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Water vapour in the middle atmosphere of Mars by SPICAM/MEX

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Abstract

While the H_2O column density in the Martian atmosphere is well known now and has been monitored by different missions for last decades the behavior of water in the middle atmosphere, its interannual and seasonal variability, is still opened question due to an absent of observational material. We present here 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 connected to such special event as the 2007 global dust storm.

1. Introduction

The Martian atmospheric water vapor is trapped close to the surface 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 [1]. The hygropause (condensation level) altitude is as low as 10-15 km. During warmer perihelion season this altitude could reach 40-50 km.

Recent observations of the Martian hydrogen corona reported a rapid change of the hydrogen escape rate for weeks/months during the global dust storm and on the seasonal scale during the Martian year [2-4]. One proposed explanation of observed changes in coronal emission is that water vapor can be transported to higher altitudes (up to 80 km) where the rate of photodissociation by near-UV sunlight increases, providing an additional source of hydrogen for the upper atmosphere. Recent photochemical model has supported a contribution of high-altitude water in the hydrogen escape on the short time scale [5]. Based on the SPICAM/MEX observations we study seasonal variations of water at altitude from 20 to 80 km during several Martian years.

2. Observations

Since 2004 the SPICAM IR spectrometer on Mars-Express [6] 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 including the global dust storm in MY28 (observations at Ls = 250-310°).

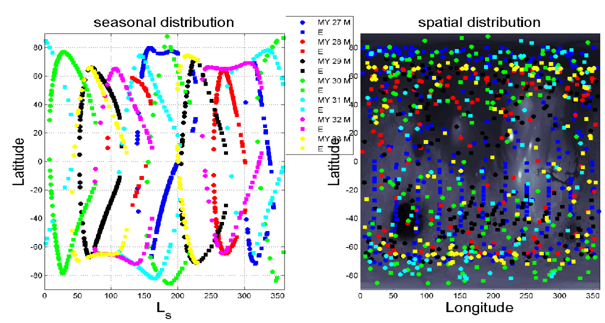

Figure 1: Seasonal and spatial coverage of SPICAM/MEX solar occultations

3. The interannual variations

Despite the solar occultation campaigns are not completely repeatable in spatial distribution and time, the interannual comparison and a seasonal trend can be obtained. Figure 2 shows a comparison of the H_2O density at 60 and 70 km for MY 28, 29, 32 and 33. In the Northern hemisphere observations in MY28,29,32 don't show prominent increase of the water content as it was during the MY28 global dust storm. This difference can not be completely related to the difference in latitudinal coverage. The increase of the water density above 60 km in the northern hemisphere looks like special case of the global storm on Mars. In the Southern hemisphere MY28, 29, 32 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.

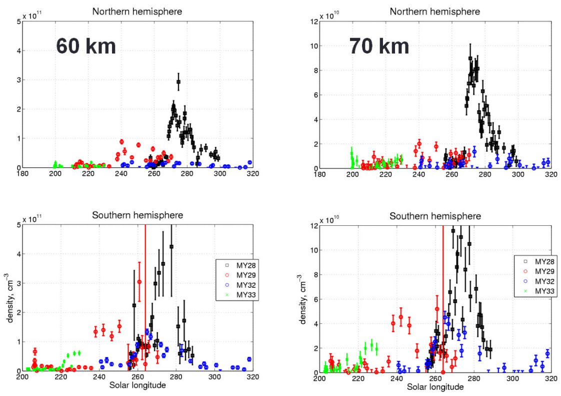

Figure 2: H_2O density for MY28, MY 29, MY32 and MY33.

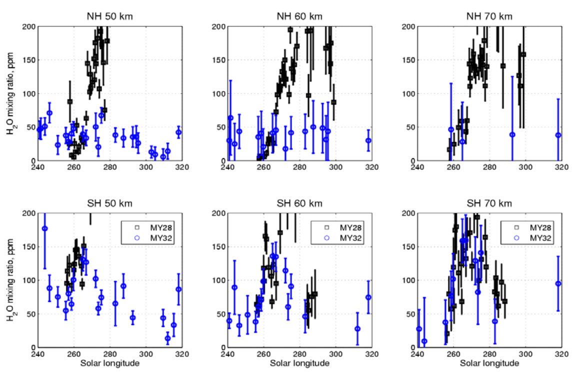

Figure 3: Evolution of the H_2O mixing ratio at the altitudes of 50, 60 and 70 km during MY28 and MY32 shown for the Northern and Southern hemispheres separately.

Using the CO_2 density from 1.43 µm band we can obtain the vertical distribution of H_2O mixing ratio. Figure 3 presents the H_2O mixing ratio for two Martian years (28 and 32) at 50, 60 and 70 km respectively. These figures also support the global dust storm was a really unique event where the water vapor reaches altitude up to 70 km with mixing ratio higher than 100 ppm in the northern hemisphere. Meanwhile the MY32 observations show a high value of H_2O 40-100 ppm at altitude of 50-70 km than could give a seasonal feedback to the hydrogen escape rate.

Acknowledgements

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