

**THE**  
**DIRECTOR'S REPORT**

*1 July through 31 December 1961*



*Solar Eclipse Expedition Equipment Trailers\**

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

The High Altitude Observatory is a non-profit research and educational institution operated by the University Corporation for Atmospheric Research and associated with the University of Colorado. Its major research objectives are a better understanding of the sun and the space surrounding the sun and the earth.

\*Cover: The two house trailers containing the equipment sent to Lae, New Guinea, for observing the total eclipse of 5 February 1962. In this picture the trailers are parked by the door to the HAO shop in Boulder while various instrumental tests are conducted.

## I. HIGHLIGHTS

### Solar Eclipse Expedition to New Guinea

In September we decided to send an expedition to attempt observations of the total solar eclipse to occur in February 1962 in New Guinea. Ordinarily, of course, the decision to send an expedition to observe an eclipse is made many months, or even years, ahead of time in order to allow for the elaborate preparations which are necessary. For a number of reasons we had earlier concluded that the most fruitful use of our time and efforts consisted in preparing the equipment on a leisurely time schedule and observing either in Alaska or Northern Canada the eclipse to occur during the summer of 1963. However, during discussions with our Japanese colleagues at the International Astronomical Union Meeting in Berkeley, California, in August of 1961, we were impressed by what they told us of the possibilities of a successful eclipse expedition in New Guinea. These discussions caused us to re-examine our earlier decision, and during September we finally decided to make the try in New Guinea.

The equipment used for making the observations (because of its large size and great weight) had to be shipped by sea. This, of course, meant that the equipment had to be loaded on board a freighter many weeks before the eclipse to allow for the trans-Pacific passage. The early shipping date left us with a tight time schedule for the preparation and checking of the cameras and electronic equipment. Moreover, our experience during previous expeditions had led us to conclude that constructing a building at the observing site was a difficult way to mount the equipment; a much better system would be to permanently install the cameras and electronic equipment in a pair of specially built house trailers, which could then be shipped intact to whatever observing site was chosen. Obtaining delivery on two special house trailers and installing the equipment in them further tightened our time schedule.

However, the trailers were shipped from the West Coast in mid-November. During those few weeks between the final decision to send the expedition and the shipping of the trailers, more people probably spent more evenings and more week-ends working on a single project than at any other time in HAO's history. Dr. Richard Dunn from Sacramento Peak and Dr. John Jefferies from the NBS both moved into the HAO shops and could, during this hectic period, be found at almost any time of the night or day adjusting, measuring, and improving the eclipse cameras and associated equipment.

In spite of this extremely rapid time schedule the equipment went off in good condition. Not only had the cameras and electronic equipment been installed in the house trailers, but the entire equipment had been put through its paces several times in the HAO parking lot. During

these tests and practice runs, several difficulties were encountered and were eliminated by further adjustment of the equipment or actual modification of some parts of the apparatus.

Six members of the HAO Staff made the trip to New Guinea to try for the valuable eclipse observations. These were Athay, Firor, Garcia, Hansen, Lacey and Lee. They were joined by Dunn and Jefferies. After several more weeks of preparation on the site in Lae, New Guinea, the eclipse day arrived amid heavy rains. The clouds broke, however, and the sun moved into clear sky minutes before the total phase of the eclipse. The equipment was operated and roughly a thousand feet of photographic film exposed to the chromospheric and coronal spectrum. When returned to the United States and processed, the spectrograms proved to be of extremely high quality, resulting both from the clear sky during the eclipse and the flawless operation of the complex equipment.

### IGY Solar Maps

This report period saw the completion of a work covering several years, resulting from the measurements made during the International Geophysical Year. Late in the year the IGY solar maps were published and made available to the scientific world. These maps, which give a comprehensive survey of solar activity for every day during the IGY, are printed in four colors so as to incorporate, conveniently, a large amount of information in concise form suitable for intercomparison on a day-to-day basis. The maps were prepared at the IGY Data Center at HAO under the supervision of Hansen and include data from a number of observatories around the world.

The maps actually consist of two sets: one containing sunspots, plages, flares and active prominences on the disk and limb; the second set also contains sunspots with other kinds of information together with prominences, coronal line intensities and radio isophotes. These maps provide a uniformly displayed set of solar information of many kinds, and undoubtedly they will provide research materials for those interested in solar activity and solar terrestrial relations for many years.

## II. RESEARCH ACTIVITIES

### Chromospheric Research - The Sun's Lower Atmosphere

Athay, Tandberg-Hanssen and House of the scientific staff, and several of the Astro-Geophysics students were actively engaged in studying chromospheric problems. But by far the largest single effort directed at answering questions concerning the chromosphere was the eclipse expedition already described under "Highlights". A complete



description of the type and nature of the information obtained by the eclipse observations and the plans for their reduction and study will appear in later reports.

In addition to the eclipse work, other kinds of studies of the chromosphere are in progress at the Observatory. For example, in an effort to understand more concerning the physical conditions in the various forms of activity which occur in the chromosphere-corona region, Tandberg-Hanssen has made a comparative study of the spectra of flares and active prominences. He has found that it is possible to distinguish between the two spectroscopically from their iron and titanium emission. He has found that in prominences the ionized titanium lines are, in general, stronger than the ionized iron lines; while the reverse holds true in flares. The study, of importance to understanding the sun's atmosphere, also has interesting connections with the broader field of the nature of stars, since the ionized iron-ionized titanium comparison is also useful in studying in stellar emission spectra.

House completed his thesis work for a degree in the Astro-Geophysics Department. His thesis work was a study of the departures from thermodynamic equilibrium of a number of elements in the solar chromosphere as mentioned in earlier reports. The fundamental observational data which he used were taken from the 1952 eclipse plates; and, from this body of information, House was able to show that the populations of energy levels of both neutral magnesium and neutral oxygen depart appreciably from thermodynamic equilibrium distributions. Neutral calcium does not show similar departures from equilibrium. House coupled his analysis of the data with a theoretical study of neutral magnesium and its behavior in the solar atmosphere. He found that agreement between theory and observations could be obtained if one assumed a two-component atmosphere. That is, he assumed that at any one height the chromosphere had both hot and cold regions. Similar work by Athay and others had already pointed to the necessity of a two-component chromosphere; the work of House brought this need down to much lower altitudes in the solar atmosphere.

#### Coronal Research - The Sun's Upper Atmosphere

For several years Billings has pursued the question of what can be learned concerning the physics of the solar corona by studying the profiles of emission lines (gotten by plotting the intensity of the coronal spectrum lines as a function of wavelength, and using methods described in earlier reports\*). Before such a study can come to grips with problems of the solar corona, many technical problems must be solved. For example, one must develop techniques for objective analysis of the profiles in spite of confusing effects of scattered light and absorption

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\* See Director's Report, January to June, 1960.

lines. Billings has successfully solved these problems and is able to draw several general conclusions concerning the corona. (1) The profiles of each emission line are remarkably constant in space and in time both with regard to line-width and wavelength position. These facts have a profound bearing on the nature of the heating mechanism in the corona. For example, if the corona is heated by shock waves rising from the low solar atmosphere, these waves must have either a much higher frequency or a much smaller scale than any that have been postulated previously. (2) There is some evidence of a slow decrease in line-width with height corresponding to about  $3^{\circ}$  Kelvin per kilometer if this line-width decrease is interpreted as a temperature change. This observation, of course, has important bearing on "solar wind" or solar evaporation theories. (3) There is some evidence for an oscillatory pattern of line-width with height which does not change with time over several hours. This suggests standing waves of about 30,000 km in length. (4) The width of the green coronal line, which arises from Fe XIV (iron atoms with 13 electrons removed), consistently corresponds to a few hundred thousand degrees higher temperature than that of the red coronal line, which comes from Fe X (iron with 9 electrons removed.) This situation holds even in regions in which the brightening follows an identical pattern in the two lines and indicates that the lines come from different positions in space.

From a careful consideration of these general conclusions, Billings has devised a mechanism for heating regions of bright coronal line emission by the propagation of hydromagnetic waves along prominence loops. The mechanism appears very promising. It applies the heat in the places that are observed to become the hottest and gets the energy out of the sun in a manner that overcomes many of the difficulties encountered in other models of coronal heating.

One of the exciting new developments in coronal studies in recent years has been the measurement of the far ultraviolet spectrum of the sun from rockets and satellites by groups at the University of Colorado, the Naval Research Laboratory, and the Geophysics Research Directorate of the Air Force. The far ultraviolet spectrum, which cannot be observed at ground level stations, originates for the most part in the chromosphere and corona and, therefore, gives added information concerning the conditions in those regions. Zirin, extending the work of Follen and others, has made a careful study of the ultraviolet emission lines occurring in the rocket spectra and has been able to obtain convincing identifications of most of the stronger lines. He finds that lines which should be emitted by the gas at a temperature intermediate between the highest chromosphere temperature and the coronal temperature are missing, indicating that the transition between the two regions is very sharp indeed. In this study Zirin worked closely with Dr. Hans Hinterreger of GRD.

## JUPITER

The planet Jupiter seems to go through periods when it is studied intensively because of some interesting characteristic which comes to light but also periods of relative neglect. In the late 19th century, when the planet developed a large, reddish spot in its atmosphere, considerable interest in studying the characteristics of Jupiter's atmosphere followed. The red spot was detected on "pre-discovery" photographs back to an earlier part of the century and its rotation rate and changes in color and shape were carefully noted.

Another period of considerable interest in this planet was begun in 1955 by the discovery that the planet is a source of strong radio waves. These radio waves, with wavelengths of 10 meters and greater, were found to be variable with time and have been studied since 1955 by several groups. At HAO Warwick and Lee have built a dynamic spectrograph primarily for use on the solar radio emission, but which has been adapted for observations of the Jupiter radio waves. This receiver, which displays the intensity of the radio waves as a function of frequency and time and, as well, gives information concerning the position in the sky of the radio source, has now accumulated several hundred observations of radio storms occurring on Jupiter.

When the dynamic spectrum records were first examined, they showed some similarity to the spectra observed for radio bursts from the sun; that is, the emission was observed to change its principle frequency with time, drifting either to higher or lower frequencies as a storm on Jupiter progressed. In the case of the sun, these drifting characteristics of the radio burst have been used to deduce information concerning conditions in the corona where the source of the radio burst lies. It was at first thought that similarly the Jupiter burst drifts could be traced back to conditions at the Jupiter source - conditions which changed with time.

However, from an analysis of all of the Jupiter storms recorded by the spectrograph Warwick has been able to show that the drifting of the radio bursts appears to depend on the orientation of the radio source on Jupiter as seen from the earth, rather than on intrinsic characteristics of the source. The drifting, therefore, becomes a characteristic of the rotation of Jupiter, or, more exactly, that rotation as seen from the earth, and is therefore not related to time changes within the source itself. This surprising result has not been completely explained since it has proved difficult to devise a model of the source and the possible ionosphere on Jupiter which will give the observed drifting characteristics.

## The Earth's Atmosphere

A basic problem under study by Haurwitz is that of the dynamics of planetary atmospheres, especially of the earth's atmosphere, and his main efforts during the last year or so have been concentrated on the terrestrial mesosphere and its motion. The upper part of this layer and the lower ionosphere (80-100 km) are much more than the lower stratosphere subject to regular oscillations with periods of a day and its subharmonics, caused by the tidal action of the sun and the moon and by the thermal action of the sun. Accordingly, Haurwitz completed a study in which the few data showing the diurnal and semi-diurnal variations were pieced together.

Since the thermal effect of the daily heating of the atmosphere by the sun, especially its variation over the earth, is only imperfectly known, he also investigated the geographical distribution of the diurnal temperature wave and its subharmonics in the surface layer of the atmosphere, the only part of the atmosphere for which a reasonable amount of data for such a study is available.

Haurwitz has also continued his theoretical study of a thermally driven non-linear circulation model. This model is very simplified, but it retains one of the essential features of many atmospheric and oceanic circulations, namely the tendency to destroy the temperature difference which is the driving force of the circulation.

Julian is also interested in the general circulation of the stratosphere and mesosphere. More particularly, his work at present is designed to describe the structure of the stratosphere and the seasonal changes taking place there, and to investigate statistically the nature of the coupling between the stratosphere and tropopause. By coupling in this context is meant a relationship of some character (at present unspecified) in the circulation, or pressure, or temperature between the two regions of the atmosphere. So far the work has been mainly data processing and statistical analysis.

London has studied one of the more detailed processes which should be important in the picture of the dynamics and energetics of the stratosphere and mesosphere. Atmospheric ozone plays an important role in this region of the atmosphere because of its strong absorption in the ultraviolet. Ozone, therefore, acts as a heating agent for the atmosphere and thus largely controls the temperature distribution in the region 25 to 80 km. At 30 km and below, ozone is a rather stable component of the atmosphere and as such can be used as a tracer in studying the circulation processes of the upper tropopause and lower stratosphere. The first problem in understanding the role of ozone in the atmosphere is to determine the variation in the photochemical distribution of ozone with height, latitude and season, and the subsequent absorption and heating distribution of the atmosphere. The results of London's study



have confirmed that the temperature structure in the vicinity of the stratopause, that is about 50 km high, can be explained quite well by the absorption per unit mass of solar radiation by the computed ozone.

In order to study the total ozone distribution with relation to atmospheric circulation, total ozone observations have been analyzed by London on a hemispheric scale and for the various seasons. The large scale patterns, thus disclosed, show that the ozone distribution has significant longitude variations which are closely tied to the variations of the general circulation pattern at about 15 km.

London plans to continue his study with the hope of gaining understanding of the fundamental relationship between the latitudinal and seasonal distribution of non-equilibrium ozone and the three-dimensional atmospheric circulation patterns.

#### Other Research Areas

As usual, it is not possible in a report of this kind to detail all of the work in progress at the High Altitude Observatory. The above paragraphs have tried to summarize a few of the areas which deserve particular attention at this time. Later reports will discuss such work as Matsushita's study of the interrelation between the geomagnetic field and the ionosphere, the continuation of Newkirk's study of particulate matter in the high atmosphere radio noise from the sun, and Chapman's study of aurora and geomagnetic storms.

One of the visiting scientists to the HAO, Robert Duncan from CSIRO in Sydney, has completed a study of the Arctic and Antarctic ionosphere. He has studied the behavior of the F-region near the pole with the hope of explaining the maintenance of this region during the long winter night, and the marked diurnal variation in this region in the absence of a diurnal variation of solar zenith angle. His analysis of the ionosonde data revealed that polar F-region electron densities are controlled by universal time. This is particularly marked in the Antarctic; there in summer universal time control extends as far north as a latitude of  $43^{\circ}$ .

In this context universal time control indicates simply that although there is a variation in the ionosphere with a 24 hour period, it takes place simultaneously throughout the polar cap, independent of longitude. Electron densities increase almost simultaneously, actually a little earlier at the pole than in the surrounding areas, and therefore, it seems unlikely that drift from surrounding sunlit areas is a major source of ionization. Duncan compared the month-to-month variations of F-region electron densities at magnetically conjugate stations near the north and south poles. This comparison, however, gives little support to the idea of "distillation" of ions from the summer to the

winter poles along geomagnetic field lines. Furthermore, the nature of the diurnal variation and other quantitative considerations tend to discount the idea that ionization may be produced by sunlight at great altitudes and subsequently diffuse down to F-region heights.

Thus an explanation for the universal time control of the polar winter ionosphere is yet to be found.

### III. DEPARTMENT OF ASTRO-GEOPHYSICS

The Department of Astro-Geophysics has now reached a degree of maturity as evidenced by the fact that the students, who have successfully completed their degree in the Department, are now employed at several research organizations throughout the United States. We are pleased also that, for the most part, our students upon completion of their Ph.D. degrees have remained in the research field and, in general, in fields closely related to the solar work, which is so central to the activities of the HAO.

During the fall two students completed the work on their degrees. John Eddy finished his thesis under the direction of Newkirk and is now employed at the Bureau of Standards. The balloon coronagraph work which supplied the basic data for Eddy's thesis has been described in earlier reports.

Lewis House, whose work has also been described from time to time in these reports, also completed his degree in the fall and has now joined the staff of the HAO.

Other students involved in thesis work were Wynne Calvert, working under the direction of Mr. Robert Cohen of the Bureau of Standards; William Curtis, working with Dr. John Jefferies, also of the Bureau of Standards; and Oran White, who is completing a study of the limb darkening of solar lines on the basis of measurements he made at Sacramento Peak. Less far along are Charles Hyder and John Kulander. For the first time also several masters theses are under way.

### IV. CLIMAX

Watson continued as observer-in-charge at Climax. Richey resigned during the report period and was replaced by Peter Stevenson. Previously Stevenson was a student in mathematics at the University of Colorado.

During this period we tried to eliminate one of the sources of inflexibility which had developed at Climax. Because the observing

program required four full-time observers, the housing available at Climax was essentially completely filled, and there was no opportunity for a staff member or graduate student to spend weeks or months pursuing an observational program. In an attempt to overcome this handicap we leased a large house trailer and installed it to the west of Watson's house. The trailer was soon occupied by Heynekamp, who is pursuing a course of study involving measurements made with the K-coronameter. The Yale shack is still available for short term visits from the shop or scientific staff, but the trailer fills a different need, that of the longer term observational program.

During the report period development of the 16" coronagraph-spectrograph moved into its final phase. Planning and design for this instrument have been under way since 1958. Construction of optical and mechanical components began during 1960. During the fall Perkin-Elmer Corporation completed the optics for the coronagraph. Rush visited the Perkin-Elmer plant to verify tests of the optical system and found the performance remarkably good. Indications are that, despite its complexity, the system will approach its theoretical resolution of approximately  $\frac{1}{4}$  second of arc in the shorter wavelengths. Design and construction of the optical mountings, under the direction of Lacey, were largely completed and installation of these at Climax is scheduled for the summer of 1962.

The spectrograph design is proceeding on the basis of a larger and more flexible version of the present Climax spectrograph. This is an over-and-under uncorrected Schmidt mirror design mounted horizontally across the polar axis with an image rotator in the spectrograph room to orient the solar image on the slit. The optical design for this instrument was completed during the report period, except for some additional work that is needed on the method used to control astigmatism. Mechanical designs for the spectrograph are in the layout stage.

## V. NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

The last several reports have described the developments leading up to the merger of the High Altitude Observatory with the University Corporation for Atmospheric Research. This merger was actually accomplished in December, when the HAO Trustees met for the last time as the HAO Board, and changed the name of the HAO Corporation to the University Corporation for Atmospheric Research. At about the same time the earlier UCAR corporation, set up to plan and develop the atmospheric research facility, dissolved and transferred its assets to HAO under its new name. With the merger taking place in this fashion HAO was the surviving corporation, and as such, the merger has required very few changes or disruption of activities at the HAO.

The University Corporation for Atmospheric Research has as its main purpose the operation of a national laboratory, which is called the National Center for Atmospheric Research. We have arranged the research activities of the National Center in two groups: (1) the HAO, whose staff and activities go on unchanged, and (2) the newer more rapidly growing portion, which has been named the Laboratory for Atmospheric Science. One small change, which will be noticed by readers of this report, will be that in the future the HAO Director's Report will appear as a section of a larger document embracing the research activities of both HAO and the Laboratory of Atmospheric Science.

At the dinner celebrating the merger of the two corporations the Honorable William S. Jackson spoke of the history of the High Altitude Observatory. Judge Jackson, up to the merger, was President of the HAO Board of Trustees and has been associated with HAO as a Trustee since the first corporate structure to manage the Observatory affairs was developed over twenty years ago. It is with great pleasure that we note that Judge Jackson will continue his association with the HAO as a Trustee at Large for the University Corporation for Atmospheric Research. The previous Report mentioned also that the HAO Board continues its association with the Observatory as the "HAO Advisory Board."

## VI. PERSONNEL CHANGES

On August 1, Dr. Einar Tandberg-Hanssen returned to the HAO staff after an absence of approximately two years, which he spent at the Institute for Theoretical Astrophysics in Oslo, Norway. In Oslo he had been continuing his work in solar physics.

Dr. John W. Firor arrived on September 1 from the Carnegie Institute of Washington and officially took over the reins as Associate Director of UCAR for HAO.

On September 2 Dr. Julius London took up a joint appointment in the HAO and the University of Colorado. Dr. London comes to the HAO from New York University and has earlier been a frequent summer visitor at the Observatory.

Dr. Takao Tohmatsu arrived on October 1 from the Geophysical Institute of the University of Tokyo, Japan, for a one-year appointment. He is working jointly with Dr. F. E. Roach and other scientists at the National Bureau of Standards, as well as with scientists at the HAO.

Dr. Lewis House joined the staff of the HAO on a Post-Doctoral Fellowship after receiving his Ph.D. in Astro-Geophysics on December 22.



Dr. Kuniiji Saito joined the HAO visiting research staff from August 14 thru October 15 and worked at the Sacramento Peak Observatory.

Other new employees at HAO during this period included: Clara Mae Place, Nancy E. Curry, and Carolyn R. Lipton, Research Assistants; Eleanor H. Dixon, Carol M. Nash, and Sallie P. Scheufler, Office Staff; Howard K. Hull, Electronics Shop; and Robert F. Wendler, Engineer.

#### Terminations

Dr. Terence L. John completed his one-year appointment and returned to the University College, London.

Dr. Ram G. Rastogi also completed a one-year appointment and returned to the Physical Research Laboratory, Ahmedabad, India, as Chief of the Radio Physics Division.

Other terminations included Janice Atkins, Dianne Hackett, and Janice C. Kaufman. Martha L. Arnett and M. Elizabeth Andrews left HAO to join the staff of NCAR.

Terminations from Sacramento Peak during this period included M. Khary Aly, Callie E. Booker, Bernard E. J. Pagel, and Raymond Michard.

#### Other Changes

Mr. Claus Hume was transferred to the HAO Staff from Sacramento Peak.

#### VII. HAO VISITORS DURING JULY - DECEMBER 1961

5 - 11 July	T. Rikitake, University of Tokyo, Japan
21 - 25 July	Evry Schatzman, Institute d'Astrophysique, Paris, France
26 - 27 July	Robert Kreplin, Naval Research Laboratory, Washington, D. C.
31 July - 12 August	Paul Wild, CSIRO, Sydney, Australia
31 July - 13 August	J-C. Pecker, Paris Observatory, Meudon, France
3 August	Walter Steiger, University of Hawaii, Honolulu, Hawaii
9 - 11 August	Winfried Petri, University of Munich, Germany

4 - 8 September	R. E. Loughhead, CSIRO, Sydney, Australia
23 - 30 September	M. M. Komesaroff, CSIRO, Sydney, Australia
26 - 28 September	R. Michard, Paris Observatory, Meudon, France
28 - 29 September	Norman McDonald, Geophysics Research Directorate, AFCRL, Bedford, Massachusetts
28 - 29 September	Fred Ward, Geophysics Research Directorate, AFCRL, Bedford, Massachusetts
2 - 7 October	H. Mitra, Indian Meteorological Office, New Delhi, India
4 - 7 October	Robert Bessey, University of Wyoming, Laramie, Wyoming
16 - 30 October	M. R. Kundu, University of Michigan, Ann Arbor, Michigan
6 - 7 November	Waldo E. Smith, National Academy of Sciences, Washington, D. C.
7 - 8 November	Eugene Parker, University of Chicago, Chicago, Illinois
8 - 9 November	Roger Olson, Headquarters Air Weather Service, Scott AFB, Illinois
8 - 9 November	Ramon Wilkins, Headquarters Air Weather Service, Scott AFB, Illinois
15 - 16 November	Marshall Cohen, Cornell University, Ithaca, New York
20 - 21 November	Ludwig Oster, Yale University Observatory, New Haven, Connecticut
29 November - 3 December	V. Gaizauskas, Dominion Observatory, Ottawa, Canada

Other visitors included Mutsumi Ishitsuka and Francisco Dominguez, Instituto Geofisico del Peru, Huancayo, Peru; T. Obayashi, Kyoto University, Japan; E. S. Batten, The Rand Corporation, Santa Monica, California; A. D. Fokker, Nera, The Netherlands; James Murray, CSIRO, Sydney, Australia; Thomas Gehrels, University of Arizona, Tucson, Arizona; Vern Stone and Thomas Pappas, Geophysics Corporation of America, Anoka, Minnesota; DeWitt Purcell and Martin Kooman, Naval Research Laboratory, Washington, D. C.;

Jitendra Davé, University of California, Los Angeles, California;  
Bernhard Vonnegut, A.D. Little Company, Cambridge, Massachusetts;  
William Erickson, Convair, San Diego, California; Russell Nidey, Kitt  
Peak Observatory, Tucson, Arizona; Dave Dodgen, Roger Carson, Dick  
and Alice Dunn, and Robert Hunter, Sacramento Peak Observatory, Sunspot,  
New Mexico; D. H. Menzel, Harvard College Observatory, Cambridge, Mass-  
achusetts; K. G. McCracken, Massachusetts Institute of Technology,  
Cambridge, Massachusetts; Susan McKenna, Dunsink Observatory, Dublin,  
Ireland; G. Godoli, Observatorio Astrofisico di Arcetri, Italy;  
Z. Suemoto, Tokyo Astronomical Observatory, Japan; S. Nagasawa,  
Mitaka, Tokyo, Japan; B. Edlen, Fysiska Institut, Lund, Sweden;  
Kuniji Saito, Mitaka, Tokyo, Japan; A. T. Price, Coast and Geodetic  
Survey, Washington, D. C. (on leave from the University of Exeter,  
England); K. O. Kiepenheuer, Fraunhofer Institut, Germany; Richard  
Duffee, Battelle Memorial Institute, Ohio; George Whitelic, Batelle  
Memorial Institute, Ohio; Z. Sekera, University of California, Los  
Angeles, California; Lloyd White, Office of Naval Research, Chicago,  
Illinois; Roger Moore, National Aeronautics and Space Administration,  
Washington, D. C.; A. P. Mitra, National Physical Laboratory, India;  
Dino Zei, Ripon College, Ripon, Wisconsin; and Joseph Lamberg, Air  
Weather Service, Scott AFB, Illinois.

## VIII. PUBLICATIONS FROM HAO DURING PERIOD

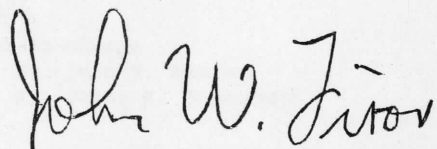
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#### IX. SOLAR ACTIVITY REPORTS

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