Seasonal variation of stratospheric BrO and NO_2 derived from ground based measurements during 1997-2000 in Kiruna, Sweden

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INTRODUCTION

BrO in the stratosphere plays a crucial role as a catalyst of O_3 destruction. In this study, we investigated the temporal characteristics of stratospheric BrO and NO_2 in a polar region using zenith-sky DOAS. The observation was conducted at the Swedish Institute for Space Physics in Kiruna (Sweden, 68.84N, 20.41E) since 1996. We present the seasonal variation of BrO and NO_2 for the period of 1997–2000 and focus on their averaged seasonal trends with respect to different years.

MEASUREMENT

The ground-based zenith sky DOAS observations of scattered sunlight has been performed at Kiruna, Sweden since 1996. The two spectrograph/detector systems were operated in the UV/Vis spectral range (300 nm to 400nm/374 nm to 682nm) to monitor the absorption of stratospheric trace gases, such as O_3, NO_2, OClO, and BrO. Being one of the longest measurements of spectroscopic measurements of trace gases in the Arctic, the Kiruna observation will contribute to a better understanding of the impacts of stratospheric trace gases on the stratosphere and insights into mechanisms of their chemical reactions.

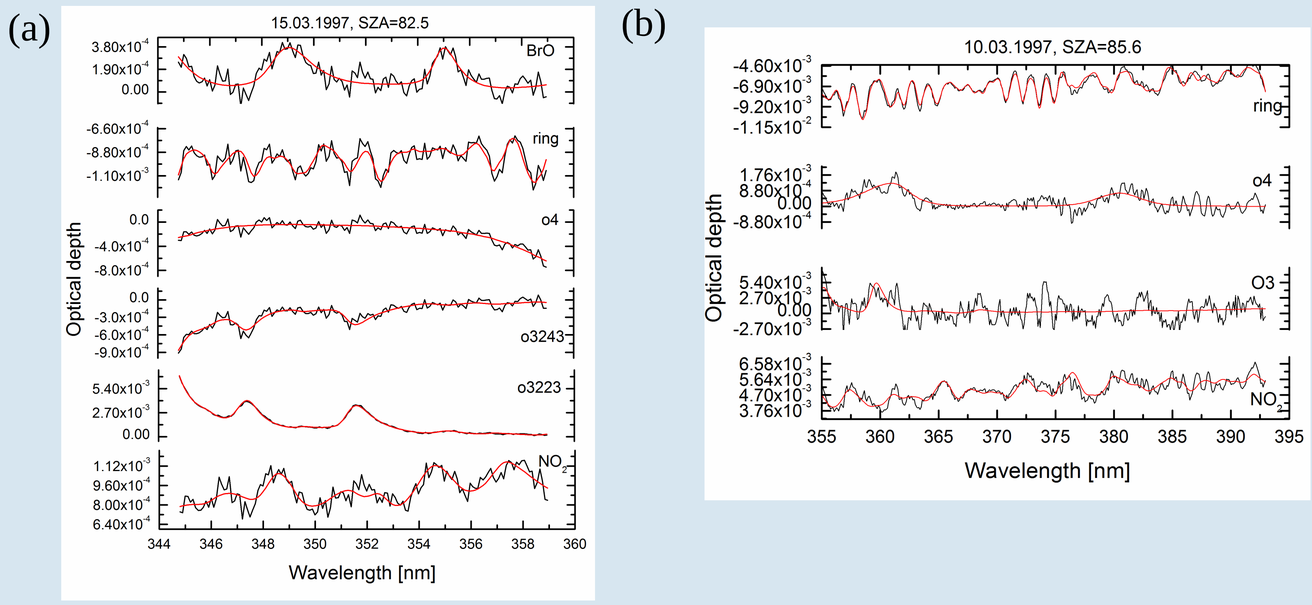
DATA ANALYSIS

1. Spectral Analysis

The spectral signal recorded by Zenith-sky DOAS system was analyzed to obtain BrO and NO_2 slant column densities (SCDs) based on the passive DOAS technique. Results of the spectral fitting of the different absorbers are presented in Fig. 1.

Trace gas	Analysis range	Fitted spectra	Polynomial order
BrO	334.7 – 359 nm	Ring, O_3, NO_2, O_4, BrO	4
NO_2	353 – 395 nm	Ring, O_3, NO_2, O_4	3

Fig.1 Example of fit result for (a) BrO and (b) NO_2 slant column densities (SCDs). Red lines indicate the absorption cross sections scaled to the absorptions in the measured spectrum (black).
The example spectrum was obtained at SZA 85.6˚ on 10 March 1997 and on 15 March 1997 at SZA 82.5˚.



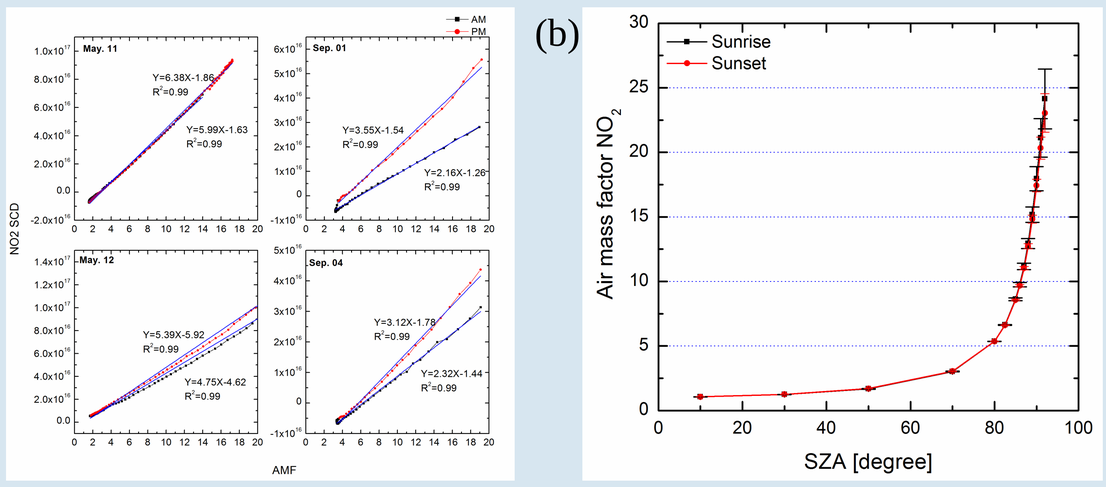
2. Retrieval of vertical column density

For BrO daily Fraunhofer reference spectra at SZA 80° were used.
BrO differential slant column density (90˚ - 80˚ SZA) have been considered because zenith-sky DOAS observations have significant uncertainties that would affect the conversion to vertical column amounts without accounting properly for strong diurnal change of BrO [Fish et al., 1995].

Langley plots provide a method for deriving VCDs. The vertical column density at SZA(θ)—VCD(θ), which is related to SCD(θ) —can be computed from the following equation. SCD_{ref} is obtained from the Langley plot.

$$VCD(\theta) = \frac{SCD(\theta) + SCD_{ref}}{AMF(\theta)}$$

SCD_{ref} indicates the amount of absorber in the reference spectrum and AMF(θ) is the air mass factor at SZA(θ).
For NO_2 Fraunhofer reference spectra were used : one from March 10, 1997 for the first half of 1997 and the other one from September 4, 1997.
Fig. 2 (a) illustrates the Langley plot on May and September, 1997. The slope and y intercept of the plot refer to VCDs for NO_2 and SCD_{ref}, respectively. In this study, we used the NDACC climatology NO_2 AMFs Look-up-tables (LUTs) that is based on the harmonic climatology of stratospheric NO_2 profile, Fig. 2(b).



RESULTS AND DISCUSSION

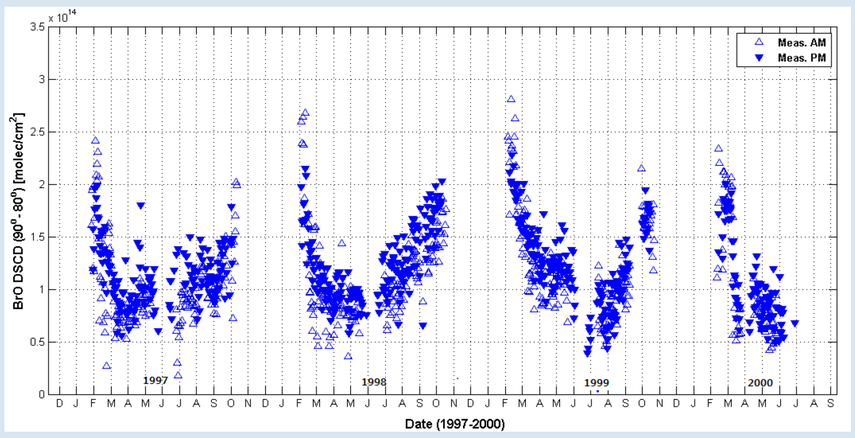


Fig.3. BrO daily mean of DSCD for a.m. and p.m. observations from 1997-2000.

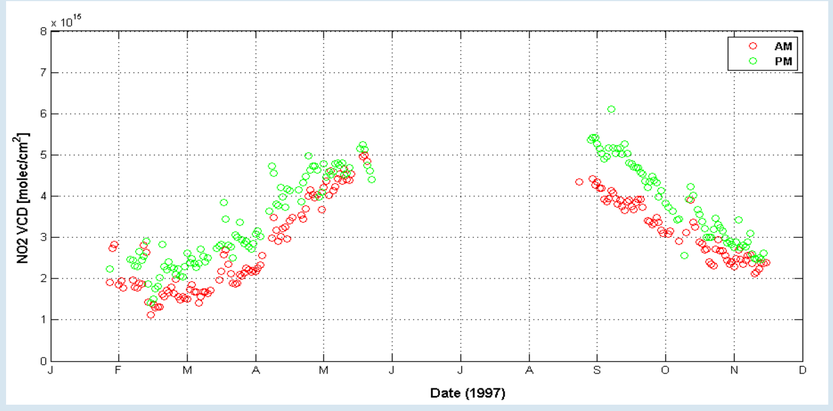


Fig.4. Temporal variations in NO_2 VCD measured at 90°. The NO_2 VCDs at AM(PM) measured by zenith-sky DOAS ranges from 1.13×10^{15}(1.51×10^{15}) to 5.14×10^{15} (6.12×10^{15}) molec/cm^2.
NO_2 VCD shows increasing trend in spring-autumn due to stratospheric photochemistry.

OUTLOOK

-Analysis of longer period to show the continuation of the time series of the stratospheric BrO and NO_2 trends.

-Our future work involves profile inversion, comparison of SCIAMACHY limb with ground-based UV BrO profile retrievals, OClO retrieval, and calculation of Polar Stratospheric Clouds Colour Index.

REFERENCE

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