RF EFFECTS ON OEDIPUS-C FLOATING VOLTAGES

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The OEDIPUS-C tethered payload was launched on 7 November 1995 from the Poker Flat Research Range, Alaska. The Tether Current Monitor (TCM) instrument operated the two subpayloads and the conducting tether as a double electrostatic probe. During the part of the experiment discussed here, the flight upleg, the angle between the tether and the geomagnetic-field direction was less than 5 degrees. The TCM configured the payload cyclically as a high-impedance voltage probe and as a low-impedance current probe.

OEDIPUS C also carried a high-frequency exciter (HEX) on its forward subpayload. With the HEX connected to the forward subpayload dipoles and with the frequency swept from 25 kHz to 8.0 MHz, the transient response of the TCM voltage showed a number of reproducible features. At the lowest frequencies of the sweep, the RF pulses drove the forward subpayload potential negative with respect to the aft by several tens of volts. The time-constant of relaxation of the payload's potential between the HEX pulses increased as background density decreased.

The TCM voltmeter data showed a steady rise in the time-averaged floating voltage of the forward subpayload as the HEX transmitter was swept from lower to higher frequencies. This is as expected when ponderomotive effects become relatively more important relative to rectification. Superposed on this was another feature in which the forward subpayload was driven increasingly negative as the frequency approached the electron gyrofrequency from below, and increasingly positive as it approached it from above. This suggests that RF forcing of the electrons counteracted geomagnetic restriction of the electron collection below the gyrofrequency, but enhanced it above the gyrofrequency.

In order to verify this explanation, we have performed a model calculation of electron collection in the combined RF near-field and steady geomagnetic field in the neighbourhood of an antenna element, assumed to be an infinite cylinder perpendicular to the geomagnetic field. Our model includes effects of time-dependent sheath expansion following the start of RF pulses, and of time-dependent sheath collapse following their end.