Time-dependent observations and modeling of the enhanced ion-line matching height during HF heating of the F-region ionosphere

Christopher T. Fallen*[(1)] and Brenton J. Watkins [(2)]
(1) Arctic Region Supercomputing Center, University of Alaska Fairbanks, Fairbanks, AK 99775 USA
(2) Geophysical Institute, University of Alaska Fairbanks, Fairbanks, AK 99775 USA

HF pumping of the F-region ionosphere can generate Langmuir waves (LW) and ion-acoustic waves (IA) through mechanisms such as the Oscillating Two Stream Instability (OSTI) and the Parametric Decay Instability (PDI). HF-pumped IA and LW are often observed as enhanced ion and plasma lines in backscatter UHF radar spectra from an altitude known as the matching height. The matching height can be parameterized by the HF-pump frequency, the UHF-radar frequency, the ambient plasma density, and the electron temperature. Enhanced ion lines that persist for tens of seconds have been observed to descend several kilometers in altitude and model results indicate that ion-line descent can be attributed to electron temperature enhancements during HF heating. However, HF heating in the F region over a time scale of minutes has been predicted by models and observed by radar to cause significant plasma density depletions over a distance of tens of kilometers so the enhanced ion-line matching height may actually increase by several kilometers. A one-dimensional self-consistent ionosphere model has been developed to simulate the response of the high-latitude ionosphere to HF-heating experiments. Results from the model are compared with ionosonde observations and measurements of the enhanced ion-line matching height made with the MUIR incoherent scatter radar at the HAARP facility in Gakona, Alaska to infer the time and spatial dependence of plasma density perturbations during HF-heating experiments. A frequency sweep of HF pulses is used to probe the ionosphere at a range of altitudes; the frequency sweep is performed in serial with and in parallel to continuous HF heating over a time scale of minutes.