Supplemental Information

1. Additional Information about the approach used for downscaling

This study used 2 datasets: the Livneh dataset with a spatial resolution of about 7km^2 and the Merra dataset with a resolution of ~ 70x55km^2. Because this latter resolution was deemed as being to coarse for adequately modelling snow related processes, it was decided to downscale this dataset.

Initially, it was sought to downscale the data using a quantile mapping approach using the Livneh data as reference. However, this would not allow to make comparisons between both datasets. Because of this, it was decided to use just simple correction factors for temperature and precipitation based on available monthly data.

This data is provided by Wang et al. (detailed reference in the main text). It provides monthly data using observed measurements for three decades. The tool does not provide the information for each year, but a monthly average value for each decade. It is accessible with a tool that provides monthly data for any point supplied by the user. Monthly data was downloaded for the center of each Livneh and Merra cell in each decade. The relationships between the large Merra cell and each of the small Livneh cells inside it, were used for correcting the information of each of the smaller cells.

The approach used here for downscaling the data is very crude, as it corrects daily data based on the monthly deviations between the large and small cells. There are much better approaches for downscaling climate data at low spatial resolutions. However, all statistical downscaling approaches require the use of other datasets that can be used for extracting the statistical properties of the point of interest. This makes the assessment of the datasets more difficult, as their performance will depend on both, the original dataset and the dataset that is used in the downscaling.

Considering the large number or available datasets, it is probably best to work with datasets that already have an adequate resolution for the intended purpose.

Different datasets should be compared at their original spatial resolution or after having downscaled both of them with the same approach.

2. Nash-Sutcliffe coefficient for the validation period

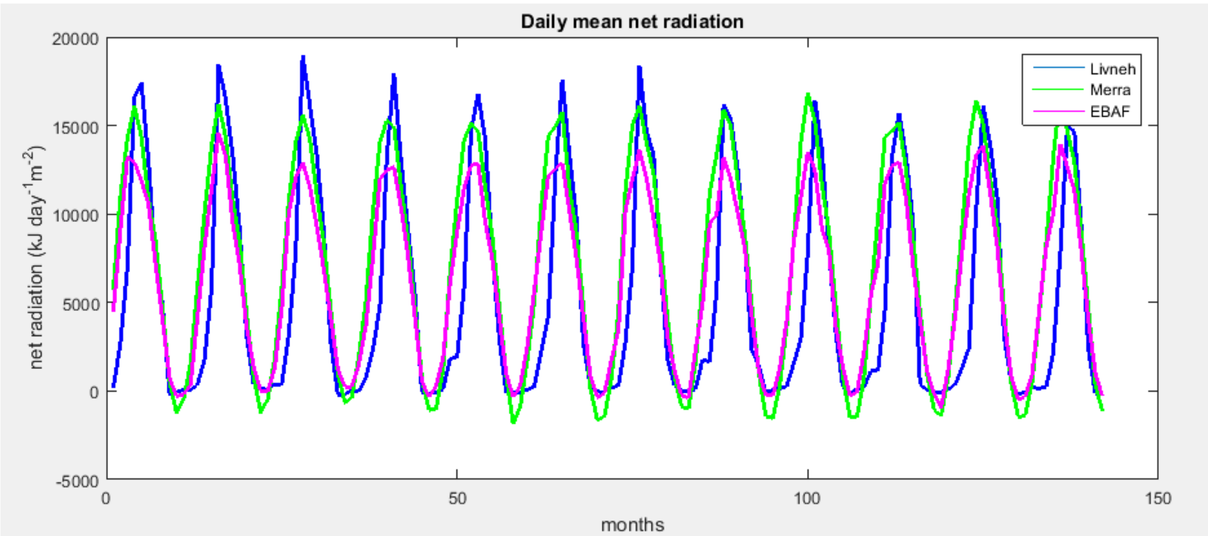
The following table shows the value of the Nash-Sutcliffe coefficient for the M4 model during validation:

% pp as snow	Livneh				Merra			
	Tb	TR	Eb	Wa	Tb	TR	Eb	Wa
<20	0.58	0.57	0.59	0.57	0.55	0.53	0.45	0.53
20-40	0.63	0.62	0.63	0.60	0.65	0.51	0.42	0.56
40-60	0.60	0.53	0.66	0.52	0.69	0.32	0.35	0.46
>60	0.80	0.71	0.76	0.56	0.83	0.13	0.34	0.50

3. Comparing Merra and Livneh net radiation with the EBAF product

Ceres is an experiment carried out by NASA for investigating the earth radiation budget. Among the datasets it provides is the Energy Balanced and Filled (EBAF) datasets. The EBAF-Surface Product Features provides information that can be used for comparing the MERRA and Livneh datasets. The considered EBAF variable was the surface all-sky net monthly radiation ('sfc_net_tot_all_mon'). The data is provided at a 1 degree resolution (~111 km).

The following plot shows the daily mean net radiation for the catchment 06622700 (area=99km^2)



The EBAF radiation seems to agree better with the MERRA-2 data than with the Livneh data after the winter when there is a disagreement between the Livneh and MERRA radiations that is relevant for snowmelt modelling.

An explanation for the better performance achieved with the Livneh dataset might be its improved adaptation to the local conditions. As the Livenh datasets is obtained through interpolation of measured data and using known relationships between the climate variables and topographic properties, it might be that this dataset, at a higher resolution, is better at representing the local conditions.