Mem. Natl Inst. Polar Res., Spec. Issue, 48, 313–317, 1987

THE 1985–1986 SOUTH POLE BALLOON CAMPAIGN

E. A. BERING, III[1], J. R. BENBROOK[1], J. M. HOWARD[1], D. M. ORO[1], E. G. STANSBERY[1], J. R. THEALL[1], D. L. MATTHEWS[2] and T. J. ROSENBERG[2]

[1]*Physics Department, University of Houston–University Park, Houston, Texas 77004, U.S.A.*
[2]*Institute for Physical Science and Technology, University of Maryland, College Park, Maryland 20742, U.S.A.*

Abstract: This paper will provide an overview of the University of Houston–University Park/University of Maryland–College Park balloon program that was carried out at Amundsen-Scott Station, South Pole, Antarctica, during the 1985–1986 austral summer. The paper will emphasize objectives, instrumentation and operations. The quality of the data and periods of special interest will be discussed while final conclusions will be left necessarily to a later time.

The primary experimental tools used in this program were unmanned stratospheric balloon payloads. The balloons used were helium-filled and had a volume of 5100 m^3. The payloads had a mass of 24.5 kg, giving a nominal float altitude of 32 km. The payloads were instrumented with three-axis, double-probe field detectors and X-ray scintillation counters. Secondary instrumentation onboard measured the stratospheric conductivity, the ambient temperature and pressure. Three of the payloads also included tone-ranging transceivers. Equally essential to the program are the ground-based data from the South Pole Station Cusp Lab, the newly developed conjugate observatory, the Goose Bay HF radar, the Søndrestrøm radar, and satellite data from the DE spacecraft.

In the month starting on 16 December 1985 and ending 16 January 1986, 8 successful balloon flights were conducted, ranging in duration from 6 to 103 h 30 min. A total of 468 h 30 min of data were obtained under a wide range of magnetic conditions. Periods of particular interest include 19 December 1985, 28 December 1985, 30 December 1985, 2–3 January 1986, and 7–8 January 1986.

This paper describes the flight of eight stratospheric balloon payloads from Amundsen-Scott Station, South Geographic Pole, Antarctica, during the 1985–86 austral summer.

The primary tools used in this program were stratospheric balloon payloads. The balloons were helium filled, had a volume of 5100 m^3, and a payload mass of 24.5 kg, giving a nominal float altitude of 32 km. The payloads were instrumented with three axis double-probe electric field detectors and X-ray scintillation counters. The electric field detector had a dynamic range of 0.2–980 mV/m for the horizontal components and 0.5–2500 mV/m for the vertical component. The diameter of the X-ray scintillation NaI crystal was 7.7 cm. Other instrumentation measured the electrical conductivity, the ambient temperature and the pressure. Three of the payloads included tone-ranging transceivers. A picture of a payload is shown in Fig. 1. Also essential to the program are the ground-based data from the South Pole Station Cusp Lab; the

Fig. 1. A photograph of the launch of flight No. 4. From top to bottom, the flight train consists of the balloon, tone ranging unit, rotator motor/reel-down, and the payload with the six electric field antennas and the telemetry transmitting antenna.

new conjugate observatory at Frobisher Bay, NWT; the Goose Bay, Labrador high frequency (HF) coherent scatter radar; the Søndre Strømfjord, Greenland incoherent scatter radar; and satellite data from the Dynamics Explorer (DE-1), from Defense Meteorological Satellite Program (DMSP F-6 and F-7), and Interplanetary Monitoring Platform (IMP) 8 spacecraft.

The location of Amundsen-Scott Station at the South Pole provided unique advantages for this project. The geomagnetic latitude of the South Pole (Λ=74.9°S) puts it in the middle of the expected magnetic dayside cusp latitude range (FELDSTEIN, 1963; FAIRFIELD, 1977; EATHER *et al.*, 1979) and about 5° into the polar cap on the magnetic nightside. In addition to the presence of the observatories mentioned above, an advantage of this location for a balloon experiment is that the mean winds at 10 mb in summer are 3–4 km/h (ENVIRONMENTAL DATA SERVICE, 1974, 1975, 1977). Since the elevation of the sun varies very slowly, flights of 3–4 days duration were obtained.

Scientific objectives: The program had nine major objectives: to make (1) long-term balloon measurements of the ionospheric electric field in the vicinity of the polar cusp; (2) long-term balloon measurements of high energy electron precipitation in the vicinity of the polar cusp; (3) long-term balloon measurements of the foregoing in the midnight sector of the low latitude polar cap; (4) conjugate measurements of the ionospheric electric field near the polar cusp and in the midnight sector of the low latitude polar cap; (5) a continuous patrol study of the ionospheric electric field and high energy electron precipitation at 75° geomagnetic latitude for one solar rotation; (6) measurements of the electric component of ultra-low frequency (ULF) waves near the cusp; (7) a study of the spatial structure of the electric field near the cusp by making simultaneous measurements with nearby balloons; (8) a continuous mesaurement of the vertical geoelectric field and stratospheric conductivity for a solar rotation; and (9) a short-time-scale study of stratospheric winds above the geographic South Pole in summertime.

Table 1. A summary of flight activity, giving final ballon positions and activity levels. Note that winds, and therefore flight tracks between launch and loss of signal (LOS) were highly variable.

Flight No.	1	2	3	4	5	6	7	8
Launch time[1]	350 0704 (16 Dec.)	353 0536 (19 Dec.)	355 2205 (21 Dec.)	358 2112 (24 Dec.)	362 0807 (28 Dec.)	002 0508 (2 Jan.)	007 0945 (7 Jan.)	012 1234 (12 Jan.)
Float reached[1]	350 0900	353 0730	356 0000	358 2300	362 1000	002 0715	007 1200	012 1730
Loss of signal[1]	351 0900 (17 Dec.)	354 0000 (20 Dec.)	356 0342 (22 Dec.)	362 0424 (28 Dec.)	365 0715 (31 Dec.)	006 0600 (6 Jan.)	010 0521 (10 Jan.)	016 2013 (16 Jan.)
Flight duration[2]	26 h	18 ½ h	5 ½ h	79 h	71 h	97 h	67 ½ h	103 ½ h
Final azimuth	55°	86°	32°	350°	292°	202°	215°	124°
Maximum range	300 km	225 km	30 km	370 km	480 km	600 km	580 km	240 km
Activity	Moderate ULF in $\vec{E}$. No X-rays	Strong ULF and dc $\vec{E}$. Intense X-rays 0800–1300	Moderate ULF in $\vec{E}$. No X-rays	Strong $\vec{E}$ event at 361 1910	Strong $\vec{E}$, X-rays for first 12 h	X-ray events 002 1300–1500 and 003 0230–0300	Very strong on 007 and 008, X-rays and $\vec{E}$. Large $\vec{E}$ on 009	None
Other remarks		Strong μ pulsations on ground. Søndres-trøm operating		Strong μ pulsations on ground at 361 1910. X-ray detector failed at 359 1309	Strong μ pulsations, VLF large substorm. 364 1800		Micro-bursts observed 007 1200–1700 008–0021	Søndres-trøm operating

[1] All times in UT. December dates are 1985; January dates are 1986.

[2] To nearest half-hour.

Flight summary: In the month starting on 16 December 1985 and ending on 16 January 1986, 8 balloon flights were conducted, ranging in duration from 6 to 103 h 30 min. A total of 468 h 30 min of data were obtained under a wide range of magnetic conditions. A summary of the flight times, final positions, and geomagnetic activity levels is shown in Table 1.

Comparison data availability: There are a lot of data available for comparison with the balloon data. These data can be grouped into three categories: ground-based data from the South Pole, ground-based data from the northern hemisphere, and satellite data. The relevant instrumentation at Amundsen-Scott Station was all operational and obtained good data for the entire campaign. In the Northern Hemisphere, 400 h of simultaneous data were obtained by the Goose Bay HF radar and 74 h of simultaneous data were obtained by the Søndrestrøm radar. Good data were also obtained by most of the other instruments in the North.

The spacecraft data that we expect to be of major interest are the IMP 8 solar wind data, the DE ultraviolet imager data, and the SSJ package particle data and northern

Table 2. A summary of the scientific objectives and potential results of the balloon program

Objectives	Results expected from analysis of the data
1. To make long-term balloon measurements of the ionospheric electric field in the vicinity of the polar cusp.	Can be accomplished. We had balloons aloft at magnetic noon on 20 different days in a variety of conditions.
2. To make long-term ballon measurements of high-energy electron precipitation in the vicinity of the polar cusp.	Can be accomplished. See No. 1 above.
3. To make long-term balloon measurements of the ionospheric electric field and high-energy electron precipitation in the midnight sector of the low latitude polar cap and poleward edge of the auroral oval.	Can be accomplished. We had balloons aloft at magnetic midnight on 19 different days in a variety of conditions.
4. To make conjugate measurements of the ionospheric electric field near the polar cusp and in the midnight sector of the low latitude polar cap.	Can be accomplished. There were about 400 h when we had balloons aloft and the Goose Bay HF radar was running, and 74 h of overlap with operation of the Søndrestrøm radar.
5. To make a continuous patrol study of the ionospheric electric field and high-energy electron precipitation at 75° geomagnetic latitude for at least one solar rotation.	Can be 72% accomplished. Bad weather and leaky balloons prevented 100% continuity. In 31 days, we had a balloon aloft 19 days 6 h.
6. To measure the electric field components of ULF waves near the polar cusp.	Can be accomplished. Very significant activity levels were seen regularly.
7. To study the spatial structure of the electric field near the cusp by making simultaneous measurements with nearby balloons.	Cannot be accomplished. High surface winds prevented overlapping flights.
8. To make a continuous measurement of the geoelectric vertical field and stratospheric conductivity for a solar rotation.	Can be 72% accomplished. See No. 5 above.
9. To make a detailed, short-time-scale study of stratospheric winds above the geographic South Pole in summertime.	Can be accomplished.

hemisphere imager data from DMSP F-6 and F-7 (RICH *et al.*, 1985). IMP 8 was in the solar wind during at least flights 1, 2, 7 and 8. The DE imager was operating and viewing the region poleward of 81°S approximately 2 hours per day during every flight except flight 3.

Expected results: The 1985–86 South Pole Balloon Campaign acquired 468 h 30 min of data. Almost all of both the balloon and the other instruments worked well. The program's objectives and the results that we will be able to obtain are summarized in Table 2.

Acknowledgments

The members of the field team were James R. BENBROOK, Edgar A. BERING, III, Jenny M. HOWARD, David M. ORÓ, Eugene G. STANSBERY and Jeffrey R. THEALL. BERING, ORÓ, STANSBERY and THEALL left the United States on November 26, arrived McMurdo on November 29 and South Pole on December 2, 1985. BENBROOK and HOWARD left the U.S. on November 29, arrived McMurdo on December 2, and arrived South Pole on December 12. The entire party left South Pole on January 18 and left McMurdo on January 23, 1986.

This research was supported by National Science Foundation Grants DPP-8415203 to the University of Houston and DPP-8217260 to the University of Maryland.

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(Received November 11, 1986; Revised manuscript received February 7, 1987)