The Discovery of Novel Ionospheric Phenomena using Ionospheric High Frequency Software-Defined Radar

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We present results from the first high frequency (HF; centered at 4.42 MHz) radar observations of apparent ionospheric highly-structured plasma instability produced during pulsed HF heating of the ionosphere at mid-latitude. These results were obtained using a newly introduced software-defined HF radar, the Penn State Ionospheric Radar Imager (PIRI), which was deployed near Arecibo Observatory (18.36°N, 66.75°W), Puerto Rico during the March 2017 Arecibo HF heating campaign. In this presentation, we will focus our attention on the probing of two unique events. One event shows the possible generation of an artificial spread-F during continuous wave 5.125 MHz HF heating. In this case, the HF-radar returns appear to be scattering from a wide ensemble of (presumably) small structures generated by the pulsed HF heating to which we apply the term artificial spread-F as suggested by traditional ionosonde observations. During the experiment, the range extent of the scattering reaches near 250 km. The results of the second event show non-classified and unique ionospheric plasma instabilities that were detected during 8.175 MHz pulsed heating. This event is a case of under-dense heating and shows spectacular radar pulse-heater interaction. Both data sets include original and insightful observations of ionospheric plasma instabilities. We examine and discuss the implications of these observations and demonstrate substantial lack of understanding of the space-time variability of plasma instabilities structures of the magnetic mid-latitude regions of the ionosphere.