Name of research institute or organization:

Remote Sensing Research Unit, Institute of Geography, University of Bern

Title of project:

APEX flight campaign: Retrieval of snow properties from hyperspectral imaging data

Project leader and team:

Dr. Stefan Wunderle (Project Leader)
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Project description:

Scientific objectives

The Hyper-Swiss-Net project aims at developing and supporting the scientific expertise and infrastructure in Switzerland for the exploitation of imaging spectrometry technology for different Earth observation applications.

A number of dedicated flight campaigns with the airborne imaging spectrometer APEX (Airborne Prism Experiment) of the European Space Agency were carried out in June 2011. One of the research modules, allocated at the Remote Sensing Research Unit, University of Bern, aims at developing and implementing a physically-based algorithm for the snow processing to accurately detect inherent snow properties. From imaging spectrometer data, the snow grain size as well as absorbing impurities on the surface layer can be estimated. Derived grain sizes coupled with an estimate of impurity concentration can be further used to determine broadband albedo. Albedo in the SWIR spectrum is mainly determined by grain size while soot influences snow albedo in the visible part of the electromagnetic spectrum. The later forces the radiative balance of the snow surface.

In the frame of this project, one overflight took place over the Jungfraujoch/Aletsch testsite on June 21, 2011. Predestined for snow research, the area lies above treeline and is dominated by a mountainous topography with elevations ranging from 1800 m asl up to 3500 m asl. The Aletsch Glacier, starting at the Jungfraujoch and spanning a length of about 23 km, allows to investigate many different snow characteristics within one flightline. While the very top of the glacier is covered with perennial rather dry snow cover, the bottom is strongly influenced by melting (metamorphosis, different snow grain sizes) and erosion processes (degree of impurity) at this time of the year. At times, also dust depositions from the Sahara desert can be observed in this region.

For validation purposes, ground observations (spectral measurements using A Field Spec Pro high-resolution spectroradiometer (Analytical Spectral Devices, Boulder, CO, USA), on-site snow cover characterization and snow probes for computer tomography) were carried out simoultanously within the test area. The specific ground measurement test area lies close to the Jungfraujoch station (at 3500 meters asl, yellow square in Figure 1) and is characterized by undisturbed, mostly flat and rather homogeneous snow fields of the Jungfraufirn. It is located in the dry snow zone of the accumulation area of the glacier where almost no melt occurs, even in summer, and the snowpack remains dry (perennial snow and ice cover). Therefore the snow cover was still abundant at the late acquisition time (June 21, 2011).

Preliminary results:
Due to increasing cloud cover over the region during the planned time slot, only two flight lines could effectively be acquired (see blue lines in Figure 1) under partly cloudy conditions. Even though sufficient reference data was sampled on June 21 (10:00 – 15:00), unfortunately the test site was not covered by the discontinued overflight (red lines in Figure 1, not acquired). Hence, the ground-based measurements have not been analyzed yet and no results from this campaign are available so far.

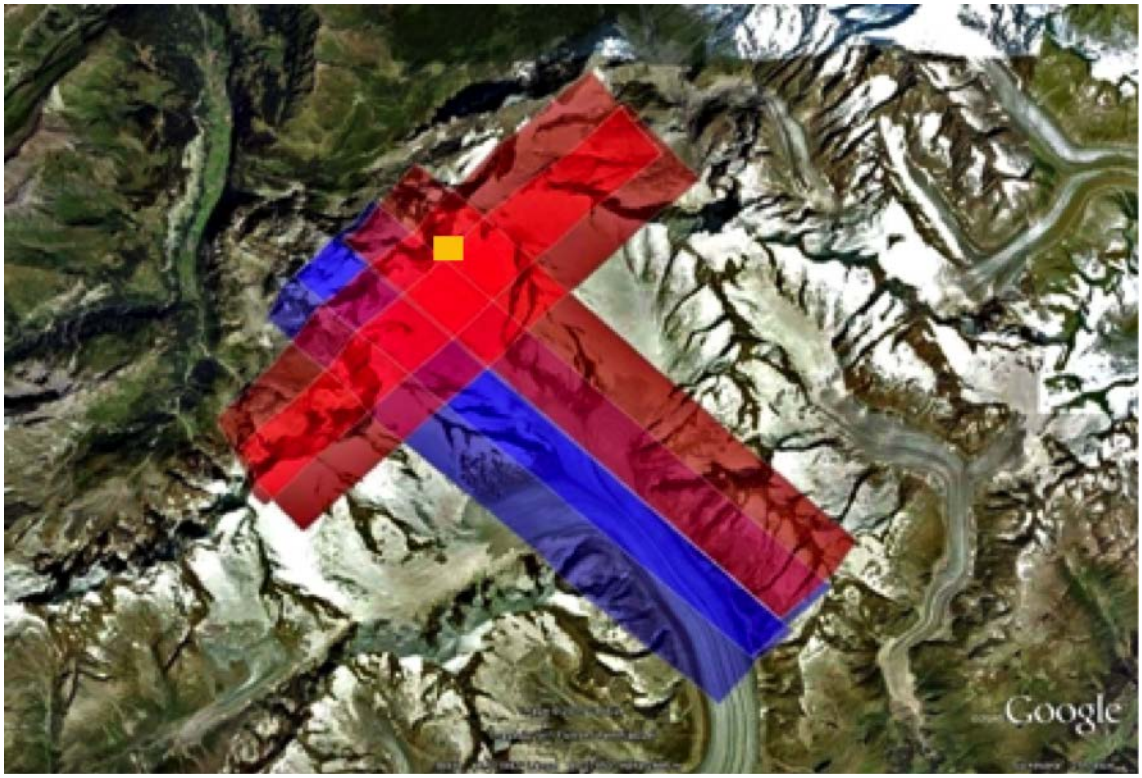

Figure 1. *Study site Jungfraujoch. APEX flight lines JFJ_1 - JFJ_2 were acquired under cloudy conditions (marked in blue). Red marked APEX flight lines could not be acquired in the 2011 campaign. The yellow square indicates the test site for ground measurements*.

Significance of the results:
The results of this and other (more successful) flight campaigns will be used for the calibration/validation of the APEX data as well as for an accurate retrieval of snow physical properties. Algorithms have been developed and implemented previously and could potentially be applied to the two flight lines on the Jungfraujoch/Altesch area acquired under cloudy conditions. However, the algorithm testing phase using ground data from earlier flight campaigns is still ongoing. Finally, these results can be used for the improvement of spatially distributed snowmelt models and precise broadband albedo estimation. Furthermore, the high spectral resolution of airborne APEX data could further help to extend the methods for fractional snow-cover and albedo estimates to multi-spectral satellite sensors.

Key words:
hyperspectral imaging of snow, Airborne Prism Experiment, snow optical properties

Internet data bases:

https://hyperswissnet.wiki.geo.uzh.ch/Project

Collaborating partners/networks:

Remote Sensing Laboratories (RSL), University of Zurich
WSL Institute for Snow and Avalanche Research (SLF), Davos

Scientific publications and public outreach:

Conference contributions

Koetz B., K. Itten, M. Borgeaud, D. Brunner, B. Buchmann, C. Feigenwinter, F. Hüsler, M. Kneubühler, E. Parlow, A. Psomas, S. Wunderle and N. Zimmermann, HYPER-SWISS-NET: Fostering the Swiss Research Community in the Field of Imaging Spectroscopy, in Proc EARSeL Imaging Spectrometry Workshop. Tel Aviv, Israel, 2009.

Dizerens C., F. Hüsler and S. Wunderle, Application and evaluation of a hyperspectral method for remotely sensing the snow grain size in the Swiss National Park, Bern, Switzerland, 8 February 2011, 6th EARSeL LISSIG Workshop

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