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Hydrogen variability in the Martian thermosphere

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Abstract

We model the diurnal and seasonal variations of the hydrogen species (H_2, H) in the Martian thermosphere using a 3D GCM model. This model has been improved recently to include all the physical processes controlling the hydrogen density in the Martian thermosphere. We are able to study the impact of each process and their interrelation, as well as to compare with previous models.

1. Physical processes and 3D GCM implementation

Recent observations of the Martian Lyman-alpha emission suggest temporal variability of the hydrogen corona [1]. The variations of the hydrogen corona are linked to variations of hydrogen in the Martian thermosphere. In the Martian thermosphere, hydrogen is present under molecular H_2 and atomic H forms, both ultimately coming from water vapor photodissociation in the mesosphere. Because of their light mass, hydrogen density profiles are sensitive to Jeans escape and therefore to exospheric temperatures. Strong diurnal as well as seasonal variations are then expected. Several improvements have been done in the 3D GCM-Ground-to-exosphere model [2] to describe hydrogen species. Physical processes controlling the hydrogen content in the Martian thermosphere are photochemistry, molecular diffusion, turbulent diffusion, large scale winds and thermal escape. In the lower thermosphere photochemical reactions and winds control its density whereas molecular diffusion and thermal escape control its density in the upper thermosphere. We improved the molecular diffusion scheme and add two photochemical reactions controlling thermospheric hydrogen to the photochemical scheme of the previous version of the 3D GCM [2]. It is then possible to simulate diurnal and seasonal variations of H and H_2 in the Martian thermosphere. We will present and discuss the results obtained with the model, including the vertical profiles, their variability, and the roles of diffusion and transport.

2. Conclusion and future work

A 3D-GCM model has been improved to describe the hydrogen variability in the Martian thermosphere and Jeans escape, As the first application, we will couple this GCM to an exospheric model [3] and 3D radiative transfer model to interpret the numerous UV observations done by SPICAM-MEX [4]. In the future, such a model will be also adapted to include D species and study the spatial and temporal variability of D/H ratio useful to constrain accumulated water escape.

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