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Discussions

Interactive comment on "Modelling runoff from a Himalayan debris-covered glacier" *by* K. Fujita and A. Sakai

Anonymous Referee #3

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Fujita and Sakai present an interesting modelling study in which they combine remote sensing and a runoff model in the Tsho Rolpa catchment in Nepal. They use the thermal bands of the ASTER satellite to estimate debris properties of the glaciers and they use this information to parameterize the melt under the debris covered glacier, which is novel in runoff modelling of Himalayan catchments. The paper is generally well written and an important contribution to the field. The paper certainly has potential for publication in HESS, I think there are several shortcomings that need to be addressed before the paper can be accepted.

As the authors are well aware, melt of debris covered glaciers is for a large part controlled by ice cliffs and supra-glacial lakes. I think this effect is largely ignored when the thermal resistance approach is used. This should at least be comprehensively

discussed and possibly it should be corrected for.

I have some concerns on using re-analysis data in forcing small catchment models in mountain environments. NCEP-NCAR data have a resolution of several hundreds of kilometers and it has little relation with the local climate in Tsho Rolpa. Figure S3 shows that the correlations are indeed quite poor for most variables. Temperature does relatively well, but this is logical given the seasonality of the climate. Did the authors use the reanalysis data without correction to force the model? If so, I think that is not acceptable. If not, then it should be described how the re-analysis data are corrected using the observations that are available.

APHRODITES is used for precipitation and the authors use a multiplicative factor and a lapse rate with elevation to generate spatial fields. They estimate these factors using the Nash Sutcliffe Model efficiency. However this assumes that all other model parameters are correct and equifinality is not an issue, which to my opinion is a critical issue when such a (heavily) parameterized empirical model is used. A cynic may say that the precipitation correction can be used to mask all other errors in model parameters. A discussion on the values used for the precipitation ratio and the gradient is required and if possibly substantiated with references. In addition the use of the precipitation gradient assumes that precipitation will increases with height unlimited, while in reality there will be an elevation of peak precipitation above which the atmosphere becomes so dry and cold that significant precipitation is unlikely.

The authors address uncertainty in the thermal resistance by analyzing imagery from multiple dates. This a valuable addition to previous work. However the model they present consists of a comprehensive set of mostly empirical relations including some very strong assumptions (e.g. latent and sensible heat fluxes are equal to zero for clear sky days). Many of these relations and their parameters are presented as is, but I would like to know the basis of all of those assumptions. (e.g. maximum water content = 5 mm w.e., bulk coefficient for snow = 0.002, albedo of ice free terrain = 0.1, etc. etc.) Uncertainty in thermal resistance if just one of the many uncertainties. The paper does not really discuss how the model is calibrated and it would benefit from a more rigorous discussion on model parameter uncertainty. At least a table should be included with the model variables/parameters, their assumed values and the basis for that assumption when possible. Ideally, in Figure 6 the model uncertainty should also be included in the shaded areas in addition to the inter-annual variation.

From equation 10 it seems that evaporation of water from the debris cannot occur, but only condensation. I would say that this could be a significant factor. Also for the other surface types it is not clear.

It is assumed that all water that precipitates into the lake is immediate transferred to runoff. I would think that the lake has a strong buffering role and that a significant part evaporates from its surface. It is not clear if this is considered or not. It also seems that the model does not contain a routing routine. Is all runoff generated on a day immediately at the outlet? This needs further explanation.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 2441, 2014.