



Supplement of

Modelling runoff in a glacierized catchment: the role of forcing product and spatial model resolution

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The Supplementary Material provides 4 tables and 5 figures that support the analyses and model experiments performed in the main paper “Modelling runoff in a glacierized catchment: the role of forcing product and spatial model resolution”.

S1. Supplementary Tables

S1.1. Parameter Overview

Table S1: Applied monthly constant temperature lapse rates (in °C per 100 m of elevation) for each meteorological product applied in this study. The table refers to the hydrological year.

Month	Grimsel	MS _{grid}	ERA5-Land	ERA5-Reanalysis
October	-0.52	-0.47	-0.44	-0.41
November	-0.53	-0.45	-0.42	-0.39
December	-0.60	-0.43	-0.41	-0.38
January	-0.64	-0.43	-0.42	-0.37
February	-0.65	-0.44	-0.42	-0.38
March	-0.65	-0.49	-0.45	-0.41
April	-0.65	-0.52	-0.48	-0.43
May	-0.62	-0.53	-0.48	-0.44
June	-0.59	-0.55	-0.49	-0.45
July	-0.56	-0.55	-0.50	-0.46
August	-0.53	-0.54	-0.48	-0.44
September	-0.56	-0.51	-0.45	-0.40

Table S2: Retention factors and maximum capacity volumes (V_{max}) for different surface types/reservoirs used in the GERM simulations:

Surface Types	Ice	Snow	Rock	Pasture	Forest	Slow
Retention constant (d)	2	5	4	9	15	80
V _{max} (mm)	100	-	800	1000	1500	-

S1.2. Estimation of evaporation

Table S3: Estimated catchment-wide evapotranspiration according to Bernath (1989) and annual average modelled evapotranspiration by GERM for each applied meteorological forcing. Values are given in mm/year averaged over the modelling period.

Bernath (1989)	Grimsel	MS _{grid}	ERA5-Land	ERA5-Reanalysis
131-240	179.5	173.1	181.9	206.5

S1.3. Mean annual water balance components

Table S4: Mean annual Q (total runoff), Snow melt, Ice melt, ET (Evapotranspiration) for each experiment. Values are averaged to annual means over the modelling period and given in mm/year.

Experiment 1	Single-data-calibration				Mutli-data-calibration			
	Q	Snow melt	Ice melt	ET	Q	Snow melt	Ice melt	ET
Grimsel	2251	1200	407	-176.4	2344	1193	485	-179.5
MS _{grid}	1861	899	438	-175.7	2129	1061	474	-173.1
ERA5-Land	1966	891	408	-179.6	2318	1120	448	-181.9
ERA5-Reanalysis	1858	844	439	-203.9	2228	1070	486	-206.6
Experiment 2								
100 m	2331	1187	485	-173.3	2331	1187	485	-173.3
200 m	2314	1180	475	-174.9	2314	1180	475	-174.9
1000 m	2348	1110	509	-170.4	2348	1110	509	-170.4
2000 m	1992	1022	419	-186.3	2223	1048	600	-180.6
3000 m	2809	1377	447	-169.2	1932	856	364	-172.5

S2. Supplementary Figures

S2.1. Spatial resolution of precipitation

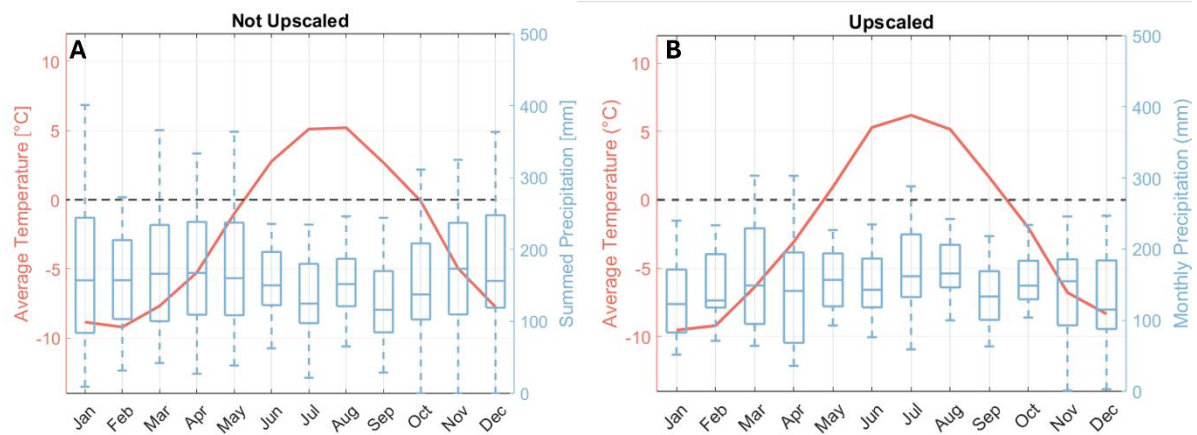


Figure S1: Average monthly temperature and precipitation from the MSgrid for the period 2000-2022. (A) Temperature and precipitation from the products original spatial resolution (1 km) aggregated over the catchment area. (B) Temperature and precipitation aggregated over the catchment area after degrading the products to the 30 km resolution of the coarsest meteorological products used in this study. In both panels temperature was then corrected to the mean catchment elevation using product-specific monthly constant temperature lapse rate provided in Table S1. Precipitation is plotted as the mean catchment precipitation.

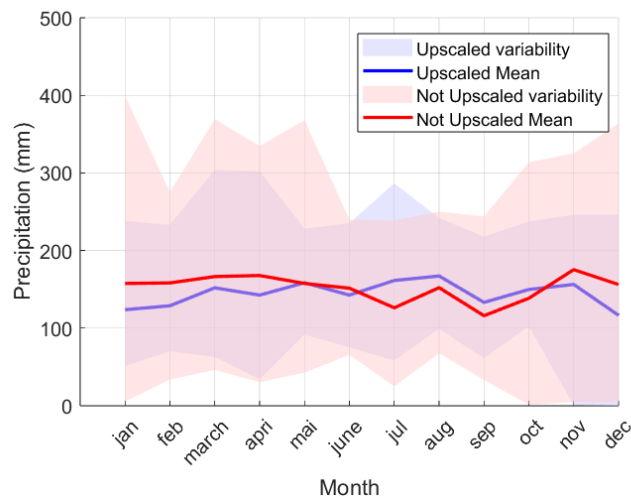


Figure S2: Comparison between the mean 2000-2022 precipitation from the MSgrid product for both the upscaled (blue) and not upscaled (red) methods. The coloured area shows the interannual variability of precipitation, while the line corresponds to the mean precipitation.

S2.2. Uncalibrated model results

To isolate the effect of the meteorological forcing itself, we have added these figures with uncalibrated model runs. In this setting “uncalibrated” means that we did not re-calibrate for every applied forcing product but instead used the parameter combination obtained from a default run (in this case the in which the model is forced with the Grimsel station data, which can be considered to be the most accurate meteorological information available for our study area) to all other model runs too, no matter the forcing product.

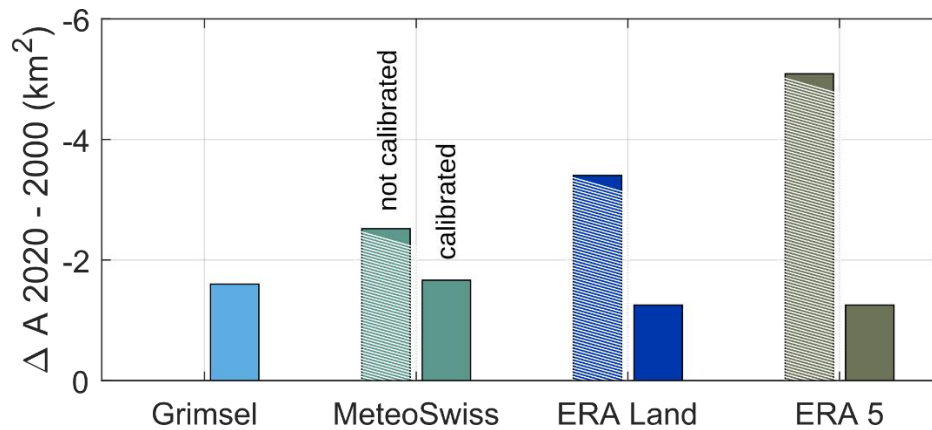


Figure S3: Comparison of the glacier area change in the period of 2000-2022 obtained for each of the applied forcing products of Experiment 1 when not calibrated (left bars) and when calibrated (right bars). For this sensitivity analysis, “Grimsel” is the default, thus only the calibrated result is shown.

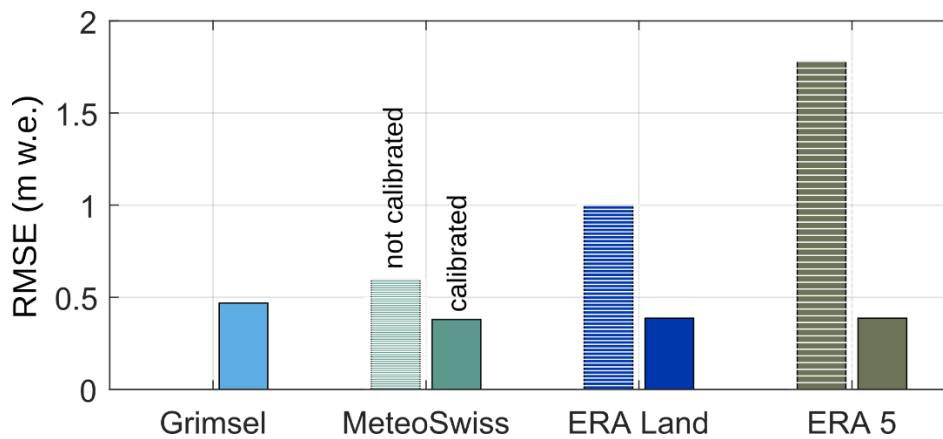


Figure S4: Comparison of the RMSE between the modelled and observed annual glacier-wide mass balance (2007-2022) for all forcing datasets in Experiment 1. The model runs with (right bars) and without (left bars) calibration is shown. For the sensitivity analysis, “Grimsel” is the default, thus only the calibrated result is shown.

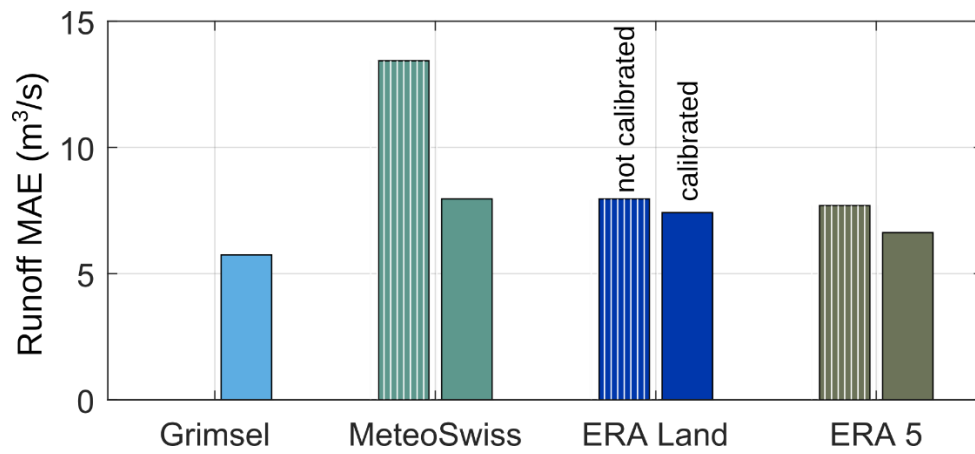


Figure S5: Comparison of the MAE in modelled annual runoff (2001-2021) relative to observations for all forcing datasets in Experiment 1, both with (right bars) and without (left bars) calibration. For this sensitivity analysis, “Grimsel” is the default, thus only the calibrated result is shown.