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Experimenting with a Convective Parameterization Scheme Suitable for High-Resolution Mesoscale Models in Tropical Cyclone Simulations

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Results from numerical experiments using high-resolution mesoscale models have presented evidence that the use of the explicit microphysics scheme only at grid spacing from few hundred meters to a few kilometers is often not sufficient to neutralize moist instability within the grid box. A consequence of such a problem is that artificial grid-point storms may occur, which in tropical cyclone simulations can lead to erroneous representation of tropical cyclone development. The use of conventional sub-grid convection parameterization schemes to alleviate artificial grid-point storms is not appropriate in this situation since these schemes assume that the updraft area is much smaller than the model grid spacing and this assumption becomes invalid when the grid size is a few kilometers or smaller.

A sub-grid convection scheme suitable for high-resolution mesoscale models has been developed by Grell and Freitas (2013) to remove the aforementioned assumption used in conventional sub-grid convection parameterization schemes. This scheme can be used for grid spacing equal to or smaller than a few kilometers to help sufficiently remove moist instability for the entire grid point. This scheme behaves similarly to conventional schemes when the updraft area is much smaller than the grids size. As the updraft area in a grid box approaches the grid size, the parameterized sub-grid convection gradually diminishes.

This presentation highlights major results from experimenting with this newly developed scheme in the Advanced Research WRF (ARW) model with an idealized tropical cyclone intensification case. We will demonstrate the scheme converges (i.e. the parameterized convection diminishes as the updraft area in a grid box approaches the grid size) using the change of the intensity of parameterized sub-grid convection with the decrease in grid size. We will also discuss the issues and challenges in refining this scheme for its application in operational models.