EPSC Abstracts
Vol. 12, EPSC2018-595, 2018
European Planetary Science Congress 2018

O_2 distributions and related chemistry on Mars: Potential scientific targets for the future Mars terahertz sensor missions

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The importance of O_2 (molecular oxygen) for the atmospheric chemistry on Mars had been overlooked historically, because it has been thought to exist horizontally and vertically constant (~1400 ppmv) and impossible to observe from ground-based telescopes due to the deep absorption of the terrestrial O_2. However, the recent sub-millimeter spectroscopic observation using the Herschel Space Observatory suggested the possibility of higher concentration of O_2 near the Martian surface based on which detected the non-uniform vertical distribution of O_2 in global-mean abundance [1], and, since then, we have started to investigate the importance of O_2 for the atmospheric environment of Mars.

The abundance of O_2 is chemically related to the existences of O_3, H_2O, HO_2, H_2O_2, CO and methane. Simulated results by a Mars global climate model (MGCM) including a chemical suite (Mars Climate Database v5.3) [2,3] did not show the specific vertical variances of O_2 abundance except the winter polar regions where the composition changes due to the condensation of CO_2 (Figure 1). It means that current MGCMs may lack the processes which cause the vertical gradient in the O_2 abundance that suggested by the Herschel observation: e.g., unusual chemical reactions inside local dust storms and/or other surface activities including biological and geological ones.

Terahertz sensors which are planned to be onboard future satellite missions may observe the abundances of O_2 and chemically-related molecules (O_3, H_2O, H_2O_2) (Figure 2), and would be suitable for the first specific observational investigations of O_2 distributions and its formation/loss processes on Mars. In this presentation we show test experiments of O_2 distributions using our high-resolution MGCM (DRAMATIC) with water cycle [4] and a chemical module, and discuss the potential scientific interests for future terahertz observations from Mars landers/orbiters.

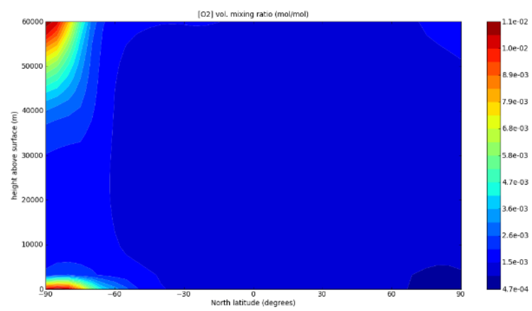

Figure 1: Zonal-mean O_2 volume mixing ratio at Ls=90° in the Mars Climate Database v5.3.

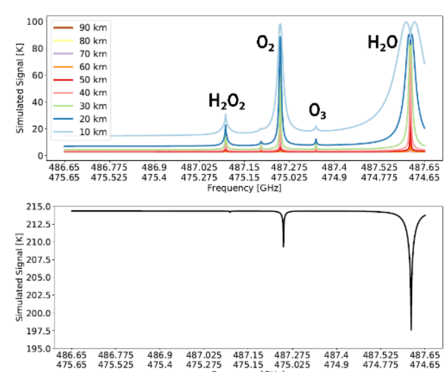

Figure 2: Simulated limb (upper) and nadir (lower) spectra of a planned terahertz sensor on Mars [5].

References

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