

Astrophysics Subcommittee

March 17, 2015
NASA Headquarters

“Balloon Program Update”



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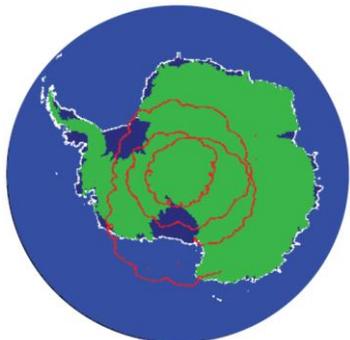
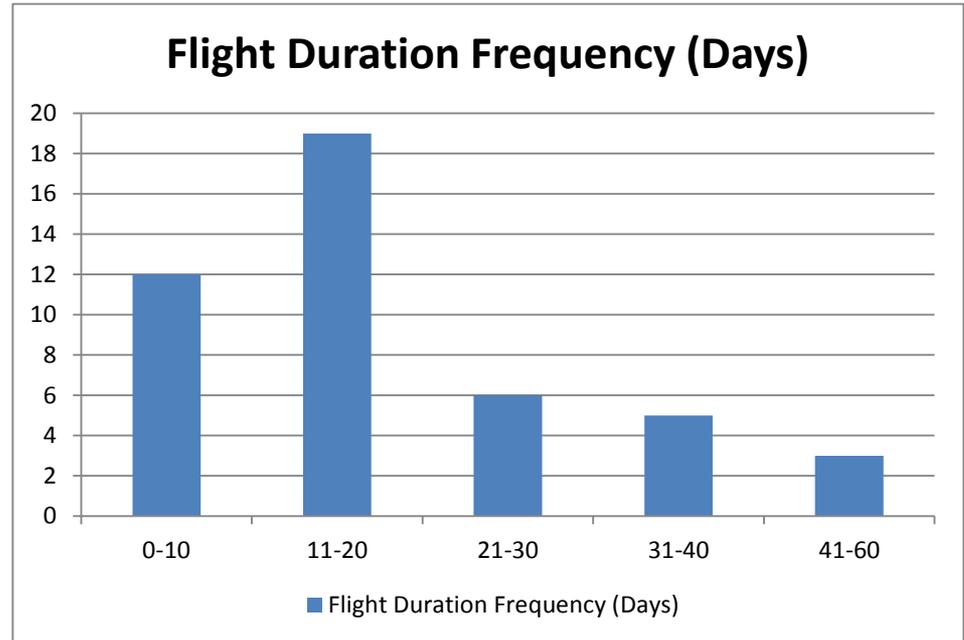
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Scientific Ballooning in Antarctica

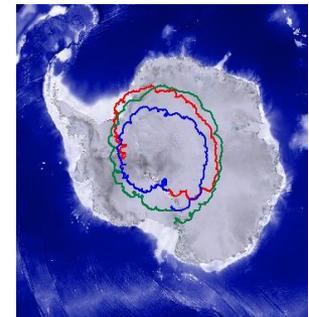
- Since the first successful launch in 1991 by the NASA/NSF Division of Polar Programs partnership, 47 Long-Duration Balloon (LDB) flights have been conducted over Antarctica, an average of ~ 2 balloon flights per year (890 total flight days).
- Since 1991, the historical average LDB flight duration is 19 days.
- Since 2002, 15 flights have requested double orbits
 - Of those, half achieved 30 days or longer duration.



Triple circum-polar
LDB flight of
CREAM - 42 days
Dec.-Jan. 2004-05

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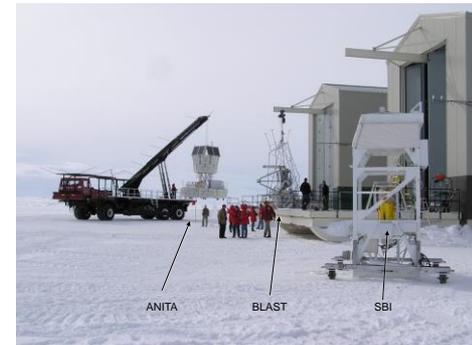
Triple circum-polar
LDB flight of Super
- Tiger - 55 days
Dec.-Feb. 2012-13



- FY 2013 Campaign (2012-2013 Season) 96 days.
 - Balloon Large Aperture Sub-millimeter Telescope (BLAST).
 - E and B EXperiment (EBEX).
 - Super-Trans Iron Galactic Element Recorder (Super-TIGER).
 - EBEX and Super-TIGER left on the Ice.
- FY 2014 Campaign (2013-2014 Season).
 - Cancelled due to U. S. Government Shutdown October 1-16, 2013 !
- FY 2015 Campaign Payloads (2014-2015 Season).
 - Antarctic Impulsive Transient Antenna (ANITA).
 - A Large Angular Scale Millimeter-wave Polarimeter (SPIDER).
 - Compton Spectrometer Imager (COSI) on a Super-Pressure Balloon.
- FY 2016 Upcoming Campaign (2015-2016 Season) has two known candidates at this time:
 - Stratospheric Terahertz Observatory (STO-2).
 - Gamma Ray burst Investigation by Polarimetry and Spectroscopy (GRIPS).

NSF Antarctic Support to LDB

- **The NASA – NSF Long-Duration Ballooning (LDB) partnership** implements the annual LDB campaign
- **NSF provides annual support for:**
 - Setup and outfitting of LDB facilities
 - LDB Camp Management
 - Launch pad maintenance and grooming
 - Transportation, logistics, and housing for science teams
 - Aircraft operations support and recovery of payloads
 - Retrograde shipment
- Infrastructure and Operations augmentations are underway to enable a sustained three-launch capability, including:
 - A third Antarctic Payload Processing Facility is being implemented in 2015 & 2016 to support three large science payloads in a single campaign (start in FY17).
 - Dedicated aircraft support for timely recovery of balloon payloads late in the Antarctic season.



Payload Integration at LDB Site



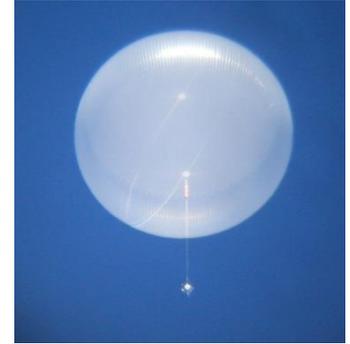
LDB Launch Facility Management



Aircraft – Payload Recovery

Very Successful NASA/NSF Partnership

- NASA/NSF partners have focused on expanding the highly successful LDB flight capability in Antarctica.
 - Proven history of scientific discoveries from Antarctica.
 - Many high priority projects require Antarctica flights.
 - Implementing 3 flights every year with increased duration.
- Super-Pressure Balloon (SPB) / Ultra Long Duration Ballooning (ULDB),
 - SPB offers a great increase in capability, e.g., ULDB flights.
 - ULDB flights leaving Antarctica will yield long exposures: 60-100 days should be possible in local summer.
 - SPB opens areas of exploration closed to zero-pressure balloons in non-polar / mid-latitude regions.
- NASA/NSF can leverage ULDB flights leaving Antarctica with recovery in South America, New Zealand, or Australia.
- Flights comparable to Antarctic LDB flights should be possible from Wanaka, NZ in local summer.



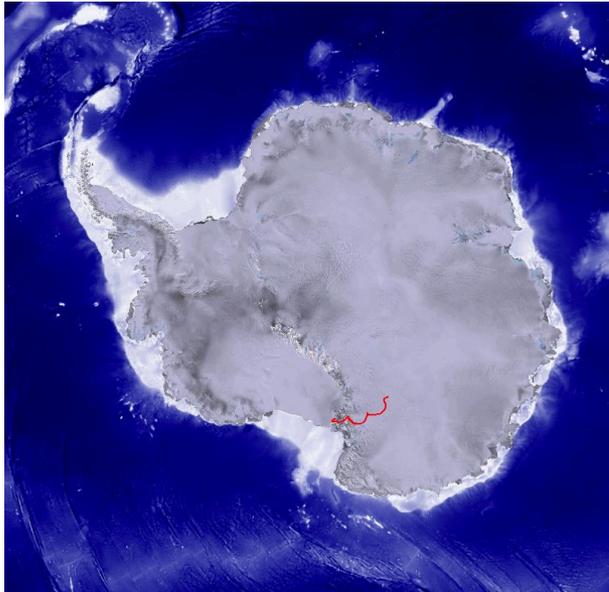
Record 54-day SPB
flight Dec - Feb 2008-09

FY-15 Campaign of 3 Balloon Flights

- ❖ **COSI** (COmpton Spectrometer and Imager) Boggs/UCB gamma-ray telescope on Super Pressure Balloon (SPB).
 - To understand the development of structure and the cycles of matter and energy in the evolving universe.
 - It was planned for an extended flight with potential recovery off the Antarctic continent.
- ❖ **ANITA** (ANtarctic Impulsive Transient Antenna) Gorham/UH cosmic neutrino detector.
 - Radio detection of neutrinos with energy above 10^{18} eV interacting in Antarctic ice, as well as ultra high-energy cosmic ray showers with similar energies.
- ❖ **SPIDER** Jones/Princeton CMB detector to study the genesis of the early Universe.
 - A balloon-borne polarimeter that borrows heavily from combined heritage of the successful BOOMERANG and BICEP experiments.



FY 2015 Antarctic Campaign (40 days)



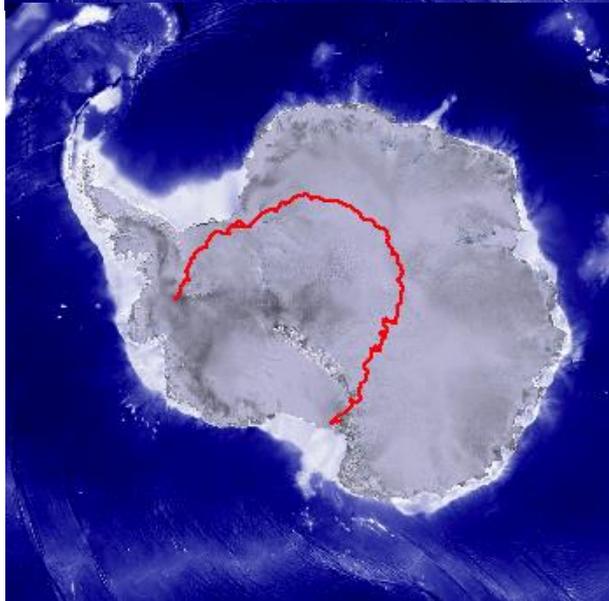
**SPB/C
OSI**

~2 days



ANITA

22 days, 9 hours, 14 min

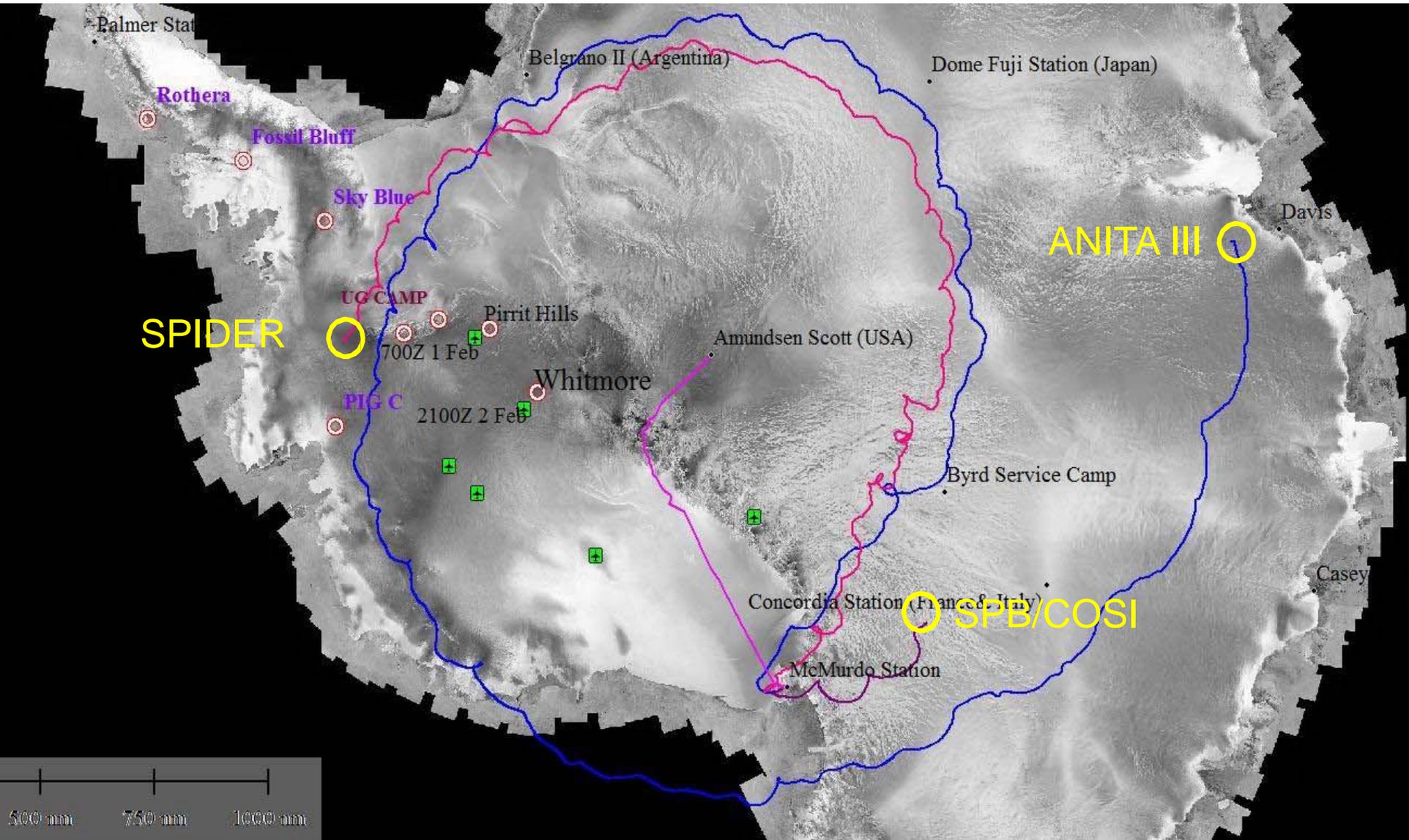


SPIDER ~15 days

British Antarctic Survey (BAS) Recovered payload to Argentina.

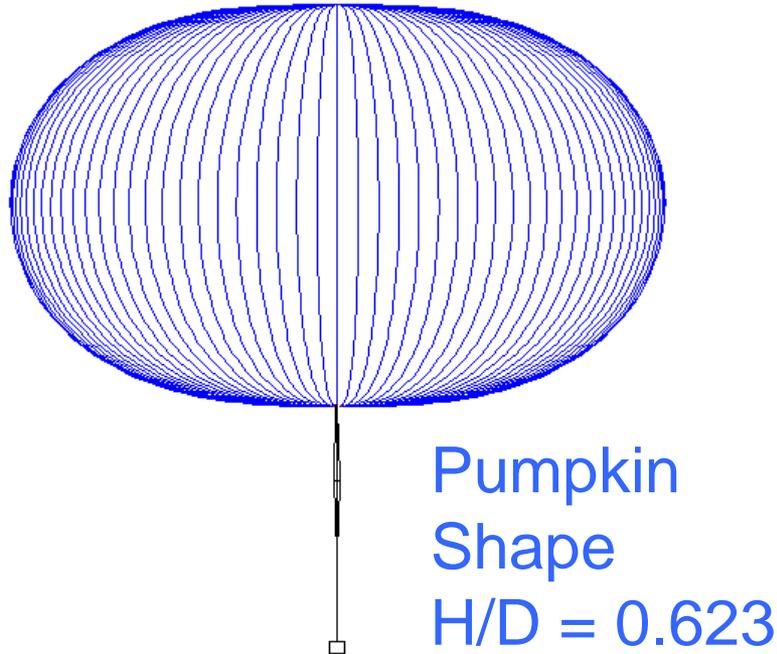
**** Super-TIGER was fully recovered after spending two seasons on the ICE!**

FY15 Antarctic Balloon Payload Impact Sites



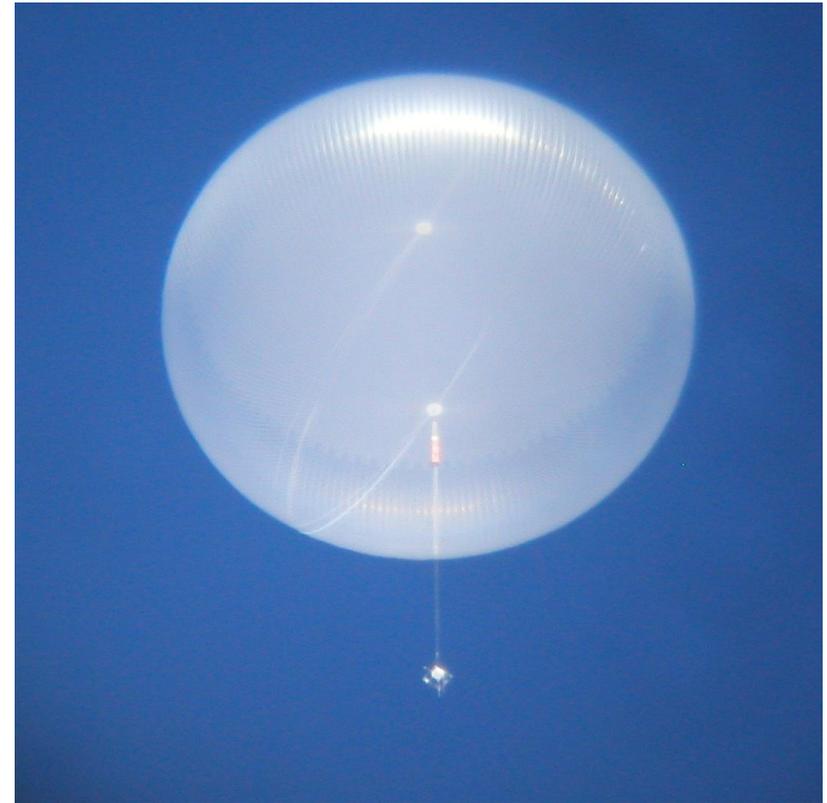
Super Pressure Balloon (SPB)

“First Totally New Balloon Design in more than 60 Years”



Schematic / Statistics

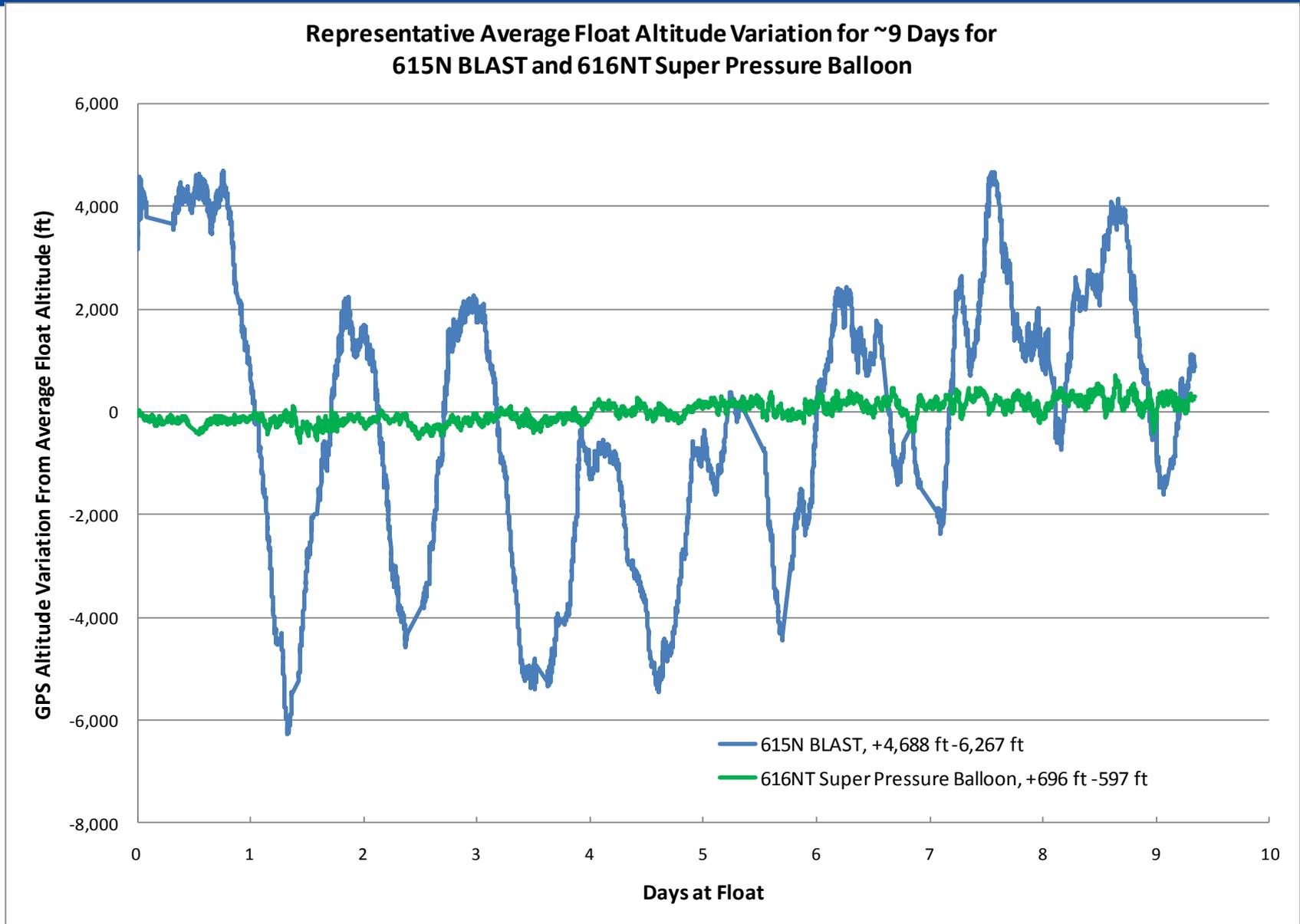
- Volume = 420,150 m³ (14.837 MCF)
- Diameter = 105.832 m
- Height = 65.946 m
- Number of gores = 230
- Gore length stressed = 139.023 m
- Gore width stressed = 1.471 m
- Film thickness 38 microns (1.5 mil)



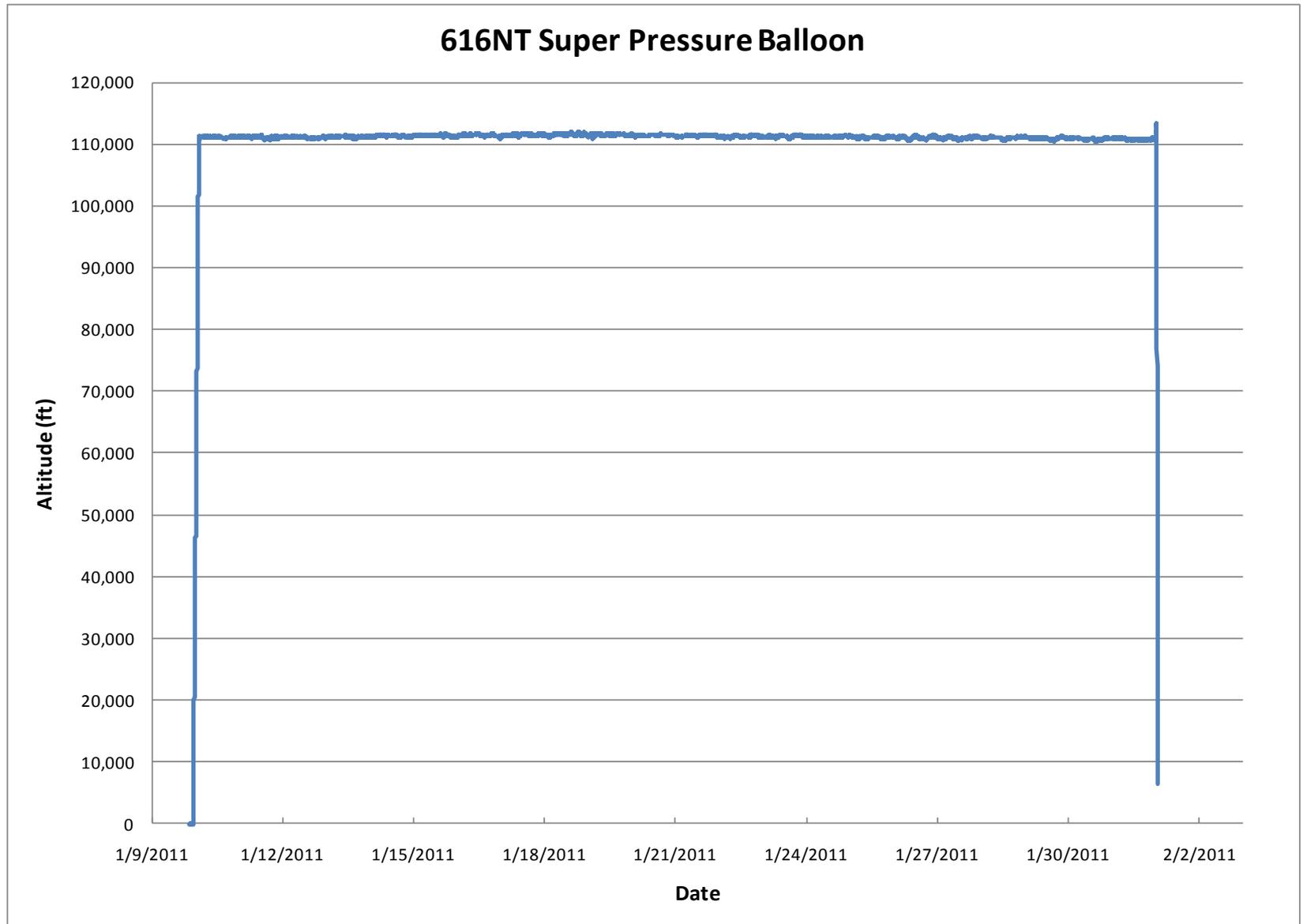
Photograph of 7 MCF SPB at float Altitude: ~33.87 km (~111,100 ft)

- 54-day test flight 12/28/08 – 2/20/09
- 22-day flight of 14.8 MCF with 4000 lb payload during January 2011

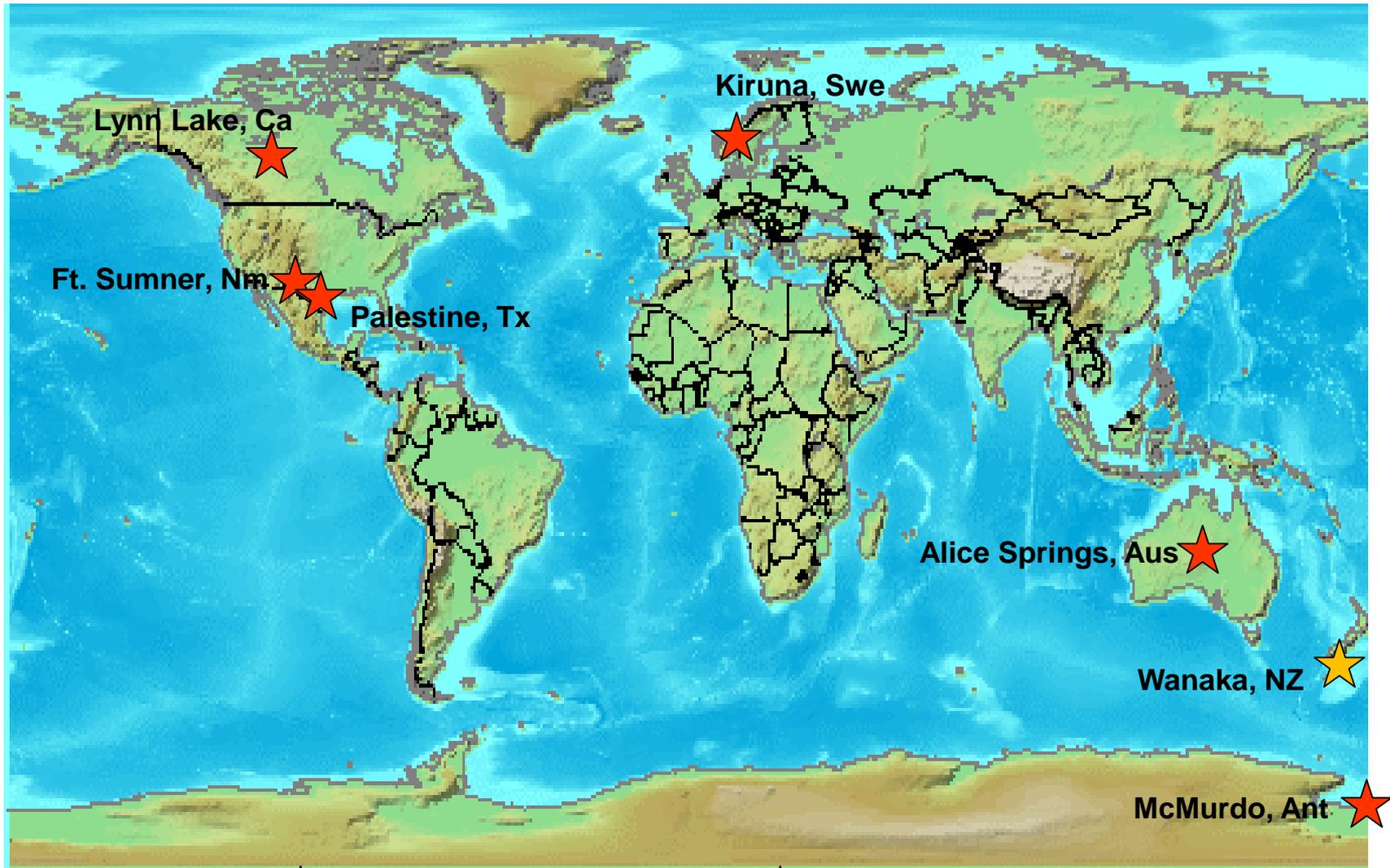
Zero-Pressure and SPB Altitude Comparison



14.9 MCF Super Pressure Balloon Test Flight



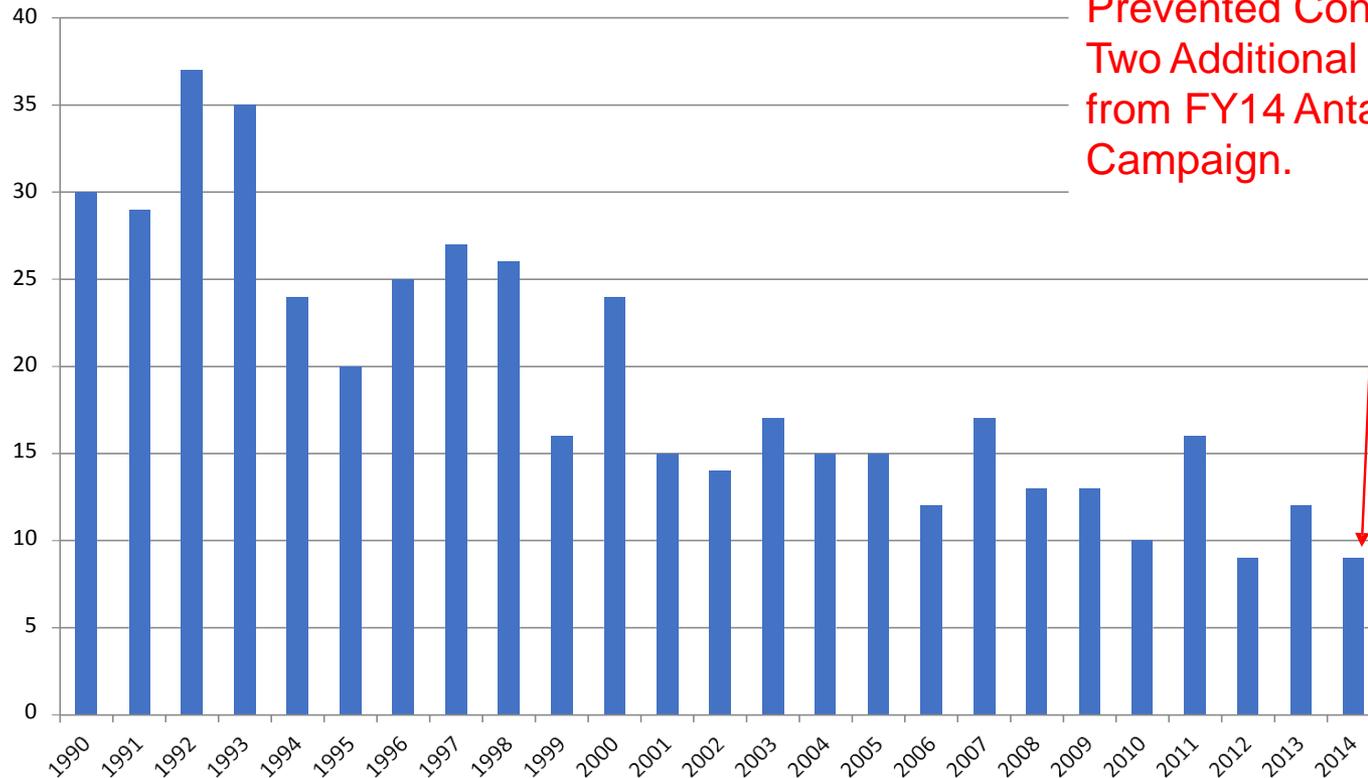
Balloon Launch Sites



★ Established Launch Site ★ New Launch Site

Flight Statistics

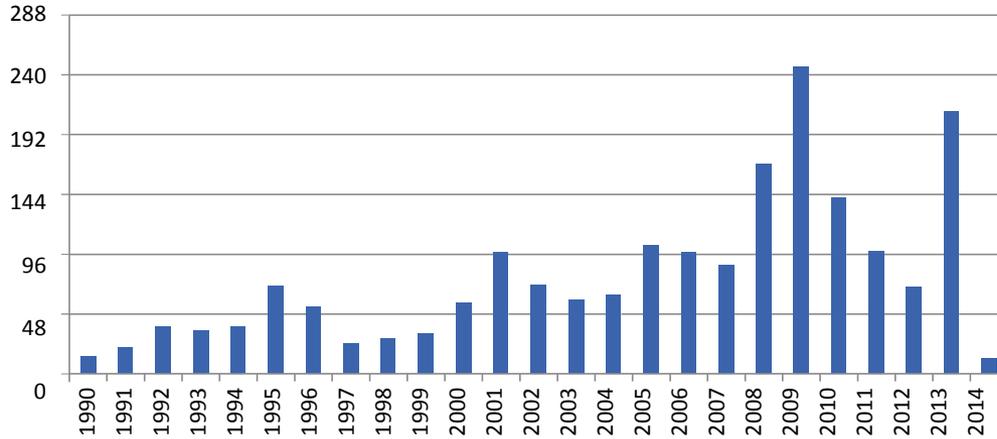
Total Flights per Fiscal Year



Government Shutdown Prevented Conduct of Two Additional Flights from FY14 Antarctic Campaign.

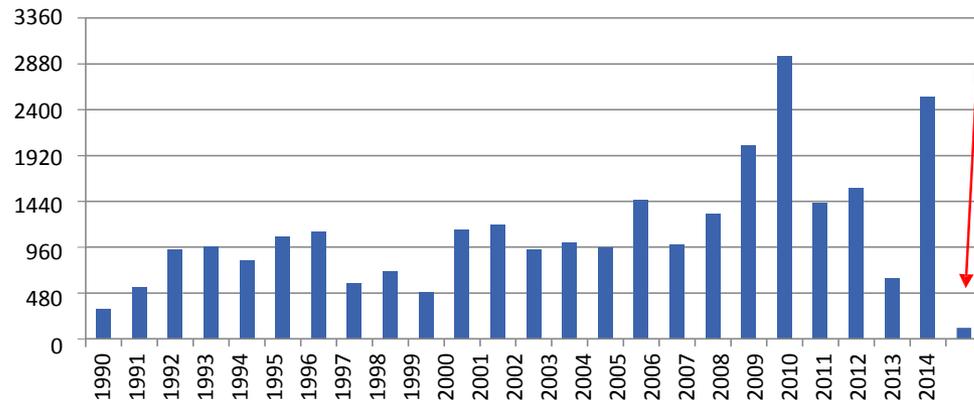
Flight Statistics

Average Float Hours Per Flight



Government Shutdown Prevented Conduct of FY14 Antarctic Long Duration Campaign. Significant Impact to Flight Hours.

Cumulative Float Hours



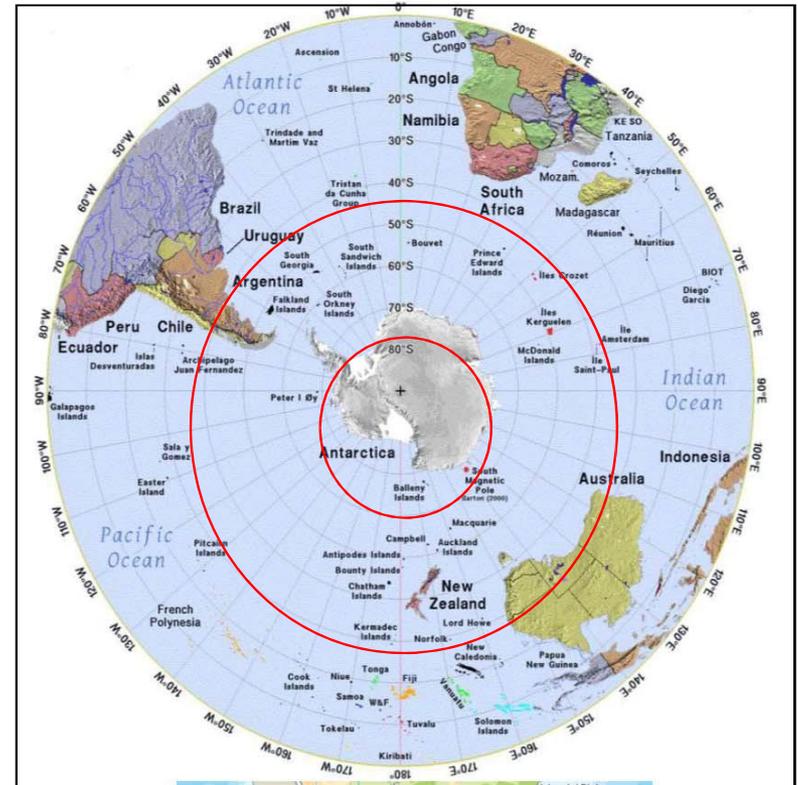
LDB / ULDB SPB Mission Profile

- SPB Mid-latitude Mission approval for flight between 29° and 85° S enables 60 - 100 Day LDB / ULDB missions.
- Mission allowed to depart and overfly Countries/Territories in Southern Hemisphere.
 - State Department reviewing Overflight Agreements.
- Alternate termination procedures for Off-Nominal Water Terminations (Valve down).
- Studies indicate good chance for terra firma termination of 60 - 100 day flights:
 - New Zealand: ~75% (South America Termination).
- OTH Command/Control resident to CSBF Operations Control Center for SPB and Mission Operations.
- Mission Operations Center (MOC) established at WFF for BPO / RSO Insight/ Oversight.
 - MOC will duplicate real time flight performance data and flight tracking.
 - MOC Provides Safety Office insight throughout mission.



LDB / ULDB Implementation - Safety

- Wanaka is a mid-latitude location that meets safety constraints to conduct launch and provide acceptable trajectories with nominal land termination locations in South America.
- Flight Safety will implement an Active Risk Assessment approach utilizing Go/No Go criteria for continental overflights. BPO will utilize established ground and launch safety protocols.
- Prior to continental transit an Operational Go/No Go decision will be based on Risk (combination of Overflight location and Dwell time).
- South America preferred termination location; Approved for other termination locations and Oceanic, if required.



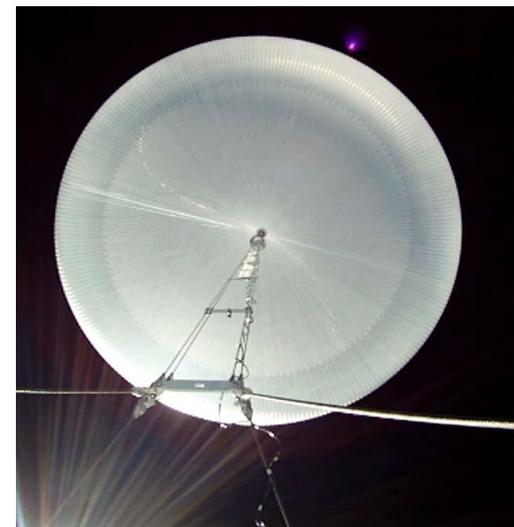
Super Pressure Balloon Development

Volume	Suspended Weight	Altitude	Flight Number	Duration	Launch Date
7 MCF	1,500 Lbs	~110 KFT	591 NT	54 days	Dec 28, 2008
14.9 MCF	4,000 Lbs	~110 KFT	616 NT	22 days	Jan 9, 2011
18.8 MCF	5,000 Lbs	~110 KFT	631 NT 659 NT	6.5 hours 43 hours	Aug 14, 2012 Dec 28, 2014
26 MCF	4,000 Lbs	~117 KFT			

The 18.8 MCF Super Pressure Balloon is the mid-range for Science!!



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SPB History – Qualification of the 18.8 MCF

	Launch Window	Flight Type	Assessment of First Flight Items	Deployment	Pressurization	Day/Night Cycling	Flight Duration (constant sunlight)	Day/Night Cycling for Duration
Sweden	August 2012	Turnaround	First 18.8 MCF	✓	✓			
Sweden	March 2013	Cancelled To Move Flight to Antarctica						
Antarctica	Dec 2013	Cancelled Due to Government Shutdown						
Ft. Sumner	May 2014	Cancelled Due to Budget Issues-BPO Directed to Fly Antarctica 2014						
Antarctica	Dec 2014	COSI Science (Former NCT)	No Recovery	✓	Leak Developed			
New Zealand	Mid March or later 2015	Circumglobal	Possible if Recovery at end of Mission	✓	✓	✓		✓
New Zealand	Mid March or later 2016	Circumglobal		✓	✓	✓		✓

Some Highlights of the Past Year

- The 18.8 MCF Super Pressure Balloon (SPB) was originally integrated for flight in the Spring Fort Sumner campaign.
 - ✓ Flight was cancelled, and the SPB was shipped to Antarctica for the FY15 campaign with the first piggyback science instrument.
 - ✓ **This SPB developed a leak during the second day!**
- Successful test flight of the **Low Density Supersonic Decelerator** (LDSD) from Hawaii in FY14.
- Two successful **Wallops Arc Second Pointer** (WASP) test flights during 2014 Fall Fort Sumner campaign.
 - ✓ Piggyback science instruments: HySICS and OPIS.
- 9th High Altitude Student Platform (HASP) mission also flown during that Fall Fort Sumner campaign.
 - ✓ 3 Undergraduate Student Investigator Program (USIP) payloads also flown during Fall Fort Sumner campaign.
 - ✓ 4th USIP instrument will fly during Fall 2015 Fort Sumner.
- The CSBF Support Contract awarded to Orbital Sciences Corporation, effective February 1, 2015.
 - ✓ Base plus option periods total *5 years*.



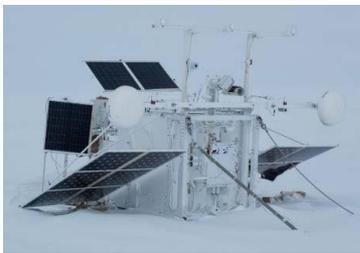
Low Density Supersonic Decelerator

- JPL Low Density Supersonic Decelerator test for landing larger/heavier payloads on Mars.
- Inflatable SIAD and largest supersonic parachute ever built.
- First balloon launch of a rocket since small scale rockets launched in the 1950's.
- Specialized launch tower (static launch) and new flight electronics developed by PSL/CSBF.
- Highly sophisticated meteorological support for ascent time/trajectories required by PMRF/WFF Safety.
- 7,861 lb Suspended.
- 34 MCF Heavy Balloon.
- Flight time 3 hours, 35 minutes
- Operations and Test Success.



More Highlights of the Past Year

- NSF has exceeded their CSBF land and NSF buildings.
 - ✓ NASA has filed paperwork to accept that property at no cost.
 - ✓ GSA will request OMB approval for no-cost transfer.
- Complications prevented moving out on the third Antarctic Payload building in 2014.
 - ✓ Discussions with NSF and ASC are planned in early April 2015.
 - ✓ Current target is to put a prefab building on a resupply ship in late 2016,.
 - ✓ Assemble it in Antarctica for first use during FY18 Campaign (Dec 2017 – Jan 2018).
- The Biological Evaluation and Environmental Assessment for ULDB Program Southern Hemisphere Flight Operations was:
 - ✓ Completed for SPBs launched in Antarctica and New Zealand
- All high priority items were recovered for the Super-Tiger, ANITA II, SPIDER and COSI Antarctic LDB flights.



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Astrophysics Subcommittee



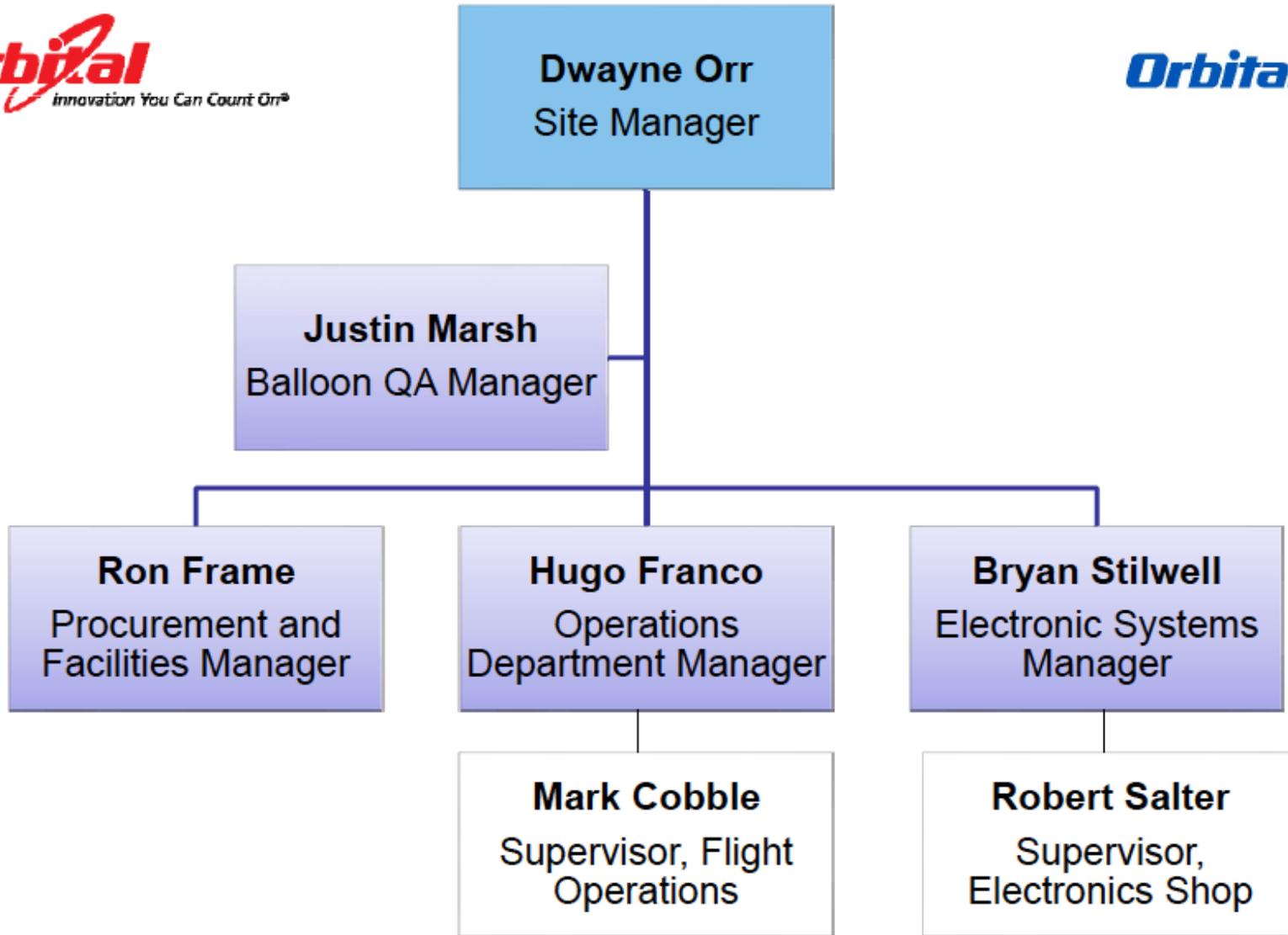
CSBF Operations Contract Has Changed !

- CSBF is a **Government Owned Contractor Operated (GOCO)** Facility.
- Request for Proposals (RFP) was Released January 8, 2014.
- Initial proposals were due March 10, 2014.
- Two proposals were received:
 - Orbital Science Corporation (Orbital).
 - New Mexico State University (NMSU)/Physical Science Laboratory (PSL).
- Both offerors were notified on July 30, 2014 that they were in the competitive range and that NASA would go into discussions.
- Final proposals were due September 10, 2014.
- Selection was announced November 13, 2014.
- Phase-In process started December 1, 2014.
- Orbital Contract started February 1, 2015.
- The Contract with NMSU/PSL (NAS5-03003) was extended beyond March 2013 with a 15 month extension and 7 one-month options.
 - End of options was January 31, 2015.

Incumbent Capture

- The Orbital Team has hired 69 of the former 75 NMSU/PSL employees.
 - 64 are now Orbital Employees.
 - 5 are now Hawk Employees.
- 6 Employees Did Not Transition.
 - 1 Retired.
 - 4 Remained with PSL.
- Orbital has subcontracted with PSL for their support.
 - 1 pursued new opportunity with PSL.
 - He may be involved in select activities.

Current CSBF Management



Suborbital Research Program

NASA SMD manages the **Suborbital Research Program**, which provides

- Cutting edge Earth and Space science,
- Developing space technologies to enable new missions, and
- Promoting STEM and inspiring students through hands-on student training missions.

This **Program is characterized by** frequent flight opportunities utilizing:

- Aircraft,
- Balloons,
- Sounding Rockets,
- Cube Sats,
- Commercial Reusable Vehicles, and
- Small ISS payloads.



**Cutting Edge
Scientific Research**



**Science/Technology
Development**



**Hands-on Student
flight Projects**

Need for a Suborbital Strategic Plan

Since FY 2011, SMD has:

- Launched **114 Sounding Rocket and Balloon missions;**
- Flown over **14,100 airborne science hours** in support of science and technology investigations;
- While providing **3,900 undergraduate and graduate students the opportunity to participate in scientific research!**



Science/Technology
Development



Cutting Edge
Scientific Research

Suborbital Strategic Plan.

- The **Senior Program Executive for Suborbital Programs**, and
- **Senior Scientist for Suborbital Research**, have suggested this need, and it was recently
- **Suggested independently** by the Balloon Working Group (BWG).



Validation of Satellite
Measurements

Thank You!