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Constrains on atmosphere-surface water exchange on Mars derived from OMEGA/MEX data

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Abstract

We present global and mesoscale mapping of water contents variations at the surface of Mars, including water ice, frosts and hydrated minerals, based on Mars Express/OMEGA data. No significant seasonal changes in the zonal distribution of chemically bound water has been detected. Microphysical structure of water ice deposits at the polar caps reveals patterns associated with mesoscale atmospheric wave activity as well as with wind systems controlled by local relief.

1. Global mapping of hydrated mineral spectral feature 1.93 μm.

OMEGA instrument onboard Mars Express provides global mapping of the Martian surface in the visual and NIR spectral ranges being at the orbit since 2003 [1]. For evaluation of the bound water content, the density and characteristic grain size in the ice deposits we apply synthetic spectral indices – the relative depth of 1.93 μm adsorption band of hydrated minerals, 1.25 and 1.5 μm bands of water ice.

An example of global mapping for MY27-28 presented in Figure 1 shows the remarkable enhancement of bound water contents in the North polar region compared to tropics and extratropics. The map also reveals some zonal modulation of bound water, with the maxima near 120°E and 300°E, coinciding with the annual maxima of water vapor. To search for possible seasonal trends, we also present zonal average bound water contents in Ls-φ coordinates (Figure 2). The map confirms the enhancement in the polar regions compared to tropics, evident from Figure 1, and the apparent asymmetry between the North and South pole. As one may expect, more intense water exchange in the North hemisphere has resulted in larger contamination of the surface by bound water compared to the South polar region.

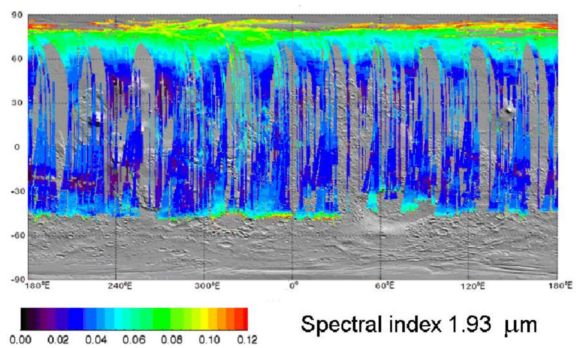

Figure 1: Global map of 1.93 μm feature, data were averaged over the period L_S = 90º - 180º.

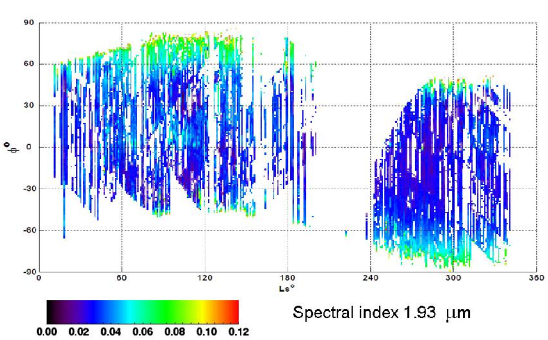

Figure 2: Zonal average map of spectral feature 1.93 μm vs. season and latitude.

2. Water ice sublimation above Martian North Polar Cap.

The water ice signature were mapped using the relative square inside of water ice bands of adsorbtion: 1.25 and 1.5 µm, with the 1.25 µm band being sensitive to ice microstructure. The maps of index 1.25 µm reveal mesoscale patterns that we interpret as a signature of the cyclonic wind systems in the circumpolar vortex (Figure 3).

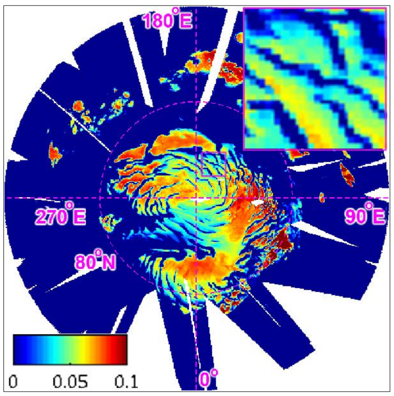

Figure 3: Result of mapping water ice spectral index 1.25 µm

The analysis at smaller scale implies the local variations in effective grain size across spiral terraces of the North polar cap. Inner edges of the terraces systematically reveal larger grains than the outer ones. MRO/HiRISE image analysis shows that the orientation of dunes also changes across the terraces, which may imply changing direction of the local wind systems. One possible interpretation is that the inner edges, more affected by catabatic winds, aligned in the meridional direction, develop dunes with preferentially zonal orientation, which in turn are more affected by insolation and therefore accelerate aging of the seasonal ice deposits.

3. Conclusions

The bound water seasonal variation in global scale is not obvious. The global variations in the water ice microstructure are due to the contamination of wave-2 and wave-3 dynamics. Small-scale variations at the surface polar cap microstructure probably are due to influence of local catabatic winds.

References

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