Mechanism of Infrasound Radiation from Sprites

Victor P. Pasko* and Jonathan B. Snively
CSSL, Penn State University, University Park, PA 16802, USA

The possibility of infrasound generation by sprite discharges has been discussed by Bedard et al. [Eos Trans. AGU, 80 (46), Fall Meet. Suppl., F227, A51B-18, 1999]. Specific chirp-like infrasound signatures possibly related to sprite discharges have been identified by Liszka [J. Low Freq. Noise Vibr. Active Control, 23, 85, 2004], and their phenomenology further discussed by Liszka and Hobara [JASTP, 68, 1179, 2006]. Farges et al. [GRL, 32, L13824, 2005] provided first direct correlation of the chirp-like signatures in 0.1-9 Hz range with optical observations of sprites. The sprite correlated infrasound signatures are characterized by arrival of low frequencies before high frequencies, pressure amplitudes on the order 0.01-0.1 Pa at horizontal distances $\simeq$400 km, and durations of several tens of seconds, which are well correlated with physical horizontal dimensions of sprites observed optically [Farges et al., 2005]. The strength of observed infrasound emissions may appear to contradict available analysis of air heating in sprite streamers giving temperature changes $\Delta T/T\sim$0.2-2% [Pasko et al., GRL, 25, 2123, 1998], an accurate analysis of energy budget of sprite discharges indicating $\Delta T\leq$ 0.5 K [Sentman et al., JASTP, 65, 537, 2003], and limited information on sprite rotational temperature indicating consistency of observed molecular nitrogen band emissions with rotational temperatures in the range 220-230 K (not exceeding 300 K) [Green et al., GRL, 23, 2161, 1996; Morrill et al., JASTP, 60, 811, 1998; Bucsela et al., 65, 583, 2003; Kanmae et al., GRL, 34, L07810, 2007]. In this talk an analysis is presented demonstrating that observed sprite infrasound signatures are consistent with weak air heating in streamer channels in sprites on the order of several degrees K, and with known atmospheric absorption properties of infrasound [Blanc, Ann. Geophys., 3, 673, 1985; Sutherland and Bass, J. Acoust. Soc. Am., 115, 1012, 2004, and references therein].