Balloons - Stable Platforms for Payloads in the Higher Atmosphere

The application of balloons for scientific use as a supplement to satellites and ground based instruments has increased in particular during the past decade. Balloons are stable platforms that can hold a payload in the higher atmosphere for several days.

There are three launch areas for scientific balloons in the Nordic countries, and Esrange in Northern Sweden is the main launch area for large scientific balloons.

Long Duration Balloon Flights from Esrange Space Center

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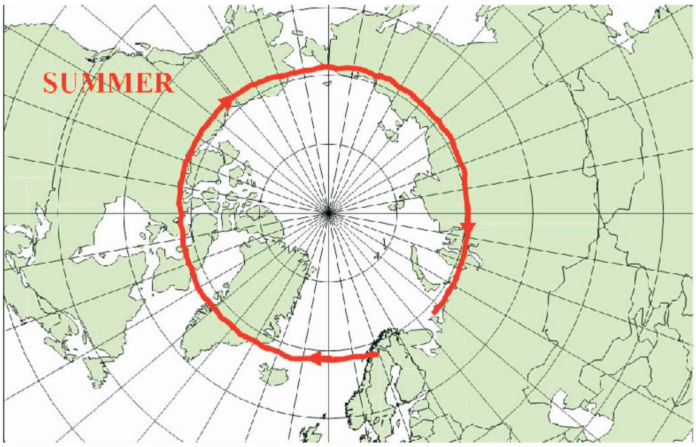
Esrange Space Center in northern Sweden has been a leading launch site for both rockets and balloons during the last 45 years. The geographical location, the comprehensive infrastructure and the competent personnel offer a unique possibility of maintaining both stratospheric balloons and sounding rocket launch operations.

Esrange near Kiruna, Northern Sweden.Launching site for sounding rockets in the background and for balloons to the right.
Photo: Swedish Space Corporation.

We are able to launch extremely large balloons carrying payloads up to two tonnes. Flights can last anything from a few hours to several days, normally within Scandinavia. However, long duration semi-circular flights with recovery in northern Canada have been performed since 2005. Besides required launch and scientific conditions, the success of a balloon flight depends on achieving enough flight time and a safe recovery.

Many scientists, like astronomers studying weak signals from deep space, need a long measuring time for their experiment onboard. The stratospheric wind conditions will determine both the duration and the direction of the balloon. Stratospheric balloons are launched all year round but we take advantage of specific seasonal conditions like the dominating flight directions eastwards during the winter and westwards during early summer.

During the turn-around periods April-May and August-September the winds are very low in the stratosphere and the balloons will remain above northern Scandinavia for up to three days. Most remarkable is the minor deviation on the westward flight trajectory during the summer season. This fact opens a new possibility for us to fly circumpolar long duration balloon flights around the pole.



Circum Polar trajectory in the summer period. Figure: Swedish Space Corporation

On March 9th 2010 the Swedish and Russian Governments signed an agreement regarding peaceful exploration of space by permitting balloon flights over Russia. Within this agreement we are able to provide the science community with long duration circumpolar balloon flights in the northern hemisphere with durations of several weeks.

The balloon operations at Esrange Space Center are expanding yearly. Both NASA and CNES have long term plans for balloon flights from northern Sweden. We have also received requests from Japanese universities and JAXA for future balloon missions. In order to handle balloon campaigns with large numbers of payloads or two different campaigns simultaneously, a new larger assembly hall will be ready for use in April 2011.

Since 2005, a total of 7 payloads have been flying for 4 to 5 days from Esrange westwards and landed in northern Canada. The SUNRISE balloon borne solar telescope is one example of a more than 4 days semi-circular balloon flight from Esrange in June 2009. The Sunrise project was a collaborative project between the Max Planck Institute for Solar System Research in Katlenburg-Lindau and partners in Germany, Spain and the US.

In March 2010 Sweden and Russia signed a corporation agreement for peaceful exploration of space.
Russian President Dmitry Medvedev (R) shakes hands with Swedish Prime Minister Fredrik Reinfeldt in Moscow.

The first circumpolar flight will take place in the second half of June 2011 with the PoGOLite balloon borne telescope studying the polarisation of gamma-rays from pulsars. This balloon will be recovered in Scandinavia after 12-15 days. The PoGoLite project is a collaborative project between Swedish, French, Japanese and US scientific teams.

The Operator

The Swedish Space Corporation (SSC) is internationally recognised as a flexible and successful partner in space operations. The space operations are performed at Esrange Space Center as the prime range located at 68°N and 21°E in northern Sweden, an ideal site for launch of sounding rockets, balloons and for satellite operations. SSC/Esrange is together with DLR/Moraba within the framework of EuroLaunch capable of launching sounding rockets and balloons worldwide.

Stratospheric balloons are primarily used in supporting atmospheric and astronomical research and testing of space systems. Balloon operations have been carried out at Esrange since 1974. A large number of balloon flights are launched yearly in cooperation with CNES, France. Since 2005, NASA/CSBF and Esrange provide long duration semi circumpolar balloon flights to North America.

Launch Site

The Esrange facility was established by ESRO, the European Space Research Organisation in 1966. At the start the facility was using sounding rockets and ground based scientific equipment to conduct research mainly in the field of auroral research and atmospheric physics.

The location north of the Arctic Circle (68o N, 21o E) combined with a favourable sub-arctic climate made the site excellent for sounding rocket launches into the aurora. The first sounding rocket was launched from Esrange in November 1966. Nowadays, five to ten rockets are launched yearly, mostly micro-gravity flights for ESA and Germany. Since the start of the range a total of 500 rockets have been launched from Esrange.

Esrange Launch Vehicle Hercules Carrying the Payload

Launch Window/Trajectories
Winter Period

Balloon launches during the winter period are mainly for atmospheric research where many of the balloons are launched into the polar vortex but some of the campaigns are also in the field of astronomical research.

The predominating stratospheric winds are rather strong from W to NW which gives 5-10 hours of ceiling time and recovery of the payloads in Finland or after 10-20 hours flight in Russia. Some of the balloon projects in the winter period are carried out in cooperation with CNES, France. The Archeops payload was flown in January 2001 by CNES into Russia and landed after a 22 hour flight near Norilsk.

Another example of a project during the winter period is the MIPAS-B/TELIS flown in January 2010, with a 400 000 cubic metres Zodiac balloon in the extremely cold stratosphere with temperatures down to minus 90 C. Flying 14 hours with such a large balloon in such cold stratospheric conditions was a unique achievement.

The experiments onboard were successful and the payload was safely recovered in

Northern Finland. The campaign was carried out under the provisions laid down in the Esrange/Andøya Special Project agreement and operated within the framework of the EuroLaunch cooperation between DLR/MORABA and SSC/Esrange.

Summer Period

During the summer period from mid-May to mid-July the stratospheric winds are very stable from the east, which makes that period very suitable for medium to Long Duration Balloon (LDB) flights. These LDB flights are very suitable for astronomical and cosmic ray payloads where a long measuring time is needed. During this period the latitude excursions are not expected to exceed +/-3°.

The payloads are equipped with redundant flight proven systems for line-of-sight and over-the horizon telemetry and commanding. Total flight duration would be in the order of 5-7 days. This new capability is a joint effort between the Swedish Space Corporation (SSC) Esrange and the National Aeronautics and Space Administration (NASA).

The inauguration flight named BLAST was performed on 11 June, 2005. Seven semi-circular balloon flights have been performed between 2005-2010. The Sunrise solar telescope was launched in June 2009, and landed after 6 days and 14 hours in northern Canada. A balloon with 976 000 cubic metres volume carried the 2000 kg gondola to a ceiling of 37 kilometres altitude.

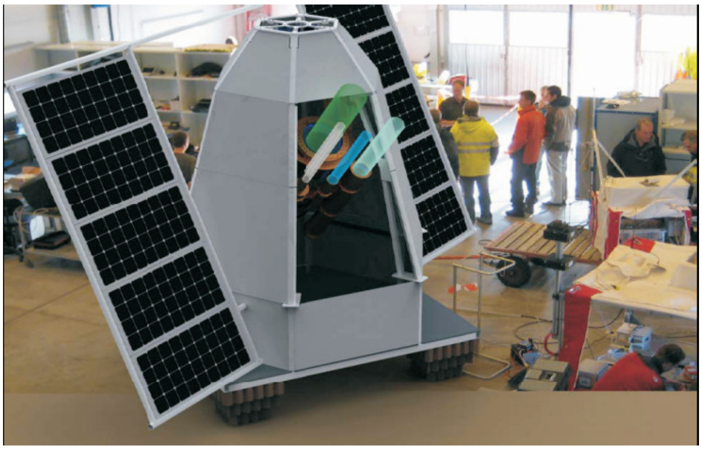
Turn-around Periods

During the turn-around periods in late April and early May and the second half of August the stratospheric winds are very low and irregular which means that the payloads can be in the line-of-sight telemetry up to 2-3 days. These types of flights are performed in the following areas: astrophysics, atmospheric research, drop tests from high altitudes and testing of space systems.

PoGoLite

The PoGoLite telescope studying polarised gamma rays from pulsars in the 25-80 keV range is planned to be flown on a circumpolar flight in May-June 2011.

A 1 120 000 cubic metres balloon will carry the 2000 kg gondola to 38 kilometres altitude for up to 20 days journey. PI is Prof. Mark Pearce, KTH Sweden, in collaboration with scientists from France, Japan and USA.



The PoGoLite Gamma Ray Telescope

The Student Programme BEXUS

The BEXUS programme is an agency agreement between the German Aerospace Center (DLR) and the Swedish National Space Board (SNSB). The Swedish share of the payload has been made available to students from other European countries through collaboration with the European Space Agency (ESA). The BEXUS programme allows students from universities and colleges across

Europe to carry out scientific and technological experiments on balloons. Each year, two balloons are launched carrying up to 20 experiments designed and built by students. A Zodiac balloon with a volume of 12 000 m^3 will carry the gondola to a maximum altitude of 35 km with an experiment mass of 40-100 kg and a flight duration of 2-5 hours. All equipment will be recovered.

FACTS ABOUT BALLOONS.

A stratospheric balloon is a type of research balloon that is constructed of polyethylene, a high-grade plastic with a thickness no greater than the average dry-cleaning bag. These balloons can be up to 800 feet (240 metres) long and are filled with helium, the same gas used to inflate party balloons. They are filled only partially at launch so that they will rise to an altitude where their internal pressure is equal to the atmospheric pressure and they can float.

The largest balloons can carry instrument payloads weighing more than two tonnes. Both the balloon material and the instruments must be able to withstand extremes of temperature. In the tropopause the boundary between the troposphere and the stratosphere temperatures can fall to minus 75 degrees Celsius (minus 103 degrees Fahrenheit), yet in the stratosphere, radiant heat from the sun can raise temperatures on sunlit surfaces to 100 degrees Celsius (212 degrees Fahrenheit).

At 20 to 30 miles (30 to 45 kilometres) above the Earth's surface, scientists can measure chemical reactions in the ozone and the effect of human-manufactured pollutants, as well as cosmic radiation, using these balloons.

The balloon was invented by the Portuguese priest Bartolomeu de Gusmão and the first public exhibition was in 1709. The best known use of balloons is the radio-sonde (Sonde is French for probe), mainly used for meteorological purposes. Regularly, such probes have been launched with different types of instruments onboard and via radio transfer information about atmospheric conditions to ground stations.

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