Name of research institute or organization:

Empa – Swiss Federal Laboratories for Materials Testing and Research

Title of project:

National Air Pollution Monitoring Network (NABEL)

Project leader and team:

Martin Steinbacher, Martin K. Vollmer, Stephan Henne, Stefan Reimann, Christoph Hüglin (project leader)

Project description:

The National Air Pollution Monitoring Network NABEL is a joint project of the Swiss Federal Office for the Environment (BAFU/FOEN) and Empa. The NABEL network was established in 1978 with initially 8 sites emerging from activities that started already in 1968 as contributions to international observations networks as part of WMO and OECD. In-situ measurements by Empa at Jungfraujoch started in 1973. Early activities mainly focused on sulfur dioxide and particulate matter. In 1990/1991 the NABEL network was extended to 16 monitoring stations that are distributed all over Switzerland. The monitoring stations represent the most important air pollution levels from curbside to remote free tropospheric background. The NABEL site at Jungfraujoch is a very little polluted site, representing a background station for the lower free troposphere in central Europe.

The current measurement program at Jungfraujoch includes continuous *in-situ* analyses of ozone (O_3), carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), the sum of nitrogen oxides (NO_y) and sulfur dioxide (SO_2). The concentrations of methane (CH_4), nitrous oxide (N_2O), molecular hydrogen (H_2), and sulfur hexafluoride (SF_6) are measured in 30 min intervalls. An extended set of halocarbons and a selection of volatile organic compounds (VOCs) (alkanes, aromatics) are measured with a time resolution of two hours. Daily samples are taken for determination of particulate sulfur. The concentrations of particulate matter < 10 μm (PM10) are continuously observed as well as measured as 24-hour bulk samples.

Figure 1 shows the time series of CH_4 mixing ratios at Jungfraujoch from early 2005 to the end of 2008. Methane is the second most important greenhouse gas and exhibited significant growth rates until the end of the 1990s due to anthropogenic sources. This lead to a triplication of the atmospheric CH_4 concentration since pre-industrial times. Since about 2000 a period of rather constant CH_4 levels has been observed. No significant trend can be observed for the first three years of the observation period at Jungfraujoch. More recent data point to a slight increase in CH_4 at Jungfraujoch in agreement to the latest observations at other remote sites that detected a renewed growth of atmospheric methane since early 2007 (Rigby et al., Geophys. Res. Lett, 2008). The reasons for this global increase in CH_4 are still uncertain, especially because it is a global phenomenon with simultaneous growth in both hemispheres. It is also still unclear if this latest increase is only a short-term episode or the beginning of a continuing growth. The data gap at Jungfraujoch in June 2008 was caused by an instrument failure. Low concentrations after the restart of the

measurements are due to atmospheric variablity as confirmed by other trace gases and CH_4 time series at other sites.

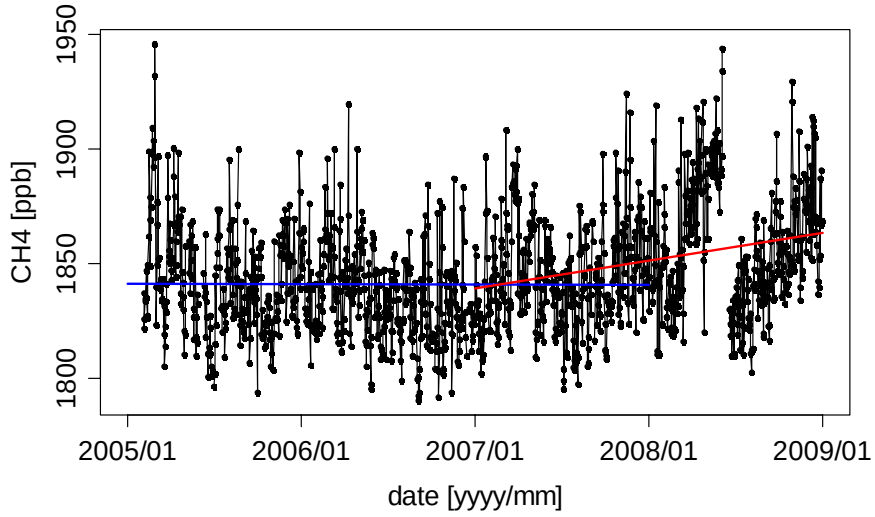

Figure 1: Time series of daily mean CH_4 mixing ratios at Jungfraujoch (preliminary data). The blue and red line illustrate the linear regression for the 2005-2007 and the 2007-2008 period, respectively.

The hourly averaged data reveal that the CH_4 mixing ratios are closely correlated with short-term changes in atmospheric CO (see Figure 2) and points to the influence of collocated sources and sinks on the concentrations of these two trace gases. This legitimates the application of the so-called tracer-ratio technique for emission estimates, that relates measurements of a substance with an unknown source to concurrent measurements of a substance with a known source. This requires a-priori information of the emission inventory of one compound. Most commonly,

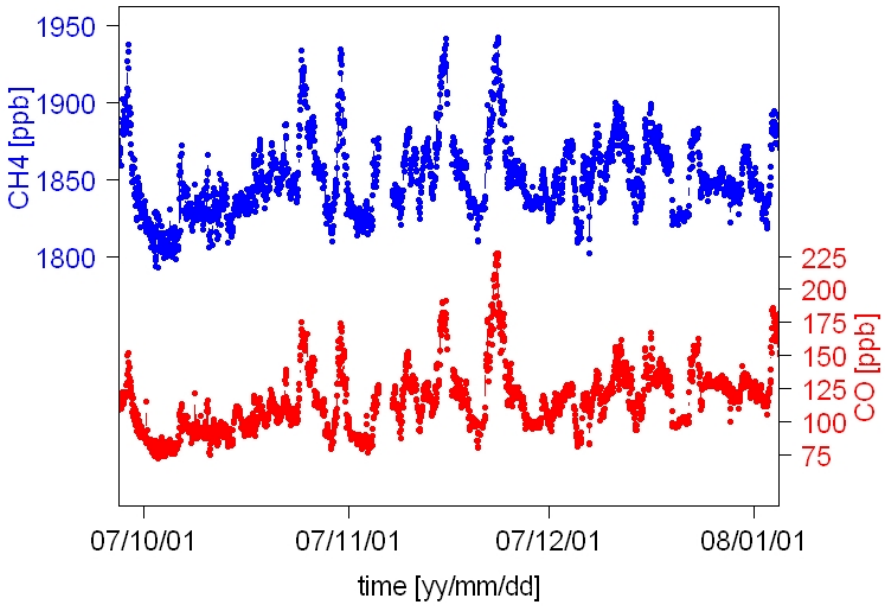

Figure 2: Time series of hourly mean CH_4 and CO mixing ratios at Jungfraujoch for October to December 2007 (preliminary data).

CO is used as known source as the reported emissions of this species are known with relatively small uncertainty. Estimates of regional source allocations can be determined when combining this approach with air mass back-trajectory analysis to select episodes predominantly influenced by boundary layer air from specific countries (Switzerland, Italy (I) , France (FR) and Germany (DE)). Pollution events were detected by applying a statistical background determination algorithm. Tracer-ratios are assigned to Switzerland and other countries if the air mass' residence time in the country's atmospheric boundary layer (ABL) is > 10 hours (CH) and > 8 hours (IT, FR, DE) and if it contributes to > 75% (CH) and > 66% (IT, FR, DE) of the total ABL residence time over Europe. The results finally allow an independent experimental verification of reported emissions such as the National Inventory Reports on Greenhouse Gases to the UNFCCC. Figure 3 illustrates estimates of CH_4 emissions.

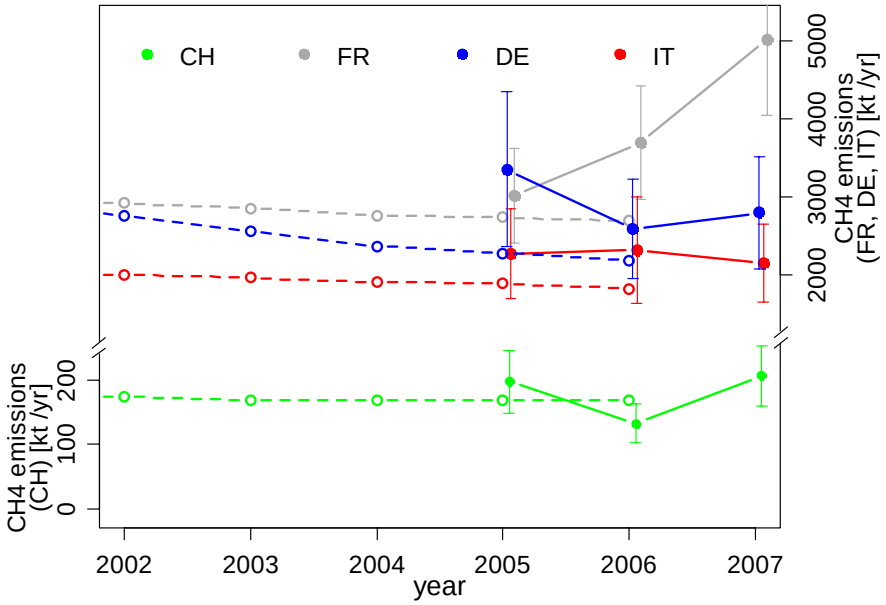

Figure 3: Estimates of the European emissions of CH_4 according to the National GHG inventories (open circles) and Jungfraujoch measurements (filled circles).

Our results agree reasonably well with the National Inventories reported to UNFCCC based on economic data. However, the experimentally derived top-down emission estimates show usually higher emissions than reported. This might be likely due to natural CH_4 emissions that are not considered in the National Inventory Reports.

Key words:

Air quality, long-term monitoring

Internet data bases:

http://www.empa.ch/nabel
http://www.umwelt-schweiz.ch/buwal/de/fachgebiete/fg_luft/luftbelastung/index.html

Collaborating partners/networks:

Bundesamt für Umwelt (BAFU)/ Federal Office for the Environment (FOEN)
Global Atmosphere Watch (GAW)
Labor für Atmosphärenchemie, Paul Scherrer Institut
Meteo Schweiz

Scientific publications and public outreach 2008:

Refereed journal articles and their internet access

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