WATER VAPOR IN THE MIDDLE ATMOSPHERE OF MARS DURING THE SOUTHERN SUMMER SEASON BY SPICAM/MEX

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Introduction: Recent observations of the Martian hydrogen corona in the UV H Ly-emission by Hubble Space Telescope (HST) (Clarke et al., 2014) and the SPICAM UV spectrometer on Mars Express (Chaffin et al., 2014) reported its rapid change an order of magnitude for the short period of a few months in 2007 (MY 28), which is inconsistent with the existing models. One proposed explanation of observed decrease in coronal emission is that during the global dust storm water vapor can be transported to higher altitudes where the rate of photodissociation by near-UV sunlight increases, providing an additional source of hydrogen for the upper atmosphere. Following HST observations discovered a strong seasonal dependence in the Martian hydrogen exosphere in the absence of global dust storms and significant solar variability, that could relates to the seasonal water cycle (Bhattacharyya et al., 2015).

Observations: Since 2004 the SPICAM IR spectrometer on Mars-Express (Korablev et al., 2006) carries out measurements of the vertical distribution of water vapor in the 1.38 µm band, the CO_2 density in the 1.43 µm band and aerosol properties in the middle atmosphere of Mars by means of solar occultations. The observations cover now 7 Martian Years with 2 occulation campaigns for a year (Figure 1). In this work we present vertical distribution of water vapor observed for several years during the perihelion season (Ls=180-360°) with the global dust storm at MY28 (observations at Ls = 250-310°).

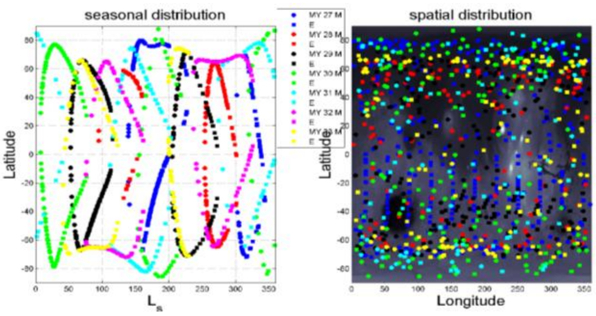

Figure 1. Seasonal and spatial coverage of SPICAM/MEX solar occultations

Water vapor in the global dust storm MY28: According the dust extinction profiles of SPICAM occultations the global dust storm reached observable areas at Ls=268° in the Southern hemisphere and Ls=275° in the Northern hemisphere. SPICAM observations confirmed the increase of the H_2O concentration up to an order of magnitude at 60-70 km from Ls 268° to 285° in MY28 (Figure 2 and 3). It is interesting that in the Northern hemisphere (latitudes of 40-60°N) the concentration increases by a factor of ten from <10^{10} cm^{-3} to 8 10^{10} cm^{-3} at 70 km and from 2 10^{10} cm^{-3} to 2 10^{11} cm^{-3} at 60 km, but in the Southern hemisphere (latitudes of 40-60°S) only in 3-4 times from 2 10^{10} cm^{-3} to 6-8 10^{10} cm^{-3} at 70 km and from 0.5-1 10^{11} cm^{-3} to 1.5 10^{11} cm^{-3} at 60 km.

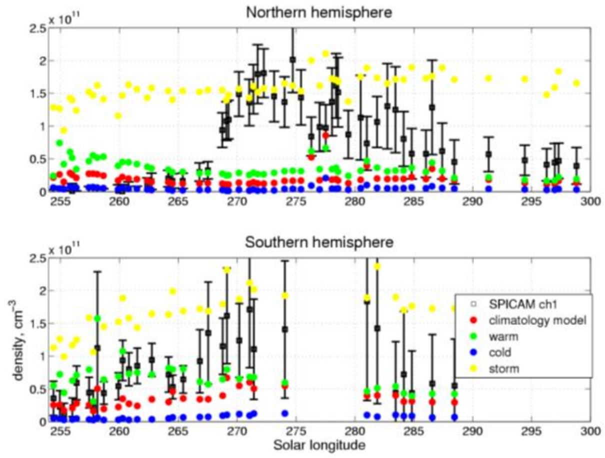

Figure 2. H_2O density in MY28 at 60 km. Comparison with the Martian Climate Database (MCD 5.2) are presented (Millour et al., 2015)

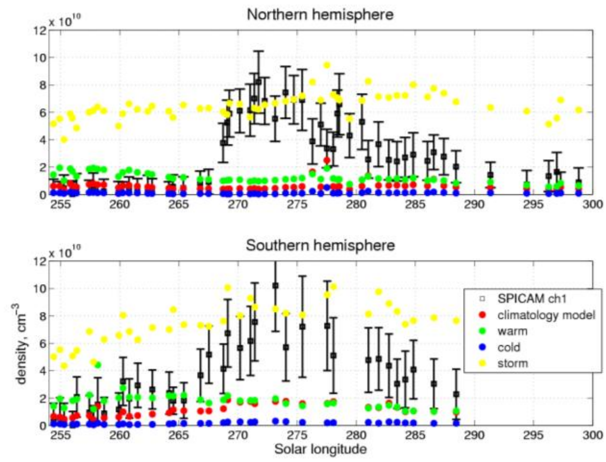

Figure 2. H_2O density in MY28 at 70 km. Comparison with the Martian Climate Database (MCD 5.2) are presented (Millour et al., 2015)

The interannual comparison: Despite the solar occultation campaigns are not completely repeatable in spatial distribution and time, the some kind of interannual comparison and a seasonal trend could be obtained. MY 32 has a special interest due to it has an intersection with MY28 at all latitudes in the Southern hemisphere and for 60-65° of latitude in the Northern hemisphere. Figure 3 shows a comparison of the H_2O density at 60 km for MY 28, 32 and 33. In the Northern hemisphere observations in MY32 Ls=240-320° don't show prominent increase of the water content as it was in the dust storm. This difference can not be completely related to the difference in latitudinal coverage because the intersection for these two years happened at Ls 270° where the dust storm already began. In the Southern hemisphere the both years show the increase of the density with higher values for MY28. MY33 at Ls=199-230° didn't show the prominent increase of the density.

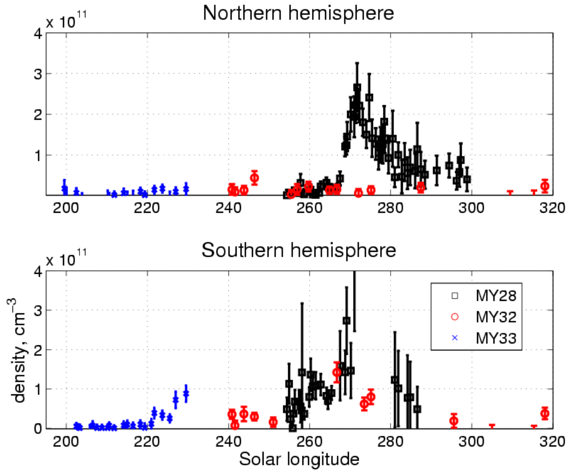

Figure 4. H_2O density in MY28, 32, 33 at 60 km.

Using the CO_2 density from 1.43 µm band we can obtain the vertical distribution of H_2O mixing ratio. Figures 5 and 6 present the H_2O mixing ratio for three Martian years at 50 and 70 km respectively. These figures also support the global 2007 dust storm was a really unique event where the water vapor reaches altitude up to 70 km with mixing ratio higher than 100 ppm. Meanwhile the observations show a high value of H_2O 40-100 ppm at altitude of 50-60 km for all years than could give a seasonal feedback to the hydrogen corona escape.

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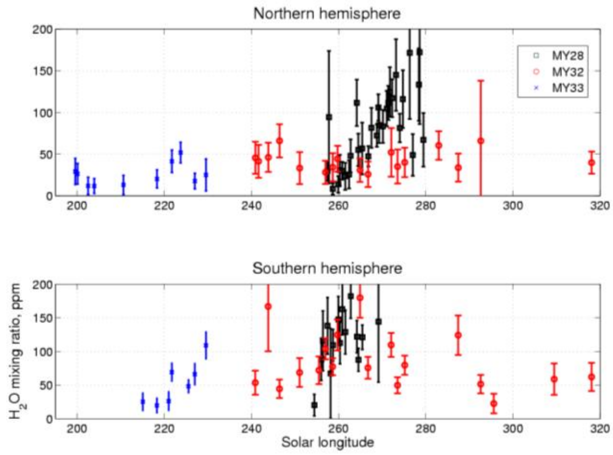

Figure 5. H_2O mixing ratio in MY28, 32, 33 at 50 km.

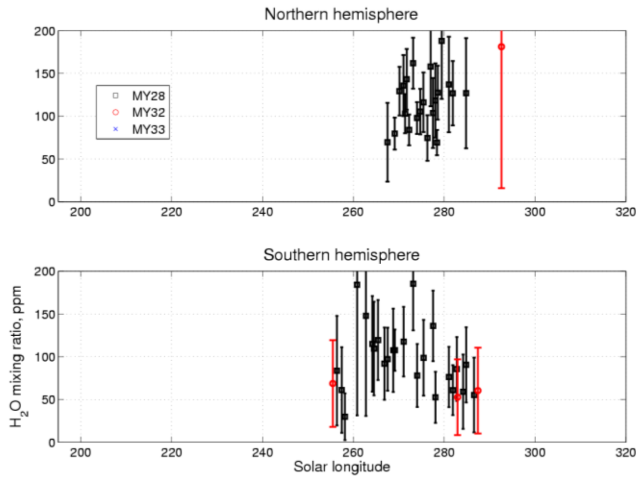

Figure 6. H_2O mixing ratio in MY28, 32, 33 at 70 km. The absence of observations for MY33 means that all values for this altitude were outside a detection limit.

References

Bhattacharyya, D. et al., 2015, A strong seasonal dependence in the Martian hydrogen exosphere, Geophys. Res. Lett., 42, 8678–8685, doi:10.1002/2015GL065804.

Chaffin, M. S., et al., 2014. Unexpected variability of Martian hydrogen escape, Geophys. Res. Lett., 41, 314–320, doi:10.1002/2013GL058578.

Clarke, J. T., et al., 2014. A rapid decrease of the hydrogen corona of Mars, Geophys. Res. Lett., 41, 8013–8020, doi:10.1002/2014GL061803.

Korablev, O. et al., 2006. SPICAM IR acousto-optic spectrometer experiment on Mars Express. J. Geophys. Res. 111, E09S03.

Millour, E. et al., The Mars Climate Database (MCD version 5.2). European Planetary Science Congress 2015, held 27 September - 2 October, 2015 in Nantes, France