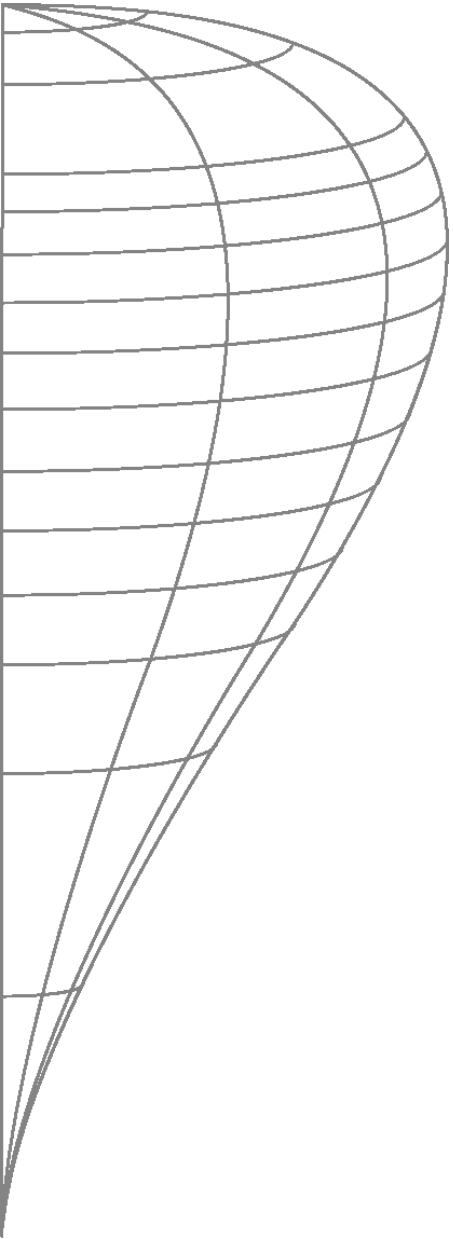

2017 Scientific Ballooning Technologies Workshop

NASA Super Pressure Balloon

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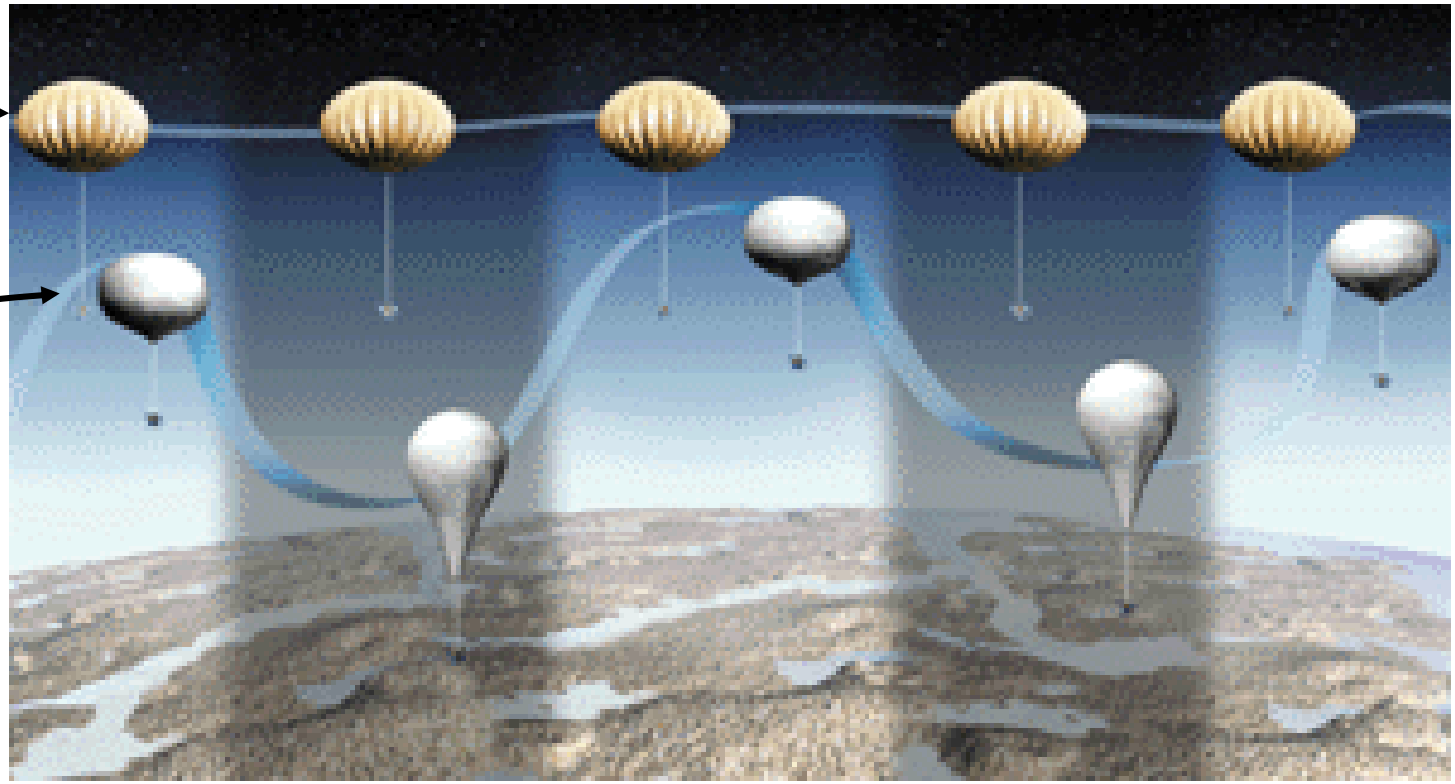
NASA Balloon Program Office
Suborbital and Special Orbital Projects Directorate
Wallops Flight Facility

May 16, 2017

Two Types of Balloons

Super Pressure Balloon maintains nearly constant volume – ***under development***

- Allows Ultra Long Duration Balloon (ULDB) Flights
- Provides stable altitude Long Duration Balloon (LDB) flights at mid-latitudes

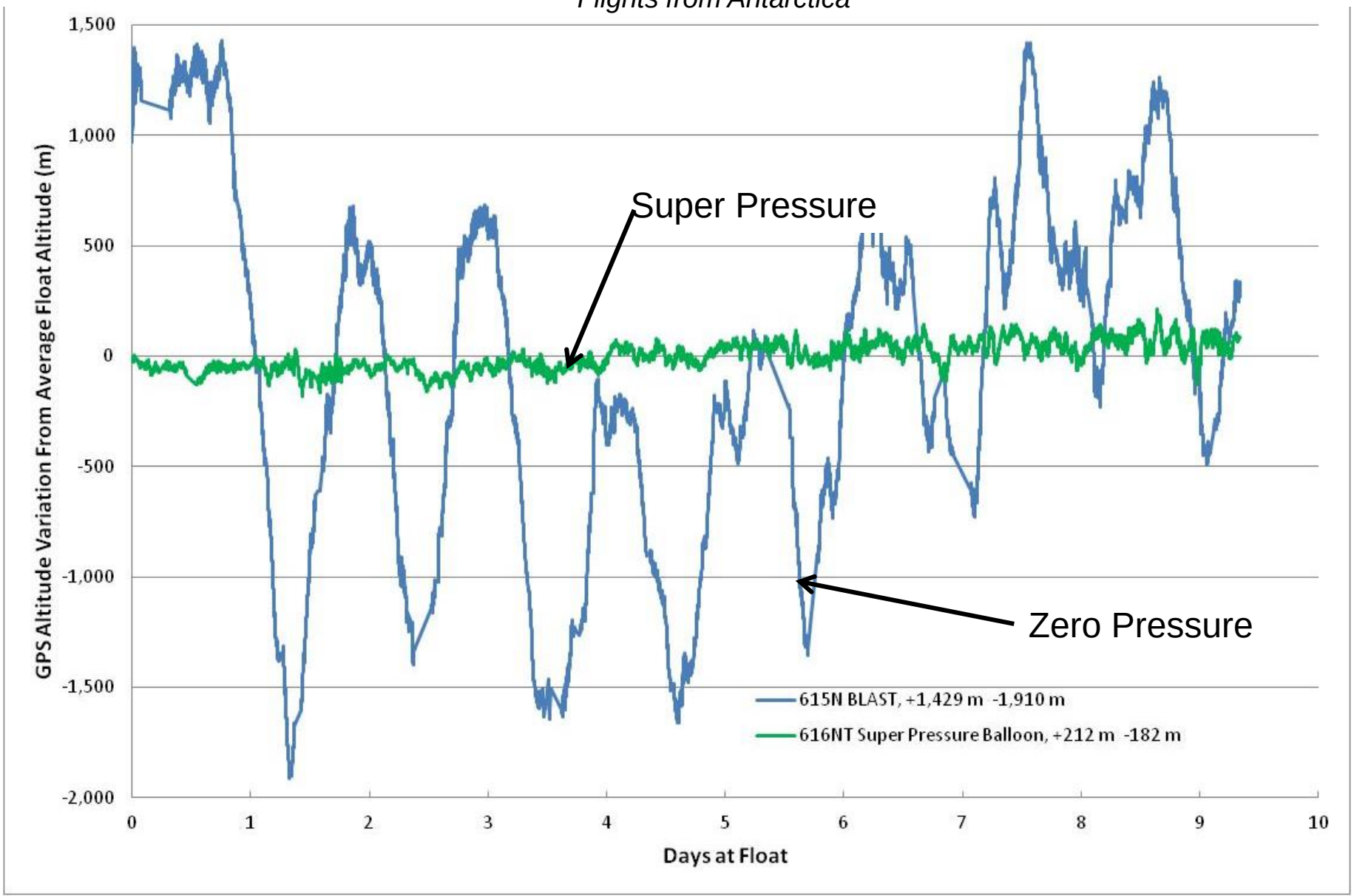


Zero-Pressure (ZP) Balloon changes volume due to radiative input

- Used for Conventional Flights and Polar LDB Flights

Altitude Stability Comparison

Flights from Antarctica



Super Pressure Development

- The NASA SPB is being developed to provide a stable platform at constant density altitude for extended duration science investigations at polar and mid-latitudes

- An incremental approach has been applied to the 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	6.5 hours	Aug 14, 2012
	5,000 Lbs		659 NT	43 hours	Dec 28, 2014
	5,000 Lbs		662 NT	32 days	Mar 26, 2015
	5,000 Lbs		669 NT	46 days	May 16, 2016
	5,500 Lbs		679 NT	12 days	April 24, 2017
26 MCF	4,000 Lbs	~117 KFT			

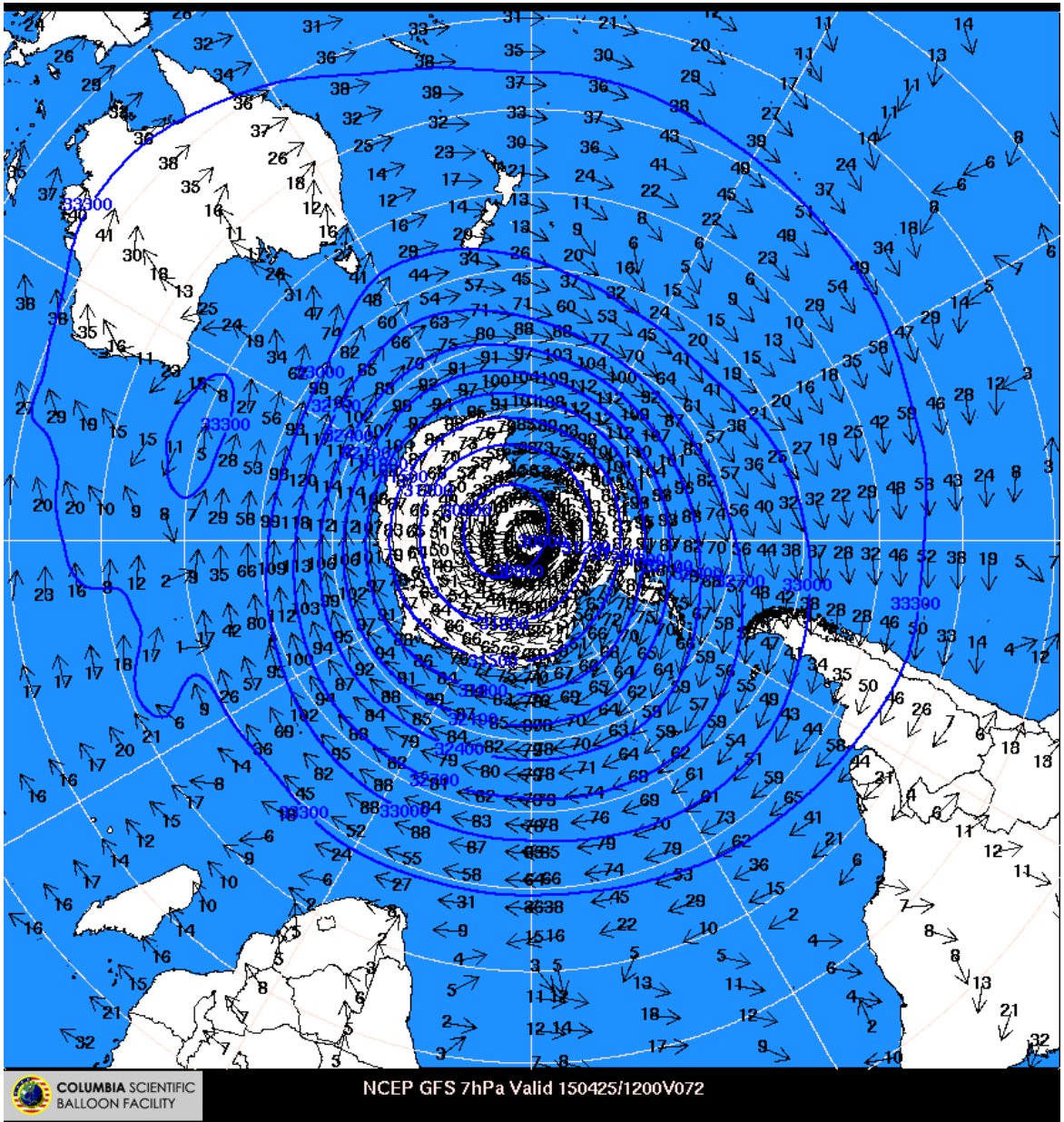
Several science groups are requesting a suspended weight of 5,500 pounds on the 18.8 MCF; therefore, some future test flights will have higher suspended weights when appropriate.

Mid-Latitude Location for SPB

Wanaka, New Zealand

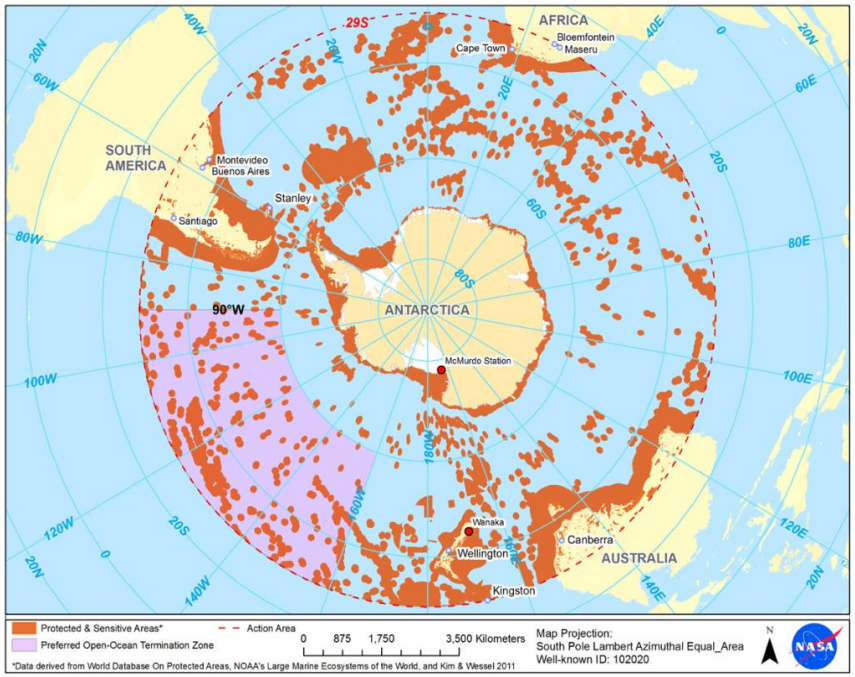
- Far Enough North
- Far Enough South
- Airport Location
- Geography
- Low Populations
- Stratospheric Trajectories
- Infrastructure
- Accommodations

Stratospheric Winds



Environmental Considerations

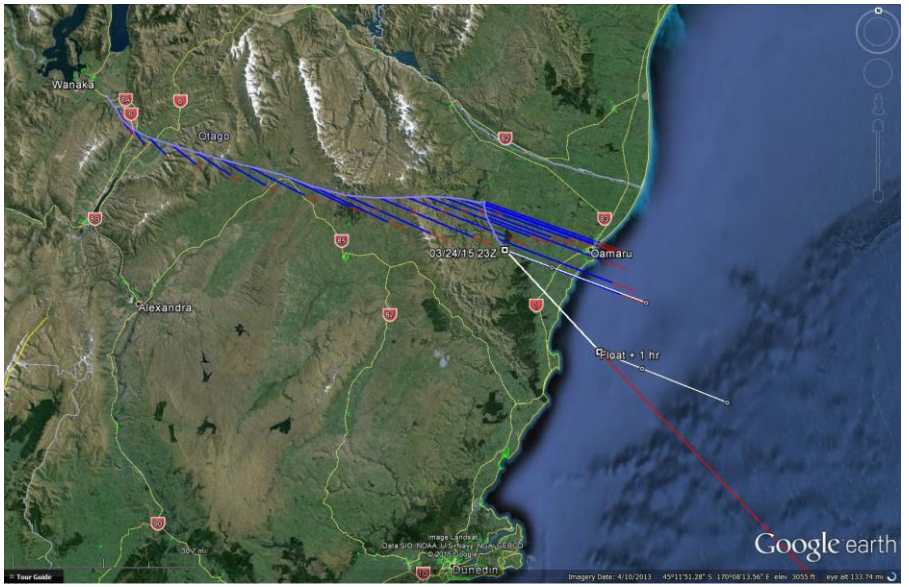
- *WFF Completed a Biological Evaluation and Environmental Assessment for SPB (ULDB) Program Southern Hemisphere Flight Operations covering Antarctica and New Zealand-launched SPBs.*
- *The Program received a Finding Of No Significant Impact and has received approval from NASA and concurrence from NOAA and NSF to proceed with Operations.*
- *The stratospheric anticyclone over Antarctica provides a stable balloon trajectory, once the anticyclone breaks down trajectories are highly variable.*
- *Increased operational area (more northern latitudes) for 2017 mission.*

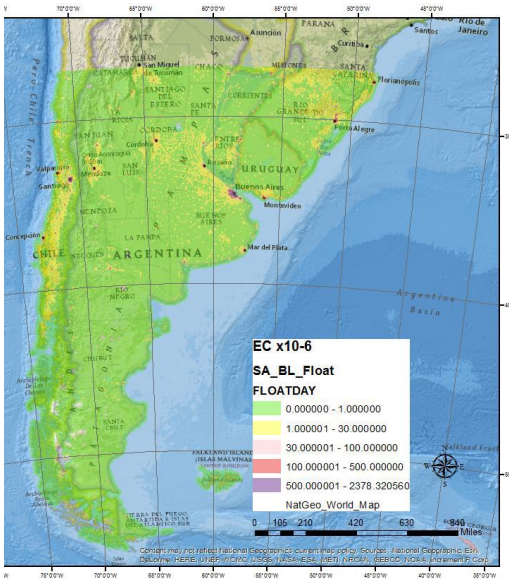


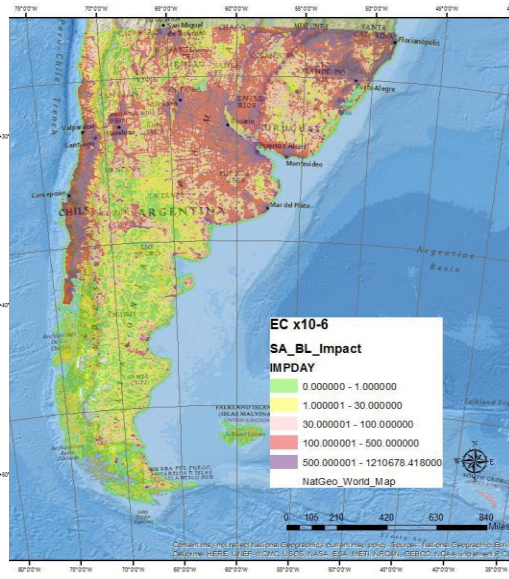
- *In the event of ocean termination, the entire balloon system will be valve downed to the water surface and submerged.*

Safety Considerations

- Trajectory Analysis Pre-Launch
- Airport Closed During Launch Operations
- Roadblocks
- Go-No Go prior to Land Mass
- Go-No Go ~ every 24 hour when over land







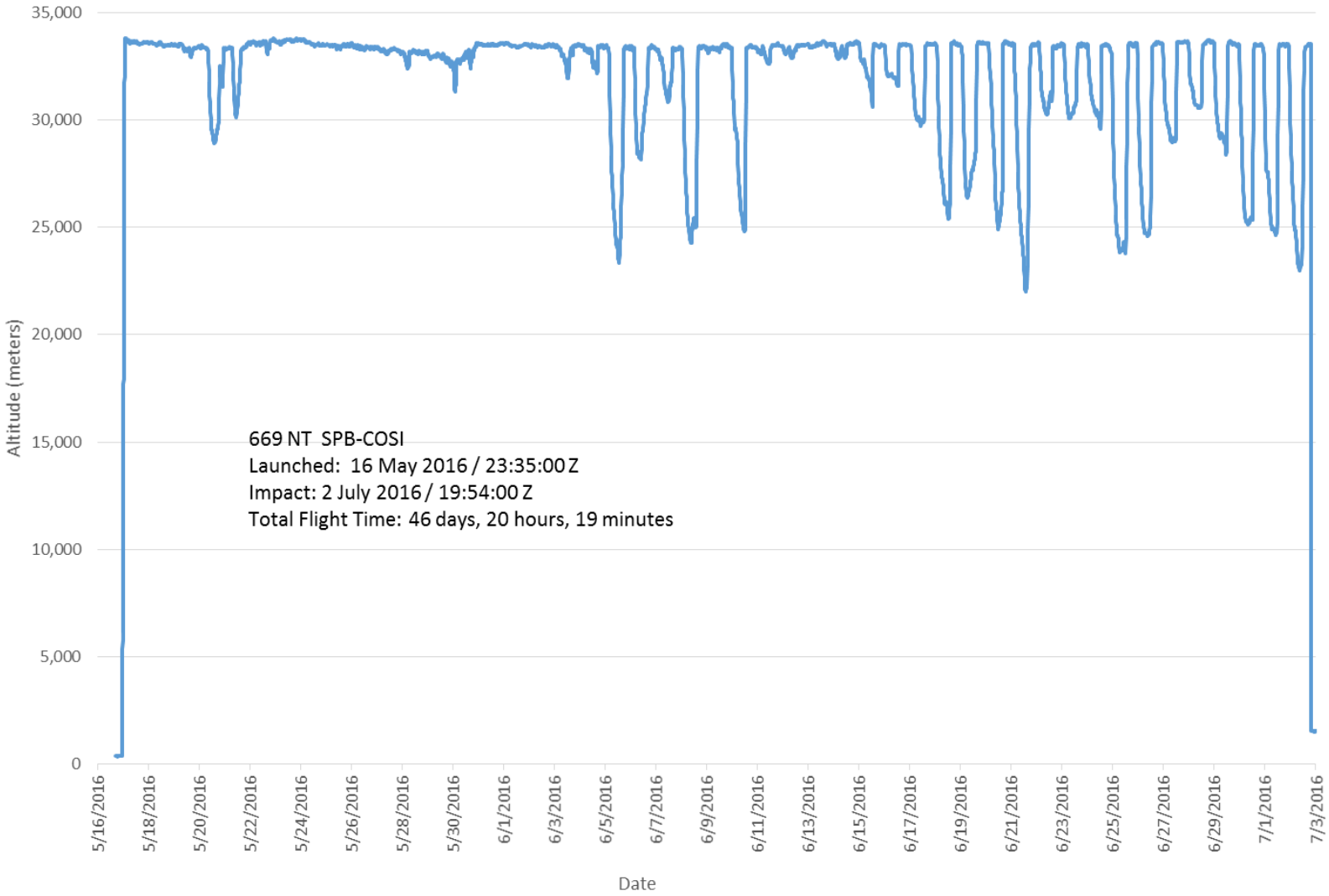
Flight Monitoring

- Wanaka team will monitor and support flight from launch pre-ops to end of LOS
- Palestine Operations Control Center will be online at launch and take over after leaving LOS capabilities in Wanaka
- SPB team will monitor the entire flight remotely
- Palestine Operations Control Center will be manned 24 hours from launch until termination
- Science typically monitors from home institution

2016 - 18.8 MCF SPB

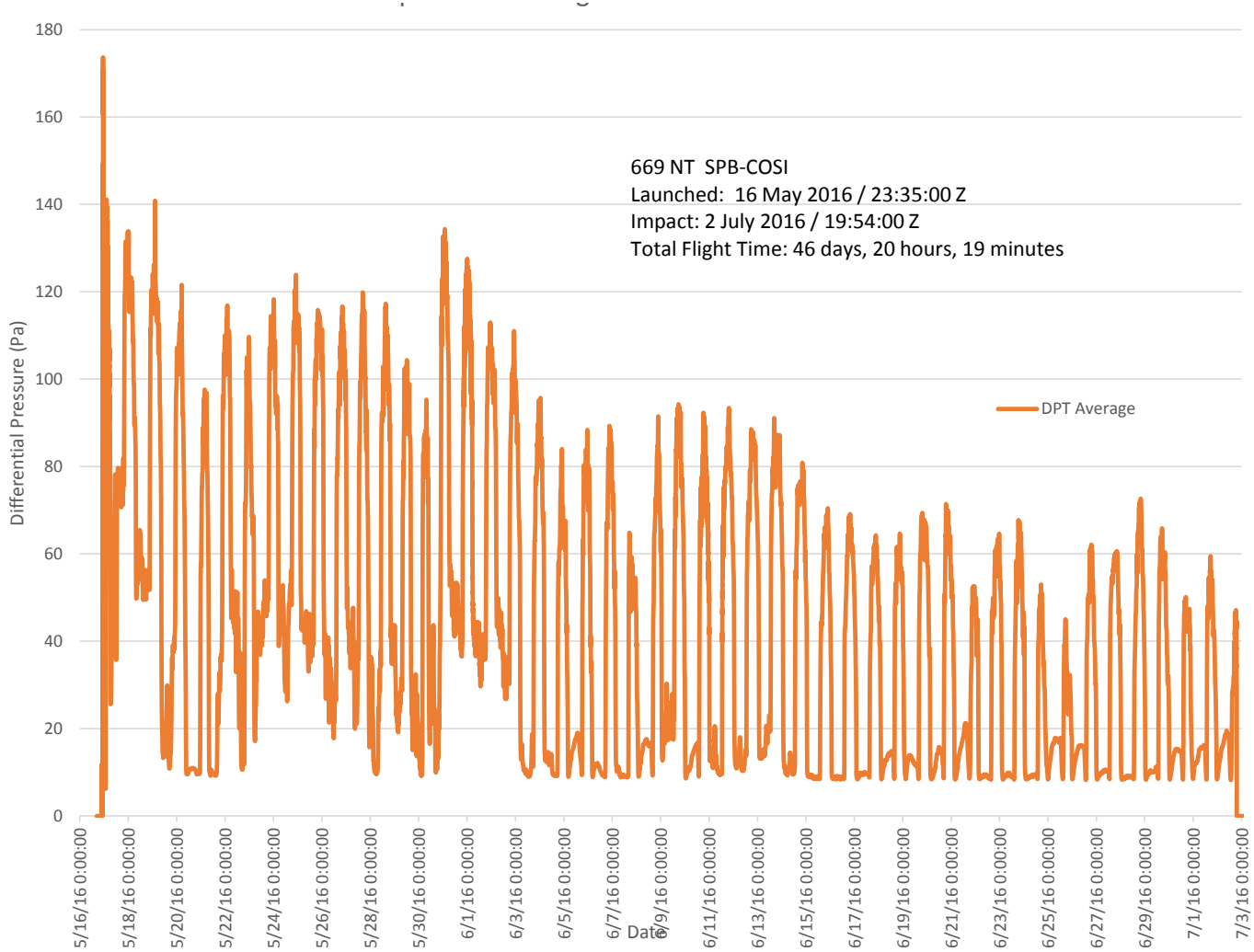
- Launch Site: Wanaka, New Zealand
- Volume: ~532,152 m^3 (~18,793,000 ft^3)
- Launch Date: May 16, 2016 @ 23:35 Z
- Suspended Load: 2,268 kg (5,000 lbs.)
- Flight Time – 46 Days, 20 hours, 19 minutes

2016 - 18.8 MCF SPB

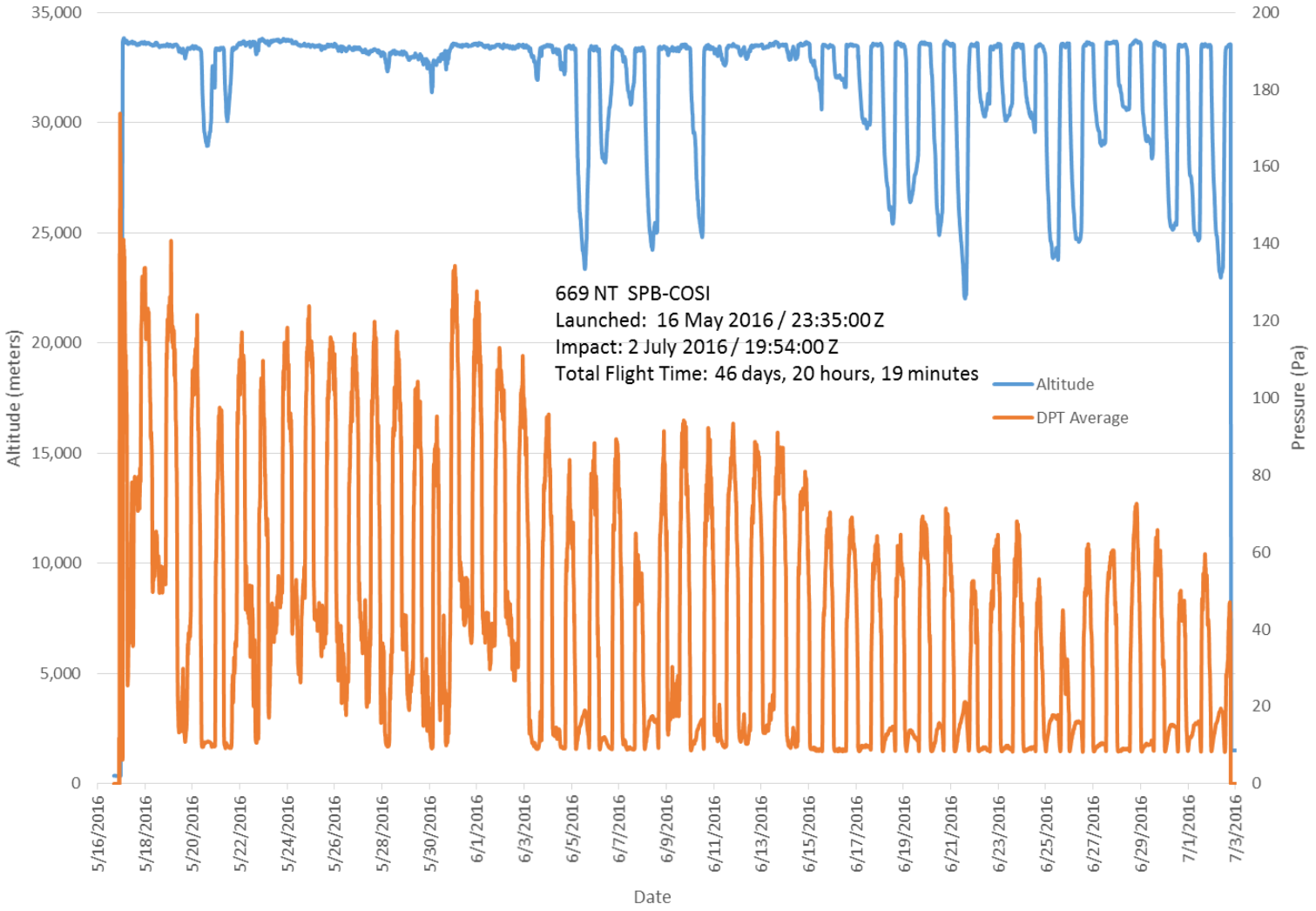


west Altitude During Flight ~ 22 km Due to Loss of Gas During Flig

2016 - 18.8 MCF SPB



2016 - 18.8 MCF SPB



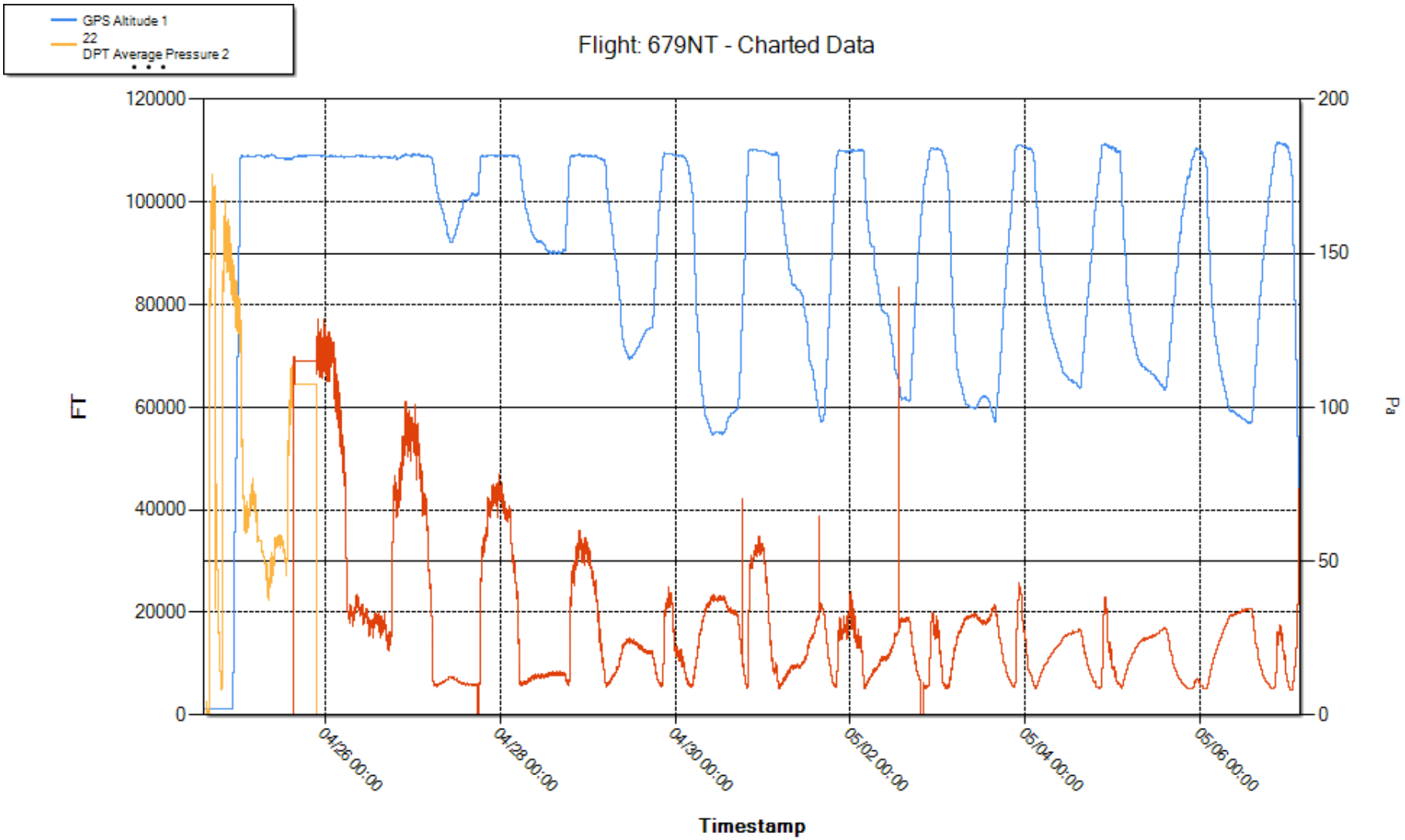
e Balloon Performed as a Hybrid – SPB During Day – ZP at Night Later in the Missi

2017 - 18.8 MCF SPB

- Launch Site: Wanaka, New Zealand
- Volume: ~532,152 m^3 (~18,793,000 ft^3)
- Launch Date: April 24, 2017 @ 22:50 Z
- Suspended Load: 2,495 kg (5,500 lbs.)
- Flight Time – 12 days, 4 hours, 34 mins
- Flying the Extreme Universe Space Observatory (EUSO) as a Mission of Opportunity

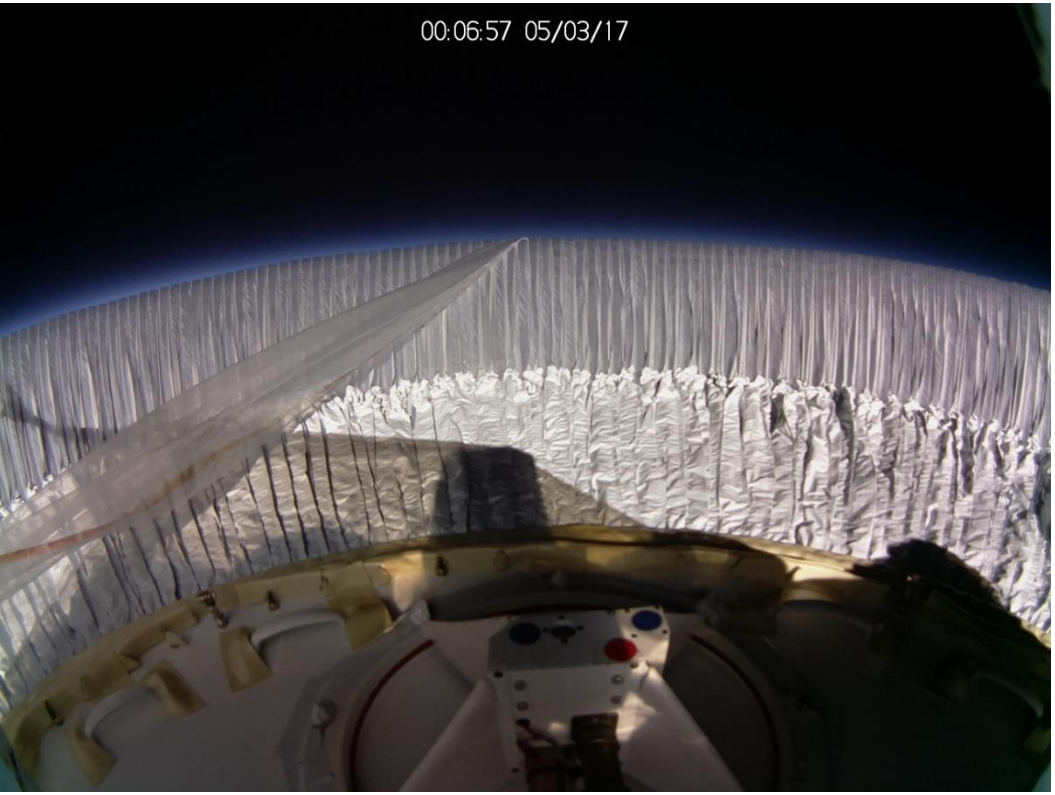
2017 - 18.8 MCF SPB

2017 - 18.8 MCF SPB

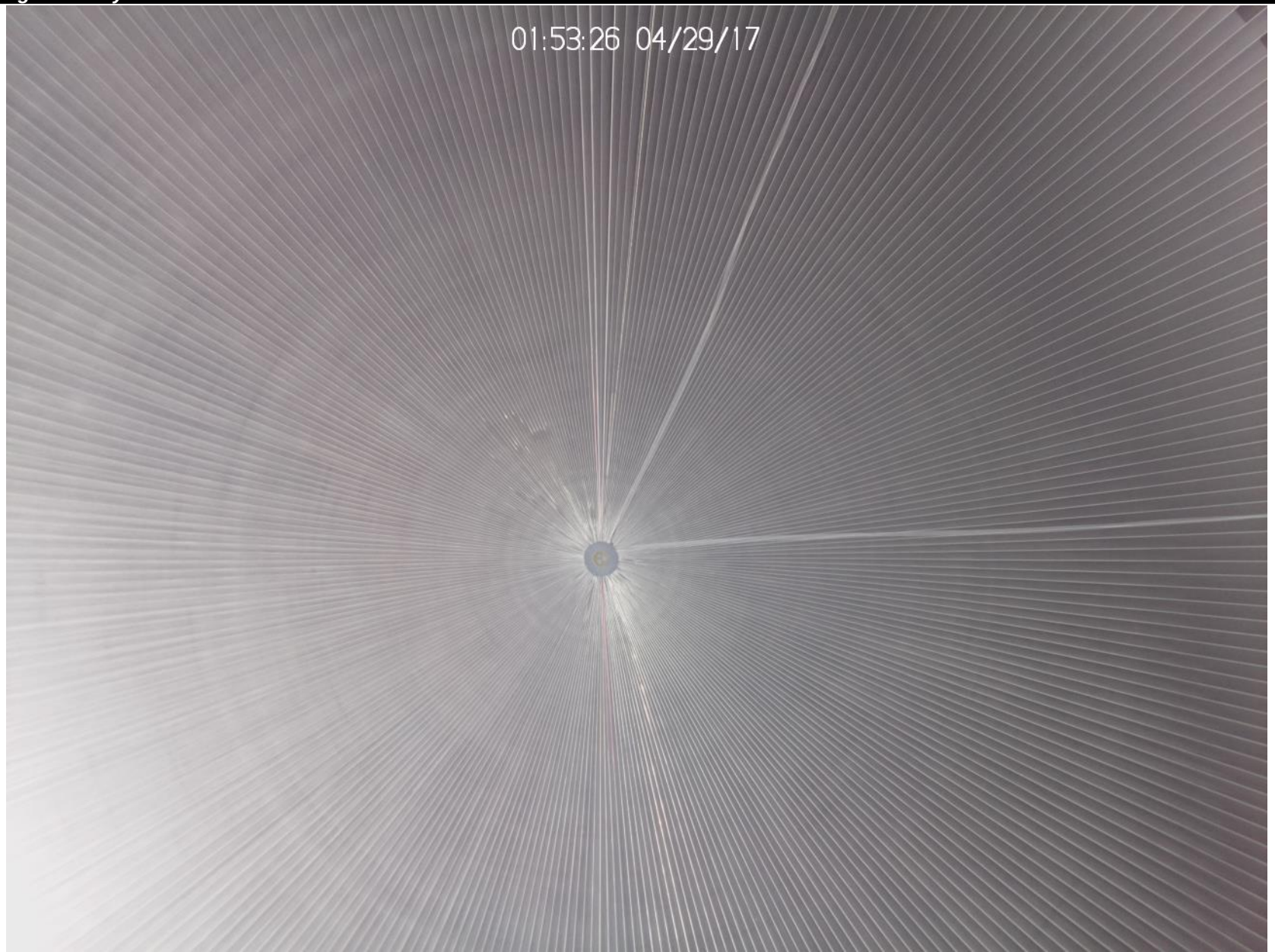


Note: Initially, 1200 pounds of ballast – dropped over 1100 pounds of it in drops on 4/29, 4/30, 5/1, 5/3, and 5/6

2017 - 18.8 MCF SPB



2017 - 18.8 MCF SPB



SPB Fun Facts

- Inflated volume = 18.8 million cubic feet
- Number of Gores = 280
- Number of Gore Width Measurements = 6,440 (23 per gore)
- Amount of Load Tape Tendon in Balloon=137,760 feet (26 miles)
- Amount of film visually inspected, re-rolled and dispensed for this balloon > 1.3 million square feet - over 30 acres of film
- Minimum amount of walking just to seal balloon = 55 miles
- Balloon shipping box 16 ft. x 6 ft. x 5.3 ft.
- Gross Weight of Balloon in Box = 8,832 pounds