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A new device to acquire high-resolution vertical profiles of snow specific surface area

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The Specific Surface Area (SSA) is an important variable characterizing the complex micro structure of snow. Its application range is wide and covers the physical evolution of snow (metamorphism), photochemistry and optical and microwave remote sensing.

A new device based on the NIR reflectance approach has been developed at LGGE to suit our research work on microwave remote sensing in Antarctica. Microwaves are sensitive to snow properties, including the optical grain size which is directly related to SSA. For the particular application of microwave remote sensing in Antarctica, where the snow is usually dry and relatively transparent in the microwave range, SSA profile are needed with a high vertical resolution ($\sim$ 1-2cm) down to about 20m.

The new instrument called POSSSUM (Profile Of Snow Specific Surface area) measures reflectance at 1310 nm along the face of a drilling hole. A laser diode illuminates the snow at nadir incidence angle and the reflected radiance is measured at 3 zenithal angles (20°, 40° and 60°) each for 2 azimuthal angles (0 and 180°). A second laser operating at a shorter wavelength (635 nm) that is less sensitive to SSA than 1310 nm radiations, allows to estimate the distance to the snow surface, that is then used to perform corrections of the NIR reflectances. With a proper calibration and distance correction, we obtain the bidirectional reflectance at 6 different zenith/azimuth angles. They are then converted in to the hemispherical reflectance i.e. albedo. The SSA is estimated using a theoretical formula presented in Kokhanovsky and Zege (2004) and Picard and al. (2009).

The evaluation and validation of POSSSUM SSA measurements took place in spring 2009 in the Alps. The new method was inter compared with other techniques such as methane adsorption, tomography and other NIR-based techniques. Results show good agreement with other techniques and SSA profiles are consistent with the stratigraphic observations, i.e. general decrease of the SSA with depth.

First results from a field campaign during the 2009-2010 austral summer at Dome C, Antarctica will also be shown.