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Validation of TROPOMI tropospheric BrO columns employing CHACHA airborne campaign measurements

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The observation of bromine monoxide (BrO) in the polar regions, in particular the study of tropospheric bromine explosion events (BEEs) during the polar spring, has been an ongoing task since the late 1980s. Since the mid-1990s, BrO has also been monitored from satellites, allowing global observation of BrO, and the large-scale tropospheric BrO plumes resulting from BEEs in polar regions. With the launch of the TROPOspheric Monitoring Instrument (TROPOMI) in October 2017, there is an instrument that enables daily high-resolution measurements of BrO. From the satellite measurements, total BrO columns are obtained. However, the total column consists mainly of stratospheric BrO and usually only a small amount of BrO is located in the lower troposphere. In order to investigate the tropospheric BEEs, a stratospheric separation method must be applied to subtract the stratospheric contribution from the total BrO column and thereby estimate the amount of tropospheric BrO.

In this study, five different stratospheric separation methods are applied to the TROPOMIBrO dataset to calculate the amount of tropospheric BrO: (1) a constant stratospheric BrO value, (2) a high pass filtering method applied in near real time processing, (3) an empirical multiple linear regression model, (4) a climatology-based method developed by Theys et al. (2011), and (5) a recently developed method for the OMPS satellite by Chong et al. (2024). The different separation methods are compared to each other and the results of all five methods are validated employing airborne tropospheric BrO measurements from the ‘Heidelberg Airborne Imaging DOAS Instrument’ (HAIDI) during the ‘Chemistry in the Arctic, Clouds, Halogens and Aerosols’ (CHACHA) campaign, which took place in Alaska in spring 2022.