New lidar Observation at the Jungfraujoch Alpine Station, Switzerland

B. Calpini[1]
P. Quaglia[2]
J. Balin[1]
G. Larchevêque[1]
R. Nessler[1]
H. van den Bergh[1]

[1]Air Pollution Laboratory, Swiss Federal Institute of Technology, CH - 1015 Lausanne, Switzerland
[2] Participated in lidar activities until November 2000. Presently in Monaco, France.

General context

The Jungfraujoch Alpine Station is a unique site for atmospheric observations, as it is in the free troposphere (3'850 m asl) most of the time. It is equipped with instruments that have performed essential global observation for decades, in particular column measurements by FTIR of some of the most important trace gases in the earth's atmosphere and a detailed local characterization of the aerosol formation (particle size and chemical composition). The Jungfraujoch Station is part of the Network for Detection of Stratospheric Change (NDSC). Up to very recently no range resolved observation was available from that site, with the exception of passive microwave remote sensing in the stratosphere. The recent installation of a lidar station at Jungfraujoch by EPFL, based on previous experience in the lidar field [1-6], is a technique that will bring essential input into aerosols, water vapor, and temperature vertical profiles. The present activities are based on the challenging development of a Raman lidar for water vapor observation up to the tropopause, with an initial phase dedicated to the range resolved measurements of aerosols based on the backscatter lidar technique using three different wavelength as well as depolarization. Long term lidar observations will allow in the future to validate the numerical models used for trend studies and also to validate satellite observations carried out in the next decade.

The Jungfraujoch lidar with the green laser beam

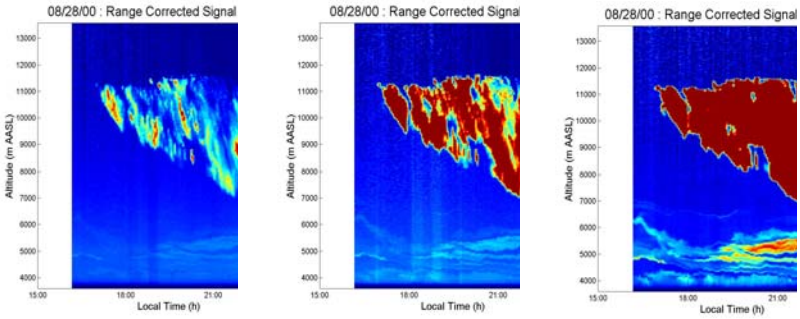
The Jungfraujoch lidar

The present project focuses on the need for range resolved measurements of aerosols, water vapor, and temperature in the troposphere and stratosphere with observation on a regular basis. These observations are performed using three laser wavelengths, two telescopes (one of them being the station's original astronomic telescope) with seven receiving channels each.

The system is equipped with a powerful Nd-Yag laser source, emitting 355, 532 and 1064 nm wavelength with a repetition rate continuously adjustable up to 100 Hz. The pulse to pulse energy variation is measured less than 1 %, for energy of some hundreds of mJ at each wavelength. For each wavelength, the beam is expanded 5 times and emitted to the atmosphere using piezo-controlled stages. The two detection boxes for each telescope measure the total elastic signal at 355 nm, the Raman nitrogen at 387 nm, the Raman water vapor at 408 nm, both polarized elastic signals at 532 nm, the Raman nitrogen at 607 nm, and the total elastic signal at 1064 nm.

The aerosols profiles will be linked with the in-situ measurement performed by PSI about the aerosols properties and number density (particle size and chemical composition) in an attempt to define a more complete database on the tropospheric aerosol. This new aerosols lidar is also part of the European lidar network EARLINET which will monitor aerosols on the European scale on a regular basis.

With the installation of an additional 20 cm telescope for short altitude range measurements, an intensive campaign was held between mid February and end of March 2000 (CLACE 2000). Here we focused on the measurements of aerosols optical properties, together with a number of top of the line *in situ* technique for the characterization of the aerosols properties collected directly at the altitude of the Jungfraujoch Station.



Eight hours records of backscattered signal using the 20cm telescope, from left to right, at 355nm, 532nm and 1064nm, acquired with a 200s time resolution. The use of three wavelengths highlights the aerosols size-dependant backscattering.

The algorithms for the retrieval of the extinction and backscatter coefficient are currently being tested, and a time series of the range corrected signals is also presented.

Since beginning of March 2000, the lidar system has been operated on the basis of one week of measurement every two weeks, with operators on site whatever the weather conditions were. This repetition rate of the lidar measurement will be maintained in the next years in order to catch the aerosol and water vapor trends at high altitude. In the frame of the European EARLINET project, algorithms inter-comparison will be performed, as well as direct lidar measurements inter-comparisons with a portable system.

Recent References:

[1] B. Calpini, V. Simeonov, F. Jeanneret, J. Kuebler, V. Sathya, and H. van den Bergh; "Ozone LIDAR as an Analytical Tool in Effective Air Pollution Management : The Geneva 96 Campaign", Chimia 51, 700-704, (1997).

[2] P. Quaglia, G. Larcheveque, R. Jimenez, V. Simeonov, G. Ancellet, H. van den Bergh, and B. Calpini; "Planetary Boundary Layer ozone fluxes from combined airborne, ground based lidars and wind profiler measurements", Eur. J. Anal. Chem.

Analysis, 27, pp 305-313 (1999).

[3] B. Lazzarotto, P. Quaglia, V. Simeonov, G. Larcheveque, H. van den Bergh and B. Calpini; "A Raman differential absorption LIDAR for ozone and water vapor measurement in the lower troposphere"; Int. J. Env. Anal. Chem., 74 (1-4), 255-261 (1999).

[4] B. Lazzarotto, M. Frioud, G. Larchevêque, V. Mitev, P. Quaglia, V. Simeonov, A. Thompson, H. Van den Bergh and B. Calpini; "Raman-DIAL O_3 and H_2O measurements in the planetary boundary layer", submitted to Applied Optics (2000).

[5] F. Jeanneret, F. Kirchner, A. Clappier, H. Van den Bergh and B. Calpini; "Total VOC reactivity in the Planetary Boundary Layer. Part one: Estimation by a new experimental technique", in press, J. Geophys. Res., (2000).

[6] F. Kirchner, F. Jeanneret, A. Clappier, B. Krüger and H. Van den Berghn and B. Calpini; "Total VOC reactivity in the Planetary Boundary Layer. Part two: A new indicator for determining the sensitivity of the ozone production to VOC and NOx", in press J. Geophys. Res., (2000).