

IONOSPHERIC EFFECTS OF ELECTROMAGNETIC PULSES RADIATED BY LIGHTNING RETURN STROKES

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The occurrence of a lightning discharge leads to the release of both electromagnetic and quasi-electrostatic energy, both of which are now known to produce detectable electrodynamic effects at high altitudes, in the form of elves, sprites, blue jets, and terrestrial gamma-ray flashes. While sprites produced largely by the quasi-electrostatic fields constitute the more spectacular and readily observable of Transient Luminous Events (TLEs), recent data, especially from space-borne measurements have confirmed earlier expectations that the more rapid (i.e., shorter duration) phenomena, such as elves and terrestrial gamma-ray flashes may well be much more common. This realization is particularly important, since lightning discharges of all types, positive, negative, cloud-to-ground or intracloud, are known to lead to the production of intense electromagnetic impulses (or EMPs), and the totality of high altitude effects produced by such EMPs may well be significant contributor to the state of the nighttime ionosphere on a global scale. In this paper, we present a review our current understanding of the interaction with the lower ionosphere of lightning EMPs and discuss their possible role in the production of terrestrial gamma-ray flashes as well as elves. We also discuss results of a three-dimensional model of the interaction, which allows the calculation of the effects of the static magnetic field (i.e., finite dip angle), leading to azimuthal asymmetries in rapidly expanding luminous rings of elves, which may possibly be detectable. Azimuthal asymmetries of EMP-ionosphere interaction may also have detectable implications for terrestrial gamma-ray flashes, depending on the altitude at which the gamma-rays photons are emitted.

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