

Comments on "Collision Efficiency of Water Drops in the Atmosphere"

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19 January 1976

This numerical study is of particular interest since it relates to a laboratory experiment we conducted in 1970 (Cataneo *et al.*, 1971). Our experimental results, which Lin and Lee (1975) apparently overlooked, substantiate the statement in their conclusion that "In an atmospheric environment, where only inertia, gravity and drag forces are significant, the dominant factor in forming precipitation appears to be the collisional growth of drops of water of approximately equal size."

Our laboratory experiment, contrary to what is believed by Lin and Lee, did allow us to observe the "catching up" of equal-sized droplets in the size range we studied (115–700 μm diameter). This was possible because the droplets achieved terminal velocity quickly, permitting us to observe droplets at separations of 1–2 diameters within 0.5–1.5 m from the generating point. These observations raise a point of disagreement between their numerical calculations and our experimental results. Their flow pattern calculations indicate that an initial vertical separation of 27 diameters between two droplets assures that the flow fields are not noticeably disturbed by the presence of each other. However, our

experimental results for equal size drops indicated a disturbance of the flow field for droplets separated by distances ≥ 100 diameters. This was evidenced by a velocity increase of the following droplet at the observed maximum distance. These results suggest that the flow pattern model of Lin and Lee should be tested with initial separations comparable to those used in our experiments to determine whether any significant changes in Y_c are observed.

Regarding their results concerning linear collision efficiency (Y_c) vs radius ratio (their Fig. 6) for nearly equal sized droplets (radius ratio ≈ 1.0), their values of Y_c range from 3–7 for droplet diameters 60–400 μm . If linear collision efficiencies are calculated from our results, values of 4–6 are obtained for equal size droplets. This is obviously excellent agreement.

REFERENCES

- Cataneo, R., J. R. Adam and R. G. Semonin, 1971: Interactions of equal-sized droplets due to the wake effect. *J. Atmos. Sci.*, **28**, 416–418.
 Lin, C. L., and S. C. Lee, 1975: Collision efficiency of water drops in the atmosphere. *J. Atmos. Sci.*, **32**, 1412–1418.

The Effect of Vertical Separation on Droplet Collision Efficiency (Reply to Comments by Cataneo and Semonin)

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16 March 1976

The experimental data of Cataneo *et al.* (1971) and the analytical results of Lin and Lee (1975) appear to be in excellent agreement on collision efficiency, which

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is the nondimensionalized distance of the maximum horizontal separation between two free-falling drops. However, an apparent discrepancy exists with regard to the amount of their vertical separation that may affect the collision efficiency. Upon reexamining the two