Vertical column abundance and profile retrievals of water vapor above the Jungfraujoch.

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FTS-SPM intercomparison

For many years, the University of Liège has been operating at the Jungfraujoch (Swiss Alps) two high resolution (0.0010 to 0.0025 cm^{-1}) Fourier transform infrared spectrometers (FTS) using the sun as a source of light. To measure the water vapor in the spectra recorded by these instruments, three lines have been selected : H_2O at 841.90 cm^{-1} (E" = 52.9 cm^{-1}; S = 2.63 × 10^{-24} cm/molec.), HDO at 2612.54 cm^{-1} (E" = 490.4 cm^{-1}; S = 3.34 × 10^{-24} cm/molec.) and H_2O at 4580.07 cm^{-1} (E" = 224.8 cm^{-1}; S = 1.03 × 10^{-24} cm/molec.) [spectroscopic parameters from HITRAN 96]. Figure 1 shows excerpts of two solar spectra in the 841.90 cm^{-1} region, recorded under dry (18 Feb. 1992) and wet (5 Oct. 1991) conditions.

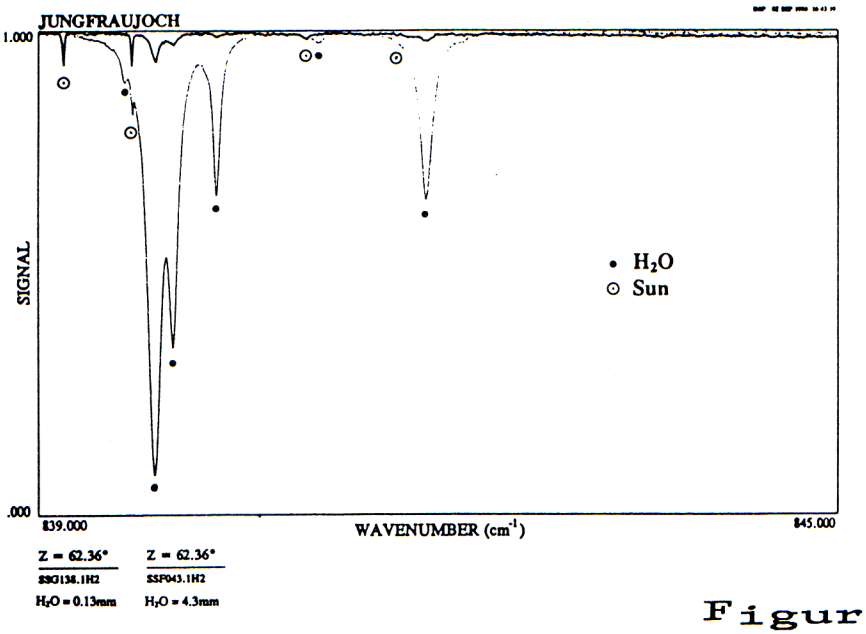


Figure 1

The Institute of Applied Physics, University of Bern has developed a 12-channel solar photometer (SPM) operating in the 370 to 1025 nm range (Schmid et al., 1996). The 946 nm channel is used to monitor the water vapor in the atmosphere.

Two intercomparison campaigns have been organized from September to December 1993 and in June - July 1995 at the Jungfraujoch to compare the water vapor amounts retrieved by the different instruments. Precipitable water amounts ranged from 0.17 to 4.2 mm and from 0.72 to 5.0 mm respectively (1 mm $H_2O = 3.345 \times 10^{21}$ molec./cm^2). Figure 2 shows the water columns retrieved during the 1995 campaign by the FTS and by the SPM.

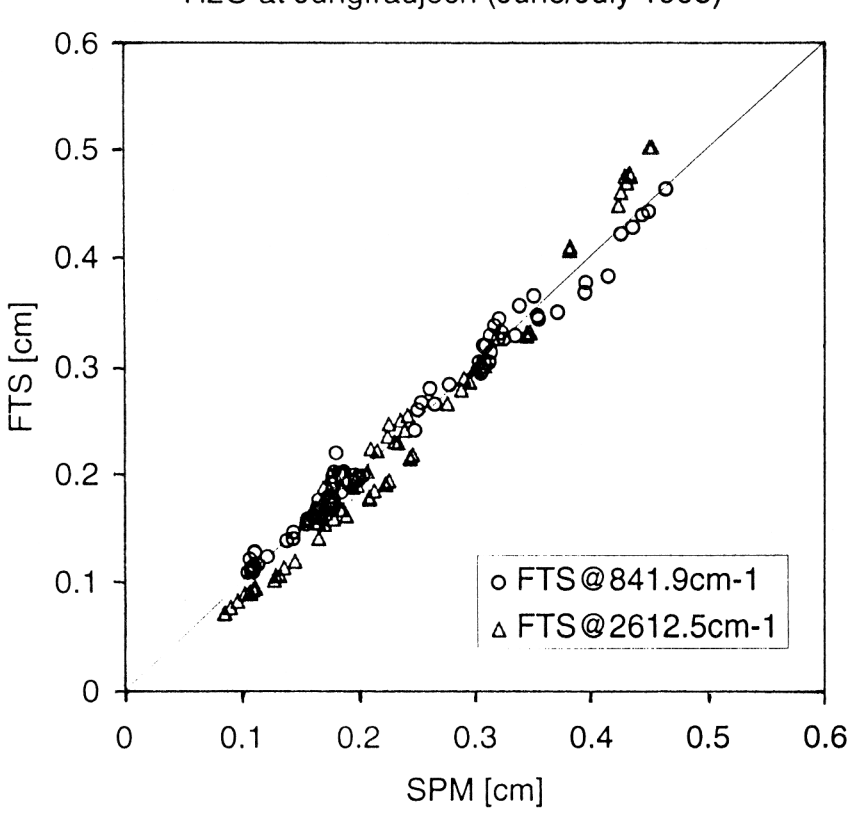


Figure 2

A summary of the results of both campaigns is given in the following table:

Line	841.90 cm^{-1}		2612.54 cm^{-1}	
Campaign	1993	1995	1993	1995
# coincident spectra	13	87	69	81
Mean H_2O (mm)	1.07	2.30	1.04	2.29
Bias FTS-SPM (mm)	0.21	0.025	0.042	0.046
Stdev (mm)	0.21	0.111	0.095	0.207
Relative bias	20 %	1 %	4 %	2 %
Relative stdev	20 %	5 %	9 %	9 %

This intercomparison enabled us to calibrate, in a relative way, the 3 lines we used with FTS for water retrievals : to obtain the same water column as the SPM, arbitrarily chosen as a reference, we have to divide the column obtained from the 841.90 cm^{-1} line by 1.11, from the 2612.54 cm^{-1} line by 0.94, and from the 4580.07 cm^{-1} line by 1.53. The discrepancy between the 3 lines probably arises from the poor quality of the spectroscopic parameters of the water lines used.

Vertical profile tests

When fitting spectra with the SFIT program (Rinsland et al., 1992), the "effective apodization" parameter may be adjusted during the procedure. This parameter indicates how different the contour of a line in the observed spectrum is from the computed one : an effective apodization greater than 1 means that the computed line is too broad and a value less than 1 means that the computed line is too narrow. In the case of the water lines, it is very sensitive to the vertical distribution used, far more sensitive than the r.m.s. of the fit. A manual iterative method starts fitting the spectrum with a "standard" H_2O vertical distribution and, according to the effective apodization obtained, chooses from a series of H_2O distributions, decreasing more or less rapidly from the ground to the tropopause; the process continues until the effective apodization reaches 1; which corresponds to the expected value for a perfect instrument; this provides a crude approximation of the actual H_2O distribution. Some tests have been run, with

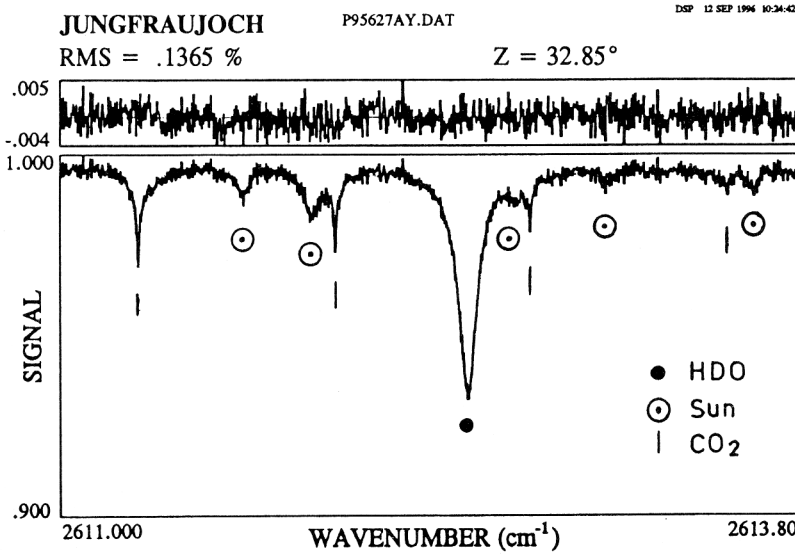
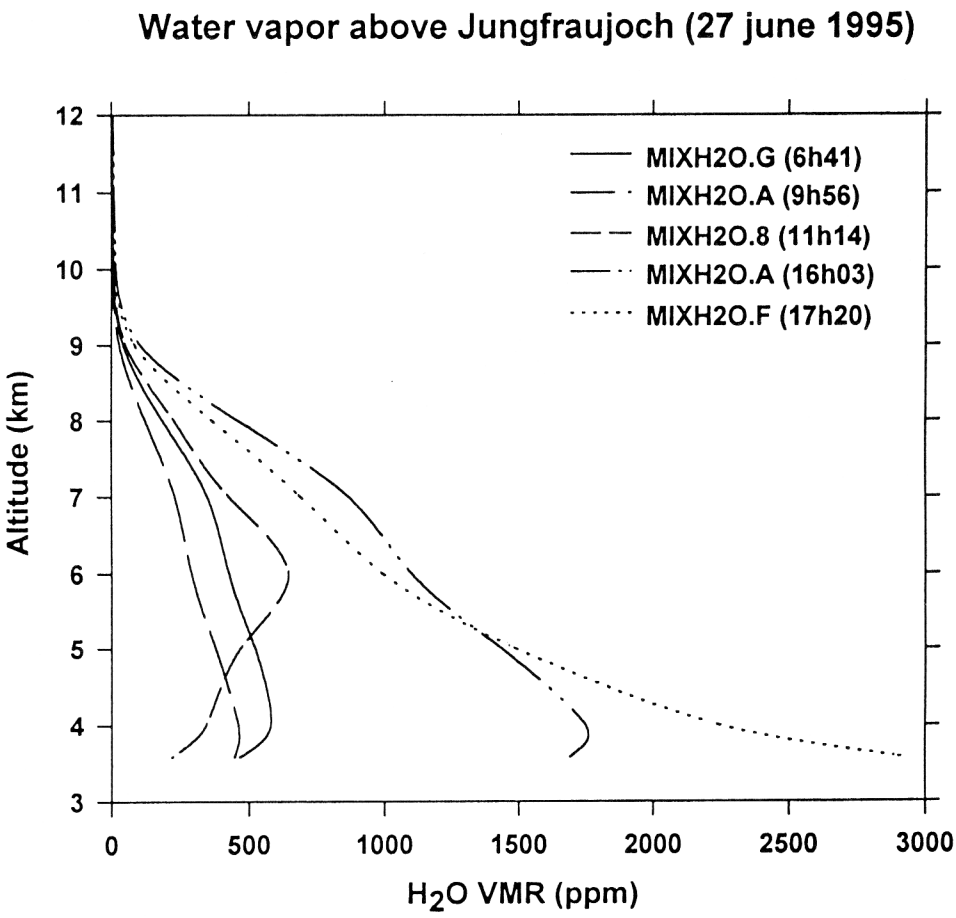


Figure 3

spectra of June and July 1995, leading to acceptable fits of spectra; samples of water vapor profiles obtained for June 27, 1995 are reproduced in Figure 3. Figure 4 shows an example of fitting the HDO line at 2612.54 cm^{-1} with the profile MIXH2O.8 of Fig. 3.



Figure

An important point to notice is that, in the test we made, the retrieved water vertical columns change only a little (0 to 3 %) when using a standard H_2O distribution shape or a more realistic one, even when these are very different from each other.

Acknowledgments :

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