Analysis of electric and magnetic lightning-generated wave amplitudes measured by the Van Allen Probes

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Lightning flashes emit powerful electromagnetic lightning-generated waves. Some of this power propagates and escapes into the magnetosphere. Resonant interactions of trapped electrons in the Van Allen belts with lightning-generated waves cause pitch angle diffusion, leading to scattering of those electrons into the atmosphere, an important process for estimating the radiation levels encountered by satellites in low Earth orbits. The Van Allen Probes were two identical satellites which flew from September 2012 to 2019. Their main purpose was to explore the Earth's radiation belt environment. They particularly carried two instruments which measured the electric and magnetic fields: EMFISIS [1] and EFW [2]. In this study, we provide a statistical analysis of both electric and magnetic field wave amplitudes of very low frequency lightning-generated waves (LGW) based on the survey mode measurements of these two instruments. The observation time is equivalent to 11.5 years made by the both Van Allen Probes. We complement this analysis with data from the ground-based World-Wide Lightning Location Network (WWLLN) (for instance [3]) to explore differences between satellite and ground-based measurements. We discuss the main features of the LGW amplitude distributions with respect to position relative to the Sun (local time), magnetic field lines (L-shell, L), longitude, and time (month or season). Monthly and yearly statistics of electric and magnetic LGW amplitudes will be presented and compared to other whistler waves amplitude. We will discuss the contribution of extreme events to the overall LGW energy budget. We will also discuss the correlations we found between WWLLN power and wave amplitudes in space at various longitudes. We will reveal fundamental differences between space measurements of LGW power and Earth's intense equatorial lightning activity.

References

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