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Snowpack modelling in central Italy: analysis and comparison of high-resolution WRF-driven Noah LSM and Alpine3D simulations

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Italy is a territory characterized by complex orography. Its main mountain chains are the Alps, which identify the northern Italian border, and the Apennines, which cross the entire Italian peninsula ranging from north-west to south-east. The major Apennines peaks reach almost 3000 meters and are located in central Italy, in the Abruzzo region. The near Mediterranean sea is an important source of moisture, which permits to this region to experience a substantial snow cover during winter. Thanks to the orientation of the Apennines chain and the height of its peaks the Abruzzo region is characterized by different climate types. This affects the precipitation patterns and the snowpack evolution, resulting in high regional variability of the snow cover. The goal of this study is to investigate the snow cover evolution in the Abruzzo region, using and comparing different snowpack models. To this end we have used the Weather Research and Forecasting (WRF) model to drive the Noah Land Surface Model (LSM) and the sophisticated three-dimensional snow cover model Alpine3D to simulate the snow cover evolution at regional scale. Noah LSM is already on-line coupled with WRF, but this is not the case for Alpine3D. Thus we have modified and used the interfacing library MeteoIO to force Alpine3D with the meteorological data simulated with WRF, off-line coupling the two models. We have validated the WRF simulation using a dense network of automatic weather stations (AWS), obtaining good agreement between simulated and observed data. We have found that the snow depth simulated with Noah LSM presents a negative bias, caused by the inability of the model to reproduce correctly the snow densification rate. Instead, Alpine3D is capable to better reproduce the observed densification rate, thanks to its more detailed description of the snow metamorphism processes. However, the snow depth simulated with Alpine3D presents a negative bias, caused by an underestimation of the new snow depth, which has a negative impact on the entire simulation.