Summary and outlook

In this PhD-thesis algorithms for the retrieval of atmospheric BrO and OClO column densities from GOME satellite data were developed. These algorithms are based on previous works but were adapted and improved for the application to satellite data. In particular the dependence of the Ring effect from the changing ground albedo and cloud cover was investigated.
The results of the BrO analysis were compared to those of several other groups and an agreement within a few per cent was found. A good agreement was also found from the comparison to ground based and balloon measurements.
Also for the GOME OClO data good agreement was found with ground based observations.

The results of the GOME BrO and OClO observations are discussed in detail in chapters 6 and 7. Thus, here we only give a brief summary of the main conclusions:

BrO

The GOME BrO results largely confirm the present understanding of the stratospheric BrO concentrations. However, they provide new findings with respect to tropospheric bromine chemistry:

Within this PhD-thesis enhanced BrO concentrations in the polar boundary layer were detected by a satellite instrument for the first time [Wagner and Platt, 1998]. It was found that in both hemispheres such events occur during the respective spring periods (6 months shifted) and also cover similar areas. In particular it was found that these events are strongly related to the presence of extended areas of sea ice. Enhanced BrO concentrations in the boundary layer were also observed at mid latitudes above the Caspian Sea. It turned out that enhanced BrO concentrations in the boundary layer are present in the Earth's atmosphere during almost the whole year.

As another interesting result several indications for the presence of BrO in the free troposphere were found. From these findings we conclude that BrO mixing ratios up to about several ppt might be present in the free troposphere on a global scale.

OClO

The GOME OClO observations provide an unique data set for the investigation of stratospheric chlorine activation.

The periods of chlorine activation in the northern hemisphere were found to be highly variable, in particular they are at least one month shorter than in the southern hemisphere. Nevertheless, e.g. in 1996/97 a very persistent chlorine activation in the northern hemisphere was observed until the end of March. The maximum OClO values in the northern hemispheres were found to be about only 70% of those in the southern hemisphere.

The chlorine activation in the northern hemisphere was found to be strongly related to the temperatures at altitudes ≤19 km but not to those at higher altitudes. This finding is in contrast to frequent observations of PSCs at altitudes ≥ 22 km. One reason might be that at these altitudes the BrO concentration decreases strongly with height. Thus, the formation of OClO even in the presence of high concentrations of ClO might be smaller compared to lower altitudes.

An upper limit for the OClO mixing ratio in the boundary layer during an event of enhanced BrO concentration of about 3.5 ppt was determined, allowing to deduce an upper limit on the boundary layer ClO mixing ratio of about 14 ppt.

Future work

Improvements of the analysis of GOME data in the future should concern the following aspects:

- The use of new cross sections of atmospheric trace gases with high spectral resolution.

- The Modelling of the 'Filling-in' not only of the Fraunhofer lines but also of the atmospheric absorption lines

- The improvement of algorithms for the determination of cloud properties, the ground albedo and the atmospheric aerosol loading from GOME data and their application to the AMF calculation

Further application and interpretation of the GOME data:

- Tropospheric and stratospheric ClO concentration can be derived from simultaneous GOME BrO and OClO measurements.

- While GOME provides a temporally and horizontally resolved global data set, the vertical resolution of the data is rather poor. From further combination of GOME data with those from balloon and ground based instruments the knowledge of the 3 dimensional distribution of atmospheric trace gases should be increased.

- GOME data provide a unique possibility for the validation of global 3D chemical transport models.

- The experience gained with the GOME instrument can be transferred to its successors SCHIAMACHY and GOME-2.

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