



A field study of the hemispherical directional reflectance factor and spectral albedo of dry snow

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Hemispherical directional reflectance factors (HDRF) were collected under solar zenith angles from 49° to 85° at the Greenland Summit Environmental Observatory ($72^\circ 35' N$, $34^\circ 30' W$, 3203 m above sea level) where both the snow and the atmosphere are very clean. The observations were carried out for two prevailing snow surface types: a smooth surface with wind-broken small snow grains and a surface covered with rime causing a higher surface roughness.

A specially designed Gonio-Spectrometer (wavelength range 350 - 1050 nm) was developed at the Institute for Atmospheric and Climate Science, ETHZ, and used to collect spectral HDRFs over the hemisphere. The angular step size was 15° in zenith and azimuth.

The HDRFs showed strong variations ranging from 0.6 to 13, depending on the solar zenith angle. The HDRF distribution was nearly isotropic at noon. It varied with increasing solar zenith angle, resulting in a strong forward scattering peak. Smooth surfaces exhibited stronger forward scattering than surfaces covered with rime. At a solar zenith of 85° , an HDRF of ~ 13 was observed in the forward scattering direction for $\lambda=900$ nm.

Spectral albedos were calculated and showed variations depending on the solar illumination geometry and the snow surface properties.

Broadband albedos were derived from the directional measurements; they showed diurnal patterns comparable to the ones measured with two back-to-back broadband pyranometers.