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The role of melting and shedding in supercells and squall lines

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The dynamics of convective systems are inherently linked to microphysical processes through phase changes that result in warming or cooling. This is especially true of near-surface cooling via evaporation and melting of falling hydrometeors. In most numerical simulations, the melting of frozen hydrometeors (e.g., hail, graupel, snow, etc.) is computed within parameterized bulk microphysics schemes, many of which lack the ability to accurately represent mixed-phase hydrometeors (i.e. partially melted ice). To better understand the microphysical and dynamical effects of melting and shedding in convective storms, numerical simulations using a bin microphysics scheme coupled to the Weather Research and Forecasting model are performed for an idealized supercell storm and an idealized squall line. Physically based predicted liquid fraction, instantaneous melting, and instantaneous shedding schemes are used to examine the role of melting hydrometeors and subsequent shedding for these two storm modes. The results suggest that the amount of precipitation is dependent on the representation of melting, especially in the squall line simulations. The dynamic and thermodynamic environments are found to differ substantially between the simulations performed with the different representations of melting and shed drop sizes, resulting in varied storm system evolution; these differences are found to be dependent on the ambient aerosol concentration, although the differences induced by changing the representation of melting generally outweigh those of changing the aerosol loading. The results highlight the large role of melting and shedding in convective storm characteristics and suggest that further improvements to bulk microphysics schemes, which are used in numerical weather prediction models, are needed in the near future.