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On the added value and sensitivity of WRF to driving conditions over CORDEX-Africa domain

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The assessment of the climate variability over Africa has recently attracted the interest of the regional climate downscaling research community. The main reasons are not only because Africa is a climate change hot-spot, but also due to the low capacity of this region for the adaptation and mitigation under negative impacts and its direct dependency on its socio-economic sustainability of the climate variability. Therefore, improvements in the understanding of the African climate could help the governments in decision-making. Under this umbrella, regional climate models (RCMs) are promising tools to assess the African regional climate. The main advantage of the RCMs, with respect to global reanalysis datasets, is the higher detail provided by the increased resolution which implies a better representation of land-surface interactions and atmospheric processes. However, the confidence on the RCMs strongly depends on the reduction/bounding of uncertainties. One of these sources of uncertainties is associated with the selection of the boundary conditions for driving the regional models.

In this work, two identical CORDEX-compliant simulations have been performed over Africa with the unique difference of being driven by two different reanalyses. The reanalyses used were the European Centre for Medium Range Weather Forecasts Interim reanalysis (ERA-I) and the Japanese 25-year reanalysis (JRA-25) by the Japanese Meteorological Service. Both reanalyses have identical temporal resolution (6-hr) but different spatial grid resolution, 0.75 and 1.25 degrees, respectively. The regional model used was the Weather Research and Forecasting Model (WRF). The numerical experiments encompass the period 1989-2010 covering the Africa-CORDEX domain with a 50 km horizontal spatial resolution and 28 vertical levels up to 50 hPa. The WRF simulations are compared between them and against observations. For the mean and maximum temperature the CRU monthly time series (0.25deg) from Climatic Research Unit of the University of East Anglia are used. The precipitation is compared against the Tropical Rainfall Measuring Mission Project (TRMM) monthly data (0.25deg).

The results depict that none of the reanalyses used outperforms the other in representing the African climate, since their performance depends on the variable, season and region assessed. The simulations show a noticeable disagreement for 2-m temperature in north-western Africa, where WRF-JRA tends to underestimate this variable mostly in winter and spring. For the monthly mean daily maximum temperature, WRF-JRA tends to overestimate the temperature in the Sahel in summer and in the border between Angola and Namibia in Winter. When comparing with CRU observations, there is a remarkably better spatial representation for the WRF-EI simulation in the North of Africa. However, the behaviour of WRF-EI and WRF-JRA is similar in the South of Africa. Intra-annual variability is well represented except in Atlas mountains where WRF-JRA underestimates temperature. Regarding precipitation, the main differences appear over the Sahel region in JAS and in the Congo area during JFM. The comparison with the TRMM data shows a better agreement with the WRF-JRA simulation except during summer in the Sahel region. The monthly annual cycle is well captured, except in Ethiopian highlands and Northern West Africa where WRF-JRA (WRF-EI) underestimate (overestimate) the annual cycle.