Name of research institute or organization:

Institute for Atmospheric and Climate Science, ETHZ Zürich (IACETH)

Title of project:

Measurements of PAN and formaldehyde at the interface between the planetary boundary layer and the free troposphere

Project leader and team:

Prof. J. Johannes Staehelin (IACETH)
Jacob Balzani Lööv (IACETH)

Project description:

The work of the year 2006 was devoted to the analysis of the field campaigns of PAN and formaldehdye at Jungfruajoch performed in 2005. The project was performed in collaboration with Geir Legreid working at Empa. In his PhD thesis an instrument was developed by which a variety of organic volatile compounds including oxgenated species (such as alcohols, carbonyls, etc.) and some hydrocarbons can be measured simultaneously with very low detection limits. This instrument was employed at Jungfraujoch simultaneosly with the measurements of PAN and formaldehyde providing (together with the continuous trace gas measurements performed by Empa) a unique data set. The data were analyzed by using the ALMO trajectories with high spatial resolution (provided by MeteoSwiss) in order to study the the origin of the organic gases within Europe (Legreid et al., 2007).

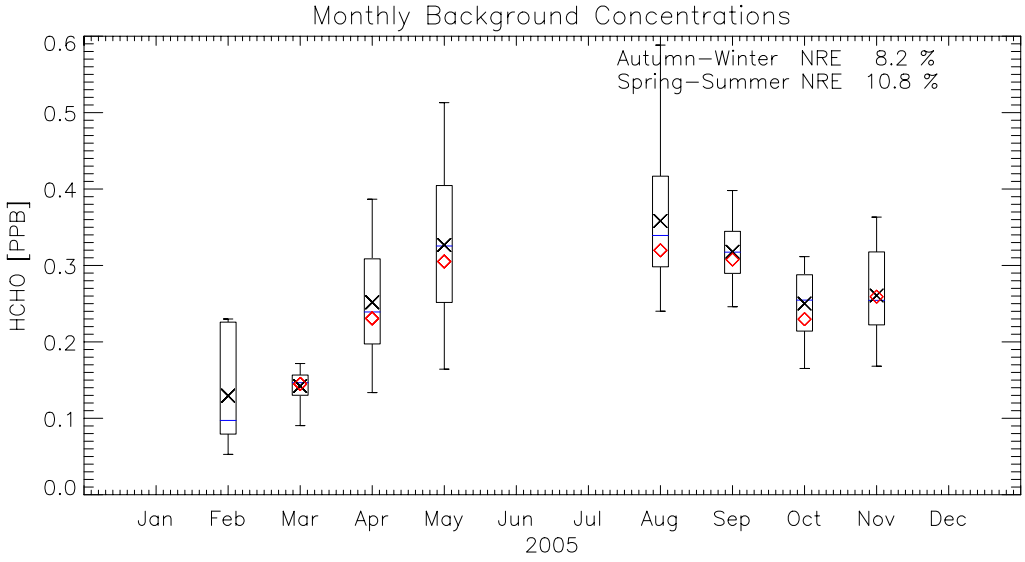

Figure 1 - Background concentrations of formaldehyde, lower quartiles are represented by the box, the line is the median and the cross is the mean. With the red diamond are displaced the background concentrations calculated using only data from 3AM to 9AM.

Field measurements of tropospheric gases at Jungfraujoch are partcularly attractive because the air often originates from the free troposphere. Special filters (based on chemical composition of air constituents and meteorlogical data) have been

successfully developed in the past to discriminate air parcels of planetry boundary layer and the free troposphere. Within this project a novel approach was developed to separate free tropopsheric air without contact with planetary boundary layer air from the European continent within the last 15 days (Balzani et al., 2007). For this purpose 15 days backward trajectories were calculated using LAGRANTO trajectories which are calculated based on the data of the European Centre of Medium Range Weather Forecast (ECMWF). In addition to the selection based on trajectories largest concentrations (75% quantile) were excluded since LAGRANTO trajectories can not adequaetly describe local effects because of the large grid resolution of the used ECMWF fields. The results for formaldehyde are shown in Fig. 1.
The method was tested by studying the diurnal variation of the trace gases in the selected air parcels which are expected to describe air of free tropospheric air excluding any contact with the polluted European planeatry boundary air within the last 15 days. Within free tropospheric air no systematic diurnal variation of the trace constituents (at least for primary species) is expected. The data analysis showed, that the diurnal variation of primary trace gases in these air masses is absent for measurements performed in fall, winter and spring, different to the summer measurements. This finding provides evidence that the method is adequate for the cold seasons. For the summer season, however, the approach can only provide an upper limit for trace gas concentrations of free tropopsheric air, most probably because the Jungfraujoch site is still under the influence of primary pollutants of planetery boundary layer. This result is in agreement with earlier results showing that the planetery boundary layer influence extends over the altitude of Jungfraujoch because of convection in summer.
We further intend to use a chemical box model based on the extended series of simultaneous field measurements for comparison with the peroxyradiacal measurements performed by University of Leeds.

Key words:

Atmospheric trace gases, free troposphere, planetary boundary layer, tropospheric ozone

Internet data bases:

http://iac.ethz.ch

Collaborating partners/networks:

Empa Dübendorf , University of Leeds

Scientific publications and public outreach 2006:

Refereed journal articles

Balzani Lööv, J., G. Legreid, J. Staehelin, et al., Background concentrations of formaldehyde, PAN and other Volatile Organic Compounds, in prep.

Legreid, G., S. Reimann, J. Staehelin, J. Balzani Lööv, M. Steinbacher, D. Folini, Measurements of organic trace gases including OVOCs at the high alpine site Jungfraujoch (Switzerland): Seasonal variation and source contribution, in prep.

Thesis

Legreid, G., Oxygenated Volatile Organic Compounds (OVOVs) in Switzerland: From the Boundary layer to the polluted troposphere, PhD Thesis, ETH No. 16982, 2006.

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