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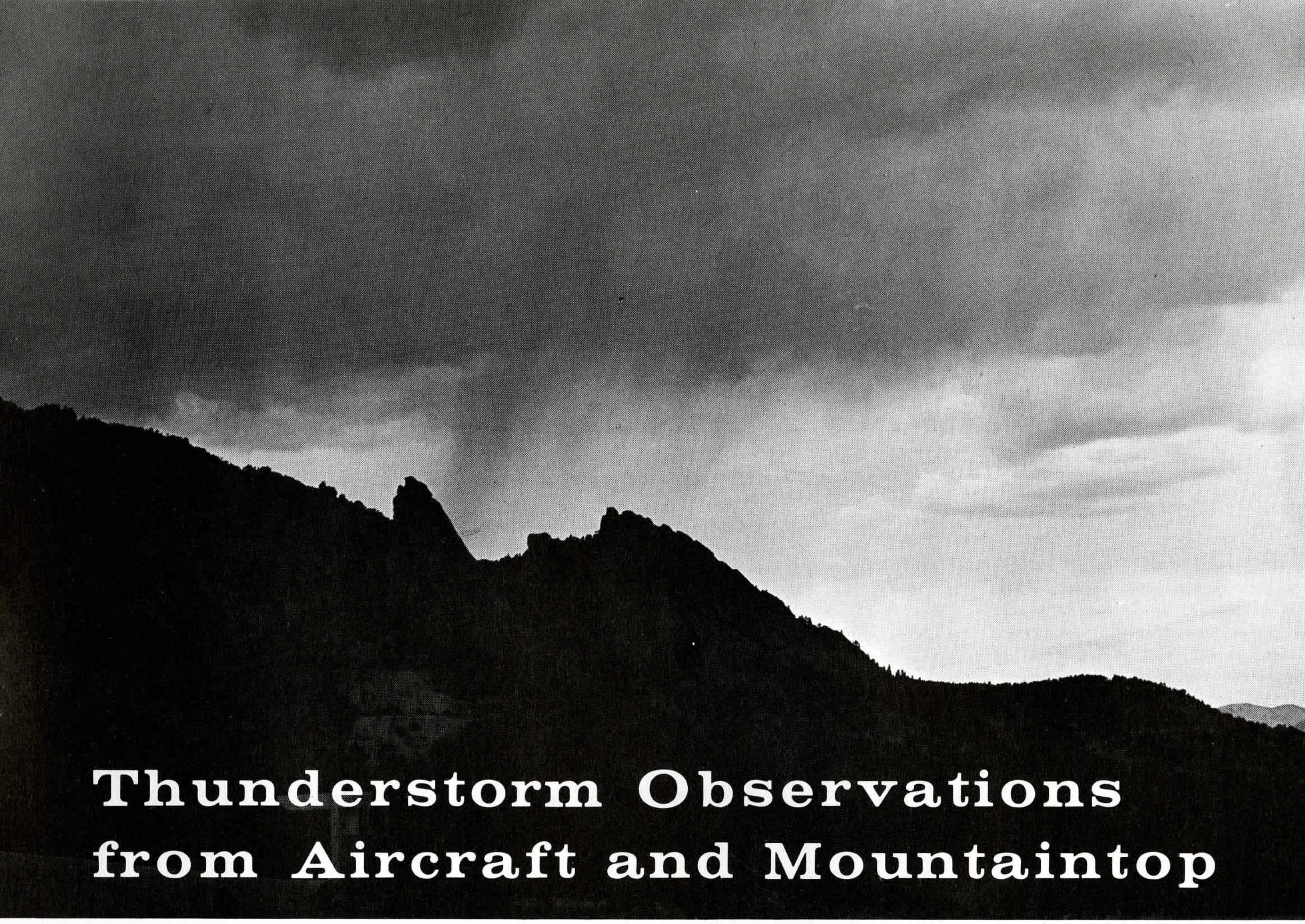
Cover: Photograph of a lightning strike southeast of Boulder, Colorado. An article entitled "Thunderstorm Observations from Aircraft and Mountaintop" begins on page 2.



Thunderstorm Observations from Aircraft and Mountaintop

For many years scientists at the New Mexico Institute of Mining and Technology have made use of the regular midday buildup of thunderclouds over nearby mountain ranges to investigate thunderstorm mechanisms and related atmospheric phenomena. Many mountain chains in the southwest U.S. are centers of strong convective chimneys during the peak of summer heating. This convective activity, combined with the relatively high moisture in the region of the Sonoran heat low, generates intense thunderstorms that water the arid high plains and semideserts almost daily for about two months.

A mountain based project, headed by Charles B. Moore, associate professor of physics at NMIMT in Socorro, is directed toward learning more about the relations between cloud electrification and precipitation formation. The project is part of Moore's long-standing collaboration with Bernard Vonnegut, now chairman of the Department of Atmospheric Sciences of the State University of New York at Albany, and dates from their work together at Arthur D. Little, Inc. Vonnegut has persistently questioned the widespread tendency to base thunderstorm theories on the still undemonstrated assumption that charged raindrops or ice particles must exist in clouds before electrification can occur. His work suggests that cloud electrification may be an underlying cause of precipitation formation, rather than its result. Since coming to NMIMT, Moore has been able to support Vonnegut's position with a strong foundation of experimental data available at the well equipped Langmuir Laboratory, located on the 10,800 ft Mount Baldy crest of the Magdalena Mountains southeast of Socorro.

To support Moore's studies, the NCAR Research Aviation Facility has provided a Queen Air aircraft each summer since 1965. A number of the Facility's pilots have taken part in the program. For several weeks each summer, daily missions have been flown to about 30,000 ft to measure potential gradient and electrical conductivity from the time of cloud initiation until the onset of lightning discharge. William Bullock, one of the pilots participating in the program, had flown for Moore in Illinois, Florida, New Mexico, and the Bahamas before joining the NCAR staff.

The Queen Air flights have allowed Moore to compare airborne detection of cloud electrification with ground based radar detection of the first formation of rain in the growing thunderstorms. Such "competitive" measurements should help settle the dispute over the cause and effect relation of these two processes. While radar can penetrate to specific cloud regions to reveal the onset of precipitation, electrical sensors must be raised by aircraft or balloons as close as possible to the clouds in order to compete with an equivalent sensitivity. Moore suggests that previous evidence interpreted as demonstrating precipitation formation prior to electrification may have been derived from inadequately sensitive ground based electrical measurements.

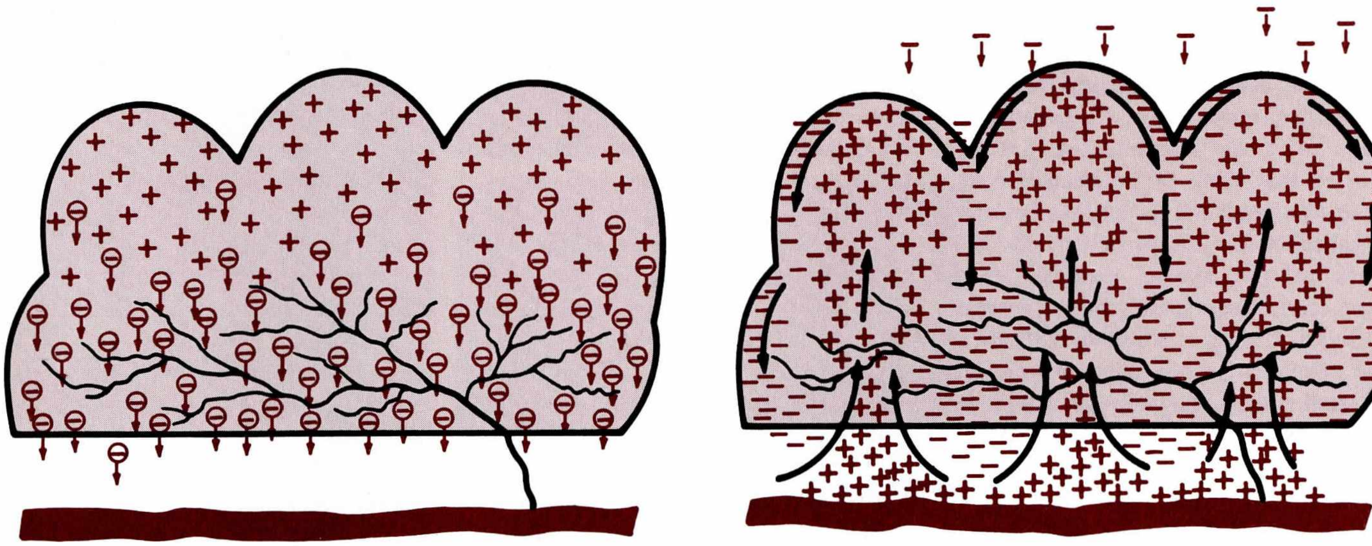
Once the cloud is electrified and producing lightning discharges, there is visible evidence of a dramatic effect of electricity on precipitation. Two to three minutes after overhead lightning strokes occur, intense rain gushes frequently arrive at the ground. The rain gush phenomenon has been noted from early Roman times and is described in Lucretius' great epic on natural wonders. Moore has documented the effect many times with rainfall measurements and radar scannings. Just prior to the lightning flash the radar often detects only light precipitation falling within the cloud. After the flash there is often a prodigious radar echo brightening, indicating the formation of heavy rain. The rain gush is one of the strongest points in favor of Vonnegut's thunderstorm hypothesis.

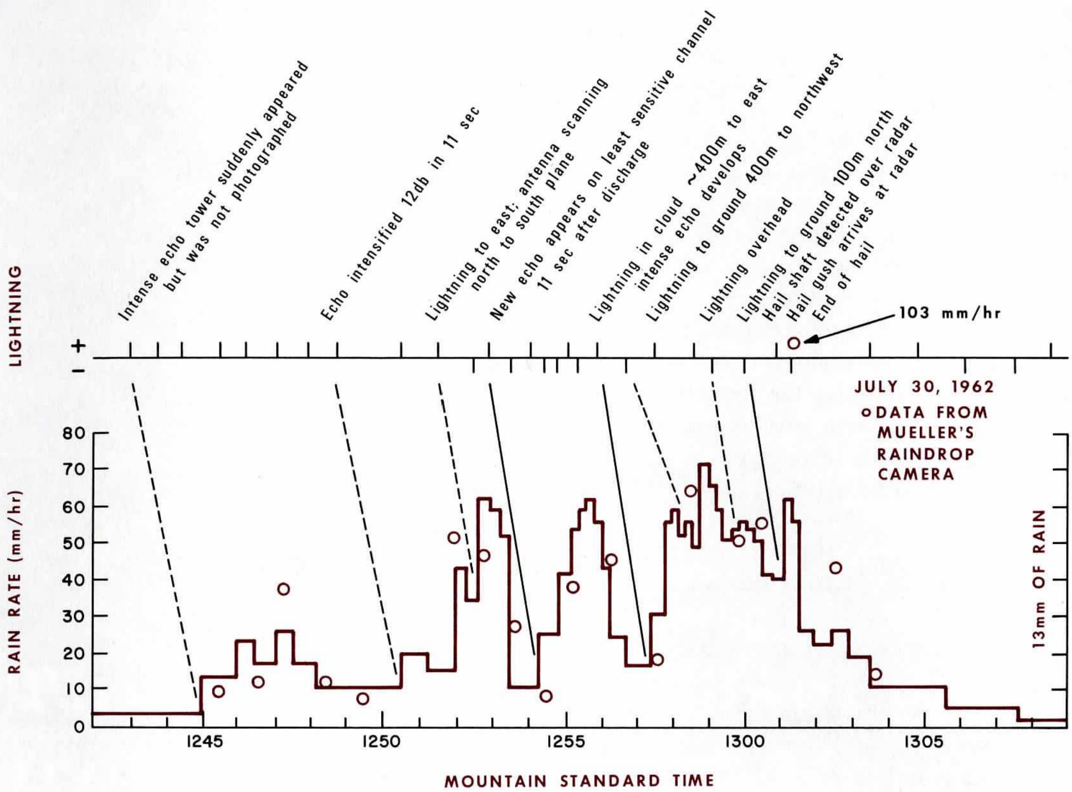
Convective Theory

Arguing that lightning may be a cause and not a result of precipitation processes within a cloud, Vonnegut ascribes one origin of cloud electrification to the organization of elementary atmospheric charges by convection. By transporting space charge upward into the cloud and clear air charge downward over the cloud's outer flanks, convective updrafts and downdrafts create a discontinuity in electrical conductivity between the inner and outer portions of the cloud. This allows the cloud to gain considerable charge prior to the formation and

Many investigators believe that electrical charge in thunderstorms is caused mainly by falling precipitation particles electrified by the separation of charges inside the cloud (left). Vonnegut and Moore have presented evidence that charge is accumulated by updrafts carrying positively charged cloud particles and downdrafts carrying negatively charged cloud particles (right).

Graphic concept courtesy of Science Journal *(incorporating* Discovery*), London.*





The rain gush phenomenon is illustrated in a plot of the occurrence of lightning and the rain rate during a New Mexico thunderstorm in which each intense period of precipitation occurred shortly after a nearby lightning discharge. Solid and dotted lines connect observed rain gushes with the associated lightning; for the cases marked by solid lines radar indicator plots were obtained showing the development of a new precipitation echo immediately after a nearby discharge.

movement of precipitation or ice particles. This principle is central to Vonnegut's well known convective theory of cloud behavior—a theory which, though disputed by some, has strongly influenced thunderstorm research.

One of the early experiments which helped give rise to Vonnegut's theory was the release of electric charge into the air from horizontal wires strung near the ground. By connecting a stainless steel wire to a high voltage, Vonnegut and Moore released a current of positively or negatively charged particles into the atmosphere. Measurements made with an instrumented aircraft showed that some of the electrified air molecules produced in this way became attached to aerosol particles, and that these charged aerosol particles were then carried into clouds by convective updrafts. Having established that artificial space charge can affect the charge of small cumuli, they hope to show that convective transport of a very large charge can actually reverse the polarity of mature thunderstorms. S.A. Colgate and Moore are continuing such experiments at the Langmuir Laboratory, using an airplane engine to generate a vertical air column with defined characteristics. They are also installing a 7000 ft, 0.5 in. steel wire from the laboratory over a canyon to an adjacent ridgetop to attempt high current electrical "seeding" of clouds.

Aircraft Data

Data collected in the summer flights have added valuable documentation to Moore's study. In several instances electrical perturbations in clouds were detected from the aircraft before a precipitation echo appeared on the radar. The flights over cloud tops showed that electrical perturbations were associated only with clouds undergoing rapid turret development; other clouds, similar in appearance but without significant turret development, produced no perturbations. Earlier, Vonnegut and Moore had obtained similar evidence in experiments along the east coast of Florida. From a U-2 aircraft they simultaneously photographed cloud tops and measured the vertical component of potential gradient, and found electrical development closely associated with turret development.

In the New Mexico experiments Moore has determined that shortly after instruments aboard the Queen Air have begun to record electrical activity within a cloud, an inverted cup with a hollow center develops on the radar scope. This cup follows the outline of the cloud, but does not extend to the cloud edges. Moore feels it corresponds to the cloud's region of high electric field, and represents enhanced rain drop coalescence in the region between the charge on the inside of the cloud and the charge on the outside. He notes that when the airplane is directly over the top of the echo, the echo is still 1000 ft or more below and is thus not a cloud surface effect. Moore has raised electric sensors on balloons into this part of the cloud and has found it to be highly electrified. He attributes the detection of this characteristic radar echo shape, which he observes frequently in convective clouds, to the high sensitivity and scan pattern of the radar, and to the advantages of a mountaintop laboratory.

Flight Procedures

From the Socorro airport the pilot was able to watch cloud initiation over the Magdalena crest and to judge whether convection was progressing without interference by wind shear. Mountaintop measurements of atmospheric mixing ratio also indicated the expected time of thunderstorm development. The initial maneuver after takeoff was to climb to about 11,000 ft and skim the ridgetop, to obtain data below the clouds and to verify proper instrument function. (High concentrations of fair weather electricity within 100 ft of the ridgetop momentarily run all instruments up scale.)

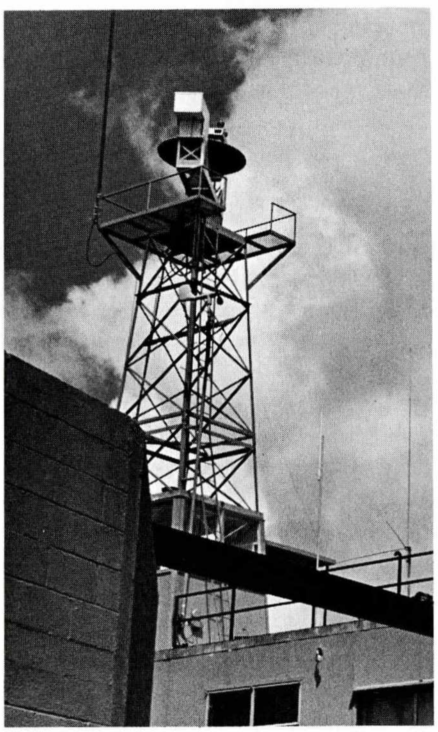
During the next 2-3 hr the pilot would fly over the cloud tops measuring perturbations of the fair weather field which are indicative of changes in the cloud's electrical interior. When possible he flew directly over rapidly developing turrets to enable electrical measurements to be correlated with the cloud's physical growth. Passes over the clouds were discontinued when lightning activity began, since a discharge within 2 mi of the aircraft sends all instruments off scale.

At altitudes approaching the Queen Air's 30,000 ft ceiling, it was necessary to assess carefully the cloud growth rate vs the aircraft climb capability in order to remain above the rapidly growing cloud tops. Actual contact with cloud droplets highly charges the aircraft body, and makes measurements of cloud electricity on that pass dubious. These flight maneuvers require close coordination between the pilot and the instrument observer. Altitude limitations of the Queen Air made the larger clouds inaccessible for study, but by this summer the Aviation Facility will be able to use its new jet Sabreliner to fly as high as 45,000 ft.

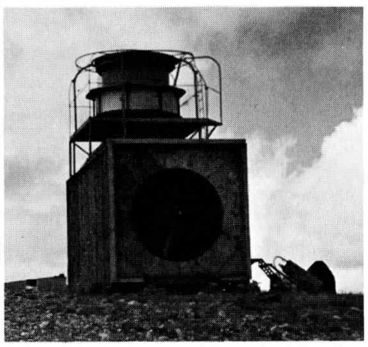
Aircraft Instrumentation

To measure the electric potential gradient of the air, the Queen Air was outfitted with radioactive polonium probes designed by Vonnegut and Moore during the late 1950s.* Electric potential gradient is a vector quantity, exerting a force in all three dimensions. Its component vectors can be measured as the difference in potential between three sets of radioactive probes aligned on X, Y, and Z axes with respect to the aircraft. The probe pairs were mounted on the Queen Air at the nose and tail, and above, below, and to both sides of the cabin area. Vonnegut and Moore's design includes an adjustable rotating capacitor system to compensate for asymmetry in the exposure of the probes. Adjustment of the coupling between the probes and the electronic amplifier allows in-flight balancing of the apparatus in order to negate the effect of the aircraft's own charge. General calibration is made by comparing data from identical probes raised on a radiosonde balloon. The slower motion and lesser distortion of the balloon vehicle allows using balloon instruments for calibration.

Air conductivity was measured with a Gerdien tube mounted on the fuselage of the Queen Air. It consists of an 18 in. long by 6 in. diam cylinder charged at 45 V, with an axial electrode connected to ground through a picoammeter. The flow of electricity to the rod is a measure of the atmosphere's conductivity. Conductivity depends chiefly on ion



a.



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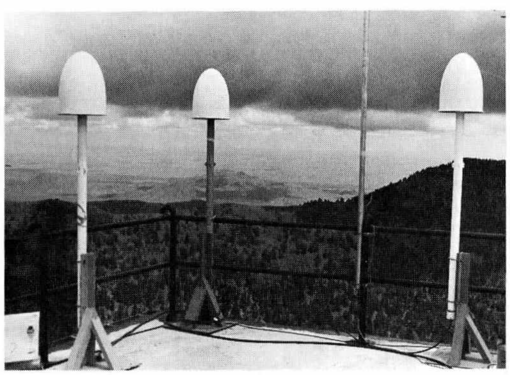
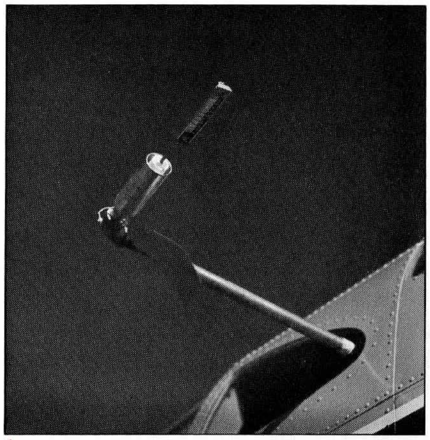


c.

(a) Langmuir Laboratory with hemisphere-scanning radar on roof. Radar depicts vertical anatomy of clouds by scanning in 48 separate vertical planes once every 2 min. (b) Airplane engine generates a vertical column of air for studying the transport of space charge. (c) Lightning detectors on lab roof automatically record changes in potential gradient caused by the flash.

a.



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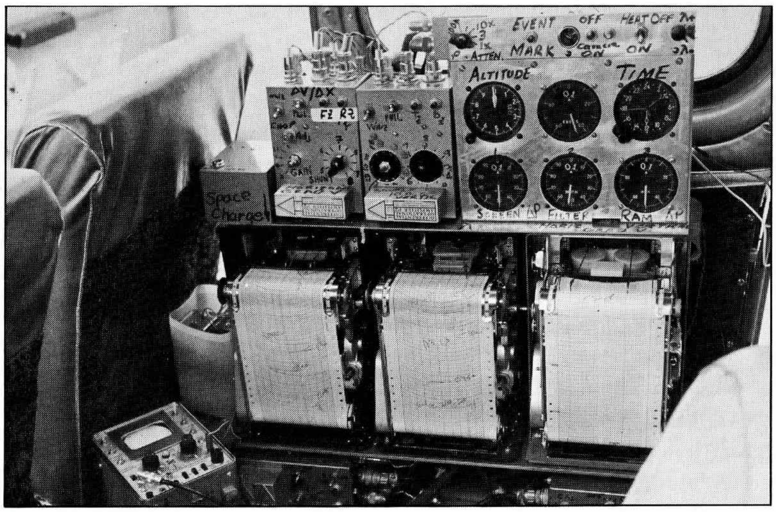


c.

(a) Space charge filter, (b) polonium potential gradient probe, (c) Queen Air cabin installation.

production and on atmospheric particle content, and generally increases with altitude.

Space charge measurements were not made last summer, but in the past have supplied good evidence depicting the work done on atmospheric charges by convection against an electrical force. Space charge is the net concentration of free charge in the air. Moore and Vonnegut measure the charge by passing air through special filters at a given flow rate and recording the charge with a sensitive picoammeter. Their measurements show that convection can draw fair weather space charge into the growing cloud from an area of high concentration near the ground to begin the process of electrification.

Ground Observations

The Langmuir Laboratory is equipped to make abundant and overlapping measurements for the complete description of storms. Standard housekeeping measurements include electrical field near the earth, vertical and horizontal components of the atmospheric potential gradient, corona current density from the earth, space charge, occurrence and nature of lightning strokes, and the currents and charge carried on raindrops. All common meteorological events are also recorded. On the laboratory roof are raingages, lightning detectors, and other apparatus. An all-sky camera uses a photoelectric shutter timer to adjust exposure times automatically from 0.4 to 20 sec. When storm clouds reduce light, the shutter is open for long periods, thus increasing the chance of photographing lightning directly.

Twenty-five miles to the east of the laboratory is a photographic installation which views cloud development over Mount Baldy and transmits the information to a closed-circuit television in the laboratory. Thus the scientists can view features of the clouds such as turreting, shear, or storm decay, not visible from their own position in or below the clouds. The distant camera station also makes time-lapse movies of the storms over Mount Baldy. Lightning events from the detectors on the laboratory roof are transmitted to the station and recorded on the time-lapse pictures.

The NMIMT scientists maintain two main radars for use in atmospheric studies. A large radar at the Langmuir Laboratory scans the hemisphere overhead in 48 separate vertical planes once every 2 min, thus supplying a view of the vertical anatomy of the clouds. Its modulator-driven 40 kW magnetron has a PRF of just under 1000/sec, with a high-resolution pulse length of 0.5 μsec. Cameras record the cathode ray tube displays along with supporting data such as occurrence of lightning and rain, gain setting, azimuth of scan, and time. Four gain settings allow high or low sensitivity scanning of general structures or dense precipitation cores, which may differ in radar brightness by a factor of 100 million. (Separate cameras are used to photograph the high and low sensitivity channels.) One of the radar channels is coupled to a high-frequency response picoammeter that permits the resolution and counting of individual elements of lightning discharges. When lightning strikes nearby, its initial polarity, up or down direction, and features of the leader stroke, dart leaders, etc., can be recorded.

On the 7300 ft summit of Mount "M" near Socorro, a 10 cm, S-band radar with a 28 ft diam dish antenna scans a limited sector in the direction of Mount Baldy. Its rapid 5 sec scan time makes it efficient in recording echo brightening immediately after lightning strokes, which can evade the Mount Baldy radar when it is looking away from the discharge. The Mount "M" radar was also used in the summer program to track the Queen Air, correlating positional data with an automatic time code. Knowledge of the Queen Air's exact position at the time the airborne sensors recorded electrical data made it possible to reconstruct the geometry of the cloud's physical and electrical structure.

Lightning Targets

Another technique in Moore's versatile repertory is to initiate lightning strokes within the scanning sector of the radar to measure the extent of rain echo brightening at very close range. He has experimented both with small rockets trailing steel piano wires and with a long steel wire stretched to an adjoining summit, which he also plans to use for space charge emissions, as mentioned earlier. Moore also hopes to experiment with lightning initiation over the ocean where the electrical field is much higher, and where other investigators have reported frequent strikes of their targets. There are in fact a number of decisive differences between thunderstorms over land and over water, and in a storm's electrical behavior as it passes from land to water, which Moore feels could illuminate specific points in Vonnegut's hypothesis. Moore plans to carry out experiments with University of Miami scientists in the near future, and hopes to employ the Queen Air in flights with several other aircraft at different levels in coastal regions.

Further Work

Moore has documented additional details about a cloud's electrical composition by placing sensors directly in the cloud. In particular, simultaneous measurements of vertical air currents and electrical charge density reveal whether the total charge flux in a storm is sufficient for electrification to occur predominantly by convection, as Vonnegut proposes. Moore has worked extensively with radiosonde electrometers and a Faraday cage raised on tethered balloons into the lower portions of clouds. The Faraday cages are covered with canopies to prevent precipitation from entering from above, and thus measure only the charge density of the air. Recent experiments with dropsondes carrying electrical measuring apparatus through clouds, such as those made by Walter Evans at the University of Arizona, offer another possible approach. And a new possibility which Bullock and Moore have been considering is the use of a glider to traverse navigable portions of clouds below the icing level. The lower speed of the glider produces less spurious charge and allows more time in one area for observing how cloud electricity develops. •

Information on Balloon Flight Facilities

An information manual for users of NCAR's Scientific Balloon Flight Station at Palestine, Texas, is now available on request. Frank E. McCreary, Superintendent of the Flight Station, has assembled the most important facts describing available facilities to give scientists a guide in planning their flight experiments at Palestine.

The manual describes available work areas; rigging and launching capabilities; electronics, telemetry, and electronics test equipment; machine, welding, and photographic facilities; and office space. It also describes engineering assistance available to experimenters, aircraft tracking and recovery, radar target tracking, meteorological advisory services, and criteria for selecting the best launch season. General information on nearby commercial facilities for food, lodging, etc., is also presented. The manual is available from:

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

On the Strength of High Altitude Balloons*

Arnold D. Kerr, Professor of Aeronautics and Astronautics, New York University

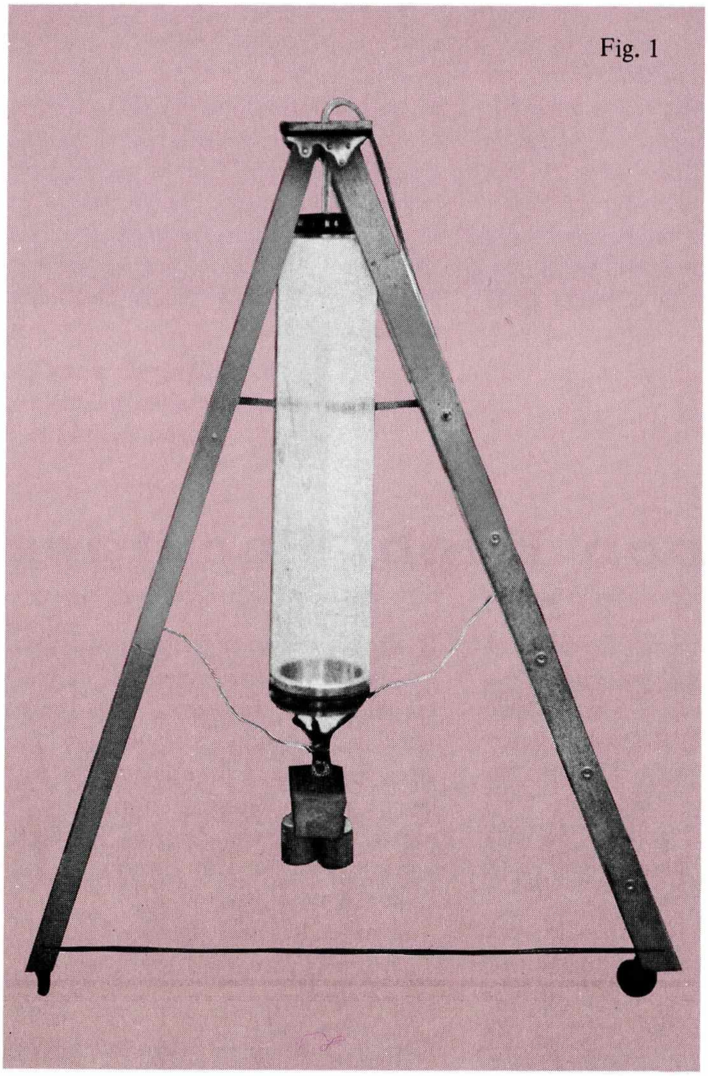


Fig. 1

Introduction

A significant step in the development of balloon technology was the introduction, more than two decades ago, of strong, easily sealable, thin plastic films. Because of the light weight and relatively high strength of these films, it is presently not unusual to build balloons of 10 million cu ft which can lift a payload of 150 lb to an altitude of 150,000 ft. The relatively low cost of these balloons has made them suitable for a variety of high altitude scientific experiments—which, in turn, has created a steadily increasing demand for balloons able to carry heavier loads to higher altitudes.

This development has been accompanied, however, by an increasing number of balloon ascent failures, particularly during the first half of the present decade. In 1965 the writer initiated an extensive research program, supported by AFCRL, with the aim of finding the causes of failure of high altitude balloons. This program and some of its accomplishments are described below.

Research Program and Findings

As a first step the "natural shape" equations, which are used extensively for the design of balloons, were examined [1]. It was found that the tabulated shapes used by balloon designers to cut the gores of tailored balloons are actually those of deformed balloons; hence, the desired stress condition will not be realized when the strains are large. This

*Research sponsored by Air Force Cambridge Research Laboratories under contracts AF 19 (628) 4990 and F 19628/67/C/0241.

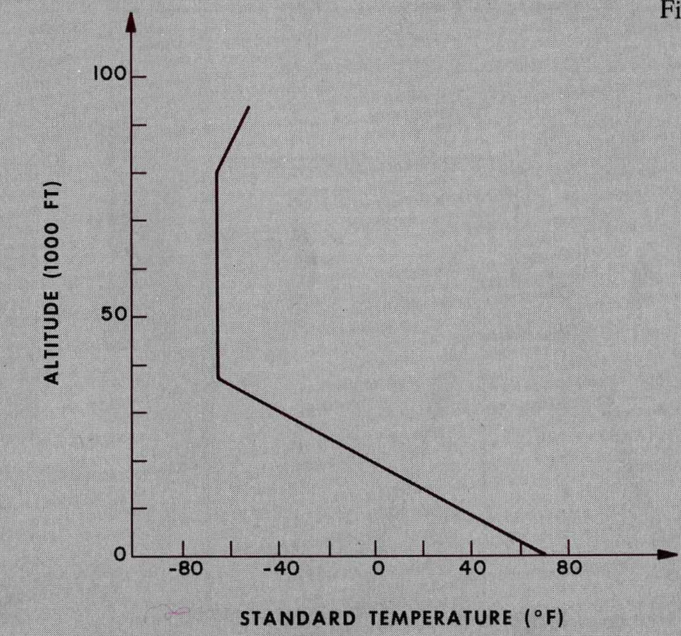
study did not, however, reveal any results which would indicate the causes of failure of balloons at ascent.

Another analytical study [2] showed that a tensile instability exists in the elastic range and also that a balloon may fail after a certain time because of creep. While tensile instability is of interest only in the case of highly extensible films, failure due to creep may occur for films whose elastic deformations are rather small.

It soon became evident that a thorough examination of the mechanical properties of balloon films was needed, in addition to the analytical studies. Since the films used in balloons had all passed the tests prescribed in the various balloon specifications, it was concluded that these prescribed tests do not check some material characteristics important for balloon flights. In order to determine the causes of balloon failures, it seemed logical to devise tests for balloon films which would simulate the potentially critical situations that a balloon experiences during launch and ascent.

Preliminary uniaxial tensile tests were conducted using one inch wide film samples as specified in MIL-P-4640A (USAF), and described in *Standard Test Methods for Balloon Materials* [3]. Because the samples exhibited very large axial deformations before rupture (which appreciably change their mechanical properties), and because such deformations are absent in an actual balloon, the uniaxial sample was considered inadequate. Instead, a cylindrical sample was chosen as a standard for the entire testing program. Such a sample is formed of two long film strips, one on top of the other, heat-sealed along both edges. The sample is closed off at both ends by disk-like end fittings. A mounted sample is shown in Fig. 1. The pressurizing gas is introduced through the upper end fitting. The lower fitting is equipped with a hook for attaching an axial load. The advantage of this arrangement is that the sample consists of the balloon film as well as the seals, and that both film and seals may be subjected to a variety of biaxial stress ratios.

Fig. 2

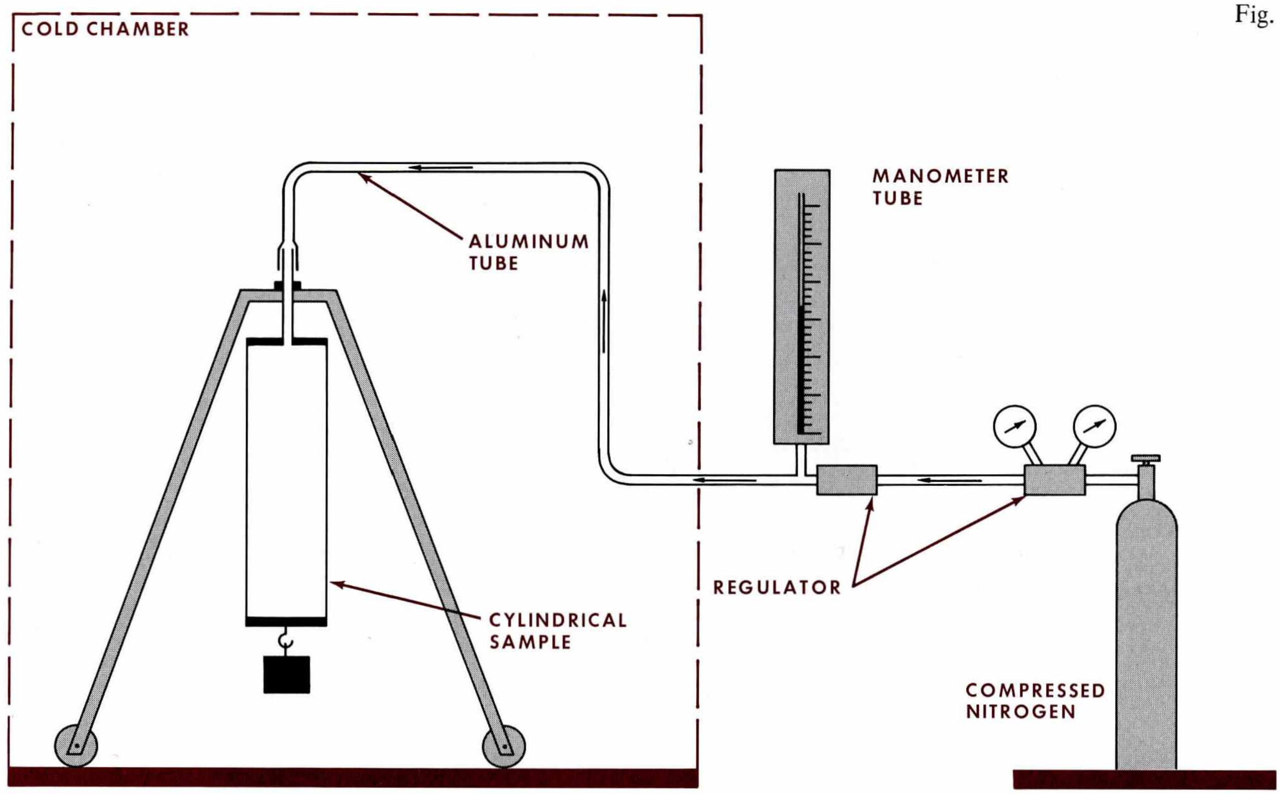


This test setup was first used to determine the viscoelastic response characteristics of a number of balloon films. The results for DFD-5500 (new) film are presented in [4]. During these creep tests it was noticed that in all tested Startex cylinders (ten specimens) one of the two seals consistently broke at a relatively low pressure. One inch wide strips were then cut from these cylinders in such a way that they contained the weak seal normal to the long axis of the strip; these samples were then subjected to uniaxial tension until failure. The tested samples (twenty specimens) did not fail at the seal, thus casting doubt upon the peel strength test of seals, as described in *Standard Test Methods for Balloon Materials* [3].

Records of numerous balloon flights conducted by AFCRL and NCAR showed that the majority of balloon failures occur during ascent at altitudes between 40,000 and 60,000 ft [5; 6]. A review of the temperatures through which a balloon must pass during ascent (Fig. 2) revealed that from launch to an altitude of 35,000 ft the temperature drops by more than 100°F. At 36,000 ft the temperature reaches about -65°F.

After studying the forces, temperatures, and time intervals to which a balloon is subjected during launch and

Fig. 3



ascent, it was conceived that creep at launch may have a detrimental effect upon the strength of the balloon at the cold temperatures encountered at the failure altitudes. J. F. Dwyer, reviewing balloon failure statistics, indeed found evidence to support this hypothesis [5].

In view of this finding, a test program was initiated to study the effect of creep at launch on balloon strength at lower temperatures. In these tests the plastic cylinder is first preloaded at a temperature of +75°F, +92°F, or +110°F, by attaching a load to the lower end fitting. After a predetermined time the setup is rolled into a cold chamber and allowed to cool for 15 min at a temperature of -70°F. Finally, the cylinder is pressurized until failure. The entire test arrangement is shown in Fig. 3. The cold chamber tests were conducted at the Climatic Research Laboratory of the U.S. Army's Natick Laboratories.

The purpose of the uniaxial preloading at a high temperature is to simulate launch conditions. The additional pressurization in the cold chamber is to simulate the effect of deployment and pressure inside the balloon at the failure altitude. The cooling time of 15 min was chosen on the assumption that the ascent velocity is about 1000 ft/min. The selected axial loads (about 800 psi) correspond to the axial stress levels often encountered in actual situations at launch.

Tests were conducted on samples made of various films. These tests revealed that the strength of some samples did indeed decrease at -70°F when preloaded by axial forces at temperatures encountered at launch. It is of interest to note that samples made of balloon films which had a poor flight record also proved to be weaker in these tests. It was found that the samples which failed at the lower burst pressures exhibited larger axial creep deformations due to the axial preloading force, and that these ruptures appeared to start along the seal. The detailed findings are described in [7] and [8].

A continuation of these tests revealed that when a preloaded sample is unloaded for a few minutes before placement in the cold chamber, a large part of the creep deformation recovers, and that the burst pressure is not affected by preloading. This indicates that the burst pressure drop described above is not necessarily caused by permanent damage due to preloading. These and related findings will be contained in a forthcoming report by H. Alexander.

Another finding of interest is that the mechanical properties of films made of the same resin, and hence carrying the same designation, vary significantly with small changes in the details of the manufacturing process, such as blow up ratio. The details of this finding are also described in [7] and [8].

In order to furnish the balloon designer with a simple means of checking whether the stress levels he works with are on the safe side for a given balloon film, an attempt was made to devise a "safe stress" chart. The criteria used and some related results are described in [9].

An extensive investigation was also conducted on the response of neoprene balloon films when subjected to stresses. In an attempt to extend the analysis presented in [2] to actual neoprene meteorological balloons, Alexander conducted a number of tests on neoprene samples. On the basis of his results he formulated and solved a number of problems associated with highly extensible balloons [10-14].

Remarks and Recommendations

As part of a study for determining the cause of strength degradation of samples in the cold chamber tests, it is planned to use high speed photography to record the failure mechanism and, in particular, to locate the point of failure initiation, which appears to be at the seal. It is also planned to determine the effect on sample strength of both lower temperatures at burst and longer cooling periods. At this stage of the testing program it appears that a materials study of the film at the seal is urgently needed. Such a study should clarify the effect of the various sealing methods upon the properties of the film at the seal; it should also clarify the reason for the burst pressure drop due to axial elongations, and should yield information on how to produce strong seals for the various materials under consideration.

The findings of the plastic film tests described above, as well as the results of the cold brittleness tests reported by R. Hauser [15] suggest that revisions in current balloon specifications are needed to eliminate those tests which have proved to be of little or no relevance for balloon films and seals, and to include meaningful tests which will contribute to successful balloon flights. Serious consideration should be given to the pressurized cylindrical sample as a standard, instead of the uniaxially loaded strip. The advantages of the cylindrical sample are that the film can be subjected to various biaxial load ratios, and that film strength and the strength of the seals (the type to be used in an actual balloon) can be tested simultaneously. Such a test is also suitable for checking the permeability of the film and the effect of possible film imperfections, such as die lines and creases.

During the past decade a large number of high altitude balloons have been designed and flown, and in this connection certain methods of analysis have been developed and used. Balloon technology would benefit greatly from the publication of a manual containing descriptions of balloon configurations and the corresponding procedures presently used to analyze them. It is reasonable to expect that such a summary would reveal some shortcomings in the current methods of balloon analysis, and would initiate discussions and investigations which might lead to improvements in the analysis and design of balloons.

Acknowledgments

The writer gratefully acknowledges the cooperation of Harold Alexander throughout the various phases of this program. Thanks are also due to James F. Dwyer, AFCRL, for helpful discussions on balloon technology and for his active participation in the cold chamber test program. •

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[15] R. L. Hauser, 1967: Round-robin cold brittleness tests of balloon films. In *Proc. Fourth AFCRL Scientific Balloon Symposium*, Sept. 1966, Bedford, Mass., J. F. Dwyer, ed., 125-132. (Also NCAR Technical Note TN-27, 16 pp.

Computer Graphics for Large Data Presentations

Geophysical data collections are often so large that despite the use of statistical techniques to condense and order the data, interpretation remains difficult. Among such large collections are those of the United States Public Health Service Radiation Surveillance Network and the International Geophysical Year Nuclear Radiation Program, each with records of more than ten years of daily observations. A convenient method of dealing with such large collections is to use the rapid data handling capacity and programmed microfilm output of large digital computers to produce motion picture data displays. Movies allow the viewer to examine the major features of large data records, including time and space variations, and to combine several data sets into a single presentation.

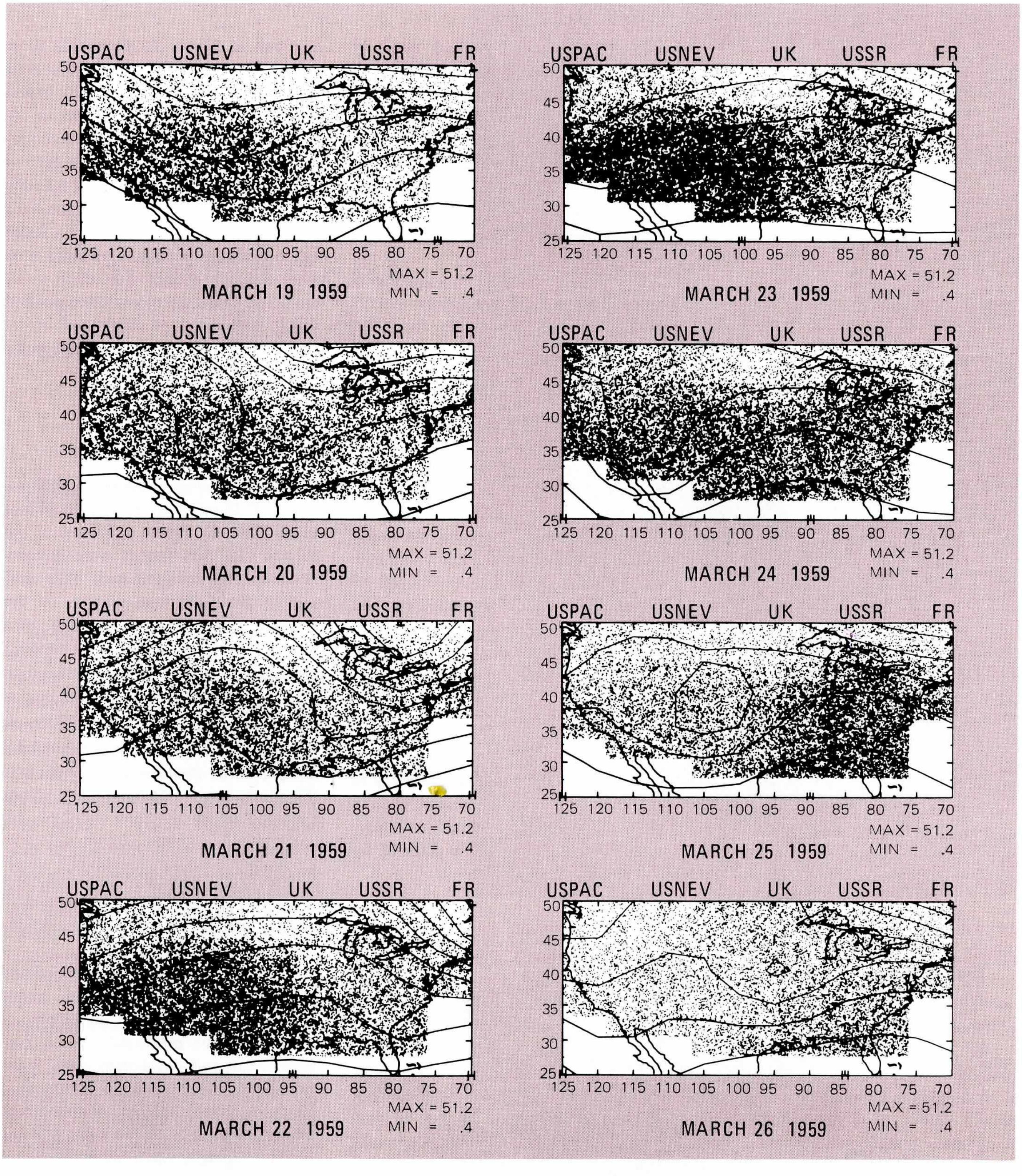
Irving Blifford, Jr., of NCAR's Laboratory of Atmospheric Science, and James Burgmeier, a graduate student at the University of New Mexico, have used the NCAR Control Data 6600 computer and the dd80 cathode ray tube plotter to portray several years of USPHS radiation data together with atmospheric pressure data at 500 mb during the peak period of U.S. and U.S.S.R. atomic testing. The films show large scale changes in the daily concentrations of radioactivity over the U.S., clearly depicting the influx of fallout over the U.S. from Russian atomic tests and fallout dispersion from Nevada tests. Apparent deposition of stratospheric radioactivity into surface air in years following tests is also evident.

Blifford and Burgmeier note that some of their methods of preparing the data records for film plotting can be used for similar applications in which time-space mapping of statistical descriptors is required.

Approximation Schemes

The data records of the USPHS Radiation Surveillance Network contain large variations in the frequency and geographic coverage provided by the 66 monitoring stations. In order to insure pictorial continuity of the radioactivity concentration patterns over the entire U.S., it was necessary to derive close estimates for regions sparse in data during certain periods. Blifford and Burgmeier experimented with three approximation methods for this purpose, and found that a method of direct arithmetic averaging most conveniently supplied regional values. The first step in preparing the data was to divide the U.S. into a rectangular 10 × 10 grid. Next, the daily values of radioactivity concentration from all monitoring stations within a rectangle were averaged and entered at the grid intersection point forming the lower left corner of the rectangle. Grid point values for rectangles with no data reports on a given day were estimated by averaging the values at the eight surrounding grid points; if data at these points were also missing, the next outer perimeter of grid points was used. Finally, the values at the four grid points surrounding each rectangle were averaged and taken as the radioactivity concentration for the rectangle. Once these values were derived, the computer random number generator was used to plot a proportional number of dots on microfilm.

The other two approximation methods provided results neither consistently better nor worse than the direct averaging method. They were not adopted because of their considerably higher cost in computation time. One of these methods derived each grid point as the "weighted average" of the concentrations in the surrounding four rectangles, using inverse distance as the weighting



Uninterpolated frames for eight successive days show radioactivity during period following the end of major atomic testing. Radioactivity is assumed to be primarily from the stratosphere. In many instances radioactivity appears to coincide with passage of low pressure troughs and to be correlated with rainfall. During period shown, however, the southwest U.S. was dry, yet received high concentrations of fallout. Maps of mean vertical motion suggest that radioactivity was brought into the troposphere and was subsequently transported eastward in the low level flow.

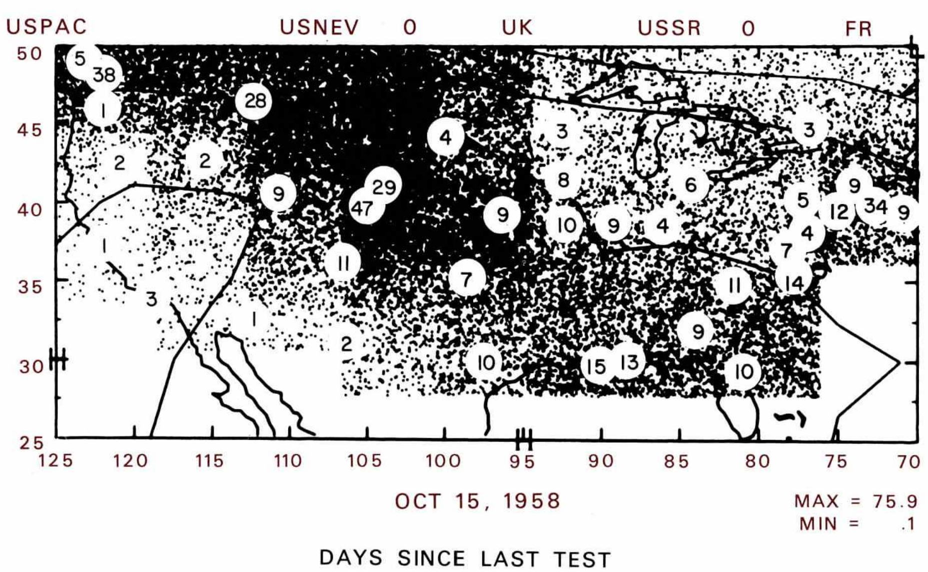
function. The other method involved expanding a first order Taylor series in time and space to express the concentration function. It resulted essentially in adding a small correction term to the values obtained by direct averaging.

Approximation Check

The direct averaging approximation scheme was checked against several synthetic space and time functions chosen to simulate probable radioactivity distributions. On each of several consecutive days the synthetic function was evaluated for those stations with known radioactivity values. Values of the function were entered at the station locations, and the averaging process carried out. Dot patterns were then plotted. Next, the synthetic function was evaluated exactly at all grid points, and new dot patterns plotted. The two sets of dot patterns were then compared. The generally good agreement of the patterns attested to the reliability of the averaging scheme.

Dot Plotting

Some experimenting was necessary to determine a suitable number of dots to represent the average fallout concentrations. Concentration ratios differed by as much as 220:1. To distinguish these differences, a maximum of 3000 dots could be plotted without totally blackening a rectangle. Plotting dots in exponential proportion to the concentrations was tried but the resulting pattern was found to be subjectively confusing to the viewer. Thus a straightforward linear proportion was chosen. To facilitate visual interpretation, variable time intervals were chosen over which maximum and minimum values corresponded to the full range of black and white. Each film frame is annotated to specify the range depicted.



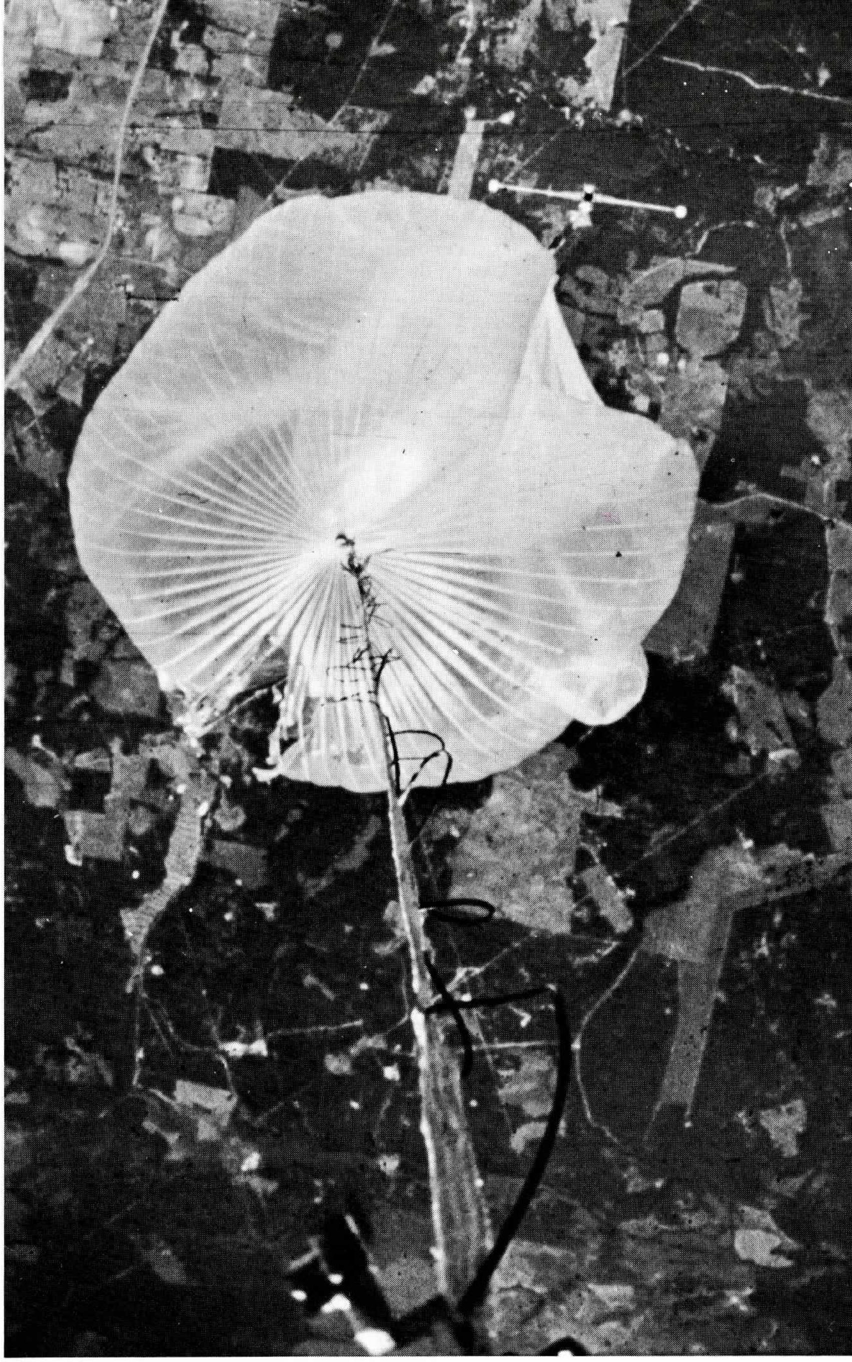
Computer derived concentration pattern shows good agreement with reported concentration values at monitoring stations, shown in white circles. Numbers indicate picocuries of fission product beta radioactivity per cubic meter of air. The appearance of high concentrations over the northern U.S. and moving toward the east is typical of patterns produced by Russian atomic tests.

Film Production

A simple copying process transfers the dd80 35 mm film strips onto 16 mm movie film. To assure even flow of the picture, 15 film frames were interpolated linearly between each daily pattern to give 16 frames per day on the finished film. Prior to copying onto movie film, the dd80 superimposed the desired weather data––in this case 500 mb pressure contours––and an outline map of the U.S. over the dot patterns. The pressure data were taken from NMC records kept by the NCAR Computing Facility. Since weather maps are available twice daily, 7 frames were interpolated between half days of data. Notations were also entered for the dates and locations of atomic tests. Optimum viewing speed for the movie films is 25% below normal projection rate.

Further development of Blifford and Burgmeier's methods should enable maps of many kinds of statistical descriptors to be produced, making possible quick and convenient visual interpretation of large data stores otherwise likely to remain obscure. An important advance would be to use color plotting to allow simultaneous comparison of a larger number of variables. The same methods can be used to show the results of various data analysis techniques. And by recognizing the major characteristics of the data, the experimenter can locate specific features needing closer investigation. •

Statistical Study of Balloon Performance



As part of its program to determine methods of improving balloon performance, the NCAR Scientific Balloon Facility recently carried out a statistical study of 634 balloon flights to identify correlations between various flight factors and balloon failure. Data for the study were taken from a computer file of balloon performance information covering several years of flight operations. While statistical analysis does not actually establish causal relationships, it can identify factors possibly related to failure and indicate areas warranting further examination.

Statistical Method

A set of 46 numerical factors, or regressor variables, was examined by means of a stepwise regression program designed to retain only that combination of variables contributing significantly to balloon failure. All the regressor variables were chosen to represent physical characteristics of the balloon during manufacture, shipping, or flight, as well as conditions of flight environment. Regression equations were derived from the program, relating the retained variables to changes in the dependent variable, failure. The significance of each regressor variable was tested by an F test, calculated at the 5% level. Regression equations were determined for several balloon categories, shown as column headings in the accompanying table. Non-quantitative factors such as balloon manufacturer, balloon film material, etc., were also analyzed, using residuals from the regression analysis.

Correlations Low

The analysis revealed that although correlations between the retained variables and balloon failure were statistically significant, they were without exception low. Taken together in the regression equation for all balloons, the correlations explain less than 16% (R^2) of the variance in failure.

As had been commonly supposed, increased balloon size correlated with increased balloon burst rates. Among the balloon size parameters, surface area was the most significant for taped balloons, while volume was most significant for tapeless balloons. Reinforcement of the balloon top with a cap correlated with balloon success. Balloon failure due to leaks showed an entirely different pattern from failure due to bursts, and correlated most significantly

BALLOON TYPE		TAPED		TAPELESS		ALL BALLOONS		TAPED	TAPELESS	ALL BALLOONS
FAILURE TYPE		BURSTS	LEAKERS	BURSTS	LEAKERS	BURSTS	LEAKERS	ALL FAILURES		ALL FAILURES
REGRESSOR VARIABLES										
SIZE VARIABLES	SURFACE AREA	(−) 0.076		(+) 0.028		(−) 0.077		(−) 0.088		(−) 0.086
	VOLUME			(−) 0.110					(−) 0.092	
CONSTRUCTION VARIABLES	NO. OF GORES	(+) 0.025				(+) 0.018		(+) 0.012	(+) 0.018	(+) 0.014
	GORE WIDTH								(+) 0.020	
	CAPPED	(+) 0.082				(+) 0.060		(+) 0.030		(+) 0.022
	TAPE STRENGTH		(+) 0.019				(+) 0.008			
	NO. OF DUCTS				(+) 0.035		(−) 0.028			
	DUCT AREA	(+) 0.010	(−) 0.059			(+) 0.006				
	DUCT DISTANCE ABOVE BOTTOM OF BALLOON				(−) 0.017					
LOAD VARIABLES	LOAD ON TOP		(+) 0.010		(−) 0.172			(+) 0.009	(−) 0.037	
	LOAD ON BOTTOM				(−) 0.014					
FLIGHT AND ENVIRONMENT VARIABLES	DATE OF LAUNCH			(−) 0.017						
	(DATE OF LAUNCH)^2	(+) 0.022		(+) 0.016						
	RATE OF ASCENT (LAUNCH TO 30,000 FT)			(+) 0.013						
	RATE OF ASCENT (AVG. 30,000-60,000 FT)				(−) 0.015			(−) 0.017		(−) 0.013
	AVG. TO MAX. ALTITUDE	(−) 0.024		(−) 0.029	(+) 0.015	(−) 0.026			(−) 0.021	
	THEORETICAL FLOAT ALTITUDE		(−) 0.009				(−) 0.013			
	TEMPERATURE AT LAUNCH					(+) 0.010				
	MINIMUM TEMPERATURE			(−) 0.023					(−) 0.011	
	LATITUDE		(−) 0.038				(−) 0.059	(−) 0.014	(+) 0.013	(−) 0.016
SIGMA "(BALLOON SHAPE FACTOR)"					(+) 0.041					
SQUARE OF THE MULTIPLE CORRELATION COEFFICIENT (R^2) FOR EACH COLUMN		0.24	0.13	0.23	0.31	0.20	0.11	0.17	0.21	0.15

Tabular values except R^2 (bottom line) are increases in the square of the multiple correlation coefficient of the variables selected by the stepwise regression program. This increase is an indication of the relative importance of the variables retained. Negative signs indicate a direct relation with failure, positive signs an inverse relation (i.e., favor balloon survival). R is the multiple correlation coefficient for all variables in a given column; R^2 is the proportion of variance in balloon failure explained by the group of factors in each column.

with latitude of flight. Among the non-quantitative factors not entered in the table, only the balloon material showed a statistically significant relationship to balloon performance, StratoFilm and VisQueen X-124 being superior to previously used polyethylenes

Conclusion

The low correlations between balloon variables and failure indicate that no outstanding cause of failure can be isolated. This finding provides an objective reply to the diversity of untested assumptions about single or dominant causes of failure, often expressed by workers in ballooning. The results demonstrate that failure can be ascribed to any one of many factors, some known, some probably not even suspected. Balloon flight planners must therefore continue to maintain thorough precautions in all matters pertaining to balloon integrity.

The Scientific Balloon Facility plans to continue recording balloon performance data, and if possible to implement a semiautomatic method of sequentially sampling balloon system performance. Frequent statistical examination of performance will make it possible to identify significant trends as early as possible. •

Scientific Ballooning Standards Committee

Representatives from eight organizations engaged in scientific ballooning and balloon manufacture have formed an *ad hoc* Scientific Ballooning Standards Committee to recommend uniform terminology, procedures, and hardware for the ballooning community. The purposes of the standards will be to improve communication, reduce costs, and increase reliability. The committee was formed in August 1968 by a larger group of representatives from the organizations who met to discuss the need for standardization in this growing field. The participants are: AFCRL, NASA, USAF Det. 31 6th Weather Wing, ONR, Raven Industries, Inc., G. T. Schjeldahl Co., Winzen Research, Inc., and NCAR. Chairman for the first term of a rotating chairmanship is Justin H. Smalley of NCAR.

The committee will meet every six months to act on measures suggested by subcommittees appointed to investigate particular standards. So far, subcommittees have been appointed for standardizing terminology for balloons and balloon design, electronics, and operations; for suggesting uniform balloon packaging methods; and for recommending safety procedures. The subcommittees reported their preliminary findings in February. The next meeting of the committee will be in August.

Once the committee has settled on standards agreeable to the eight member organizations, it will make its recommendations available for wider distribution. Recommended standards will not be mandatory, and will not seek to supersede standards already in use in some areas of ballooning. •

A New Electronic Barometer

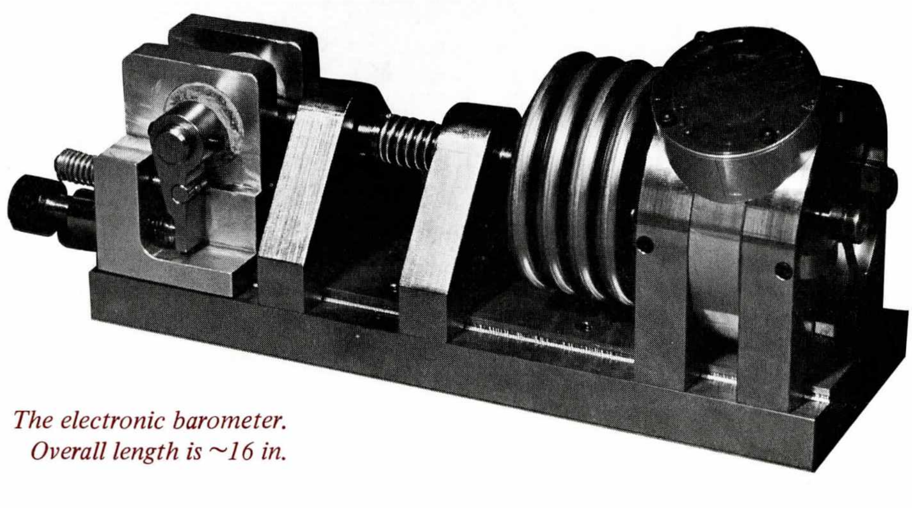
Tests were recently carried out aboard the CGSS *Discoverer* to evaluate a new electronic barometer for possible use in this summer's BOMEX experiments or for general use as an alternate to conventional aneroid or mercury barometers. The NCAR Design and Prototype Development Facility developed the barometer in response to a need expressed by BOMEX project planners for a pressure sensor of high precision. Arden L. Buck directed development of the instrument; Alan R. Owens was responsible for electronics design, and Charles C. Catlin for mechanical design.

The barometer's design specifications include absolute accuracy within 0.2 mb over a 100 mb range, resolution of 0.01 mb, and a response time of 0.1 sec. The output signal is a dc voltage, linearly proportional to barometric pressure, with V/mb sensitivity variable over a wide range. Calibration stability varies no more than 0.2 mb/day. The barometer operates on 110 V, 60 Hz power, or ± 20 V dc. It is designed to operate remotely or at unattended stations.

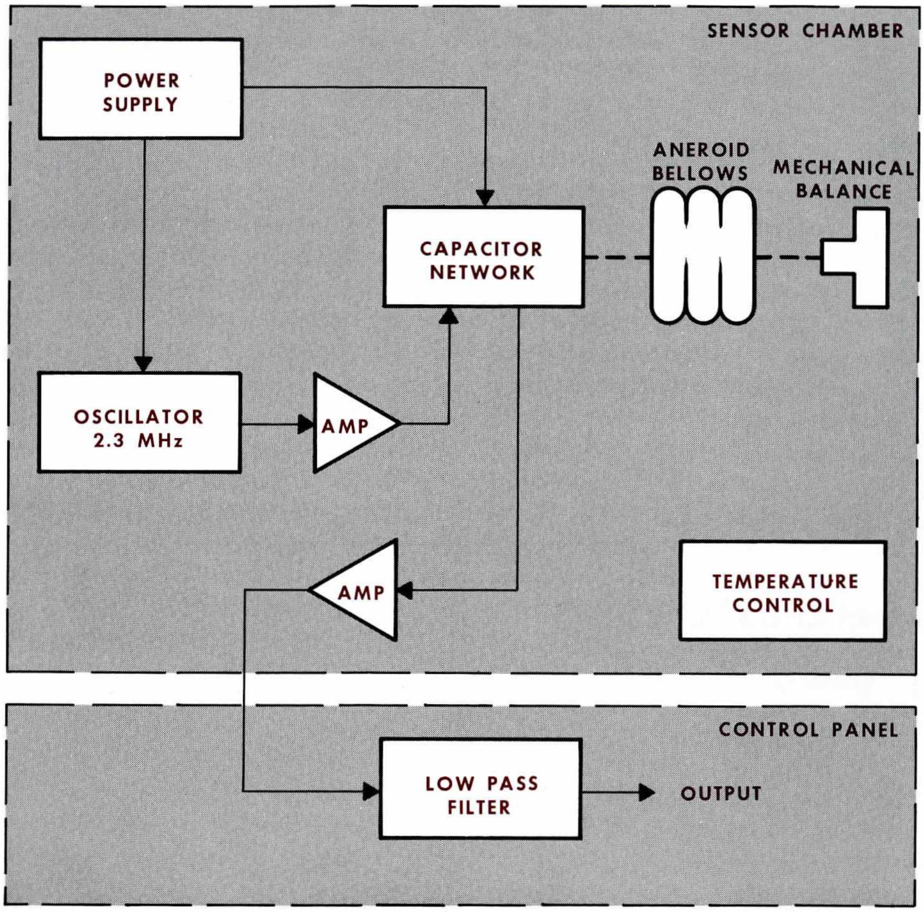
Construction

The barometer's sensor is a standard aneroid pressure element which is mechanically coupled to the center plate of a cylindrical differential capacitor. A displacement in the aneroid element caused by a change in atmospheric pressure thus increases the capacitance in one half of the capacitor and decreases it in the other. The capacitor sections are part of a twin-tee comparison circuit which is driven by a crystal controlled oscillator at 2.3 MHz. The resulting circuit output is a pulsating dc voltage proportional to the pressure. The voltage is smoothed and amplified for readout.

The barometer resembles a number of commercial devices which also measure the change in capacitance caused by a displacement of one of the capacitor elements. However, these devices use the capacitor plate itself—usually a



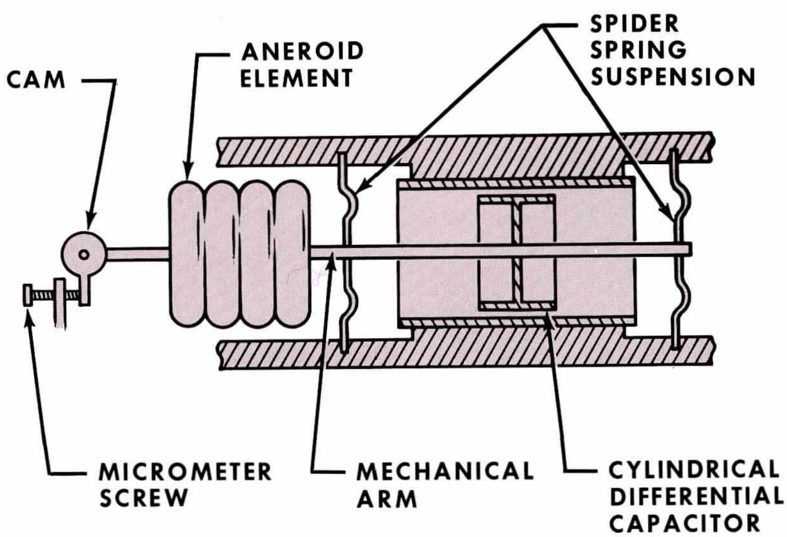
The electronic barometer. Overall length is ~16 in.



Block diagram of the electronic barometer.

thin, conducting membrane––as the pressure-sensing element. Pressure differences between the two sides of the membrane cause it to deflect and unbalance the capacitor. A bridge circuit provides the electrical output. The light weight and simplicity of barometers using a combined pressure-sensing and transducing membrane render the instruments less sensitive to tilt and jarring than the mechanically coupled NCAR barometer. However, the latter instrument provides other important advantages. Its cylindrical capacitor provides much higher capacitances and thus greater overall sensitivity than membrane-deflecting devices. In addition, the resolution and accuracy of the aneroid pressure element––a well corrected linear sensor which has been undergoing refinement for many years––are also better than those of membrane transducers. A third, though indirect, advantage is gained from the mechanical coupling between the aneroid element and the transducer plate. By disengaging the aneroid, the capacitor can be used to sense any other mechanical displacement with accuracies to within 1 μ in.

Detail of aneroid-capacitor link. Air pressure change sensed in aneroid element produces linear displacement of mechanical arm, deflecting middle plate of capacitor. The spider spring provides firm suspension for the arm without hindering minute axial displacements. Curved cam surface linking micrometer screw with arm allows calibration adjustments within a few μ in.



Operation

The sensor chamber is temperature stabilized, requiring a warmup time of about an hour. Micrometer adjustments balance the differential capacitor after warmup. However, linearity does not depend upon precision of null, so a rough balance is sufficient for relative measurements.

During evaluation tests of the instrument both digital and analog readouts are being used. Oscillator amplitude and chamber temperature are measured in addition to pressure. The outputs are fed to a strip chart recorder and commutator, with barometer outputs smoothed before commutating to prevent aliasing. The four commutator outputs are then digitized and printed.

In the final version of the barometer, output will be only in the form of analog voltages, the most convenient form for the instrument's projected use. •

Laser Standards Committee

Laser Standards Committee

A Standards Committee, created following the Conference on Laser Probing at NCAR in April 1968, has begun the task of compiling measurement standards for this still highly innovative branch of atmospheric research. The conference (see *Facilities for Atmospheric Research*, No. 6, September 1968) brought together for the first time the principal workers in laser probing. The university, government, and industrial scientists who participated have continued their association in a Group on Laser Atmospheric Probing. The Standards Committee of nine members is chaired by John A. Cooney, NCAR visiting scientist from RCA.

The committee has defined its principal role as that of a review board to act on suggestions from all members of the Laser Group; only with their full participation can the many areas needing attention be dealt with effectively. The committee also intends to act as a clearing house for the exchange of information and advice. Though a secondary function, such an exchange will benefit all laser users and will in some cases undoubtedly generate standardization through usage.

In a recent report to the Laser Group, the Standards Committee listed suggested work areas to be explored under the supervision of four subcommittees. Actual work will begin once group members have had an opportunity to comment on the proposed topics.

One subcommittee will attempt to catalog instruments available for measuring laser energy and power, and to study laser beam stability and methods

LOCATION	TRANSMITTER CHARACTERISTICS							RECEIVER CHARACTERISTICS								SPECIAL FEATURES	
	WAVELENGTH (Å)	ENERGY (J)	PEAK POWER (MW)	PULSE LENGTH (NSEC)	"Q" SWITCH	PULSE REPETITION RATE (PULSE/MIN)	TEMPERATURE CONTROL (°C)	OUTPUT BEAM COLLIMATOR (IF NONE, STATE BEAM DIVERGENCE)	APERTURE	TYPE OF OPTICAL SYSTEM	DIVERGENCE ANGLE (MRAD)	CENTER WAVELENGTH λ (Å)	FWHM (δλ)	TUNING	DETECTOR CATHODE	GATING MECHANISM (TIMING CONTROL)	
UNIVERSITY OF WISCONSIN MADISON, WISCONSIN 53706	6943	1	50.0	20	PASSIVE DYE	2	WATER COOLING	NO INFO.	6 IN.	NEWTONIAN REFLECTOR	5	6943	20A	NONE	S-20	NO INFO.	NO INFO.
NAVAL MISSILE CENTER POINT MUGU, CALIFORNIA 93041	6943 10600	>0.75 0.060	>5.0 5	>20 >20	PASSIVE DYE POCKEL CELL	4 600	± 0.2° WATER	8 IN. REFLECTOR 2 IN. REFRACTIVE	8 IN. 5 IN.	CASSEGRAINIAN REFRACTIVE	1.0 5.0	6943 10600	NO INFO.	± 2A NONE	S-20 S-1	NONE NONE	NONE
NCAR BOULDER, COLORADO 80302	6943 6943 } 3472 }	≈ 2 2.0 – 5.0 0.1	≈ 150 25 1.25	≈ 25 400	ROTATING PRISM AND SAT. DYE ROTATING PRISM	10 4	15° WATER BATH WATER BATH	NONE LASER CAVITY	60 IN. 30 IN.	CASSEGRAINIAN NEWTONIAN	≈ 10 12.0	6943 MULTIPLE WAVELENGTH	± 4A STEPWISE VARIABLE 12A – 150A	THERMAL NONE	S-20 S-20	NONE DYNODE GATING	COAXIAL AND PARAXIAL TRANSMISSION MODES OUTPUT DOUBLER
GENERAL ELECTRIC COMPANY SPACE SCIENCE LABORATORY PHILADELPHIA, PENNSYLVANIA 19101	6943 3472	1 0.1	75 7.5	25	DYE CELL AND ROTATING PRISM	5 PPS MAX.	35°F CHILLED WATER	LENS SYSTEM 0.4 MRAD DIV.	43 IN. EFFECTIVE	MODIFIED CASSEGRAINIAN	1.0	6942 3472	3A 120A @ 3472	TEMP. CONTROL	S-20	GATING OUTPUT OF PHOTOMULTIPLIER ANODE	TWO PHOTOMULTIPLIERS WITH SPLITTER
ESSA NATIONAL ENVIRONMENTAL SATELLITE CENTER WASHINGTON, D.C. 20233	6943	1	25 – 50	20 – 40	NO INFO.		THERMOSTAT WATER COOLING	NONE 3 MRAD	8 IN. TELESCOPE	NEWTONIAN AND OPTICAL TRAIN	NO INFO.	6943	± 10A	NONE	S-20	PULSE GRID AFTER 3 μSEC FOR 100 μSEC	NO INFO.
DEPT. OF PHYSICS AND ASTRONOMY UNIVERSITY OF MARYLAND COLLEGE PARK, MARYLAND 20742	6943	10	NO INFO.	~ 20	POCKEL CELL	3	± 0.2°	NONE 20 IN. TELESCOPE 3 OR 10 MRAD DIV.	8 IN. DIAM 20 IN. DIAM	NEWTONIAN BROKEN CASSEGRAINIAN	6 0.4	6943	10A	TEMP.	S-20	ELECTRICAL MECHANICAL	NO INFO.
ATMOSPHERIC PHYSICS AND CHEMISTRY LABS ESSA BOULDER, COLORADO 80302	6943	0.15	3	30 – 50	ROTATING PRISM (AND PASSIVE CELL IF DESIRED)	60	WATER COOLING	NONE <70 MRAD	85 MM DIAM	CASSEGRAINIAN CATADIOPTRIC	17.0	6943	10A	NONE	S-20	NONE	NONE
AEROSPACE CORPORATION LOS ANGELES, CALIFORNIA 90043	6328 6328 4880 } 5150 }	CW CW CW	1 30 3	CW	NO INFO.	CW	NO INFO.	NO INFO.	30 CM TINSLEY CASSEGRAINIAN TELESCOPE	TINSLEY CASSEGRAINIAN TELESCOPE	NO INFO.	6328 4880	3A 10A 30A 100A	NONE	NO INFO.	NO INFO.	NO INFO.
UNIVERSITY OF MICHIGAN MOUNT HALEAKALA OBSERVATORY WAILUKU, MAUI, HAWAII 96793	6943	>200 IN CONV. >20 IN Q SW.	≅ 400	≅ 50	POCKEL CELL	30	15° WATER COOLING	30 IN. CASSEGRAINIAN <10 MRAD	48 IN.	CASSEGRAINIAN	<0.2	6943	10A 20A 50A	TEMP. CONTROL	S-20	OUTGOING LASER PULSE TRIGGER "A" SCOPE AND COMPUTER	SHUTTER IN FRONT OF PMT QUANTUM EFFICIENCY OF PMT ≅ 5%
DEPT. OF PHYSICS BRIGHAM YOUNG UNIVERSITY PROVO, UTAH 84601	6943	25-IN NON Q SW.	NO INFO.	500	NO	1.0	THERMOSTAT WATER COOLING	NO INFO.	12 IN.	NEWTONIAN	8.5	6953	100A	TEMP.	NO INFO.	NO INFO.	BISTATIC SYSTEM
METEOROLOGICAL AND GEOPHYSICAL INST. JOHANNES GUTENBERG UNIVERSITY 65 MAINZ, GERMANY	6943	1	20	50	DYE CELL	1.0	WATER COOLING	NONE	1.1×10^3 CM^2 APERTURE AREA	MODIFIED CASSEGRAINIAN	17.0	6936	13A	NO INFO.	S-20	NO INFO.	PHOTOMULTIPLIER COOLED TO –78°C
NASA LANGLEY RESEARCH CENTER HAMPTON STATION, VIRGINIA 23369	6943 10600 } 6943 }	2 1	~ 200 ~ 50	10 – 20 30 – 40	POCKEL CELL PASSIVE CELL	~ 1 ~ 1	YES YES	5:1 610 MRAD ON BOTH	31 IN. 60 IN.	CASSEGRAINIAN SEARCHLIGHT	1 ~ 10	6943 ~ 6943	~ 20A 700A	YES NO	S-20 S-20	ROTATING SHUTTERS FOCUS GRID OF PHOTO-MULTIPLIER GATED	COOLED PHOTOMULTIPLIER
SCIENCE RESEARCH COUNCIL RADIO AND SPACE RESEARCH STATION DITTON PARK, SLOUGH, BUCKS, U.K.	6943	5	NO INFO.	500	ROTATING MIRROR	5	WATER CIRCULATION	12x NEWTONIAN TELESCOPE	0.3 M^2	4 f/6 MIRRORS WITH COMMON FOCUS	2	6943	10A	TEMP.	S-20	PHOTODIODE PROVIDES GATE SIGNAL	ROTATING SHUTTERS TO BLANK OFF RECEIVER DURING T_x PULSE
DOUGLAS ADVANCED RESEARCH LABORATORY HUNTINGTON BEACH, CALIFORNIA 92646	6943	1	50	30	SATURABLE FILTER	0.33	FORCED AIR COOLING	GALILEAN TELESCOPE	4 IN. 8 IN.	ASTRONOMICAL CASSEGRAINIAN	VARIABLE 10^{-3} TO 3×10^{-3}	6943	6943 ± 5A	NONE	S-20	NONE	MOBILE VAN
PHYSICS DEPT. UNIVERSITY OF THE WEST INDIES KINGSTON 7, JAMAICA	6943 6943 6943	(1) 3 (2) 12 (3) 1.5	NO INFO.	600 1000 400	ROTATING PRISM	3 10 1	THERMOSTATIC WATER CONTROL	0.4 MRAD 0.5 MRAD 0.2 MRAD	0.2 M^2 20 M^2 0.08 M^2	NEWTONIAN NEWTONIAN NEWTONIAN	0.4 0.5 0.2	6943 6943 6943	20A AND 4A ROTATION 20A		S-20 S-20 S-20	ROTATING MECHANICAL SHUTTERS AND DYNODE NONE	NO INFO.
UNIVERSITY OF ARIZONA TUCSON, ARIZONA 85720	6943	NO INFO.	100	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.	NO INFO.
BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK 11973	6943	0.5 TO 1.28 IN Q SWITCH 11.2 NORM. MODE	200	20	ROTATING PRISM AND PASSIVE CELL	60	WATER COOLING	NONE	ADJUSTABLE 165 MM MAX.	CELESTRON 6 TELESCOPE	NO INFO.	6943	18A	NO INFO.	S-20	NO INFO.	NO INFO.

The Laser Standards Committee has assembled a descriptive table of laser probing installations now in operation. Though the table is incomplete and may contain inaccuracies, it provides a useful summary of trends and progress to date. The committee estimates that up to 11 new laser installations will begin operation in the next year.

of calibrating total lidar systems.

A subcommittee on atmospheric composition standards will attempt to consolidate methods of appraising the atmospheric path transmission to and from the scattering volume, normalizing scatter data to absolute values, standardizing altitude resolution, and presenting data results.

A third subcommittee will compile signal detection standards, with initial emphasis on the detailed cataloging of the properties of all available photomultiplier tubes.

The fourth subcommittee will deal with frequency and cross-section measurement standards, including estimating allowable frequency uncertainty; determining, recording, and processing output frequencies in field use; and investigating natural relative calibration standards.

The Standards Committee does not expect formally documented standards to be ready for several years. However, it hopes by late 1969 to compile an informal collection of recommendations on various work procedures received from individual scientists in the group. •

Ballooning Publications Available

The Scientific Balloon Facility has a limited supply of NCAR publications on ballooning topics available for free distribution on request. The publications cover such topics as film testing, balloon shapes and stresses, launch methods, balloon-borne instrumentation, platform stabilization and orientation, and telecommand systems. A list of the available documents may be obtained by writing to:

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