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Potential benefits of using regional climate model output to drive a snow model over the Austrian Alps

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An evaluation is undertaken of the accuracy with which the Joint UK Land Environment Simulator (JULES) and the Hadley Centre Regional Climate Model simulate snow cover and depth. The objective of this study is to evaluate the potential benefits of using regional climate model data to drive a large-scale model of snow accumulation and melt. The JULES model provides the facility to diagnose the thermal and hydrological state of the land surface and soil given time-varying inputs of air temperature, wind speed, humidity, shortwave and long-wave radiation, and precipitation. The observed dataset used in this study consists of daily snow depths measurements at 601 climate stations with more than 15 years of observations in the period from January 1976 to December 2000. In this study, the JULES model was driven using two datasets at 25 km horizontal resolution: one produced using the UK Met Office Hadley Centre regional climate model, HadRM3-P (RCM), the other in which RCM precipitation and air temperature data were replaced with observed values (RCM+PT). The results indicate good agreement between the land-surface model simulations and snow observations at climate stations. The median accuracy indices for all 601 stations were 89% and 91% for the RCM and the combined RCM+PT driving datasets, respectively, with only a small inter-annual variation. In contrast, the differences between modelled and measured snow depth were much larger. The median values of mean snow depth bias were similar, -0.4 cm for the RCM and -1.2 cm for the RCM+PT, however, the RCM simulation was found to significantly overestimate the observed snow depth at more than 25% of climate stations. We note that even if snow cover can be simulated with a high degree of accuracy, this should not imply a similarly high degree of accuracy in the simulation of snow depth. Model performance was poorest in regions of significant topographic heterogeneity and our findings suggest that the most promising additional model developments should be directed towards computationally-efficient representation of sub-grid topography. Our findings indicate that regional climate models provide a useful alternative source of driving data for use in snow simulations in ungauged basin, although for accurate simulation of snow depth, bias correction of precipitation amounts may be required, especially in mountainous terrain.