Towards user-friendly, public domain simulations of the precursor of lightning: streamers

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Streamers play an important role in the early stages of lightning and can be directly seen as sprite discharges. Many kinds of streamer discharge models developed at CWI are presented, using Particle-in-cell/Monte Carlo, fluid and hybrid codes from 1D to 3D. The codes are being improved and documented currently, to make them user-friendly and available on internet for potential users.

1. Streamers

Streamers are rapidly growing plasma filaments that can penetrate into non-ionized regions due to the electric field enhancement at their tips. Two kinds of streamers can be distinguished: positive streamers and negative streamers (see Fig. 1), depending on their propagation directions.

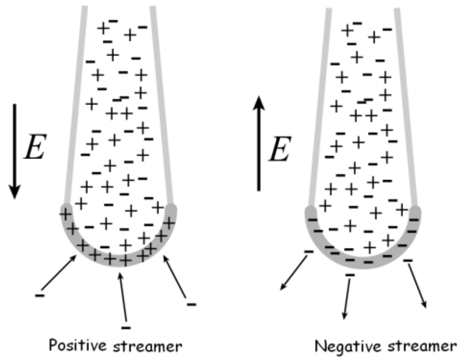

Fig.1 Illustration of streamers

In nature, streamers play an important role in creating the paths of sparks and lightning, and they appear directly as sprites in the upper atmosphere. On the other hand, streamers are also widely used in industrial applications.

2. Numerical models

In past years, a number of computer simulation codes for streamer discharges have been developed by our group at CWI, using Particle-in-cell/Monte Carlo, fluid and hybrid codes from 1D to 3D (see Fig. 2)[1-6]. Adaptive grid refinement and parallelization techniques are also adopted. Our codes have the ability of modelling problems in plasma-technology, in high voltage engineering as well as in lightning-related processes. However, a few shortcomings of the codes also exist at this moment, because they were written by different members; some codes are difficult to understand and to reutilize due to their weak annotation. The goal of current work is to co-develop and improve streamer discharge simulation software in our group, in particular, optimizing and documenting the codes in detail. The codes will be made available on internet as freeware for academic and industrial users.

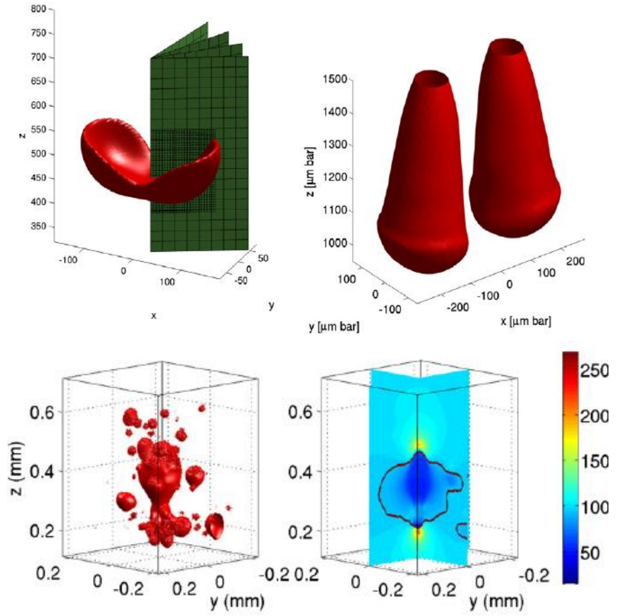

Fig. 2 Numerical results of the 2.5D fluid model with adaptive grid refinement (upper panel, from Ref.[4-5]) and of the 3D hybrid model (lower panel, from Ref.[6])

3. References

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