Total and tropospheric BrO columns retrieved from GOME-2: first results and validation using ground-based DOAS observations

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Total BrO columns retrieval

Bromine monoxide total columns are retrieved from the radiance measurements using a DOAS technique optimized for GOME-2. The fitting intervals previously used for GOME and SCIAMACHY intruments are tested. The results are compared with ground-based observations and coincident GOME and SCIAMACHY measurements.

DOAS settings (details in Van Roozendael et al., 2008)

Fitting interval 336-351.5 nm (SCIAMACHY int.)
or 344.7-359 nm (GOME-1 int.)
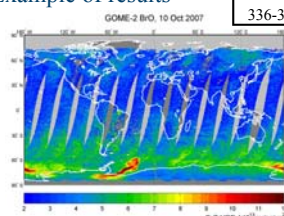**Sun reference** sun irradiance
Absorption cross-sections
BrO (Fleischmann, 223°K), NO_2 (GOME FM3,243°K),
O_3 (GOME FM98 at GOME-2 resol, 221°K+241°K),
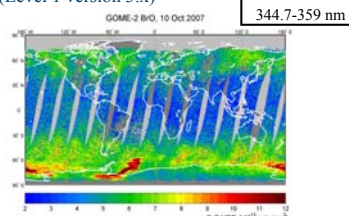O_4 (Greenblatt), Ring effect (generated using SCIATRAN)
Polynomial 3rd order
Intensity offset correction constant offset
Air mass factor geometrical approximation
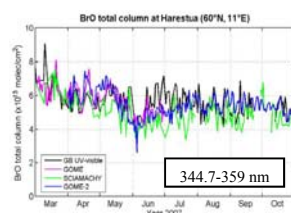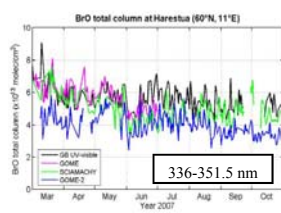(stratospheric absorber)

Example of results (Level 1 version 3.x)

♦ Bromine explosion events observed with an excellent spatial and time resolution
♦ The results in the SCIAMACHY interval minimise the noise, but present a systematic bias low with respect to retrieval performed in the GOME interval ($\sim$ -30%).

Comparison with GOME, SCIAMACHY and ground-based observations

♦ The values in the 336-351.5 nm interval are lower than satellite and ground-based data sets. The origin of the bias is currently not understood.
♦ Retrievals in the GOME interval show a much improved agreement with correlative data sets at Harestua.

Future work

♦ improvement of the DOAS settings (minimization of the noise) + possible improvement based on new Level 0-1 processing.
♦ extend the validation to ground-based observations at Observatoire de Haute-Provence (44°N, France).

Selected Reference

- Van Roozendael et al., Initial validation of GOME-2 GDP 4.2 BrO total columns - ORR A3, Technical note, 2008.

Tropospheric BrO columns retrieval

Algorithm overview
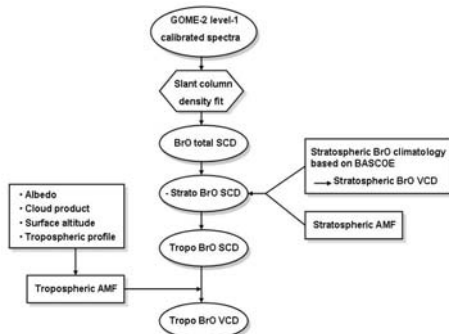
Stratospheric correction (details in Theys et al., 2008)

A new climatology of stratospheric BrO profiles has been developed, and is used in the tropospheric BrO column retrieval algorithm to correct for the BrO absorption in the stratosphere.

♦ the impact of the atmospheric dynamics and the photochemistry on the stratospheric BrO distribution is accounted for by making use of ozone and stratospheric NO_2 columns simultaneously measured by GOME-2.
♦ the parameterization is based on the output from a version of the 3D chemical transport model BASCOE which has been fully optimized for bromine chemistry and budget, and validated through comparisons using an extensive data set of ground-based, balloon-borne and satellite limb (SCIAMACHY scientific product v3.2 from the Univ. of Bremen) stratospheric BrO observations.
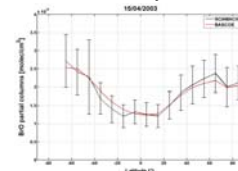
Example of comparison between BASCOE and SCIAMACHY limb BrO 15-30 km partial columns (zonal mean).

Tropospheric AMF

calculated with the radiative transfer model DISORT for the following parameters:
♦viewing geometry: SZA, line-of-sight and azimuth angles.
♦surface altitude
♦albedo: monthly database at 335 nm from Koelemeijer
♦clouds: cloud fraction (CF), cloud top pressure (CTP), cloud albedo (CA) from FRESCO+.
- snow/ice mode: reflector at CTP and with CA.
- CF≤0.1: cloud-free pixel.
- 0.1≤CF≤0.4: independent pixel approximation
- CF≥0.7 & low cloud: fresh snow pixel not detected as is in fresco → reflector at CTP and with CA.
♦tropospheric BrO profile
high albedo(>0.2): column-resolved monthly climatology based on the output from a recent version of the pTOMCAT model (Yang et al., 2005).
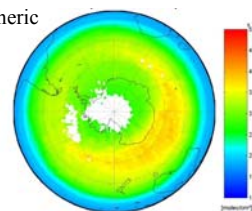*low albedo(≤0.2):* free-tropospheric profile (gaussian profile peaking at 6km, fwhm: 2km).

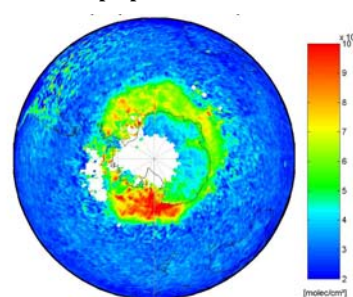### Preliminary results **September 2007 (monthly mean - sza<80° - CF<0.4)**

Total VCD
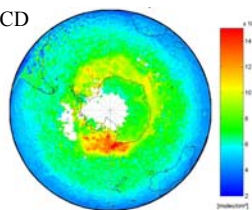
Stratospheric VCD

Tropospheric VCD

Future work

♦ Improved tropospheric profiles by the use of satellite measurements over cloudy scenes (cloud slicing concept)
♦ Establish a detailed error budget
♦ Validation with tropospheric BrO measurements and comparison with model results (e.g. pTOMCAT)

Selected References

- Theys et al., A global stratospheric bromine monoxide climatology based on the BASCOE chemical transport model, accepted for publication in Atmos. Chem. Phys. Discuss., 2008
- Yang et al., Tropospheric bromine chemistry and its impacts on ozone: A model study, J. Geophys. Res., 110, D23311, doi: 10.1029/2005JD006244, 2005.

Acknowledgements