A GLOBAL MODEL OF ARTIFICIAL IONOSPHERIC DUCTS

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Ducts in the Earth's ionosphere along magnetic field lines - defined by their density gradients perpendicular to the magnetic field, enhancing refractive indices and acting as wave guides to whistler-range waves - have implications to the transmission of ELF radio waves across the globe. Strong HF ionospheric heating has been shown to create a depletion of electrons at the heated region, and could lead to a pressure perturbation that propagates along the entire magnetic field line. The objective of this paper is to present results from an ionospheric numerical model (Sami2) to study duct formation through HF heating. The existing Sami2 ionospheric modeling code has been modified to include a flexible source of strong HF heating, which can be varied to mimic the fluctuations in HF heating efficiencies and ionospheric conditions. A parametric study was performed by varying the heating source in intensity and location along the magnetic field line. Both linear and non-linear relationships were found connecting these source parameters to maximum pressure, temperature, and density perturbations, propagation velocity of density perturbations, and characteristic heating and cooling times of the irradiated region. After a transient state, the duct structure was found to achieve a quasi-steady state, showing electron depletion at the heated region, surrounded by density increases in the regions just below and above the heated region. The density perturbations also propagate deep inside the plasmasphere down to the conjugate F2 point, with density enhancements all along the traveling wavefront. These results suggest that it should be possible to use these perturbations, which propagate along the entire field line, as an ionospheric duct.