Long Duration Gamma-ray Glows above Thunderclouds

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The Airborne Detector for Energetic Lightning Emissions (ADELE) observed 13 gamma-ray glows during its Summer 2009 campaign with flights above Colorado and Florida thunderstorms. Glows are a long-duration emission of high energy photons that last at least several tens of seconds. Glows may be evidence of continuous, relativistic runaway with feedback occurring during thunderstorms. We present the spectra of our glows with detailed Monte Carlo models of relativistic runaway with full effects of electron and positron feedback (relativistic feedback) for comparison. To explain the hardness of our glows (many of the counts are over 5 MeV) we will show that we are measuring glows from within or very close to the avalanche production region with a significant portion of the radiation coming from the positrons that are necessary for feedback. The bremsstrahlung from the positrons is harder than that of electrons because they do not undergo avalanche multiplication as the electrons do allowing them to maintain higher energies. Comparing our observed glows to the nearby cell's lightning activity, we find that lightning activity diminishes during the onset of a glow. This implies that lightning and glows measure different aspects of cloud electrification. From our simulations we attempt to distinguish between the two possibilities for the decrease in lightning: (1) the mechanism responsible for glows is only able to become significant when lightning activity subsides or (2) glows actually stifle the lightning activity and considerably limit the charging of the cloud. We will calculate if feedback is necessary to explain the glow brightness and if these mechanisms significantly influence to the total charging of the cloud.