

Name of research institute or organization:

EMPA Dübendorf, Swiss Federal Laboratories for Materials

Title of project:

Monitoring of halogenated greenhouse gases

Project leader and team:

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Project description:

Abstract

In this project the Central European emissions of a wide range of halogenated greenhouse gases are investigated by high-quality measurements at the High Alpine Research Station Jungfrauoch. The dominant European source regions of the individual trace gases are identified and quantified by meteorological models. Within an EU-project, designed in the course of this project, a European network consisting of four monitoring stations has been developed in order to observe the emissions of these greenhouse gases from entire Western Europe. This approach has the potential to control compliance of European countries with important international protocols (Montreal, Kyoto).

Background

Halogenated gases are important industrial products, which are used in a wide variety of applications, such as refrigeration, foam blowing, cleaning and fire extinction. Many of these halocarbons are very persistent in the environment and therefore accumulate in the atmosphere. They act as greenhouse gases and contribute to the radiative forcing of the atmosphere depending on their emissions, their atmospheric lifetimes and their infrared-absorption coefficients.

With regard to their environmental impact the halogenated substances can be divided into two groups. First, substances containing chlorine and bromine (i.e. chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halones and long-lived chlorinated solvents), which are responsible for the depletion of the stratospheric ozone layer. They are regulated under the Montreal Protocol and will be banned in 2010. Second, fluorocarbons (i.e. hydrofluorocarbons (HFCs), perfluorocarbons (PFCs)), and SF₆, which do not affect the earth's ozone layer. These compounds often have long atmospheric lifetimes and are listed, among carbon dioxide, methane and nitrous oxide in the Kyoto Protocol as anthropogenic greenhouse gases. Halocarbons in total are estimated to be responsible for about 14% of the radiative forcing of all anthropogenic greenhouse gas emissions.

Results

In January 2000 we began to measure halogenated greenhouse gases continuously by gaschromatography-mass spectrometry (GCMS) at the High Alpine Research Station Jungfrauoch. The instrument is designed to monitor the increasingly important fluorocarbons in ambient air, which was not possible with previous analytical methods. The instrument is one of only five units of this type worldwide. Four instruments (Monte Cimone, Italy; Spitsbergen, Norway; Jungfrauoch, Switzerland; and Mace Head, Ireland) were combined in the network of the EU-project SOGE (System

for Observation of Halogenated Greenhouse Gases in Europe) with the aim to model the emissions of halogenated greenhouse gases of large parts of Western Europe. Additionally, the measurement at the Jungfraujoch is used for the Swiss National project HALCLIM, with the aim of estimating the Swiss emissions of these gases.

The 3 years of measurement data of the different halocarbons show a stabilization of the concentrations of Montreal Protocol regulated substances, whereas the newer HFCs exhibit a rapid growth in their atmospheric concentrations. As an example for an important hydrofluorocarbon, Fig. 1 shows the increase of the atmospheric background mixing ratio of refrigerant HFC 134a, the major replacement product for the forbidden CFC 12. Remarkably, deviations from the background concentration are higher in the data series from the Jungfraujoch than in those from Ireland and Spitsbergen. This is due to the vicinity of the Jungfraujoch to the most important European source regions.

By combining measurements at Jungfraujoch with backward trajectories in a statistical model, potential source regions can be detected. Thus, in Fig. 2 potential source regions and their temporary evolution are shown. Thereby, a decline in the source strength of the cooling agent HFC 134a has been observed in Southern Europe within the last 2 years. On the other hand, source strengths of the foam propellant HFC 152 have been increased considerably over Europe in the same time period.

In future the modeling activities at the four SOGE stations will be combined in order to reach an integral and quantitative emission source allocation over Europe.

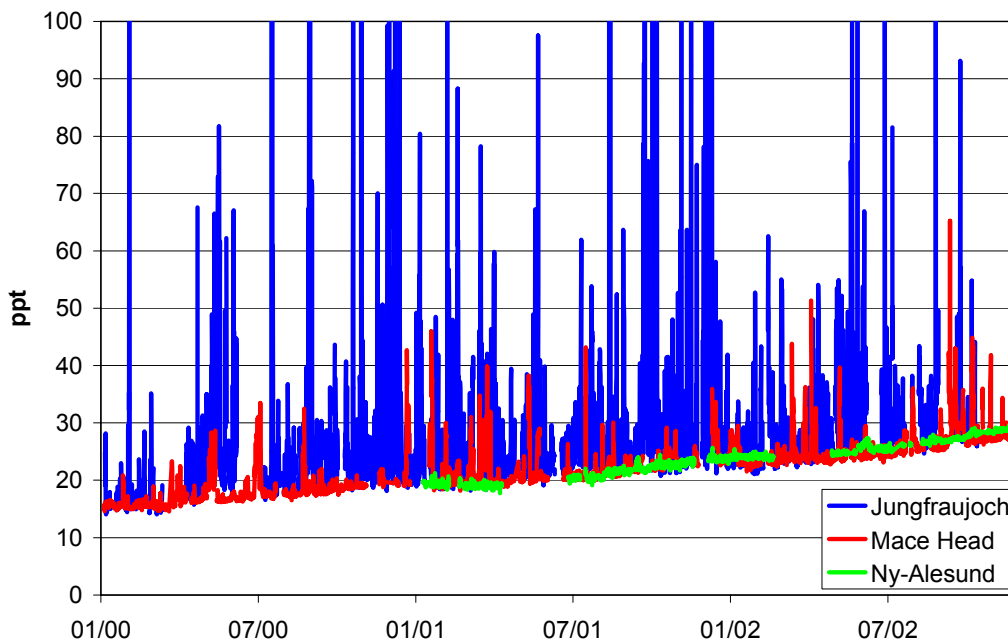


Fig. 1: Data series of the refrigerant HFC 134a at the European background sites of Jungfraujoch, Mace Head (Ireland) and Ny-Alesund (Spitsbergen).

Scientific publications and public outreach 2002:

Conference papers

Reimann, S. et. al. Emission estimates of halogenated greenhouse gases by analysis of on-line measurements at a high Alpine station (Jungfraujoch), EUROTRAC conference proceedings Garmisch-Partenkirchen, Germany, 2002.

Reimann, S. et. al. Estimated emissions of halogenated greenhouse gases by analysis of on-line measurements at a high Alpine station (Jungfraujoch), Conference on Non-CO₂ Greenhouse Gases, Den Haag, Netherlands, 2002.

Reimann, S. et. al. Ambient air measurements of halogenated greenhouse gases at Jungfraujoch as a tool for verification of their anthropogenic emissions, IGAC meeting, Crete, Greece, (2002).

Buchmann, B. et al. Analyses of halogenated greenhouse gases at Jungfraujoch for allocation of European sources, Proc. Workshop on 'Atmospheric Research at the Jungfraujoch and in the Alps', Davos, Switzerland, 20 September 2002, Swiss Academy of Sciences SAS, 2002.

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