Charging of layer cloud edges in overcast conditions

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Cloud microphysical processes are still poorly understood, despite their importance in regulation of Earth climate. One little-explored aspect is charging, which influences aerosol and droplet behaviour, such as particle-droplet collisions, droplet-droplet collisions and droplet activation. Currents generated in disturbed weather regions are distributed by the global atmospheric electrical circuit to air weather regions. Fair weather conditions are not necessarily cloudless, but they will not have appreciable local sources of charge generation. In fair weather conditions, the global circuit sustains a vertical conduction current density Jz, which flows continuously from the ionosphere to the Earth surface. Long series of Jz measurements have been made in the UK during fair weather conditions, but with differing cloud amounts present. Using co-located simultaneous solar radiation measurements, the amount of cloud present has been derived, to distinguish between Jz data obtained in clear, semi-overcast and overcast conditions. In fully-overcast conditions, vertical current flow through a widespread horizontal layer cloud causes the upper and lower cloud edges to become electrified, due to the change in electrical conductivity between clear and cloudy air. At the cloud boundary, Jz continuously transfers charge to droplets and aerosol particles. Measurements demonstrating the sustained nature of the vertical current density in overcast conditions will be discussed, together with empirical evidence for the associated cloud edge charge arising, obtained from recent balloon-carried instrument campaigns. Variations in Jz are known to result from solar changes, and are also likely to arise from climate-induced changes in electrified cloud activity through the global circuit. In principle therefore, cloud edge charging could provide a small forcing or feedback on the climate system.

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