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Inorganic and organic bromine measurements around the extratropical tropopause: Insights into total stratospheric bromine

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Bromine greatly influences the UT/LS ozone concentrations, however the transport of bromine across the tropical tropopause layer and in particular across the extratropical tropopause is not well quantified. Air-borne measurements of atmospheric trace gases such as organic and inorganic bromine along the tropopause are studied during the WISE (Wave-driven ISentropic Exchange) research campaign over the northern Atlantic and western Europe from September 13 - October 21, 2017. The remote sensing instrument mini-DOAS (Differential Optical Absorption Spectroscopy) is mounted on the HALO (High Altitude and Long range) aircraft and measures BrO (O₃, NO₂ among other trace gases). The novel scaling method is applied to infer the target gas BrO mixing ratios from slant column densities using in-situ O₃ measurements from the FAIRO instrument (operated by KIT) as the scaling gas. For each flight, the inferred mixing ratios are directly compared with CLaMS (Chemical Lagrangian Model of the Stratosphere) simulated curtains of the trace gases along the flight path. The partitioning coefficient of inorganic bromine from CLaMS and all relevant organic halogen species and air mass ages (SF₆, CO₂) from the GhOST-MS instrument (operated by UFra) are used to determine the total bromine budget along the UT/LS. A climatology of organic, inorganic and total bromine is constructed with respect to the extratropical tropopause as well as the air mass ages. This indicates the interplay of bromine transport across the extratropical tropopause and of the transport of air via the lower branch from the tropics as well as potential losses of inorganic bromine by uptake onto and sedimentation of ice particles.