The impact of vertical resolution on tropical cyclone simulation

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It is well known that horizontal resolution has a great deal of impact on tropical cyclone simulations using numerical weather prediction models. It is relatively less discussed in the literature how vertical resolution affects the solution convergence of tropical cyclone simulations. In this study, the resolved kinetic energy spectrum, the Richardson number probability density function and resolved flow features are used as metrics to examine the behavior of solution convergence in tropical cyclone simulations using the Weather and Forecast Model (WRF). It is found that for convective-scale simulations of a real tropical cyclone case with 3-km horizontal resolution, the model solution does not converge until a vertically stretched vertical resolution approaches 200 layers or more. The results from this study confirm the results from a few previous studies that the subgrid turbulent mixing, particularly, the vertical mixing, plays a significant role in the behavior of model solution convergence with respect to vertical resolution. They also provide a basis for the vertical grid configuration selection for the operational tropical cyclone model of Shanghai Meteorological Service.