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Broadband Scattering off the HAARP-Disturbed D-Region Ionosphere

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Utilizing the High Frequency Active Auroral Research Program (HAARP) phased array system transmitting between 3-10 MHz waves, with up to 600 MW Effective Radiated Power (ERP), we can heat the electrons within a patch of the D-region (60-90 km) of the ionosphere to thousands of degrees Kelvin. This electron temperature shift will increase the electron collision frequency thereby increasing the conductivity of the D-Region plasma. The D-region is a frequency selective surface in the Very Low Frequency (VLF) regime which varies with height. As the electron collision frequency increases the height of reflection decreases, and the skin depth decreases with increased conductivity creating a higher absorption rate.

We will use VLF (3-30 kHz) radio remote sensing. In particular, we can measure lightning-generated sferics generated by lightning that are scattered by the heated patch of the ionosphere. We pulse the HAARP beam on/off at a set interval of a few seconds much greater than the relaxation period for the heating/cooling (on the order of milliseconds) of the patch. This type of experiment has been validated several times using VLF transmitters as signals of interest to derive the scattered field but never with broadband signals. During HAARP pulse on-time, there will be a decrease in amplitude and a phase shift for VLF signals propagating through the medium. We can use disruptions to narrowband VLF transmitters as markers to confirm the behavior in the D-region is as expected as we process the lightning-generated sferics.

The broadband scattering of the sferic energy from the disturbed region, as well as the pattern as a function of scattering angle from HAARP to the receiver, will yield new information about the interaction between HAARP HF energy and the ionosphere, which we will discuss. We will present experimental results with the HAARP facility and VLF receivers in multiple locations across Alaska.