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Transport processes of polar BrO events

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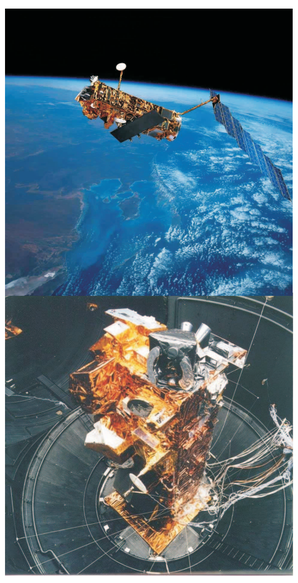
Introduction

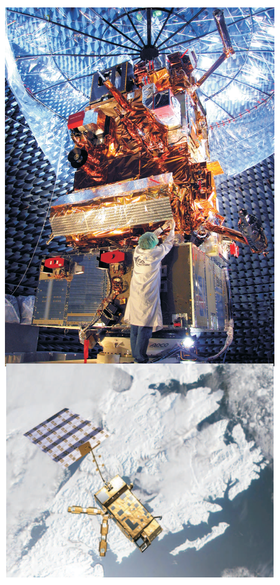
Every year in polar springtime periods, in which ozone is nearly completely removed from the polar boundary layer can be observed in widespread parts of Arctic and Antarctic.
These so called **O**zone **D**epletion **E**vents (ODEs) can be explained with the catalytic ozone destruction by halogens. Bromine here has been identified as the key halogen in this destruction cycle. Its source is sea salt, whereas the bromine is released to the gas phase by heterogeneous reactions on aerosols, ice or snow surfaces.
One key molecule in the reactions is BrO, which can be measured from the ground and from satellite via remote sensing by absorption spectroscopy. Furthermore BrO has a large impact on the deposition of gaseous mercury in the sensitive polar ecosystem. The exact mechanism, which leads to an initial BrO release and the influence of transport processes on the spread of BrO is still not clearly understood.
In this study BrO measurements from two satellite instruments, SCIAMACHY and GOME 2, are compared with trajectory calculations, to get more information about source regions of BrO, transport processes and the life time of individual BrO events. The main focus lies on single, well observable BrO events in Polar Regions.

SCIAMACHY



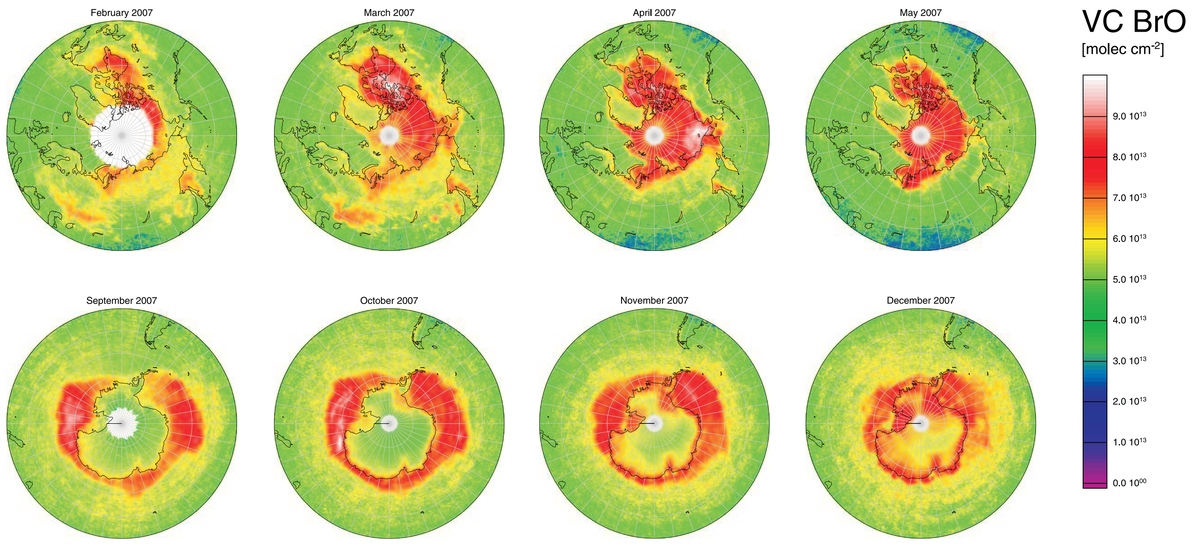
SCIAMACHY (**SC**anning **I**maging **A**bsorption SpectroM**e**ter for **A**tmospheric **CH**artograph**Y**) is an eight channel grating spectrometer measuring in nadir, limb and occultation (solar and lunar) geometries. SCIAMACHY covers the spectral range from 220 to 2400 nm with a spectral resolution of 0.25 nm in the UV, 0.4 nm in the visible and less in the NIR. The size of the nadir ground-pixels depends on wavelength range and solar elevation and can be as small as 30 x 30 km².
SCIAMACHY was launched with nine other instruments on the **ENVI**ronmental **SAT**ellite ENVISAT in a sun-synchronous orbit on 1 March 2002 and is in nominal operation since August 2002.
By combining the alternately executed nadir and limb measurements, information about the vertical composition of the atmosphere can be achieved. Because of the time sharing between the two measurement modes, the nadir coverage is reduced by a factor of two.
Using the **D**ifferential **O**ptical **A**bsorption **S**pectroscopy (DOAS) the retrieval of different atmospheric trace gases like O_3, NO_2, SO_2, H_2O and OClO, IO, BrO from the spectra is possible.

GOME 2



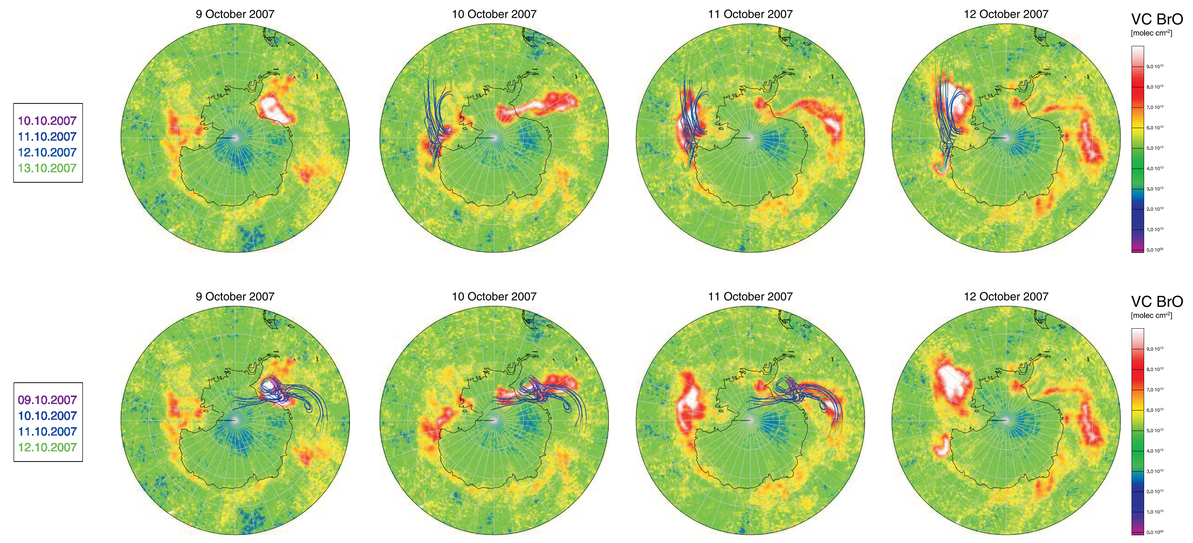
As well as SCIAMACHY, GOME 2 (**G**lobal **O**zone Monitoring **E**xperiment 2) is a multi channel grating spectrometer. With its four channels it covers the wavelength range from 240 to 790 nm. The spectral resolution lies between 0.2 nm in the UV and 0.4 nm in the visible.
Because no measurements in limb geometry are done, a full nadir coverage can be achieved. The size of a nadir ground pixel is with 40 x 80 km² comparable to the spatial resolution of SCIAMACHY.
GOME 2 was brought in a sun-synchronous orbit on 19 October 2006 together with ten other instruments on the weather satellite MetOp-A (**Mete**orological **Op**erational satellite **A**).
GOME 2 is the direct successor of the GOME instrument on the satellite ERS-2 (**E**uropean **R**emote **S**ensing satellite **2**). This is in orbit since 21 April 1995 and after nearly 13 years of operation it still is providing measuring data.
The mission duration of the new MetOp satellites is initially designed for five years. The launch of the next satellites MetOp-B and MetOp-C is planned in 2010 and 2015.

Bromine oxide in polar springtime



The figures above show the strongly increased monthly vertical columns of bromine oxide in the polar springtime in the Arctic from February to May and in the Antarctic from September to December 2007. The observed bromine oxide is the product, which is created by the reaction of photolytic activated bromine with ozone. Due to this it is an indicator for the ozone destruction in the polar boundary layer.
The data were generated from SCIAMACHY measurements by using the **D**ifferential **O**ptical **A**bsorption **S**pectroscopy (DOAS) technique.

Special BrO events



Here, two remarkable antarctic BrO events in October 2007 were analysed in detail. With the aid of the HYSPLIT model (**HY**brid **S**ingle-**P**article **L**agrangian **I**ntegrated **T**rajectory), trajectory calculations were made so that the influence of transport processes on the spreading of bromine oxide can be estimated. Thereby multiple 72 hour forward trajectories were started from the ground for different points in the region with increased BrO values. As acceleration time the moment of the satellite measurements was used (top: 12h UTC / bottom: 21h UTC).
All data were taken from the GOME 2 instrument, due to the better nadir coverage in comparison to the SCIAMACHY instrument.

Conclusions

- The trajectory calculations show good agreement with the observed spreading of bromine oxide. However some variances can be identified.
- It is conspicuous, that in spite of the short life time of BrO a transport over several days can be observed, partly even far up to the antarctic continent.
- These transport processes are a hint to highly efficient recycling processes on aerosols in the transported air masses or the deposition and re-emission of bromine compounds on ice and snow.
- Such long-range transport processes are as well important for the interpretation of ice cores from the inner part of the Antarctic.

Acknowledgements

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- The GOME 2 data have been provided by EUMETSAT
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Selected References

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See also: www.iup.physik.uni-bremen.de/doas