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Coupling climate and hydrological models: Requirements for representing floods in small to medium sized catchments

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This paper presents results coupling (one-way) two different re-analysis (ERA-Interim) driven regional climate models (WRF and COSMO-CLM) using different grid resolution (0.44°, 0.11°, 0.03° grid spacing) with a spatially distributed hydrological model (1 km^2 grid) which is in use for operational flood warning in small and medium sized catchments (30 km^2 - 1000 km^2) in Austria. The aim is to determine general requirements for bridging the scale gap, in particular, the added value of convection-permitting simulations with 0.03° ($\sim$ 3 km) grid and 1 hour time resolution, and the application of a novel bias correction method (Scaled Distribution Mapping - SDM, Switanek et al., 2016). Hindcast simulations (1989-2010) of the small multi-model ensemble are evaluated in terms of accurately representing flood frequency, seasonality, as well as other flood event characteristics, such as weather type, antecedent soil moisture, etc.. The results show, that for small catchments (< 200 km^2) a resolution of 3 km is essential to accurately simulate the magnitude of flood events. Also, due to the short response times in the small sub-catchments a time step of 1 hour is required. In the larger catchments a resolution of 0.11° ($\sim$ 12.5 km) and 0.44° ($\sim$ 50 km) and a 3 hour time step already yields statistically satisfying results. Biases in precipitation and temperature, which sometimes lead to unrealistic hydrological conditions, are corrected by the SDM method. This improves results in magnitude and seasonality of annual maximum floods in all settings except for the small catchments (< 100 km^2). This is also due to the aggregated 3 hour time step used in the bias correction. Conclusions and recommendations are given for a model and downscaling chain for an accurate representation of floods depending on the catchment size.

Switanek, M.B., P.A. Troch, C.L. Castro, A. Leuprecht, H-I. Chang, R. Mukherjee, and E.M.C. Demaria (2016), Scaled distribution mapping: a bias correction method that preserves raw climate model projected changes. Hydrol Earth Sys Sci Discuss; doi:10.5194/hess-2016-435.

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