

Last year NCAR's High Altitude Observatory (HAO) launched a major three-part program to describe and model the solar corona and the region between the sun and the earth's orbit. Aspects of this program, which grew from earlier research at HAO, have been described in several previous *NCAR Quarterly*: coronal observations in *Quarterlies* No. 26, 29, and 35; the solar wind in No. 34; and plans for an HAO coronagraph on the Skylab satellite in No. 31.

The HAO program will be carried out by three groups, each attacking one phase of the problem. A team led by Richard Hansen, John Eddy, and Martin Altschuler will work on an increasingly complete description of physical features (density, temperature, and magnetic fields) of the sun's surface and the inner corona, hoping to reach an understanding of these features and their role in forming and controlling the outer corona and the solar wind. This team will interpret already existing eclipse observations, coronagraph and K-coronameter data, and studies of solar magnetic fields. By combining such data with newly available satellite measurements, the group will develop a factual and theoretical background for studying the entire corona and its changes with time.

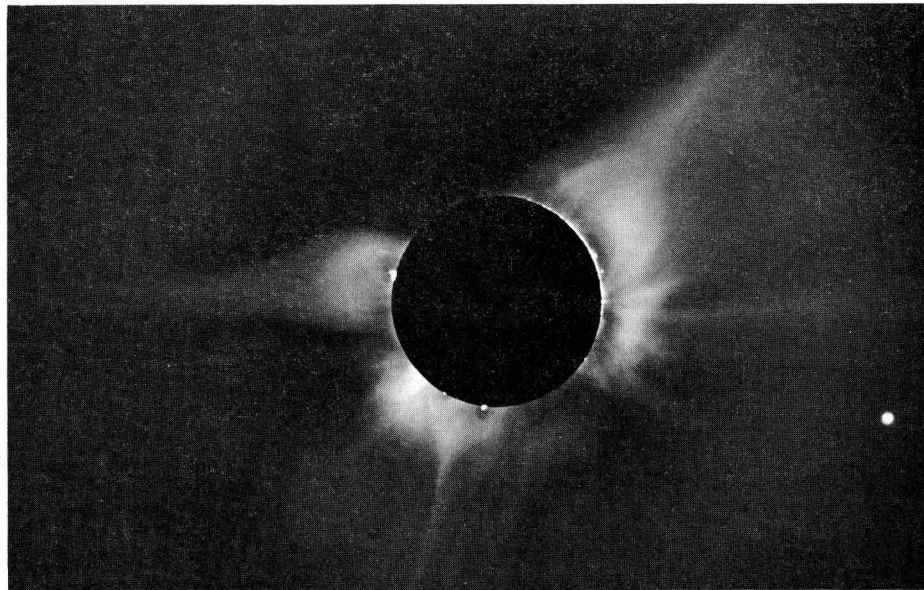
A second group, led by Arthur Hundhausen (who will also head the entire HAO program), will collect and integrate observations of the solar wind. These observations come from satellites orbiting outside the earth's magnetic field and from space probes traveling toward other planets. They are limited to the ecliptic plane, in which the earth and other planets orbit, by the prohibitive energy requirements involved in sending a space probe out of this plane.

The third group, led by Gerald Pneuman, is designing the theoretical model of the magnetic fields and the flow of solar material between the sun and the earth; this model will connect features seen in the sun's corona with those of the solar wind as measured near the earth.

The three teams include visiting and associate scientists, and efforts of the three groups involve collaboration with other institutions participating in spacecraft experiments, especially the Harvard College Observatory, NASA Goddard Space Flight Center, the American Science and Engineering Company, and the Los Alamos Scientific Laboratory. The

Sun, Earth, and Interplanetary Space

The eclipse photograph obtained by HAO in 1966 shows that coronal material is caught up in a tug-of-war between the tendency of its highly activated particles to fly off into space, and the restoring forces of solar magnetic fields. Low in the corona, where magnetic fields are strongest, they hold the coronal material in helmet-like loops. Higher in the corona, or in weak field areas such as the sun's polar regions, expansion pulls the field lines out into streamers.



massive archive of data resulting from the experiments will require a major reduction and interpretation effort, some of which will center at HAO and at NCAR's Computing Facility. The Computing Facility will also aid in parts of the program that involve formulating new models of the corona, the solar wind, and magnetic fields in interplanetary space.

The Corona and the Solar Wind

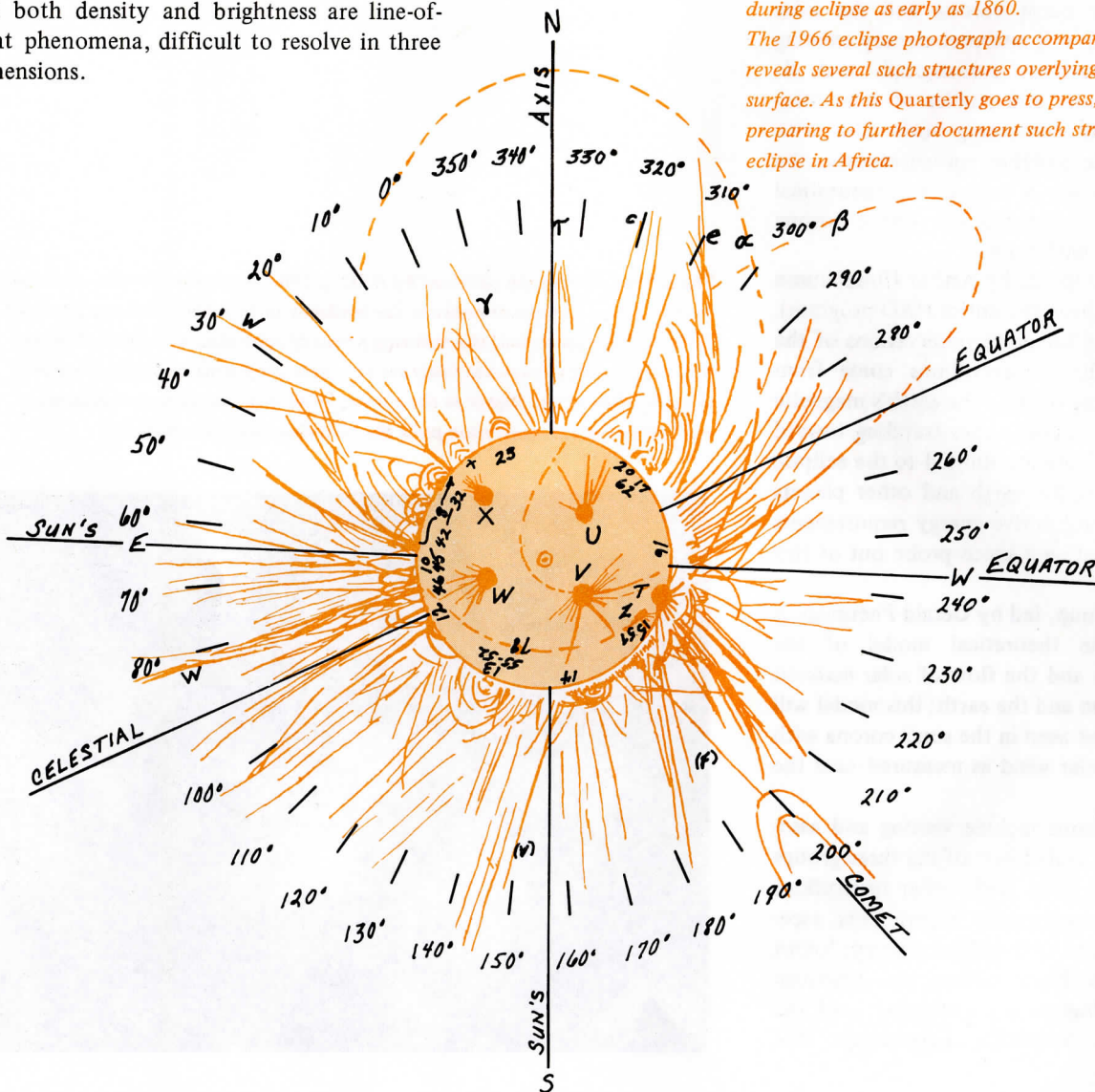
Eclipse observations and photographs show that the solar corona, the tenuous, luminescent outer atmosphere of the sun, is highly structured. Brilliant rays and streamers radiate from the solar surface, changing in shape and position between one eclipse and the next. Their brightness is a measure of their density, but both density and brightness are line-of-sight phenomena, difficult to resolve in three dimensions.

Nevertheless, eclipse photographs record a number of significant aspects of coronal structures, giving clues to why they exist. In the 1950s it was conjectured that some of the structures—the so-called helmet streamers—are related to solar magnetic fields, for loops like those formed by magnetic field lines could be seen at the base of the streamers. Low-density regions were at first thought not to have magnetic field lines, but high-contrast photographs that show slight changes of density now suggest that the field lines are open in these regions and extend far out into space.

The corona itself is known to be hotter than the underlying photosphere, so hot (two

A drawing made by J. M. Schaeberle of the Lick Observatory from photographs taken in 1893 shows helmet-like structures in the lower corona. Such structures were noted in the corona during eclipse as early as 1860.

The 1966 eclipse photograph accompanying this article clearly reveals several such structures overlying prominences at the sun's surface. As this Quarterly goes to press, HAO scientists are preparing to further document such structures at the 30 June eclipse in Africa.



million degrees) and highly ionized that it is an excellent electrical conductor. As a consequence, the material in it interacts closely with the magnetic field. Magnetic field lines are "frozen" to the gaseous material of the corona: neither can escape the other, and, as the gas moves, the field lines are pulled with it. The ionized particles of the coronal gas are so hot and so active that in regions where the magnetic field is weak they can escape the strong gravitational field of the sun, dragging the field lines along with them into interplanetary space.

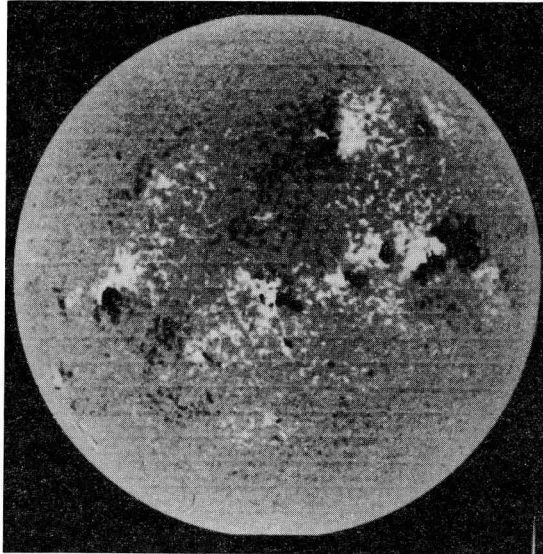
Although some researchers feel that differences in coronal density may be caused by "geographic" differences in the heating of various parts of the solar surface, others think they are due to loss of energy to space where field lines are open. Thermal conduction, like the coronal gas itself, is closely bound to magnetic field lines, so where the field lines are closed, the energy is bottled up; where they are open, the energy is dissipated in space.

The closed loops of magnetic field lines associated with helmet-shaped streamers connect areas of positive and negative polarity in the solar magnetic field. Field lines extend into space above the loops, and accordingly the streamers carry both negative and positive fields. These fields have been recorded by earth-orbiting satellites as the solar wind sweeps past the earth; the oppositely directed field regions are separated by narrow neutral sheets observed near the earth as sudden changes in polarity. Areas near the neutral sheets are measurably denser and do seem to represent streamers that are no longer visible.

Interplanetary Models

The magnetic field, the density structure of the solar wind, and the effects of the sun's rotation (discussed in *Quarterly* No. 34) must be taken into account in designing a model connecting known coronal features with features measured at 1 AU.¹

Several models, each more sophisticated than its predecessor, have been designed by



Studies of the sun's surface show there is strong correspondence between magnetic fields in the photosphere and areas of coronal brightness. An x-ray picture of the sun's disk is shown at the bottom; at the top is a map of magnetic fields on the sun as recorded by the Kitt Peak National Observatory magnetograph. Both pictures were taken at the same time. Dark areas represent negative polarity; light areas show positive polarity. Bright areas in the corona correspond closely to regions where layer areas of negative and positive polarities lie adjacent to each other.

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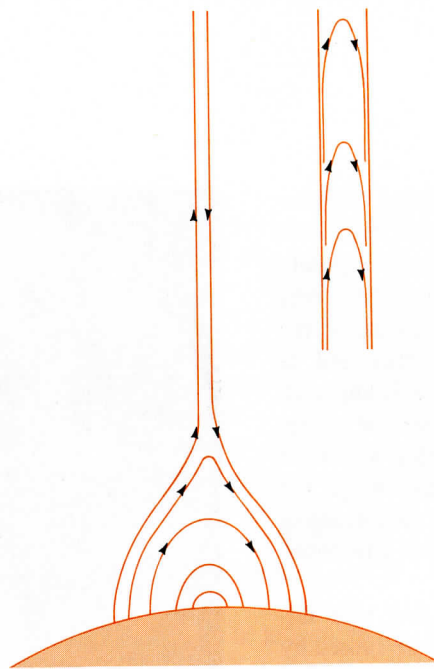
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¹ Astronomical unit, the mean distance of the earth from the sun, about 150 million kilometers.

Pneuman and Roger Kopp to show the relationship of magnetic fields and helmet structures to features in the solar wind. Their first model was based on a simplified corona, represented as having just two types of regions: streamer and interstreamer regions. It produced a single simple helmet streamer somewhat resembling those seen in eclipse photographs. Coronal material contained by the magnetic field in the inner corona is drawn out into a radial streamer some distance above the sun's surface.

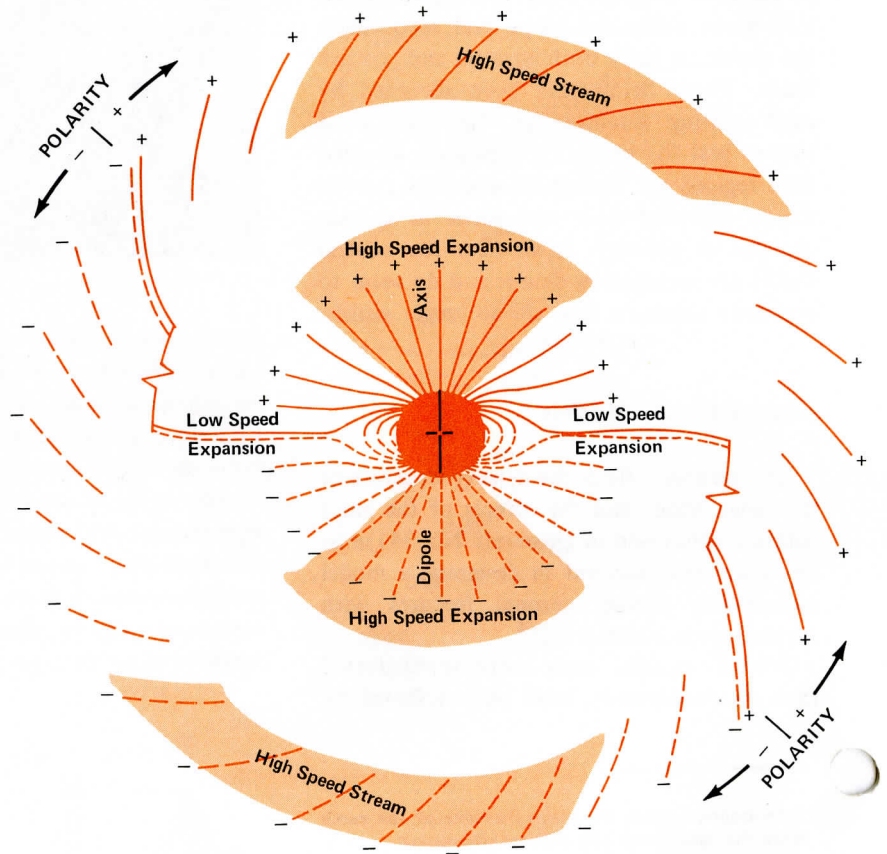
Later models were more exact, and considered the distribution of magnetic fields both at the surface and in the solar wind. To produce them, Kopp and Pneuman again began with a simplified surface field, this time a dipole field much like the earth's. For their model, they assumed uniform density and temperature at the sun's surface, in accordance with average temperature and density already known. Solving magnetic and solar wind equations exactly, they obtained a solution with many properties that nearly conform with observed coronal features: some field lines are closed near the sun's surface, and open at about one solar radius above the sun's surface. In their first solution, Pneuman and Kopp computed forces acting on the field, and in a second run, they introduced these forces, let the field change in response to them, and solved the solar wind equations again. This procedure was repeated until the magnetic field in the model reached a state of equilibrium, giving them a stable coronal solution in which they can have considerable confidence. Interestingly, the same solution has been obtained independently by Franz Ender in Germany, using a quite different approach.

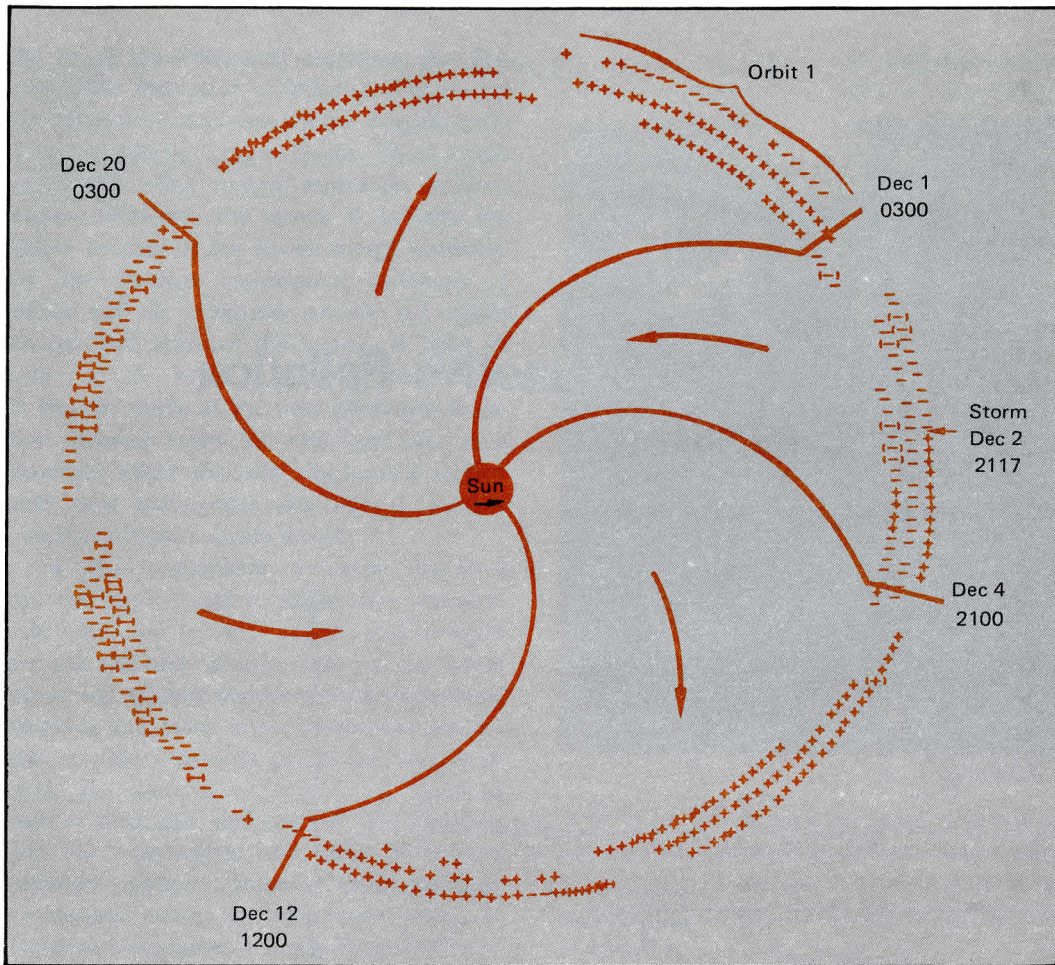
The coronal model compares reasonably well with gross features of the solar wind at 1 AU, thus indicating that it at least partially fills in the great unknown reach of space between the sun and the earth. In principle, at least, it can now be used with more realistic solar conditions. Hundhausen tipped the model sideways, for instance, so that the dipole axis is in the sun's equatorial plane—almost in the plane of the ecliptic. Adding the effects of the sun's rotation, he found that the model produced a solar wind at 1 AU which showed the type of sector structure recorded in the solar wind by satellites. Regions of low velocity occur over streamers, and regions of



A basic model of a coronal streamer illustrates the theoretical behavior of the corona above a simple bipolar magnetic field on the sun's surface. Close to the surface, magnetic field lines form loops, but farther out they are drawn out into space by highly energetic solar wind particles.

When the dipole coronal model developed by Pneuman and Kopp (center) is reoriented so that the dipole lies in the sun's equatorial plane, the relationship of coronal features to features of the solar wind at 1 AU (outer ring) can be clearly modeled. High-speed streams and abrupt changes in polarity are offset about 45° by the sun's rotation. In this representation, the space between the sun and the earth's orbit is much reduced.





higher velocity over interstreamer areas; positive and negative sectors containing high-speed streams of the solar wind are separated by neutral sheets. The model is still, of course, simpler than the real solar wind, which often is divided into five or more sectors.

Continuing Research

The usefulness of the HAO solar-interplanetary model depends on continuing observations close to the sun and at 1 AU. The model will be checked against the extensive new data on the inner corona expected from the Skylab satellite, continuous series of pictures showing the corona as the sun rotates. These pictures will make it possible to resolve overlapping features and to describe the corona and its magnetic fields accurately in three dimensions. The model will also be compared with available satellite measurements of the solar wind at 1 AU.

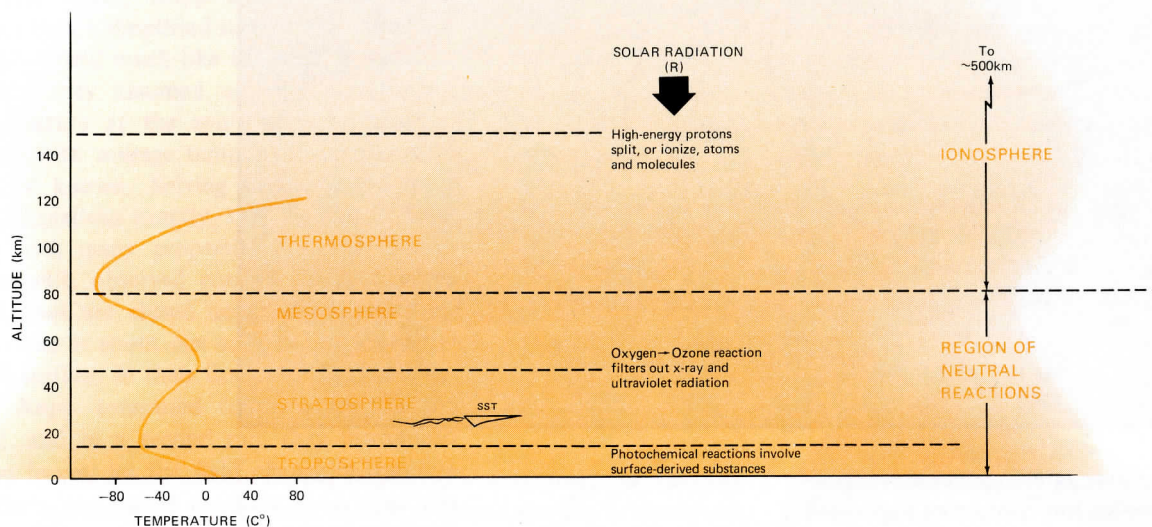
The theoretical part of the program will continue along two lines:

The magnetic polarity pattern recorded by an earth-orbiting satellite shows four sectors of reversing polarity in the solar wind. Each plus or minus sign represents a 3-hr average value of the radial field component. Compare these observations with the theoretical model in the previous diagram. (Courtesy N. F. Ness and J. M. Wilcox)

- SIM I (Solar Interplanetary Model I). Further development of a single, tractable model producing quick but approximate results.
- SIM II. A more exact model of the interplanetary region, developed in greater detail and based on realistic boundary conditions derived from new solar observations. This time-dependent model will portray as exactly as possible the large-scale changes in physical characteristics such as magnetic field, temperature, and density of the interplanetary medium from the inner corona to 1 AU.

Both models will lead to a greater understanding of the role played by solar magnetic fields in controlling the solar wind, and enable predictions of day-to-day variability in the outer solar atmosphere and the solar wind in the region of the earth's orbit.

Photochemistry and Automotive Pollution



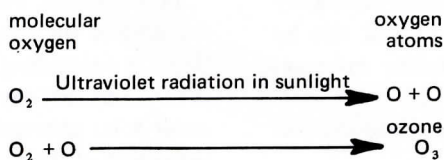
In terms of temperature, the atmosphere is divided into four layers: the thermosphere, mesosphere, stratosphere, and troposphere. Photochemically, there are only two important regions: the ionosphere, where solar energy breaks molecules and atoms into ions and electrons, and the region below 80 km where chemical reactions involve predominantly neutral substances.

In the upper reaches of the atmosphere, more than 80 km above the surface of the earth, sunlight acts on atmospheric molecules and atoms with energy sufficient to split them into their component ions and electrons. This is the ionosphere, a region of free, electrically charged particles that has become important to man as the medium by which radio waves can be transmitted around the world.

Below the ionosphere, sunlight is still an effective agent in fragmenting molecules or in exciting them electronically, and solar radiation (particularly ultraviolet radiation) continues to interact with all the gases in the atmosphere. But the photons (particles of radiation) that have filtered through the ionosphere are less energetic and do not carry enough "punch" to produce ionization. Instead, they produce neutral atoms and excited

molecules and bring about chemical reactions between these non-ionized chemical particles.

In the clean, dry mesosphere and stratosphere, photons bombard molecular oxygen; the most notable photochemical reaction in these regions involves production of ozone. The process of ozone production may be represented in simplified form by using chemical notation:

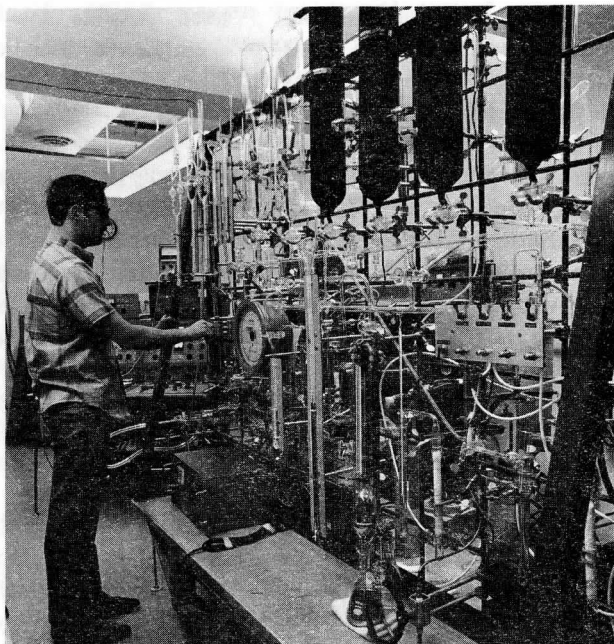


As in all photochemical reactions, the first step is the absorption of radiation. The energy of radiation breaks apart some oxygen molecules, producing oxygen atoms. These atoms react with other oxygen molecules to form ozone. Although the ozone is initially unstable because of the excess energy produced by the reaction, subsequent collisions of ozone and air molecules remove the excess energy and stabilize the ozone. A layer of ozone at 25 - 30 km is produced in this way; it absorbs much of the near ultraviolet radiation coming from the sun, and acts as a powerful filter shielding the earth's surface and lower atmosphere and helping to make conditions there suitable to life.

In the troposphere, chemical reactions become more complex. Many more chemical substances are present: oxygen and nitrogen are still the most abundant by far, but water vapor and carbon dioxide are found in small amounts and many other substances are present in trace amounts (parts per million or less). In addition, surface-derived materials such as dust, ash, and sea salt are drawn up into the troposphere and held aloft by its turbulent motions. Some of these materials are natural; others are man-made. Man, for instance, contributes a negligible quantity of water vapor to the atmosphere, but his agricultural activities are thought to have doubled the amount of atmospheric dust; his industries, burning fossil fuels, add fly ash and (in vapor or solid form) many organic molecules and compounds of sulfur and nitrogen. In nonurban areas nature's contributions are significant. For example, more than a quarter of the aerosols in the atmosphere—pollens, spores, and humus particles—are contributed naturally by plants, and volcanoes add water vapor, fine dust, and sulfur compounds. Aside from the water vapor, all these atmospheric additives, whether natural or man-made, can be considered pollutants.

Reaction Chains and Computer Chemistry

NCAR's photochemical team, led by Eric Allen, is exploring reactions of neutral substances that occur in the troposphere and stratosphere. These are of course the areas of most crucial interest to man, as they are the regions that most directly affect his existence.



NCAR's electron spin resonance spectrometer (the black case in the background) is almost hidden by the maze of gas storage cylinders and flow control tubes that lead to it. This instrument is used in studies of isolated segments of chain reactions at temperatures and pressures at least as low as those in the stratosphere.

Many chemicals which occur here in molecular or aerosol form are present only in minute, hard-to-measure quantities. Moreover, some of the reactions being studied are strikingly complex; they are better considered as chains of reactions, with many interdependent steps or stages. Often both photochemical and thermal reactions occur as parts of these chains. To add to the complexity, the rates at which the reactions take place may vary with temperature, pressure, and the amount of available sunlight, so that a process predominant in one region may be inconsequential in another.

Hoping to untangle the web of reactions in the troposphere and stratosphere, the NCAR team is now zeroing in on certain significant reaction chains by systematically studying each component link in the laboratory. They

start by determining the rate at which a reaction takes place under laboratory conditions, where temperature, pressure, and concentration can be controlled. From their laboratory data they extract a value known as the *rate constant*, which relates the reaction rate to concentrations of reactants under varying temperature and pressure conditions. Combining the rate constant with known atmospheric concentrations of the reacting substances, they can then estimate the rate of the process in various regions of the atmosphere.

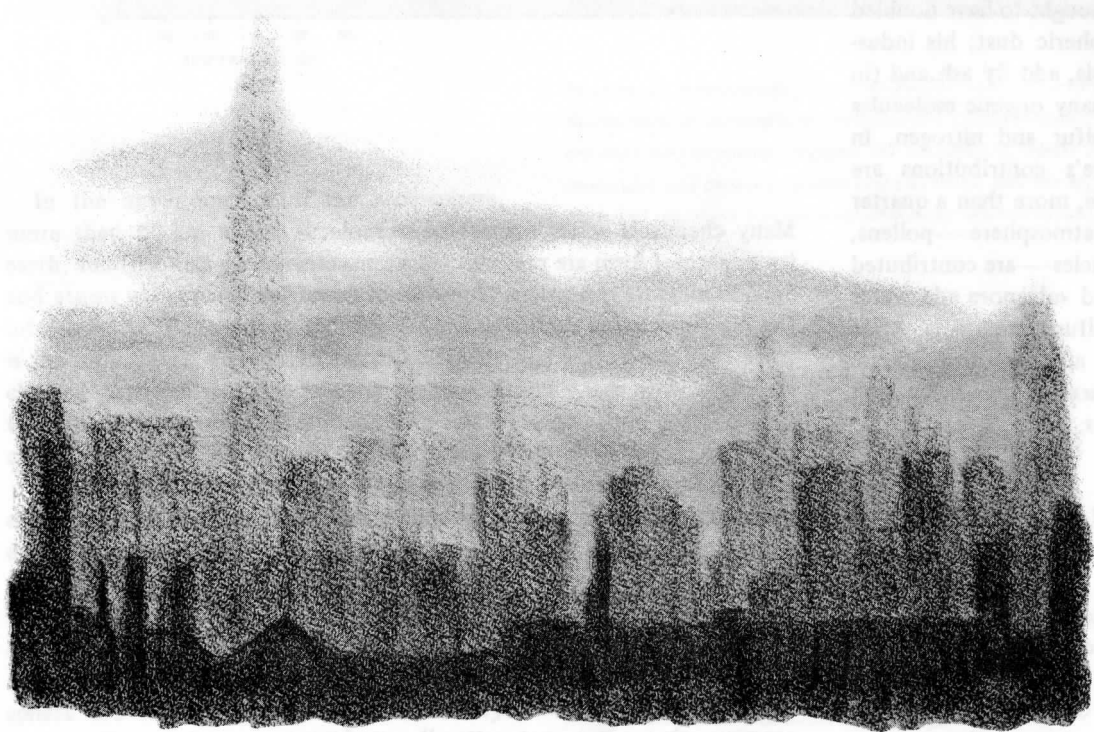
Allen and his group are also studying the efficiency with which radiation triggers each reaction, thereby establishing the *quantum yield*, the number of molecules decomposed or produced per photon absorbed.

Once the rate constant and quantum yield of each successive link in a reaction chain are known, all the links (20 or more for some complex chains) can be combined in a computer program to produce a picture of the total chemical process and its variation under different atmospheric conditions. Through this combination of laboratory and modeling

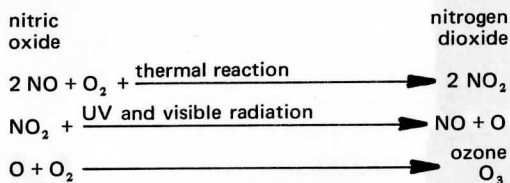
techniques, Allen and his group seek to determine more accurately than has previously been possible the mechanisms of photochemical reactions in the atmosphere and the rates at which they take place.

Primary and Secondary Pollutants

An example of research being done in NCAR laboratories is that on selected pollutants found in automobile exhausts. Colorless gaseous pollutants released by internal combustion engines are nitric oxide, oxides of carbon, and partially combusted or uncombusted hydrocarbons derived directly from petroleum. Of these primary pollutants, the nitric oxide (NO) and hydrocarbons are potentially the most important in terms of production of photochemical smog. NO reacts thermally, and relatively slowly, with atmospheric oxygen to produce a secondary pollutant, nitrogen dioxide (NO₂), a noxious brown gas that is a visible sign of automotive pollution in urban areas. However, this reaction does not in itself account for the rapid



build-up of NO₂ observed daily in smog areas. Instead, the NO₂ absorbs visible radiation (as is evidenced by the fact that it is colored) in a process that breaks it down again into NO and free oxygen atoms:



As can be seen above, most of the atomic oxygen produced in the second stage of this reaction combines with oxygen molecules to form ozone. Because of its oxidizing ability, ozone reacts rapidly with NO to re-form NO₂. Also, and more importantly, a few of the oxygen atoms react directly with specific hydrocarbons in exhaust to produce other highly reactive substances that accelerate the oxidation of NO to NO₂ in efficient reaction chains. It is now thought that these chains produce most of the NO₂ associated with automotive pollution.

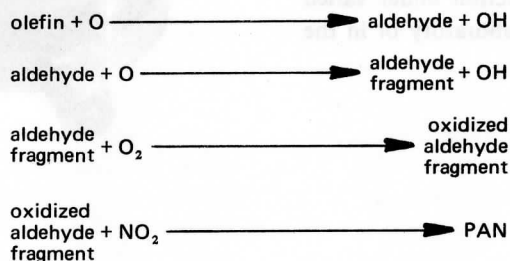
In photochemical smog, NO is converted to NO₂ in a matter of hours, but accumulation of NO₂ is limited by its tendency to be consumed by reactions with other pollutants. In general, however, NO₂ reaches its highest concentration just a few hours after peak traffic periods, when it is visible as a brown haze such as that found in Los Angeles, Denver, and other metropolitan areas with pockets of stable, relatively motionless air.

Hydrocarbons

The hydrocarbon fuels—petroleum derivatives—are made up of chains or rings of carbon-hydrogen units which vary in their combustion efficiency. Within an automobile engine the hydrocarbon molecules burn rapidly during the combustion process that drives the engine. Complete combustion would result in release of only carbon dioxide and water. In practice, the combustion is far from 100% efficient, and partially oxidized, fragmented (“cracked”), and unconsumed hydrocarbons are dumped into the atmosphere as “exhaust.”

Among the uncombusted and fragmented hydrocarbons in automobile exhausts are olefins. These hydrocarbon molecules react

rapidly with oxygen atoms and ozone to produce many other chemical products. Lately NCAR interest has turned toward studies of the conversion of olefins into epoxides, compounds of particular interest because they have recently been shown to cause tumors in laboratory animals. Other products of the olefin reactions—including some aldehydes—are also known to be deleterious to the health of experimental animals and plants and of human beings. Peroxyacyl nitrates (called PANs) cause damage to citrus, lettuce, and other crops near heavily traveled freeways; they are produced by a complex chain reaction initiated by sunlight acting upon NO₂ and olefins or aldehydes:



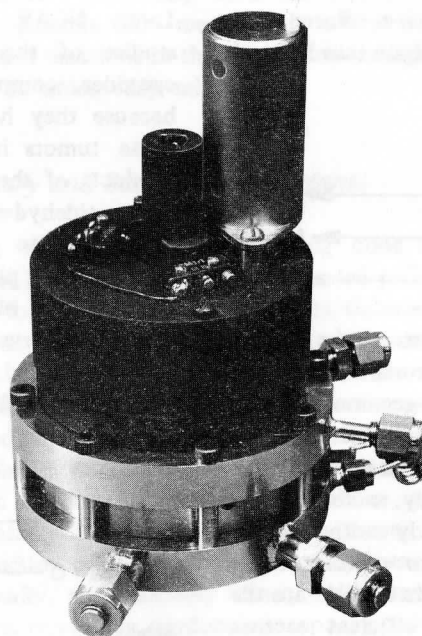
Pollutants in the Stratosphere

The supersonic aircraft problem is closely related to that of automotive pollutants. In the stratosphere, where ozone is abundant, all of the ingredients of photochemical smog already exist naturally, *except one*: the hydrocarbons. Atmospheric scientists are especially concerned with the effects of introducing hydrocarbons at SST flight altitudes, since the stratosphere is relatively nonturbulent and nonmixing and is not periodically cleansed by precipitation as is the troposphere. The presence of photochemical smog in the stratosphere might, by changing the optical and chemical properties of the stratosphere, significantly alter the radiation reaching the lower atmosphere. For example, removal of ozone by involving it in photochemical reactions could allow increasing amounts of dangerous ultraviolet radiation to reach the earth's surface.

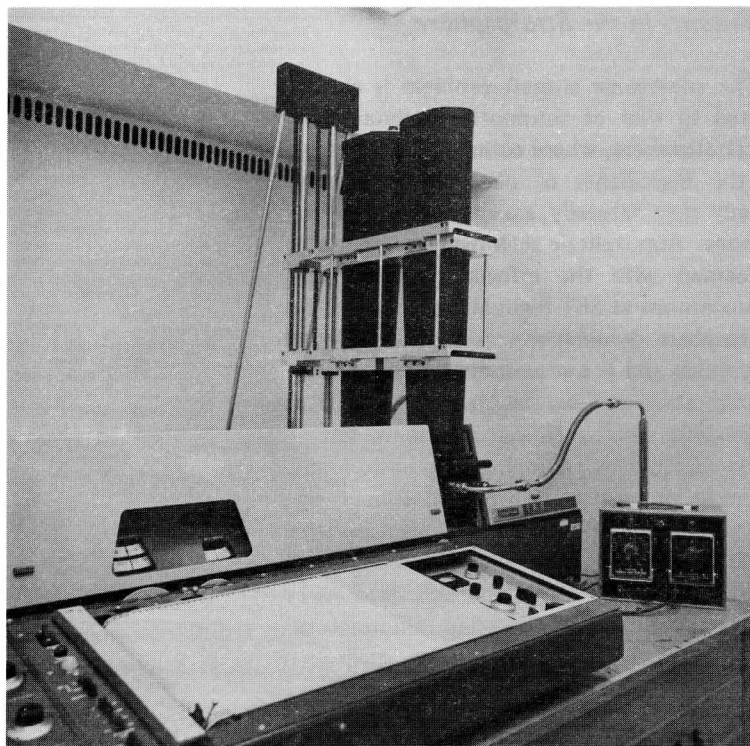
Step-by-Step Chemistry

Photochemical processes in the atmosphere generally do not stop at the initial photon-

activated reaction: products of the initial step continue to react thermally, particularly with oxygen, until a stable or relatively stable compound is formed. Step-by-step chemistry, where each stage in each process is analyzed separately, will ultimately give rate constants and quantum yields which can be entered into a computer program to produce solutions for some of the most crucial problems in atmospheric chemistry and atmospheric quality. The approach being used at NCAR is unique: to develop methods for measuring specific reactions, to find their rate constants and quantum yields in the laboratory, to define exactly the mechanism of each reaction, to develop a numerical model based on rate constants and quantum yields, and then to use the model to test the reaction under varied conditions, either in the laboratory or in the natural atmosphere.



A leak-free gas sampling valve designed and built at NCAR enables NCAR chemists periodically to extract and analyze complex mixtures of gases as they are produced in photochemical experiments.



In two optically matched long-path cells (background), infrared light can be bounced back and forth between mirrors. The effective paths traversed by the light range up to 40 m. Using these cells in conjunction with the spectrometer in the foreground, NCAR photochemists are studying reactions of trace substances in parts-per-million concentrations. Gases to be studied are fed into one cell; the other serves as a control.

New Projects and Goals

Formal revisions in UCAR and NCAR organization, management, and operation were adopted by the UCAR Board of Trustees and Members' Representatives during their May meetings. The revisions focus UCAR's primary attention on the operation of NCAR, with guidance by "the best collective judgment" of the university atmospheric sciences community.

NCAR's missions are to provide research services to the universities and to carry out a scientific program consisting of mission-oriented projects that require teamwork among scientists from many disciplines. Adjusted staffing ratios will favor exchange and collaboration: approximately equal numbers of the scientific staff will have long-term, limited-term, and visitor appointments. University viewpoints will be solicited on all important decisions concerning NCAR's research programs, as well as the development and operation of NCAR's research facilities for joint use.

These changes were implemented in response to comments from the National Science Foundation, advice from university representatives and scientists, and the conclusions of a Joint Evaluation Committee

report issued last November at the request of NSF and UCAR. The JEC Report criticized certain aspects of the NCAR/UCAR operation but provided constructive recommendations that catalyzed basic discussions about the role of UCAR and the atmospheric sciences nationally. Strengthening the link between NCAR and the universities was considered a crucial step in revitalizing UCAR's effectiveness. Throughout the review and redefinition process the NCAR staff has worked closely with NCAR and UCAR administrators and with university colleagues across the country.

NCAR Organization

The change to mission-oriented programs prompted the creation of two new scientific divisions to replace the NCAR Laboratory of Atmospheric Science (LAS). The divisions, titled Atmospheric Analysis and Prediction (AAP) and Atmospheric Quality and Modification (AQM), each contain a variable number of projects with assigned terms of longevity. The projects focus on specific research goals, in contrast to the discipline-oriented departments of atmospheric chemistry, physics, and

dynamics that formed LAS.

Projects are classed as approved major projects, approved candidates for major projects, or projects scheduled for termination at a fixed date. Creation, approval, and termination of all projects requires UCAR action with direct participation by university scientists.

In the first category are large, cooperative projects that form the backbone of NCAR research. They are assigned long-term reclassification and interim review dates. Two projects endorsed and begun before NCAR's reorganization currently hold this status:

- The *NCAR GARP Project*, containing most of NCAR's research for the Global Atmospheric Research Program (including numerical modeling of the general atmospheric circulation).

- The *National Hail Research Experiment (NHRE)*, a five-year study of hail-producing storms and hail suppression techniques, now in its second summer in the field. NHRE is a cooperative project among several agencies and universities, and is also closely allied with parts of NCAR's former cloud physics program.

Candidate projects are promising research programs that require preliminary in-depth investigation of their importance, feasibility, and cost before they can be approved as major projects. Recommendations for new candidate projects can come from NCAR, the universities, or national science advisory agencies. Upgrading or termination of candidate projects will usually occur in six to 18 months. The four present candidate projects, regroupings of major portions of NCAR's expertise, are:

- *Small-Scale Processes of the Atmosphere*. Focus is on improved short-range prediction of severe downslope winds and clear air turbulence, boundary layer processes, and isentropic methods of prediction (see *NCAR Quarterly* No. 39, May 1973).

- *Climate*. Special emphasis is on adapting NCAR's general circulation model to climate studies, modeling dominant climatic factors, applying statistical-dynamical approaches to climate modeling, and conducting university-NCAR field studies of the role of aerosols in the radiation balance.

- *Urban and Global Pollution*. Goals are to determine long-term global trends of natural

and man-made trace constituents in relatively unpolluted regions, and to evaluate the impact of concentrated urban pollution sources on global trends.

- *Upper Atmosphere*. Focus is on global-scale models of the atmosphere above the troposphere, comparison of models with observational data, and the use of models in assessing man's impact on the upper atmosphere.

The High Altitude Observatory (HAO) and the Advanced Study Program (ASP) have retained their basic structures and purposes. A special committee is reviewing HAO's role within NCAR. ASP will continue its pre- and postdoctoral fellowship and visitor programs and its summer colloquia.

Increased Services

The Facilities Laboratory (FAL) will also retain its basic structure and purposes. It has initiated improvements in services, project review procedures, and cost-effectiveness measures. The FAL's mission is closely tied to NCAR's commitment to provide services for the universities, and initial plans are now being made for enlarged computing, aircraft, and project-support services.

The universities have strongly endorsed plans for a network of remote computer terminals. NCAR's Control Data 7600/6600 computers are used annually by more than 300 university scientists from over 80 institutions, but the inconvenience of traveling to NCAR has prevented university scientists from using their full time allocations. Experiments with terminals at several universities are scheduled to begin operation this fall. As numerical modeling increasingly dominates atmospheric research, university investigators will use half or more of NCAR's total computing capacity. Plans are being made for acquisition of a larger Advanced Computer for Array Processing, which would also be linked by terminals to the universities.

Improved aircraft services will follow two trends:

- Cooperative development of advanced instrumentation that can be integrated into large field programs and that will serve large numbers of university investigators. The inertial navigation and air turbulence equipment

aboard NCAR's Buffalo aircraft is considered to be an outstanding first example.

- Coordinated use of several aircraft and ground field support. The NCAR Research Aviation and Field Observing Facilities will provide an important national resource to fulfill many measurement requirements that isolated aircraft or ground equipment cannot satisfy. Reductions in government research aviation facilities and cutbacks in support by military aircraft have increased the importance of these NCAR services.

NCAR's planning, implementation, and management of large atmospheric projects date from the Line Islands Experiment in 1968, and are currently best typified by the National Hail Research Experiment. Large projects are often beyond the manpower and logistics resources of individual university atmospheric science departments, but with NCAR as a focal point the resources of many groups can be brought together.

Staff

In their joint sessions this May the UCAR Board and Members' Representatives expressed confidence in UCAR President Walter Orr Roberts and NCAR Director John Firor for their leadership toward the new goals. Roberts, however, in anticipation of his retirement in 1975, will vacate his post and act as past president and trustee ex officio before that date if a successor is found. A committee has begun to seek candidates from among the nation's leaders in atmospheric research and administration. Other UCAR committees are examining long-range provisions of UCAR's organization and seeking directors for NCAR'S AAP and AQM divisions. Acting division leaders are serving until UCAR has approved permanent appointments.

Other internal improvements include reviews of staff quality and personnel policies. University scientists and other experts are being consulted in evaluations of NCAR's senior scientific staff, and by this fall scientists will be assigned long-term or limited-term (one to three years) appointments. UCAR has determined that about one-third of the senior staff should receive long-term appointments; this number will provide the necessary cadre of scientific leadership and advancement

opportunities for outstanding young scientists.

UCAR has also emphasized each scientist's obligation to provide "service to colleagues in the university community and other atmospheric sciences organizations." Primary forms of service are planning and carrying out projects, developing facilities, and aiding university entry into NCAR projects. Such provisions add responsibilities analogous to teaching duties and help to achieve parity between NCAR and academic careers. Like many of the new emphases, they reflect UCAR's concern to work with the universities toward goals of mutual interest and national benefit.

Upper Stratosphere Air Sample Collected

NCAR's rocketborne cryogenic air sampler was flown successfully at White Sands Missile Range (WSMR) on 23 May. A column of air 150 cm² in cross-sectional area was collected at supersonic speeds during rocket ascent between 40 and 50 km altitude. The air sample, about 150,000 l of upper stratosphere air, is equivalent to 11.3 moles or about 250 l of air at sea-level pressure.

The cryogenic sampler used in this experiment employed liquid neon as cryogen; its stainless steel sample chamber was subjected to prolonged bakeout at 450°C prior to rocket flight. These features provide a greatly improved capability for water vapor and molecular hydrogen concentration measurement, compared to that for the earlier, liquid hydrogen cooled cryogenic sampler (see *NCAR Quarterly* No. 25, November 1969). The rocketborne cryogenic samplers have been developed and built at NCAR for use in a research project headed by Edward Martell. The construction, instrumentation, testing, and preparation of the samplers were carried out by Edward Denton and Richard Lueb of NCAR.

After parachute recovery, the payload was returned to the Aerobee Preparations Building at the WSMR where, after warm-up to room temperature, the high-altitude air sample was transferred into baked-out stainless steel vessels. Analysis of the sample will be carried out by Dieter Ehhalt and other NCAR chemists. The results will provide the first direct measurements of water vapor, molecular hydrogen, methane, carbon dioxide, carbon monoxide, nitrous oxide, and other minor constituents of the upper stratosphere.

Hodgkins Medal Awarded to UCAR President

The Hodgkins Medal of the Smithsonian Institution has been awarded to Walter Orr

Roberts, the President of the University Corporation for Atmospheric Research, NCAR's governing body. Supported by the Hodgkins Fund, based on a gift made to the Smithsonian in 1891 by Thomas C. Hodgkins, the medal is awarded periodically to honor important contributions to knowledge of the physical environment, with special reference to man and his cultures.

The medal was presented at an international symposium on "The Nature of Scientific Discovery," held in observance of the 500th anniversary of the birth of Copernicus. In awarding the medal, S. Dillon Ripley, Secretary of the Smithsonian, cited Roberts' work in helping to create and administer NCAR.

Roberts is the second NCAR-associated scientist to receive the Hodgkins Medal. In 1965 it was awarded to Sydney Chapman, the distinguished British geophysicist who was associated with the University of Colorado, the Geophysical Institute of the University of Alaska, and NCAR for a number of years before his death in 1970.

HAO Coronagraph on Skylab

NASA's Skylab space laboratory, launched on 14 May, carries on its Apollo Telescope Mount the White Light Coronagraph designed at NCAR's High Altitude Observatory (HAO). Despite the trouble-fraught early days of the Skylab mission, the coronagraph, as well as other solar instruments, functioned properly when put into operation by the astronaut-observers of the satellite laboratory (see "The Sun from Space," *NCAR Quarterly* No. 31, May 1971).

Built to HAO specifications by Ball Brothers Research Corporation, the coronagraph creates an artificial eclipse by blocking out the disk of the sun. Similar instruments have been used from a number of high-altitude bases, and NCAR has launched two balloon-borne coronascopes, but Skylab offers an unprecedented opportunity to study the

Notes

corona from the vantage point of space, far above the light-scattering atmosphere of the earth.

Solar studies are a featured part of the three manned Skylab missions. Observations of day-to-day changes in the corona promise to help solve a number of problems concerning coronal magnetic fields and the evolution of coronal structures.

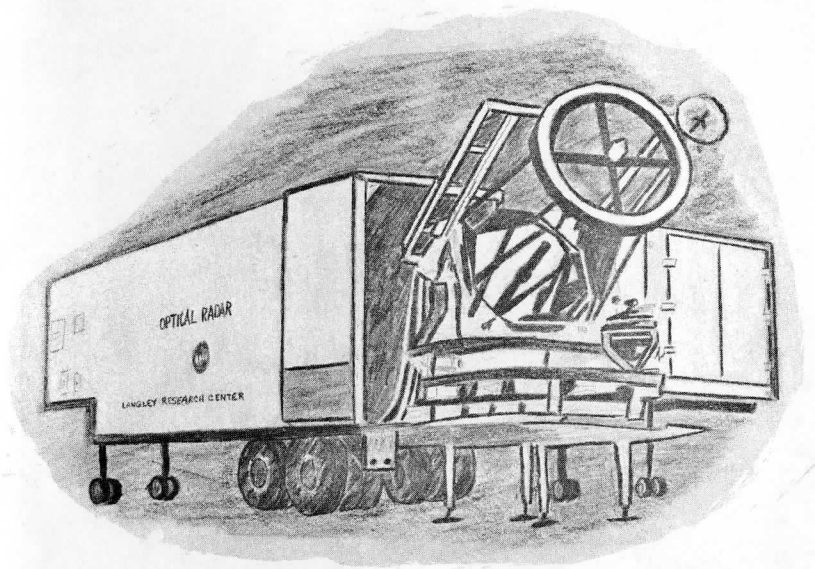
An HAO team headed by Robert MacQueen was in Houston for the launch, the subsequent repair mission, and the initial scientific phase of the mission. This group was able to see the White Light Coronagraph view of the corona via a television link from Skylab.

NCAR/NASA Laser Study

In March of this year, Gerald Grams of NCAR and Patrick McCormick of NASA operated NASA's mobile laser radar at NCAR's Marshall Field Site near Boulder, Colorado. Their aim was to obtain high-resolution data on atmospheric structure as part of WAMFLEX, the Wave Momentum Flux Experiment, but lack of strong wave-producing westerly winds during the period when the laser radar was in use prevented attainment of this objective. However, they did obtain new data on optical properties of atmospheric aerosols, including some which can be related directly to aerosol samples collected above the observing site by Irving Blifford in NCAR's Sabreliner. Correlation of backscatter measurements from the ground with aircraft aerosol samples will improve techniques for separating the effects of aerosol scattering from the effects of scattering by air molecules, and will aid in deriving accurate molecular density profiles of the atmosphere.

In an NCAR/NASA joint project in January, Blifford and Grams mounted an NCAR optical instrument on the NASA Convair 990 research aircraft. This instrument measures angular variation of intensity of light scattered from a laser beam by aerosols, and simul-

taneously measures the size distribution of the aerosol particles. (Additional flights of the instrument were canceled by the tragic loss of the NASA aircraft on 12 April.) Study of the data obtained will establish an upper limit to the ratio of loss of incoming solar energy by absorption to loss by aerosol scattering. Definitive knowledge of this ratio must be obtained before the influences of aerosols on climate and climatic change can be precisely assessed.



NASA's mobile laser radar was used in an NCAR/NASA study of optical properties of atmospheric aerosols.