Geophysical Research Abstracts
Vol. 17, EGU2015-2956, 2015
EGU General Assembly 2015

Subgrid Convective Cloud Parameterization for Tropical Cyclone Prediction at Grey-Zone Resolution

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The use of only the explicit microphysics scheme in high-resolution weather prediction models at grey-zone horizontal resolutions (i.e. from one to a few kilometers)is often insufficient to neutralize moist convective instability for the entire grid box because the grid-resolved updrafts may not be strong enough. A consequence of such a problem is that unrealistically-intense grid-size convection may occur in model simulations, which in tropical cyclone simulations can lead to erroneous representation of tropical cyclone development. The use of a conventional subgrid convective cloud parameterization scheme along with the explicit microphysics scheme to alleviate this problem is not appropriate since such a scheme assumes that the subgrid updraft area is much smaller than the model grid size and this assumption becomes invalid when the grid size is a few kilometers or smaller.
This presentation will introduce a subgrid convective cloud parameterization scheme that has been developed at the Shanghai Typhoon Institute in which the aforementioned assumption about the subgrid updraft area is removed. The newly-developed scheme can be used for grid spacing equal to or smaller than a few kilometers to help eliminate moist convective instability for the entire grid point. The scheme behaves similarly to conventional ones when the subgrid updraft area is much smaller than the grid size. As the subgrid updraft area in a grid box approaches the grid size, the parameterized sub-grid convection in the scheme diminishes. A special consideration is taken in the scheme to ensure that a unified formulation of cloud microphysics is applied to both subgrid and grid-resolved clouds. Preliminary results from experimenting with the scheme in the Advanced Research WRF (ARW) model with an idealized tropical cyclone intensification case will be reported in this presentation. It will be demonstrated that the scheme converges (i.e. the parameterized convection diminishes as the updraft area in a grid box approaches the grid size)as the model's horizontal resolution increases. Remaining issues and challenges in refining this scheme for operational models will also be discussed.