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PROJECT: OGO-C

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To be launched no earlier than October 14.

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NASA TO LAUNCH
SECOND ORBITING
GEOPHYSICAL OBSERVATORY

The National Aeronautics and Space Administration will launch the second in its series of Orbiting Geophysical Observatory satellites (OGO-C) no earlier than Oct. 14 at the Western Test Range, Vandenberg Air Force Base, Calif.

The 1,150-pound OGO will be the first NASA satellite launched by a Thrust-Augmented Thor-Agena D rocket.

If successfully placed in orbit, OGO-C will inaugurate the second phase of NASA's OGO program. This program consists of a series of seven programmed spacecraft, four of which will fly in highly elliptical and three in near-Earth polar orbits.

Like OGO-I, which was launched Sept. 4, 1964, from Cape Kennedy, Fla., into a highly elliptical orbit, OGO-C in its polar orbit will carry 20 different experiments. The OGO-C experiments were contributed by 11 U. S. universities, one foreign university, two NASA field centers and two other government agencies.

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The orbit planned for OGO-C will take it to projected apogee of 575 miles above the Earth and a perigee or low point of about 207 miles. Its inclination will be 86 degrees from the equator with an orbital period of one hour and 37 minutes. It will be designated OGO-II if orbit is achieved.

The mission of OGO-C is to concentrate on near-Earth space phenomena. Emphasis will be on global mapping of the geomagnetic field, on measurements of the neutral, ionic, and electron composition of the Earth's atmosphere. Data will be correlated with solar ultraviolet and X-ray emissions, and such events as particle dumping in the auroral zones and airglow.

OGO-I with its high elliptical orbit of 93,000 miles apogee was designed to operate in interplanetary space as well as near-Earth regions. Data from the two OGOs will be complementary.

OGO-I was officially classified as a failure because it did not achieve its designed Earth-stabilized orientation in orbit because of a boom deployment malfunction. It completed its first year of operation last month. It has provided valuable scientific data from 16 of its 20 experiments and should continue to operate at least during a portion of the time OGO-C is in orbit.

The 20 scientific experiments for OGO-C were completed last year and installed on the spacecraft. However, some delay in the projected launch date of OGO-C was caused by the OGO-I malfunction, and an intensive failure analysis investigation was conducted by the NASA Goddard Space Flight Center, and the spacecraft contractor, TRW Systems, Inc.

OGO has been described as one of the most advanced unmanned satellites ever developed. OGOs are designed to use the same basic structure, power supply, attitude control, thermal control, telemetry and command systems and to provide space for 20 to 30 different experiments. These experiments are mounted in the spacecraft main body or on booms away from the disturbing influences of the main body.

The insect-like appearance of OGO is the result of booms, antennas, attitude control jets and solar panels attached to its rectangular box-shaped main body.

OGO spacecraft contain more than 100,000 separate parts. With booms and solar panels fully extended in orbit the OGOs measure 49 feet long and almost 20 feet wide. These appendages are jack-knifed against the main body inside the rocket fairing during launch. They deploy after orbit is achieved by means of hinge and spring-type mechanisms.

Other unusual OGO engineering features include:

-An attitude control system which permits the bottom portion of the main body to point always toward the Earth, the solar panels to automatically turn toward the Sun, and rotating experiment packages to face the direction of motion.

-An advanced thermal control subsystem featuring several types of controls. For example, three sides of the main body are insulated with multiple layers of aluminized Mylar. The remaining three sides, which will never face the Sun, include a series of louvers, like Venetian blinds, which will automatically open and close to maintain a main body interior temperature range of from 41 to 95 degrees F.

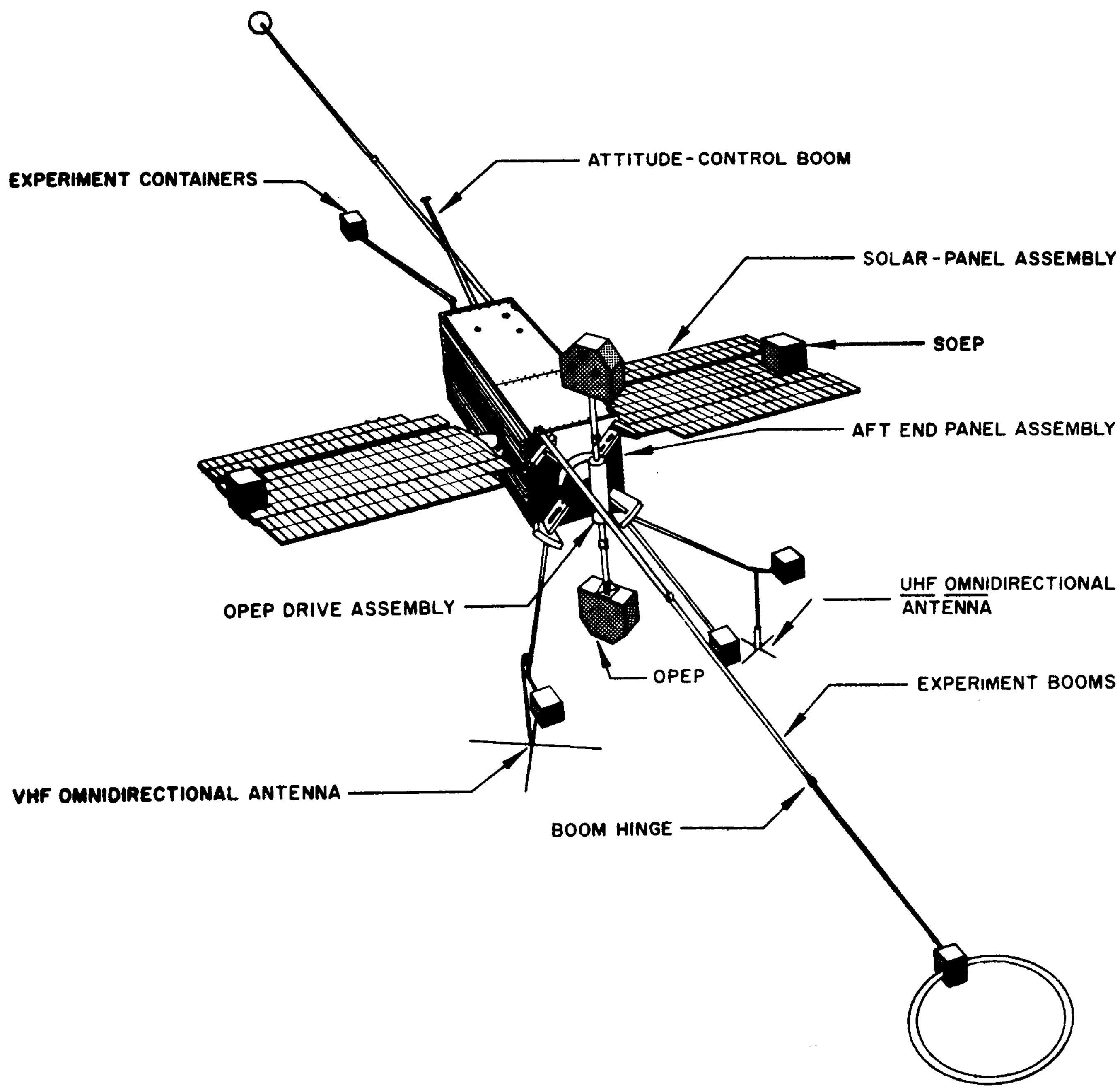
-A communications system--the most advanced ever incorporated into a satellite--able to handle 298 different ground-originated commands and a data handling system which will store up to 86,000,000 bits of data on tape recorders with play back at 128,000 bits per second and a real time transmission rate of 64,000 bits per second.

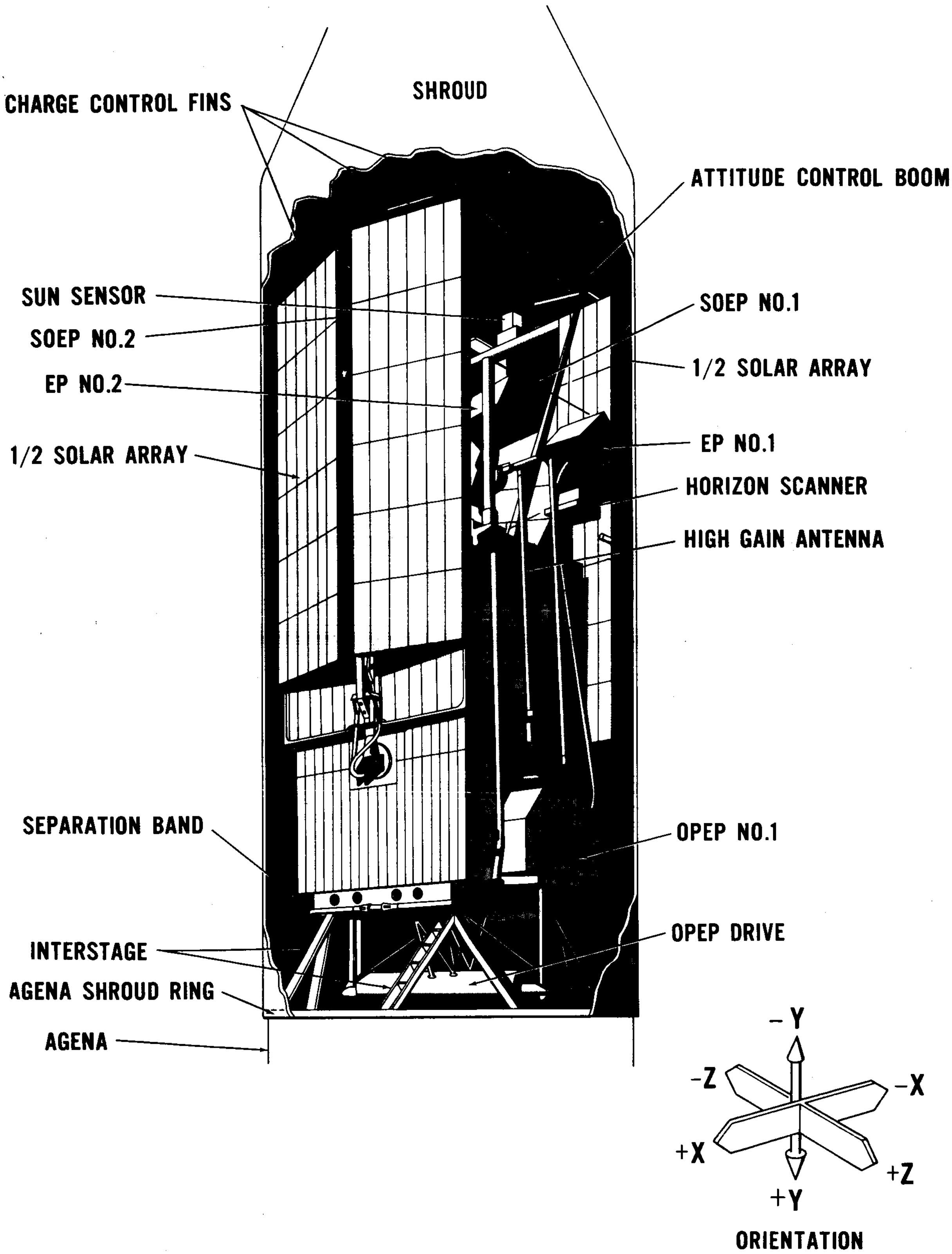
Orbiting Geophysical Observatory satellites are part of the scientific space exploration program conducted by NASA's Office of Space Science and Applications. OGO project management is under direction of the Goddard Space Flight Center, Greenbelt, Md.

Development of the satellite was accomplished by the OGO prime contractor, TRW Systems, Inc., Redondo Beach, California, under the technical direction of Goddard. Contractors from throughout the country provided various subsystems and instrumentation for the satellite.

(BACKGROUND INFORMATION FOLLOWS)

OGO FULLY DEPLOYED IN ORBIT





SHROUD
CHARGE CONTROL FINS
ATTITUDE CONTROL BOOM
SUN SENSOR
SOEP NO.2
EP NO.2
1/2 SOLAR ARRAY
SOEP NO.1
1/2 SOLAR ARRAY
EP NO.1
HORIZON SCANNER
HIGH GAIN ANTENNA
SEPARATION BAND
OPEP NO.1
OPEP DRIVE
INTERSTAGE
AGENA SHROUD RING
AGENA
-Y
-Z
-X
+X
+Z
+Y
ORIENTATION

CHARACTERISTICS OF THE OGO-C

The observatory consists of a main body about six feet long, three feet deep and three feet wide. Attached to this section are the 12 appendages which give the spacecraft its insect-like appearance.

Two 22-foot-long booms, longest on the satellite, carry experiment instrumentation which must be mounted away from the main body to avoid magnetic and other disturbing effects. Four, four-foot-long booms carry somewhat less sensitive experiments. OGO antennas are mounted away from the main body to take advantage of improved antenna patterns made possible by this technique.

Other external characteristics of the satellite include two box-like packages which carry experiments and can be rotated about an axis normal to the long axis of the satellite. These packages, known to OGO project people as the OPEPs (Orbital Plane Experiment Packages) are approximately 18 inches long, 10 inches wide and 10 inches deep. They carry experiments which will take readings in the orbital plane of the satellite.

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Also mounted externally are attitude control jet nozzles. These are placed on booms at the forward end of OGO in order to increase the lever arm action needed to help stabilize the satellite and reduce gas system weight.

Two large solar-cell panels convert energy from the Sun into electricity to power the satellite. The panels are mounted on a shaft running through the main body. They rotate automatically, and orientation of the satellite changes to permit them to face the direction of the Sun at all times. Mounted on the solar panels are two solar oriented experiment packages (SOEPs) containing experiments which are designed to look toward or away from the Sun.

Experiments not sensitive to the satellite's local environment are mounted inside two large hinged doors, much like refrigerator tray-doors. The doors can be opened for access to equipment or experiments.

Attitude Control System

The OGO attitude control system, providing five degrees of freedom, consists of sensors, servos, and torquing components to keep the experiments properly oriented.

Control of the bottom section of the main body to insure it points toward the Earth is accomplished by infra-red horizon scanners to provide error signals and inertia wheels and gas jets to turn about the roll and pitch axis. Error signals to control motion about the third body axis and rotation of the solar panels about their long axis are controlled by Sun sensors located on the ends of the panels.

The body yaw torque, produced by another inertia wheel and a set of gas jets, keeps the axis of the solar panels normal and the plane of the main body thermal radiation louvers parallel to the Sun line.

A third portion of the system controls the OPEPs to permit some of the experiments to look along the path of the satellite at all times. These experiments are directed forward in the plane of the orbit and normal to the observatory-Earth line. OPEPs can also scan across the orbital plane on command. The OPEP sensor is a gyroscope operated in a gyrocompass mode. Its error voltage controls a drive which rotates the OPEPs with respect to the body.

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Thermal Control System

A combination of active and passive thermal control techniques is employed to regulate the temperatures of the electronics system compartments of the observatory. The temperatures of all assemblies within the main body are kept between about 41 to 95 degrees F. by sets of radiating panels and 112 temperature-actuated aluminum louvers located on three sides of the main body.

The temperatures of appendage packages containing experiment instruments are controlled by a similar thermal balance technique, except that louvers are not used. Heaters are used to maintain temperature limits when experiments are turned off. This system is designed to keep the temperatures within the appendage containers within the range of about 32 to 104 degrees F.

Communications and Data Handling

The OGO communications and data handling system is designed to provide for tracking and command functions both for satellite housekeeping and experiment data, plus telemetry for 20 to 30 separate experiments. The main telemetry is a wideband PCM (pulse code modulation) system using a nine-bit word and capable of operating at three data rates which are selected by ground command.

The realtime data rate capability of the system ranges from 4,000 to 64,000 bits per second. Data stored in tape recorders at 4,000 bits per second play back at 128,000 bits per second. This system is composed of two redundant data handling units that operate with outputs transmitted to Earth in real time or are connected to one of the two tape recorders provided for storing up to six hours of data. The system uses four watts of power at 400 mc.

A special purpose telemetry system is provided which is capable of operating from an experiment whose output is an FM (Frequency Modulated) signal varying from 300 to 100,000 cps to enable transmission of data from up to five standard sub-carrier oscillators. For back-up, a second mode includes the transmission of the output of the wideband telemetry system. The special purpose transmitter is rated at 0.5 watt at 400 mc.

Data Processing

Data received on magnetic tape by the world-wide network of acquisition and tracking stations will be forwarded to the OGO Control Center at the Goddard Space Flight Center. Tracking data also will be sent to Goddard for use by OGO project people to operate the satellite and to provide an accurate orbit for use by experimenters.

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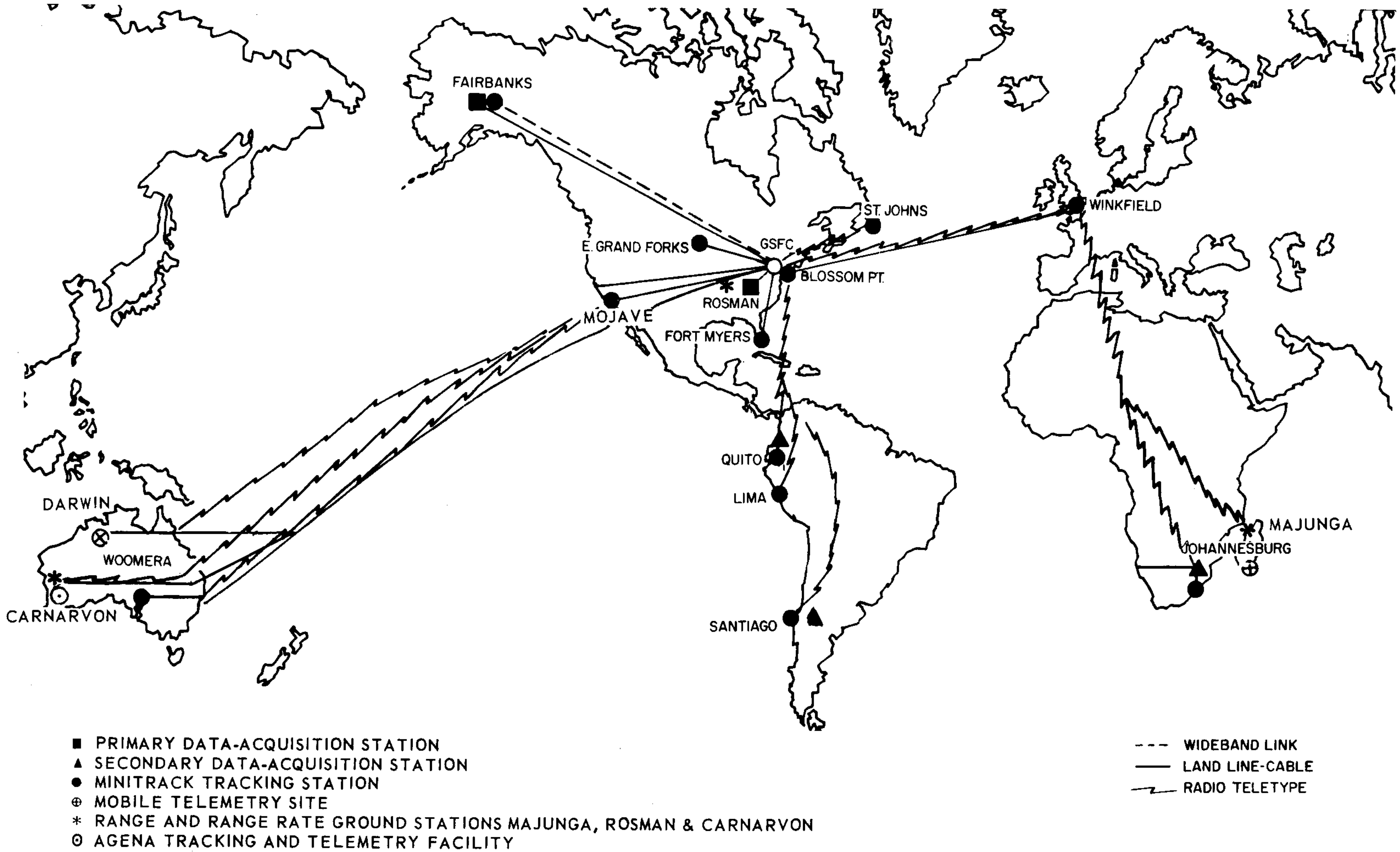
OGO-C TRACKING NETWORK



The taped data will be processed by high-speed computers. When the processing is completed, digital computer tapes will be produced for each experimenter. These tapes will contain data from each individual experiment, necessary timing information, as well as data on spacecraft temperatures, voltages, and orbital data--the standard housekeeping information.

The production data processing conducted at Goddard will be basically a computer sorting operation, providing experimenters with raw data from their experiments. Following the necessary analysis and evaluation by experimenters the scientific data to the scientific community will be published in scientific journals. The data will also be submitted to the National Space Science Data Center at Goddard Space Flight Center for the use of other interested scientists.

Modification of OGO-C Spacecraft

The OGO-I failure resulted in intensive investigations by the Goddard Space Flight Center and TRW Systems, Inc. The following conclusions were reached:

-There was no apparent common cause of non-deployment of appendages.

-There was no indication that the malfunctions were associated with the Atlas-Agena launch rocket.

-The spacecraft attitude control subsystem, except for the horizon scanner, functioned normally.

Although no common cause for failure was evident from these studies, they did, however, reveal a number of areas where spacecraft modifications were needed.

Modifications to the OGO-C spacecraft include:

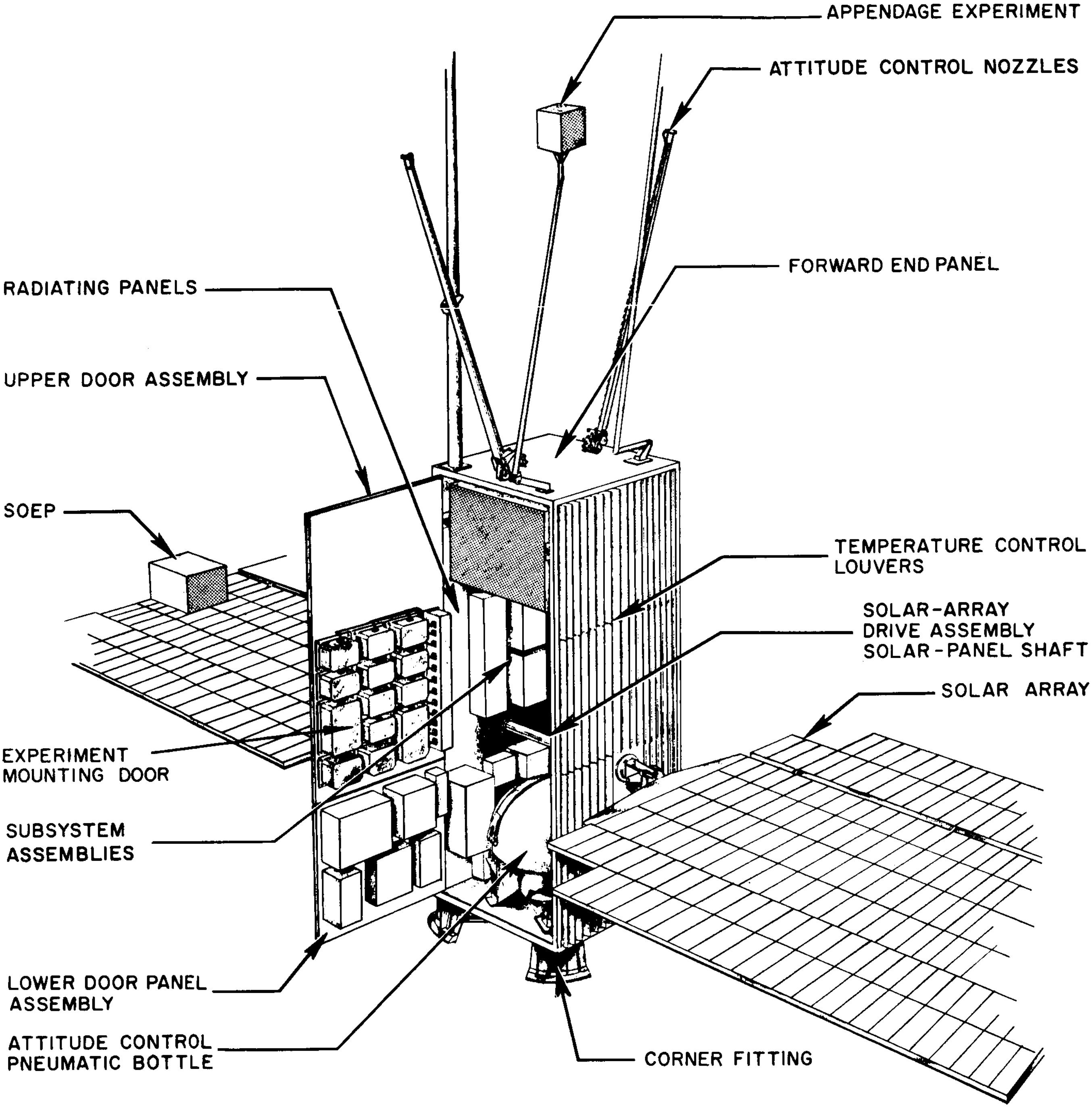
-Relocation of the horizon scanner and certain boom appendages to assure a clear field of view for the horizon scanner.

-The use of a new type deployment spring and the addition of separate appendage "kick-off" springs.

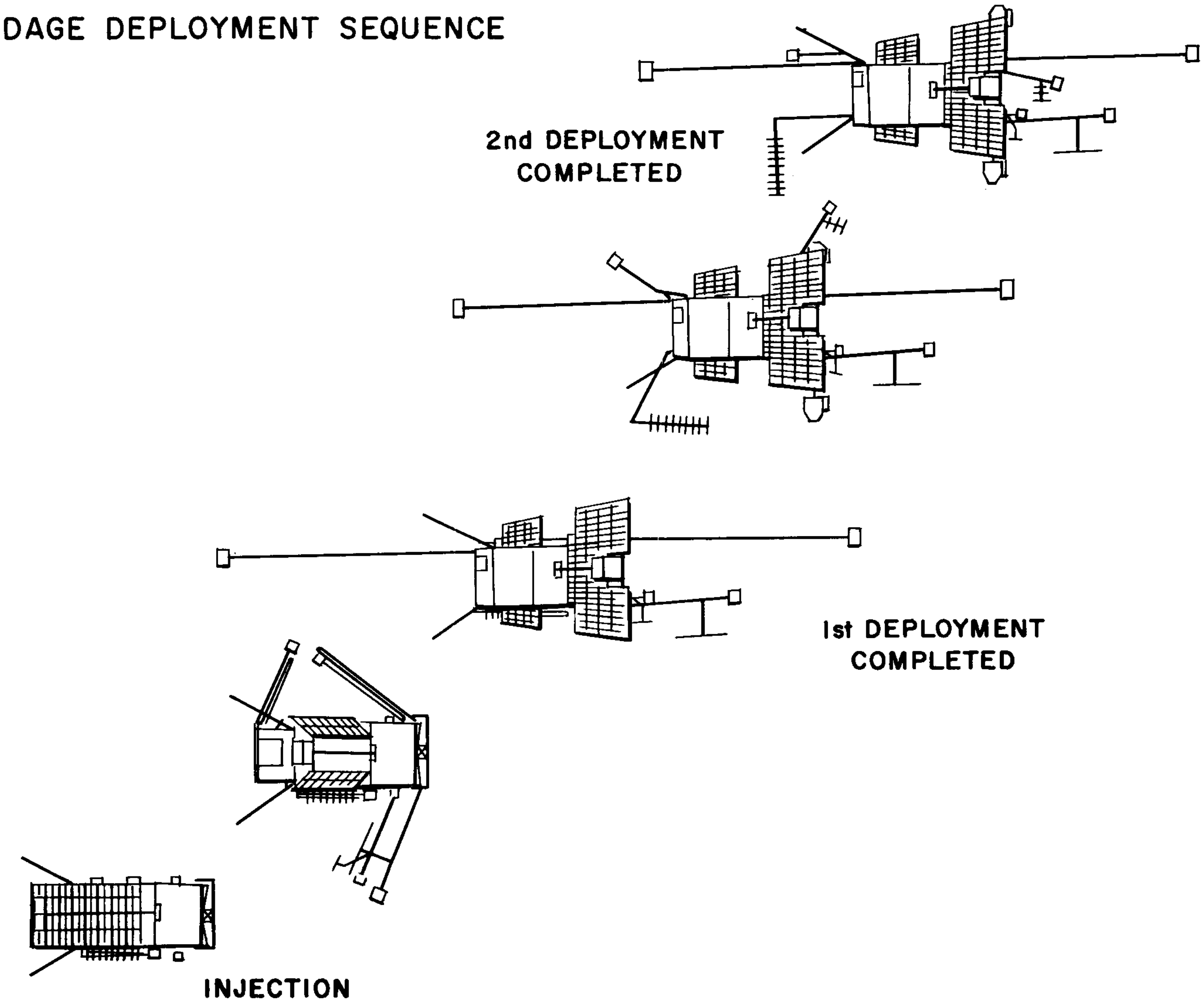
-The relocation of the omnidirectional antenna.

Tests of the full deployment of all OGO appendages are not possible, since a zero gravitational field is required.

OGO-C MAIN BODY



ORBITING GEOPHYSICAL OBSERVATORY
APPENDAGE DEPLOYMENT SEQUENCE



Simulation of zero gravity in deployment tests of OGO appendages was obtained by using either specially prepared floors and air-bearing pads to support the boom weight or by elastic cords fixed to a point directly above the boom hinge. In addition, the partial release of all OGO-C appendages was conducted before and after simulation of the launch rocket vibration and after extended exposure to the simulated space environment. It is expected that this intensive program will preclude deployment failures during the OGO-C launch phase.

OGO-C SCIENTIFIC OBJECTIVES AND EXPERIMENTS

The 20 experiments designed for the OGO-C mission not only cover the broad spectrum of space science disciplines but are capable--as were those of OGO-I--of performing on an inter-disciplinary basis, simultaneous, correlated investigations.

Information obtained from these experiments should help in understanding the time-dependent relationship that exists in galactic, interplanetary and planetary events, with emphasis on solar-terrestrial relationships.

Following are some of the OGO-C near-Earth areas of investigation:

--Mapping and fluctuation studies of the Earth's magnetic field.

--Trapped radiation and auroral particles.

--Airflow and auroral studies.

--Atmospheric composition and density.

--Ionospheric composition.

--Solar ultraviolet and X-ray emissions.

--Very low frequency radio phenomena.

--Cosmic rays.

--Micrometeorites (cosmic dust).

--Radio astronomy.

These investigations should help achieve some of the following objectives:

(1) Global mapping of the geomagnetic field as part of the United States' commitment to the International Year of the Quiet Sun.

(2) Measurement of solar ultraviolet and X-ray emissions during a period of low solar activity.

(3) An insight into the dumping of trapped radiation and the influx of solar cosmic rays into the auroral and polar regions and the occurrance of aurora.

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(4) New knowledge on the pressure, temperature, density and chemistry of the neutral atmosphere surrounding the Earth.

(5) The relationship between solar X-ray and ultraviolet emissions and their effect on the Earth's ionosphere, atmosphere and airglow.

(6) Detailed knowledge concerning the size, velocity distribution and trajectory of micrometeorites in near-Earth space as an extension of similar measurements in interplanetary space.

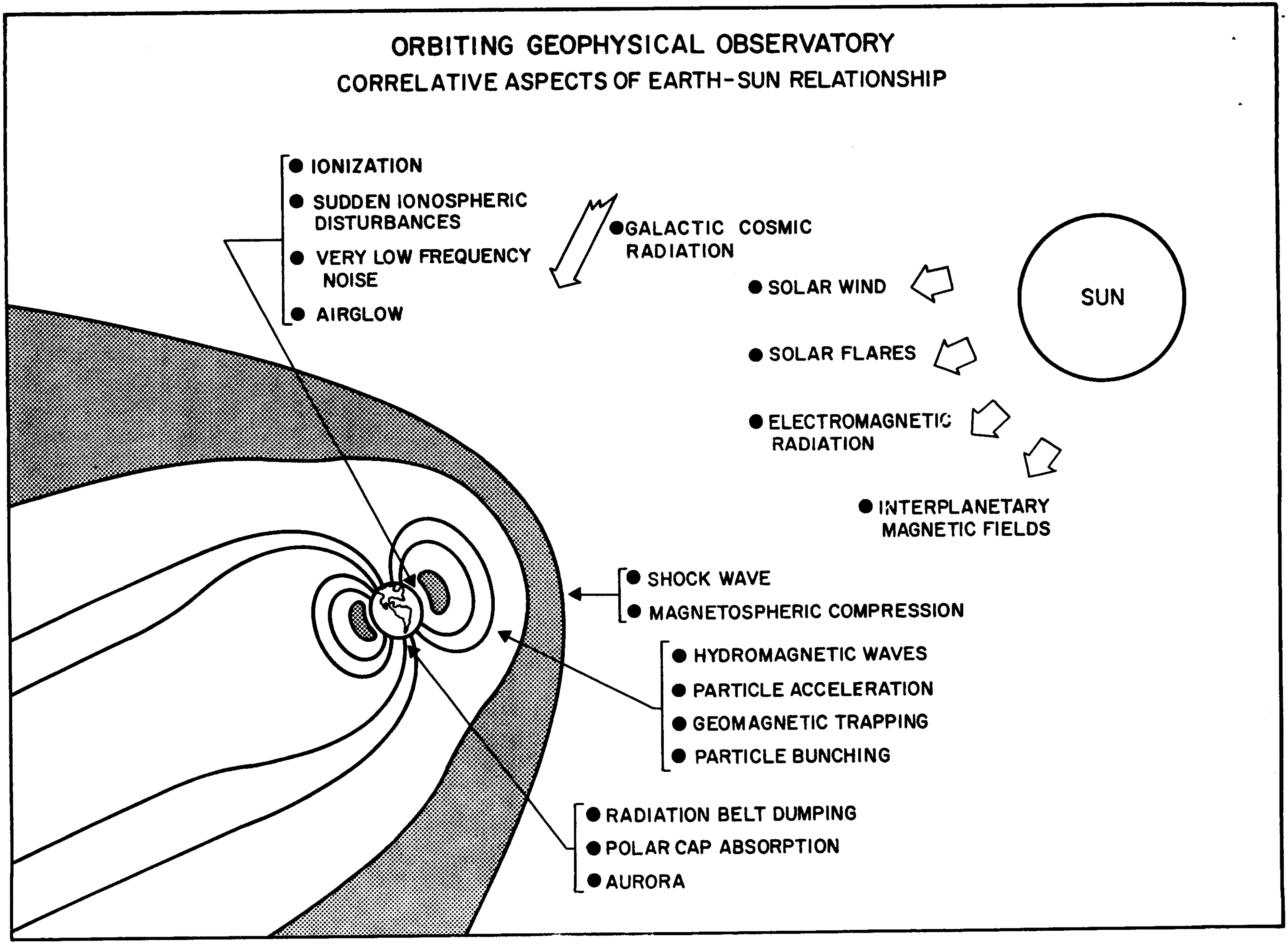
(7) More information concerning energetic particles trapped in the Earth's magnetic field; the intensity of the magnetic field, and the overall relationship of the phenomena with very low frequency radio noise, ionospheric absorption and solar activity.

(8) Data on how the solar wind interacts with magnetic fields.

(9) A better understanding of cosmic rays reaching the Earth from the Sun and from galactic sources.

(10) Mapping of radio noise in space and identification of planetary and solar noise bursts.

A technical description of each of the OGO-C experiments follows in order to help place in context the types of experiment devices to be employed and the specific areas to be studied by each experiment.


ORBITING GEOPHYSICAL OBSERVATORY
CORRELATIVE ASPECTS OF EARTH-SUN RELATIONSHIP
IONIZATION
SUDDEN IONOSPHERIC DISTURBANCES
VERY LOW FREQUENCY NOISE
AIRGLOW
GALACTIC COSMIC RADIATION
SOLAR WIND
SOLAR FLARES
ELECTROMAGNETIC RADIATION
INTERPLANETARY MAGNETIC FIELDS
SUN
SHOCK WAVE
MAGNETOSPHERIC COMPRESSION
HYDROMAGNETIC WAVES
PARTICLE ACCELERATION
GEOMAGNETIC TRAPPING
PARTICLE BUNCHING
RADIATION BELT DUMPING
POLAR CAP ABSORPTION
AURORA

MAGNETIC FIELD MEASUREMENTS

World Magnetic Survey - Goddard Space Flight Center

The detailed survey of the strength of the Earth's magnetic field to be obtained by this experiment is part of the United States' commitment for the IQSY-world magnetic survey. The scaler field measurements combined with other data extrapolated from surface and airborne measurements will provide a refinement of the mathematical description of the Earth's main field and a measurement of the contribution of the Earth's main field to the total measured field at any point in space. Only by having such a reference can space geomagnetic measurements be used to study particle effects on the field. It is also essential that other OGO-C experiments measuring trapped particles have an accurate main field reference.

Time variances of the field will also be studied. It will also be possible to derive the diurnal and storm variations as seen above the ionosphere. The orbit of the observatory should allow a comprehensive determination of the solar daily variations during both quiet and disturbed conditions as well as a study of such phenomena as the equatorial and auroral electrojets. Extensive correlation with ground observatory measurements will be necessary.

The magnetometer used will measure the absolute scaler magnitude of the magnetic field. It is located at the end of one of the long booms for isolation from the magnetic effects of the spacecraft and other experiments. Additional electronics are located in the main body. Total weight is 20.6 pounds.

Magnetic Field Fluctuations - Jet Propulsion Lab and UCLA

The objective is to investigate the naturally occurring magnetic field fluctuations in the low-audio and sub-audio frequency ranges (0.01-1000 cps). This includes signals which have been observed at the surface of the Earth and which are known to originate in or above the ionosphere. It may also be possible to detect terrestrial ELF (extremely low frequency) radio noise associated with lightning. Other signals which have not been observed at the surface of the Earth but which may reasonably be expected to occur in or above the ionosphere include:

--Magnetic variations associated with the penetration of plasma clouds in the vicinity of the auroral zone.

--Travelling ionospheric disturbances.

--Signals arising from the motion of the observatory with respect to magnetic fields created by the polar and equatorial electrojets.

A comparison of magnetic field fluctuations in the ionosphere and throughout the magnetosphere will be possible since a similar experiment is aboard OGO-I.

The magnetometer is composed of a triaxial array of search coils situated at the end of one of the long booms for isolation from magnetic noise generated by the spacecraft and other experiments and additional electronics housed in the main body. Total weight is 5.6 pounds.

COSMIC RAY EXPERIMENTS

<u>Cosmic Ray and Polar Ionization Study - Rice University, Jet Propulsion Laboratory and California Institute of Technology</u>

The primary objective of this experiment is to study the behavior of cosmic rays in the Earth's magnetic field and to correlate this information with that obtained with similar instruments mounted on balloons released at various latitudes. These two sets of data, either individually or correlated, should provide:

--Data on primary radiation down to the lowest expected energies.

--Information of the number of particles outbound from Earth as compared with those approaching Earth.

--The precise location of the cosmic ray geomagnetic poles and the accurate location of the cosmic ray equator.

--The variations of cosmic rays with longitude at different latitudes, in particular along the cosmic-ray equator.

--Fluctuations in primary radiation at all latitudes. High latitude data may provide information concerning the behavior of the Earth's field at large distances and the mechanism involved in allowing particles to enter the atmosphere at latitudes normally inaccessible.

--The contribution of the total ionization by trapped radiation, radiation dumped from the trapping region, and auroral particles.

Instrumentation consists of an integrating ionization chamber. The five-inch chamber, filled with argon, is situated on one of the short booms to minimize the effects of secondary radiation from the large mass of the observatory main body. It weighs 2.9 pounds.

Galactic and Solar Cosmic Ray Study - University of Minnesota

Data collected by this experiment will allow the determination of the energy spectrum of both galactic and solar protons over the energy range from 40 mev to 1 bev as well as other particles over a comparable range. The direction of approaching particles also will be determined. By using the Earth's field as a magnetic analyzer, the energy range is extended to 30 bev for protons over the equatorial regions. Also, the experiment functions as a high counting rate monitor for certain radiation.

The experiment consists of a detector mounted to the space-facing door of the observatory mainbody. The sensing device is composed of a scintillation crystal and a combination scintillation and Cerenkov detector. The minimum detectable energy is governed by the crystal thickness and the amount of shielding. All particles capable of producing a detectable light pulse are counted by the scintillation crystal. This provides a monitor for the total radiation. Otherwise, only coincident detector outputs are analyzed in order to measure the energy spectrum. Weight of the experiment is 16.7 pounds.

Energetic Particles Survey - University of Chicago

Protons in the energy spectrum from 0.5 mev to 40 mev and alpha particles between 2 mev and 160 mev will be investigated. In a continued study of cosmic radiation, the objective of this experiment is to search for an extension of the spectra of untrapped protons and helium nuclei to very low energies and low intensity during the period of minimum solar activity and to provide evidence regarding whether the radiation is of solar or galactic origin. These data and data obtained during solar flare events will be studied to determine the characteristics of storage and propagation of particles as modulated by the interplanetary magnetic fields during a relatively quiet Sun. Radiation belt proton and alpha fluxes at low altitude, and auroral protons in the energy range of the detectors will also be measured. Two perpendicular telescopes are located in the space facing side of the observatory. The vertical telescope consists of two solid state detectors mounted in a scintillator cup. Pulse height analysis and total count rate for various coincidence combinations will yield the desired parameters. The horizontal telescope consists of a single solid state detector to measure proton-alpha flux isotropically incident to the earth's magnetic field. Weight of the experiment is 6.8 pounds.

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AURORAL AND AIRGLOW STUDIES

Corpuscular Radiation in Auroral and Polar Regions - State University of Iowa

This experiment includes a comprehensive time and location study of the intensities of trapped (Van Allen Belt) electrons at low altitudes and of electrons penetrating into the Earth's upper atmosphere. This mapping of the low altitude distributions of electrons of these energies is a basic step toward determing the distributions of trapped electrons throughout the Earth's magnetosphere. Further information will be obtained concerning: the interrelationships of these penetrating electrons with the geomagnetically trapped electrons of similar energies; the latitude, temporal and daily variations of the rough energy spectra; as well as any geographic longitude dependence of electrons intensities at lower latitudes (for example, over the South American magnetic anomaly). The electron measurements and monitoring of solar proton events over the polar cap regions will be correlated with studies of the aurora, ionospheric radio absorption, and other OGO-C experiments.

The experiment consists of two sets of two thin-window geiger tubes mounted on a short boom.

One set measures electrons with energies above 120 kev and the other set above 40 kev. The experiment weighs four and one-half pounds.

Trapped Radiation and Auroral Particles - Goddard Space Flight Center

Low energy trapped radiation and auroral particles will be studied to extend OGO-I measurements to lower altitudes. Studies include the energy spectrum, intensity, energy flux and spatial structure of low energy electrons and protons contributing to auroral and subauroral zone phenomena and a continuation of investigations of solar protons and plasma beams by measuring their time variations and any latitude effects due to magnetic cut-offs.

Two ion-electron scintillation detectors are designed to measure 10 to 100 kev electrons, 100 kev to 10 mev protons, and 10 kev to 10 mev total particle energy fluxes. The detectors are mounted on a short boom. Weight of the experiment is 7.4 pounds.

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Airglow and Auroral Study - University of Paris and Goddard Space Flight Center

Comprehensive observations of airglow and aurora at visible and ultraviolet wave lengths is the objective of this experiment. Photometers are mounted in the main body of the observatory and in an OPEP.

The main body photometer extends from the Earth side to the space side and views in both directions. Incident light from the Earth side is alternately directed through six filters corresponding to six emission spectral lines by an automatic stepping mirror system. Only 6300 Angstrom (atomic oxygen emission) is observed in the space direction. The mirrors can be commanded to remain in any of the spectral positions for a more comprehensive study of the distribution of a particular line.

The OPEP photometer views towards Earth and projects the light through a 6300 Angstrom filter. A mirror scan system and the commandable OPEP rotation provide a two dimensional sweep from the observatory's horizon to 30 degrees in the direction of Earth over a large angular range.

Weight of the instrumentation is 26.6 pounds.

Lyman-Alpha and Ultraviolet Airglow study - U.S. Naval Research Laboratory

This experiment will measure scattered hydrogen Lyman-Alpha radiation and the Earth albedo (ratio of Earth-reflected radiation to that approaching Earth) at several wave bands. Measuring the excitation of ultraviolet fluorescence produced by particles provides an effective means of measuring the rate at which particles deliver energy to the atmosphere. This could be important in understanding the nighttime ionosphere. A knowledge of the rate of energy input into the upper atmosphere as a function of time and location will greatly aid the understanding of both high altitude airglow emissions and of the origin of the electron component of the Van Allen belts.

The Lyman-alpha measurements are designed to examine the space and time variations of the atmospheric emissions. The measurements will provide information concerning variations in the rise of water vapor and methane, the photo-dissociation of which is believed to be the source of the atomic hydrogen.

Eight ionization chambers are used as detectors and are located in the main body. Two of the chambers are sensitive to Lyman-alpha radiation incident from the Earth and space directions. The other six chambers are connected in two groups of three chambers, with the outputs of each group connected in parallel to increase the sensitivity. Weight of the experiment is nine pounds.

Airglow Study - Jet Propulsion Laboratory - Colorado University and Kitt Peak National Observatory

The objective of this experiment is to measure the ultraviolet spectra of the Earth's upper atmosphere from 1100 angstroms to 3400 angstroms. These spectra will provide a study of the following atmospheric phenomena:

> The nature and energy of the luminous particles in the aurora; the abundance and distribution of the molecular and atomic constituents in dayglow and twilight glow; the abundance and distribution of ozone.

The spectrometer is located in the main body and consists of three basic parts: a telescope, monochrometer, and detectors. The telescope (Cassegrain) projects an image of the central portion of the Earth into an entrance slit of the monochrometer.

The light is then separated by a ruled diffraction grating and projected onto an exit slit for selection of a minimum number of spectral lines for detection by photomultiplier tubes. The diffraction grating is automatically rotated to scan the spectrum. Experiment weight is 27.4 pounds.

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ATMOSPHERIC AND IONOSPHERIC MEASUREMENTS

Neutral Particle Study - Goddard Space Flight Center

An ionization gauge is used in this experiment to directly measure the variance of neutral particle temperatures and densities with longitude, latitude, altitude, day-night and seasonal changes. The data will extend the knowledge of both the structure of the atmosphere and its thermal equilibrium and are important to satellite drag studies. The gauge, located in an OPEP, is scanned about the velocity vector. The instrumentation weighs eight and one-half pounds.

Neutral Particles and Ion Composition Study - University of Michigan

The purpose of this experiment is to measure the neutral gas and positive ion composition (1 to 50 atomic mass units) of the atmosphere at various altitudes and geographical positions. The data will be an extension of composition measurements made primarily by sounding rockets. Of prime interest is the dissociation and diffusive separation of the constituents of the atmosphere and of the verification of a protonosphere.

The mass spectrometer used (located in an OPEP) is the Paul massenfilter weighing 8.3 pounds.

Positive Ion Study - Goddard Space Flight Center

This experiment will obtain high resolution measurements of 1 to 45 Atomic Mass Units within the Earth's lower ionosphere and the unexplored polar regions. These data will help identify and study suspected transition regions where the predominent constituents may change. Results of a similar experiment on OGO-I have revealed a strong influence of the Earth's magnetic field upon the distribution of ions. This experiment extends this study to the polar regions. The instrument used is a Bennett r-f mass spectrometer located in an OPEP. It weighs 6.3 pounds.

Ionospheric Composition and Solar Ultraviolet Radiation - Goddard Space Flight Center

The scientific objectives of this experiment are to measure the solar ultraviolet radiation intensity, specifically the number of photons striking the detector as a function of wavelength and to correlate these data with certain ionospheric data related to charged particle density, ion composition, ion temperature and electron temperature. This involves two instruments, one for the solar radiation and the other for the ionosphere measurements.

The experimental approach involves a technique where various voltages on grids allow only certain particles to enter a collector. Two identical sensors are employed. The ionospheric sensor is located in an OPEP for orientation into the observatory velocity vector and the solar radiation sensor in a SOEP with the sensor axis directed toward the Sun. Each sensor consists of three circular grids and a collector mounted in planar parallel geometry. Total weight of the experiment is 6.3 pounds.

Micrometeorite Study - Goddard Space Flight Center

This experiment is one of a series of similar experiments designed to provide a basic measure and understanding of the dust particle environment of the Earth. The experiment on OGO-C is designed specifically to measure the spatial density, velocity, mass, and initial charge of dust particles. These measurements will be used to determine the orbits of these particles and to detect the existence of dust particle streams, if such exist. Investigations of the importance of geomagnetic control on the dynamics of the dust particles and correlation of the various measurements with geophysical, geomagnetic and solar phenomena will also be attempted.

The particles are detected by four tubular detectors mounted to a short boom and aligned along the body axes of the observatory. They weigh seven pounds.

SOLAR RADIATION EXPERIMENTS

Solar X-Ray Study - U. S. Naval Research Laboratory

Measuring the solar x-ray energy input to the Earth and its variations in order to further understand the geophysical parameters of the upper atmosphere is the objective of the experiment. Change in the solar radiation is one of the primary environmental influences effecting the ionosphere. In particular, solar x-ray bursts accompanying flares and active prominences are considered the direct cause of increased D region ionization, which in turn is responsible for some types of radio fadeouts, sudden cosmic noise absorption, and other manifestations of the sudden ionospheric disturbances. By establishing a set of x-ray indices of solar activity, correlation with other geophysical phenomena can be made. A study of time variations in solar events and perhaps a more quantitative method of classifying solar events can be made by use of these indices. (Size classification of flares provides an incomplete measure of the ionospheric effects of flares).

Four x-ray bands are monitored by ionization chambers located in a SOEP. The time variations in emissions within these bands play an important role in the formation and variations in the D and E regions of the ionosphere and appear to constitute the predominent strongly variable component of solar radiation reaching the lower ionosphere. Weight is 7.4 pounds.

Solar Emissions UV - A. F. Cambridge Research Laboratories

The objective of this experiment is to monitor radiation intensities in the extreme ultraviolet portion of the solar spectrum. A scanning, grating spectrometer is located in one of the SOEP packages which is pointed toward the Sun. Radiation from the entire solar disk illuminates six gratings clamped together with parallel planes of dispersion and a common angle of incidence.

The experiment is not expected to contribute new spectral information of solar emissions at these wavelengths. Instead, it will provide needed information on intensity levels and the temporal variations of these levels for correlative studies of ultraviolet emissions with ionospheric and atmospheric phenomena. Experiment weight is 8.8 pounds.

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RADIO MEASUREMENTS

Radio Astronomy - University of Michigan

The prime objective of this experiment is to map the brightness distribution of cosmic radio noise.

Other objectives of the experiment are to observe certain ionospheric phenomena, one of which is a form of what is apparently locally generated noise in the topside ionosphere. The origin of this noise is not yet clear. Also, the behavior of an antenna in a plasma, which is presently not completely understood, will be studied by antenna impedance mesurements. Finally, it should be possible to detect tenuous ionized interstellar hydrogen by its absorption effects.

Instrumentation consists of a common preamplifier driving three separate output channels: 2.5 mc and 2.0 mc receivers and an antenna impedance measurement channel. A 60-foot tubular antenna of approximately 0.56 inches in diameter will be deployed from a SOEP after the observatory is in orbit. Experiment weight is seven pounds.

VLF Noise and Propagations - Stanford University

The objectives of this experiment are to study very low frequency propagation (VLF), properties of the ionosphere, the origin of VLF ionospheric noise, and a synoptic noise survey in the frequency range 0.2-100 KC. The phenomena to be studied include the terrestrial noise produced from such atmospherics as lightning noise, VLF emissions generated by moving charged particles, and the propagation of VLF signals from low frequency ground stations. The polar orbit will provide data at high latitudes and low altitudes, where the polar coverage should provide information relating to the origin of VLF ionospheric noise.

A similar experiment on OGO-I is providing measurements at lower latitudes and a wide range of altitudes. The OGO-C experiment will provide complementary information at high latitudes and low altitudes.

The experiment instrumentation consists of five receivers: three step-frequency receivers, each covering one octave of the 0.2 to 100 kc range, a 0.2 to 12.5 kc broadband receiver, and a tunable narrowband receiver (14.7 to 26.1 kc) for reception of Navy VLF transmitters. The antenna, a 9.5 foot toroid to be inflated after the observatory is in orbit, is located at the end of a long boom. The receivers and other instrumentation are located in the main body. Total weight is 6.4 pounds.

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Whistlers and Audio-Frequency Electromagnetic Waves - Dartmouth College

The effects of the ionosphere on the propagation of whistlers and other audio-frequency electro-magnetic waves of natural origin will be studied by this experiment. To meet these objectives, most of the data from the experiment will be subjected to a detailed comparison with observations made simultaneously at a network of ground-based whistler stations.

A simple broadband (500 cps to 18 kc) receiver with adjustable gain is the heart of the experiment. All data output is by a special purpose transmitter. In orbit, a 10-foot dipole antenna will be deployed from a short boom. Experiment weight is 4.5 pounds.

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LAUNCH VEHICLE

This first in the OGO series to be launched from Western Test Range represents several firsts in NASA's launch Vehicle program:

First NASA Agena mission to use a Thrust-Augmented Thor booster.

First NASA Agena-D to be launched from WTR.

First NASA Agena singled-burn mission.

First NASA pre-perigee orbital injection.

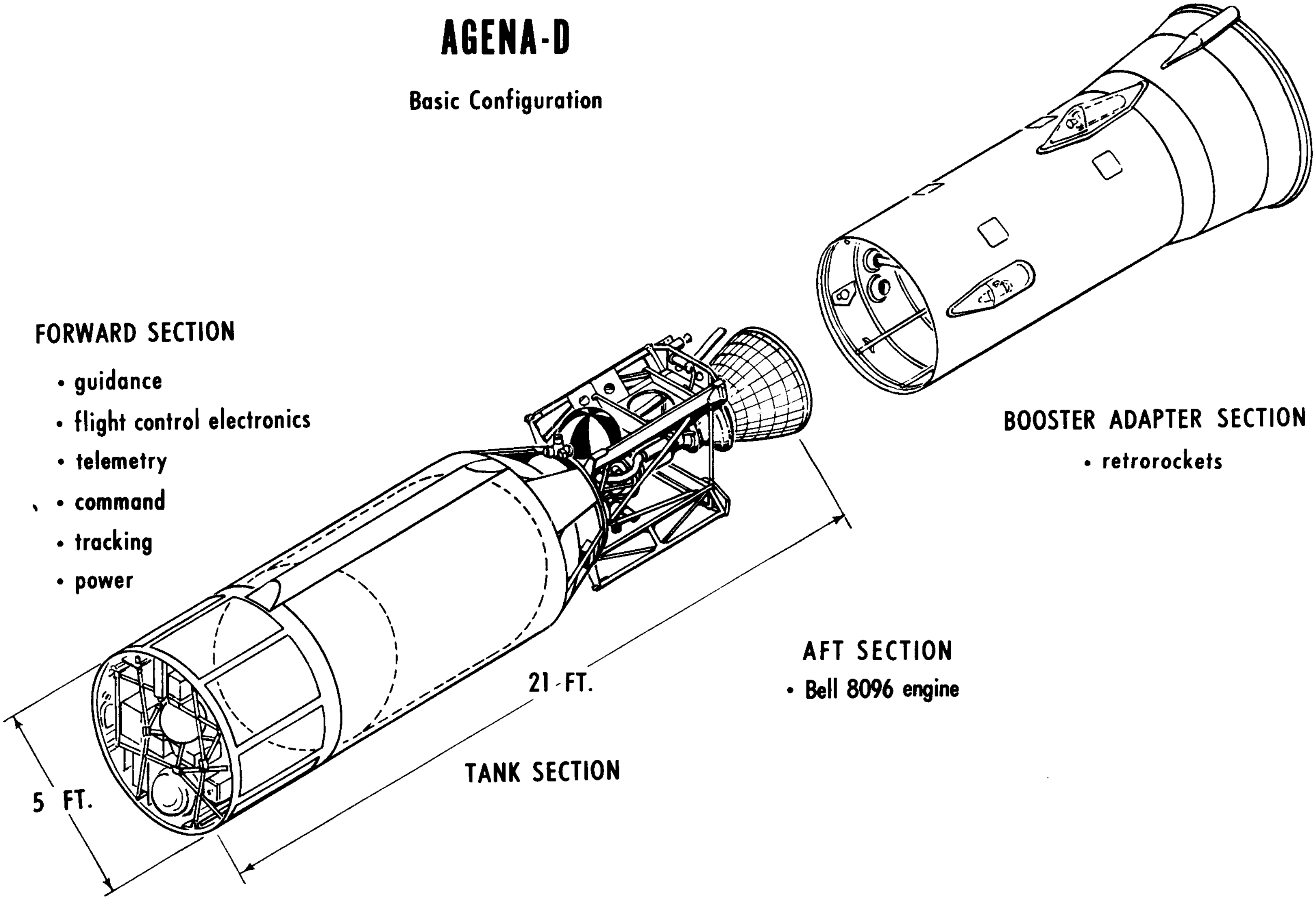
The Thrust-Augmented Thor booster permits observatory injection with a single burn of the upper stage Agena. The single burn also allows observatory injection within sight of WTR. Range telemetry ship coverage will overlap the land-based telemetry and it will extend well beyond Agena/OGO-C separation.

The single-burn OGO-C mission requires a pre-perigee injection. That is, Agena will inject the 1150-pound OGO-C spacecraft downward to its 207-mile-high perigee.

Since the observatory requires maximum sunlight in its first orbit, launch times are limited to about two hours either immediately after dawn or immediately before dusk.

AGENA-D

Basic Configuration



FLIGHT SEQUENCE

Thrust-Augmented Thor lifts off verically with both the main engine and the three strap-on solid motors firing. The vehicle follows a programmed roll and pitchover on its trajectory. These two actions are controlled by Thor's autopilot programmer. The solid rockets are depleted, and jettisoned some 65 seconds into the flight. At about 90 seconds, the radio guidance system begins to steer the vehicle from the ground.

Based on space vehicle altitude and velocity as compared to the nominal trajectory, the main engine is shut off about 150 seconds after liftoff. Vernier engine cut off follows some 10 seconds later.

Midbody primacord and the retrorockets in the adapter section are ignited to retard the spent booster while Agena and its OGO-C payload move away. Agena coasts for about 10 seconds controlled by its inertial reference system.

Agena is ignited some 247 seconds after liftoff. At ignition, the pneumatic pitch and yaw controls are deactivated and the engine hydraulic system controls the pitch and yaw of the Agena. Roll control stays under pneumatic control.

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The clamshell shroud is ejected about 10 seconds after engine ignition. Total Agena burn lasts some 240 seconds.

Agena coasts for some 90 seconds from its burn cutoff altitude of about 226 statute miles to the observatory separation altitude of about 282 miles. (The injection point has been selected to place apogee in the Northern Hemisphere for the initial orbits. Perigee altitude is 207 miles.) About ten minutes after liftoff, the Agena-D/OGO-C separation pyrotechnics are fired and OGO-C moves away from Agena at about five feet per second.

After separation, the Agena is yawed 90 degrees and pitched until it is essentially parallel to the Earth.

Deployment of OGO appendages will start, automatically, some 15 seconds after separation. The Sun acquisition phase (solar paddles following the Sun) is completed approximately 23 minutes later. The observatory will be inhibited (ground command from Johannesburg, South Africa) from continuing to the Earth acquisition phase.

Towards the end of the fifth orbit after launch, Quito, Ecuador, Station will command Earth acquisition. This will be observed in real time at the GSFC OGO Control Center via a microwave link to the Rosman, N. C. Station.

On the next orbit Quito and Rosman will initiate experiment turn-on which will continue for several orbits.

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LAUNCH VEHICLE STATISTICS

	BOOSTER	AGENA
Propulsion	Rocketdyne MB3-Block III main engine Thiokol TX33-52 strap-on solid motors (three)	Bell 8096 main engine
Thrust	Main: 170,000 lbs. Strap-ons: 54,000 lbs. each	16,000 lbs. at altitude
Propellants	Main engine: liquid oxygen oxidizer: RJ-1 fuel Solids: polybutadiene acrylic acid co-polymer (PBAA) and ammonium perchlorate	unsymmetrical dimethyl-hydrazine (UDMH) and nitric acid (IRFNA)
Weight	132,000 lbs.	16,000 lbs.
Height	57 feet	21 feet
Diameter	5.33 feet upper diameter 8.00 feet lower diameter	5 feet
Prime Contractor	Douglas Aircraft Co., Santa Monica, Calif.	Lockheed Missiles & Space Co. Sunnyvale, Calif.

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The OGO-C Program Team

The following key officials are responsible for the Orbiting Geophysical Observatory satellite program:

NASA Headquarters

Dr. Homer E. Newell, Associate Administrator for Space Science and Applications

Jesse Mitchell, Acting Director, Physics and Astronomy Programs

C. Dixon Ashworth, OGO Program Manager

Dr. Robert F. Fellows, OGO-C Program Scientist

J. B. Mahon, Agena Program Manager

William E. Williams, OGO Tracking Manager, Office of Tracking and Data Acquisition

NASA-Goddard Space Flight Center

Dr. John F. Clark, Acting Director

Dr. John W. Townsend, Deputy Director

Robert E. Bourdeau, Acting Assistant Director for Projects

Wilfred E. Scull, OGO Project Manager

Nelson W. Spencer, OGO-C Project Scientist

R. O. Britner, II, OGO Tracking and Data Systems Manager

NASA-Lewis Research Center

Dr. Seymour C. Himmel, Agena Project Manager

NASA-Kennedy Space Center

Dr. Kurt H. Debus, Director

Robert Gray, Assistant KSC Director for Unmanned Launch Operations

TRW Systems, Inc.

Dr. A. K. Thiel, Director, Spacecraft Systems Program Management

E. T. Wiggins, OGO Program Director

Prime Contractor

Spacecraft design, development, fabrication and test, TRW Systems, Inc. Redondo Beach, Calif.

Major Subcontractors

Battery Cells, Yardney Electric Corp., New York, N. Y.

Gyroscopes, Minneapolis-Honeywell Corp., Boston, Mass.

Horizon Scanners, American Standard, Advanced Technology Division, Mountain View, Calif.

Power Converters, ITT Industrial Products Div., San Fernando, Calif.

Reaction Wheels, Bendix Eclipse Pioneer Div., Teterboro, New Jersey

Solar Cell Modules, Hoffman Electronics Corp., El Monte, Calif.

Solar Cells, International Rectifier Corp., El Segundo, Calif.

Static Inverters, Kinetics Corp., Solana Beach, Calif.

Tape Recorders, RCA Astro-Electronics Division, Princeton, New Jersey

Tape Transporters (in Ground Support Equipment), Ampex Corp., Redwood City, Calif.

FACT SHEET

ORBITING GEOPHYSICAL OBSERVATORY-C

OBSERVATORY

Weight: About 1,150 pounds, including

Experiments:	198 pounds
Power supply:	183 pounds
Spacecraft Structure and Thermal Control System:	253 pounds
Communications and Data Handling Systems:	135 pounds
Spacecraft Integration Element and Wiring:	201 pounds
Stabilization and Attitude Control System:	156 pounds
Interstage and Separation Mechanism:	24 pounds

Shape: Main body, rectangular box, about six feet long, three feet wide, three feet high

Appendages: Two 22-foot booms

Four four-foot booms

Two solar panels, six feet wide, seven and one-half feet long with approximately 80 square feet total area covered with 32,928 N/P solar cells

Two Orbital Plane (OPEP) experiment packages, 18 inches long, 10 inches wide and 10 inches deep

Overall Dimensions:	Length, booms extended 49 feet
	Width, Solar panels extended: 20.5 feet
Power Supply:	Solar supply to two 28-volt silver-cadmium batteries using unregulated direct current with maximum capability of about 500 watts

COMMUNICATIONS AND DATA HANDLING SYSTEM

Wideband telemetry (PCM/PM):	Two four-watt 400 mc RF transmitters
	Two data-handling units
	Two high-capacity tape recorders (six-hour capability at 4,000 data bits per second)
Special Purpose Telemetry (FM/PM):	One 500-mw, 400-mc RF transmitter
	One signal combiner and AGC unit
Tracking:	Two 100-mw, 136 mc beacons One Range and Range Rate Transponder
Command:	Two Receivers at frequency of 149 mc. PCM/FM/AM

LAUNCH PHASE

Launch Site:	Complex 75-1-1, Air Force Western Test Range
Launch Rocket:	Thrust-Augmented Thor-Agena D
Orbit:	Apogee, 575 statute miles; Perigee, 207 statute miles

Angle of Inclination: 86 degrees

Orbital Period: About 97 minutes

TRACKING AND DATA ACQUISITION STATIONS*

Primary Stations:	Rosman, N. C. Fairbanks, Alaska
Secondary Stations:	Quito, Ecuador Johannesburg, Republic of South Africa Santiago, Chile Winkfield, England
Tracking Stations:	World-wide Space Tracking and Data Acquisition Network (STADAN) and during launch phase WTR down-range ship
Range and Range Rate Stations:	Rosman, N. C. Carnarvon, Australia Tanararive, Malagasy

* All tracking and telemetry stations are operated by the Goddard Space Flight Center

OGO-C EXPERIMENTS

Principal Investigators	Experiment Title	Brief Description
1. Professor F. T. Haddock (University of Michigan)	Radio Astronomy	Measurements of galactic emissions: Radio receiver, (7.0 lbs.) 2.5 and 2.0 mc.
2. Dr. R. A. Helliwell (Stanford University)	VLF Noise and Propulsion	Measure terrestrial and other emissions. VLF receiver (6.4 lbs.), 0.5 to 10 kc.
3. Professor M. G. Morgan and Professor T. Laaspere (Dartmouth College)	Whistlers and Audio-Frequency Electromagnetic Waves	Measure terrestrial and other emissions; VLF receiver (4.5 lbs.), 0.5 to 18 kc.
*5. Dr. E. J. Smith (Jet Propulsion Laboratory) Dr. R. E. Holzer (University of California at Los Angeles)	Magnetic Field Fluctuations	Triaxial search coil magnetometer (5.6 lbs.), 0.01 to 1000 cps.
6. Dr. J. P. Heppner (Goddard Space Flight Center)	World Magnetic Survey	Rubidium-vapor, magnetometer (20.9 lbs.), 1 to 50,000 gamma.
7. Dr. H. R. Anderson (Rice Institute-Jet Propulsion Laboratory) Dr. H. V. Neher (Calif. Institute of Technology)	Cosmic Ray and Polar Ionization Study	Ionization chamber (2.9 lbs.), 10 Mev to 15 Bev.
8. Dr. J. A. Simpson (University of Chicago)	Energetic Particles	Scintillation telescope detector (6.8 lbs.)
9. (University of Minnesota)	Galactic and Solar Cosmic Rays	Scintillation and Cerenkov detector (16.7 lbs.)
10. Dr. J. A. Van Allen (State University of Iowa)	Corpuscular Radiation in Auroral and Polar Regions	Geiger Counter (4.5 lbs), measure electrons above 40 and 120 Kev.

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11. Dr. A. Konradi (Goddard Space Flight Center)	Trapped Radiation and Auroral Particles	Phosphor scintillation counter (7.4 lbs), measure electrons from 10 to 100 Kev. and protons from 100 Kev. to 4.5 Mev.
12. Professor J. Blamont (University of Paris) Mrs. Edith Reed (Goddard Space Flight Center)	Airglow and Auroral Study	Photometers (26.6 lbs), measuring at 6300,5577 and 3914 Angstroms and in near ultraviolet region.
13. Dr. P. W. Mange (U.S. Naval Research Lab.)	Lyman-Alpha and Airglow Study	Ionization chambers (9.0 lbs.), measurements in Lyman-Alpha, far ultraviolet and 1230 to 1350 Angstroms.
14. Dr. C. A. Barth (University of Colorado-Jet Propulsion Laboratory) Dr. L. Wallace (Kitt Peak Nat'l Observatory)	Airglow Study	UV spectrometer (27.4 lbs.); Measurements between 1100 and 3400 Angstroms.
15. Prof. L. Jones (University of Michigan)	Neutral Particles and Ion Composition Study	Paul massenfilter mass spectrometer (8.3 lbs.); measurements in mass ranges of 0-6 to 7-50 AMU.
16. Mr. H. A. Taylor, Jr. (Goddard Space Flight Center)	Positive Ion Study	Bennett RF mass spectrometer (6.3.lbs.); mass ranges of 1-6 AMU and 7-45 AMU.
17. Mr. G. P. Newton (Goddard Space Flight Center)	Neutral Particle Study	Bayard-Alpert ionization gauge (8.5 lbs.); Measurements of neutral particle density.
18. Mr. W. M. Alexander (Goddard Space Flight Center)	Micrometeorite Study	Time-of-flight and momentum detector (7.0 lbs.); measure mass, velocity and charge of micrometeorites.

19. Mr. R. E. Bourdeau (Goddard Space Flight Center)	Ionospheric Composition and Solar UV Flux	Planar retarding potential analyzer (6.3 lbs.); measure ionospheric charged particles and solar UV radiation.
20. Dr. H.E. Hinteregger (AF Cambridge Research Labs.)	Solar Emissions	Scanning spectrometer (8.8 lbs.); monitor solar emissions in 170 to 1700 Angstroms.
21. Mr. R. W. Kreplin (U.S. Naval Research Lab.)	Solar X-Ray Study	Ionization chambers (7.4 lbs.); measurements in 0.5 to 3; 2 to 8; 8 to 16 and 44 to 60 Angstrom regions.

*Because the experiments on this list are numbered according to official records, there is no experiment No. 4. An experiment originally numbered 4 was withdrawn by the experimenter.

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