

Most Significant Contributions

a) Supply of Ionospheric Ions to the CPS: C. Cully (then my MSc student) and I used Akebono SMS data to characterize <70 eV H^+ & O^+ outflow at 8000 km as a function of location (ie, cusp, auroral zone, etc.), solar wind parameters, and activity. We developed an empirical model of outflow and a particle tracer to map the fluxes to the CPS. We found that this flux is ever-present and a sudden decrease in convection (e.g., due to a northward turning) will cause an *instantaneous* decrease of flux to the CPS. **We therefore elucidated *for the first time* a credible scenario for these ions to play a role in substorm onset.** This work was published in two papers [31, 32] (note: numbers refer to list below).

b) Optical b2i: I developed an algorithm to identify the equatorward boundary of CPS proton precipitation (the *b2i*) in Meridian Scanning Photometer (MSP) data, demonstrated that this *optical b2i* correlates well with the inner CPS B-field topology, and developed a proxy (analogous to Sergeev’s “MT-index”) for the B-field inclination at geosynchronous orbit based on the optical b2i [see paper 30]. This allows us to track the B-field inclination in the inner CPS on a continuous basis on meridians away from those of GOES. We went on to demonstrate use of this technique with data from multiple MSPs, global SI12 images, and the equatorward boundary of SuperDARN E-region echoes [see papers 14, 25, 67]. **With appropriate caveats, the ability to continuously track the magnetic topology in the inner CPS has important implications for research into magnetotail dynamics** (see next contribution).

c) Dispersionless Injection (DE): An injection *dispersionless* if the fluxes at different energies increase simultaneously. Until now, DEs have been studied with near-geosynchronous *in situ* measurements, and the region where they start has not been elucidated. Emma Spanswick and I developed a method for remote sensing DEs with riometer data, and proved they *typically* start as an azimuthally extended disturbance beyond geosynchronous, but within 10 Re [16, 12, and 17]. **Given the optical b2i, the riometer data, and new SuperDARN coverage over our MSPs and riometers, we now can track the 2D ionospheric projection of the magnetic field inclination, DE, and convection in the inner CPS during dynamic magnetotail events (including BBFs and the substorm).** This will be a powerful complement to *in situ* observations by the two GOES and three inner THEMIS probes.

d) GeoSpace Imaging: I have dedicated myself to creating new capabilities in auroral imaging. Together with S. Mende I was an architect of the THEMIS-ASI program [20, 15]. My group has installed 25 ASIs over the last four years, and now operates a network of >50 instruments (ASIs/MSPs/riometers + 8 magnetometers). I initiated GAIA-VxO to facilitate accessing auroral images. I came up with the concept of a two-satellite mission that would provide continuous global auroral imaging (Ravens), allowing the first-time continuous imaging spanning storms and SMCs. Ravens led directly to my involvement in the Chinese KuaFu project, which includes two satellites with orbits/payload specified in my Ravens Concept study [9]. KuaFu is currently in Phase A or pre-Phase A in China, Canada, Belgium, and the UK, with tentative launch in 2013). Throughout, I have developed the ground- and space-based imaging programs with specific science objective, and to utilize new technologies to allow for new capabilities to meet them. **I assert that I am now an internationally recognized leader in geospace imaging, as evidenced by my accomplishments, my invited review in *Advances of Space Research* [13], and the nature of some of my invited talks (see section 2).**

e) Magnetospheric Modelling: My PhD work involved development and testing global magnetospheric B-field models [Donovan and Rostoker, *GRL*, 18(6), 1991; Donovan et al., *JGR*, 97(A6), 1992; Donovan, *JGR*, 98(A8), 1993; Skone et al., *JGR*, 100(A12), 1995]. In Donovan [1993], I presented the first-ever quantitative estimates of the effects of field-aligned currents on magnetic mapping. In the months after my PhD, I developed a method to numerically solve the MHD wave equation in a non-axially symmetric B-field (using a formulation of *H. Singer*). This work enabled C. Waters to use ground-based magnetometer measurements of frequencies of ULF field line resonances to infer radial profiles of inner-magnetospheric plasma density. This work was published in two papers [Waters et al., *JGR*, 100(A5), 1995; Waters et al., *JGR*, 101(A11), 1996]. My contribution to this work was essential to utilizing the magnetometer data for remote sensing, and is still leading to involvement by me in magnetoseismology studies [see e.g., 18, 19].

2. Research Contributions (2003-2008)

Over the past five years I have >70 publications in refereed journals and conference proceedings, with roughly 10 more submitted and in review, and an additional 13 papers in nonrefereed conference proceedings. Mikko Syrjäsuo and I edited the Proceedings of the 8th International Conference on Substorms. I underline the names of my students and underline the names of myself and my PDFs/RAs. To save space I abbreviate author lists and titles, and have not included “doi” numbers for GRL and JGR articles (in those cases I indicate issue number or month of issue in brackets after the italicized volume number). GRL, JGR, AG, ASR, CJP, and JASTP refer to Geophys. Res. Lett., J. Geophys. Res., Ann. Geophys., Adv. Space Res., Can. J. Phys., and J. Atmos. Solar-Terr. Phys., respectively.

My contributions to the majority of the publications were significant, usually some combination of suggesting the study, providing critical data/interpretation, or writing/dealing with reviewer comments. Many of these studies were led by students or PDFs of mine. In a few cases (>10) my contribution was either small (involving provision of data with minimal interpretation), or I was included as a member of the project development team (e.g., some recent THEMIS papers).

2.1a) Papers Submitted and in Review for Publication in Refereed Journals

- ▷ Uritsky, V., E. Donovan 3rd, A. Klimas, and E. Spanswick, Quantifying scaling regimes of bursty particle precipitation initiating in the inner and outer plasma sheet, **submitted to AG**, 2008.
- ▷ Liang, J., W. Liu, E. Donovan, and B. Jackel, In situ and ground-based THEMIS observations of two-stage evolution of substorm intensification, **submitted to GRL**, 2008.
- ▷ Spanswick, E., E. Donovan (2nd), and 7 others, Global observations of substorm injection region evolution: August 27th 2001, **submitted to AG**, 2008.

Plus an additional 5 papers in review in refereed journals as of October 31 2008

2.1b) Papers Published or Accepted for Publication in Refereed Journals

- 1 Uritsky, V., A. Klimas, E. Donovan, and E. Spanswick, Scale-free and scale-dependent modes of magnetotail dynamics, *in press in GRL*, 2008.
- 2 Liu, W., J. Liang, and E. Donovan, Interaction between kinetic ballooning mode and thin current sheet, *in press in GRL*, 2008.
- 3 Partamies, N., E. Donovan, and D. Knudsen, Statistical study of inverted-V structures in FAST data, *AG*, 26(June), 2008.
- 4 Lui, A., and 12 others (E. Donovan 6th), Determination of the substorm initiation region from a major conjunction interval of THEMIS satellites, *in press in JGR*, 2008.
- 5 Angelopoulos, V., and 15 others (E. Donovan 10th), Tail reconnection triggering of substorm expansion onset, *Science*, 2008.
- 6 Donovan, E., and 20 others, including E. Spanswick, B. Jackel, M. Syrjäsuo, T. Trondsen, and G. Baker, Simultaneous in situ and ground-based observations of a small substorm, *GRL*, 35, 2008.
- 7 Liang, J., E. Donovan, W. W. Liu, B. Jackel, M. Syrjäsuo, S. Mende, H. Frey, V. Angelopoulos, M. Connors, Intensification of preexisting auroral arc at substorm expansion onset: wave-like disruption during the first tens of seconds, *GRL*, 35, 2008.
- 8 Mende, S., S. Harris, H. Frey, V. Angelopoulos, E. Donovan, B. Jackel, M. Grefen, C. Russell, and L. Peticolas, The THEMIS array of ground based observatories for the study of substorms, *SSR*, 2008.
- 9 Tu, C.-Y., R. Schwenn, E. Donovan, E. Marsch, Y.-S. Wang, L.-D. Xia, and Y.-W. Zhang, Space Weather Explorer - The KuaFu Mission, *ASR*, *in press*, 2008.
- 10 Liu, W., J. Liang, E. Donovan, G. Sofko, B. Jackel, and 4 others, An isolated high-speed auroral streamer and its interpretation as optical signature of Alfvénic fronts generated by BBFs, *GRL(February)*, 35, 2008.
- 11 Liu, W., E. Donovan, J. Liang, I. Voronkov, E. Spanswick, P. Jayachandran, B. Jackel, and M. Meurant, Equatorward motion & fading of proton aurora during growth phase, *JGR*, 112(A10), 2007.

- 12 Liang, J., W. Liu, E. Spanswick, and E. Donovan, Azimuthal structures of substorm electron injection and their signatures in riometer observations, *JGR*, 112(A9), 2007.
- 13 Donovan, E., and 19 others, including T. Trondsen, E. Spanswick, M. Syrjäsuo, and B. Jackel, Global auroral imaging, system level science, and ILWS, *ASR*, 40, pp 409-418, 2007.
- 14 Meurant, M., C. Blockx, E. Spanswick, E. Donovan, B. Hubert, J.-C. Gérard, V. Coumans, and M. Connors, EL - a possible indicator to monitor magnetic field stretching during substorm expansive phase: statistical study, *JGR*, 112(A5), 2007.
- 15 Mende, S., V. Angelopoulos, H. Frey, S. Harris, E. Donovan, B. Jackel, M. Syrjäsuo, C. Russell, and I. Mann, Substorm onset location and timing using the THEMIS GBOs, *GRL*(September), 34, 2007.
- 16 Spanswick, E., E. Donovan, R. Friedel, and A. Korth, Ground based identification of dispersionless electron injections, *GRL*, 34(January), 2007.
- 17 Liu, W., J. Liang, E. Spanswick, and E. Donovan, Remote-Sensing Magnetospheric Dynamics With Riometers: Observation and Theory, *JGR*, 112(A5), 2007.
- 18 Kabin, K., R. Rankin, C. Waters, R. Marchand, E. Donovan, and J. Samson, Different models for field line resonances in cold plasma: effect on magnetospheric density estimates, *Planet. Space Sci.*, 55(6), 820, 2007.
- 19 Waters, C., K. Kabin, R. Rankin, E. Donovan, and J. Samson, ULF wave polarization and magnetic field model effects on the estimation of proton number densities in the magnetosphere using field line resonances, *Planet. Space Sci.*, 55(6), 809, 2007.
- 20 Donovan, E., S. Mende, B. Jackel, H. Frey, Syrjäsuo, I. Voronkov, T. Trondsen, L. Peticolas, V. Angelopoulos, S. Harris, M. Greffen, and M. Connors, The THEMIS All-Sky Imager Array - System design and initial results from the prototype imager, *JASTP*, doi:10.1016/j.jastp.2005.03.27, 2006.
- 21 Jayachandran, P., J. MacDougall, and E. Donovan, Ground-based radar detection of the equatorward boundary of ion aurora in the dusk-midnight sector and its association with substorms, *Adv. Polar Upper Atmos. Res.*, 20, 63-75, 2006.
- 22 Amm, O., E. Donovan, and 11 others, Coordinated geospace studies using Cluster, and ground-based data: An interim review, *AG*, 23, pp 2129-2170, 2005.
- 23 Rae, I., E. Donovan, and 10 others, Evolution and characteristics of global Pc5 waves during a high solar wind speed interval, *JGR*, 110(A12), 2005.
- 24 Spanswick, E., E. Donovan, and G. Baker, Pc5 modulation of high energy electron precipitation: particle interaction regions and scattering efficiency, *AG*, 23, pp 1533-1542, 2005.
- 25 Jayachandran, P., E. Donovan, and 5 others, Global and local growth-phase equatorward expansion of the ion oval, *JGR*, 110(A5), 2005.
- 26 Liang, J., G. Sofko, and E. Donovan, On the spatial & temporal relationship between auroral intensification and flow enhancement in a pseudosubstorm, *JGR*, 109(A6), 2004.
- 27 Syrjäsuo, M., and E. Donovan, Diurnal Auroral Occurrence Statistics Obtained Via Machine Vision, *AG*, 22, pp 1103-1113, 2004.
- 28 Frey, H., Mende, Angelopoulos, and E. Donovan, IMAGE-FUV substorm observations, *JGR*, 109, 2004.
- 29 Baker, G., E. Donovan, and B. Jackel, A comprehensive survey of auroral latitude Pc5 pulsation characteristics, *JGR*, 108(A10), 2003.
- 30 Donovan, E., B. Jackel, I. Voronkov, T. Sotirelis, F. Creutzberg, and N. Nicholson, Ground-based optical determination of the b2i boundary: a basis for an optical MT-index, *JGR*, 108(A3), 2003.
- 31 Cully, C., E. Donovan, A. Yau, and G. Arkos, Akebono/SMS observations of low-energy ion outflow: dependence on magnetic activity and solar wind conditions, *JGR*, 108(A2), 2003.
- 32 Cully, C., E. Donovan, A. Yau, and H. Opgenoorth, Supply of ionospheric ions to the Central Plasma Sheet, *JGR*, 108(A2), 2003.
- 33 Voronkov, I., E. Donovan, and J. Samson, Pseudo-breakup, breakup (full substorm onset), and poleward border intensifications, *JGR*, 108(A2), 2003.

34-63 Plus an additional 30 papers in refereed journals between 2003 and 2008**2.2) Other Refereed Contributions (referred conference proceedings and AGU monographs)**

- 64 Syrjäsuo, M., and E. Donovan, Using relevance feedback in retrieving auroral images, *Proc. of the IASTED Int. Conf. on Computational Intelligence (CI 2005)*, 420-425, 2005.
- 65 Syrjäsuo, M. and E. Donovan, Content-based retrieval of auroral images - thousands of irregular shapes, *Proc. of the IASTED Conf. on Visualization, Imaging and Image Processing*, 224-228, 2005.
- 66 Donovan, E., B. Jackel, D. Klumpar, and R. Strangeway, Energy dependence of the isotropy boundary latitude, *Proc. of Atmos. Studies by Optical Methods*, 2003.
- 67 Nicholson, N., E. Donovan, B. Jackel, L. Cogger, and D. Lummerzheim, Multipoint measurements of the ion isotropy boundary, *Proc. of Atmos. Studies by Optical Methods*, 2003.

68-73 Plus an additional 6 papers in refereed proceedings between 2003 and 2008**2.3a) Non-refereed Contributions - Papers in Conference Proceedings**

Graduate students and PDFs/RAs under my direct supervision were 1st authors of 11 of these papers.

- 74 Donovan, E., S. Mende, B. Jackel, M. Syrjäsuo, M. Meurant, I. Voronkov, H. Frey, V. Angelopoulos, and M. Connors, Azimuthal evolution of substorm expansive phase onset aurora, *ICS-8 Proc.*, 55, 2007.
- 75 Knudsen, D., E. Donovan, and 10 others, Ionosphere-magnetosphere-thermosphere science in Canada: opportunities for Swarm, in *Proc. 1st Swarm International Science Meeting*, ESA, WPP-261, 2007.
- 76 Prosolin, V., I. Voronkov, and E. Donovan, Effects of pressure gradients and convection on the inner plasma sheet stability, *ICS-8 Proc.*, 241, 2007.

77-86 Plus an additional 10 papers in nonrefereed proceedings between 2003 and 2008**2.3b) Non-refereed Contributions - Selected Invited Presentations**

I have given >40 invited talks, seminars, and colloquia over the last six years, some of which I list here. Of particular note was my hour-long plenary “Interdisciplinary Lecture” at COSPAR (July, 2008). There were only five interdisciplinary lectures at this major international meeting. I was the only Canadian scientist giving one of these prestigious lectures, and mine was the only one on geospace science.

- ▷ Imaging the aurora, *Invited Plenary Interdisciplinary Lecture*, COSPAR, Montreal, July, 2008.
- ▷ Why substorm onset is so difficult to understand, *Invited Tutorial*, GEM, Midway, Utah, June, 2008.
- ▷ The Diffuse Aurora, *Invited Tutorial*, GEM, Midway, Utah, June, 2007.
- ▷ DASI Mission Overview, “kickoff” talk for the *CEDAR-DASI Workshop*, Santa Fe, June, 2007.
- ▷ Magnetic Storms, *UBC Department of Physics & Astronomy Colloquium*, October 2006.
- ▷ Global auroral imaging: geospace remote sensing in ILWS, *Invited talk at WPGM*, Beijing, 2006.
- ▷ High energy electron precipitation during substorms, *AGU Invited talk*, December 2004.
- ▷ The Future of Passive Remote Sensing of Auroral Precipitation in Canada, *Invited talk at the NSF DASI “Blue Sky” Visioning Workshop*, Boulder, April, 2004.

3. List of Evidence of National and International Leadership

- ▷ **Lead Applicant:** \$20M CFI proposal for Canadian Resolute Bay AMISR (submitted October 2003).
- ▷ **Canada Research Chair (Tier II) in Auroral Studies:** renewed in October 2008.
- ▷ **Co-Proposer (with M. Lester):** ISSI “System-Level Science” Study Group (1st meeting Nov. 2007)
- ▷ **Member:** ISSI “Cluster Ground-Based Science” Study Group (1st meeting Nov. 2007)
- ▷ **Member:** ESA Swarm Mission Advisory Group (membership awarded by competitive process).
- ▷ **Founder:** Global Auroral Imaging Access (GAIA) Virtual Observatory program.
- ▷ **CoI:** *THEMIS* (5 spacecraft NASA MIDEX mission; V. Angelopoulos, PI).
- ▷ **CoI:** *KuaFu* (proposed 3 spacecraft Chinese mission; C.-Y. Tu, PI).
- ▷ **CoI:** *AMISR* (approved (NSF) incoherent scatter radar at Resolute Bay; J. Kelly, PI)

- ▷ **Chair:** International Living With a Star Ground-Based Task Group.
- ▷ **Member:** Canadian Association of Physicists Committee on Science Policy.
- ▷ **Member:** NSERC GSC-17 (2005-2007).
- ▷ **Member:** EISCAT Science Advisory Committee (2004-2007).
- ▷ **International Liaison:** US NSF GEM Steering Committee (2003-).
- ▷ **Member:** US NSF CEDAR Steering Committee (2005-2007).
- ▷ **Convenor:** 8th International Conference on Substorms (March 2006).
- ▷ **Convenor:** 2nd International Workshop on Riometry (March 2006).
- ▷ **Chair:** Canadian Geospace Monitoring Program Supervisory Group (2002-2008).
- ▷ **PI:** NORSTAR, a CSA, NSERC, & CFI funded array MSPs, riometers, and ASIs (2001-).
- ▷ **PI:** THEMIS-Canada CSA Contract for Operations of GBO Network in Canada (2003-).
- ▷ **PI:** Ravens, a CSA concept study to explore a Canadian imaging mission for ILWS.
- ▷ **PI:** Operations contract for all CANOPUS instruments from 2001-2004.
- ▷ **Co-wrote:** CANOPUS-2000 science plan (with J. Samson and I. Voronkov).

4. Contributions to Training of HQP

It is my objective to provide outstanding opportunities for students and PDFs. I try, for example, to give students first crack at unique data sets, and science questions that can be addressed best with those data sets in hand. For PDFs I have always focussed on their science projects, but also have tried to allow them to take advantage of interesting and often unusual career opportunities. As a result, I have what I consider to be a very high success rate in terms of outcomes, meaning my students and PDFs have done very well during their time with me, and more importantly, afterwards. Some specific examples are listed below:

- ▷ Since 2001, my students have been first authors on a total of 8 refereed and 4 non-refereed papers, and co-authors on another 16 refereed and 4 non-refereed papers (**in other words, students of mine have had a total of 32 authorships and co-authorships during the last six years**).
- ▷ **Two PDF/RAs working for me have found permanent positions.** Brian Jackel was hired as an Assistant Professor in our department, starting July 2007. Noora Partamies returned to her native Finland in July 2007 as the coordinator of the Finnish national graduate program in space physics. I have handed over PI-ship of the MSP program to Brian Jackel as of January 2008.
- ▷ **Since 1999, my students have been awarded a total of eight awards for talks or posters at international and national conferences:** four AGU Outstanding Student Paper Awards (Cully, two for Spanswick, and Hiebert); two DASP Outstanding Student Paper Awards (Nicholson, Spanswick); two ICS Outstanding Student Poster Awards (Hiebert and Prosolin).
- ▷ Early in her PhD, Emma Spanswick demonstrated that the dispersionless injection can be identified in riometer data. She used this to demonstrate that the dispersionless injection *likely* starts in the 8-9 Earth radii region and subsequently expands tailward and Earthward. **She is now internationally regarded as an expert in the scientific use of riometer data, and is involved in numerous collaborations, several not involving me. Now four years into her PhD program, she has been offered five PDF positions.**
- ▷ **Students working with me have been granted a total of 4 NSERC PGS awards, 2 AIF Scholarships, and 1 Deans Silver Anniversary Graduate Fellowship, and 1 Killam Memorial Scholarship. As well, I have attracted three PDFs who were successful in competing for AIF Fellowships.**
- ▷ **Trond Trondsen started a high-tech imaging company based on early work done on NORSTAR.** This company got its start by acquiring the assets of Keo Consulting (Robert Eather's company), and now has CFI, US NSF, and US Air Force contracts. The new company, Keo Scientific, is now posting profits.