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Simulation of electric discharges in unsteady airflow using a 3D fluid model

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We have developed a 3D fluid model to simulate streamer discharges in unsteady air flow. The model couples the drift-diffusion equations for the charged particles, the Navier-Stokes equations for the air and the Poisson equation for the electric field. It allows to study electrical discharges at different timescales defined by light and heavy particles and to investigate the effects of unsteady airflow. The model treats the time integration in an implicit manner to allow longer time steps, which makes the simulation of long duration discharges feasible. Moreover, the model uses an unstructured mesh with adaptive refinement allowing the incorporation of solid bodies with complex geometries. The accuracy of the model has been verified by comparing its results with a test case from the literature comparing simulation in steady air from five different streamer codes. Our results were consistent and among the most accurate. We present results from a simulation of long duration discharges, in which a series of successive positive streamers are initiated from a positive polarity electrode in a transverse airflow condition. It shows that the impact of a low speed air flow on the streamer comes essentially from the ions being blown away by the wind.