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Supporting Online Material for

Dynamics of Saturn's South Polar Vortex

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Materials and Methods
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Movie S1

Supporting online material

Earth-based telescopic observations (*S1*) revealed a hot spot at Saturn's south pole in 2003. Cassini imaging observations (*S2*, *S3*) revealed cyclonic rotation around the spot in 2005. Our observations from 11 October 2006 have spatial resolution of $\sim$20 km/pixel, about ten times the resolution of the previous ISS observations (*S2*, *S3*).

The SPV eye in Fig. 1 has two boundaries. The inner boundary is oblong (major axis = 2400 km); the outer one is circular (diameter = 4200 km). The 889 nm, 727 nm, and 750 nm ISS filters cover different methane gas absorption bands (*S4*, *S5*). In the original images the sun was 15° above the horizon at the pole. We accounted for this slant illumination in calculating the attenuation due to methane absorption, which is used to estimate cloud heights (see also modeling results in (*S3*)). To reduce the effect of varying solar illumination across the image, each color plane in Fig. 1A is high-pass filtered at the spatial scale of 150 pixels (which is $\sim$300 km, or $\sim$0.3° of latitude).

Figure 1(B-D) shows a sample of three images out of nine that we used to measure the wall heights. To obtain the eyewall height we multiplied each shadow length by the tangent of the solar elevation angle above the horizon, assuming the clouds inside the eye are flat and horizontal.

In Fig. S1A, the points represent the zonal velocity (positive eastward) of individual cloud features. We tracked the clouds on 14 images in the continuum band filter at 750 nm taken within a 3-hour period. The average of the points is the mean zonal velocity $\bar{u}$. Without frictional losses by eddies, rings of air moving poleward would produce a profile with constant angular momentum, which is a much steeper curve than the curve in Fig. S1A and did not fit the data. Instead angular momentum decreased toward the pole. In Fig. S1B, the smooth curve is the mean relative vorticity $\bar{\zeta}$ computed from the measured $\bar{u}$ in Fig. S1A. Each point is the relative vorticity of a puffy red cloud in Fig. 1A.

We searched for the weakening of the cyclonic circulation with altitude using a 4-frame color movie S2 of images like the one in Fig. 1A, and found no difference in the wind with altitude, at least at -84°where there were features in the blue-green haze suitable for tracking.

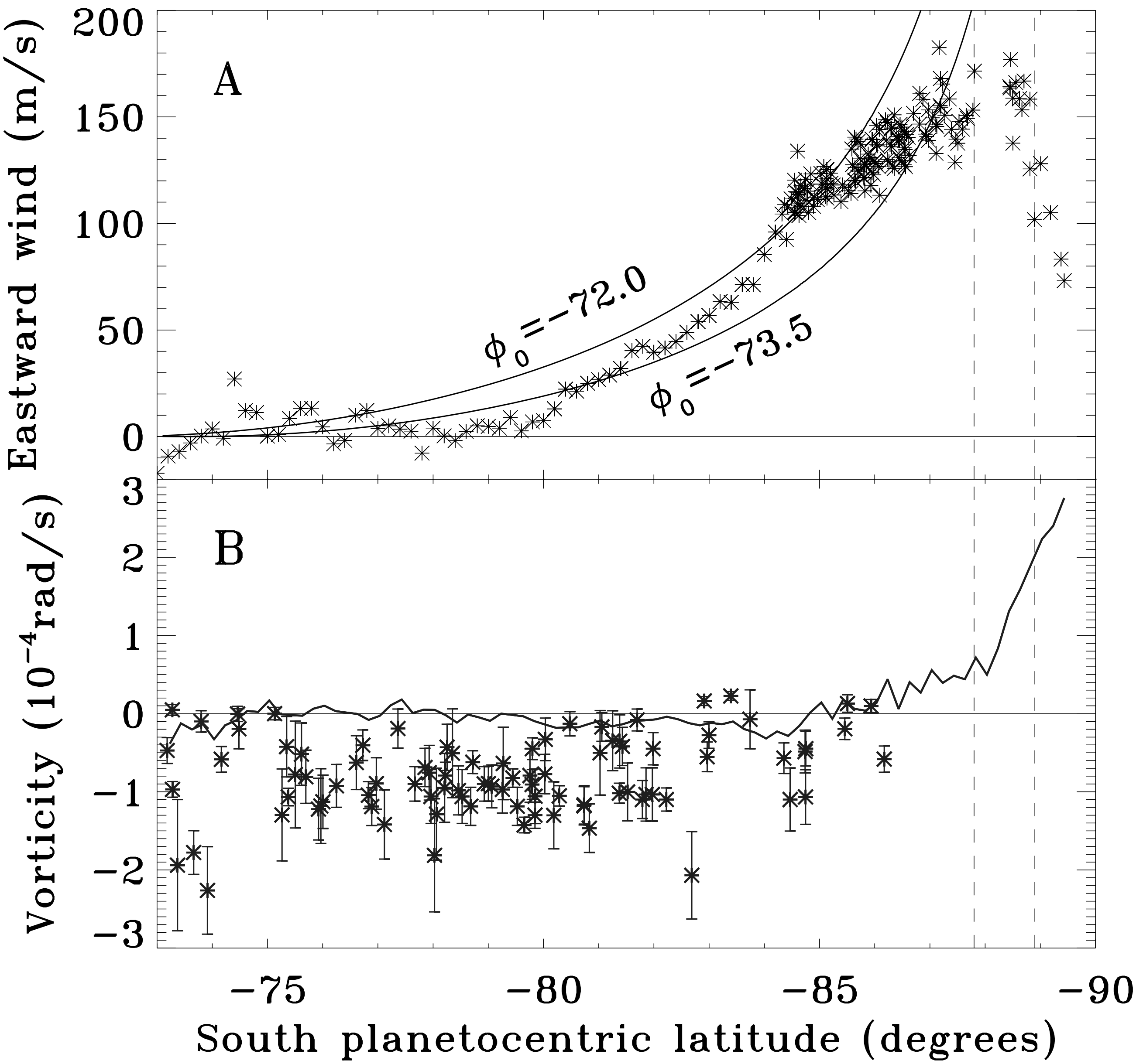

Figure S1: Profiles of zonal velocity (eastward) and cyclonic vorticity (clockwise) around Saturn's south pole. The dashed vertical lines indicate the inner and outer eyewalls. (**A**) Zonal velocity measured by tracking clouds in a sequence of images over a 3-hour period. The solid curves are for constant absolute vorticity $\bar{\zeta} + f$ starting at latitude ϕ_0 (values labeled on the curves) with $\bar{u} = 0$ and $\bar{\zeta} = 0$ at that point. (**B**) Relative vorticity ζ. The solid curve is a spline fit to the velocity data of Fig. S1A . The points are the puffy red clouds of Fig. 1A. To determine the relative vorticity of a puffy red cloud, we measured its angular velocity of rotation relative to the rotating planet. Twice this angular velocity is the vorticity of the cloud. We repeated the procedure three to four times for each cloud and assigned error bars from the residuals.

Movie caption

Movie S2: A four-step movie combined from the color images similar to Fig. 1A taken within approximately 2 hr 20 min during the 11 October 2006 ISS observation.

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