Oscillations within Jupiter's Great Red Spot

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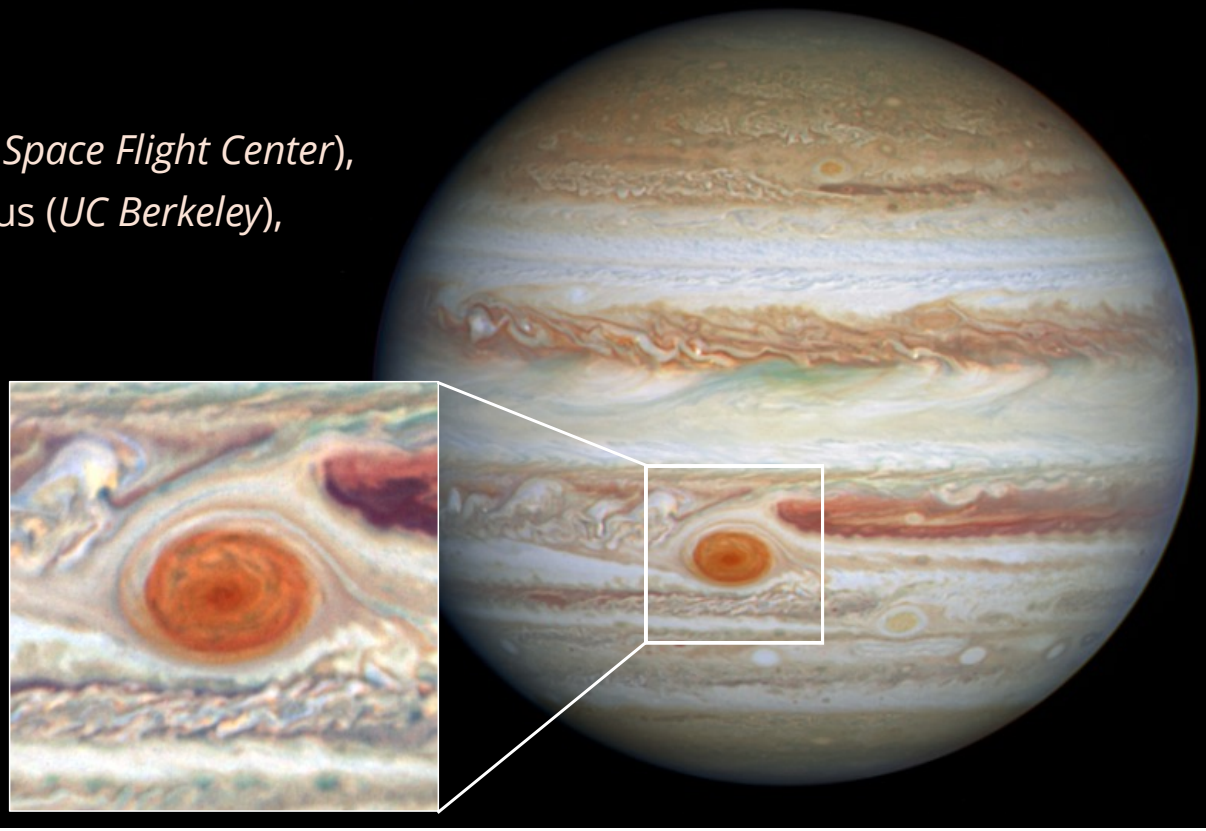

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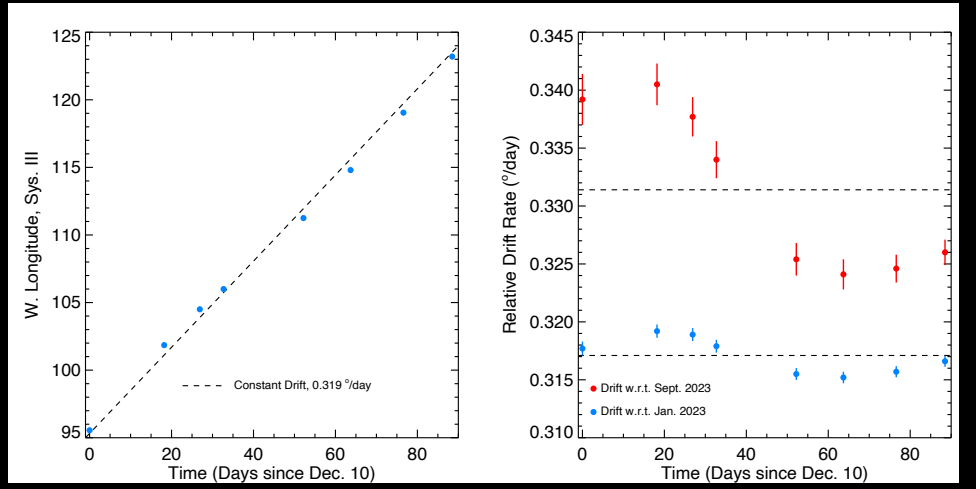
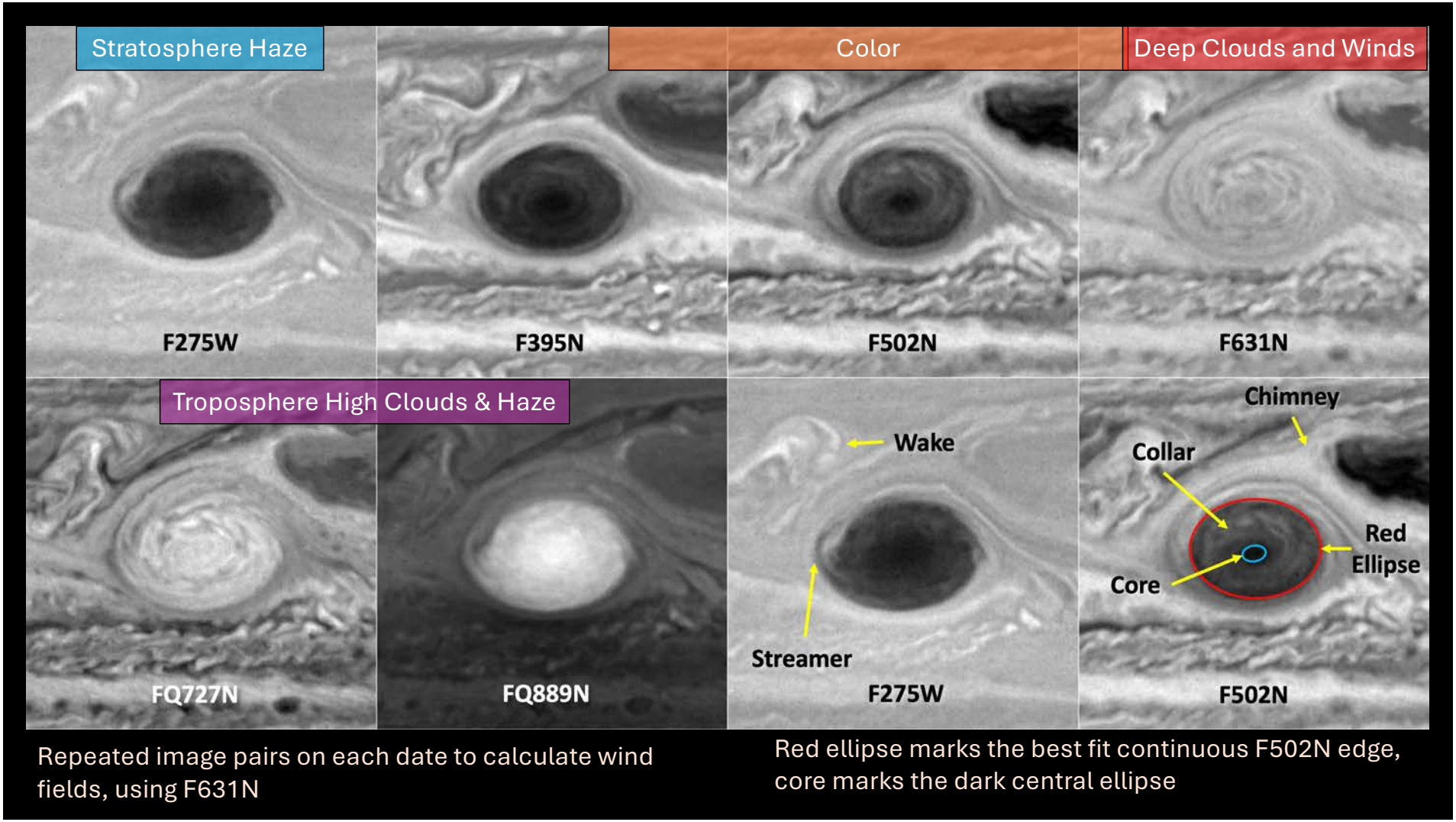
The 90-day Oscillation

- The GRS drifts westward with respect to the planet's rotation
  - The rate oscillates with a 90-day period, clearly seen in historical and ground-based data
  - Some other large anticyclones (e.g., Neptune's GDS) also oscillate in longitude, latitude, tilt
  - GRS is much smaller now than during Voyager
- We used Hubble to study how the GRS's characteristics (latitude, size, shape, color, interior velocities) vary over an oscillation
  - WFC3 data were obtained on 8 dates between 10 December 2023 and 8 March 2024
  - UV, visible, and methane absorption band filters

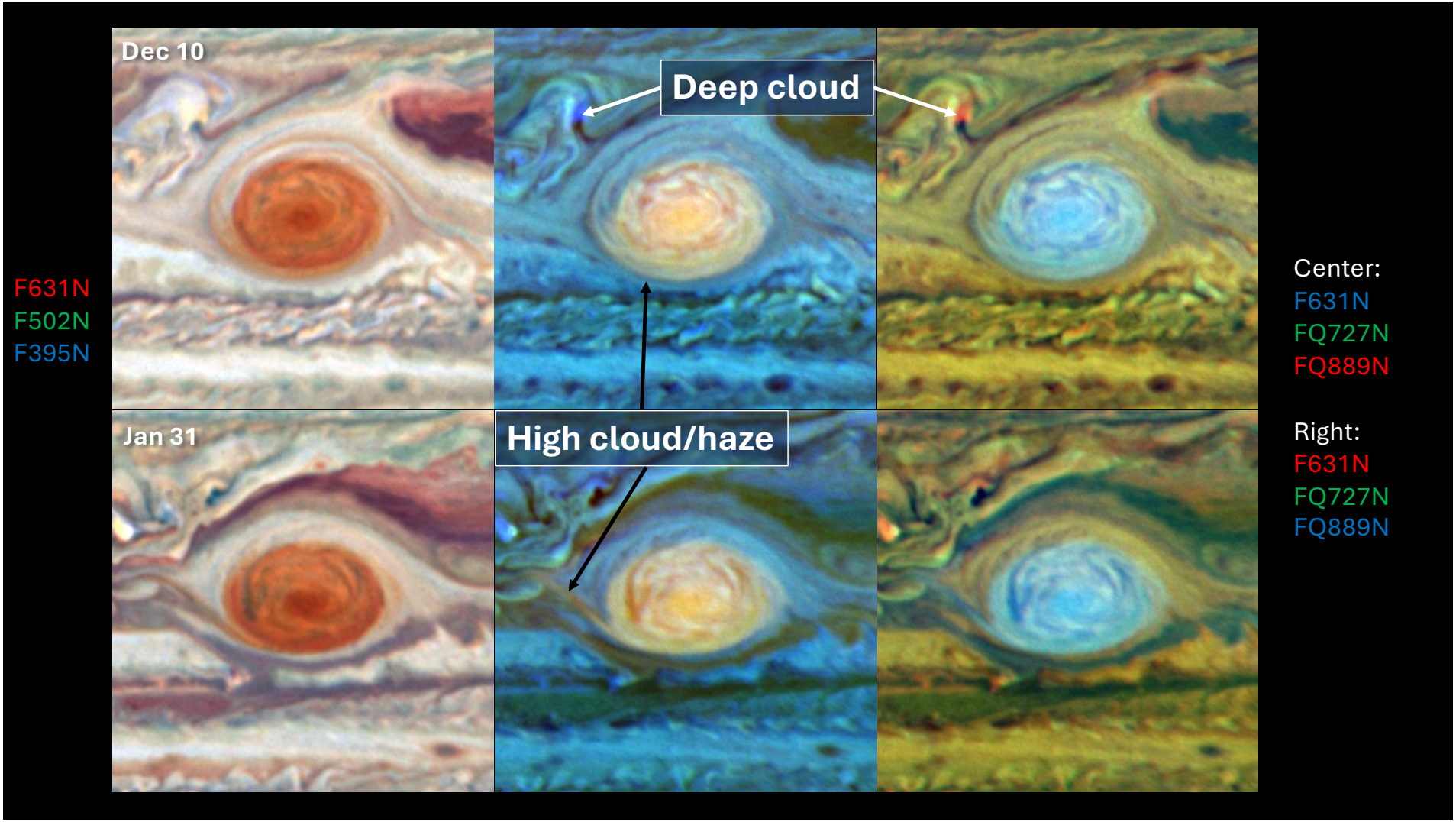


The goal is to better understand atmospheric balance and structure within the GRS

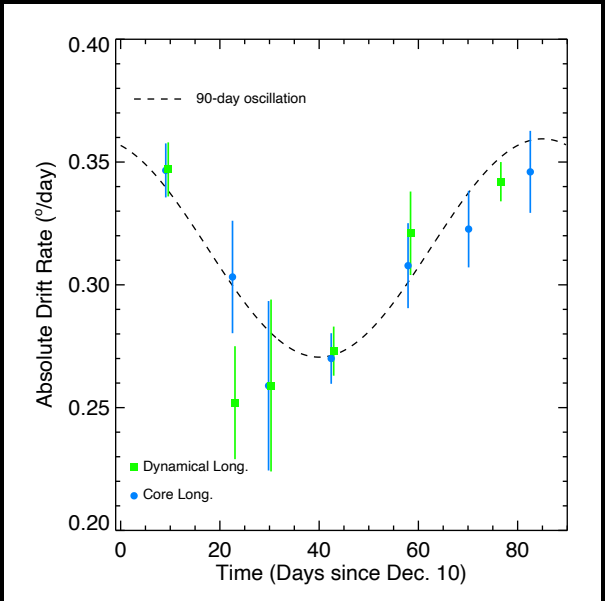


Repeated image pairs on each date to calculate wind fields, using F631N

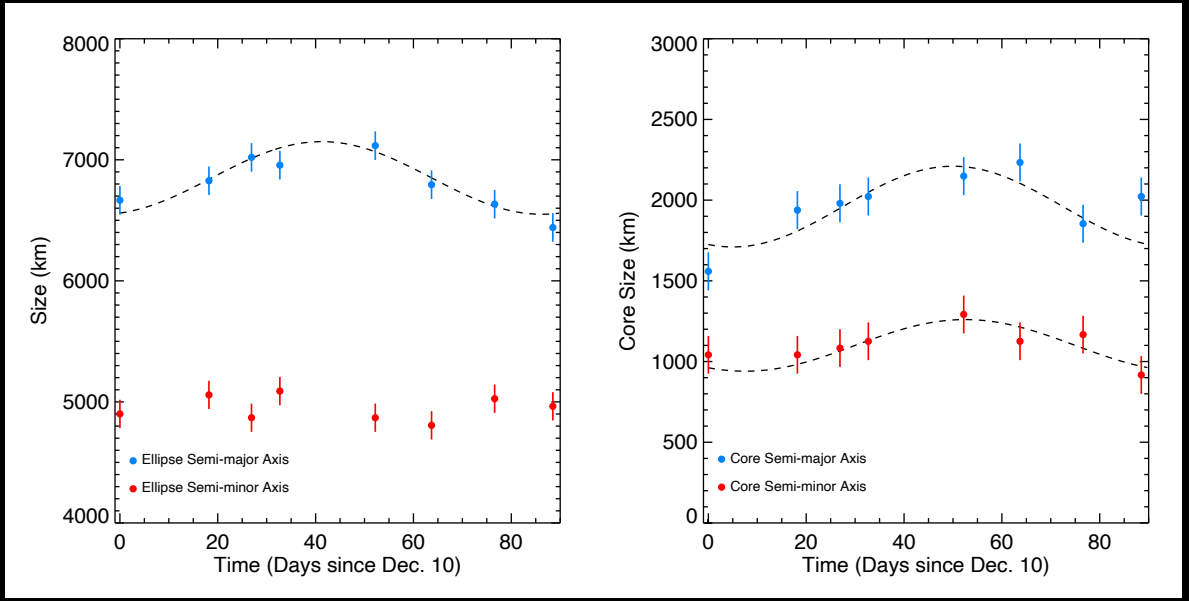
Red ellipse marks the best fit continuous F502N edge, core marks the dark central ellipse


Dec 10
Deep cloud
Jan 31
High cloud/haze
F631N
F502N
F395N
Center:
F631N
FQ727N
FQ889N
Right:
F631N
FQ727N
FQ889N

Size/shape oscillation phase

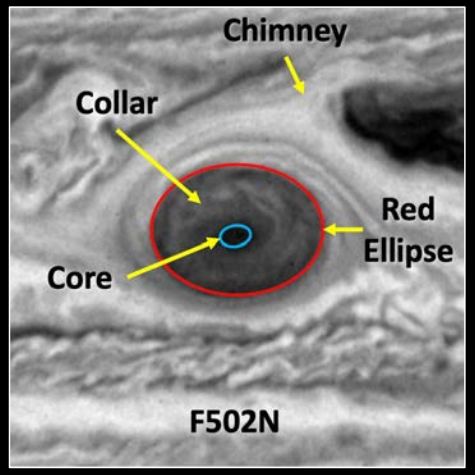


GRS longitude was measured from the core and from the velocity fields. Date-to-date position change gives the drift rate and phase of the oscillation.

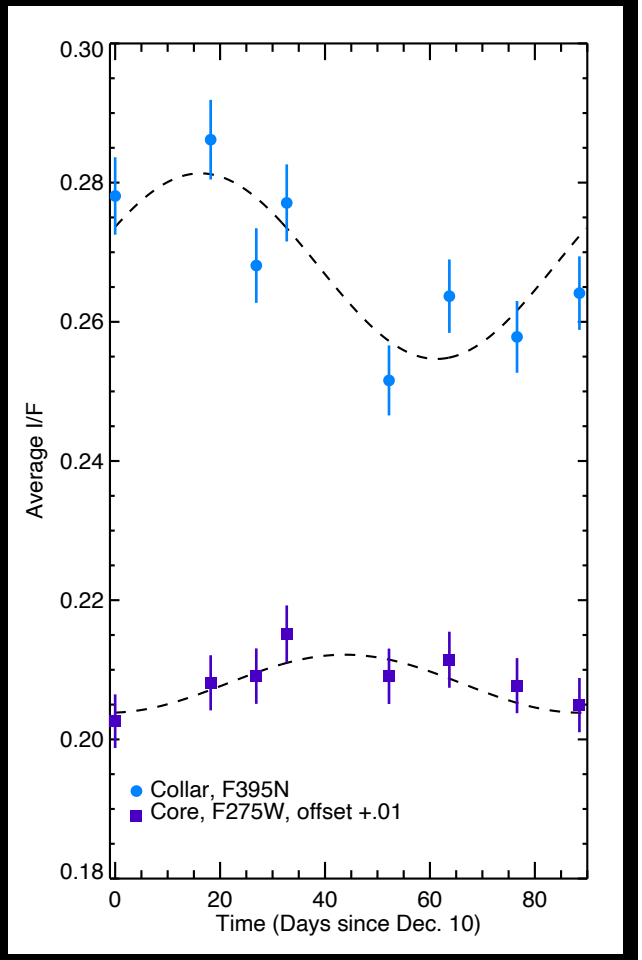


The measured sizes of the red ellipse and the darker core vary. The semi-major axis of the outer red ellipse and both axes of the dark core ellipse correlate with a 90-day oscillation.

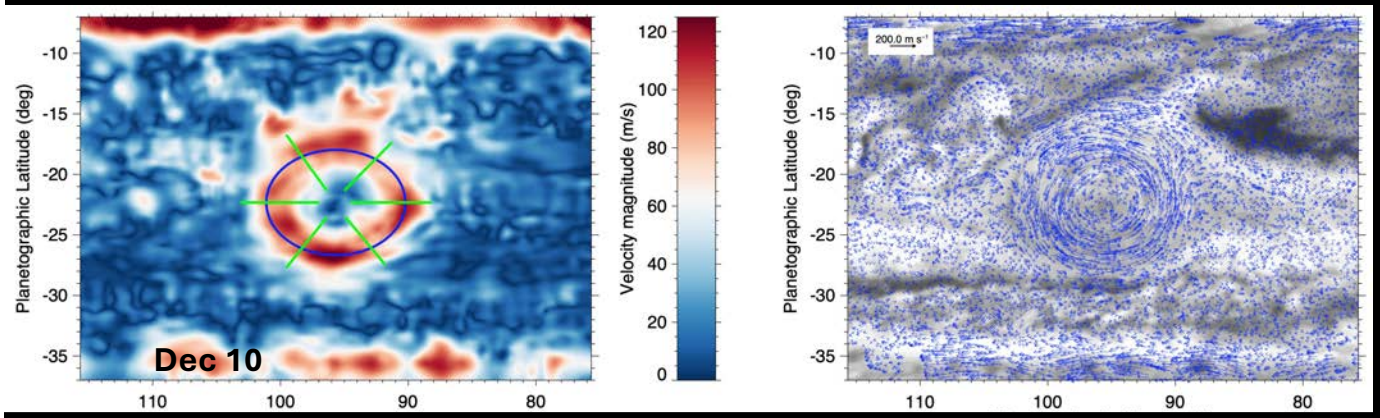
Brightness/Color



- Each map was converted to absolute reflectance
- Locations on collar and core plotted for trends in color and brightness
  - Core showed a 90-day oscillation in the UV
  - Collar showed an out-of-phase 90-day oscillation at violet wavelengths



Extracted Velocity Fields



- Retrieved velocity fields were used to find average velocities
  - Along radial spokes
  - Average of the highest speed ellipse (in the collar)

Despite some large uncertainties, no velocity oscillations were seen

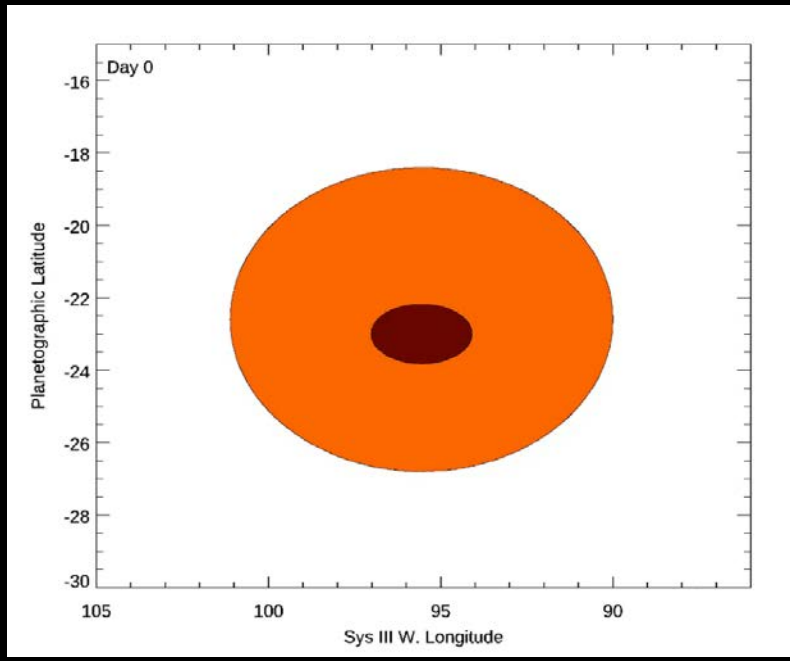
Relative vorticity (velocity over radial distance) is not compensating for other oscillations

- In a simple 2-layer atmospheric model, vorticity changes would balance changes in shape/size
- Indicates that the GRS has a more substantial 3D structure than those simple models allow.

Summary

- 90-day oscillations were observed in:
  - Drift rate, semi-major axis of the red ellipse, dark core size and shape, collar color (blue absorption), & core UV haze brightness

- Some GRS parameters are correlated:
  - The GRS has a larger width and aspect ratio when it is at its slowest absolute drift.
  - Although only a small variation, the GRS's core is brightest (UV) when the GRS is largest.
  - The collar color (F395N) variation is ~90° out of phase with the other oscillations.



Animation of oscillations: Color changes exaggerated, but size and motions match the measurements.