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Corresponding Author : Prof. Ming-Jen Yang (mingjen@cc.ncu.edu.tw)

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Title: The Dependence of Simulated Azimuthal-Mean Primary and Secondary Circulations of Hurricane Gloria (1985) on Cumulus Parameterization

Abstract: The development of cumulus parameterization in numerical models started in the 1960s and 1970s (Manabe and Strickler 1964; Kuo 1965, 1974;Ooyama 1971; Yanai et al. 1973; Arakawa and Schubert 1974), and one of the purposes was to represent the effects of cumulus convection within tropical cyclones. Since then, many schemes of cumulus parameterization with various degree of physical complexity are formulated to represent the collective effects of subgrid-scale clouds and precipitation in terms of the grid-scale prognostic variables. With the advance of observational instruments (insitu aircraft measurement, ground-based/aircraft Doppler radar and dropwindsonde observations), detailed three-dimensional kinematic and thermodynamical structures of tropical cyclones are now available. The cumulus parameterization schemes (CPSs) used in tropical cyclone simulations may have significant impacts on simulated primary and secondary circulations, as well as the latent heating and precipitation fields. Following the work of Yang et al. (2000) on sensitivity of Mei-Yu frontal convection to CPSs, this study examines the dependence of simulated azimuthal-mean primary and secondary circulations of a mature hurricane on CPSs. Hurricane Gloria (1985) is chosen to perform evaluation testing, because there are comprehensive analyses of observations from airborne Doppler radar and Omega dropwindsondes to describe its eyewall and synoptic-scale features (Franklin et al. 1993). The fifth-generation Pennsylvania State University—National Center for Atmospheric Research Mesoscale Model (MM5) is used to simulate Hurricane Gloria. The model configuration includes three nesting domains with grid size of 45, 15, and 5 km, respectively; both grid-scale microphysics and subgrid-scale cumulus parameterization schemes are used on 45-km and 15-km domains, and only microphysics parameterization scheme is only on the 5-km grid. Five CPSs chosen for evaluation are the Anthes-Kuo scheme (Kuo 1974; Anthes 1977), the Betts-Miller scheme (Betts and Miller 1986), the Grell scheme (Grell 1993), the original Kain-Fritsch scheme (Kain and Fritsch 1993), and the updated Kain-Fritsch scheme (Kain 2003). Vertical profiles of horizontal divergence and latent heating from tropical cyclone simulation experiments with different CPSs will be compared with observational analyses, using the Stokes's theorem, and the implications of CPS sensitivity in tropical cyclone simulation will be further investigated.

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Co-Authors

No.	Title	First Name	Family Name	Organization
1	Mr.	Quen-Chi	Tung	National Central University