Reply

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We agree with Prof. Freier's contention that the equations developed and utilized in our paper contain inaccuracies. Indeed, we were at pains in the original article to emphasize the approximate nature of our treatment. However, since it is impossible to solve analytically problems concerned with the interaction of pairs of large deformable drops, and since an accurate numerical solution of this problem would be unjustifiably protracted and expensive, we considered it logical to attempt to obtain a moderately accurate solution using a structure of reasonable assumptions. The maximum discrepancy observed to exist between our theoretical predictions and our measurements was around 15%, with much closer agreement in the majority of situations studied.

It should also be stated that the objective of our article was not to provide a definitive solution to an atmospheric problem but to demonstrate that the electrohydrodynamics of processes related to those occurring inside clouds can be established to a reasonable degree of accuracy by the utilization of several simplifying assumptions.

Prof. Freier's strongest objections appear to be the employment of the spheroidal assumption and the neglect of some of the asymmetries present in the problem. However, in previous studies the spheroidal assumption has been shown to provide good agreement between theory and experiment in a number of different situations [see, for example, Nolan (1926), Macky (1931), Taylor (1964), Ausman and Brook (1967) and Abbas *et al.* (1967)]. In addition, the related asymmetrical problem of the stability of pairs of drops situated in an electric field was solved by means of a similar treatment to a reasonably high degree of accuracy by Latham and Roxburgh (1966).

With reference to smaller points raised by Prof. Freier, we would point out that it is clear from the title of Taylor's paper that he considered his calculations applicable to water drops and that photographs of large drops exposed to electrical forces show conclusively that *at the moment of disruption* they possess a profile which is almost exactly spheroidal.

We do not agree with Prof. Freier's statement that the electric field term $V/[b(1-e)^{\frac{1}{2}}I]$ should be excluded. At very large separations $2V/X$ is negligible, but an immense electrical pressure will nevertheless exist in the drop surfaces if the value of V is high. The reasons for determining the electrical stress from the sum of these two terms are discussed fully in the original article.

REFERENCES

Abbas, M. A., A. K. Azad and J. Latham, 1967: The disintegration and electrification of liquid drops subjected to electrical forces. *Static Electrification Conference*, London, Institute of Physics and the Physical Society, 69–77.

Ausman, E. L., and M. Brook, 1967: Distortion and disintegration of water drops in strong electric fields. *J. Geophys. Res.*, **72**, 6131-6135.

Latham, J., and I. W. Roxburgh, 1966: Disintegration of pairs of water drops in an eletric field. *Proc. Roy. Soc.* (*London*), **A295**, 84–97.

Macky, W. A., 1931: Some investigations on the deformation and breaking of water drops in strong electric fields. *Proc. Roy. Soc.* (*London*), **A133**, 565–587.

Nolan, J. J., 1926: The breaking of water drops by electric fields. *Proc. Roy. Irish Acad.*, **37**, 28–39.

Taylor, G. I., 1964: Disintegration of water drops in an electric field. *Proc. Roy. Soc.* (*London*), **A280**, 383–397.