Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

The collision efficiency of cloud droplets in a non-continuum gas

ANUBHAB ROY, DONALD KOCH, Cornell University — The collision efficiency of bidisperse drops in a non-continuum gas is determined, subject to the coupled driving forces of differential sedimentation and turbulent shear. A major source of uncertainty in predicting precipitation formation comes from the absence of reliable theoretical predictions for the collision efficiency. Since coalescence requires molecular contact between two drops, it is sensitive to the non-continuum gas flows and van der Waals (vdW) attractions occurring between colliding drops. As two drops interact, the disturbances to the velocity and pressure of the gas induced by the particle motion retard their rate of approach. An especially important aspect of the hydrodynamic interactions between drops (radii a_1 and a_2) is the lubrication interaction that occurs when the drop separation r is such that $h = r$-a_1-a_2<<1. At such small separations, the relative velocity w_r of the drops along their line-of centers induces a very large O(w_r/h) force. Since the forces driving this relative motion remain finite, w_r will vanish as $h \to 0$. This leads to a prediction that the collision efficiency would be zero if one considered the interaction of two drops in a continuum gas in the absence of attractive colloidal forces. Therefore, it is clearly essential to include an accurate description of all the relevant near field interactions to accurately predict the true collision efficiency. We will treat the coupled sedimentation and turbulent shear effects governing cloud droplets, treated independently in previous works. We show that it is the non-continuum effects rather than vdW that primarily allows finite collision efficiency for drop sizes $a > 5\mu$m at atmospheric conditions.

Anubhab Roy
Cornell University

Date submitted: 31 Jul 2015 Electronic form version 1.4