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ROCKET INVESTIGATIONS OF THE AURORAL ELECTROJET

NGR 02-001-080

Final Report

October 1973

Principal Investigator:

T. Neil Davis

I. PROGRAM SCOPE

This contract (NGR 02-001-080) was a follow-on to an earlier contract (NGR 02-001-025) awarded for the preparation and flight of five experimental packages. Upon its completion in September 1972, work was carried on under a new contract (NGR 02-001-087) still in effect.

The scientific purpose of the work originally was primarily to investigate the morphology of the auroral electrojet currents by use of rocket-borne scalar magnetometers. The scope was enlarged to include investigation of electron and proton precipitation and its effect on the auroral atmosphere through addition of particle counters and photometers to the rocket payloads and application of ground-based optical instrumentation in support of the rocket flights.

The five Nike-Tomahawk rockets flown during this project were:

Rocket	Date	Location
18.13	March 1968	Ft. Churchill
18.15	17 March 1969	Poker Flat
18.16	10 February 1970	Ft. Churchill
18.14	15 March 1971	Poker Flat
18.17	20 March 1971	Poker Flat

II. SCIENTIFIC RESULTS

Scientific publications resulting so far from the flights of these rockets and from related activities supported by the contract are listed below:

Johnstone, A. D. Measurements of low energy protons in a pulsating aurora, Ph.D. Thesis, Univ. of Alaska, Fairbanks, May 1970.

Johnstone, A. D., Correlation between electron and proton fluxes in post-breakup aurora, J. Geophys. Res., 76, 5259, 1971.

Johnstone, A. D., The spreading of a proton beam by the atmosphere, Planet. Space Sci., 20, 292, 1972.

Johnstone, A. D., The geomagnetic factor of a cylindrical plate electrostatic analyser, Rev. Sci. Inst., 42, 1030, 1972.

Boyd, J. S., T. N. Davis, N. B. Brown, T. J. Hallinan and D. D. Wallis, Observations of fast auroral waves, Planet. Space Sci., 20, 437, 1972.

Davis, T. N. and D. D. Wallis, Observations of ionospheric motions using barium ion clouds, Space Research XII, 935, 1972.

Boyd, J. S., Rocket measurements of precipitating electrons in a system of multiple auroral arcs, Ph.D. Thesis, Univ. of Alaska, Fairbanks, July 1973.

Johnstone, A. D. and T. N. Davis, Low altitude acceleration of auroral electrons during breakup observed by a mother-daughter rocket, accepted by J. Geophys. Res.

Johnstone, A. D., J. S. Boyd and T. N. Davis, Study of a small magnetospheric substorm, accepted by J. Geophys. Res.

These various papers report on a variety of findings and describe contributions to the methodology of this type of work. However, from the viewpoint of examining the most important scientific achievements there are several results which stand out as being particularly significant.

1. The coordinated rocket flights and ground-based observations have shown conclusively that the visible aurora is directly

related to the precipitating particle flux in a quantitative way. That is, whenever the particle flux is greater than a given threshold there is a visible aurora produced. Conversely, a given auroral intensity implies a given particle flux.

2. The coordinated observations, and particularly those of particle pitch angles, have shown that instability processes must be operative whenever the brightness of the aurora reached a certain level (IBC II).

3. Pitch angle observations have shown that particle acceleration by parallel electric fields near to the earth cannot be a primary mechanism causing precipitation, at least in certain types of auroras. In general, I think it fair to claim that these various rocket results have gone further to pin down specific acceleration mechanisms than any other similar body of data.

4. While performing optical support observations of barium clouds the discovery of fast barium rays was made pointing to the existence of transient, high electric fields in rayed auroras.

Under the new contract now in effect additional analyses of data are underway and particularly of magnetometer results. Upon completion these analyses will be published.

III. DEGREES AWARDED

The work carried on in this project led to the award of two Ph.D. degrees. The recipients and the titles of their theses were:

A. D. Johnstone, "Measurements of low energy protons in a pulsating aurora", May 1970.

J. S. Boyd, "Rocket measurements of precipitating electrons in a system of multiple auroral arcs", July 1973.