OMI NO_2 VALIDATION BY GROUND-BASED MULTI-AXIS DOAS AND DIRECT SUN OBSERVATIONS DURING THE DANDELIONS CAMPAIGNS

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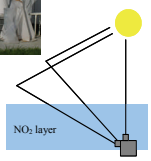
1. The DANDELIONS campaigns

The DANDELIONS (**D**utch **A**erosol and **N**itrogen **D**ioxide **E**xperiments for **v**alidation of **O**MI **a**nd **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.

2. The measurements

Overview of the campaigns, datasets and main results can be found in *Brinksma et al. 2007*, including a detailed intercomparison between BIRA, Bremen and Heidelberg MAXDOASes.
Focus of this study: Comparison of OMI NO_2 products to total and tropospheric NO_2 columns retrieved from ground-based DOAS instruments, with particular attention to cloud impact and strength of collocation criteria.



	BIRA MAXDOAS 2005/2006	BIRA Direct Sun DOAS 2006	OMI Level 2	OMI Level 4
Instrument details	Cooled spectrometer, resolution of ~ 0.55/0.7 nm, 308-455/322-467 nm	Cooled spectrometer, resolution of ~ 0.56 nm, 335-450 nm	Imaging spectrograph with a spectral resolution of ~ 0.5nm, 279-500 nm	
Measurement type and frequency	1 or 2° steps from 1 to 15°, 30°, 90° Continuous acquisition. scan duration ~30 min	Sun tracking Continuous acquisition	Nadir view, 1 or 2 overpasses per day	
Retrieval	DOAS, 425-450 nm	DOAS, 425-450 nm	DOAS, 405-465 nm	
Tropospheric correction	Simple geometrical approximation, assuming the NO_2 layer being located below the scattering altitude:	Sensitive to total columns	Unpolluted fields (strato + free tropo) identifies through spatial filtering of the geographical NO_2 field.	Stratospheric column by assimilation of GOME NO_2 slant columns with the TM4 chemistry-transport model
AMF calculation	$VC_{trop} = \frac{SCD_{off} - SCD_{zen}}{\sin^{-1}(LOS) - 1}$	Geometrical path over the whole atmosphere	Profile shape factors assembled from the GEOS-CHEM (tropospheric) and GSFC-CTM model profile and correction for polluted conditions	Polluted cases: NO_2 tropospheric profile shape factors based on TM4 chemical transport model
Cloud treatment	Validity checked by comparing values retrieved from 15° and 30° elevation	Measurements only under sun conditions	Based on OMI operational cloud fraction and cloud top height product derived from O_2-O_2	

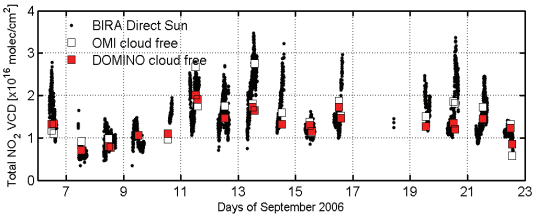
3. The intercomparisons and OMI validation

Several OMI products:

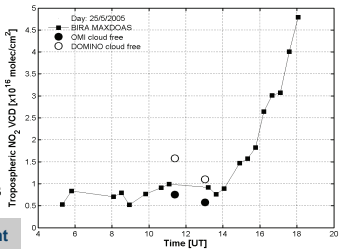
OMI L2 (operational algorithm, including ghost column) and **OMI L4** (DOMINO) **closest pixels** above Cabauw within a radius of 50 km and **cloud free conditions** (cloud fraction < 20%) are compared to:
- MAXDOAS tropospheric columns
- Direct Sun total columns

A general good agreement is found, considering the different viewing geometries, spatial field of view (OMI pixel: 13x24Km) sensitivity to atmospheric parameters (cloud, aerosols, albedo, …).
Quantitative agreement and statistical analysis results are shown in the tables, for **OMI cloud free data** and several products:

Total columns



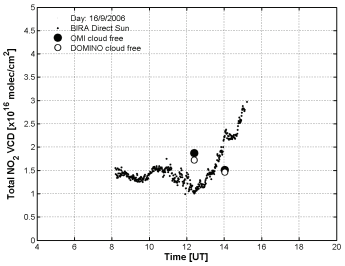
Tropospheric columns

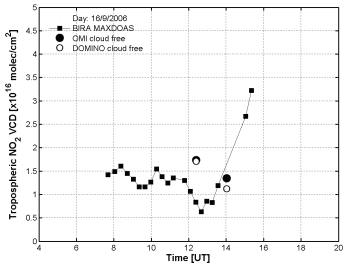


Total column mainly dominated by the tropospheric content

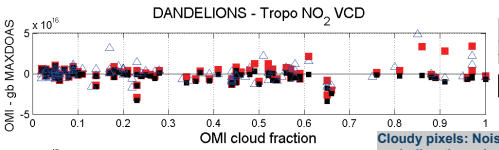
2006	BIRA Direct Sun DOAS total columns					
	Number of points	Correlation coefficient	Slope	Intercept	RMS of difference	RMS/mean OMI
OMI L2 with ghost column	22	0.68	0.54	6.08e15	5.32e15	35%
OMI L2 without ghost column	22	0.69	0.55	5.44e15	5.49e15	37%
OMI L4 (DOMINO)	22	0.66	0.33	7.39e15	6.57e15	50%

2005 & 2006	BIRA MAXDOAS tropospheric columns					
	Number of points	Correlation coefficient	Slope	Intercept	RMS of difference	RMS/ mean OMI
OMI L2 with ghost column	48	0.63	0.56	4.73e15	4.98e15	46%
OMI L2 without ghost column	48	0.63	0.55	4.24e15	4.62e15	43%
OMI L4 (DOMINO)	48	0.51	0.41	6.58e15	5.80e15	50%



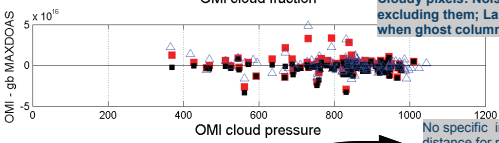


Investigation of the sensitivity to clouds and distance to Cabauw for **all OMI data** where both products have valid results for **tropospheric columns**:

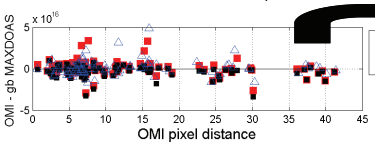


Details for CF<0.2: in the table!

Cloudy pixels: Noise reduction if excluding them; Large dispersion when ghost column application

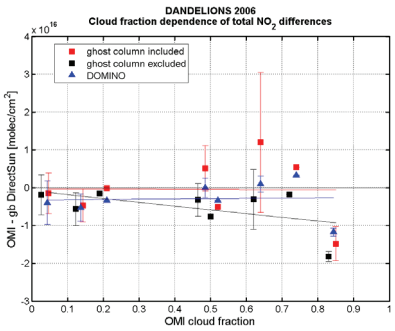


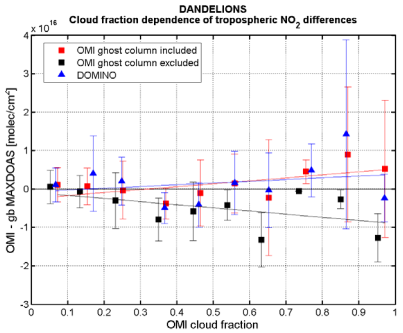
No specific impact of distance for pixels within 50 Km



2005 & 2006

NO_2 column differences versus the OMI **cloud fraction**: differences averaged in successive bins of CF, with one sigma standard deviations:





- OMI columns without applying a ghost column tend to be underestimated, while adding a ghost column improves the situation in average, BUT to the expense of a large increase of the dispersion for cloudy cases
- DOMINO columns tend to be globally closer to the ground-based measures
Best match with OMI L2 including ghost column for cloud free conditions, but this lead to an overestimation of OMI for cloudy cases.

4. Conclusions and future work

- The combined ground-based BIRA-IASB MAXDOAS and Direct Sun technique have been used to validate OMI NO_2 tropospheric and total columns. The intercomparison focuses on sources of discrepancies between the two OMI product retrievals (including role of ghost column) for cloud free and cloudy cases. It has been shown that OMI Level 2 columns without applying a ghost column tend to be underestimated with respect to ground-based measurements, while adding a ghost column improves the situation for cloud free data and in average, but to the expense of a large increase of the dispersion for cloudy cases. In average, OMI Level 4 tend to be closer to the ground-based measurements. Detailed statistical analysis has been done for cloud free conditions (CF<0.2). No specific impact of the OMI pixels distance, for data within a radius of 50Km around Cabauw, has been found.
- Intercomparison with the other MAXDOAS present during the DANDELIONS campaigns and Inclusion of SCIAMACHY data is planned (Pinardi et al., in preparation).

Acknowledgements

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Selected References

Brinksma et al., 2007: NO_2 and aerosols validation during the 2005 and 2006 DANDELIONS campaigns, *to be published in JGR AURA special issue.*
Celarier et al., 2007: Overview of the validation of nitrogen dioxide retrieved from the Ozone Monitoring Instrument, *to be published in JGR AURA special issue.*
Campaign website: http://www.knmi.nl/omi/research/validation/dandelions