A Fully 3-D, Time-Dependent and Self-Consistent Model of Relativistic Feedback Discharges

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We have developed a fully 3-D and time-dependent code that self-consistently simulates relativistic feedback discharges in our atmosphere. Relativistic feedback discharges are a promising mechanism for explaining terrestrial gamma-ray flashes (TGFs). These discharges generate large numbers of relativistic runaway electrons avalanches (RREAs) through a positive feedback effect produced by backward propagating positrons and Compton backscattered x-rays. In addition to creating large fluxes of gamma-rays, these discharges generate lightning-like currents within thunderstorms that make detectable radio pulses. This new code simulates the propagation of runaway electrons, runaway positrons, x-rays and gamma-rays using a Monte Carlo technique. The electric currents and charge densities from the low-energy electrons and ions generated from the ionization of air are then found. Finally, a successive over-relaxation (SOR) method is used to calculate the change in the electric field produced by the discharge. Because the code is fully 3-D, the effects of the Earth's magnetic field may also be included. It is found that the geomagnetic field causes the discharge region to become noticeably asymmetrical, especially at higher altitudes within or above the thunderstorm. In this presentation, the new code will be described and initial results will be presented. In particular, we will self-consistently model the production of TGFs within thunderstorms and show that the model matches the observe properties of TGFs.