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Lower atmosphere water/hydrogen activity during the MY 34 regional dust storm

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Our understanding of the evolution of water on Mars can be advanced through the provision of bounded constraints on the rates of water loss. To understand observed variations in the loss rate, the processes via which hydrogen escapes the martian atmosphere and coupling to the lower atmosphere water cycle also need to be explored. During the Mars Year (MY) 34 regional dust storm that occurred from L_S = 320.6-336.5°, an increase in the Lyman alpha brightness (a proxy for hydrogen escape) was observed by the Mars Atmosphere and Volatile EvolutioN Imaging Ultraviolet Spectrograph (MAVEN/IUVS) instrument. Vertical profiles of water vapour can be retrieved from the Nadir and Occultation for MArs Discovery (NOMAD) and Atmospheric Chemistry Suite (ACS) instruments on the ExoMars Trace Gas Orbiter (TGO). Retrievals could not be made, however, at the time of peak activity observed by MAVEN/IUVS, during the MY 34 regional dust storm.

We investigate the global distribution of lower atmosphere water using data assimilation covering the time period leading up to and during the MY 34 regional dust storm. The data includes observations of water vapour from NOMAD/ACS (that constrain the initial global distribution of water), temperature profiles from ACS and the Mars Climate Sounder (MCS) on the Mars Reconnaissance Orbiter spacecraft, and dust column from MCS, which are combined with the Open University modelling group Mars Global Circulation model. During the time period of the MY 34 regional dust storm unobserved by ExoMars TGO we can still constrain the simulation using MCS temperature and dust column retrievals, a powerful advantage of multi-spacecraft data assimilation. This method provides the most realistic simulation possible of the chemical and dynamical structure of the lower atmosphere during the observed peak in MAVEN/IUVS observations.

We identify peak abundance of water vapour and hydrogen at altitudes above 70 km that are consistent with the peak emission observed by MAVEN/IUVS. Spatial variations in elevated water/hydrogen across the globe are linked to the underlying circulation patterns during the MY 34 regional dust storm.