NASA's Balloon Program in Support of Canadian Payloads

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on behalf of the
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Topics To be Discussed

- **Mission of the NASA Balloon Program**
- **Important New Science conducted from Balloons**
- **Balloon Program Capabilities & Launch locations**
- **Campaign Mission Model**
- **Operations Support**
- **Future Plans (ULDB)**
- **Concluding Remarks & Contact Information**

Mission of the NASA Balloon Program

- The NASA Balloon Program provides low-cost access to the near space environment for the science Community to enable Cutting Edge Science Investigations
  - Large Observatory-class Payloads With Advanced Technologies
- Provide hands-on training of Students and Young Scientists – tomorrow's Science leaders
- The scientific ballooning program is a vital component of the NASA science program and can be utilized in support of Canadian payloads.

Recent Cited Achievements in Ballooning

- **Instruments carried on high-altitude balloons have produced important scientific results, and one can expect future significant results from balloon-borne instruments**
- *Wefel/ATICII- Nature/New York Times for possible indirect measurement of dark matter*
- *Devlin, Netterfield, Halpern/BLAST- Nature for discoveries regarding star formation*
- *Kogut/ARCADE- highlight of AAS conference for discovery of previously unknown very loud source of radio emissions similar to CMBR*

Balloon Sizes / Mass - Altitude Capability

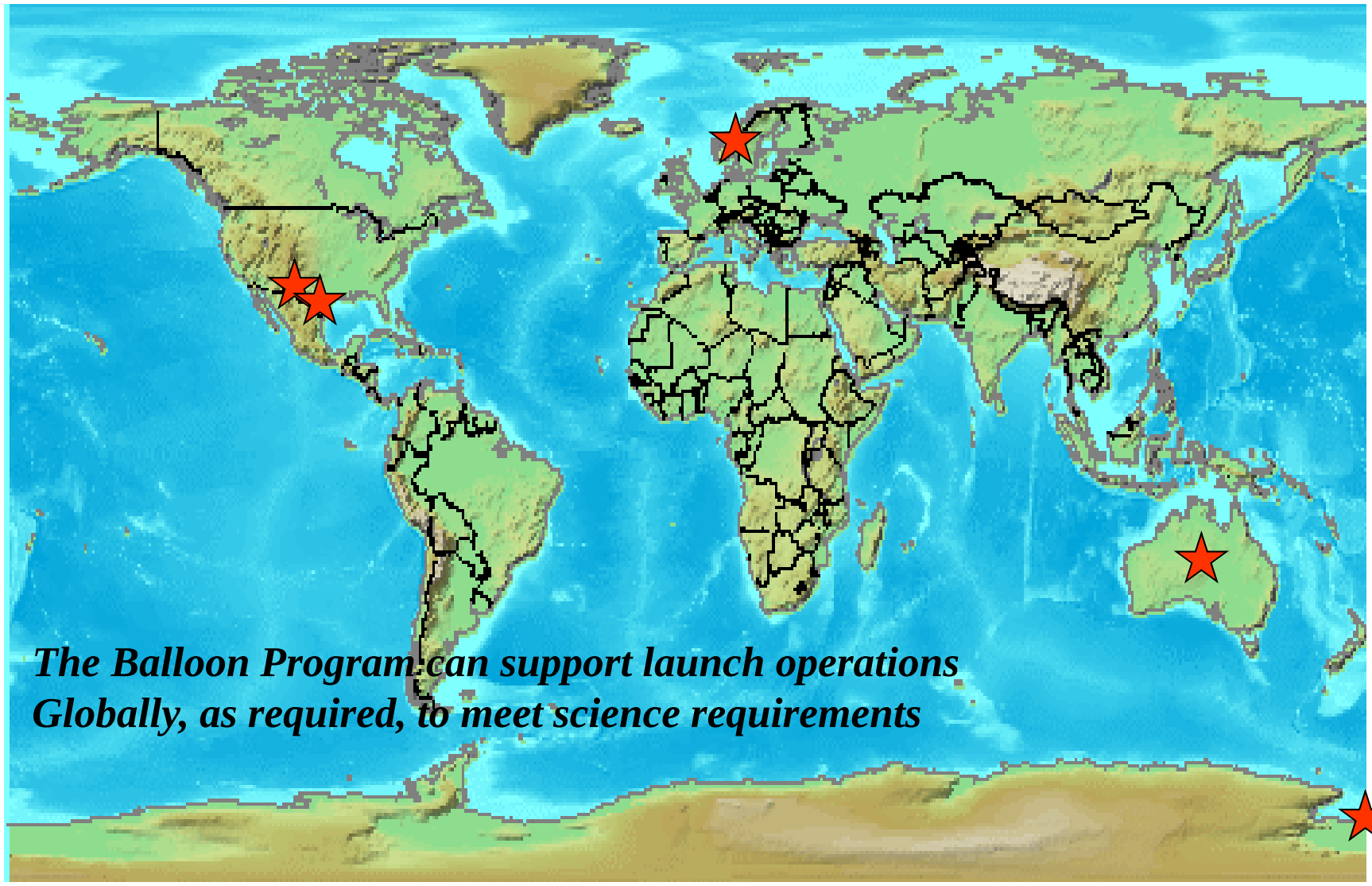
Balloon Size	*Maximum Suspended Weight (lbs)*	*Float Altitude (ft)*
59.84 MCF	1650	160,000
36.73 MCF	8000	120,000
39.97 MCF	6000	127,000
28.47 MCF	6500	119,000
11.82 MCF	7450	98,000
11.82 MCF	2875	116,000
4.0 MCF	3500	96,000

Balloon Program Capability / Costs

	Conventional	LDB	ULDB*
Duration	Up to 2 days	Up to 40+ days	Up to 100 days
Flight Opportunities	~16 per year	3-6 per year	1-2 per year
Suspended Capacity	1650-8000 lbs		6000 lbs
Float Altitude	Nominally 110KFt – 130 KFt (Working on Up to 160 KFt)		Up to 110,000 ft
Flight Support Systems **All NASA Flight Support Systems are highly reliable proven systems**	CIP •Line of Sight •300 kbps direct return	SIP •Over the Horizon •100 kbps TDRSS downlink (With High Gain Antenna)	SIP •Over the Horizon •100 kbps TDRSS downlink With High Gain Antenna)
Launch Locations **Operations Costs per flight, excluding Instrument**	Fort Sumner, NM; Palestine, Texas; Alice Springs, Australia **ROM $ 300-400 K**	Antarctica; Kiruna, Sweden; Alice Springs, Australia; **ROM $ 500 - 750 K**	**ROM $ 1000-1200 K**

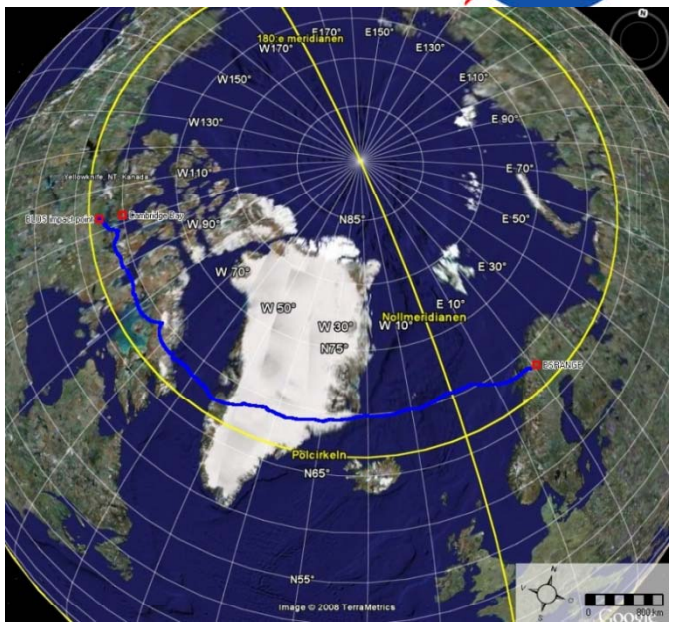
*** Current development project**

NASA Established Launch Sites



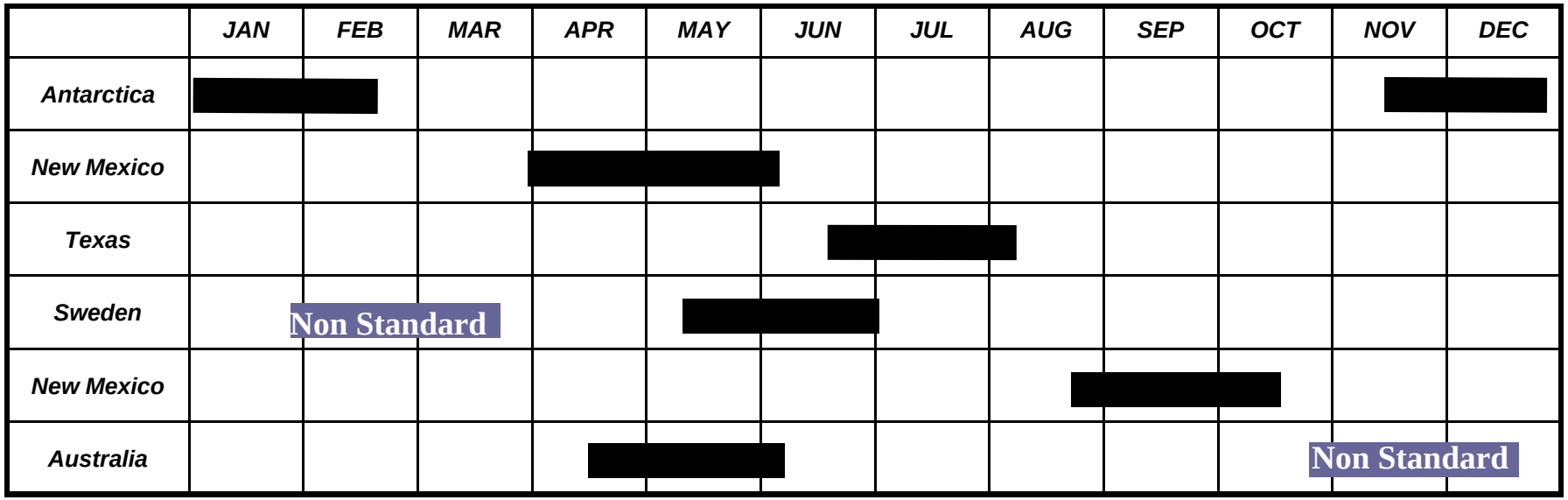
LDB Flights From Esrange Sweden

- NASA Established Northern Hemisphere LDB Capability in 2005 (Sweden to Canada)
  - The program routinely supports 4 payloads per campaign, every other year.
  - Flight durations on the order of 4 to 7 days from Sweden to Canada
  - Hopeful of future circumnavigation over Russia with flight durations on the order of 3 weeks
    - Recent Sweden – Russia overflight agreement
    - The NASA Balloon Program will be assessing possibility of using this agreement for launching NASA payloads, which could benefit Canada as well
  - Ideal launch access for Canadian Scientists with world class facilities & support



Campaign Mission Model

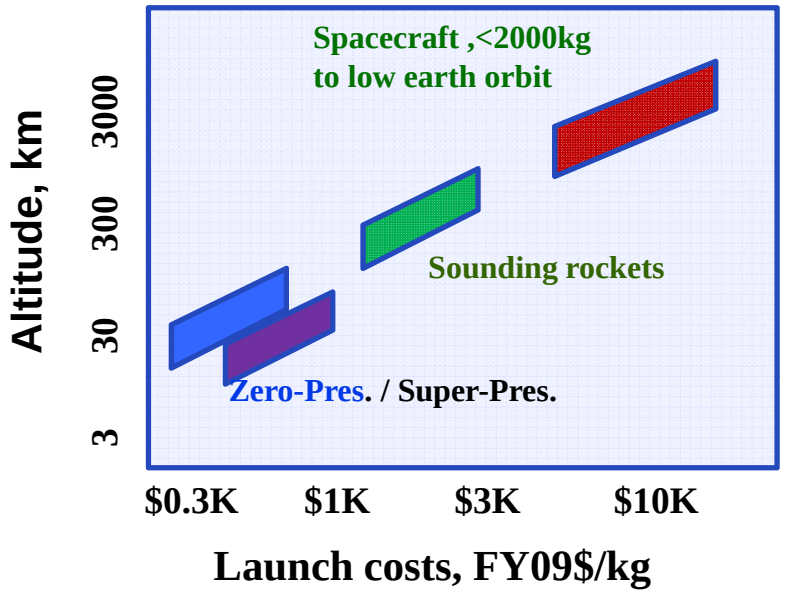
- NASA Conducts 3 U.S. Campaigns (New Mexico, Texas) per year, plus
- Antarctica LDB Campaign, and either a Northern Hemisphere LDB (Sweden), or a mid-latitude LDB (Australia) campaign each year
- **NASA's established Launch Sites and typical mission durations:**
  - **Ft. Sumner, New Mexico** **~2 days**
  - **Sweden to Canada (66 degs N lat)** **~5-7 days**
  - **Australia (23 degs S lat)** **~ 24-48 Hrs (conventional) 9-14 days (LDB)**
  - **Antarctica (77 degs S lat)** **~ 14-50 days**

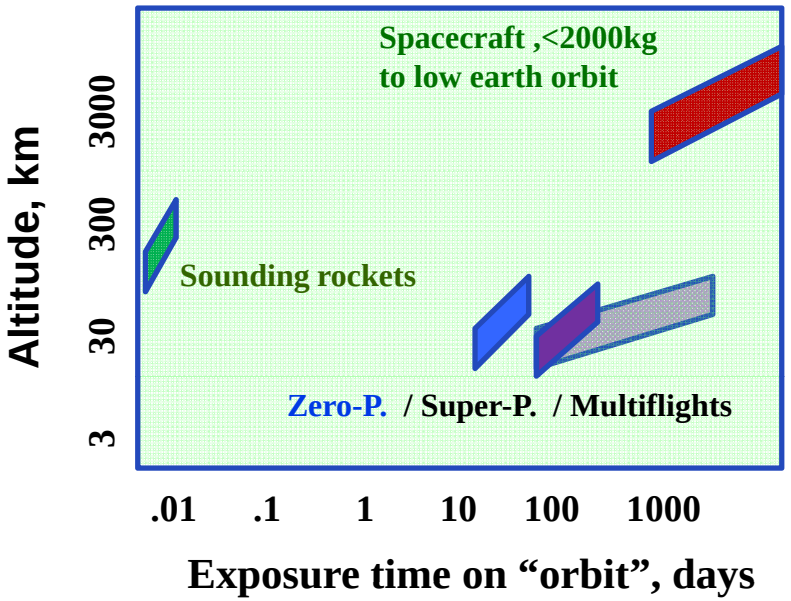


Operations Support for Missions

- Located at CSBF in Palestine, Texas
- Can support 3 missions in flight simultaneously
- Receipt and processing of telemetry
- Flight management
- Transferring experiment data to users home institutions
- Communications and Airspace coordination

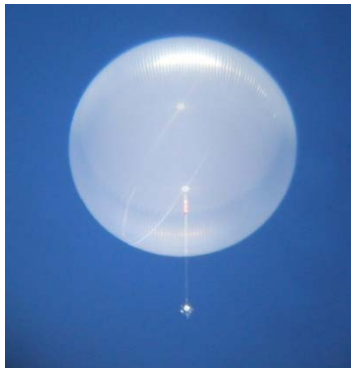
Future Plans: Ultra-Long-Duration Ballooning



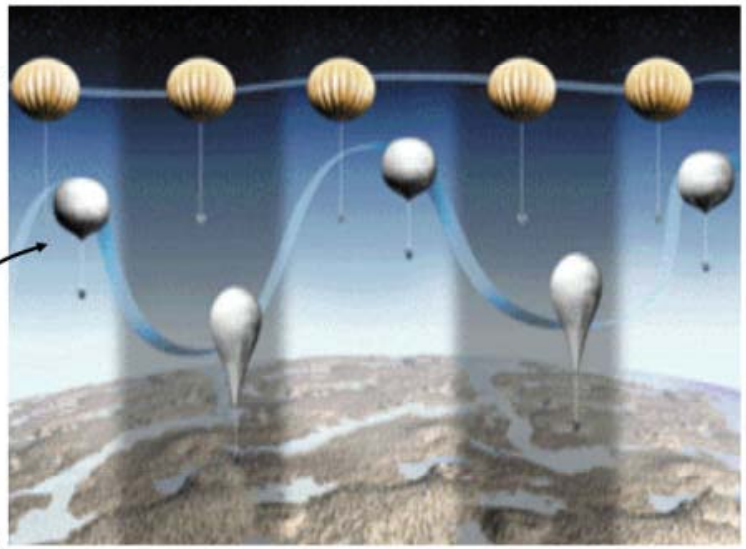


- **LDB/ULDB: NASA's lowest cost access to space (>= stratosphere)**
  - **Super Pressure Promises an order of magnitude increase in capability**
    - -- spacecraft-scale payloads (1000-2000 kg)
    - -- exposures comparable to short-duration spacecraft
    - -- recoverable & re-usable payloads: increased exposure at low cost
  - **Rapid response to new phenomena**

The Advantage of Super-Pressure Balloons



Super-Pressure: Ultra Long Duration Balloon (ULDB)
"Pumpkin"



Zero-Pressure Balloon

Zero-pressure balloons are vented at bottom, $P_{internal} = P_{external}$

Expand and contract with sunlight, gas leaks out

Must drop ballast to maintain height

➔ **flight duration limited to 5-6 days in mid-latitudes**

Long flights only possible in polar summers

Super-pressure balloons: $P_{in} > P_{out}$

~ 150 - 200 Pa typically

Maintain nearly constant volume and height (and shape) in day/night cycle

Constant density volume is achieved allowing stable bobbing at a constant density altitude

No ballast needed, no loss of gas

Can have long flights at ANY latitude

Support Logistics

• Parties interested in NASA Support should contact the NASA Program Office NLT12 months prior to the desired launch date to discuss the technical, scientific and programmatic details of the science mission.

• The NASA Program Office will compile a cost estimate based upon mission requirements and will deliver it back to the Canadian Point of Contact. Upon approval by the Canadian representative, the Program will serve as an advocate for the mission to NASA Headquarters to seek mission approval.

• The NASA Program Office & NASA Headquarters will work with the Canadian party to complete an Implementation Plan to specify elements of the mission support, including funds transfer.

• The Canadian PI should complete a CSBF Flight Application (found on the CSBF website) after contacting the Balloon Program Office.

• Once approved by both parties (CSA & NASA), the Columbia Scientific Balloon Facility will interface with the PI Team to implement the mission.

Concluding Remarks

- Scientific Ballooning has a proven history of scientific discovery with many recent cited achievements
  - There is available capacity within the program to support Canadian payloads for Polar LDB Missions in the northern hemisphere

- Balloon missions can be adapted quickly to new challenges and are:
  - Ideally suited as space craft quality missions for young scientists
  - Able to do significant science at a fraction of the cost of a space mission

- Super-pressure ballooning
  - Technological advance →order of magnitude increase in capability
  - Opens new areas of exploration closed to zero-pressure balloons

- Current LDB/ULDB cost impacts are modest when leveraging off current NASA large launch capabilities and during existing NASA campaigns
  - Canadian Missions can be flown during routine NASA campaigns
  - Balloons can help Canada get more science done in the current Budget
- NASA respects Canada's heritage in ballooning is open to partnering with CSA in supporting Large Canadian payloads as a means of enabling science

Balloon Program Contacts

- **NASA/Headquarters**
  - Dr. Vernon Jones, Senior Scientist for Suborbital Research
    (202) 358-0885

- **NASA/Balloon Program Office**
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  - Mr. David Gregory, Asst. Chief (757) 824-2367

- **Columbia Scientific Balloon Facility (CSBF)**
  - Mr. Danny Ball, Site Manager (903) 723-8007