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Comparing effects of gridded input data from different sources in glacier mass balance modelling using a minimal glacier model

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The knowledge of the development of glaciers in both past and future is valuable for understanding our climate system. The vast majority of the world′s glaciers is poorly observed and often no data or resources are available to study them. Minimal modelling approaches requiring a minimal amount of easily available input data can be a valuable first step to gain valuable information at low cost. This study is concerned with the effects of the spatial and temporal resolution of gridded input data on the applicability of a minimal surface mass balance model.
Three sources of temperature and precipitation data freely available for the Alpine region were used to drive a statistical multiple linear regression surface mass balance model (HISTALP 'grid mode 2' instrumental database, monthly, 5' spatial resolution (Auer et al., 2007); CRU TS 3.10.01 instrumental database, monthly, 0.5° spatial resolution (Harris et al., 2013); European temperature and precipitation reconstructions 1500-2000, seasonal, 0.5° spatial resolution (Luterbacher et al., 2004; Pauling et al., 2006)). The model is trained, tested and cross-validated to test the model's robustness using the different datasets. The surface mass balance model is coupled to a simple volume-area and volume-length scaling scheme to roughly include surface mass balance and glacier geometry feedbacks. Observed mass balance data of Hintereisferner in the Ötztal Alps (Austria) allow for a sound validation of the model.
The findings of the study reveal that there is only a weak dependency of the reliability of the multiple linear regression model on the spatial resolution of the input data sets. The anomalies of the regional HISTALP 5' grid mode 2 data series were not found to lead to better model results than the anomalies of the 0.5° global CRU TS 3.10.01 data set. An artificial deterioration of the input data quality by aggregating the 5' data grid to 10' and 0.5° of spatial resolution did even lead to slightly enhanced model performance. No reliable model could be set up from the Luterbacher et al. (2004) and Pauling et al. (2006) seasonal climate data, and the influence of their precipitation data on mass balance was found not to be significant.
The volume-area and volume-length scaling cannot serve as a robust basis for reliable time-dependent modelling of glacier geometry on a single glacier. This is mainly due to the uncertainty of the applied global scaling parameters. Nevertheless, the approach can deliver valuable insights to glacier behaviour on a conceptual level, when they are compared to the observational data of Hintereisferner. Due to the ideally valley-shaped glacier and exceptionally good data basis available for Hintereisferner, further investigation is planned by including additional mass balance series of other glaciers with the grid-cell based model.