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Downscaling of a seasonal ensemble forecast at the convection-permitting resolution over the Horn of Africa using the WRF model

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Studies have shown the benefits of convection-permitting downscaling at the seasonal scale using limited-area models. To evaluate the performance with real forecasts as boundary conditions, four members of the SEAS5 global ensemble were dynamically downscaled over Ethiopia during June, July, and August 2018 at a 3-km resolution. We used a multi□physics ensemble based on the WRF model to compare the effects of boundary conditions and physics parametrization producing 16 ensemble members. With ECMWF analyses as a reference, SEAS5 averaged to a +0.17°C bias over Ethiopia whereas WRF resulted in +1.14°C. With respect to precipitation, the WRF model simulated 264 mm compared to 248 mm for SEAS5 and 236 mm for GPM-IMERG. The maximum northward extension of the tropical rain belt decreased by about 2° in both models. Downscaling enhanced the ensemble spread in precipitation by 60% on average, correcting the SEAS5 underdispersion. The WRF ensemble spread over Ethiopia was mostly generated by the perturbed boundary conditions, as their effect is often 50% larger than the physics□induced variability. The results indicate that boundary condition perturbations are necessary, although not always sufficient, to generate the right amount of ensemble spread in a limited-area model with complex topography. The next step is to use specific methods to calculate the added value provided by the downscaling.