Wave Forcing of Saturn's Equatorial Oscillation

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Ground-based measurements and Cassini data from CIRS thermal-infrared spectra and radio-occultation soundings have characterized the spatial structure and temporal behavior of a 15-year equatorial oscillation in Saturn's stratosphere. The equatorial region displays a vertical pattern of alternating warm and cold anomalies and, concomitantly, easterly and westerly winds relative to the cloud-top winds, with a peak-to-peak amplitude of 200 m/s. Comparison of the Cassini data over a four-year period has established that the pattern of mean zonal winds and temperatures descends at a rate of roughly 1 scale height over 4 years. This behavior is reminiscent of the equatorial oscillations in Earth's middle atmosphere. Here the zonal-mean spatial structure and descending pattern are driven by the absorption of vertically propagating waves. The maximum excursions in the pattern of easterly and westerly winds is determined by the limits of the zonal phase velocities of the waves. Here we report on the characterization of the waves seen in the temperature profiles retrieved from the Cassini radio-occultation soundings. The equatorial profiles exhibit a complex pattern of wavelike structure with dimensions one pressure scale height and smaller. We combine a spectral decomposition with a WKBJ analysis, where the vertical wavelength is assumed to vary slowly with the ambient static stability and doppler-shifted phase velocity of the wave. Use of the temperature and zonal wind maps from CIRS makes this approach viable. On Earth, the wave forcing associated with the equatorial oscillations generates secondary meridional circulations that affect the mean flow and planetary wave ducting well away from the equator. This may relate to the triggering of the recently reported mid-latitude storms on Saturn.