Ionospheric D-region Remote Sensing using ELF Sferics

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The ionospheric D-region is difficult to measure directly since it is too high for balloons, too low for spacecraft and does not contain plasma dense enough for simple direct radio sounding. Here we consider a method of D–region remote sensing using ELF waves radiated from lightning discharges. Such lightning induced radiation signatures are commonly referred to as ‘sferics’ and excite the ELF and VLF bands. The ELF component of sferics below 300 Hz propagates at a group velocity slower than the speed of light and the magnitude of the group velocity is a function of the ionospheric D region electron density profile. This is in contrast to the VLF component which propagates as a multimodal signal at close to the speed of light. The observed group velocity of sferics can be used to remotely sense the D-region ionosphere. Such remote sensing is possible if lightning locations and occurrence times are known. We use the Vaisala Global Lightning Detection (GLD360) detection network to obtain locations and times of cloud to ground discharges that generate significant ELF content. These wave forms are observed at ELF receivers in Colorado and Poland. Observations of a large amount of sferics allows for diagnosing day and night changes to D region density profiles as well as transient changes from solar flares. Observations are analyzed with the Long Wave Propagation Capability (LWPC) software tool, which models propagation in the Earth-ionosphere waveguide.