



Sprites and Early ionospheric VLF perturbations

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Past studies have shown a correlation between sprites and early VLF perturbations, but the reported correlation varies widely from $\sim 50\%$ to 100% . The present study resolves these large discrepancies by analyzing several case studies of sprite and narrowband VLF observations, in which multiple transmitter-receiver VLF links with great circle paths (GCPs) passing near a sprite-producing thunderstorm were available. In this setup, the multiple links act in a complementary way that makes the detection of early VLF perturbations much more probable compared to a single VLF link that can miss several of them, a fact that was overlooked in past studies. The evidence shows that sprites are accompanied by early VLF perturbations in a one-to-one correspondence. This implies that the sprite generation mechanism may cause also sub-ionospheric conductivity disturbances that produce early VLF events. However, the one-to-one “sprite to early” event relationship, if viewed conversely as “early to sprite”, appears not to be always reciprocal. This is because the number of early events detected in some cases was considerably larger than the number of sprites. Since the great majority of the early events not accompanied by sprites was caused by positive cloud to ground (+CG) lightning discharges, it is possible that sprites or sprite halos were concurrently present in these events as well but were missed by the sprite-watch detection system. In order for this option to be resolved we need more studies using highly sensitive optical systems capable of detecting weaker sprites, sprite halos and elves.