UPDATE AND EVALUATION OF THE GEISA SPECTROSCOPIC DATABASE IN THE FRAME OF EARTH OBSERVATION SPACE MISSIONS: APPLICATIONS TO MERLIN ET MICROCARB.

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Modern and future space missions aim at measuring the concentration and flux of greenhouse gases with increasing accuracy. This ambition requires not only the improvement of the radiometric performances of the instruments, but must also be accompanied by an increased knowledge of the spectroscopic processes in the concerned bands, requiring to push the limits of the spectroscopic models usually considered. A strong demand thus exists for highly comprehensive, well validated, efficiently operational, and desirably interactive computer-based spectroscopic databases to benefit the research in direct and inverse radiative transfer. To this aim, the LMD laboratory is highly involved in several spaceborne missions (among which Merlin and Microcarb) notably the GEISA spectroscopic database [1], maintained from a long time. Recent works have thus been devoted to the study of sophisticated spectroscopic models, including line-shape, line-mixing and collision-induced absorption (CIA). These studies are intended to be integrated into the GEISA database and to be distributed and accessible to the greatest number of people via its website. Recent spectroscopic studies performed in the frame of Merlin and Microcarb missions will be exposed here. For Merlin, the absorption of methane in the 1.64 μm region was accurately measured at various temperatures and then analyzed to propose an accurate model able to reproduce methane absorption with a precision better than 0.1% over a wide range of pressure and temperatures. For Microcarb, we will focus on O2 absorption bands in 0.76 μm and 1.27 μm for which new CIA continua were developed along with line-shape parameters in the concerned bands. In addition, two recent tools developed within the laboratory were used to evaluate and validate these new data on atmospheric spectra:

- the SPARTE [2] (Spectroscopic Parameters And Radiative Transfer Evaluation) chain, based on the comparison between direct radiative transfer simulations performed by the 4AOP algorithm and various remote sensing observations for

[1] doi:10.1016/j.jms.2021.111510, T. Delahaye et al., The 2020 edition of the GEISA spectroscopic database, *J. Mol. Spectrosc.*, **380**, (2021).

[2] doi:10.1016/j.jms.2016.04.004, R. Armante et al., Evaluation of spectroscopic databases through radiative transfer simulations compared to observations. Application to the validation of GEISA 2015 with IASI and TCCON, *J. Mol. Spectrosc.*, **327**, (2016)

thousands of well-characterized atmospheric situations (typically the ground-based Fourier Transform Fourier transform spectrometers of the TCCON network between 2.5 and 0.7 μm).

- the 5AI [3] (Adaptable 4A Inversion) inverse scheme, based on the Optimal Estimation algorithm, which aims to retrieve geophysical parameters from any remote sensing observation and applied here to TCCON and OCO-2 retrievals.

[3] doi:10.5194/amt-14-4689-2021, M. Dogniaux et al., The Adaptable 4A Inversion (5AI): description and first XCO2 retrievals from Orbiting Carbon Observatory-2 (OCO-2) observations, *Atmos. Meas. Tech.*, **14**, (2021)