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THREE-DIMENSIONAL STREAMER MODEL IN THE AMREX ENVIRONMENT

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Abstract. Streamers appear in nature as sprite discharges in the upper-planetary atmospheres, and as precursors of lightning, see Teunissen and Ebert 2017. They have a wide variety of applications in technology including the ignition of high-intensity discharge lamps and the purification of gases and liquids from harmful organic pollutants. The further development of these applications requires a joint effort of experimental investigations and computer modelling of streamer discharges.

We have developed a 3D streamer model in the AMReX environment. AMReX is an open-source C++ library for massively parallel block structured adaptive mesh refinement applications, see Zhang et al. 2019. AMReX has inbuilt geometric multigrid solvers for solving elliptic differential equations, and it allows both MPI and OpenMP parallelization on CPUs as well as parallelization on GPUs. AMReX also has many inbuilt classes which enable a convenient implementation of both grid and particle data.

Our model is based on the first-order fluid model with local field approximation. The time integration in our code is performed by employing the second order Runge-Kutta method. The spatial discretization is performed by using the finite volume method. In our model, the non-local source term due to photoionization is represented by solving a set of Helmholtz equations, and we apply the Bourdon three term parametrization for representing the photon absorption function, see Bourdon et al. 2007. The verification of our code is performed by comparing its results to the results of the Afivo-streamer open-source code, see Teunissen and Ebert 2017.

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