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Variations of Zonal Thermal Waves in Saturn from Cassini CIRS Observations

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Hemispherical maps of Saturn's atmosphere made by Cassini's Composite Infrared Spectrometer (CIRS) reveal the presence of zonal thermal waves. We surveyed their properties and their variability in time, concentrating on the period from 2004 to 2010, prior to the great northern springtime storm of 2010. The most inclusive CIRS surveys, FIRMAPs (15 cm-1 spectral resolution), covered the planet from the equator to either north or south pole, sweeping through the latitude range while the planet rotated beneath over its ∼10-hour rotation. We sampled spectral ranges dominated both by upper-tropospheric emission (80-200 mbar) and by stratospheric emission (0.5-3 mbar). We examined data that were taken between 2004 and 2010. During this time, the strongest waves were found between planetographic latitudes of 30° and 45°S. The strongest waves in the northern hemisphere were found between the equator and 30 degrees N. Some long-wave (low-wavenumber) components cover all 360 degrees in longitude, similar to the slowly moving thermal waves in Jupiter's atmosphere. However, the strongest zonal thermal waves were found in "trains" that covered only one hemisphere or less. Waves at the top of Saturn's troposphere had a mean peak-to-peak temperature variance that varied around 1.5 K and was never greater than 1.8 K. In the stratosphere, temperatures had a much greater variation as a function of time: maximum peak-to-peak variations were between 5 and 6 K between 2005 and 2007, diminishing to about half that through 2008, after which they were in the 3 – 5 K range. The phase of the waves moved about 0.5 degrees of longitude per day retrograde with respect to System III. The phase of tropospheric and stratospheric waves appeared to be highly correlated with one another with little offset in longitudes. While qualitatively similar to slowly moving thermal waves in Jupiter, Saturn's counterparts are more variable over several years and much more coherent over time scales of months.