

The impact of convection in the West African monsoon region on global weather forecasts – explicit vs. parameterised convection simulations using the ICON model

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The West African monsoon is the driving element of weather and climate during summer in the Sahel region. It interacts with mesoscale convective systems (MCSs) and the African easterly jet and African easterly waves. Poor representation of convection in numerical models, particularly its organisation on the mesoscale, can result in unrealistic forecasts of the monsoon dynamics. Arguably, the parameterisation of convection is one of the main deficiencies in models over this region. Overall, this has negative impacts on forecasts over West Africa itself but may also affect remote regions, as waves originating from convective heating are badly represented.

Here we investigate those remote forecast impacts based on daily initialised 10-day forecasts for July 2016 using the ICON model. One set of simulations employs the default setup of the global model with a horizontal grid spacing of 13 km. It is compared with simulations using the 2-way nesting capability of ICON. A second model domain over West Africa (the nest) with 6.5 km grid spacing is sufficient to explicitly resolve MCSs in this region. In the 2-way nested simulations, the prognostic variables of the global model are influenced by the results of the nest through relaxation.

The nest with explicit convection is able to reproduce single MCSs much more realistically compared to the stand-alone global simulation with parameterised convection. Explicit convection leads to cooler temperatures in the lower troposphere (below 500 hPa) over the northern Sahel due to stronger evaporational cooling. Overall, the feedback of dynamic variables from the nest to the global model shows clear positive effects when evaluating the output of the global domain of the 2-way nesting simulation and the output of the stand-alone global model with ERA-Interim re-analyses. Averaged over the 2-way nested region, bias and root mean squared error (RMSE) of temperature, geopotential, wind and relative humidity are significantly reduced in the lower troposphere. Outside Africa over the Atlantic or in Europe the effect of the 2-way nesting becomes visible after some days of simulation. The changes in error measures are not as clear as in the nesting region itself but still improvements for some variables at different altitudes are evident, most likely due to a better representation of African easterly waves and Rossby waves.

This work shows the importance of the West African region for global weather forecasts and the potential of convective permitting modelling in this region to improve the forecasts even far away from Africa in the future.