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The Effects of Precipitation on the Local Atmospheric Electric Field

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The atmospheric electric field (or Potential Gradient, PG) is often influenced by rainfall due to charge carried on rain drops themselves and charge released during splashing. The variability inherent in rainfall (both in terms of its charge and intensity) makes it difficult to characterise the behaviour of the PG during rainfall. This is typically an issue when using PG to observe the charge structure of clouds or local space charge during rainfall events as many processes often act at once. Here we characterise rainfall from an electrical viewpoint considering the charge present on the droplets as they fall from the cloud, as well as the splashing caused at the surface, which can release both positive and negative ions.

The relationship between precipitation and the local PG is investigated during non-thunderstorm rain events using 8 years of data (2007-2014) from the Reading University Atmospheric Observatory (RUAO), UK. A clear and robust non-linear relationship was found between PG and rain rate. A negative correlation was found for small rain rates (< 4mm/hr), which is attributed to negative charge released from droplet splashing. At higher rain rates (> 4.9 mm/hr) there is an increase in PG with rain rate which is attributed to effects of positive and negative charge released from droplet splashing. No statistically significant differences in the PG behaviour were found between rain events dominated by stratiform and cumuliform clouds. This suggests that the charge carried on rain drops is not the dominant influence on the average PG if we assume that rain from convective clouds carries a greater charge. The shape and charge released (magnitude and polarity) of a splashed droplet is influenced by the amount of water on the incident surface. The inferred surface wetness was found to be related to the minimum PG, but only for small rain rates (< 10 mm/hr). This suggests a saturation limit which limits the amount of charge released from droplets as the surface becomes wetter, in agreement with current literature.

These findings enable the effects of rainfall on PG to be distinguished from other electrical influences. Rainfall provides an appreciable influence on the PG which inverts the polarity for all rain rates above 0.5 mm/hr. The release of positive and negative ions highlights splashing as a charge separation mechanism that can occur both within the cloud (droplet to droplet collision) and at the surface (droplet to surface collision) without the need for the droplets to be polarised.