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Challenges in Storm Resolving Models: Biases and consistency in the representation of tropical precipitation in the coupled ICON model

Hans Segura, Cathy Hohenegger, Christian Wengel, and Bjorn Steven
Max-Planck-Institute for Meteorology, Hamburg, Germany (hans.segura@mpimet.mpg.de)

State-of-the-art Global circulation models (GCMs) are characterized by the use of parameterization of convection and low spatial resolution, resulting in persistent biases in the representation of tropical precipitation. Now, Storm Resolving Models (SRM), a new generation of global climates models which, due to their high spatial resolution (<10 km) do not rely on a convective parameterization, may allow bypass some of these well-known precipitation biases. In this study, we present results of coupled SRM simulations conducted with the ICON model and integrated on seasonal time scales (SRM-ICON). We consider three different versions of the model (SRM-ICON16, SRM-ICON29, SRM-ICON52). From SRM-ICON16 to SRM-ICON29, the scheme of the vertical mixing was changed (from TEE to Smagorinsky), along with its vertical length. In addition, a problem in the ocean-atmosphere coupling regarding momentum transfer was fixed. SRM-ICON52 differs from SRM-ICON29 in the vertical coordinates in the ocean (different discretization), land initialization, and a bug in the sensible heat flux calculation was solved. Using these three versions of SRM-ICON, we aim to understand which aspects of tropical precipitation are robust, even to model bugs, and are directly improved just by using an explicit representation of convection. We find that precipitation over land is well reproduced compared to observations and robust across the three versions. Monsoon areas in the longest run of SRM-ICON are well represented when compared with GPM for the year 2020. Moreover, the meridional pattern of precipitation during the wet season of the North American, the South African, and the Australian monsoon systems, as well as the Maritime Continent in SRM-ICON, show similar characteristics to the observed in GPM. Also, the diurnal cycle of precipitation over land and ocean can be reproduced by SRM-ICON and is robust among the three versions. In contrast, the ITCZ structure over the ocean is highly sensitive to the model version and not necessarily improved compared to low-resolution simulation. Finally, we verified that changes in total tropical precipitation amounts among the three versions of SRM-ICON are consistent with differences in atmospheric radiative cooling, and can be mainly explained by the net longwave flux divergence.