How density fluctuations influence the motion of streamers

C. Köhn, O. Chanrion and T. Neubert

DTU Space, Elektrovej Bld.328, 2800 Kgs. Lyngby, Denmark

In an electric gas discharge, free electrons and photons create additional electrons and photons through impact- and photoionization of the neutral constituents. The probability of ionization within a distance Δz is $1\text{-}e^{\Delta z \cdot \sigma_j \cdot n}$, where σ_j is the cross section of the *j*th ionization process and n the density of ambient air molecules. The density is therefore an important parameter of the discharge process, with temporal and spatial parameters scaling with the density [1]. Commonly, streamers are modelled in a homogenous gas with a few exceptions of streamers in the mesosphere as in sprites, with the positive polarity streamer propagating towards increasing density [2]. However, here we discuss gradients in a more general geometrical configuration. With a 2.5D cylinder symmetric particle code we have simulated streamer dynamics in the atmosphere with density perturbations around $n_o = 2.54 \cdot 10^{23}\ m^{-3}$ typical for the atmospheric density at sea level. Fig. 1 shows one example of a spatially inhomogeneous density distribution along the symmetry axis z. The ambient field pointing towards $-z$ with a magnitude 1.5 times the conventional breakdown field. Fig. 2 shows the electron density of a streamer after 1.65 ns. The left half shows the simulation with a constant air density of n_o and the right half with the density as shown in Fig. 1. In this configuration, there is already a visible effect. We will present how differing density distributions changes the velocity of the streamer and the electric field evolution.

References
[1] T.M.P. Briels et al., 2008. J. Phys. D: Appl. Phys., vol. 41, 234008
[2] A. Luque and U. Ebert, 2010. Geophys. Res. Lett., vol. 37, L06806

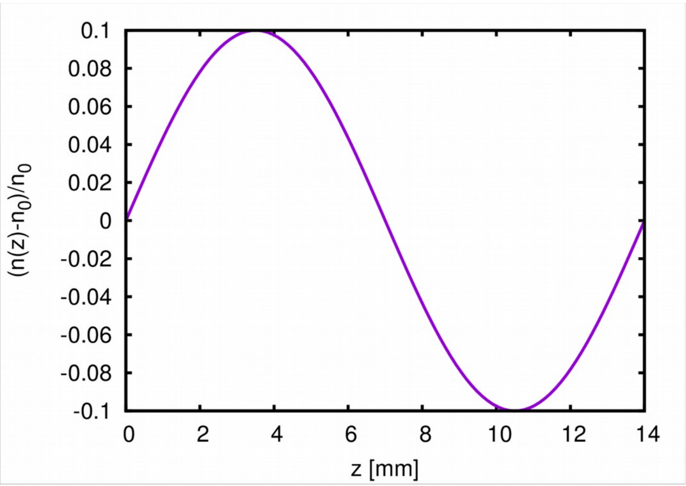

Fig. 1: The relative difference of the disturbed density distribution and the homogeneous density n_0 as a function of z.

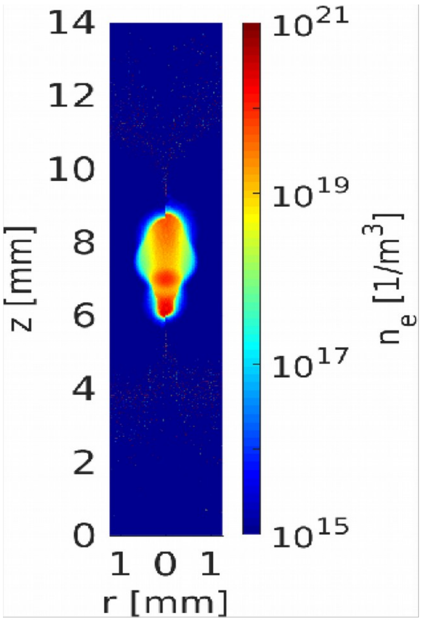

Fig. 2: The electron density of a streamer in air at sea level pressure. Left half: homogeneous density, right half: the density of Fig 1. The ambient field is 1.5 times the conventional breakdown field.