CHARACTERIZATION OF THE H_2O+CO_2 CONTINUUM ABSORPTION WITHIN THE INFRARED TRANSPARENCY WINDOWS FOR PLANETARY APPLICATIONS

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Accurate knowledge of the absorption by a gas mixture of CO_2 and water is crucial for planetary sciences, as it allows for better modeling the atmospheres of rocky planets, e.g. improving our understanding of the early climate of Mars or why Venus and the Earth have evolved so differently. In addition to local monomer lines proportional to the density of each species, the absorption spectrum of such a gas mixture includes binary absorption features varying smoothly with frequency: self-continuum absorption proportional to the squared density, and "crossed" absorption involving both species and scaling as the density product $\rho_{CO_2}\rho_{H_2O}$. We used highly sensitive spectroscopy techniques (CRDS and OFCEAS) to measure the absorption by H_2O+CO_2 gas mixtures in several spectral regions situated in transparency windows where the monomer absorption of both species is weak (1.5-1.53 μm, 1.68-1.75 μm, 2.06 μm, 2.2-2.35 μm, 3.5 μm). For both water and CO_2, the monomer lines, modeled using HITRAN parameters, and the self-continuum absorption, calculated from literature values or measured in dedicated experiments, were subtracted from the measured absorption. The obtained "crossed absorption" coefficients are compared to the only available empirical model based on far wings of line shape profiles scaled by χ-factors.[a] An additional absorption peak centered at about 6000 $\mathrm{cm}^{-1}$was attributed to a collision-induced simultaneous transition of H_2O and CO_2 through the ν_1 and ν_3 modes, respectively. The assignment was confirmed using humidified $^{13}CO_2$, where a similar band was observed about 68 cm^{-1}away corresponding to the isotopic spectral shift of the ν_3 band of CO_2. Classical molecular dynamics simulations (CMDS) of the considered collision-induced absorption were conducted and are found in good agreement with the experiment.[b]

[a] Fleurbaey H, Campargue A, Carreira Mendès Da Silva Y, Grilli R, Kassi S, Mondelain D. J Quant Spectrosc Radiat Transf 108119 (2022)

[b] Fleurbaey H, Mondelain D, Fakhardji W, Hartmann J-M, Campargue A. Submitted to J Quant Spectrosc Radiat Transf