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Modeling the Distribution of H2O and HDO in the upper atmosphere of Venus

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The chemical and dynamical processes in the upper atmosphere of Venus are poorly known. The recently obtained vertical profiles of trace species from the Venus Express mission, such as HF, HCl, H2O, and HDO [Bertaux et al., 2007] provide new information to constrain these processes. The Venus middle and upper atmospheres (above the cloud tops) are known to possess highly variable retrograde superrotating zonal (RSZ) winds and more stable subsolar-to-antisolar (SS-AS) winds [e.g., Bougher et al., 1997; Lellouch et al., 1997]. Using the middle and upper atmosphere wind structure (obtained from the Venus Thermospheric General Circulation Model (VTGCM) code; Bougher et al., 1997, 2007) coupled with the tidal modes and planetary scale waves responsible for the simulated RSZ wind variations we can obtain realistic wind profiles governing transport conditions in the this region of the Venusian atmosphere. Utilizing these profiles in conjunction with a model we have developed and described in a companion paper [Yung et al., this issue], with special emphasis on the modeling of H2O and HDO. The photolysis-induced isotopic fractionation (PHIFE) of H2O/HDO and HCl/DCl is adequately taken into account. We find that the observed enhancement of HDO can be attributed to (1) large scale transport that increases the age of air (equivalent to amplifying the photolytic rate in an air parcel) at mid to high-latitudes and (2) escape of hydrogen that enhances the abundance of D and hence its parent molecule HDO. Sensitivities to the changes of the two mechanisms are discussed.