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The effect of water vapour upon atmospheric cluster ions

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Atmospheric molecular cluster-ions are produced by cosmic rays and natural radioactivity, and comprise the ionosphere-to-surface drift current (the conduction current) in the global electric circuit. We report investigations of ion physical properties made using a modern ion spectrometer with co-located meteorological and atmospheric electrical measurements, at Reading, UK, during May and June, (days 147-154) 2005. Mean ion currents and their variability were recorded, permitting derivation of positive and negative ion number concentrations, and their associated mean mobilities, on a 30 minute cycle. The ion measurements were validated by comparing the derived air conductivity with another global electric circuit parameter, the atmospheric potential gradient measured nearby. As expected from the global electric circuit model, both these independently measured parameters correlated closely under fair weather conditions. Histograms of the mean mobility for positive and negative ions across the 7 days of measurement verified that the negative ion mass was less than that of positive ions. Adjacent air humidity measurements were used to analyse the mobility data. Using the median water vapour pressure of 4.1hPa as a threshold, the mean positive ion mobility was found to be significantly lower when vapour pressures were above the threshold, but there was no significant change in negative ion mobility with vapour pressure. As the positive ion effect remains present in strong sunlight, weak sunlight, and darkness, it is unlikely to be solely of photochemical origin but, more probably, caused by changes in ion hydration. Asymmetric responses of positive and negative ions to water vapour will influence the aerosol electrification in fogs and clouds, and modify the radiative response of hydrated ion clusters.