HF cross modulation as a function of HF power

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HF cross modulation is employed as a technique to probe the D region ionosphere during modulated HF heating experiments at the High frequency Active Auroral Research Program (HAARP) observatory in Gakona, Alaska. The presented technique is a modified version of a more typical pulsed HF cross modulation experiment, based on Fejer's method, in which a low power pulsed radio wave probes the D region ionosphere that is modulated by a second high power pulsed radio wave. During the modulated heating experiments discussed herein, the ionosphere is heated with amplitude modulated (AM) waves at a large number of different HF power levels.

It has previously been established that careful measurements of the amplitude and phase of cross modulated signals can be used to quantify the HAARP-modified characteristics (i.e., the conductivity) of the D region ionosphere with high time resolution. Past experiments were used to demonstrate that the modified conductivity could produce an additional 5–6 dB of HF signal attenuation and additionally could produce rapidly varying cross modulation phase equivalent to Doppler shifts of several 10's of km/sec. We apply the same concept in this paper, analyzing the depth of cross modulation as a function of the power of the modifying HF signal. Our results are consistent with a saturation effect that has previously been observed during ELF/VLF wave generation experiments. We compare these past ELF/VLF experimental observations with new HF cross modulation observations performed using sinusoidal AM waveforms at 2.5 kHz (X-mode). The HF cross modulation experiments were performed during HF heating campaigns at HAARP in March 2013.