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Ice hydrometeor terminal velocity and convective mass flux

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Parodi and Emanuel (2009) found that, within certain limits, updraft velocities in a radiative-convective equilibrium cloud-resolving model scale with hydrometeor terminal velocity. Two classes of hydrometeors typically exist above the freezing level in tropical oceanic convection, aggregates of ice crystals with small terminal velocities (of order 1 m/s) and graupel with larger terminal velocities (of order 5 m/s or greater). Below the freezing level a narrower distribution of terminal velocities typically occurs. We present results from an idealized cloud-resolving model calculation in which the terminal velocity is fixed at 5 m/s below the freezing level but is set to either 1 m/s (aggregates) or 5 m/s (graupel) above this level. The model is run in weak temperature gradient mode with a radiative-convective equilibrium reference profile. The aggregates case produces a much more top-heavy mass flux profile than does the graupel case. The former resembles a "stratiform" mass flux profile while the latter is more "convective". The factors controlling the ratio of aggregates to graupel above the freezing level involve complex questions of cloud physics. These issues may have to be addressed to understand the fraction of convective to stratiform cloudiness over tropical oceans.