Geophysical Research Abstracts,
Vol. 11, EGU2009-3522, 2009
EGU General Assembly 2009

Analysis of Spitzer IRS Observations of Uranus: Implications for Temperature Structure, Composition and a Standard Calibration Model for Herschel

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The Spitzer Infrared Spectrometer (IRS) was used to observe the disk of Uranus on 17 December 2007, shortly following its equinox. The low-resolution (R$\sim$90) spectral modes of the IRS covered wavelengths between 5 and 21.5 μm, and its high-resolution (R$\sim$600) modes covered wavelengths between 10 and 36.5 μm. Spectral features arising from methane, ethane, acetylene, diacetylene and methylacetylene are easily detectable. Sufficient coverage of the spectrum which is dominated by the opacity provided by the collision-induced absorption of molecular hydrogen allowed disk-averaged temperatures to be determined between 100 and 600 mbar pressure. An upward extension of this coverage to the lower stratosphere was facilitated by matching discrete hydrogen quadrupole S(1) and S(2) lines, which also provided constraints on the stratospheric para- vs ortho-H_2 ratio. These constraints were merged with those at lower pressures derived from Voyager-2 occultation experiments. Regular and deuterated methane absorption and emission are consistent with vapor-pressure-limited mixing of methane in the stratosphere, an upper-tropospheric abundance which is 40% of its fully saturated value, and a D/H ratio consistent with one derived from earlier measurements by ISO. Observations of the disk-averaged spectrum over different longitudes imply substantial spatial variability of stratospheric temperatures at pressures below 1 mbar, but no variability above the 3