at the storm latitude.
- But sadly the ethylene signature has been gone since 2012

Temperature map from Rich Achterberg

Saturn April 3, 2014



A special thank you to Val Klavans for processing this ISS data and posting it to her Facebook page.