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Sensitivity of the hydrological cycle to corrections of the sea surface temperature biases over southern Africa in a regional climate model

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High resolution climate change projections of the hydrological cycle are of particular importance for southern Africa since possible changes of the climate will affect the water availability and thus the lives of the people in this region. In order to obtain high resolution climate change information for the future, regional climate models (RCMs) are used to downscale climate change projections generated with general circulation models (GCMs). These GCMs are usually coupled with an ocean model providing ocean parameters such as sea surface temperature (SST) needed by GCMs. The hydrological cycle in southern Africa is strongly affected by the moisture transport from the Atlantic and Indian Ocean and, consequently, from their SSTs. In the Atlantic Ocean, the cold up-welling Benguela current flows up the west coast of southern Africa whereas the Agulhas current flows down the east coast in the Indian Ocean. Deficiencies in the description and representation of such currents in ocean models cause biases in simulated SSTs and affect the moisture uptake of lower air layers.

Initially, a historical simulation conducted with the general circulation model ECHAM6 was downscaled with the regional climate model REMO to a spatial resolution of 50 x 50 km^2 for the whole African continent. To analyse the sensitivity of the hydrological cycle to SST corrections, five experiments were carried out with REMO covering five simulation years. The five sensitivity experiments were downscaled with REMO to a spatial resolution of 25 x 25 km^2 for southern Africa using the coarser simulation as input. In the first experiment, the entire SST in the coupled ECHAM6 simulation both of the Atlantic and Indian ocean was replaced by the SST from the ERA-Interim reanalysis data, and in two another ones, only the Atlantic Ocean with the Benguela current and the Indian Ocean including the Agulhas current were replaced by the SST from the ERA-Interim reanalysis data, respectively. Besides a control experiment, in which the SST from the coupled ECHAM6 simulation has been kept unchanged, an experiment with perturbed atmospheric conditions was performed with REMO to assess the internal model variability. The results show a distinct impact of the SST biases on the hydrological cycle in southern Africa. In particular, the contribution of the SST bias of the Atlantic Ocean is stronger, which should be taken into account for climate change projections.