Synthetic Retrievals of CO_2 from NOMAD and ACS Solar Occultation Spectra

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Introduction: The ExoMars orbiter will soon be finishing its aerobraking phase, and then, in summer 2018, it will start taking science measurements of the Martian atmosphere. From that point TGO will be making systematic solar occultation observations for the first time of the Martian atmosphere. This presents us with a unique opportunity to explore the atmospheric vertical structure (composition and temperature) at high spatial resolution, and hopefully in a wide range of altitudes extending into the upper thermosphere. Making good use of this data requires specialized tools, specifically a line-by-line radiative transfer model and an appropriate inversion scheme.

Our team at the Instituto de Astrofísica de Andalucía (IAA/CSIC) has experience in simulating CO_2 emissions in the upper atmospheres of the three terrestrial planets under conditions of non-local thermodynamic equilibrium (non-LTE) [1][2][3]. We also performed successful retrievals of CO densities in the Venus atmosphere under optically thin conditions in the limb [4], and of CO_2 in nadir pointings [5]. In addition, our team has helped develop, in partnership with the University of Karlsruhe, a line-by-line radiative transfer model (KOPRA) [6] used to simulate emission and absorption spectra primarily of the Earth's atmosphere, and our team has performed retrievals of atmospheric CO_2 on Earth in the infra-red using KOPRA [7][8]. In a recent and on-going effort, an extension of this retrieval scheme to the Martian dayside hemisphere is permitting the derivation of CO_2 in emissions up to very high altitudes from OMEGA/Mars Express [9]. These two successful retrieval strategies correspond to emission spectra by CO_2 in its 4.3 um strong ro-vibrational bands. We expect that with some additional adaptations this tool will become a valuable asset for us in taking advantage of the solar occultation data from ExoMars TGO instruments in other spectral regions in the near-IR.

In this talk, we would like to go over the adaptations that we have made to our radiative transfer model KOPRA in order to handle solar occultation measurements, the application of the modified tool to specific selections of NOMAD orders containing strong CO_2 bands, and the incorporation of the effects of the NOMAD and ACS instruments' responses on synthetic spectra. We present the first results from our synthetic retrievals, a comparison of behavior from both instruments (NOMAD and ACS), and our plans to apply it to other atmospheric species like methane and water vapor.

Keywords: ExoMars TGO, NOMAD, ACS, inverse methods, Mars, planetary atmospheres, trace gas detection, remote sounding, CO_2, methane, water

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