Addressing the hydrometeor theory of lightning initiation with experiments in a high-voltage laboratory

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The intent of the study was to verify, in a high-voltage laboratory, two concepts that may affect the development of lightning leaders from large frozen hydrometeors in a strong ambient electric field. The first concept suggests that coalescing hydrometeors require a lesser ambient electric field than a single hydrometeor in order to produce bidirectional corona streamers. The second concept, proposed by Nguyen and Michnowski [JGR, 1996], suggests that within an array of hard hydrometeors in a strong ambient electric field, a kind of a chain reaction of corona streamer interactions develops between neighboring particles that requires a lesser field for formation of an emerging leader. The hollow metallic balls, of ³/₄ "diameter, that simulated large hydrometeors were suspended vertically by teflon threads in a 1-meter-wide gap between the vertical ground plate and a high-voltage electrode. The electric field in the gap at the location of the metallic balls was 1 MV m⁻¹. Our measurements included: the voltage from a high-voltage generator, the electric field in the gap, the current, and the luminosity from a light sensor. In addition we employed a high-speed video recording with the speed up to 450,000 fr s⁻¹. We conducted a series of runs with a single ball, with two and also with three balls merged together; all these were meant to address the first concept mentioned above. Another series of runs was with three balls separated by a horizontal gap of $\frac{3}{4}$ from each other, in order to address the second concept. The results of our observations are presented.



Fig. 1: Horizontal Air Gap Model with Vertical Ground Plane and Electrode.

Fig. 2: Static Simulation Results, Electrode Voltage at 1 MV, Equipotential lines from 0 V to 1 MV.