SEASONAL VARIATION OF THE STRUCTURE OF MARTIAN ATMOSPHERE FROM PFS MARS EXPRESS DATA:WATER ICE CLOUDS

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Introduction:

Planetary Fourier Spectrometer is working on orbit around Mars for more than one Martian year. More than 300 000 spectra were obtained for different seasons, locations and local times. Longwavelength channel of PFS covers a spectral range 300 – 1500 cm-1 (7-35 μm) with spectral resolution 1.8 cm-1 and allows retrieval of vertical temperature profiles from the surface up to 50-55 km. (Formisano et al., 2005). Vertical temperature profiles and aerosol opacity may be retrieved from a single spectrum on the day side, when the surface temperature is rather high. At night side the temperature is low and spectra have to be averaged. As well in the polar region we deal with spectra averaged over 2 - 10, so effective field of view increases up to 40-200 km respectively (Zasova et al.2005)

Observations

Mars Express works at near polar orbit and at each orbit PFS gives a temperature field in coordinates latitude-altitude practically along the meridian at the same local time. The aerosol, dust or ice clouds opacity is obtained also from each spectrum. We discuss the water ice clouds of the following types: oreographic clouds, observed above volcanoes, polar hoods and equatorial cloud belts.

Oreographic clouds

Measurements were started during the late winter in the Northern hemisphere, Ls ≈ 330˚. In papers Zasova et al., 2005, Grassi et al. 2005 we show the strong influence of topography on water ice clouds appearance in this period: at orbits through low lands like Hellas and Isidis homogeneous dust distribution was observed, without any signature of appearance of water ice clouds. The water ice clouds were observed above calderas of Ascraeus and Olympus Mons, with opacity reached of 0.5 in the visual spectral range.

When season changes the opacity of the oreographic clouds increased. In Fig. 1 we show the mass loading in the clouds observed above Pavonis Mons at aphelion (Ls=97˚). Highest about 60 ppm mass loading was observed at the southern flank of volcano. It was minimum on the Northern flank, just after summit. Similar behavior was described in Zasova et al., 2005 for another Tharsis volcanoes Ascraeus Mons in late southern summer.

An error in water ice abundance in the clouds may be significant: it reaches of 1.5 – 2 times for error in particle size of 0.5 μm.

Polar hood

The first orbits covered the polar hood. Its position and mass loading of the water ice clouds are shown in Figs. 2-4. depending on the season.

At late northern winter on orbits 10 and 20 ,which comes through pretty flat areas the water ice clouds are observed only in the polar hood, which is observed at φ> 39˚ at orbit 10 and at φ> 45˚ at orbit 20. It reduces and disappeared during summer.

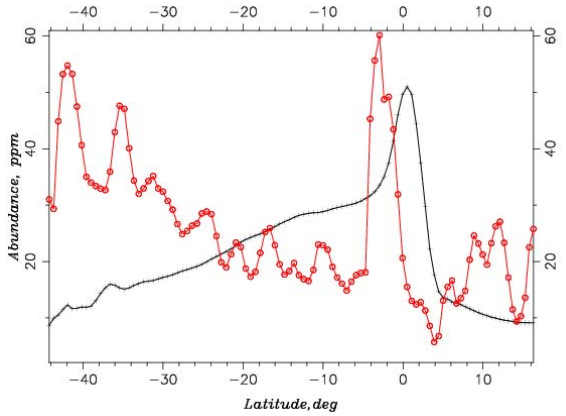

Fig. 1. Orbit 913. Mass loading in water ice clouds, observed at this orbit (red), black –normalized altitude. Maximal abundance is found on the southern flank of Pavonis Mons. Ls=97.

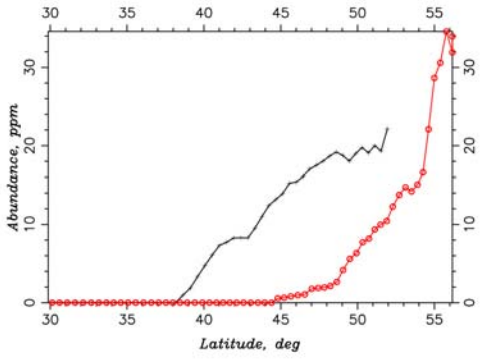

Fig. 2. Water ice clouds mass loading: orbit 10 - black orbit 10 (Ls=331˚) and 20(Ls=334˚)

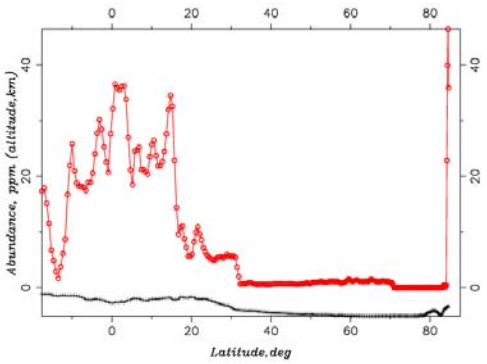

Fig. 3 Same as Fig.1, but for orbit 912. Black – surface altitude, Ls=96˚

At northern summer (fig.3) , during the intensive melting of the polar cap the dense ice clouds are observed above pole at φ> 84˚. These clouds are in the near surface layer. From PFS measurements we can identify where the H2O ice is found on the surface or in the atmosphere: asymmetrical behavior of the water ice absorption in the 15 μm band allows this (absorption coefficient in the shortwavelength wing exceeds by a factor of 10 that in the longwavelengh for 1-2 μm particles).
After the northern equinox at Ls = 192˚ the northern polar hood was observed at φ > 45˚, with around 20 ppm abundance of ice in the clouds on the day side and of 50 ppm on the night side.

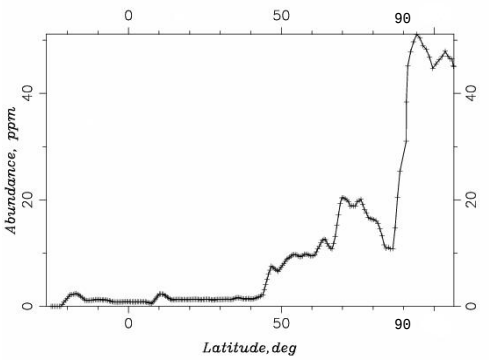

Fig.3. Mass loading in the water ice clouds. Orbit 1588. Ls= 192°

Equatorial cloud belt
The example of water ice clouds in equatorial cloud belt is shown in Fig. 2. Position of the orbit on MOLA map is shown in Fig. 4. Equatorial clouds belt at this orbit was observed above Margaritifer and Arabia Terra.

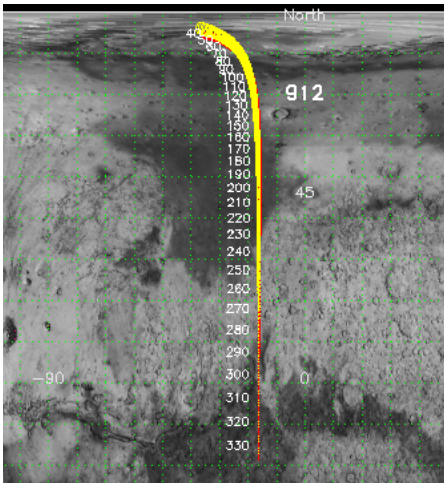

Fig. 4. Orbit 912 plotted on MOLA map. Numbers of spectra are given along the orbit.

Conclusion.

Different type of water ice clouds are observed with the help of LWC PFS. Self consistent retrieval of temperature profile and aerosol opacity from single or averaged over several spectra allows obtaining of mean particle size in the water ice clouds and consequently the mass loading.

Acknowledgements
We acknowledge the Italian Space Agency ASI for financial support of PFS; Russian Foundation of Basic Research for grant RFFI 04-02-16856a.

References
Formisano et al., 2005. The Planetary Fourier Spectrometer (PFS) onboard the European Mars Express
mission. Planet. Space Sci., 53, 963-974
Grassi, D. Et al.,2005. The Martian atmosphere above great volcanoes: early Planetary Fourier Spectrometer observations. Planet. Space Sci., 53 (2005) 1053-1064.
Zasova et al., 2005. First results of PFS experiment: observations of water clouds and dust aerosol, Planet. Space Sci., 53, 1065-1077.