LONG-TERM OBSERVATIONS OF WATER VAPOR IN THE MIDDLE ATMOSPHERE OF MARS BY SPICAM/MEX

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Introduction: While the H_2O column density in the Martian atmosphere is well known now and has been monitored by different missions for last decades [1, 2, 3], the behavior of water in the middle atmosphere, its vertical distribution, interannual and seasonal variability, is still opened question due to a few amount of observational material.

It is well known that the Martian atmospheric water vapor is trapped close to the surface of Mars by condensation and its vertical distribution is variable with season and location. In the aphelion season when the atmosphere is colder, water is located near the surface and blocked in the Northern hemisphere by the aphelion cloud belt [4]. The hygropause (condensation level) altitude is as low as 10-15 km. During warmer perihelion season this altitude could reach 40-50 km [2].

Several recent findings in water vapor vertical distribution were related to changes of Martian climate and evolution of the atmosphere. The discovery of the water supersaturation and access of water to altitude higher 30 km in the aphelion season [5] is directly affecting long-term representation of water transport, chemistry and accumulation on Mars on a global scale. Recent observations of the Martian hydrogen corona reported a rapid change of the hydrogen escape rate on the seasonal scale [6-8] that can relate to water access at 80 km, providing an additional source of hydrogen for the upper atmosphere [9]. That was supported by SPICAM observations of high altitude water during the MY28 global dust storm [10].

In this work we present long-term observations of the H_2O vertical distribution in the Martian atmosphere by SPICAM on Mars-Express for a period of several Martian years and study the seasonal and spatial variations of the H_2O density and mixing ratio at different altitudes as well as interannual variations.

Observations: Since 2004 the SPICAM IR spectrometer on Mars-Express [11] 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 more than 7 Martian Years from MY27 to MY34 with 2 occultation campaigns for a year (fig.1).

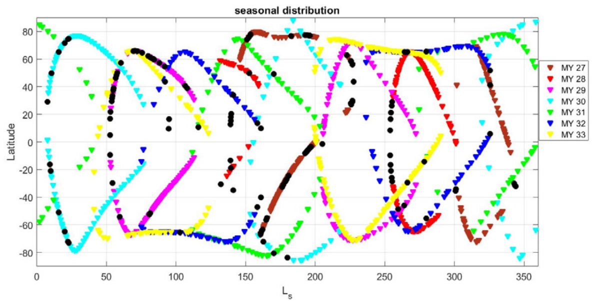

Figure 1: Seasonal-latitudinal coverage of SPICAM observations in solar occultations for MY27-33. The black circles mark the observations inapplicable for retrieval for different reasons.

Results: Fig.2 shows the seasonal variation od water density averaged for all Martian years excluding the global storm in MY28 Ls=269-300°. Upper level of water density detectable by SPICAM (5-8x10^9 cm^{-3}) is 50-60 km in the aphelion season and 70-90 km in perihelion season.

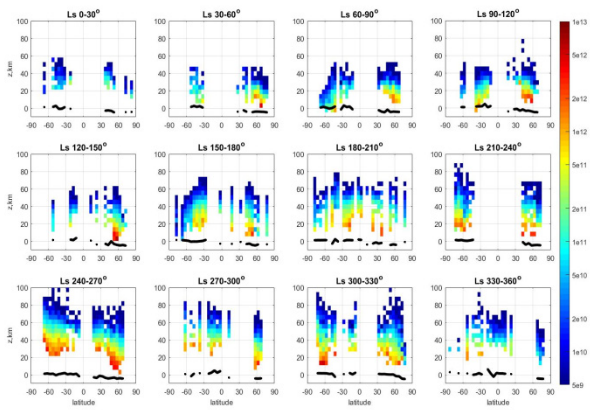

Figure 2: H_2O density distribution for 7 years (MY27-33)

Despite the solar occultation campaigns are not completely repeatable in spatial distribution and time, the interannual comparison of water amount has been made and a seasonal trend were obtained. We have studied an access of water to high altitude during the perihelion season [10] and supersaturation of water in the aphelion season following [5]. Vertical distribution of H_2O mixing ratio show a high value >100 ppm in the Southern hemisphere during the

South summer at altitude of 50-80 km for all years at Ls=240-300°. The low H_2O mixing ratio <30 ppm was obtained in the aphelion season Ls=0-120° but the observed altitude range in this season was mostly higher than a hygropause.

Several spectrometers on TGO ExoMars will measure of water vertical distribution in the different infrared bands [12,13]. For example, 1.38 μm band (same as for SPICAM) measured by NIR/ACS with high spectral resolution will allow to study a water vertical distribution up to 80 km with accurancy better than 1 ppm that was unreachable by SPICAM. The mid-infrared experiments of TGO will obtained even better sensitivity up to 100 km. The TGO orbit has the high freqiuency of occultation events, up to 24 per day that provides in several orders better spatial and seasonal coverage that was not possible with SPICAM on MEX. This improve a lot the knowlenge about variations and distribution of water at high altitudes.

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