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Parameterizing snow interception over forest canopy

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Snow interception drives spatial heterogeneity of snow under forest canopies and displays significant differences between forested, open and alpine areas at a variety of scales. Beyond giving a first order control on snow accumulation, interception by canopy drives other processes. A prime example is canopy albedo, as large differences are readily visible between forest canopy albedo with and without intercepted snow. As such a correct parameterization of interception is necessary as it drives many physical processes important for snow hydrology, climatology and meteorology studies. However, current parameterizations of snow interception have not always been able to preserve the large variance of snow beneath canopies at all scales. Various snow interception parameterizations are applied in land surface models but are generally not validated for different snow climates and/or scales.

Here, we developed parameterizations for spatial mean and standard deviation of interception over horizontal scales of 50 m. They were developed from a comparison of (1) computed forest structure metrics (sky view factor and standard deviation) from a high-resolution Lidar derived digital terrain model and (2) an existing dataset of several thousand interception measurements collected after nine storm events in a coniferous forest in the Eastern Swiss Alps. By scaling open area snow precipitation with the calculated forest structure metrics, we computed spatial mean and standard deviation of forest canopy interception. We obtained similar performance statistics compared to previously suggested parameterizations, i.e. a RMSE of 1.3 cm (1 mm SWE) for spatial mean and 0.6 cm (0.4 mm SWE) for the standard deviation of canopy interception.

Furthermore, we then validated both new interception parameterizations with data from two different geographic regions and snow climates, namely from a study site in Utah, U.S. and one in the French Alps. This comparison suggests that our sub-grid parameterizations for snow interception are applicable in models to describe snow depth heterogeneities for different snow climates and mountain forest environments.