Simulation of Abramov glacier energy balance and firn properties

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It is predicted that the majority of glaciers world-wide will continue to experience mass loss. This can have dire consequences for regions (e.g. Central Asia) that rely heavily on meltwater from snow and glaciers for agriculture, energy, and domestic consumption. Thus, mass balance studies are important for studying the relationship between glaciers and climate; yet need to account for both surface and subsurface processes to be accurate. This study reports for the first time a coupled distributed energy balance and snow model for Abramov glacier, Kyrgyzstan for the period 2013-2017. Such models are imperative as they add to our understanding of the potential responses of glaciers in the context of global warming trends.

In order to run the model, input variables were acquired from various sources; including automatic weather station data, modelled and ERA-Interim reanalysis data. Calibration was accomplished using literature and in-situ measurements from ablation stakes for 2014-2017. Furthermore, the reliability and accuracy of the modelled outputs was assessed through comparison with ice core data and literature.

The model simulated a positive mass balance (+0.94 m w.e. a-1) in contradiction to previous study estimates. This discrepancy was mainly attributed to spatial and temporal differences in precipitation events. By better representing and accounting for this variability in the initial input and calibration could result in a more realistic modelled output. However, as the overall mass balance relied on both surface (i.e. energy balance) and subsurface models each were assessed individually to identify parameters adding further inaccuracies into the coupled model output. Relative humidity and cloud cover were identified as the most problematic parameters within the energy budget. Whereas, the main issue identified with the subsurface model was its inability to simulate densification with depth.

Notwithstanding the identified shortfalls, the coupled model still has significant potential. Through slight modification it is foreseen that problematic areas can be overcome and it successfully applied in the future to model surface and subsurface processes of Abramov glacier.

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