Methane spectroscopy in the 2ν3 band

Motivation: SCIAMACHY measurements of CH4

- The SCanning Imaging Absorption spectro-Meter for Atmospheric Characterography (SCIAMACHY) on board the ENVISAT satellite was launched on March 1, 2002.
- CH4 is measured in the short wave infrared (SWIR) between ~1630-1670 nm, covering the Q and R-branch of the 2ν3 methane band. Details about the IMAP retrieval algorithm can be found in Frankenberg et al., 2005.
- As the spectral resolution of SCIAMACHY in the methane channel is only 1.3nm FWHM, spectral lines are not resolved and absorptions therefore show a saturation effect which is influenced by pressure broadening of methane transitions. As these parameters were previously measured only for few transitions in this band, a precise determination for pressure broadening coefficients in the SCIAMACHY retrieval window was the main driver for this study.
- An example of a typical SCIAMACHY NADIR spectra is shown in the lower panel of Figure 1

Results and data sets shown in this poster are published in Frankenberg, C., Warneke, T., Butz, A., Aben, I., Hase, F., Spelz, P., and Brown, L. R.: Methane spectroscopy in the near infrared and its impact on atmospheric retrievals, Atmos. Chem. Phys. Discuss., 8, 10021-10055, 2008.

http://www.atmos-chem-phys-discuss.net/8/10021/

Laboratory measurements and spectral retrievals

Laboratory spectra were recorded over the 5600–5800 cm−1 spectral range with a Bruker IFS 125HR Fourier transform spectrometer (FTS) located at the Institute of Environmental Physics of the University of Bremen. The gas samples were introduced in a 2-m long cell. The cell was located behind the interferometer and the light passed twice through the cell before being detected. Transmission spectra were calculated by dividing sample spectra (resolution=0.011 cm−1) by the spectra obtained for the evacuated cell (resolution=0.1 cm−1). Twenty-five interferometers were co-added for the calculation of the spectrum. Table 1 (in the right side) gives details about the set of 4 spectrum used in this study. N2 was used as foreign gas.

Multi-spectrum retrievals for the Q and R-branch

We applied a nonlinear fitting approach to derive the spectral line parameters pressure broadening coefficient and pressure-induced shift. Parameters for each individual line were fitted using multiple laboratory spectra simultaneously. Relative line intensities were strictly constrained to the Margolis (1988) values given in HITRAN, permitting only small deviations. Details about the multispectrum fitting technique and its advantages can be found in Boeckx et al., 1995. Even though the multispectrum approach greatly reduced uncertainty in the retrieval, the inverse problem remained underdetermined as the blended lines cannot be fully separated. For this reason, we added additional constraints using the Optimal Estimation Technique (Rodgers, 2000). This approach allowed us to attribute prior uncertainties to the target parameters, thereby minimizing oscillations of parameters whose retrieval errors would be strongly correlated in an unconstrained least squares approach.

Results & Discussion

The retrieved pressure broadening coefficients are, especially at higher J, systematically lower than given in HITRAN and this difference is more crucial. For other regions, a seasonal bias of about 1% can be introduced which is crucial for methane source inversions.

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