Overview

NASA Scientific Balloon Program

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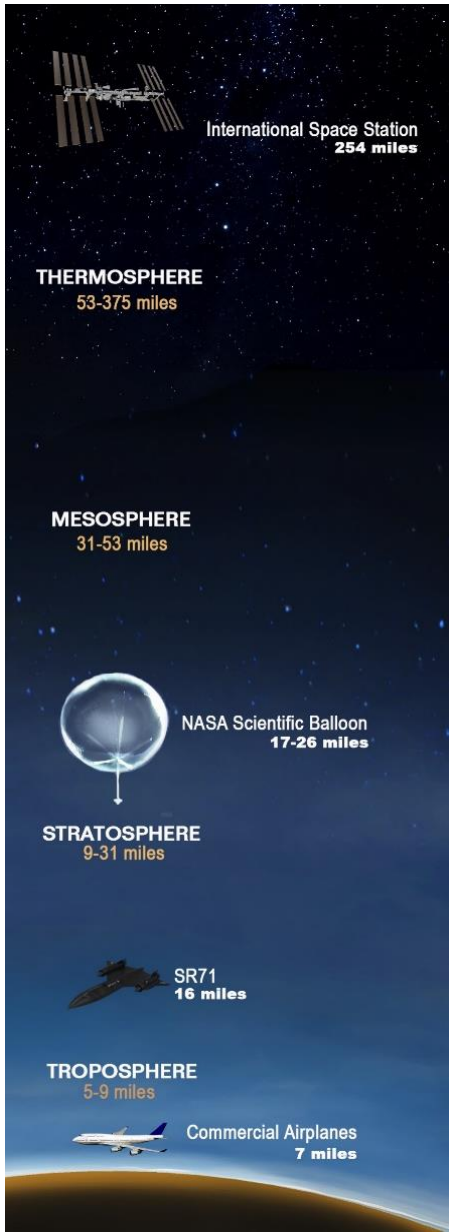
Overview of NASA's Scientific Balloon Program

Goddard Space Flight Center *Wallops Flight Facility*

- A scientific balloon is a stable stratospheric flight platform capable of supporting observatory-class science payloads for durations exceeding 50 days. The Program utilizes unpressurized and pressurized platforms (Zero Pressure and Super Pressure).
- The NASA Scientific Balloon Program (SBP) is the largest of its kind with the singular capability of heavy lift suborbital stratospheric platforms serving the greatest breadth of science disciplines and providing end-to-end engineering, operations, and management.
- The Balloon Program is managed out of **NASA Wallops Flight Facility** providing program and project management, engineering, and integration and testing. The **Columbia Scientific Balloon Facility** is a Government-owned Contractor-operated location that provides operations and maintenance, engineering, integration and testing, and operational implementation of ground and flight systems.
- The SBP supports an on-going flight manifest of approximately **8-16 flights** per year with **40-60 missions** in progress at various stages of the mission lifecycle and of varying complexities.
- The SBP maintains a Balloon inventory of 2-5 years with capability of developing lighter than air structures.
- Operations are conducted world-wide at both fixed and temporary launch sites.
- Funded by the NASA Science Mission Directorate, Astrophysics Division.
- The technical program is implemented via the **NASA Balloon Operations Contract II** (NBOC II) with Government management. Peraton is the prime contractor.
- Customers include Astrophysics, Heliophysics, and other NASA and non-NASA customers. The SBP has partnerships across Government agencies including NSF, DoD and internationally through the Swedish National Space Agency, Japanese Aerospace Exploration Agency, among others.
- The balloon platform is utilized by several government agencies, private companies, and countries with broad application in military, science research, and space tourism. Sweden, France, India, and Japan balloon programs conduct science and technology flights at a normal cadence.



Mission of NASA's Balloon Program

Goddard Space Flight Center *Wallops Flight Facility*

Strategic Objective: The primary objective of the NASA Balloon Program is to provide high-altitude scientific balloon platforms for scientific and technological investigations. These investigations include fundamental scientific discoveries that contribute to our understanding of the Earth, the solar system, and the universe. Scientific balloons also provide a platform for the demonstration of promising new instrument and spacecraft technologies that enable or enhance the objectives of the Science Mission Directorate Strategic Plan.

Annual Program Snapshot
10-16 Missions
3+ Campaigns
300+ Students
40+ Research Institutions

Balloons provide low-cost, quick response, near-space access for:

- Conducting cutting-edge research.
- Developing technologies to enable future spacecraft science missions.
- Advancing lighter-than-air platform technologies.
- Providing calibration and validation of on-orbit instrumentation.
- Enabling hands-on training for the next generation of scientists and engineers.

Program Background: Launch Locations

Highlights – Current and Upcoming

Accomplishments

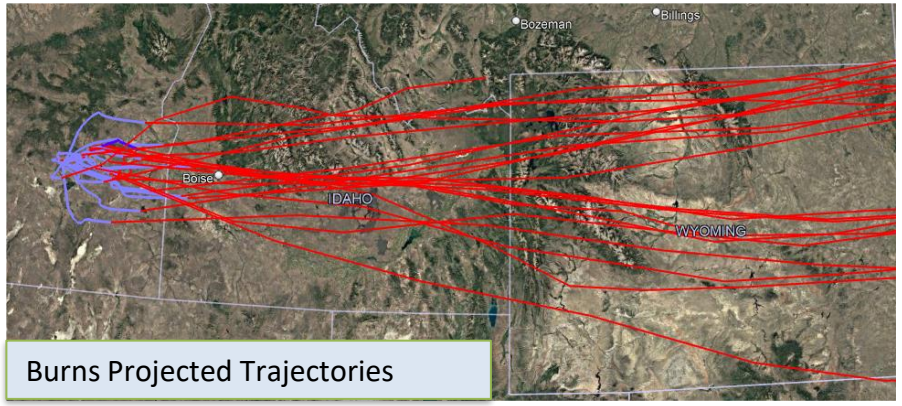
- FY24: three campaigns totaling 14 flights
  - Antarctica: GUSTO (Walker): 57-day Record-breaking flight
  - Sweden: 4 flights successfully launched (3 within 7 days)

Highlights

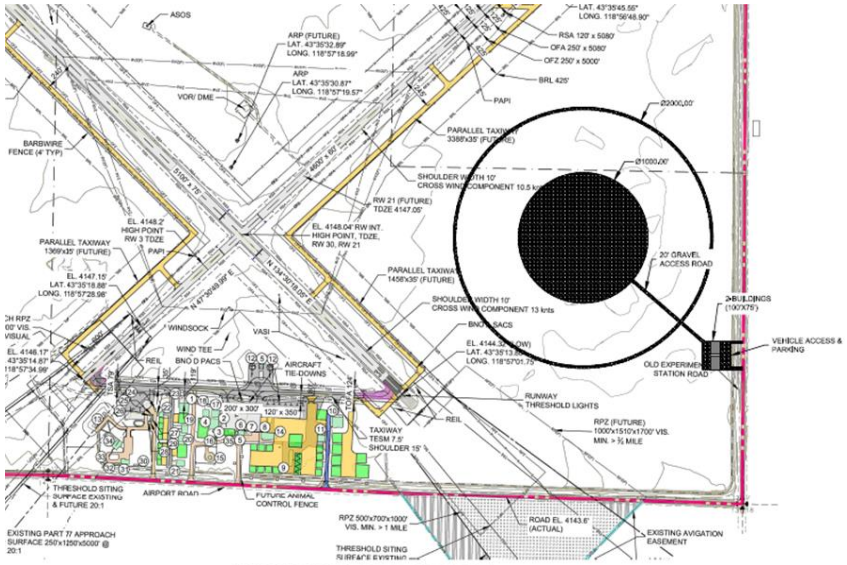
- FY25: three campaigns scheduled totaling 9 flights
  - New Zealand SPB Campaign: Two flights successfully launched. SN11 completed one circumnavation. SN12 currently in flight.
  - Fort Sumner: Six missions plus 33 piggybacks are planned.
- FY26: three campaigns scheduled totaling 14 flights
  - *Inaugural* Burns, OR: Two missions scheduled.
  - Antarctica: Four launches scheduled.

Investments

- Science enabling: Annual WFF-Hosted Payload initiated to support new Science & Technology Missions of Opportunity (BOOP!) (*11 MoO's currently*)
- Infrastructure improvements: Mobile Launch Vehicle fabrication, NZ facility upgrades, recovery capabilities
- Technology development focus: telemetry, avionics, power, structural lightweighting, and hydrogen.



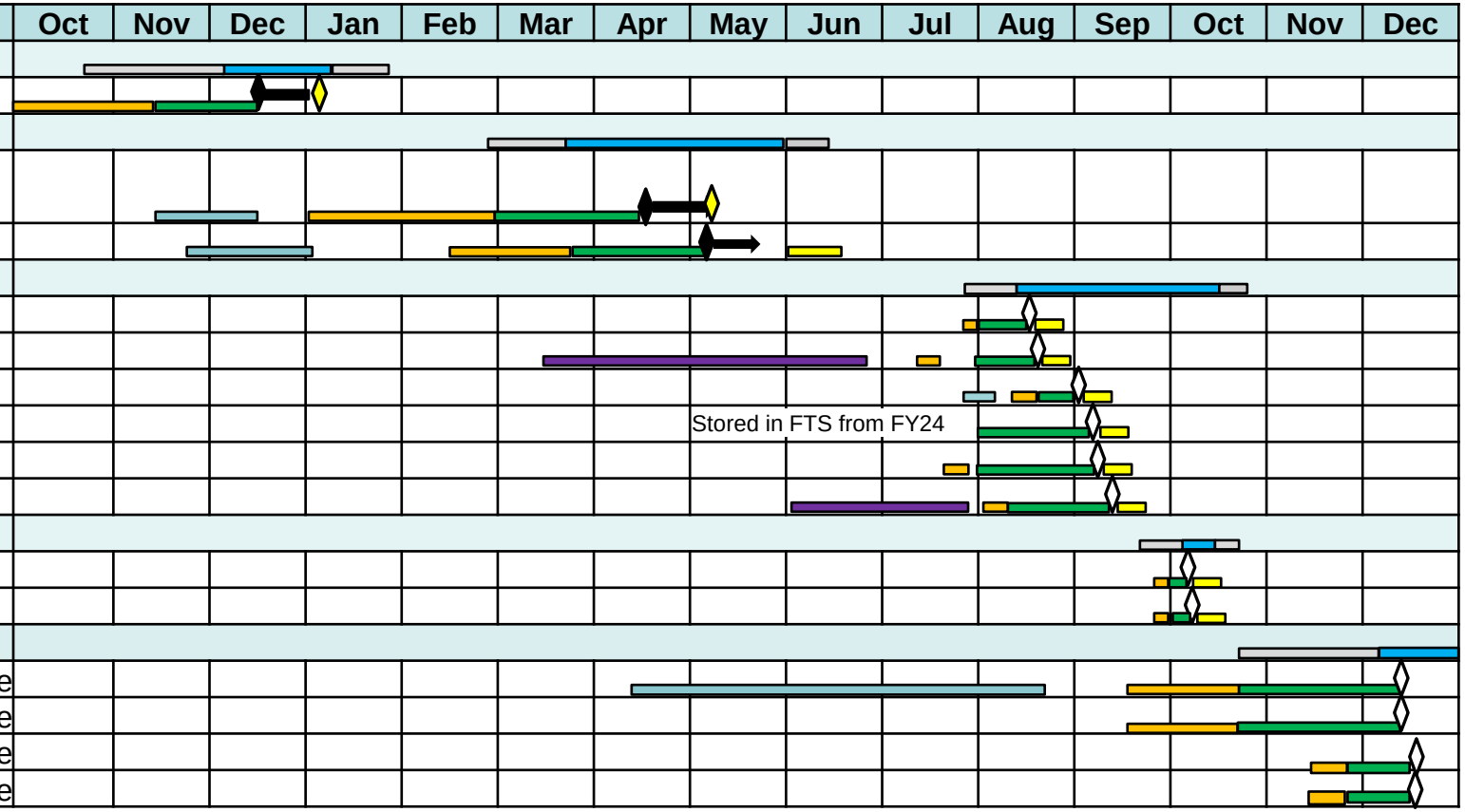
Burns Projected Trajectories



2025 Flight Manifest

Goddard Space Flight Center — *Wallops Flight Facility*

Mission	Discipline
McMurdo Station, Antarctica	***Austral Summer '24***
Salter / CSBF / STF	Test Flight
Wanaka, New Zealand	***Austral Fall'25***
Fairbrother / WFF / SPB SN11	Qualification Flight
Wu / NCAR / HIWIND	Upper Atmosphere
Fairbrother / WFF / SPB SN12	Qualification Flight
Fort Sumner, New Mexico	***Fall '25***
Salter / CSBF / STF	Test Flight
Roth / WFF / BOOP!	Test Flight
Granger / LSU / HASP	Student Outreach
Young / SwRI / THAI-SPICE	IR, UV, and Visible
Kleinboehl / JPL / JPL Remote	Upper Atmosphere
Mendillo / UML / WASP PICTURE-D	UV-Visible
Burns, Oregon	***Fall '25***
Fries / JSC / CDCP	Solar System
Tsai / UCLA / ELVES	Heliophysics
McMurdo Station Antarctica FY 26	***Austral Summer '25***
Vieregg / UoC / PUEO	Astro – Cosmic Ray, Particle
Hailey / CU / GAPS	Astro – Cosmic Ray, Particle
Vieregg / UoC / PUEO PF 1	Astro – Cosmic Ray, Particle
Vieregg / UoC / PUEO PF 2	Astro – Cosmic Ray, Particle

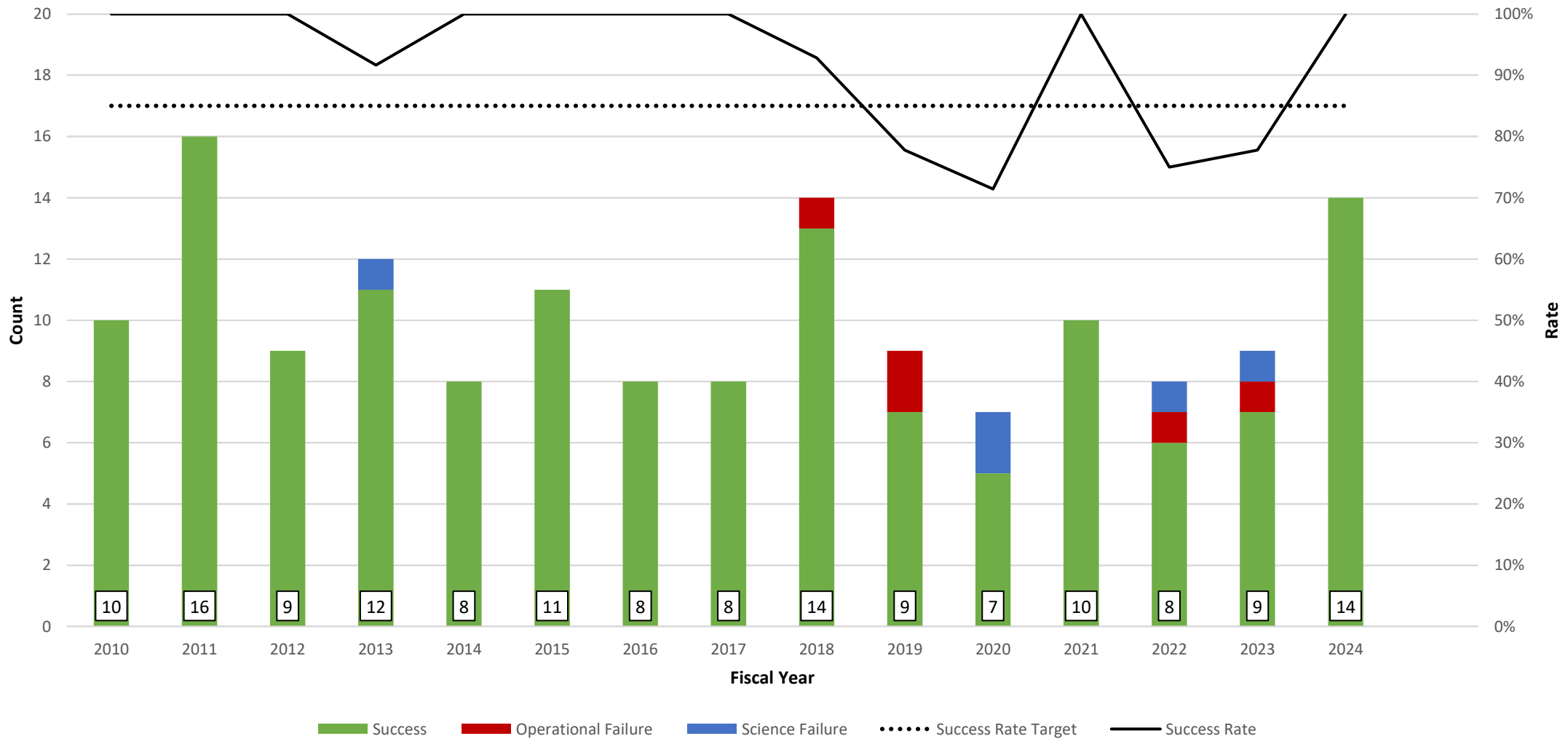


Key
CSBF Integration
WFF Integration
Shipping
Onsite Integration
Personnel on Site
Launch Window
Target Launch
Actual Launch
Flight Duration
Recovery Window
Actual Recovery

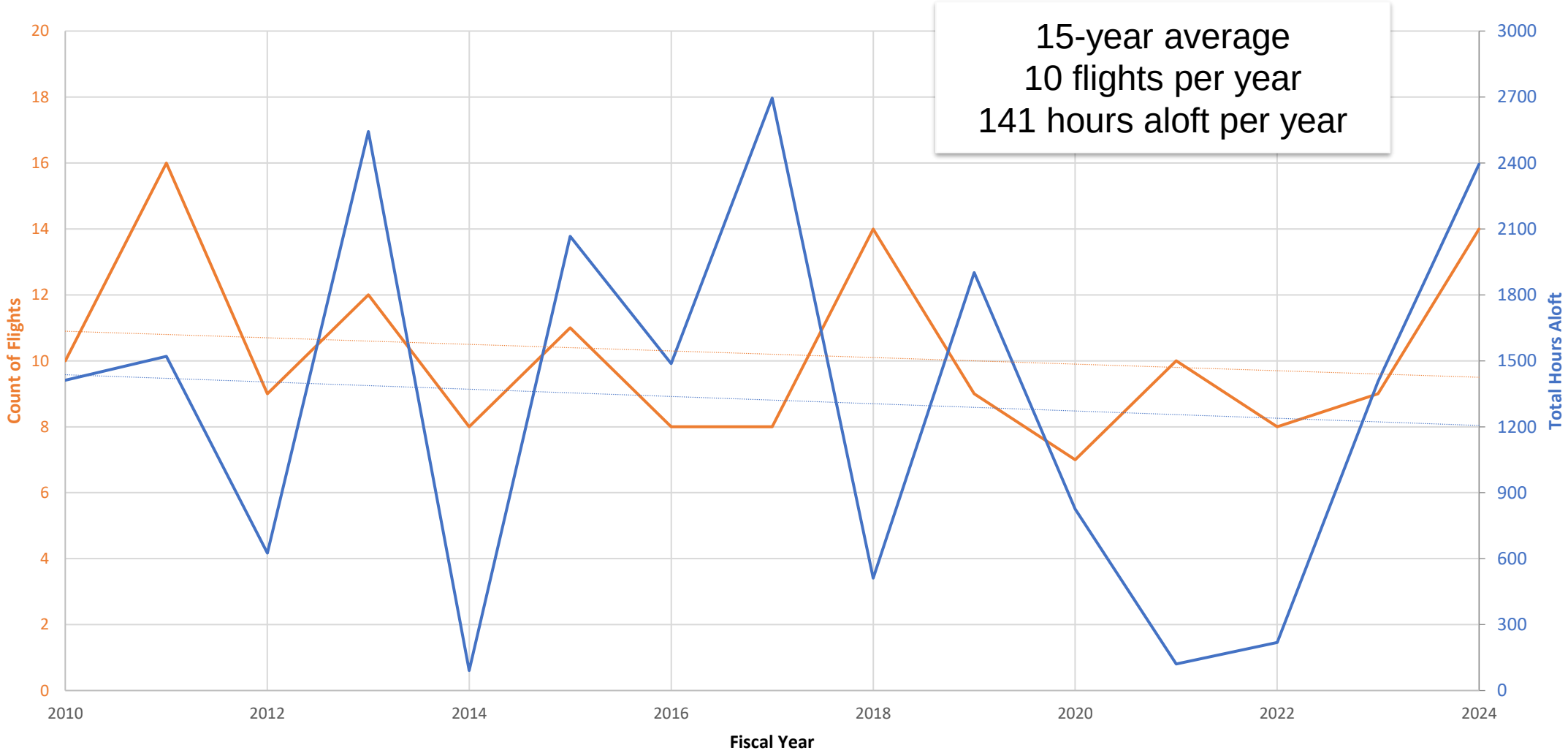
McMurdo Station, Antarctica (8)	*Wanaka, New Zealand (5)*	*Fort Sumner, New Mexico (27)*	
BRGR	HIGS	MaxIQ	EMIDSS-7
DRAGONFLY	INDIGO	CHARIOT	CASBa
EMIDSS-6	MOANA	PHE_A	DINGO
INDIGO	SPARROW-7	SpaceLoon	INDIGO
IRIS	CoMIC	MiniROZE	WISTLS
MARSBOx		EAGLE	CiS
SPARROW-6		RAWH	SPARROW-8
WALRUSS		CSTARS-B	TIMcam

Piggyback Payloads – 38 total

Balloon Program Success and Failures



Flight Tempo vs Time Aloft (FY10 – FY24)



Results of 2020 Astrophysics Decadal Survey

- *National Academies Astrophysics Decadal Survey (2023)*
  - *Report outlined NASA's Suborbital Programs (Sounding Rockets and Scientific Balloons) "**allow rapid revision and reuse of payloads, speeding the technology development cycle. Many of NASA's largest visions have built upon the technology and expertise developed through these programs. Time and again, the program has demonstrated its efficacy in producing leaders for space missions**."*
  - *The Balloon Program is recognized for offering "**access to a near-space environment with a wide variety of options for duration and sky coverage … The balloon program's impact on innovation and science can be seen in its breadth of payload instrumentation**"*
  - *Notably, the Decadal recognized challenges confronting the program and outlined "[p]**athways to improving the balloon program to take maximum advantage of these promising opportunities"** issuing a Recommendation: "**NASA should undertake an external review of the balloon program to establish a framework for accomplishing the competing needs of achieving flight capabilities and launch rates that meet demands, ensuring adequate investment in payloads, and lowering barriers to entry."***
  - *The Balloon Program Independent Review Team conducted a review of the program in 2023 and is working to finalize its report*

Quotes from National Academies of Sciences, Engineering, and Medicine. 2023. *Pathways to Discovery in Astronomy and Astrophysics for the 2020s*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26141.

Projected Mission Model and Primary Science Mission for Remote Campaigns

NOMINAL MISSION MODEL																												
Fiscal Year	**25**				**26**				**27**				**28**				**29**				**30**				31			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Conventional																												
Fort Sumner				6				8				8				8				8				8				8
Australia																												
Palestine																												
Burns					2				2				3				4				4				4			
LDB/ULDB																												
Antarctica	1				4				4				2				2				2				2			
New Zealand		2								2									2								2	
Sweden																												
Total	9				14				16				13				16				14				16			

- ***Launching heavy lift balloons out of Palestine, Texas is getting more difficult, if not impossible, due to risk to public safety; therefore, number of flights set to zero. As conditions allow, launches from Palestine will be conducted.***

Projected Upcoming International Science Missions

	FY25	FY26	FY27	FY28	FY29	FY30
New Zealand	HIWIND BPO Test Flight		TAURUS PBR		TBD	
Sweden						
Australia						
Antarctica	Test Flight	PUEO, GAPS	TIM, ADAPT, AESOP-Lite	XL-Calibur, GRAPE	CORSAIR EXCITE	B-Solitaire, Olimpo

Planned / Manifested by Science Need

FY24 Program Highlights

FY24 Antarctica Long Duration Ballooning Campaign:

- Launched three missions
- Set a duration record for the GUSTO mission
- Set an Antarctic altitude record for the AESOP-Lite mission

FY24 Sweden:

- Launched and had four successful missions.
- Set a Sweden altitude record for the 60MCF test flight

FY24 Fall Fort Sumner Balloon Campaign:

- Successfully launched seven missions

FY24 Balloon Program Office Flight Manifest

Goddard Space Flight Center — *Wallops Flight Facility*

Mission	Discipline	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
McMurdo Station, Antarctica	***Austral Summer '23***												
Walker / UArizona / GUSTO	IR-Submillimeter				**Launched 12/31/2023**								
Roth / WFF / 60 MCF Qualification Flight IV • Clem / UD / AESOP-Lite	Qualification Flight				**Launched 01/10/2024**								
Salter / WFF-CSBF / LAURA [Hand Launch]	Test Flight			**Launched 12/11/2023**									
Kiruna, Sweden	***Austral Spring '24***												
Roth / WFF / 60 MCF Qualification Flight V • Sample / MSU/ BOOMS	Qualification Flight							**Launched 07/28/2024**					
Krawczynski / WashU / XL-CALIBUR	Gamma Ray							**Launched 07/09/2024**					
Wakely / Uchicago / HELIX	Cosmic Ray						**Launched 05/27/2024**						
Solanki / MPS / SUNRISE 3	Heliophysics							**Launched 07/10/2024**					
Palestine, Texas	***Summer '24***												
Cancelled													
Fort Sumner, New Mexico	***Fall '24***												
Roth / WFF / BADDE • Salter / WFF-CSBF / STFU	Special Projects								**Launched 08/15/2024**				
Viera / UI / TIM	IR-Submillimeter								**Launched 09/23/2024**				
Guzik / LSU / HASP2	Special Projects								**Launched 08/28/2024**				
Guzik / LSU / HASP	Student Outreach								**Launched 09/04/2024**				
Krawczynski / UWSTL / DR-TES	Gamma-Ray								**Launched 09/24/2024**				
Nagler / GSFC / EXCITE [ETF] (T)	IR, Submm, Radio								**Launched 08/31/2024**				
Young / SWRI / THAI-SPICE (T)	UV and Visible	**Delayed until 2025**											
Wender / LANL / TinMan [Hand Launch]	Astro – High Energy								**Launched 08/22/2024**				
Fries / JSC / CDCP [Hand Launch]	Solar System Exploration	**Delayed until 2025**											
Samra / SAO / CORSAIR	IR-Submillimeter	**Delayed until 2025**											

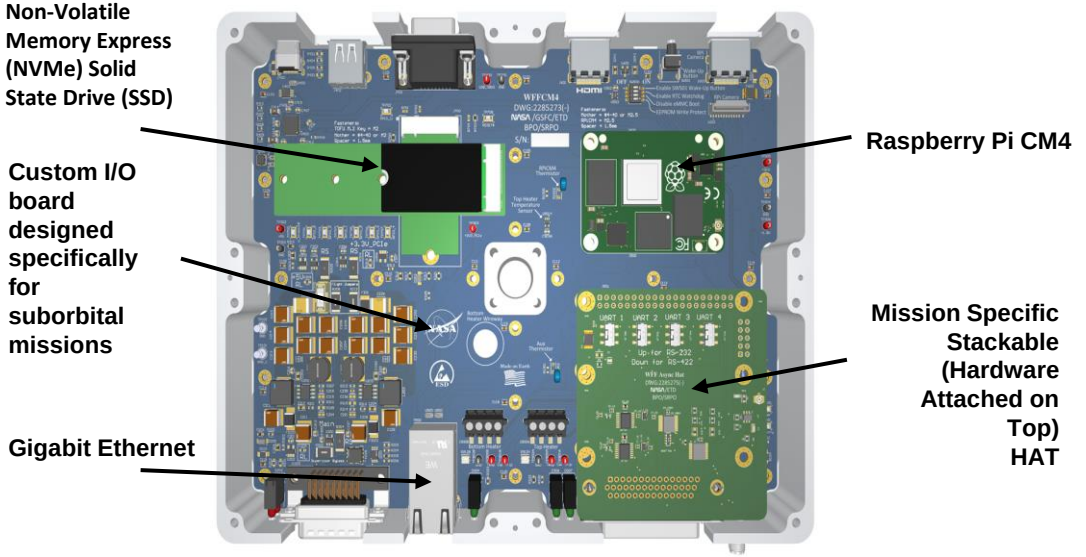
Technology Management

The BPO strives to develop capabilities to support the science community's needs. These inputs are derived from science decadal publications, the Balloon Working Group, conversations with individual scientists, and the NASA Strategic Plan.

- *Technology Management is divided into two divisions:*
  - ***Operational Support***
    - *Primarily supported through the NASA Balloon Operations Contract with personnel from the Columbia Scientific Balloon Facility (CSBF)*
  - ***Research and Development***
    - *Personnel*
      - *Management through NASA Balloon Program Office (BPO)*
      - *Matrixed engineers from NASA Engineering & Technology Directorate and NASA Balloon Operations Contract*
    - *Priority Determination*
      - *Science requirements*
      - *Obsolescence*
      - *Risk Reduction*
      - *Capability enhancement*
    - *Funding*
      - *Program funds*
      - *Internal Research And Development*
      - *Small Business Innovation Research*
      - *Reimbursable Projects*
    - *Annual Test Flight Opportunity*
      - *Increased support for new PIs to fly piggyback*
      - *Fall Fort Sumner, New Mexico*

PICTURE-C Nighttime Pointing

BITSE Station Keeping on Sun



Wallops Arc Second Pointer (WASP)

- *WASP maintains arcsecond level control with a neural network control scheme, which can rapidly adapt to the static friction of the system when high-frequency vibrations from the pitch and yaw hub shaft rotation motors are observed within the science data set.*
- *Current capabilities*
  - *Consistently demonstrating 0.1 – 0.5 arc-second RMS stability depending on century body configuration*
  - *Updated tracking system can point to stellar, solar, and planetary targets as well as fixed Earth targets*
- *Pointing improvements*
  - *Upgrades to star-tracker algorithms to permit more robust daytime performance*
  - *Star tracker focus stage to accommodate thermal drift*
  - *Software improvements focused on improved automation to support long-duration flights*
- *During the FY22 flight of the Picture-C payload, the combination of WASP and the Picture-C instruments deformable mirror reached 0.1-arcsecond accuracy. That is on par with the James Web Telescope.*

- *Coarse Rotator*
  - *Current capabilities*
    - *Flight proven capability of 1 degree RMS*
    - *Regularly achieves less than 10 arc-minutes RMS*
    - *Accuracy will depend on the sensor source (solar or GPS compass)*
  - *Improvements*
    - *New Slip-Ring (In pre-testing phase)*
      - *Reduced friction may increase pointing performance by reducing the minimum amount of torque used during station keeping and offering improved electrical pass throughs.*
    - *Embedded Motor Driver EMI filter (potential future)*
      - *Reduce sensor noise levels (solar & inertial rate) and reduce EMI power bus noise seen while the rotator is powered.*

Wallops Arc Second Pointing (WASP)

- *Developed as a stable pointing system for balloon borne science flights, WASP has been providing a two-axis platform for scientific instruments while suspended beneath a high-altitude balloon since 2010.*
- *WASP maintains sub-arcsecond level control with a neural network control scheme, which can rapidly adapt to the static friction of the system when high-frequency vibrations from pitch and yaw hubs shaft rotation motors are observed with the science data set.*
- *Current capabilities*
  - *Consistently demonstrates 0.1-.05 arcsecond RMS stability depending on the center body configuration*
  - *Updated tracking system can point to stellar, solar, and planetary target as well as fix earth objects.*
- *During the FY22 flight of the Picture-C payload, the combination of the WASP system and the Picture-C instrument's deformable mirror reached 0.1 arcsecond accuracy. That is on par with the James Web Telescope.*

WASP Payloads

- **XL-Calibur** incorporated an X-Ray telescope along a 12 m truss.
- 2022
  - Launch from Esrange, Sweden - Landed in Yellowknife, Canada
  - Total flight time: 6 days, 7 hrs, 49 mins
- 2024
  - Launch from Esrange, Sweden - Landed in Kugluktuk, Canada
  - Total flight time: 4 days, 16 hrs, 51 mins

- **Picture-C** incorporated a coronagraph with a deformable mirror.
- 2022
  - WASP pointing summary
    - Time on target: 7 hours, 29 mins
    - Pitch RMS: 0.1 – 0.2 arcsec
    - Yaw RMS: 0.2 – 0.4 arcsec
    - Total flight time: 19 hours, 16 mins

Super Pressure and Balloon Enhancements

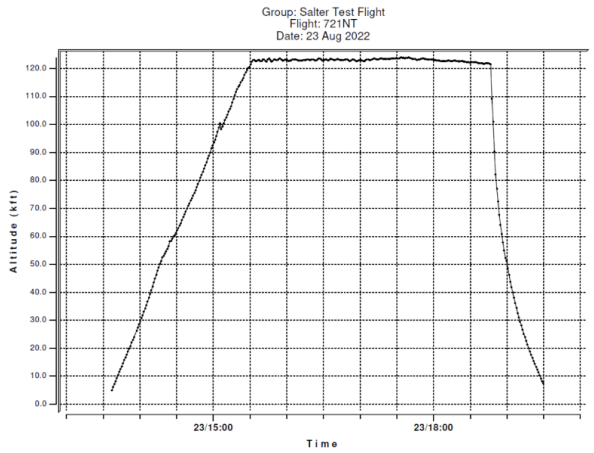
- *The BPO is committed to expanding our balloon arsenal to increase both available suspended mass and reachable altitude.*
- *The **SPB** focuses on qualifying the 18.8 million cubic foot (mcf) balloon for science. The science allocation is between 2,500 and 2,800 pounds, depending on the requirements. The science allocation includes the gondola and power system for the science team.*
- *The **60 mcf balloon** will be capable of 1,650 lbs of suspended mass to an altitude of approximately 157,000 ft*
- *Materials research is a constant endeavor of the BPO to determine the ideal materials for the longest possible flights, with the science instrument the priority for mass allocation.*
  - *Currently researching additional qualified resins to reduce the risk of supply chain log jams for balloon film.*
  - *Parachute materials for ultra-long duration flights are also being studied, and specific data on UV flux and ozone concentration in the stratosphere is being collected.*

Balloon Optimization Opportunity Platform!

- BOOP! is designed to lower the barrier of entry for new investigators.
- This is an **annual** flight opportunity during late-August from Fort Sumner, New Mexico.
  - 3-4 hours of flight (2 hours at or above 100,000 ft)
- Integration is based at Wallops with limited engineering and technician support available.
- Payloads should be self contained but power is available (28 VDC) and a master relay switch can power experiments on the morning of flight and off after flight termination.
- Payloads should be smaller than 2 ft cube and less than 100 lbm (some exceptions can be made for antenna booms and camera baffles on a case-by-case basis).
- All missions of opportunity will fly as an accepted risk.
- Following termination, the payloads will be recovered and returned to their owner.
- **Collaborators must meet structural integrity and comply with other hazardous systems/operations safety requirements levied by the program.**
- Inquiries should be addressed to Gabriel Garde (Chief), Dr. Sarah Roth (Chief Technologist), and/or Andrew Hamilton (Deputy Chief).
- More details can be found here.
- Submit a flight application at any time to begin discussions for flight support.

Notional Timeline

- Solicitation begins May 2025,
  - Applications can be submitted at any time.
- January 31, 2026 – Application deadline for payloads requiring support
- April 15, 2026 – Application deadline, no more payloads will be manifested after this date.
- May 1, 2026 – Integration begins at WFF, PIs can ship their experiment and supervised virtually or attend in person.
- June 30, 2026 – Function testing begins.
- July 31, 2026 – Payload shipped to Fort Sumner
- Late August 2026 – Flight, payloads recovered and shipped back to owner.



Considerations

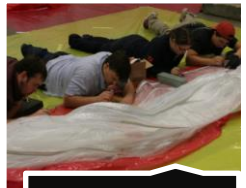
- Elements for the Flight Application or Intake Meeting
  - Instrument Field of View requirements
  - Power
  - Mass
  - Physical and electrical interfaces
  - Data storage
  - Event triggers
  - CONOPS and launch day instructions (no recharging)
    - Payload access after integration is very limited.
  - Do you need to travel to the field?
  - Recovery instructions
- Hazards that must be declared
  - Pressurized or Vacuumed Systems
  - Chemical & Flammable Substances
  - Cryogenic Systems
  - Ordnance
  - Radiation: Non-Ionizing and/or Ionizing
  - High Voltage (>50V)
  - Battery Chemistry
  - Lifting Devices and Equipment
  - Magnets

Education and Public Outreach

The Balloon Program Office's (BPO) outreach program flows down from the Agency Strategic Plan and the Office of STEM Engagement's specific goals

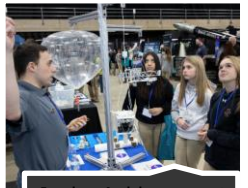
- *Program outreach can be divided into **FIVE** subcategories:*
  - *K-12*
    - *tours, visits to local schools, career day events, science fairs, formal and informal mentoring and tutoring, internships*
  - *Higher education*
    - *internships, dedicated student science flight, tours, formal and informal mentoring, large-scale engineering challenges*
  - *Institutional and Educator Support*
    - *open house events, career fairs, ABET accreditation committees, partnerships with local educators on curricula and mentoring*
  - *Outreach for the public at large*
    - *tours, presentations, and news media*
  - *Cross-cutting*
    - *professional organizations (formal and informal), leverage experts across the globe to better serve the science community*


[redacted]


OSTEM Internships


Virginia Aerospace Days


WFF Visitor Center


Junior Achievement Inspire Day

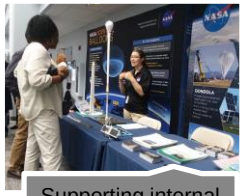
Tours of the Columbia Scientific Balloon Facility


Events for locals during remote campaigns

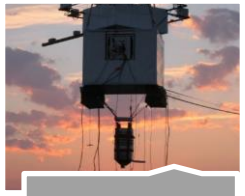

Virginia Space Coast Scholars and Virginia Space Flight Academy


Nationwide Eclipse Balloon Project


Tours of WFF Balloon Facility

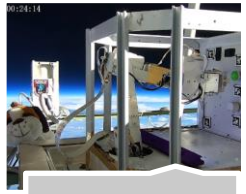

Supporting internal opportunity fairs

Engineering Design Challenge


HASP


WFF Programs


Hosting government officials


Web presence

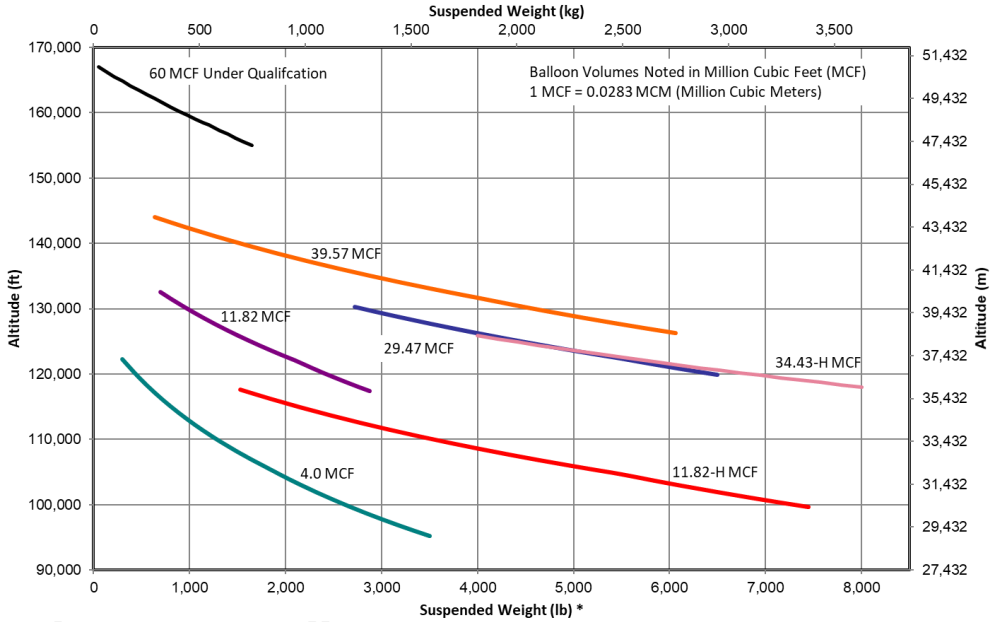

Pathways Internships

Support for local Delmarva schools

Program Background

- The Balloon Program conducts frequent flight opportunities for NASA fundamental scientific, technological, and educational investigations in Earth and Space science research. Balloons are an enabling suborbital platform and play an important role in developing and validating science instrumentation and space technologies, while serving as a training ground for young scientists and engineers.

- The NASA Balloon Program supports an on-going flight manifest of approximately 10 to 16 flights per year supporting 18 to 25 different science teams.
- Managed under NPR 7120.8 (Research and Technology), the Balloon Program operates in a "higher likelihood x lower consequence" risk environment that enables low-cost access to near space for scientific research, technology development, and training.
- Customers include Astrophysics, Heliophysics, Planetary, Earth Science, and other NASA and non-NASA customers.

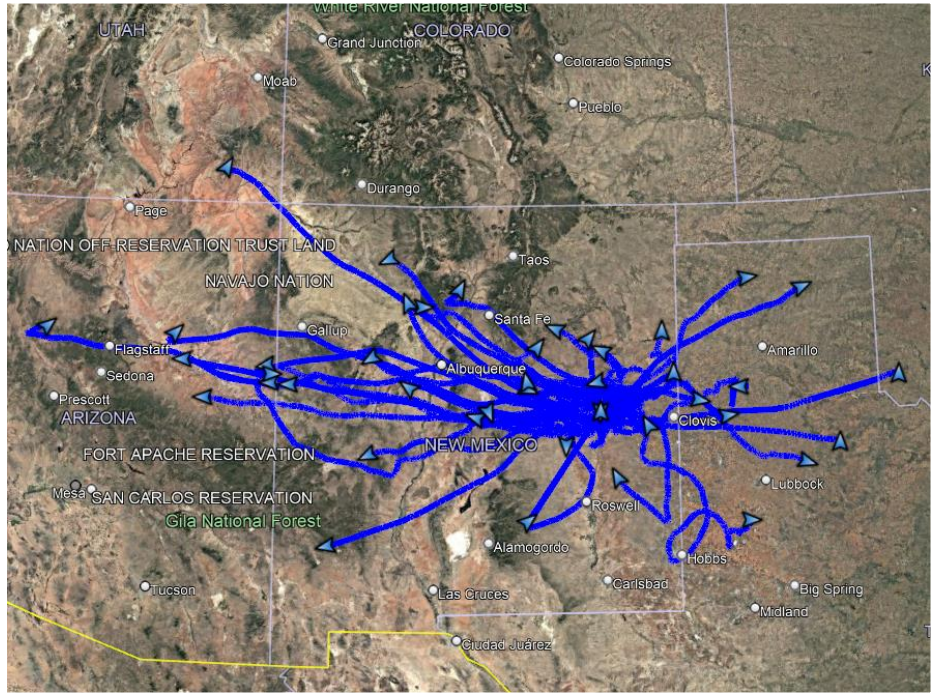


- Balloon Program operations and sustaining engineering is implemented via the NASA Balloon Operations Contract (NBOC) based out of the Columbia Scientific Balloon Facility in Palestine, TX.
- Operations are conducted world-wide at both fixed and temporary launch sites.

Fort Sumner, New Mexico

Goddard Space Flight Center — Wallops Flight Facility

Flight Season: Spring (as needed); Fall (annual)
Campaign Duration: April – June; Aug – Oct
Lat / Long: 34.4731° N, 104.2422° W
Trajectory: West / East / Turnaround
Flight duration: up to 36 hours
Missions per campaign: 2 – 9
Type: Science, Technology, Education and Test Flights

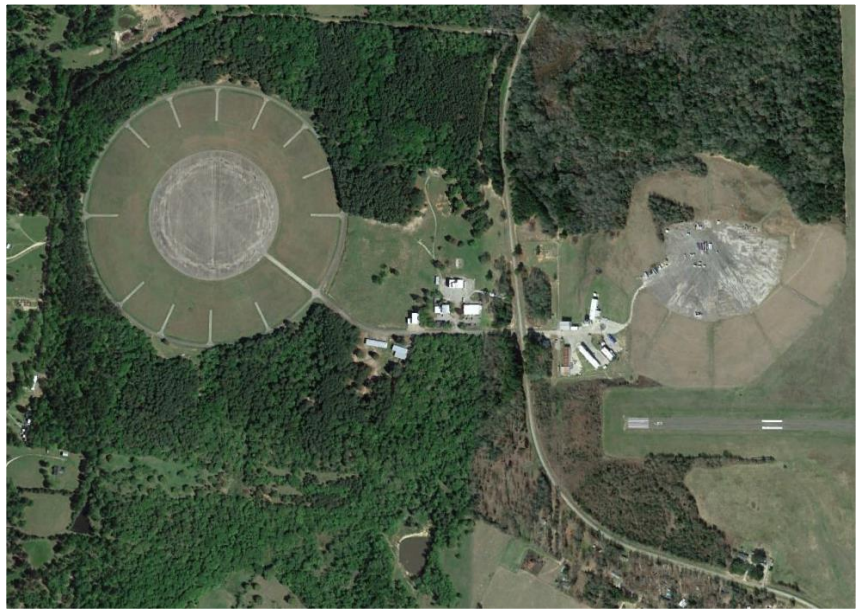


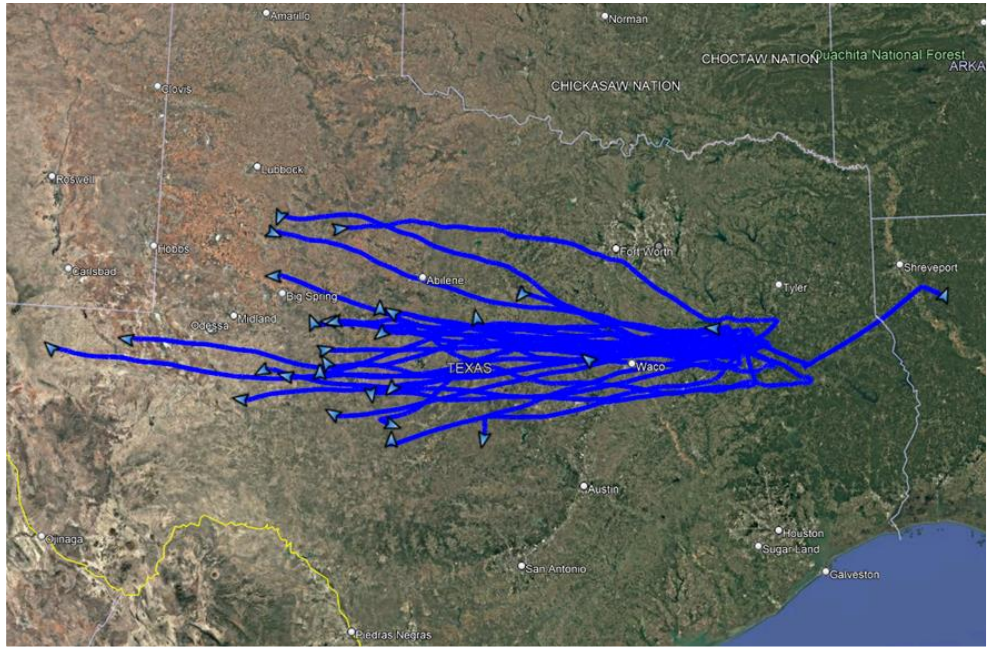
Palestine, Texas

Goddard Space Flight Center

Wallops Flight Facility

Flight Season: Spring / Summer
Campaign Duration: May - Jul
Lat / Long: 31.7786° N, 95.7144° W
Trajectory: West
Flight duration: up to 24 hours
Missions per campaign: 1-2
Type: Science, Technology, Education and Test Flights



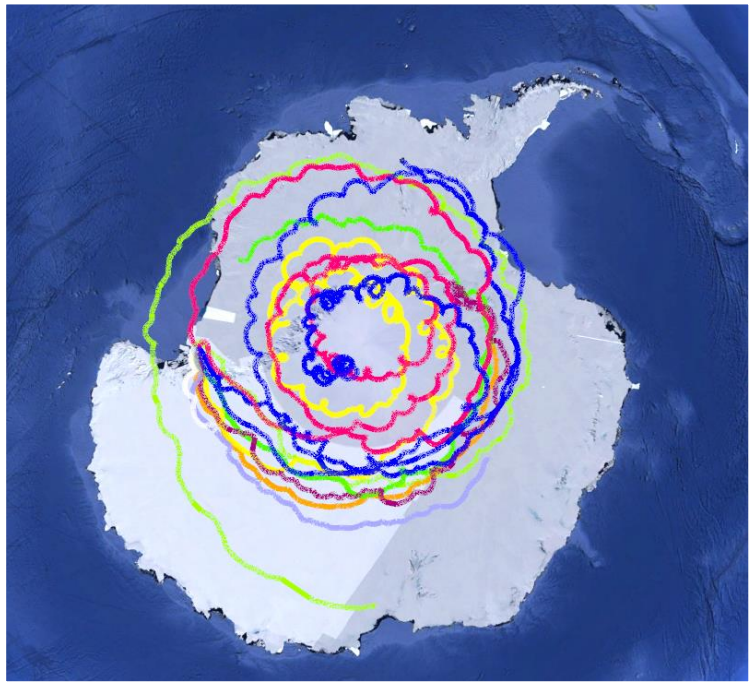


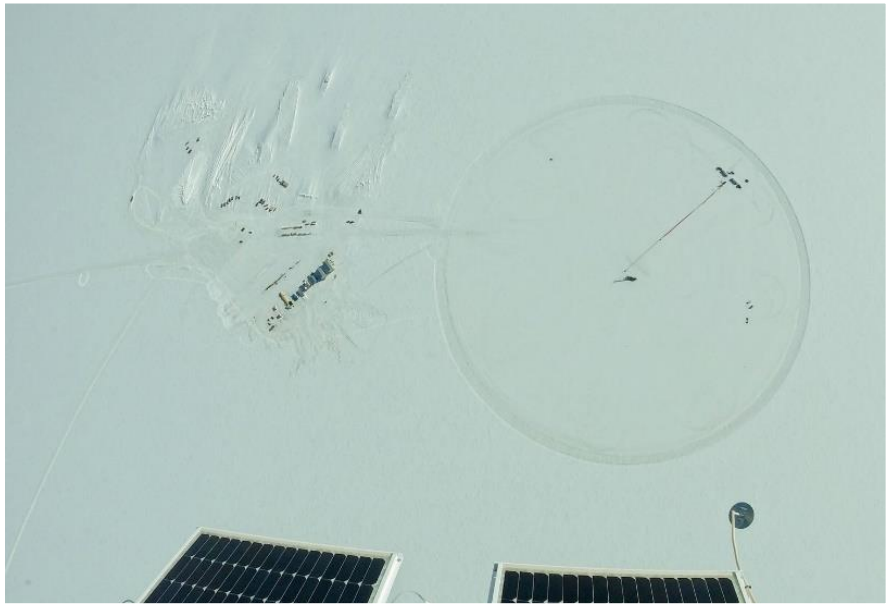
McMurdo Station, Antarctica

Goddard Space Flight Center

Wallops Flight Facility

Flight Season: Austral Summer
Campaign Duration: Nov - Jan
Lat / Long: 77.8500° S, 166.6667° E
Trajectory: West Circumpolar
Flight duration: 7 - 57 days
Missions per campaign: 1 - 4
Type: Science, Technology





Esrange, Kiruna, Sweden

Goddard Space Flight Center

Wallops Flight Facility

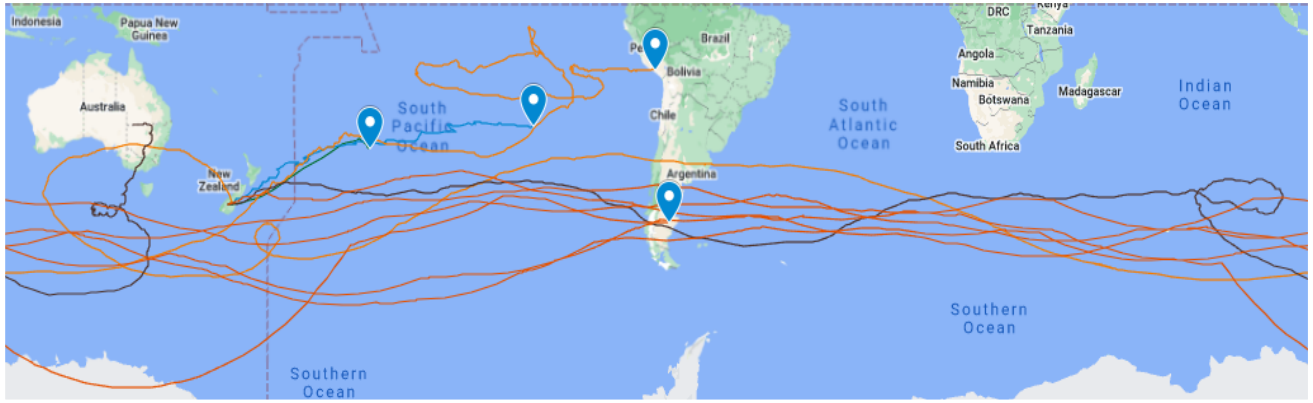
Flight Season: Spring/Summer
Campaign Duration: May – Jul
Lat / Long: 67.8833° N, 21.1167° E
Trajectory: West
Flight duration: 4 - 7 days
Missions per campaign: 1 - 4
Type: Science, Technology, Education and Test Flights

Wanaka, New Zealand

Goddard Space Flight Center

Wallops Flight Facility

Flight Season: Austral Fall
Campaign Duration: Mar - May
Lat / Long: 44.7222° S, 169.2455° E
Trajectory: East
Flight duration: up to 100 days
Missions per campaign: 2
Type: Science, Technology, Education and Test Flights
Super Pressure Balloon campaign location

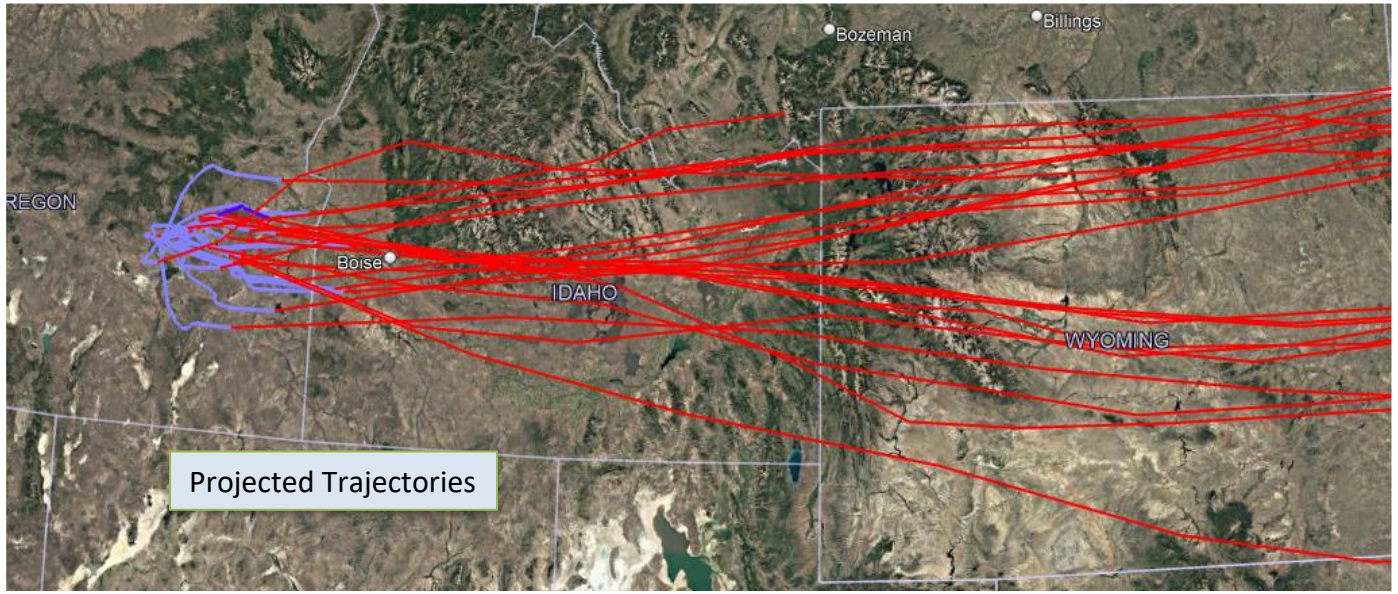


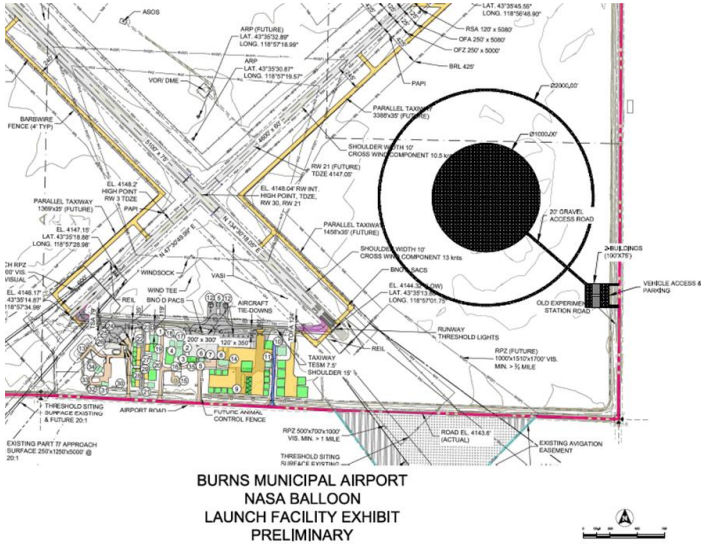
Burns, Oregon

Goddard Space Flight Center

Wallops Flight Facility

Flight Season: Fall (annual)
Campaign Duration: Sep – Oct
Lat / Long: 43.5919° N, 118.9555° W
Trajectory: East / Turnaround
Flight duration: up to 36 hours
Missions per campaign: Under development
Type: Science, Technology, Education and Test Flights





Alice Springs, Australia

Goddard Space Flight Center

Wallops Flight Facility

Flight Season: Austral Fall
Campaign Duration: Mar - May
Lat / Long: 23.80° S, 133.89° E
Trajectory: West / Turnaround
Flight duration: up to 36 hours
Missions per campaign: 1-2
Type: Science, Technology, Education and Test Flights