STUDIES ON THE BASIC ATMOSPHERIC ELECTRICAL PARAMETERS OF FAIR-WEATHER AND RELATED PROCESSES IN THE ELECTRODE LAYER

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Abstract

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Aeroelectrostatics and aeroelectrodynamics of basic electrical parameters and related processes in the atmospheric boundary layer under different atmospheric stratification conditions were investigated by means of numeral and analytical techniques.

The well-defined electrode effect was observed under fair-weather when the atmospheric stratification condition is nearly neutral and the ionisation gradient is very high. Theoretical space charge profiles calculated with the electrode effect model given by Tuomi (1982) were compared with experimental profiles measured in the lowest layer of the atmosphere. Space charge density shows good approximation at lower levels for all ionisation rates. This approximation is better at all heights when the ionisation gradient is high. The nature of the ionisation profile (whether height varying or uniform) does make considerable effect on the space charge density profile but not the nature of the electric field.

Under very stable atmospheric stratification conditions reverse electrode effect was observed. Space charge density profiles under height varying ionisation rate were measured, and temporal variation of average space charge density within the first 3-m layer from the earth surface was observed with cage method. Polarity of space charges is found to change from positive to negative in the lowest layer of the atmosphere, under very stable atmospheric conditions. It was fond that stability of the atmosphere enhanced the intensity of the negative ion layer. The ionisation profile in nocturnal temperature inversions with low wind situation decreases linearly with height.

The high electric fields created by thunderclouds at ground level are enhanced by the irregularities of the surface. This causes corona discharges to occur easily. The field strengths prevailed were up to 3 kV m^{-1} and the maximum space charge density recorded was 1.2 nC m^{-3}. A fast increase of the space charge density was also observed when the electric field higher than 2 kV m^{-1}.

The space charges generated by gasoline engines running on a traffic road disperse logarithmically with distance in the downwind area. The distribution of the space charge density was investigated using diffusion grading model. The Gaussian plume model with slender-plume approximation was used as the solution for the two-dimensional diffusion equation for a continuous crosswind line source in the presence of wind. From the different horizontal profiles it is noted that the change of concentrations is greatest near the traffic route and most pronounced for the lowest wind-speeds. The effect of the traffic route is fairly low in the downwind when the distance from the road is more than 2 km.

The aero-electrodynamics of a horizontal long-wire antenna collecting the fair weather air-earth current has also been investigated to find out the effect of the wind. A new model was developed in the presence of wind. The solution shows that the resultant effect of wind on the conduction current collected by the antenna is zero. Further it shows that the conduction current collecting area is inversely proportional to the speed of air ions. The model developed also suggest that the idea of a universal effective area of the horizontal long-wire antenna is not valid in the presence of wind since it is a function of the ambient electric field.