Top-down estimation of European halocarbon emissions with four independent inversion systems (INGOS Task 15.5)

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Halogenated organic compounds in the atmosphere are mostly synthetic products of the chemical industry designed for a wide range of applications. Due to their ozone depletion potential (ODP) the chlorine and bromine containing compounds have been banned or regulated under the Montreal Protocol. Hydrofluorocarbons (HFC), which are free of chlorine or bromine, have been introduced as a replacement for ozone depleting CFCs and HCFCs. While being not harmful for the ozone layer, HFCs are often strong greenhouse gases and therefore have been regulated under the Kyoto Protocol.
In this study we summarize the results of Task 15.5 of the EU project INGOS which was dedicated to top-down estimation of European halocarbon emissions. We applied four state-of-the-art independent inverse modeling systems to quantify European emissions of HFC-134a and HFC-125, the two most relevant HFCs in terms of their present-day radiative forcing, as well as emissions of SF_6. Measurements were obtained from the two mountain sites Jungfraujoch and Monte Cimone and the coastal background site Mace Head.
Four different model experiments have been conducted with the aim to (i) compare different state-of-the-art inversion approaches, (ii) obtain a more robust estimate of the uncertainties of the results than possible with a single inversion system only, (iii) better understand the capabilities and limitations of the current observation and modeling framework for halocarbons in Europe, and (iv) independently evaluate officially reported emissions.
The results indicate that emissions can be quantified for a subset of European countries to a level of accuracy that is sufficient to challenge current bottom-up estimates and to identify major shortcomings in current emission inventories. However, the results also indicate that the spatial distribution of emissions is not well constrained by the currently sparse observation network and that the model results are sensitive to the treatment of background concentration levels and a priori uncertainties and to the choice of atmospheric transport model.