Jet Propulsion Laboratory
California Institute of Technology

Results from the Juno MWR Instrument

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Presented by Steven Levin

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[5] *University of Michigan*
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[8]*Cornell University.*
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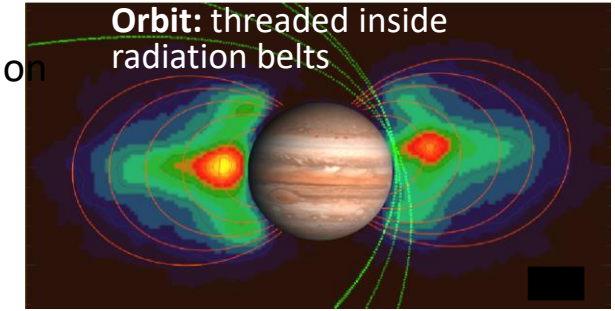
AOGS
7 June 2018
Honolulu, Hawaii

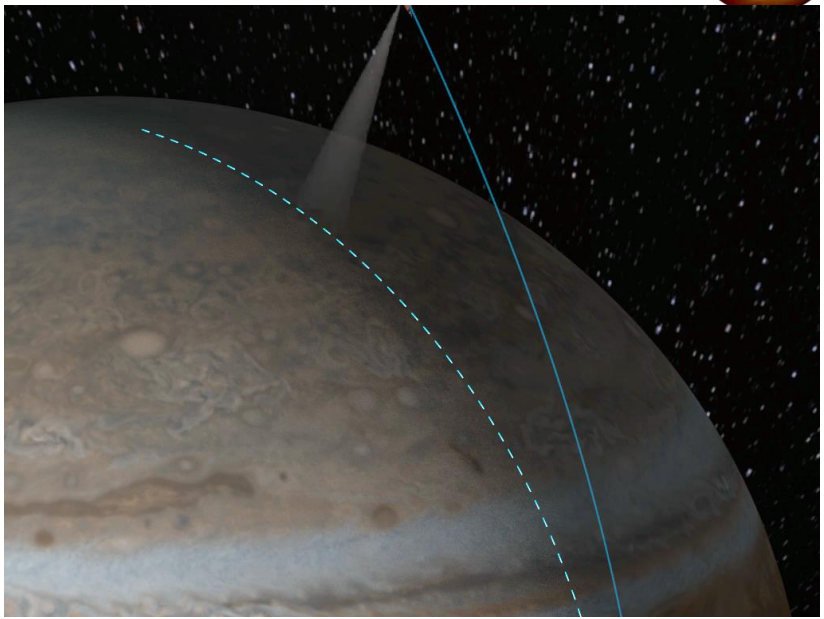
The Juno Microwave Radiometer Investigation

Antennas: mounted on two sides of the spacecraft



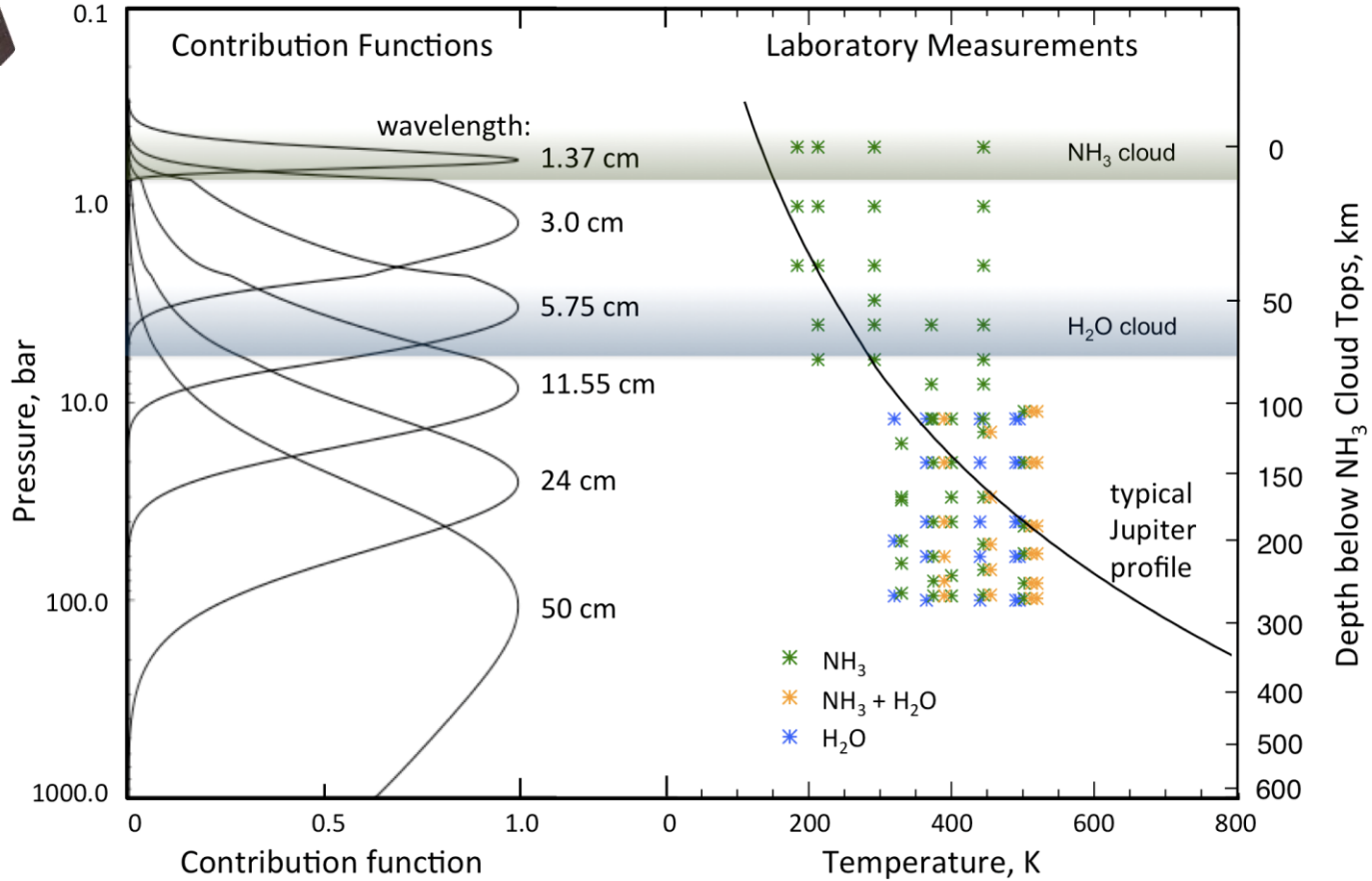
Radiometers: in spacecraft vault

Channel	Wavelength cm	Frequency GHz
1	50	0.6
2	24	1.25
3	11.55	2.6
4	5.75	5.2
5	3	10
6	1.37	21.9



Observations: As the spacecraft spins, each point along the subspacecraft track is observed many times at many emission angles

Radiative Transfer in Jupiter's Atmosphere

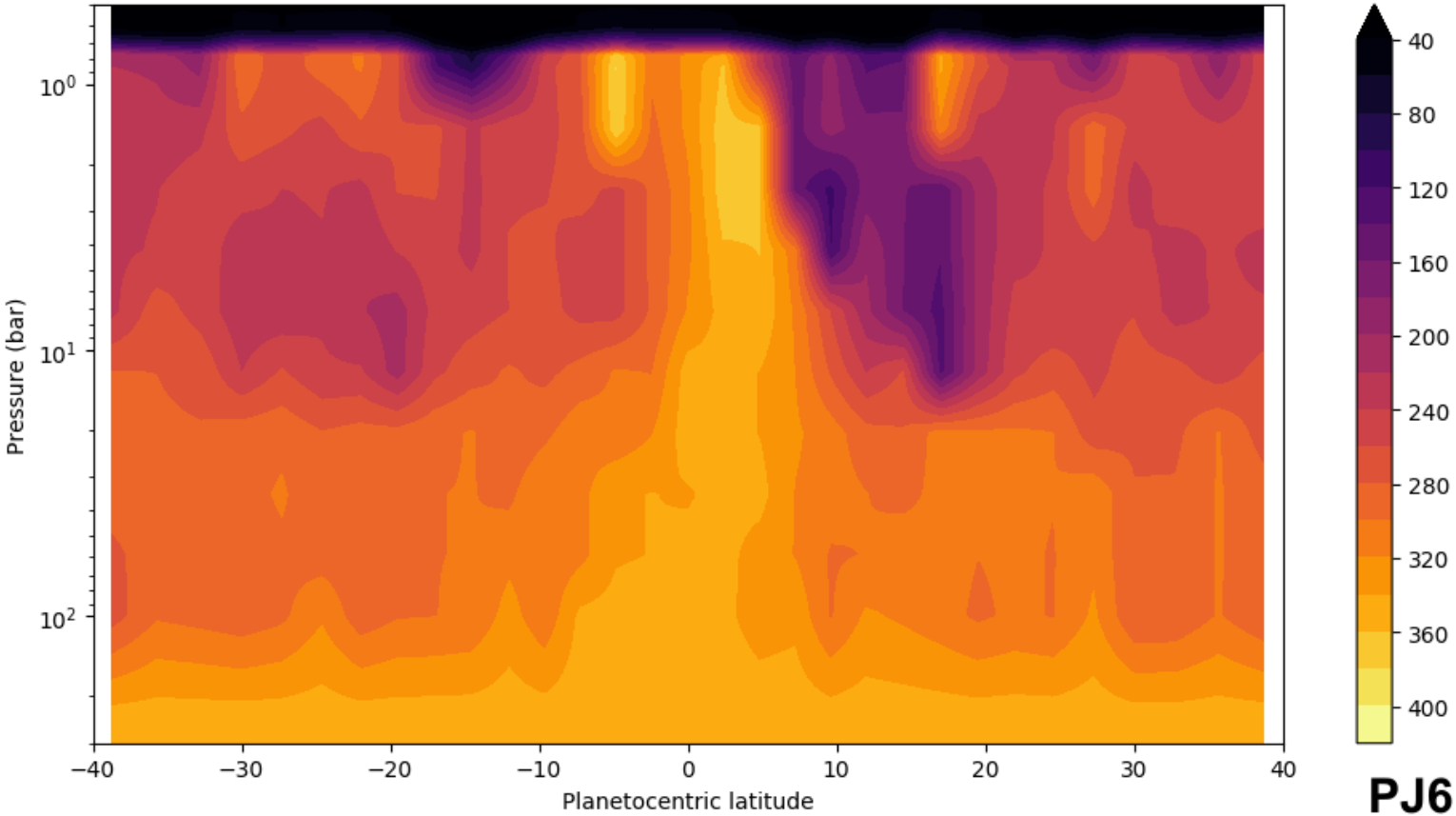


Pressure vessel at Georgia Tech with Steffes and students

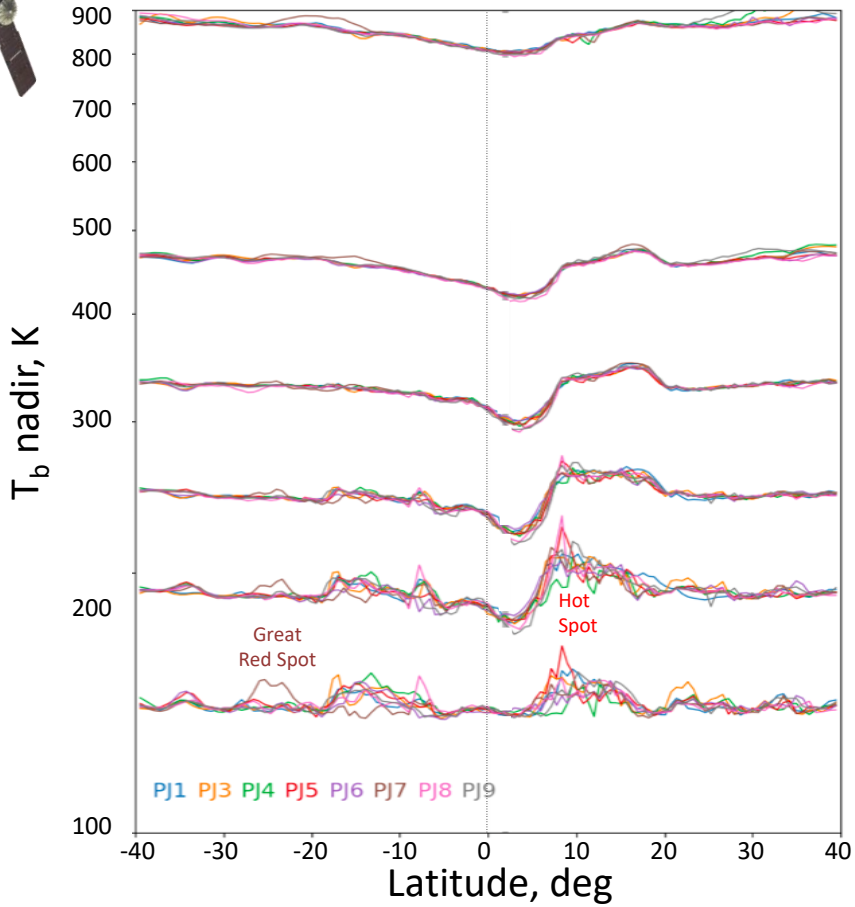
MWR Science Objectives

- **Understand atmospheric structure and dynamics**
  - to pressures ≥ 100 bars
- **Determine global water and ammonia concentration**
  - abundances to pressures ≥ 100 bars
- **Observe non-thermal emissions (radiation belts)**
  - Synchrotron emission as seen up close from multiple perspectives
  - Lightning
  - Polar currents and auroral phenomena

Retrieved NH_3 Concentration [ppm]

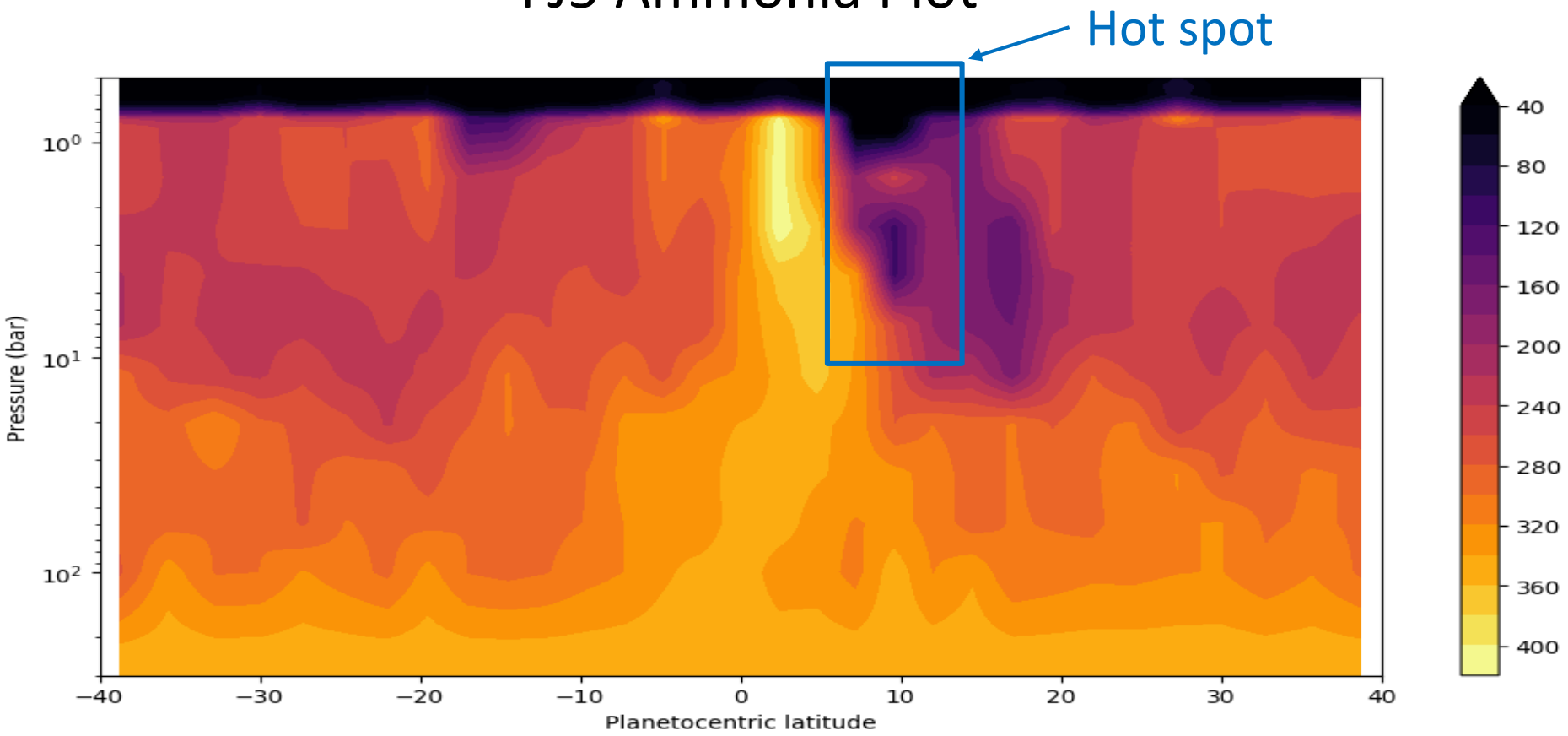


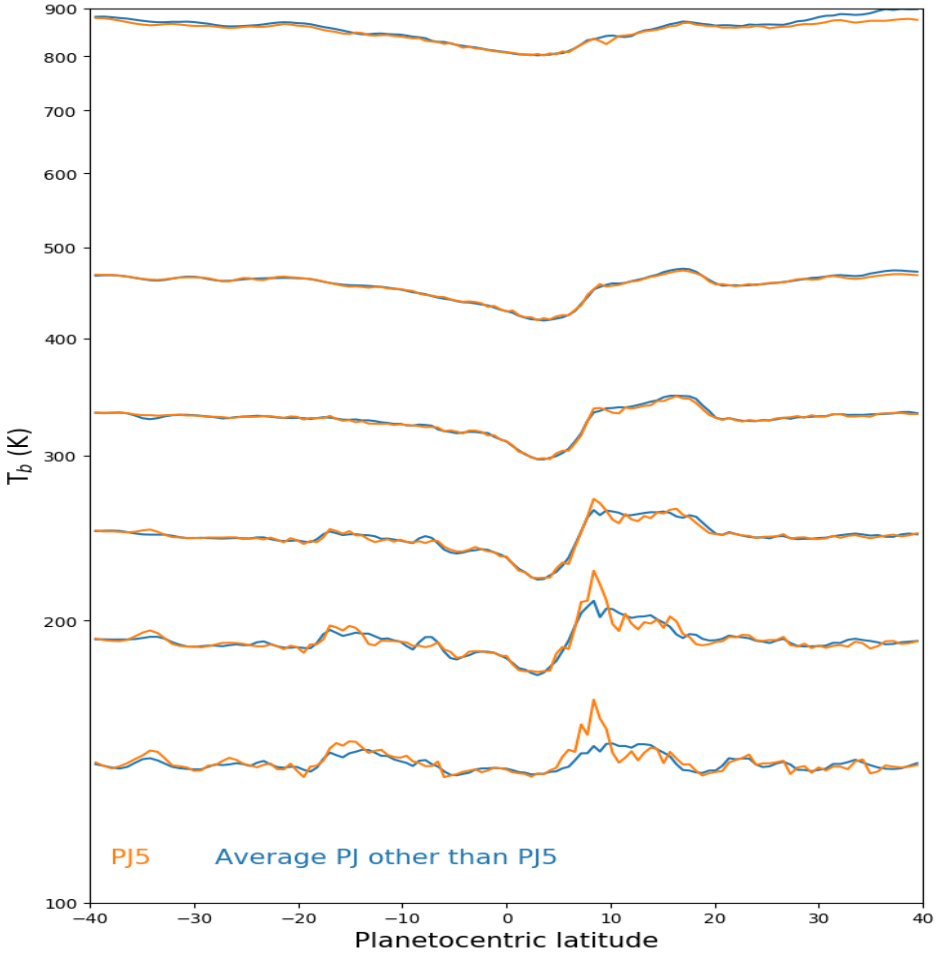
Nadir Brightness Tracks

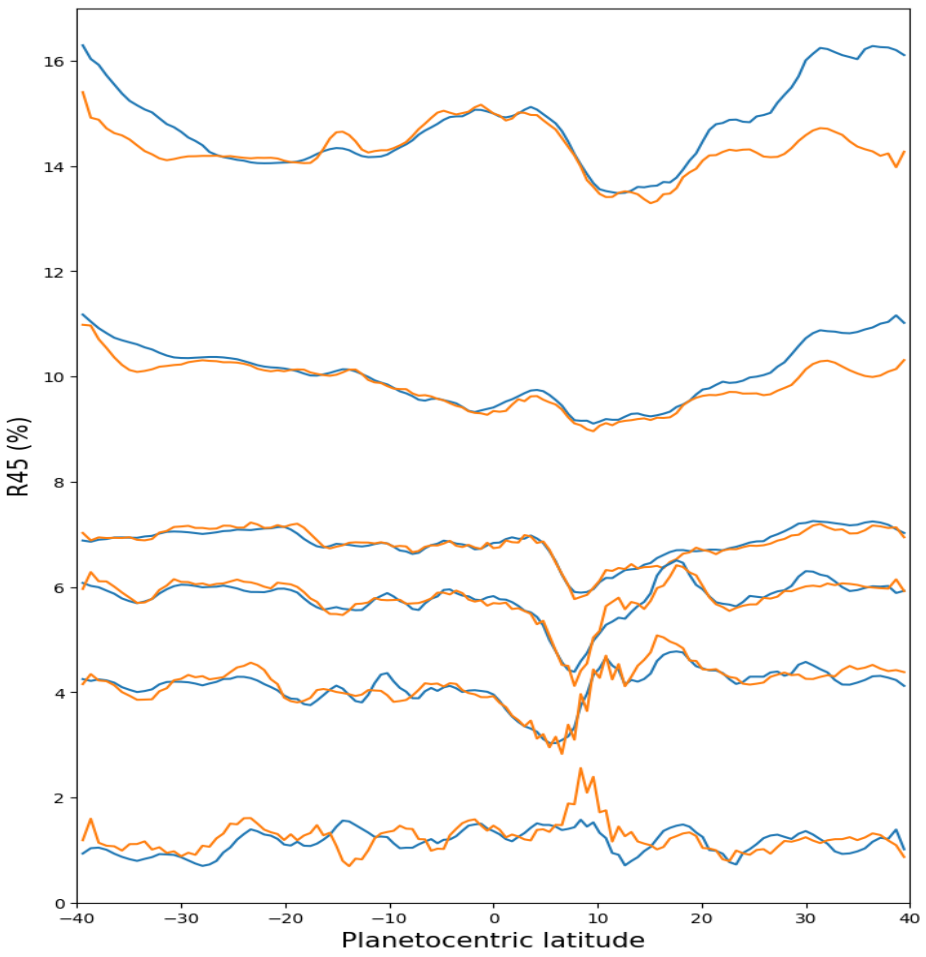


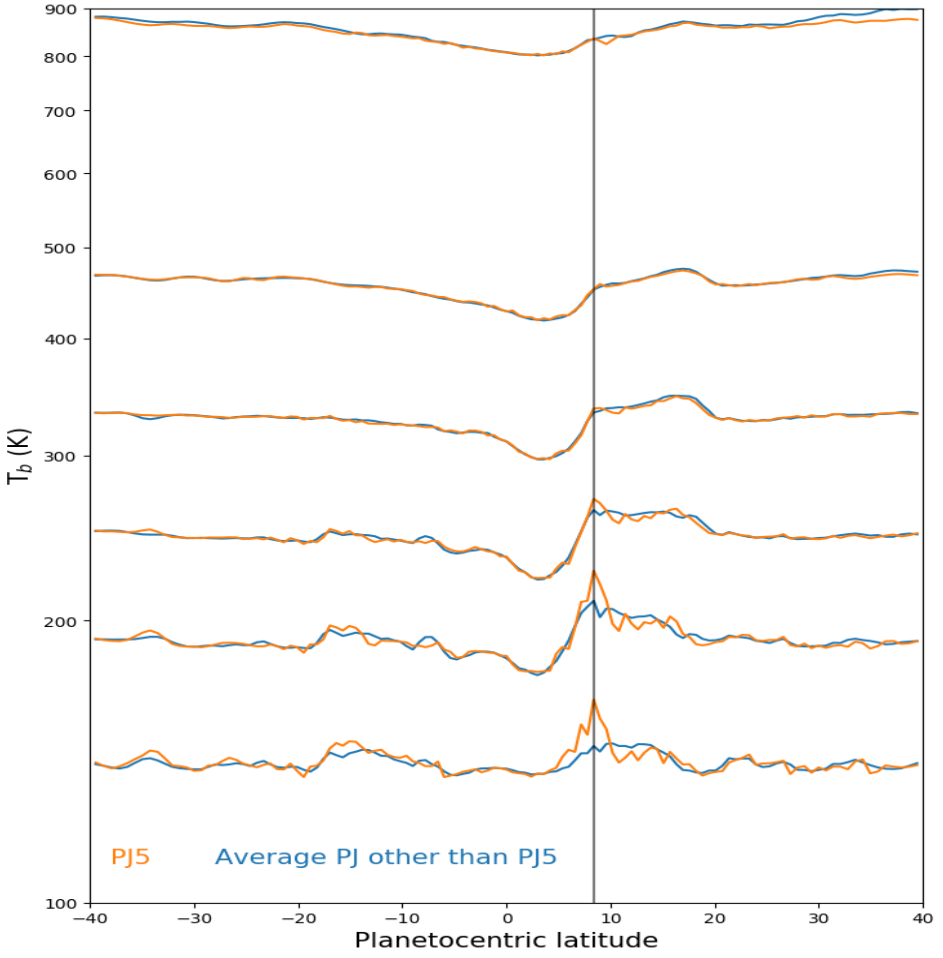
- Long-term instability << 1% as evidenced by pass to pass repeatability in “quiet” zones
  - Equatorial zone
  - Deep atmosphere
- “Weather” apparent in
  - NEB and SEB
  - Shallow atmosphere
- Starting to identify features at particular longitudes

PJ5 Ammonia Plot




900
800
700
600
500
400
300
200
100
T_b (K)
PJ5
Average PJ other than PJ5
−40
−30
−20
−10
0
10
20
30
40
Planetocentric latitude


16
14
12
10
8
6
4
2
0
R45 (%)
−40
−30
−20
−10
0
10
20
30
40
Planetocentric latitude


900
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T_b (K)
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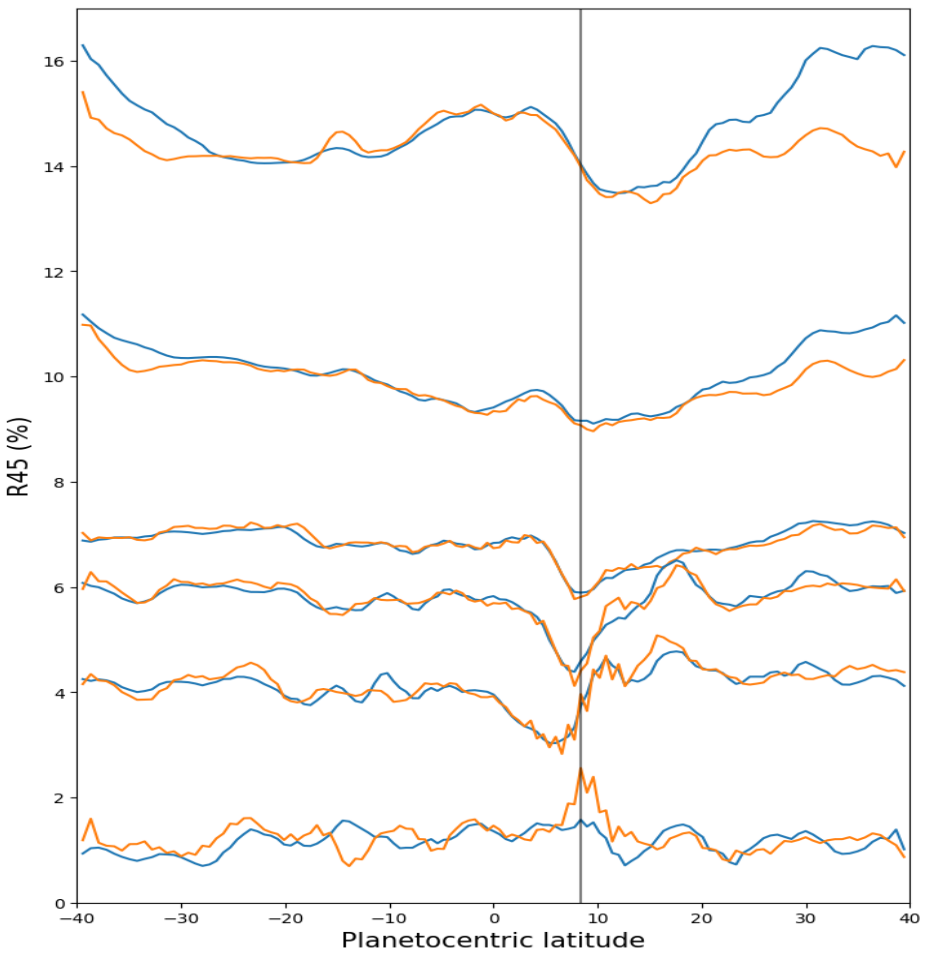
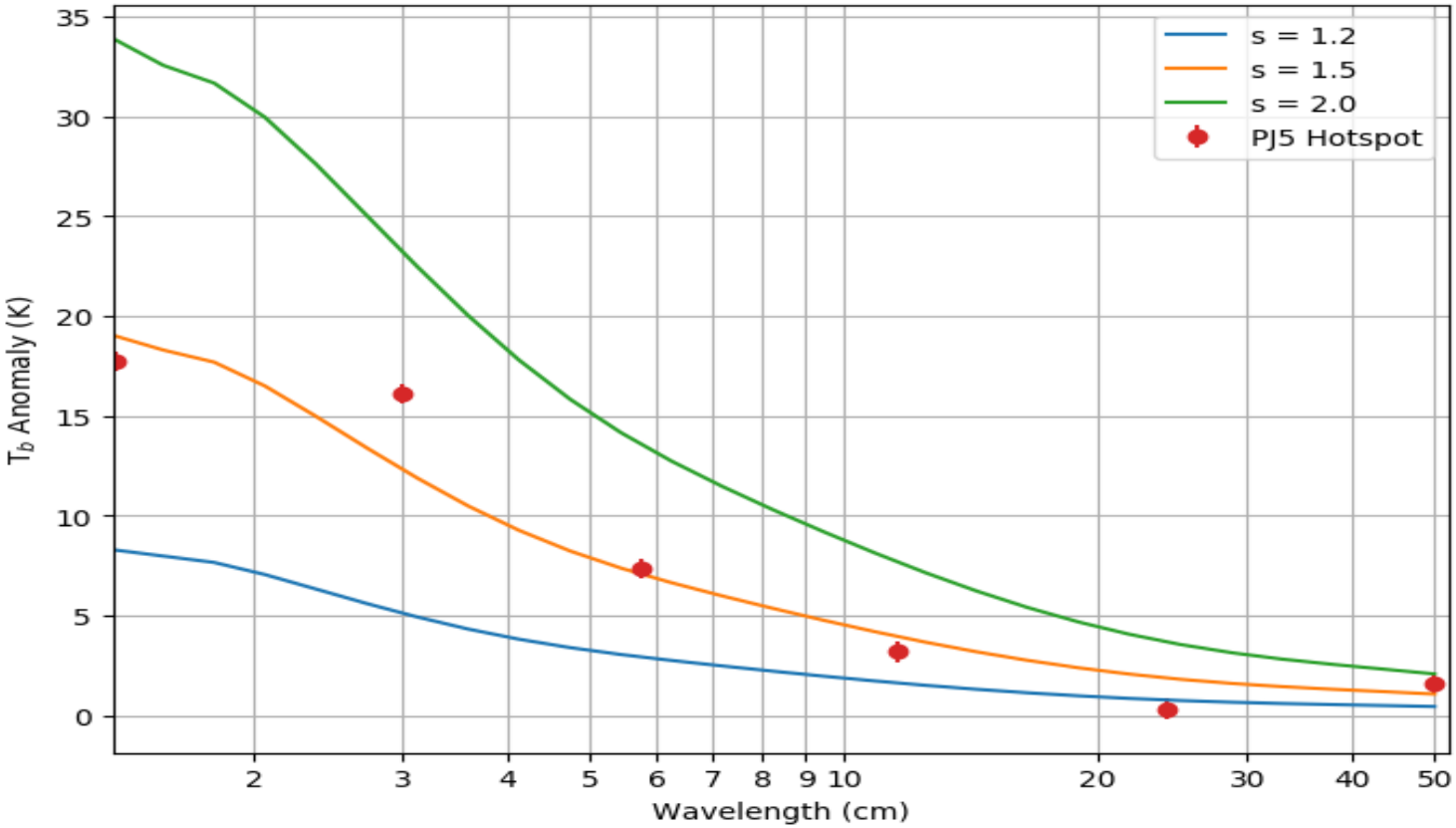
Planetocentric latitude

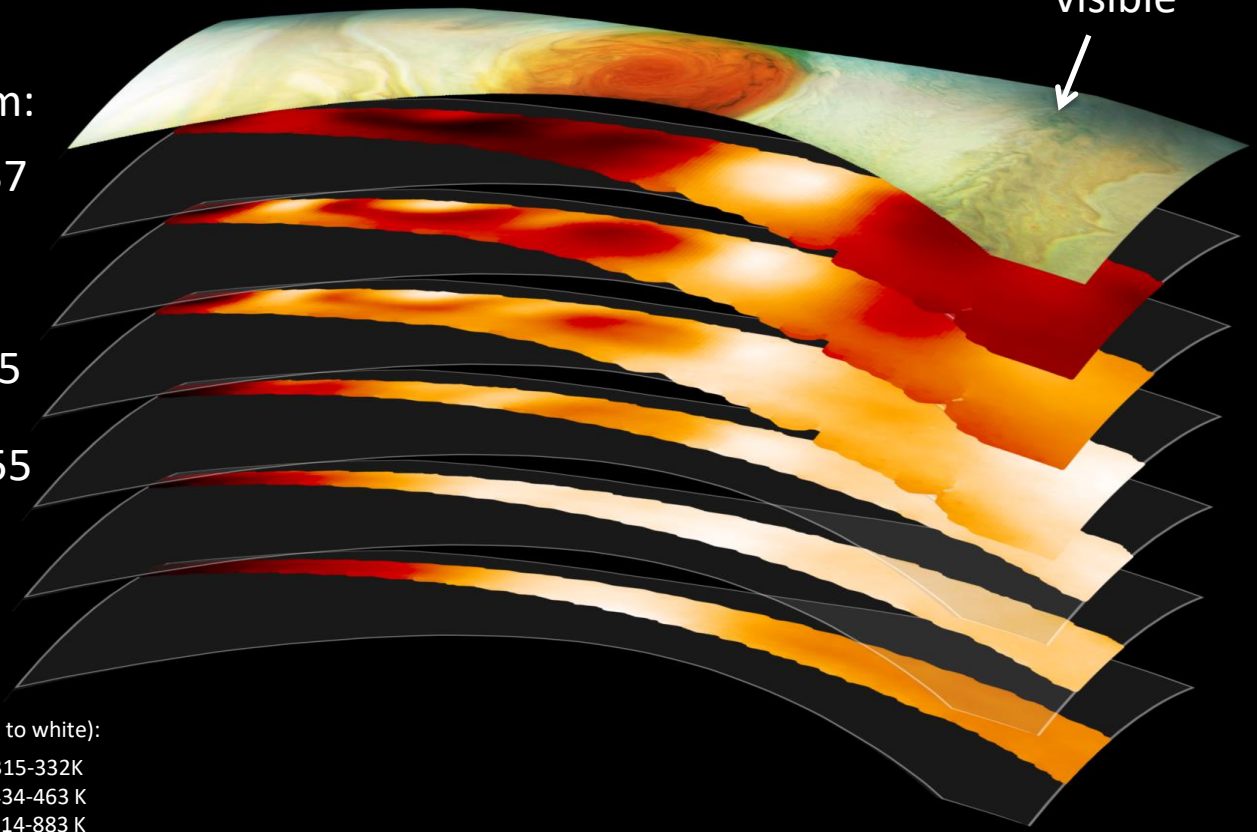

16
14
12
10
8
6
4
2
0
R45 (%)
−40
−30
−20
−10
0
10
20
30
40
Planetocentric latitude

MWR hotspot



Cheng Li 2018

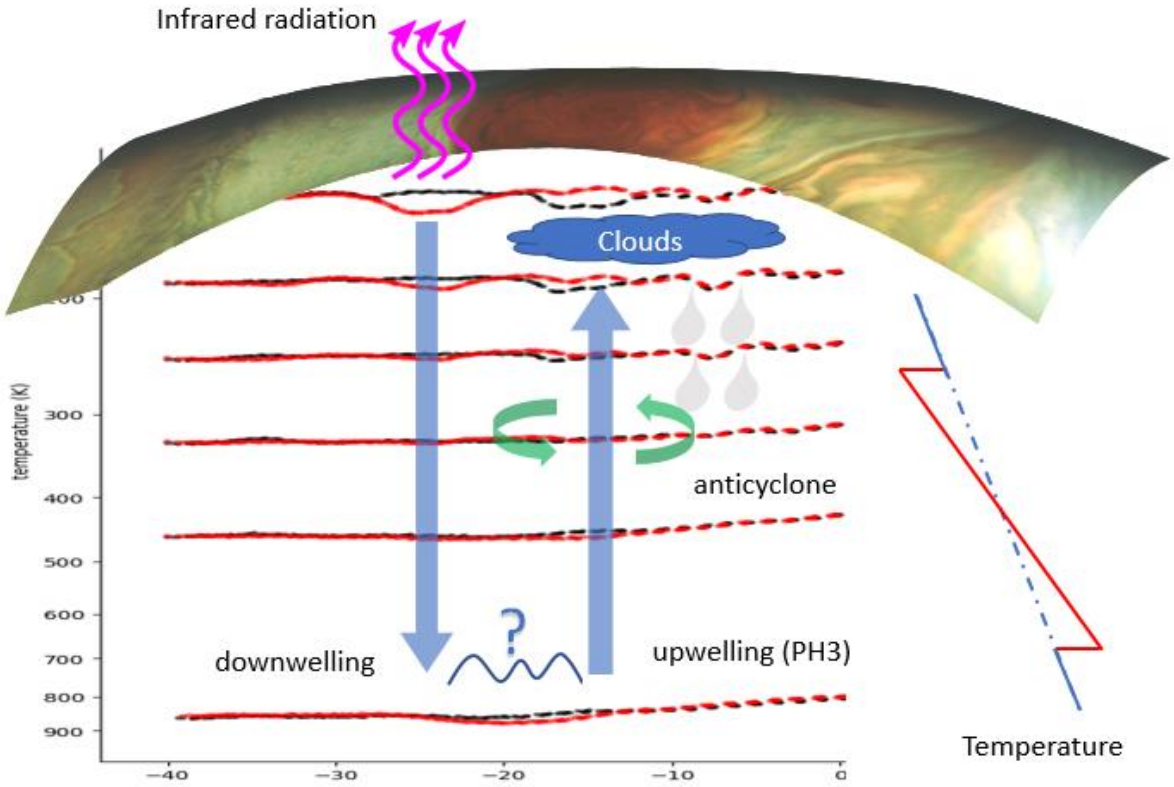
Great Red Spot in 3D



Color temperature scale (red to white):

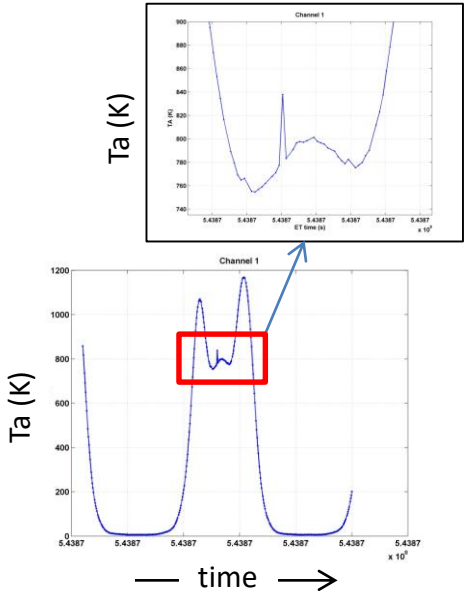
1.37	136-150 K	11.55	315-332K
3	181-194 K	24	434-463 K
5.75	234-248 K	50	814-883 K

Conceptual Model of the GRS

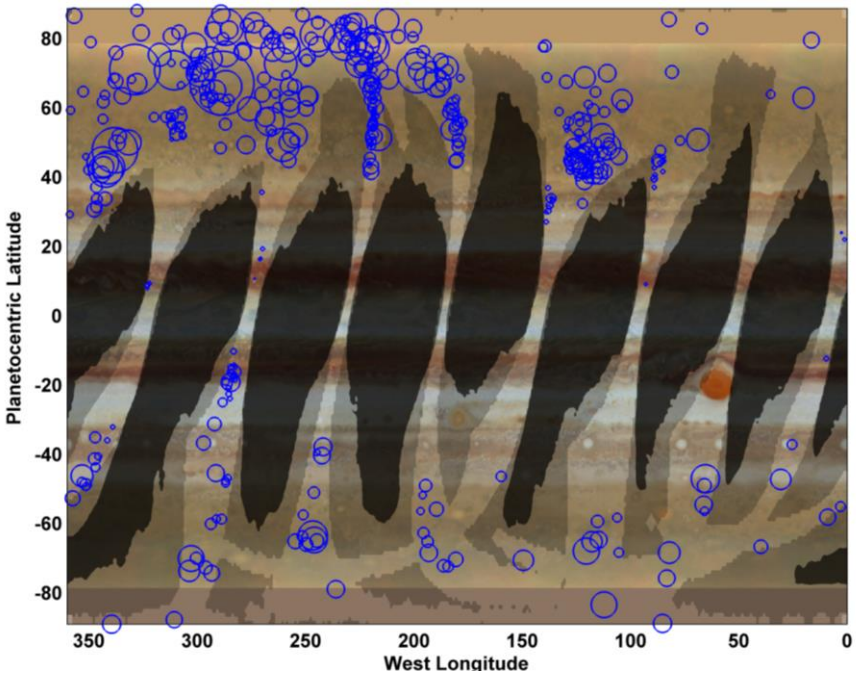


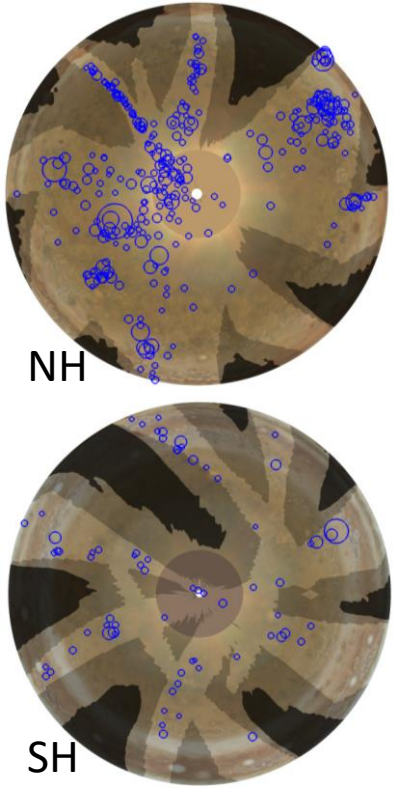
Lightning (PJ1 – PJ9)

Lightning produces diagnostic spikes at 100-ms sampling:



One spacecraft spin at 500 MHz (50-cm λ)

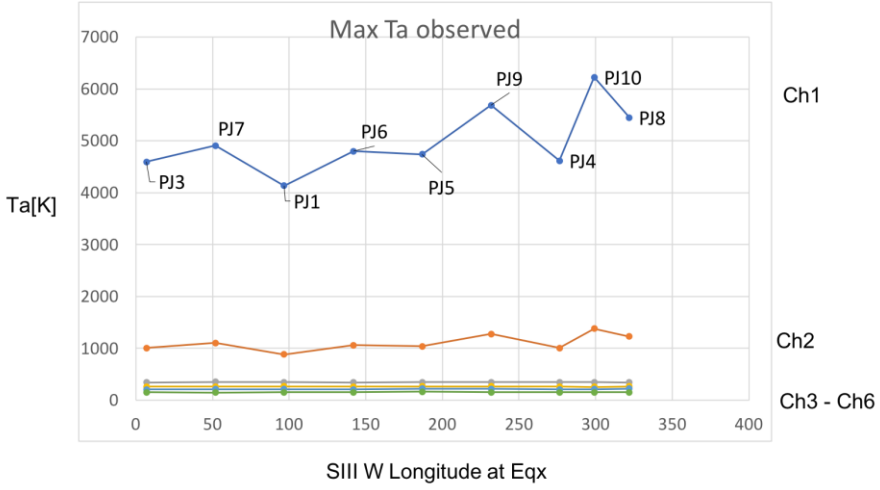


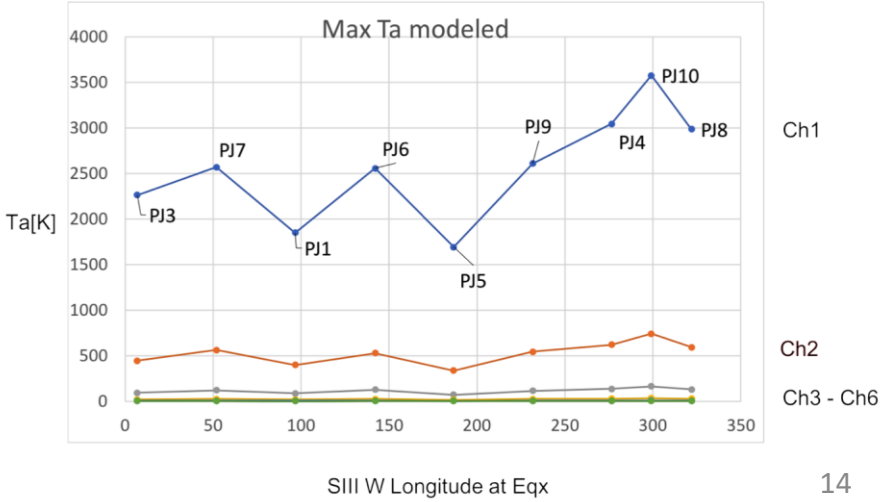


Shannon Brown 2018

Synchrotron Radiation

Observed vs. Modeled Maximum Antenna Temperature (Synchrotron Radiation) from 10 Perijove Passes

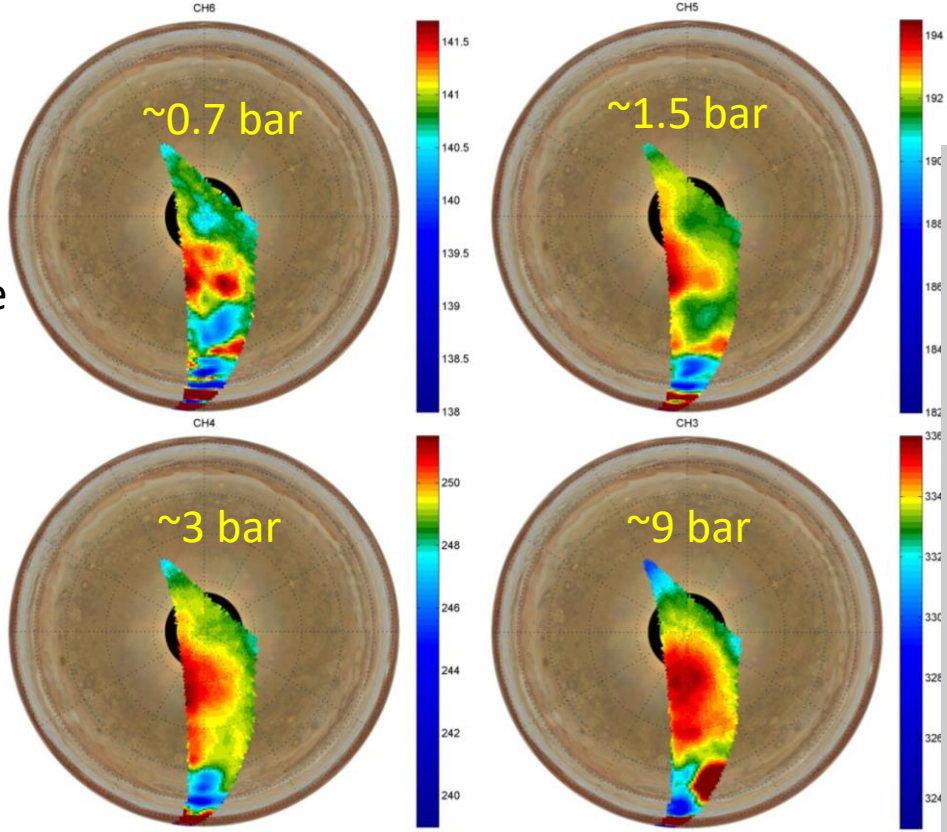




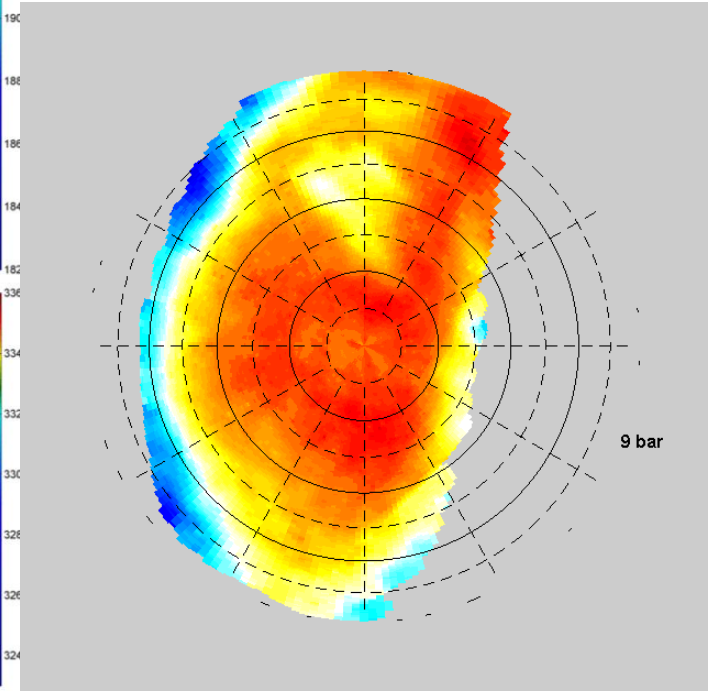
Polar View Improves In Later Orbits

Sample polar map fragments from PJ3.

As MWR accumulates polar data, we can map structure at depth by making assumptions about limb darkening.



Very preliminary map fragments from PJ11.



Summary

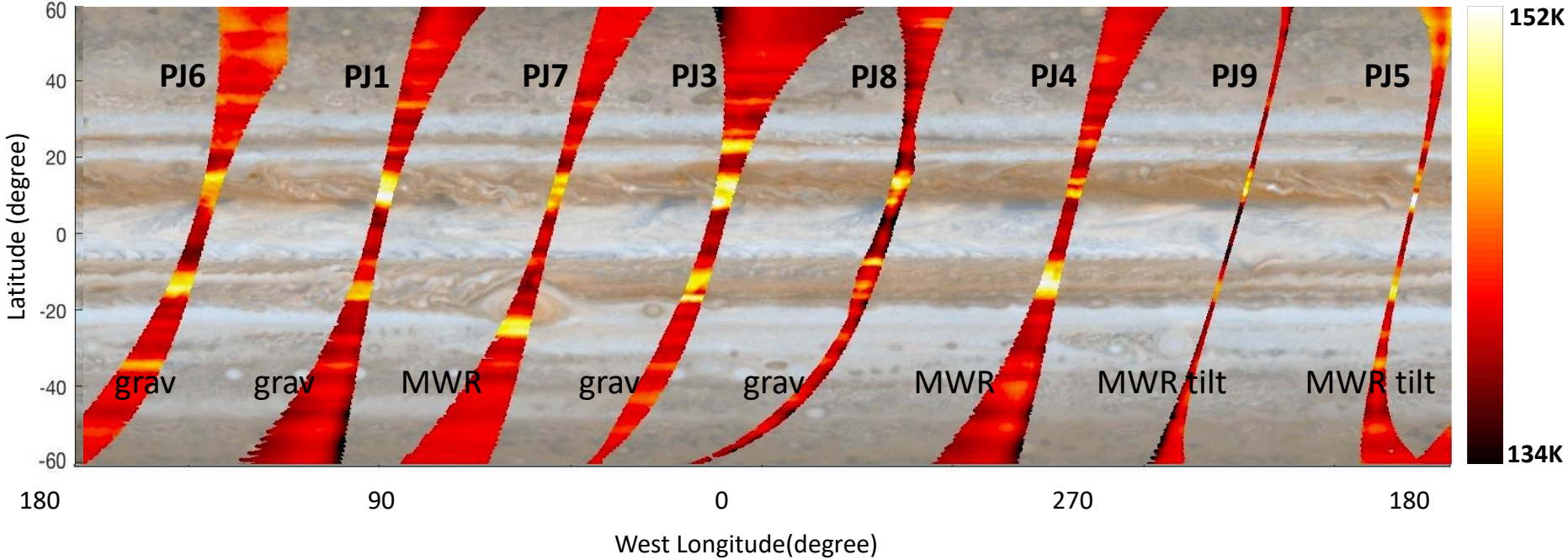
- MWR instrument performance remains nominal
- Progress made on many fronts:
  - NH_3 distribution extended globally in longitude
  - Comparison of individual perijove passes to global average yielding new insights
  - Non-thermal emission studies expanded
  - Lightning adds new dimension for understanding composition and circulation
- Future
  - Expand global coverage to poles
  - Determine dynamical model that supports the data
  - Explore water constraints and address concentration
  - Model radiation belts and other magnetospheric phenomena

Questions?

Backup Slides

Coverage Through PJ9 (Oct 2017)

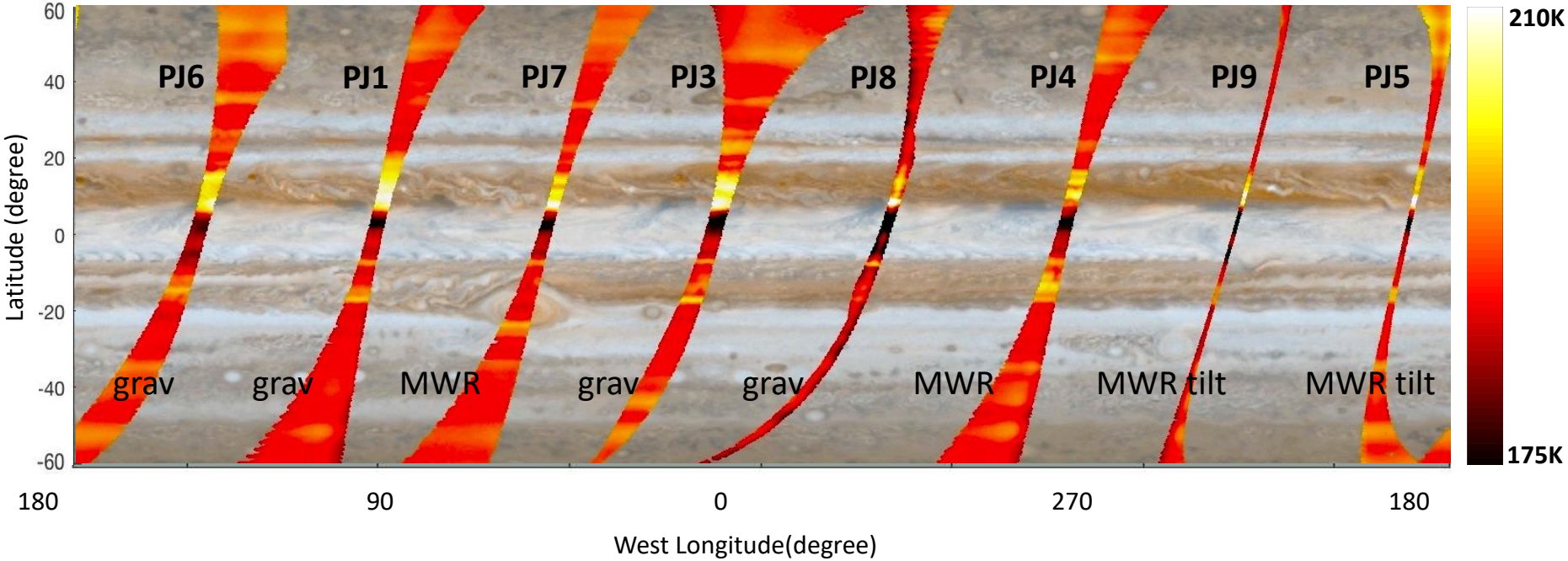
1.37 cm wavelength



Mean Pressure = 0.7 bar

Coverage Through PJ9 (Oct 2017)

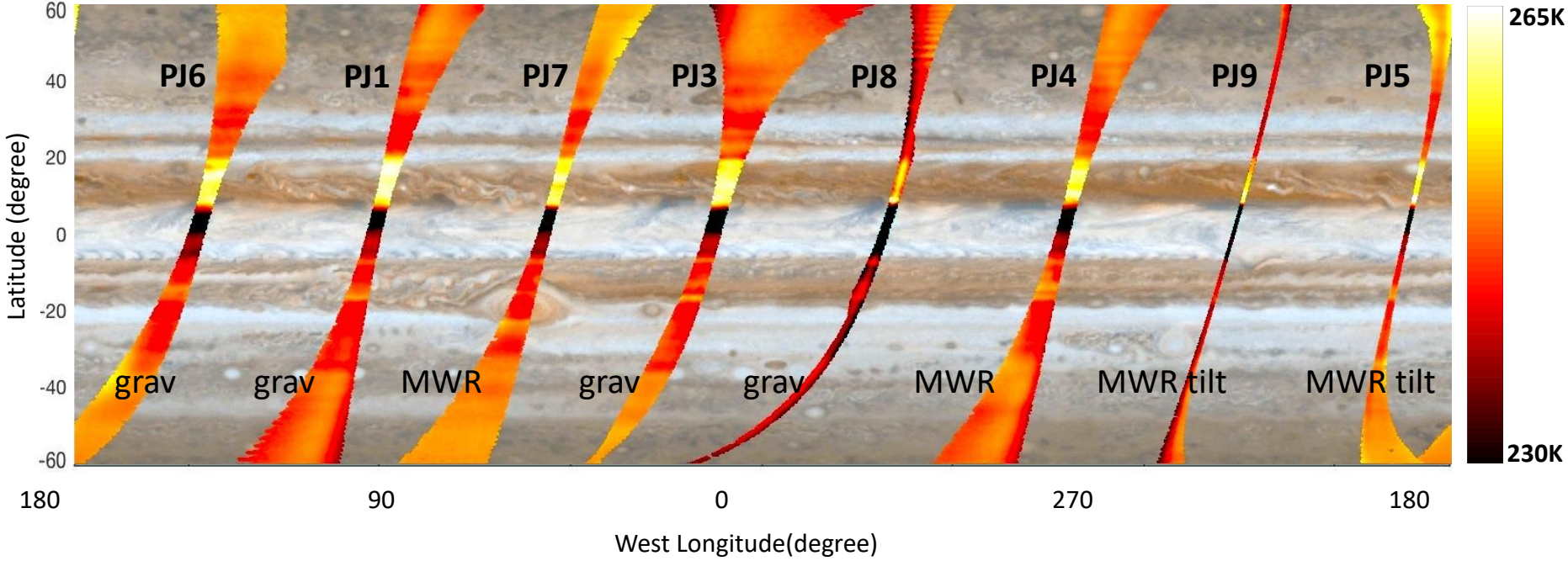
3 cm wavelength



Mean Pressure = 1.5 bar

Coverage Through PJ9 (Oct 2017)

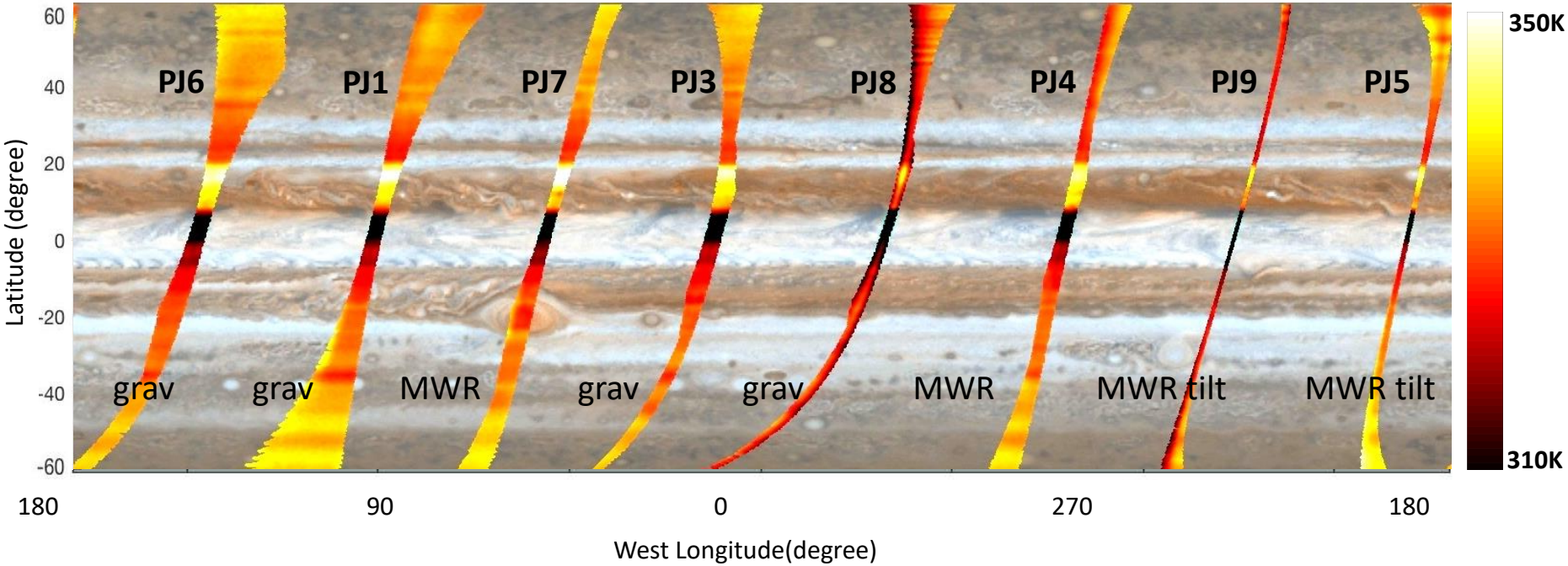
5.75 cm wavelength



Mean Pressure = 3 bar

Coverage Through PJ9 (Oct 2017)

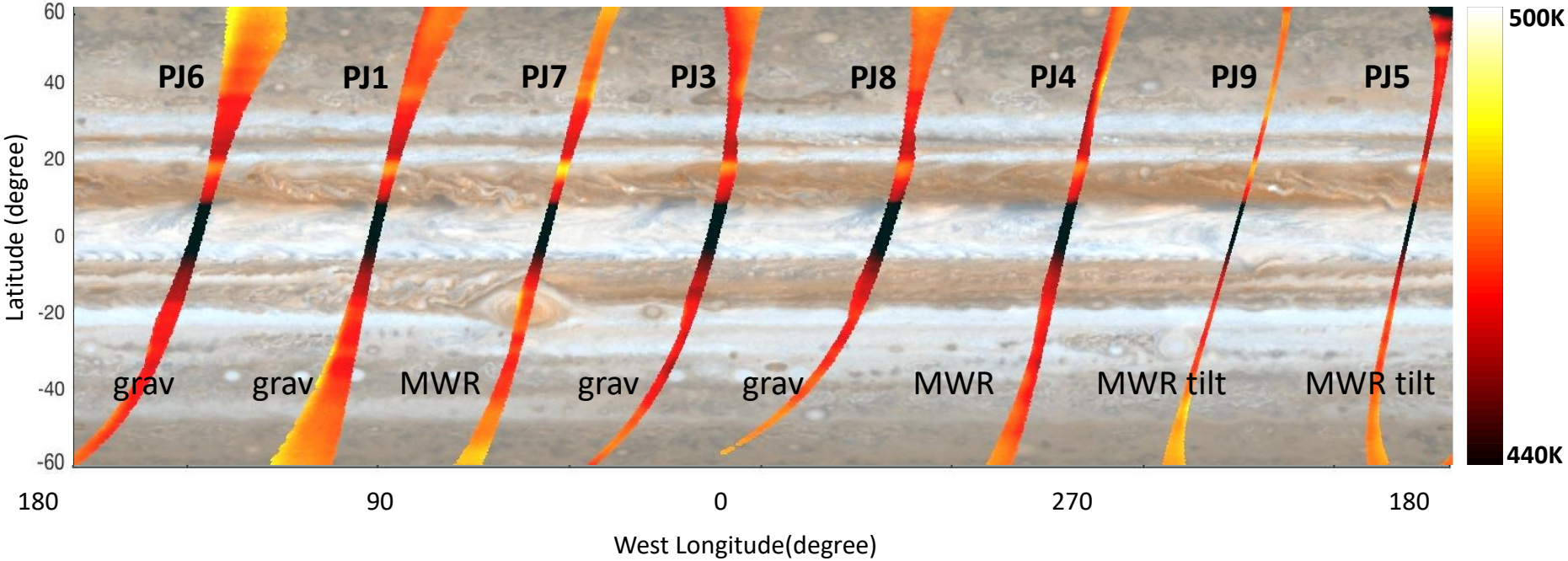
11.55 cm wavelength



Mean Pressure = 9 bar

Coverage Through PJ9 (Oct 2017)

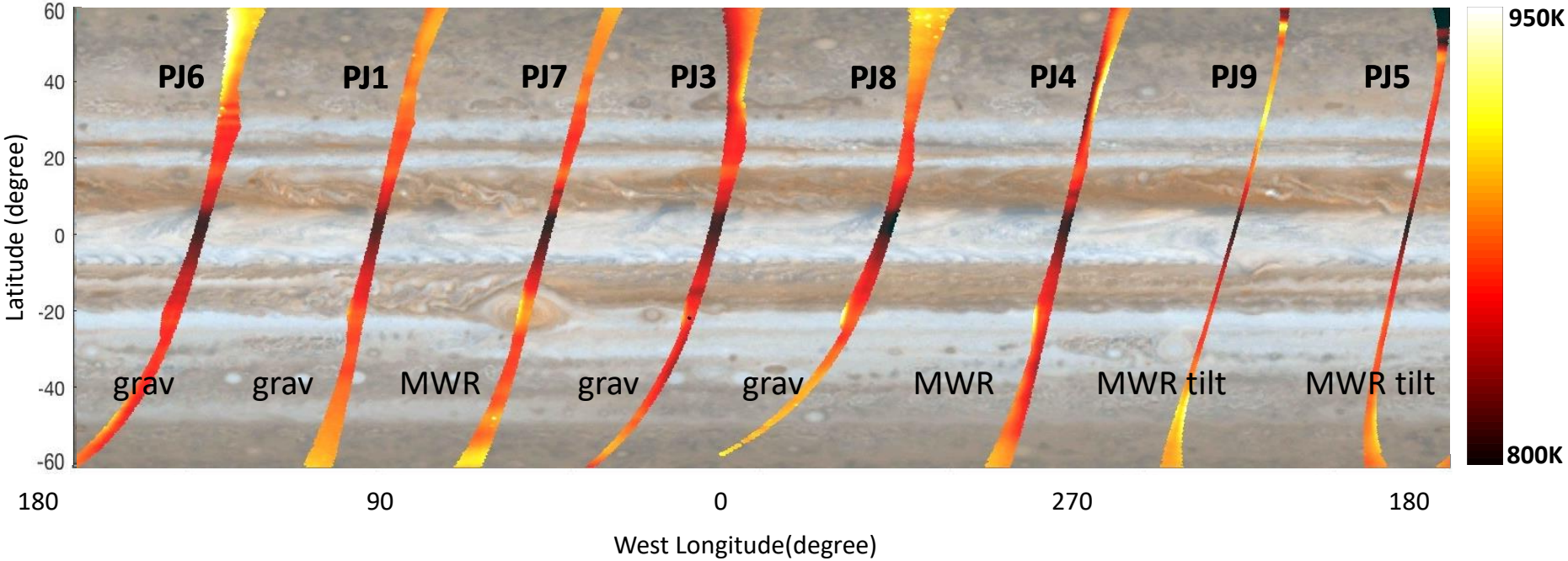
24 cm wavelength

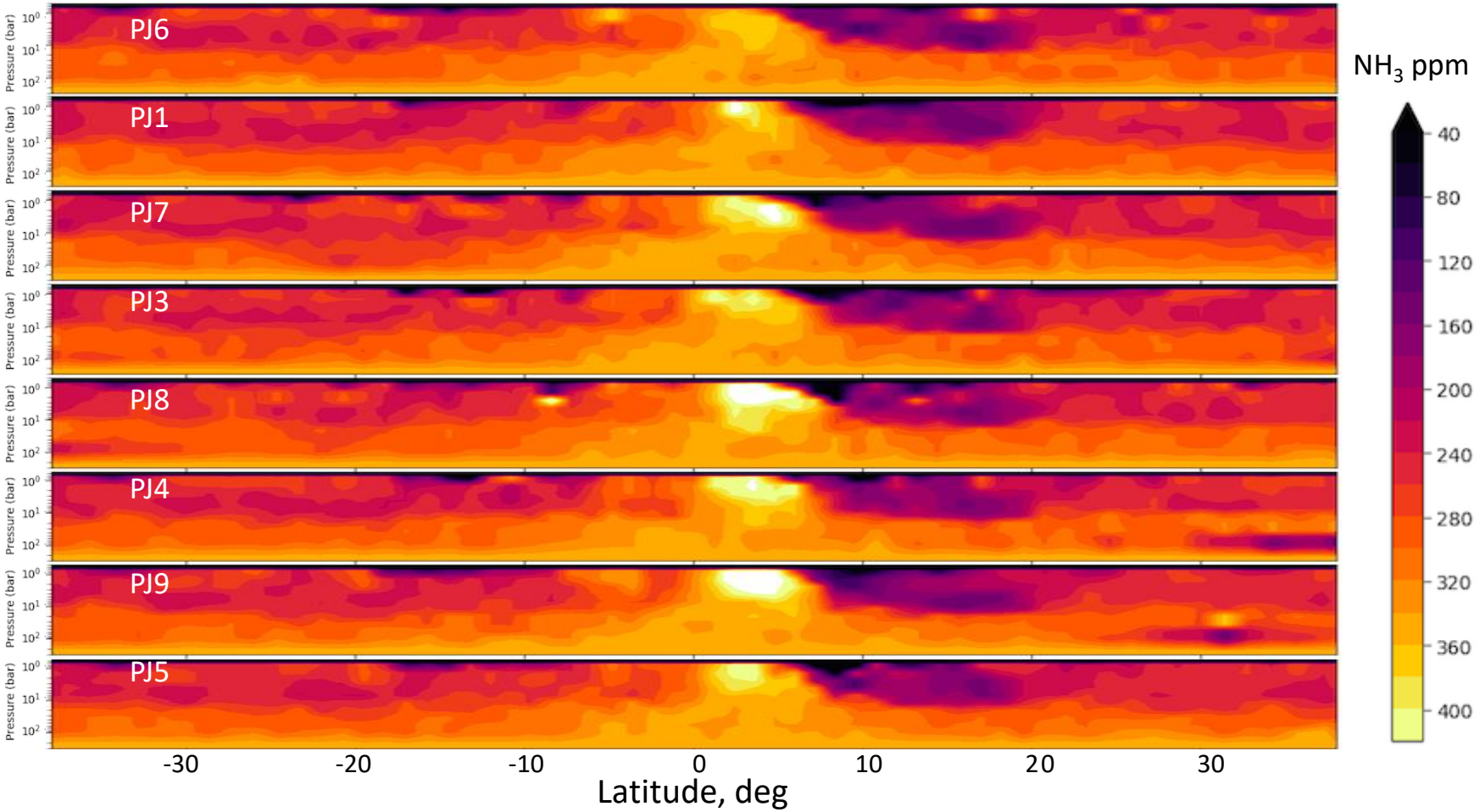


Mean Pressure = 30 bar

Coverage Through PJ9 (Oct 2017)

50 cm wavelength



Mean Pressure = 200 bar

Ammonia Distribution