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The use of regional climate models for estimating past and future precipitable water vapor and extreme precipitation over Ethiopia

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There exist well known relations between Precipitable Water Vapor (PWV) and extreme rainfall which are of prominent importance in the context of climate change. These relations, however, are mostly established in mid-latitudes and for flat terrain. Ethiopia, however, is located in the tropics and features a complex orography, both of which may modulate these relations. We investigate PWV and extreme precipitation over Ethiopia by use of Regional Climate Models (RCMs) from the Coordinated Regional Climate Downscaling Experiment (CORDEX). We first evaluate the RCMs by comparing their annual PWV cycles with the ones obtained from Global Positioning System observations and reanalysis in the past. Additionally, we focus on the behaviour of PWV before and after a heavy-rainfall event. It is found that there are two characteristic timescales, both for the build-up and for the decline around the event of the heavy precipitation: a timescale of about 2 days and a longer timescale that extends beyond ten days which seems unreported in the literature. The RCMs are capable of reproducing the PWV annual cycle and the spatial variability. However, there is a predominantly dry bias that strongly increases with elevations. The RCMs reproduce well the spatial differences of the PWV anomaly peak during a heavy-rainfall event but overestimate the timescales of build-up and decline. Future PWV-changes scale linearly with the near-surface temperature changes at a rate of 7.7% per degree warming and locally increase up to 40% for the end-of-the-century RCP8.5 scenario. Changes in rainfall extremes, on the other hand, do not follow this trend especially in north-western Ethiopia, potentially caused by an overall decrease in rainfall in that region.