Quasi-continuous CH_4, N_2O, and SF_6 measurements at the high Alpine site Jungfraujoch: influence of transport processes and emissions estimates

EMPA
Materials Science & Technology

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Outline

Long-term quasi-continuous ground based *in-situ* observations of greenhouse gases at the Jungfraujoch allow trend analyses, investigations of transport processes as well as evaluations of the success of air pollution reduction strategies and emission estimates, e.g. for an independent verification of compliances of the Kyoto and Montreal Protocols.

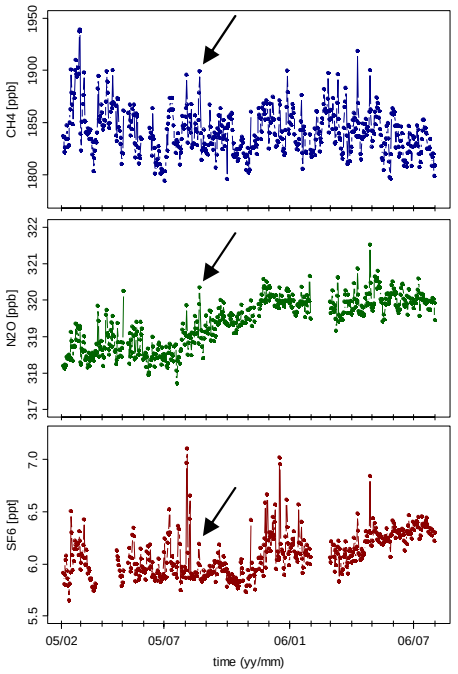
Study site / data availability

Besides our halocarbon (CFCs, HCFCs, HFCs) measurements that are running since 2000, we commenced quasi-continuous measurements of methane, nitrous oxide and sulphur hexafluoride at the high-Alpine research station Jungfraujoch (3580 m a.s.l.) in February 2005 to complete our data set of non-CO_2 greenhouse gases.

Time series

Analyses of data from February 2005 to August 2006 show:

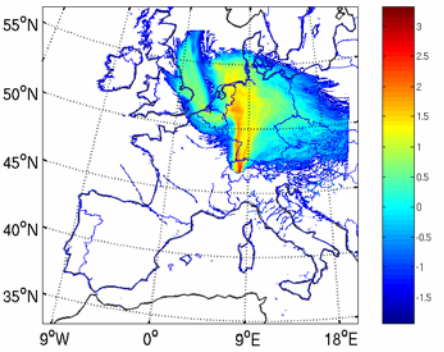
- a small seasonal cycle and no positive trend but some pollution events for CH_4
- a small seasonal cycle, a positive trend and little pollution episodes for N_2O
- no seasonal cycle, a positive trend and some distinct pollution episodes for SF_6



Time series of daily mean CH_4, N_2O and SF_6 mixing ratios at the Jungfraujoch.

Case study – August 22, 2005

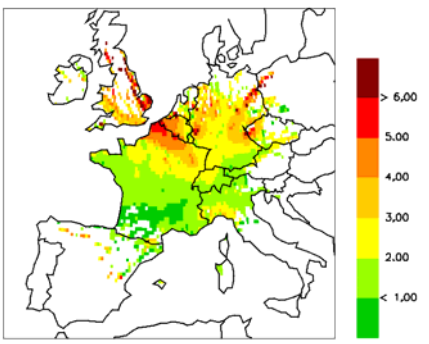
Pollution events are occasionally observed due to location of the Jungfraujoch in central Europe and its proximity to anthropogenic source regions. Backward trajectories and a Lagrangian Particle Dispersion Model (LPDM) in backward mode are used to investigate air mass origins and transport processes, especially during such pollution events. The Figure below shows the footprint derived from the LPDM for a pollution episode with enhanced CH_4, N_2O and SF_6 (marked with arrows in the time series). Strong advection from the boundary layer in Germany led to the observed concentration increases.



Footprint for Jungfraujoch on August 22, 2005.

Source apportionment

We identify pollution events and combine our continuous measurements with concurrent air mass trajectories to allocate specific European source regions in Central Europe for individual non-reactive gases. The Figure below shows the potential source regions for SF_6 for 2005. The major SF_6 emissions are the use in gas insulated switchgears and in blanketing or degassing molten aluminium and magnesium [1].

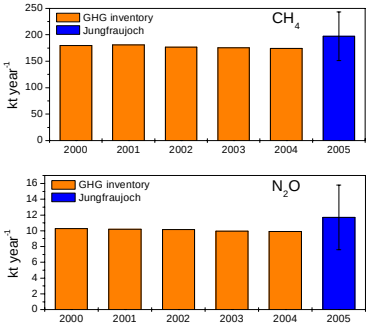


Potential SF_6 source regions resulting from trajectory statistics for 2005.

We find the major source regions in western Germany, northern France and Belgium in contrast to the potential source regions of most of the halocarbons that are mostly situated in northern Italy [2]. Since certain advection regimes are more frequent than others resulting in some underrepresented areas, the extension to longer time periods and the combination of several stations could lead to more representative results.

Estimates of Swiss emissions

The Figure below illustrates estimates of the Swiss emissions of the Kyoto Protocol targeted greenhouse gases CH_4 and N_2O. Our estimates in blue are based on measured trace gas ratios to carbon monoxide during pollution events. These ratios allow - under the assumption of known CO emission sources for Switzerland – an independent experimental verification of other reported emissions. Our results for 2005 agree well with the Swiss greenhouse gas inventory based on economic data that is provided by the Swiss Federal Office for the Environment according to UNFCC and IPCC guidelines [3].



Estimates of the Swiss emissions of CH_4 and N_2O according to the Swiss greenhouse gas inventory and Jungfraujoch measurements.

Conclusions

The Empa activities at the Jungfraujoch comprise perennial long-term measurements of trace gases, trajectory analyses and the consideration of existing emission inventories. The combination of these approaches allowed to identify

- positive trends for N_2O and SF_6, no significant trend for CH_4
- the major potential source regions for SF_6 in western Germany, Belgium and northern France
- a good agreement of measurement-derived emission estimates with reported emissions

Outlook

Future improvements are planned to achieve by

- applying an improved background/pollution event determination
- the extension of the analysis to longer time series
- the integration of other sampling sites in Europe to get more representative source apportionments

References

[1] Maiss & Brenninkmeijer (1998), EST, **32**, 3077-3086.
[2] Reimann et al. (2004), JGR, **109**, D05307.
[3] www.climatereporting.ch; provided by FOEN.

Acknowledgements

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