Physical Mechanisms Associated with Long Range Propagation of Signals from Ionospheric Heaters

N. Zabotin* (1), and V. Zavorotny (2)
(1) ECEE, University of Colorado Boulder, Boulder, USA
(2) NOAA/ESRL, Boulder, USA

Long range (hundreds and thousands km) propagation of heater-produced signals has been studied in experiments with EISCAT and HAARP ionospheric heating facilities (A. V. Zalizovski et al., Radio Sci., 44, RS3010, 1-12, 2009; V. G. Galushko et al., Antennas Prop. Mag., IEEE, 50, 155-161, 2008) and with several globally distributed receiving sites. Two different modes of propagation can be distinguished in the signals spectra. The first one is the regular multihop ionospheric propagation of HF waves radiated by the side lobes of the heater's antenna array. A distinctive feature of the second component is strong variations in the Doppler frequency shift, which in most cases were synchronous at the different receiving sites. This effect is most likely produced by dynamic effects at the ionospheric altitudes within the main beam of the heater.

The tricky part is to explain how a portion of the HF energy contained in the main beam of the heater is redirected towards the remote receiving locations. We believe that mechanism of self-scattering from the heater-induced irregularities (with subsequent excitation of the interlayer ionospheric waveguide) employed in the above publications for this explanation is not the most efficient one and that its theoretical justification suggested in (V. G. Galushko et al., Radio Sci., 48, 180–189, 2013) is flawed in several respects. We analyze the true role that self-scattering can play in spatial redistribution of the heater's signal and how it may be related to observed relaxation and rise times of the remote signals. We also suggest a new, robust explanation for the long-range propagation of the heater-generated waves that does not involve the self-scattering but preserves observed properties of the signals.