Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09727, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09727
EGU General Assembly 2008

Methane and its Isotopologues on Saturn from Cassini/CIRS Observations

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Saturn's deep elemental and isotopic composition provides constraints on theories of giant planet formation and evolution. High spectral resolution observations from the Cassini Composite Infrared Spectrometer (CIRS, Flasar et al., 2004) have been analysed to derive new estimates of the mole fractions of methane, deuterated methane and $^{13}CH_4$ on Saturn. The analysis combines data from the far-IR methane rotational lines and the mid-IR absorption features of methane and its isotopologues, using both the correlated-k retrieval algorithm of Irwin et al. (2004) and a line-by-line approach to evaluate the reliability of retrieved quantities. The use of thousands of spectra at many spatially resolved locations on the planet, along with independent temperature constraints and improved calibration of the CIRS dataset, make these new abundance determinations more accurate than previous measurements.

The methane mole fractions show no hemispherical asymmetries or significant latitudinal variability. The newly measured C/H ratio is consistent with an increasing fractional core mass as we move from Jupiter to Saturn. A comparison of the Jovian and Saturnian D/H, C/N, C/S and C/P ratios suggests the formation of planetesimals within a primordial nebula whose composition varies with distance from the Sun. Saturn's derived D/H ratio is indistinguishable from that of Jupiter (Lellouch et al., 2001), and the $^{12}C/^{13}C$ ratio is consistent with both the terrestrial and Jovian ratios. These and other elemental abundances will be discussed.