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Mars surface hydration seen by MEx/OMEGA

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One of the major elements for the habitability of a planet is the presence of liquid water. Under the current temperature and pressure conditions of Mars the presence of liquid water is not sustainable, therefore water is present only as ice at the poles [1], vapor and ice clouds in the atmosphere [2], permafrost [3] and surface hydration. Surface hydration on Mars is due to water adsorbed at the surface of minerals or strongly bound in their lattice and to hydroxyl groups (for a review, see e.g. [4] or [5]). The study of surface hydration may provide new elements for the present and past habitability of Mars, because (1) adsorbed water is weakly linked to minerals and may influence the current water cycle of Mars; (2) the layers of adsorbed water molecules may enable biological processes [6, 7]; (3) structurally bound water and hydroxyl groups are the results of an past interaction with liquid water.

The bending and stretching vibrations of the water molecules are responsible for a broad and deep absorption band at around 3 μm. The near infrared surface mapping of Mars done by OMEGA gives the first opportunity to study its global and detailed characteristics. The 3 μm band is acquired by the OMEGA L channel ([2.5 – 5.1 μm]). The measure of the L channel calibration state reveals strong variations which have an important influence on the radiance value [5]. The current available transfer function is adapted to nominal data, therefore we present here the method we developed to derive new transfer functions for other calibration states. This work is based on the comparison of two observations of a same point close in time but with different calibration levels.

The OMEGA data are processed in a pipeline [5] that converts raw data to radiance, removes atmospheric absorptions and gets I/F. Then the reflectance spectra are retrieved through a deconvolution of the diffused and thermal emissions after an estimation of the surface temperature. The 3 μm band depth is then assessed through the integrated band depth and through the comparison with laboratory measures of Yen et al. [8] so as to get the water content. All OMEGA spectra exhibiting water ice features must be removed from the dataset since water ice is responsible for an important absorption at around 3 μm. This rejection is based on the 1.5 μm water ice absorption band (see e.g. [9]), but this band is subject to hysteresis which may affect its value by a couple of percents with the received light flux. We therefore developed a method that automatically reduces these instrumental problems.

Previous studies [5, 10] handled with one third of the Martian surface; we should now increase our coverage up to 60% once several calibration states are processed. Preliminary results based on the analysis of a first part of this additional dataset present the same trends that those exposed in [5,10]:

- The 3 μm band is detected everywhere on the Martian surface, which could be explained by the presence of adsorbed water [11] and by rinds or coating resulting from weathering (see e.g. [12] or [13]).

- Of special interest is the observation of an increase of hydration with albedo on the entire dataset which is discussed. Terrains enriched in phyllosilicates [14], sulfates [15] or hydroxides also exhibit an increased hydration at 3 μm which is interpreted as structurally bound water. We notice that the 3 μm band shape is modified when composition varies. Moreover a decrease of hydration with elevation is observed especially for low albedos, probably due to the decrease of atmospheric pressure.

- A strong increase of hydration with high latitudes (over 60°N) is observed, maybe due to a change in composition or resulting from the water exchange between subsurface permafrost and the atmosphere [16, 17]. Such water contents could favor biological processes. This increase is very well correlated with the GRS observations of the increase of hydrogen in the high latitudes, interpreted as permafrost [3].

- Finally seasonal variations are also detected with the decrease of the surface hydration between spring and summer for mid latitudes regions. This phenomenon is associated to an increase of hydration with latitude in spring. This temporal variation is not instrumental or atmospheric and can be explained by the presence of frost in winter which makes water fix on minerals. During spring, when ice has disappeared, the amount of adsorbed water returns to equilibrium with the atmosphere. These variations seem to confirm the important role of regolith on water cycle, which was predicted from numerical simulations (e.g. [18] or [2]).

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