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Direction of Waves Propagating from Ground Radio Transmitters Detected by the Orbiting e-POP Radio Receiver Instrument

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Extended Abstract

The reception by the Radio Receiver Instrument (RRI) [1] in the Enhanced Polar Outflow Probe (e-POP) [2] payload on the low-earth-orbiting Canadian small satellite CASSIOPE, of waves radiated by various transmitters on the ground may lead to improved understanding of the propagation physics of these waves in the ionospheric F region. A technique for measuring the direction of propagation at RRI is predicated on the detection of one cold-plasma mode by the orthogonal, crossed 6-m dipoles connected to the RRI. In the case of ground sources like transmitters that emit only one cold-magnetoplasma propagation mode, like the US Navy very-low-frequency (VLF) communications transmitters, or the high-frequency (HF) ionospheric heaters with polarization control, analysis can be applied directly to voltage signals induced on the dipoles. Expressions for the ratio of dipole-signal magnitudes and for the dipole-signal phase difference can be written as a function of the wave vector in the satellite coordinate system. Inversion of these expressions provides the direction of the wave vector in the satellite system. This method requires a knowledge of the electron characteristic frequencies, but not of absolute received signal magnitudes.

In the cases of HF waves from dipole arrays emitting a mixture of O and X modes, we can sometimes operate at a frequency that is not far above the mode cut-off frequencies. Then the received mode pulses are partially resolved in time: the early, O-mode-only part of a pulse can be analyzed under the O-mode polarization relations, and the late, X-mode-only parts under the X-mode polarization relations.

Polarization of mixed-mode pulses at CASSIOPE may be used to analyze the direction of propagation of HF waves incident on regions of the irregular ionosphere where horizontal density gradients intervene to cause SuperDARN ray bending away from traditionally assumed great-circle paths.

References

1. James, H.G., E.P. King, A. White, R.H. Hum, W.H.H.L. Lunscher, and C.L. Siefring, The e-POP Radio Receiver Instrument on CASSIOPE**,** *Space Sci. Rev.,* **189**, January 2015, pp. 79-105, doi 10.1007/s11214-014-0130-y.

2. Yau, A.W and H.G. James, CASSIOPE Enhanced Polar Outflow Probe (e-POP) Mission Overview, *Space Sci. Rev.*, **189**, March 2015, pp. 3-14, doi 10.1007/s11214-015-0135-1.