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Retrieval of snow parameters using simultaneous light reflection and transmission measurements

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Usually the snow optical characteristics are retrieved from the spectral reflectance measurements applied either horizontally or vertically in a snow pack. In this work we show that the simultaneous light transmission and reflectance measurements for the same snow layer improves the solution of inverse problem and allow for the derivation of important snow characteristics such as the snow extinction coefficient not accessible for just reflectance alone measurements. In particular, the applications of asymptotic analytical radiative transfer (AART) theory are discussed for the retrieval of snow parameters from reflectance and transmittance observations as well as from spherical albedo and global transmittance data. Snow optical parameters such as extinction efficient, diffuse exponent, asymptotic flux extinction coefficient (AFEC), snow optical thickness and probability of photon absorption were retrieved for a temperate snow cover from spherical albedo and global transmittance data. The AFEC values were retrieved for different types of snow cover (thick, thin, dry, wet, new and old snow). A good agreement between AART and an independent radiative transfer model retrievals shows that AART theory can be applied for different types of snow. The values of e-folding depths were in the range from 4.5 to 17 cm, where the minimum value was for wet snow and the maximum was for old dry snow. The snow physical characteristics such as grain size and density were also retrieved using derived optical parameters and found in agreement with in situ measurements.