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An original statistico-dynamical modeling chain integrating convection-permitting atmospheric models with process-based hydrological modeling for Africa

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An original modeling chain that integrates regional climate simulations for precipitation, debiasing methods, stochastic spatio-temporal disaggregation, and hydrological modeling is presented and applied to the intertropical zone in West Africa. Previous regional climate models (RCMs) for Africa have not integrated the convective processes that commonly govern precipitation in the tropics. RCMs also tend to be biased, and outputs are not at a small enough scale for use in hydrological and agricultural applications. The newly-developed RCM CP4 is unique in that it is the first convection-permitting model to provide precipitation outputs over Africa. Simulations currently exist for 10 years in the present period and 10 years in a future period (approximately 2080). It is also at a small enough spatial resolution (4.5km) for use in impact studies. In this study, CP4 outputs are debiased using an adaptation of the CDFt method, with 28 years of data from the AMMA-CATCH network in southwest Niger as the control set. CP4 present and future outputs are used to calibrate a stochastic rainfall simulator "Stochastorm," which is used both as an evaluation tool to compare present and future precipitation characteristics and to generate precipitation scenarios. Finally, the simulation outputs are used as inputs to a process-based hydrological model for a mesoscale catchment within the Sahelian region of West Africa. The future CP4 simulations display a moderate decrease in the number of events at the core of the season but a significant increase in the magnitude and variability of event rainfall. In particular, there is an increase in extreme events. Annual cumulative rainfall increases by 64%. Results show the potential of using convection-permitting models for evaluating the hydrological impact of climate change in Africa.