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Interferometric millimeter observations of water vapor on Mars

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Abstract

We present interferometric mapping of the 225.9-GHz HDO and 203.4-GHz $H_2{}^{18}O$ lines on Mars obtained with the IRAM Plateau de Bure facility (PdBI). The observations were performed during martian year 28 (MY28), at $L_s = 320.3°$ for the HDO line, and at $L_s = 324.3°$ for the $H_2{}^{18}O$ line. The HDO line is detected at the eastern (morning) and western (evening) limbs of the northern hemisphere, corresponding to a water column density in the range 3–6 pr.-μm(Fig. 1). The $H_2{}^{18}O$ line is not detected, which is compatible with the column densities derived from the HDO line (Fig. 2). Quasi-simultaneous far infrared measurements obtained by the Planetary Fourier Spectrometer (PFS) onboard the Mars Express spacecraft confirm our PdBI results, yielding a 5 ± 1 pr.-μm meridionally constant water column abundance (Fig 3).

Such a low water abundance during the southern mid-autumn of MY28 does not correspond to the standard martian climatology as observed during the previous years. It was however already retrieved from near-infrared observations performed by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) onboard the Mars Reconnaissance Orbiter spacecraft [Smith, M. D., Wolff, M. J., Clancy, R. T., Murchie, S. L. 2009. CRISM observations of water vapor and carbon monoxide. *J. Geophys. Res.* **114**, doi:10.1029/2008JE003288]. Our observations thus confirm that the planet-encircling dust storm that occured during MY28 significantly affected the martian water cycle. Our observations also demonstrate the usefulness of interferometric submillimeter observations to survey the martian water cycle from ground-based facilities.

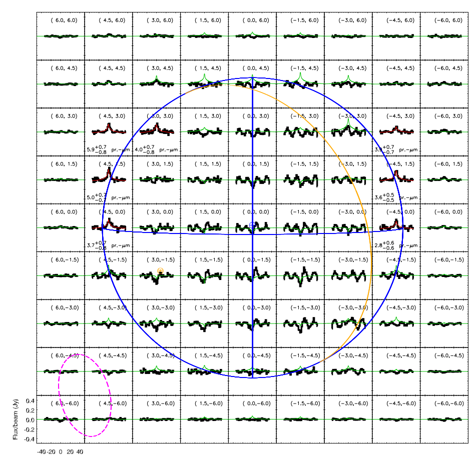

Figure 1: Spectral map in the HDO line at 225.897 GHz (black histogram lines), compared with synthetic models. At beam positions where the HDO line is detected the best-fit model is displayed in red along with the best-fit water column density. At beam positions where the HDO line is not detected a synthetic spectrum calculated for 5 pr-μm is displayed in green. RA, Dec offsets (in ″) are indicated for each beam position. The surface, equator, central meridian and terminator of Mars are indicated along with the sub-Earth and subsolar points, and the synthetized beam.

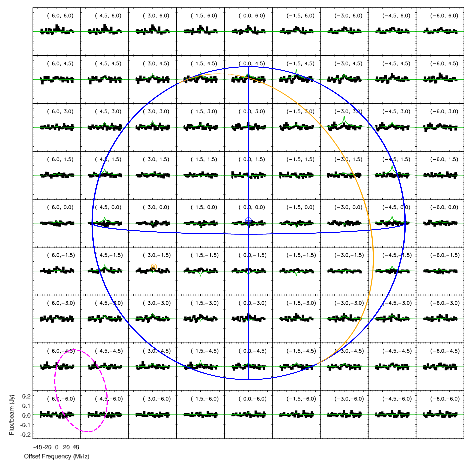

Figure 2: Spectral map in the $H_2{}^{18}O$ line at 203.407 GHz (black histogram lines), compared with synthetic models calculated for 5 pr-μm (green lines). RA, Dec offsets (in $''$) are indicated for each beam position. The surface, equator, central meridian and terminator of Mars are indicated along with the sub-Earth and subsolar points, and the synthetized beam.

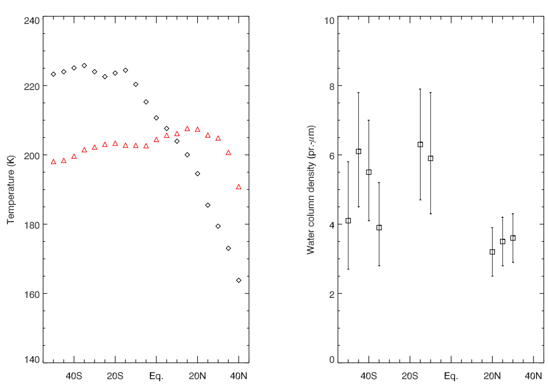

Figure 3: Left panel: Surface temperature (black diamond) and atmospheric temperature at 100 Pa (red triangles) retrieved from PFS spectra obtained during orbit #4791. Right panel: Water column abudance retrieved from the same dataset.