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UCAR

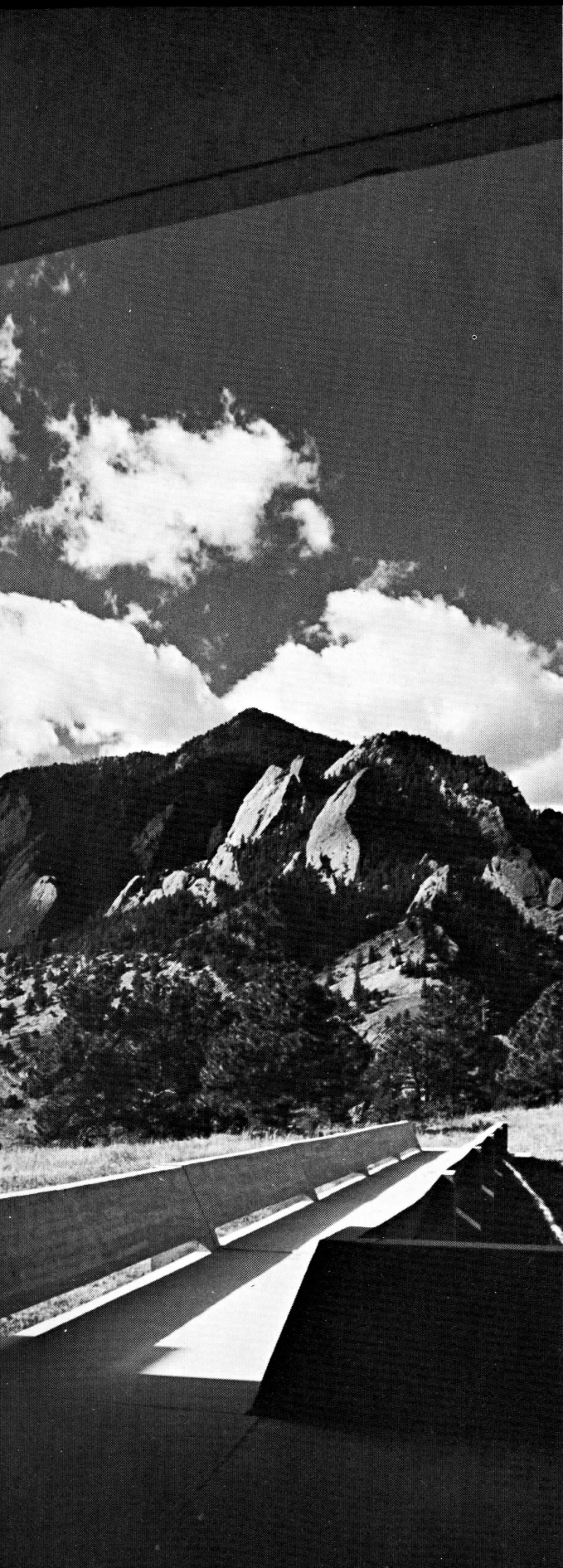
UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

Report for 1967

UCAR

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UCAR-1967

Just ten years have passed since the Committee on Meteorology of the National Academy of Sciences released, in January 1958, its report, Research and Education in Meteorology. Among the proposals in this report was a recommendation for the establishment of a national institute of atmospheric research, to “bring together scientists from meteorology and related physical sciences” and to “provide research facilities on a scale required to cope with the global nature of the meteorological problem.” The authors of the report suggested that such an intellectual center be established as an institute operated by a corporation sponsored by a group of universities under contract with the National Science Foundation.

The development of UCAR followed most of the guideposts established in the report. The University Committee on Atmospheric Research — the original UCAR prior to formal incorporation — was made up of representatives from meteorology departments of eleven (soon fourteen) universities, and met first in 1958. During the first six months of that year the Committee, with the encouragement of the National Science Foundation, reviewed the entire field of atmospheric research in great detail, and recommended a long-term basic research program directed toward important and fundamental scientific questions about the atmosphere, with the ultimate goal of making the atmospheric sciences fulfill their potential in helping solve the weather, water, and climate-related problems of mankind. The Committee drew attention to the urgent national need for greatly enlarged and improved programs of atmospheric research, and recommended the creation of a national institute of atmospheric research sponsored by interested universities. They realized that although much research could be conducted in universities, many projects in the field of atmospheric science were of too great a scope or demanded too wide a variety of disciplines to be attacked by individual university departments.

In 1959 the fourteen universities listed below became charter members of the University Corporation for Atmospheric Research, incorporated in Delaware:

University of Arizona
University of California
University of Chicago
Cornell University
Florida State University
Johns Hopkins University
Massachusetts Institute of Technology
University of Michigan
New York University
Pennsylvania State University
Saint Louis University
Agricultural and Mechanical College of Texas
University of Washington
University of Wisconsin

In 1960 the UCAR Trustees appointed the first Director of UCAR, who was commissioned to direct the research laboratory that was to be created. Later in the same year, the name National Center for Atmospheric Research was chosen for this scientific organization, and Boulder, Colorado was decided upon as the site for the main NCAR Laboratory. The National Science Foundation, as NCAR's sponsor, allocated funds to the new organization under a contract with UCAR. The following year, UCAR of Delaware was dissolved, and its assets transferred to a Colorado corporation also known as the University Corporation for Atmospheric Research, which had identical purposes with UCAR of Delaware.*

NCAR first shared quarters with the High Altitude Observatory, and then moved into other temporary quarters leased from the University of Colorado. Now, in just a decade, NCAR is established in permanent quarters near Boulder and has reached a vigorous level of effort in research and in establishment of research facilities. It is also beginning to serve as a focal point for university interests in the rapidly growing realm of atmospheric research.

*UCAR of Colorado is a restructuring of the High Altitude Observatory, Inc., founded in 1946 under joint sponsorship of Harvard University and the University of Colorado, with its major interests in solar physics and sun-earth relationships. The Observatory is now one of NCAR's research divisions, and all the physical assets and research programs of the High Altitude Observatory have continued under the control of the Trustees and Director of the Corporation under its new name.

THE STRUCTURE OF UCAR

UCAR, as outlined above, was first incorporated in Delaware in 1959, and moved to Colorado in 1961. In 1963, UCAR membership was opened to all United States universities with graduate programs leading to the doctorate in atmospheric sciences or closely related disciplines. Ten universities have joined since that time:

University of Alaska	1964
Colorado State University	1964
University of Colorado	1964
University of Texas	1964
University of Utah	1964
University of Hawaii	1965
University of Minnesota	1965
University of Denver	1966
University of Oklahoma	1966
University of Maryland	1967

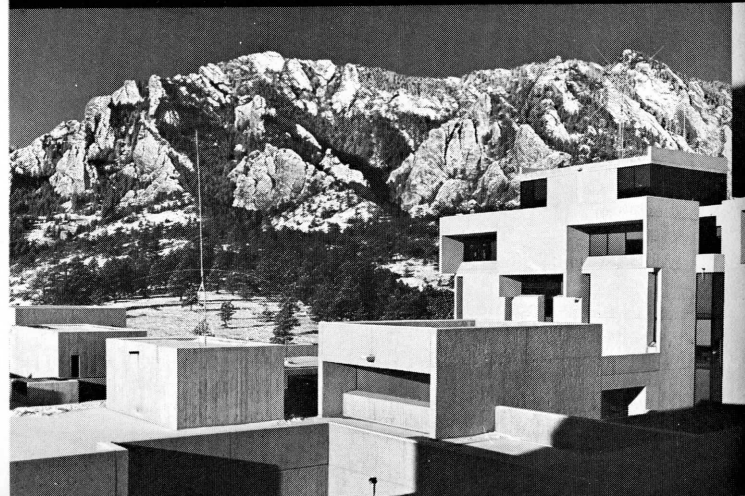
Between 1959 and 1967, the UCAR Board of Trustees was composed of two representatives from each of the fourteen charter universities, and six trustees-at-large. A Council of Members was established in 1963 to give new universities an advisory representation in management. It was made up of one scientist from each member university, old or new. Corporate reorganization within UCAR in 1967 now gives to the new universities an equal voice in corporate management of NCAR and other UCAR activities.

As part of the 1967 reorganization plan, the 34-member Board of Trustees held its last meeting on the morning of 9 May 1967. At that time the number of trustees was reduced to sixteen, twelve elected from representatives of the universities, three elected at large, and the President of UCAR, ex-officio. Under the new structure, the fifteen trustees other than the President will serve for three-year terms on a rotating basis: five trustees (four representing member institutions and one elected at large) will

be replaced each year by election at an annual meeting of member universities, at which each university will be represented by a scientist and an administrator. The functions of the Council of Members were assumed by the Board of Trustees and by the Members' representatives at their annual meeting.

In another change introduced into UCAR in 1967, the members amended the bylaws to make it possible, at the discretion of the Trustees, to separate the offices of the President of UCAR and the Director of NCAR, which have been held by the same person since the inception of NCAR. The Board of Trustees now has the step under advisement; it is expected that the Board will establish the two offices as full-time appointments, in order that each may be more effective. The President of UCAR will then be free to direct his primary attention to fostering the growth and progress of atmospheric science in the universities and in the nation as a whole, and to determining that the policies of the Board of Trustees and UCAR member universities are carried out. The Director of NCAR, appointed by the Board of Trustees upon the recommendation of the President of UCAR (and with NSF approval), will be responsible to the President for planning and directing NCAR's work, within the policies laid down by UCAR.

The Mesa Laboratory of the National Center for Atmospheric Research



NCAR, the scientific research center operated by UCAR, is the primary means by which UCAR promotes the advancement of atmospheric research. NCAR's principal research laboratory, on a pine-studded mesa near Boulder, Colorado, was completed in early 1967. Designed by I. M. Pei and Partners of New York, the Laboratory complements its setting and blends with the natural beauty of the 567-acre site donated by the State of Colorado. The two towers of the Laboratory, joined by a two-story center section, house scientific laboratories and offices.



Dedication ceremonies took place on 10 May 1967, on the occasion of the first meeting of the newly reorganized corporate members and trustees. Henry G. Houghton presents Mrs. Ralph S. Damon, whose late husband is honored in the Damon Room. Governor John A. Love is seated at right.

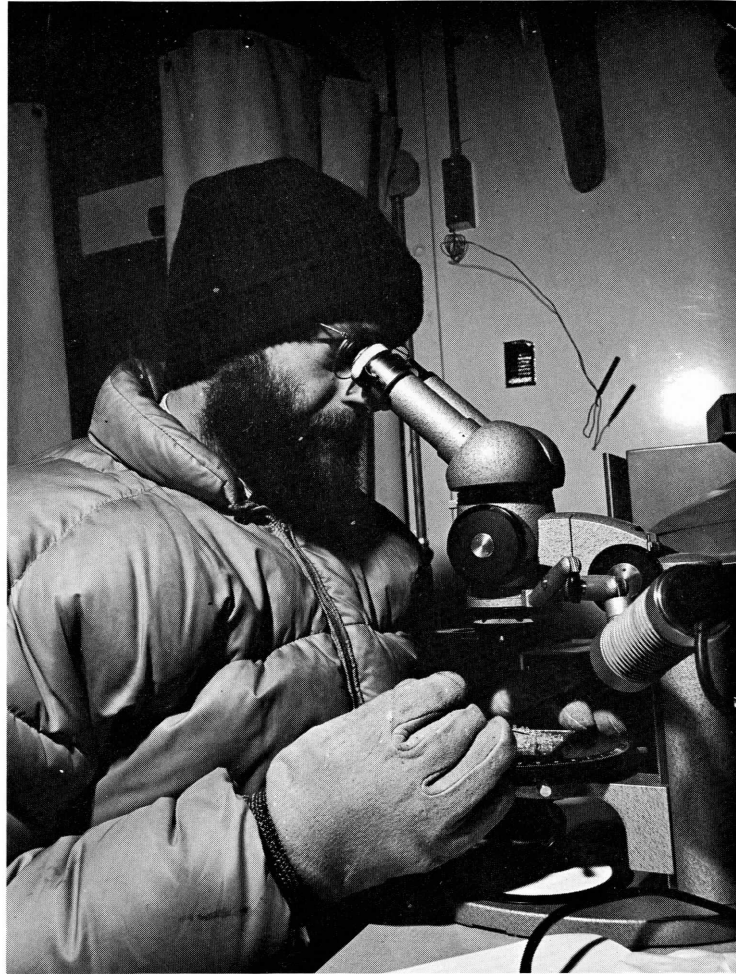


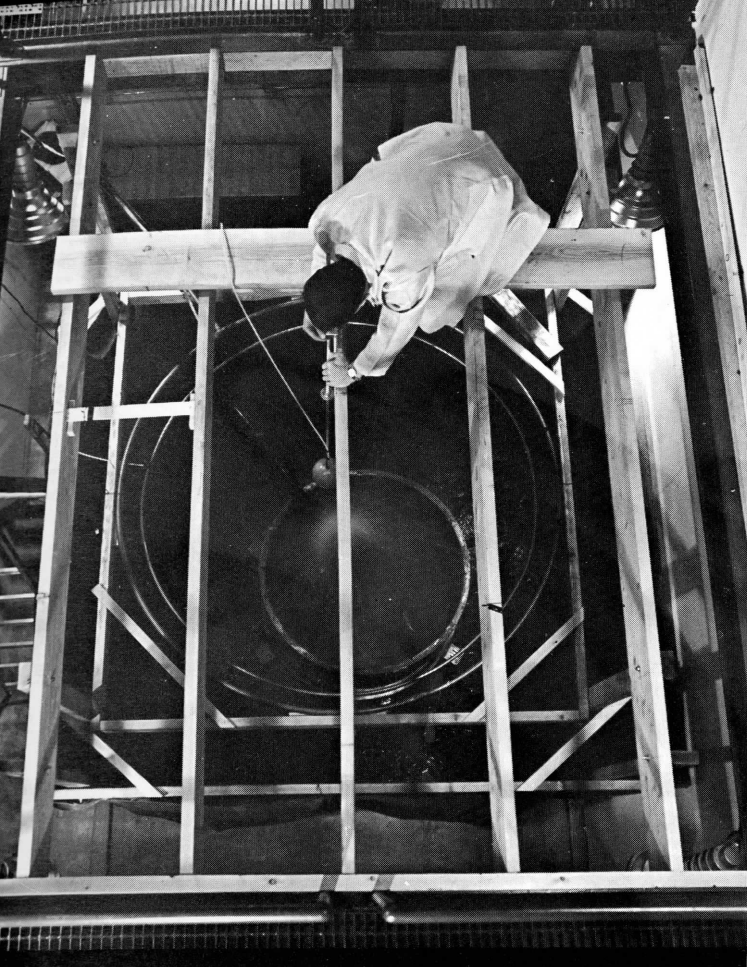
Walter Orr Roberts, Director of NCAR and President of UCAR, and architect I. M. Pei.



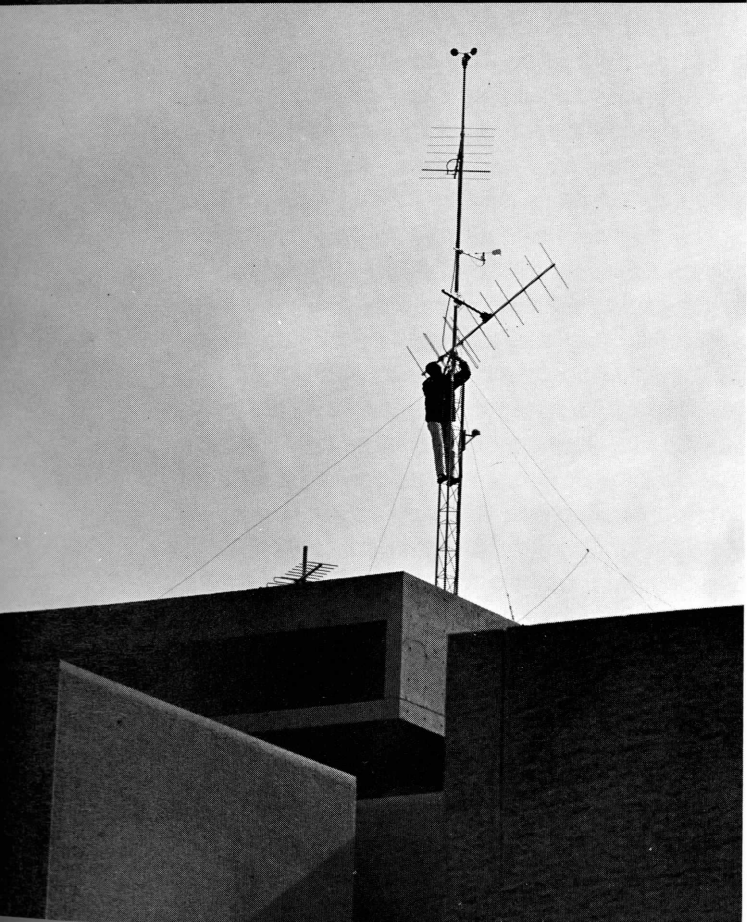
Five thousand visitors attended a public open house at the new building on 9 January 1967.

In the NCAR cold room, Charles A. Knight
studies the formation of ice
crystals and the structure of hail.





A thirty-five foot rainshaft in one of the Laboratory towers will facilitate studies of rain formation.



Sensors and aerals of the Laboratory of Atmospheric Sciences ornament NCAR's east tower.

NCAR RESEARCH HIGHLIGHTS —1967

NCAR's mission is to accelerate the advancement of basic knowledge in the atmospheric sciences through programs of fundamental research, and to assist experimental, observational, and educational programs of universities and other organizations by developing facilities for atmospheric research and by initiating and participating in large-scale cooperative research programs. To these ends, NCAR's divisions conduct or stimulate others to conduct investigations in many areas of atmospheric science.

The Laboratory of Atmospheric Sciences (LAS) spans the fields of atmospheric physics and chemistry and includes a large effort in atmospheric dynamics. Since LAS scientists are special-

ists in many fields, they have unusual opportunities to attack successfully problems demanding a multidiscipline approach.

The High Altitude Observatory (HAO) devotes most of its effort to solar physics, planetary studies, and solar-terrestrial relationships. These studies depend strongly on observations possible at solar eclipses and on daily coronagraph observations from stations at Climax, Colorado and Mauna Loa, Hawaii.

The Advanced Study Program (ASP), which supports visiting postdoctoral and senior scientists, conducts seminars, summer studies, and other activities designed to illuminate fundamental problems common to many areas of the atmospheric sciences.

The Facilities Laboratory (FAL) fulfills NCAR's responsibility to provide support research facilities and to develop new observational and data-handling techniques for NCAR scientists and those of other scientific and educational institutions. This division of NCAR at present operates four joint-use facilities: the Computing Facility, the Scientific Balloon Facility, the Research Aviation Facility, and the Field Observing Facility. FAL also includes the Global Atmospheric Measurements Program, which is developing new observational systems for obtaining atmospheric data on a three-dimensional worldwide scale, and the Design and Prototype Development Facility, a focal point for engineering and systems design within NCAR.

During 1967, NCAR research included studies of the gaseous composition of the atmosphere, air pollutants (both gaseous and solid), solar effects in geomagnetism, convective motions in the atmosphere, hail, climatic change, the impact of weather modification on human populations, and other theoretical, laboratory, and field work. Among the projects undertaken, only a few particularly wide in scope or significant in effect will be discussed here as highlights of NCAR research for the year. NCAR's scientific activities are reported fully in the Annual Report, NCAR Research and Facilities Programs.

An NCAR research balloon floats high over Texas. It is photographed from above by a camera on a smaller balloon. The conical top of the main balloon forces balloon material to unfold symmetrically during ascent, reducing stresses on the fabric. Cameras on the ends of a fifty-foot spar beneath the main balloon film balloon performance from below.



NCAR Beechcraft Queen Air aircraft are instrumented for atmospheric studies. Here, a boom supports an air pressure indicator ahead of aircraft-caused pressure changes.



THE LINE ISLANDS EXPERIMENT

When NCAR was proposed, one special attribute envisioned for it by UCAR and NSF was that it could serve as a center for planning cooperative field programs too large to be handled by single university departments, and when appropriate could coordinate the efforts and resources of universities, other research organizations, and the federal government in such programs.

The first large-scale program to be organized and managed by NCAR was the Line Islands Experiment. In 1967, participants from nearly two dozen universities, government agencies, and other organizations joined to conduct field experiments from the Line Islands, about 1,000 miles south of Hawaii. Edward J. Zipser, of the NCAR Laboratory of Atmospheric Sciences, served as scientific coordinator for the Experiment, and William S. Lanterman of the Facilities Laboratory was field program manager.

The Line Islands Experiment (LIE) was designed to increase knowledge of the equatorial trough zone, a data-poor region as far as meteorology is concerned, but a region that plays a critical role in atmospheric circulation. In the vicinity of the Line Islands, this zone is characterized by a convergence of the northeast and southeast trade winds, and is important as the region where large quantities of moisture and heat are transported upward through the atmosphere to levels where diverging winds bear them poleward into the temperate latitudes. The program was scheduled to take advantage of the best satellite cloud photographic coverage yet available, the pictures from NASA's ATS-1 satellite, in a synchronous orbit (stationary with respect to earth), 22,300 miles above the equator, almost over the Line Islands. Equipped with a camera designed by Verner E. Suomi of the University of Wisconsin, this satellite is capable of transmitting cloud cover pictures of the entire Pacific Ocean at twenty-minute intervals throughout the daylight hours.

The Line Islands Experiment was proposed by university, government, and NCAR scientists meeting at NCAR in August 1966. The ATS-1 was scheduled for launch in December 1966, and no one could promise how long its camera would operate, nor, until after the launch, whether it would operate at all. The scientists were eager to begin the Experiment as soon as possible after the satellite was stabilized in orbit and transmitting pictures,

especially as the trough zone, swinging north and south with the seasons, is best developed in the Line Islands region in winter and spring.

With only about six months available between initial planning and the beginning of the observing period, NCAR assumed the role of coordinating agency, and reprogrammed its own research funds, equipment, and staff members to fill many of the needs of the Experiment. Additional funds were provided by the National Science Foundation. A preliminary survey indicated that bases could be established on Christmas, Fanning, and Palmyra atolls. These islands, spaced about 200 miles apart, were well located for the Experiment because Christmas is actually slightly south of the trough zone, Fanning is normally in the trough zone during the winter and early spring, and Palmyra is in it most of the year.

Some 120 people from NCAR, universities, government agencies, and private contractors manned the three island stations from mid-February to the end of April. The Army, Navy, Air Force, Air National Guard, and Coast Guard flew support and weather missions, and equipped and manned ground stations. NASA loaned satellite readout equipment for Palmyra Island, so that pictures from the satellite would be available directly. The ESSA ship **Surveyor** joined the expedition for about a month, taking station about 250 nautical miles northeast of the Line Islands to make a series of air and sea soundings. An NCAR aircraft was flown to the islands for use in data collection — it flew 60 scientific missions in 53 days, mostly out of Palmyra. A Woods Hole Oceanographic Institution research aircraft also participated, flying out of Christmas and Canton Islands.

A number of scientific groups collected data at the three islands, and thousands of photographs were made from the islands, the **Surveyor**, and the aircraft. Data brought back from the Line Islands have been catalogued and are now being analyzed by participating scientists. Some of the projects undertaken are:

- Edward J. Zipser, Henry van de Boogaard, Roland A. Madden, and Frank E. Robitaille of NCAR are analyzing time and space scales of tropical circulation in

the Line Islands region, and the structure and mechanics of disturbances in the winter equatorial trough zone, including the role of convection.

- Irving H. Blifford, Jr. and Julian P. Shedlovsky of NCAR are analyzing aerosol samples collected during the LIE.
- Colin S. Ramage and Ronald C. Taylor of the University of Hawaii are undertaking an analysis of large-scale weather patterns over the Pacific Ocean during the LIE period. They are also considering instrumentation desirable for future tropical field programs.
- Verner E. Suomi and several other University of Wisconsin scientists are studying the effectiveness of the synchronous satellite as a meteorological tool. They are also investigating cloud motions and development in the tropics.
- Tetsuya Fujita and Dorothy L. Bradbury of the University of Chicago are developing techniques for study of cloud motions and development as observed by the synchronous satellite, partially through the analysis of photographs taken from Maui during the LIE.
- Stephen Cox of the University of Wisconsin is analyzing radiometric data collected by surface and balloon-borne instruments, and is evaluating the adequacy of operational radiosonde data for tropical field programs.
- Robert A. Ragotzkie and Krishna Menon of the University of Wisconsin are studying the large volume of radiometric sea-surface temperature data obtained from the NCAR aircraft.
- Andrew F. Bunker of Woods Hole Oceanographic Institution is analyzing most of the data collected by the Woods Hole aircraft.
- William E. Marlatt and William M. Gray of Colorado State University are analyzing radiometric sea-surface temperature data collected by the Woods Hole aircraft.
- Aylmer H. Thompson of Texas A & M University is

studying large-scale meteorological phenomena of the equatorial trough zone, using satellite and aircraft data.

- Mariano A. Estoque of the University of Miami is working with serial double-theodolite pibal data taken from Christmas Island, to learn more about the structure of the atmospheric boundary layer near the equator.
- Klaus Wyrtki of the University of Hawaii is analyzing oceanographic data collected by the **Surveyor**.

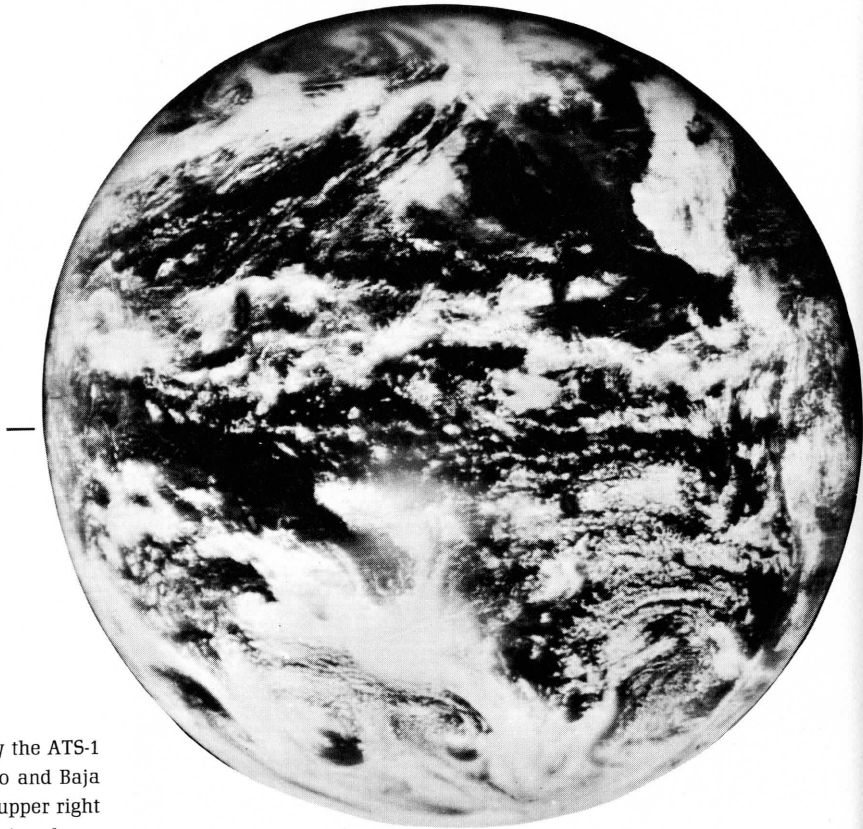
This list is by no means complete; many other scientists, including quite a few who did not participate directly in the Line Islands Experiment, have expressed an interest in studying and analyzing the data obtained.



Palmyra Island, Lat. 6°N, Long. 162°W, was one of the bases of operation for the Line Islands Experiment. The World War II airstrip was rehabilitated for use by supply aircraft. Photo courtesy of Bob Kendall.



An Air National Guard C-97 flew weekly supply missions to Palmyra from California and Hawaii.



The earth, as photographed by the ATS-1 satellite. The coast of Mexico and Baja California are visible in the upper right quadrant; the coast of South America shows at the lower right. Australia and China are cloud covered but within range of the camera. The Line Islands, too small to show, would be almost exactly in the center of the photograph. The band of cloudiness north of the equator indicates the position of the trough zone.



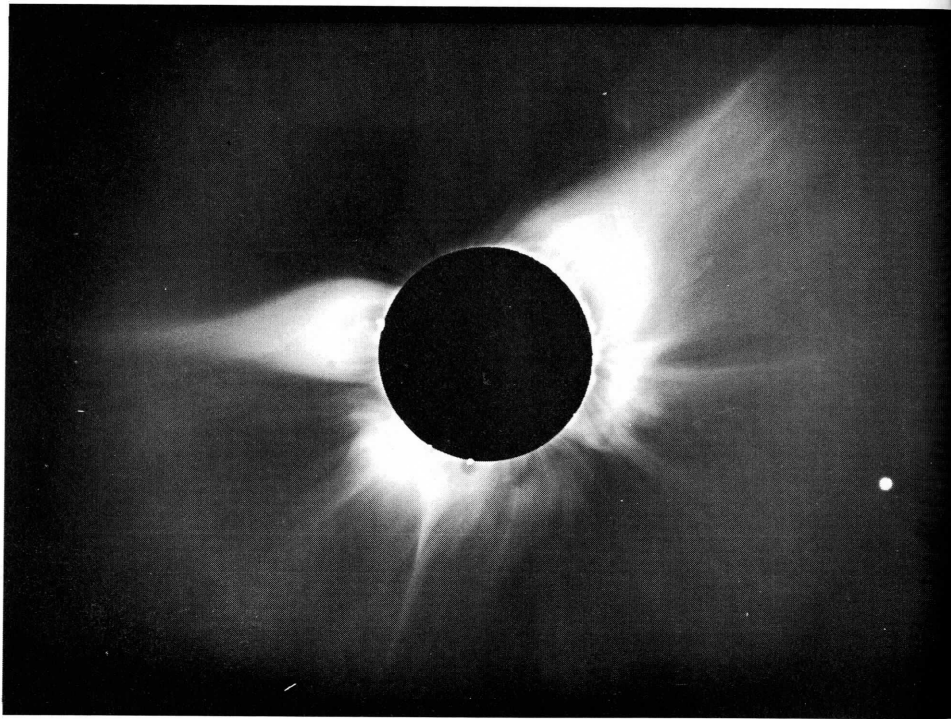
Sgt. J. Nichols of the Army Meteorological Service checks MRI equipment on Fanning Island. Eight MRI stations collected wind, temperature, and rainfall data automatically during the Line Islands Experiment.



Ralph L. Coleman checks a time-lapse camera on Fanning Island. This camera was one of six used to record cloud cover over the islands.

ECLIPSE EXPEDITIONS

In November 1966, the High Altitude Observatory sent several expeditions to observe a total eclipse visible from certain parts of South America, and to carry out a variety of experiments relating to the corona and to the earth's upper atmosphere. Analysis of data from these expeditions has been a major task for HAO in 1967.



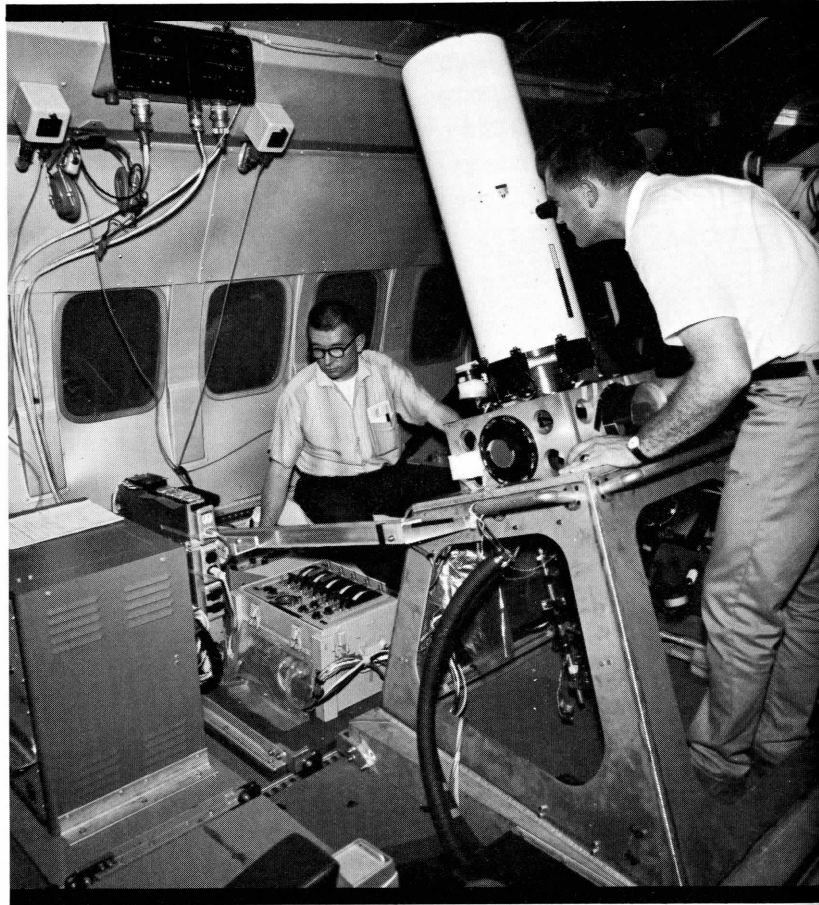
The photograph above, made in Bolivia by Gordon A. Newkirk, Jr., shows on a single exposure the fine structure of the corona from near the solar disk to a distance of about 4.5 solar radii. The difference in intensity of the light from these two regions is on the order of ten thousand to one. Although the

human eye can register this wide range, photographic film cannot. To obtain this photograph, Newkirk used a graded filter which was very dense near the center and decreased in density toward its outer edges. Attached to a simple white-light telescope, the filter balanced the variation in intensity and recorded the structure of the corona as it has never previously been revealed on any single photograph.

Another member of the Bolivian expedition, J. M. Malville, obtained photoelectric measurements of the $\lambda 5303$ and $\lambda 10747$ coronal lines in order to measure the polarization of these emission lines and determine the iron abundance in the corona.

John W. Firor and John A. Eddy of HAO conducted an eclipse experiment from a NASA Convair 990 jet research aircraft flying out of Porto Alegre, Brazil. They sought to record the polarization of light in a coronal Fe XIII line of the solar spectrum. At jet aircraft altitudes there is relative freedom from dust and cloudy skies, both of which degrade surface-based observations of the corona. An aircraft can also prolong the time of totality for several minutes by flying along the eclipse path. This was the Observatory's first experiment with a gyro platform — a telescope platform stabilized against aircraft motions. Results show that the direction of polarization is quite variable, apparently responding to the intensity and direction of magnetic fields in the solar corona. They strongly indicate the potential value of further airborne astronomical experiments.

Aboard a NASA Convair jet research aircraft,
Robert H. Lee and John A. Eddy prepare
NCAR equipment for eclipse observations.
Photo courtesy of NASA.



TROMEX PLANNING MEETING

In September 1967, NCAR was host to 75 scientists from U.S. universities and government laboratories, who gathered to continue planning for a large-scale tropical meteorological experiment to be conducted about 1972. This group, the originators of the Line Islands Experiment, now propose an experimental program known as TROMEX, which is expected ultimately to involve research groups from Japan, Australia, New Zealand, France, and perhaps other countries. The object of the TROMEX program is to study more intensively than ever before the interactions between motions of various scales in the tropical atmosphere.

Starting basis for the TROMEX discussions was a review of the Line Islands Experiment. It was followed by a summary of plans for tropical experiments in the vicinity of Barbados, to be conducted by Florida State University in 1968 and by ESSA and other government groups in 1969. Three working groups then discussed the essential problems of boundary layer and flux measurements, meso-scale interactions, and influences of the tropical atmosphere on the general circulation.

In addition to providing an abundance of new data on tropical processes, TROMEX will help to determine the kind of observational network which will be required in the mid-1970s during the Global Atmospheric Research Program (GARP), now being planned jointly by the World Meteorological Organization and the International Council of Scientific Unions. NCAR's Laboratory of Atmospheric Sciences and Facilities Laboratory plan to participate in and support GARP, which has as its purpose the advancement of understanding of the large-scale circulation of the earth's atmosphere.

CORONAGRAPH RESEARCH

Although a natural total eclipse of the sun provides the best opportunity for observing the fine structure of the corona, the rarity of natural eclipses makes it impossible to deduce from them the day-to-day changes in the corona. For more than twenty-five years, HAO has made coronal observations from Climax, Colorado, on the Continental Divide at an elevation of more than 10,000 feet. Here a 16-inch eclipse-making telescope known as the coronagraph, in conjunction with such equipment as a birefringent filter, a spectrograph, and a magnetograph, is used to study various features of the corona and the changes that take place in them over long periods of time.

A second solar observing station is operated by an HAO group on Mauna Loa, Hawaii. An electronic coronagraph known as the K-coronameter, or koronameter, is used to study that portion of the corona formed by sunlight scattered by electrons.

An HAO group headed by Newkirk is planning to place a coronagraph aboard an earth-orbiting satellite, completely above the ocean of air that normally reduces the coronagraph's ability to create an artificial eclipse. This coronagraph will be one of several solar observing instruments aboard a manned spacecraft of the Apollo series, probably in 1970.



The Climax, Colorado observing station, at an elevation of 11,200 feet, was founded by Harvard College Observatory in 1940. It is now operated by the High Altitude Observatory as part of NCAR.



At the HAO koronameter station on Mauna Loa, studies of the K-corona give new knowledge of coronal temperature changes and the origin of radio noise bursts in disturbed coronal regions.

ATMOSPHERIC DYNAMICS AND THE CONTROL DATA 6600

NCAR has directed major attention to studies of the general circulation of the global atmosphere. During 1967, the atmospheric dynamics group at NCAR, under the direction of Philip D. Thompson, Akira Kasahara, and Warren M. Washington, has continued to work on mathematical models simulating the global circulation. Their models, one with two levels in the atmosphere and one with six, divide the earth's surface into a grid with intervals of five degrees of latitude and longitude. At each grid point, for each level, equations linking atmospheric parameters are integrated in steps that correspond to five minutes of real time. On NCAR's Control Data Corporation model 6600 computer, step-wise forecasts can be run on the grid pattern, giving computer-generated maps showing simulated pressure patterns for hundreds of consecutive days.

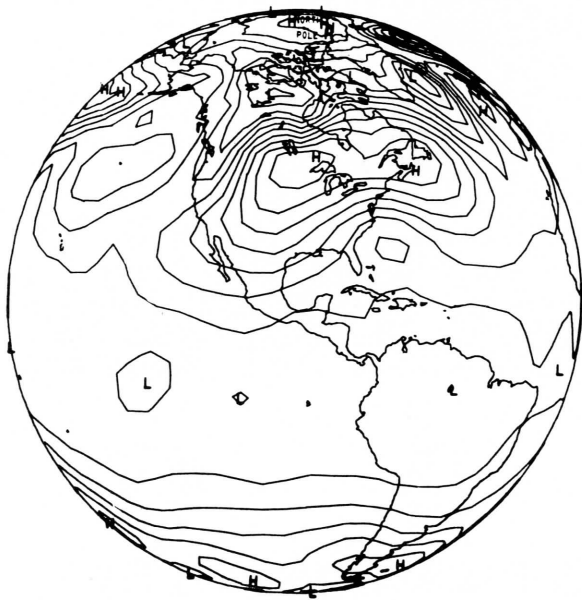
Kasahara and his group now plan to use real weather data to specify the initial state for computer-produced forecasts. By comparing computer weather patterns with real weather patterns, they hope to be able to pinpoint some of the major gaps in knowledge which, when remedied, will bring to long-range forecasting a greater degree of accuracy.

The dynamic framework of the NCAR model is similar to one proposed by the English meteorologist L. F. Richardson in 1922. Richardson's ideas about numerical weather prediction were three or four decades ahead of their time; there was no way to test their validity until the advent of the modern high-speed computer.* Since the early 1950s, however, several groups — at MIT, UCLA, ESSA, NCAR, and elsewhere — have used computers in developing mathematical circulation models.

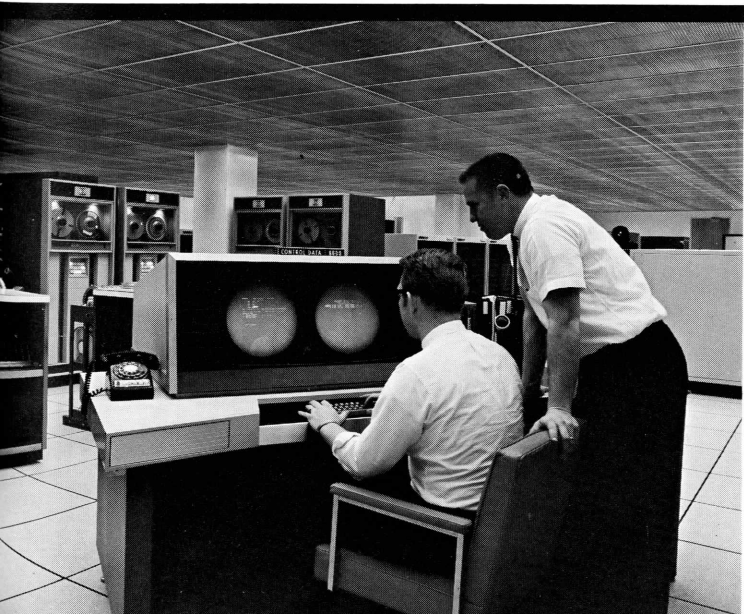
At NCAR, models of increasing complexity have been made possible by the steadily increasing capacity of the Computing Facility. The Control Data 6600 computer system now in use has proved to be three to five times as fast in routine operations as the Control Data 3600 used previously by NCAR scientists, and for certain network problems it is up to ten times as fast.

*Richardson predicted that "Some day in the dim future it will be possible to advance the computations faster than the weather advances and at a cost less than the saving to mankind due to the information gained. But that is a dream."

The NCAR Computing Facility is now working directly with groups developing even larger and faster computers, to insure that such machines can accommodate the needs of the atmospheric sciences. With advances in computer technology and meteorological data-gathering techniques, we can look forward to computer-produced long-range global weather forecasts of increasing detail and accuracy.



A computer-produced map showing sea-level pressure from the six-layer general circulation model, on an orthographic view of the earth.



In the NCAR computer room, Walter A. Lukasik and Raymond E. Wehry communicate directions to the Control Data 6600 computer.

ATMOSPHERIC TIDES

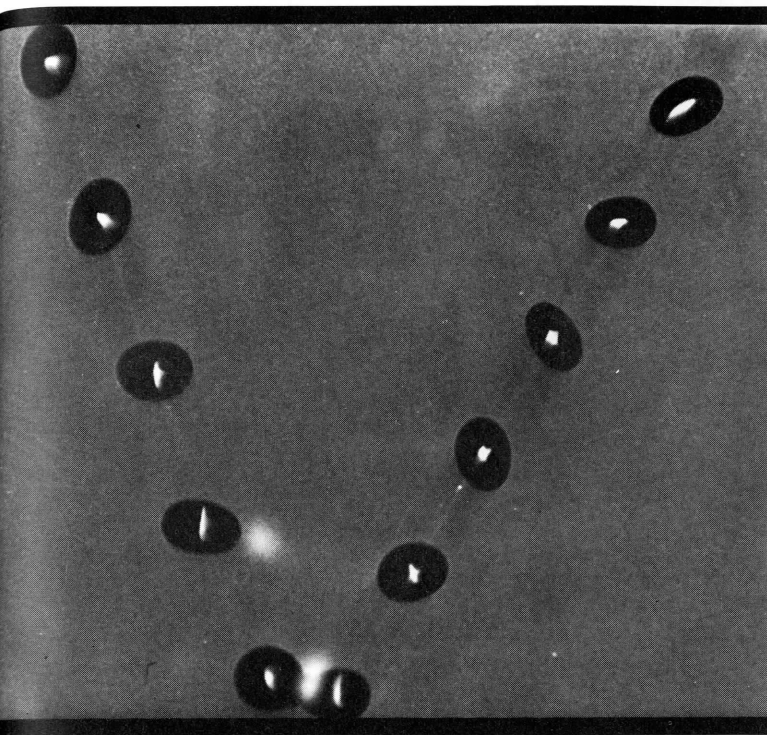
Bernhard Haurwitz of ASP has continued a numerical program to calculate lunar tides in the earth's atmosphere. These tides, revealed by barometric changes, result from the rotation of the earth through the moon's gravitational field. During 1967, the lunar barometric surface tide was determined at twenty-four new stations, mainly in the southern hemisphere, bringing to more than one hundred the total number of stations whose lunar tide is now known. These new computations will permit a meaningful analysis of the global distribution of the lunar barometric tide and its seasonal variation.

Thermal tides, due to rotation of the earth in the field of solar radiation, have also been detected. Thermal solar tides appear to become increasingly influential on atmospheric circulation with decrease in density—i.e., at higher elevations. At ionospheric heights thermal tides appear to account for a major part of the atmosphere's motion. Theoretical work conducted at NCAR by Richard S. Lindzen has dealt with the diurnal component of thermal tidal oscillations, and indicates that such atmospheric tides may have a maximum amplitude at the equator at elevations of about 95 kilometers, but that above this the amplitude probably decreases because of various dissipative processes.

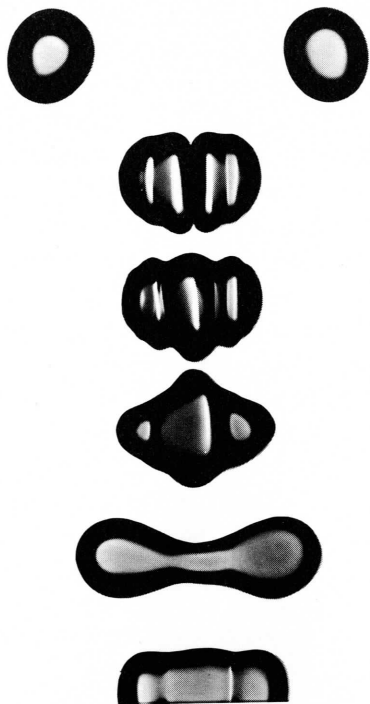
RAIN DROPLET GROWTH

In a program directed by J. Doyne Sartor, the contributions of various physical processes to droplet growth and rain formation have been studied theoretically and by photographing the behavior of charged and uncharged droplets as they collide. Charged droplets discharge upon coalescing, as do uncharged drops in electric fields, giving off electromagnetic radiation that could contribute to the apparent radiation temperature of clouds.

The main purposes of this work are to determine the effects of electric fields and droplet charges on the rate of growth of cloud particles to form rain, and to study the processes which produce electrification in thunderstorms. One by-product of the research has been the development of a novel method for measuring, from an aircraft, the size distribution of droplets in clouds.



A time exposure records the light generated by 200,000 encounters between tiny charged water drops. Superimposed on the time exposure is a single-flash exposure revealing the location of the drops. Drop radius is 0.08 mm.



As drops meet they merge in a characteristic pattern.

INSTRUMENTS AND TECHNIQUES

- Studies in 1956-1957 indicated the possibility of launching fleets of tough plastic superpressure balloons to drift at constant-density levels in the atmosphere for long periods of time, transmitting information on temperature, pressure, and winds to communication satellites for relay to central ground stations. This concept, known as GHOST (Global Horizontal Sounding Technique), promises an intensive and continuous harvest of meteorological data on a global basis, with virtually equal coverage for all parts of the earth. (Eighty-five per cent of the earth's area is now inadequately represented on weather charts.) Vincent E. Lally, one of the originators of the GHOST concept, is directing a program to develop an operational GHOST system. From March 1966 to the end of 1967, in cooperation with ESSA and the New Zealand Weather Service, 115 superpressure balloons were launched from Christchurch, New Zealand and McMurdo Station, Antarctica in the first extensive test of the balloon portion of the future system.

The balloons have performed well at altitudes above 30,000 feet. Six of them remained aloft for more than six months, and one flew for 351 days and made more than thirty circuits of the southern hemisphere. Most flights at lower altitudes ended after a few days because of icing; a variety of methods for combating the icing problem are now being tested.

- An ice nucleus counter, for use in the laboratory or on aircraft, has been developed by Gerhard Langer. By passing air through a cold chamber that is saturated with water vapor, so that ice crystals will form on nuclei present in the air, and then passing the air through an acoustic particle counter, it is possible to monitor continuously the concentration of ice nuclei in the air.

- The NCAR spectrophotometer, a highly sensitive and accurate instrument system for measuring and recording ultraviolet and visible radiation in the atmosphere, is being developed under the direction of Carlton L. Mateer and Claire E. Shelden, Jr. This instrument will be used in studying the ozone content of the atmosphere and its distribution throughout the day, at first from the earth's surface and possibly later from aircraft. A much smaller instrument, similar in principle to that developed at NCAR, is being built by NASA for use on a satellite of the Nimbus series.

- Refinements in a mobile laser system will make it possible to probe the atmosphere up to about 50 kilometers for clouds of dust, ice crystals, water droplets, and other aerosols.

- A balloon launch system known as Stonehenge has been developed by John W. Sparkman, Jr. and the late George P. Mellor of the NCAR Scientific Balloon Facility, and William E. Humphrey of the Space Sciences Laboratory of the University of California. This launch system compensates for variations in wind direction and isolates the payload from the balloon until the moment of launch. In tests conducted at Chico, California by the University of California, and at Palestine, Texas by the NCAR Balloon Flight Station, balloons carrying heavy yet delicate scientific instruments were launched gently, even in moderate winds. Loads of up to five tons have been lifted safely.



The instrument package on a GHOST balloon is solar-powered, and during the daylight hours it reports the angle at which sunlight strikes its sensor. From successive readings the position of the balloon can be calculated.

UCAR AND NCAR
EDUCATIONAL
ACTIVITIES

UCAR FELLOWSHIPS

UCAR fellowships are supported by grants from foundations and other organizations. The fellowship program was established to attract outstanding students into graduate study in the atmospheric sciences and related fundamental disciplines. The fellowships cover a year of study in any accredited graduate school, in fields extending well beyond the usual definition of atmospheric science. They include research appointments at NCAR for the summer preceding the academic year for which the fellowship is awarded and, if expected standards are met, for the summer following the fellowship year. While at NCAR, a UCAR fellow has the opportunity to work under the supervision of senior members of the NCAR scientific staff. In 1966-1967, three UCAR fellowships were awarded; four were awarded in 1967-1968.

ADVANCED STUDY PROGRAM

NCAR's Advanced Study Program draws together a small group of postdoctoral appointees from fields of physics, chemistry, and mathematics, and involves them in problems and techniques of the atmospheric sciences. Each participant is encouraged to pursue his own research, or to work in association with ASP, LAS, or HAO staff members. Informal seminars emphasize the body of theory common to the several aspects of the atmospheric sciences.

Postdoctoral appointments are made for one year, and may be extended for a second year. Eight appointees were at NCAR in 1966-1967, and nine in 1967-1968.

The ASP also sponsored its second summer colloquium in 1967, a series of lectures on the physics of the solar corona co-sponsored by the Astro-Geophysics Department of the University of Colorado. Ten students from nine universities were awarded summer fellowships to attend the program.

AFFILIATE PROFESSORSHIPS

The NCAR affiliate professorship program, established in 1965, permits NCAR staff scientists to establish formal ties with universities, to teach and otherwise participate in university activities. At the end of the 1967 fiscal year, ten NCAR scientists held affiliate professorships at as many different universities.

STUDENT WORK-STUDY PROGRAMS

Summer work-study programs for students interested in learning to use the tools of atmospheric research have been conducted by the Computing Facility and the Research Aviation Facility at NCAR. The Computing Facility program provides graduate students and advanced undergraduates preparing for scientific careers with experience in programming a large-scale computer. Eight students participated in the 1967 program. The Research Aviation Facility program, which enrolled four students in 1967, familiarizes graduate students with the skills and techniques required for efficient use of research aircraft in the atmospheric sciences.



A work-study group of visiting university students meets with Jeanne C. Adams in the Sydney and Katharine Chapman Room, to discuss computer techniques in the atmospheric sciences.

UCAR – Members' Representatives

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*After 19 December 1967:
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Cornell University
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Professor of Meteorology
University of Oklahoma
- Alan T. Waterman (deceased 30 November 1967)
Washington, D.C.
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NCAR – Senior Management Staff

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Director

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Associate Director and
Director, High Altitude Observatory

William W. Kellogg
Associate Director and
Director, Laboratory of Atmospheric Sciences

Philip D. Thompson
Associate Director and
Head, Atmospheric Dynamics Department, Laboratory of
Atmospheric Sciences

Daniel F. Rex
Associate Director and
Director, Facilities Laboratory

Bernhard Haurwitz
Director, Advanced Study Program

Fred W. Roecker
Assistant Director for Administration

UCAR—Financial Report

In fiscal 1967, contracts, grants, and gifts administered by UCAR totaled approximately \$14.2 million, including the management fee. The corporate management fee from the National Science Foundation for services rendered by UCAR in management of the National Center for Atmospheric Research was \$140,000.

On 1 July 1966, UCAR entered into its second five-year contract (NSF-C460) with NSF for the management and operation of NCAR. Funding from this contract, which is derived principally from a line item in the NSF request to Congress, totaled \$12.2 million in fiscal 1967. NSF funds are apportioned among the operating divisions of NCAR; salaries for the entire staff are provided through this contract. Approximately \$2.7 million was used for acquisition of the Control Data 6600 computer system and approximately \$800,000 for funding the Line Islands Experiment.

An additional \$1.9 million was received from contracts with NASA, the Air Force, the Office of Naval Research, and the National Institutes of Health. Included in this was \$570,000 from the Air Force to support the work of thirty-two High Altitude Observatory staff members at the Air Force's Sacramento Peak (New Mexico) Observatory. HAO also received approximately \$725,000 from NASA to design and construct a white-light coronagraph to be flown in an Apollo spacecraft in 1969. The Facilities Laboratory received \$360,000 from NASA to support NASA-sponsored balloon flights from NCAR's Balloon Flight Station at Palestine, Texas. Approximately \$245,000 was received from NASA, ONR, NIH, and the Department of the Army for specific research projects, with definite termination dates, in the Laboratory of Atmospheric Sciences and the High Altitude Observatory.

About \$33,000 in restricted gifts was received by UCAR in fiscal 1967. These gifts were primarily used to furnish the Sydney and Katharine Chapman Room and the Ralph S. Damon Room, conference and lounge areas in the new NCAR Laboratory building.

Property is recorded at cost except for property acquired from United States Government excess, donations, and grants, which is recorded at an appraised value of \$4,106,343. Title to the great proportion of UCAR property is vested in the National

Science Foundation and other government agencies, though, as shown on the UCAR balance sheet, some is owned outright by the Corporation. In accordance with practices generally followed by organizations similar to the Corporation, no provision has been made for depreciation of property.

At 30 June 1967 the National Center for Atmospheric Research had fulfilled purchase order and contract commitments of approximately \$2,274,160, and a contingent liability of approximately \$405,000 for employee vacations which would be satisfied by NSF in event of termination of the NSF contract for the convenience of the government.

The number of regular staff members employed by UCAR in the operation of NCAR was 490 on 30 June 1967. Of this number, 220 were scientists, engineers, and professional staff; 160 technical and maintenance staff; and 110 administrative, secretarial, and clerical staff.

UCAR's balance sheet as of 30 June 1967, and a statement of revenues and expenditures for fiscal 1967, are included at the end of this section.

University Corporation for Atmospheric Research

Balance Sheet
30 June 1967 and 1966

	<u>1967</u>	<u>1966</u>
ASSETS		
Current Fund		
Cash (includes \$230,000 in 1967 and \$229,455 in 1966 in interest-bearing deposits)	\$ 313,111	\$ 299,169
Receivables	1,782,030	4,353,708
Prepaid expenses	60,621	18,982
Total Current Fund	<u>2,155,762</u>	<u>4,671,859</u>
 Plant Fund — Property, Plant and Equipment		
Government-owned	16,494,037	11,788,223
UCAR-owned	2,692,194	2,719,439
Total Plant Fund	<u>19,186,231</u>	<u>14,507,662</u>
TOTAL.....	<u>\$21,341,993</u>	<u>\$19,179,521</u>

LIABILITIES AND FUND BALANCES

Current Fund		
Liabilities	\$ 370,995	\$ 575,953
Balance		
National Science Foundation other government contracts and grants (restricted)	1,495,784	3,843,087
Corporate (unrestricted)	288,983	252,819
Total balance	<u>1,784,767</u>	<u>4,095,906</u>
Total Current Fund	<u>2,155,762</u>	<u>4,671,859</u>
Plant Fund Balance	19,186,231	14,507,662
TOTAL.....	<u>\$21,341,993</u>	<u>\$19,179,521</u>

See Financial Report Commentary

University Corporation for Atmospheric Research

Revenues and Expenditures
and Changes in Current Fund Balance
for the Years Ended 30 June 1967 and 1966

	<u>1967</u>	<u>1966</u>
Revenues from Contracts,		
Grants and Gifts	\$14,182,672	\$11,629,599
Expenditures		
Operating		
Salaries and wages	4,612,387	3,744,659
Employee benefits	512,667	405,599
Materials and supplies	1,564,062	1,233,964
Services	3,715,788	2,568,726
Travel	490,828	399,929
Other	652,643	198,988
TOTAL.....	<u>11,548,375</u>	<u>8,551,865</u>
Property	4,945,436	4,149,678
TOTAL.....	<u>16,493,811</u>	<u>12,701,543</u>
Expenditures over revenues	2,311,139	1,071,944
Current Fund Balance,		
Beginning of Year	4,095,906	5,167,850
Current Fund Balance, End of Year	<u>\$ 1,784,767</u>	<u>\$ 4,095,906</u>

Changes in Plant Fund Balance
for the Years Ended 30 June 1967 and 1966

	<u>1967</u>	<u>1966</u>
Fund Balance, Beginning of Year	\$14,507,662	\$ 9,284,595
Acquisitions	5,362,864	5,795,313
Disposals	(684,295)	(572,246)
Fund Balance, End of Year	<u>\$19,186,231</u>	<u>\$14,507,662</u>

See Financial Report Commentary

HASKINS & SELLS

CERTIFIED PUBLIC ACCOUNTANTS

818 SEVENTEENTH STREET
DENVER 80202

ACCOUNTANTS' OPINION

Board of Trustees,
University Corporation for Atmospheric Research:

We have examined the balance sheet of the University Corporation for Atmospheric Research as of June 30, 1967, the related statement of revenues, expenditures, and changes in current fund balance, and the related statement of changes in plant fund balance for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the above-mentioned statements present fairly the financial position of the University Corporation for Atmospheric Research at June 30, 1967 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

July 27, 1967

Haskins + Sells