How simulated fluence of photons from Terrestrial Gamma ray flashes at aircraft and balloon altitudes depends on initial parameters

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The last years, the possibility of observing Terrestrial gamma-ray flashes from balloons or aircraft has been discussed. An important question in this discussion is wich count rates we can expect and how these are affected by the initial property of the TGF. Based on simulations of photon propagation in air we find the photon fluence at different observational points at aircraft and balloon altitudes. The observed fluence is highly affected by the initial parameters of the simulated Terrestrial Gamma ray flashes. The results is presented and compared with earlier simulation results.

1. Observations by aircraft or balloon

Until now most attempt to observe TGFs have been made by instruments in space. The distance between the photon production and the point of observation is then at least 500 km. The large distance will give a decrease in observed fluence both due to the effect of decrease in radiation by distance and the attenuation of photons in air. This have made us look for the possibility of making observations closer to the TGF production.

Photons produced in a TGF are attenuated when travelling through air. This gives both an advantage and a disadvantage for observations of TGFs from aircrafts or balloons. We will lose photons due to photoelectric absorption, but the Compton scattering will enable us to see photons outside their original direction.

2. Monte Carlo simulations

The simulations used to find the expected detection rates are based on the Monte Carlo model described in [1]. The initial photons are given an initial energy, altitude and angular distribution and are tracked through the atmosphere. The model takes Compton scattering, photoelectric absorption and pair production into account.

As the expected production altitude of TGFs are below 20 km we have used initial production altitudes between 8 and 20 km. To be able to compare with earlier modelling results we have used both discrete and distributed photon production altitude distributions.

We have used a cone with isotropic initial angular distributions of 30° and 40° degrees half angle as well as an angular distribution out to 90 degrees, all centred around the vertical direction.

The photons going downwards due to the feedback process have been approximated by sending 0-1% of the initial photons downwards with the same initial angular distribution as the photons going upwards.

3. Results

When the observational altitude is above the initial production altitude of the TGF the main parameters that affect the fluence are the initial production altitude and the initial photon angular distribution.

When the altitude of observation is below the initial production altitude we see a strong effect also from the amount of feedback and the initial photon altitude distribution used in the simulation.

We will present these results together with a discussion of the fluences and the initial conditions.

3. References

[1] N. Østgaard, (2008). J. Geophys. Res., 113 , 1–14,