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Observations of Jupiter at 5 micron from IRTF/TEXES: latitudinal variability of disequilibrium species

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Abstract

Observations of Jupiter in the 5 µm spectral window, obtained in March/April 2015 at IRTF are presented, in preparation of the arrival of the NASA/JUNO mission in 2016. Sounding of the troposphere of Jupiter below 2 bars is obtained from the observations, to search for the variability of disequilibrium species, related to deep atmospheric circulation.

1. Introduction

In preparation of the JUNO observations of Jupiter in 2016, imaging spectroscopic observations were performed between March 31 and April 4, 2015 on IRTF with TEXES (Texas Echelon Cross Echelle Spectrograph) instrument [1] in 5-12 µm range to search for composition variability over the Jovian disk. The spectral resolving power was ~13500, and radiometric calibration was done using standard procedures of the instrument.

2. Observations and modeling

This work presents the 5-micron part of the observations, and preliminary interpretation, in the following spectral ranges:

- 1931-1941 cm^{-1} (NH_3)
- 2027-2045 cm^{-1} (PH_3, CH_3D, NH_3)
- 2140-2150 cm^{-1} (PH_3, CH_4 faint lines)
- 2152-2169 cm^{-1} (PH_3, CH_3D, CO, GeH_4)

A standard radiative transfer model with simplified cloud opacities is used in this study. Thermal emission is calculated through a standard atmospheric model derived from Galileo observations [4]. A complication in atmospheric inversion comes from cloud opacities, which can affect the formation of lines. As confirmed from Galileo/NIMS interpretation at 5 micron, the simplification of a grey opacity cloud layer reproduces very well the spectral shape and can be used in a first approach [2].

3. Interpretation

Variability of tropospheric constituents are expected from different origins:

- Condensable species (NH_3, H_2O) exhibit strong variability related to local meteorological conditions, in particular in convective active regions, like the 5 µm hot spots [3].

- Disequilibrium species (PH_3, CO, GeH_4, AsH_3) could trace deeper atmospheric variability, as the transport of these species from the quenching temperature depth is dependent on the vertical mixing of the atmosphere.

4. Figures

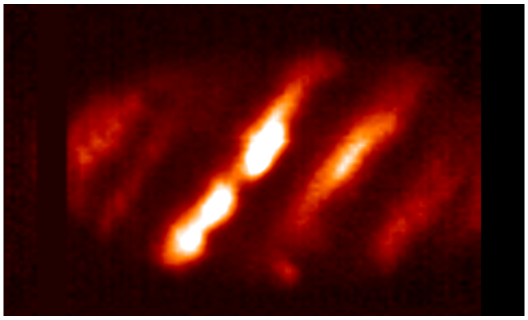

Figure 1: Image of Jupiter at 2034 cm^{-1} wavenumber (continuum) – 31/3/2015-IRTF/TEXES

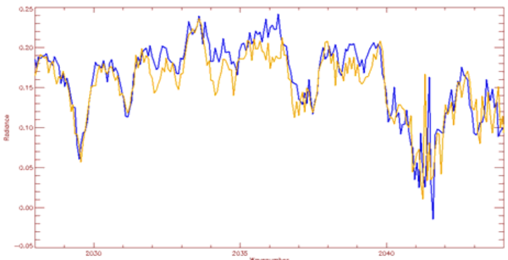

Figure 2: Two spectra selected from Jupiter at ~50N and~50S latitudes from Fig.1 spectral image. Variations in spectral absorption for a similar continuum level suggests a variation in the PH_3 abundance spatially, and hence a variation of turbulent mixing.

5. Summary and Conclusions

Preliminary models show that variability in PH_3 tropospheric abundance is present. The most plausible interpretation for such a variation would be a latitudinal variation of vertical mixing between quenching temperature levels for PH_3 stability, related to the anisotropies of convection in a rotating atmosphere.

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References

[1] Lacy, J. H., Richter, M. J., Greathouse, T. K., Jaffe, D. T., Zhu, Q., TEXES: A Sensitive High-Resolution Grating Spectrograph for the Mid-Infrared, The Publications of the Astronomical Society of the Pacific, Vol. 114, pp. 153-168, 2002.

[2] Roos-Serote, M., Drossart, P., Encrenaz, Th., Carlson, R. W., Leader, F., Constraints on the Tropospheric Cloud Structure of Jupiter from Spectroscopy in the 5-mum Region: A Comparison between Voyager/IRIS, Galileo-NIMS, and ISO-SWS Spectra, Icarus, Vol. 137, pp. 315-340, 1999.

[3] Roos-Serote, M., Vasavada, A. R., Kamp, L., Drossart, P., Irwin, P., Nixon, C., Carlson, R. W. Proximate humid and dry regions in Jupiter's atmosphere indicate complex local meteorology, Nature, Vol. 405, pp. 158-160, 2000.

[4] Seiff, A., Kirk, D. B., Knight, T. C. D., Young, R. E., Mihalov, J. D., Young, L. A., Milos, Frank S., Schubert, G., Blanchard, R. C., Atkinson, D.: Thermal structure of Jupiter's atmosphere near the edge of a 5-µm hot spot in the north equatorial belt, Journal of Geophysical Research, Vol. 103, pp. 22857-22890, 1998.