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Global and regional emission estimates for three ozone-depleting hydrochlorofluoro-carbons (HCFCs) with no known end-uses

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We present first results on atmospheric abundances and inferred emissions of the previously undetected ozone depleting hydrochlorofluorocarbon HCFC-132b (1,2-dichloro-1,1-difluoroethane). In addition we report significant updates on observations and inferred emissions for HCFC-133a (2-chloro-1,1,1-trifluoroethane) and HCFC-31 (chlorofluoromethane). All three compounds are Ozone Depleting Substances (ODSs) and their productions are regulated under the Montreal Protocol on Substances that Deplete the Ozone Layer. However, they are not known as end-user products from which potential emissions to the atmosphere could occur. Rather, we hypothesize that the compounds are emitted as byproducts during the production of hydrofluorocarbons (HFCs). If this holds true, then the phase-out regulations of the Protocol do not apply to them, nevertheless the Protocol's overarching Vienna Convention encourages the parties to minimize such ODS byproduct emissions.

In-situ fully intercalibrated high-precision measurements of the recently discovered HCFC-132b have been made for several years at the stations of the Advanced Global Atmospheric Gases Experiment (AGAGE) and are complemented with measurements from archived air samples (1978 – present) of the Cape Grim Air Archive. Based on these measurements we reconstruct global HCFC-132b trends showing its first appearance in the atmosphere in the late 1990s, followed by a general growth in the atmosphere to current globally-averaged mole fractions of approx. 0.13 ppt (picomol mol^{-1}). Global emissions, which are derived from these observations using the AGAGE 12-box model, show a general increase to approx. 1 Gg yr^{-1} in 2019. Observation-based top-down regional emission estimates for the East-Asian region, as derived from a Bayesian inversion with the FLEXPART Lagrangian model, can explain all of the global emissions within the uncertainties of the method. Half of these emissions are allocated to Eastern China, a region where enhanced emissions for other ODSs were previously found. Emissions from Europe are comparably insignificant, but an analysis of the source locations supports the hypothesis that HCFC-132b emissions are a byproduct from HFC production. In addition to HCFC-132b, we present significant updates on observations of HCFC-133a and HCFC-31. HCFC-133a measurements are now fully integrated into the AGAGE network and provide a wealth of atmospheric observations. Similar to HCFC-132b, we show, for example, that abundances and global emissions of these two compounds have generally increased over the last few years.

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