



A Study of Early/Slow VLF Perturbations Observed at Agra, India

Uma PANDEY^{1,2,3}, Ashutosh K. SINGH^{2,5}, Om P. SINGH², Birbal SINGH¹,
and Vibhav K. SARASWAT⁴

¹Department of Electronics and Communication Engineering,
Raja Balwant Singh Engineering Technical Campus, Bichpuri, Agra, India;
e-mail: pandeyuma68@gmail.com

²Department of Physics, Raja Balwant Singh Engineering Technical Campus,
Bichpuri, Agra, India

³Department of Electronics, Banasthali University, Rajasthan, India

⁴Department of Physics, Banasthali University, Rajasthan, India

⁵Department of Physics, SRM University, Tindola, Barabanki, India

Abstract

We present here the results of sub-ionospheric VLF perturbations observed on NWC (19.8 kHz) transmitter signal propagating in the Earth-ionosphere waveguide, monitored at our low latitude station Agra. During the period of observation (June-December 2011), we found 89 cases of VLF perturbation, while only 73 cases showing early character associated with strong lightning discharges. Out of 73 events, 64 (~84%) of the early VLF perturbations are found to be early/slow in nature; the remaining 9 events are early/fast. The onset duration of these early/slow VLF perturbations is up to ~5 s. A total of 54 observed early events show amplitude change lying between ± 3.0 dB, and phase change ± 12 degree, respectively, and found to occur mainly during nighttime. One of the interesting results we found is that the events with larger recovery time lie far away from the VLF propagation path, while events with smaller duration of recovery are within the ± 50 -100 km of signal path. The World Wide Lightning Location Network (WWLLN) data is ana-

lysed to find the location of causative lightning and temporal variation. The lightning discharge and associated processes that lead to early VLF events are discussed.

Key words: early VLF perturbations, Transient Luminous Events (TLEs), Earth-ionosphere waveguide, lightning.