Search for hydrogen peroxide in the Martian atmosphere

V. Formisano[1], A. Geminale[1],
S. Aoki[2], Y. Kasaba[2]
[1] IFSI-INAF, via del Fosso del Cavaliere 100, 00133, Rome, Italy
[2]Tohoku University, Japan

- It has been suggested that the large and fast variations of methane in Martian atmosphere could be caused by oxidation with H2O2 , which could be produced in quantities much larger than foreseen by water photochemistry during dust storms (small, like dust devils, or large like the global dust storms) by means of electrostatic charging of the dust grains. Past measurements of H2O2 mixing ratios are few and contradictory. Table 1 shows the summary of past measurements. The mixing ratio, in case of generation of H2O2 around dust grains, is computed to be up to 4 ppm in the ground reservoir. Assuming that a small portion of these molecules could escape freely into the atmosphere, it is possible that the mixing ratio in the atmosphere could be larger than predicted by the photochemistry.
- Our Japanese collegues have suggested to use the PFS data of the Long Wavelength Cannel , to search for H2O2 , and to measure its mixing ratio and its variation with season.

Introduction

Table. past H_2O_2 observation

Ref.	Ls	Instrument	Date	Wavelength ($\mu m/cm^{-1}$)	Mixing ratio
Encrenaz et al., 2002	112°	IRTF/TEXES (R=80000)	2001/2	8.05-8.10 1235-1243	upper limit (6ppb)
Clancy et al., 2004	254°	JCMT	2003/9	362.156 GHz	18±4ppb
Encrenaz et al., 2004	206°	IRTF/TEXES	2003/7	8.05-8.10 1235-1243	20-50ppb
Encrenaz et al., 2008	332°	IRTF/TEXES	2005/11/30-12/1	8.05-8.10 1235-1243	15±10ppb

TABLE I

Hydrogen peroxide has a mixing ratio that is not well defined from these ground based telescopic measurements.

It is also not clear if there is a real seasonal variation or if the numerical variation reported is simply due to the large error bars reported.

The mixing ratio predicted by the photochemistry is of the order of 20-30 ppbv.

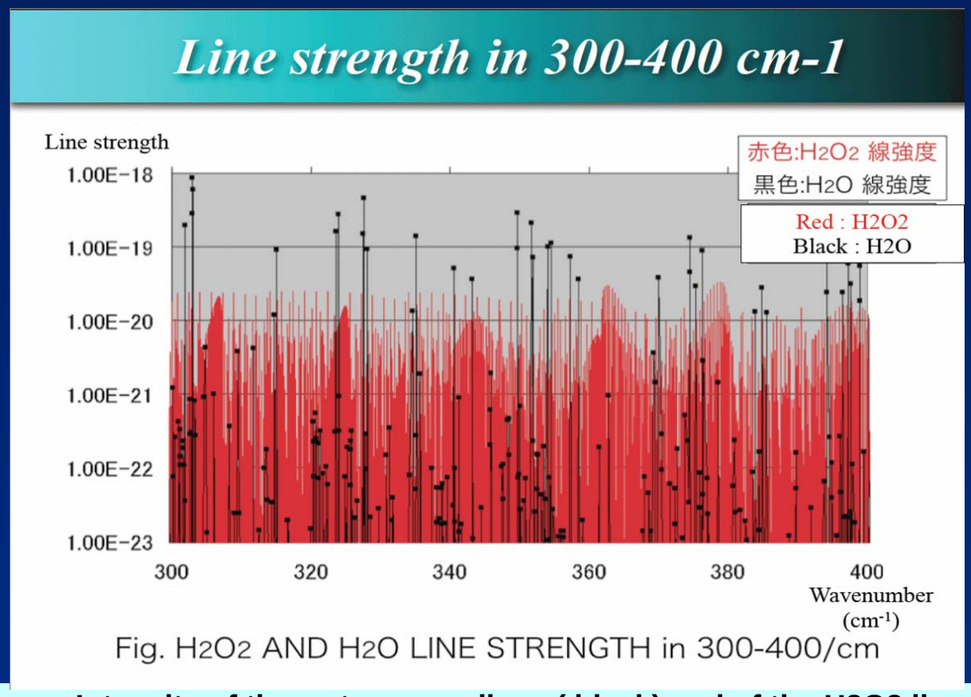
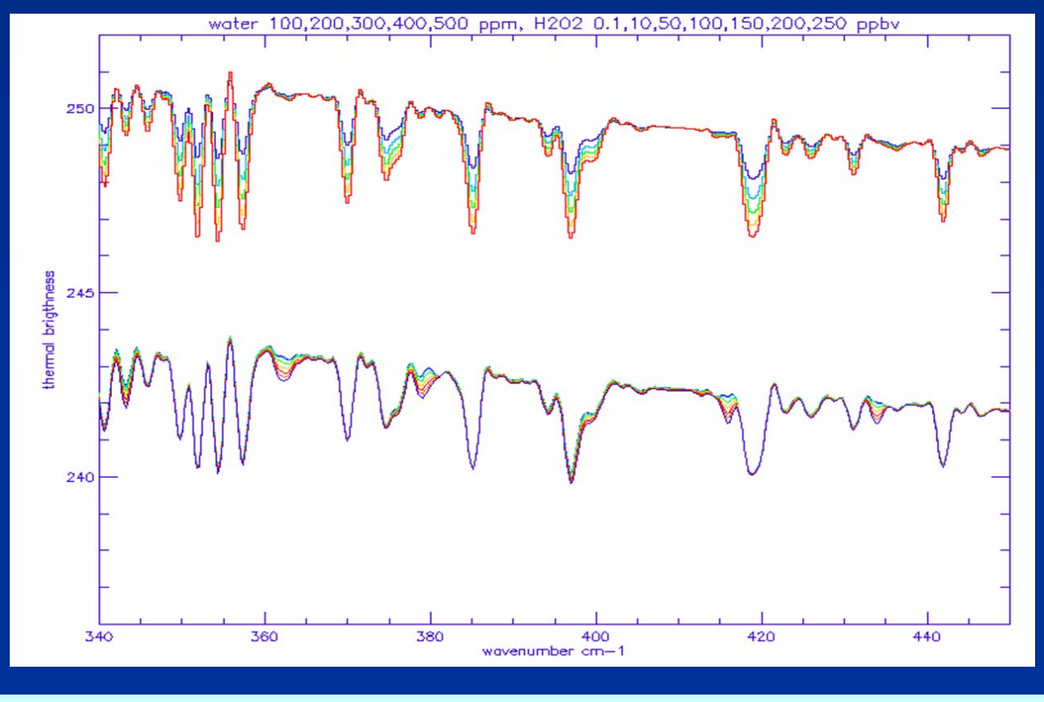
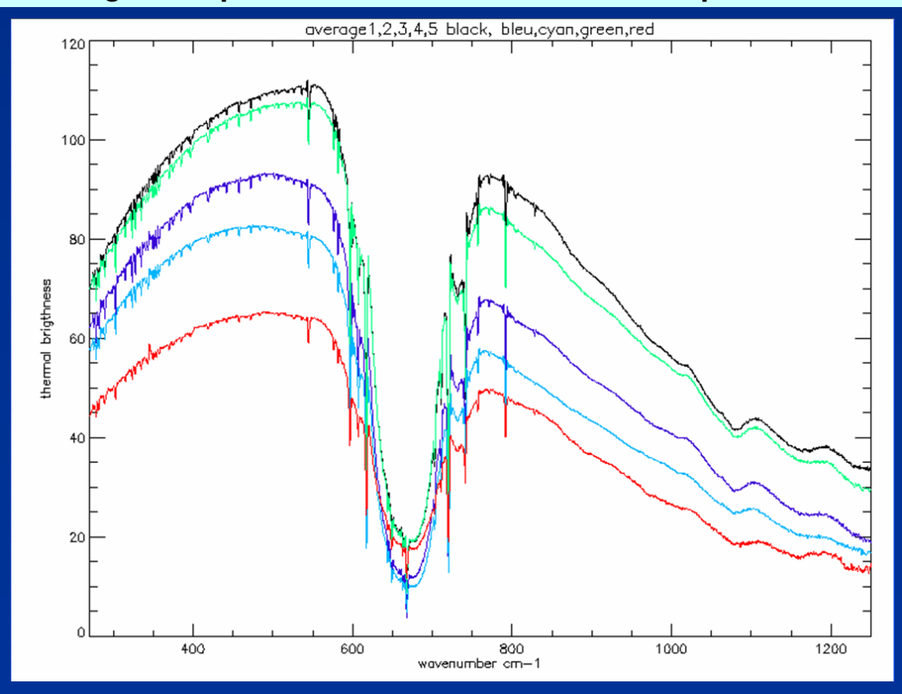


Fig. H_2O_2 AND H_2O LINE STRENGTH in 300-400/cm

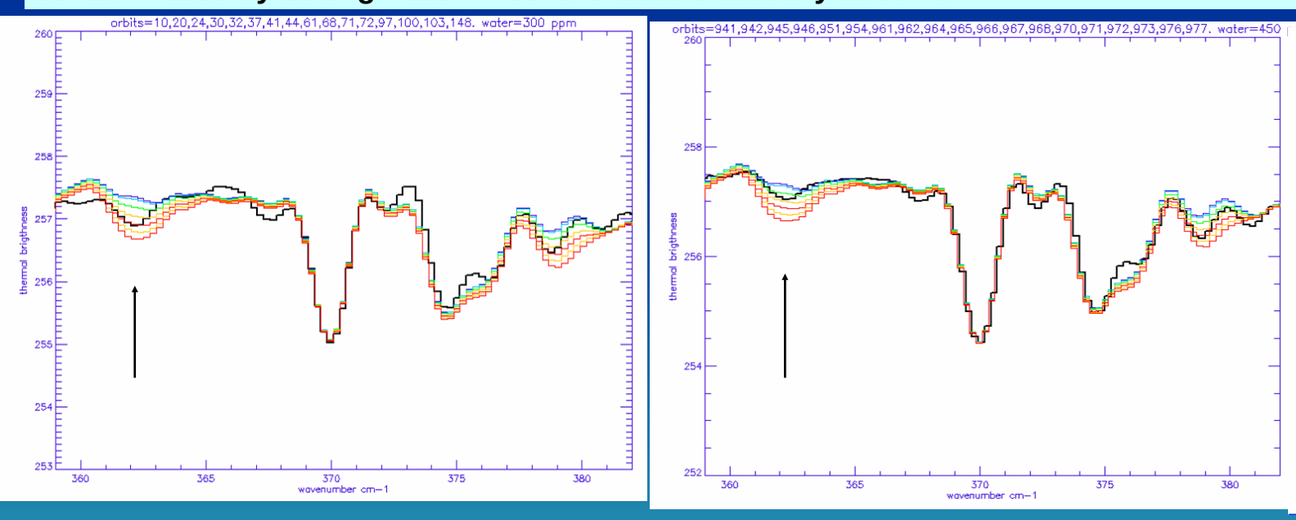
From Hitran : Intensity of the water vapor lines (black) and of the H2O2 lines (red). It is evident that in the wavenumber range examined there are several possible hydrogen peroxide bands (Q-branches) that could be observed if a good spectral resolution is available for the observations. Clearly this interval is not usable from ground because of the strong effect predicted for the Earth's water vapor.



A number of synthetic spectra (expressed as thermal britness) computed for different mixing ratios of water vapor and of hydrogen peroxide with the spectral resolution of PFS : the water vapor synthetic spectra are for 100, 200, 300, 400 and 500 ppm, while for H2O2 (shifted for clarity) we have 0.1, 10, 50, 100, 150, 200, 250 ppbv.
It is evident that that at 362, 379, 416, 434 cm-1 we have 4 possible lines of H2O2 not contaminated by strong water lines: the best is actually at 362 cm-1



Five large average spectra have been built (many orbits each) for different Ls, in order to increase SNR and be able to evaluate the mixing ratio of H2O2.



Fitting of four out of five average spectra: The temperature profile retrieved has been used with a water vapor mixing ratio of respectively : 300, 450, 200, and 300 ppm, The coloured curves are for 0.1, 10, 50, 100, 150, 200, 250 ppbv of H2O2. The hydrogen peroxide mixing ratios appear to be of the order of :150, 90 , 90, 130 ppbv. On average in these 5 cases we have found 120 +- 40 ppbv for hydrogen peroxide.

CONCLUSIONS: PFS IS ABLE TO MEASURE THE MIXING RATIO OF H2O2 IN THE LWC . THE MIXING RATIO SEEMS TO BE OF THE ORDER OF 120 +- 40 PPBV. PERHAPS A BIT LARGER THAN PREDICTED BY THE ATMOSPHERIC PHOTOCHEMISTRY. IT IS NOT OBVIOUS FROM THIS ANALYSIS THAT THERE IS A SEASONAL VARIATION. A BETTER STUDY IS NEEDED ON MORE DATA.