Lunar Echo Experiments at Long Wavelength using HAARP and LWA

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Summary

We have begun experiments in radar backscatter at long wavelength from the lunar surface using the high power HF Active Auroral Research Program (HAARP) phased array in a bistatic configuration with Long Wavelength Array (LWA) receiving antennas. In these experiments the HAARP array in Alaska provides a total power of 3.6 MW; the phased array forms a beam with gain of about 28 dB and width of about 20º, which tracks the moon. A given experiment consisted of HAARP illumination of the moon for one hour at frequency f_1, followed by another hour at frequency f_2. In each 1-hr interval, HAARP transmitted 2-s pulses at 5-s intervals, allowing a 3-s interval between pulses for detection of the lunar echo. Only power modulation was imposed on the transmitted frequency, i.e., ON for 2 s and OFF for 3 s in each 5-s interval. In the 3-s OFF interval, the lunar echo returns to earth for reception with digital waveform receivers and antennas at the LWA site in New Mexico.

Initial experiments in October 2007 and January 2008, acquired waveform samples of the lunar echo pulses at several frequencies between 9.4 MHz and 6.8 MHz, a range that includes the lowest frequencies (longest wavelengths) at which earth-based lunar radar echoes have been recorded. It had been expected and confirmed that the HAARP transmitted 2-s pulse would also be detected in New Mexico by propagation via a skywave mode. Thus, the measurements by LWA include the HAARP skywave mode followed by the lunar echo pulse. An example of the LWA measurements at 7.4075 MHz showing three 5-s cycles of skywave and lunar echoes is shown below.

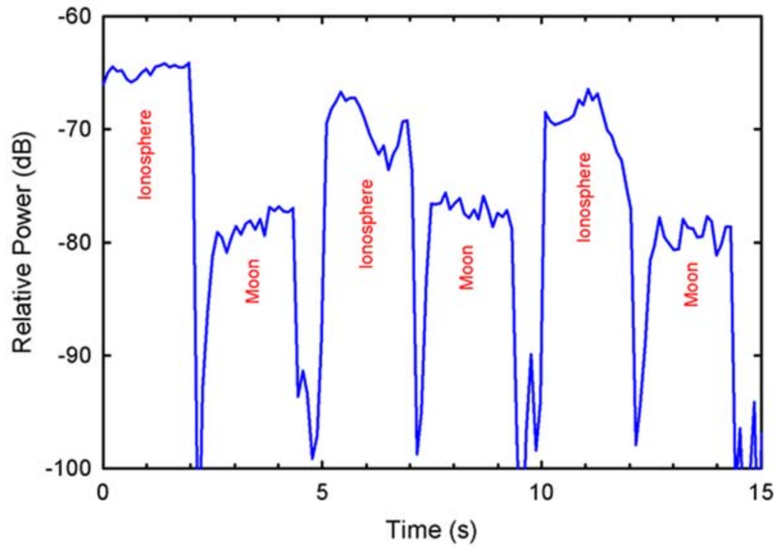

Figure 1. Three cycles of HAARP skywave and lunar echoes at 7.4075 MHz received by LWA.

These data acquired for the lunar echo pulses are expected to provide information on the backscattering interaction at the moon at long wavelength. Measurements of the lunar surface composition and conductivities in the U. S. Apollo program, and subsequent models of lunar subsurface conductivities, suggest that long wavelength radio waves will penetrate various distances below the visible lunar surface, depending on the electrical conductivity of the lunar regolith. A study of such subsurface properties is a science objective of the HAARP-LWA lunar echo investigation.