NERC-funded Research Experience Placement (REPs) Summer 2025

Project title

Pan-Arctic BrO Changes in Early Spring Derived from Satellite Remote Sensing

Lead supervisor

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Project description

Reactive bromine is crucial in determining the atmospheric oxidising capacity, particularly in the polar troposphere. However, the direct source of reactive bromine remains poorly understood and debated, especially during polar spring when enhanced BrO concentrations are frequently detected. One proposed source of reactive bromine is the photochemistry of snowpack on sea ice. Therefore, changes in sea ice extent may influence the strength of bromine sources. However, our recent work (Yang et al., 2024) suggests this view may be inaccurate. This is evidenced by ground-based BrO measurements at a high Arctic site in Canada (Eureka 80 ° N) conducted with the Multi- Axis Differential Optical Absorption Spectrometer (MAX- DOAS), which showed a clear decreasing trend of BrO (between 0-4 km) in early spring during March 2018 and 2019. This phenomenon contradicts previous narratives, as Arctic sea ice typically reaches its annual peak around March, indicating no significant changes in sea ice extent are observed. We instead propose that the decreased BrO in March results from an unbalanced atmospheric bromine budget due to the difference between deposition and emission fluxes rather than solely reduced emissions. To examine whether this observed reduction in BrO is a unique phenomenon across the entire Arctic rather than a localised event, we will reanalyse the satellite remote sensing BrO (> 70 ° N) used in the Bougoudis et al. (2020) study from 1996 to 2017. The focused period will be from March to mid-April, to minimise the impact of sea ice. Additionally, we will impose strict constraints to reduce other factors (locations, solar zenith angle, and time) that may influence atmospheric BrO concentration and partitioning in the total bromine family. The result of this research will contribute to an ongoing study that may lead to a potential publication. You are expected to manage large satellite datasets, so experience in data analysis and familiarity with Python would be ideal.

Yang, X., Strong, K., Criscitiello, A. S., Santos-Garcia, M., Bognar, K., Zhao, X., Fogal, P., Walker, K. A., Morris, S. M., and Effertz, P.: Surface snow bromide and nitrate at Eureka, Canada, in early spring and implications for polar boundary layer chemistry, Atmos. Chem. Phys., 24, 5863–5886, https://doi.org/10.5194/acp-24-5863-2024, 2024.

Bougoudis, I., Blechschmidt, A.-M., Richter, A., Seo, S., Burrows, J. P., Theys, N., and Rinke, A.: Long-term time series of Arctic tropospheric BrO derived from UV–VIS satellite remote sensing and its relation to first-year sea ice, Atmos. Chem. Phys., 20, 11869–11892, https://doi.org/10.5194/acp-20-11869-2020, 2020.

Project restrictions

You will work on a large amount of satellite datasets, thus a strong background in the natural sciences - particularly chemistry, physics, computing or mathematics is welcome but is not necessary. Experience in data analysis using visualisation software such as Python is ideal.

Working arrangements

This project is primarily computer-based; therefore, it can be done remotely but only for a small portion of the total time. You are expected to join the weekly group meeting (the tropospheric chemistry group) and are welcome to attend relevant seminars and the Atmosphere, Ice and Climate (AIC) team meetings.