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Analysis of TGF-associated thunderstorms with the Meteosat geostationary satellites

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We analyzed a sample of 278 TGFs detected by the RHESSI, AGILE, and Fermi satellites between 2003 and 2015, occurring within the 60°W and 60°E longitude range. Each of these events has an associated lightning sferic occurring within $\pm$500 μs, detected by the World Wide Lightning Location Network (WWLLN), that provides the best geographic localization of the source thunderstorm (<20 km). We performed a systematic analysis of the 278 TGF-associated storms, by exploiting data acquired by the Spinning Enhanced Visible and Infrared Imager (SEVIRI) instrument, onboard the Meteosat Second Generation (MSG) geostationary satellites (i.e. Meteosat-8/9/10, or MSG-1/2/3). For each storm, we analyzed several meteorological parameters, such as the cloud top temperature, the cloud extension, the cloud top altitude, the convective level, and the lightning flash rate, provided by the WWLLN. Furthermore, we studied those quantities at the time that TGFs occurred (taken into account the MSG time resolution), and their evolution within a time interval of $\pm$100 min about the TGF time.

The TGF-associated thunderstorms turn out to follow the typical behavior of tropical thunderstorms, peaking in the afternoons and over continental regions. The study of the meteorological parameters shows that these systems exhibit a wide range of values, mostly involving storms with lowest cloud top temperatures (<-75°C), highest top heights (>15 km), and large top extensions (> 35,000 km2), confirming what already found in other studies; morevoer, the study of the time evolution shows that TGFs tend to take place during the peak of the cooling phase, when the top temperature reaches its lowest value and the lightning flash rate is at its maximum. In order to investigate whether thunderstorms found producing TGFs show peculiar characteristics, with respect to typical thunderstorms, we carried out a cross-check with random storms occurring in the same geographic region, and performed a statistical analysis to establish whether differences are present between the two populations.