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The effects of aerosol and cirrus clouds on the retrieval of atmospheric methane (CH_4) from SCIAMACHY

Diane Knappett (1), Hartmut Boesch (1), Austin Cogan (1), and Paul Monks (2)

(1) Dept. of Physics and Astronomy, University of Leicester, United Kingdom (dsk4@le.ac.uk), (2) Dept. of Chemistry, University of Leicester, United Kingdom (p.s.monks@le.ac.uk)

Atmospheric methane (CH_4) plays a significant role in global warming despite being present in the atmosphere in smaller quantities than carbon dioxide (CO_2) as it has a radiative forcing efficiency or 'global warming potential' of 21 times greater than that of CO_2. The annual global source strength of CH_4 is fairly well constrained to 550 ($\pm$50) Tg (Frankenberg et al., 2006) from the study of tropospheric OH, the dominant sink for atmospheric CH_4, however the temporal and spatial variability of individual sources and sinks is currently less well quantified. Satellites can provide comprehensive, global datasets of CH_4 which can lead to large improvements in our understanding of the global atmospheric CH_4 distribution and how it is likely to evolve in the future. However, satellite retrievals of CH_4 are often hindered by the presence of atmospheric aerosols and/or cirrus clouds which can lead to biases in the resulting trace gas total column if not properly accounted for. This necessitates a new method for the inclusion of a priori aerosol and cirrus cloud data in retrievals.

For retrievals of CH_4 we utilise satellite data from the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) instrument which is a nadir/limb viewing spectrometer of moderate resolution that observes in the UV, visible and NIR. SCIAMACHY detects sunlight reflected from the Earth's surface and therefore has high sensitivity to the lowest atmospheric layers where anthropogenic trace gas emissions peak. The FSI WFM-DOAS retrieval algorithm, previously applied to CO_2 data from SCIAMACHY (Barkley et al., 2006) has been adapted to perform retrievals of CH_4. Retrieved CH_4 vertical column densities (VCD) are converted to volume mixing ratio (VMR) by taking the ratio of the retrieved CH_4 VCD with the corresponding CO_2 VCD (also retrieved using FSI WFM-DOAS) and then multiplying by a mean model value of the CO_2 VMR; using this method the effects of spectral features due to aerosol or cloud contamination of the observed scene mostly cancel out. However, since atmospheric extinction is wavelength dependent and we retrieve CO_2 and CH_4 from separate spectral windows (centred on 1575nm and 1650nm respectively) some discrepancies remain, particularly at high optical depths ($\tau > 0.6$).

Here we present the results of a series of sensitivity tests that have been carried out to characterize the FSI algorithm for various aerosol, albedo and solar zenith angle scenarios. Furthermore, we have investigated the spatial distribution of biases introduced when either an inadequate representation of aerosol is used within retrievals or when aerosol is neglected from retrievals altogether. We therefore propose a modified version of FSI WFM-DOAS which takes aerosol extinction into consideration by incorporating the Global and regional Earth-system Monitoring using Satellite and in-situ data (GEMS) aerosol product from the European Centre for Medium-Range Weather Forecasts (ECMWF) into the retrieval initialisation. The presence of cirrus clouds will also result in detrimental spectral effects and requires further investigation to correct for within the retrieval, however this will be taken into account in a future version of FSI WFM-DOAS.