Tropospheric bromine monoxide time-series from GOME-2 and a possible extension using TROPOMI

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1. Introduction

- Bromine monoxide (BrO) is one of the most dominantly observed indicators of reactive bromine species in the ozone catalytic loss process
- BrO can be measured by space-borne remote sensing platforms
- We generated a tropospheric BrO column dataset covering a period of 14 years using GOME-2 measurements with the framework of the AC-SAF project
- The present algorithm is planned to be applied to TROPOMI measurement which has a finer spatial resolution and a high signal to noise

2. Satellite tropospheric BrO column retrieval

(1) DOAS BrO slant column retrieval

- **Fitting window**: 332 – 359 nm
- Solar reference
- **Absorption cross sections**: BrO (223 K), O_3 (223 K and 243 K), NO_2 (220 K), HCHO (298 K), OClO (293 K), 2 pseudo-cross sections for O_3 at 223 K, Ring
- Polynomial: 5th order
- Two additional polarization functions (Eta and Zeta from GOME-2 calibration key data) are included in the fit
- Linear offset correction

(2) Stratospheric correction

- Stratospheric BrO profiles are estimated using a stratospheric BrO climatology which is based on the output of the chemical transport model BASCOE
- Stratospheric vertical column derived from the Theys et al. (2009) method via BrO/Br_y ratio, O_3 and NO_2 columns form GOME-2 measurements

(3) Tropospheric air mass factor and vertical column computation

$$V_t = \frac{S - M_s V_s}{M_t}$$

V_s: stratospheric BrO vertical column V_t: tropospheric BrO vertical column
M_s: stratospheric air mass factor M_t: tropospheric air mass factor

- The altitude-dependent air mass factors (AMF) are calculated with the LIDORT
- Viewing geometry, surface albedo (GOME-based monthly minimum GLER; Tilstra et al., 2017), surface pressure, clouds, a priori BrO profile
- **For high albedo**, a constant distribution in the first km above the surface
  For low albedo, a Gaussian profile with a maximum at 6 km and FWHM of 2 km

3. GOME-2 tropospheric BrO vertical column

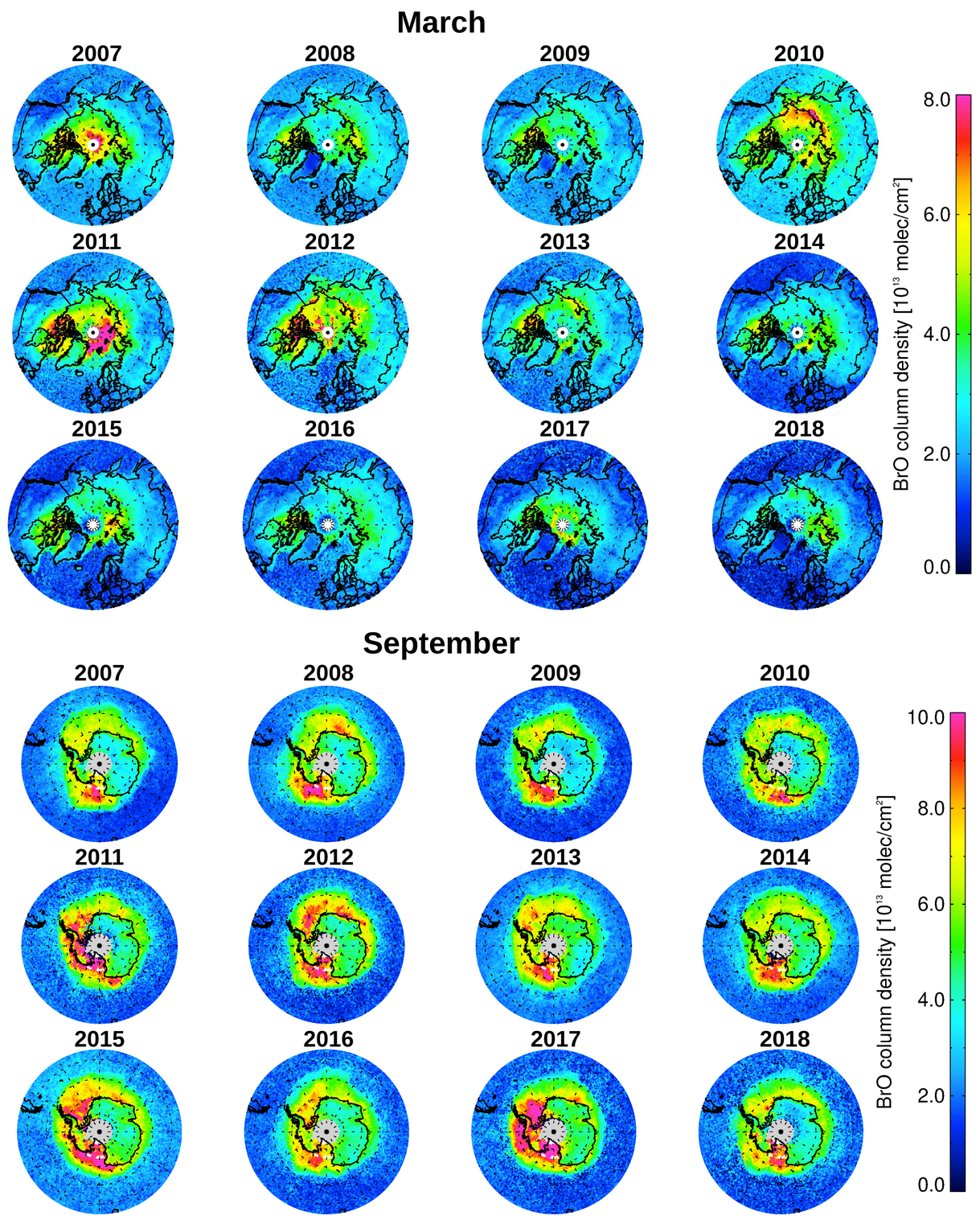
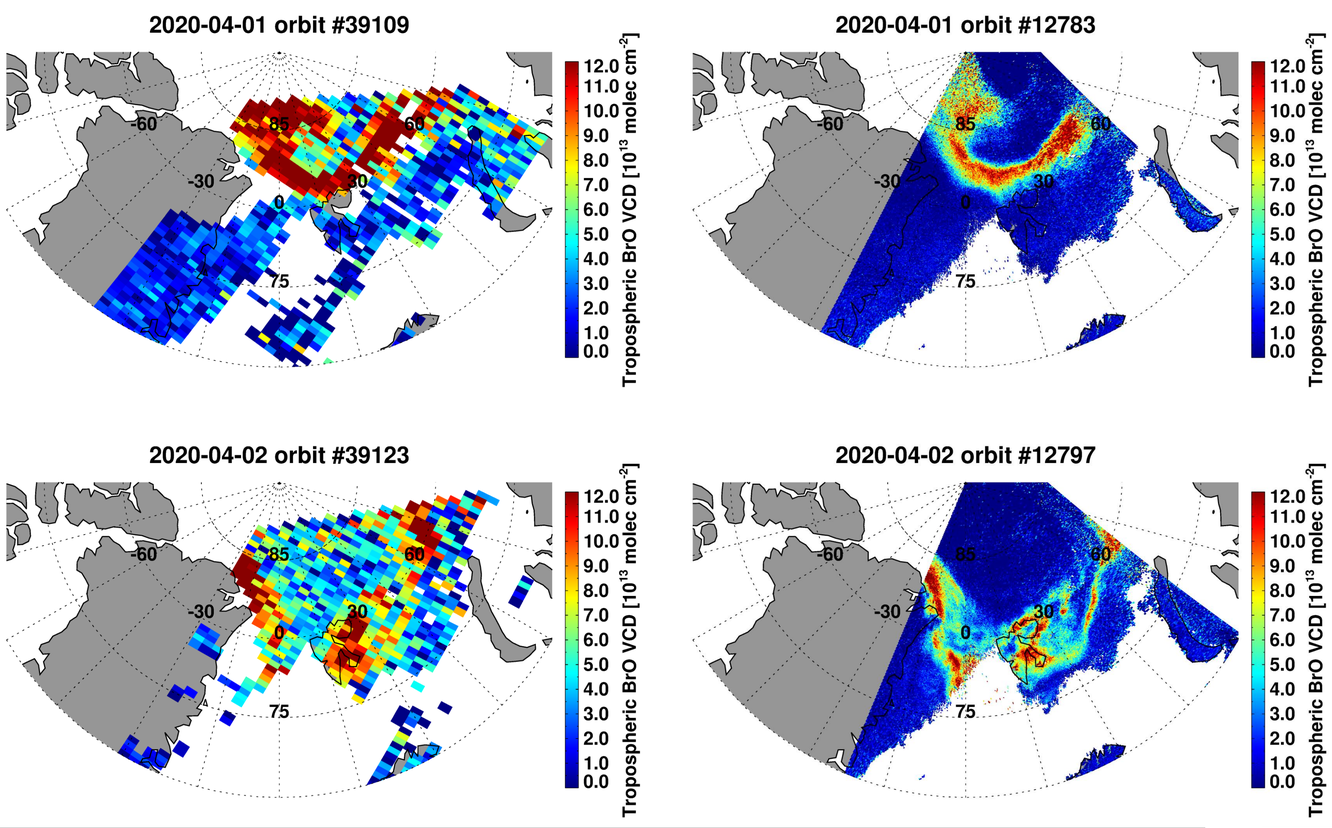


Figure 1. Monthly average of tropospheric BrO vertical columns from GOME-2 measurements for the Northern Hemisphere (upper plots) and the Southern Hemisphere (lower plots). Only data corresponding to solar zenith angles lower than 85° are used.

4. Comparison to TROPOMI and MAX-DOAS observations



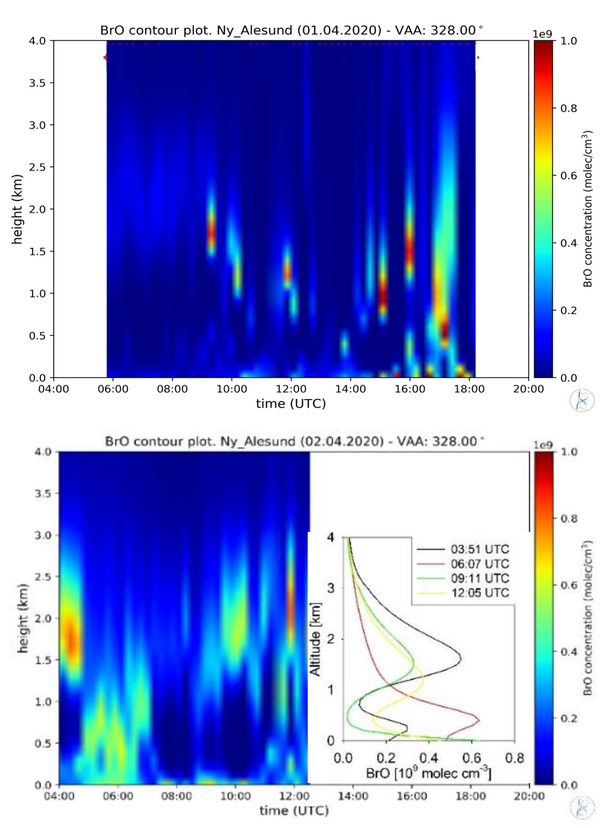


Figure 2. Tropospheric BrO vertical columns retrieved from GOME-2B (left) and TROPOMI (middle) measurements on 1 and 2 April 2020.
BrO concentration profiles from MAX-DOAS measurements at the NDACC station in Ny-Ålesund (right).

- Here, TROPOMI tropospheric BrO vertical columns are beta version results based on Seo et al., 2019.
- GOME-2 and TROPOMI show similar spatial distributions of tropospheric BrO columns in spite of the differences in instrument resolution and overpass times.
- Small scale variations of tropospheric BrO can be observed by TROPOMI with a high spatial resolution (3.5x5.5 km).

5. Conclusions and Outlook

- We have developed an algorithm for the retrieval of tropospheric BrO columns from GOME-2 instruments on Metop-A/B as part of the AC-SAF.
- This algorithm has been used to generate long-term tropospheric BrO records from GOME-2 measurements.
- The spatial distributions of tropospheric BrO columns show a good consistency between GOME-2 and TROPOMI measurements despite the difference in spatial resolution and overpassing time.
- This algorithm is planned to be applied to TROPOMI measurements for the tropospheric BrO column retrieval, which makes it possible to extend the time series and monitor the spatial variations with a high spatial resolution

6. Selected references and Acknowledgements

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- Seo, S., Richter, A., Blechschmidt, A.-M., Bougoudis, I., and Burrows, J. P.: First high-resolution BrO column retrievals from TROPOMI, Atmos. Meas. Tech., 12, 2913–2932, 2019

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