Explanation for the increase in high altitude water on Mars observed by NOMAD during the 2018 global dust storm

*Lori Neary[1], Frank Daerden[1], Shohei Aoki[1], James Whiteway[2], Robert Todd Clancy[3], Michael Smith[4], Sébastien Viscardy[1], Justin Tyler Erwin[1], Ian Thomas[1], Geronimo Villanueva[4], Giuliano Liuzzi[4], Matteo Crismani[5], Michael Wolff[3], Stephen Lewis[6], James Holmes[6], Manish Patel[6], Marco Giuranna[7], Cedric Depiesse[1], Arianna Piccialli[1], Séverine Robert[1], Loic Trompet[1], Yannick Willame[1], Bojan Ristic[1], Ann Carine Vandaele[1]

1. Royal Belgian Institute for Space Aeronomy, Brussels, BE, 2. Centre for Research in Earth and Space Science, York University, Toronto, ON, CA, 3. Space Science Institute, Boulder, CO, USA, 4. NASA Goddard Space Flight Center, Greenbelt, MD, USA, 5. NPP/USRA, NASA Goddard Space Flight Center, Planetary Systems Laboratory, Code 693, Greenbelt, MD, USA, 6. School of Physical Sciences, The Open University, Milton Keynes, UK, 7. Instituto di Astrofisica e Planetologia Spaziali, Instituto Nazionale di Astrofisica, Rome, IT

Using the GEM-Mars three-dimensional general circulation model (GCM) (Neary and Daerden, 2018), we examine the mechanism responsible for the enhancement of water vapour in the upper atmosphere as measured by the Nadir and Occultation for MArs Discovery (NOMAD) instrument on board ExoMars Trace Gas Orbiter (TGO) during the 2018 global dust storm on Mars (Aoki et al., 2019).

GCM experiments with different prescribed vertical profiles of dust show that when more dust is present higher in the atmosphere, the temperature increases and the amount of water ascending over the tropics is not limited by saturation until reaching heights of 70-100 km. The warmer temperatures allow more water to ascend to the mesosphere. The simulation of enhanced high-altitude water abundances is very sensitive to the vertical distribution of the dust prescribed in the model (Neary et al., 2019).

The GEM-Mars model includes gas-phase photochemistry, and these simulations show how the increased water vapour over the 40-100 km altitude range results in the production of high-altitude atomic hydrogen which can be linked to atmospheric escape. The figure below shows the ratio of results from two simulations, GDS0008 (with a dust vertical profile corrected to be similar to observations) and nonGDS (no correction to dust profile) for water vapor and hydrogen volume mixing ratios in the equatorial region (between 30N/S) for the period between L_s = 160-280. At the onset of the global dust storm, the water vapor profile responds with a large increase by more than a factor of 150 at a height of around 70 km. At this altitude, the photolysis of water vapor is strong, and atomic hydrogen is produced. After several sols, an increase in hydrogen is seen.

Keywords: Mars, Global circulation modelling, water vapor, water ice clouds, atmospheric escape

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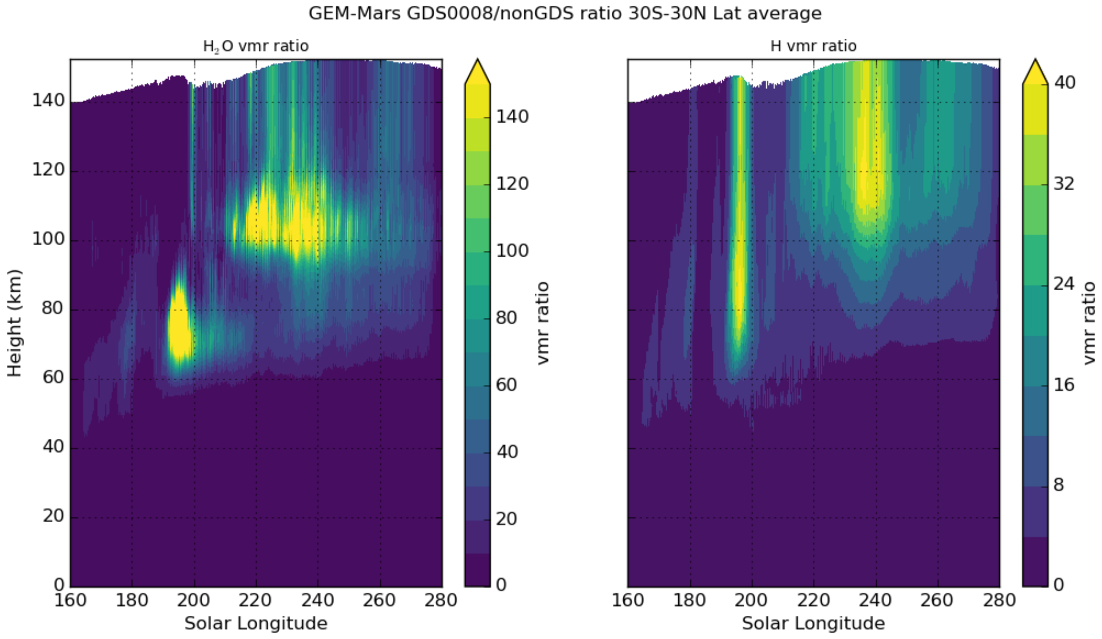

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