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Towards a scale-independent fractional snow-covered area parameterization for complex terrain

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Whenever there is snow on the ground, there will be large spatial variability in snow depth. The spatial distribution of snow is significantly influenced by topography due to wind, precipitation, shortwave and longwave radiation, and even snow avalanches relocate the accumulated snow. Fractional snow-covered area (fSCA) is an important model parameter characterizing the fraction of the ground surface that is covered by snow and is crucial for various model applications such as weather forecasts, climate simulations and hydrological modeling.

We recently suggested an empirical fSCA parameterization based on two spatial snow depth data sets acquired at peak of winter in Switzerland and Spain, which yielded best performance for spatial scales larger than 1000 m. However, this parameterization was not validated on independent snow depth data. To evaluate and improve our fSCA parameterization, in particular with regards to other spatial scales and snow climates (or geographic regions), we used spatial snow depth data sets form a wide range of mountain ranges in USA, Switzerland and France acquired by 5 different measuring methods. Pooling all snow depth data sets suggests that a scale-dependent parameter should be introduced to improve the fSCA parameterization, in particular for sub-kilometer spatial scales. Extending our empirical fSCA parameterization to a broader range of scales and snow climates is an important step towards accounting for spatio-temporal variability in snow depth in multiple snow model applications.