FACILITIES FOR atmospheric research

NO. 1 FALL 1966

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

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NCAR

The National Center for Atmospheric Research (NCAR) was established in 1960 to conduct and foster basic research in the atmospheric sciences, to supplement and augment the research and educational programs of universities and research groups in the United States and abroad, and to work toward increasing the effectiveness of atmospheric research efforts as a whole.

NCAR is operated by the non-profit University Corporation for Atmospheric Research, representing 23 U.S. universities with graduate programs in the atmospheric sciences or related fields, and is sponsored by the National Science Foundation.

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Ballooning

Aviation

Computing

Field Observation

COVER: Flight path of first GHOST balloon to circumnavigate the earth. See Page 2.

ghost

a progress report on the Southern Hemisphere experiment

The GHOST (Global (HOrizontal Sounding Technique) system is a concept for a global meteorological observing system using free-floating superpressure balloons, equipped with sensing instruments and telemetry, to gather data on winds, temperature, pressure, and humidity. An operational GHOST system, which lies many years in the future, would employ a fleet of 10,000 or more balloons; one or more earth-orbiting satellites to relay the data from the balloons to a ground station; and a super-computer, programmed with a mathematical model of the atmospheric general circulation, which would use the data to produce long-range global weather forecasts.

The Southern Hemisphere GHOST experiment, now being conducted by a group under the direction of Vincent E. Lally of the NCAR Scientific Balloon Facility, is the first step in developing such a system. The experiment is a joint effort of NCAR, ESSA, and the New Zealand Weather Service, and has been endorsed by the World Meteorological Organization. The principal aim of the experiment is to determine the life expectancy of GHOST balloons floating at pressure levels of 500, 200, and 30 millibars (approximately 20,000, 40,000, and 80,000 ft).

Balloons and Telemetry

The GHOST balloons were designed and developed under Lally's direction. They are made of two-ply Mylar laminate and are inflated with helium to a slight overpressure so that they will float at a constant atmospheric-pressure level in spite of daytime heating and nighttime cooling.

The telemetry system used in the experiment is powered by solar cells. Its miniature circuits are built on a very thin Fiberglas circuit board, and it is housed in a lightweight plastic dome. The system can transmit up to four channels of data, but most of the balloons in the Southern Hemisphere experiment will use only one channel to transmit a Morse-code letter which identifies the balloon. The signal repetition rate is controlled by a sun-angle sensor and enables anyone with a high-frequency receiver, a stopwatch, an instrument calibration curve, and tables of solar position to locate the balloon. Tracking is limited to daylight hours because of the solar-cell power supply, and a balloon which drifts too far south may be lost to the tracking station for days or weeks as it drifts through the long Antarctic night.

200-mb Flights

The most successful test flights have been at the 200-mb level. The first balloon was launched from Christchurch, New Zealand, on March 6, and early in June 12 balloons were being tracked as they floated at 200 mb. Eight of these balloons had been up for more than 30 days. One had been up for 74 days, and had circumnavigated the globe at least eight times. Ten of the 200-mb balloons had circled the earth at least once.

Three 200-mb balloons have been lost by the tracking stations. They may have gone down, but Lally believes they may have wandered south into the polar night and will be picked up again when they drift back into the sunlight.

Two of the 200-mb balloons were brought down during ascent, apparently by ice which formed as they passed through cloud decks.

500-mb Flights

The 500-mb GHOST balloons have had typical flight durations of only 7 to 14 days. As long as these balloons remain in tropical latitudes they encounter no serious difficulties. When they drift poleward into temperate latitudes, however, they are brought down, apparently by ice which forms as they pass through frontal zones.

The 500-mb balloons are 1.5 m in diameter and weigh 1.1 kg, including the payload. The ones flown thus far had only 10 to 12 per cent free lift. Ground tests show that these balloons can collect water droplets weighing up to 35 per cent of their gross weight. This indicates that the balloon cannot survive passage through altostratus clouds where supercooled droplets collect and freeze on its surface.

To counteract this icing problem, the balloons have been coated with wax and other substances to enhance their water-shedding ability. The waxing decreased the weight of collected water droplets to 10 to 15 per cent of the gross weight in ground tests. Lally plans to increase the free lift of the balloons to 20 to 30 per cent, and he hopes that this increase, in combination with the wax treatment, will permit the 500-mb balloons to stay up for as long as 180 days.

30-mb Flights

Early in June, no flights had been made at the 30-mb level, but 20 flights at that level are planned for the Southern Hemisphere summer months.

Future Plans

Additional flights at 200 mb are planned during the next few months, and work will continue toward solving the icing problem with the 500-mb balloons.

The planned 30-mb flights should provide new information on the climatology of the stratospheric easterlies. ●

Aircraft Instrumentation Workshop

An Atmospheric Research Aircraft Instrumentation Workshop and Symposium will be held at Will Rogers Airport, Oklahoma City, Okla., on November 17-18, 1966.

The meeting will be sponsored by the Environmental Science Services Administration (ESSA) and the National Center for Atmospheric Research (NCAR). The Federal Aviation Agency (FAA) Aeronautical Center at Will Rogers Airport will serve as host. Oklahoma City was selected for the workshop because of its excellent FAA facilities, as well as its central location and generally mild weather at that time of year.

The meeting is being held in response to increased aircraft utilization in atmospheric research and recent developments in instrumentation technology. The workshop will include sessions on practical applications of existing technology, on new instrumentation techniques, and on problems encountered by scientists and engineers working in the field.

Detailed plans for the workshop are being prepared by a steering committee chaired by Gene Prantner of the Research Aviation Facility, National Center for Atmospheric Research, Boulder, Colo. ●

Measuring Wind Fields

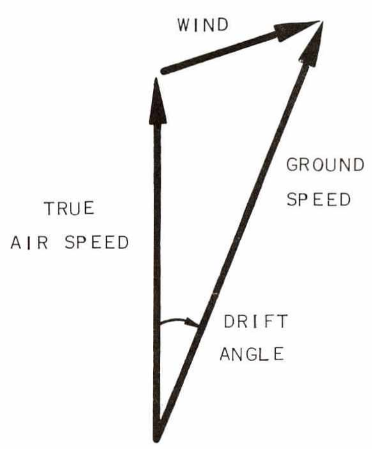
aircraft system provides continuous measurements of wind speed and direction

The NCAR Research Aviation Facility has installed an instrumentation system on one of its aircraft which automatically and continuously provides information on wind speed and direction, and latitude and longitude of every measurement. This system is of great potential value for projects in which air motion is of interest, such as studies of jet streams, sea breezes, diffusion, atmospheric wave motions, heat and moisture flux, atmospheric tracers, and inflow and outflow of air around thunderstorms.

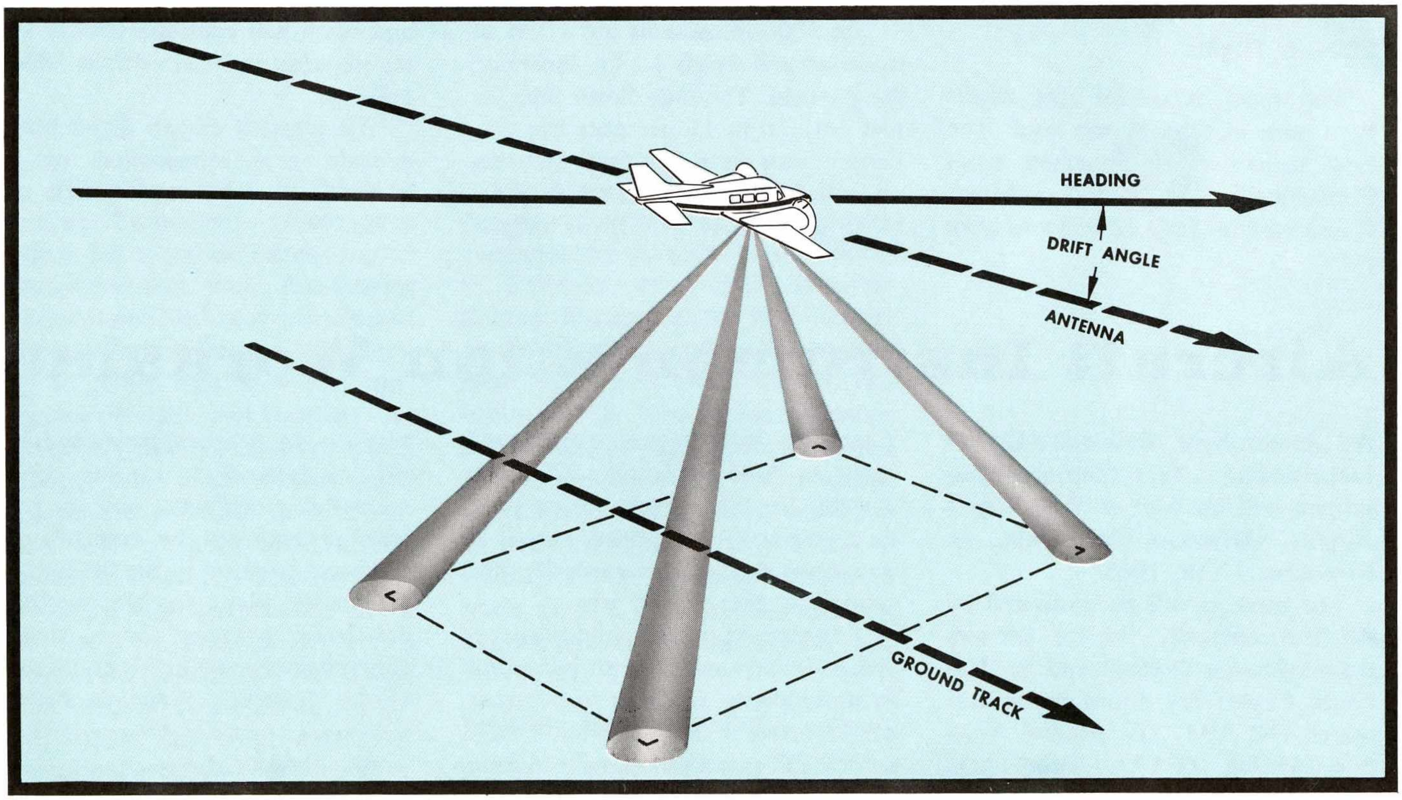
The major components of this airborne system are a doppler radar system, a high-speed computer, and a magnetic tape system.

Doppler Radar System

The doppler radar system is a model AN/APN-153 (V), manufactured by General Precision, Inc. The system is self-contained and is not dependent on ground radio navigation facilities or radar fixes. Its primary function is to make direct, accurate, and continuous measurement of ground speed and drift angle over all types of terrain, including open water. The basis for its operation is the



VECTOR FORCE DIAGRAM



doppler shift in the frequency with which energy reaches a receiver, when the receiver and the energy source are in motion relative to each other.

The doppler system consists of three units: receiver-transmitter, control-indicator, and antenna assembly. The transmitter radiates four separate beams of microwave energy toward the ground. A portion of the radiated energy is reflected by the ground back to the receiver in the aircraft. Since the aircraft is moving in relation to the ground, each beam undergoes a doppler shift as it strikes the ground and again as it strikes the receiver in the aircraft. Thus, the frequency of each received signal is slightly different from that of the original transmitted signal, and this difference is proportional to the ground speed of the aircraft.

The four beams strike the ground at the corners of a rectangle, but only two (diagonally opposite) beams are transmitted and received at a time. Of each diagonal pair of beams the forward beam is shifted to a higher frequency, the rearward to a lower frequency. These two shifts are compared to obtain a difference signal for each pair of beams. The two difference signals are then compared and the antenna is automatically rotated so that it is always parallel to the ground track. Since drift angle is derived directly from antenna position, drift-angle accuracy is never affected by signal quality or terrain, as long as a signal is received.

Computer

Information on heading, true air speed, drift angle, and ground speed is continuously and automatically fed into an ASN-41 computer, manufactured by the Kearfott Division of General Precision, Inc. Magnetic heading input comes from the compass, true air speed from the true air speed computer, and drift angle and ground speed from the doppler system. From this information, wind speed and direction and present position (latitude and longtiude) are calculated by the computer and displayed on a control-indicator.

Magnetic Tape System

Information on wind speed and direction and the latitude and longitude of every measurement is automatically fed into NCAR's Aircraft Research Instrumentation System (ARIS) where it is continuously recorded on magnetic tape for future analysis. Several other variables, including humidity, refractive index, liquid water, and pressure altitude are also recorded on the magnetic tape.

* * *

The doppler principle provides a superior method of determining wind speed and direction because it yields information on the actual speed and direction of the wind at discrete points, instead of just the average speed and direction between points. Such detailed information is essential for any dynamic study of the wind field.

The doppler system only permits determination of the horizontal components of wind, but the Research Aviation Facility hopes eventually to employ an inertial platform, which will make it possible to measure the vertical components as well. At present, the doppler system offers great potential as a tool for dynamic meteorological studies. ●

New NCAR Aircraft

The NCAR Research Aviation Facility has procured the services of a third Beech Queen Air 80, a twin-engine, propeller-driven aircraft with gross weight of 8000 lb and maximum altitude exceeding 30,000 ft. This aircraft has the same research platform and operating capabilities as NCAR's other two Queen Airs. All three have been modified so that they have specific capabilities for atmospheric research; they are all available for use by researchers outside NCAR.

Testing Balloon Films

biaxial testing simulates stresses actually encountered in flight

During the past few years, as balloon volumes and operational altitudes have increased, the failure rate of balloons has also increased. Improvements in balloon film properties have somewhat reduced this failure rate, but the main problem is that we do not know how much each film property contributes to balloon performance. In an effort to obtain significant correlations between film properties and balloon reliability, Hauser Research and Engineering Company, of Boulder, Colo., working with the NCAR Scientific Balloon Facility, is engaged in a program to develop improved methods for testing balloon films. These methods make use of two testing devices: a biaxial tester and a cold-toughness tester.

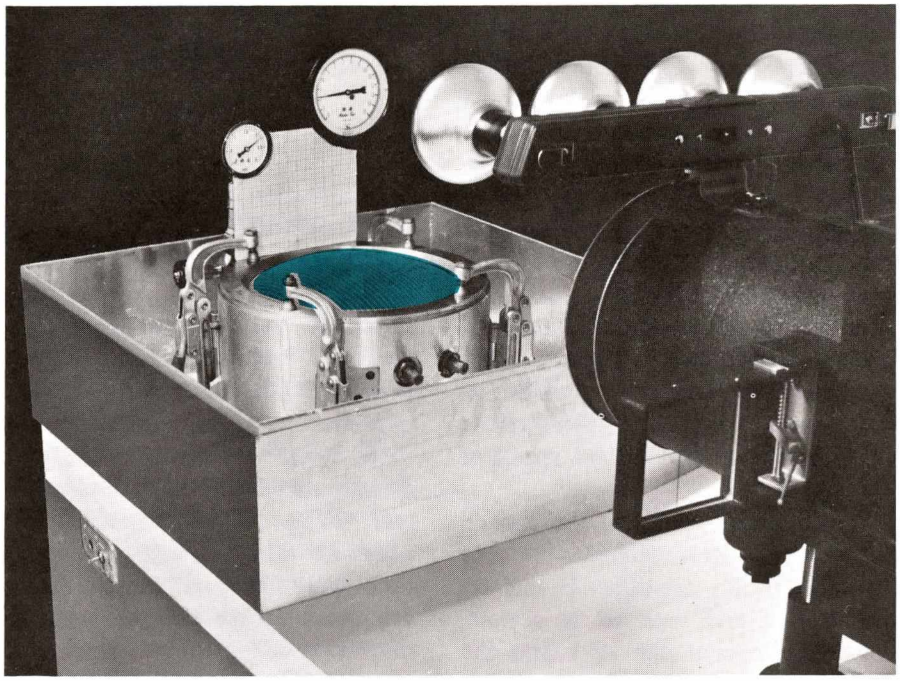


Fig. 1

Biaxial Tester

The biaxial tester, as adapted for balloon film use by Hauser Research, consists of a cylindrical base, over which is clamped a 10-in.-diam circular diaphragm of balloon film (Fig. 1). Cooling and heating coils and a chamber for hydraulic fluid are contained within the base, and low- and high-range pressure gauges are mounted on the top.

Hydraulic fluid is pumped into the diaphragm chamber at a constant rate until the film fails. As pressure builds up in the base, the diaphragm distends. The profile of the distended diaphragm is photographed and the radius of curvature at the crown of the diaphragm is measured from the photographs, using a template (Fig. 2). Stress in the film is calculated using this radius of curvature and the hydraulic pressure against the diaphragm. The film usually fails by bursting, but failure by pinholes and by breaking of the fibers of scrim-reinforced films has also been observed.

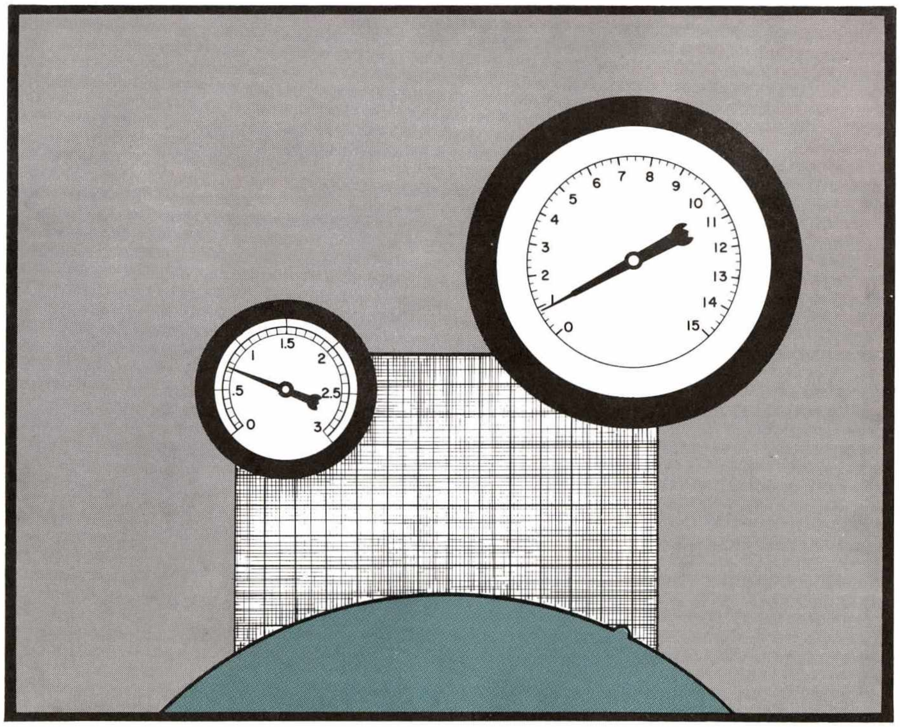


Fig. 2

At present, only stress is being measured, but Digitape instrumentation is being installed to measure strain in the *x* and *y* coordinates.

Non-reinforced films are being tested to correlate the results with those of conventional uniaxial tests and with balloon performance and thus establish the validity and accuracy of the method. Scrim-reinforced films, which may provide an optimum combination of strength, weight, and cost, will also be evaluated. Future tests will use elliptical diaphragms for application of unbalanced stresses and will be conducted at temperatures down to about -80°C.

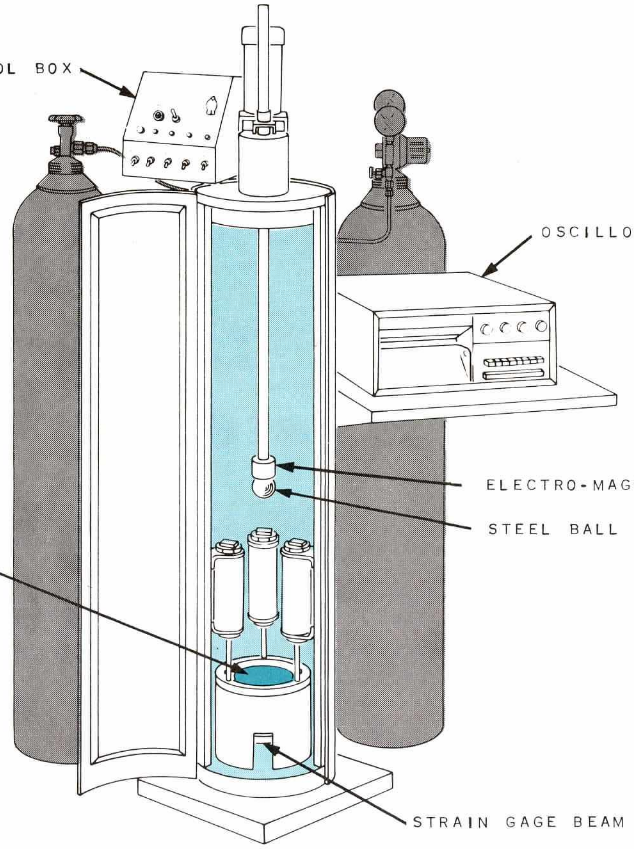


Fig. 3

Purpose of Biaxial Testing

Stresses that occur in balloon films during flight are not necessarily uniaxial. In fact, there is mounting evidence that in-flight failures of films probably occur in areas that are stressed in more than one direction. Since the physical properties of films are different under biaxial loading than they are under uniaxial loading, it is reasonable to believe that a correlation exists between the biaxial properties of films and balloon performance. Thus, the objectives of the biaxial testing program are:

To determine the significance of the biaxial properties of films in balloon performance.

If a significant correlation is found, to determine correlations between biaxial properties and uniaxial or other properties which are feasible to measure in the production of film in large quantities.

Cold-Toughness Tester

The cold-toughness tester (Fig. 3) is designed to measure the amount of energy absorbed at a given temperature, and to indicate the mode of failure. The test is carried out in a 12-in.-diam reinforced-plastic pipe, which is cooled to approximately -80°C with carbon dioxide. A steel ball is dropped vertically from an electromagnet through a 5-in.-diam diaphragm of balloon film onto an impact bar of 17-7 PH hard steel, equipped with strain gauges. The apparatus is calibrated by dropping the steel ball directly onto the impact bar from known heights. The deflection of the bar is translated into an electric signal by the strain gauges. This signal is amplified, and the peak voltage output, as registered on an oscillograph, gives a measure of the impact energy.

The film, which is inserted at room temperature, contracts as the temperature in the cabinet decreases. After this contraction has taken place, the film is clamped in place. The energy required for the ball to penetrate the film is a measure of the toughness of the film at the temperature of the test. Visual inspection of the film indicates whether the mechanism of failure is ductile or brittle.

Since balloons must deploy at temperatures near -80°C, this is an appropriate temperature at which to measure the toughness of balloon films. However, the dropping-weight tester can also be used at temperatures below -80°C by injecting liquid nitrogen, and at temperatures up to room temperature by adapting a temperature controller to the carbon dioxide supply.

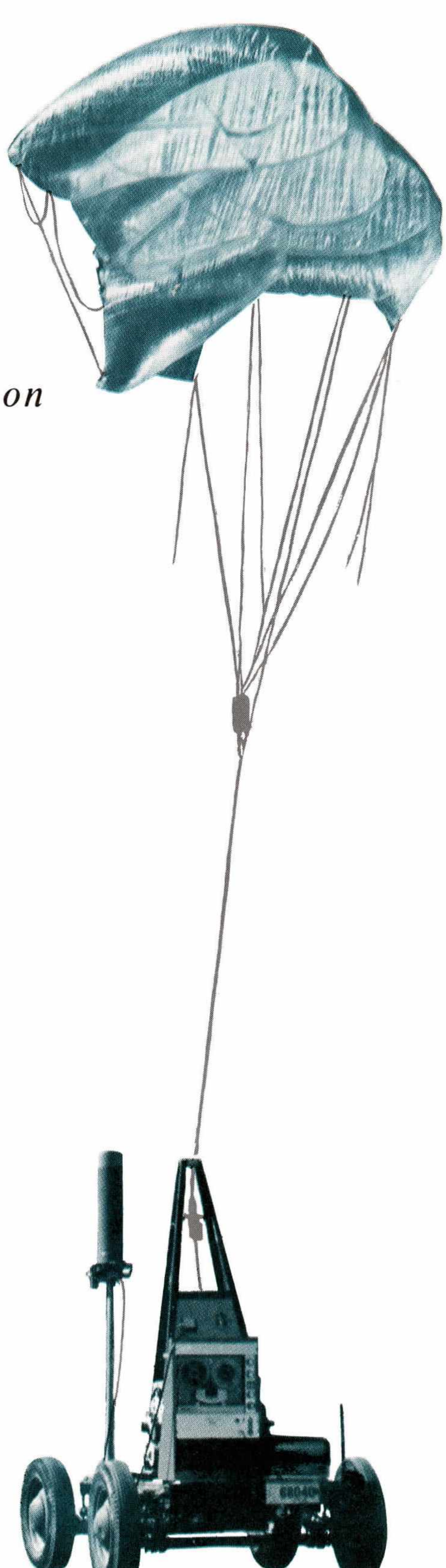
The cold-toughness test is valuable because it measures quantitatively the simultaneous effects of high strain rate (shock) and cold temperatures on balloon films. It is expected that performance under these conditions will be a significant measure of balloon film quality.

* * *

The goal of this program is to improve the quality of balloon films and thereby to increase the reliability of flight vehicles. The development of more meaningful tests will make it possible to establish more effective specifications for film manufacturers, which will result in improved balloon flight performance. ●

Boundary Layer Profile System

new observing system uses tethered balloon



A new tethered-balloon system for making meteorological measurements of the vertical profile of the atmospheric boundary layer up to 5000 ft above the ground has been developed by E. Bollay Associates, Inc., Boulder, Colo., under a subcontract with UCAR to work with NCAR. This system, which consists of a Mylar balloon wing, a 2-lb telemetry package, an electrically operated winch, and a ground receiver with magnetic tape recorder, is designed to overcome the tendency of tethered balloons to lose altitude in the face of strong winds. This is accomplished by use of an airfoil-shaped balloon, known as the Meteorological Atmospheric Testing (MAT) Wing, which uses aerodynamic lift generated by the flow of air over the surface to counteract the downward vector produced by wind, drag, and restraining tether.

The system is available for cooperative research use by meteorologists at other institutions. A brief descriptive report (NCAR Technical Note TN-16) and an extensive engineering report (NCAR Technical Note TN-17) are available on request. Inquiries should be directed to:

Field Observing Facility
National Center for
Atmospheric Research
Boulder, Colo. 80302

Aviation Work-Study Program

students learn how aircraft are used as atmospheric research tools

During the past summer, the NCAR Research Aviation Facility conducted a nine-week work-study program on aircraft research observation and instrumentation for students interested in airborne research in the atmospheric sciences.

This program was designed to acquaint the students with the capabilities and limitations of aircraft as tools for atmospheric research. It provided laboratory and field experience, as well as basic instruction, in aeronautics, airmanship, pertinent aeronautical engineering, instrumentation, and data processing. The students also had the opportunity to carry out original work in designing experiments and planning and directing actual research flight operations.

Some specific topics covered by the program were: theory of flight, aircraft types, components, and systems; aircraft safety; survival; air and radio discipline; flight planning; clearances; weather; FAA, FCC, and DOD regulations and policies; typical NCAR Research Aviation Facility projects and operations; and other meteorological research aircraft.

Other topics were: airframe structure and modification; instrument theory, design, accuracy, installation, and techniques; telemetry; data recording, reduction, and analysis; subsonic and supersonic aerodynamics; aircraft performance, stability, and control; design of experiments; and execution of actual flight operations.

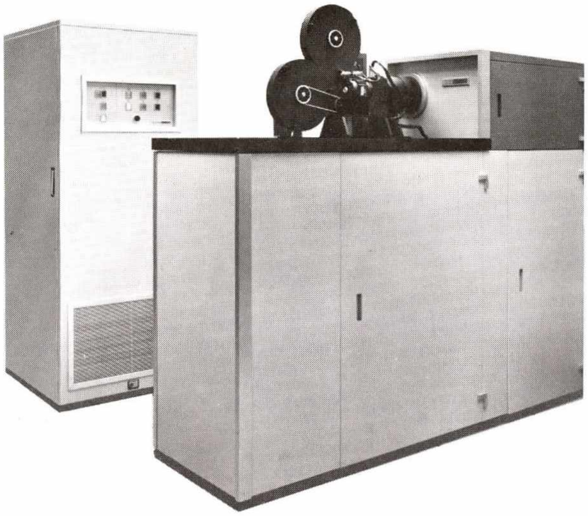
Eight graduate students participated in the program. They were:

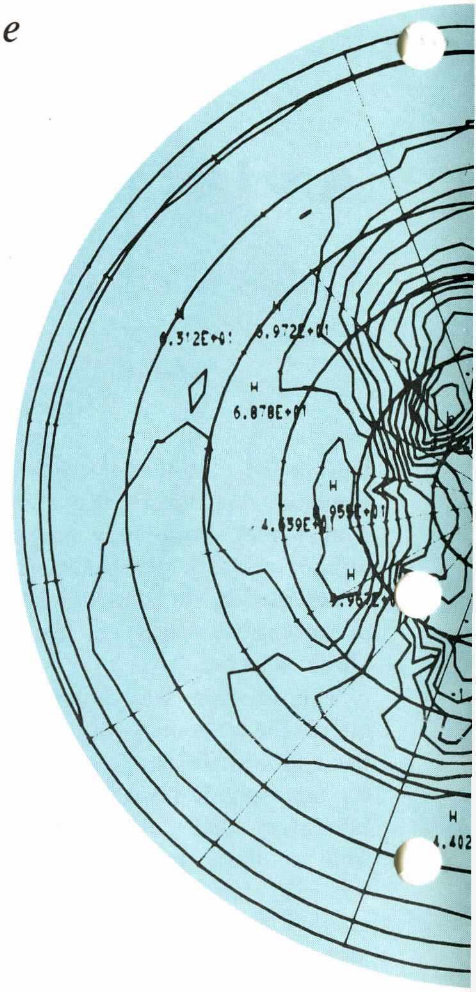
Richard P. Augulis (Saint Louis University), James R. Connell (Colorado State University), William R. Cotton (State University of New York, Albany), Claude E. Duchon (University of Texas), James W. Fitzgerald (University of Chicago), Marshall C. Hudson (University of Minnesota), Noel B. Plutchak (Lamont Geological Observatory, Columbia University), and John L. Vogel (Saint Louis University).

Each student was paid a modest salary and was reimbursed for his travel expenses. The students were not required to have any previous background in aviation.

The program was approved by the Graduate School of Saint Louis University for its 1966 summer session. It was coordinated by Gene D. Prantner under the direction of J. W. Hinkelman, Jr., Manager of the NCAR Research Aviation Facility, with the cooperation and assistance of F. C. Bates, Associate Professor of Geophysics and Geophysical Engineering, Saint Louis University. ●

Data Display *high-speed device displays and records output from computer*



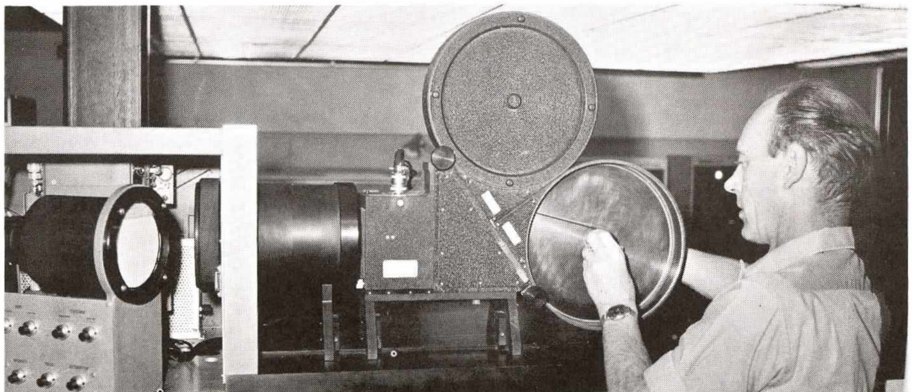


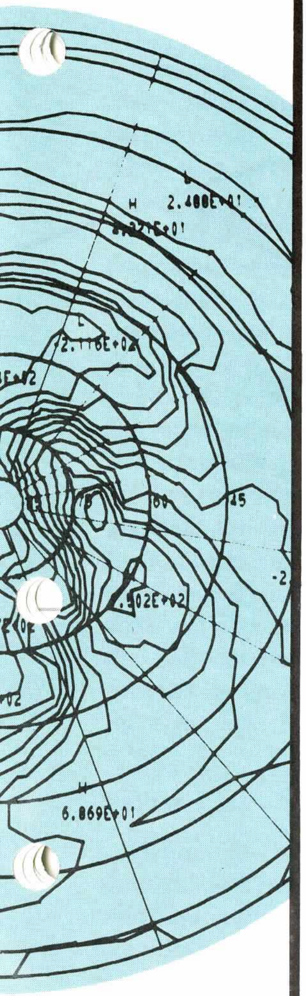
The Computing Facility of the NCAR Facilities Laboratory acquired a dd80 high-speed output recorder in 1965 for use with its Control Data 3600 computer. The 3600 was replaced early in 1966 with a Control Data 6600, and the dd80 has proved to be even more useful with the larger, faster 6600 than it was with the 3600.

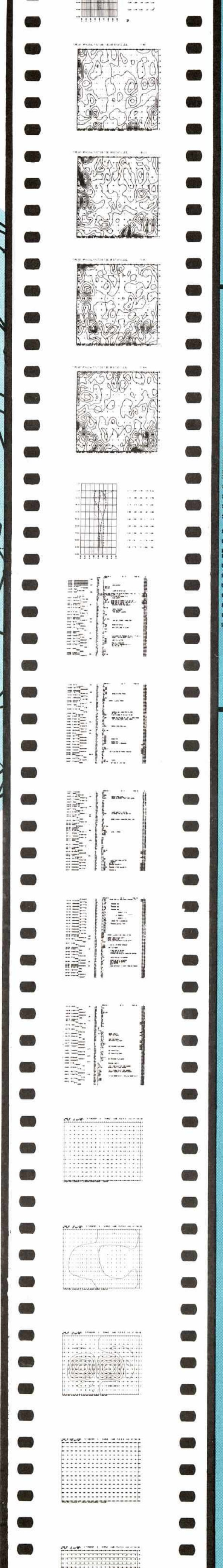
The dd80 is used primarily to record graphic output such as weather maps based on mathematical models of the general circulation. The dd80 can plot and record such material at speeds far higher than the maximum speed of any mechanical plotter.

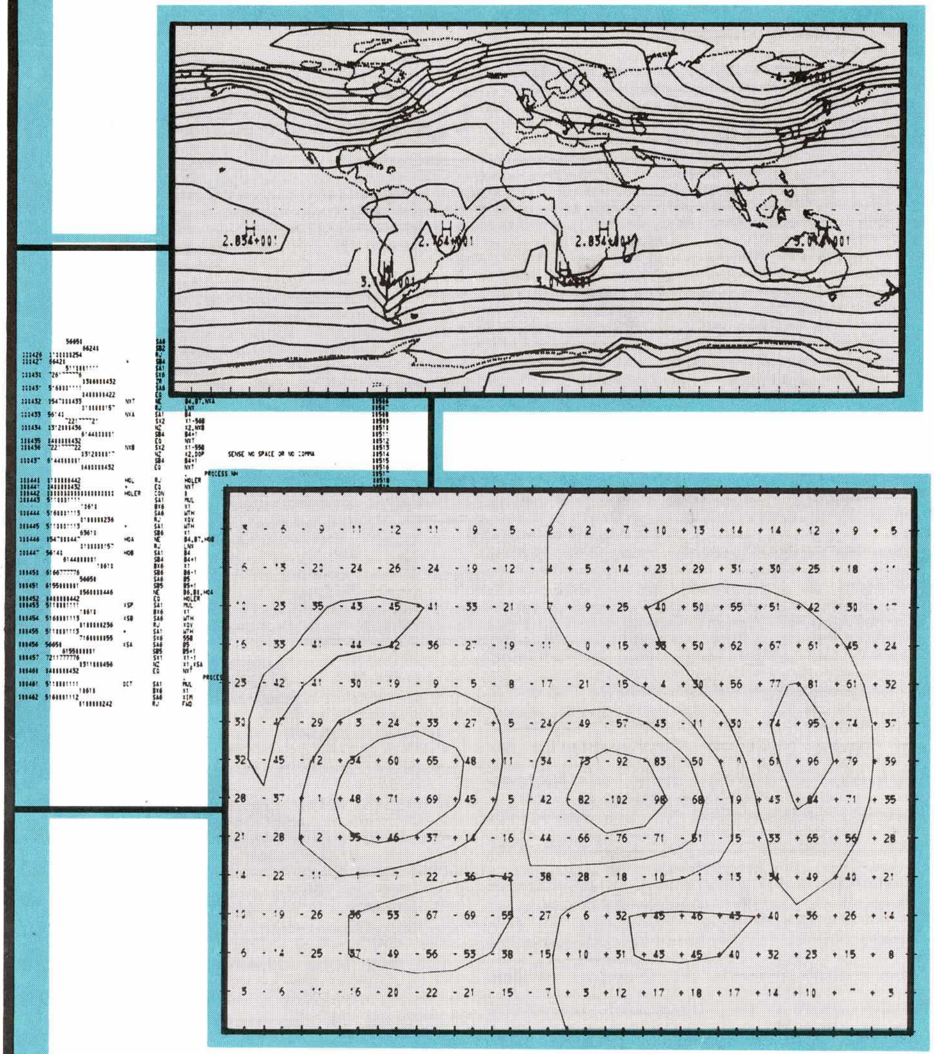
The dd80 displays the computer output on the face of a cathode-ray tube. This image is photographed on standard 35-mm microfilm by a camera which is controlled by the computer. As each frame of microfilm is exposed, an image is built up as a series of points and lines on the screen of the cathode-ray tube. When the image is complete, the film is advanced automatically to the next frame.

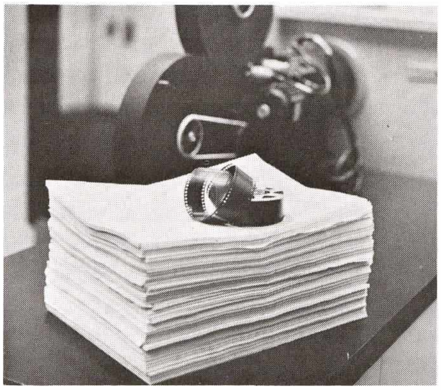
The dd80 can also record tabular output. Tabular material can be recorded on microfilm by the dd80 in one-sixth of the time needed to print it out on a high-speed printer. Using the dd80 instead of a printer for tabulations can mean a considerable saving in the bulk of the end product as well as in machine time. One small roll of microfilm will hold the equivalent of a thick stack of printed output.



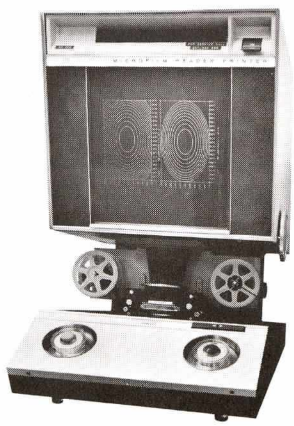








The microfilm may be scanned on the Filmac 400 reader-printer, which projects an 8½-by-11-in. image on its screen. If hard copy is needed, the reader-printer will produce a paper print from any frame in a few seconds. ●



Scientific Ballooning

NCAR flight facilities and services at Palestine

The NCAR Scientific Balloon Flight Station at Palestine, Tex., has been fully operational since August 1963. Since the beginning, the ballooning crew has been provided under contract, first by Raven Industries, Inc., of Sioux Falls, S. D., and now by Winzen Research, Inc., of Minneapolis, Minn. The NCAR Panel on the Scientific Use of Balloons has recommended that NCAR personnel should provide continuing competence in all aspects of ballooning at the Flight Station. As a result of this recommendation, since the beginning of the Winzen contract NCAR personnel have been placed in key positions in the operating crew at the Flight Station.

Facilities at the site include office space, machine shop (limited), photo lab, 3-ft by 3-ft temperature- and pressure-controlled environmental chamber, electronic test equipment, launch equipment, launch area, two tracking aircraft, and standard telemetry and command systems. Weather forecasting, launch, tracking, and recovery services are also provided.

These facilities and services are generally available to scientists from federal agencies, universities, and non-profit research organizations whose projects require balloon flights. The facilities are also available for company-sponsored test programs designed to improve scientific ballooning, provided the results of such tests will be made available to NCAR and the balloon community.

Types of Support

Service to individual investigators who wish to take advantage of NCAR's complete services. NCAR provides launch, tracking, and recovery services from its fixed launch site. It also provides work space at the launch site, standard command and telemetry equipment, and balloon and helium purchasing service. The costs for facilities and services are borne by NCAR excepting for certain costs which are directly assignable to the investigator. These assignable costs are usually limited to the balloon and helium, but long-distance phone calls and special services requested by an investigator may also be charged to his project.

Service to balloon operations groups of recognized competence, flying experiments for qualified investigators. These groups normally provide the launch, tracking, and recovery services required for their flights, but limited tracking service can be provided by NCAR on request. Facilities are provided by NCAR and costs are allocated to these groups on virtually the same basis as to individual investigators.

Services to private companies operating for profit when a company wishes to carry out a test program designed to improve scientific ballooning. The company must satisfy NCAR that the test is likely to result in improved scientific ballooning and must make the results available to the scientific ballooning community as soon as possible after the test. Company projects which qualify are supported on the same basis as non-profit research flights.

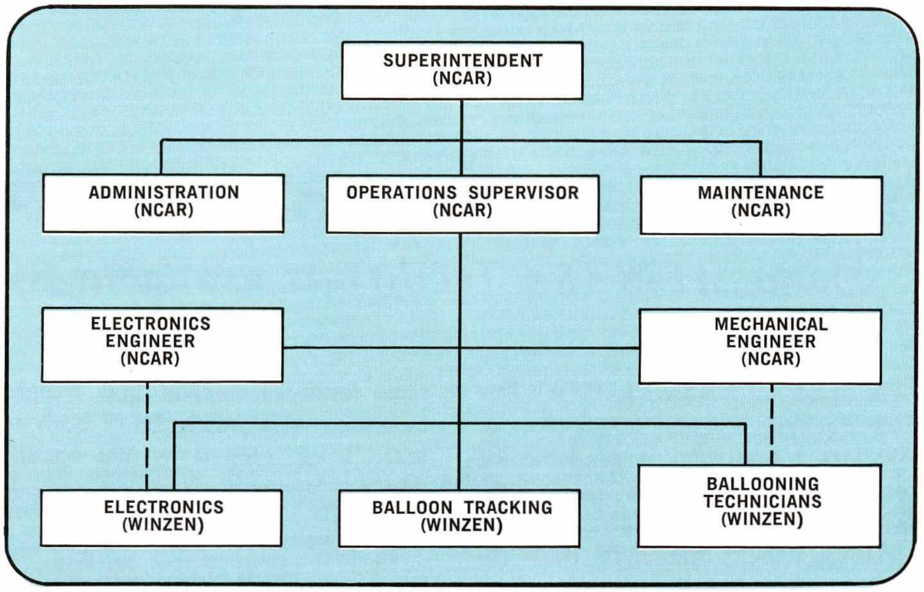
Consulting Services

NCAR personnel at Palestine are available to discuss ballooning requirements with scientists. They review each request for ballooning service with the prospective user. They then advise how and when the flight can best be accomplished, what type and size balloon should be used, what auxiliary equipment (i.e., telemetry, stable platforms, etc.) will be necessary, and what the approximate cost will be to the user.

NCAR personnel will help select the appropriate balloon vehicle for the scientist's program by reviewing his proposed flight profile and requesting bids and specifications from balloon manufacturers. After reviewing the bids and specifications, the NCAR staff will recommend to the scientist the balloon which they believe will provide the most reliable vehicle for the flight.

Helium

Helium is available at the site through an independent contractor who invoices the scientist's parent organization directly.



Flight Priorities

As a general rule, field programs involving the largest number of personnel and having the most stringent operational and scientific requirements are given scheduling priority. Actual flight priority at the Station is determined by the Superintendent on the basis of readiness and suitable weather for a given flight.

For further information, call or write:

Superintendent
NCAR Scientific Balloon
Flight Station
P.O. Box 1175
Palestine, Tex. 75801
Phone: 214-729-6921

Computing Work-Study Program

summer program in scientific computing for graduate students

During the past summer, the NCAR Computing Facility conducted an eleven-week work-study program in scientific computing for students planning careers in meteorology or related fields. This program was designed to provide experience in programming a large-scale computer to solve problems in the atmospheric sciences.

The students were not given a "how-to" recipe. Instead, the computer was used as a "responsive environment" in learning a computer language. Each student was encouraged to try ways of programming which suited him, and to learn at his own pace. After each student completed a period of orientation, which was tailored to his individual experience and interests, he either was assigned programming for an NCAR scientist or was allowed to carry out a project of his own.

The NCAR Computing Facility installation includes a Control Data 6600 computer, two high-speed printers, a disk file, and a dd80 high-speed output recorder, which displays the output on a cathode-ray tube and records it on microfilm.

Eight graduate students participated in the program. They were Ernest Agee (University of Missouri), Fred Alyea (Colorado State University), William Barchet (Drexel Institute of Technology), Yeong-Jer Lin (New York University), Roy McCrory (New Mexico Institute of Mining and Technology), Daniel Rousseau (Massachusetts Institute of Technology), and William Slusser (San Fernando Valley State College). Each student received a modest stipend and was reimbursed for travel expenses. No prior experience in programming was required.

The program was directed by Mrs. Jeanne C. Adams under the supervision of Glenn E. Lewis, Head of the NCAR Computing Facility.

Radar Meteorology

joint AF-NASA facility is available for atmospheric research

The Joint AF-NASA (JAFNA) Radar Facility, a major installation at Wallops Island, Va., is available for experimental studies in the atmospheric and related sciences. The JAFNA Facility maintains three radars:

wavelength (cm)	*beamwidth (degrees)*
3.2 (X-band)	0.2
10.7 (S-band)	0.5
71.5 (UHF)	2.9

The Facility also possesses a variety of data-recording systems, including Polaroid and 35-mm cameras, simultaneous A-scope photography of all three radar videos, and a 14-channel FM tape recorder. The combination of ultra-sensitivity, ultra-high resolution, multi-wavelength, and doppler capability at wavelengths of both 10 and 71 cm offered by the Facility provide valuable tools for atmospheric research.

In 1965 the JAFNA Facility was taken over by the Air Force Cambridge Research Laboratories for a period of three years to carry out an extensive study of clear air turbulence. Although this program takes precedence, time is available at the site for programs of limited duration or those which will not interfere with this program. AFCRL does not expect to charge for use of the Facility for programs of restricted scope, but if use by "outside" organizations is extensive, it may be necessary to charge for film, magnetic tape, etc.

The JAFNA Facility will be available for atmospheric research until June 30, 1968. Its status after that date has not yet been decided. It is hoped that full advantage will be taken of the Facility's potential for atmospheric research, as its future disposition may depend on demonstration of its wide applicability.

For further information, contact:

Dr. Kenneth Hardy
Weather Radar Field Station
Air Force Cambridge Research Laboratories
Sudbury, Mass. 01776

New NCAR Publications

These reports are available on request to:

NCAR Scientific Balloon Facility
National Center for Atmospheric Research
P.O. Box 1470
Boulder, Colo. 80302

NCAR-TN-12 Quality Analysis of Visqueen Balloon Film

NCAR-TN-14 Material Strength Properties of Winzen Strato Film

NCAR-TN-15 Strength Characteristics of Grace Cryovac YH Polypropylene Film

NCAR-TN-19 Low Modulus Strain Gages for Stress Analysis of Balloon Structures

NCAR-TN-20 Ballooning Support for Cosmic-Ray Experiments. (A report covering the ballooning support provided for the joint United States-India International Quiet Sun Year expedition).

NCAR-TN-21 Balloon Stress-Band Analysis

Scheduled Flight Support

NCAR Research Aviation Facility

Flight support scheduled by the NCAR Research Aviation Facility for June through August 1966 is listed below. An asterisk indicates continuing programs in which the experiment remains essentially unchanged.

***Flight Test of Equipment for the Measurement of Liquid Water Content, Humidity, Pressure and Radar Altitudes, and Aircraft Flow Characteristics;** E. Brown (NCAR). Boulder, Colo., and southwest U.S.; as required.

Project Hailswath; E. Bollay Associates, Inc. (Boulder, Colo.) and G. Langer (NCAR). Field observations of ZnS tracer and AgI seeding nuclei will be carried out during hail modification experiments. Rapid City, S. Dak.; approximately 20 flights; Jun.-Jul.

Thunderstorm Dynamics Study; C. Newton (NCAR) and F. Bates (Saint Louis University). Cine-cameras and K band radar will be used to study the dynamics of thunderstorms and associated peripheral clouds. Central Plains of the U.S.; eight flights, initial flights below 10,000 ft, later flights up to 30,000 ft; Jun.-Aug.

Observational Study of Texas Gulf Coast Sea Breeze; A. Eddy (University of Texas). Temperature, humidity, pressure, and wind will be recorded. Galveston-Port Arthur area, Tex.; 15 flights, ground level to 20,000 ft; Jun.

***Measurements of Atmospheric Water Vapor, Methane, Hydrogen, and Particulate Matter;** A. Bainbridge, I. Blifford, D. Ehhalt, J. Shedlovsky (NCAR). Background data will include dry and wet bulb temperature, altitude, air speed. Scottsbluff, Nebr.; three flights per month, ground level to 30,000 ft; Jun.-Aug.

***Cloud Physics Studies Using a Dropsonde System;** R. Bushnell (NCAR). Temperature, humidity, pressure, altitude, and air speed will be recorded. Dropsondes will be ejected from the aircraft into the tops of thunderstorms. Northeast Colo.; Jun.-Aug.

***Tracking AgI Plumes and Natural Freezing Nuclei; Detection of Ice Crystals in Mixed Clouds;** J. Rosinski and G. Langer (NCAR). Altitude and temperature will be recorded. Boulder, Colo., and Bemidji, Minn.; Jun.-Aug.

***Air Sample Collection for Analysis of Total Nuclei and Cloud Nuclei;** P. Squires (NCAR). Background data will include altitude and temperature. Boulder, Colo.; Jun.-Aug.

***Radio Emissions from Cumulus Clouds;** S. Rossby (University of Wisconsin). Two frequencies (VLF, UHF) of radio emission from cumulus clouds will be observed simultaneously with air temperature, humidity, cloud water content, electric field, cloud top altitudes, and aircraft position. Bahamas; 10 to 20 flights, 5,000 to 20,000 ft; Jun.

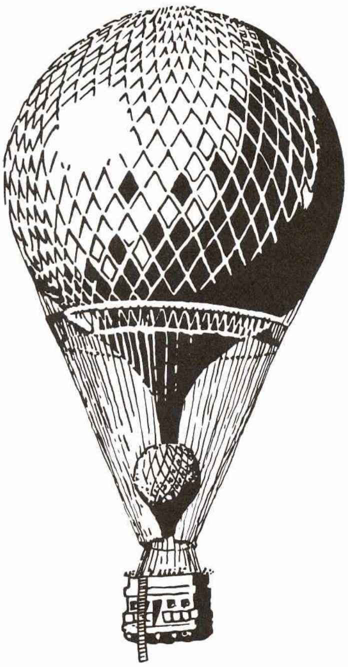
Thunderstorm Electrification Study; W. Evans (University of Arizona). Instrument package will be ejected from the aircraft into active thunderstorms to collect data on the electric field and conductivity within the clouds. Tucson, Ariz.; 50 flights, 25,000 ft to aircraft ceiling; Jul.-Aug.

Infrared Radiometry for Surface Temperature Mapping of Lake Superior and for Ascertaining Whether Moisture Structure can be Determined by IR Techniques; R. Ragotzkie (University of Wisconsin). Lake Superior and Bahamas; seven flights at 1,000 ft for surface temperature mapping and six flights at 500 to 10,000 ft for moisture structure; Jun.-Aug.

Cloud Electrification Study; C. Moore (New Mexico Institute of Mining and Technology). Temperature, altitude, position, heading, air speed, potential gradient, and conductivity will be recorded. Socorro, N. Mex.; 18 flights, above 20,000 ft (above the clouds); Jul.-Aug.

Investigation of Use of Radon and Radon-Daughter Ions as Tracers in the Convective and Electrical Environments of the Atmosphere; M. Wilkening (New Mexico Institute of Mining and Technology). Radon and radon-daughter ions will be collected and potential gradient, conductivity, and temperature will be recorded. Socorro, N. Mex.; 12 flights, from 5,000 ft to aircraft ceiling; Jul.-Aug.

Investigation of Feasibility of Determining Vertical Ozone Distribution and Total Ozone Content from the Atmospheric Albedo in the UltraViolet; R. Bettinger (University of Maryland). Spectral measurements of the earth's surface albedo will be obtained. Palestine, Tex.; one flight (coordinated with a high-altitude balloon flight), about 30,000 ft; Aug.



Scheduled

Month (1966)	Location	Sponsor	Investigator
Jul	Palestine	NASA	G. Clark (MIT)
"	"	"	E. Chupp (UNH)
"	"	"	K. Frost (GSFC)
"	"	"	G. Frye (Case Inst.)
"	"	"	W. McDonald (CalTech)
"	"	"	J. Overbeck (MIT)
"	"	"	W. Webber (U. Minn.)
"	"	"	"
"	"	NSF	K. Pinkau, R. Huggett (LSU)
"	"	ONR	J. Lord (U. Wash.)
"	"	"	J. Waddington (U. Minn.)
Aug	"	ESSA	R. Bettinger (U. Md.)
"	Holloman AFB	GSFC	E. Boldt (GSFC)
"	"	"	D. Kniffen (GSFC)
"	Palestine	NASA	L. Alvarez, L. Smith (U. Calif.)
"	"	"	A. Barrett (MIT)
"	"	"	C. Hemenway (Dudley Obs.)
"	"	"	W. Krashaar (U. Wis.)
"	"	"	L. Peterson (UCSD)
"	"	"	R. Sullivan (MIT)
"	"	ONR	J. Lord (U. Wash.)
Sept	Canal Zone	AEC	G. Frye (Case Inst.)
Oct	"	"	"
"	Mildura	NASA	E. Boldt (GSFC)
"	"	"	D. Kniffen (GSFC)
Jun-Jul	Ft. Churchill	NASA	P. Meyer (U. Chicago)
"	"	"	"
"	"	"	W. Webber (U. Minn.)
"	"	"	"
Jun-Aug	"	"	T. Foelsche (LRC)
"	"	"	"
"	"	"	R. Vogt (CalTech)
"	"	"	"
Jul	"	GSFC	C. Fichtel (GSFC)
"	"	NASA	M. Kaplon (U. Rochester)
"	"	ONR	E. Ney (U. Minn.)
"	"	"	R. Olson (U. Minn.)
Jul-Aug	"	NASA	U. Earl (U. Md.)
"	"	"	"
"	"	"	D. Guss (GSFC)
"	"	"	W. McDonald (JPL)
Aug-Oct	"	NSF	K. Anderson (U. Calif.)
"	"	"	"
"	Flin Flon	"	"
"	"	"	"

States and countries of locations given in the *Flight Record* and *Scheduled Flights* are as follows:

Canal Zone, Panama
Chico, California
Flin Flon, Manitoba, Canada
Ft. Churchill, Manitoba, Canada
Holloman Air Force Base, New Mexico
Litchfield Naval Air Facility, Arizona
Medicine Hat, Alberta, Canada
Mildura, Australia
Palestine, Texas
Paradise, California
Sioux Falls, South Dakota

Balloon Flights

Polyethylene balloon specifications (volume in cu ft)	Float altitude (ft)	Flight duration (hr)	Payload (lb)	Experiment
9 million, 0.75 mil	132,000	14	300	Gamma rays
3 million, 0.55 mil	135,000	15	75	Neutron detector
10.6 million, 0.75 mil	130,000	12	350	Gamma rays
10.6 million, 0.7 mil	135,000	14	250	Spark chamber (2 flights)
5 million, 0.75 mil	128,000	12	300	"
5 million, 0.75 mil	130,000	14	250	X rays
2.94 million, 0.7 mil	130,000	8	80	X-ray telescope, source point study
1.6 million, 0.5 mil	110,000	10	150	Scintillation counters, heavy nuclei
3 million, 0.75 mil	108,000	12	900	Spark chamber (2 flights)
600,000, 0.75 mil	110,000	12	75	Emulsions
6 million, 0.5 mil	130,000	14	100	"
5 million, 0.75 mil	120,000	12	500	Ozone measurements (2 flights)
10.6 million, 0.5 mil capped	140,000	8	320	Specific x-ray sources (3 flights)
10.6 million, 0.5 mil capped	130,000	8	275	Gamma-ray point source (3 flights)
2.94 million, 1 mil	100,000	13	800	Spark chamber
5 million, 0.75 mil	125,000	10	400	Oxygen spectrum (2 flights)
1.25 million, 1 mil	110,000	20	200	Micrometeorite collection (2 flights)
3.5 million, 0.75 mil	118,000	12	500	Gamma rays (3 flights)
3 million, 0.55 mil	128,000	14	200	"
5 million, 0.75 mil	133,000	12	130	Proportional counter
360,000, 0.75 mil	105,000	12	50	Emulsions
2.94 million, 0.7 mil	121,000	15	450	Cosmic-ray studies (2 flights)
10.6 million, 0.5 mil capped	144,000	15	450	"
10.6 million, 0.7 mil	140,000	8	320	X-ray detector (3 flights)
10.6 million	140,000	8	270	Spark chamber, point source search (2 flights)

Skyhook Series

Polyethylene balloon specifications (volume in cu ft)	Float altitude (ft)	Flight duration (hr)	Payload (lb)	Experiment
10.6 million, 0.7 mil capped	132,000	18	685	Electron-positron ratio (3 flights)
4 million, 0.7 mil	130,000	15	320	Primary electron flux (3 flights)
10.6 million, 0.5 mil capped	149,000	12-24	70	Charge and energy spectrum of primaries
"	149,000	12-24	130	"
2.94 million	125,000	12-24	261	Radiation component at high altitudes
425,000, 1.5 mil	70,000	12-24	261	"
10.6 million, 0.5 mil capped	145,000	12-24	110	Nuclear and electron spectra (4 flights)
10.6 million, 0.6 mil capped	145,000	18	220	"
10.6 million, 0.5 mil capped	146,000	12-24	180	Galactic cosmic ray electrons
10.6 million, 0.5 mil capped	145,000	12	230	Energy spectrum up to 25 Mev (2 flights)
250,000, 0.5 mil capped	109,000	minimum	75	Vertical distribution of dust and ozone (2 flights)
3,000, 0.75 mil	65,000	2-4	5	Current density of atmosphere (6 flights)
5.25 million, 0.8 mil	125,000	12-24	120	Cosmic ray electrons (2 flights)
1 million, 0.5 mil	120,000	12-24	120	"
10.6 million, 0.5 mil capped	130,000	10	——	Cosmic ray measurements (3 flights)
5.25 million, 0.7 mil	132,000	10-20	300	" (2 flights)
100,000, 0.5 mil	112,000	20	20	Auroral zone x-ray energy spectrum (10 flights)
250,000, 0.5 mil	120,000	20	20	" (5 flights)
2.9 million, 0.5 mil	140,000	36	42	" (12 flights)
250,000, 0.5 mil	112,000	20	20	" (5 flights)

Balloon Flight Record

	Date (1965-66)	Location	Sponsor	Investigator	Flight operation conducted by	Balloon specs (polyethylene unless specified; volume in cu ft)
(1965)	Oct 20	Holloman AFB	AFCRL	B. Glidenberg (AFCRL)	AFCRL	360,000, 2 mil Startex
	" 26	"	NASA	G. Steffan (Hughes Aircraft)	"	125,000, 2 mil
	" 27	Chico	AFCRL	N. Sissenwine (AFCRL)	"	511,270, 1.5 mil
	" 30	"	"	"	"	511,270, 2 mil
	Nov 3	"	"	H. Prevett (AFCRL)	"	2.94 million, 1.5 mil StratoFilm
	" 7	Palestine	NCAR	NCAR Balloon Facility	NCAR	5.4 million, 1 mil
	" 10	Chico	AFCRL	H. Prevett (AFCRL)	AFCRL	2.94 million, 1.5 mil StratoFilm
	" 12	Holloman AFB	NASA	G. Steffan (Hughes Aircraft)	"	125,000, 2 mil
	" 16	"	AFSC, OAR	Maj. Mock (AFSC)	"	804,000, 2 mil
	" 17	Palestine	NASA	C. Hemenway (Dudley Obs.)	NCAR	1.25 million, 1 mil StratoFilm
	" 19	"	"	"	"	1.25 million, 1 mil StratoFilm
	" 22	Holloman AFB	"	G. Steffan (Hughes Aircraft)	AFCRL	125,000, 2 mil
	" 30	"	AFSC, OAR	Maj. Mock (AFSC)	"	804,000, 2 mil
	" 30	Palestine	NCAR	NCAR Balloon Facility	NCAR	1.6 million, 1.5 mil
	Dec 1	"	"	"	"	100,000, 1.2 mil
	" 3	Litchfield NAF	NSF, NASA	T. Gehrels (U. Ariz.)	"	4 million, 1 mil StratoFilm
	" 6	Holloman AFB	NASA	E. Boldt (GSFC)	AFCRL	10.6 million, 0.7 mil StratoFilm
	" 7	"	AFSC, OAR	Maj. Mock (AFSC)	"	804,000, 2 mil
	" 7	Paradise	AFCRL	N. Sissenwine (AFCRL)	"	511,270, 1.5 mil
	" 12	Palestine	BRL	J. Conley (BRL, APG)	NCAR	360,000, 0.75 mil
	" 13	"	NASA	J. Arnold (UCSD)	"	360,000, 1.5 mil
	" 14	Holloman AFB	"	G. Steffan (Hughes Aircraft)	AFCRL	125,000, 2 mil
(1966)	Jan 6	Palestine	BRL	J. Conley (BRL, APG)	NCAR	360,000, 0.75 mil
	" 7	"	ONR	W. Webber (U. Minn.)	"	2.94 million, 0.7 mil StratoFilm
	" 10	"	BRL	J. Conley (BRL, APG)	"	2.94 million, 0.7 mil StratoFilm
	" 11	Holloman AFB	NASA	G. Steffan (Hughes Aircraft)	AFCRL	125,000, 2 mil
	" 11	"	"	E. Boldt (GSFC)	"	9 million, 0.75 mil X-124
	" 12	"	"	"	"	10.6 million, 0.7 mil StratoFilm
	" 13	Holloman AFB	NASA	G. Steffan (Hughes Aircraft)	AFCRL	125,000, 2 mil
	" 17	"	"	"	"	125,000, 2 mil
	" 17	Medicine Hat	Dugway	——	Raven	Mark II blimp
	" 23	Litchfield NAF	NSF	T. Gehrels (U. Ariz.)	NCAR	6.5 million, GT-99
	" 25	Chico	AFCRL	N. Sissenwine (AFCRL)	AFCRL	2.94 million, 1.5 mil
	" 26	Holloman AFB	NASA	G. Steffan (Hughes Aircraft)	"	125,000, 2 mil
	" 26	Litchfield NAF	ONR	B. Stiller (NRL)	NCAR	360,000, 0.75 mil X-124
	" 27	"	NASA	A. Barrett (MIT)	"	5 million, 0.75 mil X-124
	" 27	Chico	AFCRL	N. Sissenwine (AFCRL)	AFCRL	802,000, 2 mil
	Feb 1	Holloman AFB	NASA	G. Steffan (Hughes Aircraft)	"	125,000, 2 mil
	" 2	Sioux Falls	Space, Inc.	N. Piantanida	Raven	5 million, 0.75 mil
	" 2	Litchfield NAF	NASA	A. Barrett (MIT)	NCAR	5 million, 0.75 mil X-124
	" 3	"	"	"	"	5 million, 0.75 mil X-124
	" 4	Holloman AFB	AFCRL	A. Howell (Tufts U.)	AFCRL	5.025 million, 1 mil StratoFilm
	" 6	Litchfield NAF	NSF	R. Huggett (LSU)	NCAR	3 million, 0.75 mil X-124
	" 10	Holloman AFB	AFCRL	Capt. Ferguson (AFCRL)	AFCRL	27,000, 2 x 1.5 mil
	" 11	"	NASA	G. Steffan (Hughes Aircraft)	"	125,000, 2 mil
	" 12	Litchfield NAF	"	L. Peterson (U. Calif.)	NCAR	360,000, 1.5 mil X-124
	" 16	"	NSF	T. Gehrels (U. Ariz.)	"	9 million, 0.75 mil X-124
	" 17	"	NASA	L. Peterson (U. Calif.)	"	3 million, 0.55 mil X-124

Float altitude (ft)	Flight duration (hr)	Payload (lb)	Experiment	Remarks (* = Successful flight)
70,000	7	940	Balloon system test	*
1,500	2.5	707	Tethered Surveyor flight	*
87,000	6.5	443	Stratospheric humidity	*2000 ft reel-down
75,000	59.3	1,000	"	*Horizontal flight
104,000	30	1,000	Encoder test	*
43,000	—	—	Familiarization flight	*
105,900	5	1,000	Encoder test	*
1,500	3	702	Tethered Surveyor flight	*
82,000	3	825	UHF radio relay test	*
110,900	5.8	242	Micrometeorite collection	*
112,300	5.5	217	"	*
1,430	4	602	Tethered Surveyor flight	*
83,700	4.8	1,137	UHF radio relay test	*
—	—	—	Launch familiarization	Balloon secured by long tether
—	—	—	"	"
111,000	10.4	726	Mariner—lunar UV radiation	*
127,500	11.8	595	Cosmic-ray and x-ray sampling	*
—	1.5	825	UHF radio relay test	Balloon burst near tropopause
57,000	1.4	434	Stratospheric humidity	Leaker; command cut down
—	—	195	Ion density measurements	*
—	—	425	Micrometeorite collection	Reel did not deploy
1,430	1.2	702	Tethered Surveyor flight	*
—	—	220	Ion density measurements	*
127,300	1	263	X-ray spectra measurements	Telemetry link failed; flight terminated early
129,000	—	299	Ion density measurements	*
—	—	—	Tethered Surveyor flight	Flight cancelled due to high winds at altitude
—	1	641	Cosmic-ray and x-ray sampling	Balloon burst at 73,000 ft
133,000	10.3	593	"	*
1,200	1.9	704	Tethered Surveyor flight	*
1,420	2.2	704	"	*
1,300	—	100	Particle diffusion	*
—	—	1,848	UV photopolarimetry of moon	Squibs fired during inflation
109,000	9	430	Stratospheric humidity	*2000 ft reel-down
1,250	3.5	726	Tethered Surveyor flight	*
102,300	7	160	Gemini 8 emulsion-stack test	*
125,000	5.4	632	Oxygen spectrum	*
84,841	12.4	1,100	Stratospheric humidity	*
1,460	2	726	Tethered Surveyor flight	*
123,500	0.25	840	High altitude parachute jump	*Experiment failed; air hose coupling failed
—	—	607	Oxygen spectrum	Flight electronics failure forced ascent cut down
127,000	5.5	605	"	*
106,500	11.5	1,610	IR mapping of moon	*
107,000	10	1,078	High energy nuclear particles	*
1,000	1.5	277	Tethered payload stability test	*
1,450	2.3	745	Tethered Surveyor flight	*
78,000	10	627	Lunar x-ray	*
—	—	1,848	UV photopolarimetry of moon	Balloon burst at 48,000 ft
[illegible],500	12.5	253	Crab Nebula x-ray study	*

Balloon Flight Record (Cont'd.)

Date (1966)		Location	Sponsor	Investigator	Flight operation conducted by	Balloon specs (polyethylene unless specified; volume in cu ft)
Feb	17	Holloman AFB	AFCRL	G. Steffan (Hughes Aircraft)	AFCRL	125,000, 2 mil Visqueen
"	17	"	"	Capt. Ferguson (AFCRL)	"	80,000, 0.803 Dacron x 1 mil Tedlar
"	18	Litchfield NAF	NASA	L. Peterson (U. Calif.)	NCAR	3 million, 0.55 mil X-124
"	23	Sioux Falls	Raven	Raven Ind.	Raven	135,000, 0.75 mil
"	23	Holloman AFB	AFCRL	J. Strong (Johns Hopkins U.)	AFCRL	3.2 million, GT-12
"	24	"	"	J. Ely (AFCRL)	"	2.69 million
"	24	"	NASA	G. Steffan (Hughes Aircraft)	"	125,000, 2 mil Visqueen
"	25	Litchfield NAF	"	L. Peterson (U. Calif.)	NCAR	80,000, 0.75 mil X-124
Mar	6	Palestine	ONR	J. Waddington (U. Minn.)	"	10.58 million, 0.5 mil StratoFilm
"	7	Holloman AFB	AFCRL	Morrissey (AFCRL)	AFCRL	540,000, 1.5 mil StratoFilm
"	8	"	"	D. Murcray (U. Denver)	"	242,000, 1.5 mil StratoFilm
"	8	Medicine Hat	Dugway	———	Raven	Mark II blimp
"	11	Chico	AFCRL	Capt. Crummie (AFCRL)	AFCRL	2.94 million, 1.5 mil StratoFilm
"	12	"	"	H. Prevett (AFCRL)	"	2.94 million, 1.5 mil Visqueen
"	16	"	"	"	"	2.94 million, 1.5 mil StratoFilm
"	24	Palestine	NCAR	NCAR Balloon Facility	NCAR	2.94 million, 1.5 mil
"	25	"	"	"	"	2.94 million, 1.5 mil
"	30	"	ONR	H. Demboski (ONR)	"	500,000, 0.7 mil capped
"	30	"	"	"	"	4.5 million, variable gage capped
"	31	Holloman AFB	AFCRL	W. Wagner (AFCRL)	AFCRL	2.9 million, 1.5 mil
Apr	6	Palestine	NASA	E. Chupp (UNH)	NCAR	1.6 million, 0.5 mil StratoFilm
"	14	Holloman AFB	Cornell	K. Greisen (Cornell)	AFCRL	2.9 million, 1.5 mil StratoFilm
"	18	"	AFCRL	A. Korn (AFCRL)	"	298,000, GT-12 tandem
"	27	Palestine	NASA	F. Bartman (U. Minn.)	NCAR	250,000, 0.75 mil X-124
"	27	Holloman AFB	GSFC	E. Boldt (GSFC)	AFCRL	10.6 million, 0.7 mil capped
May	6	"	AFCRL	J. Howard (AFCRL)	"	125,426, 2 mil
"	8	Palestine	NASA	F. Bartman (U. Minn.)	NCAR	2.94 million, 1 mil StratoFilm
"	11	Holloman AFB	"	G. Steffan (Hughes Aircraft)	AFCRL	125,426, 2 mil
"	14	Palestine	ESSA	N. Abshire (ESSA)	NCAR	2.94 million, 1.5 mil StratoFilm
"	20	Holloman AFB	NASA	G. Steffan (Hughes Aircraft)	AFCRL	125,426, 2 mil
"	26	Palestine	U. Minn.	F. Bartman, J. Shaw (U. Minn.)	NCAR	3.2 million, GT-11
"	26	"	NSF, NASA	T. Gehrels (U. Ariz.)	"	10.6 million, 0.9 mil StratoFilm
"	26	Holloman AFB	AFCRL	J. Payne (AFCRL)	AFCRL	119,000 & 3.2 million, GT-11 & GT-112.1 tandem
"	28	Palestine	NASA	G. Fazio (Smithsonian Obs.)	NCAR	5 million, 0.75 mil
Jun	2	"	"	J. Arnold (U. Calif.)	"	190,000, 1.5 mil
"	2	Holloman AFB	GSFC	C. Fichtel (NASA)	AFCRL	10.6 million, 0.5 mil
"	6	"	AFCRL	J. Cook (AFCRL)	"	2.94 million
"	6	"	"	J. Ely (AFCRL)	"	4.85 million
"	8	Holloman AFB	NASA	S. Sommer (NASA)	AFCRL	4.85 million, 0.75 mil
"	10	Palestine	"	J. Arnold (U. Calif.)	NCAR	360,000, 1.5 mil
"	12	"	AFOSR	R. Haymes (Rice U.)	"	10.6 million, 0.7 mil StratoFilm
"	13	Chico	AFCRL	Nolan (AFCRL)	AFCRL	360,057, 2 mil
"	14	Palestine	NASA	K. McCracken (SWCAS)	NCAR	5.25 million, 0.7 mil StratoFilm
"	15	Holloman AFB	AFCRL	J. Cook (AFCRL)	AFCRL	4.85 million, 0.75 mil
"	16	Palestine	NASA	K. McCracken (SWCAS)	NCAR	5 million, 0.75 mil
"	17	Chico	AFCRL	Nolan (AFCRL)	AFCRL	360,057, 2 mil
"	23	Palestine	NASA	J. Arnold (U. Calif.)	NCAR	190,000, 1.5 mil X-124

Float altitude (ft)	Flight duration (hr)	Payload (lb)	Experiment	Remarks (* = Successful flight)
1,450	2	745	Tethered Surveyor flight	*
1,400	3.8	663	Tethered balloon test	*
127,200	9	319	Solar x-ray measurements	*
105,000	3	65	Instrumentation test	*
90,400	7.3	3,518	Venus spectra	*
110,400	7.3	591	Primary radiation measurements	*Supplement to Titan 3c experiment
1,450	2	745	Tethered Surveyor flight	*
72,000	9.5	201	Lunar x-ray study	Flight profile not met; beacon antenna did not fully deploy
—	—	933	Ultrahigh energy gamma rays from Crab Nebula or Quasars	Payload damaged at launch
82,000	7.1	464	Humidity measurements	*
65,000	3.5	1,013	IR measurements	*
1,300	—	100	Particle diffusion	*
104,000	30	950	VOR balloon locating system test	*
44,000	1.1	1,000	Hypsometer controlled ballast system test	Failed at 44,000 ft
101,000	48	1,000	"	*
—	—	30	Launch technique tests	*
—	—	40	"	*
—	—	400	Balloon test	Balloon split on release
85,000	—	181	"	Required use of all ballast to reach 85,000 ft
110,500	5	450	Heat conductivity altitude sensor	*
12[illegible]0	5	190	Solar gamma-ray system test	*
94,800	31.25	1,302	High energy gamma rays	*
67,400	34.5	10,445	Heavy load balloon test	*
101,400	2	97	Telemetry check	Partial scientific data obtained due to antenna failure
129,000	15.25	537	Study x-ray sources	*
51,500	1.25	1,006	Balloon-borne instrumentation test	*
108,000	7.5	918	Atmospheric temperatures	*
800	2	745	Surveyor platform descent test	*Tethered system
100,800	3.5	1,399	Atmospheric water vapor	*
800	2.25	747	Surveyor platform descent test	*Tethered system
—	—	1,230	IR measurements	Launch malfunction
119,800	9.5	1,805	Photopolarimetry of planetary atmospherics	*
92,000	4	3,500	Simulated Voyager systems	*
125,000	7	713	High energy gamma rays	*
—	—	513	Micrometeorite collection	Collector did not deploy
68,000	8	535	Gamma radiation research	Balloon failure
98,500	8	1,300	Optical beacon for geodetic determinations	*
114,000	13.5	593	Heavy primary cosmic radiation	*
130,000	5.25	402	Mars probe	*
80,000	8.5	516	Micrometeorite collection	*
128,000	3	1,005	Gamma rays from Crab Nebula	*
70,000	36	1,096	High altitude minimum wind fields	*
—	—	538	Gamma rays from Crab Nebula	Balloon leaked
—	3	613	Optical beacon for geodetic determinations	Balloon failure
12[illegible]0	7.5	558	Gamma rays from Crab Nebula	*
44,000	1	1,092	High altitude minimum winds	Balloon failure
70,000	1	501	Micrometeorite collection	Collector did not deploy