Sprite and Lightning Infrasound Measurements during the 2005 Eurosprite Campaign

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Liszka [2004] first assumed that infrasound have a specific signature in their spectrogram (a chirp) when a sprite occurs. During the Eurosprite 2003 campaign, Farges et al. [2005] correlated such kind of infrasound with camera observation of sprite. They used data of an infrasound station located in the North-West of France (in Flers) which was at 350 to 500 km away from the sprites. The correlation between the time of an infrasound due to sprite and the sprite time is done by calculating the propagation time with a ray-tracing model. A clear relation between the infrasound duration and the sprite size has been found.

For the Eurosprite 2005 campaign, a temporary station has been set up in the South-West of France (in St Just) where the storms are more frequent. The main objectives for the infrasound campaign were: i) to measure the same sprite infrasound with two stations (the station used in 2003 was still in operation in 2005), ii) to determine the geometry of the infrasound source when a sprite is observed close to the infrasound station and iii) to evaluate the attenuation with distance and the frequency spectrum of infrasound produced by lightning.

Studies on the characteristics of infrasound of lightning have been done, particularly on August 31st, when a storm moved North-Eastward from the Bay of Biscay, passing just over the St Just station. At the same time, no lightning activity was recorded at less than 200 km away from Flers station. The amplitude of infrasound, produced by lightning and recorded in St Just station, is higher than the noise only when lightning are located at distances lower than 50 km from the station. When lightning are close to station, the infrasound amplitude reach few Pa and a dynamic of 30 dB (in comparison to the noise level) is then found. Simultaneously, nothing has been detected in the Flers station data. These joined measurements show clearly that infrasound produced by lightning could be only measured at short distance from the source. The chirp signature is then definitely a property of sprite infrasound. Frequency spectrum of infrasound produced by isolated lightning is also examined. A flat response between 0.3 and 10 Hz is found when the lightning distance is less than 20 km from the station. We deduce from our observations that the recorded wave are due to the infrasound part (frequency spectrum speaking) of the thunder.

An infrasound station is composed of 4 microbarographs organised in a roughly equilateral triangle with a sensor in its barycentre. Using this network geometry, we can process data of the four sensors to detect coherent wave (using correlation method) and to calculate their apparent speed and arrival azimuth. With these wave characteristics, we try to determine the geometry of the source when a chirp is detected. On September 9th, few small sprites have been detected with camera observation. They produced faint chirp infrasound. The observed sprites were located less than 200 km from the infrasound station and camera observation point. The camera was rapidly masked after the observation of these events by the thunderclouds moving towards camera. However, several chirp infrasound lasting up to one minute with high varying apparent speed (indicating a large elevated source) and large azimuth range (of several ten degrees, indicating a large lateral extent). Assuming that sprites did not stop to be produced when the camera has been masked and chirp pattern is the signature in infrasound data, we try to determine the source geometry using the wave characteristics and assumptions on +CG parent lightning location. The geometry derived from infrasound measurements is close to that we know from optical measurements: large vertical extent (from 40 to 100 km), large lateral extent (several ten of kilometres) and spatial shifting (from 50 to 100 km) in comparison to the location of the +CG parent lightning.