Modeling Short Wave Radiation Penetration into the Snowpack: What can we Learn from Near-Surface Snow Temperatures?

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Short wave radiation penetrates the top portion of the snowpack and is responsible for both sub-surface heating and fast changing temperature gradients during daytime. This affects snow metamorphism and hence weak layer formation and can affect mechanical properties of deeper layers. It is thus of crucial importance that snow-cover models represent this process as realistically as possible. Carefully measured near-surface snow temperatures can be used to check model performance in this respect. Numerical simulations performed with the Swiss snow-cover model SNOWPACK are thus compared to short time series of temperature measurements taken in the top 40 cm of the snowpack on a knoll located in the Columbia Mountains of British Columbia, Canada. In contrast to simpler models, SNOWPACK treats short wave radiation as a volume source of heat, like refreezing. It is shown that a multi-band approach is needed to obtain the best results. Switching off short wave radiation on a sunny day results in a reduction of temperature increase of about 5.2 °C at 15:00 at 10 cm depth while differences below 30 cm are negligible even later in the day.