

**THE
DIRECTOR'S QUARTERLY REPORT**

FIRST QUARTER, 1957

1 JANUARY to 31 MARCH



*Measuring corona spectrum photographs**

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

The High Altitude Observatory of the University of Colorado is a non-profit research and educational institution dedicated to the study of the sun and its effects on the earth.

* Cover: Measuring corona spectrum photographs. On every suitably clear day the observers at Climax make spectrum photographs of the sun's corona, from which they subsequently measure the brightness of the emission of the corona at all different positions of the sun's edge. Here, Mr. David Dodgen, member of the Climax staff, is measuring and recording the corona prior to radioing the intensity values to Boulder for use by the Central Radio Propagation Laboratory of the National Bureau of Standards in its forecasting work.

SUMMARY

Fluctuations of the sun's activity have been known from the first years after the invention of the telescope. Galileo's sunspot drawings made in 1612 are comparable in quality with those we make today with a small telescope. Day to day changes of sunspot activity were clearly apparent to him, despite his retractions during the Inquisition.

What Galileo could scarcely have imagined, however is the wealth of solar phenomena we now recognize as variable and the complexity of the interconnections amongst these. Nor could he have foreseen the multitude of earth effects from solar activity that we now identify.

HAO officially acknowledged the scope and importance of solar physics and of sun-earth effects by creating, last year, the HAO Institute for Solar-Terrestrial Research. This year the University of Colorado made another stride in the same direction by creating a new graduate department, the Department of Astro-Geophysics. Its goal is advanced teaching and research on the basic physics of the effects of astronomical bodies on the earth. Teaching is being done by members of the HAO staff, with emphasis given to understanding just what it is that varies in the sun, and how these variations influence conditions on the earth. Applications are now being received from all over the world from young scientists who wish to build their profession around this important field. We believe that a strong graduate student program

is essential to a strong research effort, so we are most pleased by the new development.

Every few weeks the earth's wind flow patterns at about 30,000 feet above sea level change definitely and often quite abruptly. These breaks usually result in temperature and rainfall effects. The current winter produced a good example of weather with frequent jumps of this character. We have now studied carefully the winter's weather maps to see if we can find any sign that the jumps were triggered off by solar changes. A tendency seemed present for the larger weather developments to commence some three to four days after bursts of solar corpuscular energy. The period of time over which we have tested this hypothesis is much too short for us to put great confidence in the result, but we feel that the discovery deserves more attention, and that it also is consistent with other solar-weather clues that have been found in recent years. We are pushing the work vigorously, now, into data from other years.

The sun's activity showed signs this quarter of a leveling off from the peaks of 1956, though there were numerous active centers and on March 2 an outstanding aurora and magnetic storm. Some of us, myself included, began to wonder if the summit of the solar activity cycle had not already been passed. The spurt that took place in the second quarter, to be described in our next report, put an end to such thoughts, though it did not produce earth effects comparable with the extraordinary cosmic ray rise of the 23rd of February of last year.

I. HIGHLIGHT OF THE QUARTER

A Graduate Department of Astro-Geophysics

Astro-geophysics, though the word does not yet appear in dictionaries, describes a new field of growing importance: the science of the relations between astronomical bodies and the earth. The subject matter of astro-geophysics lies at the boundaries of the sciences of astronomy and geophysics, and overlaps far into both. Included are such things as effects of solar X-rays and ultraviolet light on the radio reflecting layers of the earth's atmosphere, the generation of auroras by clouds of electrified gas ejected from the sun, and the possible cosmic cloud-seeding effects of meteor dust from interplanetary space.

The University of Colorado and the HAO have jointly recognized the importance of the field by creating a new graduate department of astro-geophysics. Its staff comes principally from the HAO through part-time academic appointments. The close ties between the department and the HAO are formalized by the fact that I, as Director of HAO, have also been appointed Professor of Astro-Geophysics and Head of the Department.

To support the program further, the HAO plans to provide four to six full fellowships for graduate students in the new department. These will carry a stipend of \$1,800. To the recipients the University will also grant tuition-free scholarships. Four to six students will be enrolled in the department in the coming fall. Applications have come in from different parts of the U.S. and from Japan, Pakistan, India, and Turkey.

The National Bureau of Standards has extended closest cooperation to the new department and has assisted in providing visiting lecturers for some of the courses offered. Three lecture courses were given in the spring semester and four are scheduled each semester for the coming year.

II. CRITICALLY NEEDED: A HOME FOR HAO

The Boulder operations of HAO critically need a permanent building. For nearly 10 years HAO has been housed in temporary structures on the Boulder campus, and for most of these years we have been simultaneously operating under several roofs. The University, commendably, is tearing down many of these old wooden temporaries. The building in which we

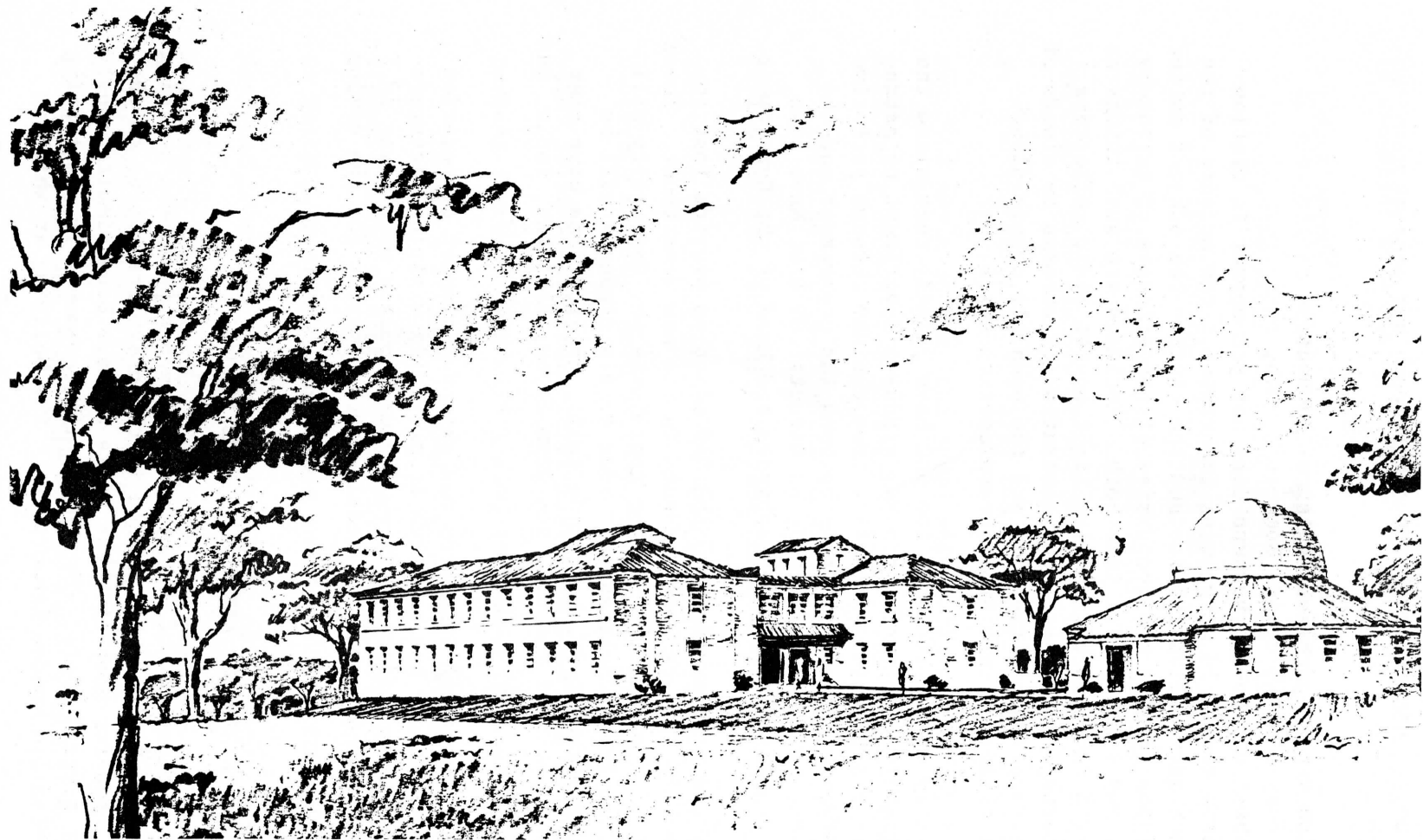


Figure 1

Architect's sketch of the proposed new building for HAO, shown on the top of the hill adjacent to Sommers-Bausch Observatory, shown at the right. Close physical proximity of these two buildings is essential to HAO's research program.

started out in Boulder is gone; it looks as though our present main laboratory is to go within 12 months.

The solution is to get all 25 or so of us under a single roof in a new building conveniently beside Sommers-Bausch, where much of our work must be done. As most of you know, HAO is a non-profit corporation separate from the University, in spite of our close and friendly ties. For this reason, we must find the funds for the building from sources other than those of regular University departments. Grants from foundations or individuals either to HAO or to the University are necessary. It will take \$250,000 to put up the sort of building we need, with 17,000 square feet of space. We propose a single building to include the HAO's entire Boulder operations, and to include as well the World Data Center for Solar Activity, which the HAO will operate, and the new Department of Astro-Geophysics.

We will be most grateful to any of our friends who have good suggestions of possible places to turn for help on this. Low will be carrying out the effort to find the funds, and I'll be helping. We'd have no objections to attaching a name to the building, either!

III. INSTITUTE FOR SOLAR-TERRESTRIAL RESEARCH

Solar-Weather Studies

Weather maps that deal with conditions at the earth's surface are extremely complicated. Maps for higher altitudes, on the other hand, are simpler. However, part of the simplicity is illusory. When the number of available observing stations diminishes, as it does for higher altitudes, the resulting maps are bound to look less complicated, but, nevertheless, a good part of the greater simplicity seems to be real. The effects of mountain ranges, oceans, and other surface irregularities are less, and the wind flow patterns show a greater measure of large-scale continuity. For this reason, it seems to us desirable to search for possible large-scale solar influences on weather in maps for high altitudes, even well into the stratosphere if possible. If solar effects can be proven at these great altitudes, where they are perhaps most likely to show up, then it will be a far simpler matter to trace them to the surface weather in which we are obviously more practically interested.

Using this kind of reasoning, we began work last December to study maps from the Canadian Department of Transport for the winds and pressure

patterns at 30,000 feet above sea level. These beautifully executed maps cover the Northern Hemisphere from 0° longitude to 180° longitude, thus embracing all of the North American continent, with ample regions of the oceans to either side.

From this work we found that there were frequent deep low pressure "troughs" that tended to develop on the map in the northwestern part of the continent. We noted signs that these were more likely to form if a large solar corpuscular cloud had struck the earth about three or four days earlier. A typical instance of the type that showed up in our analysis is the following:

Just before noon of the 24th of March the observers at the Sacramento Peak Observatory noted the abrupt rise of a solar flare of good proportions in a region near the sun's center. Radio noise bursts accompanied it, suggesting that the flare might produce a corpuscular ejection and subsequent aurora and magnetic storm. So we were not taken by surprise when such a storm did develop, though to very modest proportions, on March 25th, accompanied by a pronounced aurora.

On March 28th, four days later, the 30,000 foot level weather maps showed the birth of a small low pressure "trough," a southwards depression in the west-east flow lines over the Aleutian Islands. In succeeding 12-hour periods the maps showed it deepening abruptly, and moving in over the west coast of the United States. In five or six days it reached maximum stage, caused a readjustment of the wind and barometric pressure patterns over all of the country, and formed an isolated low pressure cell over Arizona and New Mexico--a cyclonic storm had been born. The storm then pumped warm moist Gulf of Mexico air into Colorado, east of the mountains. A tongue of cold Canadian Pacific air moved in to meet the moist air, and the result was a heavy blanket of snow that brought much needed ground moisture to the area.

What did the solar eruption have to do with this weather development? It's still an open question. Perhaps nothing, as many meteorologists contend. The sequence may be simple coincidence. There are suggestions, however, that for the winter just past at least, the developments have come on the same timing too often to look like accidental coincidence. There seems to be a chance that there was some real physical connection, though its nature is still obscure.

It's along such lines, and the underlying statistical evaluations,

that we are working now. Macdonald of our staff, and our associates Mr. Theodore Pohrte and Dr. David Woodbridge, of the Colorado School of Mines, are doing most of the analysis. We are also trying to extend a similar study to previous winters, using the high level weather maps of the U.S. Weather Bureau.

If the trends found this winter hold up in other data, we believe that we will have a useful forecasting tool for rainfall, temperature and wind at the surface, and for jet-stream level winds that affect commercial and military air operations. We also think that the time scale of the developments that we have located offers a prospect of explaining the interesting findings of Dr. Ralph Shapiro of the Air Force Cambridge Research Center--which have been outlined in these reports earlier.¹⁾ Caution must still be the watchword, however, until an independent test with new data has been done.

Analysis of K-Corona

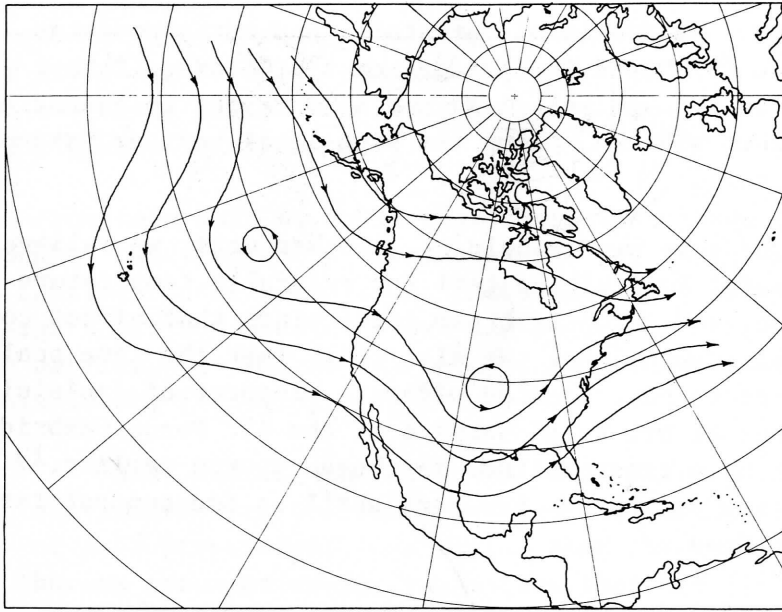
Analysis of the K-corona of the sun, by the method outlined in the last report, was hampered by bad observing weather at Climax this late winter and spring. The cloudy weather was quite hard on Axtell's efforts, which began this quarter, to obtain data for calculation of the average variation of the K-corona density with height from the sun's edge. He hopes to obtain a sufficient number of measures of high quality to permit him to do his Ph.D. thesis on this problem.

IV. OTHER RESEARCH PROGRAMS OF HAO

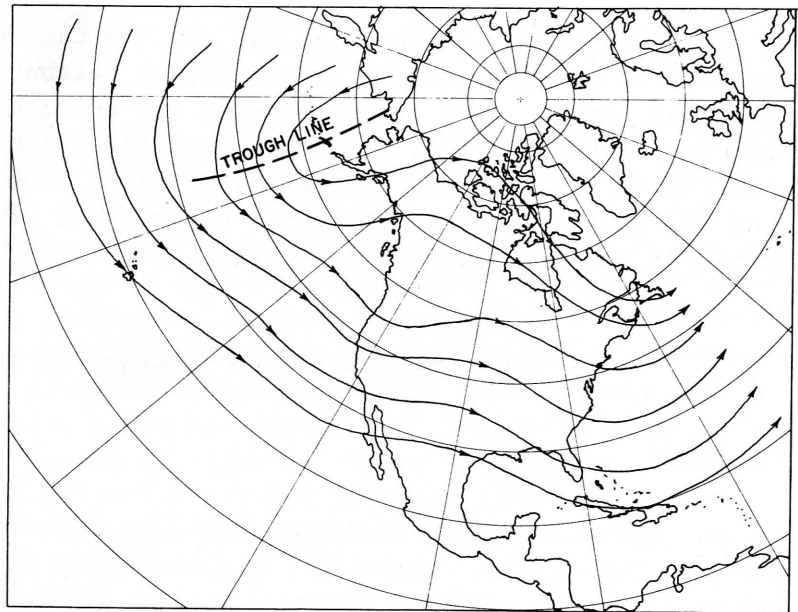
A. Staff

Dr. Kenneth Budden, distinguished ionospheric research worker from Cambridge University, joined HAO in January for five months. During this time he will work with the National Bureau of Standards ionospheric groups on problems of radio propagation and solar-radio influences. He also began teaching a course on the "Theory of Reflection of Radio Waves from the Ionosphere," as a Visiting Lecturer in astro-geophysics at the University. His visit is supported by the National Bureau of Standards. Also in January, Mr. Norman Macdonald, a meteorologist formerly with

¹⁾ Report 1955-1, Page 1; Report 1955-4, Page 11; See also, W.O. Roberts, Scientific American, April 1957, Page 138.



A

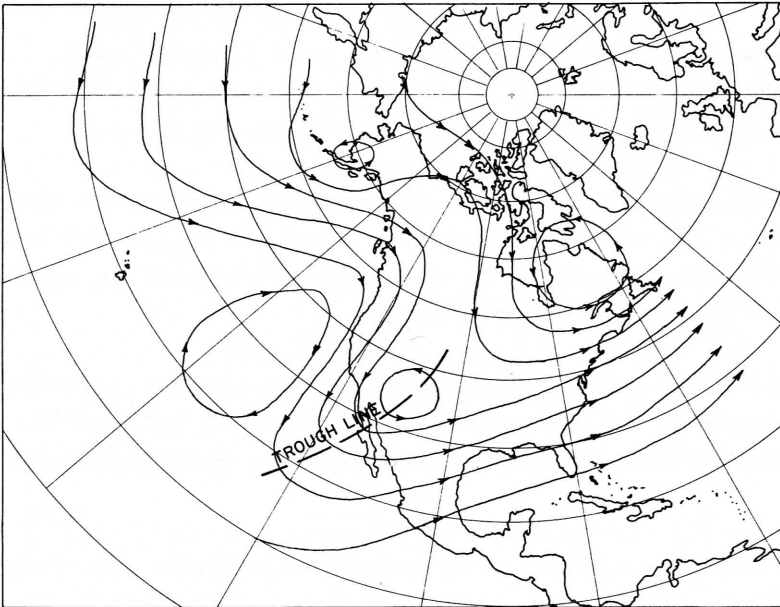
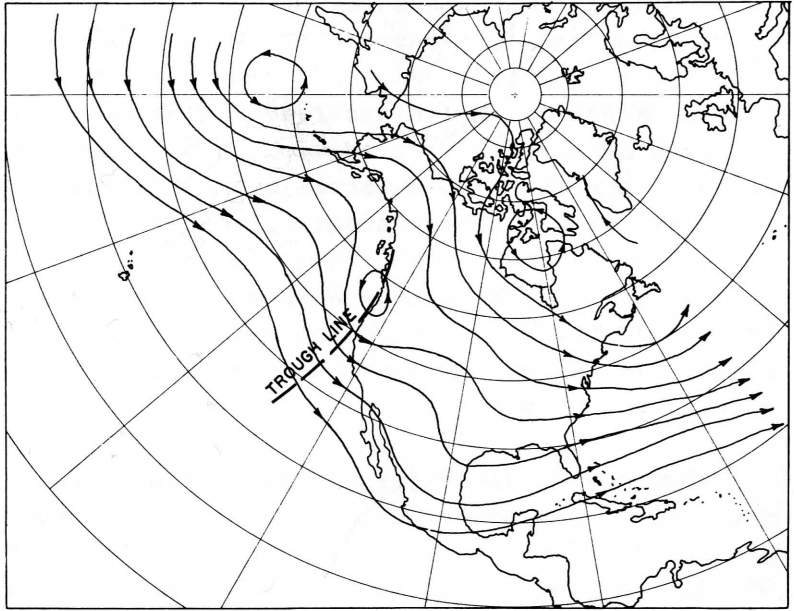


B

FIGURE 2

A series of wind flow maps showing the direction of winds at approximately 30,000 feet altitude on days following the sun-produced aurora and magnetic storm of 25 March 1957 (see text). (A) 25 March - the day of the geomagnetic storm. The trough whose development became great has not yet formed, though there is another definite trough and

C



D

a "closed low" pressure system in the Pacific between the Aleutians and Hawaii. (B) 29 March - the "trough" is now clearly evident at high latitudes, over the Aleutians; note that the other trough of (A) has practically disappeared. (C) 31 March - the trough has reached the west coast. (D) 2 April - the trough has deepened to major proportions; at this stage it produced serious weather effects over western U.S.

Dr. Irving Krick, joined the HAO staff to work in the Institute program on problems of solar-terrestrial relationships.

On March 1st Mr. Einar Tandberg-Hanssen came to the HAO staff as a research assistant to spend much of his time with the joint HAO-NBS research programs in sun-earth relationships. Tandberg-Hanssen is from the Institute for Theoretical Astrophysics in Oslo, Norway.

In January, Miss Mary N. Fleming joined HAO to assist Miss Dorothy Trotter in the data collection and reporting program of HAO. She replaces Mrs. Elizabeth Sue Klein who left the Observatory to start raising a family.

Two new trustees joined HAO this quarter. They are Dr. Robert L. Stearns, of the Boettcher Foundation, who served as a trustee during his presidency of the University, and Mr. Quigg Newton, who succeeded Dr. Ward Darley as President of the University of Colorado. Dr. Darley resigned as an HAO trustee at the time of his resignation from the University.

Chapman moved from Göttingen, where he had been working with Bartels, to the Geophysical Institute in College, Alaska on March 1st. He returns to Boulder early in July, for a four month stay.

Dr. Joseph M. Chamberlain, of Yerkes Observatory, making an extended research stay at National Bureau of Standards, also served in the new academic program during the quarter. As a Visiting Lecturer in astrophysics, he gave lectures in auroral theory.

Hansen assumed administrative duties during the quarter, serving as an assistant to Low, who, in turn, has begun devoting half of his time, with University support, to fund-raising for a new building, as mentioned above.

Curtis moved to Climax with his wife and their newborn son to take up observing duties that will continue through the International Geophysical Year. They are living in the former cosmic ray laboratory-garage that we have remodelled into a very attractive small home. They moved in at the end of March, when the snow was at the deepest level in many years and getting deeper.

B. Conferences Attended

Space navigation no longer looks like the fantastic impossibility

that it did a few years ago. As a consequence, serious conferences and discussions have been held recently on the subject of what problems will be encountered by space vehicles after they leave the protective environment of earth, with or without living passengers. The Air Force Office of Scientific Research and Convair Division of General Dynamics Corporation sponsored one such conference in February in San Diego. I attended the conference and delivered an invited paper summarizing the probable effects of unusual solar activity on space flight. Publications from the symposium will be available soon as a bound volume. Manuscript copies of my paper can also be obtained from HAO.

C. Research in Progress

As usual, the principal milestones are all that we note in this section. Some active programs still in progress are given by name only.

1. Active Solar Region Analysis -- Corona and Prominences

Analysis of the November and December 1956 active regions described in our last report²⁾ continues.

J. Warwick completed a paper for publication in the *Astrophysical Journal*³⁾ on the connections between fast-moving prominence ejections induced by flares, which he calls "sprays", and the occurrence of bursts of meteor wave radio noise. (See Figure 3.)

2. Solar Effects in the Ionosphere

The study of the diurnal changes of the ionosphere as detected by absorption of cosmic radio noise at 18 mc/s continues. J. Warwick and Zirin have prepared the observing data in a form suitable for numerical analysis on the Los Alamos "Maniac" computer this summer.

3. Solar Effects in Geomagnetism

Tandberg-Hanssen joined this research effort in March, and concentrated his effort towards investigating possible changes in F₁ ionospheric layer heights at times of geomagnetic storm. Theoretical work of Dr. Eugene Parker of University of Chicago suggests that the layer should be elevated at the start of magnetic distur-

²⁾Report 1956-4, Pages 7 and 8.

³⁾J. Warwick, *Ap. J.*, 125, 811, 1957.

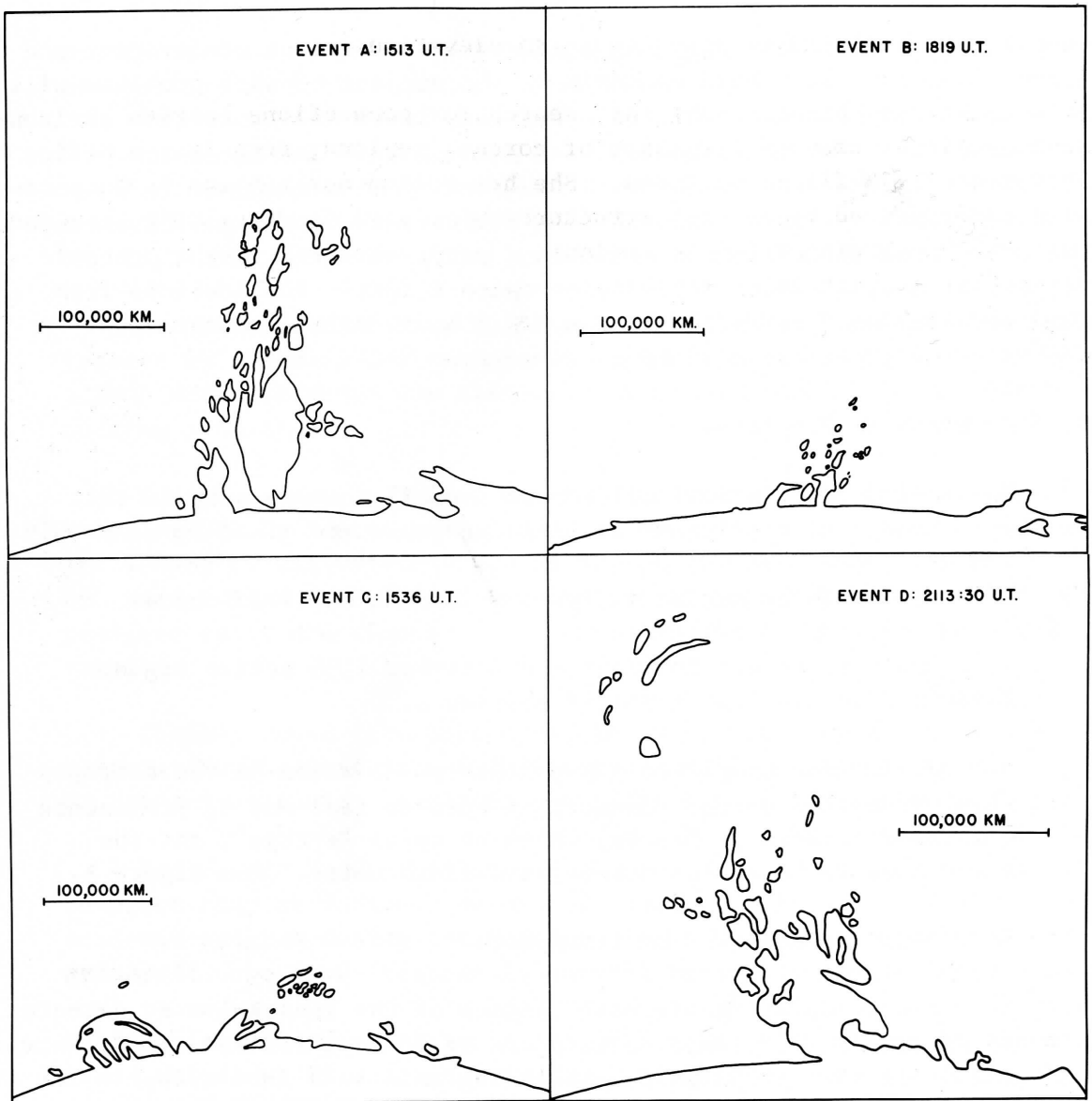


FIGURE 3

Sketches of the four "spray" prominences studied by Dr. J. W. Warwick. (See Page 11.) Event A, on 8 May 1951 and Event D on 10 February 1956 ejection velocities of 400 miles per second and 830 miles per second, and in both cases there were powerful associated radio noise bursts. Both also had associated solar flares. Warwick concludes that such prominences are activated by bursts of ultraviolet light from associated solar flares, and that their curved ejection paths suggest that the magnetic fields above the flares are strong.

bances. He will try to detect such an elevation.

C. Warwick has continued her search for connections between geomagnetic storms and the shape of coronal regions, seen in Sacramento Peak filter pictures. She has sorted out regions that are characterized by an open structure, with upwards directed streamers diverging from the regions. These centers appear to divert storm-producing solar gas clouds from the earth's direction, when the regions are near the sun's center, as seen from earth. The effect is not strong, however, and is not a reliable forecasting aid. Main results of the work on this program await the punch-card computer work now in progress.

4. Solar Activity Observing

The principal news here has been the deplorably bad weather of the quarter. It brought record snows to Climax, but very few days of satisfactory observing.

5. Temperature and Motions in the Corona.

Several programs in this area moved ahead simultaneously. We were delayed by problems with the plate-driving carriage of the microphotometer, which needs to be rebuilt to standards of higher driving uniformity.

Newkirk studied the relations between prominence structures and coronal structures in selected regions, and also began intensive work to determine whether the occurrence of relatively rare instances of appreciable coronal motion detected by Doppler effects in coronal spectra can be related to prominence motions in the same regions. (See Figure 4.) The results show that pronounced coronal motions usually appear just at the tops of the associated "loop type" prominences, and that the prominence motions generally exceed the coronal, though the directions are always the same.

Billings and Bretz worked on line profile studies of the two yellow coronal lines that arise from highly ionized calcium (5446A and 5694A of Ca XV). December 1956 spectra from Climax will yield better temperature determinations than any thus far derived.

Cooper and Billings worked on a paper describing the average fading of the brightness of the coronal emission lines with increasing height above the sun's edge. There is a surprising de-

gree of consistency to the average height gradients, though individual values vary widely.

6. Sunspot Spectra

7. Chromospheric Spectra and Spicules

8. Measurements of Older Coronal Spectra

By the end of the quarter Billings and his associates had finished up all of the measurements of the green coronal line for the older coronal spectra from Climax and were well underway with the red coronal line.

9. Guide Book on Solar Activity

Progress was very slow on this guide book. I am the principal bottleneck and I would like to take a semester off to complete the whole thing--but that will be hard to do. The IGY makes the completion of the book even more important.

10. Eclipse Research

Athay plans to write, in collaboration with Dr. R. N. Thomas, a monograph on the solar chromosphere that will summarize all of the findings from our study of the 1952 eclipse, and the relevant related work of other observatories. This will compare and critically review all of the conflicting bits of evidence, and attempt to arrive at a consistent solar chromospheric model that fits all known reliable data. The monograph will probably be completed in 1958.

The designs for the equipment for the October 1958 eclipse are taking shape. A working model, half-size for the mechanism that advances the film between exposures has been started. A full scale model will be tried next. Dr. Joseph Rush, formerly of HAO, is working as a consultant to HAO in this enterprise.

11. IGY Preparations

HAO has undertaken a large IGY observing load. We are well towards completion with most of the new instruments we plan to operate routinely for IGY. The indirect flare detectors are essentially finished; the K-coronameter is done; the flare profile instrument is in operation. The flare patrol instruments are the ones farthest

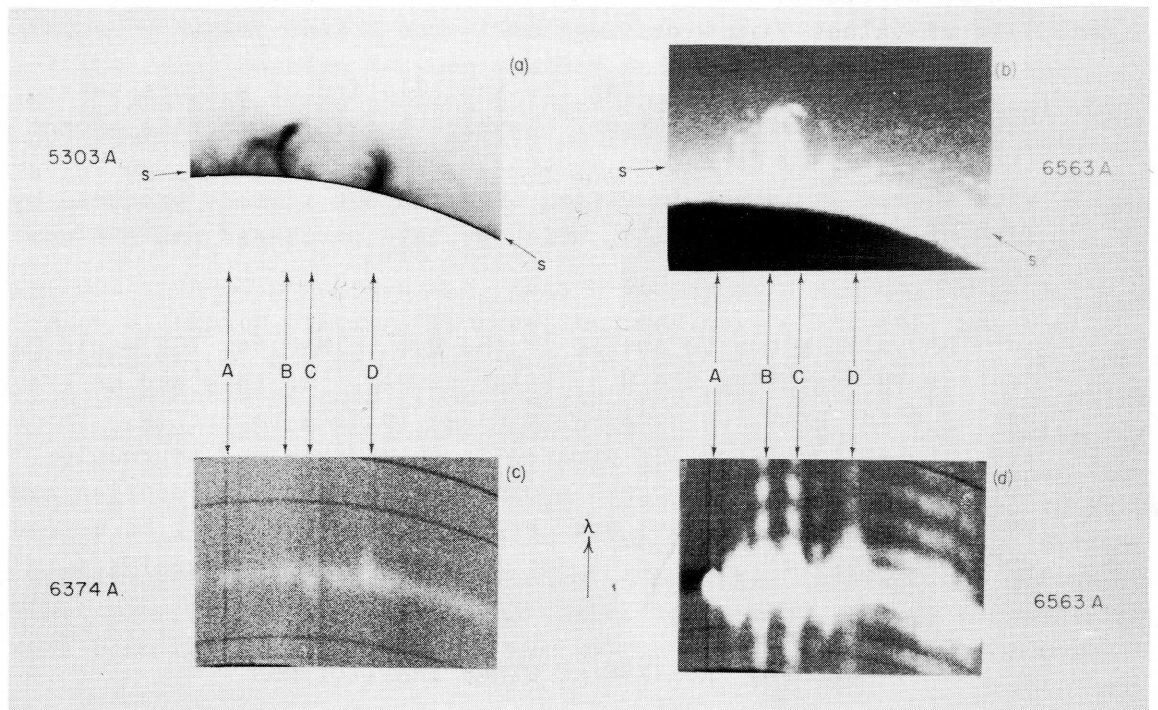


FIGURE 4

A diagram showing the association of active prominence loops with coronal regions exhibiting unusual line-of-sight motions and changeable coronal loops. The pictures at the left show the structure (above) and spectrum of the corona; those at the right the structure (above) and spectrum of prominences at the same place and time. The coronal spectrum shows gases whose position in the spectrum is displaced, by the Doppler effect, upwards and downwards from the normal spectrum position, corresponding to coronal motions away from and towards the observer. Such motions are rare, but where found are associated with similar but larger motions in the prominences (Page 13). Note the similarity of forms of the prominences and corona. (Photos from joint HAO-Sacramento Peak observing programs.)

from completion.

We are also supervising the installation of a flare patrol in Hawaii by Dr. Walter Steiger. Newkirk has followed this aspect of the work, and we hope that successful IGY instruments can be operated with modest equipment involving birefringent filters produced by the firm of B. Halle in Berlin, which we have purchased and are now testing.

HAO also plans to assist in the U.S. plans for IGY World Data Centers by operating the U.S. solar center. To this end we are preparing data forms for world-wide usage in data reporting. The scale and complexity of the IGY program is formidable and impressive. The IGY is certainly the largest cooperative research enterprise ever undertaken. Unless plans are carefully laid, we shall be buried under a deluge of "raw" data not in usable form for analysis.

V. RELATED PROGRESS AT OTHER INSTITUTIONS

A. Solar Weather Research

F. Baur, of Germany recently published a book giving a list of 48 weather forecasting rules derived from physical-statistical reasoning.⁴⁾ In this book, it is interesting to note, Baur states that strong solar activity tends to increase the west-east circulation of wind, which ultimately results over Europe in warm moist air from the Atlantic. He considers measurements of solar plages as important indices for evaluating the solar ultraviolet emission he considers responsible. For this reason he recommends that channels be established to distribute such solar data promptly for forecasting uses.

A recent paper by Dr. Siegfried J. Bauer, of the U.S. Army Signal Corps Engineering Laboratories,⁵⁾ suggests evidence for relationships between the ionosphere and troposphere. Such relationships have been

⁴⁾F. Baur, "Physikalisch-statistische Regeln als Grundlagen für Wetter- und Witterungsvorhersagen," published by Akadem. Verlagsgesellschaft, Frankfurt, 1956.

⁵⁾S. J. Bauer, paper at 2 May 1957 A.G.U.--AMS meeting in Washington, D.C. (pre-publication abstract).

reported previously in these reports, and have been summarized by Mitra.⁶⁾ Father Gherzi, some time ago, suggested that there were definite relationships between weather and the ionosphere, with the E, F₁, and F₂ regions showing changes correlated with the arrival of maritime, polar, or tropical air at Shanghai.⁷⁾ He used these relations in forecasting.

In this recent paper Bauer finds evidence that there are apparent connections between F₂ region ionospheric virtual heights (also F₂ region critical frequencies) and days of frontal passage at Washington, D. C. He picked out, for the period July through September 1955, 14 cases of cold front passage, and then computed the mean values of the ionospheric parameters observed at Washington. The results showed relations (lowering of virtual height and rise of critical frequency) on the zero day of frontal passage. The results appeared to be significant at about the 5 percent level. This result, though still highly speculative, is another clue to possible interactions between the sun-affected ionosphere and weather phenomena. Bauer's results do not seem to be related in any way we can see to our own recent works.

B. Planetary Meteorology

Mars comes close enough to earth, at times, so that its weather can be studied directly. Last fall the planet came unusually close and was subjected to intensive study at many observatories. Dr. G. Kuiper reports⁸⁾ that between the 29th and 30th of August 1956 great dust storms developed on Mars over the "Mare Sirenum" which is a permanent marking, but not a sea since there appears to be no standing bodies of water on Mars. Kuiper reports that within a few days the storm had spread out over the whole planet, giving the whole surface a ghost-like appearance and obscuring the normally visible polar snow cap. Kuiper states, moreover, that the rapidity and ribbon-like mode of spreading of the dust resembled what one would expect if a strong jet stream were present, as on the earth and about at the same latitude (35°). A few days later, again, a cloud cap formed over the pole, and when it cleared there was a new cap of clean, white snow over the pole. Kuiper also states evidence that the Martian summer was unusually dry and dusty. The

6) S.K. Mitra, The Upper Atmosphere, publ. by the Asiatic Society, Calcutta, 1952.

7) E. Gherzi, Nature, 165, 38, 1950.

8) G. P. Kuiper, Astrophysical Journal, 125, 307, 1957.

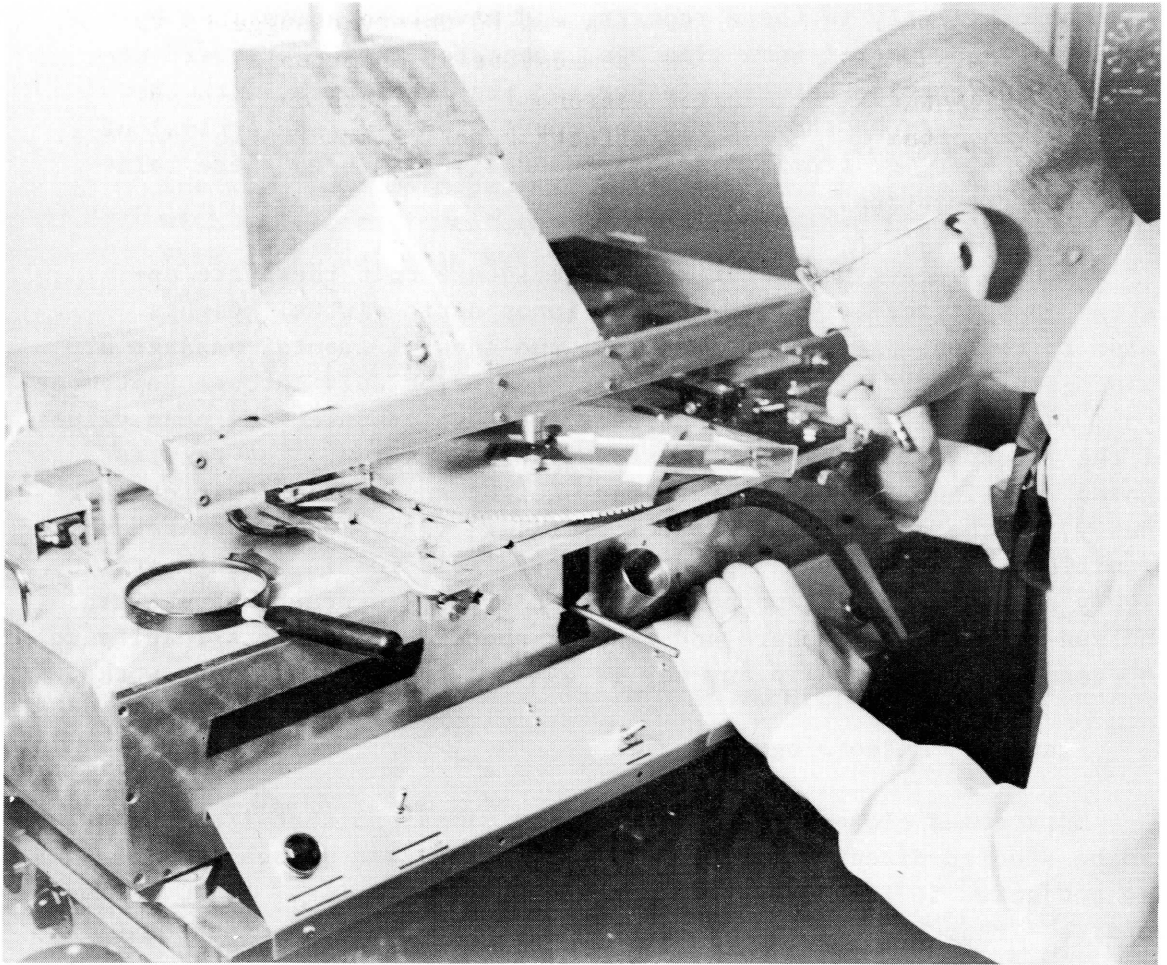


FIGURE 5

The cover picture shows the preliminary rapid-schedule measures of the corona from spectrum photographs. Here, Mr. Robert H. Cooper, of the Boulder staff of HAO, runs the same spectrum photograph through the photoelectric microphotometer, which automatically traces the brightness of the coronal lines with far more accuracy, for final published tables of coronal intensity values. These published tables of intensities are one of HAO's principal research services, and are utilized by research workers in many fields of astro-geophysics.

fact that such meteorological details can be observed suggests that at times of close approach there may someday be an opportunity to check experimentally the hypothesis of astronomical effects on weather by determining whether simultaneous effects occur on both earth and Mars.

During the last week of January 1957 an explosive warming occurred at great altitudes (25 mb) in southeastern Canada, southern Greenland and Iceland. The temperature rise amounted to about 40°C. It followed close on the heels of a large solar corpuscular stream that intercepted earth on 21 January after a sustained lull. Thus we have, again, a suggestion of a solar-weather tie where the magnitude of the effect is larger by far than the directly available solar energy increment can supply. Careful studies of the phenomenon have been made by R. A. Craig and W. S. Hering,⁹⁾ who find that the heating cannot be explained by horizontal movements of warm air from other regions, but that the heating involved a supply of energy vertically. These workers emphasize, however, that they do not consider the energy to be the direct result of solar heating, but that it must be some triggering phenomenon involving a redistribution of lower level available energy, with effects on the weather in a major part of the northern hemisphere for several weeks.

C. A Suggested New Solar-Terrestrial Effect

During the quarter we examined a recent paper by U. Becker of the Fraunhofer Institute in Germany on a suggested connection between solar activity and the rate of settling of a suspension of bismuth oxychloride in the laboratory.¹⁰⁾ The author suggests that when average solar activity is high for a solar rotation, the precipitation rate is increased appreciably. He also gives data that apparently show an increased precipitation rate on the day of occurrence of large solar flares.

No physical explanation is suggested, and the observational data for the precipitation rates are taken, apparently, entirely from published values of Piccardi, who first discovered the effect. No independent experimental confirmation of the precipitation rate measures have been made. The result is so striking and so unexpected that a com-

⁹⁾ Unpublished data reported privately, and not to be referenced without authorization and correction by the authors, R. A. Craig and W. S. Hering, Geophysics Research Directorate, Air Force Cambridge Research Center, Air Research and Development Command.

¹⁰⁾ U. Becker, Arkiv f. Meteorologie, Geophysik und Bioklimatologie, B, 6, 511, 1955.

We take this occasion to thank Dr. Ward Darley for his staunch support during his term as a Trustee of HAO. His resignation as President of the University of Colorado and as a Trustee of HAO is a great loss to both institutions.

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