VLF perturbations and causative cloud-to-ground discharges observed during EuroSprite-2003 in association with sprites

A. Mika (1), C. Haldoupis (1), R. A. Marshall (2), T. Neubert (3) and U. S. Inan (2)

1. Department of Physics, University of Crete, Iraklion, Crete, Greece
2. Space Telecommunications and Radio Science Laboratory, Stanford University, Stanford, USA
3. Danish Space Research Institute, Copenhagen, Denmark

We present results based on VLF observations and MÉTÉORAGE lightning data made during EuroSprite-2003 when a large number of sprites occurred over France. The sprites were detected with a camera from the Pyrenees over storms monitored with MÉTÉORAGE, the French national lightning detection network. The storms under study were situated in the vicinity of a VLF transmitter (HWV) at Le Blanc, France, whose signal was received on the island of Crete with a narrowband, and nearby at Nançay with a broadband VLF receiver. This study focuses on the issues of: a) detection of early VLF perturbations possibly due to backscatter from a sprite-affected subionospheric region, and b) occurrence of causative positive cloud-to-ground discharges prior to a sprite. With respect to the first issue, early VLF perturbations resulting from narrow angle forward scatter have been observed in Crete in nearly one-to-one association with the sprites. On the other hand, bandpass filtering of the broadband VLF signal revealed that only about 5% of the sprites were escorted by early VLF perturbations, possibly due to backscatter, all originating from a single storm located relatively close to the Nançay receiver. On the second issue, analysis of the time lags of the sprites to the preceding +CG discharges showed that one third of the observed sprites were lagging the +CG discharges by more than 30 ms up to 300 ms. In these cases there were no radio-sferics present during the sprite observation period, in
contrast to the short-delayed sprites which were escorted nearly always by enhanced, burst-like, radio-sferic activity. These observations endorse the notion of long delayed sprites reported in past studies and show that their occurrence is much more frequent than it was thought before.