



Present and future snow cover in the alps: Using MODIS satellite observations to evaluate and bias correct the EURO-CORDEX regional climate model ensemble

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Snow is a key environmental parameter in mountains, and in this changing climate reductions in snow are expected. Traditionally, future estimates of snow are based on dedicated snow/hydrological models forced by climate projections, which, however, are computationally intensive and which decouple hydrology from climate forcing. Recently, regional climate models (RCM) have been used as an alternative, although snow is only an auxiliary parameter in RCMs and not as accurately represented as compared to dedicated snow models. Nonetheless, RCMs encompass the climate-hydrology feedbacks, cover large areas, and have become available in moderate horizontal resolutions. Here, we compare observed snow cover (from MODIS satellites) over the whole Alps to the five EURO-CORDEX RCMs that provide snow cover as output. The comparison is done using the evaluation run of the RCMs, which is forced by ECMWF ERA-INT, and at the RCM native resolution of 0.11° that corresponds to approximately 8.5km by 12.5km in the Alps. We found a spatially and seasonally heterogeneous bias in snow cover, which can be partly explained by the temperature bias and the orographic smoothing in the EURO-CORDEX RCMs. The highest biases can be found in mid-altitudes (1000-1500m) and in spring and fall, which correspond to the spatial transition zones and temporal transition times. Moreover, there are large differences between the various RCMs: DMI-HIRHAM5 produces unrealistically low values of snow cover (at least in the alps), KNMI-RACMO22E generally overestimates snow cover, while the others (CLMcom-CCLM4-8-17, IPSL-INERIS-WRF331F, SMHI-RCA4) have the lowest bias. Next, we applied a statistical bias correction, which results in a model ensemble view of future bias corrected snow cover for the whole Alps until 2100 for the RCP 4.5 and 8.5 scenarios, with 12 and 13 models (GCM-RCM combinations, excluding DMI-HIRHAM5), respectively. These are the first results of CliRSnow, a project that aims at providing bias corrected and downscaled projections of snow cover for the whole Alpine region until 2100. This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 795310.