

EGU2020-8384

<https://doi.org/10.5194/egusphere-egu2020-8384>

EGU General Assembly 2020

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Streamer discharges in the atmosphere of Primordial Earth

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Motivated by the Miller-Urey experiment suggesting that lightning may have contributed to the origin of life on Earth through the formation of amino acids and carbonic acids, we here investigate the occurrence of electric discharges in the atmosphere of Primordial Earth. We focus on the early stages of lightning in the atmosphere of Primordial Earth, the so-called streamers, thin ionized plasma channels.

We study electron avalanches and potential avalanche-to-streamer transitions by modeling the motion of electrons with a particle-in-cell Monte Carlo code in gas mixtures of H₂O:CH₄:NH₃:H₂=37.5%:25%:25%:12.5% [S. L. Miller. Production of Some Organic Compounds under Possible Primitive Earth Conditions. *Am. Chem. Soc.*, 77:9, pp. 2351-2361 (1955)] and N₂:CO₂:H₂O:H₂:CO=80%:18.89%:1%:0.1%:0.01% [J. F. Kasting. Earth's Early Atmosphere. *Science*, 259:5097, pp. 920-926 (1993)] suggested for Primordial Earth approx. 3.8 Ga ago in different electric fields and for different levels of background ionization mimicking the photoionization process. We compare the evolution of the electron density, electric field, and electron energies with those for Modern Earth. Finally, we will discuss which conditions favour streamer inception, as well as consequences for discharges on Primordial Earth.