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Influence of sub-kilometer precipitation datasets on simulated snowpack and glacier winter balance in alpine terrain.

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Capturing spatial and temporal variabilities of meteorological conditions at fine scale is necessary for modelling snowpack and glacier winter mass balance in alpine terrain. In particular, precipitation amount and phase are strongly influenced by the complex topography. In this study, we assess the impact of three sub-kilometer precipitation datasets (rainfall and snowfall) on distributed simulations of snowpack and glacier winter mass balance with the detailed snowpack model Crocus for winter 2011-2012. The different precipitation datasets at 500-m grid spacing over part of the French Alps (200*200 km^2 area) are coming either from (i) the SAFRAN precipitation analysis specially developed for alpine terrain, or from (ii) operational outputs of the atmospheric model AROME at 2.5-km grid spacing downscaled to 500 m with fixed lapse rate or from (iii) a version of the atmospheric model AROME at 500-m grid spacing. Others atmospherics forcings (air temperature and humidity, incoming longwave and shortwave radiation, wind speed) are taken from the AROME simulations at 500-m grid spacing. These atmospheric forcings are firstly compared against a network of automatic weather stations. Results are analysed with respect to station location (valley, mid- and high-altitude). The spatial pattern of seasonal snowfall and its dependency with elevation is then analysed for the different precipitation datasets. Large differences between SAFRAN and the two versions of AROME are found at high-altitude. Finally, results of Crocus snowpack simulations are evaluated against (i) punctual in-situ measurements of snow depth and snow water equivalent, and (ii) maps of snow covered areas retrieved from optical satellite data (MODIS). Measurements of winter accumulation of six glaciers of the French Alps are also used and provide very valuable information on precipitation at high-altitude where the conventional observation network is scarce. This study illustrates the potential and limitations of high-resolution atmospheric models to drive simulations of snowpack and glacier winter mass balance in alpine terrain.