Using MERIS data in the calculation of NO₂ airmass factors

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Introduction

Nowadays the distribution of trace gases (such as O₃, NO₂, etc) in the troposphere can be determined from measurements performed by various instruments flying on satellites: GOME, GOME-2, SCIAMACHY and OMI. The retrieval of tropospheric columns of NO₂ from satellite measurements is based on several assumptions that in one way or another contribute to the uncertainty in the final retrieval. The improvement of the a priori assumptions used for the computation of the airmass factor (AMF) is a main concern to obtain the correct values of NO₂ present in the troposphere.

A sensitivity study is shown in this poster as an example for the impact of a different aerosol optical thickness (AOT) and albedo values on the computation of the AMF with the radiative transfer model (RTM) Sciatran (Rozanov et al., 2005).

From data of MERIS instrument it is possible to obtain AOT and spectral surface reflectance values, and also cloud cover information. This can later be used in the calculations of the AMF for SCIAMACHY retrievals. However, in this poster, only an example of AOT data calculated with the BAER algorithm is presented.

Need for a change...

It is known that the presence of aerosols has an impact on the measurements of tropospheric NO₂. Depending on the retrieval method used, this effect is currently accounted for in different ways:

- included in the cloud treatment used (e.g. FRESCO used by KNMI)
- corrected based on model results (case of Harvard and Dalhousie groups)
- with data taken from climatological assumptions (IUP, Bremen) (Richter et al., 2005)

In the IUP the surface albedo data used is currently taken from a database derived by R. Koelemeijer (2003) based on GOME climatologies.

Obviously, the current approach used in the IUP does not account for the spatial and time variability of both aerosols and surface albedo. Therefore, we attempt to include in the retrieval method data that can be continuously updated, i.e. using real measurements when available and dynamical "climatology" when it is necessary to fill gaps.

Sensitivity Study

Settings:
- RTM: Sciatran 2.0
- Type of aerosol: "continental average"
- Wavelength: 437.50 nm

Figure 1: Profiles of NO₂ (red and blue) and aerosol used for this study.

- AMF of NO₂ in lower layers (profile 1) tends to decrease with increasing AOT, especially for larger solar zenith angles (SZA).
- Signal of NO₂ can be amplified when it is homogeneously mixed in an aerosol layer, however this influence is not systematic.
- For all cases an increase of albedo values will lead to an increase of the NO₂ AMF. This effect becomes weaker with increasing aerosol load.

Figure 2: NO₂ AMF for profile 1 (left) and profile 2 (right) for SZA of 20° (top) and 75° (bottom) for different albedo values.

Figure 3: NO₂ AMF for profile 1 (top) and profile 2 (bottom) for SZA of 75° for different AOT values:

Conclusions & Future work...

- From the sensitivity study it is clear that aerosol and albedo can have a large influence on the NO₂ AMF and such influence cannot always be predicted.
- The profile and type of aerosol considered influences greatly the AMF calculations and therefore it needs to be selected carefully – data from ECMWF may be used to select and define the profiles.
- Improvements in BAER are necessary to better identify clouds and eliminate artefacts that interfere with the calculation of accurate AOT values (e.g., effect of sunglint).
- The novel dataset of aerosol and albedo values (taken from MERIS) will be later incorporated in the retrieval method of tropospheric NO₂.
- This new method (with the latest a priori assumptions) can then be applied to a larger data set.

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References


Figures:

- Figure 4: Schematic representation of the BAER algorithm on MERIS data (left) and values when masked with available SCIA measurements (right).
- Figure 5: Global AOT values for the period of 18 to 20 of April of 2007 as retrieved using the BAER algorithm on MERIS data (left) and values when masked with available SCIA measurements (right).