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Extension of the long-term total column time series of atmospheric methane above the Jungfraujoch station: analysis of grating infrared spectra between 1976 and 1989

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Methane (CH_4) is one of the most abundant greenhouse gases in the Earth's atmosphere, with current mean volume mixing ratio close to 1800 ppb. Since methane has a global warming potential of 25 (100-yr horizon) and an atmospheric lifetime of 12 years, the Kyoto Protocol has included it among the species to be regulated to limit global warming. Anthropogenic sources of methane are mainly energy production (coal and leaks) and agriculture while main natural sources are swamps and biomass waste. The main sink of methane is oxidation in the troposphere, primarily by reaction with the hydroxyl radical.

Methane trends have exhibited significant changes during the last twenty-five years. For instance, long-term monitoring of its vertical total column above the high-altitude station of the Jungfraujoch (46.5°N, 8°E, 3580 m asl) has indeed allowed to derive column changes ranging from +0.72% in 1987-1988 to +0.14% in 1999-2000 (Zander et al., 2002), relative to 1988 and 2000, respectively. More recently and for the same site, Duchatelet et al. (2010) have even reported a significant slowdown of -0.02%/yr between years 2000 and 2005. This study also showed that since then, CH_4 is on the rise again, at a rate close to +0.30%/yr.

While the numbers reported here above have been derived from the Fourier Transform Infrared (FTIR) data set starting in 1984, earlier pioneering observations have been collected at the Jungfraujoch since 1950, using grating spectrometers. During the 1958-1975 period, the main objectives has been the study of the solar photosphere in the visible and the near infrared and the publication of high-resolution solar atlases. From 1976 to 1989, narrow-band IR solar absorption observations achieving a spectral resolution of about 0.02 cm^{-1} have been recorded with the high-performance double-pass grating spectrometer. Analysis of these historical spectra provides a unique opportunity to extend the Jungfraujoch's total column time series of important atmospheric gases, including methane, by nearly 10 years.

The aim of this contribution is to present the inversion strategy adopted to derive CH_4 from the grating spectra, using the SFIT-2 algorithm (v3.91) We will evaluate the impact of resolution, spectroscopic parameters (from the EU HYMN project -see www.knmi.nl/samen/hymn-, and from HITRAN 2004), atmospheric pressure and temperature profiles on the error budget. The 1976-1989 total column time series produced will be presented and critically discussed. In particular, we will identify and correct for possible biases between double-pass grating spectrometer measurements and more recent FTIR total columns. The harmonized and consolidated time series will be investigated to characterize the long-term trend of methane for the 1976-2010 time period. Comparisons with synthetic data produced by the CHASER 3-dimensional chemical transport model will also be presented and analyzed.

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