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Development of an Axisymmetric Tropical Storm Model from PSU/NCAR MM5

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The prediction skill on tropical storms has been improved continually over the past couple of decades through the improvement in forecast models as well as the initial field. No analyses and forecasts from the operational centers have yet enough resolution to fully describe the tropical storms. Therefore, in many operational centers, the initial storm vortex is redefined by various bogus techniques and improved through assimilation of various data in the initial condition. The bogus is an important technique for the tropical storm prediction. It is known that the use of a spin-up bogus vortex, which is consistent with the forecast model, gives better result than a simple bogus vortex, which would not be in good balance with model equations. In many recent theoretical studies, cloud or high resolution mesoscale models are often used to investigate the formation, structure, and dynamics of the eye and eyewall of a storm.

We constructed an axisymmetric high resolution model from PSU/NCAR MM5. An axisymmetric tropical storm model can have many advantages that 1) the fully verified nonhydrostatic equation system is used, 2) the versatile physics options of from the simplest form to the most complex could be used for tests, and 3) the application of the spin-up vortex to the forecast experiments would be easily achieved. For the model verification, we conducted an ideal case experiment after Rotunno and Emanuel (1987). From the model-neutral atmosphere with perturbation wind given with the simplest physical parameterizations, the tropical storm like a vortex is developed similarly from their result. The sensitivity of the formation, structure, and dynamics of the eye and eyewall to the physical processes (planetary boundary, explicit moisture, and radiation) is investigated. For the bogus experiment, we can control the development of the vortex by adding the sea-level pressure and vorticity nudging terms to the prognostic equations. From an appropriate bogus vortex, we may obtain a spin-up vortex which is dynamically consistent with the forecast model. The impact on the forecast is investigated.

Keywords: axisymmetric; bogus; high resolution; mesoscale model; tropical storm.