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Modelling the coupled influence of climate and glacier change on discharge

Karin Spiegelhalter (1) and Kerstin Stahl (1,2)

(1) Inst. of Hydrology, University of Freiburg, Germany (kerstin.stahl@hydrology.uni-freiburg.de), (2) Dept. of Geosciences, University of Oslo, Norway

Glacier melt is an important source of freshwater in mountain regions around the world. Glacier retreat as a response to global warming initially causes an increase in the meltwater contribution to streamflow, in the long-term, however, streamflow will be decreasing as a result of the declined glacier coverage. Predicting these changes requires the consideration of all uncertainties from climate to glacier to hydrology models. We present a study that uses the semi-distributed rainfall runoff model, HBV, coupled with a mass balance and an empirical glacier response model to investigate and compare the sensitivity of glaciated catchments to climate change. The coupled model is driven into the future with two transient climate scenarios downscaled from different GCMs. The modelled glacier mass balance is used to re-scale the glacier every decade using an empirical volume-area scaling relation. With an ensemble approach the study systematically analysed the uncertainty propagation within the model chain for the responses of three different basins in British Columbia, Canada. While all basins have similar glacier areas they vary in terms of basin area, climate, glacier type, and other catchment characteristics. Without data to constrain the glacier mass balance, model uncertainty from the coupled glacio-hydrological model is similar to the uncertainty from GCM and downscaling. While icemelt decreases in all basins over the scenarios period, seasonal changes and effects on total streamflow differ considerably though with large uncertainties. The different responses highlight the necessity for a transient coupled modelling approach including land cover changes for reliable prediction of future streamflow changes.