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Simulation of CO and H_2O_2 on Mars

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Abstract

We present new results of the GEM-Mars General Circulation Model with interactive atmospheric chemistry [1]. The simulation of the vertically integrated column of carbon monoxide (CO) is compared to the most complete dataset to date, obtained from CRISM [2]. The general trends in the data are reproduced by the model while differences expose possible issues with atmospheric mixing in the model. The simulation of the vertically integrated column of hydrogen peroxide (H_2O_2) is compared to the complete set of available data [3] and provides an exceptionally good result, which illustrates that the water cycle and the Mars photochemistry are well implemented in the model. The abstract is accompanied by one that presents results for ozone (O_3) and oxygen dayglow ($O_2(a^1\Delta_g)$) (Neary et al., this session), and another one on the simulation of semiheavy water (HDO) (Daerden et al., ExoMars session).

1. Introduction

The atmospheric chemistry on Mars is dominated by CO_2 and H_2O and their photolysis products. The interaction between these products has been understood to be crucial in the stabilization of the Martian atmosphere [e.g. 4]. In this photochemical cycle, only a few species have been observed, and only for some of those, the spatiotemporal coverage is dense enough to confine seasonal trends: CO [e.g. 2], H_2O_2 [e.g. 3], O_3 [e.g. 5], and $O_2(a^1\Delta_g)$ airglow (e.g. [6]). These datasets provide important constraints for global model simulations of atmospheric chemistry.

2. Simulations

For the simulation of gas enrichment upon condensation of CO_2, a parameterization was developed that calculates the local enrichment factor from the amount of CO_2 ice condensing/evaporating. This led to a simulation of the polar argon enhancement that was in agreement with other models [1, 2]. The resulting seasonal trend of the vertically integrated abundance of CO was compared to the latest dataset retrieved from CRISM observations, comprising 5 Mars years of data [2]. The most important features are reproduced although some model-data differences remain, providing insight in the accuracy of model parameterizations.

The GEM-Mars chemistry was updated from previous versions, e.g. by including improved cross-sections for CO_2 and H_2O, especially in the 190 nm region, and by improving the calculation of photolysis rates taking into account the true direction of the sun. This led to a much improved simulation of H_2O_2, that is now consistent with all observational data (except for a few outliers).

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References

[1] Neary, L., and F. Daerden (2018), Icarus, 300, 458–476, https://doi.org/10.1016/j.icarus.2017.09.028
[2] Smith, M., F. Daerden, L. Neary and S. Khayat (2018), Icarus, 301, 117–131, https://doi.org/10.1016/j.icarus.2017.09.027
[3] Encrenaz, T., et al. (2015), Astron. Astrophys. 578, A127, doi:10.1051/0004-6361/201425448.
[4] Lefèvre, F., et al. (2004), J. Geophys. Res., 109, E07004, doi:10.1029/2004JE002268.
[5] Clancy, R. T., et al. (2016), Icarus, 266, 112–133. doi:10.1016/j.icarus.2015.11.016
[6] Guslyakova, S., et al. (2016), Planet. Space Sci. 122, 1–12. doi: 10.1016/j.pss.2015.12.006.