MY34 DUST STORM EFFECT ON MIDDLE ATMOSPHERE WATER VAPOR AND UPPER ATMOSPHERE HYDROGEN ON MARS USING THE LMD-GCM

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Introduction:

Variations in Hydrogen escape at different seasons that could be attributed to water vapor variations in the middle atmosphere as stated by Chaffin et al. (2017) [1]. Water vapor is also seen to increase by an order of magnitude in the middle atmosphere due to dust storms [2]. This in turn results in an increase in Hydrogen escape due to dust storms as observed by Mars Climate Sounder Data [3]. The proper understanding of how dust storms affect the rise of water vapor in altitude that in turn enhances hydrogen escape is studied.

Motivated by the Emirates Mars Mission's Objective of correlating the escape rates between the upper and lower atmosphere of Mars, this paper aims to provide theoretical expectations for the effect of dust storms on the escape of Hydrogen in the upper atmosphere [4].

The Laboratoire de Météorologie Dynamique (LMD) 3D Global Climate Model (GCM) of the Martian atmosphere provides different scenarios of dust distributions including reconstructions of dust storms on mars during various Mars years based on available observations [5][6].

In order to observe the effect of dust storms on the atmosphere, we use GCM outputs of the Mars Year 34 (MY34) dust event and compare it to the cold scenario of the GCM which shows the minimum amount of dust observed on the planet.

Methodology:

We use the outputs provided by LMD of the entire year for the two scenarios, MY34 and cold. We compare the mixing ratios of the dust, water vapor, and hydrogen at their relevant pressure levels in order to observe the changes that occur with the different dust storm intensities throughout the year. The three plots (Figure 1, 2, and 3) are showing the mean mixing ratios over the labeled pressure ranges. The water vapor pressure is chosen to represent 50 km-100 km, and the hydrogen pressure range is based on the exobase. We also differentiate between seasonal effects and dust storm effects by comparing the two scenarios. The streamfunction of the two scenarios are also compared in order to look at how the atmospheric flows is affected. We also look at the water ice cloud changes in the GCM output during the dust storms.

Results:

We notice an increase in water vapor during the dust storms of MY34 in the LMD-GCM outputs that is not seen in the cold case scenario. We also see an increase in the streamfunction during the storm that is more than what is seen in the cold case scenario. We compare the water ice clouds to look at the differences between the two scenarios.

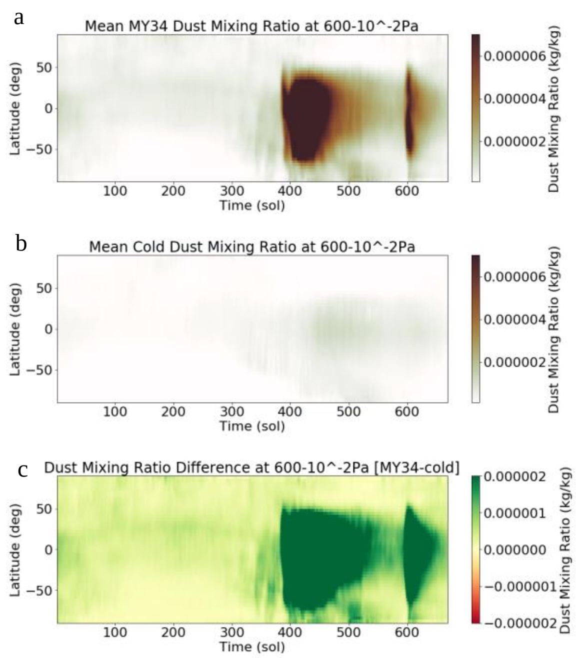

Figure 1: Dust mixing ratio for MY34 and the cold case and their difference

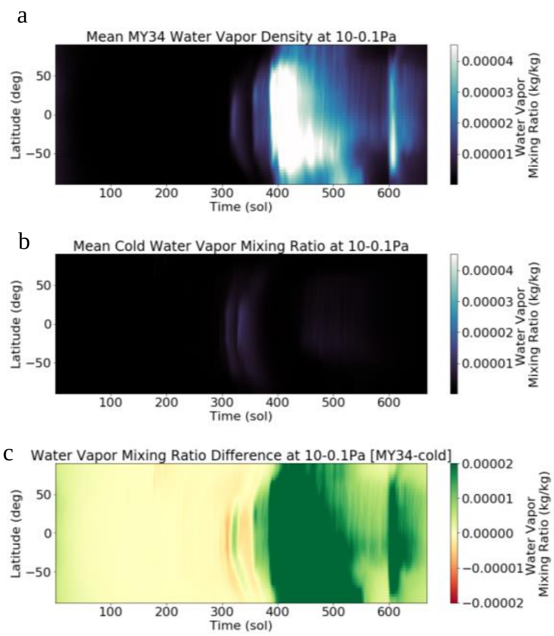

Figure 2: Water vapor mixing ratio for MY34 and the cold case and their difference

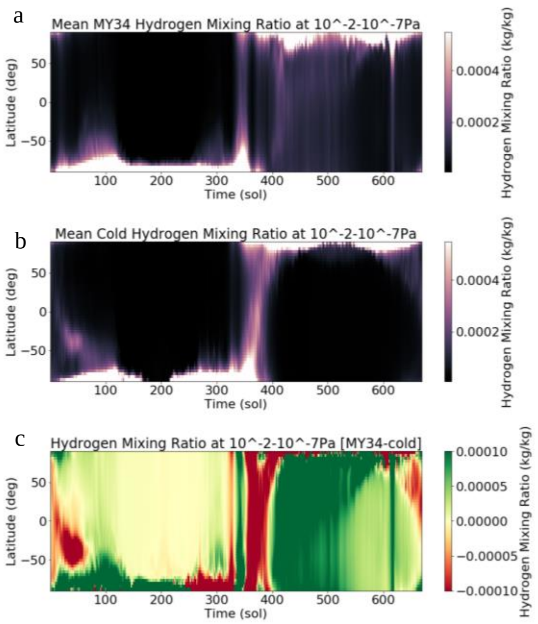

Figure 3: Hydrogen mixing ratio for MY34 and the cold case and their difference

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