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Climate change signal of convective precipitation through cloud-resolving climate model simulations

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Climate change is a global phenomenon but its impact differs substantially on local and regional scales. Regional Climate Models (RCM) are crucial to study the effect of climate change at regional level and to create effective adaptation strategies. Much of the debate is now focusing on the advantage of cloud-resolving scale versus coarser resolution. On one side the higher resolution could help overcoming uncertainties related with the convective parameterisation; on the other it requires high computational cost. In this context, long-term simulations (30 years) were performed with RCM COSMO-CLM over the state of Baden-Württemberg in southwestern Germany, a region known for its abundant orographically induced convective precipitation. The model was driven with both ERA40 reanalysis data and ECHAM5 for the recent past (1971-2000) and with ECHAM5 (A1b scenario) for the near future (2021-2050). A triple nesting strategy was applied to reach 2.8km resolution from the GCM resolution. For the finest nest, most parameterisations of convection were turned off. The study analyses first the effects of different forcing (ERA40 versus ECHAM5) and then focus on the identification of variations in the precipitation field between recent past and near future. The ERA40 driven simulation clearly shows the advantage of using a cloud-resolving scale when simulating convective events, with significant improvements in e.g. the diurnal precipitation cycle and physical consistency between convective precipitation and the atmospheric processes affecting it. In addition, it highlights the importance to increase the temporal resolution of the analysis together with the spatial resolution. The improvements of the diurnal cycle and intensity distribution of precipitation is retained in the ECHAM5 simulations, as these are mainly controlled by local processes, and not so much by the boundary data. An extensive investigation of the precipitation pattern is performed at different temporal scales for the ECHAM5 driven simulations to find out to what extent convective precipitation is affected by a changing climate.