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Radiation risk assessment associated with TGFs for aircraft passengers and aircrews

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Terrestrial Gamma ray Flashes (TGFs) are bursts of high-energy photons, produced in common thunderstorms [1, 2]. They can be very bright events with $\sim$1 photon/cm^2 detected when observed from a low Earth orbit (e.g., [3]), last less than one millisecond [4], and contain photons with energies up to $\sim$40 MeV [3, 5]. Their occurrence rate is estimated to be $>$ 400,000 per year as detectable by the Fermi Gamma ray Burst Monitor (GBM) [6].

The exact production mechanism of TGFs still remains uncertain, but all models proposed agree with the fact that Relativistic Runaway Electron Avalanches (RREAs) explain fluences and spectra observed by satellites (e.g., [7]). With a typical altitude of production of $\sim$12 km, TGF sources are close to altitudes of commercial flights, and these events could represent an exposure to ionizing radiation for aircraft passengers. Extremely high doses have been estimated to be delivered in the electron acceleration region albeit in compact regions (hundreds of meters), whereas in the photon beam, doses should be relatively low while over wider areas (some kilometers) above the source [8, 9].

The need for a thorough risk assessment associated with TGFs for aircraft passengers and aircrews is outlined by the predicted doses but impeded by the fact that the spatial and temporal distribution of TGFs is still not well known. In this work, we will present a statistical study using TGF data from satellite catalogs and commercial aircraft routes. The aim of this study is to estimate the probability for a commercial flight to find itself in a TGF photon beam or in the electron acceleration region and draw conclusions about the overall risk incurred by aircrew.

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