Recent results from studies of electric discharges in the mesosphere - DTU Orbit

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The paper reviews recent advances in studies of electric discharges in the stratosphere and mesosphere above thunderstorms, and their effects on the atmosphere. The primary focus is on the sprite discharge occurring in the mesosphere, which is the most commonly observed high altitude discharge by imaging cameras from the ground, but effects on the upper atmosphere by electromagnetic radiation from lightning are also considered. During the past few years, co-ordinated observations over Southern Europe have been made of a wide range of parameters related to sprites and their causative thunderstorms. Observations have been complemented by the modelling of processes ranging from the electric discharge to perturbations of trace gas concentrations in the upper atmosphere. Observations point to significant energy deposition by sprites in the neutral atmosphere as observed by infrasound waves detected at up to 1000 km distance, whereas elves and lightning have been shown significantly to affect ionization and heating of the lower ionosphere/mesosphere. Studies of the thunderstorm systems powering high altitude discharges show the important role of intracloud (IC) lightning in sprite generation as seen by the first simultaneous observations of IC activity, sprite activity and broadband, electromagnetic radiation in the VLF range. Simulations of sprite ignition suggest that, under certain conditions, energetic electrons in the runaway regime are generated in streamer discharges. Such electrons may be the source of X- and Gamma-rays observed in lightning, thunderstorms and the so-called Terrestrial Gamma-ray Flashes (TGFs) observed from space over thunderstorm regions. Model estimates of sprite perturbations to the global atmospheric electric circuit, trace gas concentrations and atmospheric dynamics suggest significant local perturbations, and possibly significant meso-scale effects, but negligible global effects.

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