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Model reduction for streamer discharges

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An advancing lightning channel is composed of a hot, highly conductive core called leader surrounded by a corona of many thin filaments called streamers where pristine air is turned conductive by means of impact ionization. Understanding leader progression therefore requires realistic models for the streamer corona and for the coupling between this corona and the leader channel that feeds it. However, current streamer models are limited to a few streamers and they cannot be extended to a full corona due to computational limitations.

Here we discuss how the knowledge gained from streamer simulations in the past decades can be used to develop simplified models of the streamer dynamics to serve as building blocks for future corona models. We focus on a model where a streamer is represented as a propagating, imperfect conductor with a prescribed shape. Within this one-dimensional, simplified model we investigate streamer features such as the relationship between channel conductivity and field enhancement at the tip. We also show that, since this model can be followed up to long timescales of the order of the microsecond at atmospheric pressure, it provides clues about channel heating and the streamer-to-leader transition.