# OMI AND SCIAMACHY $NO_2$ VALIDATION BY GROUND-BASED MULTI-AXIS DOAS OBSERVATIONS DURING THE DANDELIONS CAMPAIGNS


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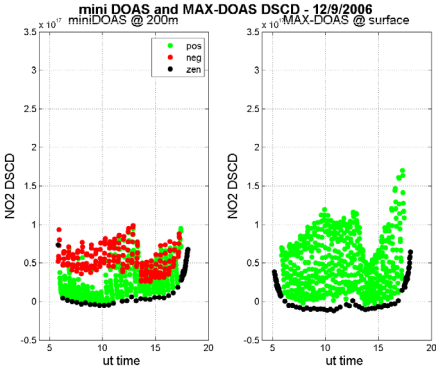
## 1. The DANDELIONS campaigns

The DANDELIONS (**D**utch **A**erosol and **N**itrogen **D**ioxide **E**xperiments for va**l**idation of **O**MI a**n**d **S**CIAMACHY) project encompasses validation of OMI, SCIAMACHY and AATSR measurements of aerosols and $NO_2$ over the Netherlands. Two measurement campaigns took place in **Cabauw** (52°N, 5°E - conditions are expected to be clear, within a mainly polluted area) from May to July 2005, and in September 2006. Overview of the campaigns, datasets (AVDC website) and main results can be found in *Brinksma et al. 2007*, including a detailed intercomparison between BIRA, Bremen and Heidelberg MAXDOASes, showing very good agreement. **In this study** we will focus on characterizing the vertical homogeneities and the validity of the approximations used (inducing errors on the ground-based retrievals) and highlight some aspects of the satellite validation.

## 2. The MAXDOAS retrievals

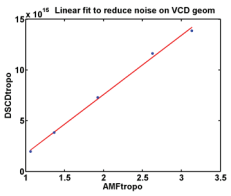


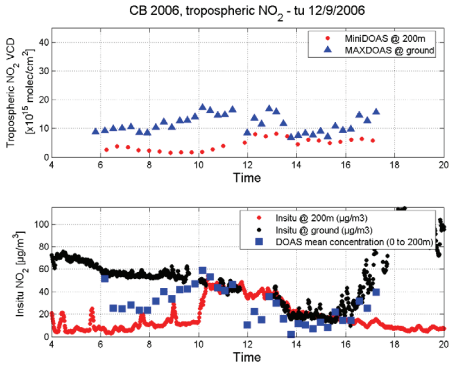

$$VC_{geom} = \frac{SCD_{off} - SCD_{zen}}{\sin^{-1}(LOS) - 1} = \frac{DSCD_{tropo}}{AMF_{tropo}}$$

**Geometrical approximation:** assumptions

- $NO_2$ layer located below the scattering altitude
- similar stratospheric contribution

**Reduce the noise** on the tropospheric VCD retrieval, applying a selection based on the difference between the VCD retrieved at 15° and at 30°, or using **several elevation angles** and the **mean** or the **fitted** value.



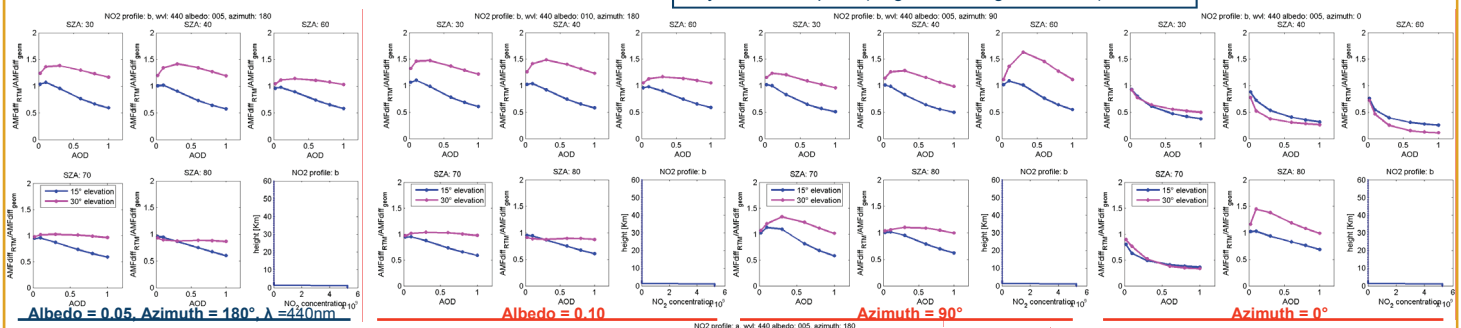




Comparison of the VCD retrieved with the geometrical approximation (mean value of 14°,16°,20°,25°,30°) from the MAXDOAS at 0m and at 200m. The difference, divided by 200m gives the DOAS mean concentration within the mast height, that is compared to the insitu samplers values.

**Estimate the error** on the tropospheric $NO_2$ VCD retrieval with the geometrical approximation, for several aerosols conditions: **RTM calculations**, (changing the albedo, the azimuth, the $NO_2$ profile …)

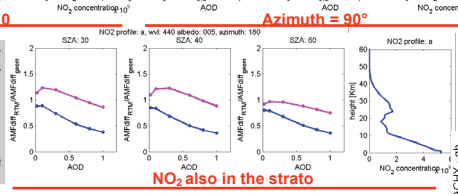
$$VCD_{underestimation} = \frac{VCD_{geom}}{VCD_{RTM}} = \frac{DAMF_{RTM}}{DAMF_{geom}} = \frac{AMF_{off} - AMF_{zen}}{\sin^{-1}(LOS) - 1}$$

**aerosols**: cst within 0-1km and 0 above, asym. factor = 0.68, very small absorption (single scattering albedo = 1)




Albedo = 0.05, Azimuth = 180°, λ =440nm — Albedo = 0.10 — Azimuth = 90° — Azimuth = 0°

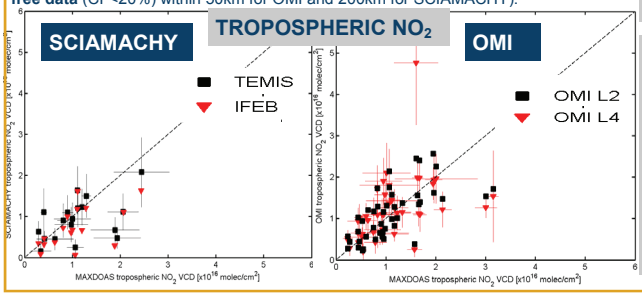
For small SZA and +/- all AOD, the VCD retrieved with the geometrical approximation at **30° elevation**, is over-estimating the column, while at **15°** is under-estimating the column. At higher SZA this different behaviour is less pronounced.
Changing the **albedo** increases the 30° over-estimation (-> multiple scattering).
Changing the **azimuth** viewing direction greatly affects the relative behaviour, especially when pointing in the sun direction.
Changing the **$NO_2$ profile**, adding stratospheric content, do not change the general findings.




$NO_2$ also in the strato

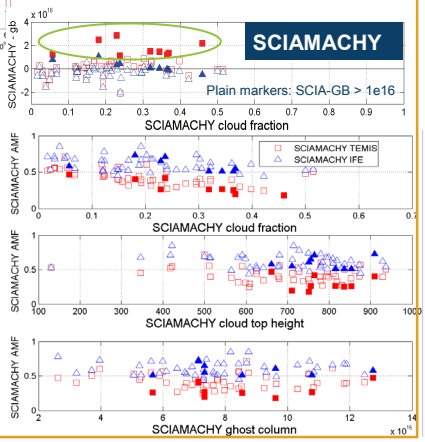
## 3. The satellite validation

Ground-based data interpolated at time of satellite overpass (closest point of **cloud free data** (CF<20%) within 50km for OMI and 200km for SCIAMACHY).




**Cloud free conditions:** satellites tend to see less $NO_2$ than the ground-based measurements, especially for large VCD (>2.5e16). These are probably related to local pollution, averaged within the corresponding pixel.

**Cloudy pixels:**
For OMI (CF up to 100%), large deviations appear, which are related to very **high OMI L2 ghost columns** calculated under **high clouds**. (not shown here)
For SCIAMACHY (CF up to 50%), a large difference between TEMIS product and ground-based MAXDOAS VCD appear, not present in the IFE product, related to the AMF differences. Analysis of the role of clouds (fraction and height) and of the ghost column do not allow to extrapolate a clear tendency. The new TEMIS cloud product (FRESCO +) generally showing higher clouds and less $NO_2$, should be tested on these dataset.




## 4. Conclusions and future work

- Example of retrieval of **$NO_2$ vertical information** combining 2 MAXDOAS instruments at 2 different heights. Highlight of the presence of an $NO_2$ layer under and over the highest instrument (through the analysis of the DSCD). Good agreement of the DOAS mean concentration within the 2 instruments, compared to the 2 insitu samplers (calculation of the VCD thought the geometrical approximation). More information will be inferred from the profile retrievals.
- Radiative transfer calculations to asses the **errors relative to the ground-based MAXDOAS** tropospheric VCD retrieval, for several geometrical settings, aerosols loads and $NO_2$ distribution .
- MAXDOAS tropospheric VCD used to **validate satellite measurements.** The importance of the cloud cover and the ghost column correction is underlined by comparing several satellite retrieval schemes. Further comparisons with a new cloud product for SCIAMCAHY (TEMIS FRESCO +) which should gives higher clouds and less $NO_2$, will be performed on the DANDELIONS dataset.


**Acknowledgements**

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**Selected References**


*Brinksma et al., 2007*: $NO_2$ and aerosols validation during the 2005 and 2006 DANDELIONS campaigns, *submitted to JGR AURA special issue.*

*Celarier et al., 2007*: Overview of the validation of nitrogen dioxide retrieved from the Ozone Monitoring Instrument, *submitted to JGR AURA special issue.*


Campaign website: http://www.knmi.nl/omi/research/validation/dandelions AVDC website: http://avdc.gsfc.nasa.gov/Data/index.html