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Disentangling the mechanisms of wave-convection coupling in the tropics

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Tropical weather prediction remains one of the main challenges in atmospheric science due to a combination of insufficient observations, data assimilation algorithms optimized for midlatitudes and large model errors. Due to a strong dependency of many people in the tropics on rainfall variability, combined with a high vulnerability, improved precipitation forecasts have the potential to create substantial benefits in areas such as agriculture, water management, energy production and disease prevention.

Recent studies found that the coupling of equatorial waves to convection is key to improving weather forecasts in the tropics on the synoptic to subseasonal timescale but many models struggle to realistically represent this coupling. Here we use aquaplanet simulations with the ICOsahedral Nonhydrostatic (ICON) model with a 13 km horizontal grid spacing to study the underlying mechanisms of convectively coupled equatorial waves in an idealized framework. We filter the divergence at 200 hPa using a standard wave filtering tool tapering to zero that allows us to identify dynamical characteristics of convectively coupled waves in our simulations. To diagnose thermodynamical aspects of wave-convection couplings, we compare the obtained waves to the total precipitable water and analyze the spatial variance of the budget analysis for column-integrated moist static energy. The same filtering tool and diagnostics are carried out on a realistic ICON simulation with a 2.5 km horizontal grid spacing from the DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains (DYAMOND) project.

In the future we plan to run and analyze idealized tropical channel simulations with 2.5 km horizontal resolution, i.e. using the same grid spacing as in the DYAMOND simulation. The comparison between the idealized and the realistic simulations identifies mechanisms of wave-convection coupling. In addition, we will apply this set of diagnostics to forecast experiments using different approaches of data assimilation.