

## Electric Field Observations of Plasma Convection, Shear, Alfvén Waves, and other Phenomena Observed on Sounding Rockets in the Cusp and Boundary Layer

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On December 14, 2002, a NASA Black Brant X sounding rocket was launched equatorward from Ny Ålesund, Spitzbergen (79° N) into the dayside cusp and subsequently cut across the open/closed field line boundary, reaching an apogee of 771 km. The launch occurred during Bz negative conditions with strong By negative that was changing during the flight. SuperDarn (CUTLASS) radar and subsequent model patterns reveal a strong westward/poleward convection, indicating that the rocket traversed a rotational reversal in the afternoon merging cell. The payload returned DC electric and magnetic fields, plasma waves, energetic particle, suprathermal electron and ion, and thermal plasma data. We provide an overview of the main observations and focus on the DC electric field results, comparing the measured  $\mathbf{E} \times \mathbf{B}$  plasma drifts in detail with the CUTLASS radar observations of plasma drifts gathered simultaneously in the same volume. The in situ DC electric fields reveal steady poleward flows within the cusp with strong shears at the interface of the closed/open field lines and within the boundary layer. We use the observations to discuss ionospheric signatures of the open/closed character of the cusp/low latitude boundary layer as a function of the IMF. The electric field and plasma density data also reveal the presence of very strong plasma irregularities with a large range of scales (10 m to 10 km) that exist within the open field line cusp region yet disappear when the payload was equatorward of the cusp on closed field lines. These intense low frequency wave observations are consistent with strong scintillations observed on the ground at Ny Ålesund during the flight. We present detailed wave characteristics and discuss them in terms of Alfvén waves and static irregularities that pervade the cusp region at all altitudes.