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The impact of convection in the West African monsoon region on weather forecasts in the North Atlantic-European sector

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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 type 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. Such pairs of simulations are conducted using different initialisation data sets and different model versions.

The nest with explicit convection is able to reproduce single MCSs much more realistically compared to the stand-alone global simulations with parameterised convection. This leads to more realistic diurnal cycles of precipitation in the Sahel, a robust result independent of model initialisation and version. The impact of this improvement on larger-scale features like the Saharan heat low or Azores High is less robust and varies between different model versions. Those simulations with stronger interactions between monsoon and heat low dynamics do show a positive impact on the forecasts over the Atlantic Ocean and in Europe: Standard error measures such as bias and root mean squared error (RMSE) of temperature, geopotential, wind and humidity are significantly reduced throughout the troposphere for forecast days 6 to 10, most likely due to a better representation of African easterly waves and Rossby waves. Simulations with a weaker coupling of monsoon dynamics and the Saharan heat low show rather little systematic differences in the error measures outside Africa.

This work shows the potential importance of West African convection for weather forecasts in the North Atlantic-European sector but more work is needed to disentangle the mechanisms of how improvements due to convection permitting modelling are communicated to regions outside of Africa.