1. Introduction & Motivation

- Air temperature in the Arctic increases at a double rate compared with the worldwide mean. This phenomenon is called Arctic Amplification.
- Bromine plays a key role in the Arctic atmospheric composition. During polar spring, it is released from young sea ice, blowing snow & frost flowers, and through an autocatalytic chemical cycle known as BrO explosion (Ref 1). It depletes ozone by creating bromine oxides and consequently changes the oxidizing capacity of the atmosphere.
- BrO explosion events can be effectively studied by satellite remote sensing (Fig 2).
- Our goal is to assess the changes in the halogen atmospheric composition of the Arctic due to Arctic Amplification, by creating a consistent long-term BrO dataset, which will act as the basis for evaluating possible trends and links to drivers of tropospheric BrO.

2. DOAS Retrieval Method – Geometric Columns & Stratospheric BrO Separation

- In order to study the evolution of BrO over the Arctic, we have retrieved BrO columns from four UV – VIS remote sensing instruments using the DOAS method, which is based on Beer – Lambert’s law: \[ c = c_0 e^{-\alpha d} \]

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Platform</th>
<th>Time Period</th>
<th>Footprint</th>
<th>Equatorial Overpass</th>
<th>swath</th>
<th>Fitting Window</th>
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<tr>
<td>EAS-2</td>
<td></td>
<td>1995 – 2003</td>
<td>300 km²</td>
<td>13.30</td>
<td>960 km</td>
<td>336 – 358</td>
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<td>EASAT</td>
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<td>2002 – 2012</td>
<td>300 km²</td>
<td>10.00</td>
<td>960 km</td>
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<td>MatOp – A</td>
<td></td>
<td>2007 – Present</td>
<td>80 km²</td>
<td>09.30</td>
<td>1920 km</td>
<td>337 – 357</td>
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<td>MatOp – B</td>
<td></td>
<td>2013 – Present</td>
<td>80 km²</td>
<td>09.30</td>
<td>1920 km</td>
<td>336 – 360</td>
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- The geometric BrO vertical column is obtained by dividing the output of the retrieval (Slant Column) for each instrument with a simple geometric Air Mass Factor:

\[ \text{Average Daily Geometric VCDs of BrO over the Arctic (≈ 70° N)} \]

- To extract the tropospheric BrO column from our retrievals, we first obtain the BrO stratospheric vertical column, a model based BrO climatology is used (Ref 8), which takes as inputs satellite retrievals of NO, NO₂ and tropopause height (Ref 4, 5, 6) and gives an estimation of vertical columns of stratospheric BrO, independently of the performed BrO retrievals:

\[ \text{Stratospheric VCD Estimates of BrO over the Arctic (≈ 70° N)} \]

3. Tropospheric BrO in the Arctic & Relation to Sea Ice

- The formula that is used for the calculation of the BrO tropospheric vertical column is: \[ \text{VCD_{br}} = \frac{(\text{VCD}_{total} - \text{VCD}_{strato}))}{\text{AMF}_{total}} \]

- Tropospheric BrO maps provide additional information regarding the spatial distributions of BrO plumes; in the figure below, we see polar spring (March, April & May, MAM) mean BrO maps (merged between instruments, when we had an overlapping year) in the 1st and the corresponding mean MAM Sea ice age maps (Ref 7, 8, 9) (12th row) for every year (columns):

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<tbody>
<tr>
<td>BrO</td>
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4. Conclusions & Outlook

- A consistent long-term Arctic BrO dataset was developed, by using four UV-VIS satellite instruments
- By applying the stratospheric separation method, we extracted the first to our knowledge long-term tropospheric BrO dataset for the Arctic region
- Our tropospheric BrO time-series indicate that there is an increase of BrO explosion events over the last years
- Furthermore, we see an increase of first year ice covered regions may favor the increase of tropospheric BrO (also regarding the areas where it appears)

Future Work:
- Compare and evaluate the trends of our time-series
- Study the relationship of tropospheric BrO to meteorological drivers

5. References & Acknowledgements


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