Retrieval of Carbon Monoxide Vertical Column Densities from SCIAMACHY Infrared Nadir Observations

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Abstract
Nadir observations of the near infrared channels of SCIAMACHY onboard the ENVISAT satellite can be used to derive information on CO. For retrieving CO information, the BIRRA (Bremen Infrared Retrieval Algorithm) is a least squares fit of the measured radiances with respect to molecular column densities and surrounding parameters. The algorithm was developed at DLR.

1 Introduction
Nadir sounding of molecular column densities is well established in atmospheric remote sensing. For UV instruments such as SCIAMACHY (Bovensmann et al., 1999) the analysis is traditionally based on a DOAS methodology. This approach has also been successfully applied to SCIAMACHY’s near infrared channels (Buchwitz et al., 2007; Frankenberg et al., 2005) to gain more flexibility and an efficient and robust inversion for the operational level 2 data processing. “BIRRA” has been developed at DLR.

2 Retrieval Methodology
The objective of SCIAMACHY nadir NIR measurements is to retrieve information on gases such as CO, CH4, or O3, e.g., volume mixing ratio \( q_X(z) \) or density \( N_X(z) \) of molecule X. Unfortunately analysis of the NIR channels of SCIAMACHY is challenging because of:

- Tiny signal on huge background (low signal-to-noise ratio)
- Channel 8 ice layer on the detector
- CO and \( XO_3 \) retrieval: very weak absorbers

Furthermore, vertical sounding inversions are ill-posed, so it is customary to retrieve only column densities

\[
N_X = \int n_X(z) \, dz \tag{1}
\]

3 Results
For the retrieval of carbon monoxide vertical column densities with BIRRA, level 1 data of SCIAMACHY channels 3 and 4 of the Bremen nadir/dual pixel mask have been used, hence a single spectrum comprises 51 data points in the interval 1429.0615 to 1432.1130 cm\(^{-1}\). An US standard atmosphere was assumed. Surface reflectivity was modelled with a second order polynomial baseline. Intercomparisons of monthly means with other SCIAMACHY retrievals and with AIRS (Atmospheric Infrared Sounder) data are shown in the subsequent figures. These months indicate local sources of CO associated with highly populated areas and biomass burning as well as seasonal variability.

4 Summary and Outlook
Carbon monoxide column densities retrieved with the “BIRRA” prototype of the operational SCIAMACHY nadir IR level 2 processor have been compared with results obtained with the WFM-DOAS (University of Bremen) and IMLM (SRON) algorithms. Furthermore, intercomparisons with the CO product obtained with the Atmospheric Infrared Sounder (AIRS) have been shown. Results indicate high sensitivity to the bad/dual pixel mask and the crucial importance of correct filtering of dubious retrieval results. Despite significant conceptual differences of the three SCIAMACHY codes w.r.t. forward modelling and inversion a good overall agreement has been found.

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