

Evolution of Saturn's equatorial oscillation from Cassini/CIRS limb data analysis.

S. Guerlet (1,2), T. Fouchet (1,3,4), B. Bézard (1), F. M. Flasar (5) and A. A. Simon-Miller (5)

(1)Observatoire de Paris, LESIA, Meudon, France, (2) SRON, Netherlands Institute for Space Research, Utrecht, The Netherlands, (3) Université Pierre et Marie Curie, UMR 8109, Paris, France, (4) Institut Universitaire de France, Paris, France, (5) NASA/Goddard Space Flight Center, Greenbelt, Maryland, USA.

Abstract

We present an analysis of thermal infrared spectra acquired in limb viewing geometry by Cassini/CIRS in February 2010. We retrieve vertical profiles of Saturn's stratospheric temperature from 20 hPa to 10^{-2} hPa, at 9 latitudes between 20°N and 20°S . Using the gradient thermal wind equation, we derive a map of the zonal wind field. Both the temperature and the zonal wind vertical profiles exhibit an oscillation in the equatorial region (Fig. 1 and 2). These results are compared to the temperature and zonal wind maps obtained from 2005–2006 CIRS limb data, when this oscillation was first reported. In both epochs, strong temperature anomalies at the equator (up to 20K) are consistent with adiabatic heating (cooling) due to a sinking (rising) motion at a speed of 0.1–0.2 mm/s. Finally, we show that the altitude of the maximum eastward wind has moved downwards by 1.3 scale heights in 4.2 years, hence with a phase speed of ~ 0.5 mm/s. This rate is consistent with the estimated period of 14.7 years for the equatorial oscillation (Orton et al. 2008). It requires a local zonal acceleration of $1.1 \times 10^{-6} \text{ m.s}^{-2}$ at the 2.5 hPa pressure level. This downward propagation of the oscillation is consistent with it being driven by absorption of upwardly propagating waves, in agreement with other studies (Schinder et al. 2011).

References

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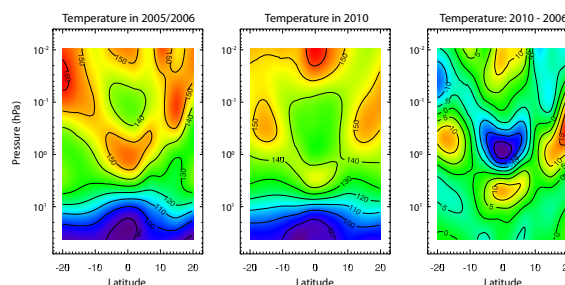


Figure 1: From left to right: Temperature map obtained from Cassini/CIRS limb data acquired in 2005–2006 (Fouchet et al. 2008), in 2010 (Guerlet et al. 2011) and the difference of temperature between the two dates.

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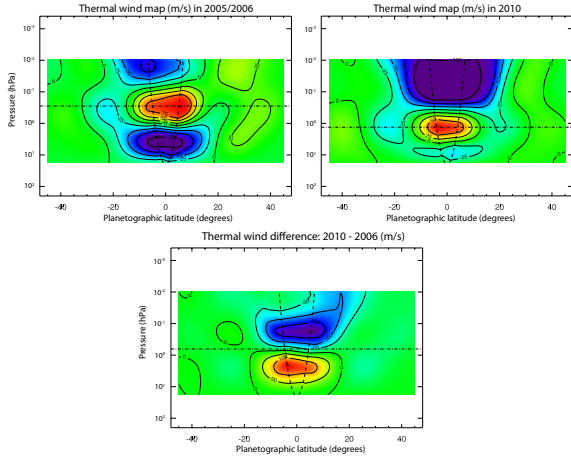


Figure 2: Map of the thermal zonal wind obtained from Cassini/CIRS limb data acquired in 2005–2006 (upper left panel, Fouchet et al. 2008), in 2010 (upper right panel, Guerlet et al. 2011), and the difference between the two maps (bottom panel). The horizontal dot-dashed lines on the three panels highlight the altitude of the westerly jet respectively in 2005–2006, 2010, and the average altitude between the two dates. Equatorward and above the line defining the cylinder tangent to the equator at 20 hPa, the wind field is unconstrained by the thermal wind equation, and it has been linearly interpolated on constant pressure surfaces.