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Estimation of radiation doses delivered by Terrestrial Gamma ray Flashes

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Terrestrial Gamma ray Flashes (TGFs) are bursts of photons with energies up to $\sim$40 MeV associated with common lightning discharges. They last less than one millisecond and their occurrence rate is estimated to be > 400,000 per year as detectable by the Fermi Gamma ray Burst Monitor (GBM). With an altitude of production of $\sim$12 km, TGF sources are close to altitudes of commercial flights, and these events could potentially represent an exposure to ionizing radiation for aircraft passengers.

Currently, the exposure of aircrew is monitored by software that estimates the dose received for each individual, using the route flight data, taking into account the galactic component (cosmic rays) and relevant solar flares. Depending on regulations, maximum annual doses for aircrew members can reach 6 mSv. In 2010, Dwyer et al. [1] estimated the dose that a TGF could produce, and showed that TGFs in principle could be an additional non negligible factor to the exposure of aircraft passengers. If TGF doses are assessed as significant, this could challenge the paradigm of dose calculation and require the implementation of re-routing strategies and on-board measurement systems, which would be a significant cost for airlines.

In this work, we will present calculations of doses produced by high-energy electrons in TGF sources, within two different models of production: a pure lightning leader model and a homogeneous electric field model. We find that although the photon and secondary electron doses are weak, the dose received by passengers inside TGF source regions may be very high (> 6 mSv). These results call for a need to perform a thorough risk assessment including the probability for an aircraft to be in a TGF source region during such an event.

References

[1] J. R. Dwyer, D. M. Smith, M. A. Uman, Z. Saleh, B. Grefenstette, B. Hazelton, and H. K. Rassoul, "Estimation of the fluence of high-energy electron bursts produced by thunderclouds and the resulting radiation doses received in aircraft," *J. Geophys. Res.*, **115**, D09206, 2010, doi:10.1029/2009JD012039.