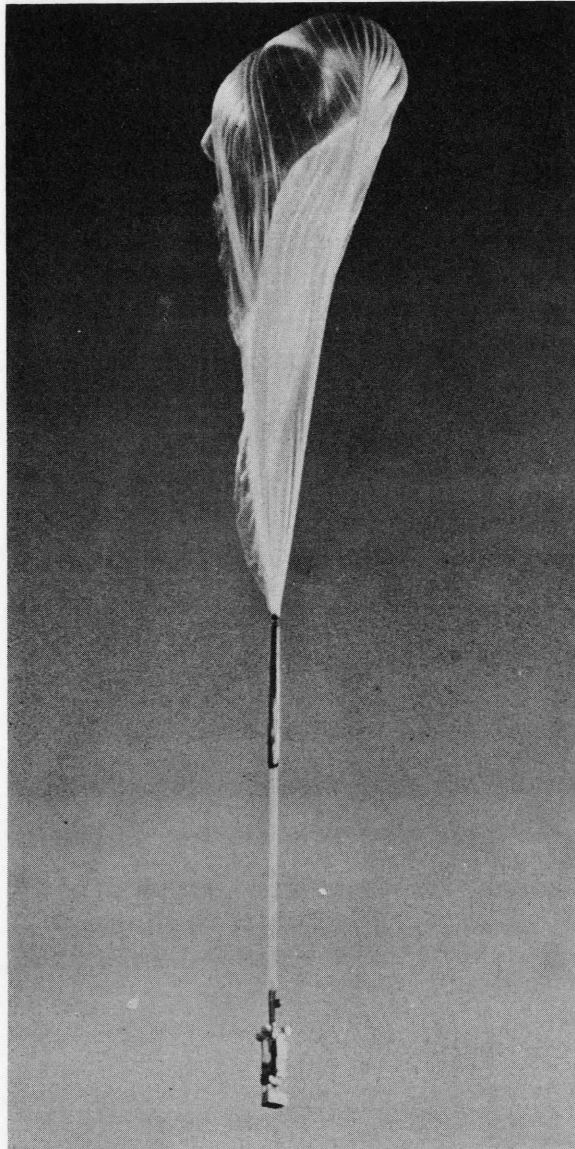


THE DIRECTOR'S REPORT

1 July through 31 December 1960



High Altitude Observatory

Balloon Flight

3 October 1960

*High Altitude Observatory
of the
University of Colorado
Boulder and Climax, Colorado*

The High Altitude Observatory is an independent non-profit research and educational institution closely associated with the University of Colorado. Its major research objectives are study of the sun and the sun's effects on the earth.

*Cover: The 3 October 1960 HAO Balloon Flight shortly after take-off. The flight attained an altitude of 80,000 ft. and allowed information to be obtained on the scattering of sunlight by dust in the upper atmosphere.

I. HIGHLIGHTS

Stratospheric Balloon Flights

The few years just past have seen momentous changes in astronomical and geophysical research. Shortly after World War II, many weapons of destruction were converted to instruments for scientific research. German-built V-2 rockets, quickly followed by newer and more effective versions, penetrated the upper reaches of the earth's atmosphere carrying valuable scientific payloads. Sensitive instruments for photographing heretofore inaccessible regions of the solar spectrum and for studying the tenuous atmospheric environment of the rocket itself either carried back with them or telemetered directly to the ground startling new information about the sun and our outermost atmosphere. These initial probes of outer space rekindled the astronomer's desire to overcome one of his most severe deterrents to research. The same atmosphere that shields us from harmful radiations from outer space and that makes life on Earth possible, dims, distorts, and, in some cases, completely obstructs the astronomer's view of the universe. No wonder, then, that he had long ago determined to some day carry out his observations from beyond the atmosphere.

Rocket probes of the upper atmosphere were preceded, of course, by both manned and unmanned balloons. The balloon offered the astronomer hope of rising above the denser regions of the earth's atmosphere, thereby obtaining less obscuration and, hopefully, less distortion of his telescopic images. Paradoxically, however, the techniques of instrumentation and the technical skill required to successfully utilize such an observing station had to wait for the emergencies of a World War before being developed. Thus, the basically more difficult observations from rockets preceded really successful balloon observations.

Orbiting earth satellites, heavily instrumented for scientific experiments, followed but a few years behind the first rocket probes. The next few years will, in all probability, see complete observatories orbiting the Earth and telemetering back valuable data. Each of the three space probes, balloons, rockets, and satellites, have continuing roles in astrophysical and geophysical research and will be increasingly used in the future.

On 10 September and 3 October 1960, under the scientific direction of Gordon Newkirk, the High Altitude Observatory successfully flew 1200 lbs. of scientific gear to altitudes of 80,000 ft. in 3 giant 1,000,000 cu. ft. unmanned balloons launched by General Mills, Inc. The instruments were carried in a tubular framework lent to us by Dr. Martin Schwarzschild of Princeton University, who had earlier carried a 12" telescope aloft in the same framework and photographed minute details of the solar surface with unprecedented success. His instrument, as ours, was accurately pointed at the sun by modified rocket-pointing controls developed at the University of Colorado. Our successful flights in September and October were pioneered by a manned balloon flight in August 1959. Robert H. Cooper of the High Altitude Observatory and Commander Malcolm Ross of the U.S. Navy flew at

that time to an altitude of 38,000 ft. to explore the feasibility of the unmanned flights that followed.(1)

The instrument package flown by Newkirk was designed for a dual purpose: (1) to study the brightness and polarization of the sky near the sun as a function of balloon altitude; and (2) to study the sun's corona from maximum balloon altitude. At 80,000 ft., the instruments had risen above all but 3 percent of the atmosphere. As a result, they observed a much darker daytime sky than is seen from the ground. The pilot flight of Cooper and Ross indicated that a coronagraph at 80,000 ft. should be able to photograph the faint solar corona directly against the dark sky background. If so, this would be a major advance in solar physics and solar-terrestrial relationships. The primary experiment in our balloon flights viz, the observations of sky brightness and polarization, was successful. Our attempts to photograph the corona at 80,000 ft. in the unmanned flights were not successful, however, because of excessive stray lights in the instruments. In future flights direct coronal photographs should be feasible.

One purpose in studying the sky brightness and polarization near the sun from high altitudes is to determine the total amount of small particulate matter in the outer atmosphere. Such particles may arrive in the outer atmosphere as dust stirred up from below or they may be the debris of outer space bombarding the atmosphere as the earth sweeps through its orbit about the sun. If they are of the latter origin, they may well show measurable increases during times of meteor showers when such small particles are known to bombard the earth. With this thought in mind, three flights were planned: one to follow shortly after the Perseid meteor shower on August 12; one to precede it; and one to follow it by a few weeks. Unanticipated delays, partly due to unfavorable weather, and an unsuccessful launching of the first flight that damaged the equipment prevented the proper timing of the flights. A series of numerous follow-up flights will be carried out during the summer of fall of 1961 using smaller balloons and much lighter equipment modified to measure sky brightness only. These flights should successfully tell us whether the particulate content of the high atmosphere does indeed change measurably as a result of meteor showers or other geophysical effects.

National Center for Atmospheric Research

Plans for the National Center for Atmospheric Research continue to develop at a vigorous pace. Several major decisions have been made during the report period.

The Board of Trustees of the new organization, meeting at Boulder in October, unanimously adopted the recommendation of its Executive Committee that the NCAR headquarters be located on the Table Mountain site at the foot of the Rocky Mountains immediately south of Boulder. This recommendation had been made after extensive studies by the Board's Site Committee,

(1) Director's Report, 1959, July-December - I. pp.4-5.

supported by detailed evaluations of several sites in the Boulder area by Ken R. White Consulting Engineers of Denver. The Boulder site was selected with the understanding that the State of Colorado will make it available free of cost for the use of NCAR.

The site will provide a near-ideal setting for intellectual work. It is isolated locally from noise, air pollution, and other adverse influences; yet it allows easy access to the High Altitude Observatory, the National Bureau of Standards Laboratories, and the University of Colorado, so that the close cooperation that is anticipated among these institutions will be facilitated by easy communication. Plans for building on the site will be developed during 1961, and it is anticipated that construction may begin in 1962.

Dr. Philip D. Thompson, a Colonel in the Air Weather Service now at the International Institute for Meteorology, in Stockholm, was appointed Associate Director of NCAR by unanimous vote of the Board. The appointment is necessarily contingent on arrangements with the Air Force to assign Dr. Thompson to NCAR, since he is still on active duty. It is expected that Dr. Thompson will join the Boulder staff in July, 1961. Most of Dr. Thompson's eighteen years in the Air Force have been devoted to meteorological research, particularly in the development of methods for using high-speed electronic computers in solving the difficult dynamical problems underlying weather prediction. In recognition of his outstanding service, he was awarded the USAF Legion of Merit in 1958, and also the Meisinger award of the American Meteorological Society in 1960. As Associate Director of NCAR, he will bring to the new institution a background of specialized knowledge and scientific achievement that will be a tremendous asset. Dr. Thornton C. Fry, formerly of Bell Telephone Laboratories and Sperry Rand Corporation, has been appointed to the NCAR staff as Consultant to the Director. Dr. Fry brings to the organization a rich background of experience in technical and scientific administration, as well as a professional specialization in mathematics of probability. He will advise on administrative matters, represent us in negotiations with other institutions and agencies, and will be in charge of our computer operations. He will also pursue his own research in probability theory. We are very fortunate to have the benefit of Dr. Fry's wisdom and experience, particularly during the period in which NCAR is being organized.

Plans are proceeding to accomplish the merger of HAO with UCAR as rapidly as practicable, along the lines indicated in the previous Director's Report. Such a merger is necessarily a complex and time-consuming procedure, and many detailed questions must be resolved in bringing it about. This reorganization is not expected to result in any appreciable change in HAO's research activities, except to stimulate more interest in interdisciplinary problems. NCAR and HAO will complement and strengthen each other, and together will constitute a versatile and resourceful research organization.

NCAR sponsored a conference on balloon flight facilities, which met at the National Science Foundation on 7 December. Representatives from most of the agencies and institutions that are concerned with heavy-load research balloon flights participated in the conference. The primary purpose was

to assess the availability of heavy-load research balloon facilities in the USA, to consider whether additional such facilities are needed, and to discuss how any additional facilities can best be organized. The discussions indicated that, while numerous and varied balloon facilities are available, better coordination and communication would be advantageous.

Proposals that NCAR should set up a Balloon Panel to advise on proposed flight programs, and a Balloon Engineering Group to develop launch capabilities and to disseminate information on flight experience, were favorably received. Roberts agreed to appoint a committee to study the feasibility of these proposals, and to report later on developments.

Dedication of the New HAO Quarters

The new High Altitude Observatory-Astro-Geophysics Building was dedicated on 8 October. Nearly one hundred friends of the Observatory joined staff and students to thank the donors for making the building possible and to celebrate the union of the entire HAO staff under one new roof.

The research staff and students moved into the building in early August from an old World War I temporary building on the campus and were followed immediately by the technical and business office staff who had been housed for many years in an old factory building off campus.

On the morning of dedication day ceremonies were held in the classroom of the new building. Judge William S. Jackson welcomed the guests on behalf of the HAO Board of Trustees and Dr. Robert L. Stearns, speaking for the donors, presented the building. Vice President Eugene H. Wilson accepted for the University. Dr. Donald Menzel, Director of the Harvard College Observatory, paid tribute to Captain Mary P. Converse in dedication a seminar room beautifully furnished by her and bearing her name.

In the evening all the staff, trustees and guests gathered for a dinner at which Dr. John W. Evans, Director of the Sacramento Park Observatory and long time friend and associate of the HAO, reviewed in a moving and amusing talk the history and purpose of HAO. Judge Jackson was master of ceremonies and President Quigg Newton of the University and Dr. Roberts both spoke briefly. It was a memorable day in the history of the High Altitude Observatory.

II. INSTITUTE FOR SOLAR-TERRESTRIAL RESEARCH

Activities carried out under the Institute for Solar-Terrestrial Research were diminished during the period of this report pending clarification of the administrative structure of the Observatory following the anticipated merger with NCAR. Now that this structure is more sharply in focus, we plan again to solicit the help of private sponsors, including the private foundations, industry and commerce, in supporting certain phases of the basic research programs of the Observatory. Work during this period was sponsored primarily by the American Railroads Association.

The first four years of the program, formally ending 31 December 1959, but carrying over into 1960, because of available added funds, were productive in basic research and in placing the Observatory's research programs on a broader basis than would be so if government contract sponsorship were our only major source of research support. Because of our feeling that this initial Institute period was very successful and proved to be one of the Observatory's most valuable research programs, it seems extremely desirable to continue it even after our merger with NCAR.

III. ASTRO-GEOPHYSICS

Chairmanship of the Astro-Geophysics Department of the University of Colorado remains in the hands of Donald E. Billings. The staff, as before, consists of senior research scientists from the Observatory and the Boulder Laboratories of the National Bureau of Standards. The department undertakes only graduate level teaching, and accepts only students working toward the Ph.D. degree. Nineteen students were enrolled at the beginning of the academic year.

Students with theses well under way and who are expected to complete their degrees within the next year are J. M. Malville, O. R. White, L. L. House, and J. A. Eddy.

Jack B. Zirker of the Sacramento Peak Observatory came to Boulder for the Fall semester to give a course in Stellar Atmospheres. The same course continued Spring semester with John Jefferies, of NBS, as lecturer.

IV. CLIMAX

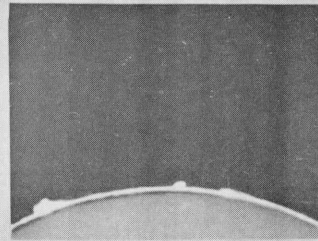
Watson continued as observer-in-charge at Climax. Manning resigned during the report period to resume his studies at the University of Colorado. He was replaced by Robert Eddy, who brings to the Climax staff an unusual backlog of experience in mechanical and electrical maintenance. James and Ritchie round out the observing staff.

Research programs utilizing the five-inch coronagraph, flare patrol and K-coronameter were active during this period. The vibration problems that have delayed full usage of the flare patrol instrument now seem to be under control, and the instrument is ready to go to work on its initially planned programs. A sequence of photographs of a flare and high-speed spray ejection near the west solar limb is shown in Figure 1. This event produced a sea-level cosmic ray increase, as did preceding flares on 12 and 15 November in the same region. The 20 November event is notable in that the region was two days (30°) beyond the west limb of the sun - and thus on the hemisphere of the sun facing away from the earth. The cosmic ray increase did not begin, however, until after the flare reached sufficient height to be visible at the limb ($\sim 100,000$ km).

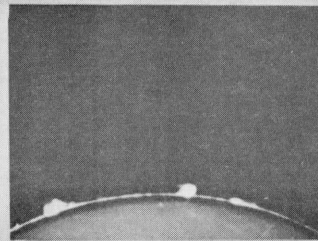
Members of the research staff in Boulder are traveling to Climax for observing programs with increasing frequency. This is due, in part, to a refurbishing of visitors' quarters in the converted laboratory formerly used by Yale University for cosmic ray research and now affectionately called the "Yale Shack".

THE EXPLOSIVE LIMB FLARE OF 20 NOV. 1960 - WEST LIMB, 25° NORTH-

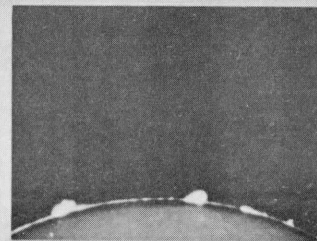
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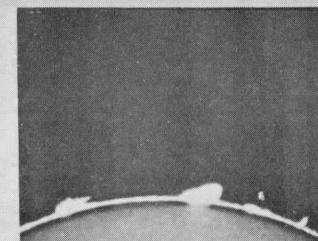
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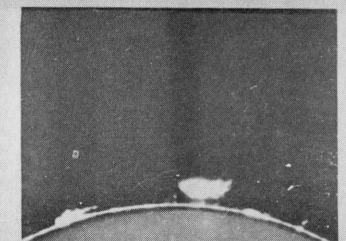
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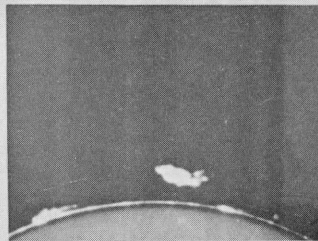
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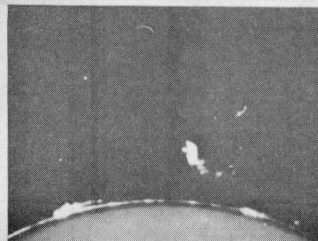
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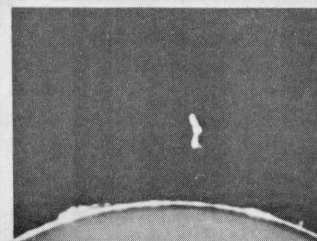
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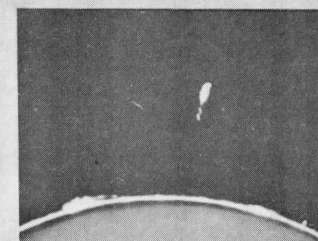
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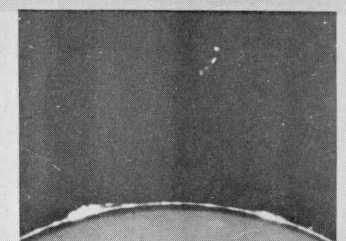
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2027



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2030 U.T.

FIGURE 1

Observations of the 20 Nov. 1960 limb flare made with the new Climax flare patrol.

Work on the new coronagraph and spectrograph for the 26-foot spar is progressing. Installation of some of the components will take place during the summer or fall of 1961.

Several important changes in the Climax operation were initiated during the report period. These have been followed up with the hiring of Frank Juan Sanchez as a permanent maintenance man. This relieves the observing staff of much of the time-consuming labor not directly related to observing programs. A move was initiated to transfer the Climax offices and dark room to the large dome in order to centralize the observers' activities. This move will be made during the summer of 1961. Also, plans were made for the construction of an electronics control and maintenance room adjacent to the small dome. This would have the advantage of better temperature control and easier maintenance of the guiding and programming equipment. Additional plans were made for the acquisition of a new house at the observing site to help solve the housing problems for observers and visiting research personnel.

V. PERSONNEL CHANGES

New Staff

On 21 July 1960, Mr. Kin-aki Kawabata of the Tokyo Astronomical Observatory, Japan, joined the HAO staff on a one-year appointment. While in Boulder, Mr. Kawabata has been working on various problems of solar physics using IGY data in the Solar Data Center at HAO and the Ionospheric Data Center at the National Bureau of Standards.

Mr. Hiroyoshi Tanabe, also of the Tokyo Astronomical Observatory, joined the HAO staff on a one-year appointment in September 1960. He has been working closely with Franklin Roach of NBS on the zodiacal light program.

In December 1960, Dr. Ram G. Rastogi came to us from the National Research Council in Ottawa, Canada, for a one-year appointment. Dr. Rastogi is originally from Ahmadabad, India, and is working on ionospheric variations.

Dr. Terrance L. John, University College, London, joined the HAO staff on 28 October 1960 on a one-year appointment. He will be working on stellar atmospheres.

Other new employees at HAO include M. Elizabeth Andrews, Administrative Assistant; Barbara L. Hill, Secretary; Margo Walsh, Clerk; Harold Braidwood, machinist; and Florence Scohy and Adelle Wightman, research assistants.

Terminations

Hans Dütsch returned to Arosa, Switzerland, after completing his one-year appointment on our staff.

Hermann Schmidt completed his year's stay with us and returned to the Max-Planck Institute in Munich, Germany, during this period.

Walter Steiger ended his sabbatical leave and returned to the University of Hawaii.

Geoffrey A. M. King returned to Christchurch, New Zealand after spending a year at HAO.

Other terminations were Sylvia Cohen, research assistant; Elizabeth Ann Winter, secretary.

General

Dr. and Mrs. Sydney Chapman arrived at HAO on 1 July 1960 for their annual 3-4 month stay. They were accompanied by Syun-Ichi Akasofu, a graduate student of Chapman at the University of Alaska.

Leaves-of-absence were taken by DeArliiss Henderson and Janice Atkins.

VI. RESEARCH ACTIVITIES

The following outline of research activities at the High Altitude Observatory for the period June - December, 1960, touches only briefly on some of the projects and not at all on others. Cooperative research projects involving graduate students and staff members are contributing more and more to our overall research effort. The graduate students, in effect, add to our research capabilities. Thus, we feel that the time taken from research in departmental teaching and supervision is more than regained through the research contributions of the students and the added stimulus to the staff that comes through teaching at the graduate level.

A. Balloon Project

Newkirk's balloon project, in which he has been assisted by Heynekamp, Eddy, and several of the technical staff, has already been mentioned in the preceding section on Highlights. The data obtained include information of the distribution of sky brightness with both wavelength in the spectrum and angular distance from the sun from heights of 12,000 ft. and 80,000 ft. Both types of data contain information on the size and number of small, light scattering particles between the instrument and the zenith sky. Reduction of the data on angular distribution of brightness is being carried out by Newkirk. That on wavelength distribution is being carried out by Eddy as his doctoral dissertation.

The analysis, to date, indicates a surprisingly large number of very small dust particles above the maximum balloon altitude of 80,000 ft. A radial column of one square centimeter cross-section from 80,000 ft. to the vicinity of the sun contains about 104 particles whose diameters range from 0.1 to 1 micron. By comparison, the interplanetary dust

particles giving rise to the F-corona of the sun number only about 1 in a similar column and their size is of the order of 10 microns. The smaller, more numerous particles indicated by the balloon data are most probably near the earth. In fact, they may well be the particles of the terrestrial "dust-corona" recently discovered from satellite data.

The smaller balloons currently being flown with sky-photometers should add substantially to the data acquired on the initial flights with the larger balloons and heavier equipment. If substantial day-to-day changes in the abundance of these small dust particles are found, the information will have great geophysical interest.

Figure 2 shows sky brightness relative to the sun's brightness for a zenith angle of about 45° for the sun and an angular distance from the sun of 10° .

B. Solar Activity November 1960

After the passage of the most remarkable sunspot maximum in history, from 1956 through 1960, solar observers towards the end of 1960 were beginning to relax and look ahead to the halcyon days of sunspot minimum. There was, however, "another dance in the old dame yet", and this was forcibly demonstrated during 10 November through 20 November, 1960. During this interval, the total number of sea-level solar cosmic ray events on record was increased by one-third. Ten days produced one-third as many cases as the previous twenty years added together! Furthermore, the polar regions of the earth's lower ionosphere were bombarded on at least three occasions during this period by floods of solar protons following major flares, all produced in a single active solar region. There is, of course, some danger that we are overemphasizing the rarity of this high activity, because we are better prepared to observe the sun and its terrestrial consequences now than we have ever been before. Activity of even modest importance can't very easily escape detection by at least one of the solar observatories of the world. Nevertheless, that argument doesn't seem to detract from the outstanding nature of the solar activity during the period in question.

The High Altitude Observatory was not in position, because of our time zone, to observe more than the declining phases of the biggest flare, that of 12 November 1960, associated with the active region. Big flares on 10 November and 15 November also escaped us. The new limb and disk patrol at Climax paid off, however, on the 20 November limb flare, shown in Figure 1. For the first time we have a practically perfect correlation between an optical event on the sun and a sea-level cosmic ray event, observed at Chalk River in Canada. The flare literally exploded, even on the time scale of events at the sun, and was followed in but a few minutes by the appearance of cosmic rays at the earth.

The radio noise from the region was as spectacular as might be expected. It began on the 10th of November with a very intense noise storm that we observed in Boulder first at sunrise on that date. This

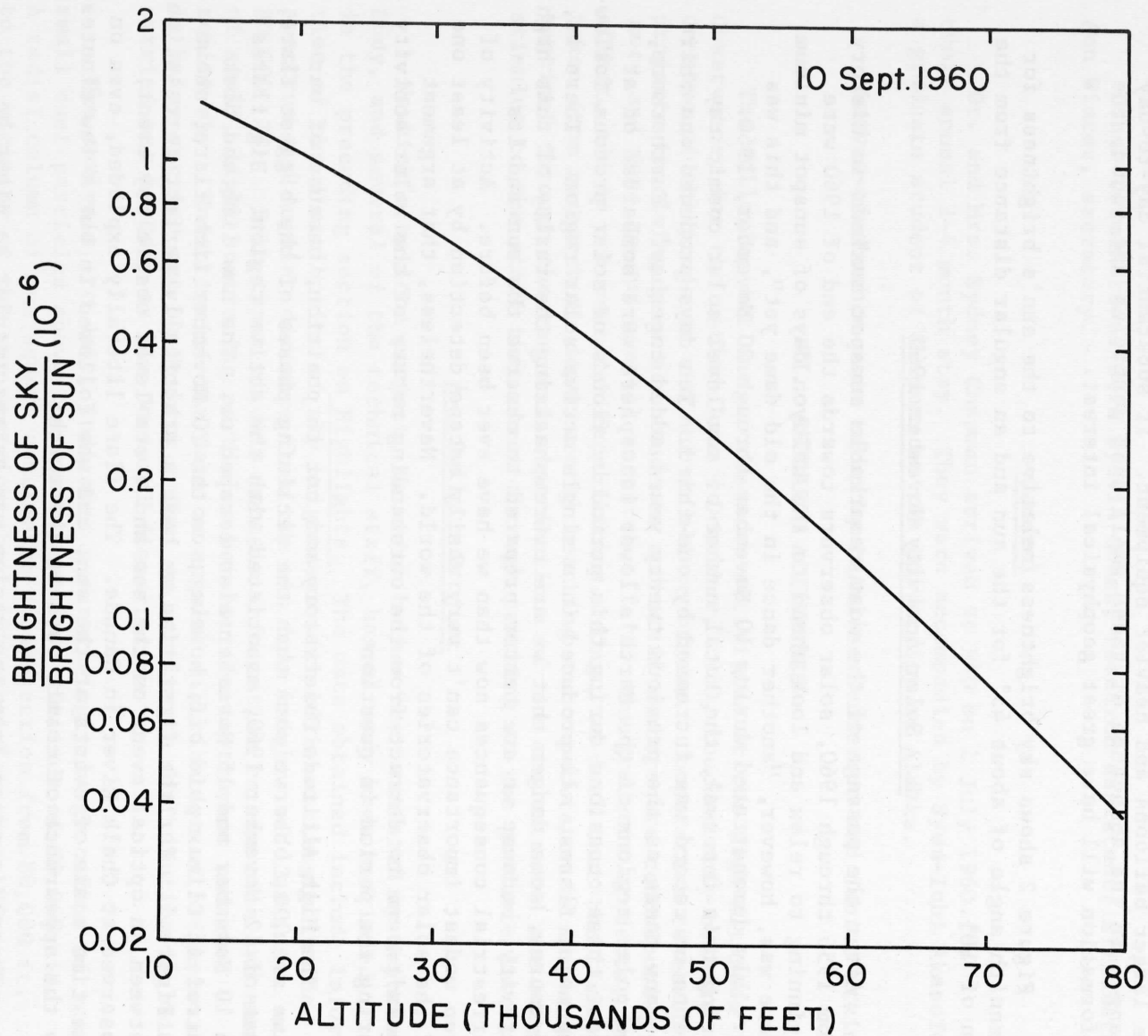


FIGURE 2

Sky brightness relative to the sun's brightness for a zenith angle of about 45° for the sun and an angular distance from the sun of 10° .

noise persisted through the 10th, 11th and 12th of November, but was clearly declining in intensity throughout 12 November. Remarkably, by 13 November the noise storm was completely gone, as though the preceding day's activity wiped out the source of radio waves. The activity on 15 and 20 November produced only minor resurgences in radio noise activity, in comparison with the earlier noise storm. Figure 3 illustrates the development and subsequent disappearance of this noise storm during November.

The solar and solar-terrestrial events of November 1960 were notable for their great magnitude. They are also important because, with improved instrumentation now available, it was possible to make observations never before performed on solar activity. For example, the direction of arrival of the cosmic rays at the earth was measured by cosmic ray physicists who found that the particles were traveling in a beam apparently curved so that the direction of arrival of the cosmic rays was from a point to the west of the optical sun. This gives important information on the magnetic field configuration of interplanetary space - one of the most interesting and important problems facing interplanetary probing vehicles soon to be launched. The short time delay of the cosmic rays following the flare suggests that they followed a fairly simple, but curved, path to the earth.

C. Chromospheric Studies

Studies of the solar chromosphere and corona over the past decade, or so, have been marked by emphasis on physical processes in the absence of thermodynamic equilibrium.

Departures from thermodynamic equilibrium are now well established for the corona and for the formation of the chromospheric spectral lines of hydrogen and helium. One of the prime questions of interest in solar physics is whether such departures exist in the formation of the spectral lines of other elements as well.

J. B. Zirker, of the Sacramento Peak Observatory, inferred from an analysis of the spectral lines of metallic elements observed by the observatory's expedition to the 1952 total solar eclipse, Khartoum, Sudan, that many of the emission lines of the chromosphere at the limb and many of the absorption lines in the disk Fraunhofer spectrum were formed out of thermodynamic equilibrium. His analysis was not unambiguous, however, and much doubt still remained as to the reality of the inferred effects. J.-C. Pecker and his co-workers in Paris have found rather convincing evidence of departures from thermodynamic equilibrium in the Fraunhofer spectrum of such elements as TiI, TiII, VI, and CrI. Some ambiguity still exists, however, because of uncertainties in the atomic and solar parameters needed in the interpretational work.

House and Athay have re-examined the problem for MgI, CaI, and OI, whose energy level structure is like that of HeI. Each of these elements has spectral lines in the eclipse spectra arising from particular configurations of atomic energy levels that should be very sensitive as indicators of departures from thermodynamic equilibrium. By a careful

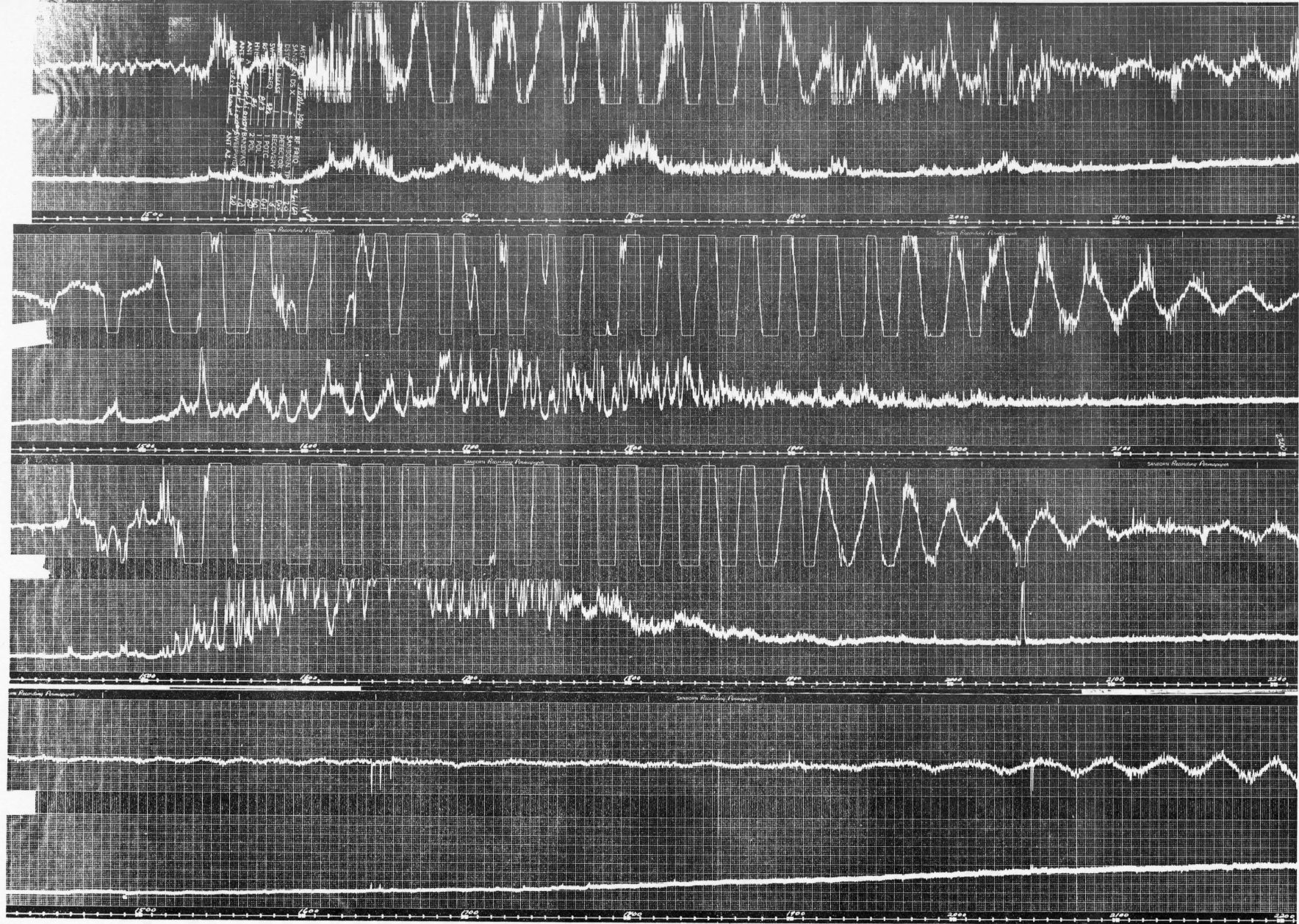


FIGURE 3

Solar radio emission at 36 mc/s during the period 10-13 Nov. 1960. The two halves of each record represent respectively the solar signal going through the fringes of our interferometer, and the lower half the total signal of the galaxy and the sun combined. The records show that immediately after the great flare of 12 Nov., solar emission rapidly declined to zero. Whether there is a causal connection between the occurrence of the flare and this wiping out of solar emission, we do not know.

study of these lines, marked departures from thermodynamic equilibrium have been found for MgI and OI and, less clear, but somewhat convincing, evidence for similar departures in CaI. The observational evidence is in several ways less ambiguous than in previous studies, and the effects are parallel to those in HeI where the same ambiguity does not exist.

A theoretical study of the MgI atom under chromospheric conditions, by House and Athay, clearly accounts for the observational effects. We feel, therefore, that these departures from thermodynamic equilibrium are indeed real in MgI and, at least by implication, in the other elements mentioned as well. The analysis of MgI is being continued by House as his doctoral dissertation, and should lead to a much better understanding of the structure and physics of the lower chromospheric layers.

Another very important research in chromospheric problems is being carried out by White as a thesis project, with Dennison of Sacramento Peak, Jefferies of NBS and Athay. This project is an attempt systematically to observe and interpret the central regions of the strong Balmer lines of hydrogen in the Fraunhofer spectrum. Photoelectric observations made at the Sacramento Peak Observatory are revealing a number of important features of these lines, which are known to be formed in the chromosphere. The analysis has confirmed the previous indications of departures from thermodynamic equilibrium in these lines, and promises to reveal a wealth of interesting new details on the chromospheric model.

D . Gegenschein and Zodiacal Light

The faint glow of the zodiacal light radiating outward from the setting or rising sun along the plane of the ecliptic and the still fainter glow of the Gegenschein at the anti-solar point (the point of the sky opposite to the sun as viewed from the earth) have long been a challenge to astrophysicists. Observations of suitable quality are difficult to obtain and interpretational problems are complex.

Recently Dr. H. Tanabe, who joined our staff last fall as a visitor from the Tokyo Astronomical Observatory, has discovered that the Gegenschein reaches a maximum brightness when the earth passes through the invariable plane of the solar system (the plane defined essentially by Jupiter's orbit about the sun) and reaches a minimum when the earth is farthest from it. This strongly suggests that the mechanism producing the Gegenschein is intimately connected with the invariable plane. Tanabe concludes from his findings that the Gegenschein is caused by backscattering of sunlight from the dust particles of interplanetary space.

A further finding of Tanabe is that the Gegenschein brightens anomalously at times of intense solar flares. This effect has, as yet, no satisfactory explanation. Tanabe's work in Boulder is carried out in collaboration with F. E. Roach of NBS.

E. Tidal Winds

Tidal winds in the upper atmosphere, between 80 and 100 km can at present best be determined from radio meteor observations. Determinations of solar semi-diurnal tidal winds in these altitudes have been published for Jodrell Bank, England (Greenhow and Neufeld) and for Adelaide, Australia. Haurwitz has subjected these data to a statistical analysis and has shown that the strong variations of tidal winds with season and with elevation must be regarded as real, although the magnitude of the variations cannot yet be considered as known reliably. Because the height distribution of the solar semi-diurnal air tide is not yet known accurately, it is at present impossible to choose between different theories for the origin of the oscillations on this basis.

Even at the earth's surface, the tidal winds, lunar as well as solar, are only imperfectly known (for the lunar tidal surface wind only one determination, for Mauritius, by Chapman, exists). Therefore, a pilot study using one year's data for Balboa, Canal Zone, was undertaken to determine how many years of data will be required for satisfactory computations of solar and lunar tidal winds at the surface. It was found that a satisfactory number of stations have sufficiently long records, and such an investigation is now being organized.

F. World Data Center

IGY World Data Center A for Solar activity continued operation under the guidance of Hansen. The principal activity continues to be centered in preparation of the multicolor maps of solar activity for the IGY period to be published in the near future in the Pergamon IGY Series. Activity in the Data Center is still at nearly the same level as during IGY. The coming sunspot minimum program "IQSY", will necessitate the continuance of the Data Center for another several years.

Lists of publications of the Data Center and available solar data for IGY and subsequent periods are available on request.

G. Other Research Projects

Other active research projects of the Observatory not discussed in the foregoing are: (1) Julian's study of Colorado River flow and precipitation in the river basin; (2) Matsushita's study of associations between sudden absorption of cosmic radio noise as it traverses the ionosphere and sudden commencement geomagnetic storms, and his study of lunar tidal variations of the ionosphere; (3) Kawabata's study of coronal x-ray radiation; (4) Heynekamp's reduction of data obtained with the K-coronameter at Climax; and (5) Chapman and Akasofu's new theory of the aurora.

VII. RECENT VISITORS TO HAO

4 - 6 July

P. L. Bhatnagar, Department of Applied Mathematics,
Indian Inst. of Science, Bangalore, India

14 July	Walter B. Langbein, U.S. Geological Survey, Washington, D.C.
14 July	Raymond L. Nace, U.S. Geological Survey, Washington, D.C.
21 July	Horst Mauter, Sacramento Peak Observatory, Sunspot, New Mexico
25 July and 7 Sept.	David Woodbridge, Army Ballistic Missile Agency, Huntsville, Alabama
23 August	F. E. Volz, Blue Hills Meteorological Observatory, Harvard University, Milton, Massachusetts
6 September	S. Schultz-Grunow, Aachen, Germany
21 September	Robert Myers, Geophysics Research Directorate, Air Force Cambridge Research Laboratories, Cambridge, Massachusetts
21 September	Wayne Hering, GRD, AFCRL
3 October	B. L. Moisewitsch, Queens University, Belfast, N. Ireland
27-29 October	Robert W. Hiatt, University of Hawaii, Honolulu, Hawaii
31 October	Ralph Shapiro, Geophysics Research Directorate, Air Force Cambridge Research Laboratories, Cambridge, Massachusetts
1 November	Fr. Paul Simon, Paris Observatory, Meudon, France
3 November	L. A. Ramdas, National Physics Laboratory India
4 November	Louis S. Kornicker, Office of Naval Research, Chicago, Illinois
1 December	P.M S. Blackett, Imperial College of Science and Technology, South Kensington, London, England
6 December	Paul Herrick, Chief, Geophysical Section, Service de Meteorologie de Geophysique, Leopoldville, Republic of the Congo
27 December	Heinz P. Wachter, Department of Meteorology, University of Utah, Salt Lake City, Utah (Home address: Meteorologisches Institut d Universitat, Frankfurt, Germany)

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