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Consistency among microphysics-convection-radiation processes in a numerical forecasting model

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Radiative fluxes are mainly affected by the cloud optical properties calculated with effective radius, water path of hydrometeors, and cloud fraction. A prognostic cloud fraction scheme, which considers the cloud fraction with increments as a result of each physics process, is implemented in the Global/Regional Integrated Model system (GRIMs) (Park et al., 2016). However, the original RRTMG scheme does not consider the hydrometeor information from convection processes, resulting in inconsistency between cloud process and radiation activity. To ensure consistency among physics processes, the amount of hydrometeors from both the cumulus parameterization scheme (CPS) and microphysics schemes is explicitly taken into account in computing radiative fluxes. The effects of this modification are tested for a heavy rainfall over Korea to identify the feedback between the precipitation and radiation processes. It is found that the information of hydrometeors from CPS tends to increase water path, which leads to larger cloud optical depth and cooling. Skill scores of the simulated precipitation in a medium-range forecast testbed confirm benefits of the consistent treatment of hydrometeors in both CPS and radiation processes.