SPICAM ON MARS EXPRESS: FIRST RESULTS AND FIRST OBSERVATIONS OF WATER ICE AT SOUTH POLE. Jean-Loup Bertaux[1], Oleg Korablev[2], E.Quemerais[1], S. Perrier[1], A. Fedorova[2], C. Muller[3] and the SPICAM team, [1]*Service d'Aéronomie du CNRS/IPSL,BP.3, 91371, Verrières-le-Buisson, France* (bertaux@aerov.jussieu.fr), [2]*Space Research Institute (IKI), 84/32 Profsoyuznaya, 117810 Moscow, Russia,* [3]*Belgian Institute for Space Aeronomy, 3 av. Circulaire, B-1180 Brussels, Belgium*

Instrument description. SPICAM, a light-weight (4.8 kg) UV-IR dual spectrometer on board Mars Express orbiter, is dedicated primarily to the study of the atmosphere and ionosphere of Mars, but has also provided important results on the surface albedo of Mars [1]. A UV imaging spectrometer (118 - 320 nm, resolution 1 nm, intensified CCD) is dedicated to nadir viewing, limb viewing and atmospheric vertical profiling by stellar and solar occultation. An IR spectrometer (1.0-1.7 microns, resolution 0.5-1.2 nm, or $\lambda/\delta\lambda$= 1300, mass 0.8 kg) is dedicated primarily to nadir measurements of H_2O abundances [2]. It is based on AOTF technology; and it is the first time that such a spectrometer is flying in deep space. The whole instrument was built as a cooperative effort of the three institutes (see affiliations), under overall management of Service d'Aéronomie.

Atmospheric vertical profile by UV star occultation. By orienting Mars Express to the star Zeta Puppis, the UV spectral transmission of the atmosphere was measured as a function of altitude and wavelength, at a latitude of + 16°. The main absorbers are CO_2 (below 200 nm) and dust (above 200 nm, Figure 1). The atmospheric pressure and temperature are retrieved from 120 km down to 25 km, where dust is preventing further measurements. This is the first ever stellar occultation around Mars, and the first measurement of the UV absorption of CO_2 in the upper atmosphere of Mars. Collection of future vertical profiles of density and temperature will help in the development of meteorological and dynamical Mars atmospheric models. This is essential for future missions that will rely on aerocapture and aerobraking.

UV ozone measurements in nadir viewing, The UV solar spectrum reflected by Mars is analyzed. Figure 2 represents the relative albedo at latitude of 55°N, obtained by division of one spectrum at this latitude by a spectrum obtained at a lower latitude, where it is assumed that there is no ozone. The UV absorption of ozone is well identified, and the depth of the trough is a direct measure of the vertical quantity of ozone. Assuming an optically thin atmosphere, the ozone quantity was recovered along the orbital track as a function of latitude, as shown on Figure 3.

Water vapor and O_2 Airglow at 1.27 µm $O_2(^1\Delta_g)$ in nadir viewing. The water vapor band around 1.38 µm (the very band used by MAWD/Viking) is shown on Figure 4. Together with the UV ozone measurements, SPICAM has thus obtained for the first time from an orbiter simultaneous measurements of ozone and H_2O, which are found to be anti-correlated as expected on the ground of chemistry consideration: catalytic destruction of ozone from OH and HO_2 radicals (H_2O distribution is not shown here).

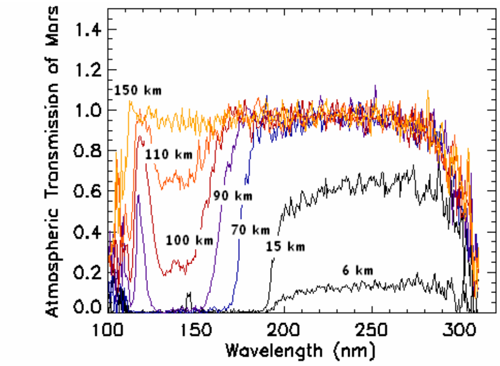

Figure 1: Mars atmospheric transmission as a function of altitude from star occultation.

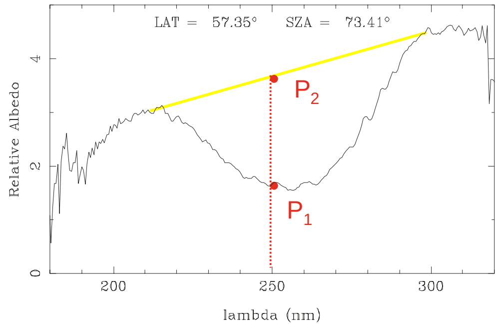

Figure 2: Relative albedo spectrum showing strong ozone absorption

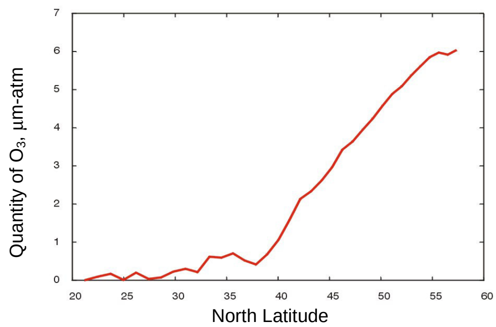

Figure 3: Latitude variation of ozone column amount (Orbit 24) in units of micrometer-atmosphere (10 µm-atm = 1 Dobson Unit).

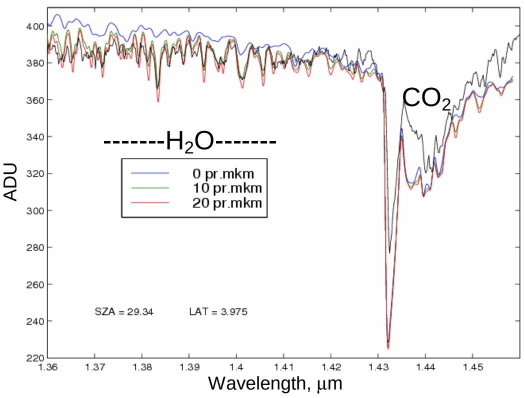

Figure 4: SPICAM IR spectrum (black curve) showing H_2O and CO_2 absorption features compared with synthetic models (0-10-20 pr. µm of H_2O)

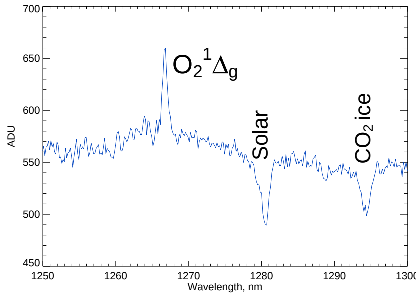

Figure 5: $O_2{}^1\Delta_g$ emission line at 1.27 µm.

We observed also the O_2 emission line (Figure 5), resulting from the photo-dissociation of O_3 molecule by one solar UV photon, and is therefore a sensitive way to measure ozone, quite different than the UV one. It will be particularly interesting to compare the two methods. Since this emission is quenched by CO_2 at low altitudes, it is more sensitive to ozone above 10-20 km. Therefore, the combination of UV and IR in the nadir mode will allow to discriminate the ozone at high altitude from the total ozone.

South Pole observations in UV and IR: water ice and CO_2 ice detection. Over the perennial South polar cap, the UV albedo is very large (Figure 6), with strong fluctuations corresponding to lobe boundaries internal to the polar cap. Figures 7 and 8 is a relative albedo IR spectrum obtained over the South cap where both the CO_2 and H_2O ice signatures are recognized. This shows for the first time without ambiguity the presence of H_2O ice in the South polar cap, simultaneously with OMEGA and PFS findings on MEX. H_2O ice may be present either as a thin layer of condensed atmospheric water vapor coming from the north above the CO_2 ice, or may represent the bulk of the South polar cap, and being visible at the bottom of "swiss cheese" holes detected on MOC images [3].

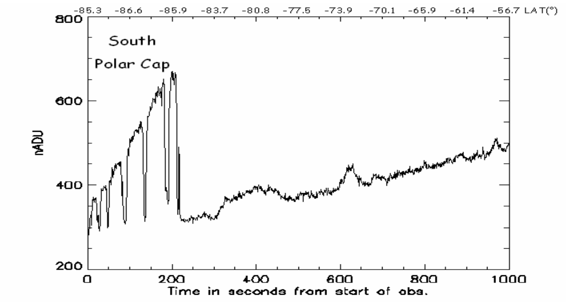

Figure 6: Nadir UV brightness at 250 nm along track over the South Pole and further north.

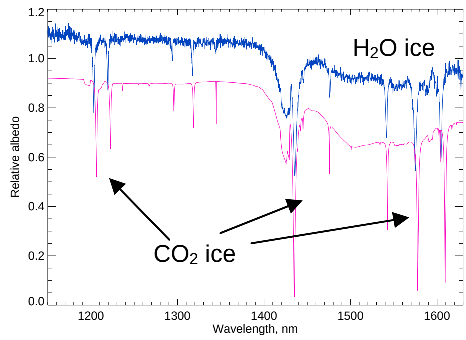

Figure 7: IR relative albedo spectrum of South Pole, compared with laboratory spectrum (G. Hansen), showing signatures of both CO_2 [4] and H_2O [5] ices.

References. [1] Bertaux, J.L., et al. *Planet. Space Sci.*, 48, 1303 (2000). [2] Korablev, O. et al. *Adv. Space Res.* 29, 143 (2002). [3] Byrne S., Ingersoll A., *Science* 299, 1051 (2003). [4] Hansen G., *Adv Space Res*. 20, 1613 (1997). [5] Hansen G., *LPSC28* abstr. 1565 (1997).

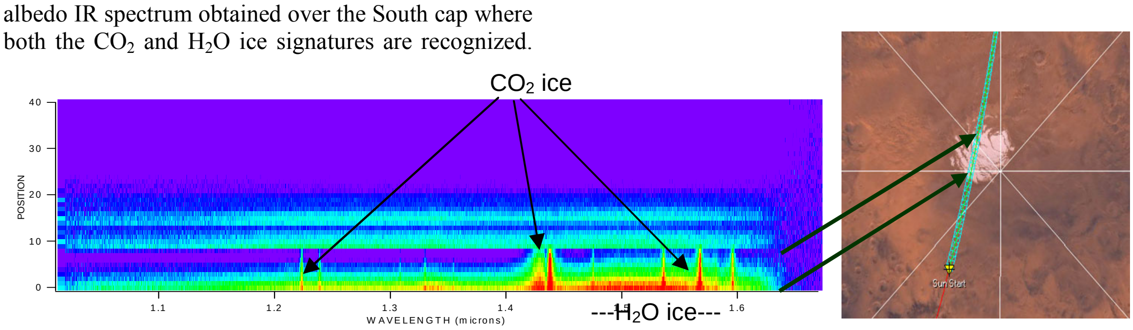

Figure 8: Succession of near-IR spectra along nadir track as function of MEX with signatures of H_2O and CO_2 ices.