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Impact of Parameterized Warm-Rain Microphysical Processes on Simulated Tropical Cyclone Development

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This is a presentation of a study in which the Weather Research and Forecasting (WRF) model was used to investigate the impact of parameterized warm-rain processes in three bulk microphysics parameterization (MP) schemes on the model-simulated tropical cyclone development. The three MP schemes investigated are the Ferrier single-moment 3-category, the WRF single-moment 6-category (WSM6) and the Thompson double-moment 6-category schemes. By diagnosing the source and sink terms of the hydrometeor budget equations, we found that the differences in the warm-rain production rate, particularly by conversion of cloud water to rain water, contribute significantly to the variations in the frozen hydrometeor production and in the overall latent heat release above the freezing level. These differences in parameterized warm-rain production reflect the basic differences of the schemes in the definition of rain droplet size distribution and consequently in spectrum-dependent microphysical processes such as accretion growth of frozen hydrometeors and their sedimentation. Hydrometeor budget analysis of the three schemes indicates that the assumed pathways to the production of frozen hydrometeors are quite sensitive to the amount of available super-cooled rain water and, thus, the uncertainties in the parameterized warm-rain processes can affect the intensification and structure of the model-simulated tropical cyclone. Results from this study strongly suggest that the differences in the single- and double-moment formulations of the three schemes are not the primary factor causing the schemes to behave differently in the tropical environment. More importantly, model users should be aware of the impact of the assumed hydrometeor size distributions on results when choosing any MP scheme for tropical cyclone simulations.