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Monitoring water-phase dynamics in mixed-phase clouds

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Mixed-phase clouds play a significant role on the surface energy budget through modulation of radiative fluxes in cold regions. Mixed-phase clouds are also a frequent atmospheric hazard, particularly when its supercooled droplets are abundant enough to disturb aviation and ground transportation. This work presents observations of water phase dynamics that demonstrates the theoretical Wegener-Bergeron-Findeisen concepts in mixed-phase winter storms. For this, the work analyzes vertical profiles of air vapor pressure, and equilibrium vapor pressure over liquid water and ice. Based only on the magnitude ranking of these vapor pressures, we identified conditions where liquid droplets and ice particles grow or deplete simultaneously, as well as the conditions where droplets evaporate and ice particles grow by vapor diffusion. The method is applied to ground-base remote-sensing observations during two snowstorms, using two distinct microwave profiling radiometers operating in different climatic regions (North American Central High Plains and Great Lakes). The results corroborate well with independent radiometer retrievals of vertically-integrated liquid water, cloud-base estimates from a co-located ceilometer, reflectivity factor and Doppler velocity observations by nearby vertically-pointing radars, and radiometer profile estimates of liquid/no-liquid volumes. This translates in a positive contribution toward monitoring and nowcasting the evolution of supercooled droplets in winter clouds.