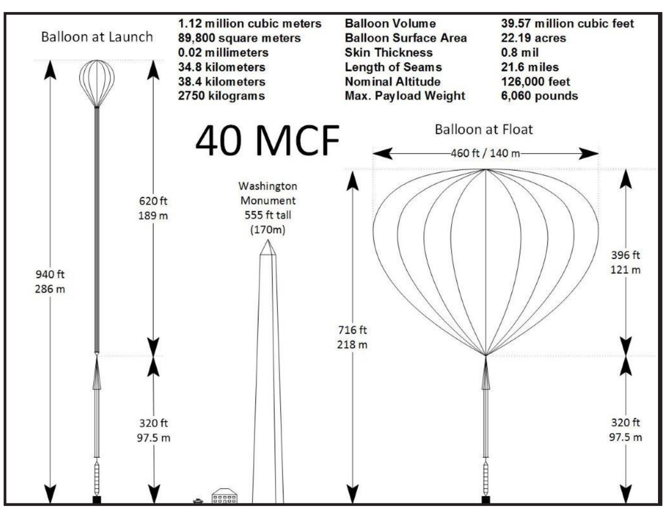
Scientific Balloons

The National Aeronautics and Space Administration (NASA) Scientific Balloon Program Office (BPO) is a suborbital space flight program utilized primarily in support of space and earth sciences research activities sponsored by NASA. A balloon serves as a carrier for science instruments in a similar manner as an orbiting satellite or the Space Shuttle would, but at much lower costs. Added benefits of balloons compared to other carriers are that balloons can fly larger and heavier payloads in as little as six months time once being approved for mission support. Balloon instruments can also be recovered and flown again.

Balloon System

Scientific balloons are very large structures typically made of a thin, 0.02 mm (0.8 mil) thick, polyethylene film, about the same thickness as an ordinary sandwich wrap. The structure is assembled from gores shaped like "banana peels". For the commonly used 1.12 x 10^6 m^3 (40 million cubic foot) balloon, each gore is approximately 183 m (660 ft) long and 3 m (9 ft) wide at the mid-point. Heat is used to seal the gores together to make up the final structure. The seals also include load tapes for supporting the suspended payload. When the balloon is fully inflated, it can reach up to 140 m (460 ft) in diameter and 121 m (396 ft) in height. The balloon system at launch includes a balloon, a parachute and a gondola that carries the science experiment or test article. The total suspended load from a scientific balloon can weigh as much as 3600 kg (8,000 lbs) and can be lifted to an altitude of 36 km (118,000 ft). Higher altitudes can be achieved with lighter payloads. For decades, balloons have been used to conduct scientific studies. While the basics of ballooning remain unchanged, balloons have increased in size, and their dependability has greatly improved.



Balloons Contributed to Many Scientific Discoveries

Balloon missions support all science disciplines including Astrophysics, Earth Science, Planetary Science, Heliophysics, and Technology Development. Since its inception, scientific balloons have produced profound cutting edge science discoveries. NASA balloon science has yielded previously unknown insight of the Earth's atmosphere, the sun, the near-Earth space environment and the universe. The Boomerang and MAXIMA balloon science instruments mapped the anisotropies of the edge of the expanding universe through Cosmic Microwave Background (CMB) science, thus confirming the inflation model of the universe's expansion, one of the great scientific confirmations of the 20th Century.

Balloons contributed to identification of cosmic-ray antiprotons, which were shown to be the result of well-known cosmic rays colliding with interstellar gas and dust, placing constraints on the kind of super symmetric particles that make up dark matter. Scientific balloons made the earliest detections of gamma-ray lines from Super Nova 1987A, positron emission from the galaxy, and black-hole X-ray transients in the galactic center region. NASA Earth Science instruments made observations of chlorofluorocarbons (CFCs) and chlorine monoxide (ClO) radicals in the stratosphere, confirming the CFC ozone-depletion theory.

NASA scientific balloons have provided fundamental discoveries leading to maturation of science and technologies on spacecraft missions. The Compton Gamma Ray Observatory (CGRO) instruments were developed on scientific balloons. Cosmic Microwave Background (CMB) scientific balloon payloads flown in the late 1980's and 1990's provided the basis for the design of the Wilkinson Microwave Anisotropy Probe (WMAP) Spacecraft. Dr. David Wilkinson conducted numerous scientific balloon flights during his career studying the CMB. Detectors on the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) mission were first developed and demonstrated on scientific balloons. The scintillating fiber trajectory detector on the Advanced Composition Explorer (ACE) Cosmic Ray Isotope Spectrometer was demonstrated first on a balloon flight. The Microwave Limb Sounder (MLS), Tropospheric Emission Spectrometer (TES), and High Resolution Dynamics Limb Sounder (HIRDLS) instruments on the Earth Observing System (EOS-Aura) satellite all trace their heritage to instruments that first flew on balloons.

Scientific balloons have contributed to numerous NASA strategic objectives. Measurements were made to determine the portion of the polarization of the CMB that was caused by primordial gravitational waves, which offers great promise for understanding the inflationary period of the universe. Scientific balloon experiments advanced cosmological models and played a key role in development of detectors and technologies necessary for polarization measurements made on space missions. Balloon instruments such as the Primordial Anisotropy Polarization Pathfinder Array (PAPPA), E-and B-mode Explorer (EBEX), and Balloon Borne Large Aperture Submillimeter Telescope (BLAST) have made important measurements of the CMB and foreground microwave radiation and are vital for developing technologies required for future space satellite investigations of CMB polarization.

In the area of high-energy cosmic ray physics, the Department of Energy, National Science Foundation, and NASA are developing a coordinated, broad program of ground, scientific balloon, and space satellite platforms to discover and study the highest energy matter in the universe and the sources that produce them. The Antarctic Impulsive Transient Antenna (ANITA) instrument has detected neutrinos with energy above 10^{18} eV interacting with the Antarctic ice. Collisions of the highest-energy cosmic rays with the CMB must produce neutrinos with energy on the order of $10^{17\text{-}19}$ eV. Balloons can monitor a million square kilometers of Antarctic ice looking for bursts of coherent gigahertz radio frequency emission which arises from the Askaryan effect in a high energy electromagnetic cascade. These radio bursts are produced by interactions of ultrahigh energy neutrinos in the ice. This is a unique capability, not achievable with ground or spacecraft instruments.

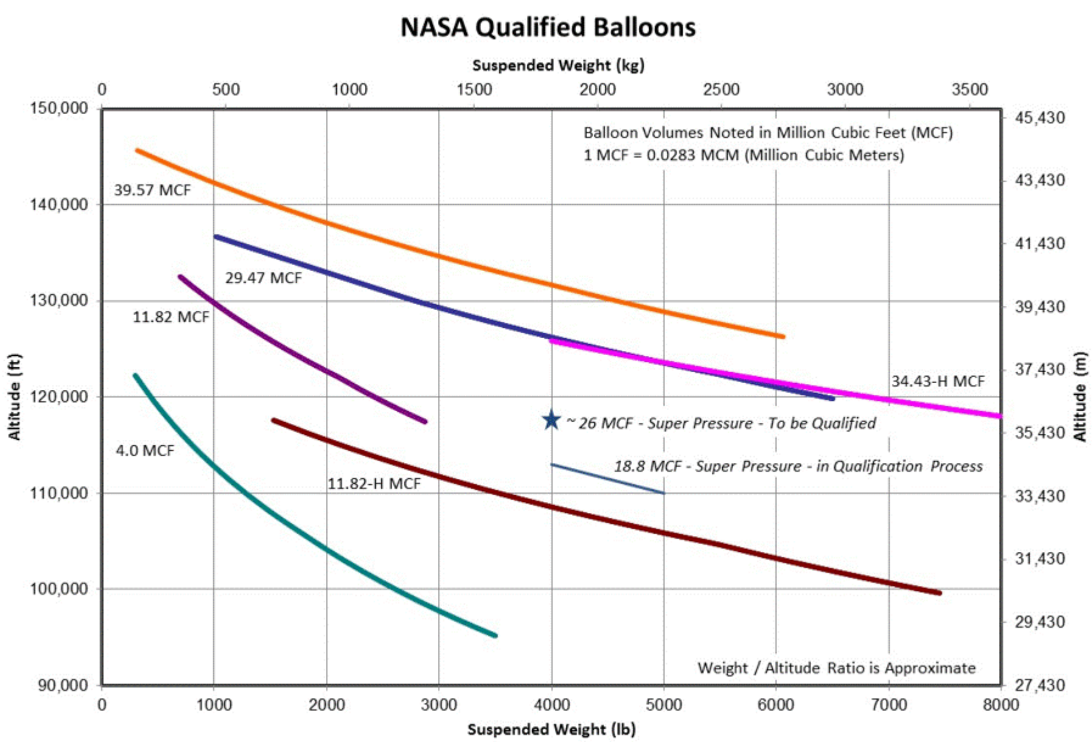
The balloon-borne X-Calibur investigation will greatly extend our capability for high-resolution X-ray spectroscopy to learn what happens to space, time, and matter at the edge of a black hole. Balloon-borne prototype experiments for the Energetic X-ray Imaging Survey Telescope (ProtoEXIST) will further develop technology for large area arrays of CdZnTe imaging detectors and test scanning coded aperture imaging in a space-like environment. The balloon-borne Compton Spectrometer and Imager (COSI) will advance earlier studies to understand the development of structure and the cycles of matter and energy in the evolving universe and, thereby, provide support for a satellite-borne Advanced Compton Telescope (ACT).

Heliophysics scientific balloon telescopes will determine conditions that cause heating of the solar chromosphere that produces many of the strongest emission lines in the solar Extreme Ultraviolet (EUV) spectrum. Scientific balloons will also be used to study netosphere that cannot be obtained from in-situ observations alone.

Scientific balloons compliment earth observing satellites by providing in-situ validation to understand how future changes in atmospheric composition will affect ozone and climate. They provide observations of detailed processes on much finer spatial and temporal scales than satellites. Arctic winter flights can probe detailed microphysical processes leading to polar stratospheric clouds that cannot be studied from space satellite observations. NASA scientific balloons are direct contributors of world class cutting edge science and integral for technology development for spacecraft missions.

ANITA-3 will search for ultra-high energy neutrinos from cosmic ray particle interactions using an array of broadband radio antennas. The antennas are optimized for detection and localization of impulsive radio events that originate from the Antarctic ice sheets.

Balloons Provide a Versatile and Cost Efficient Platform for Conducting Scientific Investigations

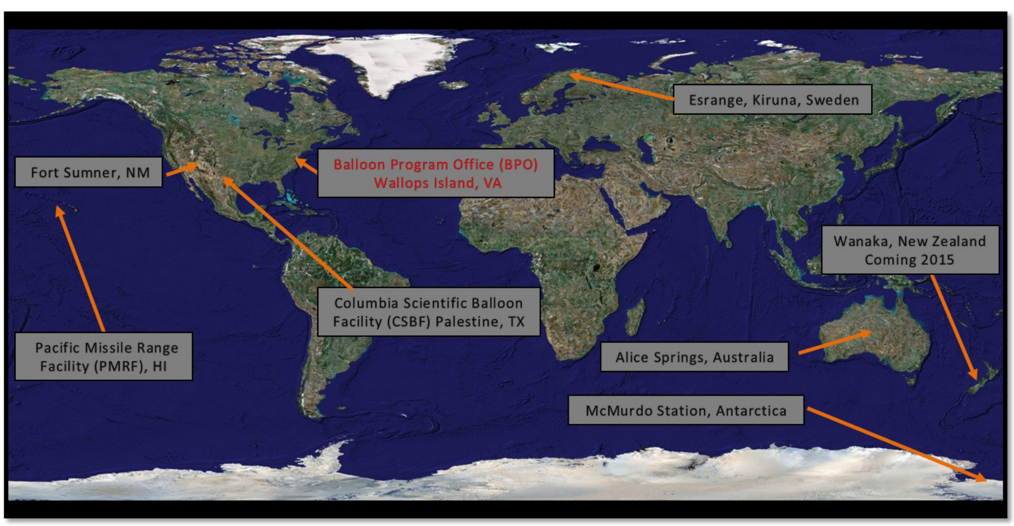


Balloon Type	Zero Pressure (ZP)	ZP	Super Pressure (SP)
Mission Type	Conventional	LDB	ULDB
Duration	2 hours to 3 days	Typical 7-15 days Up to 55+ days	Up to 100 days
Science Payload Weight	Up to 2,721 kg (Up to 6,000 lbs)	Up to 2,721 kg (Up to 6,000 lbs)	18.8 MCF* – 907 kg (2000 lbs) 26 MCF – 454 kg (1000 lbs)
Typical Float Altitude	29.2 to 38.7 km (96 to 127 kft)	36.5 to 38.7 km (120 to 127 kft)	18.8 MCF – up to 34 km (~110 kft) 26 MCF – up to 36 km (~117 kft)
Support Package	Consolidated Instrumentation Package (CIP) ● Line of Sight (LOS) ● Up to 1 Mbps direct return	Support Instrumentation Package (SIP) ● Over The Horizon (OTH) ● 6 kbps TDRSS downlink ● 100 kbps option with TDRSS or Iridium	
	Micro Instrumentation Package (MIP) ● Stand alone package for small payload support ● LOS and OTH TM & Command (Iridium) 255 byte/min packets ● Up to 1 Mbps LOS option System without batteries ~20 lbs (9 kg) * MCF – Million Cubic Feet		

Balloon Launch and Operation

The balloon is inflated with helium and launched with the payload suspended beneath it. As the balloon rises, the helium expands and fills the balloon until it reaches full inflation. Two to three hours after launch, the balloon will reach its “float” altitude. As the balloon drifts across the sky driven by the stratospheric winds, the science instrument gathers data. At the end of the mission, a command is sent from a ground station to separate the payload from the balloon. The parachute opens, bringing the payload back to the ground for safe impact and recovery to be returned to the science team. The balloon falls to the ground where it is recovered and disposed of.

NASA presently flies conventional and Long Duration Balloon (LDB) flights. Test flights of the new Super Pressure Balloon (SPB) are underway and full operation is expected in the very near future. SPB will enable Ultra Long Duration Missions (ULDB) on the order of 100 days. It will also maintain “near” constant altitude at any latitude.



Scientific Balloons Launch Locations Worldwide

For more information on the NASA Scientific Balloons, Please Contact the Balloon Program Office at (757) 824-1480; or visit http://sites.wFor more information on the NASA Scientific Balloons, Please Contact the Balloon Program Office at (757) 824-1480; visit ***http://sites.wff.nasa.gov/code820/; or scan the QR code to the right.***

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