Two TGF populations detected by AGILE?

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Terrestrial Gamma-ray Flashes (TGF) (Fishman et al., 1994) are very short bursts of gamma-rays associated to thunderstorm activity, currently observed by detectors onboard satellites or research airplanes. TGFs are likely produced by Bremsstrahlung of energetic electrons accelerated by a mechanism (e.g., the Relativistic Runaway Electron Avalanche mechanism, RREA, Gurevich et al., 1992) in close association with the lightning leader propagation.
The AGILE satellite (Tavani et al., 2009) is one of the only three currently active space instruments capable of TGF detection, together with RHESSI (Smith et al., 2005), and *Fermi*-GBM (Briggs et al., 2010). AGILE is especially tailored for the detection of high-energy photons in the tens of MeV regime (Marisaldi et al., 2010a). Up to November 2011 the full AGILE TGF sample includes more than 300 events, with an average detection rate of about 10 TGFs/month. AGILE indicates that TGF high-energy spectral behavior deviates from the canonical RREA model (Dwyer 2008), reporting photon energies as large as 100MeV (Marisaldi et al., 2010b; Tavani et al., 2011) that require electrons acceleration across a large fraction of the full available potential difference in a thundercloud.
The most recent AGILE observations suggest the existence of two distinct populations in the AGILE TGF sample. The first population includes about 90% of the TGFs and consists of events with maximum energy lower than 30 MeV, whose cumulative spectrum can be well described by a power law with exponential cutoff well reproduced by the canonical RREA model. The geographical and local time distributions of this population well match those of standard lightning (Fuschino et al., 2011). The remaining 10% of the AGILE TGF sample include events with photon energy as large as 100 MeV and a cumulative spectrum well described by a power law with no evidence for a spectral cutoff. This spectral behavior can hardly be reconciled with the standard RREA model. The geographical distribution of this latter sub-class may be different from the low-energy sub-class, but more statistics is needed for a clear assessment of this point. We suggest the hypothesis that this high-energy population is a separate class of TGFs whose production process and parent lightning can differ significantly from the bulk of TGFs population. Apart from spectrum and geographical distribution, the high-energy and low-energy populations do not differ significantly in terms of duration, fluence and peak flux distributions. A first attempt of correlation with lightning detected on ground by the Global Lightning Network (GLN) did not yield conclusive results, probably because of the limited efficiency of the network.

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