

Observations and numerical simulations of gas giant atmospheres

Dr. Raúl Morales-Juberías



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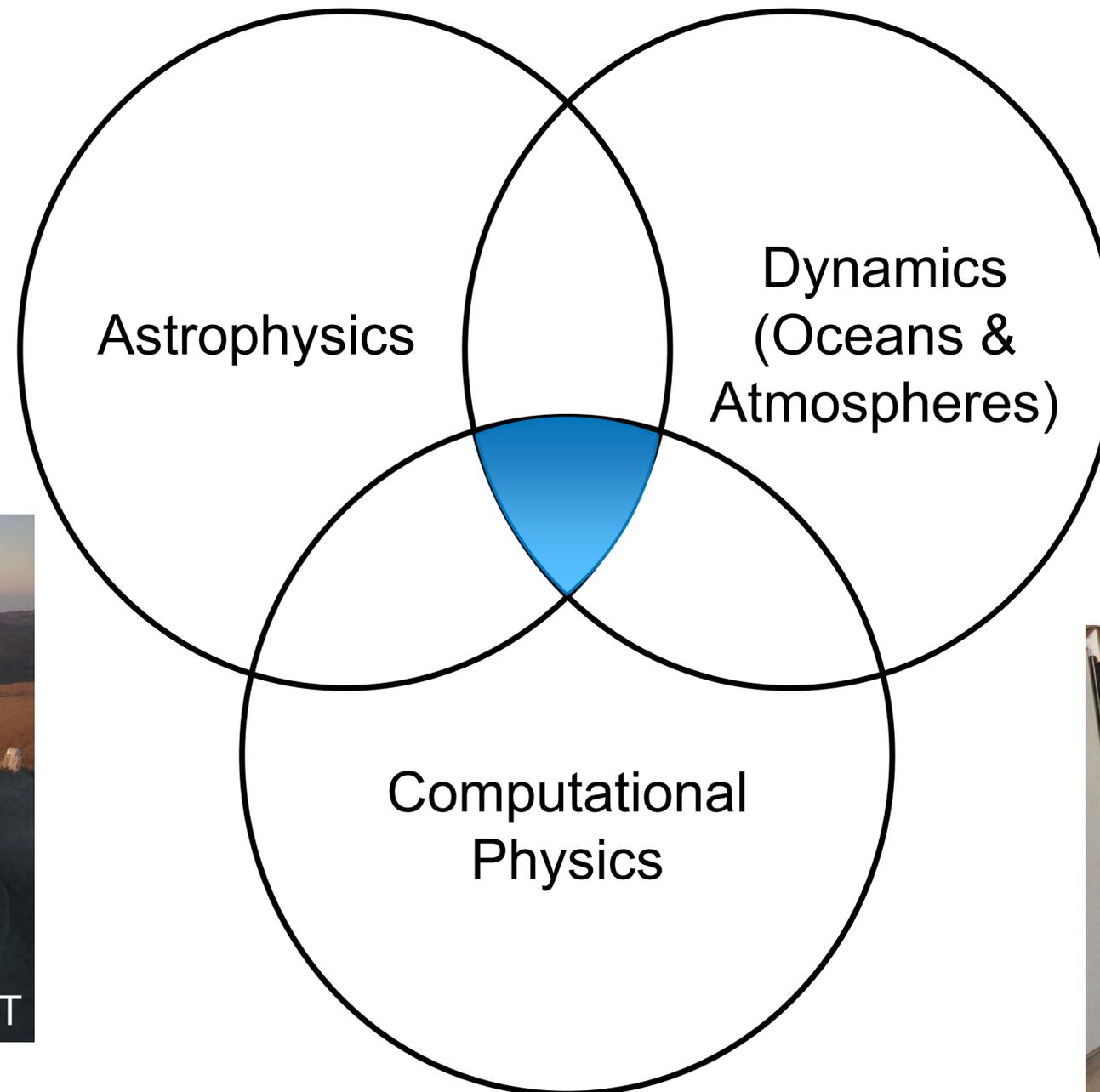
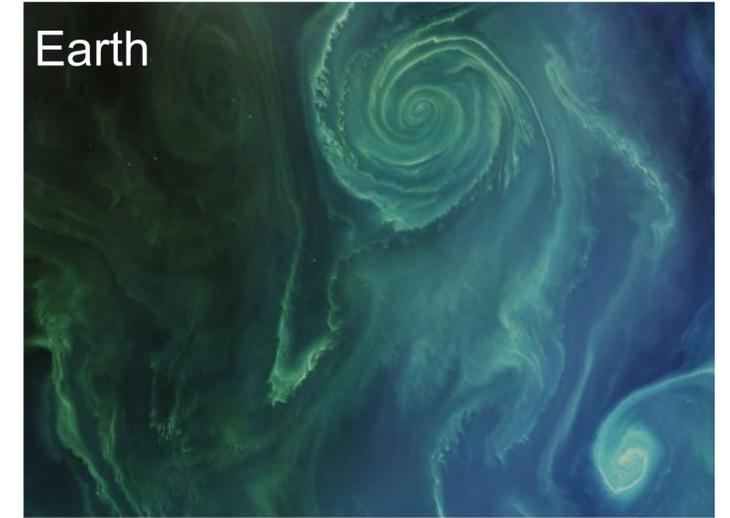
Outline

Observations and numerical simulations of gas giant atmospheres

1. Planetary atmospheres
2. Measuring winds - two techniques
 1. Cloud correlations (1D & 2D winds)
 2. Doppler (3D)
3. Life cycle of spots
 1. Neptune
4. Conclusions & Questions

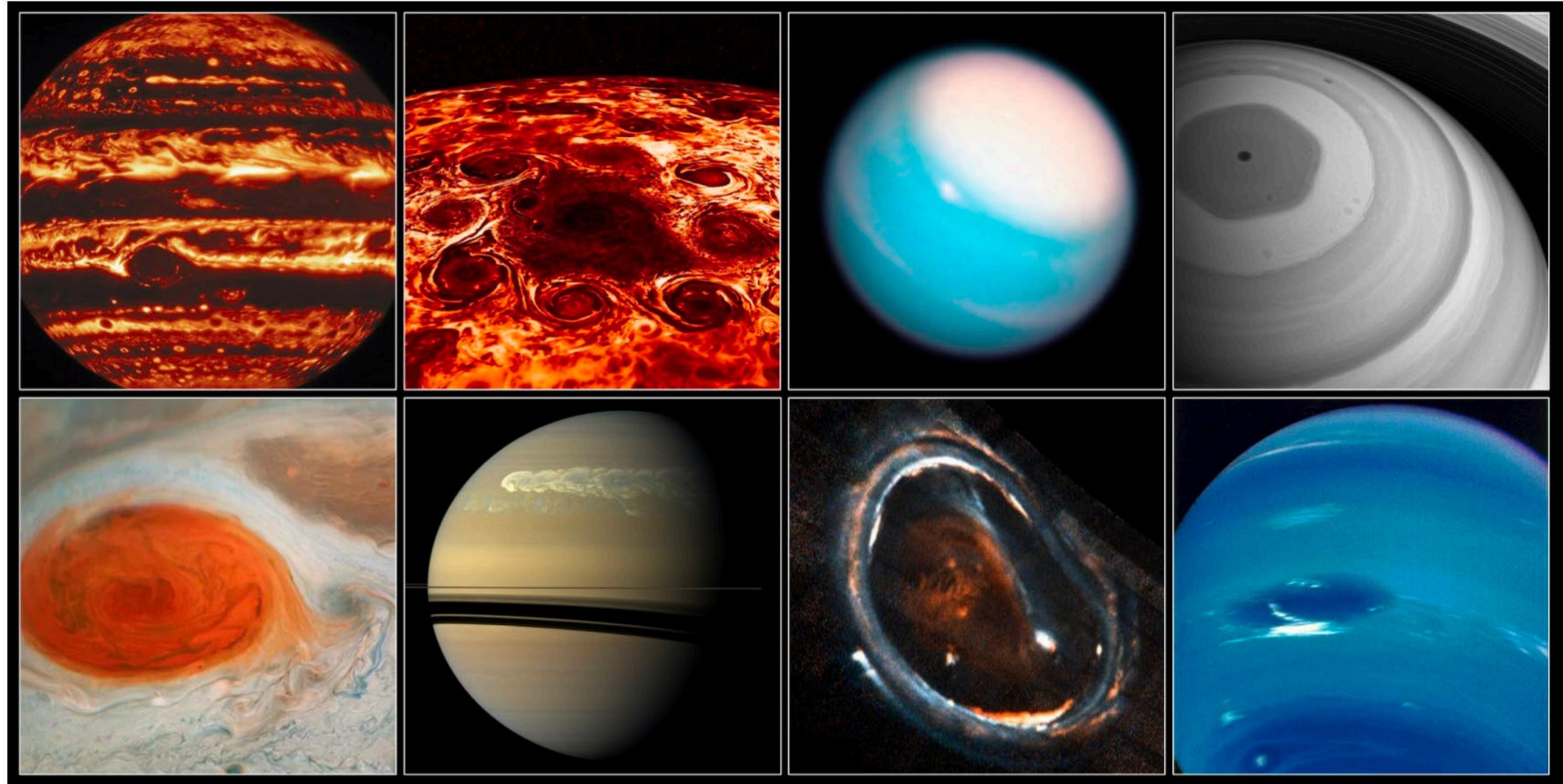
Planetary Atmospheres

Interdisciplinary research



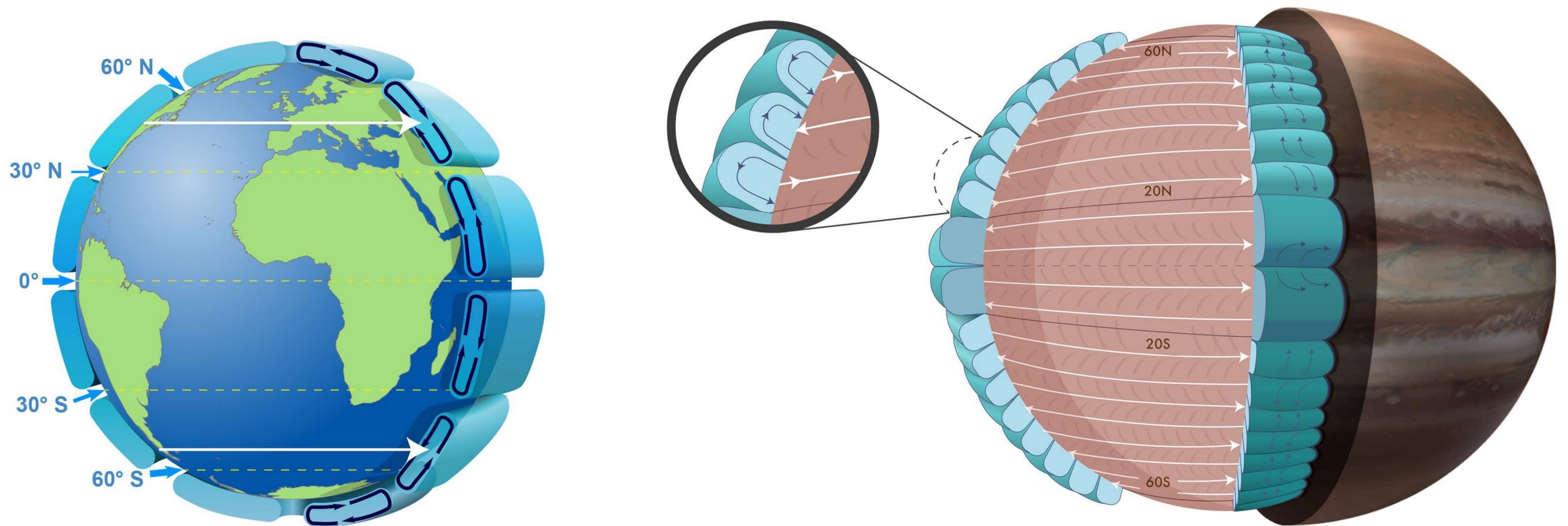
Planetary atmospheres

Rich phenomenology



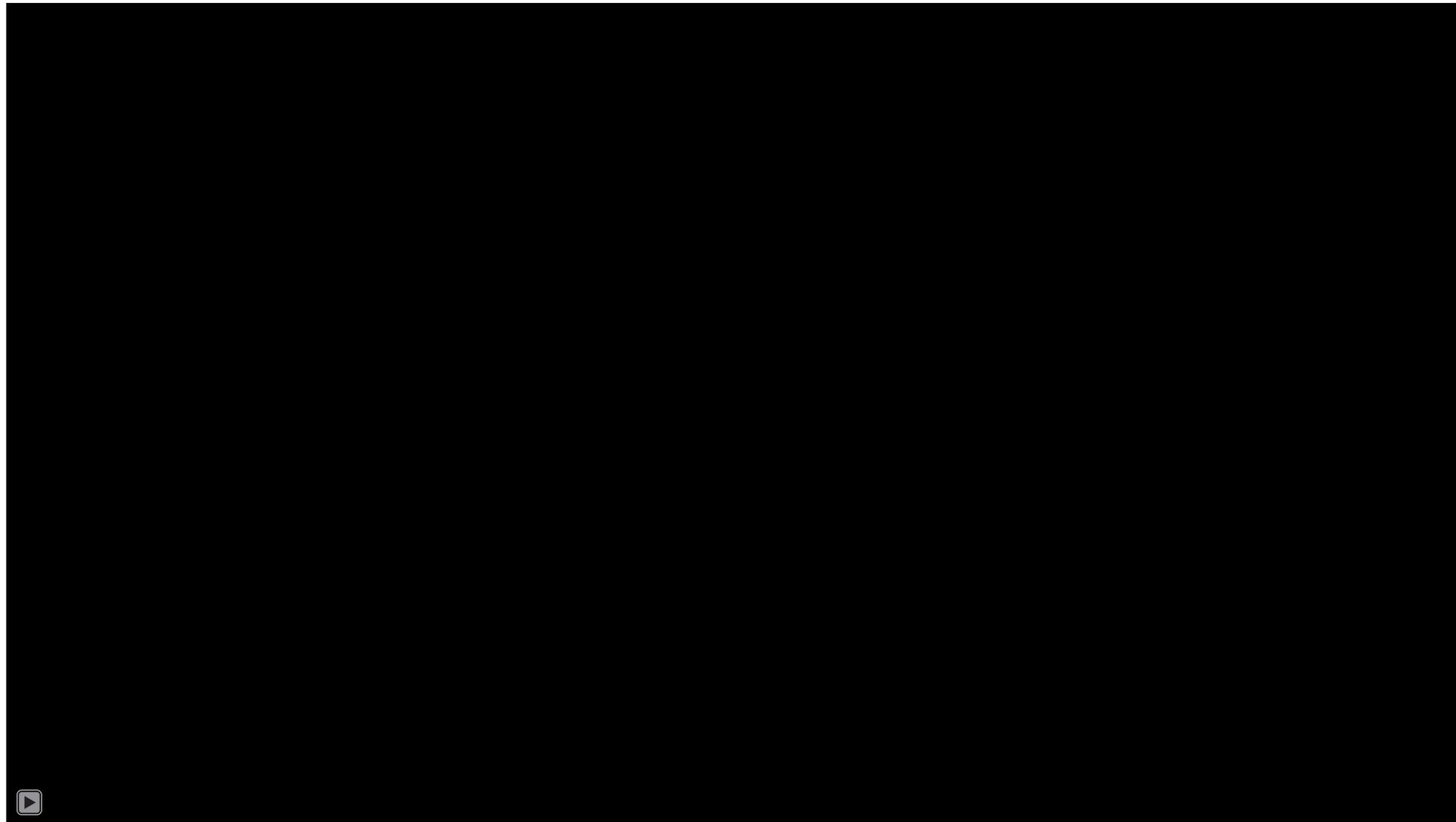
Planetary atmospheres

Circulation Models

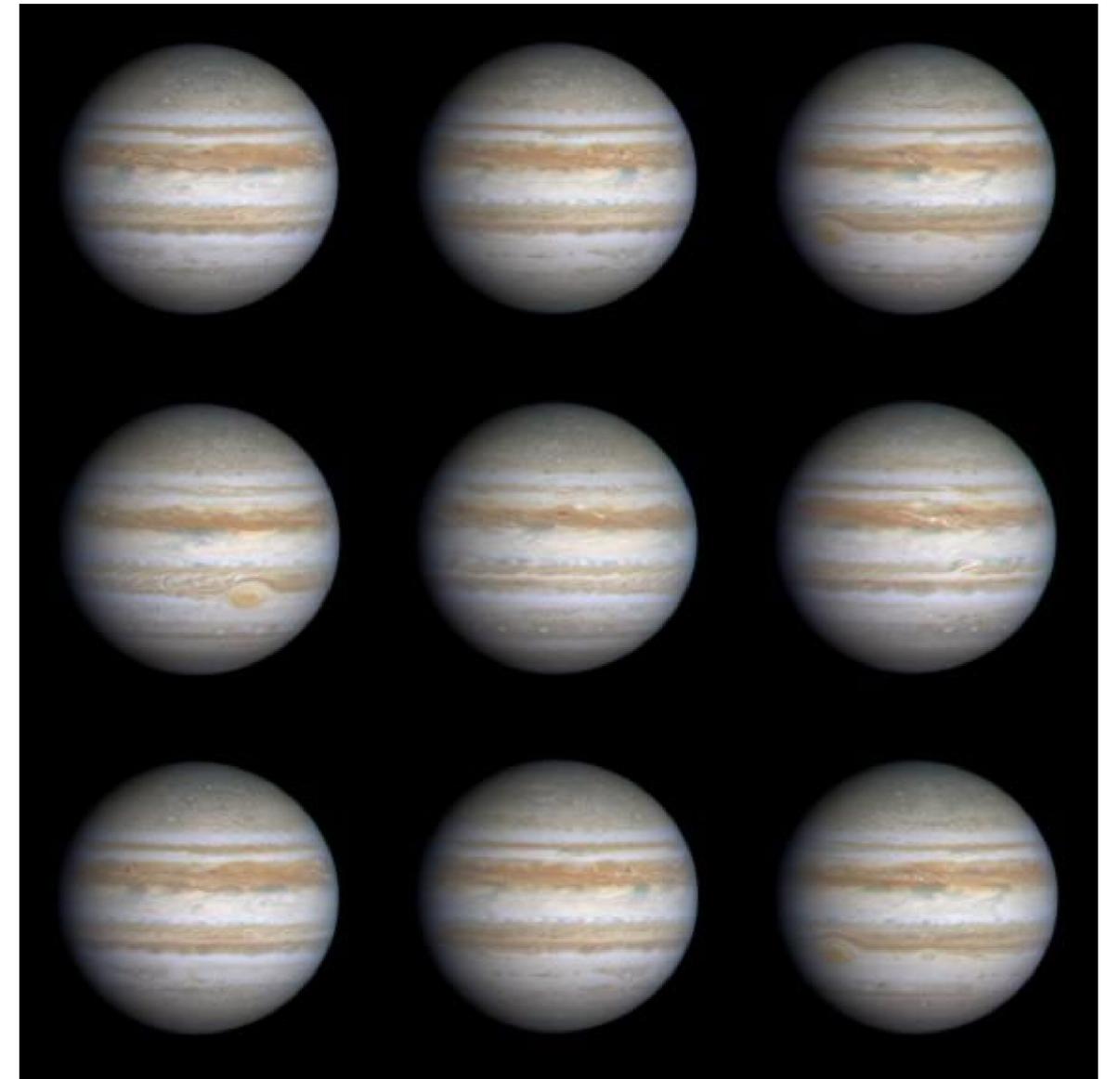


Measuring winds - Cloud tracking

Ex. Jupiter



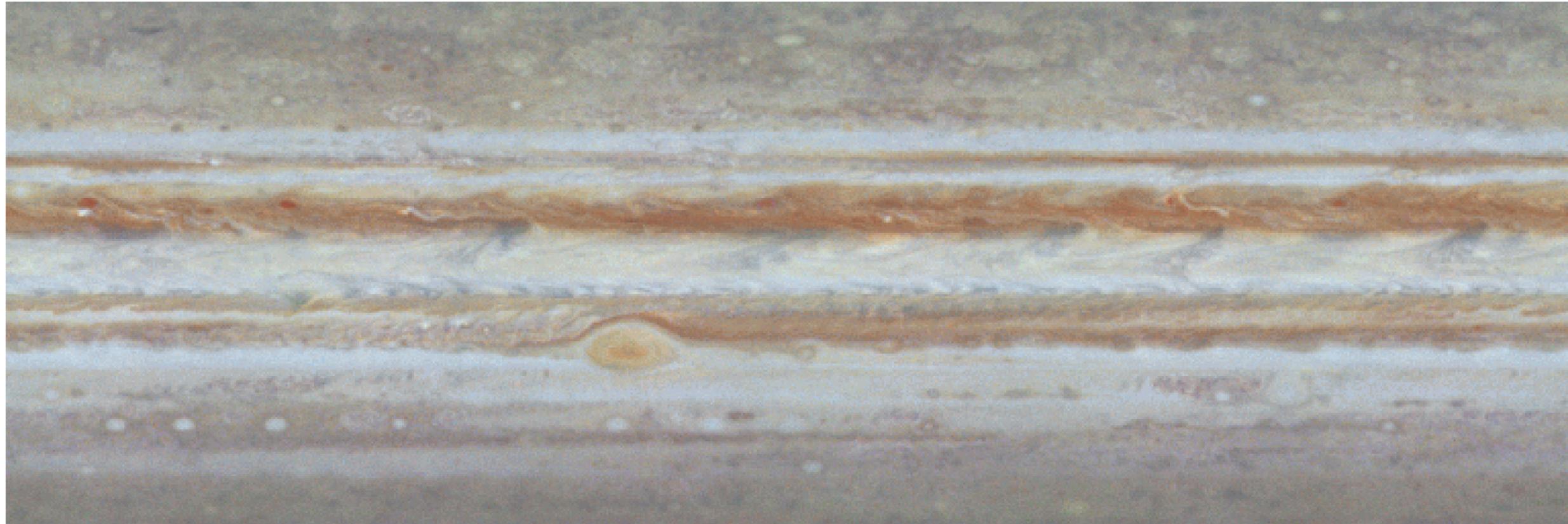
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NASA/JPL/University of Arizona

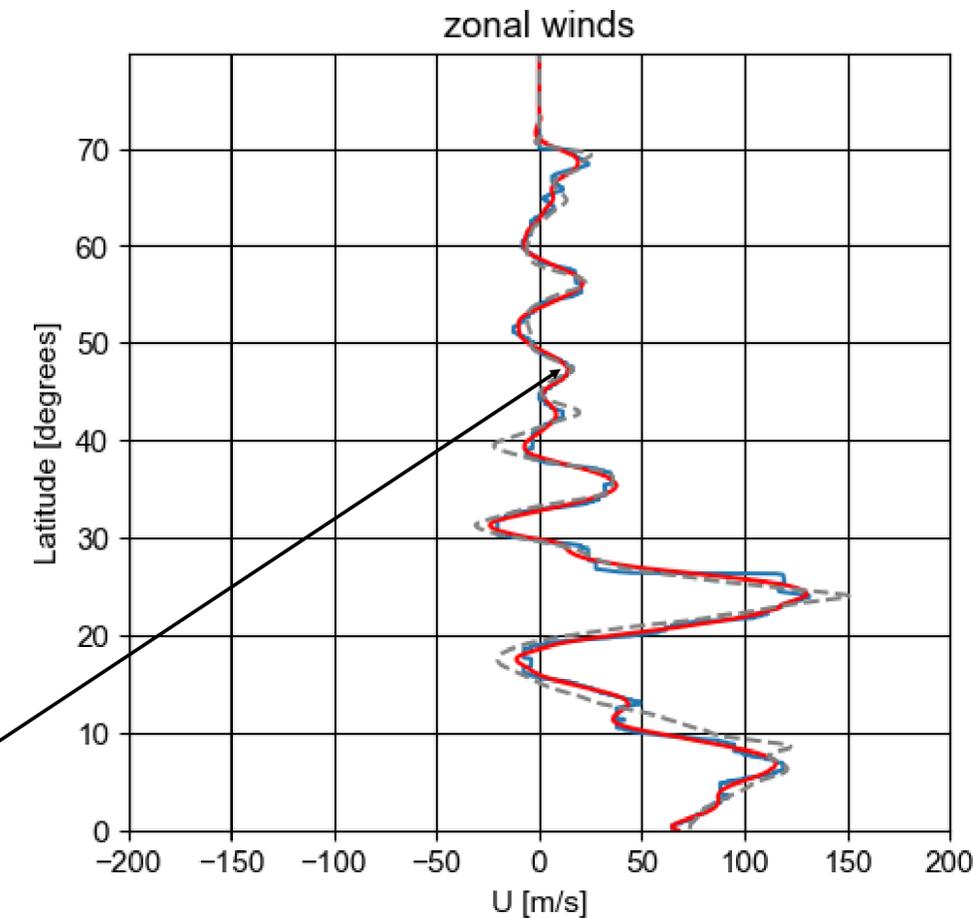
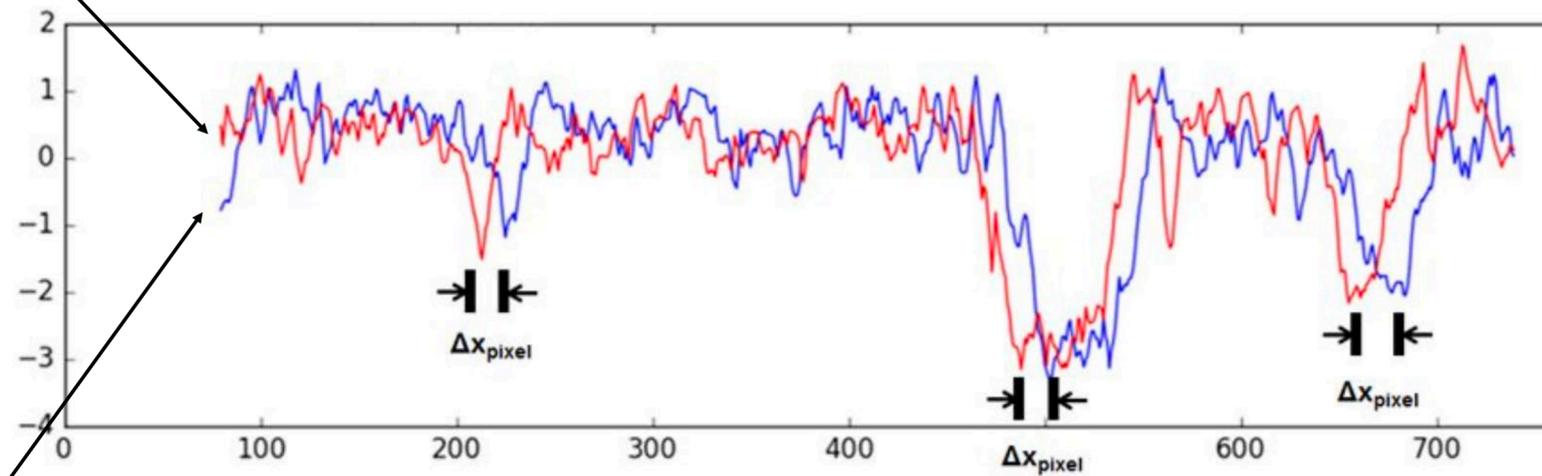
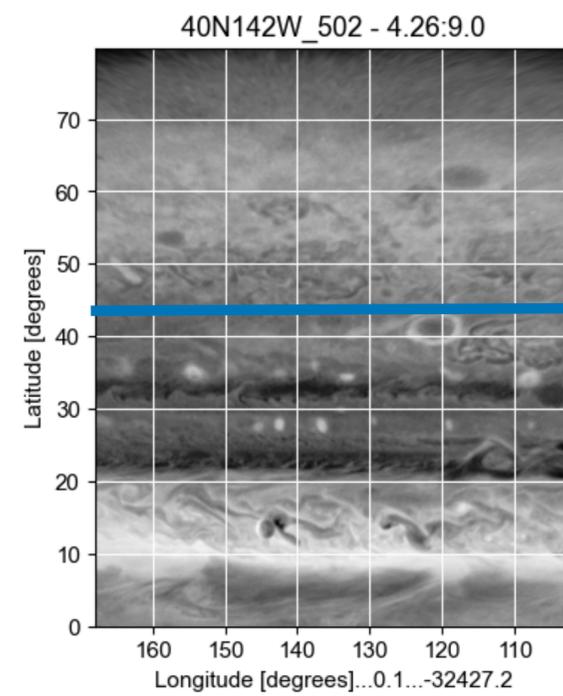
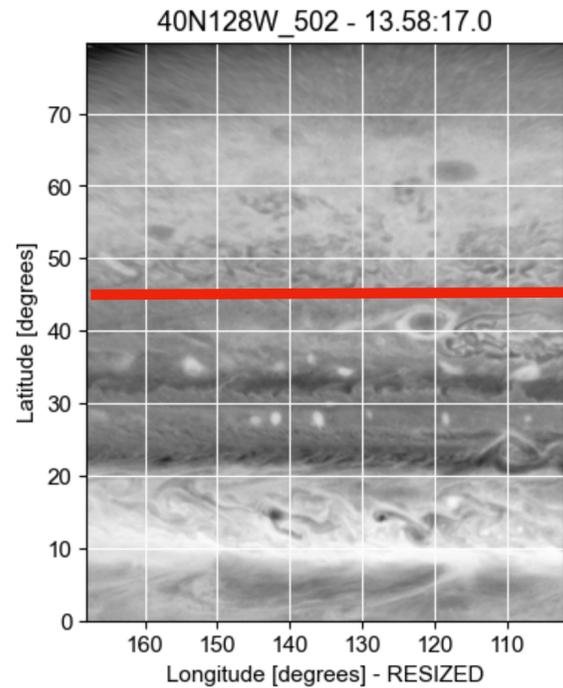
Measuring winds - Cloud tracking

Ex. Jupiter



Measuring winds - Cloud tracking

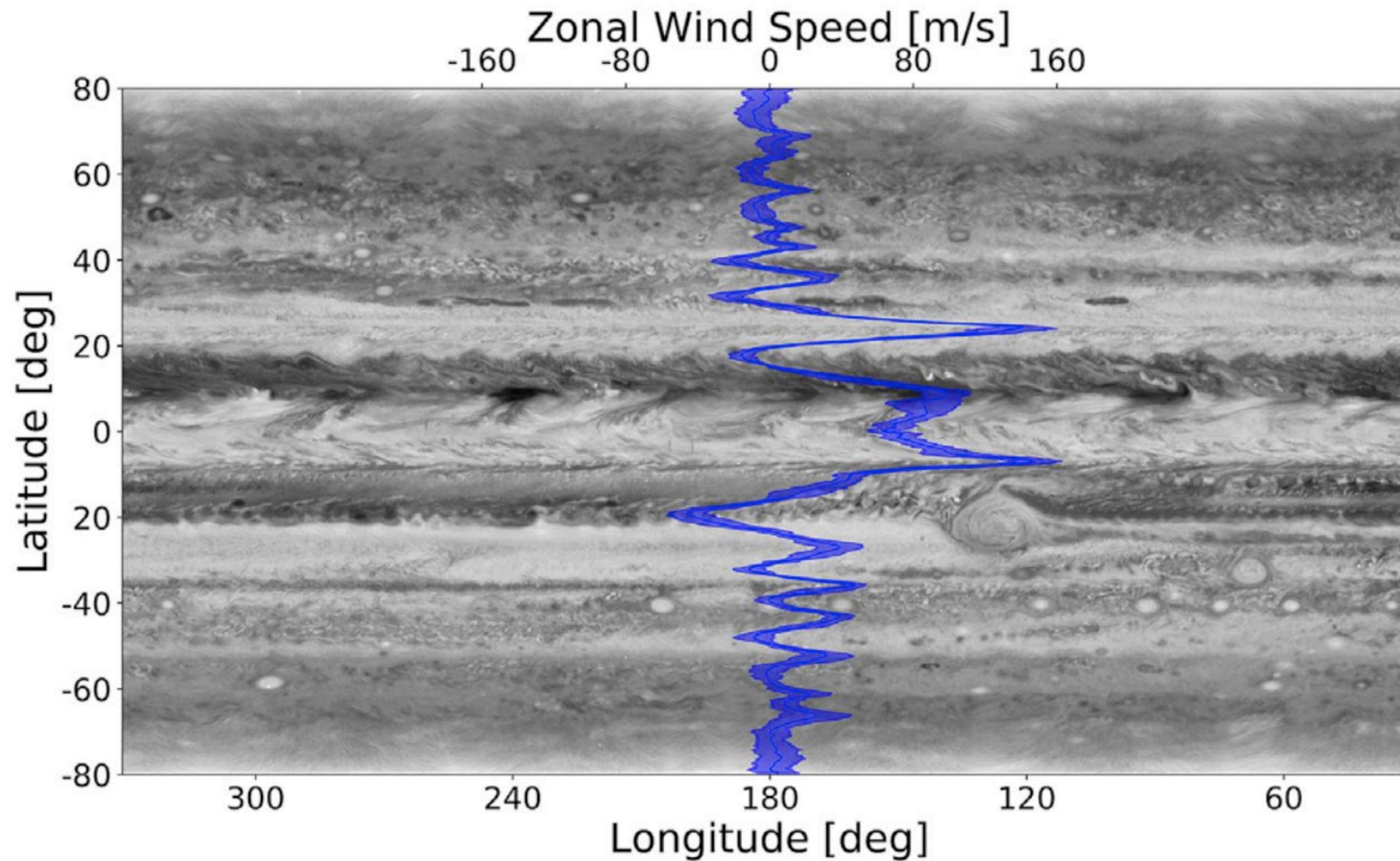
Correlations



$$\frac{\Delta x}{\Delta t} = v$$

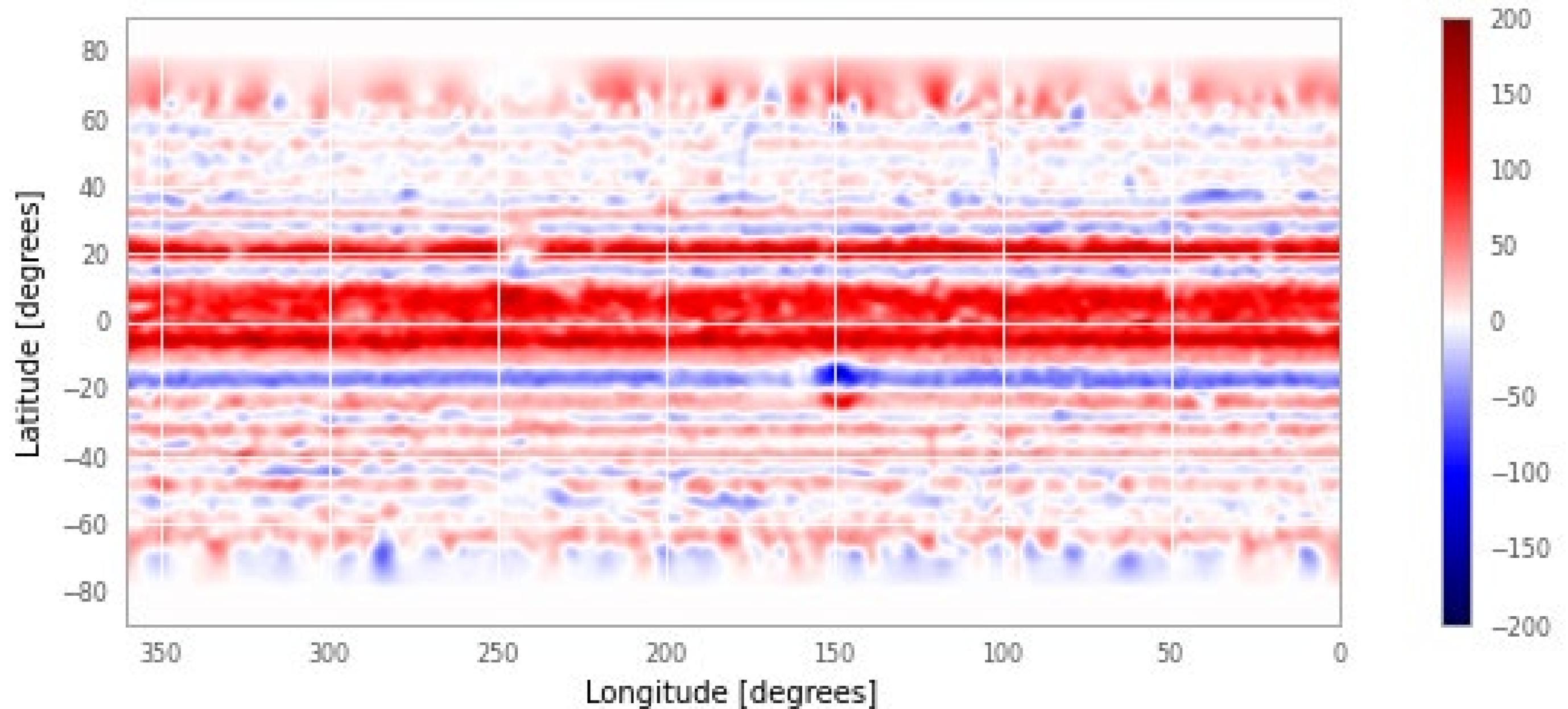
Measuring winds - Cloud tracking

1D Zonal Winds



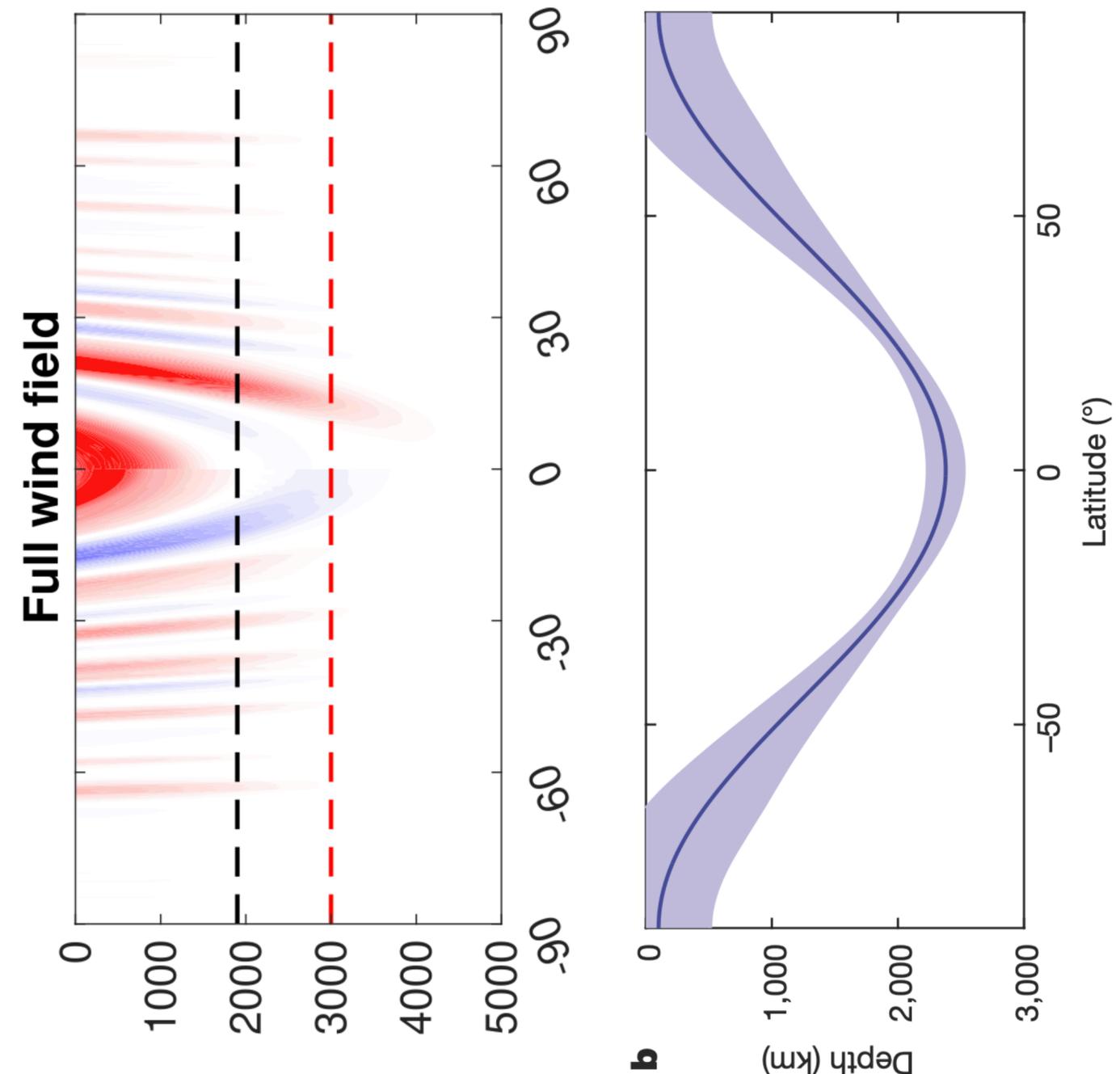
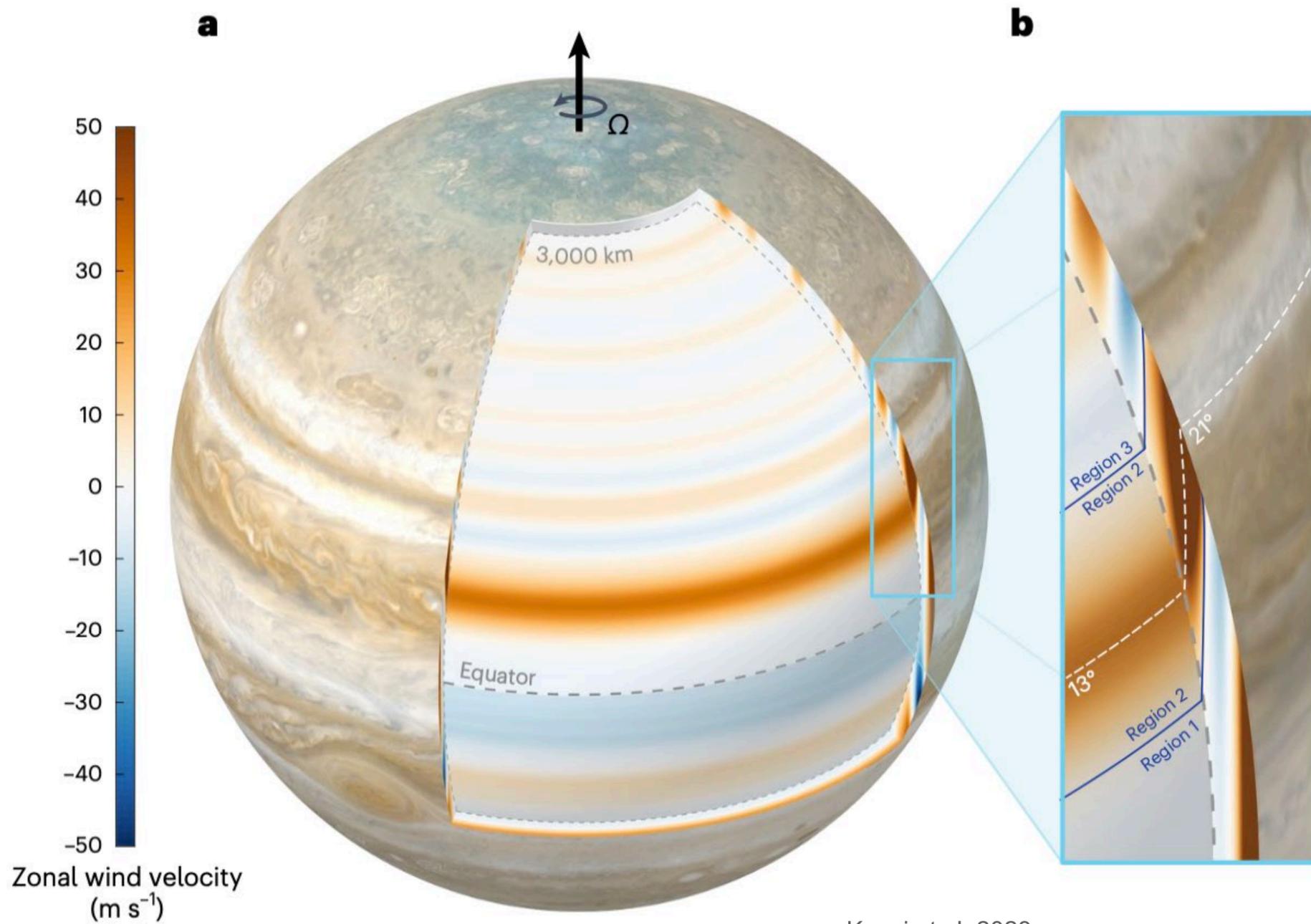
Measuring winds - Cloud tracking

2D Zonal Winds



Planetary atmospheres

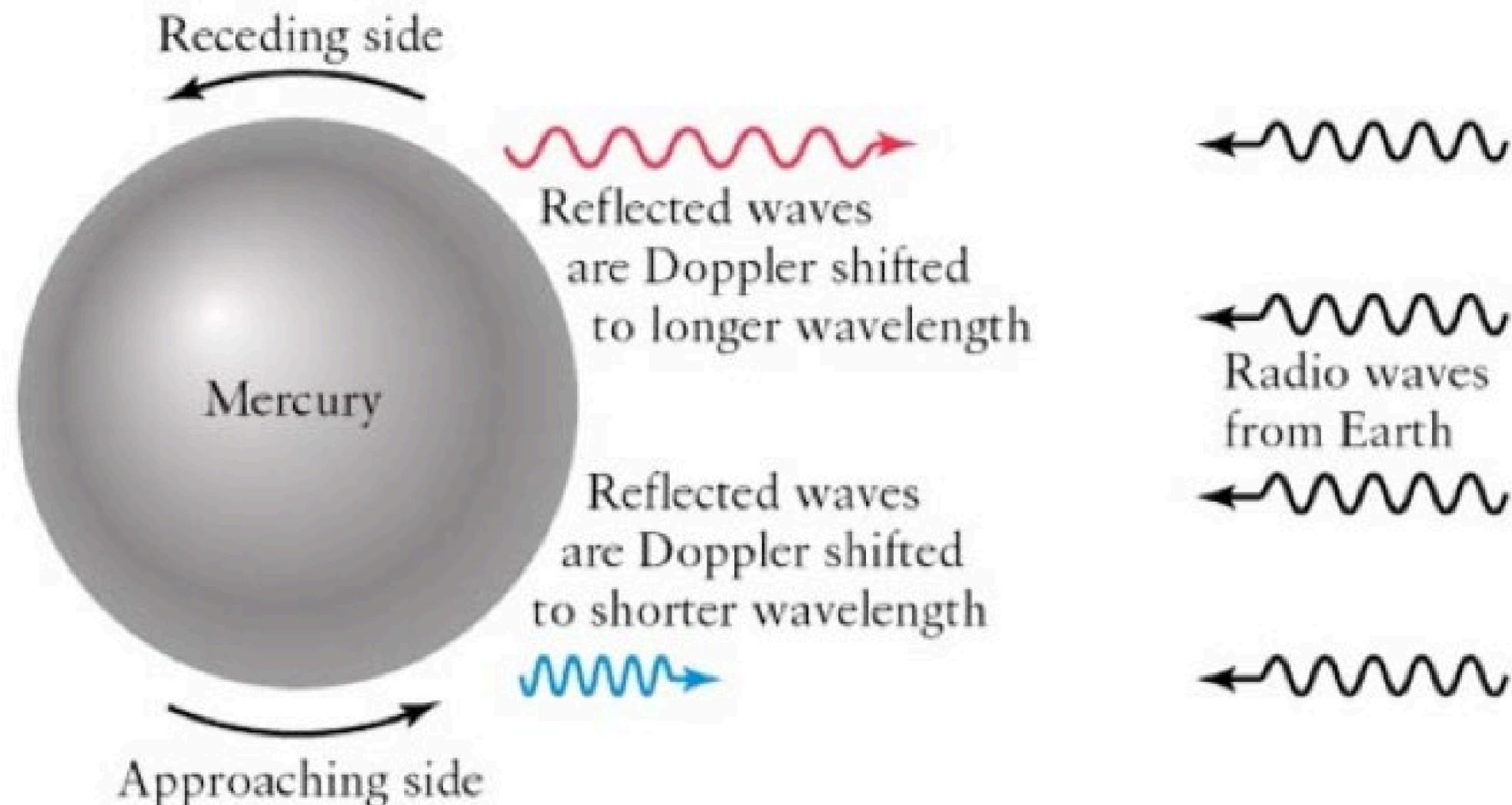
Winds with depth



Measuring winds - Doppler

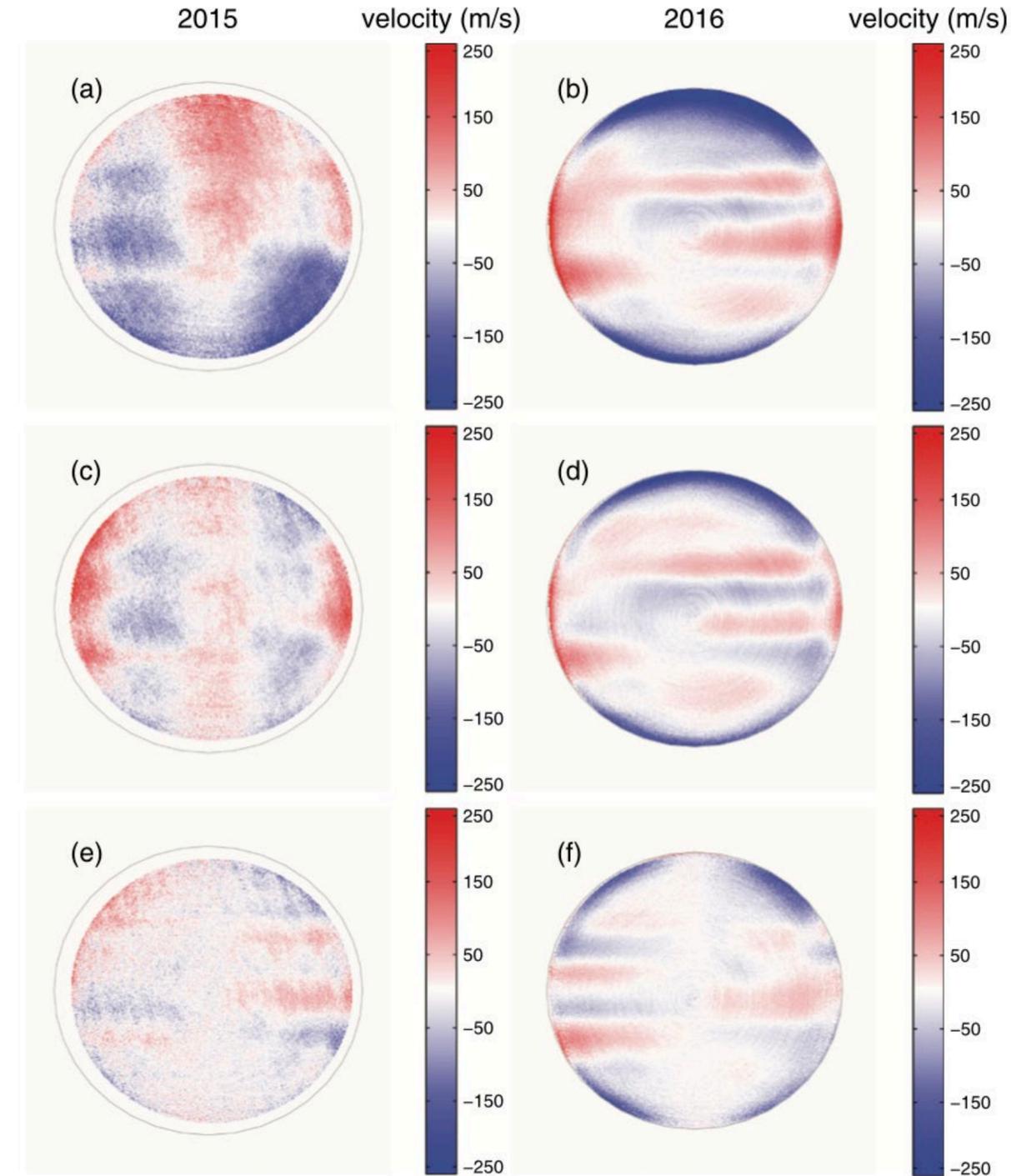
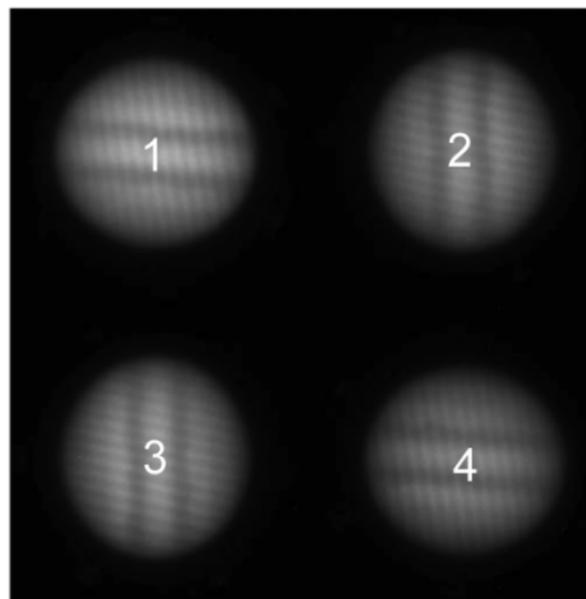
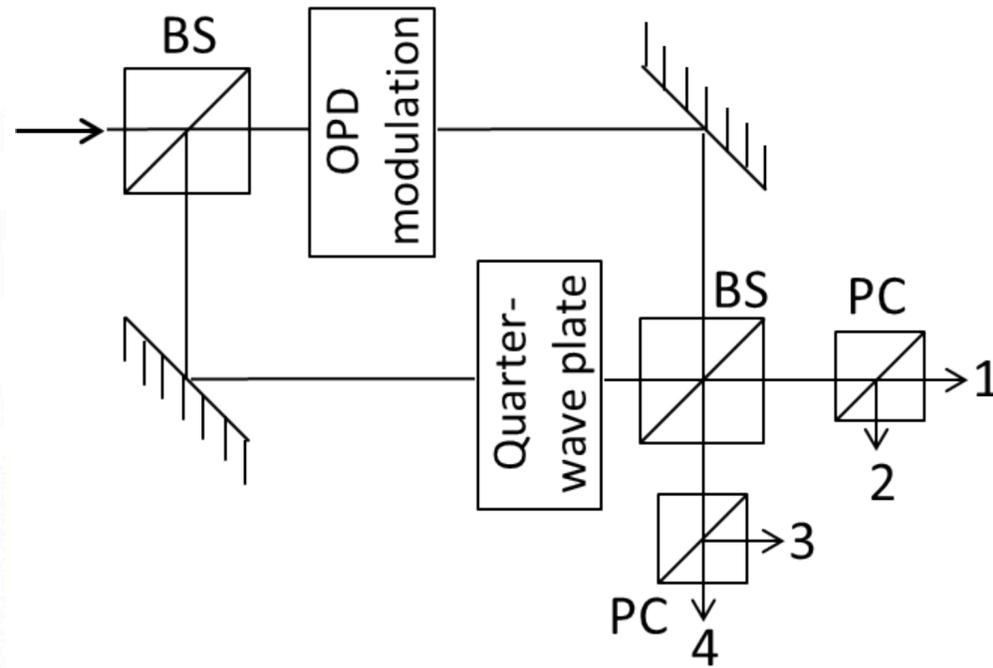
Main idea

1962 – Rotation period of Mercury (~ 59 days) measured by bouncing radar waves from the surface of the planet



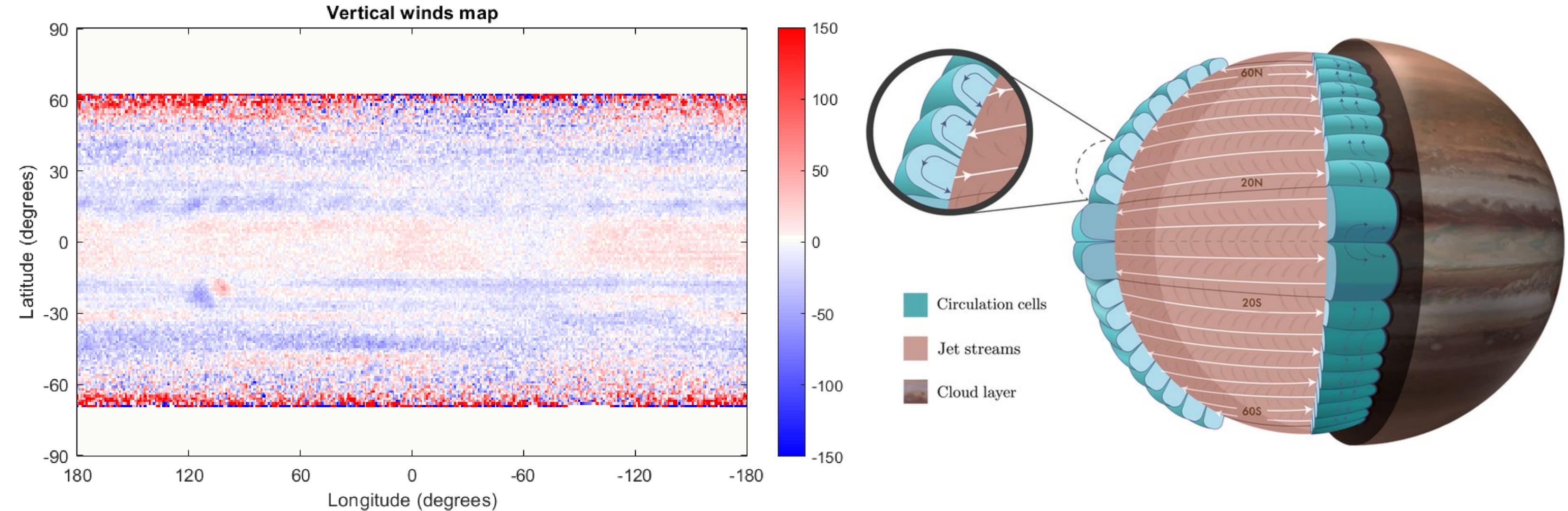
Measuring winds - Doppler

JIVE instrument



Measuring winds - Doppler

3D winds



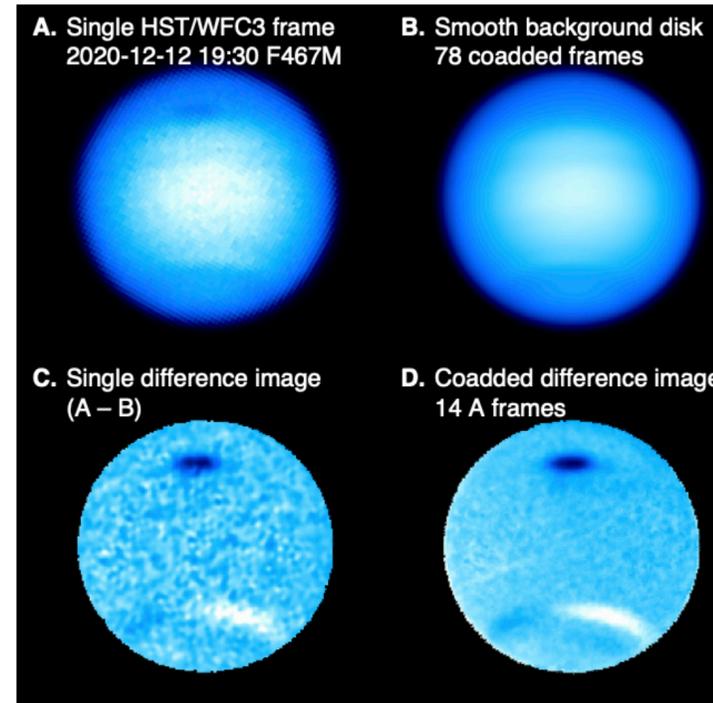
Vortices

Neptune's Great Dark Spots

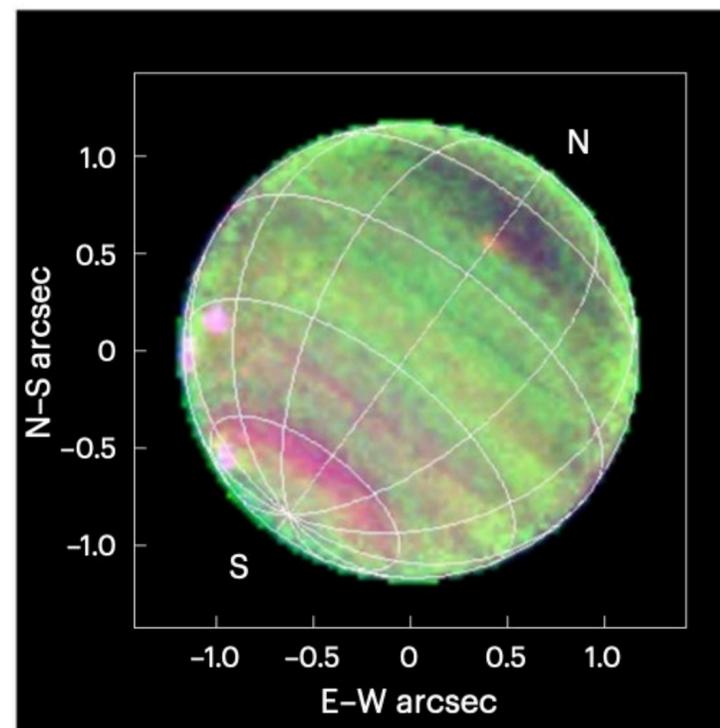


1989

NASA/JPL

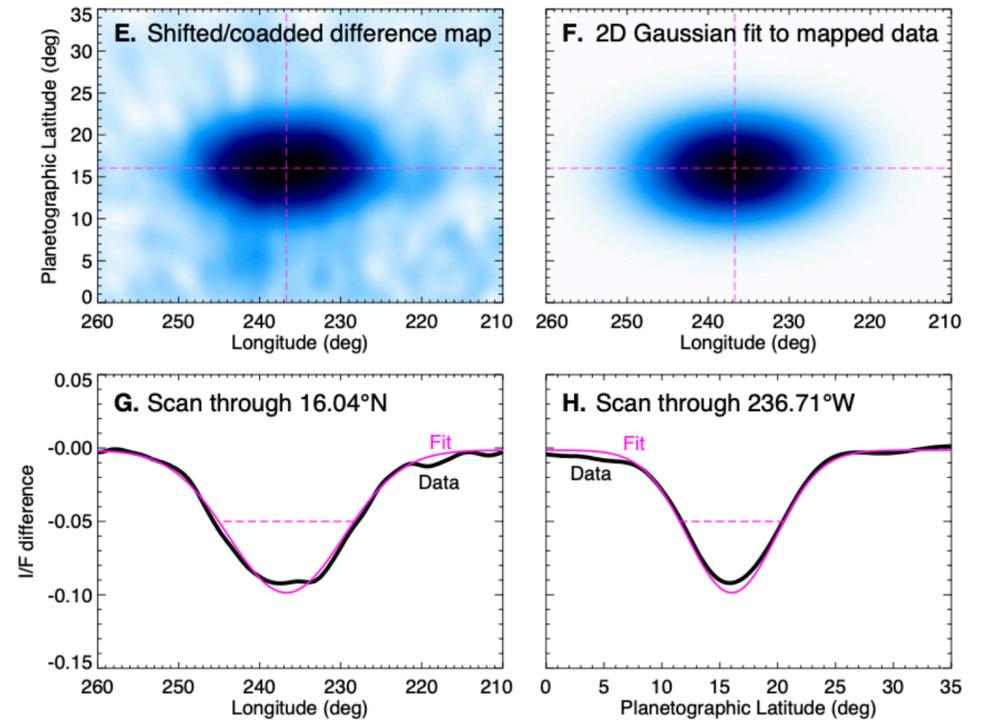


2020

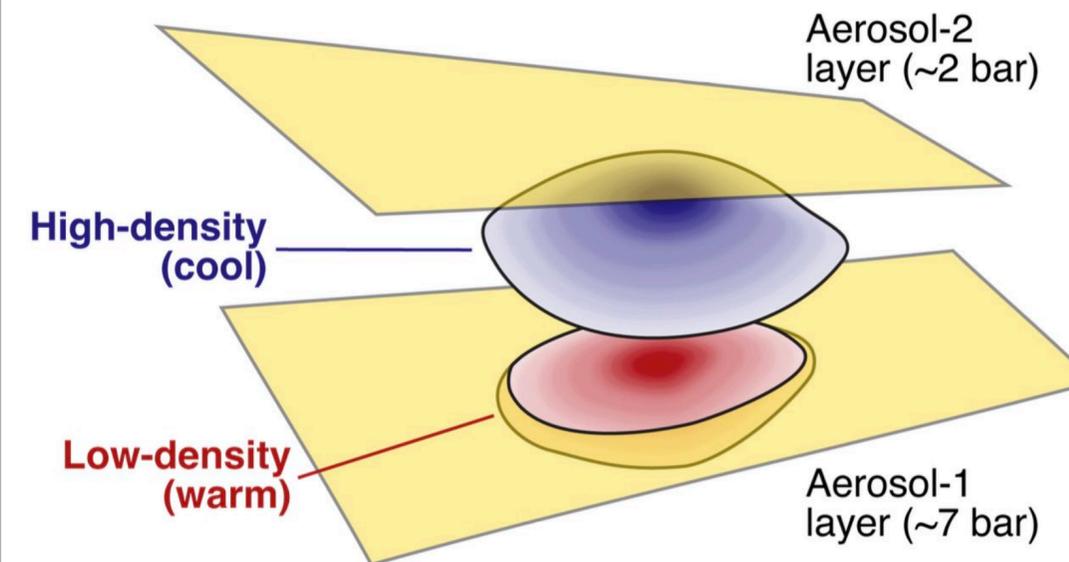


R = 831 nm, G = 511 nm, B = 848 nm

Planets



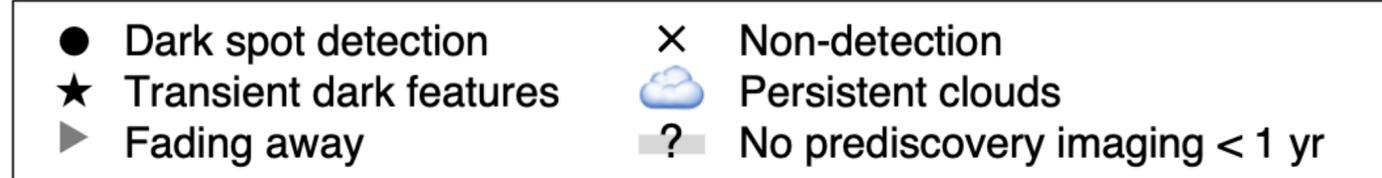
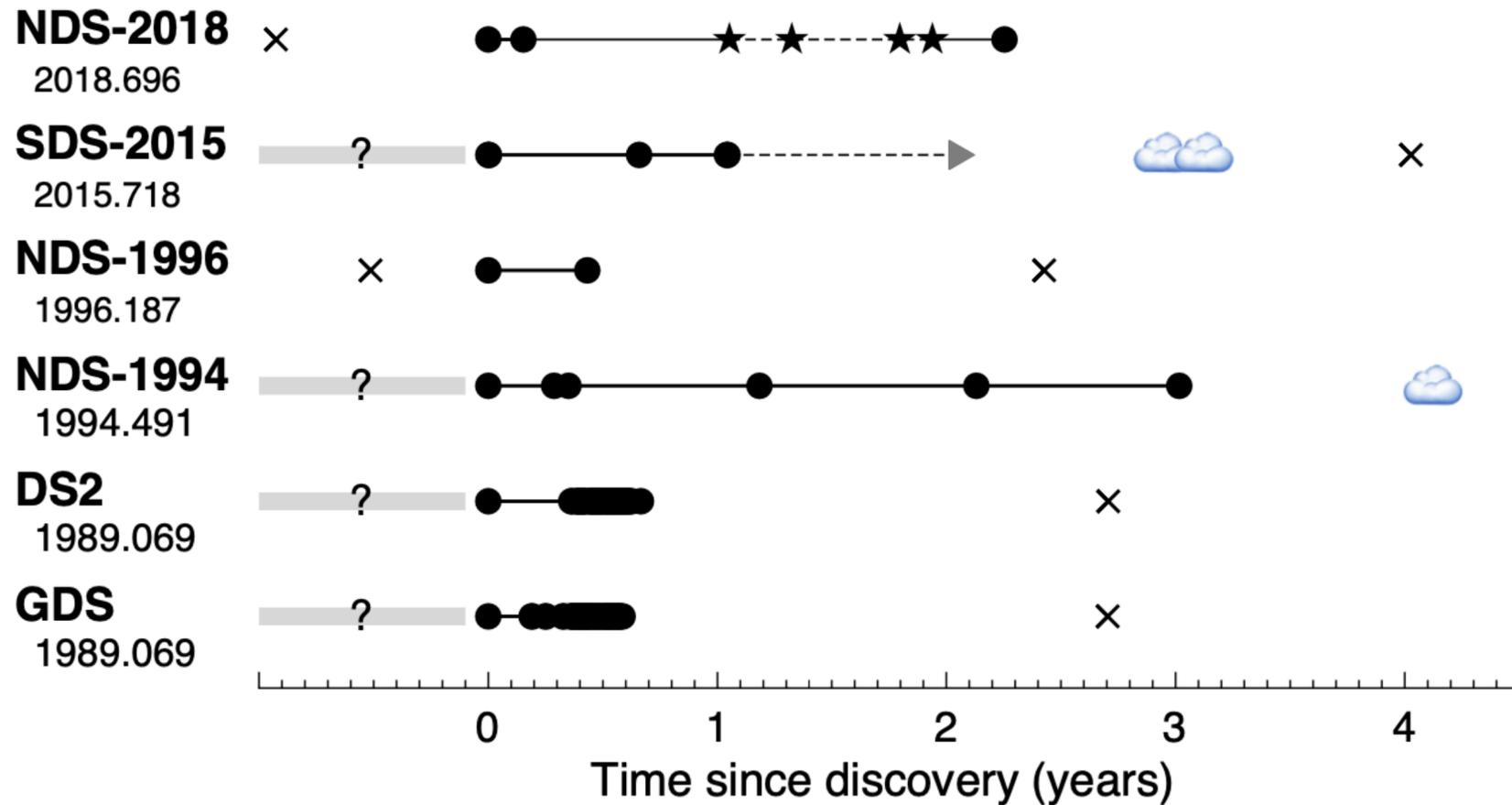
Wong et al 2022 Icarus 387



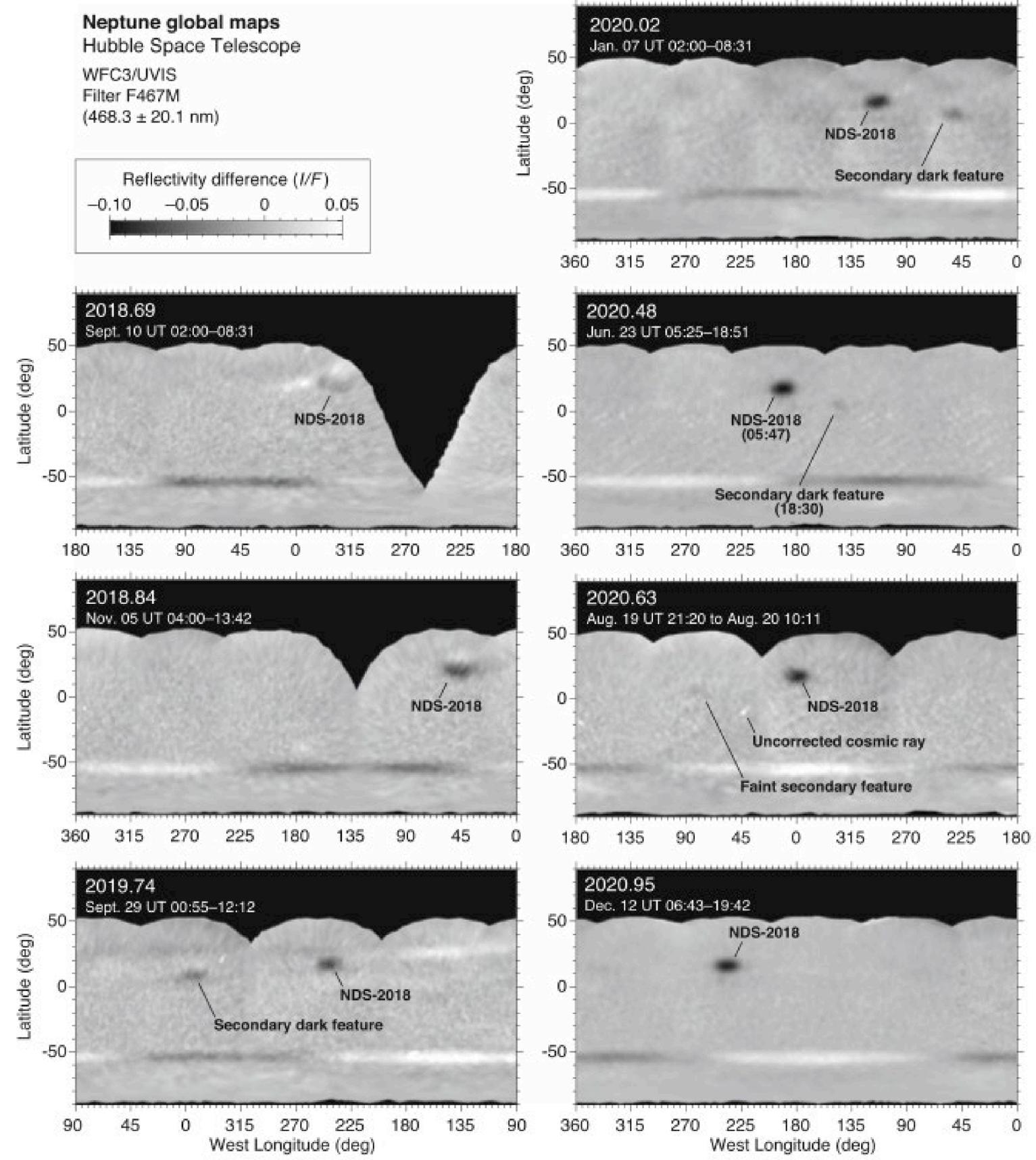
Neptune anticyclone

Vortices

NDS 2018 - life cycle

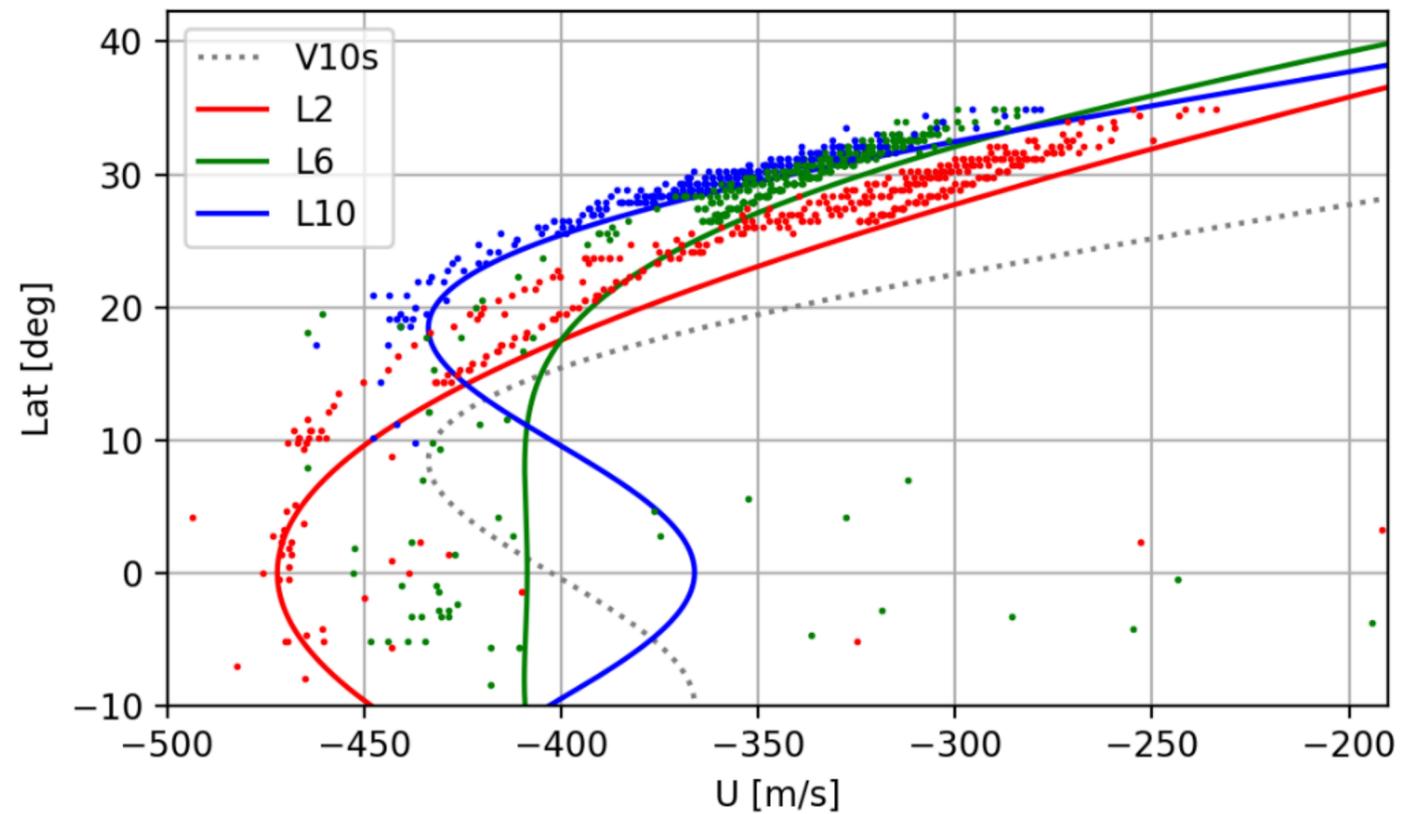
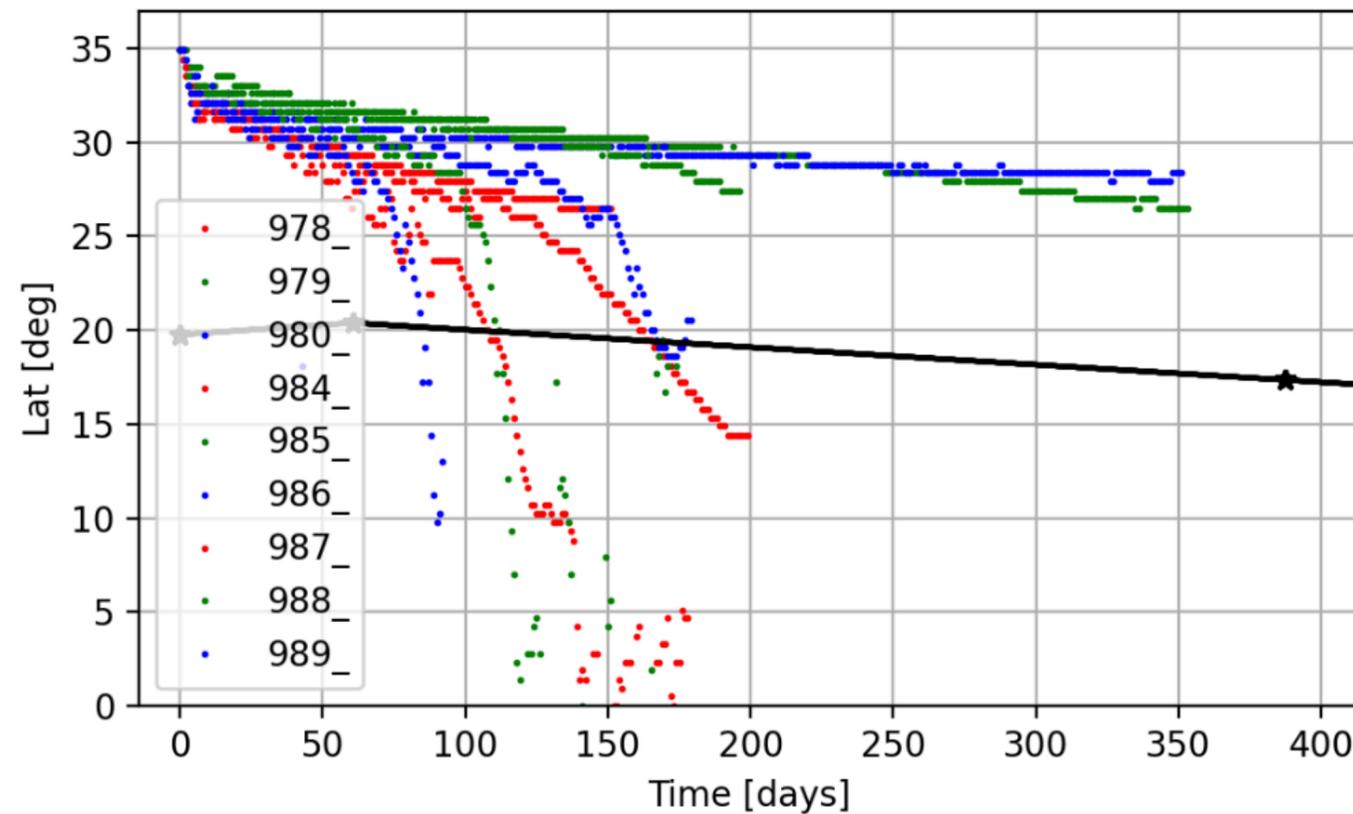
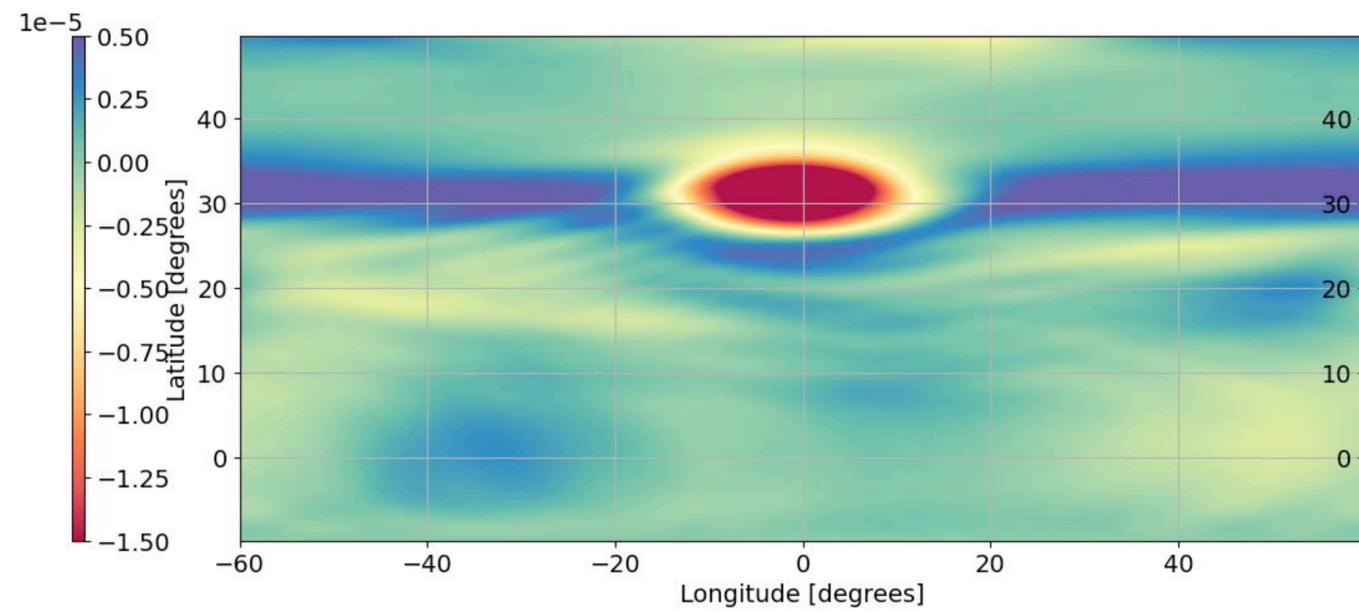


Wong et al 2022 Icarus 387



Vortices

NDS 2018 - New simulations

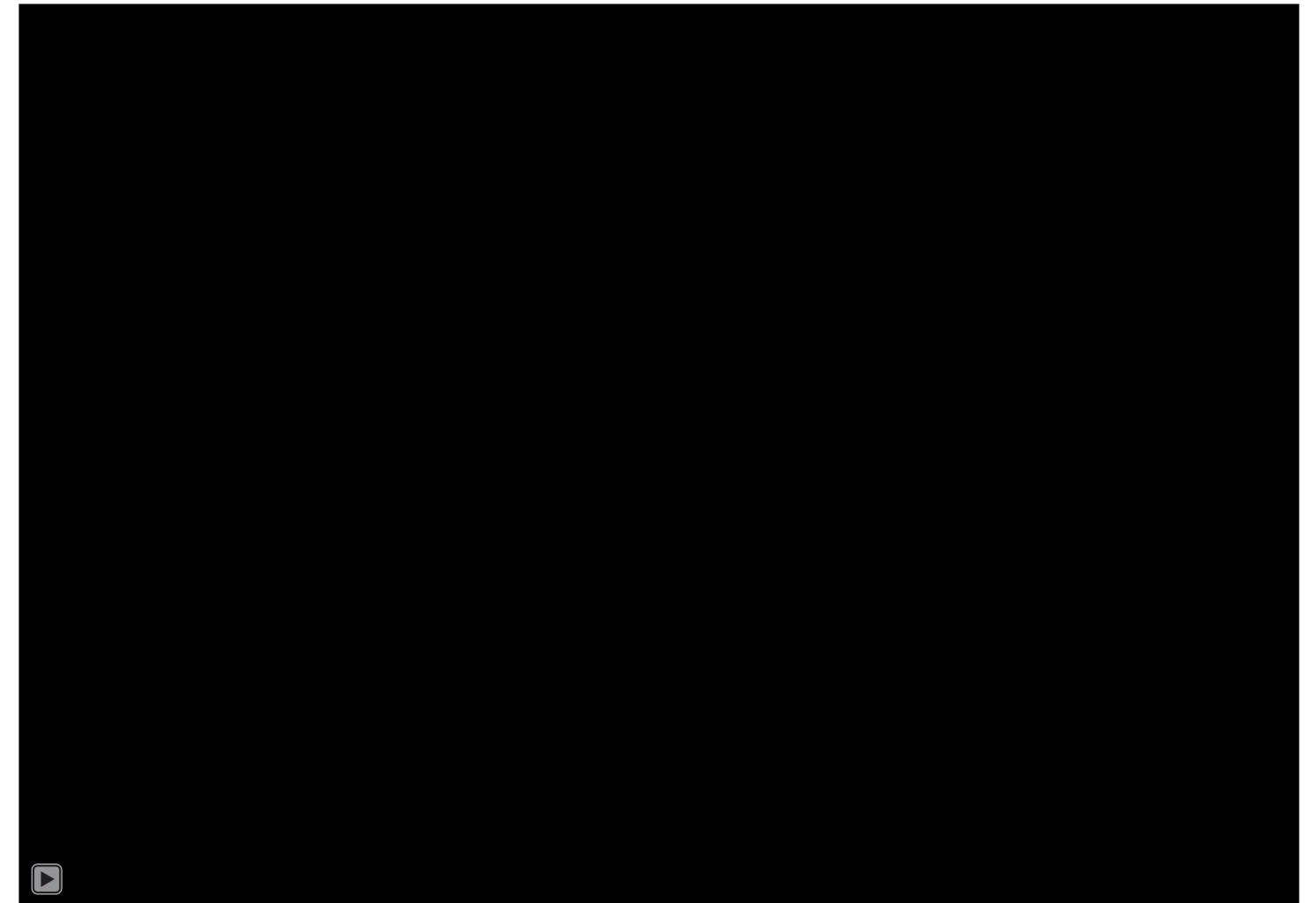


$$\frac{d\lambda}{dt} \propto N(\beta - u_{yy})V_t$$

equatorial drift rate \propto *atm. static stability* \times *zonal wind curvature* \times *vortex strength*

Conclusions

- **Atmospheric circulation** in these planets **changes in complex and surprising ways** as a function of height and latitude.
- **Measuring accurate winds is important** to understand the 3D dynamical structure of these atmospheres.
- **Measuring & simulating spots drift rates and oscillations is also important** to better understand the 3D structure of these atmospheres.
- **High resolution and high temporal cadence observations are needed** to improve our models and understanding of these atmospheres.



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