IDENTIFICATION AND SPATIAL DISTRIBUTION OF WATER FROST AT LOW LATITUDES ON MARS. F. G. Carrozzo [1], G. Bellucci[1], F. Altieri[1] and J-P. Bibring[2], [1]INAF, Istituto di Fisica dello Spazio Interplanetario, via del Fosso del Cavaliere, 100 – 00133 Rome, Italy, giacomo.carrozzo@ifsi-roma.inaf.it, [2]Institut d'Astrophysique Spatiale, Orsay Campus, France.

Introduction: Although water vapour is one of the smaller constituents in the Martian atmosphere, it plays a key role in the climate of the planet, together with the carbon dioxide and the dust. The key factor in the stability of water frost is the amount of humidity in the atmosphere: the more it increases, the higher the probability that water vapour saturates. On Mars, water ice is found in the polar cap deposits [1,2], in the clouds in the form of ice crystals and at high latitudes in the form of surface frost. This work reports on the identification and the spatial distribution of water frost at low latitudes on Mars.

Dataset: The analysis, carried out with the OMEGA instrument on board the Mars Express, covers the range of latitudes between 30° S and 30° N and it includes the analysis of 2485 orbits. The data acquisition occurred during all seasons, but water frost has been identified during the winter and fall of the southern hemisphere, between ~30° S and ~15° S, and during the summer of northern hemisphere, between ~15° N and ~30° N. Water frost has not been identified between 15° S and 15° N.

Analysis procedures: The identification of water frost is based on detection of three bands: ~1.5 µm, ~2.0 µm and ~2.5 µm. We calculated the band depth to identify the absorption features due to water frost. The band depths are calculated after that the continuum has been removed. A first order atmospheric correction has been applied following the method described in Langevin et al. [3].

In our discussion only the 1.5 µm absorption band depth has been taken in consideration to study the behaviour of water frost. We used two lower limits for the 1.5 µm absorption band depth: 0.02 and 0.04. The farmer limit is fixed at the confidence level of the linearity regime of OMEGA at such wavelength. The latter limit has been taken as a safe indicator of the water frost spectra. By applying the 0.04 lower limit, we lose the 40% of the water frost spectra but the seasonal behaviour does not change. In the analysed orbits, water frost is found in 74 tracks in the southern hemisphere (2 in fall and 72 in winter), and in 11 tracks of northern hemisphere (all in summer). The identification has been verified by means of a visual check on each orbit where diagnostic bands of water frost have been identified by a previous automatic search. The spatial distribution of the water frost is shown in figure 1. Most of water frost is found in shadow regions. This indicates a relationship with the local lighting conditions which favours the formation of

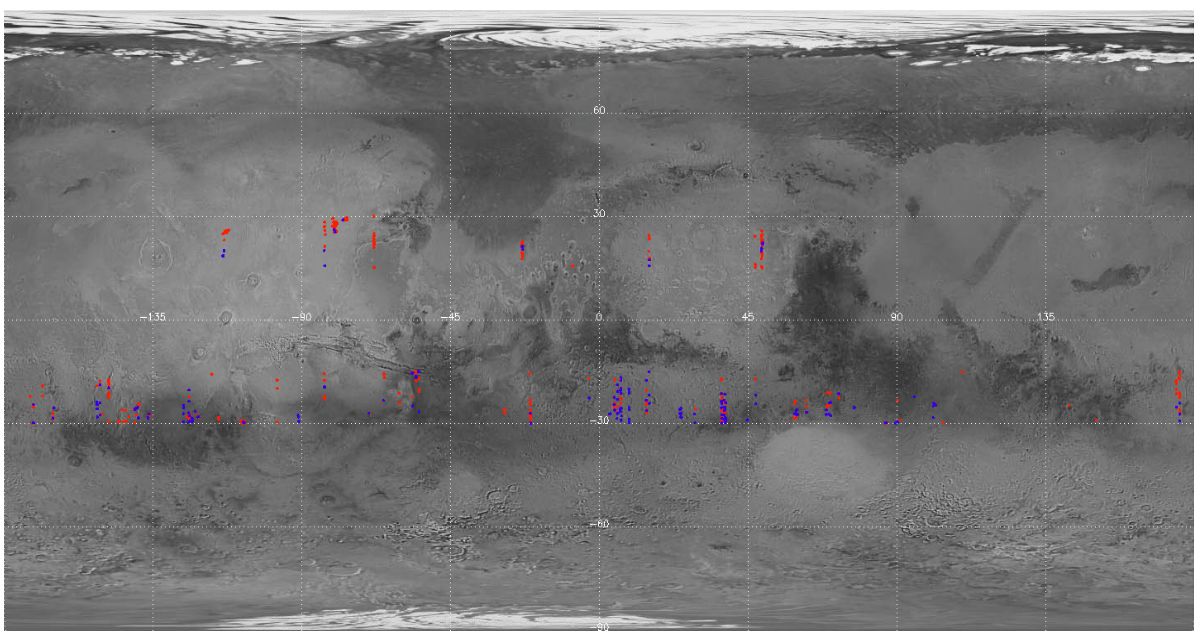

Figure 1. Spatial distribution of the water ice. The red points have a 1.5 µm band depth from 0.02 to 0.04, while those in blue >0.04.

water frost in these areas. Few water frost rich areas are also found to be illuminated by direct Sunlight.

Discussion: *Southern hemisphere.* In the southern hemisphere, the best opportunity to observe water frost would be during the southern fall, in the range of Ls from 59° to 74° [4]. Unfortunately, in this period a gap in the data exists, during which OMEGA has not worked. The ice has been identified at Ls between 19°-20° (fall) and 99°-150° (winter) respectively. The detected water frost shows dependence with the geomorphology. In fact, water frost features are found along the walls of numerous craters, scarps and feet of hills. Moreover, where the ice is observed, the areas are in shadow (fig. 2). The formation of water frost would be favoured by low Sun elevation angles and low temperatures. Moreover, the frost detection depends also on the Mars-probe distance. In fact, the amount of frost-free soil in the footprint increases as far as the probe-Mars distance increases.

As the winter proceeds, the conditions of observation become more unfavourable because the temperatures, the Sun elevation angles and the distance Mars-probe increase. However, this does not necessarily mean that the ice does not exist on the surface, but that the conditions of observation are not good to reveal water frost bands in the spectra. Even if we apply a more restrictive criterion in selecting water ice spectra, the ice is still present at low latitudes. Moreover, the ~76% of icy spectra with a band depth >0.02 is from 22.5° S to -30° S, while we have the ~87 % for a band depth >0.04. The number of spectra with ice becomes more abundant at higher latitudes as expected.

Northern hemisphere: In the northern hemisphere the ice has been observed between 94° and 135° (summer) from 15° N to 30° N. In some regions where the ice is found, the MOC narrow angle images show some albedo features which are interpreted as dust avalanches [5,6]. We do not exclude that water frost is involved in this phenomenon. The sublimation of the ice could make the soil unstable leading to collapse.

Summary: Water frost forms on cold traps as soon as Sunlight fades. The frost could form simply by condensation of atmospheric water vapour on the cold surface. The observed seasonal distribution could be connected to the sublimation of the North Polar Cap which introduces in the atmosphere large quantity of water vapour. However, we do not exclude that the frost we see at these latitudes derives from local enrichment of atmospheric water vapour.

Determining the distribution of water frost on the surface at low latitude is a primary objective for the future missions on Mars. In these places the ice could melt under particular conditions and the liquid phase could occur. It can filter through the pores of the ground and being isolated from the external environment it can favour the presence of life. The areas with ice at low latitudes could be a possible choice for a landing site of the future Mars mission.

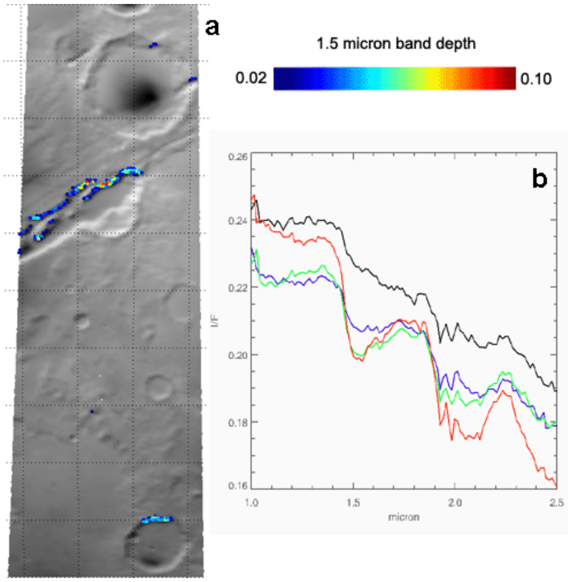

Figure 2. **a)** In the figure it is shown the OMEGA orbit 1221_4 centred at 139.8° W and 26.8° S, Ls=136°. The pixels with water frost are colored according to the 1.5 μm band depth. **b)** Examples of icy OMEGA spectra from the scarp with band depth 0.02 (black), 0.04 (blue), 0.07 (green) and 0.10 (red).

References: [1] Bibring J.P. et al. (2004) Nature, *428*, 627-630 [2] Titus T. N. et al. (2003), Science, *299*, 1048-1051 [3] Langevin Y. et al. (2005) Science, *307*, 1584–1586 [4] Schorghofer N. and Edgett K. S. (2006) Icarus, *180*, 321-334. [5] Sullivan R. et al. (2001) JGR, *106*, 23607-23633 [6] Schorghofer N. et al. (2002) Geoph. Res. Let, *29(23)*, 41-4.