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Analysis on euphotic depth in snow with SNICAR transfer scheme

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Solar radiation in the visible bands penetrates through snowpack to a considerable depth, which is called as euphotic depth in this study. If the snow depth is no greater than euphotic depth, the surface albedo would be greatly affected by the underlying surface. This study defines the euphotic depth as the depth where the vertical residual solar radiation began to be <1.0 W m−2. The vertical profiles of solar radiation transmitted in the snowpack can be predicted by a two-stream, multilayer radiation penetration model, SNICAR (SNow, ICe, and Aerosol Radiation), based on regular measurements of snow pits and downward solar radiation at Col de Porte (CDP), France from 1993 to 2011. Most of the variables required by SNICAR are available from regular measurements except for the snow grain effective radius. However, this variable can be estimated from the snow SSA, which can be parameterized using snow type and snow density.
Pronounced differences in the medians, means, and maximums between winter and spring indicated that there was a clear seasonal variation in euphotic depth at CDP. This result may partly owe to the seasonal evolution of net solar radiation. The euphotic depth in snow is proportional to the surface net solar radiation, with the correlation coefficient being as high as 0.874. Exceptional cases were further analyzed and demonstrated that the snow extinction coefficient was the interior contributor influencing the euphotic depth. Stronger illumination and smaller extinction coefficients lead to greater euphotic depths.
This study defined the euphotic depth in snowpack and provided a convenient approach to estimate it. This approach may improve our understanding of the differences in the albedo between deep and shallow snowpack in GCMs. In particular, it is important for investigations in regions with relatively shallow snowpack and strong solar radiation, where the euphotic depth is more likely to be great and the albedo is easily affected by the underlying surface. This study left aerosol effects and vegetation canopy out of consideration. As next step, more efforts are needed to understand the relationship between snow depth and snow fraction and the effects of light absorbing aerosols on solar radiation transmission in the snowpack.