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Pressure broadening in the $2\nu_3$ band of methane and its implication on atmospheric retrievals

C. Frankenberg[1], T. Warneke[2], A. Butz[1], I. Aben[1], F. Hase[3], P. Spietz[2], and L. R. Brown[4]

[1]Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands
[2]Institute of Environmental Physics, Otto-Hahn-Allee 1, 28359 Bremen, Germany
[3]Institut für Meteorologie und Klimaforschung, Forschungszentrum Karlsruhe, 76021 Karlsruhe, Germany
[4]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, USA

Abstract. N_2-broadened half widths and pressure shifts were obtained for transitions in the $2\nu_3$ methane band. Laboratory measurements recorded at 0.011 cm^{-1} resolution with a Bruker 120 HR Fouriertransform spectrometer were analysed from 5860 to 6185 cm^{-1}. A 140 cm gas cell was filled with methane at room temperature and N_2 as foreign gas at pressures ranging from 125 to 900 hPa. A multispectrum nonlinear constrained least squares approach based on Optimal Estimation was applied to derive the spectroscopic parameters by simultaneously fitting laboratory spectra at different ambient pressures assuming a Voigt line-shape. At room temperature, the half widths ranged between 0.030 and 0.071 cm^{-1} atm^{-1}, and the pressure shifts varied from –0.002 to –0.025 cm^{-1} atm^{-1} for transitions up to J"=10. Especially for higher rotational levels, we find systematically narrower lines than HITRAN predicts. The Q and R branch of the new set of spectroscopic parameters is further tested with ground based direct sun Fourier transform infrared (FTIR) measurements where systematic fit residuals reduce by about a factor of 3–4. We report the implication of those differences on atmospheric methane measurements using high-resolution ground based FTIR measurements as well as low-resolution spectra from the SCanning Imaging Absorption SpectroMeter for Atmospheric ChartographY (SCIAMACHY) instrument onboard ENVISAT. We find that for SCIAMACHY, a latitudinal and seasonally varying bias of about 1% can be introduced by erroneous broadening parameters.

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