Resolution dependencies of tropical convection in a global cloud/cloud-system resolving model

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The properties of tropical convection are evaluated using one-month long simulation datasets produced by the non-hydrostatic icosahedral atmospheric model (NICAM) using 3.5-, 7-, and 14-km horizontal meshes with identical cloud-microphysics configurations. The simulations are targeted on the 2nd Madden-Julian oscillation (MJO) event observed in the CINDY2011/DYNAMO field campaign. An increase of high cloud fraction at 200 hPa level and a reduction of surface precipitation occur as the horizontal resolution increases, corresponding to the reduction of precipitation efficiency due to the shorter residence time inside stronger updrafts that occur at the higher resolution. The increase of high cloud fraction is followed by the warming of the troposphere, which results in an increase in the column water vapor and an elevation of the freezing level. The total water condensation is decreased at higher resolutions, which is likely due to a balance with the decreased outgoing longwave radiation (OLR). The reproduced MJOs, which accounted for a large portion of the tropical convections, were similar in the 3.5-km and 14-km simulations in terms of eastward propagation speeds and structures, including the characteristic westward tilt of the moisture anomaly with height. However, the amplitude of the anomalous MJO circulation was considerably smaller in the 3.5-km simulation. The robust resolution dependence and the interpretations presented in this study underline the necessity for a resolution-aware cloud-microphysics optimization method that will have value in the coming era of global cloud-resolving simulations.

Keywords: resolution dependency , global cloud-resolving model, tropical convection

