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APPLICATION OF KINETIC POTENTIAL THEORY TO WARM CLOUD DRIZZLE FORMATION

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ABSTRACT

The kinetic potential of nucleation theory is extended to describe cloud droplet growth processes that can lead to drizzle formation. In this model drizzle formation is identified as a statistical barrier crossing phenomenon that transforms cloud droplets to much larger drizzle size with a rate dependent on turbulent diffusion, droplet collection efficiency, and properties of the underlying cloud droplet size distribution. In an analogy with the theory of phase transformation, clouds are classified into two regimes: an activated metastable regime, in which there is a significant barrier and drizzle initiation resembles nucleation, and an unstable regime where kinetics dominates analogous to the spinodal regime of phase transformation. Observational evidence, including the threshold behavior of drizzle formation and the well-known effect that aerosols have on drizzle suppression, is shown to favor drizzle formation under activated conditions. These new applications of the kinetic potential theory should lead to more accurate parameterizations of aerosol-cloud interaction and improved algorithms for weather forecasting and climate prediction.

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