



COMMUNITY WORKSHOP ON SCIENCE FROM SUBORBITAL VEHICLES (BALLOONS, AIRCRAFT, ROCKETS)

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Presentation to the
Space and Atmospheric Environment Committee (SAEAC)
CSA, 26 April 2007

Workshop Presentation to SAEAC, 26 April 2007

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Genesis of the Workshop

- Concept emerged from discussions about the future of scientific ballooning in Canada
- Proposed a two-day workshop to CSA in July 2006
- CSA welcomed this proposal and agreed to provide support
- Scope: science from suborbital vehicles, particularly balloons, aircraft, and rockets
 - Decided to extend it beyond atmospheric science, given common interests in using these platforms
 - Relevant to all communities included within the anticipated Small Payloads Program
- Held in the McTaggart-Cowan Auditorium at Environment Canada, Downsview, on February 1 and 2, 2007

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Objectives



- To raise the profile of balloons, aircraft, and rockets as platforms for scientific investigations
- To stimulate discussion of new approaches and new science questions that can be addressed with such platforms
- To determine the level of interest in these flight opportunities in Canada
- To identify the infrastructure needed to enable new missions
- To provide a vision for a “program” with regular flight opportunities
- To enhance and create new collaborations between Canadian universities, government agencies, and industry

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Relevance to CSA



Suborbital platforms offer a number of advantages that are closely allied to the mission of the CSA:

- Scientific exploration, including atmospheric science, space science, astronomy, and astrophysics
- Technology development, including testing prototypes of satellite instruments
- Validation of satellite missions, such as those making height-resolved atmospheric measurements
- Training of scientific and technical personnel, who will become the next generation of scientists, including our next generation of Principal Investigators

Ideally, we would like to see the Workshop providing input to the anticipated new Small Payloads Program.

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Attendance



- 85 registered participants; about 80 of these present
 - 11 graduate students, 13 PDFs, 7 RAs, 17 professors, 8 from industry, 20 government colleagues
- Universities – Alberta, Calgary, Cambridge (UK), Dalhousie, Ecole Polytechnique de Montreal, Leibniz Institute of Atmospheric Physics (Germany), Lethbridge, Saskatchewan, Toronto including the Space Flight Laboratory, Université Pierre et Marie Curie (France), Waterloo, York
- Industry – ABB Bomem, Bristol Aerospace, COM DEV, Optech, MPB Communications, Resonance, Scientific Instrumentation Ltd, Thoth Technology
- Government – CSA, Columbia Scientific Balloon Facility (USA), Communications Research Centre, EC, NRC, NRCan, NASA GSFC (USA), NOAA (USA)

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Program Structure - Day 1



- Opening plenary - invited talks by D. Kendall, B. McArthur
- 6 invited talks on science from balloons, aircraft, and sounding rockets
 - Prof. Roderic Jones, University of Cambridge, UK
 - Dr. Adrian Tuck, NOAA Chemical Sciences Division, USA
 - Mr. David Pierce, Chief, NASA Balloon Program Office, USA
 - Dr. Albert Hertzog, Université Pierre et Marie Curie, France
 - Dr. Robert F. Pfaff, Jr., NASA/Goddard Space Flight Center, USA
 - Prof. Dr. Franz-Josef Lübken, Leibniz Institute of Atmospheric Physics, Germany
- 11 contributed talks on past projects and case studies
- 2 contributed talks on industrial capabilities and interests
- Poster session on both past projects (4) and industrial capabilities and interests (4)

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Program Structure - Day 2



- 9 talks on proposals for future projects
- 5 talks by graduate students and postdoctoral fellows: “If I Had a Million Dollars...”.
- Break-out groups on balloons, aircraft, sounding rockets
 - To review current activities and capabilities in Canada and abroad; novel technologies and opportunities; the scope for new and exciting science; infrastructure needs; vision
- Final plenary session with short reports and recommendations from the 3 break-out groups

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Workshop Vision



“Our overall ten-year vision for suborbital missions is to establish an active and viable small payloads program whose importance in contributing to scientific exploration, instrument development, and training is recognized at CSA and in the wider community. This program would engage Canadian universities, government agencies, and industry, and would consist of regular flight opportunities for all three platforms. It would have the flexibility to support flights of both new and proven instruments, to enable the development and implementation of new technologies and capabilities, thereby leading to greater opportunities for new and exciting scientific missions.”

Workshop Final Report

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Aircraft Breakout Session I



Discussion Leader/Author: Jim Whiteway (York University)

Reporter: Michaela Hegglin (University of Toronto)

- Aircraft are best platforms for accessing heights <15 km
- Natural that aircraft be used for instrument development, validation, and advancing the scientific basis for CSA orbital missions to study the lower atmosphere
- Outstanding track record of aircraft research in Canada
 - Mainly at the Flight Research Laboratory of NRC
 - Partnership between EC and NRC for utilization of aircraft for atmospheric research
- Main session theme: to broaden the availability of the NRC aircraft for projects led by scientists at universities for research that is relevant to CSA missions

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Aircraft Breakout Session II



- Scientific Issues
 - Upper troposphere and lower stratosphere
 - Convection and transport in the tropopause region, cirrus clouds and effects of aircraft exhaust, dynamics in the UTLS
 - Tropospheric pollution and transport
 - Development of instruments
 - Validation of satellite instruments
- Aircraft
 - NRC CT-33 (to 12.5 km, best for in situ measurements)
 - NRC Falcon-20 (to 12.5 km, instruments needing operator)
 - Int'l: Egrett, HIAPER, UK Facility for Atmos. Measurements
- Planning: build up the investment in aircraft infrastructure that is available to universities; develop stronger links between the NRC, EC, CSA, and universities

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Aircraft Recommendations



That the CSA:

- (1) Include aircraft as platforms within the scope of the Small Payloads Program.
- (2) Provide funding for the use of aircraft for instrument testing, characterization, and validation. This would include the costs of installation as well as the aircraft operations.
- (3) Provide 20% matching funds for applications to the Canadian Foundation for Innovation (CFI) for aircraft infrastructure. This would include testing and characterization of instruments being developed for CSA missions.

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Balloons Breakout Session I



Discussion Leader: Ben Quine (York University)

Reporter: Kaley Walker (University of Toronto)

Section Author: Kimberly Strong (University of Toronto)

- Canada has a long history of atmospheric balloon missions
- Canada has become an active participant in a number of high-profile international astronomy balloon missions
- At a critical juncture for future ballooning in Canada
 - EC is reconsidering its support of the launch facility at Vanscoy, and much of the existing payload and launch support equipment there dates back 20-30 years
 - Should we upgrade and maintain payload support and launch capability or rely on contracting launches to CSBF or CNES?

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Balloons Breakout Session II



- Topics discussed
 - Atmospheric science questions - 17 identified
 - Astrophysics science questions - 6 identified
 - Major impact of ballooning on training of personnel
 - Importance to development and testing of new instruments
 - Recent advances in balloon technologies
 - Long-duration flight capabilities
 - Very high level of interest in balloon flight opportunities
 - Opportunities for international collaboration
 - NASA and CSBF are open to collaborations, and offered to meet with CSA personnel to discuss how agencies might work together
 - Relative merits of maintaining Canadian balloon launch capability versus purchasing launches and piggy-backing
 - Infrastructure needed to enable new missions

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Balloons Breakout Session III



- Goals for the next decade
 - Establishing an active and sustainable ballooning program, with yearly (or more frequent) flight opportunities
 - Creating large Canadian-led projects, with international collaborators
 - Building and maintaining the student experience, giving students and postdocs as much responsibility as possible
 - Involving engineers and technicians to provide expertise and continuity to projects
 - Contributing to the space program through instrument development and spin-offs for space science and space technology
 - Testing most future satellite instruments on balloon platforms, prior to their deployment in space
 - Achieving a Canadian long-duration balloon flight capability
 - Establishing an Arctic launch capability, with the possibility of circumpolar flights
 - Building a deployable launch capability that can provide access to both hemispheres

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Balloons Recommendations I



That the CSA:

- (1) Establish and maintain a Canadian-led stably-funded, long-term (10-year) balloon program, with regular flight opportunities, enabling a minimum of two flights per year. An active, ongoing program supporting several overlapping balloon projects at different stages would require a budget of at least \$1M per year.
- (2) Provide a mechanism for funding international opportunities as they arise, facilitating this in a timely manner. For example, flights of opportunity may well have timelines on the order of 3 to 6 months. If we are to take advantage of such opportunities, then CSA must be able to review and fund them in a time frame that may be on the order of a few weeks to a few months in advance.

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Balloons Recommendations II



- (3) Fund the development of new instrumentation.
- (4) Ensure that there is support for balloon flights of both new higher-risk instruments as well as well-proven ones.
- (5) Provide strong support for test flights of future satellite instruments on balloon platforms, prior to their deployment in space.
- (6) Actively support the involvement of students, postdocs, and younger scientists in ballooning.
- (7) Have realistic expectations for the management of large and small projects by university-based investigators.
- (8) Undertake multi-agency co-ordination of support for missions, insofar as possible.

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Balloons Recommendations III



- (9) Give consideration to leveraging of CFI or other funding in the upcoming Small Payloads Program Announcement of Opportunity.
- (10) Support the community's efforts to achieve new Canadian capabilities, such as a long-duration balloon flight capability, an Arctic launch capability, and/or a deployable launch capability.
- (11) Arrive at an agreement leading to the upgrade or replacement of the launch support infrastructure at Vanscoy, in partnership with Environment Canada.
- (12) The Canadian ballooning community reconvene to make a coherent plan with firm recommendations regarding the future of Canadian launch capabilities.

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Sounding Rockets Breakout Session I



Discussion Leader/Author: David Knudsen (University of Calgary)

Reporter: Johnathan Burchill (NRCAN)

- Canadian sounding rocket research began in IGY, with a peak of several launches per year in the mid 1970's
- Since closure of Churchill Rocket Range in 1984, there have been some launches from foreign ranges, with the exception of one launch from CRR in 1998
- Student involvement has been on the rise since the transfer of the space plasma instrumentation group from the NRC/HIA to the University of Calgary in 1995
 - Must continue if Canada is to have highly-qualified instrument scientists to support the long-term space plan
- Only viable platform for studies of the mesosphere, and of the lower ionosphere and thermosphere
 - Optimally suited to study micro-scale physics up to 1500 km

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Sounding Rockets Breakout Session II



- Topics discussed
 - Science questions of interest - 7 identified
 - Importance in development and testing of new instruments
 - Future: Canada should continue its participation in international collaborations, but must take its turn leading such missions
 - Bristol Aerospace has interest and infrastructure for building rocket payloads
 - New rocket technologies
 - International collaboration are vital - active collaborations with USA and Japan (need timely funding mechanism)
 - Advantages of Canadian-led rocket launches
 - Maintaining Canada's technical capabilities in rocket payload and vehicle development
 - Allowing Canadian PI's to determine scientific goals and launch conditions
 - Providing opportunities to fly and test unproven, higher-risk designs

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Sounding Rockets Recommendations I



That the CSA:

- (1) Maintain and enhance Canada's ability to participate in international collaborations by
 - i) ensuring sufficiently frequent and regular AO's,
 - ii) forming or supporting working groups with both agency-level and scientist-level participation to develop bilateral collaborations in specific disciplines, and
 - iii) weighing carefully the decision no longer to accept unsolicited proposals, which have been the mainstay of Canadian participation in international space science missions and scientific instrumentation programs for decades,
- (2) Fund a Canadian-led sounding rocket every 3-5 years, in collaboration with other national agencies where possible,

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Sounding Rockets Recommendations II



- (3) Fund participation in foreign-led collaborations at a rate of one every 1-2 years,
- (4) Work to increase the number of Canadian groups involved in rocket research by encouraging and enhancing student recruitment and outreach,
- (5) Consider rocket-borne testing of instruments destined for orbital missions but having no previous flight heritage, and
- (6) Encourage collaboration between scientific disciplines within Canada, for example by combining mesospheric and ionospheric experiments in one payload where possible. Partnering with engineering departments should also be considered.

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Workshop Documents



- Homepage
www.atmosp.physics.utoronto.ca/~workshop/
- Program Book (64 pages)
www.atmosp.physics.utoronto.ca/~workshop/CWSSV_final_program.pdf
- Proceedings (583 pages)
www.atmosp.physics.utoronto.ca/~workshop/CWSSV_proceedings.pdf
- Final Report (52 pages)
 - Submitted to CSA March 31, 2007
 - Will be released to the community after review by the Canadian Space Agency and SAEAC...

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Letters of Support from Industry



- ABB Bomem Inc.
- Bristol Aerospace Ltd.
- COM DEV Ltd.
- Continuum Aerospace Inc.
- MPB Communications Inc.
- Optech Incorporated
- Picomole Instruments Ltd.
- Resonance Ltd.
- Scientific Instrumentation Ltd.
- Thoth Technology Inc.

**All provided
letters of support
that are included
in the Workshop
Final Report**

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Concluding Remarks



- The Workshop strongly supports an ongoing Small Payloads Program, with a regular series of AOs capable of simultaneously supporting aircraft, balloon, and sounding rocket missions.
- With the limited number of upcoming Canadian space missions, the role of a reinvigorated Small Payloads Program becomes even more critical in building and maintaining expertise in our universities and industry.
- There is a high level of interest in suborbital missions, as indicated by the excellent Workshop attendance by Canadian university, government, and industrial representatives.

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Organizing Committee



- Kimberly Strong (Committee Chair), Department of Physics, University of Toronto
- Doug Degenstein, Institute of Space and Atmospheric Studies, University of Saskatchewan
- Michaela Hegglin, Department of Physics, University of Toronto
- Dave Knudsen, Department of Physics and Astronomy, University of Calgary
- Tom McElroy, Environment Canada
- Barth Netterfield, Department of Astronomy and Astrophysics, University of Toronto
- Ben Quine, Department of Physics and Astronomy, York University
- Walter Strapp, Environment Canada
- David Tarasick, Environment Canada
- Kaley Walker, Department of Physics, University of Toronto
- Jim Whiteway, Department of Earth and Space Science & Engineering, York University

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