EPSC Abstracts
Vol. 8, EPSC2013-381, 2013
European Planetary Science Congress 2013

The thermal structure of the 2011 Saturn's stratospheric beacon mapped with TEXES/IRTF

T. Fouchet (1), T. Greathouse (2), M. Richter (3), J. Lacy (4), L. Fletcher (5), S. Guerlet (6), A. Spiga (6)
(1) LESIA, Observatoire de Paris, France, (2) SWRI, San Antonio, USA, (3) University of California Davis, USA, (4) University of Texas at Austin, (5) AOPP, University of Oxford, UK (6) Laboratoire de Météorologie Dynamique (UPMC/CNRS), Paris, France (Thierry.Fouchet@obspm.fr)

Abstract

We present spectral observations of Saturn's stratosphere obtained in 2011 by the TEXES imaging spectrometer mounted on the IRTF. These observations allowed us to determine the thermal structure of the stratospheric disturbance induced by the 2010 Great White Storm.

1. Introduction

In late 2010, the yearly Great White Storm erupted on Saturn, slightly ahead of schedule compared to previous events [1]. For the first time, a stratospheric disturbance associated with the tropospheric disturbance was detected using Cassini/CIRS and ground-based observations [4]. The rise in temperature cumulated in may 2011, with a temperature of 221K, hence 80 K than the normal [5]. An increase in stratospheric hydrocarbon was also detected [5, **?**].

In July 2011, we observed the stratospheric disturbance with the TEXES (Texas Echelon Cross Echelle Spectrograph) mounted at the Infrared Telescope Facility (IRTF). Observations were performed at 8 μm to measure the CH_4 and CH_3D emissions and at 17 μm to measure the H_2 quadrupolar and Collisin-induced emissions. These emissions were analysed to retrieve the 3D therma structure within and outside the stratospheric beacon.

Due to its high resolution power, ($R = 75,000$), TEXES allowed us to determine the vertical structure of the thermal disturbance between 10 hPa and 1 Pa.

2. Results

The spectra were analysed using the line-by-line forward radiative transfer model, coupled to an optimal and regularized inversion scheme. Two examples of spectra in the methane bands are displayd Figure 1 and Figure 2. Figure 1, the spectrum observed at the center of the beacon displays a thermal inversion in the core of the methane lines, directly demonstrating that the thermal disturbance is constrained to the middle stratosphere (1–5 hPa), while the upper stratosphere has not been affected with a temperature of 140 K normal for the season. This very localized heating will help to understand the nature of the energy sources.

Figure 2, the spectrum observed outside (east) of the beacon displays very narrow methane lines, demonstrating that outside the beacon the observed stratospheric warming is located in the upper stratosphere, between 10 and 1 Pa. We will show that this vertical structure may be due to the breaking of the vortex after the end of the tropospheric convective disturbance

3. Figures

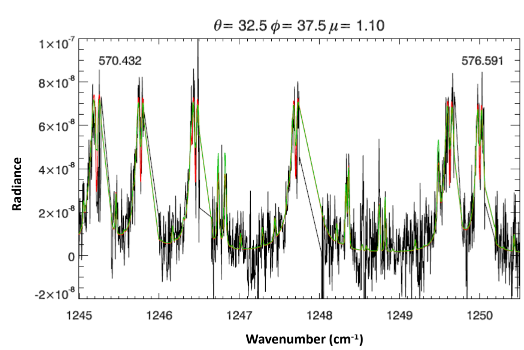

Figure 1: TEXES/IRTF spectrum (black line) obtained in the center of the stratospheric beacon compared with two synthetic model, one with a temperature of 140 K above the 3-Pa level (red line), one with a temperature of 160 K above the 3-Pa level (green line).

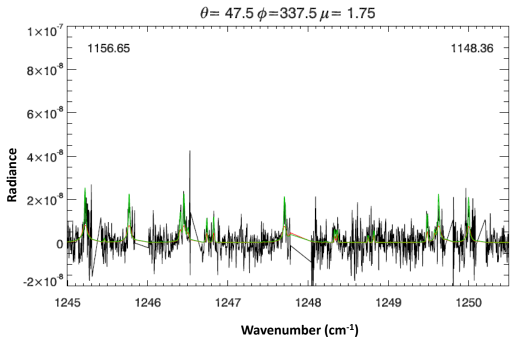

Figure 2: TEXES/IRTF spectrum (black line) obtained in the east of the stratospherc beacon compared with two synthetic model, one with a temperature disturbance centered at 1 hPa (red line), and one with a temperature disturbance centered at the 3-Pa level (green line).

Acknowledgements

SG aknowledges funding by the French ANR under grant agreement ANR-12-PDOC-0013.

References

[1] Sánchez-Lavega, A., and 42 colleagues 2011. Deep winds beneath Saturn's upper clouds from a seasonal long-lived planetary-scale storm. Nature 475, 71-74.

[2] Fletcher, L. N., and 18 colleagues 2011. Thermal Structure and Dynamics of Saturn's Northern Springtime Disturbance. Science 332, 1413.

[3] Fletcher, L., B.E. Hesman, R.K. Achterberg, P.G.J. Irwin, G. Bjoraker, N. Gorius, J. Hurley, J. Sinclair, G.S. Orton, J. Legarreta, E. Garcia-Melendo, A. Sanchez-Lavega, P.L. Read, A.A. Simon-Miller, F.M. Flasar: The origin and evolution of Saturn's 2011-2012 stratospheric vortex, Icarus, Vol. 221, p. 560-586, 2012

[4] Hesman, B. E., and 11 colleagues 2012. Elusive Ethylene Detected in Saturn's Northern Storm Region. The Astrophysical Journal 760, 24.

[5] Author, F.: Third example of a cited conference paper, The Great Science Conference, 1–7 February 2001, Sciencetown, Sciencecountry, 2001.