

MODEL OF IONOSPHERIC DUCTS TO HF-HEATING

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It is well known that naturally induced field aligned irregularities of the plasma density exhibit enhanced refractive indices and act as ducts that guide waves in the whistler range. The ducting is analogous to light pipes or waveguides that guide those waves that propagate within the critical angle for total internal refraction. There are also indications that echoes observed by satellite sounders of ordinary and extraordinary are the result of ducting by field-aligned irregularities. In this paper we present the results of a theoretical study that addresses the issue of generating and detecting artificial ducts by strong HF heating of F-region using the HAARP ionospheric heater. Such ducts should be capable of ducting whistler waves between the two hemispheres. It shown by numerical simulations that F-region HF heating create a depletion of electrons at the heating region, that drives a pressure pulse that propagates along the entire magnetic field line. The paper presents results of simulations using the Sami2 1D ionospheric modeling code, modified to include a flexible source of strong HF heating. Parametric studies involve varying the heating source in strength, location and energy deposition width. A non-linear relationship was determined that relates the source parameters to the maximum amplitude of the pressure, temperature, and density perturbations, their propagation velocity and the characteristic heating and cooling rates of the irradiated region. A steady quasi-steady state is achieved in the duct structure following a transient state. The density profile shows electron depletion at the heated region, surrounded by density increases in the regions just below and above the heated region. The density perturbations then propagate deep inside the plasmasphere to the conjugate F2 point. Utilization of such artificial ducts for injection of ELF/VLF waves generated by HAARP and requirements for proof-of-principle experiments will be presented.

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