SPECTRAL PROPERTIES OF CLEAR AREAS IN JUPITER ATMOSPHERE FROM JIRAM-JUNO DATA.

D. Grassi[1], F. Biagiotti[2,1], A. Mura[1], G. Piccioni[1], C. Plainaki[3], G. Sindoni[3] and the JIRAM-Juno team, [1]IAPS-INAF (davide.grassi@inaf.it), [2]Sapienza, Univ. di Roma, [3]DSR-ASI.

Introduction: Thermochemical models of the Jupiter troposphere foresee the occurrence of liquid water clouds below the 4-5 bar level [1,2]. However, the same models also predict layers of NH_4SH and NH_3 aerosols at higher altitudes, and therefore it comes as no surprise that spectroscopic detections of deeper water clouds have been so far rather sparse [3,4].

In this work we describe the cloud clearance areas in Jupiter's atmosphere detected from JIRAM-Juno spectra in the wake of the Great Red Spot, in the South Equatorial Belt and the possible implications for cloud structure elsewhere on the planet.

Materials: We considered the spectra acquired by the instrument during the first Juno perijove passage in August 2016. JIRAM spectra cover the range 2-5 μm with a typical resolution of 13 nm. Acquisitions occur simultaneously along monodimensional slits of 256 spatially-contiguous pixels. Slits seldom ensure complete spatial coverage because of limited datavolume and complex operational scenario (spinning spacecraft). The signal measured at $\lambda > 4\mu m$ is dominated by the thermal emission of the atmosphere (gases or aerosols). Over large areas of the planet the 5-μm signal is relatively low, being emitted at the cold tops of NH_4SH and NH_3 clouds between 1 and 0.5 bars. Regions of relative cloud clearance appear much brighter, allowing the radiation emerging from warmer levels at 4-5 bars (there, H_2 collision induced absorption represents the main source of opacity). Radiation measured at $\lambda < 3.2$ μm is dominated by reflected solar radiation (rather than thermal or auroral emission). At $\lambda > 1.5$ μm Rayleigh scattering by gases becomes negligible and therefore vertical density profiles of aerosols are the main drivers for the signal measured in JIRAM spectra, along with the variation of atmosphere opacity modulated by gases (with a major role by methane). The radiance maximum usually observed at 2.78 μm corresponds to a region of relative transparent region in both methane and ammonia spectra. Here, clouds down to 2-3 bars can be detected (by mean of their reflections) in absence of uppermost aerosol layers.

Methods: Over large areas of the planet, JIRAM data confirm the anticorrelation previously observed [5] between signals measured in the thermal region (5 μm, Fig. 1a) and those at shorter wavelengths (2.73 μm) dominated by solar scattering. This phenomenology is consistent with the simplest model of an upper gray cloud deck (putatively composed of NH_4SH and NH_3).

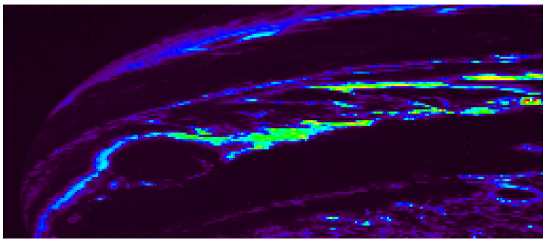

Fig. 1a

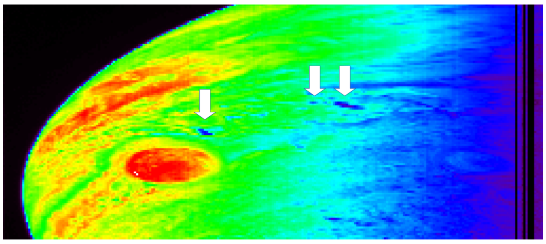

Fig. 1b

Fig. 1 The southern hemisphere of Jupiter as observed by JIRAM during the first perijove passage. Fig. 1a: 5μm, fig. 1b: 2.73 μm . The images are created as stacks of spectral slits. White arrows indicate the clearance areas.

Within this general trend, we detected in JIRAM maps a few regions of high thermal flux that display an exceptionally low signal at solar wavelengths. An extremely thin upper cloud deck is the most straightforward interpretation for the spectral behavior shown by these areas. Notably, their location is comparable to that of the structures described in Fig. 6 of [5]. There, the authors reported the occurrence of deep clouds, possibly attributed to water.

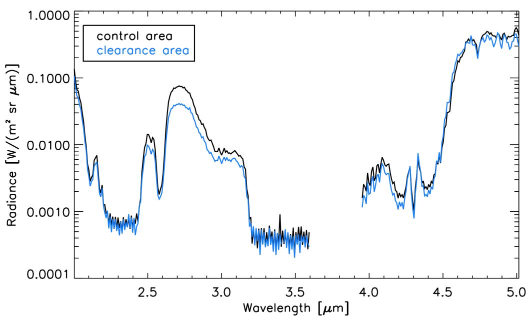

Fig. 2 Spectrum comparison between upper clouds clearance areas (in blue) and those of nearby regions with similar thermal signal

To further investigate this hypothesis, we compared the spectral properties of the upper cloud clearance areas to those of nearby regions of similar thermal intensity but higher solar signal (Fig. 2). Most intriguing *shape* difference is given by a broad increase in thermal emission centered at 4.55 µm (Fig. 3) observed over clearance areas.

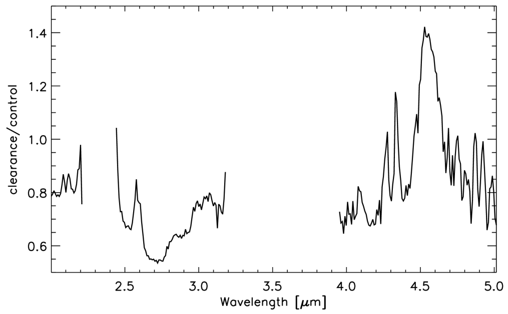

Fig. 3 Ratio of spectra presented in Fig. 3. Spectral intervals of intrinsic low signal are prone to strong random fluctuations and are not presented.

This behavior is *not* consistent with a deep cloud in JIRAM clearance areas, and conversely suggests that these regions lack an opacity source located at the 3-4 bar pressure levels (peak of contribution functions at 4.55 µm [7]) commonly seen elsewhere. The processes responsible for cloud clearance in the upper deck seems therefore to be effective down to the level of a few bars.

Preliminary simulations performed assuming a liquid water cloud located between 3 and 8 bar (following the models given in [4]) for regions *outside* the clearance areas provide a peak in spectrum ratio located at 4.7 µm rather than 4.55 µm. A similar result is achieved raising the water cloud at 1.5 bar. More systematic exploration of possible combinations in cloud altitude, density, particle composition (liquid/ice) and size distribution is therefore required to further test the hypothesis of extensive water cloud occurrence at the level of a few bars in Jupiter's atmosphere.

Acknowledgments:
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References:

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