Attenuation of Solar Radiation by the Snowpack in Dronning Maud Land, Antarctica

CHANTALE LAVOIE[1], HARDY B. GRANBERG[1], NORM O'NEILL[1]

ABSTRACT

Light penetration into the snow cover is important as it has a great effect on the surface and internal energy balance of the snow cover and, hence, its metamorphosis. Deep penetration of high-energy photons also drives photochemical processes within the snowpack. During the 1999/2000 austral summer, vertical profiles of upwelling radiance data were collected in the vicinity of the Finnish Research station Aboa (73°S 13°W) using a portable spectroradiometer. These measurements were used to compute apparent extinction coefficient of the snow. The optical consistency of the observed apparent extinction coefficients was verified by comparing the measured coefficients with simulated coefficients obtained from a delta-Eddington model. The spectral interval covered in this study ranges from 0.4 to 0.9 μm.

The measurements were performed in three different media in order to obtain a variety of optical conditions. A total of 21 profiles were acquired in semi-infinite snow, 9 in shallow snow, and 7 in blue ice. The apparent extinction coefficients were computed along with a Bouguer-Lambert like law for semi-infinite snow and blue ice media. This method was modified for shallow snowpack to take into account the underlying rock surface. The spectrally averaged apparent extinction coefficients were 0.201cm^{-1} for semi-infinite and shallow snow, and 0.0796 cm^{-1} for blue ice.

The delta-Eddington model was applied to snow profiles which were determined to be optically semi-infinite. The physical properties of these profiles were documented with stratigraphic data. 14 profiles out of 21 were compared with observed data. In general, modeled apparent extinction coefficients were lower than expected, for a given grain radius. An effective grain size was accordingly determined by fitting the model values to the observed values in the spectral region dominated by water particle absorption (0.81-0.83 μm).

Keywords: Optical properties of snow, Attenuation, Absorption

[1] CARTEL (Centre d'Applications et de Recherches en TÉLédétection)
Université de Sherbrooke, Sherbrooke (Québec), Canada, J1K 2R1.