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Chemical and electrical impact of lightning in the Earth mesosphere: the case of Halos

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We have developed a kinetic model that describes self-consistently (kinetic and electric field equations) the electrochemical impact of different types of lightning discharges (-CG and +CG) in the terrestrial mesosphere between 50 km and 87 km of altitude. This model is applied to the case of halo type Transient Luminous Events (TLE). We have implemented several electrical current intensity signals of different values for each type of lightning according to available statistics [*Williams et al.,* Radio Science, **47**, 2012]. We have studied the time-altitude evolution of more than 90 chemical species and of the reduced electric field in the mesosphere associated with –CG and +CG lightning. More than 800 kinetic processes have been included in our model using initial densities of species extracted from the Whole Atmosphere Community Climate Model (WACCM).

Our model predicts an enhancement of up to 70 cm^{-3} in the electron concentration from natural (background) values between 55 km and 80 km of altitude in the +CG lightning cases. The model also indicates an increase of more than six orders of magnitude in the concentration of the $O(^1D)$ for lightning discharges with 200 C km of charge moment change (CMC). Previous results [*Hiraki et al.,* GRL, **31,** 2004] predicted much higher values of $O(^1D)$ density than our model but with higher charge moment change ($>$ 500 C km). On the other hand, the concentrations of electronically excited species and brightness associated with their radiative decays have also been studied. In particular, for the first positive group of N_2 the calculated brightness takes values ??that exceed the threshold of visibility (1 MR) for a halo of 100 km of diameter at an altitude of 77 km for the –CG lightning cases and for lower altitudes when +CG lightning are considered.

We also implemented an actual +CG lightning signal recently measured [*Gamerota et al.* JGR, **116**, 2011] and the results obtained were compared with our synthetic lightning signals showing great similarity in both the time and altitude variation of the density of species and reduced electric field. Finally, it is worth mentioning that lightning with associated continuous current (generally +CG) produces a significant perturbation in the reduced electric field and in the electron and O^- densities in the mesosphere.