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Swiss Emissions of Halogenated Greenhouse Gases derived from Atmospheric Measurements at Beromünster

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Synthetic halocarbons reach the atmosphere due to a wide range of anthropogenic activities. They are, for example, used as propellants in foam blowing or as cooling agents in refrigeration and air conditioning. Long-lived halocarbons act as strong greenhouse gases. They are responsible for about 11% of the radiative forcing by long-lived greenhouse gases (LLGHGs). In addition, chlorinated or brominated halocarbons contribute to stratospheric ozone depletion. There are only two in situ long-term measurement programs, operated by the Advanced Global Atmospheric Gases Experiment (AGAGE) and the National Oceanic and Atmospheric Administration (NOAA) that monitor the worldwide abundance of halocarbons in the atmosphere. Based on these observations, halocarbon emissions are estimated by top-down box- or inverse modelling approaches on a global to transnational scale. However, to capture regional pollution sources and to validate country-specific bottom-up emission estimates by top-down methods, additional regional-scale measurements are required.

We present the first continuous halocarbon measurements at the Beromünster tall tower, representing the most industrialized and densely populated area of Switzerland, the Swiss Plateau. During one year, high precision, high accuracy atmospheric measurements were performed with the analytical setup of the global AGAGE network. This involves sample pre-concentration at low temperatures (down to -180 ^{o}C), and analyte separation and detection by gas chromatography and quadrupole mass spectrometry. All halocarbon compound classes of the Montreal and Kyoto Protocols are covered by our measurements. This includes the banned chlorofluorocarbons (CFCs) and halons, the regulated hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), as well as the recently introduced unregulated hydrochfluoroolefins (HFOs). The results improve our understanding of important source areas in Switzerland, and, for the first time offer the possibility to robustly quantify Swiss national halocarbon emissions with observation-based top-down methods, i.e. the tracer ratio method and Bayesian inverse modeling.