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Distributed modelling of the energy and mass balance at the surface of Langenferner, Italy using off-glacier meteorological data

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In order to study the spatial distribution of surface mass balance and the related surface energy fluxes of an alpine glacier, a physically based 2D-model was applied to Langenferner, Ortles-Cevedale Group / Northern Italy for the period 2004-2008. The model was driven by meteorological data from six permanent automatic weather stations in the vicinity of the glacier. Meteorological data from the stations which are maintained by the Hydrographic Office of the Autonomous Province of Bolzano were extrapolated to the glacier surface using simple transfer functions. The energy and mass balance model was optimized using data from an automatic weather station which was temporarily installed nearby the glacier. To validate the results, the model output was compared to stake measurements and snow probing data from the glacier.
Modelled annual mean specific mass balance showed a sufficient accordance to the measurements at Langenferner except for the hydrological year 2007/2008. The considerable underestimation of melt ablation in this year could be attributed to deficiencies in the employed albedo parameterization. Model results revealed that the spatial distribution of surface mass balance at Langenferner is strongly dependent on shortwave net radiation while other surface energy fluxes showed less influence on the spatial pattern. In order to test the sensitivity of the model to changes in selected model parameters as well as the meteorological input data, a series of sensitivity tests were performed. The model sensitivity to changes in air temperature shows that an increase of 1°C causes a change in the mean specific mass balance of -1338 mm w.e., which is similar to the result of a 20 % decrease in precipitation. Neglecting topographic shading due to surrounding peaks, in turn, would only lead to a change of -76 mm w.e. in the mean specific mass balance for 2004/05.