EGU2020-20639, updated on 17 May 2022
https://doi.org/10.5194/egusphere-egu2020-20639
EGU General Assembly 2020

Results of the IACS Debris-covered Glaciers Working Group melt model intercomparison

Francesca Pellicciotti[1,2], Adria Fontrodona-Bach[3], David Rounce[4], and Lindsey Nicholson[5]
[1]Swiss Federal Institute for Forest Snow and Landscape Research, Mountain Hydrology and Mass Movements, Birmensdorf, Switzerland
[2]Northumbria University, Department of Geography and Environmental Sciences, Newcastle upon Tyne, UK
[3]University of Birmingham, School of Geography, Earth and Environmental Sciences, Birmingham, UK
[4]University of Alaska Fairbanks, Geophysical Institute, Fairbanks, Alaska, USA
[5]University of Applied Arts Vienna, Vienna, Austria

Many mountain ranges across the globe support abundant debris-covered glaciers, and the proportion of glacierised area covered by debris is expected to increase under continuing negative mass balance. Within the activities of a newly established IACS Working Group (WG) on debris-covered glaciers, we have been carrying out an intercomparison of melt models for debris-covered ice, to identify the level of model complexity required to estimate sub-debris melt. This is a first necessary step to advance understanding of how debris impacts glacier response to climate at the local, regional, and global scale and accurately represent debris-covered glaciers in models of regional runoff and sea-level change projections.

We compare ice melt rates simulated by 15 models of different complexity, forced at the point scale using data from nine automatic weather stations in distinct climatic regimes across the globe. We include energy-balance models with a variety of structural choices and model components as well as a range of simplified approaches. Empirical models are run twice: with values from literature and after recalibration at the sites. We then calculate uncertainty bounds for all simulations by prescribing a range of plausible parameters and varying them in a Monte Carlo framework. We restrict the comparison to the melt season and exclude conditions as few current models have the capability to account for them.

Model results vary across sites considerably, with some sites where most models show a consistently good performance (e.g. in the Alps) which is also similar for energy-balance and empirical models, and sites where models diverge widely and the performance is overall poorer (e.g. in New Zealand and the Caucasus). It is also evident that with a few exceptions, most of the simpler, more empirical models have poor performance without recalibration. A few of the energy-balance models consistently give results different to the others, and we investigate structural differences, the impact of temporal resolution on the calculations (hourly versus daily) and the calculation of turbulent fluxes in particular.

We provide a final assessment of model performance under different climate forcing, and evaluate models strengths and limitations against independent validation data from the same sites. We also provide suggestions for future model improvements and identify missing model components and crucial knowledge gaps and which require further attention by the debris-covered glacier community.