Combination of different satellite observations of BrO over Antarctica

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1. Introduction
Reactive halogen species are known as one of the important components in atmospheric chemistry. They are responsible for ozone depletion through catalytic reaction cycles, changes in the OH/HO2 and NO/NO2 ratios, and oxidation of compounds such as gaseous elemental mercury and dimethyl sulphide. Thus, monitoring of their spatial and temporal distribution is necessary to understand accurately their impact on the chemistry of both troposphere and stratosphere. Data from the GOME-2 and OMI instruments has been successfully used to monitor the daily global distribution of bromine monoxide (BrO) vertical column densities. Large amounts of reactive BrO are found in polar regions during spring due to a phenomenon known as bromine explosion, the release of bromine originating from sea salt to the gas phase through an autocalytic process. In this study, we used BrO column densities from the OMI and GOME-2 satellite instruments to investigate the transport pattern and shape variations during Antarctic bromine explosion events that occurred over a large area for consecutive days.

2. BrO satellite retrieval

- **Satellite instruments**
  - OMI (Ozone Monitoring Instrument) and GOME-2A (Global Ozone Monitoring Experiment–2A)
  - UV/VIS nadir viewing spectrometers
- **Spatial resolution**: 13 x 24 km² (OMI), 40 x 80 km² (GOME-2A)
- **Overpass time**: ~1:30 p.m. (OMI), ~9:30 a.m. local time (GOME-2A)

**Theoretical background**
To obtain the slant column density from the backscattered earthshine spectrum measured by the satellite, the DOAS method (Differential Optical Absorption Spectroscopy) is applied:

\[ I(\lambda) = I_0 \exp(-\sigma(\lambda) s) \]

(the initial intensity: \(I_0\), the length of light path: \(s\), the absorption cross-section: \(\sigma\), the absorber number density: \(p\))

The retrieved slant column can be converted into a vertical column using the air mass factor (AMF)

\[ VCD_{\text{total}} = \frac{SCD_{\text{slant}}}{AMF} \]

**Retrieval settings for BrO from OMI and GOME-2A**

<table>
<thead>
<tr>
<th>Retrieval settings</th>
<th>OMI</th>
<th>GOME-2A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitting window</td>
<td>332 - 359 nm</td>
<td>332-359 nm</td>
</tr>
<tr>
<td>Polynomial degree</td>
<td>5th order</td>
<td>5th order</td>
</tr>
<tr>
<td>Trace gases cross sections</td>
<td>O3 (218K and 295K), NO2 (229K), BO (228K), HCHO (298K), OClO (231K), O4 (296K)</td>
<td>O3 (223K and 273K), NO2 (223K), BO (228K), HCHO (298K), OClO (213K), O4 (203K)</td>
</tr>
<tr>
<td>Offset correction</td>
<td>Done</td>
<td>Done</td>
</tr>
</tbody>
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3. Comparison of OMI and GOME-2 BrO in Antarctica

- **OMI total BrO VCD** (14 Oct 2013 – 19 Oct 2013)

In the Antarctic region, the shape and concentration of BrO plumes are similar between GOME-2 and OMI in general. However, due to the different local overpass time and spatial resolution between the two instruments, differences in spatial distribution are observed.

4. BrO explosion event case study

- **Meteorological and sea ice conditions**
- **Satellite data**
- **Backward trajectories**
- **Enhanced BrO plume** detected along the Antarctic coast line by OMI and GOME2-A.

5. Stratospheric correction

- O3 and NO2 column density can be used as a parameter for tropopause dynamics and stratospheric chemistry (Sihler et al., 2012).
- This assumptions are not applicable to the chemistry inside the polar vortex and ozone hole separation of stratospheric and tropospheric columns of BrO is still challenging in springtime Antarctica.

6. Summary and Outlook

- BrO maps from the GOME-2A and OMI satellite instrument show huge areas of elevated BrO above the sea ice around Antarctica.
- BrO retrievals from GOME-2A and OMI generally agree with some differences as expected from the difference in spatial resolution and overpass time.
- Satellite data sometimes detect enhanced BrO along the Antarctic coast. Overall, BrO enhancements often occur on thin first-year ice when the large-scale meteorological situation is associated with cyclonic activity and relatively high wind speeds.
- Backward trajectories indicate that BrO plumes are related to air masses previously in contact with sea ice surfaces.
- An estimation of the stratospheric BrO within the polar vortex occurring in springtime Antarctica is challenging.

7. Acknowledgement & Selected References

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