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

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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 $0.071\text{ cm}^{-1}\text{ atm}^{-1}$, and the pressure shifts varied from -0.002 to $-0.025\text{ cm}^{-1}\text{ atm}^{-1}$ 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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