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Imaging spectroscopy to assess the composition of ice surface materials: a case study on Glacier de la Plaine Morte, Switzerland

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The ice-albedo feedback plays a crucial role in various glaciological processes, but especially influences glacier ablation. Furthermore, ice surface albedo depends in a complicated way on many factors, such as cryoconite concentration, impurities due to mineral dust, soot or organic matter, grain size or ice surface morphology. Our understanding of how these factors influence glacier albedo is still limited. Therefore, it is difficult to model or to parameterize, although glacier surface albedo is one of the most important variables in the energy balance of snow and ice, and hence is usually strongly simplified.

Over the last two decades, several studies have focused on glacier surface albedo using in-situ automatic weather stations and radiation measurement setups or satellite images. Due to limitations of both approaches in matching either the spatial or the temporal length scale of glacier albedo, still fairly little is known about the state, changes and impact of glacier surface albedo in the Swiss Alps, although there are obvious changes and variations in surface characteristics on most alpine glaciers over the last years.

The project SEON (Swiss Earth Observatory Network) aims at monitoring status and functioning of Swiss ecosystems in a changing environment. One focus of the project is on the alpine cryosphere, in particular mountain glaciers. With the use of the APEX (Airborne Prism Experiment) image spectrometer, measurements of reflected radiation were acquired in high spatial and spectral resolution to spatially explicit analyse the ice surface. In-situ radiometric measurements were acquired with an ASD field spectrometer in parallel to APEX overflights. These data are intended to be used for validation purposes. Furthermore, seasonal glacier mass balance is being monitored since five years using the direct glaciological method.

This contribution presents a first evaluation of the data collected in summer 2013 on Glacier de la Plaine Morte. We present a spectral library of different materials found on the glacier surface. The obtained in-situ and airborne reflectance measurements were used in combination with a multiple endmember spectral mixture analysis (MESMA) to assess the composition and spatial distribution of cryoconite and impurities on the surface of Glacier de la Plaine Morte. Results are important to improve the understanding of the spatial distribution of glacier ablation, which appears to depend strongly on surface albedo.