Name of research institute or organization:

Institute for Atmospheric and Climate Science

Title of project:

Assessment of high altitude aerosol and cloud characteristics

Project leader and team:

Prof. Thomas Peter, project leader
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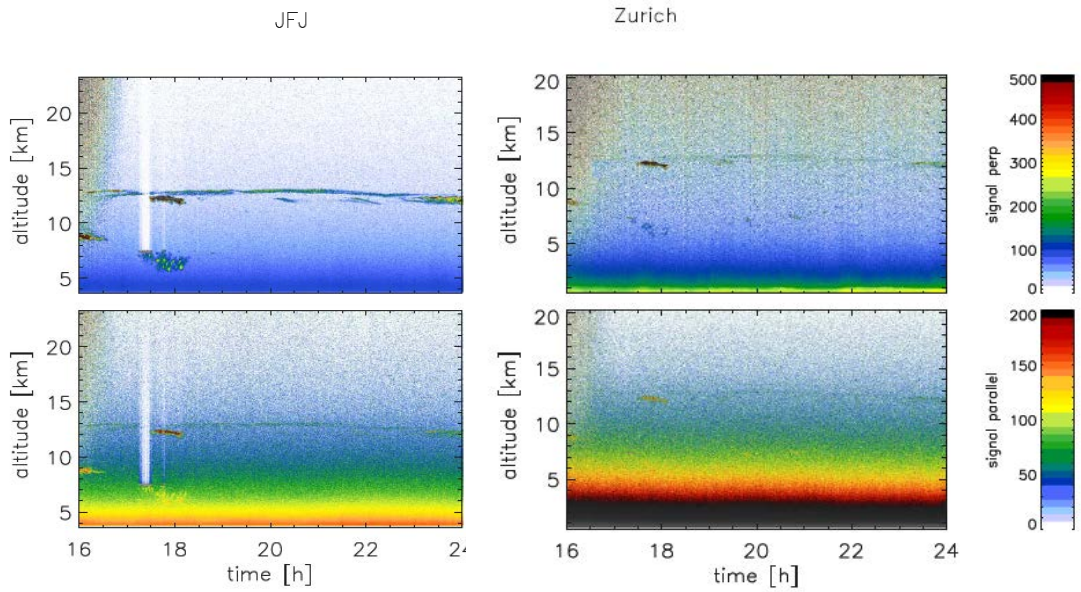
Project description:

Our Leosphere ALS 450 Lidar measures aerosols and clouds with a wavelength of 355 nm. We retrieve attenuated backscatter polarized parallel and perpendicular to the laser emission and determine the 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 our measurements is to monitor ice clouds, this is information of great value.

In 2011, continuous measurements were carried out from January to September in Zürich. In Zürich, an optically thick boundary layer is present that scatters the Lidar signal. Further, Zürich is located at only 500 m als, which results in a large distance to the cirrus clouds.

Jungfraujoch is situated at 3580 m asl, which lies above the boundary layer containing lots of aerosols originating from e.g. pollution. This unique position allows to observe thin cirrus clouds that were not observable from the Zurich location.

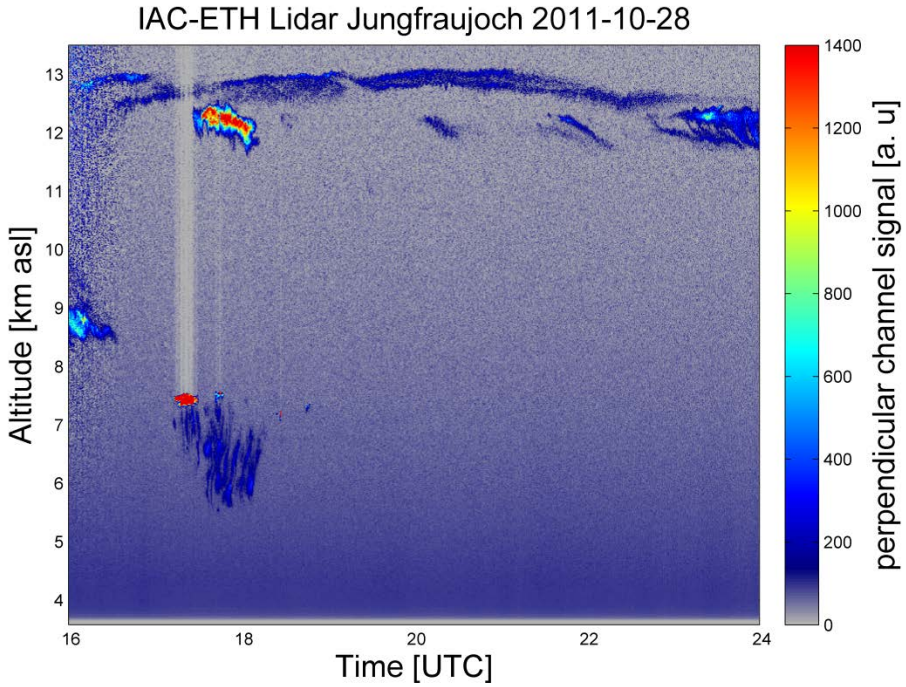


The difference between Jungfraujoch and Zürich can be seen in the plot above. The data measured on Jungfraujoch were used to simulate how the same measurement would look in Zürich. A typical Zürich boundary layer was added and the additional distance to the cirrus clouds was considered. The results clearly show the advantage of Jungfraujoch.

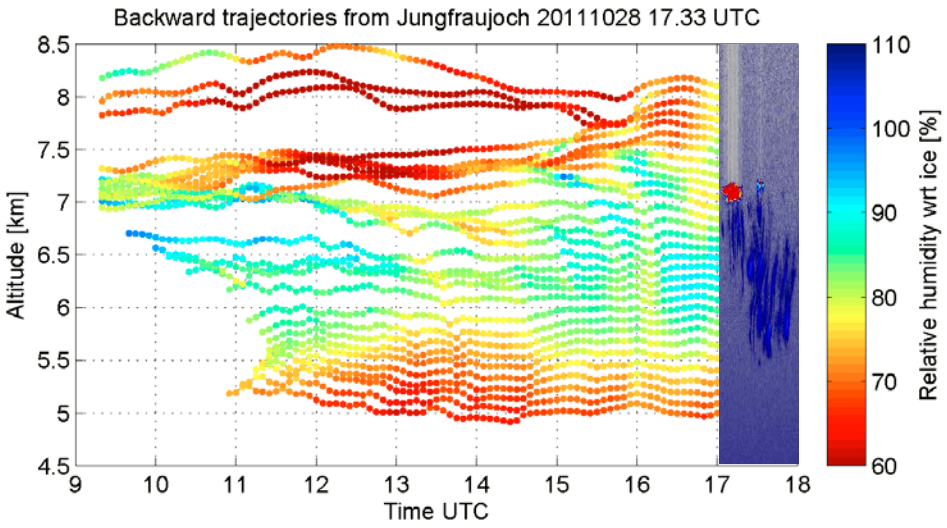
At the end of October, the Lidar was moved to Jungfraujoch where measurements during one year are planned. The Lidar is now operated together with a Ceilometer probing low level clouds to save operational costs of the Lidar. It is switched on only when the Ceilometer does not detect low level clouds.

First observations on Jungfraujoch on October, 28th 2011 (displayed on the top of next page) show geometrically and optically very thin cirrus clouds between 12 and 13 km asl.

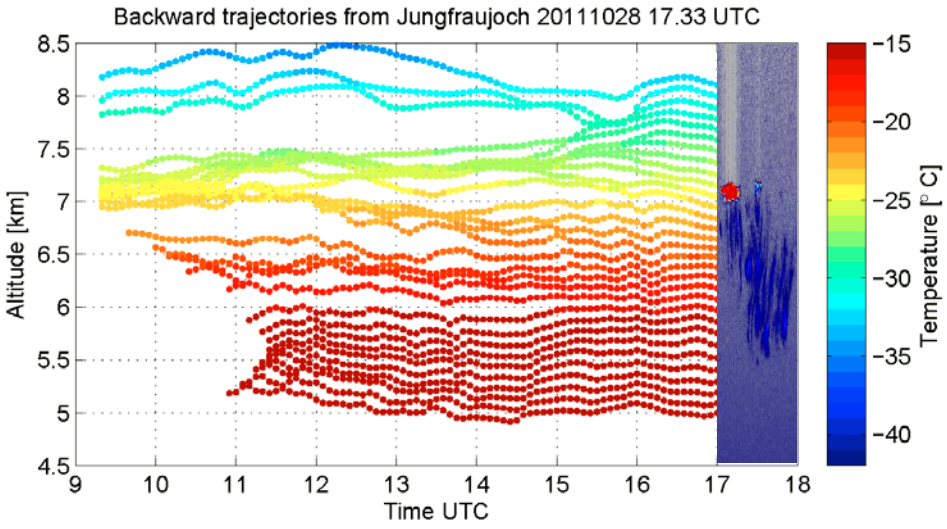
Around 18 UTC, interesting features are observed at altitudes between 5.5 and 7.5 km asl. Two small cirrus are present with a large number of particles below. These particles are optically very thin and might be fall streaks or dust.



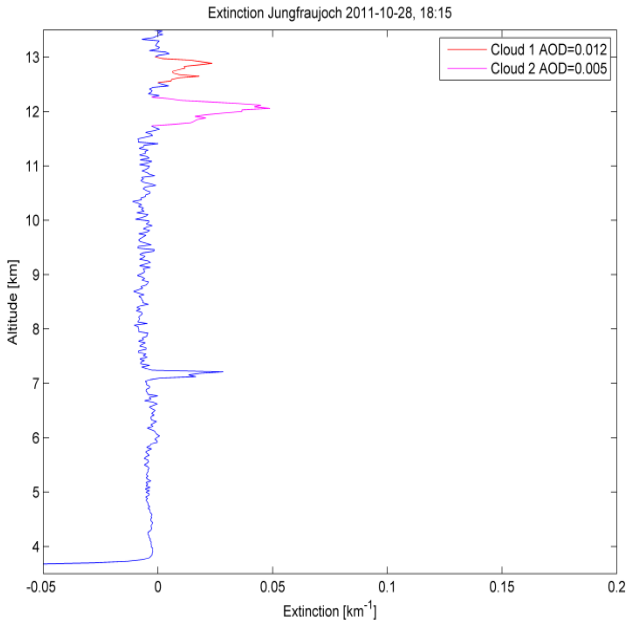
To examine this further, backwards trajectories using COSMO-2 Analysisdata were calculated. The relative humidity trajectories displayed below show that the surrounding air around the features is barely moist enough to sustain ice clouds.



The temperature trajectories displayed below are not cold enough for homogeneous nucleation to take place. Thus the trajectories clearly show that heterogeneous mechanisms are taking place. This information enables us to analyze the formation of cirrus clouds in the mid-latitude, i.e. which fraction is formed by heterogeneous and which by homogeneous nucleation. Further measurements are needed to achieve significant statistics.



Using a Lidar retrieval, we calculate extinction, backscatter and backscatter ratio assuming different values for the extinction to backscatter ratio, the so called lidar ratio. Values between 15 and 80 sr were used (Ackermann 1997, Immler 2002, Larchevêque 2002 and Seifert 2007). Using the calculated extinction values, we calculate the Optical depth of the cloud, which can be classified as described in Sassen, 2002. Sassen classify Cirrus clouds with an optical depth below 0.03 as subvisible, that is, they are not visible to the naked eye.



At 18:15 the Lidar observes two thin cirrus cloud layer above each other at the height of 12 and 13 km asl. Assuming a Lidar Ratio of 20, the observed high clouds have an optical depth of 0.012 and 0.005, which both clearly are subvisible.

Also this information is very interesting in a long time perspective with the goal to achieve a cirrus climatology. Since the Lidar is currently installed at Jungfraujoch, further measurements are currently taking place.

Key words:

Lidar, cirrus, subvisible cirrus, optical depth

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