Snow grain size and albedo in Dronning Maud Land, Antarctica: measurements and modeling

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Snow grain macro-photos collected near the Finnish Antarctic Station Aboa during summer 2009-2010 were analyzed, and the link between snow grain metamorphism and surface albedo was investigated. Snow grain macro-photos were taken twice a day for a one-month period from four snowpack layers (at the surface and at the depths of 5, 10, and 20 cm). A cave inside the snowpack was used as a cold and dark "laboratory". The dataset also includes vertical profiles of snow temperature and density (twice a day), surface broadband albedo, surface spectral reflectance during clear and overcast days, and ancillary meteorological data. With such an extensive and complete dataset, we studied the snow grain metric that best represents the grain scattering properties at various wavelengths, establishing a direct relationship between measured grain dimensions and optically-equivalent grain size. For this purpose, we analyzed the 2D macro-photos with an image processing software (based on Matlab) that allows the determination of the size distribution of many dimensional quantities. A statistical approach was applied to estimate the representativeness error in the snow grain observations. The distributions of the obtained grain size metrics and the snow density profiles were utilized in the radiative transfer model DISORT to simulate the surface spectral albedo. The comparison of the model results with the observed spectral albedo allowed the identification of the snow grain dimensions that best explain the albedo at each wavelength. The impact of the snow grain shape in the model simulations was addressed utilizing spherical and droxtal grain representations.