Long-term Time-series of Arctic BrO Derived From UV-VIS Satellite Remote Sensing

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1. Introduction & Motivation

• The Arctic is warming more rapidly than every other region on the planet. This phenomenon is known as **Arctic Amplification** (Fig. 1) and it's expected to have **drastic ecological consequences**

• **Bromine** has a crucial role in the atmospheric composition; In higher latitudes, during **polar spring**, it is released from **young sea ice, blowing snow & frost flowers**, and through an autocatalytic natural process known as **BrO explosion** (Fig.2), it **depletes ozone** by creating bromine oxides and consequently **changes the oxidizing capacity** of the atmosphere

• Our goal is to **assess** the changes in the halogen atmospheric composition of the Arctic due to Arctic Amplification and **link** these changes to **meteorological drivers & sea ice conditions**

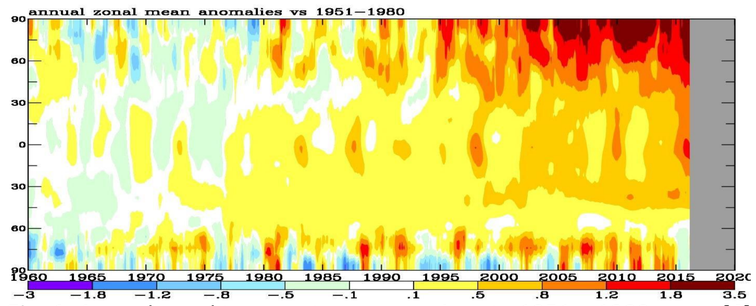


***Fig. 1**: Annual zonal temperature comparison to 1951 – 1980 mean [4]*

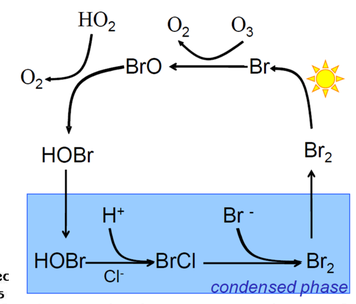


***Fig. 2**: The bromine explosion [5]*

2. BrO Time-series

• In order to study the **evolution** of BrO over the Arctic, we use **UV – VIS satellite remote Sensing** instruments

Instrument	Platform	Time Period	Footprint	Equatorial Overpass
GOME	ERS-2	1995 – 2003	320X40 km²	09.30
SCIAMACHY	Envisat	2002 - 2012	30X60 km² 30X30 km²	10.00
GOME-2A GOME-2B	MetOp – A MetOp – B	2007 – Present 2012 - Present	80X40 km² 40X40 km²	10.30
OMI	EOS - Aura	2005 – Present	13X24 km²	13.30
TROPOMI	Sentinel 5P	2017	7X7 km²	13.30

• Spring time **monthly mean total BrO VCDs** lower in 2008 compared to other years both by **SCIAMACHY** and **GOME-2A**:

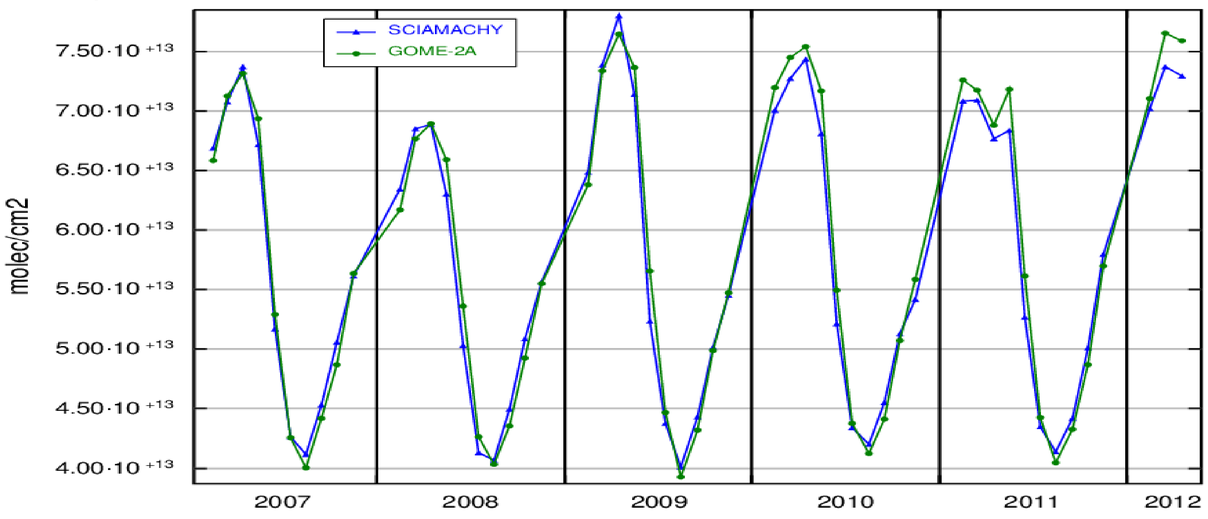


***Fig. 3**: Monthly means of total BrO vertical columns from **SCIAMACHY** and **GOME-2A** in the arctic*

• We see that BrO explosion events have become more intense (especially after 2013) in the **22 years daily total BrO vertical columns** figure:

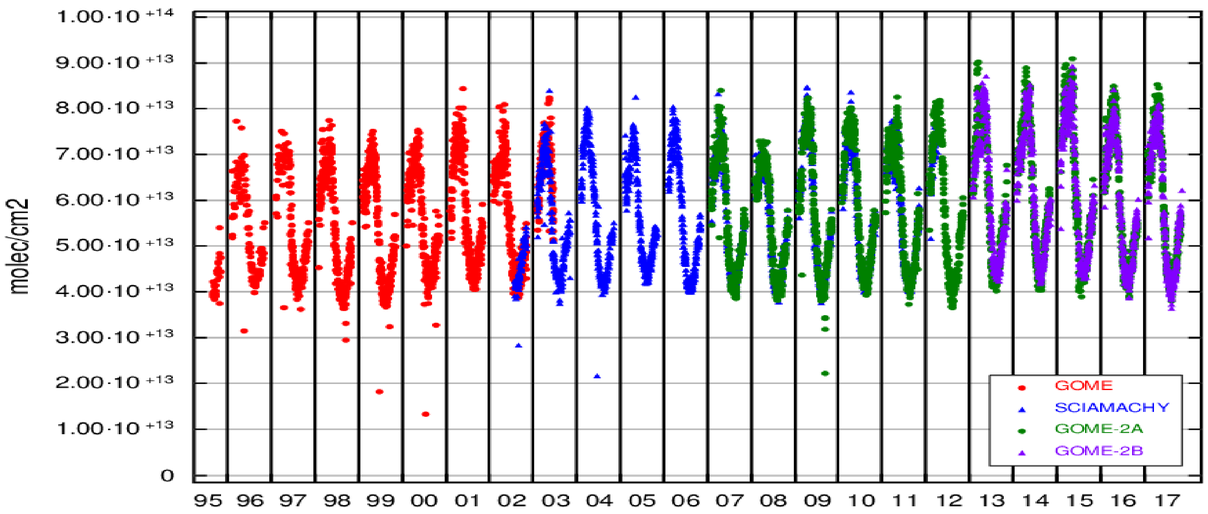
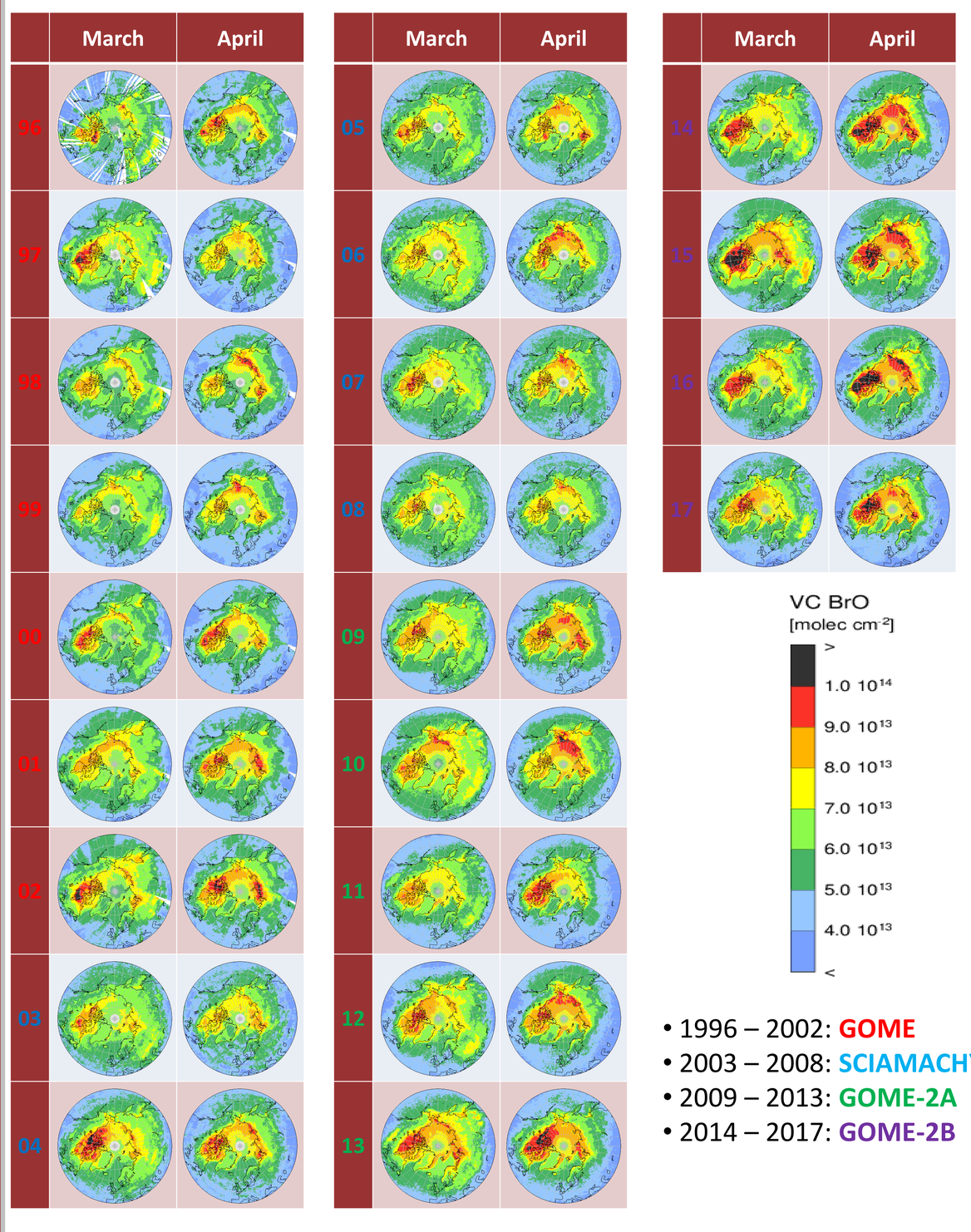


***Fig. 4**: 22 years of daily total BrO vertical columns from **GOME**, **SCIAMACHY**, **GOME-2A** & **GOME-2B** in the arctic*

3. BrO Maps

• Maps provide information not only about the **temporal evolution** of BrO, but also about the **spatial distribution of the BrO**

• We observe changes in the areas where BrO plumes appear in the long run, but also during each year in the **monthly total BrO vertical column maps** below:



• 1996 – 2002: **GOME**
• 2003 – 2008: **SCIAMACHY**
• 2009 – 2013: **GOME-2A**
• 2014 – 2017: **GOME-2B**

4. Conclusions & Outlook

• The annual cycle of total BrO vertical columns increased over the last 22 years

• Possible causes related to arctic amplification (e.g. sea ice extent decrease, higher temperatures)

• We see more BrO explosion events during April rather than March (combination of more solar radiation and young sea ice)

• Also, the areas of the events change, expanding in the last years

Future Work:

• OMI & S5P instruments should be included in our research

• Derive tropospheric BrO from total BrO VCDs

• Link long term time-series of tropospheric BrO to driving parameters of BrO explosion (e.g. sea ice, blowing snow, temperature, wind speed, cyclone frequency, phytoplankton)

5. References & Acknowledgements

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