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Local Impact of Stochastic Shallow Convection on Clouds and Precipitation in the Tropical Atlantic

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Local impact of a stochastic shallow convection scheme on clouds and precipitation is tested in a case study over the tropical Atlantic on 20th December 2013 using the Icosahedral Nonhydrostatic Model (ICON) of the German Weather Service. ICON is used at a grid resolution of 2.5 km and is tested in several configurations that differ in their treatment of shallow convection. Two versions of a scale-aware stochastic shallow convection scheme are compared to the operational deterministic scheme and a case with no representation of shallow convection. The model is evaluated by comparing synthetically generated irradiance data for both visible and infrared wavelengths against actual satellite observations. The experimental approach is designed to distinguish the local effects of parameterized shallow convection (or lack thereof) within the trades versus the ITCZ.
The stochastic cases prove to be superior in reproducing low-level cloud cover, deep convection and its organization, as well as the distribution of precipitation in the tropical Atlantic ITCZ. In these cases, convective heating in the subcloud layer is substantial, boundary layer depth is increased as a result of the heating, while evaporation is enhanced at the expense of sensible heat flux at the ocean's surface. The stochastic case where subgrid shallow convection is deactivated below the resolved deep updrafts shows that local boundary-layer convection is crucial for a better representation of deep convection. Based on these results, our study points to a necessity to further develop parameterizations of shallow convection for the use at the convection-permitting resolutions and to assuredly include them in weather and climate modelling efforts.