DIURNAL VARIABILITY IN MARTIAN ATMOSPHERIC WATER VAPOUR: NEAR SURFACE ICE OUT OF EQUILIBRIUM AS A SOURCE. H. M. Boettger[1] , B.H. Foing[1], P.L. Read[2] and S. R. Lewis[2], [1]ESTEC, ESA, Noordwijk, Netherlands, hboettger@rssd.esa.int, [2]AOPP, Oxford University, Oxford, UK.

Introduction: In this study we attempt to test the hypothesis that the observed diurnal variability in column water vapour abundances is driven by the supply of water vapour from subsurface water sources which are out of equilibrium with the current Martian climate. We will attempt to validate our results against the available Gamma Ray Spectrometer (GRS) observations.

Background: The seasonal variations in column water vapour abundance in the atmosphere of Mars are now relatively well know. The combination of Mars Atmospheric Water Detector (MAWD) Viking data and Thermal Emission Spectrometer (TES) Mars Global Surveyor data has supplied more than 4 years of observations and more is currently being gathered [1],[2]. The TES data in particular has enabled significant advances in the modeling of the Martian water cycle with models now capable of replicating the seasonal variations of water vapour and water ice with reasonable accuracy [3],[4],[5]. Unfortunately there is a lack of observations covering details of vertical distribution of water vapour and the diurnal variations in column water vapour abundance. The data which does exist is often puzzling suggesting diurnal variations in column water vapour abundances of up to a factor of 2 or 3 e.g. [6],[7]. In general it appears that the total column varies by around 10 prmicrons over the course of one day [8].

This diurnal signal of 10 microns has been suggested to be due to exchange with the regolith forced by diurnal changes in temperature [8]. Simulations have been conducted using a regolith model based on that by [9] which suggests that in equilibrium a 1D atmospheric column loaded with 12 prmicrons of water vapour will only exchange around 10% of its total column abundance [4]. This is well below the values suggested by the observations. It is also difficult to reconcile this discrepancy between the model and observations, given that for exchange between atmosphere and regolith to take place the water needs to be confined close to the surface. Certainly in equatorial and tropical regions the General Circulation Models (GCM) suggest that this is not the case. It is, therefore, easy to conclude that maybe the errors in the observations are sufficiently large to account for the differences between observations and models. Thereby concluding that exchange is indeed only 10% of the column and not up to a factor of 2-3 as has been suggested.

However, we would like to examine an alternative approach. It may be possible that this diurnal signature is caused by a near surface water source which is supplying the atmosphere with water vapour on a daily basis. In equatorial regions this water source would of course be out of equilibrium with the current climatic conditions on Mars and would hence need to be a remnant from a previous epoch. This idea is further backed up by the Gamma Ray Spectrometer on board Odyssey [10], which has found localized regions away from the high latitudes which are enriched in Hydrogen. Here, we will examine the potential for buried subsurface ice to act as a source for the observed diurnal variability in atmospheric column water vapour abundance.

Model: This study uses the Oxford Mars GCM as described in [11]. In addition the model includes a suite of parameterizations to model the water cycle, which include a condensation sublimation scheme, a bulk cloud scheme and a 10 layer regolith model. The regolith model is based on that of [9] and models the movement of water in the subsurface in the vapour, adsorbed and ice phases and further allows for the exchange of vapour between the upper subsurface layer and the lowest atmospheric layer. A detailed description of the parametrizations can be found in [4].

Method: It has already been shown that in equilibrium a diurnal exchange between the regolith and atmosphere will only account for around 10% of the total column water abundance. We will, therefore, focus our attention on the behaviour of subsurface water away from equilibrium. There are two stages to our investigation. 1. In 1D how much water at what depth is required in order to supply the atmosphere with the observed daily variability. This allows us to establish whether this is a realistic hypothesis within the constraints of the GRS observations as well as the constraints set upon the longevity of an ice source at depth away from the high latitudes. 2. How is the water vapour, once released, removed from the column in order to adhere with the observations. Because water is released from a source during the course of only one sol, the water is confined lower in the atmosphere and hence a stronger diurnal exchange then was observed in the equilibrium case can be expected. However, advection will also play an important role. In 1D the role of advection cannot be suitably studied and hence 3D studies will be conducted to examine the role of advection. Wind needs to be capable of removing near surface water vapour, especially once the regolith has

stopped supplying the atmosphere with vapour (i.e. in the late afternoon).

Conclusions: Our study will allow us to test the hypothesis that the observed diurnal variability in column water vapour abundances is driven by the supply of water vapour from subsurface water sources which are out of equilibrium with the current Martian climate. We will attempt to validate our results against the available GRS observations.

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