REAPPRAISAL OF MARS 3µm WATER SPECTRAL FEATURE USING OMEGA/MEX. J. Audouard[1], F. Poulet[1], M. Vincendon[1], J. P. Bibring[1], B. Gondet[1] and Y. Langevin[1]. [1]Institut d'Astrophysique Spatiale d'Orsay, Université Paris Sud/CNRS (contact: joachim.audouard@ias.u-psud.fr).

Introduction and background: Different water reservoirs have been identified on Mars: water ice at both poles [e.g. 1], water vapor and clouds in the atmosphere [2], water ice below the surface [3], water structurally constituting the hydrated minerals [4] and hydration water of the regolith (1-15 water wt%) [5, 6]. This latter reservoir is interpreted to be mainly adsorbed water at the surface of the minerals or confined inside them.

Whereas hydrated minerals are detected only at specific locations on Mars with their OH, H2O and Metal-OH absorption bands at 1.4, 1.9 and 2.1-2.4 µm [4], a wide absorption near 3 µm is ubiquitous on Mars, which is related to the bending and stretching vibrations of H_2O and OH, and thus an indicator of the total hydration and hydroxylation state of the surface.

The Martian regolith is therefore a sink for H_2O and could play an important role in the Martian water cycle. Both the hydration seasonal evolution of the regolith [5,7] and the monitoring of the atmospheric water vapor [2,8] reveals water exchanges between the regolith and the atmosphere on a seasonal scale, and possibly on a diurnal scale.

The purpose of this work is to reappraise the 3 µm absorption study of [5] that was performed thanks to Mars-Express/OMEGA (Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité) on the first 3050 Mars-Express (MEx) orbits with nominal calibration levels. New instrument transfer functions constructed with the method described in [9] are now available until MEx orbit #9123, which enables the use of previously non-nominaly calibrated orbits. This extended dataset provides a significant improvement in terms of spatial and temporal coverages of the Martian surface than [5], as shown below.

Data selection and processing: We use data from OMEGA instrument that is a visible/near-infrared imaging spectrometer observing the Martian surface and atmosphere with 352 contiguous spectral elements between 0.36 and 5.1µm [10]. We study the 3 µm absorption band using the L channel radiance data (2.54 – 5.1 µm). The thermal contribution is removed by evaluating the pixel temperature at wavelengths 5.0-5.1 µm as described in [5].

We select only OMEGA observations obtained at nadir, with incidence angles lower than 80°, with no detectable water ice absorption present at 1.5 µm. Data with corresponding visible MERs dust opacity measurement greater than 1.2 were also excluded (this merely concerns the MY 28 global dust storm) as well as data recorded with long wavelength channel detector not sufficiently cooled. Moreover, high resolution data recorded in 16 pixels crosstrack mode were excluded because of the little spatial coverage they provide for the present global scale study. 5428 OMEGA data cubes verify this set of criteria (out of the 10000+ ones composing the entire dataset) and were used to perform our study. The selected dataset still spans 4 Martian years (from end of MY26 to MY31) and provides a variety of local times and seasons of acquisition as illustrated in Figure 1.

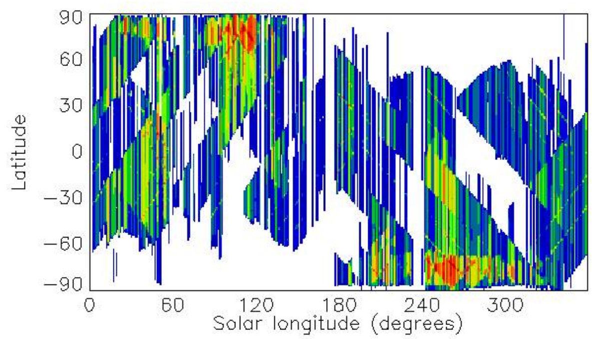

Figure 1. *Schematic distribution of the selected data as a function of solar longitude and latitude for the four Martian year of OMEGA observations. White areas means no data at given season and latitude, whereas colors data density (blue: few data to red:lots of data). The diagonal features with no data correspond to observations with the 16 pixels crosstrack mode, that are not considered in this study.*

Methodology: We compute the Integrated Band depth (IBD) for every previously selected OMEGA spectra. IBD is defined as the integral of band depth between the measured reflectance and a continuum from 3.0 to 3.7 µm in the same manner than that described in [5]. IBD is therefore representative of the total amout of energy aborbed in this spectral region and should increase with the water concentration for a given material. The chosen continuum is a linear function between the reflectances at 2.5 and 3.7 µm. Using this method we evaluate the 3 µm band of both the surface and the atmosphere. Atmospheric dust is suspected from limb observations to contain a 3 µm band. Moreover, small grained water ice particles / thin water ice clouds can be indetectable at 1.5 µm while absorbing signficantly at 3 µm [11]. We are currently working on assessing more precisely the impact of aerosols on the OMEGA 3 µm band depth. Based on experimental studies of Martian analogs and hydrated minerals, [12] and [13] have shown that IBD has a non linear relation to the water wt% of the material. [14] also showed that a strong 3 µm absorption can be caused by a relatively small (0.5 wt%) amount of water adsorbed within the material. The relation IBD vs. water content (in wt %) depends on the shape of the 3 µm absorption and thus on the composition of the material. Empirical exponential relationships between IBD and water content were derived [12, 15]. We will use that of [15] who estimate the water content retrieval uncertainty to be within 10%.

Preliminary results: The orbital evolution of MEx, when combined with the relatively large fields of view of OMEGA made possible to obtain a comprehensive coverage of the water band over the planet at a km scale. Figure 2 presents the average IBD of the entire selected dataset, so that all seasons are overlapped in this map. Spatial variations are clearly identified. The low albedo regions exhibit lower IDB than bright regions. This trend is global except for the high latitude regions where an increase with latitude is observed as already reported in [12, 16]. In addition, regions of uniform albedo do not show significant variations between overlapping orbits. Some particularly "dry" and timely stable regions like Syrtis Major are observed. Conversely, some regions exhibit variations of the IBD. This could be attributed to seasonal variations of surface hydration that may be linked to change in the atmospheric vapor content [5, 17], but in-depth studies are required to better understand the origin of these variations.

This work in ongoing and particularly the data selection has to be refined in order to avoid variations related to the atmospheric conditions. We intent to improve the constraints on the seasonal and daily variation of hydration, better contrain the origin of the 3 µm band, and assess the impact on dust and ice aerosols. Absolute water wt% maps of the surface for the four seasons will be also presented at the meeting.

References: [1] Bibring J-P. et al. (2004), *Nature*, vol. 428, I. 6983, 627-630. [2] Titov D. V. (2002), *Adv. Space Res.*, vol. 29, 2, 183-191. [3] Feldman W. C. et al. (2004), *JGR*, vol. 109, E09006. [4] Poulet F. et al. (2005), *Nature*, vol. 438, nature04274. [5] Jouglet D. et al. (2007), *JGR*, vol. 112, E08S06. [6] Milliken et al. (2007), *JGR*, vol. 112, E08S07. [7] Evdokimova N. A. et al. (2009), *Solar Sys. Res.*, vol. 43, 5, 373-391. [8] Maltagliati L. et al. (2011), *Icarus*, 213, 480-495. [9] Jouglet D. et al. (2009), *Planet. and Space Sci.*, 57, 1032-1042. [10] Bibring J-P. et al. (2004), *ESA SP-1240, 37-49.* [11] Vincendon et al., *JGR 116*, E00J02 (2011). [12] Milliken R. E. and Mustard J. F. (2005), *JGR*, vol. 110, E12001. [13] Pommerol A. et al. (2009), *Icarus*, 204, 114-136. [14] Yen A. S. et al. (1998), *JGR*, 103, E5, 11.125-11.133. [15] Jouglet D. (2008), PhD Thesis. [16] Poulet et al. (2006), LPSC 38. [17] Pommerol A. et al., LPSC 42th, 1890.

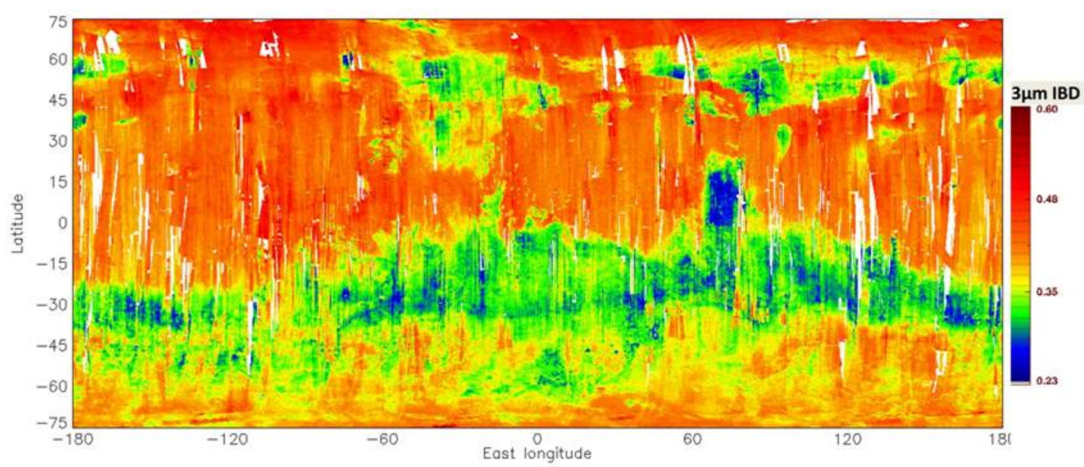

Figure 2. *3 µm IBD global map at a 32 ppd resolution (~1.8 x 1.8 km at the equator) between 75°S and 75°N. This map shows the averaged IBD of the OMEGA datacubes with seasonal and latitudinal coverage presented in Figure 1. Coverage is ~96% and white indicates that no data is available for this location.*