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Impact of Microphysical Consistency between Subgrid and Grid-Resolved Cloud Parameterizations on QPF and Simulated Radar Reflectivity

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Assumed microphysical properties are usually inconsistent between the grid-resolved cloud and subgrid cloud parameterization schemes used in operational numerical weather prediction models. This inconsistency arises because the two schemes generally apply different levels of complexity in parameterized microphysical processes due to assumed differences in spatial and temporal scales between grid-resolved and subgrid cloud parameterizations. In particular, when a double-moment formulation is used in the grid-resolved cloud parameterization scheme, and the coupling between the two schemes is achieved through only the mass-related moment, the values of the total number concentration for individual hydrometeors in the two schemes are likely to be different due to the different particle size distributions (PSDs) that are assumed in each scheme. In this presentation, it will be first shown that such an inconsistency raises difficulty in the evaluation of the grid-resolved cloud parameterizations and in the interpretation of the simulated radar reflectivity. Then, it will be shown that the inconsistency is more of problem when the double-moment formulation is used in the grid-resolved cloud parameterization scheme. It will be demonstrated that the inconsistency problem can be alleviated by using the same PSDs and mass-dimensional relationships in the two schemes. Moreover, it will be strongly advocated that it is physically preferable to unify microphysical assumptions between the grid-resolved cloud and subgrid cloud parameterization schemes in the weather and climate models that are run at "grey zone" (~1 to 10 km) horizontal resolutions in which there is a great overlapping of microphysical properties between the grid-resolved and subgrid clouds.