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Ionisation effects on precipitation

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Cloud processes leading to rainfall generation are suspected to be influenced by droplet charge. Droplet charging is abundant, and even in layer clouds, charging of droplets readily occurs at the horizontal cloud-air boundary. Droplet charging in such circumstances is proportional to the vertical current driven through the cloud by the global electric circuit. Small global circuit variations from natural influences, such as solar modulation of cosmic rays can be used to investigate this, but an alternative is presented by artificial introduction of ionisation. The atmospheric nuclear weapons test period, which reached its peak 1962-1964, caused exceptional anthropogenic disturbance to the global circuit, through the increased ionisation from steady sedimentation of stratospheric radioactive debris.

Measurements of the vertical current J_z made at Kew Observatory near London (51°28'N, 0°19'W) were several times greater than normal during 1962-1964, as a result of the widespread extra ionisation in the lower atmosphere. At Lerwick, Shetland (60°09'N, 1°08'W) where deposition of radioactive material occurred, the atmospheric electrical parameters were strongly affected by the enhanced ionisation. To investigate tropospheric ionisation effects on local cloud processes, rainfall days at Lerwick in 1962-64 have been analysed by considering reduced and enhanced ionisation periods. During the enhanced ionisation, the Lerwick rainfall distribution shifted towards heavier rainfall and is significantly different from the rainfall distribution for reduced ionisation days; the Lerwick cloud was also significantly optically thicker during the enhanced ionisation. This contrasts with other years of the Kew record, when J_z was relatively undisturbed. Whilst the ionisation conditions of 1962-64 were exceptional, controlled methods of enhancing tropospheric ionisation by non-radioactive means - such as corona emission - may nevertheless be promising for local rainfall modification, or even geoengineering of cloud properties.