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A new look at Titan's zonal winds from Cassini radio occultations

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Abstract

The Huygens Doppler Wind Experiment (DWE) [1, 2] provided an *in situ* measurement of Titan's zonal winds along the probe's descent trajectory near 10° S. At other latitudes, the temperatures retrieved from the Cassini Composite Infrared Spectrometer (CIRS) have been used to derive zonal winds in the stratosphere above the 10-mbar level [3, 4], but reported wind determinations at lower levels have been sparse. We construct a meridional cross section of geopotential height vs. pressure and latitude from the current inventory of Cassini radio-occultation soundings, spanning 2006-2009. The assumption of balanced flow permits the construction of a similar cross section of zonal winds, from near the surface to the 0.1-mbar level. In the lower troposphere, the winds are ∼10 m s^{-1}, except within 20° of the equator, where they are much smaller. The winds increase higher up in the troposphere to nearly 40 m s^{-1} in the tropopause region, but then decay rapidly in the lower stratosphere to near-zero values at 20 mbar (∼80 km), reminiscent of the DWE result. This null zone extends over most latitudes, except for limited bands at mid and high latitudes. Higher up in the stratosphere, the winds become larger, and they are greatest in the northern (winter) hemisphere. We compare the occultation results with the winds obtained from the Huygens DWE and CIRS. The null zonal-wind zone observed near 80 km is not predicted by current general circulation models and suggests some momentum damping process is at work. One possibility is atmospheric waves, and we present examples of these in the occultation soundings. The spatial structure of the mean zonal winds and static stability affects the horizontal and vertical propagation of atmospheric waves. We suggest possible identifications of the waves and comment on their effects on Titan's superrotating flow.

References

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