International Collaboration in Sounding Rocket Research

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• A “Case Study”: one person’s participatory experience
• Observations: “Lessons learned”
• International Collaboration in CSA Context 2010
## Participation in Sounding Rocket International Collaboration
### A “Case Study”

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<th>Launch</th>
<th>Project – Science Objective</th>
<th>Lead / F. Partners</th>
<th>New Results; Publications</th>
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<td><strong>1980’s</strong></td>
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<tr>
<td>C. Perry</td>
<td>CENTAUR: Dayside cusp</td>
<td>CAN / UTD+</td>
<td>m-sheath aurora structure; &gt;5</td>
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<td>S. End</td>
<td>PAC - Pulsating Aurora</td>
<td>CAN / U Tokyo+</td>
<td>Pulsation dispersion; &gt;10</td>
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<td>CRR</td>
<td>Waterhole: Auroral dynamics</td>
<td>CAN / LANL</td>
<td>Auroral currents; 5</td>
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<tr>
<td>CRR</td>
<td>Beam Plasma Discharge</td>
<td>USA / U Minnesota</td>
<td>BPD on Shuttle; 2(+)</td>
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<td>CRR</td>
<td>MARIE: Auroral acceleration</td>
<td>CAN / Cornell</td>
<td>TAI, ⇒ LHSS; &gt;5</td>
<td>⇒ SMS</td>
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<tr>
<td>PFRR</td>
<td>ERRRIS: E-region e-dynamics</td>
<td>USA / GSFC</td>
<td>Auroral E-region; 1(+)</td>
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<td><strong>2000’s</strong></td>
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<td>Svalbard</td>
<td>SS520-2: Ion outflow microphys.</td>
<td>JPN / JAXA/ISAS</td>
<td>Cleft O+ imaging; 1(+)</td>
<td>⇒ IRM</td>
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<td>KSC</td>
<td>S520-23: Ion-neutral coupling</td>
<td>JPN / JAXA/ISAS</td>
<td>(Analysis in progress)</td>
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<tr>
<td>PFRR</td>
<td>ACES: Auroral current/dynamics</td>
<td>USA / U Iowa</td>
<td>(CSA funding too late)</td>
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<tr>
<td>KSC</td>
<td>@520-26: Ion=neutral coupling</td>
<td>JPN / JAXA/ISAS</td>
<td>(2010/12 launch scheduled)</td>
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</table>
Project team in front of Operations Building at Churchill Research Range. CASSIOPE/e-POP team members in photo: P.A. Bernardt (CER PI), D. Beattie (Bus Systems Eng), A.W. Yau (Mission Scientist)
Project Waterhole 1981-1984: The Science ...

Observations of Particle Precipitation, Electric Field, and Optical Morphology of an Artificially Perturbed Auroral Arc: Project Waterhole

A. W. Yau, B. A. Whalen, and F. Creutzberg

Herzberg Institute of Astrophysics, National Research Council of Canada

Fig. 11. ASC images of the auroral arc from 0334 to 0345. All frames were taken with 3-s exposure. Visibility threshold of images is about 15 kR. The cross and the circle in the frame at 0338 denote the release point and its projection distance of 100 km, respectively.

Fig. 13. Summary plot of in situ particle and field, and ground-based photometric measurements. (From top to bottom) Relative

Ionospheric depletion ⇒ auroral current disruption ⇒ auroral dimming
Transverse ion acceleration and wave-particle interaction in auroral ionosphere

Lower hybrid waves and solitary structures (LHSS)
SS520-2 and TSA

SS520-2 Science Objective:
Ion acceleration/outflow microphysics in cleft

Launch: Svalbard, Dec. 4, 2000 Apogee: 980 km

Thermal Suprathermal Analyzer (TSA) Objective:
Suprathermal ions in cleft ion outflow using modified (from Nozomi TPA) boom, TOF gate, detector anode
International Collaboration – Benefits (at least in the past…)

• Quality opportunity for cutting edge science
  – Cutting-edge science not always possible to anticipate

• Quality opportunity for new instrument flight opportunities
  – But not only from time to time, particularly as a “guest”

• Valuable partnership experience
  – And potentially valuable long-term connection

• Leverage complementary scientific strengths and needs

• Potential stepping stones to future scientific opportunities
  – But difficult to predict which piece of stone will turn into a gem
International Collaboration – Challenges (at least in the past…)

• Opportunity often inconsistent with CSA schedule

• No NSERC International Opportunity Funds (IOF), NASA Stand Alone Mission of Opportunity (SALMON) type AO or Unsolicited Proposal

• Agency A won’t commit until Agency B does, and vice versa

• No mechanism to work opportunity into CSA Work Plan
International Collaboration on Sounding Rockets…

- Provides quality opportunity for cutting-edge science, new instrument flights, HQP training – but not every time, and seldom simultaneously
- Works best in “two-way street”
- Works best when pursued strategically – and cultivated over long term
- Can be key element of (but not replacement for) indigenous program
- Is a means to enhance (but not in itself) an end
Suggestions made in 2007 Workshop Presentation…

Optimization and Creation of Opportunities

- “Opt in” or “opt out”
  - Both CSA and community must decide

- Be strategic
  - Develop small payload international collaboration strategy
  - Target at specific international partner
  - Establish community-based “Canadian” and bilateral SWG
  - Negotiate long-term collaboration programs with “like-minded” (and like-size) agencies
Recommendations from Sounding Rocket Breakout Session in 2007 Workshop

_Extracted from Sounding Rocket Breakout Session Report:_

Maintain & enhance Canada’s ability to participate in int’l collaboration

i. Ensuring sufficiently frequent and regular AO’s

ii. Forming/supporting working groups with agency- and scientist-level participation…

iii. Weighing carefully the decision no longer to accept unsolicited proposals…

Fund Canadian-led rocket every 3-5 years, in collaboration with other agencies…

Fund participation in foreign-led collaborations at a rate of one every 1-2 years…
Suggested Update to Recommendations in 2007 Workshop

Suggested updates highlighted in red:

Maintain & enhance Canada’s ability to participate in int’l collaboration

i. Ensuring sufficiently frequent and regular AO’s

ii. Forming/supporting working groups with agency- and scientist-level participation…

iii. Weighing carefully the decision no longer to accept unsolicited proposals…

iv. Developing bilateral collaboration programs targeted at specific program objectives

Fund Canadian-led rocket every 1 to 2 years, in collaboration with other agencies*

Fund participation in foreign-led collaborations at a rate of one every 1-2 years…

* A steady stream of sufficient # of affordable missions is key to provide “end-to-end” training opportunity
Thank You

For Your Attention!
Release water vapor into F-region above aurora
H₂O⁺ and CO₂⁺ ions dissociatively recombine to produce ion hole: “Waterhole”
Reduce ionospheric conductivity and disrupt auroral current system and …
Project Waterhole 1981-1984: The Team …

Bristol Aerospace (Launch Rocket and Payload Eng.), ADGA (Range)
NRC Space Research Facility Branch (SRFB; now CSA)
NRC Herzberg Institute of Astrophysics, Los Alamos Scientific Lab (now LANL)
**TSA**

*Thermal Suprathermal Analyzer*

- Hemispheric electrostatic analyzer; time-of-flight
- 2-D ion velocity distribution
  - Fast, mass-resolved
  - 20-ms resolution
  - 1-100 AMU/q; H⁺, He⁺, O⁺
  - 0.5-20 eV/q (12 energies)
  - 8 angles
The TSA Experience