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Extreme atmospheric electron densities created by extensive air showers

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A sufficient density of free electrons and strong electric fields are the basic requirements to start any electrical discharge. In the context of thunderstorm discharges it has become clear that in addition droplets and or ice particles are required to enhance the electric field to values above breakdown. In our recent study [1] we have shown that these three ingredients have to interplay to allow for lightning inception, triggered by an extensive air shower event. The extensive air showers are a very stochastic natural phenomenon, creating highly coherent bursts of extreme electron density in our atmosphere.

Predicting these electron density bursts accurately one has to take the uncertainty of the input variables into account. To this end we use uncertainty quantification methods, like in [2], to post-process our detailed Monte Carlo extensive air shower simulations, done with the CORSIKA [3] software package, which provides an efficient and elegant way to determine the distribution of the atmospheric electron density enhancements.

We will present the latest results.

[1] Dubinova, A., Rutjes, C., Ebert, E., Buitink, S., Scholten, O., and Trinh, G. T. N. "Prediction of Lightning Inception by Large Ice Particles and Extensive Air Showers." PRL 115 015002 (2015)

[2] G.J.A. Loeven, J.A.S. Witteveen, H. Bijl, Probabilistic collocation: an efficient nonintrusive approach for arbitrarily distributed parametric uncertainties, 45th AIAA Aerospace Sciences Meeting, Reno, Nevada, 2007, AIAA-2007-317

[3] Heck, Dieter, et al. CORSIKA: A Monte Carlo code to simulate extensive air showers. No. FZKA-6019. 1998.