Name of research institute or organization:

## Institute of Applied Physics, University of Bern

Title of project:

Microwave remote sensing of the middle atmosphere

Project leader and team:

Prof. Niklaus Kämpfer, project leader
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Project description:

The objectives of our research in 2001 was to measure the altitude distribution of **water vapor** in the middle atmosphere from approx. 25km up to 70km. Water vapor plays a crucial role in atmospheric processes through its radiative, chemical and dynamical properties. In the upper troposphere it is one of the main greenhouse gases that absorbs longwave terrestrial radiation. Its distribution is strongly influenced by both the large scale circulation and localized convection. Chemically, water vapor is a major source of the hydroxyl radical, the primary oxidant in the troposphere that is able to react with most pollutants. Water vapor is also a valuable tracer of atmospheric motion due to its long chemical lifetime. Part of water vapor enters the stratosphere by vertical transport in the tropical tropopause with the air being freeze dried by the low tropopause temperature and spreads to middle latitudes with a certain phase lag.

**Measurements of water vapor** in the **upper troposphere** and in the **stratosphere** require an enormous technical effort due to large gradients around the tropopause and the stratospheric mixing ratios of a few ppmv in contrast to the moist tropospheric air masses. In addition, in the stratosphere, the spatial and temporal variability of the $H_2O$ abundance is relatively small, i.e. changes of a few tenths of 1 ppmv need to be detected with a similar accuracy of the measurement. No single existing instrument is capable of $H_2O$ measurements at all altitudes, with adequate global and temporal coverage. Therefore a combination of different techniques is necessary in order to investigate the spatial and temporal variability of water vapor.

Under favorable conditions it is possible to measure water vapor in the middle atmosphere in the **microwave** region also from the ground. Two microwave radiometers are operated on Jungfraujoch: AMSOS and EMCOR. AMSOS operates at a frequency of 183.31 GHz in order to measure the rotational line of watervapor, $H_2O$. It is an uncooled receiver in contrast to EMCOR which is cooled by liquid helium in order to operate a superconducting microwave mixer thus achieving a higher signal to noise ratio. EMCOR can be used in the frequency range of approx. 200 to 210 GHz and was originally aimed at observing the ClO line at 204 GHz. It has then been tuned to 203.41 GHz for the detection of the line of the watervapor isotope $H_2O^{18}$.

One aspect is to determine from the same location the altitude profile of **$H_2O$ and $H_2O^{18}$** at the same time. These investigations will help to understand transport of water vapor from the troposphere to the stratosphere as the isotopic ratio is affected by the temperature history. The other aspect is to complement our data above approx. 15 km by data from the newly installed **water vapor Lidar** from the ETH Lausanne under lead of Prof. B. Calpini. The microwave instrument together with the lidar on

Jungfraujoch will thus give the unique opportunity to determine the water profile from the ground up to 75km.

It was possible to detect the extremley weak transition of the isotope on a few days and measurements of normal water vapor were succesful under very dry conditions. The main work was to analyse the data also from earlier periods. Out of this work two publications resulted. Unfortunately we suffered from severe instrumental problems in the helium cooled instrument which made it impossible to gain more usable data. The EMCOR instrument will have to go through a refurbishment at the institute in Bern. The AMSOS instrument has been removed from Jungfraujoch as it was used in a flight campaign to the arctic in the fall. It is planned to operate both systems on Jungfraujoch again after the needed modifications have been performed.

Key words

Watervapor, microwave radiometry, remote sensing

Collaborating partners/networks:

GAW (Global Atmospheric Watch), NDSC (Network for the Detection of Stratospheric Change), Universite de Bordeaux

Scientific publications and public outreach 2001:

Siegenthaler, A., O.Lezeaux, D.Feist and N.Kämpfer, First water vapor measurements at 183 GHz from the high alpine station Jungfraujoch, IEEE Trans. on Geosci. and remote sensing, Vol. 39, No. 9, pp. 2084-2087, 2001.

Gerber, D., O.Lezeaux and N.Kämpfer, Ground based microwave measurements of midlatitude startospheric $H_2O^{18}$ and derivation of the isotopic ratio, Proc. Quadrennial Ozone Symp., Sapporo, Japan, pp. 399-400, July 2000.

Gerber, D., O.Lezeaux, A.Siegenthaler and N.Kämpfer, Deriving the isotopic ratio of $^{18}O$ in stratospheric watervapor from ground based microwave measurements on Jungfraujoch in the Swiss Alps., submitted to J. Geophys. Res.

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