Geophysical Research Abstracts
Vol. 19, EGU2017-15765, 2017
EGU General Assembly 2017

High-resolution dynamical downscaling of reanalysis data and coupling to a distributed hydrological model in high alpine terrain – a case study in the Berchtesgaden Alps

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High-resolution dynamical downscaling of ERA-Interim reanalysis data is performed for the high alpine region of the Berchtesgaden Alps using the regional climate model (RCM) WRF. The spatial resolutions of the two nested RCM model domains are 15 km and 5 km respectively. The RCM data is subsequently coupled to the distributed hydrological model (HM) WaSiM using several bias correction methods. A gridded observation dataset (REGNIE, German Weather Service - DWD), meteorological data from a dense station network in the region, and runoff gauge data are used to validate the RCM and HM results.

The RCM results of both model domains as well as the forcing data are compared to observations on an hourly, daily and monthly basis. The focus is on the variables necessary to force the HM, which are temperature, humidity, precipitation, wind speed and global radiation. The comparisons reveal that the high spatial resolution of 5 km is necessary to reproduce small scale spatial variations in the complex alpine terrain. The RCM simulations show an added value compared to the forcing atmospheric data by improving absolute values and temporal dynamics of the meteorological variables, especially for precipitation. However, it is shown that the spatial resolution is still not sufficient to cover and reproduce all spatial heterogeneities in the catchment, and that there are still biases in the RCM data. Therefore, several statistical bias correction methods are used to correct the RCM data for biases and elevation effects. The HM is subsequently forced using the corrected data, and model results are compared to runoff gauge data. The results show that regional dynamical downscaling in alpine regions has to be performed in very high spatial resolutions in order to reproduce small scale spatial variations and to reduce model biases. Despite these improvements, subsequent bias correction of the RCM data is still necessary to facilitate meaningful hydrological predictions.