Geophysical Research Abstracts
Vol. 12, EGU2010-4806, 2010
EGU General Assembly 2010

Seasonal Temperature Variations in Saturn's Stratosphere: Radiative Seasonal Model vs. Observations.

Thomas Greathouse (1), Julianne Moses (2), Leigh Fletcher (3), Glenn Orton (4), and Sandrine Guerlet (5)

(1) Southwest Research Institute, Division 15, San Antonio, United States (tgreathouse@swri.edu), (2) Lunar & Planetary Institute, Houston, TX, United States (moses@lpi.usra.edu), (3) University of Oxford, Oxford, United Kingdom (fletcher@atm.ox.ac.uk), (4) JPL, Pasadena, CA, United States (go@orton.jpl.nasa.gov), (5) LESIA – Observatoire De Paris, Meudon, France (sandrine.guerlet@obspm.fr)

The seasonal variations of temperatures in Saturn's stratosphere are controlled by a combination of several processes. The dominant driver of seasonal change is the variation of insolation due to Saturn's orbit and axial tilt. Radiative processes, originally thought to dominate in the stratosphere, cool or heat the stratosphere depending on the relative abundance of emitters and absorbers. To first order, photochemistry controls the abundances of C_2H_2 and C_2H_6, the dominant coolants, which also depends on the variation of insolation during Saturn's year. Finally, dynamics could be responsible for the advection of heat and transport of hydrocarbons such as C_2H_2 and C_2H_6. Transporting the hydrocarbons affects the cooling rates and thus the temperatures of the affected regions.

We present the results from a radiative seasonal climate model applied to Saturn. The seasonal model performs the full radiative exchange calculation throughout the stratosphere at all wavelengths (0-10^5 cm^{-1}). We include the effects of aerosol absorption but not scattering. The effects of dynamics are also not included. We implement vertically and meridionally variable hydrocarbon abundances as measured by Greathouse et al. (2005) and Guerlet et al. (2009), and compare them to a model with vertically and meridionally constant abundances as was done in previous models (Bezard and Gautier, 1985; Conrath et al., 1990). Finally, we compare the models to the TEXES and Cassini/CIRS observations described below.

We have performed ground based observations of Saturn's stratospheric emissions in 2002, 2004, 2005, 2007 and 2009 using the Texas Echelon Cross Echelle Spectrograph, TEXES, mounted on the NASA Infrared Telescope Facility atop of Mauna Kea in Hawaii. With a spatial resolution of $\approx 1''$ and a spectral resolving power R= $\lambda/\Delta\lambda$=80,000, we have mapped the stratospheric emission due to H_2, CH_4, C_2H_2, C_2H_4, C_2H_6, C_3H_8 and CH_3D. From the observations of H_2 and CH_4, we infer the vertical, meridional and temporal variations of Saturn's stratospheric temperatures. Then, using the inferred temperatures, we model the observations of the different hydrocarbons to retrieve their vertical, meridional, and temporal abundance variations (Greathouse et al., 2005; Greathouse et al., 2006).

Similar to the ground based observations, Cassini/CIRS observations (2004-2009) have been used to infer the vertical, meridional, and temporal variations of Saturn's stratospheric temperature and hydrocarbon abundances (Flasar et al., 2005; Fletcher et al., 2008; Fletcher et al., 2007; Fouchet et al., 2008; Guerlet et al., 2009; Howett et al., 2007). Ground based observers are unable to observe through Saturn's rings or behind the planet as viewed from the Earth. On the other hand, Cassini has no such restriction and thus can measure the global thermal and chemical state of Saturn for the duration of the mission. An important goal is to bring the ground-based and Cassini observations into agreement so that when the Cassini mission ends, continued ground-based observations can be used to constrain seasonal and dynamic changes on Saturn thereafter.

This work was funded by NASA PATM grant NNX08AL95G and NASA PAST grant NNX08AW33G.