Ionospheric Remote Sensing Using Broadband Sferics in Space and Time

Jackson C. McCormick*[1], Morris B. Cohen [1]
(1) School of ECE, Georgia Institute of Technology, Atlanta, Georgia, USA

The impulsive current from lightning generates powerful radio emissions known as ‘radio atmospherics' or ‘sferics’ which propagate to global distances due to their low attenuation. We utilize sferics to study the temporal and spatial variation of the lower ionosphere, a layer of ionized atmosphere beginning at ~70 km altitude (D-region). Very Low Frequency (VLF, 3-30kHz) radio waves are a useful diagnostic for lower ionospheric monitoring due to their reflection from this region and global propagation. Traditionally, the lower ionosphere has been sensed using single-frequency VLF transmitters allowing for analysis of a handful of single transmitter to receiver propagation paths, as there are only a small number of transmitters.

Lightning is globally distributed and very frequent, so a sferic is therefore also a useful diagnostic of the D-region. This is true both for ambient or quiet conditions, and for ionospheric perturbations such as solar flare x-ray bursts, electron precipitation, and lightning-ionosphere coupling.

Lightning strokes effectively act as separate VLF transmitting sources. As such, they uniquely provide the ability to add a spatial component to ionospheric remote sensing. Furthermore, sferics radiate a broadband wave packet allowing for broadband analysis along each and every lightning to receiver path, which cannot be achieved with the traditional technique. Even a small network of VLF receivers multiplies the potential of this technique. This technique provides the capability of studying ambient ionospheres as well as locally perturbed ionospheres in both the spatial scale and time onset and recovery. We demonstrate the broad coverage potential of sferic-based ionospheric monitoring.