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# Comparison of different snow model formulations and their responses to input uncertainties in the Upper Indus Basin

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Snow and glacier melt in the mountainous Upper Indus Basin (UIB) sustain water supplies, irrigation networks, hydropower production and ecosystems in extensive downstream lowlands. Understanding hydrological and cryospheric sensitivities to climatic variability and change in the basin is therefore critical for local, national and regional water resources management. Assessing these sensitivities using numerical modelling is challenging, due to limitations in the quality and quantity of input and evaluation data, as well as uncertainties in model structures and parameters. This study explores how these uncertainties in inputs and process parameterisations affect distributed simulations of ablation in the complex climatic setting of the UIB. The role of model forcing uncertainties is explored using combinations of local observations, remote sensing and reanalysis – including the high resolution High Asia Refined Analysis – to generate multiple realisations of spatiotemporal model input fields. Forcing a range of model structures with these input fields then provides an indication of how different ablation parameterisations respond to uncertainties and perturbations in climatic drivers. Model structures considered include simple, empirical representations of melt processes through to physically based, full energy balance models with multi-physics options for simulating snowpack evolution (including an adapted version of FSM). Analysing model input and structural uncertainties in this way provides insights for methodological choices in climate sensitivity assessments of data-sparse, high mountain catchments. Such assessments are key for supporting water resource management in these catchments, particularly given the potential complications of enhanced warming through elevation effects or, in the case of the UIB, limited understanding of how and why local climate change signals differ from broader patterns.