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Prediction of Positive Cloud-to-Ground Lightning Striking Zones for Charged Thundercloud Based on Line Charge Model

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Abstract : Bushfire is known as one of the ascendant factors to create pyrocumulus thundercloud that causes the ignition of new fires by pyrocumulonimbus (pyroCb) lightning strikes and creates major losses of lives and property worldwide. A conceptual model-based risk planning would be beneficial to predict the lightning striking zones on the surface of the earth underneath the pyroCb thundercloud. PyroCb thundercloud can generate both positive cloud-to-ground (+CG) and negative cloud-to-ground (-CG) lightning in which +CG tends to ignite more bushfires and cause massive damage to nature and infrastructure. In this paper, a simple line charge structured thundercloud model is constructed in 2-D coordinates using the method of image charge to predict the probable +CG lightning striking zones on the earth's surface for two conceptual thundercloud charge configurations: titled dipole and conventional tripole structure with excessive lower positive charge regions that lead to producing +CG lightning. The electric potential and surface charge density along the earth's surface for both structures via continuously adjusting the position and the charge density of their charge regions is investigated. Simulation results for tilted dipole structure confirm the down-shear extension of the upper positive charge region in the direction of the cloud's forward flank by 4 to 8 km, resulting in negative surface density, and would expect +CG lightning to strike within 7.8 km to 20 km around the earth periphery in the direction of the cloud's forward flank. On the other hand, the conceptual tripole charge structure with enhanced lower positive charge region develops negative surface charge density on the earth's surface in the range $|x| < 6.5$ km beneath the thundercloud and highly favors producing +CG lightning strikes.

Keywords : pyrocumulonimbus, cloud-to-ground lightning, charge structure, surface charge density, forward flank
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