System for Observation of Halogenated Greenhouse Gases in Europe (SOGE):

Observations from four European stations, model studies and expansion of the network

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The four SOGE network stations

The European **SOGE** (System for Observation of halogenated Greenhouse gases in Europe) network builds on a combination of observations and modelling. The observations are firstly surface in situ data collected continuously for a range of CFCs, HCFCs and HFCs at four background stations; Mace Head (Ireland), Ny-Ålesund (Spitzbergen), Jungfraujoch (Switzerland) and Monte Cimone (Italy). Key elements in SOGE are harmonisation of time series, and quality control procedures. The second observational component of SOGE is vertical column measurements, which are made at two of the network sites, namely Jungfraujoch and Ny-Ålesund. The in situ and column measurements are combined to determine trends in the concentrations. The SOGE observations are interpreted and exploited with various model tools. One application is to verify emissions of the measured substances in Europe down to a regional scale. This is obtained e.g. by the use of models labelling air-parcels with their location and time of origin, so it is possible to identify the various sources that contribute to the concentrations measured at the network sites and quantify their relative contributions. The results can be used to assess compliance with the international protocols regulating the emissions. Finally, global Chemistry Transport Models (CTM) and Radiative Transfer Models (RTM) are used to estimate impacts of the observed compounds on climate change and the ozone layer. The impacts are evaluated in terms of radiative forcing and Global Warming Potential (GWP), and ozone destruction and Ozone Depletion Potential (ODP), respectively. ■

Observations

High resolution in situ instruments

SOGE builds upon data from halocarbon concentrations measured continuously in situ at four background stations (see cover page).

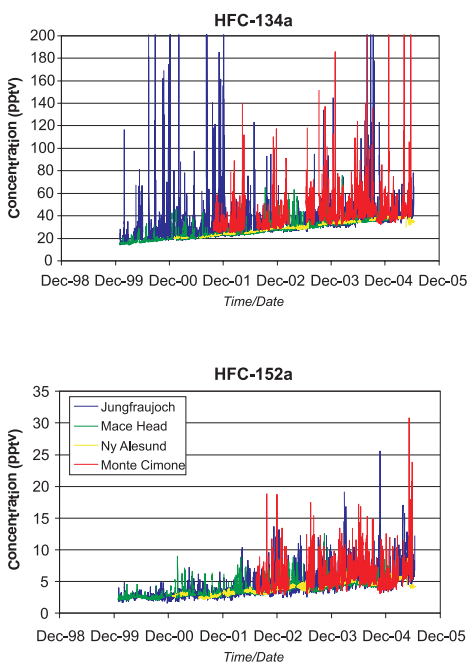
These measurements are part of national observational programs funded elsewhere. Furthermore, some stations operate in the wider context of the global monitoring network AGAGE.

Key elements in SOGE are the harmonisation of these time series, and the quality control procedures to ensure a consistent dataset. For some species (PFC, SF_6), an instrument for high-frequency measurements has been developed.

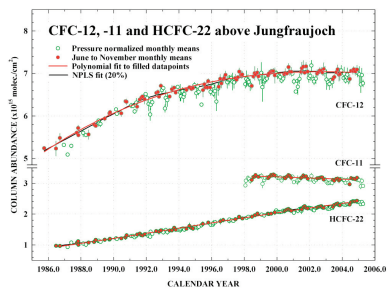
Column observations

Two FTIR spectrometers are included in the project, Jungfraujoch and Ny-Ålesund, measuring column abundances of halogenated trace gases such as CCl_2F_2, $CHClF_2$ and SF_6. These vertical column abundances are converted into local ground-based concentrations at both sites. The historical FTIR measurements have been converted into local ground-based concentrations. This has allowed to establish surface concentrations of a number of halogenated greenhouse gases in Europe well before the in situ measurements were started.

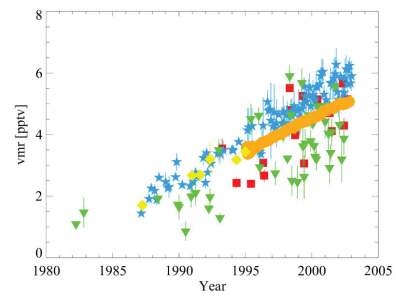
This provides a link to the Network for the Detection of Stratospheric Change (NDSC).



Increase in tropospheric HFC-134a (above) and increase in tropospheric HFC-152a (below) observed at SOGE GC-MS stations.



CFC-12, CFC-11, and HCFC-22 monthly mean time series at Jungfraujoch measured in SOGE.



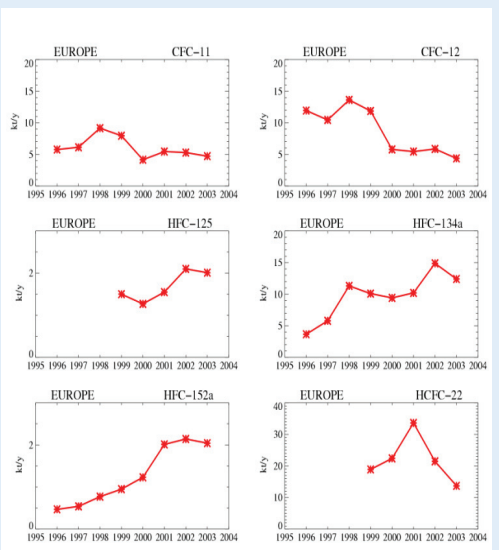
Concentrations of SF6, derived from column measurements above Ny-Ålesund (squares), Jungfraujoch (stars) and Kitt Peak (triangles). Additionally the in situ measurements from CMDL (circles, from www.cmdl.noaa.gov) averaged above the northern hemisphere and other values from the literature (diamonds) are attached.

Modelling

Emission-observation relation

Best estimates for emissions of several target species have been derived from databases maintained by industry, regulatory bodies and publications. The high temporal resolution in situ data from the four stations are used in combination with dispersion models to develop a system tracing the origin of the observed compounds. This allows an evaluation of the emissions derived in the project and comparison with emission inventories provided by European countries. Such an integrated observation/modelling system has proven reliable and useful for several compounds and offers a unique opportunity to monitor the compliance with the Montreal and Kyoto protocols.

The dispersion model has quantified the European emission source strengths of approaching 20 individual halocarbons and greenhouse gases required to support the observations made. The availability of high quality, high temporal resolution time series from four stations allows to identify episodes of long-range transport from a large part of Europe.



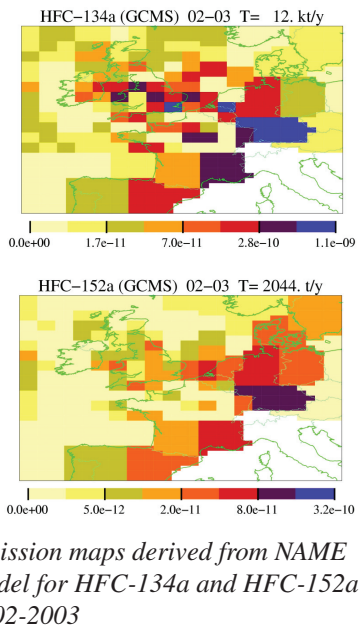
Trends of European source strengths derived from the NAME model and inversion algorithm

Impacts on climate and ozone

Climate impacts are firstly calculated on the basis of radiative forcing. The main emphasis is to calculate the global contribution to the present radiative forcing for each of the halogenated greenhouse gases and derive the total radiative forcing due to these substances. The European contribution to the radiative forcing is further estimated from the European emission and the global emission for each component.

Global Warming Potentials (GWP) are also calculated. This requires estimates of the atmospheric lifetimes of the components. In this project a global 3-dimensional chemical transport model (CTM) has been used for this purpose.

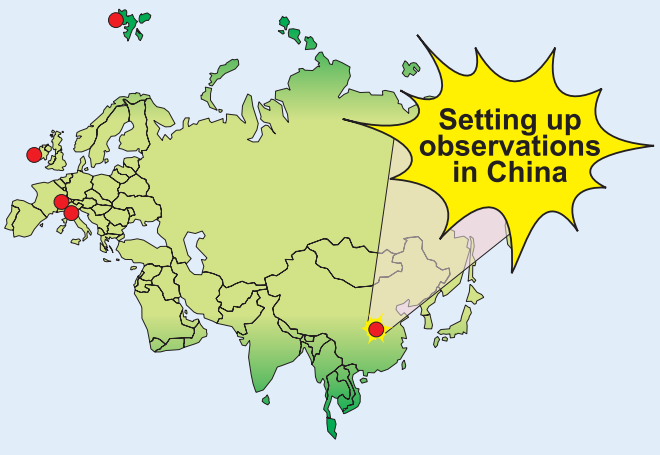
Impacts on the ozone layer are calculated. The main emphasis is to calculate the global contribution to the present ozone depletion for each of the halocarbons and derive the total ozone depletion. The European contribution to the ozone depletion is further estimated from the European emissions and the global emission for each component. Ozone Depletion Potentials (ODP) are also estimated.



Emission maps derived from NAME model for HFC-134a and HFC-152a in 2002-2003

Expanding the network to China

The SOGE network will be expanded to include a measurement station in China. Continuous measurements of several halogenated species will be made at an atmospheric research station. The aim is to infer emsissions of compounds regulated by the Montreal and Kyoto protocols in parts of China. The modelling tools which are used in SOGE in Europe for this purpose will be applied to the obervations in China.



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