Energetic Electrodynamics of the Lower Ionosphere

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The ionospheric radio lab investigates the global-scale propagation of radio waves, whether those waves travel around the world or into near-Earth space. Our studies aim to produce everyday applications, such as providing GPS-quality location and timing information when GPS is not available, as well as event-driven applications, such as mitigating the destructive electrical effects produced during solar storms. The lower ionosphere plays an integral role in all of these applications, but the fact that it is a nonlinear, dispersive, and time-varying medium significantly complicates its experimental characterization.

Our research group uses two primary sources of high-power radio waves to investigate the nonlinear and dispersive properties of the lower ionosphere: man-made transmitters and lightning. We perform ionospheric heating experiments using the High-frequency Active Auroral Research Program (HAARP) transmitter at Gakona, Alaska, to experimentally quantify the nonlinear interactions that occur within the lower ionosphere using a controllable source. We have deployed radio receivers from Greenland to Antarctica in order to study the multitude of ionospheric phenomena produced by powerful lightning strikes. Furthermore, we attempt to reproduce these effects using rocket-triggered lightning experiments at the International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, Florida.

During this talk, I provide an overview of the nonlinear processes that produce these fantastic ionospheric phenomena, I outline our efforts to produce a global network of radio receivers, and I present our most recent experimental observations.