Saturn's zonal wind profile in 2004–2009 from Cassini ISS images

(Supplemental data supporting E. García-Melendo, S. Pérez-Hoyos, A. Sánchez-Lavega and R. Hueso c, Icarus 215 (2011) 62–74)

ISS imaging data spanning 2004-2009 were used to retrieve Saturn's zonal wind profile. Methane absorbing bands at 890 and 727 nm and in their adjacent continuum wavelengths at 939 and 752 nm were used to investigate Saturn's global circulation at 60 mbar to 250 mbar with the methane filters and at 350 mbar to 500 mbar with the continuum filters. Comparisons with zonal wind profiles obtained by Voyager 1 and 2 (1980–1981), Hubble Space Telescope, and ground-based telescopes (1990–2004) reveal similar structure with the most variation at the peak of the eastward jets and the equatorial region, including a region of positive vertical shear within 25 deg (centric) of the equator.

These data were derived from images acquired by the Cassini Imaging Science Subsystem (ISS) instrument (Porco, C.C. et al., 2004. Space Sci. Rev. 115, 363–497.P). The data span a portion of Saturn's year, from 2 years after Saturn's northern hemisphere winter solstice to close to its northern spring equinox. Approximately 300 Narrow and Wide angle images were used with resolutions ranging from 160 km/pix to 30 km/pix.

The Planetary Laboratory Image Analysis (PLIA) software was used to navigate the images (Hueso, R. et al., 2010. Adv. Space Res. 46, 1120–1138.). Using SPICE (Acton, Ch.H., 1995. Planet. Space Sci. 44, 65–70.) PLIA automatically fits an ellipse (using the IAU/IAG standard ellipsoid (Seidelmann, P.K. et al., 2007. Celestial Mech. Dyn. Astron. 98,155–180) with equatorial and polar radii at the 1 bar level defined as 60,268 km and 54,364 km) to the limb of a projected image of the planet and allows the user to check and modify the fit – this is especially significant where only a small part of the limb is visible.

Zonal velocities were measured by performing automatic one dimensional cross-correlation of brightness longitude scans as described in García-Melendo and Sánchez-Lavega (Icarus 152, 316–330. 2001), which assumes small cloud tracers sustain their identity for a saturnian rotation (approx. 10.6 hours). The images were mapped into cylindrical projections with a lat/long resolution of 0.1^{o} planetocentric , allowing for longitudinal brightness scans as a function of latitude to be extracted. Pairs of scans were automatically compared by performing a one-dimensional cross-correlation. The shift required for maximum correlation was converted to zonal velocity based on the radius at that latitude as defined by the standard IAU ellipsoid.

Main error sources are navigation uncertainties, intrinsic variability of the cloud tracers, local dynamics effects such as waves, vortices, divergent movements and lack of well-defined features. For images with the lowest spatial resolution (160 km/pix at the subspacecraft's point) a one-pixel navigation error translates to an uncertainty of +/-4

m/sec, increasing away from the meridian.

These data represent average zonal wind profiles spanning the period from 2004 to 2009. For information concerning variability during this epoch see Saturn's zonal wind profile in 2004–2009 from Cassini ISS images and its long-term variability. E. García-Melendo, S. Pérez-Hoyos, A. Sánchez-Lavega and R. Hueso c, Icarus 215 (2011) 62–74.