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Settling-driven instabilities with phase-change in mammatus clouds[1] RAMA GOVINDARAJAN, International Centre for Theoretical Sciences, S. RAVICHANDRAN, Jawaharlal Nehru Centre for Advanced Scientific Research, ECKART MEIBURG, University of California, Santa Barbara — Consider a horizontal band of supersaturated atmosphere with an initially uniform distribution of small but inertial water droplets. We study the instability of such a layer. We show that the settling of the water droplets into the unsaturated air below the moist layer, combined with accompanying evaporative cooling drives the instability. We obtain scaling laws from dimensional analysis and model simulations in 1D, and compare these with results from numerical simulations. We find that the instability takes a lobe-like form, resembling mammatus clouds, at large liquid water content in the layer, and a string-like form resembling the leaky mode of Burns and Meiburg at lower liquid water content. We propose this as a model for how mammatus clouds, which have long fascinated cloudspotters and atmospheric scientists alike, and asperitas clouds, recently designated as a separate cloud species, form.

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