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Evaluating the performance of different predictor strategies in regression-based downscaling with a focus on glacierized mountain environments

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This study presents first steps towards verifying the hypothesis that uncertainty in global and regional glacier mass simulations can be reduced considerably by reducing the uncertainty in the high-resolution atmospheric input data. To this aim, we systematically explore the potential of different predictor strategies for improving the performance of regression-based downscaling approaches. The investigated local-scale target variables are precipitation, air temperature, wind speed, relative humidity and global radiation, all at a daily time scale. Observations of these target variables are assessed from three sites in geo-environmentally and climatologically very distinct settings, all within highly complex topography and in the close proximity to mountain glaciers: (1) the Vernagtbach station in the Northern European Alps (VERNAGT), (2) the Artesonraju measuring site in the tropical South American Andes (ARTESON), and (3) the Brewster measuring site in the Southern Alps of New Zealand (BREWSTER). As the large-scale predictors, ERA interim reanalysis data are used. In the applied downscaling model training and evaluation procedures, particular emphasis is put on appropriately accounting for the pitfalls of limited and/or patchy observation records that are usually the only (if at all) available data from the glacierized mountain sites. Generalized linear models and beta regression are investigated as alternatives to ordinary least squares regression for the non-Gaussian target variables. By analyzing results for the three different sites, five predictands and for different times of the year, we look for systematic improvements in the downscaling models' skill specifically obtained by (i) using predictor data at the optimum scale rather than the minimum scale of the reanalysis data, (ii) identifying the optimum predictor allocation in the vertical, and (iii) considering multiple (variable, level and/or grid point) predictor options combined with state-of-art empirical feature selection tools. First results show that in particular for air temperature, those downscaling models based on direct predictor selection show comparative skill like those models based on multiple predictors. For all other target variables, however, multiple predictor approaches can considerably outperform those models based on single predictors. Including multiple variable types emerges as the most promising predictor option (in particular for wind speed at all sites), even if the same predictor set is used across the different cases.