COMPUTER SIMULATION OF ELF/VLF GENERATION USING HIGH POWER HF RADIOWAVES

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By modulating the ambient auroral electrojet current in the high latitude ionosphere using ground-based HF transmitters it is possible to generate extremely low frequency (ELF) and very low frequency (VLF) radiation which can enter the earth-ionosphere waveguide and provide a technique for global low frequency communications. This is accomplished by heating the electrons in the lower D region ionosphere with high power HF power modulated at the desired ELF/VLF frequency. With the construction of the new High Frequency Active Auroral Research Program (HAARP) ionospheric research facility in Alaska, many issues remain regarding ELF/VLF generation using HAARP, e.g., what are the ELF/VLF generation efficiencies using high effective radiated powers (ERP) from HAARP and what the ELF/VLF radiation characteristics both in the near and far field. To address these issues we have performed computer simulation studies of the ELF/VLF generation process using a time-dependent 3D full wave code. The code typically simulates a region, centered around the HF heater, extending approximately 3000 km in the horizontal direction and 150 km in the vertical direction. A range of ELF/VLF frequencies can be simulated. For a range of ERPs, we have computed the polarization and field strength in the near field for conditions applicable to HAARP. We have found that the polarization and field strength in the near field can forecast the radiation characteristics and field strength in the far field. We have computed the ELF/VLF amplitude as a function of radial distance and found agreement with that predicted by near and far field radial dependence. We have compared the near field radiation characteristics from the 3D code with experimental observations and found good agreement.

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