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Influence of ion attachment on the vertical distribution of the electric field and charge density below a thunderstorm

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Abstract. A numerical model called PICASSO [Production d'Ions Corona Au Sol Sous Orage (French) and Production of Corona Ions at the Ground Beneath Thundercloud (English)], previously designed, is used to describe the evolution of the principal electrical parameters below a thunderstorm, taking into account the major part played by corona ions. In order to improve the model restitution of a real situation, various improvements are performed: an initial vertical distribution of aerosol particles is introduced instead of the previously used uniform concentration; time and space calculation steps are adjusted according to the electric field variation rate; the upper boundary condition is improved; and the coefficients of ion attachment are reconsidered with an exhaustive bibliographic study. The influence of the ion attachment on aerosol particles, on the electric field and charge density aloft, is studied by using three different initial aerosol particle concentrations at ground level and two types of initial vertical distributions: uniform and non-uniform. The comparison between field data and model results leads to adjust the initial aerosol particle concentration over the experimental site at the value of 5000 cm^{-3} which appears to be highly realistic. The evolutions of the electric field and of the charge density at altitude are greatly influenced by the aerosol concentration. On the contrary, the surface intrinsic field, defined as the electric field that would exist underneath a thundercloud if there were no local charges, is weakly affected when the model is forced by the surface field. A good correlation appears between the success in the triggered lightning attempts and this intrinsic field evaluation. Therefore, when only the surface field is available, the model can be used in a triggered lightning experiment.

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