Experimental Observations of Jupiter in the Optical Ammonia Band at 645nm

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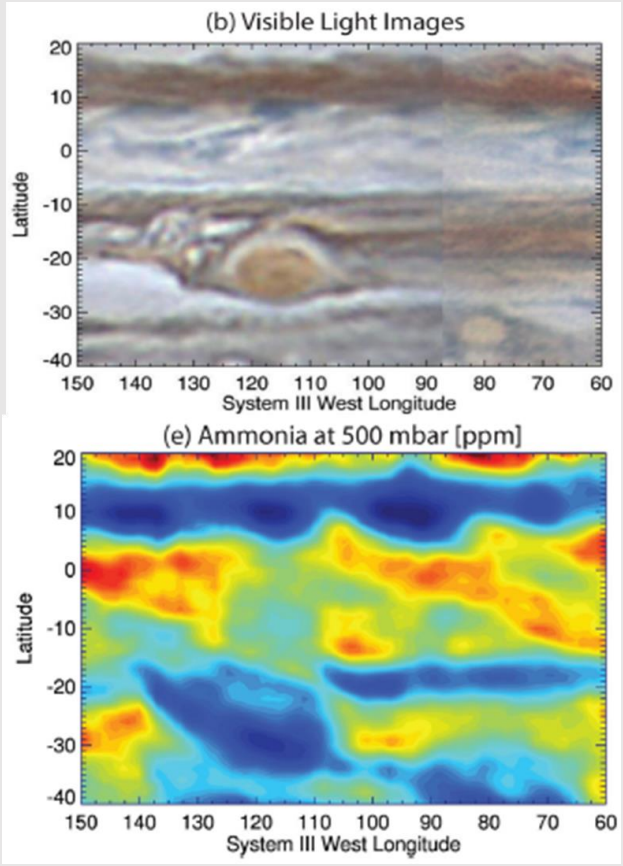
GOAL: To demonstrate the success of filter ratio method to observe Jupiter in the 645nm ammonia band.

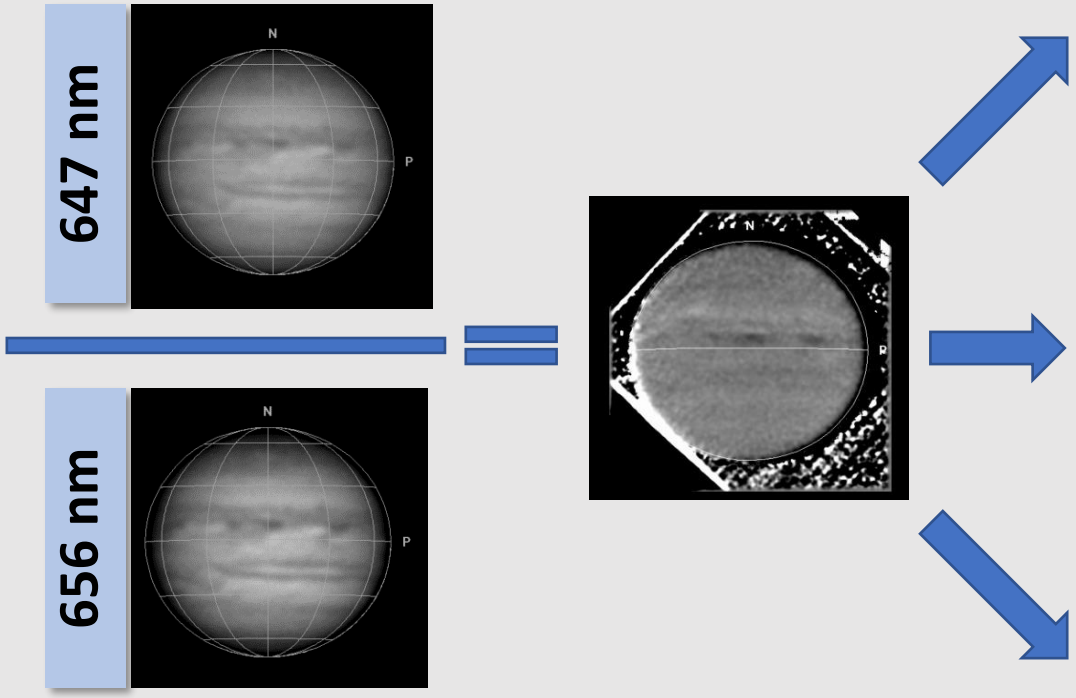
Outline

MOTIVATION



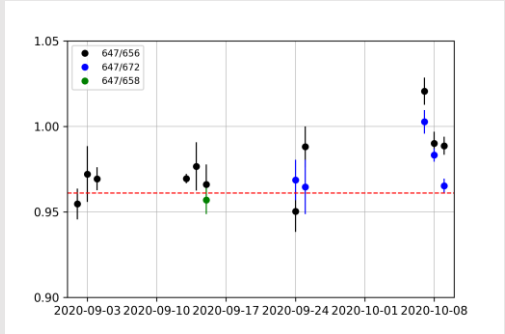
NH_3 is critical to understanding Jupiter's troposphere

TECHNIQUE

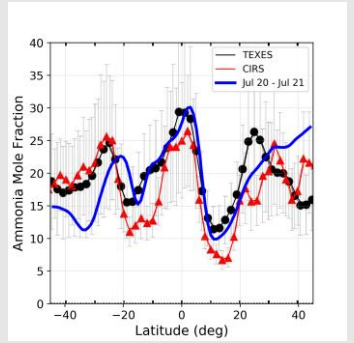


In-band and continuum images, ratioed to show absorption in the 645 nm band

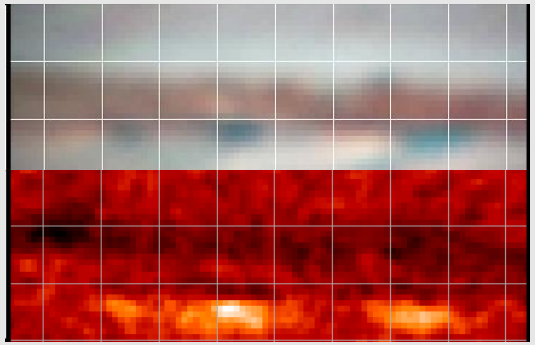
RESULTS



Disk-integrated photometry



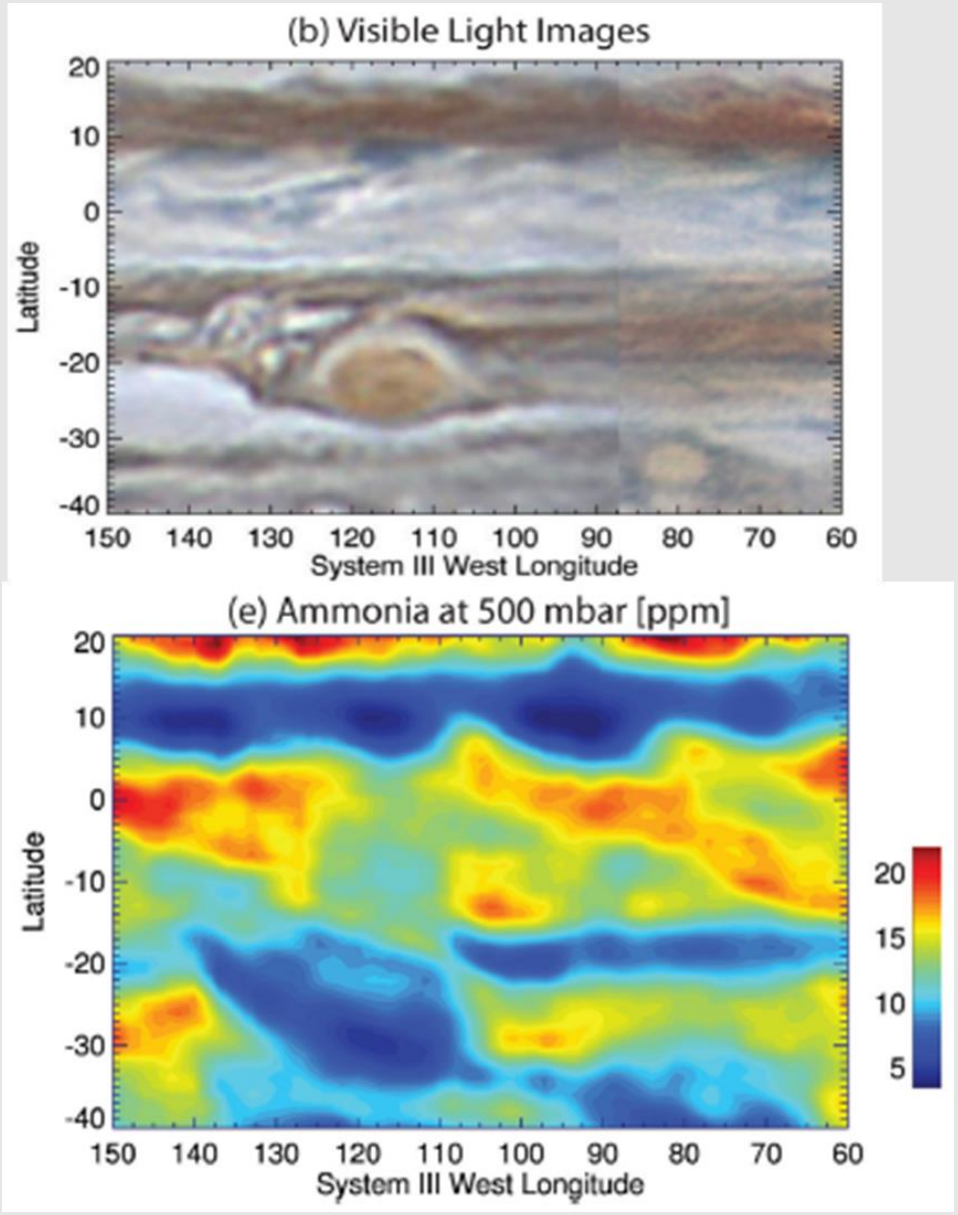
Meridional profiles



Localized relative absorption

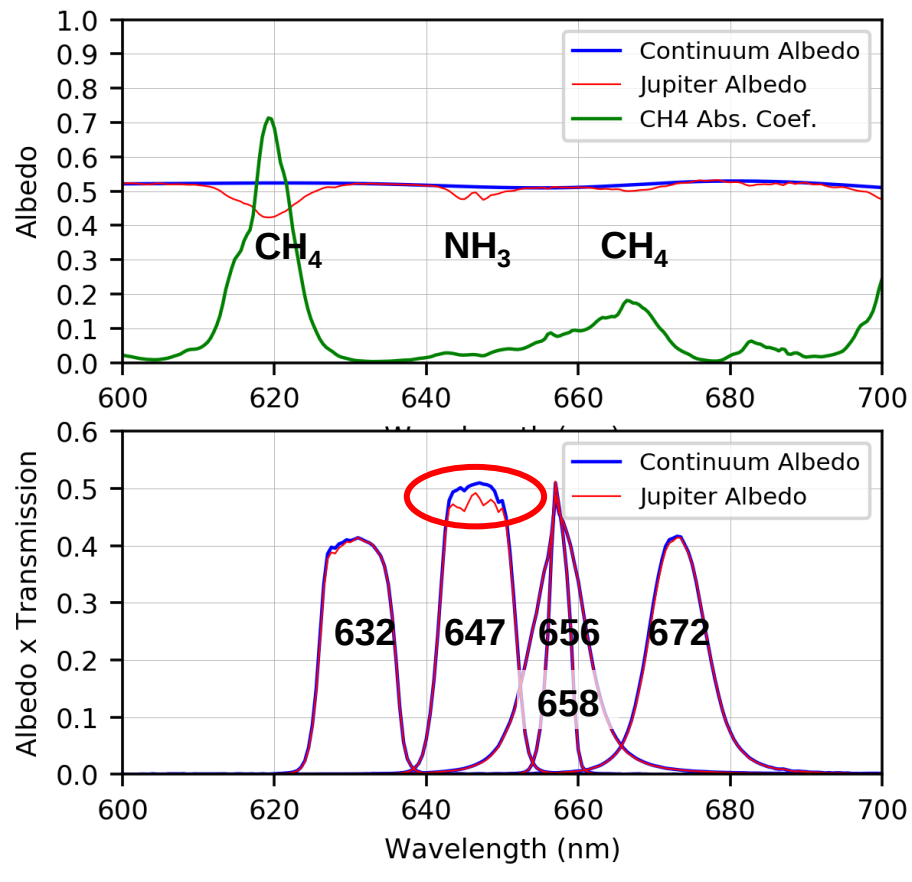
Motivation

- Ammonia condensate clouds are responsible for most of the cloud and band structure seen in visible light.
- Ammonia distribution depends on:
  - Vertical and horizontal motions
  - Sources (chemical production, evaporating condensates)
  - Sinks (condensation, photochemical destruction)
- Ammonia is a proxy for active weather in the upper troposphere.



Visible light image compared to ammonia mole fraction from the IRTF-TEXES spectrometer [Leigh N. Fletcher et al., 2016].

Technique



- **Top: Jupiter's disk-integrated albedo and methane absorption coefficient [Karkoschka, 1994]**
- **Bottom: convolution of filter transmission with Jupiter's albedo and fit to the continuum.**

Observed Jupiter signal in the 647nm filter

Retrieved transmission in the 645nm NH_3 band

$$T_{NH_3} \cong \frac{S_{J,647}}{S^*_{J,647}(\lambda)}$$

Estimated Jovian signal in the absence of NH3 absorption

Jovian signal in adjacent continuum

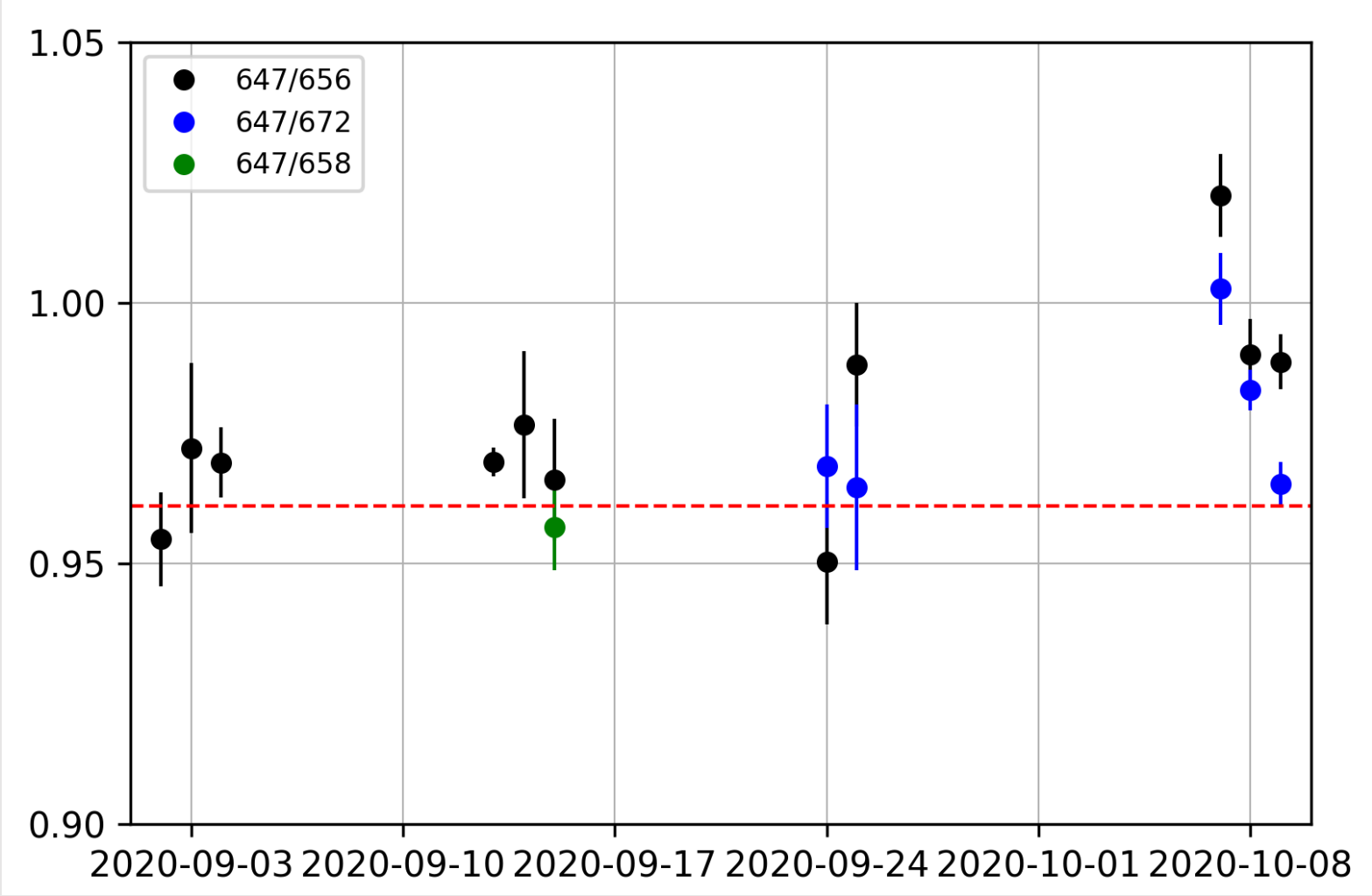
$$S^*_{J,647} \cong \frac{S_{J,cont}}{S_{m,cont}} S_{m,647}$$

Moon(s) signal in 647nm filter

Moon(s) signal in adjacent continuum

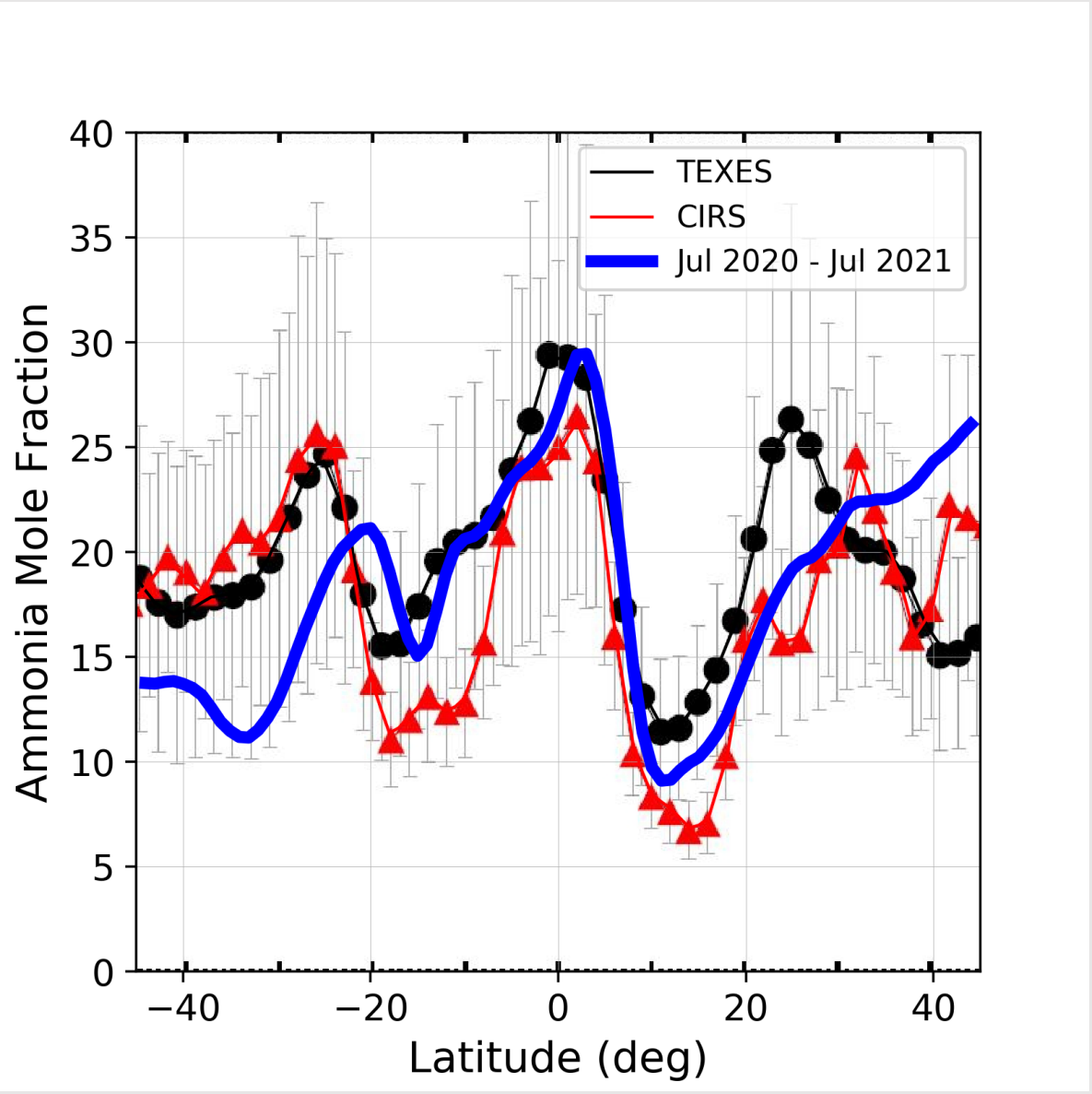
Disk-Integrated 647nm Transmission

- **Retrieved transmission is consistent with expectations**
- **October 2020 measurements may be impacted by moderate to heavy wildfire smoke**
- **Expected transmission of 0.962 is marked by the red line**

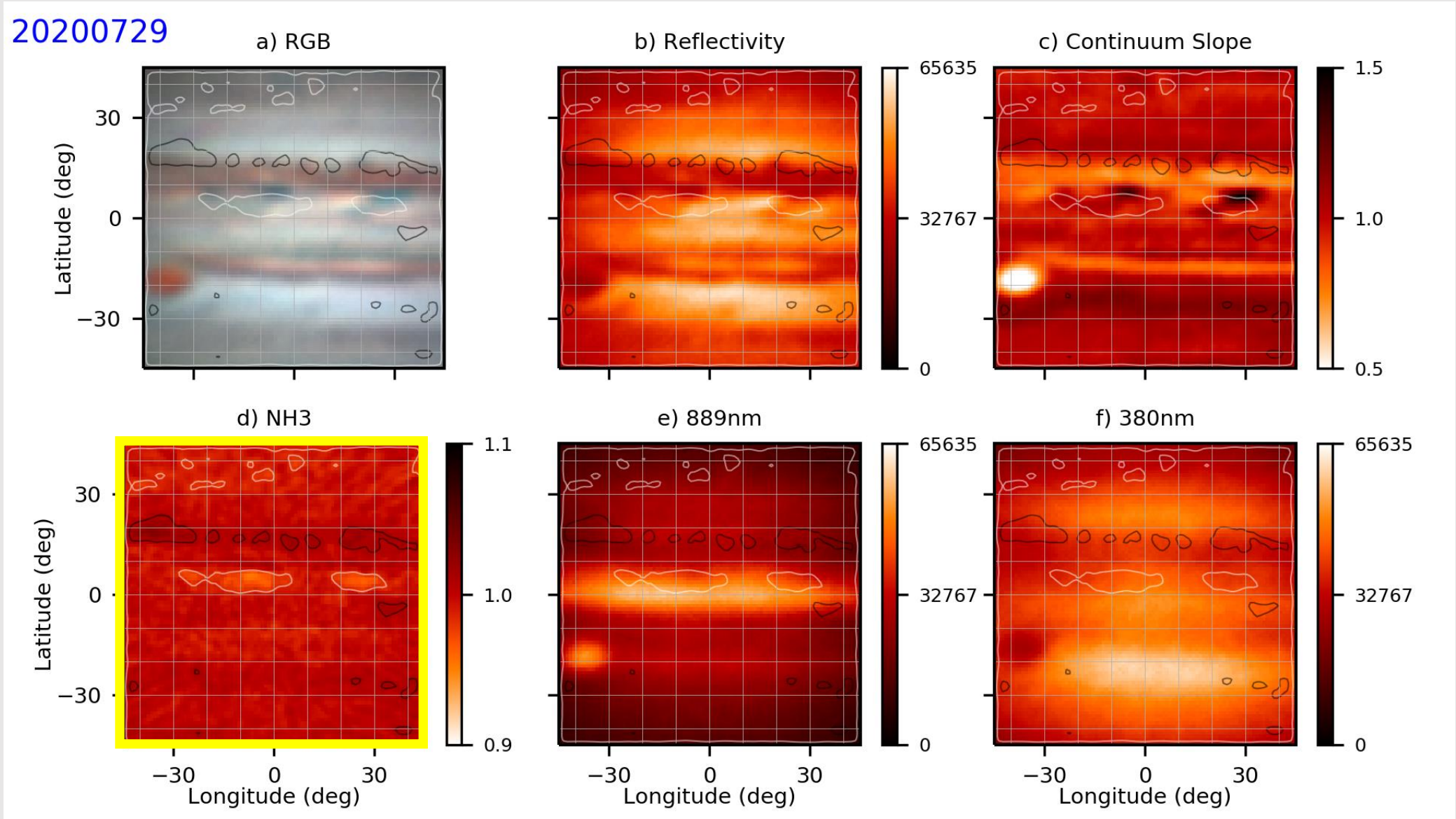


Meridional Profile

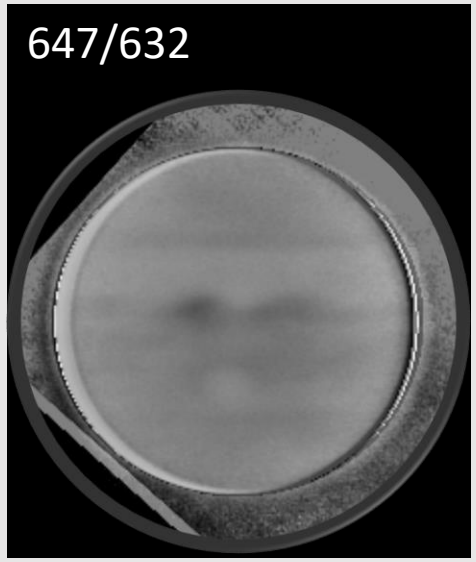
- **Black and Red: Profiles of ammonia mole fraction from IRTF-TEXES observations in 2014 and Cassini CIRS in 2000 [Leigh N. Fletcher et al., 2016].**
- **Blue: Continuum/647nm absorption profiles from the current work arbitrarily scaled to the same vertical extent.**
- **Inclusion of 2021 data improved the match around the SEB.**



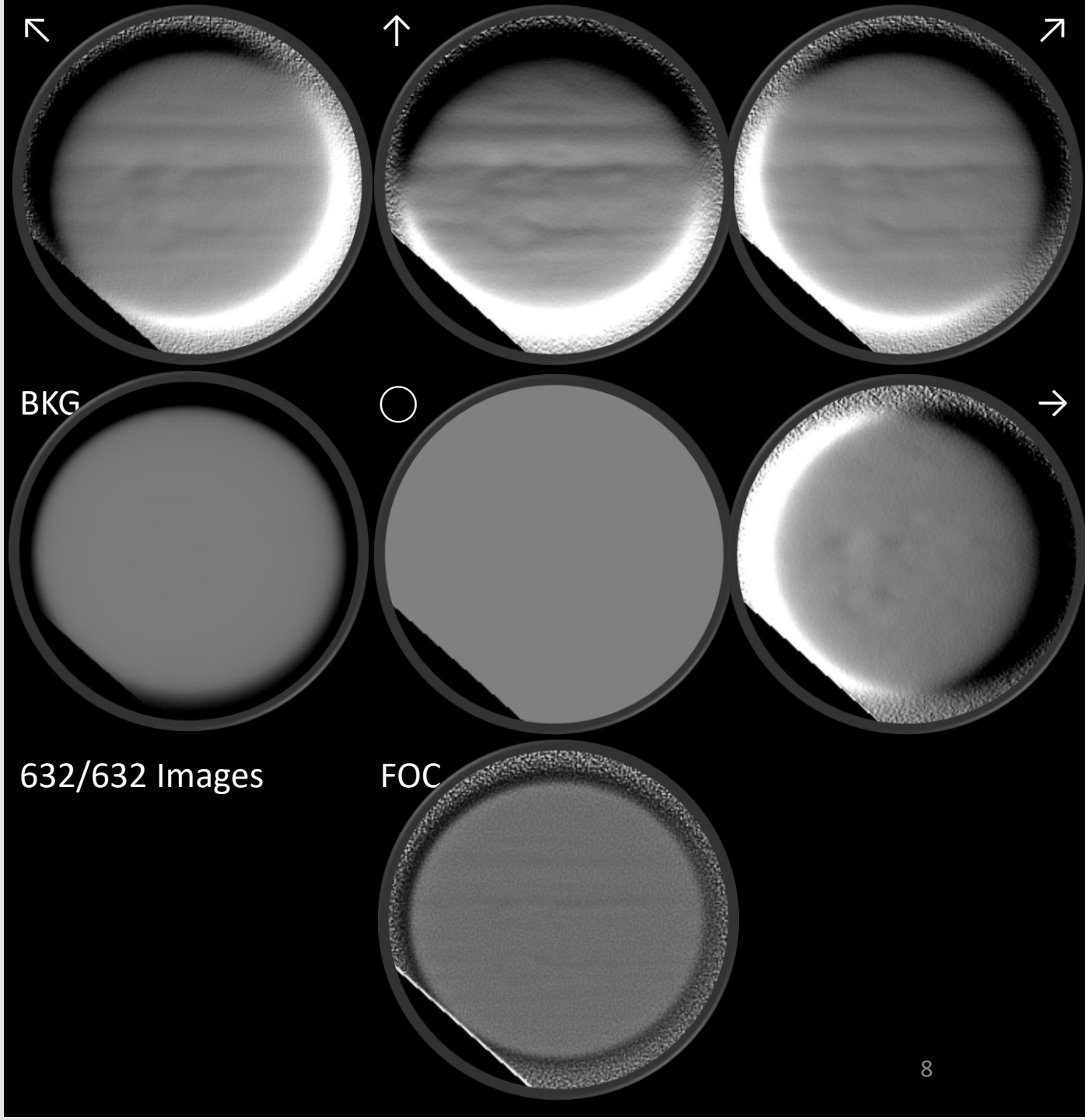
Localized Absorption Features



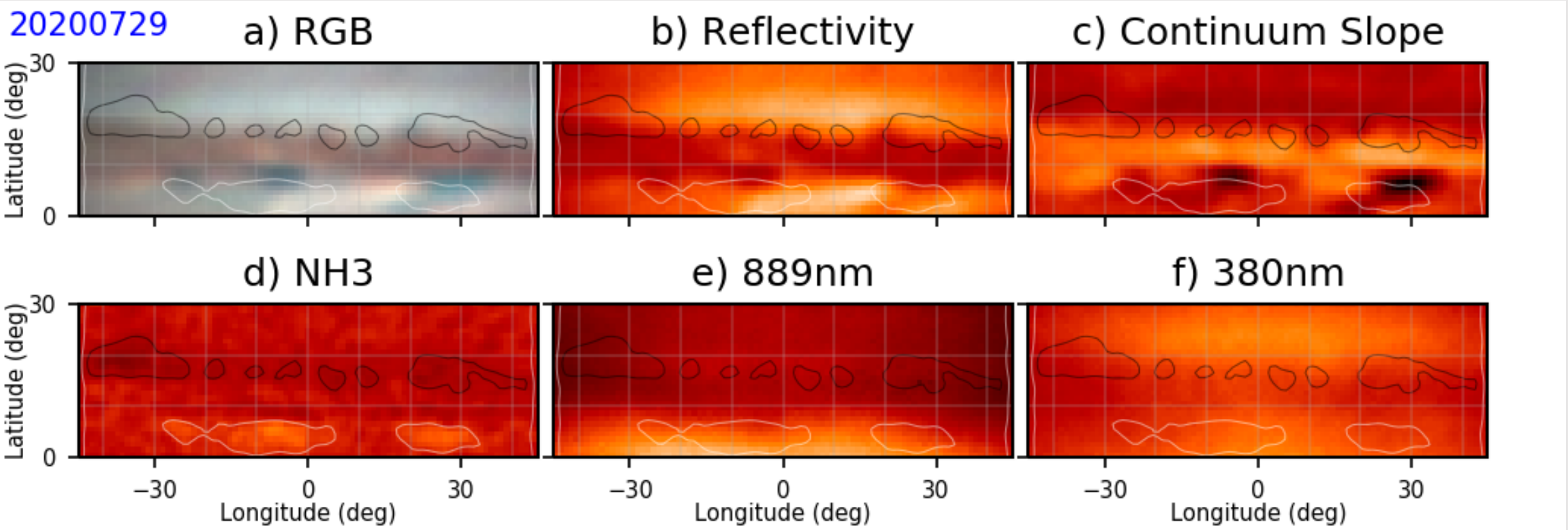
Artifacts?



- Potential artifacts were investigated using the ratio of identical continuum (632nm) images



The Northern EZ



NH_3 shows enhancement in the northern EZ, but not uniformly in longitude.

Summary

Disk-integrated ammonia absorption measurements are consistent with predictions using reference spectra.

Meridional absorption profiles show the major features seen in prior work.

High-resolution imaging shows patchy absorption enhancement in the EZ consistent with prior work.

Next Steps

Future work will be to track localized enhanced absorption in the EZ to better understand growth, decay, wind speed, and positions relative to visible cloud features.

Acknowledgements

I would like to thank Dr. John Rogers of the British Astronomical Society for insightful correspondence and encouragement regarding optical ammonia detection.