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Combining inductive and deductive methods and unorthodox observations for hydrological prediction.

Although the two main approaches, inductive (top down) and deductive (bottom-up), for hydrological modelling both seek to establish relationships between data availability and modelling predictions, in isolation, they do not entirely fulfill the expectations of obtaining reliable model predictions at different spatial and temporal scales. This situation is even more crucial when distributed and physically based models are intended to be applied in data poor environments. The cold regions are largely ungauged and have many distinctive hydrological characteristics such as large depressional storage, variable contributing area, snowmelt derived hydrographs, wind redistribution of snow, frozen soils, the impact of slope and aspect on the snowmelt energy and mass balance, sub-canopy radiation effects, and sublimation of snow. As such they are challenging study sites that need modelling strategies which can combine detailed process understanding with an overall knowledge of the system. Here, a new modelling philosophy is implemented, based on the combination of inductive and deductive reasoning approaches for predicting snowcover ablation and snowmelt runoff. This methodology considers the main sources of uncertainty such as input heterogeneity (atmospheric forcing), landscape heterogeneity (model parameters), and process representation (model structure) using a land surface hydrological model. The inductive modelling approach was used to represent landscape heterogeneity based on basin-wide understanding gained from observations of the main factors that drive the snowmelt processes, whereas the deductive approach was applied to develop detailed process descriptions. Field experiments have shown significantly different inputs of shortwave radiation due to topography and snow accumulation patterns as a result of wind redistribution of snow over topography and vegetation. Detailed descriptions of these processes were able to describe both snow cover ablation and snowmelt runoff. Conversely, not including differential initial snow accumulation and meteorological forcing conditions resulted in errors in model simulations of snowcover ablation and runoff generation. The modelling methodology, based on the combination of the strength of both modelling approaches, appears to be an effective method to reduce the size of the parameter sets and still retain physical consistency, and therefore an appropriate methodology for applying physically based hydrological models in poorly or ungauged basins.