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On the evidence of orographical modulation of regional fine scale precipitation change signals: The Carpathians

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This study investigates the greenhouse gas-induced winter and summer precipitation change signals over the Carpathian region with special focus on topographical effects and underlying processes. Six high-resolution (∼12 km grid spacing) regional climate model projections - as members of EURO-CORDEX and Med-CORDEX initiatives - are analyzed for the future period 2070-2099 with respect to the reference period 1976-2005 under the RCP8.5 scenario. We found that the Carpathian Mountains significantly affect the seasonal precipitation change patterns both in winter and summer, but with different underlying mechanisms. In the winter, the topographic forcing is mostly of dynamical nature. It is tied to the topographic shadowing effect related to changes in wind circulations, which causes an increase in precipitation on the upwind side of the mountains with respect to the main direction of the wind change. In the summer, the topographic forcing is mostly of thermodynamical nature, being related to an increase in convective potential over the mountain peaks associated to high elevation heating and moistening. This process is similar to that found previously for the Alps, with the important difference that it is of lower intensity, because of the lower elevations of the Carpathians compared to the Alps. In fact, while over the Alps the topographic forcing actually reversed the sign of summer precipitation change over the mountain peaks (from negative to positive), in the Carpathians, it only attenuates the negative summer precipitation signal. Our results draw attention to the fact that the high-resolution representation of topography in climate models is crucial for the provision of fine scale precipitation projections.