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Spatial and temporal variability of inorganic halogen sources and sinks over the marine boundary layer and free troposphere

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Very Short-Lived (VSL) Halogens are primary organic compounds that are mainly emitted to the atmosphere from the biologically productive regions of the oceans, where the rapid and permanent vertical transport can uplift halogen-rich air-masses above the Marine Boundary Layer (MBL) well into the Free Troposphere (FT). Depending on the changes of convection strength, the regional distribution of oceanic sources, and the seasonality of the VSL photochemical losses, the release of inorganic halogen atoms from their initial organic sources due to reaction with OH and/or photolysis, can present a pronounced spatio-temporal variability. In addition, depending on the height and background where the initial inorganic halogen atoms are released, an additional atmospheric halogen source arising from the efficient halide uptake occurring over sea-salt aerosols (the so-called SSA-dehalogenation) enhances the total tropospheric halogen loading. Given the variable solubility and washout efficiency of the different gas-phase halogen species, considering their instantaneous partitioning, as well as their individual sinks for different in-cloud, below-cloud and clear-sky conditions, is of major importance to determine the total inorganic halogen budget within the MBL and FT. In this work, we present a modeling study performed with the state-of-the-art CAM-Chem model, oriented to determine the vertical, geographical and temporal distribution of the inorganic halogen sources and sinks on the global troposphere, distinguishing between the different regimes prevailing between tropical and high-latitude regions, as well as the distinctive behavior controlling the day/night and seasonal variability. A species-by-species inter-comparison for the VSL Chlorine, Bromine, Iodine families is presented, distinguishing the dominant sources, sinks and photochemical channels controlling the halogen burden at different heights, and highlighting the commonalities and differences existing among the chlorine, bromine and iodine families.