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Validation of ENVISAT/SCIAMACHY columnar methane by solar FTIR spectrometry at the Ground-Truthing Station Zugspitze

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Abstract. Methane total-vertical column retrievals from ground-based solar FTIR measurements at the Permanent Ground-Truthing Station Zugspitze (47.42° N, 10.98° E, 2964m a.s.l.), Germany are used to validate column averaged methane retrieved from ENVISAT/SCIAMACHY spectra by WFM-DOAS (WFMD) version 0.4 and 0.41 for 153 days in 2003. Smoothing errors are estimated to be below 0.10% for FTIR and 0.14% for SCIAMACHY-WFMD retrievals and can be neglected for the assessment of observed bias and day-to-day-scatter. In order to minimize the altitude-difference effect, dry-air column averaged mixing ratios (XCH_4) have been utilized. From the FTIR-time series of XCH_4 an atmospheric day-to-day variability of 1% was found, and a sinusoidal annual cycle with a $\approx 1.6\%$ amplitude. To obtain the WFMD bias, a polynomial fitted to the FTIR series was used as a reference. The result is $WFMD\ v0.4/FTIR = 1.008 \pm 0.019$ and $WFMD\ v0.41/FTIR = 1.058 \pm 0.008$. WFMD v0.41 was significantly improved by a time-dependent bias correction. It can still not capture the natural day-to-day variability, i.e., the standard deviation calculated from the daily-mean values is 2.4% using averages within a 2000-km radius, and 2.7% for a 1000-km radius. These numbers are dominated by a residual time-dependent bias in the order of 3%/month. The latter can be reduced, e.g., from 2.4% to 1.6% as shown by an empirical time-dependent bias correction. Standard deviations of the daily means, calculated from the individual measurements of each day, are excluding time-dependent biases, thus showing the potential precision of WFMD daily means, i.e., 0.3% for a 2000-km selection radius, and 0.6% for a 1000-km selection radius. Therefore, the annual cycle as well as possibly the day-to-day variability could be captured under the prerequisite of further advanced time-dependent bias corrections, or the use of other channels, where the icing issue is less prominent.

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