CNSR-Transition Award Program

Annual Review 1997

Principal Investigator:
David P. Steele
University of Saskatchewan

March 13, 1997

Terms of Reference

Annual review is based on three elements:

- research activities and productivity over the past year as compared with proposal and milestones;
- future research plans;
- efforts at securing permanent employment.

Level of support determined based on progress as measured against deliverables, milestones, and the need for support.

Strengths of Past Year

1. *NiteOwl* Proposal for CSA Small Payloads Program:

    a. P.I. led the development of an innovative, high-quality proposal for an important experiment;
    b. P.I. coordinated the activities of a diverse team of highly-qualified professionals and students;
    c. P.I. developed working relationship with leading members of local industry.

2. Identified promising period of mesopause disturbance and began collaborative study of Polar Camera data with Prof. L.L. Cogger.

3. Established productive collaboration with R.A. Doe (SRI International) on optical tomography of polar arc emission at 630.0 nm.

4. Restored Polar Camera to proper working condition and recalibrated filter passbands.

Weaknesses of Past Year

1. Polar Camera maintenance and operation (including data reduction and archiving) took longer than anticipated or desired.

2. SPP proposal activities precluded significant research progress for four months.

3. P.I. initiated no new collaborations during this year, limiting his research progress.

Outline of Presentation

1. Introduction
2. Active Studies
3. Inactive Proposed Studies
4. Search for Permanent Employment
5. Search for Alternate Equipment Funding
6. Other Activities
7. Future Plans
8. Concluding Remarks

Active Studies

1. **Cusp Processes and Patch Formation -** collaborative with Dr. P. Prikryl, Communications Research Centre

Study Hypotheses:

- magnetic L-shell resonances excited by IMF B_y oscillations perturb the magnetopause and modulate magnetic reconnection into pulses;

- ionization bands associated with the field line resonances (*pre-existing structured plasma*) drift poleward through the cusp;

- pulsed reconnection excites zonal flow bursts near the cusp, producing enhanced Joule heating that accelerates plasma recombination and amplifies the plasma structuring;

P.I.'s contributions to date:

- Calibrated, background-subtracted patch images from Dec. 2, 1993, with descriptive text;
- Text on probable effects of cusp and auroral particle precipitation on ionospheric electron density;
- Provision of a list of all dates with patch observations by Polar Camera to date
- Confirmation of patch observations at Eureka on two key dates: Jan. 24 and Nov. 13, 1996.

Current status and expected future contributions:

- Original paper (discussed last year) was revised, resubmitted, returned, split into two papers which were then revised, resubmitted, and flatly rejected;
- Both papers are being extended with data from additional events;
- Polar Camera images will be contributed for all additional events where data are available;

Active Studies

2. **Characteristics of Subvisual Polar Auroras -** collaborative with Dr. R.A. Doe, SRI International

Summary of study:

- Simultaneous 630.0 nm "all-sky" images from Eureka and Resolute Bay (NSF EPCO, U. Michigan imager);

- Slant column emission brightnesses extracted from calibrated images along meridian joining imagers;

- Two-dimensional emission distribution tomographically reconstructed (Chapman function regularization; multiplicative algebraic reconstruction technique);

- Study of most recent event(s) will estimate precipitating particle distribution using 630.0 nm emission "basis functions" for monoenergetic e^- populations;

Contributions:

- Polar Camera images from Feb. 17, 1996: electronic image distortion estimated and corrected as far as possible;

- Polar Camera orientation determined from star images seen through background filters;

- Corrected images flat-field and calibrated, and "valid" data extracted with corresponding pixel look directions;

- Dec. 5-6, 1996 images: orientation, flat-fielding, calibration;

- **Plan** to estimate 557.7 nm centroid emission height using single-point auroral stereoscopy technique developed last year; could provide an independent estimate of characteristic electron energy;

Results:

- Polar arc emission is spatially and temporally determined by magnetospheric processes (*e.g.*, changes in precipitating particle source characteristics) rather than thermo/ionospheric processes (*e.g.*, neutral density variations; plasma transport, diffusion, and decay);

- Paper reporting this conclusion, by Doe, Kelly, Semeter and Steele, to appear in *Geophysical Research Letters*.

Active Studies

3. **Wave Spectrum at the Very High Latitude Mesopause -** collaborative with L.L. Cogger, U. Of Calgary

Summary of study to date:

- Four days of OH M (6,2) R- and Q-branch images (Dec. 22-25, 1994) show marked fluctuations in zenith brightness;

- Full correlation analysis of slant column brightnesses at three equidistant image locations reveals periods of apparent drift of emission structures;

- Periodogram analysis of brightness time series shows significant power at periods of ~4 hours, ~6 hours, ~9 hours, and 38-43 hours, with six cycles of marked ~6-hr oscillation over ~40 hours on Dec. 24-25

- Algorithm has been developed to support estimation of OH T_{rot} from R/Q brightness ratio, but not yet applied to data; hope to validate results against Sivjee's OH M (3,1) temperatures measured from Eureka

Inactive Proposed Studies

A. Patch Studies

- Patch signatures: McEwen/MacDougall collaboration;

- Inferring Ionospheric Convection from Patch Observations: extend Dec. 8, 1993 case study (perhaps using data from Jan. 24 and Nov. 13, 1996 as a start);

- Southward IMF Convection: depends on previous study to validate convection inference technique;

Inactive Proposed Studies

B. Polar Arc Studies

- Characteristics of Subvisual Polar Auroras: statistical survey of faint arcs observed by Polar Camera (arc spectral brightnesses, multiplicity, orientation, motion, lifetime);

- Polar Auroras and Magnetospheric Topology: merging of multistation images with global-scale convection, particle precipitation, and Birkeland current data to infer source regions for particles exciting emission;

- Northward IMF Convection: similar data inputs as above - attempt to deduce convection information from locations of arcs;

- Single-point Stereoscopy of Auroral Arcs: extend and publish single-case study presented at AGU Fall '95 meeting;

- Polar Diffuse Aurora: assess nature of "diffuse aurora" frequently observed at Eureka during '94-'95 winter using CADI, particle data, and modelling;

Search for Permanent Employment

University of Saskatchewan

- Applied for ISAS faculty position in spring 1996;
- Applied to Association of Professional Engineers of Saskatchewan for assessment of academic credentials;
- Didn't make short list: APES required 8 examinations, and Dept. perceived me as being unwilling to teach (!?)

University of Calgary

- Applied for experimental space science faculty position in winter 1997;

Industry

- Developed working relationship and friendship with Duane Sniezek, V.P. of R/D/E at SCI-TEC; asked him to keep me in mind for opportunities that arise;
- Plan to make thorough search of local opportunities;

Search for Alternate Equipment Funding

NSERC Research Grant

- Sought 4-year individual research grant to support M.Sc. student and ongoing operation of Polar Camera;

- Received 2-year grant at a level inadequate to support both student and instrument, so continued operating Polar Camera with contract support;