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Scaling precipitation input to distributed hydrological models by measured snow distribution

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Precise knowledge about the snow distribution in alpine terrain is crucial for various applications such as flood risk assessment, avalanche warning or water supply and hydropower. To simulate the seasonal snow cover development in alpine terrain, the spatially distributed, physics-based model Alpine3D is suitable. The model is often driven by spatial interpolations from automatic weather stations (AWS). As AWS are sparsely spread, the data needs to be interpolated, leading to errors in the spatial distribution of the snow cover - especially on subcatchment scale. With the recent advances in remote sensing techniques, maps of snow depth can be acquired with high spatial resolution and vertical accuracy.

Here we use maps of the snow depth distribution, calculated from summer and winter digital surface models acquired with the airborne opto-electronic scanner ADS to preprocess and redistribute precipitation input data for Alpine3D to improve the accuracy of spatial distribution of snow depth simulations. A differentiation between liquid and solid precipitation is made, to account for different precipitation patterns that can be expected from rain and snowfall. For liquid precipitation, only large scale distribution patterns are applied to distribute precipitation in the simulation domain. For solid precipitation, an additional small scale distribution, based on the ADS data, is applied. The large scale patterns are generated using AWS measurements interpolated over the domain. The small scale patterns are generated by redistributing the large scale precipitation according to the relative snow depth in the ADS dataset. The determination of the precipitation phase is done using an air temperature threshold.

Using this simple approach to redistribute precipitation, the accuracy of spatial snow distribution could be improved significantly. The standard deviation of absolute snow depth error could be reduced by a factor of 2 to less than 20 cm for the season 2011/12. The mean absolute error in snow depth distribution could be optimized by choosing reasonable large scale precipitation patterns. For inter-annual scaling, the model performance could also be improved, even when using an ADS dataset from a different season.

We conclude that using ADS data to process precipitation input, complex and computation power intensive effects such as snowdrift due to wind, can be substituted and modelling performance of spatial snow distribution is improved.