Geophysical Research Abstracts
Vol. 20, EGU2018-1770, 2018
EGU General Assembly 2018

Effect of small scale surface roughness and snowpack properties on snow albedo

Terhikki Manninen (1), Roberta Pirazzini (1), Jouni Peltoniemi (2), Kati Anttila (1), Panu Lahtinen (1), Niilo Siljamo (1), Laura Thölix (1), Aku Riihelä (1), Anna Kontu (1), Hanne Suokanerva (1), Outi Meinander (1), Juha Suomalainen (2), Teemu Hakala (2), Sanna Kaasalainen (2), Harri Kaartinen (2), Antero Kukko (2), and Jean-Louis Roujean (3)

(1) Finnish Meteorological Institute, Earth Observation, Helsinki, Finland (terhikki.manninen@fmi.fi), (2) National Land Survey of Finland, (3) CNRS

The snow grains are the main scattering elements of a snowpack and hence the volume scattering of the snow is based on the snow grain size and shape. From the theoretical point of view there is a difference in scattering from a snow pack having an ideally planar surface and a rough surface, because the rough surface has a possibility to cause multiple surface scattering. i.e. some photons hitting the surface and scattered to the air may hit another part of the surface and be scattered either deeper down in the snowpack or to the air. At every hit the probability to be scattered in the air equals the (material) reflectance value r. Then multiple scattering lowers the surface scattering by r to power n, where n is the number of individual scattering events. Hence, surface roughness should in general reduce the albedo.

To some extent the snow grain size is also related to the surface roughness, because the grain size affects also the slopes of dunes formed by wind. Hence, the effective grain size passes some information concerning the small scale surface roughness also to the albedo model. If the surfaces were completely isotropic the surface albedo might in many cases be well explained using only the grain size as a descriptor of the snow pack of sufficient thickness to be semi-infinite from the scattering point of view. But it is typical that the surface structure slopes caused by wind are not identical in the windward and leeward sides. As the black-sky albedo is by definition dependent on the sun zenith angle, this means that the albedo will not necessarily be the same for azimuthally opposite viewing directions, when the saltation effect is marked. In addition, hoar frost formation depends more on the air temperature and humidity than the grain size of the existing snowpack. All in all, despite the dominant character of the snow grain size to the scattering from a snow pack, the small scale surface roughness has also a role independent of the snow grain size that should be taken into account. This study concentrates on that.

Snow surface roughness, snow grain size, albedo, bidirectional reflection distribution factor (BRDF) measured during the SNORTEX campaign in Sodankylä in 2009 are studied and existing snow models are used to simulate the albedo. In addition, the surface roughness data set is used to estimate the surface scattering anisotropy using simple geometric optics approach. The comparison of the measured albedo values and an empirical regression based relationship based on surface roughness parameters, density and moisture of the snow shows similar temporal evolution with a coefficient of determination of 0.64. Notably, the empirical relationship is able to catch a sudden dip in the albedo in mid-March.