A role for small-balloon capability in the Canadian space science program

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Primary objective

To generate flight missions at modest cost, within the life-cycles of Ph.D. students

- Identify a significant scientific problem
- Develop the concept for a measurement solution
- Build a breadboard for a conceptual tests
- Develop the flight instruments for a suitable platform
- Conduct flight tests and measurement campaigns
- Acquire, analyze and interpret the data
- Publish both the science and technology results

University of Wyoming experience

Typical Balloon Performance

Balloon Volume (m^3)	Film Thickness (mil)	Balloon Mass (kg)	Payload Mass (kg)	Ceiling Altitude (km)
4,000	0.25	9	16	34
7,230	0.35	21	30	34
			41	33
			60	31
8,500	0.25	15	26.4	36
105,700	0.35	117	16	45

Between 1971 and 1985 the University of Wyoming launched 560 balloons from 25 sites, from South Pole to 85 N (Ice Island T-3). The goal was stratospheric aerosol from volcanic eruptions.

Current interests involve a KingAir aircraft, using cloud radar and lidar.

Funding issues

- In my opinion the small balloon program should rest on an underlying instrument development capability, for which there is sustaining infrastructure and technologists.
- Given such a base, instruments for specific missions could be developed at relatively small cost, in the range $10K to $200K.
- Having flights at regular and frequent intervals would allow stability for technical and research personnel and reduced and predictable costs. Instrument recovery also reduces costs.
- Having a sustainable base program makes it easier for researchers to obtain funds from collaborative organizations.

Scientific goals

- From a platform just above 30 km researchers can use optical or GPS remote sensing techniques:
  - To look up, upper stratosphere to the mesopause, or lower thermosphere
  - Or down, lower stratosphere through troposphere to the surface
  - Including in particular the upper troposphere and lower stratosphere
- Measurements can be made of constituents, temperatures and dynamics; daytime or nighttime, with a focus on:
  - Atmospheric processes
  - Atmospheric coupling, troposphere to lower thermosphere
  - Medium-term variability (5 to 10 years)
- A small balloon program is consistent with Canada's strong focus on the Middle Atmosphere, in the broader sense.

Suggested schedule and collaborations

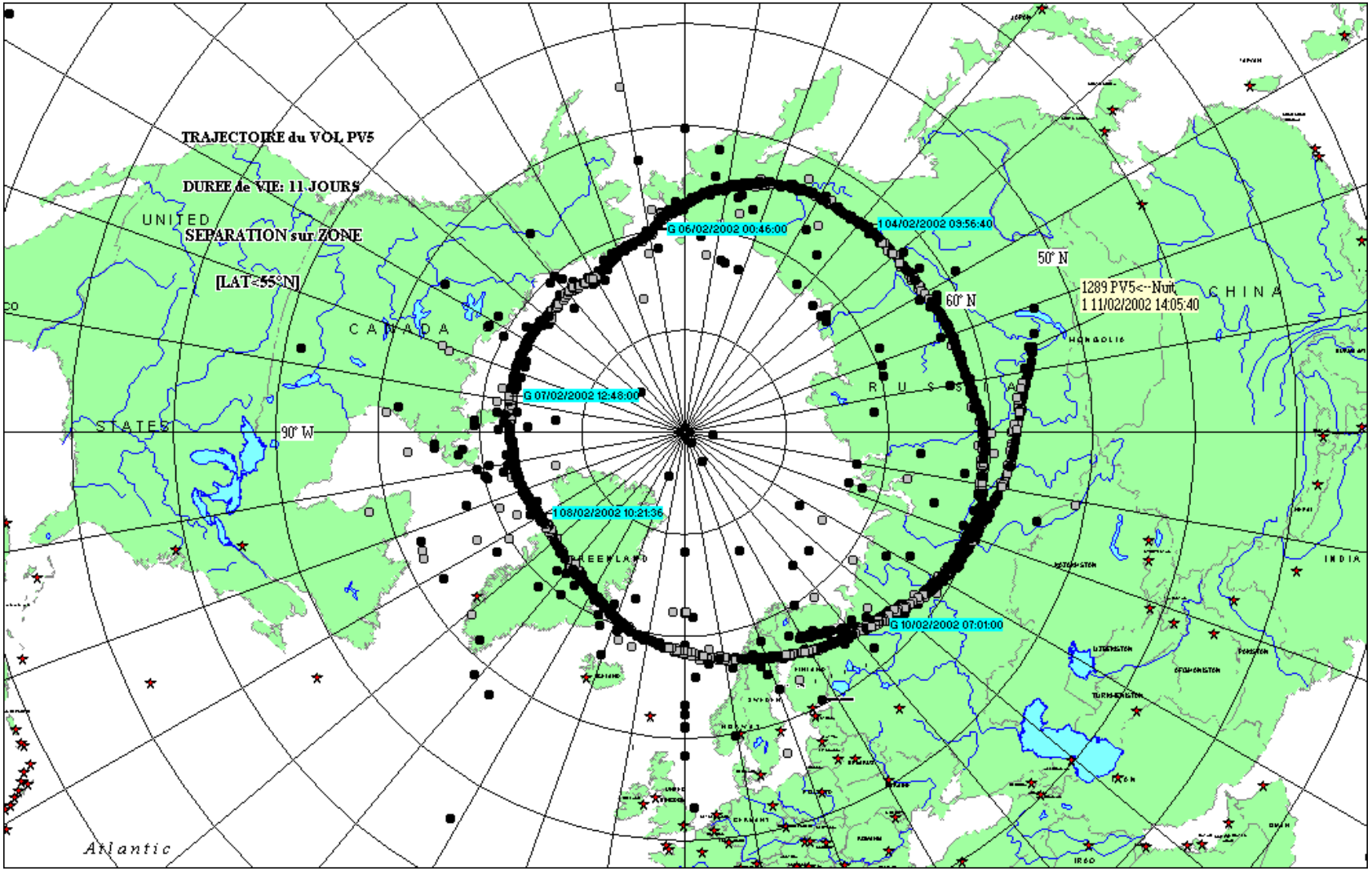
- Program duration – 10 years
- Trial flights could take place in 2011
- First five years – unpressurized balloons, moving to higher latitudes during those years
- First five years – preparations for pressurized balloon flights
- Second five years – pressurized circumpolar balloons flights from Arctic launch sites
- There is good potential for collaboration with the French, who have extensive Antarctic and Arctic experience, but other partners are possible.

Strateole flights from Kiruna, 2002

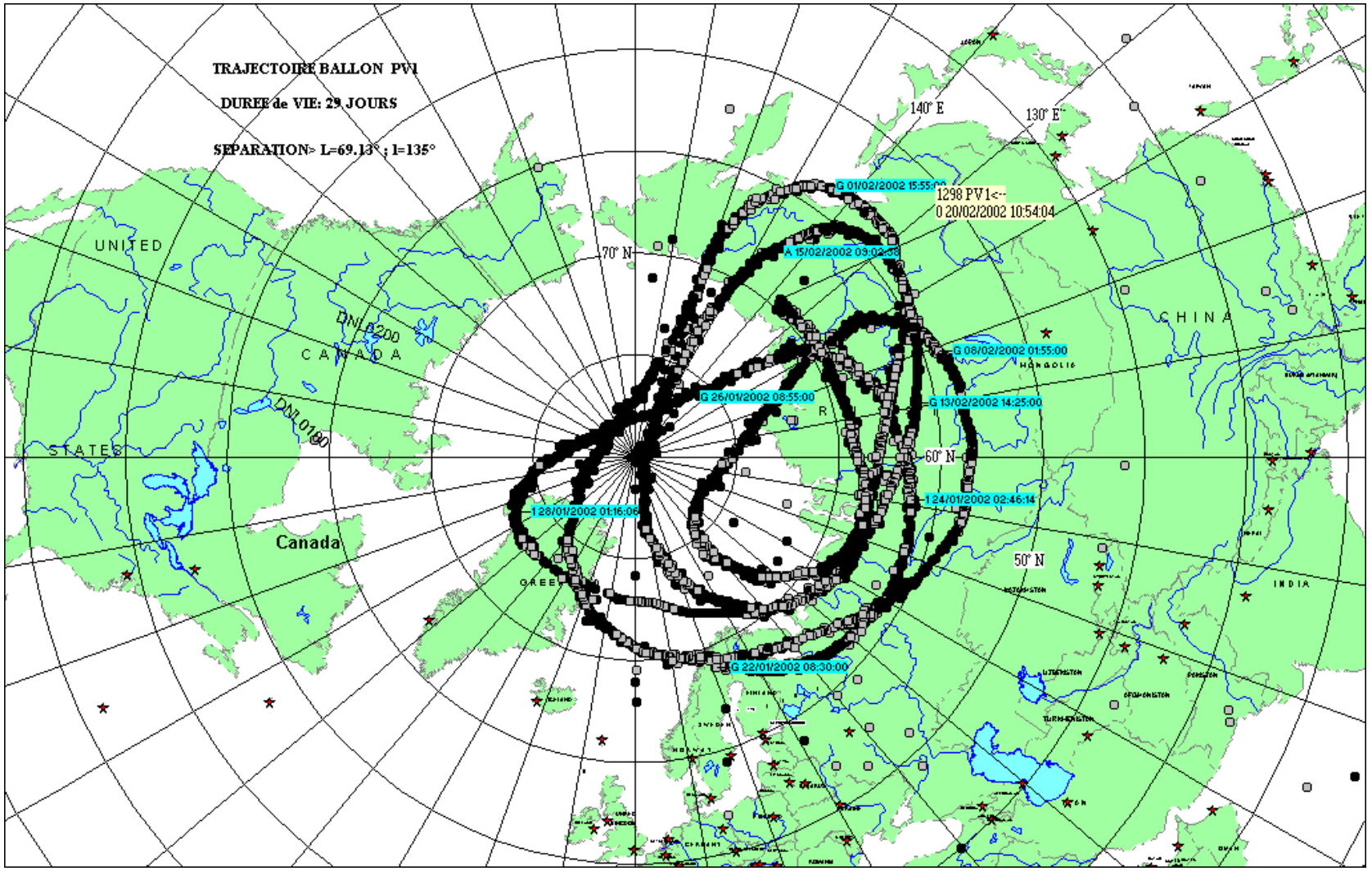
Launch	Date	Duration (days)	P (hPa)	Alt (km)
1	January 22	29	59	18
2	January 22	14	59	18.
4	January 26	8	85	16.5
5	February 1	11	85	16.5
6	February 4	45	65	17.7
7	February 5	7	65	18

The CNES STRATEOLE balloon is a 10-m diameter super-pressure balloon (SPB) with a 50 micron thick envelope made of bi-laminated polyester film. Helium is used as the lifting gas. Once at its drifting level, the SPB lifetime is limited only by helium effusion through the envelope or by loss through micro-leaks. The total number of days above is 114.

Flight PV5 – cutoff at 50N

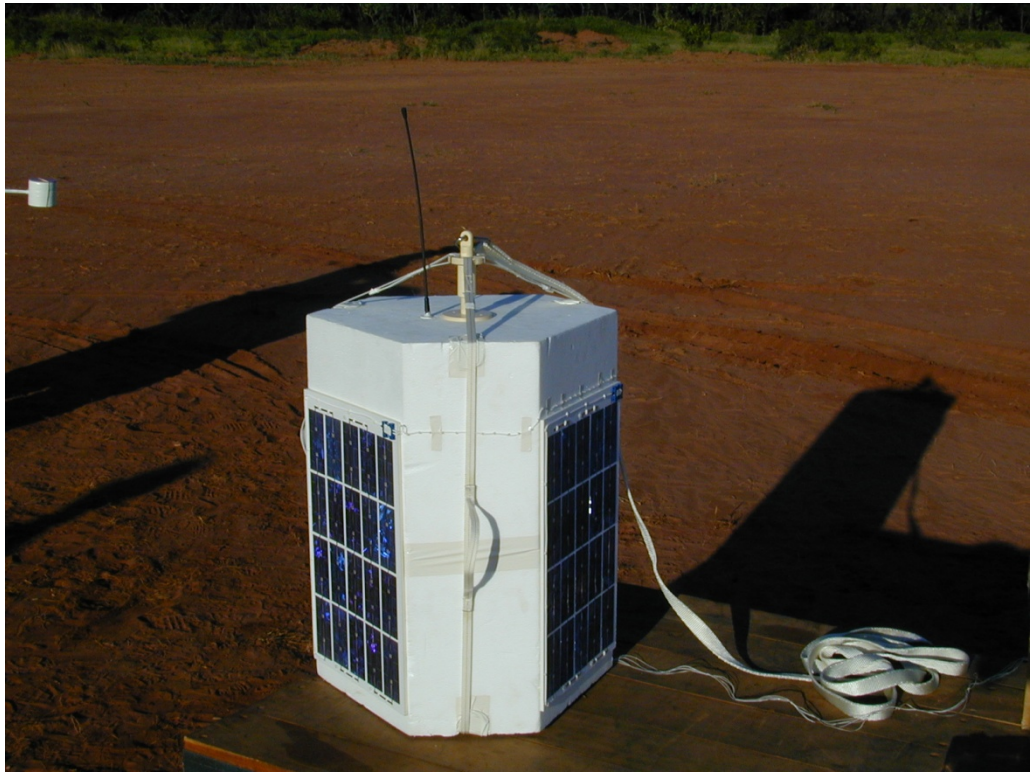


Flight PV1


TRAJECTOIRE BALLON PV1
DUREE de VIE: 29 JOURS
SEPARATION> L=69.13° ; l=135°
140° E
130° E
70° N
60° N
50° N
1298 PV1<--
0 20/02/2002 10:54:04
G 08/02/2002 01:55:00
G 26/01/2002 08:55:00
G 13/02/2002 14:25:00
124/01/2002 02:46:14
126/01/2002 01:16:06
G 22/01/2002 08:30:00
UNITED
STATES
CANADA
Canada
CHINA
INDIA

KIRUNA LAUNCH: A specific launching technique has been developed by CNES for polar conditions. For a flight level of 50 hPa and 10 m diameter the balloon can carry a 20 kg mass.

The measurement gondola consists of polystyrene tubes covered with aluminized polyester that allows the thermal conditioning of different elements. The energy onboard is provided by lithium batteries. Basic instruments in the gondola are two temperature sensors, a pressure sensor, a GPS receiver and an ARGOS transmitter.



Student and public involvement

- Alexei Karpenko launched a 1.5 kg payload to 30 km from near Goderich; his hobby interests are photography, GPS and communications. http://www.natrium42.com/halo/flight2/
- Paul Verhage, a school teacher from Boise, Idaho has launched 50 balloons, one to 35 km; he says the cost of a launch is $1,000. http://www.universetoday.com/2006/01/20/satellites-on-a-budget-high-altitude-balloons/
- Art Vanden Berg of B.C. carries UAVS to 30 km and flies them down by remote control. http://members.shaw.ca/sonde/spec.htm
- Payloads of about 1.5 kg do not require NOTAMs and so are readily launched by students.

Weber State University students, Ogden, Utah