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Impact of Hydrometeor Fall Velocity Parameterization on Convection: The Perspective of Hydrometeor Population Dynamics

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Hydrometeor fall velocity is a critical parameterized variable in cloud microphysics schemes to control diffusive and coagulation growth, as well as gravitational settling and fallout of hydrometeors in numerical weather and climate models. An accurate parameterization of fall velocity is essential for accurate simulation of precipitation amounts and characteristics of clouds. Despite previous progress over the recent decades, large uncertainties still remain in the parameterization of fall velocity. We will report on a study in which the impact of uncertaintiesin fall velocity parameterization for frozen hydrometeors on an idealized squall line development is revisited from the perspective of hydrometeor population dynamics. We will show that for large precipitating frozen hydrometeors (i.e. snow/graupel/hail), the impact of the uncertaintiesvarieswith the size of precipitating hydrometeors whichis determined not only by the assumed size-mass and size-number-concentration relations, but also by the parameterized process rates. For example, results from the sensitivity experiments with varying fall velocity of graupel show that for a given microphysics scheme, uncertainties in the parameterization strongly affect the early development of an idealized squall line. In particular, both too fast andtoo slow fall velocities of graupel result in a weaker early development of the squall line, but they lead to different dynamics of hydrometeor population balance. This study also reveals that the impact of the uncertainties in the parameterization of hydrometeor fall velocity on the overall hydrometeor population dynamics varies with different microphysics parameterization schemes, illustrating great uncertainty and complexity in the current cloud microphysics parameterizations used for weather and climate modeling.