Name of research institute or organization:

Institute for Atmosphere and Climate Science, ETH Zürich

Title of project:

Assessment of high altitude cloud characteristics, CLACE 2010 campaign

Project leader and team:

Prof. Thomas Peter, project leader
Dr. Frank Wienhold, Erika Kienast-Sjögren

Project description:

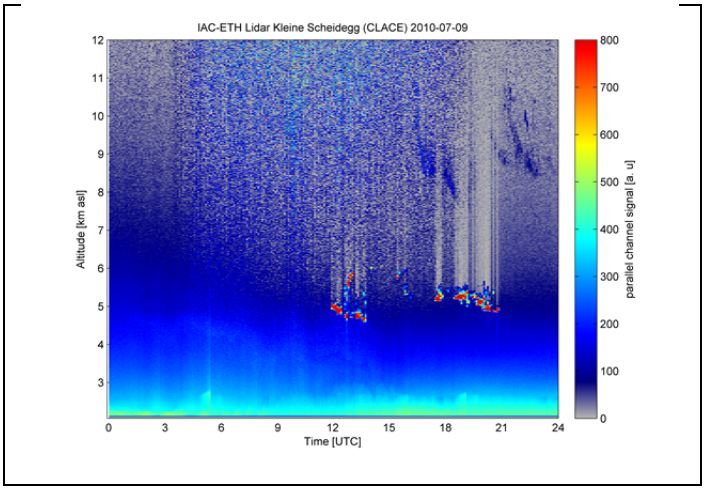
Our mobile elastic backscatter lidar (Leosphere type ALS 450) was employed for the first time in field to monitor cirrus clouds and atmospheric aerosol from a high alpine site. It worked stable and reliable without any need for in-situ maintenance.

Measurements were carried out from 2010-06-24 until 2010-07-22 on Kleine Scheidegg. Between 2010-07-08 and 2010-07-17, the lidar head was tilted towards Sphinx on Jungfraujoch in order to better compare our measured lidar data with in situ measurements at Jungfraujoch during the CLACE-2010 measurement campaign.

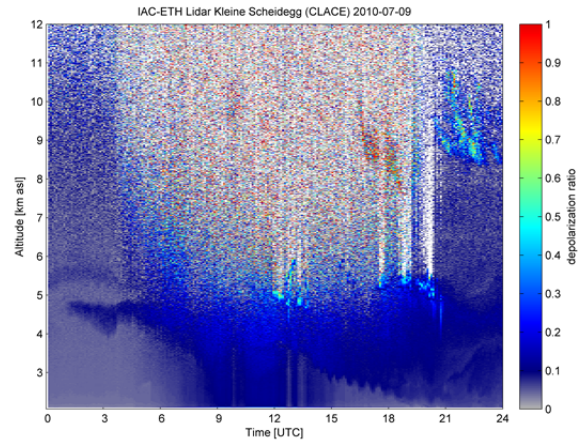
The lidar then was transferred to Jungfraujoch where measurements on the Sphinx terrace were carried out between 2010-07-28 and 2010-08-27.

The lidar measures aerosols and clouds with a wavelength of 355 nm at a laser repetition rate of 20 Hz. It retrieves attenuated backscatter polarized parallel and perpendicular to the laser emission allowing to determine depolarization ratio. The depolarization ratio depends on particle sphericity and increases with increasing asphericity. Thus this channel provides information whether liquid or ice clouds are observed. Since the aim of the measurements is to monitor ice clouds and boundary layer aerosols, this is information of great value.

An example of the measurements is given in the figures below for a day when Saharan dust was transported to the Jungfraujoch (2010-07-09). The dust is barely visible in the parallel channel while in the perpendicular channel it is clearly discernable, starting at a height of approximately 4.5 km at 01 hours UTC.



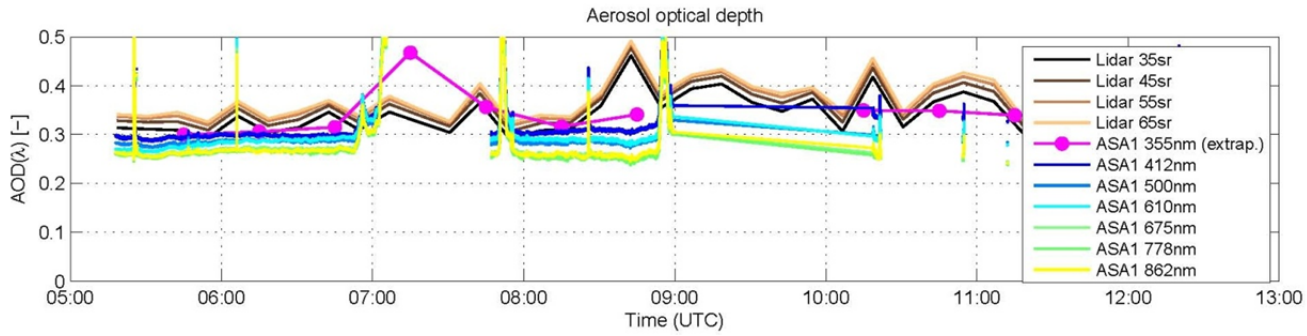
Parallel channel



Depolarization ratio

Using a Kaul-Klett lidar retrieval we calculate extinction, backscatter and backscatter ratio assuming different values for the extinction to backscatter ratio (lidar ratios: 35 sr, 45 sr, 55 sr, 65 sr). Aerosol optical depth is obtained by integrating extinction with respect to altitude. These calculated values were compared with ground based sun photometer measurements, extrapolated to the lidar wavelength. A good agreement was achieved.

The figure below indicates this for day 2010-07-10 (Courtesy of Paul Zieger, PSI). The brown and black curves show optical depth calculated from the lidar measurements for the different lidar ratios. The blue, green and yellow curves show the optical depths as measured by the Sun Photometer of PSI. The magenta curve with dots shows the extrapolated values of the sun photometer to 355 nm.



One difficulty regarding the lidar measurements is that the lowermost 200 m cannot be retrieved due to an incomplete overlap between the laser beam and the detector field of view. This can explain the difference in the data in the figure above directly before 9 am. The lidar data show a peak not visible in the sun photometer data. With the help of nephelometer data taken by PSI we now try to approximate an instrument function describing the overlap to overcome this problem.

We also try to improve our lidar retrieval developing an adaptive algorithm to choose the boundary condition used as starting point for the lidar inversion.

The measurements conducted on Jungfraujoch in 2010 were an excellent opportunity for the characterization of lidar properties. Since Jungfraujoch was often covered by clouds during the second phase when the instrument was installed on the Sphinx terrace, further measurements on Jungfraujoch are desirable.

Key words:

Lidar, Optical depth, CLACE 2010

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