NSSDC/WDC-A-R&S 85-03

National Space Science Data Center/
World Data Center A for Rockets and Satellites

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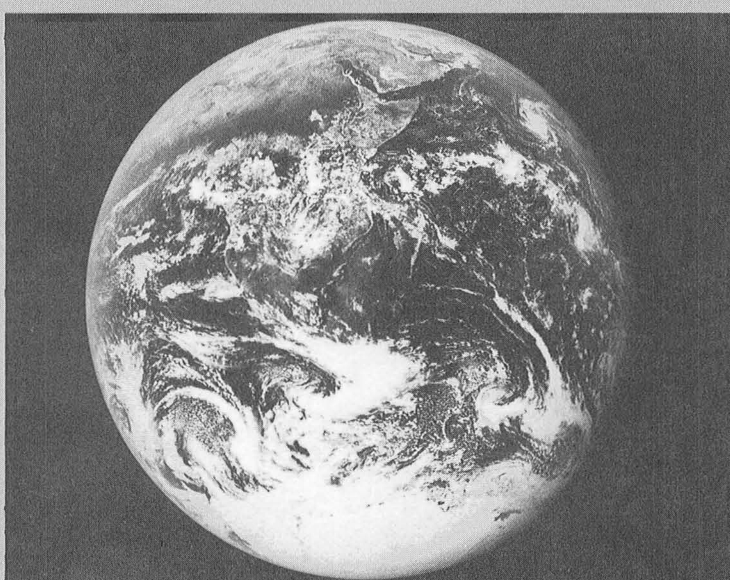
DATA CATALOG SERIES FOR SPACE SCIENCE AND APPLICATIONS FLIGHT MISSIONS

Volume 4A

Descriptions of Meteorological and Terrestrial Applications Spacecraft and Investigations



July 1985

Categories of Spacecraft Used in This Series

PLANETARY AND HELIOCENTRIC

This category includes probes to the various planets of the solar system and probes designed to make measurements of the characteristics of interplanetary space. Included are also the probes which will pass out of the solar system into interstellar space.

METEOROLOGICAL AND TERRESTRIAL APPLICATIONS

This category includes geocentric spacecraft whose primary mission is to make remote sensing measurements of the earth and its atmosphere. Spacecraft which carry instrumentation to make geodesy and gravimetry measurements are also included. Technology, engineering, and communications spacecraft or investigations are not included because NSSDC does not archive such data.

ASTRONOMY, ASTROPHYSICS, AND SOLAR PHYSICS

This category consists of scientific satellites designed to conduct investigations of the sun, stellar objects, nonstellar sources, and interstellar phenomena. These satellites are geocentric except for the selenocentric RAE-B.

GEOSTATIONARY AND HIGH-ALTITUDE SCIENTIFIC

This category includes those satellites designed to conduct investigations of the characteristics of near-earth space from orbits with apogees near geostationary altitude and higher. Three of the spacecraft are selenocentric. Communications satellites are not included because NSSDC does not archive such data.

LOW- AND MEDIUM-ALTITUDE SCIENTIFIC

This category includes those spacecraft whose apogees are well below geostationary altitude and whose primary purpose is to conduct investigations in the near-earth environment.

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DATE/FILE 5-5-86/N
PRIMARY DATA BASE ONLINE

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1	4	4	UTP/CATALOG *+1 SERIES *+2 SPACE *+1 SCIENCE

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UTTL: Data catalog series for space science and applications flight missions. Volume 4A: Descriptions of meteorological and terrestrial applications spacecraft and investigations

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ABA: E.A.K.

ABS: The National Space Science Data Center (NSSDC) provides data from and information about space science and applications flight investigations in support of additional studies beyond those performed as the principal part of any flight mission. The Earth-orbiting spacecraft for investigations of the earth and its atmosphere is discussed. Geodetic tracking data are included in this category. The principal subject areas presented are

ENTER:

NSSDC/WDC-A-R&S 85-03

DATA CATALOG SERIES FOR SPACE SCIENCE AND APPLICATIONS FLIGHT MISSIONS

Volume 4A

DESCRIPTIONS OF METEOROLOGICAL AND TERRESTRIAL APPLICATIONS SPACECRAFT AND INVESTIGATIONS

Edited by

Carolyn Y. Ng

Yi-Tsuei P. Sheu

July 1985

National Space Science Data Center (NSSDC)/
World Data Center A for Rockets and Satellites (WDC-A-R&S)
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

PREFACE

This volume is part of a series which will describe data sets and related spacecraft and investigations from space science and applications flight missions. The series will describe the data sets held by NSSDC, some of the data sets held by NASA-funded investigators, and some of those held by foreign investigators. The series will also serve as pointer documents for extensive data sets held and serviced by other government agencies.

We would like to thank the many investigators who have submitted their data for archiving at NSSDC. Their cooperation in supplying current status information is gratefully acknowledged. We are particularly indebted to the many past and present NSSDC personnel who interacted with the investigators in bringing to NSSDC the flight data and who provided the initial input for many of the descriptions appearing in this catalog. Thanks are also extended to the other NSSDC personnel, employees of the on-site contractor, Sigma Data Services Corporation, who have been involved in the information handling necessary to produce this volume. Special acknowledgment is given to Mary Elsen for her extensive editorial assistance.

The Data Center is continually striving to increase the usefulness of its data, and associated indexes and documentation held at NSSDC, as well as its information base about data sets held at, and accessible from, other institutions. Scientists are invited to submit their space science data and related documentation, or information about accessible data to NSSDC. Their comments on and corrections to the present catalog will be greatly appreciated. Catalog recipients are urged to inform potential data users of its availability.

Carolyn Y. Ng

Yi-Tsuei P. Sheu

July 1985

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Introduction

1.1 PURPOSE

The National Space Science Data Center (NSSDC) was established by the National Aeronautics and Space Administration (NASA) to provide data from and information about space science and applications flight investigations in support of additional studies beyond those performed as the principal part of any flight mission. This volume is one of a series of eleven that will describe (1) all spacecraft flight investigations for which NSSDC possesses data or can direct people to the data source, (2) all data sets held by NSSDC, (3) some of the data sets held and serviced by NASA-funded investigators, and (4) some of the data sets held and serviced by foreign investigators. The series will serve as pointer documents for extensive data sets held and serviced by other government agencies, particularly the National Oceanic and Atmospheric Administration (NOAA). There is one major omission from this series: the extensive set of data obtained from the lunar missions conducted by NASA, supplemented by a few small photographic data sets from Soviet missions. These are described in the *Catalog of Lunar Mission Data* (NSSDC/WDC-A-R&S 77-02) and will not be repeated in this series, except for a few cases. The data from IMP-E, Apollo 15 subsatellite, and Apollo 16 subsatellite are included in the series, since these data are important to disciplines other than those connected with lunar studies. Some of the experiments of the Apollo ALSEP missions also yielded useful data for magnetospheric and interplanetary physics, but these are not included in the series, since the instruments were confined to the surface of the moon. Readers should consult the *Catalog of Lunar Mission Data* if they are interested in such data sets.

The series consists of (1) five volumes that describe the spacecraft and their associated investigations separated into various categories, (2) five corresponding volumes that describe the various orbital information and investigation data sets, and (3) a master index volume. The five categories of spacecraft are (i) Planetary and Heliocentric, which include planetary flybys and probes, (ii) Meteorological and Terrestrial Applications, (iii) Astronomy, Astrophysics, and Solar Physics, which are all geocentric except the selenocentric RAE-B, (iv) Geostationary and High-Altitude Scientific, and (v) Low- and Medium-Altitude Scientific. It is impossible to provide an organization of categories that separates the investigations cleanly into scientific disciplines, since many missions were multidisciplinary. With the above organization, that is partly discipline-oriented and partly orbit-oriented, it was found that in nearly all cases a given spacecraft belonged clearly to only one of the above five categories. The few exceptions encountered have resulted in some data sets appearing in more than one data set volume.

Each volume is organized in a way that is believed to be most useful to the user and is described for each such volume in the Organization Section. For the standard types of orbital information, given in the data set catalogs, i.e., predicted, refined, and definitive, the information will be given in a tabular form to avoid repeating the same brief description an inordinate number of times. The standard description of a data set from an investigation is a free text brief description, since the wide variety of instruments precludes using a tabular format in most cases.

This catalog series has been prepared following a 2-year survey and follow-up activity by NSSDC personnel to obtain information about the completeness of the NSSDC holdings and to solicit the description of data sets that will be archived by individual investigators; these latter data sets are referred to as directory data sets. This survey was conducted only for NASA missions launched after December 31, 1962, but it includes the majority of NSSDC holdings. Of the 100 investigators surveyed, representing 346 inactive (no longer associated with an active science working team or equivalent) experiments, a small percentage failed to respond in 17 months of concerted solicitation for information. Consequently, there are now 20 investigations for which NSSDC has no data that will be dropped from this catalog series, since it would be irresponsible for NSSDC to send requesters to a possible data source that no longer has data or is nonresponsive. The surveyed investigations that are being dropped from the NSSDC catalogs are identified in the appropriate volumes in the series. A small, but nontrivial, number of investigations were identified for which data no longer exist or for which the instrument failed at launch. These investigations are included in the spacecraft/investigation volumes so that users will know that it is fruitless to try to obtain such data anywhere. Also included in the spacecraft/investigation volumes are descriptions of recent spacecraft and investigations from which NSSDC expects to receive data.

The main purpose of this series is to identify the data and the contact from whom the data can be obtained within the scope previously defined. In addition, we have tried to identify the personnel involved with the investigation, and to provide their current affiliation so that a user will know whom to contact for additional information relative to a given data set that NSSDC archives. In some cases we know that people have retired or have gone into different areas of endeavor. The latter case is treated by showing the last affiliation of such an individual and denoting that he is no longer affiliated by printing NLA after the individual's name. The spacecraft/mission personnel are identified at the institution where they performed their relevant duties since this is the place where the original project records are most likely to be found. The term NLA is printed with the names of these personnel if they are no longer associated with the given institution.

It is hoped that this series will serve for many years as the source documents for data in the disciplines that NSSDC handles. The annual *NSSDC Data Listing* will be used to update the time intervals for which data are available and to identify in brief form the new data sets that become available in the future. The annual *Report of Active and Planned Spacecraft and Experiments* will be used to describe the new spacecraft and experiments which are placed in orbit.

1.2 ORGANIZATION

This catalog deals with the earth-orbiting spacecraft mainly for investigations of the earth and its atmosphere. Geodetic tracking data are also included in this category.

Section 2 contains research type spacecraft and experiments for which NSSDC has data sets, knows of their locations, or has been notified that no data exist. Section 3 contains operational type spacecraft and their experiments. TIROS 1-10 were R&D satellites, but they also served as semi-operational meteorological satellites. They are included in this section. Most of the operational meteorological data are archived at the Satellite Data Services Division (SDSD), National Climatic Data Center (NCDC), National Environmental Satellite, Data, and Information Service (NESDIS), National Oceanic and Atmospheric Administration (NOAA), Washington, D.C. 20233. The Satellite Data Services Division is mentioned widely in the text by the acronym SDSD. To avoid needless repetition, the address, which is given here, does not accompany the acronym in the text. On manned spacecraft Geminis 3-12, two earth-observation investigations were repeated. They are also contained in Section 3. Section 4 lists the names of the spacecraft which have provided geodetic tracking data. No descriptions of the spacecraft and experiments are presented.

The organization of the descriptions of the spacecraft in Sections 2 and 3 is mainly alphabetical by the NSSDC spacecraft common name. Under each spacecraft heading, the appropriate investigation descriptions are arranged alphabetically by name of the original principal investigator.

Each spacecraft description entry in Section 2 includes the spacecraft alternate names, NSSDC ID number (see Appendix A), launch information (date, site, and vehicle), spacecraft weight, orbit parameters (type, epoch date, period, inclination, periapsis, and apoapsis), sponsoring country and agency, personnel (project manager, "PM", project scientist, "PS", and their affiliation at the start of the project), and a brief description concerning the mission. Additional information concerning the PM and PS codes is given in Appendix A. The "NLA" code that sometimes follows a person's name is explained in Appendix A.

Each investigation description entry in Section 2 includes the investigation name (as used by NSSDC), NSSDC ID number (see Appendix A), the NASA Headquarters investigative program code, the investigation discipline(s) and the names and current affiliations of the principal investigator (PI) and of the associated other investigator(s) (OI). The principal investigators are listed first, but the other investigators are not listed in any particular order. The designation "/CO-OP" under the investigative program indicates a cooperative effort between NASA and another agency. The investigation brief description is immediately below each heading.

The description entries for spacecraft and investigations in Section 3 are different from the entries in Section 2. One spacecraft description entry is given to one satellite series, since spacecraft in the same series are very similar to one another. The launch date and orbit parameters are contained in a table. The information regarding personnel is also presented in tabular form. Then, a brief description states the general features of that series of spacecraft. One investigation description entry is given to one experiment which is possibly repeated on different flights within the same series. The spacecraft on which the investigation has been carried, NSSDC ID numbers, personnel, and one brief description are included.

The Index of Spacecraft and Investigations in Section 5 lists the spacecraft and investigations described in this volume. Spacecraft common names and alternate names are in numerical and alphabetical order. Included with each spacecraft common name are the sponsoring country and agency, launch date, NSSDC ID number, and the page where the spacecraft description may be found in this volume. Grouped under each spacecraft name are the particular investigations for that spacecraft which are to be dealt with in this volume, arranged alphabetically by principal investigator's last name. Each of these entries also includes the investigation name, NSSDC ID number, and the page where the investigation description may be found in this volume. Certain words, phrases, and acronyms used in this volume are defined in Appendices A and B.

In this volume, the principal subject areas are meteorology and earth resources survey, and the spacecraft selection is made according to those subjects; but all experiments on board the spacecraft are described herein. No attempt has been made here to reference investigations that are related to the above disciplines but that are described in other volumes of this series.

1.3 NSSDC PURPOSE, FACILITIES, AND SERVICES

The National Space Science Data Center was established by the National Aeronautics and Space Administration to provide data and information from space science and applications (earth sciences) investigations in support of additional studies beyond those performed by principal investigators. As part of that support, NSSDC has prepared this series of volumes providing descriptions of archived data, divided into five categories as presented in Section 1.1 (see also inside front cover). In addition to its main function of providing selected data and supporting information for further analysis of space science flight experiments, NSSDC produces other publications. Among these are a report on active and planned spacecraft and experiments, and various users guides.

Virtually all the data available at or through NSSDC result from individual experiments carried on board individual spacecraft. The Data Center has developed an information system utilizing a spacecraft/investigation/data identification hierarchy. This catalog is based on the information contained in that system.

NSSDC provides facilities for reproduction of data and for onsite data use. Resident and visiting researchers are invited to study the data while at the Data Center. The Data Center staff will assist users with additional data searches and with the use of equipment. In addition to spacecraft data, the Data Center maintains some supporting information and other supporting data that may be related to the needs of the researchers.

The Data Center's address for information (for U.S. researchers) follows:

National Space Science Data Center
Code 633.4
Goddard Space Flight Center
Greenbelt, Maryland 20771
Telephone: (301) 344-6695
Telex No.: 89675
TWX No.: 7108289716
SPAN Address: NSSDC::REQUEST

Researchers who reside outside the U.S. should direct requests for information to the following address:

World Data Center A for Rockets and Satellites
Code 630.2
Goddard Space Flight Center
Greenbelt, Maryland 20771 U.S.A.
Telephone: (301) 344-6695
Telex No.: 89675
TWX No.: 7108289716

1.4 DATA ACQUISITION

NSSDC invites members of the scientific community involved in spaceflight investigations to submit data to the Data Center or to provide information about the data sets that they prefer to handle directly. The Data Center assigns a discipline specialist to work with each investigator or science working team to determine the forms of data that are likely to be most useful to the community of users that obtain data from NSSDC. The pamphlet *Guidelines for Submitting Data to the National Space Science Data Center* can be provided on request.

Research and Development
Spacecraft and Investigation Descriptions

**************************** ASTP-APOLLO ***********************

SPACECRAFT COMMON NAME- ASTP-APOLLO
ALTERNATE NAMES- APOLLO SOYUZ TEST PROJ., SOYUZ APOLLO

NSSDC ID- 75-066A

LAUNCH DATE- 07/15/75 WEIGHT- 14856. KG
LAUNCH SITE- KENNEDY SPACE CENTER, UNITED STATES
LAUNCH VEHICLE- SATURN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OMSF

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 07/18/75
ORBIT PERIOD- 88.91 MIN INCLINATION- 51.75 DEG
PERIAPSIS- 217. KM ALT APOAPSIS- 231. KM ALT

PERSONNEL
PM - C.M. LEE NASA HEADQUARTERS

BRIEF DESCRIPTION
The United States and the U.S.S.R. launched an Apollo spacecraft and a Soyuz spacecraft, respectively, as a joint effort called the Apollo-Soyuz Test Project (ASTP). The Soyuz spacecraft was launched first, with a two-man crew who maneuvered their spacecraft into a docking orbit. The Apollo spacecraft was launched 7-1/2 h later, with a three-man crew who placed their spacecraft into a proper configuration for docking with the Soyuz spacecraft. The docking of the two spacecraft occurred on the third day. After docking, crew transfers took place, with the Apollo crew first visiting the Soyuz. The combined Apollo-Soyuz crews performed joint experiments and presented radio and TV reports. After joint experiments were completed, the spacecraft disengaged and each continued its separate mission.

------- ASTP-APOLLO, AKOEV ------------------------------------

INVESTIGATION NAME- ZONE FORMING FUNGI

NSSDC ID- 75-066A-24 INVESTIGATIVE PROGRAM
CODE EB

INVESTIGATION DISCIPLINE(S)
SPACE BIOLOGY

PERSONNEL
PI - I.G. AKOEV SAS-IPA

BRIEF DESCRIPTION
The objective of this experiment was to investigate the effect of space flight conditions on the rhythms of vegetative and spore phase characteristics of streptomyces levoris. This species was isolated, named, and provided by the U.S.S.R. and was used as the primary test specimen for this experiment. The cultural characteristics of this organism permitted in situ comparison of spore ring features and development rates in preflight, flight, and postflight periods of the Apollo-Soyuz Test Project, within a single culture. Aspects of the experiment that were studied included: (1) cultures that had been initiated within a 12-h phase shift were exchanged during the flight, (2) the effects of local radiation on generic changes were studied, (3) characteristics of secondary cultures that were derived from different sectors of the primary cultures were studied and compared, and (4) morphological and cultural properties of different nutrient media were recorded. Each flight device held two petri dishes that contained streptomyces cultures. Radiation detectors of cellulose triacetate, cellulose nitrate, and lexan were used to register particles that passed through the biological test systems, and they were placed beneath the petri dishes as well as in a movable lid. All flight and control specimens were photographed at 12-h (plus or minus 3 h) intervals from the time the cultures were selected for the experiment until termination. Additional details of the experiment and its performance can be found in "Zone Forming Fungi - Experiment MA-147," by T. D. Rogers et al., Apollo-Soyuz Test Project, Preliminary Science Report, NASA-JSC, TM-X-58173, pp. 15.1-15.12, 1976.

------- ASTP-APOLLO, BOWYER ------------------------------------

INVESTIGATION NAME- EXTREME ULTRAVIOLET ASTRONOMY

NSSDC ID- 75-066A-01 INVESTIGATIVE PROGRAM
CODE EZ

INVESTIGATION DISCIPLINE(S)
ASTRONOMY

PERSONNEL
PI - C.S. BOWYER U OF CALIF, BERKELEY

BRIEF DESCRIPTION
This ASTP experiment searched for sources of extreme ultraviolet (EUV) radiation in the night sky. The principal instrument was a flux-collecting grazing-incidence telescope with an EUV detector at its focal point, mounted outside the spacecraft. The telescope was sensitive to radiation in the 50- to 1000-A region. On 10 revolutions, the instrument was pointed at 30 different stellar targets for periods of 1 to 20 minutes.

------- ASTP-APOLLO, BOWYER ------------------------------------

INVESTIGATION NAME- HELIUM GLOW

NSSDC ID- 75-066A-02 INVESTIGATIVE PROGRAM
CODE EZ

INVESTIGATION DISCIPLINE(S)
ASTRONOMY

PERSONNEL
PI - C.S. BOWYER U OF CALIF, BERKELEY

BRIEF DESCRIPTION
This ASTP experiment measured the intensity and spatial distribution of helium-fluorescent radiation in selected regions of the night sky. The measurements could give the distribution of helium in interplanetary space, and indicate the penetration of interstellar helium into the solar system. Measurements were made with a narrow-passband photometer, sensitive to helium radiation, and pointed to an accuracy of 4 deg.

------- ASTP-APOLLO, BUCKER ------------------------------------

INVESTIGATION NAME- BIOSTACK

NSSDC ID- 75-066A-15 INVESTIGATIVE PROGRAM
CODE EB

INVESTIGATION DISCIPLINE(S)
SPACE BIOLOGY

PERSONNEL
PI - H. BUCKER DFVLR

BRIEF DESCRIPTION
The objectives of this experiment were (1) to study the biological effects of high energy-loss (HZE) heavy cosmic particles not available on earth, (2) to study the mechanism by which HZE particles damage biological materials, and (3) to estimate the radiation hazards to man in space. The experiment packages contained bacterial spores, protozoa cysts, plant seeds, shrimp eggs, and insect eggs, together with different physical radiation detectors: nuclear emulsions, plastics, silver chloride crystals, and lithium fluoride thermoluminescence dosimeters. Eight biological systems and seven dosimetric detectors were flown. The biological objects were arranged in monolayers that were stacked between the track detector sheets so that (1) in relation to the biological objects the particle tracks could be located, and (2) the physical properties of these particles could be determined. Most of the biological objects were embedded in polyvinyl alcohol. A single bacterial spore from the flight plates could be transferred to the nutrient medium in order to observe changes in development, growth kinetics, and cell morphology. More details can be found in "Biostack III - Experiment MA-107," by H. Bucker, et al., Apollo-Soyuz Test Project, Preliminary Science Report, NASA-JSC, TM-X-58173, pp. 14.1-14.28, 1976.

------- ASTP-APOLLO, EL-BAZ ------------------------------------

INVESTIGATION NAME- EARTH OBSERVATIONS AND PHOTOGRAPHY

NSSDC ID- 75-066A-21 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
EARTH RESOURCES SURVEY
METEOROLOGY
OCEANOGRAPHY

PERSONNEL
PI - F. EL-BAZ ITEK CORP

BRIEF DESCRIPTION
The objective of the earth observations and photography experiment of the Apollo-Soyuz Test Project was to photograph various terrestrial structures using man to visually study earth features and phenomena. Eleven mapping sites and 12 visual observing sites were chosen in part from inputs provided by specialists in the following disciplines: geology, oceanography, desert study, hydrology, and environmental science. The photographs of observation and mapping sites were made with a video tape recorder (VTR), a 70-mm Hasselblad reflex camera (HRC), a 70-mm Hasselblad data camera (HDC), a 35-mm Nikon camera, and a 16-mm data acquisition camera (DAC). Real-time television transmissions were also scheduled. The "Earth Observations Book" was the principal onboard aid, and it was divided into three major sections. Section two pertained to specific visual observational targets and was arranged according to site number. For each site there was a summary page with a map showing revolution ground tracks followed by a page (one for each target) that included specific questions, appropriate diagrams and photographs, and camera settings. Studies performed included observations of major active fault zones, river deltas, volcanoes, ocean eddies, currents, internal waves, eolian landform, desert color, snowcover, drainage patterns, cloud features, tropical storms, and sources of atmospheric and water pollution. Further details and some results are contained in the report, "Earth Observations And

Photography - Experiment MA-136," by Farouk El-Baz and D. A. Mitchell, Apollo-Soyuz Test Project, Preliminary Science Report, NASA-JSC, TM-X-58173, pp. 10.1-10.64, 1976.

------- ASTP-APOLLO, LIND--

INVESTIGATION NAME- CRYSTAL GROWTH

NSSDC ID- 75-066A-18 INVESTIGATIVE PROGRAM
CODE EN

INVESTIGATION DISCIPLINE(S)
TECHNOLOGY
SPACE PROCESSING

PERSONNEL
PI - M.D. LIND ROCKWELL INTER SCI CTR

BRIEF DESCRIPTION
The crystal growth experiment involved a novel process for growing single crystals of insoluble substances by allowing two or more reactant solutions to diffuse toward each other through a region of pure solvent in zero gravity. This approach took advantage of the absence of gravity-driven convection that, on earth, predominates over diffusion as a mechanism of material transport. The three crystals investigated were calcium tartrate, calcium carbonate, and lead sulfide. Experiment apparatus consisted of six specially designed and fabricated reactors, each one having three compartments that were separated by valves operated by the knobs at each end. Each compartment had a separate filling port. The compartments varied in length. The reactor covers were flat and transparent to permit photography of the process of diffusion and crystal growth. The reactant solutions were placed in the outer compartments of each reactor, and the central compartment was filled with water. Beginning at time of activation and at 12-h intervals for 116 h of flight, an astronaut took color photographs of the 6 reactors. More details can be found in "Crystal Growth Experiment MA-028," by M. D. Lind, Apollo-Soyuz Test Project, Preliminary Science Report, NASA-JSC, TM-X-58173, pp. 30.1-30.5, 1976.

------- ASTP-APOLLO, PEPIN---------------------------------------

INVESTIGATION NAME- STRATOSPHERIC AEROSOL MEASUREMENT

NSSDC ID- 75-066A-19 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL
PI - T.J. PEPIN U OF WYOMING

BRIEF DESCRIPTION
The Stratospheric Aerosol Measurement (SAM) experiment was flown to demonstrate that solar occultation measurements by photometer and camera can be used for determining the vertical distribution of stratospheric aerosols. The instrument consisted of a photometer and associated electronics that provided a signal to the command module (CM) telemetry. Solar photographs, taken with the accompanying camera, corroborated the refraction model used here and for similar experiments on future flights. The photometer had a pin diode detector with a 10-deg field of view. A Hasselblad data camera equipped with a special infrared film and filter was used to photograph a series of timed spacecraft sunsets and sunrises. Immediately before satellite night, as the spacecraft approached the shadow of the earth, the line of sight to the sun passed first through the upper layers of the stratosphere and then steadily down to the lower layers of the troposphere. During the 1.5 min required for the instrument line of sight to pass through the lower 150 km of the atmosphere, the solar intensity was recorded by the photometer and solar disk shape changes were recorded by the camera. The same measuring procedures were followed when the spacecraft emerged from the darkside. From the measured variation of solar intensity as a function of total air mass distributed along the line of sight, the total extinction coefficient was determined. At the effective wavelength of the photometer and photographic system, the extinction was produced principally by atmospheric aerosols, and the measurements obtained were used to determine aerosol concentrations. To verify the operation of the SAM experiment, ground truth data were obtained by a balloon-borne aerosol optical counter (dust-sonde) and a ground-based laser radar (lidar) system. Further details can be found in "Stratospheric Aerosol Measurement - Experiment MA-007" by T. J. Pepin and M. P. McCormick, Apollo-Soyuz Test Project, Preliminary Science Report, NASA-JSC, TM-X-58173, pp. 9.1-9.8, 1976.

------- ASTP-APOLLO, SCHELD--------------------------------------

INVESTIGATION NAME- KILLIFISH HATCHING-ORIENTATION

NSSDC ID- 75-066A-23 INVESTIGATIVE PROGRAM
CODE EB

INVESTIGATION DISCIPLINE(S)
SPACE BIOLOGY

PERSONNEL
PI - H.W. SCHELD U OF HOUSTON

BRIEF DESCRIPTION
The experiment objective was to use the killifish Fundulus heteroclitus as a model system for the study of embryonic development and vestibular adaption in orbital flight. The experiment consisted of two parts. For the first part, several samples, preconditioned in various physical and chemical environments, were subjected to predetermined visual cues and disturbances. Video or cine recordings were made of the orientation behavior. Similar recordings were made of orientation behavior of hatchlings from embryonated eggs carried into orbit. For the second part of the experiment, a graded series of embryos representing key developmental stages were placed on board. After recovery, these flight test specimens and suitable ground controls were observed for (1) normalcy in vestibular functioning, and (2) microscopic and physiological changes.

------- ASTP-APOLLO, VONBUN--------------------------------------

INVESTIGATION NAME- GEODYNAMICS

NSSDC ID- 75-066A-17 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
GEODYNAMICS

PERSONNEL
PI - F.O. VONBUN NASA-GSFC

BRIEF DESCRIPTION
The Apollo-Soyuz Test Project geodynamics experiment was performed to determine the feasibility of tracking and recovering high-frequency components of the earth gravity field by using the synchronous orbiting Applications Technology Satellite (ATS 6). The specific objectives were (1) to demonstrate the detectability of short wavelength features of the earth's gravity field, (2) to evaluate the "high/low" satellite-to-satellite (SST) concept for geodynamics applications, (3) to test the recoverability of short wavelength features of the earth's gravity field. Gravity anomalies of 5 milligals or larger having wavelengths of 300 to 1000 km on the surface of the earth are important for geologic studies of the upper layers of the earth's crust. Small velocity changes (1 to 10 mm/s) of the low orbiting spacecraft had to be measured to determine local gravity variations. An orbit of one to one and one-half revolutions was computed for the Apollo spacecraft. From these Apollo orbits, together with the ATS 6 orbit, the range rates between ATS 6 and the Apollo spacecraft were computed. These computed range rates were subtracted from the actual measured ones to yield the input data needed to determine the surface gravity. The SST range-rate data together with direct ATS 6 tracking data and unified S-band tracking data were used in the orbit determinations. The two prime areas of data collection were the center of the African continent, and the Indian Ocean depression centered at latitude 5 deg N and longitude 75 deg E. The Apollo spacecraft was connected with Madrid by two links, the ATS 6 link and a direct ground link. To minimize atmospherically disturbed data, the data passes were limited to approximately 40 min. Further details including some measured results can be found in "Geodynamics - Experiment MA-128," by F.O. Vonbun et al., Apollo-Soyuz Test Project, Preliminary Science Report, NASA-JSC, TM-X-58173, pp. 12.1 to 12.6, 1976.

**************************** ASTP-SOYUZ ************************

SPACECRAFT COMMON NAME- ASTP-SOYUZ
ALTERNATE NAMES- APOLLO SOYUZ TEST PROJ., SOYUZ APOLLO

NSSDC ID- 75-065A

LAUNCH DATE- 07/15/75 WEIGHT- 6800. KG
LAUNCH SITE- TYURATAM (BAIKONUR COSMODROME), U.S.S.R.
LAUNCH VEHICLE- A-2

SPONSORING COUNTRY/AGENCY
U.S.S.R. SAS

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 07/16/75
ORBIT PERIOD- 88.92 MIN INCLINATION- 51.76 DEG
PERIAPSIS- 218. KM ALT APOAPSIS- 231. KM ALT

PERSONNEL

BRIEF DESCRIPTION
The United States and the U.S.S.R. launched an Apollo spacecraft and a Soyuz spacecraft, respectively, as a joint effort called the Apollo-Soyuz Test Project (ASTP). The Soyuz spacecraft was launched first, with a two-man crew who maneuvered their spacecraft into a docking orbit. The Apollo spacecraft was launched 7-1/2 h later, with a three-man crew who placed their spacecraft into a proper configuration for docking with the Soyuz spacecraft. The docking of the two spacecraft occurred on the third day. After docking, crew transfers took place, with the Apollo crew first visiting the Soyuz. The combined Apollo-Soyuz crews performed joint experiments and presented radio and TV reports. After joint experiments were completed, the spacecraft disengaged and each

continued its separate mission.

------- ASTP-SOYUZ, IVANOV--------------------------------------

INVESTIGATION NAME- USSR MULTIPLE MATERIAL MELTING

NSSDC ID- 75-065A-02 INVESTIGATIVE PROGRAM
CODE EN/CO-OP

INVESTIGATION DISCIPLINE(S)
TECHNOLOGY
SPACE PROCESSING

PERSONNEL
PI - I. IVANOV SAS-IPA

BRIEF DESCRIPTION
The objective of this experiment was to determine the degree of improvement of materials processed in zero gravity. Convective stirring during solidification and segregation in the melt due to gravity contributed to non-homogeneities, voids and structural imperfections in materials when processed on earth. The onboard multipurpose furnace system was used. Three different material systems were used. In the hot isothermal region, a sample of aluminum with tungsten spheres was melted and solidified. A germanium rod containing 2 atomic percent of silicon was partially melted and solidified in the gradient region. An additional isothermal region was created in the gradient zone to process an ampoule of powdered aluminum.

------- ASTP-SOYUZ, TAYLOR--------------------------------------

INVESTIGATION NAME- MICROBIAL EXCHANGE TEST

NSSDC ID- 75-065A-01 INVESTIGATIVE PROGRAM
CODE EB/CO-OP

INVESTIGATION DISCIPLINE(S)
SPACE BIOLOGY

PERSONNEL
PI - G.R. TAYLOR NASA-JSC

BRIEF DESCRIPTION
The objective of the microbial exchange experiment was to determine the components of the infectious disease process in space flight by measuring changes in three factors: (1) the composition of the microbial populations inhabiting the crew members and spacecraft, (2) the ability of each crew member's defense mechanism to resist infection, and (3) the ability of certain microorganisms to originate infections. Hence, this experiment was designed to monitor quantitatively the microbial load of all crew members and of selected inner surfaces of both the Apollo and Soyuz spacecraft. The normal autoflora and immunocompetence level of each crew member were established before flight through repeated sampling and analysis. Selected microorganisms recovered from the crew and spacecraft were examined to detect changes in the ability of the microorganism to become pathogenic, infective, or toxic to man. At some time, certain immunological parameters of the blood and saliva of each crew member were studied to detect changes in the ability of the individual to resist infection. Specimens were collected from the 5 prime and 5 backup crew members and from 15 areas on the inner surfaces of each spacecraft at specific times before, during, and after the flight. For inflight samples, a specially developed sample collection device was used that consisted of a cotton-tipped Teflon swab on a capillary tube containing conservation fluid to keep the microorganism alive. All four sets of swabs were launched in the Soyuz spacecraft. Two kits to be used in the Apollo were transferred from the Soyuz at the end of the first joint activity and returned to the Soyuz near the end of the last joint activity. The analyses of all samples collected during flight were divided between U.S. and U.S.S.R. laboratories. More experiment details and some flight results can be found in "Microbial Exchange Experiment AR-002," by G. R. Taylor et al., Apollo-Soyuz Test Project, Preliminary Science Report, NASA-JSC, TM-X-58173, pp. 16.1-16.31, 1976.

**************************** ATS 3****************************

SPACECRAFT COMMON NAME- ATS 3
ALTERNATE NAMES- ATS-C, 03029

NSSDC ID- 67-111A

LAUNCH DATE- 11/05/67 WEIGHT- 365.0 KG
LAUNCH SITE- KENNEDY SPACE CENTER, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 01/08/68
ORBIT PERIOD- 1436.8 MIN INCLINATION- 0.45 DEG
PERIAPSIS- 35776. KM ALT APOAPSIS- 35812. KM ALT

PERSONNEL
PM - C.M. MACKENZIE NASA-GSFC
PS - T.L. AGGSON NASA-GSFC

BRIEF DESCRIPTION
ATS 3 (Applications Technology Satellite) was one of a series of spacecraft designed to demonstrate the utility and feasibility of a variety of technological and scientific activities that could be carried out by an earth-synchronous spacecraft. Of the 11 experiments on board, 8 were technological engineering experiments concerned with navigation, communications, and spacecraft operation and equipment. Two of the remaining experiments were photographic imaging experiments that could produce near real-time daylight pictures of the earth-atmosphere system. The remaining experiment was an ionospheric beacon. The spin-stabilized spacecraft was cylindrically shaped and measured 180 cm in length and 142 cm in diameter. The primary structural members were a honeycombed equipment shelf and thrust tube. Support rods extended radially outward from the thrust tube and were affixed to solar panels which formed the outer walls of the spacecraft. Equipment components and payload were mounted in the annular space between the thrust tube and solar panels. In addition to solar panels, the spacecraft was equipped with two rechargeable nickel-cadmium batteries to provide electrical power. Eight 150-cm VHF experiment whip antennae were mounted around the aft end of the spacecraft, while eight telemetry and command whip antennae were placed on the forward end. Spacecraft guidance and orbital corrections were accomplished by 2.3-kg hydrogen peroxide and hydrazine thrusters, which were activated by ground command. Initially placed at 48 deg W longitude over the Atlantic Ocean in a geostationary orbit, the satellite position later varied between 45 and 95 deg W longitude in support of meteorological operations. In general, the various experiments have been successful.

------- ATS 3, BRANCHFLOWER------------------------------------

INVESTIGATION NAME- IMAGE DISSECTOR CAMERA (IDC)

NSSDC ID- 67-111A-03 INVESTIGATIVE PROGRAM
CODE EC

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - G.A. BRANCHFLOWER(NLA) SPAR AEROSPACE

BRIEF DESCRIPTION
The ATS 3 Image Dissector Camera (IDC) was a camera system designed to (1) test the feasibility of using electrical scanning techniques in an earth-cloud camera and (2) provide daylight cloudcover data on a real-time basis with full earth coverage. The camera was mounted with its optical axis perpendicular to the spacecraft spin axis in such a manner that the camera produced a scan line with each revolution of the spacecraft. The direction of the scan, north to south or east to west, was determined by ground command. The image dissector tube consisted of a visible wavelength electrically scanning photocathode, a 0.018-mm scanning aperture, and a 12-stage electron multiplier. Light entering the camera was focused on the face of the photocathode, causing photoelectrons to be emitted from the surface in proportion to the number of impinging light photons. The emitted photoelectrons were propelled past the aperture by means of an external magnetic deflection coil. After passing through the aperture, the signal current was amplified by the 12-stage multiplier. The signal was further amplified and then transmitted at 28 KHz to a ground acquisition station. The 2.54-cm image dissector tube had a resolution capability of 1300 TV lines, which, at nominal spacecraft altitude, corresponded to a ground resolution of about 7 km at nadir. Successfully flown for the first time, the IDC system on ATS 3 served as a prototype for similar experiments on Nimbus 3 and 4. The camera performed normally until May 1969, when the IDC system was beset by erratic spacecraft antenna performance. Routine data acquisition ceased after May 30, 1969. The IDC system, although still capable of operation, was left in an operationally off mode since that time except for periodic engineering tests. For a listing and description of the different forms of photographic data available from this experiment, see the "Meteorological Data Catalog for the Applications Technology Satellites" (TRF B09264), available from NSSDC. Data can be obtained through SDSD.

------- ATS 3, DAROSA--

INVESTIGATION NAME- RADIO BEACON

NSSDC ID- 67-111A-02 INVESTIGATIVE PROGRAM
CODE EC

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
IONOSPHERES

PERSONNEL
PI - A.V. DAROSA STANFORD U

BRIEF DESCRIPTION
The ionospheric propagation experiment consisted of continuous transmission of two phase-coherent radio frequencies (137.350 and 412.050 MHz) from the spacecraft. By study of Faraday rotation angle measurements of the lower frequency or differential Doppler frequency recordings of the two frequencies, the total electron content along the propagation path could be calculated. Ionospheric irregularities could also be observed. Performance was nominal.

------- ATS 3, SUOMI---

INVESTIGATION NAME- MULTICOLOR SPIN-SCAN CLOUDCOVER CAMERA (MSSCC)

NSSDC ID- 67-111A-01 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - V.E. SUOMI U OF WISCONSIN
OI - R.S. PARENT U OF WISCONSIN

BRIEF DESCRIPTION
The ATS 3 Multicolor Spin-Scan Cloudcover Camera (MSSCC) represented a significant advance over a similar but monochromatic spin-scan camera on ATS 1. The MSSCC was mounted with its optical axis perpendicular to the spacecraft's spin axis and viewed the earth through a special aperture in the spacecraft's side. The camera consisted of a high-resolution telescope, three photomultiplier light detectors (red, blue, and green), and a precision latitude step mechanism. Light entering the system was focused alternately on a set of three 0.038-mm aperture plates and then passed through various filters to impinge on the appropriate photodetector. The telescope multiplier assembly could be tilted in discrete steps to provide pole-to-pole coverage in 2400 scan lines. East-to-west scan was provided by the spin of the satellite itself. A total time of 24 min was required to scan one frame and 2.4 min to retrace with a nominal satellite rotation of 100 rpm. From its geostationary equatorial orbit, the camera had a ground resolution of better than 4 km at nadir. The experiment was successful, with ATS 3 being the first spacecraft to transmit operational multicolor earth-cloud photographs. Approximately 3 months after launch, however, the red and blue channels failed, and the system subsequently was limited to producing black-and-white pictures. Good quality black-and-white pictures were received daily until December 11, 1974, when operations were curtailed to three pictures a week. For a listing and description of the different forms of photographic data, see the "Meteorological Data Catalog for The Applications Technology Satellites" (TRF B09264), available from NSSDC. Data can be obtained through SDSD.

*************************** BE-B ****************************

SPACECRAFT COMMON NAME- BE-B
ALTERNATE NAMES- EXPLORER 22, S 66B
00899

NSSDC ID- 64-064A

LAUNCH DATE- 10/10/64 WEIGHT- 52.0 KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- SCOUT

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 10/13/64
ORBIT PERIOD- 104.8 MIN INCLINATION- 79.7 DEG
PERIAPSIS- 889. KM ALT APOAPSIS- 1081. KM ALT

PERSONNEL
PM - F.T. MARTIN NASA-GSFC
PS - L.H. BRACE NASA-GSFC
PS - R.E. BOURDEAU(NLA) NASA-GSFC

BRIEF DESCRIPTION
BE-B (Explorer 22) was a small ionospheric research satellite instrumented with an electrostatic probe, a 20-, 40-, and 41-Hz radio beacon, a passive laser tracking reflector, and a Doppler navigation experiment. Its objective was to obtain worldwide observations of total electron content between the spacecraft and the earth. The satellite was initially spin-stabilized, but it was despun after solar paddle erection. Subsequent stabilization oriented the satellite axis of symmetry with the local magnetic field by means of a strong bar magnet and damping rods. A three-axis magnetometer and sun sensors provided information on the satellite attitude and spin rate. There was no tape recorder aboard so that satellite performance data and electrostatic probe data could be observed only when the satellite was within range of a ground telemetry station. Continuous transmitters also operated at 162 and 324 MHz to permit precise tracking by "Transit" tracking stations for navigation and geodetic studies. In August 1968, data acquisition from the satellite telemetry channels was discontinued. In July 1969, tracking and world map production were discontinued by GSFC, and world map production based on NORAD orbit elements was subsequently assumed by ESRO. The satellite failed in February 1970 and BE-C (65-032A) was turned on in order to partially replace use made of this satellite beacon experiment.

------- BE-B, BLUMLE---

INVESTIGATION NAME- RADIO FREQUENCY BEACON

NSSDC ID- 64-064A-01 INVESTIGATIVE PROGRAM
CODE EE, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS

PERSONNEL
PI - L.J. BLUMLE(NLA) NASA-GSFC

BRIEF DESCRIPTION
A radio beacon radiated a plane-polarized signal at 20.005 MHz, 40.010 MHz, 41.010 MHz, and 360.090 MHz, all harmonics of 1.00025 MHz. The three lower frequencies underwent an appreciable number of rotations about the plane of polarization due to electron concentration. The highest frequency did not. Several methods were used to analyze these rotations and determine the total electron content between the satellite and a ground receiver. The instrument failed in January 1970.

------- BE-B, BRACE---

INVESTIGATION NAME- LANGMUIR PROBE

NSSDC ID- 64-064A-02 INVESTIGATIVE PROGRAM
CODE EE, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES

PERSONNEL
PI - L.H. BRACE NASA-GSFC
OI - N.W. SPENCER NASA-GSFC

BRIEF DESCRIPTION
Two cylindrical electrostatic probes (types of Langmuir probes) were used to measure electron density and temperature. Each consisted of a collector electrode which extended from the central axis of a cylindrical guard ring. The guard ring extended 12.7 cm from the spacecraft, and the probe extended 22.86 cm. A 2-Hz sawtooth voltage of -3 to +5 volts was swept alternately to each of the probes, and the resulting current profile to the probe was telemetered. From this profile, the electron density and temperature and mean ion mass could be determined. The experiment was operated for 22 s every 3 min while within range of any of 10 telemetry stations. This experiment performed nominally from launch until August 1968, when it was turned off.

*************************** BE-C ****************************

SPACECRAFT COMMON NAME- BE-C
ALTERNATE NAMES- EXPLORER 27, S 66C
01328

NSSDC ID- 65-032A

LAUNCH DATE- 04/29/65 WEIGHT- 60. KG
LAUNCH SITE- WALLOPS FLIGHT CENTER, UNITED STATES
LAUNCH VEHICLE- SCOUT

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSS

ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 02/28/77
ORBIT PERIOD- 107.7 MIN INCLINATION- 41.1 DEG
PERIAPSIS- 927. KM ALT APOAPSIS- 1320. KM ALT

PERSONNEL
PM - F.T. MARTIN NASA-GSFC
PS - L.H. BRACE NASA-GSFC
PS - R.E. BOURDEAU(NLA) NASA-GSFC
PS - R. NEWTON(NLA) NASA-GSFC

BRIEF DESCRIPTION
BE-C (Explorer 27) was a small ionospheric research satellite instrumented with an electrostatic probe, radio beacons, a passive laser tracking reflector, and a Doppler navigation experiment. Its primary objective was to obtain worldwide observations of total electron content between the spacecraft and the earth. The satellite was initially spin stabilized, but it was despun after solar paddle erection. Subsequent stabilization oriented the satellite axis of symmetry with the local magnetic field by means of a strong bar magnet and damping rods. A three-axis magnetometer and sun sensors provided information on the satellite attitude and spin rate. There was no tape recorder aboard so that satellite performance data and electrostatic probe data were observed only when the satellite was within range of a ground telemetry station. Continuous transmitters operated at 162 and 324 MHz to permit precise tracking by "Transit" tracking stations for

navigation and geodetic studies. The satellite was turned off on July 20, 1973, due to frequency interference with higher priority spacecraft.

------- BE-C, BLUMLE---

INVESTIGATION NAME- RADIO BEACON

NSSDC ID- 65-032A-01 INVESTIGATIVE PROGRAM
CODE EE, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS

PERSONNEL
PI - L.J. BLUMLE(NLA) NASA-GSFC

BRIEF DESCRIPTION
A radio beacon radiated a plane-polarized signal at 20.005 MHz, 40.010 MHz, 41.010 MHz, and 360.090 MHz, all harmonics of 1.00025 MHz. The plane of polarization of the three lower frequencies underwent an appreciable number of rotations due to electron concentration. The polarization plane of highest frequency did not rotate appreciably. Several methods were used to analyze these rotations and determine the total electron content between the satellite and a ground receiver. The beacons were on until the satellite operation terminated on May 6, 1968. On February 13, 1970, the beacons were again turned on to replace the 64-064A (BE-B) beacons which had completely failed by the end of January 1970.

------- BE-C, BRACE---

INVESTIGATION NAME- LANGMUIR PROBE

NSSDC ID- 65-032A-02 INVESTIGATIVE PROGRAM
CODE EE, SCIENCE

INVESTIGATION DISCIPLINE(S)

PERSONNEL
PI - L.H. BRACE NASA-GSFC

BRIEF DESCRIPTION
Two cylindrical electrostatic probes of the Langmuir probe type were used. They consisted of a collector electrode extending from the central axis of a cylindrical guard ring. The guard ring extended 5 in. from the spacecraft and the probe extended 9 in. A 2-Hz sawtooth voltage of -3 to +5 V was swept to either of the probes, and the resulting current profile to the probe was telemetered. From this profile, the electron density, electron temperature, and mean ion mass were determined. This experiment performed nominally from launch until August 13, 1968, when solar cell degradation resulting from radiation prevented operation of all systems on the satellite. The probe was not operated after that time. No archival data were produced since the experiment was a back-up for the BE-B mission, which had been flown successfully.

*************************** ECHO 2***************************

SPACECRAFT COMMON NAME- ECHO 2
ALTERNATE NAMES- ECHO-C, A 12
00740

NSSDC ID- 64-004A

LAUNCH DATE- 01/25/64 WEIGHT- 256. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- THOR

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 01/27/64
ORBIT PERIOD- 108.95 MIN INCLINATION- 81.5 DEG
PERIAPSIS- 1029. KM ALT APOAPSIS- 1316. KM ALT

PERSONNEL
PM - H.L. EAKER(RETIRED) NASA-GSFC

BRIEF DESCRIPTION
The Echo 2 spacecraft was a 41-m balloon of aluminum foil-mylar laminate. Echo 2 was designed as a rigidized passive communications spacecraft for testing propagation, tracking, and communication techniques. Instrumentation included a beacon telemetry system that provided a tracking signal, monitored spacecraft skin temperature between -120 deg C and +16 deg C, and measured the internal pressure of the spacecraft between 5E-5 mm of mercury and 0.5 mm of mercury, especially during the initial inflation stages. This system, which consisted of two beacon assemblies, used solar cell panels for power and had a minimum power output of 45 mW at 136.17 MHz and 136.02 MHz. In addition to fulfilling its communications mission, the spacecraft was used for global geometric geodesy. The spacecraft re-entered the atmosphere on June 7, 1969.

------- ECHO 2, JACCHIA---

INVESTIGATION NAME- SATELLITE DRAG ATMOSPHERIC DENSITY

NSSDC ID- 64-004A-03 INVESTIGATIVE PROGRAM
CODE EE, SCIENCE

INVESTIGATION DISCIPLINE(S)
AERONOMY
PLANETARY ATMOSPHERES

PERSONNEL
PI - L.G. JACCHIA SAO
OI - J.R. SLOWEY SAO

BRIEF DESCRIPTION
Because of its symmetrical shape, Echo 2 was selected by the experimenters for use in determining upper atmospheric densities as a function of altitude, latitude, season, and solar activity. This experiment was not planned prior to launch. Density values near perigee were deduced from sequential observations of the spacecraft position, using optical (Baker-Nunn camera network) and radio and/or radar tracking techniques. A good discussion of the general techniques used to deduce density values from satellite drag data can be found in "Smithsonian Astrophysical Observatory Special Report No. 100," by L.G. Jacchia and J.R. Slowey. This experiment resulted in the successful determination of reasonable density values until the spacecraft re-entered the earth's atmosphere on June 7, 1969.

*************************** EOLE 1***************************

SPACECRAFT COMMON NAME- EOLE 1
ALTERNATE NAMES- CAS-A, 05435
EOLE

NSSDC ID- 71-071A

LAUNCH DATE- 08/16/71 WEIGHT- 84.7 KG
LAUNCH SITE- WALLOPS FLIGHT CENTER, UNITED STATES
LAUNCH VEHICLE- SCOUT

SPONSORING COUNTRY/AGENCY
FRANCE CNES
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 08/17/71
ORBIT PERIOD- 100.7 MIN INCLINATION- 50. DEG
PERIAPSIS- 677. KM ALT APOAPSIS- 906. KM ALT

PERSONNEL
PM - S.R. STEVENS NASA-GSFC
PS - W.R. BANDEEN NASA-GSFC

BRIEF DESCRIPTION
EOLE 1, the second French experimental meteorological satellite and the first launched by NASA under a cooperative agreement with the Centre National d'Etudes Spatiales (CNES), was designed to function primarily as a communications satellite to acquire and relay telemetered data on altitude, pressure, temperature, moisture, and upper atmospheric wind velocities from instrumented earth-circling constant density meteorological balloons. The octagonally shaped satellite measured 0.71 m across opposite corners and was 0.58 m long. Electrical power (20 W average) was supplied by eight rectangular solar panels deployed 45 deg from the EOLE 1 upper octagonal structure after orbital insertion, and by 15 rechargeable silver-cadmium batteries. Constant earth orientation was maintained by a deployable 10.06-m gravity gradient boom. Satellite spin was near zero rpm in orbit, and the attitude was programmed to remain stable within 9 deg of local vertical. The data were stored on board the spacecraft and unloaded on command when the spacecraft was within range of the ground station. The onboard telemetry consisted of (1) a 136.350-MHz downlink transmitter for relaying balloon telemetry to ground stations and also to serve as a tracking beacon, (2) a 148.25-MHz receiver for receiving spacecraft commands and telemetry programs for balloon operations, and (3) a spacecraft-to-balloon transmitter (464.84 MHz) and receiver (401.7196 MHz). The satellite operation was successful with the exception of the inadvertent destruction of 71 balloons by an erroneous ground command. The last balloon ceased transmitting in January 1973. However, the spacecraft was subsequently used to track and receive data from ocean buoys, icebergs, and ships.

------- EOLE 1, BANDEEN---

INVESTIGATION NAME- UPPER ATMOSPHERE WINDS AND WEATHER DATA
RELAY SYSTEM

NSSDC ID- 71-071A-01 INVESTIGATIVE PROGRAM
CODE EE/CO-OP, APPLICATIONS

INVESTIGATION DISCIPLINE(S)

PERSONNEL

PI - W.R.	BANDEEN	NASA-GSFC
OI - A.	KASAHARA	NATL CTR FOR ATMOS RES
OI - J.	ANGELL	NOAA
OI - Y.	MINTZ	U OF CALIF, LA
OI - P.	MOREL	CNRS

BRIEF DESCRIPTION

The EOLE 1 upper atmospheric winds and weather data relay system consisted of equipment designed primarily to collect various meteorological data from balloons in the Southern Hemisphere floating at pressure altitudes of about 200 mb. A secondary objective was to develop techniques for accurately determining balloon positions from an orbiting spacecraft. The satellite carried a modified Doppler system on board, which, when combined with satellite-acquired range measurements, could locate a balloon's horizontal position to within plus or minus 3 km. As many as 500 3.66-m, helium-filled, 30-day-lifetime constant density balloons were launched at the rate of three per day from three sites in Argentina, with an additional 250 held in reserve to replace those that failed. Each balloon had a frangible 9.75-m instrumentation line carrying temperature and pressure sensors, solar cells and batteries for power supplies, a telemetry receiver operating at 464.4864 MHz, and a 4-W, 401.71796-MHz transmitter using a linear sleeve antenna. The spacecraft interrogated the balloons both day and night, individually, in sequence, or in a programmed group (up to 64 at a time). The balloon position and sensor data were relayed to the ground and were fed into a computer program that provided, for operational use, wind speed and direction, ambient temperature, ambient pressure, and balloon superpressure. Each balloon was also equipped with an explosive charge for self-destruction, which could be triggered by ground command if the balloon drifted beyond the experiment's latitudinal limits (30 deg S to 60 deg S). On September 11, 1971, 71 of the 115 balloons in operation were accidentally destroyed when ground personnel inadvertently sent up a general destruct command instead of the interrogation command. The number of balloons gradually decreased during the experiment lifetime (due to icing, leakage, etc.). The last balloons were intentionally destroyed in January 1973. The experiment was subsequently used for tracking and data collection from ocean buoys, icebergs, and ships.

*************************** GEOS 3 ***************************

SPACECRAFT COMMON NAME- GEOS 3
ALTERNATE NAMES- GEODETIC EXPLORER SAT, GEOS-C
GEODYNAM EXPT OCEAN SAT

NSSDC ID- 75-027A

LAUNCH DATE- 04/09/75 WEIGHT- 340. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- DELTA

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS

ORBIT TYPE- GEOCENTRIC	EPOCH DATE- 04/10/75
ORBIT PERIOD- 101.82 MIN	INCLINATION- 114.96 DEG
PERIAPSIS- 839. KM ALT	APOAPSIS- 853. KM ALT

PERSONNEL
PS - H.R. STANLEY NASA-GSFC-WFF

BRIEF DESCRIPTION

The GEOS 3 (Geodynamics Experimental Ocean Satellite) spacecraft was an octahedron, topped by a truncated pyramid, with a parabolic reflector for a radar altimeter on the flat bottom side. A metal ribbon boom with end mass extended upward approximately 6.1 m from the top of the pyramid. Passive laser retroreflector cubes were mounted in a ring around the parabolic reflector with the normal vector from each cube facing 45 deg outward from the direction of the earth. A turnstile antenna for VHF and UHF frequencies and separate antennae for earth-viewing 324-MHz Doppler, C-band, and S-band transponders were mounted separately on flat surfaces next to the parabolic reflector. The dimension across the flats of the octahedron was 1.22 m, and the spacecraft was 1.11 m high. The mission provided the stepping stone between the National Geodetic Satellite Program (NGSP) and the Earth and Ocean Physics Application Program. It provided data to refine the geodetic and geophysical results of the NGSP and served as a test for new systems. Mission objectives were to perform a satellite altimetry experiment in orbit, to support further the calibration and position determination of NASA and other agency C-band radar systems, and to perform a satellite-to-satellite tracking experiment with the ATS 6 spacecraft using an S-band transponder system. This system was also used for periodic GEOS 3 telemetry data relay through ATS 6, to support further the intercomparison of tracking systems, to investigate the solid-earth dynamic phenomena through precision laser tracking, to refine further orbit determination techniques and determine interdatum ties and gravity models, and to support the calibration and position determination of NASA Spaceflight Tracking and Data Network (STDN) S-band tracking stations. For more details, see special reports on the GEOS 3 in J. Geophys. Res., v. 84, n. B8, 1979.

------- GEOS 3, PURDY -------

INVESTIGATION NAME- RADAR ALTIMETER SYSTEM

NSSDC ID- 75-027A-01 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
NAVIGATION
GEODESY
OCEANOGRAPHY

PERSONNEL
PI - C.L. PURDY NASA-GSFC-WFF

BRIEF DESCRIPTION

The radar altimeter was the highest priority experiment on GEOS 3. The objectives were (1) to determine the feasibility and utility of a spaceborne radar altimeter for mapping the topography of the ocean surface with an absolute accuracy within 5 m, and with a relative accuracy of 1 to 2 m, (2) to determine the feasibility of measuring the deflection of the vertical information at sea, (3) to determine the feasibility of measuring wave height, and (4) to contribute to the technology leading to a future operational altimeter-satellite system with a 10-cm measurement capability. To meet the experiment objectives, the altimeter had two distinct data-gathering modes: a long-pulse altimetry data mode and a short-pulse mode. Performance capabilities and operating characteristics of the altimeter differed for the two modes. Both modes operated at 13.9-GHz frequency, used a parabolic antenna, had a maximum range acquisition time of 6 s, and had an altitude granularity of plus or minus 0.2 m. Differing characteristics were as follows: (1) altitude data rate for the long-pulse mode was two readings per second and for the short-pulse mode was six readings per second, and (2) input power for the long-pulse mode was 50 W and for the short-pulse mode was 100 W. The GEOS 3 radar altimeter had several features in common with the altimeter used on the Skylab spacecraft, but it had advantages over the Skylab altimeter because of improved accuracy and ability to operate over extended areas for greater periods of time, thereby providing the capability of examining the earth over longer arcs and observing extensive ocean areas. The third in the series of satellite altimeters was flown on Seasat 1. The system provided good quality data and demonstrated capabilities more than originally anticipated. More details can be found in J. Geophys. Res., v. 84, n. B8, 1979.

*************************** HCMM ***************************

SPACECRAFT COMMON NAME- HCMM
ALTERNATE NAMES- SATS, APPL EXPL MISSION A
HEAT CAPACITY MAP MSN, AEM-A
10818

NSSDC ID- 78-041A

LAUNCH DATE- 04/26/78 WEIGHT- 117. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- SCOUT-F

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSTA

INITIAL ORBIT PARAMETERS

ORBIT TYPE- GEOCENTRIC	EPOCH DATE- 04/27/78
ORBIT PERIOD- 96.7 MIN	INCLINATION- 97.6 DEG
PERIAPSIS- 558. KM ALT	APOAPSIS- 646. KM ALT

PERSONNEL

PM - C.M.	MACKENZIE	NASA-GSFC
PS - R.E.	MURPHY	NASA-GSFC
PS - J.C.	PRICE(NLA)	NASA-GSFC

BRIEF DESCRIPTION

The Heat Capacity Mapping Mission (HCMM) spacecraft was the first of a series of Applications Explorer Missions (AEM). The objective of the HCMM was to provide comprehensive, accurate, high-spatial-resolution thermal surveys of the surface of the earth. The HCMM spacecraft was made of two distinct modules: (1) an instrument module, containing the heat capacity mapping radiometer and its supporting gear, and (2) a base module, containing the data handling, power, communications, command, and attitude control subsystems required to support the instrument module. The spacecraft was spin stabilized at a rate of 14 rpm. The HCMM circular sun-synchronous orbit allowed the spacecraft to sense surface temperatures near the maximum and minimum of the diurnal cycle. The orbit had a daylight ascending node with nominal equatorial crossing time of 2:00 p.m. Since there was no inclination adjustment capacity, the spacecraft drifted from this crossing time by about 1 hour earlier per year. There was no on-board data storage capability, so only real-time data were transmitted when the satellite came within reception range of seven ground stations. The repeat cycle of the spacecraft was 16 days. Day/night coverage over a given area between the latitudes of 85 deg N and 85 deg S occurred at intervals ranging from 12 to 36 h (once every 16 days). During February 21-23, 1980, the HCMM orbital altitude was lowered from 620 km to 540 km in order to stop the drift of the orbit plane to unfavorable sun angles which in turn reduced the power collection capability of the solar panels. The operations of the spacecraft were terminated on September 30, 1980. More detailed information can be found in "Heat Capacity Mapping Mission Users' Guide" (TRF B30282), available from NSSDC.

------- HCMM, BARNES---

INVESTIGATION NAME- HEAT CAPACITY MAPPING RADIOMETER

NSSDC ID- 78-041A-01 | INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
EARTH RESOURCES SURVEY
METEOROLOGY

PERSONNEL
PI - W.L. BARNES | NASA-GSFC

BRIEF DESCRIPTION
The objectives of the Heat Capacity Mapping Radiometer (HCMR) were (1) to produce thermal maps at the optimum times for making thermal-inertia studies for discrimination of rock types and mineral resources location, (2) to measure plant-canopy temperatures at frequent intervals to determine the transpiration of water and plant life, (3) to measure soil-moisture effects by observing the temperature cycle of soils, (4) to map thermal effluents, both natural and man-made, (5) to investigate the feasibility of geothermal source location by remote sensing, and (6) to provide frequent coverage of snow fields for water runoff prediction. The HCMR transmitted analog data in real time to selected receiving stations. The radiometer was similar to the surface composition mapping radiometer (SCMR) of Nimbus 5 (72-097A). The HCMR had a small instantaneous geometric field of view of 0.83 mrad, high radiometric accuracy, and a wide 716-km swath coverage on the ground so that selected areas were covered within the 12-h period corresponding to the maximum and minimum of temperature observed. The instrument operated in two channels, 10.5 to 12.5 micrometers (IR) and 0.55 to 1.1 micrometers (visible). The spatial resolution was approximately 600 m at nadir for the IR channel, and 500 m for the visible channel. The instrument utilized a radiation cooler to cool the two Hg-Cd-Te detectors to 115 K. The experiment included an analog multiplexer that accepted the analog outputs of the detectors and multiplexed them in a form suitable for transmission by the spacecraft S-band transmitter. The instrument performed satisfactorily until the spacecraft operations terminated on September 30, 1980. More detailed information can be found in "Heat Capacity Mapping Mission Users' Guide" (TRF B30282), available from NSSDC. Data are available from NSSDC and Earthnet Users Services, via Galileo Galilei, C.P. 64, 00044 Frascati, Italy.

*************************** LOGACS 1, AGENA ******************

SPACECRAFT COMMON NAME- LOGACS 1, AGENA
ALTERNATE NAMES- 02816

NSSDC ID- 67-050B

LAUNCH DATE- 05/22/67 | WEIGHT- 870. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES | DOD-USAF

INITIAL ORBIT PARAMETERS

ORBIT TYPE- GEOCENTRIC	EPOCH DATE- 05/28/67
ORBIT PERIOD- 88.82 MIN	INCLINATION- 91.49 DEG
PERIAPSIS- 135. KM ALT	APOAPSIS- 293. KM ALT

PERSONNEL
PS - R.W. BRUCE | AEROSPACE CORP

BRIEF DESCRIPTION
This spacecraft consisted of the Agena second stage, which was used to launch a classified primary payload. The Low-G Accelerometer Calibration System (LOGACS) experiment was the only one carried on the Agena. It was mounted on the aft of the vehicle, and included an accelerometer (MESA), a tape recorder, a clock, and telemetry equipment. The orbit lifetime was extended by additional firing of the rocket engines during orbit 18. Both real-time and tape-recorded data were obtained. Designed for a flight of low perigee because the altitude of experimental interest was in that region, the satellite had a short lifetime of only 8 days. More details of the spacecraft operation were in J. A. Pearson, "The Low-G Accelerometer Calibration System Orbital Accelerometer Experiment," vols. 1 and 2, 1973 (TRF B19604).

------- LOGACS 1, AGENA, BRUCE--------------------------------

INVESTIGATION NAME- LOGACS 1, ATMOSPHERIC DENSITY SYSTEM

NSSDC ID- 67-050B-01 | INVESTIGATIVE PROGRAM SPACE TEST PROGRAM

INVESTIGATION DISCIPLINE(S)
AERONOMY
PLANETARY ATMOSPHERES

PERSONNEL

PI - R.W.	BRUCE	AEROSPACE CORP
OI - J.A.	PEARSON	AEROSPACE CORP
OI - E.G.	FOTOU	AEROSPACE CORP
OI - A.B.	PRAG	AEROSPACE CORP
OI - K.R.	YOUNG	AEROSPACE CORP

BRIEF DESCRIPTION
This experiment was a Miniature Electrostatic Accelerometer (MESA). This consisted of an electrostatically balanced proof mass, which could be electrostatically pulse rebalanced along its sensitive axis. Counts of the rebalancing pulses were observed and converted into density values. For further details, see E. G. Fotou, "LOGACS experiment," in The Low-G Accelerometer Calibration System Orbital Accelerometer Experiment, v. 1 (TRF B19604). The experiment operated, as intended, for only a few days due to the low orbit perigee (which was the location of the most useful data).

------- LOGACS 1, AGENA, CHIU----------------------------------

INVESTIGATION NAME- WIND COMPONENT NORMAL TO ORBIT PLANE BELOW 200 KM

NSSDC ID- 67-050B-02 | INVESTIGATIVE PROGRAM SPACE TEST PROGRAM

INVESTIGATION DISCIPLINE(S)
AERONOMY
PLANETARY ATMOSPHERES

PERSONNEL

PI - Y.T.	CHIU	AEROSPACE CORP
OI - W.A.	FEESS	AEROSPACE CORP

BRIEF DESCRIPTION
This experiment was not planned, but its possibilities were realized after examination of the accelerometer (67-050B-01) data. Control-gas firing data and the calibration mode for the accelerometer provided data to make possible the calculation of wind forces perpendicular to the orbit plane. These forces operated on the Agena spacecraft cross section. More details were given in W. A. Feess, "LOGACS wind analysis" in The Low-G Accelerometer Calibration System Orbital Accelerometer Experiment, v. 2 (TRF B19604). Sufficient data were available to provide wind component data perpendicular to the trajectory over a period of several days.

*************************** NIMBUS 1 ************************

SPACECRAFT COMMON NAME- NIMBUS 1
ALTERNATE NAMES- 00872, NIMBUS-A

NSSDC ID- 64-052A

LAUNCH DATE- 08/28/64 | WEIGHT- 374.4 KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- THOR

SPONSORING COUNTRY/AGENCY
UNITED STATES | NASA-OSSA

INITIAL ORBIT PARAMETERS

ORBIT TYPE- GEOCENTRIC	EPOCH DATE- 08/28/64
ORBIT PERIOD- 98.42 MIN	INCLINATION- 98.66 DEG
PERIAPSIS- 429. KM ALT	APOAPSIS- 937. KM ALT

PERSONNEL

PM - H.	PRESS(NLA)	NASA-GSFC
PS - W.P.	NORDBERG(DECEASED)	NASA-GSFC

BRIEF DESCRIPTION
Nimbus 1, the first in a series of second-generation meteorological research-and-development satellites, was designed to serve as a stabilized, earth-oriented platform for the testing of advanced meteorological sensor systems and for collecting meteorological data. The polar-orbiting spacecraft consisted of three major elements: (1) a sensory ring, (2) solar paddles, and (3) the control system housing. The solar paddles and the control system housing were connected to the sensory ring by a truss structure, giving the satellite the appearance of an ocean buoy. Nimbus 1 was nearly 3.7 m tall, 1.5 m in diameter at the base, and about 3 m across with solar paddles extended. The sensory ring, which formed the satellite base, housed the electronics equipment and battery modules. The lower surface of the torus-shaped sensory ring provided mounting space for sensors and telemetry antennas. An H-frame structure mounted within the center of the torus provided support for the larger experiments and tape recorders. Mounted on the control system housing, which was located on top of the spacecraft, were sun sensors, horizon scanners, gas nozzles for attitude control, and a command antenna. Use of a stabilization and control system allowed the spacecraft's orientation to be controlled to within plus or minus 1 deg for all three axes (pitch, roll, and yaw). The spacecraft carried (1) an advanced vidicon camera system (AVCS) for recording and storing remote cloudcover pictures, (2) an automatic picture transmission (APT) camera for providing real-time cloudcover pictures, and (3) a high-resolution infrared radiometer (HRIR) to complement the daytime TV coverage and to measure nighttime radiative temperatures of cloud tops and surface terrain. A short second-stage burn resulted in an unplanned eccentric orbit. Otherwise, the spacecraft and its experiments operated

successfully until September 22, 1964. The solar paddles became locked in position, resulting in inadequate electrical power to continue operations.

------- NIMBUS 1, BURDETT---------------------------------------

INVESTIGATION NAME- ADVANCED VIDICON CAMERA SYSTEM (AVCS)

NSSDC ID- 64-052A-01 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - G.L. BURDETT NASA-GSFC

BRIEF DESCRIPTION
The Nimbus 1 Advanced Vidicon Camera System (AVCS), which consisted of three cameras, a tape recorder, and an S-band transmitter, recorded and stored a series of remote daytime cloudcover pictures for subsequent playback to selected ground data acquisition stations. The AVCS cameras were mounted on the satellite sensory ring, facing earthward and deployed in a fan-like array to produce a three-segment composite picture. Each camera covered a 37-deg field of view with the center camera pointing straight down. The optical axes of the other two cameras were directed 35 deg to either side. Each of the cameras employed an f/4 lens with a focal length of 16.5 mm. A potentiometer attached to the solar array controlled the lens opening from f/16 when the spacecraft was over the equator to f/4 when it was near the poles. The 800-scan-line, 2.54-cm-diameter vidicon pickup tubes yielded a linear resolution of better than 1 km at nadir from an altitude of 800 km. At this altitude, the camera array produced a composite picture covering an area of 830 by 2700 km. Up to 192 pictures (two full orbits of data) or 64 pictures per camera could be stored on tape for subsequent playback to an acquisition station. Using a transmission frequency of 1707.5 MHz, the two orbits of pictures could be telemetered to a ground station in 4 min. The AVCS experiment was highly successful. It provided the first near-global, high-resolution cloudcover pictures ever assembled and confirmed the decision to use this particular camera assembly as a basis for the first operational satellite system TOS/ESSA (TIROS Operational System/Environmental Science Services Administration). Data from this experiment can be obtained through SDSD. For an index of the data, see "Nimbus 1 Users' Catalog: AVCS and APT" (TRF B04499), available from NSSDC.

------- NIMBUS 1, FOSHEE---------------------------------------

INVESTIGATION NAME- HIGH-RESOLUTION INFRARED RADIOMETER (HRIR)

NSSDC ID- 64-052A-03 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - L.L. FOSHEE USA ELECTRONICS CMD

BRIEF DESCRIPTION
The Nimbus 1 High-Resolution Infrared Radiometer (HRIR) was designed (1) to map the earth's nighttime cloudcover and thus to complement the daytime television (AVCS) coverage and (2) to measure the radiative temperatures of cloud tops and surface terrain. Mounted on the earth-oriented sensory ring, the radiometer measured thermal radiation in the 3.5- to 4.1-micrometer "window" region. The HRIR subsystem consisted of (1) an optical system, (2) an infrared detector (lead selenide photoconductive material), (3) electronics, (4) a magnetic tape recorder, and (5) a filter to minimize attenuation effects of water vapor and carbon dioxide. In contrast to the AVCS camera, no image was formed within the radiometer. The HRIR sensor merely transformed the received radiation into an electrical voltage, which was recorded on the tape recorder for subsequent playback when the satellite came within range of an acquisition station. The radiometer had an instantaneous field of view of about 1.5 deg, which at a nominal spacecraft altitude corresponded to a ground resolution of approximately 8 km at nadir. The radiometer was capable of measuring radiance temperatures from 210 to 330 K. Since the radiometer operated in the 3.5- to 4.1-micrometer region, the daytime pictures include reflected solar radiation in addition to the emitted surface IR radiation. However, the reflected solar radiation did not saturate the instrument, and a usable output was still obtained. In spite of a short operational lifetime (3.5 weeks), the HRIR system successfully demonstrated the feasibility of complete surveillance of surface and cloud features on a global scale during nighttime. With its improved spatial resolution, the radiometer yielded more detailed visual data on the structure of the Intertropical Convergence Zone (ITCZ) and on the formation of tropical storms and frontal systems than had previously been possible. For a more detailed description and an index of the data, see "Nimbus I High Resolution Radiation Data Catalog and Users' Manual" (TRF B04500), available from NSSDC.

------- NIMBUS 1, HUNTER---------------------------------------

INVESTIGATION NAME- AUTOMATIC PICTURE TRANSMISSION (APT) SYSTEM

NSSDC ID- 64-052A-02 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - C.M. HUNTER NASA-GSFC

BRIEF DESCRIPTION
The Nimbus 1 Automatic Picture Transmission (APT) system was a camera and transmitter combination designed to transmit local daytime, slow-scan television pictures of cloudcover conditions to properly equipped ground receiving stations on a real-time basis. The camera used a 108-deg wide-angle f/1.8 objective lens with a focal length of 5.7 mm. The camera was mounted facing earthward on the H-frame inside the sensory ring, with its optical axis parallel to the spacecraft spin axis. The actual picture taking required 8 s and the transmission 200 s. Earth-cloud images retained on the photo-sensitive surface of the 2.54-cm-diameter vidicon were read out at four lines per second to produce an 800-line picture. A 5-W TV transmitter (136.95 MHz) relayed the pictures to local APT stations within communication range. The faceplate of the vidicon had reticle marks that appeared on the picture format to aid in relating the picture to its geographical position on the earth's surface. At the nominal satellite altitude, a picture covered approximately a 1660- by 1660-km square with a horizontal resolution of around 3 km at nadir. The experiment supplied over 1600 high-quality cloudcover pictures to participating APT stations during the spacecraft's 3.5-week lifetime. It proved the capability of weather satellites to provide high-quality daytime local cloudcover data to operational meteorologists on an essentially real-time basis. Its success bolstered the decision to include such instrumentation in the TIROS Operational System (TOS). For more detailed information of the experiment, see "APT Users' Guide" (TRF B04499), available from NSSDC. APT data are primarily intended for operational use within the local APT acquisition station and are generally not available for distribution.

*************************** NIMBUS 2 ***********************

SPACECRAFT COMMON NAME- NIMBUS 2
ALTERNATE NAMES- 02173, NIMBUS-C

NSSDC ID- 66-040A

LAUNCH DATE- 05/15/66 WEIGHT- 414. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- THOR

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 05/16/66
ORBIT PERIOD- 108.15 MIN INCLINATION- 100.35 DEG
PERIAPSIS- 1103. KM ALT APOAPSIS- 1179. KM ALT

PERSONNEL
PM - H. PRESS(NLA) NASA-GSFC
PS - W.P. NORDBERG(DECEASED) NASA-GSFC

BRIEF DESCRIPTION
Nimbus 2, the second in a series of second-generation meteorological research-and-development satellites, was designed to serve as a stabilized, earth-oriented platform for the testing of advanced meteorological sensor systems and the collecting of meteorological data. The polar-orbiting spacecraft consisted of three major elements: (1) a sensory ring, (2) solar paddles, and (3) the control system housing. The solar paddles and the control system housing were connected to the sensory ring by a truss structure, giving the satellite the appearance of an ocean buoy. Nimbus 2 was nearly 3.7 m tall, 1.5 m in diameter at the base, and about 3 m across with solar paddles extended. The sensory ring, which formed the satellite base, housed the electronics equipment and battery modules. The lower surface of the torus-shaped sensory ring provided mounting space for sensors and telemetry antennas. An H-frame structure mounted within the center of the torus provided support for the larger experiments and tape recorders. Mounted on the control system housing, which was located on top of the spacecraft, were sun sensors, horizon scanners, gas nozzles for attitude control, and a command antenna. Use of a stabilization and control system permitted the spacecraft's orientation to be controlled to within plus or minus 1 deg for all three axes (pitch, roll, and yaw). The spacecraft carried (1) an advanced vidicon camera system (AVCS) for recording and storing remote cloudcover pictures, (2) an automatic picture transmission (APT) camera for providing real-time cloudcover pictures, and (3) both high- and medium-resolution infrared radiometers (HRIR and MRIR) for measuring the intensity and distribution of electromagnetic radiation emitted by and reflected from the earth and its atmosphere. The spacecraft and experiments performed normally after launch until July 26, 1966, when the spacecraft tape recorder failed. Its function

was taken over by the HRIR tape recorder until November 15, 1966, when it also failed. Some real-time data were collected until January 17, 1969, when the spacecraft mission was terminated owing to deterioration of the horizon scanner used for earth reference. More detailed information can be found in "Nimbus II Users' Guide" (TRF B03406), available from NSSDC.

------- NIMBUS 2, FOSHEE---------------------------------------

INVESTIGATION NAME- HIGH-RESOLUTION INFRARED RADIOMETER (HRIR)

NSSDC ID- 66-040A-03 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S) METEOROLOGY

PERSONNEL
PI - L.L. FOSHEE USA ELECTRONICS CMD

BRIEF DESCRIPTION
The Nimbus 2 High-Resolution Infrared Radiometer (HRIR) was designed (1) to map the earth's nighttime cloud cover and thus to complement the daytime television (AVCS) coverage and (2) to measure the radiative temperatures of cloud tops and surface terrain. Mounted on the earth-oriented sensory ring, the radiometer measured thermal radiation in the 3.5- to 4.1-micrometer "window" region. The HRIR subsystem consisted of (1) an optical system, (2) an infrared detector (lead selenide photoconductive material), (3) electronics, (4) a magnetic tape recorder, and (5) a filter to minimize attenuation effects of water vapor and carbon dioxide. In contrast to the AVCS camera, no image was formed within the radiometer. The HRIR sensor merely transformed the received radiation into an electrical voltage, which was recorded on the tape recorder for subsequent playback when the satellite came within range of an acquisition station. Some HRIR data were also transmitted in a real-time mode by the APT transmitter. The radiometer had an instantaneous field of view of about 0.5 deg, which at an altitude of 1100 km corresponded to a ground resolution of approximately 8 km at nadir. The radiometer was capable of measuring radiance temperatures from 210 to 330 K. Since it operated in the 3.5- to 4.1-micrometer region, the daytime pictures included reflected solar radiation in addition to the emitted surface IR radiation. However, the reflected solar radiation did not saturate the instrument, and a usable output was still obtained. The experiment was a success, and good data were obtained until the HRIR tape recorder failed on November 15, 1966. The failure of the spacecraft recorder on July 26, 1966, necessitated the use of the HRIR recorder on a part-time basis to record selected telemetry data, which resulted in a 15% reduction of available HRIR data thereafter. For more detailed information of the experiment and the index of data, see Section 3 of "Nimbus II Users' Guide" (TRF B03406), "The Nimbus II High Resolution Infrared Data World Montage Catalog" (TRF B06578), and "The Nimbus II Data Catalog" (TRF B06573), available from NSSDC.

------- NIMBUS 2, MCCULLOCH------------------------------------

INVESTIGATION NAME- MEDIUM-RESOLUTION INFRARED RADIOMETER (MRIR)

NSSDC ID- 66-040A-04 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S) METEOROLOGY

PERSONNEL
PI - A.W. MCCULLOCH NASA-GSFC

BRIEF DESCRIPTION
The Nimbus 2 Medium-Resolution Infrared Radiometer (MRIR) experiment measured the intensity and distribution of electromagnetic radiation emitted by and reflected from the earth and its atmosphere in five selected wavelength intervals from 0.2 to 30 micrometers. Data for heat balance of the earth-atmosphere system were obtained, as well as measurements of water vapor distribution, surface or near-surface temperatures, and seasonal changes of stratospheric temperature distribution. The five wavelength regions were (1) the 6.4- to 6.9-micrometer channel, which covered the 6.7-micrometer water vapor absorption band, (2) the 10- to 11-micrometer band, which operated in the "atmospheric window," (3) the 14- to 16-micrometer band, which covered the 15-micrometer carbon dioxide absorption band, (4) the 5- to 30-micrometer band, which measured the emitted long-wavelength infrared energy for heat budget purposes, and (5) the 0.2- to 4.0-micrometer channel, which yielded information on the intensity of reflected solar energy (albedo). Radiant energy from the earth was collected by a flat scanning mirror inclined at 45 deg to the optical axis. The mirror rotated at 8 rpm and scanned in a plane perpendicular to the direction of motion of the satellite. Each of the five channels contained a 4.33-cm-diameter folded telescope with a 2.8-deg field of view and a thermistor-bolometer. The collected energy was modulated by a mechanical chopper to produce an ac signal. The signal was then amplified and recorded on magnetic tape for subsequent playback to a ground acquisition station. At a satellite altitude of 1100 km, a horizontal resolution of 55 km could be obtained. The MRIR experiment was successful, and good data were obtained from launch until the recorder failed on July 29, 1966. For more detailed information of the experiment and the index of data, see Section 4 of "Nimbus II Users' Guide" (TRF B03406), "The Nimbus II Medium Resolution Infrared Pictorial Data Catalog" (TRF B06580), and "The Nimbus II Data Catalog" (TRF B06573), available from NSSDC.

------- NIMBUS 2, SCHULMAN--------------------------------------

INVESTIGATION NAME- ADVANCED VIDICON CAMERA SYSTEM (AVCS)

NSSDC ID- 66-040A-01 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S) METEOROLOGY

PERSONNEL
PI - J.R. SCHULMAN NASA-GSFC

BRIEF DESCRIPTION
The Nimbus 2 Advanced Vidicon Camera System (AVCS) was a combination of cameras, tape recorder, and transmitter that could record and store a series of remote daytime cloudcover pictures for subsequent playback to a ground-data acquisition station. The AVCS sensors consisted of three vidicon cameras mounted on the satellite sensory ring, facing earthward and deployed in a fan-like array to produce a three-segment composite picture. Each camera covered a 35-deg field of view with the center camera pointing straight down. The optical axes of the other two cameras were directed 35 deg to either side. Each of the cameras employed an f/4 lens with a focal length of 18.2 mm. A potentiometer attached to the solar array controlled the lens opening from f/16 when the spacecraft was over the equator to f/4 when it was near the poles. The 800-scan-line, 2.54-cm vidicon pickup tubes yielded a linear resolution of better than 1 km at nadir from an approximate altitude of 1100 km. At this altitude, the camera array could produce a composite picture covering an area of 720 by 3400 km. Successive frames were taken at 91-s intervals providing about 20% overlap in coverage. A 40-ms exposure time was used, and the image was scanned by the electron beam in 6.5 s. The resulting signal was frequency modulated and recorded on three tracks of a magnetic tape, one track for each camera. Sufficient tape was provided for recording 53 pictures (about 1-2/3 orbits of data). The AVCS data were multiplexed with the High-Resolution Infrared Radiometer (HRIR) data and, using a transmission frequency of 1707.5 MHz, were telemetered to a ground station in 4 min. The experiment operated normally until August 31, 1966, when the tape recorder malfunctioned. Sporadic operation was continued until September 2, 1966, when the recorder failed completely, terminating data acquisition except for direct readouts received over North Carolina and Alaska readout stations. The experiment was successful in providing high-quality cloudcover pictures over an entire season on a near-global basis and in confirming the reliability of the camera system for use in future operational weather satellites. Data from this experiment can be obtained through SDSD. For more detailed information of the experiment and the index of the data, see Section 2 of "Nimbus II Users' Guide" (TRF B03406), "Nimbus 2 AVCS World Montage Catalog" (TRF B06579), and "The Nimbus 2 Data Catalog" (TRF B06573), available from NSSDC.

------- NIMBUS 2, SCHULMAN--------------------------------------

INVESTIGATION NAME- AUTOMATIC PICTURE TRANSMISSION (APT) SYSTEM

NSSDC ID- 66-040A-02 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S) METEOROLOGY

PERSONNEL
PI - J.R. SCHULMAN NASA-GSFC

BRIEF DESCRIPTION
The Nimbus 2 Automatic Picture Transmission (APT) system was a camera and transmitter combination designed to transmit local daytime slow-scan television pictures of cloudcover conditions to properly equipped ground receiving stations on a real-time basis. The camera used a 108-deg wide-angle f/1.8 objective lens with a focal length of 6.0 mm. The camera was mounted facing earthward on the H-frame inside the sensory ring, with its optical axis parallel to the spacecraft spin axis. The actual photography required 8 s and the transmission 200 s. Earth-cloud images retained on the photosensitive surface of the 2.54-cm-diameter vidicon were read out at four lines per second to produce an 800-line picture. A 5-W TV transmitter (137.5 MHz) relayed the pictures to local APT stations within communication range. The faceplate of the vidicon had reticle marks that appeared on the picture format to aid in relating the picture to its geographical position on the earth's surface. From the satellite attitude and altitude (approximately 1100 km), a picture covered a 1200- by 1200-km square with a horizontal resolution of better than 3 km at nadir. The APT system was capable of transmitting the nighttime high-resolution infrared radiometer (HRIR) sensor output through the APT transmitter. Hence, with some minor modifications, an APT station within telemetry range could receive HRIR data in the direct readout infrared radiometer (DRIR) mode. The experiment was a success, and good data were obtained during its operational lifetime. More detailed

information can be found in Section 5 of "Nimbus II Users' Guide" (TRF B03406), available from NSSDC. APT/DRIR data are primarily intended for operational use within the local APT acquisition station and are generally not available for distribution.

*************************** NIMBUS 3 *************************

SPACECRAFT COMMON NAME- NIMBUS 3
ALTERNATE NAMES- PL-684G, NIMBUS-B2
03890

NSSDC ID- 69-037A

LAUNCH DATE- 04/14/69 WEIGHT- 576. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- THOR

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 04/25/69
ORBIT PERIOD- 107.40 MIN INCLINATION- 99.91 DEG
PERIAPSIS- 1075. KM ALT APOAPSIS- 1135. KM ALT

PERSONNEL
PM - H. PRESS(NLA) NASA-GSFC
PS - W.P. NORDBERG(DECEASED) NASA-GSFC

BRIEF DESCRIPTION
Nimbus 3, the third in a series of second-generation meteorological research-and-development satellites, was designed to serve as a stabilized, earth-oriented platform for the testing of advanced meteorological sensor systems and the collecting of meteorological data. The polar-orbiting spacecraft consisted of three major elements: (1) a sensory ring, (2) solar paddles, and (3) the control system housing. The solar paddles and the control system housing were connected to the sensory ring by a truss structure, giving the satellite the appearance of an ocean buoy. Nimbus 3 was nearly 3.7 m tall, 1.5 m in diameter at the base, and about 3 m across with solar paddles extended. The torus-shaped sensory ring, which formed the satellite base, housed the electronics equipment and battery modules. The lower surface of the torus ring provided mounting space for sensors and telemetry antennas. An H-frame structure mounted within the center of the torus provided support for the larger experiments and tape recorders. Mounted on the control system housing, which was located on top of the spacecraft, were sun sensors, horizon scanners, gas nozzles for attitude control, and a command antenna. Use of the attitude control subsystem (ACS) permitted the spacecraft's orientation to be controlled to within plus or minus 1 deg for all three axes (pitch, roll, and yaw). Primary experiments consisted of (1) a satellite infrared spectrometer (SIRS) for determining the vertical temperature profiles of the atmosphere, (2) an infrared interferometer spectrometer (IRIS) for measuring the emission spectra of the earth-atmosphere system, (3) both high- and medium-resolution infrared radiometers (HRIR and MRIR) for yielding information on the distribution and intensity of infrared radiation emitted and reflected by the earth and its atmosphere, (4) a monitor of ultraviolet solar energy (MUSE) for detecting solar UV radiation, (5) an image dissector camera system (IDCS) for providing daytime cloudcover pictures in both real-time mode, using the real time transmission system (RTTS), and tape recorder mode, using the high data rate storage system, (6) a radioisotope thermoelectric generator (RTG), SNAP-19, to assess the operational capability of radioisotope power for space applications, and (7) an interrogation, recording and location system (IRLS) experiment designed to locate, interrogate, record, and retransmit meteorological and geophysical data from remote collection stations. Nimbus 3 was successful and performed normally until July 22, 1969, when the IRIS experiment failed. The HRIR and SIRS experiments were terminated on January 25, 1970, and June 21, 1970, respectively. The remaining experiments continued operation until September 25, 1970, when the rear horizon scanner failed. Without this horizon scanner, it was impossible to maintain proper spacecraft attitude, thus making most experimental observations useless. All spacecraft operations were terminated on January 22, 1972. More detailed information can be found in "The Nimbus III User's Guide" (TRF B03409), available from NSSDC.

------- NIMBUS 3, BRANCHFLOWER --------------------------------

INVESTIGATION NAME- IMAGE DISSECTOR CAMERA SYSTEM (IDCS)

NSSDC ID- 69-037A-06 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - G.A. BRANCHFLOWER(NLA) SPAR AEROSPACE

BRIEF DESCRIPTION
The Nimbus 3 Image Dissector Camera System (IDCS) was designed to take daytime cloudcover photographs. The pictures could be transmitted to APT stations using the real-time transmission system (RTTS) or stored on magnetic tape for subsequent playback to ground acquisition stations. The camera was mounted on the bottom of the satellite sensory ring and pointed vertically down toward the earth at all times. The image dissector was a shutterless electronic scan and step tube mounted behind a wide-angle (108 deg) 5.7-mm focal length lens. Scanning and stepping functions occurred continuously while the satellite progressed along its orbital path. The field of view of the optics was 73.6 deg in the direction of flight and 98.2 deg in a plane normal to the direction of flight. The image was focused by the optics on a photosensitive surface of the image dissector tube. A line-scanning beam scanned the photosensitive surface at 4 Hz with a frame period of 200 s. At the nominal spacecraft altitude of 1100 km, each resulting picture was approximately 1400 km on a side with a ground resolution of 3 km at nadir. For a more detailed description, see Section 2 of "The Nimbus III User's Guide" (TRF B03409). The experiment was a success and produced good data until September 25, 1970, when operations were terminated owing to spacecraft yaw problems. Data from this experiment are available through SDSD. The IDCS world montages were presented in "The Nimbus III Data Catalog" (TRF B06523), available from NSSDC.

------- NIMBUS 3, CHERRIX --------------------------------------

INVESTIGATION NAME- HIGH-RESOLUTION INFRARED RADIOMETER
(HRIR)

NSSDC ID- 69-037A-02 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - G.T. CHERRIX NASA-GSFC

BRIEF DESCRIPTION
The Nimbus 3 High-Resolution Infrared Radiometer (HRIR) was designed (1) to map the earth's nighttime cloud cover and thus to complement the daytime television (AVCS) coverage and (2) to measure the radiative temperatures of cloud tops and surface terrain. The Nimbus 3 HRIR was a modified version of previous experiments on Nimbus 1 and 2. It used a dual band-pass filter which transmitted reflected solar radiation in the 0.7- to 1.3-micrometer band as well as emitted thermal radiation in the 3.4- to 4.2-micrometer band. By detecting reflected solar radiation in the 0.7- to 1.3-micrometer band, the radiometer could also map the earth's cloud cover during the daytime. Radiant energy from the earth was collected by a flat scanning mirror inclined at 45 deg to the optical axis. The mirror rotated at 48 rpm and scanned in a plane normal to the spacecraft velocity. The radiation reflected from the scan mirror was chopped at the focus of a 10.2-cm f/1 modified Cassegrain telescope. The modulated energy was then refocused on a lead selenide detector cell that transformed the received radiation into an electrical output. The output was amplified and recorded on magnetic tape for subsequent playback to a ground acquisition station. Using the direct readout infrared radiometer (DRIR) system, nighttime and daytime data could be transmitted by the real-time transmission system (RTTS) to ground APT stations. A ground resolution of 8.5 km could be obtained at nadir. The HRIR measured radiance temperatures between 210 and 330 deg K to a general accuracy of 1 deg K. For more detailed description, see Section 3 of "The Nimbus III User's Guide" (TRF B03409). The experiment was successful until August 1969, when noise in the tape recorder system gradually reduced the quality of the data. Routine processing of HRIR data was terminated after January 31, 1970. All experiment operations ceased on January 22, 1972, when the spacecraft was deactivated. The HRIR world montages were presented in "The Nimbus III Data Catalog" (TRF B06523), available from NSSDC.

------- NIMBUS 3, HANEL --

INVESTIGATION NAME- INFRARED INTERFEROMETER SPECTROMETER
(IRIS)

NSSDC ID- 69-037A-03 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - R.A. HANEL NASA-GSFC
OI - L. CHANEY U OF MICHIGAN

BRIEF DESCRIPTION
The Nimbus 3 Infrared Interferometer Spectrometer (IRIS) experiment was designed to provide information on the vertical structure of the atmosphere and the emissive properties of the earth's surface by measuring the surface and atmospheric radiation in the 5.0- to 20-micrometer band using a modified Michelson interferometer. Incoming radiation was reflected into the instrument from a plane mirror. The radiation was split into two beams that recombined and interfered after reflection on a fixed mirror and a moving Michelson mirror.

The recombined beam was then focused on a bolometer detector. Interference effects resulted from the optical path difference between the two beams as the mirror moved. The moving mirror traveled about 2 mm in 11 s to give an interferogram, which was recorded on magnetic tape. The interferograms were transmitted to an acquisition station, where a Fourier transform was performed to produce a thermal emission spectrum of the earth. From these spectra, vertical profiles of temperature, water vapor, and ozone, as well as other parameters of meteorological interest, could be derived. The instrument had a field of view equivalent to a 144-km diameter circle on the surface of the earth at a planned orbital height of 1100 km. For a more detailed description, see Section 5 of "The Nimbus III User's Guide" (TRF B03409). The experiment was successful, and good data were obtained until the instrument failed on July 22, 1969.

------- NIMBUS 3, HEATH---------------------------------------

INVESTIGATION NAME- SOLAR UV MONITOR

NSSDC ID- 69-037A-01

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
ATMOSPHERIC PHYSICS
METEOROLOGY

PERSONNEL
PI - D.F. HEATH NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 3 Monitor of Ultraviolet Solar Energy (MUSE) experiment was designed (1) to look for temporal variations in the solar UV flux in five broad bands in the interval 1150 to 3000 A, (2) to measure the solar flux in these regions, and (3) to measure the atmospheric attenuation at these wavelengths as the sensors on board viewed the setting sun after the spacecraft had crossed the terminator in the Northern Hemisphere. The sensors had their maximum response at 1216 A, 1600 A, 1800 A, 2000 A, and 2600 A. The MUSE instrumentation, which consisted of five vacuum photodiodes housed in an electronics package and a sensor package, was mounted in the rear of the Nimbus spacecraft. All sensors except the 1216-A sensor had semi-transparent photocathodes that were deposited on the windows. The 1800-, 2000-, and 2600-A sensors had aluminum oxide windows, while the 1216-A and 1600-A sensors had MgF2 and CaF2 windows, respectively. The five spectral regions were determined by the transmittance of the filter or window materials on the short wavelength side, while the long wavelength cutoffs were produced by the varying degrees of opacity of the different photocathode materials. The appropriate bands of UV flux entered the photodiodes and produced a current that was measured by an electrometer and digitized by the Nimbus pulse code modulation (PCM) system. Simultaneously, the solar aspect system measured the angle of incidence of the solar rays and transmitted its digital information to the PCM system. The PCM data were stored on magnetic tape and transmitted on playback to the data acquisition facility. The instrument had a basic 48-s cycle and a one sample per second data rate. The field of view of the sensors was about 90 deg. Solar acquisition began, therefore, at 45 deg prior to the earth day/night terminator and ceased completely at the satellite day/night transition. The instrument had only an inflight electrical calibration sequence because there were no known suitable UV sources that could provide an inflight optical calibration. A similar experiment was flown on Nimbus 4. For a more detailed description, see Section 7 of "The Nimbus III User's Guide" (TRF B03409). The detector response degraded in a known and correctable manner. This experiment was turned off when the spacecraft operations were terminated in January 1972. No archival data have been produced due to lack of funding.

------- NIMBUS 3, MCCULLOCH-----------------------------------

INVESTIGATION NAME- MEDIUM-RESOLUTION INFRARED RADIOMETER (MRIR)

NSSDC ID- 69-037A-05

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - A.W. MCCULLOCH NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 3 Medium-Resolution Infrared Radiometer (MRIR) experiment measured the intensity and distribution of the electromagnetic radiation emitted by and reflected from the earth and its atmosphere in five selected wavelength intervals from 0.2 to 23 micrometers. Data on the heat balance of the earth-atmosphere system were obtained as well as water vapor distribution data, surface or near-surface temperatures, and data on seasonal changes of stratospheric temperature distribution. The five wavelength regions were (1) the 6.5- to 7.0-micrometer channel, which covered the 6.7-micrometer water vapor absorption band, (2) the 10- to 11-micrometer band, which operated in the atmospheric window, (3) the 14.5- to 15.5-micrometer band, which covered the 15-micrometer carbon dioxide absorption band, (4) the 20- to 23-micrometer channel, which covered the spectral region containing the broad rotational absorption bands of water vapor, and (5) the 0.2- to 4.0-micrometer channel, which yielded information on the intensity of reflected solar energy. Radiant energy from the earth was collected by a flat scanning mirror inclined at 45 deg to the optical axis. The mirror rotated at 8 rpm and scanned in a plane perpendicular to the direction of motion of the satellite. Each of the five channels contained a 4.33-cm diameter folded telescope with a 2.8-deg field of view and a thermistor bolometer. The collected energy was modulated by a mechanical chopper to produce an ac signal. The signal was then amplified and recorded on magnetic tape for subsequent playback to a ground acquisition station. At a satellite altitude of 1100 km, a horizontal resolution of 45 km was obtained. The MRIR experiment was successful, in spite of a telemetry conflict that caused the experiment to be periodically turned off. During August and September 1970 (hurricane season), the MRIR was on essentially full time to cover the area from the equator to 70 deg N and from 10 deg E to 100 deg W. On September 25, 1970, the satellite's rear horizon scanner failed, making it impossible to determine where the MRIR sensor was pointing. The experiment was operated periodically until January 22, 1972, when all spacecraft operations were terminated.

------- NIMBUS 3, WARK--

INVESTIGATION NAME- SATELLITE INFRARED SPECTROMETER (SIRS)

NSSDC ID- 69-037A-04

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - D.Q. WARK NOAA-NESDIS
OI - D.T. HILLEARY NOAA-NESDIS

BRIEF DESCRIPTION

The Nimbus 3 Satellite Infrared Spectrometer (SIRS) experiment was designed to indirectly determine the vertical temperature profiles of the atmosphere by measuring the infrared radiation emitted from the earth and its atmosphere in seven spectral intervals in the carbon dioxide band (11 to 15 micrometers) and one interval in the atmospheric window centered at 11.1 micrometers. The main components of the Fastie-Ebert fixed-grating spectrometer consisted of (1) a plane, light-collecting mirror to provide a single earth-viewing beam fixed in the vertical, (2) a rotating chopper mirror, (3) a spherical mirror, (4) a 12.7-cm diffraction grating with 1250 lines per inch, (5) a set of eight exit slits with a single interference filter, (6) eight wedge-immersed thermistor bolometers, (7) a blackbody radiation source for calibration, and (8) eight preamplifiers and eight operational amplifiers. The incoming radiation was chopped, spectrally dispersed by the diffraction grating, focused on the exit slits as a spectrum by the spherical mirror, and converted to electrical signals. The signals were then amplified and stored on magnetic tape for subsequent playback to a ground acquisition station. The instrument field of view was 11.5 by 11.5 deg centered on nadir. This provided data over an area roughly 220 km on a side at a satellite height of 1100 km. Data from the 11.1-micrometer channel yielded surface and/or cloudtop temperatures. Data from the carbon dioxide band could be used to generate temperature-pressure profiles by a mathematical inversion technique. The resulting temperatures had rms errors slightly less than 1 deg C. For a more detailed description, see Section 6 of "The Nimbus III User's Guide" (TRF B03409). The SIRS experiment was successful and good data were obtained. On June 21, 1970, the experiment was turned off and all data acquisition effort was transferred to the SIRS experiment on Nimbus 4.

**************************** NIMBUS 4 **************************

SPACECRAFT COMMON NAME- NIMBUS 4
ALTERNATE NAMES- NIMBUS-D, PL-701E
04362

NSSDC ID- 70-025A

LAUNCH DATE- 04/08/70 WEIGHT- 620. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- THOR

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSTA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 04/09/70
ORBIT PERIOD- 107.2 MIN INCLINATION- 80.114 DEG
PERIAPSIS- 1092. KM ALT APOAPSIS- 1108. KM ALT

PERSONNEL
PM - C.M. MACKENZIE NASA-GSFC
PS - A.J. FLEIG NASA-GSFC

BRIEF DESCRIPTION

Nimbus 4, the fourth in a series of second-generation meteorological research-and-development satellites, was designed to serve as a stabilized, earth-oriented platform for the testing of advanced meteorological sensor systems, and for collecting meteorological data. The polar-orbiting spacecraft consisted of three major structures: (1) a ring-shaped sensor mount, (2) solar paddles, and (3) the control system housing. The solar paddles and the control system were connected to the sensor mount by a truss structure, giving the satellite the appearance of an ocean buoy. Nimbus 4 was nearly 3.7 m tall, 1.45 m in diameter at the base, and about 3 m across with solar paddles extended. The torus-shaped sensor mount, which formed the satellite base, housed the electronics equipment and battery modules. The lower surface of the torus ring provided mounting space for sensors and telemetry antennas. An H-frame structure mounted within the center of the torus provided support for the larger experiments and tape recorders. Mounted on the control system housing, which was on top of the spacecraft, were sun sensors, horizon scanners, gas nozzles for attitude control, and a command antenna. Use of an advanced attitude-control subsystem permitted the spacecraft's orientation to be controlled to within plus or minus 1 deg for all three axes (pitch, roll, and yaw). Primary experiments consisted of (1) an image dissector camera system (IDCS) for providing daytime cloudcover pictures, both in real-time and recorded modes, (2) a temperature-humidity infrared radiometer (THIR) for measuring daytime and nighttime surface and cloudtop temperatures as well as the water vapor content of the upper atmosphere, (3) an infrared interferometer spectrometer (IRIS) for measuring the emission spectra of the earth/atmosphere system, (4) a satellite infrared spectrometer (SIRS) for determining the vertical profiles of temperature and water vapor in the atmosphere, (5) a monitor of ultraviolet solar energy (MUSE) for detecting solar UV radiation, (6) a backscatter ultraviolet (BUV) detector for monitoring the vertical distribution and total amount of atmospheric ozone on a global scale, (7) a filter wedge spectrometer (FWS) for accurate measurement of IR radiance as a function of wavelength from the earth/atmosphere system, (8) a selective chopper radiometer (SCR) for determining the temperatures of six successive 10-km layers in the atmosphere from absorption measurements in the 15-micrometer CO2 band, and (9) an interrogation, recording, and location system (IRLS) for locating, interrogating, recording, and retransmitting meteorological and geophysical data from remote collection stations. A complete description can be found in "The Nimbus IV User's Guide" (TRF B06861), available from NSSDC. The spacecraft performed well until April 14, 1971, when attitude problems started. The experiments operated on a limited time basis after that time until September 30, 1980.

------- NIMBUS 4, BRANCHFLOWER --------------------------------

INVESTIGATION NAME- IMAGE DISSECTOR CAMERA SYSTEM (IDCS)

NSSDC ID- 70-025A-06   INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - G.A. BRANCHFLOWER(NLA)   SPAR AEROSPACE
OI - E.J. WERNER   NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 4 Image Dissector Camera System (IDCS) experiment was designed to take daytime cloudcover pictures. The pictures could be transmitted to APT (automatic picture transmission) stations using the real-time transmission system (RTTS) or stored on magnetic tape for subsequent playback to ground acquisition stations. This experiment was similar to those flown on Nimbus 3 and ATS 3. The camera was mounted on the bottom of the sensory ring of the satellite and pointed vertically down toward the earth at all times. The image dissector was a shutterless electronic scan and step tube mounted behind a wide-angle (108 deg), 5.7-mm focal length lens. Scanning and stepping functions occurred continuously while the satellite progressed along its orbital path. The field of view of the optics was 73.6 deg along track, and 98.2 deg across track. The image was focused by the camera optics on a photosensitive surface of the image dissector tube. A line-scanning beam scanned the photosensitive surface at 4 Hz with a frame period of 200 s. At the nominal spacecraft altitude (approximately 1100 km), each resulting picture was approximately 1400 km on a side with a ground resolution of 3 km at nadir. The experiment was a success. However, owing to spacecraft yaw problems, archival data were produced only through April 8, 1971. Six days later the spacecraft turned around and flew backwards in orbit, with the resultant loss of all usable data. On May 12, 1971, the spacecraft was successfully rotated 180 deg, and limited data were obtained until February 5, 1972. Data from this experiment are available through the SDSD. For a complete description, see Section 2 in "The Nimbus IV User's Guide" (TRF B06861), available from NSSDC.

------- NIMBUS 4, HANEL --

INVESTIGATION NAME- INFRARED INTERFEROMETER SPECTROMETER (IRIS)

NSSDC ID- 70-025A-03   INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - R.A. HANEL   NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 4 Infrared Interferometer Spectrometer (IRIS) experiment was designed to provide information on the vertical structure of the atmosphere and on the emissive properties of the earth's surface by measuring the surface and atmospheric radiation in the 6.25- to 25-micrometer range using a modified Michelson interferometer. Radiation from a cone of the atmosphere, whose base on the surface of the earth was a circle about 94 km in diameter for a nominal satellite altitude of approximately 1100 km, was received and reflected by a mirror. The reflected radiation was split into two approximately equal beams by a beamsplitter. After reflection on a fixed and moving mirror, respectively, the two beams interfered with each other with a phase difference proportional to the optical path difference between both beams. The moving mirror traveled about 3.6 mm in 13 s to give an output signal from the bolometer. This signal, an interferogram, was recorded on tape. The interferograms were transmitted to a ground receiving station, where a Fourier transform was performed to produce a thermal emission spectrum of the earth. From these spectra, vertical profiles of temperature, water vapor, and ozone were derived, as well as other parameters of meteorological interest. The instrument had a field of view of 5 deg and a spectral resolution of less than 0.4 micrometer (nominally 1.4 reciprocal centimeters). For a complete description of the IRIS experiment, see Section 4 in "The Nimbus IV User's Guide" (TRF B06861), available from NSSDC. The IRIS experiment was successful in spite of a transmission conflict with the Real-Time Transmission System (RTTS) that resulted in some periods of lost data after November 28, 1970. The IRIS experiment was turned off on January 25, 1972 to conserve spacecraft power.

------- NIMBUS 4, HEATH --

INVESTIGATION NAME- SOLAR UV MONITOR

NSSDC ID- 70-025A-01   INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
ATMOSPHERIC PHYSICS

PERSONNEL
PI - D.F. HEATH   NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 4 Monitor of Ultraviolet Solar Energy (MUSE) experiment was designed (1) to look for temporal variations in the solar UV flux in five bands from 1150 to 3300 A, (2) to measure the solar flux in these regions, and (3) to measure the atmospheric attenuation at these wavelengths as the sensors on board viewed the setting sun after the spacecraft had crossed the terminator in the Northern Hemisphere. The sensors had their maximum responses at 1216 A (plus a 1350- to 1600-A continuum), 1800 A, 2100 A, 2800 A, and 2600 A (including a 2600- to 3300-A interval). The 1216-A, 1800-A, and 2600-A sensors were identical to those carried on Nimbus 3, while the 2100-A and 2800-A sensors, utilizing interference filters, were new and replaced the two that malfunctioned on Nimbus 3. The MUSE instrument, which consisted of five vacuum photodiodes housed in an electronics package and a sensor package, was mounted in the rear of the Nimbus spacecraft. All sensors except the 1216-A photodiode had semitransparent photocathodes that were deposited on an aluminum oxide window. The 1216-A sensor had a solid tungsten cathode. The spectral regions of the sun to which three of the sensors responded (1216 A, 1800 A, and 2600 A) were determined by filter transmittance on the short wavelength side, while the long wavelength cutoffs were produced by the varying degrees of opacity of the photocathode materials. The shortwave cutoffs for the 2100-A and 2800-A sensors, however, were obtained by the interference filters, while the cesium telluride photocathode provided the longwave cutoff. The appropriate bands of UV flux entered the photodiodes and produced a current that was measured by an electrometer and digitized by the Nimbus versatile information processor (VIP) system. The VIP data were stored on magnetic tape and transmitted on playback to the data acquisition facility. The instrument could operate in either the automatic or manual mode. In the automatic mode, the instrument had a basic 48-s cycle and an analog-to-digital conversion rate of two samples per second. In the manual mode, the instrument locked on a selected sensor and remained there (two samples per second) until the instrument was commanded back into the automatic mode. The field of view of the sensors was about 90 deg in the satellite nadir direction. Solar acquisition, therefore, began at 45 deg prior to the earth day/night terminator and completely ceased at the satellite day/night transition. The instrument had only an inflight electrical calibration sequence, since there were no known suitable UV sources that could provide an inflight optical calibration. No archival data have been produced due to lack of funding.

------- NIMBUS 4, HEATH---

INVESTIGATION NAME- BACKSCATTER ULTRAVIOLET (BUV) SPECTROMETER

NSSDC ID- 70-025A-05 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL

PI - D.F.	HEATH	NASA-GSFC
OI - J.V.	DAVE	IBM CORPORATION
OI - A.J.	KRUEGER	NASA-GSFC
OI - C.L.	MATEER	ENVIRONMENT CANADA

BRIEF DESCRIPTION

The Nimbus 4 Backscatter Ultraviolet (BUV) spectrometer experiment was designed to monitor the vertical distribution and total amount of atmospheric ozone on a global scale by measuring the intensity of UV radiation backscattered by the earth/atmosphere system during day and night in the 2500- to 3400-A spectral band. The primary instrumentation consisted of a double monochromator containing all reflective optics and a photomultiplier detector. The double monochromator was composed of two Ebert-Fastie-type monochromators in tandem. Each monochromator had a 52- by 52-mm grating with 2400 lines per mm. Light from a 0.05-sr solid angle (subtending approximately a 222-sq-km area on the earth's surface from a satellite height of approximately 1100 km) entered the nadir-pointing instrument through a depolarizing filter. A motor-driven cam step rotated the gratings to monitor the intensity of 12 ozone absorption wavelengths. The detector was a photomultiplier tube. For background readings, a filter photometer measured the reflected UV radiation in an ozone-free absorption area near 3800 A. Signals from both units were read by separate range-switching electrometers with seven ranges. A BUV experiment cycle required 6144 s. Each cycle, in turn, was divided into 192 BUV frames of 32-s duration. Calibration by onboard light sources was performed in 26 of the 192 frames. The other frames were used for experimental data. During each of these data frames, the monochromator measured the intensity of the UV radiation in each of the 12 wavelength bands, while the photometer measured the UV intensity in a single wavelength band. The dwell time at each wavelength was 1.8 s, and, during this interval, four analog UV intensity measurements were taken at 400-ms intervals in addition to an integrated pulse count measurement of the UV intensity and energetic particle flux. Once each orbit, the field of view was changed to monitor the sun or moon directly. The measurement range of the signal current was from 0.2 to 3000 microamps. The vertical distribution of ozone was obtained by mathematical inversion techniques. For a complete description of the BUV experiment, see Section 7 in "The Nimbus IV User's Guide" (TRF B06861). For an index of the data, see "User's Guide to the Nimbus-4 Backscatter Ultraviolet Experiment Data Sets" (TRF B30067). Both documents are available from NSSDC.

------- NIMBUS 4, HOUGHTON---

INVESTIGATION NAME- SELECTIVE CHOPPER RADIOMETER (SCR)

NSSDC ID- 70-025A-10 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL

PI - J.T.	HOUGHTON	OXFORD U
OI - S.D.	SMITH	READING U

BRIEF DESCRIPTION

The Nimbus 4 Selective Chopper Radiometer (SCR) observed the emitted infrared radiation in the 15-micrometer absorption band of carbon dioxide. From these measurements the temperatures of six successive 10-km layers of the atmosphere were determined from earth or cloudtop level to 60-km height. Height resolution was obtained by a combination of optical multi-layer filters and selective absorption of radiation using carbon-dioxide-filled cells within the experiment. The SCR had six channels, which were arranged in three units of two. The four lower channels were called single-cell channels. The optics of each channel consisted of a cantilever-mounted blade shutter that oscillated at 10 Hz and successively chopped the field of view (FOV) between earth and space. The chopped radiation was then passed through a 10-cm path length of carbon dioxide, the pressure being set for each channel to define the viewing depth of the atmosphere. Behind the carbon dioxide path was a narrow-band filter, the centers of which were different for each channel, and a light pipe which focused the radiation on a thermistor-bolometer detector. To obtain adequate height resolution in the upper layers of the atmosphere, the upper two channels operated on a slightly different principle and were known as double-cell channels. The technique consisted of switching the radiation between two half-cells, which were semicircular in shape and of 1-cm path length, and which contained different pressures of carbon dioxide. A movable 45-deg mirror replaced the oscillating shutter used in the lower four channels. During one half-period, earth radiation passed through one half-cell and space radiation through the other. The situation was reversed during the other half-period. The radiation then passed through a light pipe onto a thermistor-bolometer detector. Inflight calibration was carried out by viewing of an internal reference blackbody of known temperature prior to the view of space. The output of each channel was sampled once every second. The upper two channels had a circular FOV approximately 160 km in diameter, and the lower four had a rectangular FOV about 112 km square. For a complete description, see Section 9 in "The Nimbus IV User's Guide" (TRF B06861), available from NSSDC. The channel 1 temperature monitoring system failed on June 15, 1970, thereby reducing the accuracy of the SCR data. Channels 3 and 4 became noisy and unusable on April 18, 1972. The remaining channels were usable until June 15, 1973.

------- NIMBUS 4, HOVIS---

INVESTIGATION NAME- FILTER WEDGE SPECTROMETER (FWS)

NSSDC ID- 70-025A-09 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL

PI - W.A.	HOVIS	NOAA-NESDIS

BRIEF DESCRIPTION

The Nimbus 4 Filter Wedge Spectrometer (FWS) experiment was designed to accurately determine the radiance from the earth-atmosphere system as a function of wavelength by measuring the emitted and reflected infrared radiation in the 1.2- to 2.4- and 3.2- to 6.4-micrometer bands. The instrumentation consisted of (1) a telescope, (2) a rotating disk chopper, (3) a rotating (3.75 rpm) circular interference filter wheel, and (4) a lead selenide detector. The filter wheel was a two-180-deg-segment (one per passband) 100-layer interference filter with the layer thickness linearly increasing as a function of angular position, causing the bandpass to shift toward longer wavelengths. Incoming radiation was reflected off a surface mirror and was collected by a telescope oriented normal to the earth's surface. The telescope had a 3-deg field of view directly below the satellite, and a pole-to-pole strip approximately 57 km wide was viewed on each satellite pass with a 2461-km separation between successive strips at the equator. The telescope focused the collected radiation onto the edge of the multitoothed chopper wheel that chopped the energy at 333 Hz. After passing through the chopper, the energy was refocused onto the edge of the circular variable filter at an aperture that acted as both spectrometer slit and a system field stop. The energy was then reimaged on a lead selenide detector radiatively cooled to 175 deg K. The incident radiation was sampled 20 times per second, resulting in a spectral intensity plot of 158 points for each passband per revolution. Onboard calibration was accomplished by alternate viewing of the earth and calibration standards by the detector. Spectral plots were analyzed by applying an inversion technique to the radiative transfer equations to obtain the water vapor content. At activation of this experiment on orbit 5, the data output was degraded, exhibiting ice absorption patterns in both channels. On June 8, 1970, the FWS suffered mechanical failure when the drive motor on the chopper wheel failed. No useful data were collected from this experiment.

------- NIMBUS 4, MCCULLOCH---

INVESTIGATION NAME- TEMPERATURE-HUMIDITY INFRARED RADIOMETER (THIR)

NSSDC ID- 70-025A-02 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL

PI - A.W.	MCCULLOCH	NASA-GSFC
OI - I.L.	GOLDBERG	NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 4 Temperature-Humidity Infrared Radiometer (THIR) was designed to detect emitted thermal radiation in both the 10.5- to 12.5-micrometer region (IR window) and the 6.5- to 7.0-micrometer region (water vapor). The window channel measured cloudtop temperatures day and night. The other channel operated primarily at night to map the water vapor distribution in the upper troposphere and stratosphere. The instrument consisted of a 12.7-cm Cassegrain system, a scanning mirror common to both channels, a beam splitter, filters, and two germanium-immersed thermistor bolometers. In contrast to TV, no image was formed within the radiometer. Incoming radiant energy was collected by a flat scanning mirror inclined at 45 deg to the optical axis. The mirror rotated through 360 deg at 48 rpm and scanned in a plane normal to the spacecraft velocity vector. The energy was then focused into a dichromatic beam splitter, which divided the energy spectrally and spatially into two channels. Both channels of the THIR sensor transformed the received radiation into an electrical (voltage) output with an information bandwidth of 0.5 to 360 Hz for the 10.5 to 12.5 micrometer channel and 0.5 to 120 Hz for the water vapor channel. The THIR sensor data were normally recorded on tape for subsequent playback to a ground acquisition station. However, direct readout infrared radiometer (DRIR) data could be transmitted to APT ground stations for both day and night portions of the orbit using the Nimbus 4 real-time transmission system (RTTS). At a nominal spacecraft altitude, the window channel had a ground resolution of about 7 km and the water vapor channel about 22 km at nadir. The THIR was initially successful but failed on January 11, 1971 (orbit 3731). It was restarted several times thereafter for very short periods of time before it finally ceased all operations in August 1971. A similar experiment was flown on Nimbus 5, 6 and 7.

------- NIMBUS 4, WARK--

INVESTIGATION NAME- SATELLITE INFRARED SPECTROMETER (SIRS)

NSSDC ID- 70-025A-04

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - D.Q. WARK NOAA-NESDIS
OI - D.T. HILLEARY NOAA-NESDIS

BRIEF DESCRIPTION

The Nimbus 4 Satellite Infrared Spectrometer (SIRS) experiment was designed to determine the vertical temperature and water vapor profiles of the atmosphere by using a Fastie-Ebert fixed-grating spectrometer. The instrument measured the infrared radiation (11 to 36 micrometers) emitted from the earth and its atmosphere in 13 selected spectral intervals in the carbon dioxide and water vapor bands plus one channel in the 11-micrometer atmospheric window. The main components of the spectrometer consisted of (1) a plane, light-collecting mirror to provide one fixed and two variable earth-viewing angles, (2) a rotating chopping mirror that served alternately to collect space radiation and earth radiation, (3) a 2.5-in. diffraction grating with 1250 lines per inch, (4) 14 slits with associated interference filters, (5) 14 thermistor bolometers, and (6) a blackbody source for calibration purposes. The SIRS used a scan mirror to observe 12.5 deg to either side of the subsatellite track. The field of view directly below the SIRS was approximately 215 sq km. The carbon dioxide band radiation data were transformed to a temperature profile by a mathematical inversion technique. By a similar technique, this information could then be combined with the water vapor band data to obtain a water vapor profile. The 11-micrometer atmospheric window data yielded surface and/or cloudtop temperatures. For a complete description of the SIRS experiment, see Section 5 of "The Nimbus IV User's Guide" (TRF B06861), available from NSSDC. The SIRS experiment performed normally for several months after launch but began to deteriorate in early 1971. Problems in the SIRS instrument calibration after April 1971, in addition to spacecraft yaw problems, significantly reduced the number of useful soundings obtained. The archival data were produced through April 8, 1971. The experiment operated on a limited time basis until March 6, 1973, when it was placed operationally off. Both NSSDC and SDSD have data.

*************************** NIMBUS 5*************************

SPACECRAFT COMMON NAME- NIMBUS 5
ALTERNATE NAMES- NIMBUS-E, PL-721B
06305

NSSDC ID- 72-097A

LAUNCH DATE- 12/11/72 WEIGHT- 770. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- DELTA

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 12/11/72
ORBIT PERIOD- 107.2 MIN INCLINATION- 99.9 DEG
PERIAPSIS- 1089. KM ALT APOAPSIS- 1101. KM ALT

PERSONNEL
PM - C.M. MACKENZIE NASA-GSFC
PS - A.J. FLEIG NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 5 research-and-development satellite was designed to serve as a stabilized, earth-oriented platform for the testing of advanced meteorological sensor systems and collecting meteorological and geological data on a global scale. The polar-orbiting spacecraft consisted of three major structures: (1) a hollow, ring-shaped sensor mount, (2) solar paddles, and (3) a control system housing. The solar paddles and control system housing were connected to the sensor mount by a truss structure, giving the satellite the appearance of an ocean buoy. Nimbus 5 was nearly 3.7 m tall, 1.5 m in diameter at the base, and about 3 m wide with solar paddles extended. The torus-shaped sensor mount, which formed the satellite base, housed the electronics equipment and battery modules. The lower surface of the torus provided mounting space for sensors and antennas. A box-beam structure mounted within the center of the torus provided support for the larger sensor experiments. Mounted on the control system housing, which was located on top of the spacecraft, were sun sensors, horizon scanners, and a command antenna. An advanced attitude-control system permitted the spacecraft orientation to be controlled to within plus or minus 1 deg in all three axes (pitch, roll, and yaw). Primary experiments included (1) a temperature-humidity infrared radiometer (THIR) for measuring day and night surface and cloudtop temperatures, as well as the water vapor content of the upper atmosphere, (2) an electrically scanning microwave radiometer (ESMR) for mapping the microwave radiation from the earth's surface and atmosphere, (3) an infrared temperature profile radiometer (ITPR) for obtaining vertical profiles of temperature and moisture, (4) a Nimbus E microwave spectrometer (NEMS) for determining tropospheric temperature profiles, atmospheric water vapor abundances, and cloud liquid water contents, (5) a selective chopper radiometer (SCR) for observing the global temperature structure of the atmosphere, and (6) a surface composition mapping radiometer (SCMR) for measuring the differences in the thermal emission characteristics of the earth's surface. A more detailed description can be found in "The Nimbus 5 User's Guide" (TRF 14758), available from NSSDC.

------- NIMBUS 5, HOUGHTON------------------------------------

INVESTIGATION NAME- SELECTIVE CHOPPER RADIOMETER (SCR)

NSSDC ID- 72-097A-02

INVESTIGATIVE PROGRAM
CODE EE/CO-OP, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL
PI - J.T. HOUGHTON OXFORD U
OI - S.D. SMITH READING U

BRIEF DESCRIPTION

The Nimbus 5 Selective Chopper Radiometer (SCR) was designed to (1) observe the global temperature structure of the atmosphere up to 50 km in altitude, (2) make supporting observations of water vapor distribution, and (3) determine the density of ice particles in cirrus clouds. To accomplish these objectives, the SCR measured emitted radiation in 16 spectral intervals separated into the following four groups: (1) four CO2 channels between 13.8 and 14.8 micrometers, (2) four channels at 15.0 micrometers, (3) an IR window channel at 11.1 micrometers, a water vapor channel at 18.6 micrometers, two channels at 49.5 and 133.3 micrometers, and (4) four channels at 2.08, 2.59, 2.65, and 3.5 micrometers. From an average satellite altitude of 1100 km, the radiometer viewed a 48-km circle on the earth's surface with a ground resolution of about 25 km. A similar experiment was flown on Nimbus 4. For a more detailed description, see Section 6 in "The Nimbus 5 User's Guide" (TRF B14758), available from NSSDC. Both NSSDC and SDSD have data.

------- NIMBUS 5, HOVIS---------------------------------------

INVESTIGATION NAME- SURFACE COMPOSITION MAPPING RADIOMETER (SCMR)

NSSDC ID- 72-097A-05

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
EARTH RESOURCES SURVEY
METEOROLOGY

PERSONNEL
PI - W.A. HOVIS NOAA-NESDIS
OI - W. CALLAHAN FAIRFIELD U

BRIEF DESCRIPTION

The Surface Composition Mapping Radiometer (SCMR) measured (1) terrestrial radiation in the 8.3- to 9.3-micrometer and 10.2- to 11.2-micrometer intervals and (2) reflected solar radiation in the 0.8- to 1.1-micrometer range. Surface composition and sea surface temperatures could be obtained from these measurements. The SCMR had an instantaneous field of view (FOV) of 0.6 mrad, equivalent to a ground resolution of 660 m at nadir. The scan mirror rotated at 10 rps to provide scan lines 800-km wide across the spacecraft track. For a complete description, see Section 3 in "The Nimbus 5 User's Guide" (TRF B14758), available from NSSDC. The instrument began malfunctioning soon after launch. The last usable data were transmitted on January 4, 1973. A modified instrument, heat capacity mapping radiometer, was flown on the Heat Capacity Mapping Mission (HCMM) later.

------- NIMBUS 5, MCCULLOCH-----------------------------------

INVESTIGATION NAME- TEMPERATURE/HUMIDITY INFRARED RADIOMETER (THIR)

NSSDC ID- 72-097A-08 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - A.W. MCCULLOCH NASA-GSFC

BRIEF DESCRIPTION
The Nimbus 5 Temperature-Humidity Infrared Radiometer (THIR) was designed to detect emitted thermal radiation in both the 10.5- to 12.5-micrometer region (IR window) and the 6.5- to 7.0-micrometer region (water vapor). The window channel measured cloudtop temperatures during both day and night. The other channel operated primarily at night to map the water vapor distribution in the upper troposphere and stratosphere. Sensor data from these two channels were primarily used to support the other more sophisticated meteorological experiments on board Nimbus 5. The instrument consisted of a 12.7-cm Cassegrain system, a scanning mirror common to both channels, a beam splitter, filters, and two germanium-immersed thermistor bolometers. In contrast to TV, no image was formed within the radiometer. Incoming radiant energy was collected by a flat scanning mirror inclined at 45 deg to the optical axis. The mirror rotated at 48 rpm and scanned in a plane perpendicular to the spacecraft velocity. The energy was focused on a dichromatic beam splitter, which divided the energy spectrally and spatially into the two channels. Both channels of the THIR sensor transformed the received radiation into electric outputs (voltages), which were recorded on magnetic tape for subsequent playback to a ground acquisition station. For more detailed information, see Section 2 in "The Nimbus 5 User's Guide" (TRF B14758). The THIR world montages were presented in "The Nimbus 5 Data Catalog" (TRF B17697). Both documents are available from NSSDC. A similar experiment was flown on Nimbus 4, 6, and 7.

------- NIMBUS 5, SMITH---------------------------------------

INVESTIGATION NAME- INFRARED TEMPERATURE PROFILE RADIOMETER (ITPR)

NSSDC ID- 72-097A-01 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - W.L. SMITH NOAA-NESDIS
OI - D.Q. WARK NOAA-NESDIS

BRIEF DESCRIPTION
The Nimbus 5 Infrared Temperature Profile Radiometer (ITPR) experiment was designed to measure the three-dimensional temperature field in the earth's atmosphere with a spatial resolution of 32 km. The radiometer sensed four intervals in the 15-micrometer CO2 band, one interval in the water vapor rotational band near 20 micrometers and two spectral intervals in the atmospheric window regions near 3.7 and 11 micrometers. The ITPR viewed the earth successively at various angles distributed symmetrically about nadir in a plane normal to the orbital track. Forty-two geographically independent scan spots were taken along a single strip. As the satellite progressed along its orbital path, the radiometer observed 10 such 42-spot strips to form a matrix of independent scan spots. Each matrix was produced in 222 s with the whole scanning sequence repeated every 240 s. The matrix data were recorded on magnetic tape for subsequent playback to a ground acquisition station. Matrix measurements taken in the CO2 and water vapor absorption bands were used to calculate temperature profiles and total water vapor content in the troposphere and lower stratosphere. The two window measurements helped to detect and eliminate cloud contamination of the radiances, thus permitting actual determination of profiles down to the earth's surface in all but completely overcast areas. For more detailed information, see Section 5 in "The Nimbus 5 User's Guide" (TRF B14758), available from NSSDC. Because of the erratic behavior of the scan mechanism which developed shortly after launch, the instrument operated only in the nadir mode except for brief periods.

------- NIMBUS 5, STAELIN-------------------------------------

INVESTIGATION NAME- MICROWAVE SPECTROMETER (NEMS)

NSSDC ID- 72-097A-03 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL
PI - D.H. STAELIN MASS INST OF TECH
OI - F.T. BARATH NASA-JPL
OI - N.E. GAUT ENVIRON RES + TECH INC
OI - P. THADDEUS NASA-GISS
OI - W.B. LENOIR NASA-JSC

BRIEF DESCRIPTION
The Nimbus E Microwave Spectrometer (NEMS) was designed primarily to demonstrate the capabilities and limitations of microwave sensors for measuring tropospheric temperature profiles, water vapor abundances, cloud liquid water content, and earth surface temperatures. The NEMS could continuously monitor emitted microwave radiation at frequencies of 22.235, 31.4, 53.65, 54.9 and 58.8 GHz. The three channels near the 5-mm oxygen absorption band were used primarily to determine the atmospheric temperature profiles. NEMS provided measurements even in cloudcover conditions that normally restrict the usefulness of conventional IR data in such situations. The two water vapor channels near 10 mm permitted the water vapor and cloud liquid water content over oceans to be estimated and also to yield an estimated temperature once the surface emissivity had been calibrated by comparison with direct measurements. The three oxygen channels shared a common signal and reference antenna. Both water vapor channels had their own signal and reference antennas. From an average satellite height of 1100 km, the NEMS viewed a 180-km diameter circle on the earth's surface. NEMS data were recorded on magnetic tape for subsequent playback to a ground acquisition station. More detailed descriptions can be found in Section 7 in "The Nimbus 5 User's Guide" (TRF B14758), available from NSSDC, and J. J. Barnett, et al., "Stratospheric Observations from Nimbus 5," Nature, v. 245, pp. 141-143, 1973. An advancement of this instrument, the Scanning Microwave Spectrometer (SCAMS), was flown on Nimbus 6 later.

------- NIMBUS 5, WILHEIT, JR.--------------------------------

INVESTIGATION NAME- ELECTRICALLY SCANNING MICROWAVE RADIOMETER (ESMR)

NSSDC ID- 72-097A-04 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
OCEANOGRAPHY

PERSONNEL
PI - T.T. WILHEIT, JR. NASA-GSFC
OI - P. GLOERSEN NASA-GSFC

BRIEF DESCRIPTION
The primary objectives of the Nimbus 5 Electrically Scanning Microwave Radiometer (ESMR) were (1) to derive the liquid water content of clouds from brightness temperatures over oceans, (2) to observe differences between sea ice and the open sea over the polar caps, and (3) to test the feasibility of inferring surface composition and soil moisture. To accomplish these objectives, the ESMR was capable of continuous global mapping of the 1.55-cm (19.36 GHz) microwave radiation emitted by the earth/atmosphere system, and could function even in the presence of cloud conditions that block conventional satellite infrared sensors. An 83.3- by 85.5-cm radiometer antenna system, deployed after launch, scanned the earth successively at various angles in a plane perpendicular to the spacecraft orbital track, producing a brightness-temperature map of the surface of the earth and its atmosphere. The scanning process was controlled by a computer on board, and it consisted of 78 symmetrically distributed independent scan spots extending 50 deg to either side of nadir. Angular separation of the scan spots allowed for an 8.5% overlap between view positions. From a mean orbital height of 1100 km, the radiometer had an accuracy of about plus or minus 1 deg C with a spatial resolution of about 25 km at nadir. The ESMR data were stored on magnetic tape for transmission to ground acquisition stations. For more detailed information, see Section 4 in "The Nimbus 5 User's Guide" (TRF B14758). Selected ESMR images were presented in "The Nimbus 5 Data Catalog." Both documents are available from NSSDC.

*************************** NIMBUS 6 *************************

SPACECRAFT COMMON NAME- NIMBUS 6
ALTERNATE NAMES- PL-731B, NIMBUS-F
07924

NSSDC ID- 75-052A

LAUNCH DATE- 06/12/75 WEIGHT- 585. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- DELTA

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 06/12/75
ORBIT PERIOD- 107.3 MIN INCLINATION- 100. DEG
PERIAPSIS- 1093. KM ALT APOAPSIS- 1101. KM ALT

PERSONNEL
PM - C.M. MACKENZIE NASA-GSFC
PS - A.J. FLEIG NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 6 research-and-development satellite served as a stabilized, earth-oriented platform for testing advanced systems for sensing and collecting meteorological data on a global scale. The polar-orbiting spacecraft consisted of three major structures: (1) a hollow torus-shaped sensor mount, (2) solar paddles, and (3) a control housing unit connected to the sensor mount by a tripod truss structure. Configured somewhat like an ocean buoy, Nimbus 6 was nearly 3.7 m tall, 1.5 m in diameter at the base, and about 3 m wide with solar paddles extended. The sensor mount that formed the satellite base housed the electronics equipment and battery modules. The lower surface of the torus provided mounting space for sensors and antennas. A box-beam structure mounted within the center of the torus supported the larger sensor experiments. Mounted on the control housing unit, which was located on top of the spacecraft, were sun sensors, horizon scanners, and a command antenna. The spacecraft spin axis was pointed at the earth. An advanced attitude-control system permitted the spacecraft's orientation to be controlled to within plus or minus 1 deg in all three axes (pitch, roll, and yaw). The nine experiments selected for Nimbus 6 were (1) earth radiation budget (ERB), (2) electrically scanning microwave radiometer (ESMR), (3) high-resolution infrared radiation sounder (HIRS), (4) limb radiance inversion radiometer (LRIR), (5) pressure modulated radiometer (PMR), (6) scanning microwave spectrometer (SCAMS), (7) temperature-humidity infrared radiometer (THIR), (8) tracking and data relay experiment (T+DRE), and (9) tropical wind energy conversion and reference level experiment (TWERLE). This complement of advanced sensors was capable of (1) mapping tropospheric temperature, water vapor abundance, and cloud water content; (2) providing vertical profiles of temperature, ozone, and water vapor; (3) transmitting real-time data to a geostationary spacecraft (ATS 6); and (4) yielding data on the earth's radiation budget. A more detailed description can be found in "The Nimbus 6 User's Guide" (TRF B23261), available from NSSDC.

------- NIMBUS 6, GILLE---------------------------------------

INVESTIGATION NAME- LIMB RADIANCE INVERSION RADIOMETER (LRIR)

NSSDC ID- 75-052A-04

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL

PI - J.C.	GILLE	NATL CTR FOR ATMOS RES
OI - F.B.	HOUSE	DREXEL INST OF TECH
OI - R.A.	CRAIG	FLORIDA STATE U
OI - J.R.	THOMAS	HONEYWELL, INC

BRIEF DESCRIPTION

The Nimbus 6 Limb Radiance Inversion Radiometer (LRIR) provided calibrated radiance versus altitude profiles by intercepting radiation emanating from an atmospheric path which is tangential to a particular geocentric height. The LRIR sensed radiation in four spectral intervals: (1) the 14.6- to 15.9-micrometer CO2 band, (2) the 14.2- to 17.3-micrometer CO2 band, (3) the 8.8- to 10.1-micrometer ozone band, and (4) the 20- to 25-micrometer water vapor rotational band. Measurements taken in the two CO2 channels and the water vapor channel were used to calculate global temperature and water vapor profiles in the stratosphere and lower mesosphere. In addition, values of the geostrophic wind up to 1 mb (approximately 48 km) were derived analytically from the deduced temperature profiles. The radiometer included an optical system, a scanning mirror, choppers, and associated electronics and employed an ammonia-methane cooler system for three of the four detector channels. While the deduced temperature profiles had an rms accuracy of 3 deg at heights above 15 km, the values for ozone were accurate to within 20% at 1 mb. Water vapor values at the same height were within 50%. For a more detailed description, see Section 7 in "The Nimbus 6 User's Guide" (TRF B23261), available from NSSDC. The instrument functioned sucessfully until January 7, 1976, when the detector temperature began to rise rapidly, and the instrument was turned off.

------- NIMBUS 6, HOUGHTON------------------------------------

INVESTIGATION NAME- PRESSURE MODULATED RADIOMETER (PMR)

NSSDC ID- 75-052A-09

INVESTIGATIVE PROGRAM
CODE EE/CO-OP, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL

PI - J.T.	HOUGHTON	OXFORD U
OI - C.D.	RODGERS	OXFORD U
OI - E.J.	WILLIAMSON	OXFORD U
OI - G.D.	PESKETT	OXFORD U
OI - P.	CURTIS	OXFORD U

BRIEF DESCRIPTION

The Nimbus 6 Pressure Modulator Radiometer (PMR) experiment took radiometric measurements in the 15-micrometer CO2 band at altitudes between 45 and 70 km on a global scale. By appropriate mathematical retrieval methods, the temperature structures of the upper stratosphere and lower mesosphere were deduced. The pressure-modulation technique permitted the extension of selective chopping techniques to higher altitudes where the pressure-broadened emission lines in the 15-micrometer CO2 band became so narrow that conventional spectrometers and interferometers had insufficient spectral resolution. In addition to pressure scanning (in discrete steps), the radiometer also employed Doppler scanning along the direction of flight. The PMR comprised two similar radiometer channels, each consisting of a plane scanning mirror, reference blackbody, pressure-modulator cell, and detector assembly. The plane mirror was gold coated and mounted at 45 deg on a 90-deg stepping motor so that the field of view of the channel could be directed to space or to the internal reference blackbody for inflight range and zero calibration. The motor was mounted on a pair of flexible pivots so that the mirror could be rotated through plus or minus 7-1/2 deg from its rest position to give the required Doppler scan. Major components in the pressure-modulator cell were a movable piston, a diaphragm, and a magnetic drive coil. The detector assembly consisted of a field lens, a condensing light pipe, and a pyroelectric flake bolometer. Each radiometer had a field of view that was 20 deg whole-angle across the spacecraft's line of flight and 40 deg whole-angle parallel to the line of flight. The derived temperature values were within 2 deg K at 65 km and about 0.2 deg K near 50 km with a vertical resolution of 10 km. For a more detailed description, see Section 8 in "The Nimbus 6 User's Guide" (TRF B23261), available from NSSDC. The instrument performed satisfactorily.

------- NIMBUS 6, JULIAN--------------------------------------

INVESTIGATION NAME- TROPICAL WIND ENERGY CONVERSION AND REFERENCE LEVEL (TWERLE)

NSSDC ID- 75-052A-01

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL

PI - P.	JULIAN	NATL CTR FOR ATMOS RES
OI - W.W.	KELLOGG	NATL CTR FOR ATMOS RES
OI - V.E.	SUOMI	U OF WISCONSIN
OI - C.R.	LAUGHLIN	NASA-GSFC
OI - R.L.	TALLEY	SIGMA DATA SERV CORP
OI - W.R.	BANDEEN	NASA-GSFC
OI - C.E.	COTE	NASA-GSFC

BRIEF DESCRIPTION

The goals of the Nimbus 6 Tropical Wind Energy Conversion And Reference Level Experiment (TWERLE) were closely associated with the objectives of the Global Atmospheric Research Program (GARP) and included (1) measuring upper atmospheric winds in the tropics, (2) studying the relative air motion along isobaric surfaces to determine the rate of conversion of atmospheric potential energy into kinetic energy, and (3) providing direct measurements of various meteorological parameters that served as reference points in adjusting indirect temperature soundings made from satellites. The experiment consisted of two basic components: (1) approximately 300 constant-level meteorological balloons to yield measurements of winds, temperature, and pressure in the tropics and at southern hemisphere midlatitudes at 150 mb (about 13.6-km altitude), and (2) the Nimbus 6 random access measurements system (RAMS) to provide data collection and location determinations from the balloons. The 3.5-m-diameter polyester-mylar balloons were equipped with a transmitter-oscillator, solar power supply, digitizer/modulator, and sensors. The sensors consisted of a radio altimeter having an accuracy of better than plus or minus 20 m, a bead thermistor monitoring the ambient air temperature to an accuracy of 0.5 deg C, and a pressure sensor measuring the 150-mb flight altitude to an accuracy of 0.5 mb. A magnetic cutdown device was used to eliminate any accidental overflights into regions of the Northern Hemisphere north of 20 deg N latitude. The RAMS merely detected each balloon signal (401.2 MHz) and extracted the carrier frequency, balloon identification, and sensor data. This information, along with time references, was stored in digital form for subsequent relay to a ground acquisition station. The balloon's position and velocity were derived from the relative motion between the platform and the satellite by measuring Doppler shifts in the carrier signal received from the balloon. TWERLE was capable of a location accuracy of 5 km and a platform velocity accuracy of 1 m/s. For more detailed information, see Section 9 in "The Nimbus 6 User's Guide" (TRF B23261). For information concerning TWERLE data, contact Dr. Paul R. Julian, NCAR, P.O. Box 3000, Boulder, Colorado 80303. In addition to the TWERLE balloon experiment, many other experiments used RAMS. These experiments used ocean buoys to measure oceanographic and atmospheric parameters. Information about experiments can be obtained from principal investigators listed as Nimbus RAMS Experiments in the User's Guide and "The Nimbus 6 Data Catalog" (TRF B26731), both available from NSSDC.

------- NIMBUS 6, KYLE---

INVESTIGATION NAME- EARTH RADIATION BUDGET (ERB)

NSSDC ID- 75-052A-05 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
ATMOSPHERIC PHYSICS

PERSONNEL

PI - H.L.	KYLE	NASA-GSFC
PI - H.	JACOBOWITZ	NOAA-NESDIS
OI - A.J.	DRUMMOND(DECEASED)	EPPLEY LAB, INC
OI - I.	RUFF	NOAA-NESDIS
OI - J.R.	HICKEY	EPPLEY LAB, INC
OI - W.J.	SCHOLES	EPPLEY LAB, INC
OI - L.L.	STOWE	NOAA-NESDIS

BRIEF DESCRIPTION

The Nimbus 6 Earth Radiation Budget (ERB) experiment measured reflected and emitted terrestrial radiation fluxes in conjunction with solar radiation. The results were used (1) to determine the earth radiation budget, (2) to determine the angular distribution of terrestrial radiation for various meteorological and geographic regimes, and (3) to correlate measurements made using identical but independent channels calibrated to the same standard. Incoming solar radiation from 0.2 to 50 micrometers was normally monitored in 10 spectral intervals as the satellite orbited over the Antarctic, just before it started its northward trip on the daylight side of the earth. Terrestrial radiation measurements were taken continuously in the 0.2- to 4-micrometer, 0.7- to 3-micrometer, and 4- to 50-micrometer intervals. The measurements were taken in two ways. Four channels, using fixed wide-angle optics (133.3-deg field of view), measured the total outgoing radiation integrated over the entire disk of the earth. The second set of measurements was obtained from eight high-resolution narrow-angle scanning channels that measured the terrestrial radiation emanating from a relatively small area over a range of zenith and azimuth angles. The multichannel radiometer employed a bi-axial scanning mechanism which enabled measurements to be obtained from the forward horizon to the aft horizon in a 64-s interval. Each axis of the scanning mechanism contained four shortwave channels (0.2 to 4.0 micrometers) and four longwave channels (4.0 to 50 micrometers) with a 0.25- by 5.14-deg field of view. The channels were oriented in a directional fan to cover 20 deg to each side of the orbital plane. The 64-s scan period allowed an area to be measured from up to 17 different angles as the spacecraft passed overhead. For a more detailed description, see Section 6 in "The Nimbus 6 User's Guide" (TRF B23261), available from NSSDC. A similar instrument was flown on Nimbus 7 later. The solar and wide-angle channels operated successfully and provided good quality data. The scanning channels developed mechanical scan problems in August 1975 and operated only in the nadir position after March 1976. Data processing had been delayed due to lack of funding.

------- NIMBUS 6, MCCULLOCH-------------------------------------

INVESTIGATION NAME- TEMPERATURE/HUMIDITY INFRARED RADIOMETER (THIR)

NSSDC ID- 75-052A-12 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL

PI - A.W.	MCCULLOCH	NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 6 Temperature-Humidity Infrared Radiometer (THIR) detected emitted thermal radiation in both the 10.5- to 12.5-micrometer region (IR window) and the 6.5- to 7.0-micrometer region (water vapor). The window channel provided an image of cloud cover and temperatures of the cloud tops, land, and ocean surfaces. The other channel mapped the water vapor distribution in the upper troposphere and the stratosphere. The ground resolution at nadir was 8.2 km for the window channel and 22.5 km for the water vapor channel. Both channels provided day and night global coverage. Sensory data from these two channels were used primarily to support other more sophisticated meteorological experiments onboard Nimbus 6. The instrument consisted of a 12.7-cm Cassegrain system and scanning mirror common to both channels, a beam splitter, filters, and two germanium-immersed thermistor bolometers. In contrast to TV, no image was formed within the radiometer. Incoming radiant energy was collected by a flat scanning mirror inclined at 45 deg to the optical axis. The mirror rotated through 360 deg at 48 rpm and scanned in a plane normal to the spacecraft velocity. The energy was then focused on a dichromatic beam splitter which divided the energy spectrally and spatially into the two channels. Both channels of the THIR sensor transformed the received radiation into electric outputs (voltages), which were recorded on magnetic tape for subsequent playback to a ground acquisition station. For more detailed information, see Section 2 in "The Nimbus 6 User's Guide" (TRF B23261). Daily world montages of the THIR were presented in "The Nimbus 6 Data Catalog" (TRF 26731). Both documents are available from NSSDC. A similar instrument was flown on Nimbus 4, 5 and 7.

------- NIMBUS 6, SMITH---

INVESTIGATION NAME- HIGH RESOLUTION INFRARED RADIATION SOUNDER (HIRS)

NSSDC ID- 75-052A-02 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL

PI - W.L.	SMITH	NOAA-NESDIS
OI - A.W.	MCCULLOCH	NASA-GSFC
OI - H.	JACOBOWITZ	NOAA-NESDIS
OI - I.	RUFF	NOAA-NESDIS

BRIEF DESCRIPTION

The Nimbus 6 High Resolution Infrared Radiation Sounder (HIRS) supported the GARP data test set by providing vertical temperature profiles twice daily on a global basis, extending up to approximately 40 km, and information on the water vapor distribution in the troposphere. The HIRS measured radiances primarily in five spectral regions: (1) seven channels near the 15-micrometer CO2 absorption band, (2) two channels (11.1 and 3.7 micrometers) in the IR window, (3) two channels (8.2 and 6.7 micrometers) in the water vapor absorption band, (4) five channels in the 4.3-micrometer band, and (5) one channel in the visible 0.69-micrometer region. The sounder consisted of a Cassegrain telescope, scanning mirror, dichromatic beam splitter, filter wheel, chopper, and associated electronics. The HIRS scanned the earth's surface in a plane normal to the spacecraft's orbital path with a maximum scan angle of 30 deg to either side of nadir to provide data with a spatial resolution of 25 km. For a more detailed description, see Section 3 in "The Nimbus 6 User's Guide" (TRF B23261), available from NSSDC. The instrument was turned off as a precautionary move on May 27, 1976, when the filter chopper motor failed. Selected HIRS images were presented in "The Nimbus 6 Data Catalog" (TRF B26731), available from NSSDC.

------- NIMBUS 6, STAELIN---------------------------------------

INVESTIGATION NAME- SCANNING MICROWAVE SPECTROMETER (SCAMS)

NSSDC ID- 75-052A-10 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL

PI - D.H.	STAELIN	MASS INST OF TECH
OI - F.T.	BARATH	NASA-JPL
OI - A.H.	BARRETT	MASS INST OF TECH
OI - W.B.	LENOIR	NASA-JSC
OI - W.	PHILLIPS	MASS INST OF TECH

BRIEF DESCRIPTION

The Nimbus 6 Scanning Microwave Spectrometer (SCAMS) was designed to map tropospheric temperature profiles, water vapor abundance, and cloud water content to be used for weather prediction even in the presence of clouds, which block conventional satellite infrared sensors. The instrument was an advancement of the Nimbus E microwave spectrometer (NEMS) on Nimbus 5. The SCAMS continuously monitored emitted microwave radiation at frequencies of 22.235, 31.65, 52.85, 53.85 and 55.45 GHz. The three channels near the 5.0-mm oxygen absorption band were used primarily to deduce atmospheric temperature profiles. The two channels near 10 mm permitted water vapor and cloud water content over calm oceans to be estimated separately. The instrument, a Dicke-superheterodyne type, scanned plus or minus 45 deg normal to the orbital plane with a 10-deg field of view. The three oxygen channels shared common signal and reference antennas. Both water vapor channels had their own signals and reference antennas. The absolute rms accuracy of the oxygen channels was better than 2 deg K and that of the water vapor channels better than 1 deg K. The dynamic range for all channels was 0-400 deg K. The ground resolution was approximately 145 km near nadir and 330 km at the scan limit. For a more detailed description, see Section 4 in "The Nimbus 6 User's Guide" (TRF B23261), available from NSSDC. The instrument ceased functioning on May 31, 1976, due to jamming of the scan mechanism. Selected SCAMS images were presented in "The Nimbus 6 Data Catalog" (TRF B26731), also available from NSSDC.

------- NIMBUS 6, WILHEIT, JR.----------------------------------

INVESTIGATION NAME- ELECTRICALLY SCANNING MICROWAVE RADIOMETER (ESMR)

NSSDC ID- 75-052A-03 INVESTIGATIVE PROGRAM CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
OCEANOGRAPHY

PERSONNEL

PI - T.T.	WILHEIT, JR.	NASA-GSFC
OI - A.T.	EDGERTON	AEROJET ELECTROSYSTEMS

BRIEF DESCRIPTION

The Nimbus 6 Electrically Scanning Microwave Radiometer (ESMR) measured the earth's microwave emission to provide the liquid water content of clouds, the distribution and variation of sea ice cover, and gross characteristics of land surfaces (vegetation, soil moisture, and snow cover). The two-channel scanning radiometer operated in a 250-MHz band centered at 37 GHz. One channel was used to measure the vertical polarization and the other measured the horizontal polarization. The antenna beam array, a 90- by 20- by 12-cm box-like structure, was mounted on top of the spacecraft sensory ring and was pointed in the direction of the spacecraft's forward motion and tilted down 45 deg from the satellite antenna axis. The antenna beam scanned the earth in 71 discrete steps for various angles extending up to 35 deg on either side of the orbital plane. The deduced brightness temperatures were expected to be accurate to within 3-5 deg K. Spatial resolution was 20 km in the cross-track direction and 45 km in the direction parallel to the subpoint track. For a more detailed description, see Section 5 of "The Nimbus 6 User's Guide" (TRF B23261), available from NSSDC. The ESMR performance was satisfactory until September 15, 1976, when the horizontal channel output was zero due to a failure of the Ferrite-Dicke switch. Selected ESMR images were presented in "The Nimbus 6 Data Catalog" (TRF B26731), also available from NSSDC.

**************************** NIMBUS 7**************************

SPACECRAFT COMMON NAME- NIMBUS 7
ALTERNATE NAMES- 11080, NIMBUS-G

NSSDC ID- 78-098A

LAUNCH DATE- 10/24/78 WEIGHT- 832. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- DELTA

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS

ORBIT TYPE- GEOCENTRIC	EPOCH DATE- 10/25/78
ORBIT PERIOD- 104.0 MIN	INCLINATION- 99.3 DEG
PERIAPSIS- 938. KM ALT	APOAPSIS- 953. KM ALT

PERSONNEL

PM - C.M.	MACKENZIE	NASA-GSFC
PS - A.J.	FLEIG	NASA-GSFC

BRIEF DESCRIPTION

The Nimbus 7 research-and-development satellite served as a stabilized, earth-oriented platform for the testing of advanced systems for sensing and collecting data in the pollution, oceanographic and meteorological disciplines. The polar-orbiting spacecraft consisted of three major structures: (1) a hollow torus-shaped sensor mount, (2) solar paddles, and (3) a control housing unit that was connected to the sensor mount by a tripod truss structure. Configured somewhat like an ocean buoy, Nimbus 7 was nearly 3.04 m tall, 1.52 m in diameter at the base, and about 3.96 m wide with solar paddles extended. The sensor mount that formed the satellite base housed the electronics equipment and battery modules. The lower surface of the torus provided mounting space for sensors and antennas. A box-beam structure mounted within the center of the torus provided support for the larger sensor experiments. Mounted on the control housing unit, which was located on top of the spacecraft, were sun sensors, horizon scanners, and a command antenna. The spacecraft spin axis was pointed at the earth. An advanced attitude-control system permitted the spacecraft's orientation to be controlled to within plus or minus 1 deg in all three axes (pitch, roll, and yaw). Eight experiments were selected: (1) limb infrared monitoring of the stratosphere (LIMS), (2) stratospheric and mesospheric sounder (SAMS), (3) coastal-zone color scanner (CZCS), (4) stratospheric aerosol measurement II (SAM II), (5) earth radiation budget (ERB), (6) scanning multichannel microwave radiometer (SMMR), (7) solar backscatter UV and total ozone mapping spectrometer (SBUV/TOMS), and (8) temperature-humidity infrared radiometer (THIR). These sensors were capable of observing several parameters at and below the mesospheric levels. More details can be found in "The Nimbus 7 Users' Guide" (TRF B30045), available from NSSDC.

------- NIMBUS 7, GLOERSEN---

INVESTIGATION NAME- SCANNING MULTISPECTRAL MICROWAVE RADIOMETER (SMMR)

NSSDC ID- 78-098A-08

INVESTIGATIVE PROGRAM
CODE EE/CO-OP. APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
OCEANOGRAPHY

PERSONNEL

TL - P.	GLOERSEN	NASA-GSFC
TM - R.O.	RAMSEIR	SURVEILLANCE SAT PROJ
TM - D.H.	STAELIN	MASS INST OF TECH
TM - W.J.	CAMPBELL	US GEOLOGICAL SURVEY
TM - D.B.	ROSS	NOAA-ERL
TM - P.	GUDMANSEN	TECH U OF DENMARK
TM - F.T.	BARATH	NASA-JPL
TM - T.T.	WILHEIT, JR.	NASA-GSFC
TM - J.C.	ALISHOUSE	NOAA-NESDIS
TM - D.J.	CAVALIERI	NASA-GSFC
TM - A.	CHANG	NASA-GSFC
TM - O.M.	JOHANNESSEN	US NAVAL POST GRAD SCH
TM - K.	KATSAROS	U OF WASHINGTON
TM - K.	KUNZI	U OF BERNE
TM - E.	LANGHAM	RADARSAT PROJ OFFICE
TM - E.P.L.	WINDSOR	BRITISH AIR CORP, LTD

BRIEF DESCRIPTION

The primary purpose of the Scanning Multichannel Microwave Radiometer (SMMR) was to obtain sea surface temperature and near-surface winds under all-weather conditions for developing and testing global ocean circulation models and other aspects of ocean dynamics. Winds, water vapor, liquid-water content, mean cloud droplet size, rainfall rate and sea ice parameters were also determined. Microwave brightness temperatures were observed with a 10-channel (five-frequency dual polarized) scanning radiometer operating at frequencies of 37, 21, 18, 10.69, and 6.6 GHz. Six Dicke-type radiometers were utilized. Those operating at the four longest wavelengths measured alternate polarizations during successive scans of the antenna; the others operated continuously for each polarization. The antenna was a parabolic reflector offset from the nadir by 42 deg. Motion of the antenna reflector provided observations from within a conical volume along the ground track of the spacecraft. The same instrument was flown on SEASAT 1. For a complete description, see Section 8 in "The Nimbus 7 Users' Guide" (TRF B30045), available from NSSDC.

------- NIMBUS 7, HEATH---

INVESTIGATION NAME- SOLAR BACKSCATTER ULTRAVIOLET/TOTAL OZONE MAPPING SPECTROMETER (SBUV/TOMS)

NSSDC ID- 78-098A-09

INVESTIGATIVE PROGRAM
CODE EE/CO-OP. APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL

TL - D.F.	HEATH	NASA-GSFC
TM - C.L.	MATEER	ENVIRONMENT CANADA
TM - A.D.	BELMONT	CONTROL DATA CORP
TM - A.J.	MILLER	NOAA-NMC
TM - A.E.S.	GREEN	U OF FLORIDA
TM - D.M.	CUNNOLD	GEORGIA INST OF TECH
TM - W.L.	IMHOF	LOCKHEED PALO ALTO
TM - A.J.	KRUEGER	NASA-GSFC
TM - P.K.	BHARTIA	SYST & APPL SCI CORP
TM - A.J.	FLEIG	NASA-GSFC
TM - V.G.	KAVEESHWAR	SYST & APPL SCI CORP
TM - K.F.	KLENK	SYST & APPL SCI CORP
TM - R.	MCPETERS	NASA-GSFC
TM - H.W.	PARK	SYST & APPL SCI CORP

BRIEF DESCRIPTION

The objectives of the Solar Backscatter Ultraviolet and Total Ozone Mapping Spectrometer (SBUV/TOMS) were to determine the vertical distribution of ozone, map the total ozone content, and monitor the incident solar ultraviolet (UV) irradiance and ultraviolet radiation backscattered from the earth. The SBUV consisted of a double Ebert-Fastie spectrometer and a filter photometer similar to the BUV on Nimbus 4. The SBUV spectrometer measured solar UV backscattered by the earth's atmosphere at 12 wavelengths between 0.25 and 0.34 micrometer, with a spectral bandpass of 0.001 micrometer. The instrument's field of view (FOV) of 0.20 rad was directed at nadir. Both channels also viewed the sun for calibration through the use of a diffuser plate deployed near the terminator. The contribution functions for the eight shortest wavelengths were centered at levels ranging from 55 to 28 km and were used to infer the vertical ozone profile. The four longest wavelengths had contribution functions in the troposphere which were used to compute the total ozone amount. The SBUV spectrometer had a second mode of operation that allowed a continuous spectral scan from 0.16 to 0.4 micrometer for detailed examination of the extraterrestrial solar spectrum and its temporal variations. A parallel photometer channel at 0.343 micrometer measured the reflectivity of the atmosphere's lower boundary in the same 0.21-rad FOV. The TOMS was a single Ebert-Fastie spectrometer with a fixed grating and an array of exit slits. The TOMS step-scanned across the orbital track 51 deg from the nadir in 3-deg steps with an FOV of approximately 0.052 rad. At each scan position, the earth radiance was monitored at six wavelengths between 0.31 and 0.38 micrometer (3125 and 3800 A) to infer the total ozone amount. The signal-to-noise ratio of the SBUV was greater than 5.E3. The TOMS signal-to-noise ratio was greater than 1.E5. For a more detailed description, see Section 7 in "The Nimbus 7 Users' Guide" (TRF B30045), available from NSSDC.

------- NIMBUS 7, HOVIS--

INVESTIGATION NAME- COASTAL ZONE COLOR SCANNER (CZCS)

NSSDC ID- 78-098A-03 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
EARTH RESOURCES SURVEY

PERSONNEL

TL - W.A.	HOVIS		NOAA-NESDIS
TM - C.S.	YENTSCH		BIGELOW LAB OCEAN SCI
TM - D.	CLARK		NOAA-NESDIS
TM - J.R.	APEL		APPLIED PHYSICS LAB
TM - S.Z.	EL-SAYED		TEXAS A+M
TM - H.R.	GORDON		NOAA-PMEL
TM - R.C.	WRIGLEY		NASA-ARC
TM - F.P.	ANDERSON		NATL RES INST OCEANOL
TM - R.	AUSTIN		SCRIPPS INST OCEANOGR
TM - E.	BAKER		NOAA-PMEL
TM - J.	MUELLER		US NAVAL POST GRAD SCH
TM - B.	STURM		EUROPE JCR

BRIEF DESCRIPTION

The Coastal Zone Color Scanner Experiment (CZCS) was designed to map chlorophyll concentration in water, sediment distribution, gelbstoffe concentrations as a salinity indicator, and temperature of coastal waters and ocean currents. Reflected solar energy was measured in six channels to sense color caused by absorption due to chlorophyll, sediments, and gelbstoffe in coastal waters. Spectral bands at 0.443 and 0.670 micrometers centered on the most intense absorption bands of chlorophyll, while the band at 0.550 micrometers centered on the "hinge point," the wavelength of minimum absorption. Ratios of measured energies in these channels were shown to closely parallel surface chlorophyll concentrations. Data from the scanning radiometer were processed, with algorithms developed from the field experiment data, to produce maps of chlorophyll absorption. The temperatures of coastal waters and ocean currents were measured in a spectral band centered at 11.5 micrometers. Observations were made also in two other spectral bands, 0.520 micrometers for chlorophyll correlation and 0.750 micrometers for surface vegetation. To avoid sun glint, the scanner mirror was tilted about the sensor pitch axis on command so that the line of sight of the sensor was moved in 2-deg increments up to 20 deg with respect to the nadir. The scan width was 1556 km centered on nadir and the ground resolution was 0.825 km at nadir. For a more detailed description, see Section 2 in "The Nimbus 7 Users' Guide" (TRF B30045), available from NSSDC. Data are archived at SDSD. Since mid-1984, the instrument experienced occasional start-up problems.

------- NIMBUS 7, KYLE--

INVESTIGATION NAME- EARTH RADIATION BUDGET (ERB)

NSSDC ID- 78-098A-07 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
ATMOSPHERIC PHYSICS

PERSONNEL

TL - H.L.	KYLE		NASA-GSFC
TL - H.	JACOBOWITZ		NOAA-NESDIS
TM - T.H.	VONDERHAAR		COLORADO STATE U
TM - F.B.	HOUSE		DREXEL U
TM - K.L.	COULSON		U OF CALIF, DAVIS
TM - J.R.	HICKEY		EPPLEY LAB, INC
TM - L.L.	STOWE		NOAA-NESDIS
TM - A.P.	INGERSOLL		CALIF INST OF TECH
TM - G.L.	SMITH		NASA-LARC
TM - A.	ARKING		NASA-GSFC
TM - G.	CAMPBELL		COLORADO STATE U
TM - R.	MASCHHOFF		GULTON INDUSTRIES, INC.

BRIEF DESCRIPTION

The objective of the Earth Radiation Budget (ERB) experiment, a continuation of Nimbus 6 ERB, was to determine, over a period of a year, the earth radiation budget on both synoptic and planetary scales by simultaneous measurements of incoming solar radiation and outgoing earth-reflected (shortwave) and emitted (longwave) radiation. Both (1) fixed wide-angle sampling of terrestrial fluxes at the satellite altitude and (2) scanned narrow-angle sampling of the angular radiance components, were used to determine outgoing radiation (reflected and emitted). The ERB subsystem consisted of a 22-channel radiometer containing separate subassemblies to perform the required solar, earth-flux (wide angle), and scanned earth radiance (narrow angle) measurements. The systems used optical filters for spectral discriminations, as well as uncooled thermal detectors, thermopile detectors in the solar and fixed-earth-flux channels, and pyroelectric detectors in the scanning channels. The 10 solar channels viewed in front of the observatory in the X-Y plane. The solar channels obtained usable solar data only during a period of about 3 min in each orbit when the spacecraft was over the Antarctic region. Their full response field of view (FOV) was 0.18 rad. The solar channel subassembly was pivoted plus or minus 0.35 rad in the X-Y plane to compensate for sun-angle deviation when required. The four earth-flux channels were mounted so that they could continuously view the total earth disk, and record data continuously at 0.25-s intervals. Demodulator output signals were integrated for periods of at least 3.8 s. There were eight narrow FOV channels (four shortwave and four longwave) mounted in the scanning head. The head was gimbal-mounted in the radiometer unit main frame. The FOVs of the telescopes were asymmetric (4.4 by 89.4 mrad) and those of the shortwave and longwave channels were coincident. The 89.4 mrad FOVs of the four pairs of channels were not contiguous, but covered only alternate 89.4 mrad angular intervals along the horizon. For a more detailed description, see Section 3 in "The Nimbus 7 Users' Guide" (TRF B30045), available from NSSDC, and "The earth radiation budget (ERB) experiment: an overview" by H. Jacobawitz, et al., J. Geophys. Res., v. 89, n. D4, pp. 5021-5038, 1984. The narrow-view scanner failed in June 1980.

------- NIMBUS 7, MCCORMICK--

INVESTIGATION NAME- STRATOSPHERIC AEROSOL MEASUREMENT-II
(SAM-II)

NSSDC ID- 78-098A-06 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
UPPER ATMOSPHERE RESEARCH
METEOROLOGY
ATMOSPHERIC PHYSICS

PERSONNEL

TL - M.P.	MCCORMICK		NASA-LARC
TM - T.J.	PEPIN		U OF WYOMING
TM - G.W.	GRAMS		GEORGIA INST OF TECH
TM - B.M.	HERMAN		U OF ARIZONA
TM - P.B.	RUSSELL		NASA-ARC

BRIEF DESCRIPTION

The objective of the Stratospheric Aerosol Measurement (SAM II) experiment was to provide vertical distribution of stratospheric aerosols in the polar regions of both hemispheres. When no clouds were present in the instantaneous field of view (IFOV), the tropospheric aerosols could also be mapped. The instrument, basically a sun photometer, measured the extinction of solar radiation at 1.0-micrometer wavelength during spacecraft sunrise and sunset. The photometer viewed a portion of the solar disk with a 0.145-mrad IFOV and a sampling rate of 50 samples per second. As the spacecraft first viewed the sunrise, the photometer-pointing axis was depressed approximately 0.52 rad with respect to the spacecraft horizontal. The photometer continued looking at the sun until its depression angle was on the order of 0.44 rad (approximately 1.4 min observing time). Before sunset, the photometer head rotated 3.14 rad in azimuth and viewed the sun from a depression of approximately 0.44 to 0.52 rad as the spacecraft orbited to the dark side of the earth. The extinction measurements were inverted for the number density times the aerosol scattering cross section by using the Lambert-Beer Law and assuming the atmosphere to be composed of layers. To determine the stratospheric aerosol optical properties, ground-truth and in situ balloon-borne aerosol measurements were also made. For more detailed information, see Section 5 in "The Nimbus 7 Users' Guide" (TRF B30045), available from NSSDC.

------- NIMBUS 7, RUSSELL, 3RD--

INVESTIGATION NAME- LIMB INFRARED MONITOR OF THE
STRATOSPHERE (LIMS)

NSSDC ID- 78-098A-01 INVESTIGATIVE PROGRAM
CODE EE/CO-OP, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL

TL - J.M.	RUSSELL, 3RD		NASA-LARC
TL - J.C.	GILLE		NATL CTR FOR ATMOS RES
TM - F.B.	HOUSE		DREXEL INST OF TECH
TM - E.E.	REMSBERG		NASA-LARC
TM - C.B.	LOEVY		U OF WASHINGTON
TM - S.R.	DRAYSON		U OF MICHIGAN
TM - H.	FISCHER		U OF MUNICH
TM - W.G.	PLANET		NOAA-NESDIS
TM - A.	GIRARD		ONERA
TM - J.E.	HARRIES		NATL PHYSICAL LAB

BRIEF DESCRIPTION

The objective of the Limb Infrared Monitor of the Stratosphere (LIMS) experiment was to map the vertical profiles of temperature and the concentration of ozone, water vapor, nitrogen dioxide, and nitric acid in the lower to middle stratosphere range, with extension to the stratopause for water vapor and into the lower mesosphere for temperature and ozone. This experiment was a follow-on to limb radiance inversion radiometer (LRIR) flown on Nimbus 6. The instrument had a six-channel infrared (IR) radiometer that incorporated Hg-Cd-Te detectors cooled by a two-stage solid cryogen cooler. The radiometer mapped vertical profiles of thermal IR emission coming from the horizon in six bands (6.2, 6.3, 9.6, 11.3, and two 15 micrometers) of the atmospheric constituents of interest. Two of the channels were used to determine radiance profiles of emission by CO_2. These profiles were mathematically inverted to obtain temperature versus pressure. The infrared temperature profile, together with radiance profiles in the other spectral bands, were then used to infer the vertical distribution of trace constituents. The temperature was determined to an accuracy of about 1.5 deg K. Constituent concentrations were determined with an accuracy of about 20%, with the exception of NO_2 which was determined to within about 50%. Instantaneous vertical field of view at the horizon was 2 km for the temperature, ozone, and nitric acid channels, and 4 km for the NO_2 and water vapor channels. For more detailed information, see Section 4 in "The Nimbus 7 Users' Guide" (TRF B30045), available from NSSDC. The instrument was turned off due to depletion of cryogen as planned in June 1979.

------- NIMBUS 7, STOWE---------------------------------------

INVESTIGATION NAME- TEMPERATURE/HUMIDITY INFRARED RADIOMETER (THIR)

NSSDC ID- 78-098A-10

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY

PERSONNEL

PI - L.L.	STOWE	NOAA-NESDIS
OI - L.J.	ALLISON(RETIRED)	NASA-GSFC
OI - P.H.	HWANG	NASA-GSFC
OI - K.F.	FLENK	SYST & APPL SCI CORP
OI - P.K.	BHARTIA	SYST & APPL SCI CORP

BRIEF DESCRIPTION

The Nimbus 7 Temperature-Humidity Infrared Radiometer (THIR) detected emitted thermal radiation in both the 10.5- to 12.5-micrometer region (IR window) and the 6.5- to 7.0-micrometer region (water vapor). The window channel provided an image of the cloud cover and temperatures of the cloud tops, land, and ocean surfaces. The other channel provided information on the moisture and cirrus cloud content of the upper troposphere and stratosphere, and the location of jet streams and frontal systems. The ground resolution at nadir was 6.7 km for the window channel and 20 km for the water vapor channel. Data from these two channels were used primarily to support other sophisticated meteorological experiments onboard Nimbus 7. The instrument was a non-imaging radiometer consisting of a 12.7-cm Cassegrain system and scanning mirror common to both channels, a beam splitter, filters, and two germanium-immersed thermistor bolometers. Incoming radiant energy was collected by a flat scanning mirror inclined at 45 deg to the optical axis. The mirror rotated through 360 deg at 48 rpm and scanned in a plane normal to the spacecraft velocity. The energy then was focused on a dichroic beam splitter which divided the energy spectrally and spatially. The two channels of this sensor transformed the received radiation into electric outputs (voltages), which were digitized and recorded on magnetic tape for subsequent playback to a ground acquisition station. For a more complete information on instrument and data products, see Section 9 in "The Nimbus 7 Users' Guide" (TRF B30045) and the "Nimbus 7 Temperature-Humidity Infrared Radiometer (THIR) Data User's Guide" (TRF B30601), both available from NSSDC. Except for data being digitized on board, the Nimbus 7 THIR was of the same design and operation as the THIR flown on Nimbus 4, 5, and 6.

------- NIMBUS 7, TAYLOR---------------------------------------

INVESTIGATION NAME- STRATOSPHERIC AND MESOSPHERIC SOUNDER (SAMS)

NSSDC ID- 78-098A-02

INVESTIGATIVE PROGRAM
CODE EE/CO-OP, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
UPPER ATMOSPHERE RESEARCH

PERSONNEL

PI - F.W.	TAYLOR	OXFORD U
OI - G.D.	PESKETT	OXFORD U
OI - C.D.	RODGERS	OXFORD U
OI - E.J.	WILLIAMSON	OXFORD U
OI - J.J.	BARNETT	OXFORD U
OI - M.	CORNEY	OXFORD U
OI - R.L.	JONES	OXFORD U
OI - J.G.	WHITNEY	OXFORD U

BRIEF DESCRIPTION

The objective of the Stratospheric and Mesospheric Sounder (SAMS) was to observe emission from the limb of the atmosphere through 12-channel pressure-modulator radiometers in order to determine temperature and vertical concentrations of H_2O, N_2O, CH_4, CO, and NO in the stratosphere and mesosphere. Measurements of zonal wind in this region were attempted by observing the Doppler shift of atmospheric emission lines. Radiation from the limb of the atmosphere was incident on a telescope of 15-cm aperture. In front of the telescope, a plane mirror scanned the limb, viewed space for calibration, and viewed the atmosphere obliquely to obtain vertical profiles. Three adjacent fields of view, each 28 by 2.8 mrad (corresponding to 100 km by 10 km at the limb), focused onto a field-splitting mirror which directed radiation to six detectors. The remaining division into channels was accomplished through dichroic beam splitters. There were seven pressure modulator cells (PMC), two containing CO_2, the remainder N_2O, NO, CH_4, CO, H_2O. Pressure in the cells could be varied on command by changing the temperature of a small container of molecular sieve material attached to each PMC. The spectral parameters for the H_2O channel were 2.7 micrometers and 25 to 100 micrometers. All other channels lay within the range 4.1 to 15 micrometers. Within the telescope, a chopper operating at 250 Hz allowed measurement of two separate signals from all detectors, one at 250 Hz and one at the PMC frequency. Comparison of these signals permitted the elimination of emission from interfering gases within a particular spectral interval. In front of the chopper, a small black body at known temperature could be introduced for calibration. Accurate measurement of the atmospheric pressure at the level being viewed was obtained from the two signals from one CO_2 channel. For a more detailed description, see Section 6 in "The Nimbus 7 Users' Guide" (TRF B30045), available from NSSDC.

*************************** SAGE****************************

SPACECRAFT COMMON NAME- SAGE
ALTERNATE NAMES- AEM-B, STRAT AERO AND GAS EXP
APPL EXPL MISSION B, 11270

NSSDC ID- 79-013A

LAUNCH DATE- 02/18/79 WEIGHT- 148.7 KG
LAUNCH SITE- WALLOPS FLIGHT CENTER, UNITED STATES
LAUNCH VEHICLE- SCOUT-F

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSTA

INITIAL ORBIT PARAMETERS

ORBIT TYPE- GEOCENTRIC	EPOCH DATE- 02/19/79
ORBIT PERIOD- 96.8 MIN	INCLINATION- 54.9 DEG
PERIAPSIS- 547.5 KM ALT	APOAPSIS- 660.2 KM ALT

PERSONNEL

PM - C.M.	MACKENZIE	NASA-GSFC
PS - R.S.	FRASER	NASA-GSFC

BRIEF DESCRIPTION

The Stratospheric Aerosol and Gas Experiment (SAGE) spacecraft was the second of the Applications Explorer Missions (AEM). The small, versatile, low-cost spacecraft was made of two distinct parts: (1) the SAGE instrument module containing the detectors and the associated hardware, and (2) the base module containing the necessary data handling, power, communications, command, and attitude control subsystem to support the instrument mode. The objective of the SAGE mission was to obtain stratospheric aerosol and ozone data on a global scale for a better understanding of the earth's environmental quality and radiation budget. The spacecraft was designed for a 1-year life in orbit. The spacecraft experienced power problems after May 15, 1979. Spacecraft operations continued until November 19, 1981. The signal from the spacecraft was last received on January 7, 1982, when the battery failed. For more detailed information, see "Satellite studies of the stratospheric aerosol" by M. P. McCormick, et al., Bull. Am. Meteorol. Soc., v. 60, pp. 1038-1046, 1979.

------- SAGE, MCCORMICK---------------------------------------

INVESTIGATION NAME- STRATOSPHERIC AEROSOL AND GAS EXPERIMENT (SAGE)

NSSDC ID- 79-013A-01

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
UPPER ATMOSPHERE RESEARCH
METEOROLOGY

PERSONNEL

PI - M.P.	MCCORMICK	NASA-LARC
OI - D.M.	CUNNOLD	GEORGIA INST OF TECH
OI - G.W.	GRAMS	GEORGIA INST OF TECH
OI - B.M.	HERMAN	U OF ARIZONA
OI - D.E.	MILLER	METEOROLOGICAL OFFICE
OI - D.G.	MURCRAY	U OF DENVER
OI - T.J.	PEPIN	U OF WYOMING
OI - W.G.	PLANET	NOAA-NESDIS
OI - P.B.	RUSSELL	SRI INTERNATIONAL

BRIEF DESCRIPTION

The objectives of the Stratospheric Aerosol and Gas Experiment (SAGE) were to determine the spatial distribution of stratospheric aerosols and ozone on a global scale. Specific objectives were (1) to develop a satellite-based remote-sensing technique for stratospheric aerosols and ozone measurements, (2) to map aerosol and ozone concentrations on a time scale shorter than major stratospheric changes, (3) to locate stratospheric aerosol and ozone sources and sinks, (4) to monitor circulation and transfer phenomena, (5) to observe hemisphere differences, and (6) to investigate the optical properties of aerosols and assess their effects on global climate. The SAGE instrument was a radiometer consisting of a Gregorian telescope and a detector subassembly which measured the attenuation of solar radiation at four wavelengths (0.385, 0.45, 0.6, and 1.0 micrometer) during solar occultation. As the spacecraft emerged from the earth's shadow, the sensor scanned the earth's atmosphere from the horizon up, and measured the attenuation of solar radiation by different atmospheric layers. This procedure was repeated during spacecraft sunset. Two vertical scannings were obtained during each orbit, with each scan requiring approximately 1 min of time to cover the atmosphere above the troposphere. The instrument had a field of view of approximately 0.15 mrad which resulted in a vertical resolution of about 1 km. Spatial coverage extended from about 79 deg N to 79 deg S latitude and thus complemented the coverage (64 deg N to 80 deg N and 64 deg S to 80 deg S) of the SAM II on Nimbus 7. The instrument performed satisfactorily. Because of power problems, the data collection was limited to sunset events after June 1979, and was eventually terminated on November 18, 1981. Both NSSDC and World Ozone Data Center, Atmospheric Environmental Services, 4905 Dufferin St., Downsview, Ontario, M3H 5T4 Canada, have data.

************************** SEASAT 1 **************************

SPACECRAFT COMMON NAME- SEASAT 1
ALTERNATE NAMES- OCEAN DYNAMICS SAT-A, SEA SATELLITE-A
10967, SEASAT-A

NSSDC ID- 78-064A

LAUNCH DATE- 06/27/78 WEIGHT- 1800. KG
LAUNCH SITE- VANDENBERG AFB, UNITED STATES
LAUNCH VEHICLE- ATLAS-AGEN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSTA

INITIAL ORBIT PARAMETERS

ORBIT TYPE- GEOCENTRIC	EPOCH DATE- 06/28/78
ORBIT PERIOD- 100.7 MIN	INCLINATION- 108.0 DEG
PERIAPSIS- 769. KM ALT	APOAPSIS- 799. KM ALT

PERSONNEL

PM - W.E.	GIBERSON	NASA-JPL
PS - J.A.	DUNNE	NASA-JPL

BRIEF DESCRIPTION
The Ocean Dynamics Satellite (Seasat 1) was designed to provide measurements of sea-surface winds, sea-surface temperatures, wave heights, internal waves, atmospheric liquid water content, sea ice features, ocean features, ocean topography, and the marine geoid. Seasat 1 provided 95% global coverage every 36 h. The instrument payload consisted of (1) an X-band compressed pulse radar altimeter (ALT), (2) a coherent synthetic aperture radar (SAR), (3) a Seasat-A scatterometer system (SASS), (4) a scanning multichannel microwave radiometer (SMMR), and (5) a visible and infrared radiometer (VIRR). The accuracies obtained were distance between spacecraft and ocean surface to 10 cm, wind speeds to 2 m/s, and surface temperatures to 1 deg C. For more information about Seasat 1, see "Seasat mission overview," Science, v. 204, pp. 1405-1424, 1979, and a special issue on the Seasat 1 sensors, IEEE J. of Oceanic Eng., v. OE-5, 1980. On October 10, 1978, Seasat 1 failed due to a massive short circuit in its electrical system. During most of its 105 days in orbit, Seasat 1 returned a unique and extensive set of observations of the earth's oceans.

------- SEASAT 1, MCLAIN ---------------------------------------

INVESTIGATION NAME- VISIBLE AND INFRARED RADIOMETER (VIRR)

NSSDC ID- 78-064A-04 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
OCEANOGRAPHY

PERSONNEL

TL - E.P.	MCLAIN	NOAA-NESDIS
TM - R.	BERNSTEIN	SCRIPPS INST OCEANOGR
TM - O.K.	HUH	LOUISIANA STATE U
TM - W.L.	BARNES	NASA-GSFC
TM - F.M.	VUKOVICH	RESEARCH TRIANGLE INST
TM - K.D.	FELLERMAN	NASA-GSFC

BRIEF DESCRIPTION
The Visible and Infrared Radiometer (VIRR) experiment provided (1) cloudcover and (2) clear air sea surface termperatures and cloud top brightness temperatures. This sensor, nearly identical to the Scanning Radiometer (SR) flown on the ITOS/NOAA series spacecraft, consisted of two scanning radiometers, a dual SR processor and two SR recorders. The radiometer measured reflected radiation from the earth/atmosphere system in the 0.49- to 0.94-micrometer region during the day and emitted thermal IR radiation from the earth and its atmosphere in the 10.5- to 12.5-micrometer region during both daytime and nighttime. The measurements were used to aid in interpreting the measurements from the microwave instruments. The spatial resolution was 9 km for both channels. More detailed information can be found in P. MaClain, "Visible and infrared radiometer on Seasat-1," IEEE J. Oceanic Eng., v. OE-5, pp. 164-168, 1980. The instrument performance was better than specified until August 27, 1978, when the scan drive ceased functioning. Data are available from SDSD.

------- SEASAT 1, PIERSON ---------------------------------------

INVESTIGATION NAME- SEASAT-A SATELLITE SCATTEROMETER (SASS)

NSSDC ID- 78-064A-03 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
OCEANOGRAPHY

PERSONNEL

TL - W.J.	PIERSON	CUNY INST MAR+ATMOS SC
TM - W.L.	GRANTHAM	NASA-LARC
TM - G.	FLITTNER	NOAA-NWS
TM - L.	BAER	OCEAN + ATMOSP SERVICE
TM - I.M.	HALBERSTAM	NASA-JPL
TM - W.L.	JONES, JR.	NASA-LARC
TM - D.	MOORE	U OF KANSAS

BRIEF DESCRIPTION
The Seasat-A Satellite Scatterometer (SASS) experiment was designed to use an active radar system to measure sea surface winds. The instrument, developed from the Skylab experimental scatterometer, determined wind direction within 20 deg and wind speed from 4 to 26 m/s with an accuracy of 2 m/s. The transmitted frequency was 14.6 GHz. The SASS illuminated the sea surface with four fan-shaped beams (two orthogonal beams, each 500 km wide, on each side of the ground track). The high wind swaths added an additional 250 km to each side. The spatial resolution was 50 km over a region of 200 to 700 km on either side of the spacecraft. For more detailed information, see J. W. Johnson, et al., "Seasat-A satellite scatterometer instrument evaluation," IEEE J. of Oceanic Eng., v. OE-5, pp. 138-144, 1980. The SASS began operating on July 6, 1978, and gathered data for approximately 2290 h. Data are available from SDSD.

------- SEASAT 1, ROSS ---------------------------------------

INVESTIGATION NAME- SCANNING MULTICHANNEL MICROWAVE
RADIOMETER (SMMR)

NSSDC ID- 78-064A-05 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
METEOROLOGY

PERSONNEL

TL - D.B.	ROSS	NOAA-ERL
TM - J.W.	SHERMAN, III	NOAA-NESDIS
TM - F.T.	BARATH	NASA-JPL
TM - J.	WATERS	NASA-JPL
TM - J.P.	HOLLINGER	US NAVAL RESEARCH LAB
TM - T.T.	WILHEIT, JR.	NASA-GSFC
TM - N.	HUANG	NASA-GSFC-WFF
TM - C.T.	SWIFT	NASA-LARC
TM - W.J.	CAMPBELL	US GEOLOGICAL SURVEY
TM - V.J.	CARDONE	OCEAN WEATHER INC

BRIEF DESCRIPTION
The primary purpose of the Scanning Multichannel Microwave Radiometer (SMMR) experiment was (1) to provide all-weather measurements of ocean surface temperature and wind speed, and (2) to obtain integrated liquid water column content and atmospheric water vapor column content for path length and attenuation corrections for the ALT and SASS. Microwave brightness temperatures were observed with a 10-channel (five-frequency dual polarized) scanning radiometer operating at 0.8-, 1.4-, 1.7-, 2.8-, and 4.6-cm wavelengths (37, 21, 18, 10.7, and 6.6 GHz). The antenna was a parabolic reflector offset from nadir by 0.73 rad. Motion of the antenna reflector provided observations from within a conical volume along the ground track of the spacecraft. The SMMR had a swath width of about 600 km and the spatial resolution ranged from about 22 km at 37 GHz to about 100 km at 6.6 GHz. The absolute accuracy of sea surface temperature obtained was 2 deg K with a relative accuracy of 0.5 deg K. The accuracy of the wind speed measurements was 2 m/s for winds ranging from 7 to about 50 m/s. The same experiment was flown on Nimbus 7. A more detailed description can be found in E. Njoku, et al., "The Seasat Scanning Multichannel Microwave Radiometer (SMMR): instrument description and performance," IEEE J. Oceanic Eng., v. OE-5, pp. 100-115, 1980. The instrument operated continuously in orbit from July 6, 1978 for a period of 95 days, until the spacecraft failed on October 10, 1978. Data are available from SDSD.

------- SEASAT 1, TAPLEY ---------------------------------------

INVESTIGATION NAME- RADAR ALTIMETER (ALT)

NSSDC ID- 78-064A-01 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
METEOROLOGY

PERSONNEL

TL - B.D.	TAPLEY	U OF TEXAS, AUSTIN
TM - S.L.	SMITH, III	USN SURFACE WEAPNS CTR
TM - B.H.	CHOVITZ	NOAA-NOS
TM - W.F.	TOWNSEND	NASA-GSFC-WFF
TM - J.T.	MCGOOGAN	NASA-GSFC-WFF
TM - H.M.	BYRNE	NOAA-PMEL
TM - E.M.	GAPOSCHKIN	SAO
TM - P.	DELEONIBUS	US NAVAL RESEARCH LAB
TM - B.	YAPLEE	US NAVAL RESEARCH LAB
TM - C.J.	COHEN	USN SURFACE WEAPNS CTR

BRIEF DESCRIPTION

The Radar Altimeter (ALT) experiment measured (1) the spacecraft height above mean sea level and (2) the significant wave height and backscatter coefficient of the ocean surface beneath the spacecraft. The altimeter was a more accurate version of the Skylab Radar Altimeter, and was similar to the altimeter flown on GEOS 3. Two of its unique features were a linear FM transmitter with a 320-MHz bandwidth, which yielded a 3.125-ns time-delay resolution, and microprocessor-implemented closed-loop range tracking, automatic gain control, and real-time estimation of significant wave height. The instrument operated at 13.5 GHz using a 1-m parabolic antenna pointed at nadir and had a swath width which varied from 2.4 to 12 km, depending on sea state. The precision of the height measurement was 10 cm (rms). The estimate of significant wave height was accurate to 0.5 m or 10%, whichever was greater, and the ocean backscatter coefficient had an accuracy of 1 dB. For a more detailed description, see W. Townsend, "An initial assessment of the performance achieved by the Seasat-1 radar altimeter," IEEE J. of Oceanic. Eng., v. OE-5, pp. 80-92, 1980. The ALT was turned on for the first time on July 3, 1978, and declared operational on July 7, 1978. The ALT operated successfully until October 10, 1978, when the spacecraft prematurely terminated the mission. Data are available from SDSD.

------- SEASAT 1, TELEKI --

INVESTIGATION NAME- SYNTHETIC APERTURE RADAR (SAR)

NSSDC ID- 78-064A-02 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
METEOROLOGY

PERSONNEL

TL - P.G.	TELEKI	US GEOLOGICAL SURVEY
TM - D.B.	ROSS	NOAA-ERL
TM - W.J.	CAMPBELL	US GEOLOGICAL SURVEY
TM - A.	LOOMIS	NASA-JPL
TM - W.E.	BROWN, JR.	NASA-JPL
TM - F.T.	BARATH	NASA-JPL
TM - D.H.	RODGERS	NASA-JPL
TM - C.L.	RUFENACH	NOAA-ERL
TM - J.W.	SHERMAN, III	NOAA-NESDIS
TM - R.	STEWART	SCRIPPS INST OCEANOGR
TM - J.	ZELENKA	ENVIRON RES INST OF MI
TM - O.H.	SHEMDIN	NASA-JPL

BRIEF DESCRIPTION

The coherent Synthetic Aperture Radar (SAR) was designed to use wave pattern and dynamic behavior information to obtain images of the ocean. The SAR, imaging in the L-band (1.275 GHz), looked to the starboard side of the subsatellite track with a swath 100 km wide at a 20-deg incidence angle. The images had a spatial resolution of 25 m. The instrument, flown on Apollo 17 as the Apollo lunar sounder, yielded images of waves with wave length in the range of 50 to 1000 m and could determine wave direction within 25 deg with the possibility of a 180-deg ambiguity for one-side images. Wave height could also be determined from the data for fully developed seas. The imaging radar functioned through clouds and nominal rain to provide wave patterns near shoreline and pictures of ice, oil spills, current patterns, and similar features. For a more detailed description, see R. L. Jordan, "The Seasat-A synthetic-aperture radar systems," IEEE J. Oceanic Eng., v. OE-5, pp. 154-164, 1980. This experiment required a very high rate of data acquisition. The SAR data were not recorded on board the satellite, but were transmitted to the earth and recorded at ground stations. Data were collected from about 500 passes, with an average pass duration of 5 min. For an index of data, see "Seasat views oceans and sea ice with synthetic-aperture radar," JPL 81-120, NASA-JPL, 1981. Data are available from SDSD and ESRIN-Earthnet Programme Office, Via Galileo Galilei, 00044 Frascati, Italy.

**************************** SKYLAB ****************************

SPACECRAFT COMMON NAME- SKYLAB
ALTERNATE NAMES- 6633

NSSDC ID- 73-027A

LAUNCH DATE- 05/14/73 WEIGHT- 90607. KG
LAUNCH SITE- KENNEDY SPACE CENTER, UNITED STATES
LAUNCH VEHICLE- SATURN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OMSF

INITIAL ORBIT PARAMETERS

ORBIT TYPE- GEOCENTRIC	EPOCH DATE- 05/14/73
ORBIT PERIOD- 93.4 MIN	INCLINATION- 50.0 DEG
PERIAPSIS- 434.0 KM ALT	APOAPSIS- 442.0 KM ALT

PERSONNEL
PM - O.G. SMITH NASA-JSC

BRIEF DESCRIPTION

The Skylab was a manned, orbiting spacecraft composed of five parts, the Apollo telescope mount (ATM), the multiple docking adapter (MDA), the airlock module (AM), the instrument unit (IU), and the orbital workshop (OWS). The Skylab was in the form of a cylinder, with the ATM being positioned 90 deg from the longitudinal axis after insertion into orbit. The ATM was a solar observatory, and it provided attitude control and experiment pointing for the rest of the cluster. It was attached to the MDA and AM at one end of the OWS. The retrieval and installation of film used in the ATM was accomplished by astronauts during extravehicular activity (EVA). The MDA served as a dock for the command and service modules, which served as personnel taxis to the Skylab. The AM provided an airlock between the MDA and the OWS, as well as containing controls and instrumentation. The IU, which was used only during launch and the initial phases of operation, provided guidance and sequencing functions for the initial deployment of the ATM, solar arrays, etc. The OWS was a modified Saturn 4B stage suitable for long duration manned habitation in orbit. It contained provisions and crew quarters necessary to support three-man crews for periods of up to 84 days each. All parts were also capable of unmanned, in-orbit storage, reactivation and reuse. The Skylab itself was launched on May 14, 1973. It was first manned during the period May 25-June 22, 1973, by the crew of the SL-2 mission (73-032A). Next, it was manned during the period July 28-September 25, 1973, by the crew of the SL-3 mission (73-050A). The final manned period was from November 16, 1973, to February 8, 1974, when it was manned by the crew from the SL-4 mission (73-090A).

------- SKYLAB, BARNETT --

INVESTIGATION NAME- INFRARED SPECTROMETER

NSSDC ID- 73-027A-18 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
METEOROLOGY
EARTH RESOURCES SURVEY

PERSONNEL
PI - T.L. BARNETT NASA-JSC

BRIEF DESCRIPTION

The primary goal of Skylab experiment S191 was to make an evaluation of the applicability and usefulness of sensing earth resources from orbital altitudes in the visible through near-infrared and in the far infrared spectral regions. Another specific goal was to assess the value of real-time identification of ground sites by an astronaut. The S191 was a dual spectral band system, with its short-wavelength band at 0.4 to 2.5 micrometers, and its long wavelength spectral band at 6.0 to 16.0 micrometers. The field of view of the system was one milliradian (0.435-km diameter circular foot print), with a spectral resolution of 1 to 5%. The experiment included a viewfinder tracking system which a crewman used in acquiring and tracking desired sites for S191 use, providing the ability to look at relatively small ground targets about 0.44 km in size. A 16-mm camera was used to photograph these sites. The primary data were recorded on magnetic tape along with data from other sensors in the earth resources experiment package (EREP). The magnetic tape and the film from the viewfinder camera were returned with each crew rotation. For information of data availability, contact the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

------- SKYLAB, DEMEL --

INVESTIGATION NAME- MULTISPECTRAL PHOTOGRAPHIC FACILITY

NSSDC ID- 73-027A-17 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
METEOROLOGY
EARTH RESOURCES SURVEY

PERSONNEL
PI - K. DEMEL NASA-JSC

BRIEF DESCRIPTION

The S190 Skylab experiment was designed to photograph regions of the earth's surface, including oceans, in a range of wavelengths from near infrared through the visible. The facility had two parts: the multispectral photographic cameras (S190A) that simultaneously photographed the same area, each viewing a different wavelength, and the earth terrain camera (S190B) which was a single-lens camera. The S190A experiment consisted of six high-precision 70-mm cameras. The matched distortion and focal length camera array contained forward motion compensation to correct for spacecraft motion. The f/2.8 lenses, with a focal length of 6 in., had a field of view of 21.1 deg providing a square surface coverage of about 163 km on each side from the 435-km altitude. The system was designed for the following wavelength/film combinations: (1) 0.5-0.6 micrometer, Panatomic-X B+W, (2) 0.6-0.7 micrometer, Panatomic-X B+W, (3) 0.7-0.8 micrometer, IR B+W, (4) 0.8-0.9 micrometer, IR B+W, (5) 0.5-0.88 micrometer, IR color, and (6) 0.4-0.7 micrometer, high-resolution color. The spectral regions designated were selected to separate the visible and photographic infrared spectrum into bands that were expected to be most useful for multispectral analysis of earth surface features. Further spectral refinements were made by using different filter combinations. This camera system provided photos with a ground resolution of 30 to 46 m in the visible wavelengths and 73 to 79 m in the infrared wavelengths. The S190B camera utilized a single 18-in focal length lens with 5-in. film. Its field of view of 14.2 deg provided a surface coverage of about 109 km by 109 km. This camera was designed to use high-resolution color film and was operated from the OWS sal window, producing photos with a ground resolution of 17 to 30 m. The camera compensated for spacecraft forward motion through programmed camera rotation. Shutter speeds were selectable at 5, 7, and 10 msec with a curtain velocity of 110 in./s. For information of data availability, contact the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

------- SKYLAB, EVANS --

INVESTIGATION NAME- MICROWAVE RADIOMETER/SCATTEROMETER/ ALTIMETER

NSSDC ID- 73-027A-20 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
METEOROLOGY
EARTH RESOURCES SURVEY

PERSONNEL
PI - D.E. EVANS NASA-JSC

BRIEF DESCRIPTION

The objectives of this S193 Skylab experiment were (1) to provide the near-simultaneous measurement of the radar differential backscattering cross section and the passive microwave thermal emission of the land and ocean on a global scale, and (2) to provide engineering data for use in designing space radar altimeters. The S193 was useful in studying varying ocean surfaces, wave conditions, sea and lake ice, snow cover, seasonal vegetational changes, flooding, rainfall and soil types. The sensor generally operated over ocean and ground areas where ground truth data were available, but additional targets of opportunity, such as hurricanes and storms, were viewed when the opportunity arose. S193 incorporated a radiometer, a scatterometer, and a radar altimeter, all operating at the same frequency of 13.9 GHz. The equipment shared a common gimballed antenna mounted on the outside of the multiple docking adapter. The scatterometer measured the backscattering coefficient of ocean and terrain as a function of incidence angle ranging from 0 to 48 deg. The radiometer was a passive sensor which measured the brightness temperature, from a cell on the earth's surface, as a function of incidence angle from the surface. The altimeter was a compressed-pulse radar system to measure average ocean-surface elevation variations with a resolution of about 0.9 km. The S193 ground coverage was 48 deg forward and 48 deg to either side of the spacecraft ground track. All data were recorded on magnetic tape on one digitized channel. The radiometer/scatterometer data were recorded at 5.33 kbs, the altimeter data at 10 kbs. For information of data availability, contact the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

------- SKYLAB, EVANS --

INVESTIGATION NAME- L-BAND MICROWAVE RADIOMETER

NSSDC ID- 73-027A-21 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
METEOROLOGY
EARTH RESOURCES SURVEY

PERSONNEL
PI - D.E. EVANS NASA-JSC

BRIEF DESCRIPTION

This Skylab experiment (S194) was to supplement experiment S193 (73-027A-20) in measuring brightness temperature of the earth's surface along the spacecraft track, which would provide ocean surface features, varying winds over ocean areas, and earth surface features information. The S194 experiment was a passive, non-scanning microwave sensor that utilized a fixed planar array antenna. Brightness temperature of the earth was recorded in the L-band range from 1.4 t 1.427 GHz with a digital output giving an absolute antenna temperature to an accuracy of 1 deg K. The system utilized a built-in calibration scheme that sampled known sources. The spatial characteristics were a half-power beam width of 15 deg, first null beam width of 37 deg (97% of power) and a circular footprint of approximately 124-km diam. (half-power). All data were recorded on magnetic tapes. The data output was at 200 bps. For information of data availability, contact the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

------- SKYLAB, KORB --

INVESTIGATION NAME- MULTISPECTRAL SCANNER

NSSDC ID- 73-027A-19 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
OCEANOGRAPHY
EARTH RESOURCES SURVEY

PERSONNEL
PI - C.L. KORB NASA-JSC

BRIEF DESCRIPTION

The primary goal of Skylab experiment S192 was to assess the feasibility of multispectral techniques, developed in the aircraft program, for remote sensing of earth resources from space. Specifically, attempts were made at spectral signature identification and mapping of ground truth targets in agriculture, forestry, geology, hydrology, and oceanography. The S192 instrument had 12 spectral bands with wavelengths ranging from 0.41 to 2.43 micrometers in the visible and near IR regions, and 1 band in the 10.2-12.5 micrometer thermal IR region. The system gathered quantitative high-spatial-resolution line-scan imagery data on radiation reflected and emitted by selected ground sites in the U.S. and other parts of the world. The motion of the sensor was a circular scan with a radius of 41.8 km. Data of ground scenes were recorded as the scan swept a track 74 km wide in front of the spacecraft, yielding a 79-m ground resolution. The S192 optical mechanical scanner utilized a 30-cm reflecting telescope with a rotating mirror. The telescope and mirror were mounted outside the multiple docking adapter. Information on days of operation and area of coverage of experiment can be obtained from the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

*************************** STS-2/OSTA-1 *********************

SPACECRAFT COMMON NAME- STS-2/OSTA-1
ALTERNATE NAMES- SHUTTLE OFT-2, OSTA-1/STS-2
SPACE TRANSPORT SYS-2

NSSDC ID- 81-111A

LAUNCH DATE- 11/12/81 WEIGHT- 2542. KG
LAUNCH SITE- KENNEDY SPACE CENTER, UNITED STATES
LAUNCH VEHICLE- SHUTTLE

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- GEOCENTRIC EPOCH DATE- 11/12/81
ORBIT PERIOD- 89.0 MIN INCLINATION- 38. DEG
PERIAPSIS- 219. KM ALT APOAPSIS- 229. KM ALT

PERSONNEL
PM - G.S. LUNNEY NASA-JSC

BRIEF DESCRIPTION

The second flight of the Space Shuttle (STS-2) carried the first scientific payload OSTA-1 (Office of Space and Terrestrial Application 1). The instruments from the OSTA-1 payload were designed to perform remote sensing of the earth's atmosphere, oceans, and land resources. During its time in orbit, the Shuttle assumed an earth-viewing orientation, thus accommodating the experiments of the OSTA-1 payload. In this attitude, called Z-axis local vertical (ZLV), the Shuttle's payload bay faces the earth on a line perpendicular to the earth's surface. The OSTA-1 payload consisted of (1) a shuttle imaging radar-A (SIR-A), (2) a shuttle multispectral infrared radiometer (SMIRR), (3) a feature identification and location experiment (FILE), (4) a measurement of air pollution from satellites (MAPS), (5) an ocean color experiment (OCE), (6) a night/day optical survey of lightning (NOSL), and (7) a helfex bioengineering test (HBT). The first five instruments were located in the payload bay. A pallet, supplied by the European Space Agency, made the interface between the payload bay and these five experiments. The NOSL and HBT instruments were located in the crew compartment. Due to the loss of one of three fuel cells, the STS-2 mission was shortened from the planned 124-h to a 54-h minimum mission. The OSTA-1 payload was activated approximately 4.5 h after launch. The earth-viewing time was reduced from the planned 88 h to 36 h. The STS-2 mission successfully demonstrated the capability of the Space Shuttle to conduct scientific research. For more detailed descriptions of the OSTA-1 payload, see "OSTA-1 Experiments," JSC 17059, NASA-JSC, and Science, v. 218, n. 4576, pp. 993-1033, 1982.

------- STS-2/OSTA-1, BROWN---------------------------------------

INVESTIGATION NAME- HEFLEX BIOENGINEERING TEST (HBT)

NSSDC ID- 81-111A-07 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
SPACE BIOLOGY

PERSONNEL
PI - A.H. BROWN U OF PENNSYLVANIA

BRIEF DESCRIPTION
The objective of the Heflex Bioengineering Test (HBT) was to determine the effect of near weightlessness and soil content on Helianthus annus (dwarf sunflower) growth. The HBT was a precursor to the Heflex (Helianthus Annus Flight Experiment) planned on Spacelab 1. The HBT experiment was a suitcase-like container loaded with 85 sealed plant modules varying in soil moisture content from 55% by weight to 77%. This plant carry-on was stored in a locker in the crew compartment of the Space Shuttle. There was insufficient time for the plants to grow because of the shortened mission. Germination percentage was 98%, but the data relating to growth required to support the Spacelab 1 experiment were not obtained.

------- STS-2/OSTA-1, ELACHI--------------------------------------

INVESTIGATION NAME- SHUTTLE IMAGING RADAR-A (SIR-A)

NSSDC ID- 81-111A-01 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
EARTH RESOURCES SURVEY

PERSONNEL

PI - C.	ELACHI	NASA-JPL
OI - W.E.	BROWN, JR.	NASA-JPL
OI - L.F.	DELLWIG	U OF KANSAS
OI - A.W.	ENGLAND	NASA-JSC
OI - M.	GUY	CNES
OI - H.	MACDONALD	U OF ARKANSAS
OI - R.S.	SAUNDERS	NASA-JPL
OI - G.	SCHABER	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION
The prime objective of Shuttle Imaging Radar-A (SIR-A) was to obtain maplike images of the earth's surface for geologic exploration. The SIR-A experiment used a sidelooking, synthetic aperture radar operating at L-band (1.278 GHz) with a viewing angle of 47 deg to create two dimensional images of the earth's surface. The imaging radar was independent of sunlight and was able to penetrate cloud cover. A swath width of 50 km and a resolution of 40 m both across and along the track of the beam was attained by this system. The sensor was in operation for 8 h during the 2-1/2 day flight, acquiring images of about 10 million sq km between 38 deg N and 38 deg S latitude. Radar imagery recorded differences in surface roughness and terrain attitude and thus was used to delineate such geological features as faults, anticlines, folds and domes, drainage patterns, and stratification. Landsat multispectral imagery was used to provide supplementary information necessary to identify rock types and types of vegetation. For more detailed descriptions, see "Shuttle Imaging Radar-A (SIR-A) Experiment," JPL 82-77, NASA-JPL, and C. Elachi, et al., "Shuttle Imaging Radar Experiment," Science, v. 218, n. 4576, pp. 996-1003, 1982.

------- STS-2/OSTA-1, GOETZ---------------------------------------

INVESTIGATION NAME- SHUTTLE MULTISPECTRAL INFRARED
RADIOMETER (SMIRR)

NSSDC ID- 81-111A-02 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
EARTH RESOURCES SURVEY

PERSONNEL

PI - A.F.H.	GOETZ	NASA-JPL
OI - L.C.	ROWAN	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION
The purpose of the Shuttle Multispectral Infrared Radiometer (SMIRR) experiment was to determine the spectral bands to be included in a future high-resolution imaging system for mapping rocks associated with mineral deposits from space. The SMIRR system consisted of a Cassegrain telescope, a filter wheel, two Hg-Cd-Te detectors, two film cameras, and supporting electronics. The telescope was a modified version of the Mariner telescope that gathered images of Venus and Mercury in 1973. Since SMIRR was not an imaging device, photographs were necessary to locate the 100-m-diameter radiometer reading within the cameras' ground view (20 by 25 km). The two cameras, one color and one black-and-white, were aligned with the telescope. Analysis showed that the cameras remained aligned after launch stresses. The filter wheel allowed 10 filters to sample the following spectral bands: filters 1 and 2 at 0.5 and 0.6 micrometer for correlation with Landsat; filters 3 and 4 at 1.05 and 1.2 micrometers for field measurements; filter 5 at the 1.6-micrometer Landsat 4 band; filter 6 at the 2.1-micrometer NO hydroxyl absorption band; filters 7, 8 and 9 at the 2.17-, 2.20-, and 2.22-micrometer hydroxyl ion absorption bands; and filter 10 at the 2.35-micrometer carbonate absorption band. The SMIRR sampled 80,000 km of the earth's surface for 3 h and 6 min. Over 1 h of prime data was obtained over cloud-free land areas.

------- STS-2/OSTA-1, KIM---------------------------------------

INVESTIGATION NAME- OCEAN COLOR EXPERIMENT (OCE)

NSSDC ID- 81-111A-05 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
OCEANOGRAPHY
EARTH RESOURCES SURVEY

PERSONNEL

PI - H.H.	KIM	NASA-GSFC
OI - L.R.	BLAINE	NASA-GSFC
OI - R.S.	FRASER	NASA-GSFC
OI - N.E.	HUANG	NASA-GSFC-WFF
OI - H.	VAN DER PIEPER	DFVLR

BRIEF DESCRIPTION
The Ocean Color Experiment (OCE) was designed to demonstrate the ability to locate plankton or chlorophyll concentrations and identify circulation features by mapping color patterns in the ocean. The OCE instrument was a modified version of a NASA high-altitude aircraft sensor known as the U-2-borne ocean color scanner. The instrument was also similar to the coastal zone color scanner (CZCS) on the Nimbus 7 satellite. It consisted of two main modules: the scanner and the electronics. The scanner was mounted on the experiment pallet shelf, and the electronics were coupled to a cold plate on the pallet deck. The rotating mirror on the OCE instrument scanned plus or minus 45 deg from nadir across the direction of flight with a ground resolution of 3 km. The scanner operated in eight spectral intervals: 486 nm (blue), 518 nm, 553 nm (green), 585 nm, 621 nm, 655 nm (red), 685 nm, and 787 nm (near-infrared). The OCE experiment operated successfully and overall image quality and spectral information were excellent. The instrument acquired approximately 20 to 30 minutes of cloud-free data.

------- STS-2/OSTA-1, REICHLE, JR.-----------------------------

INVESTIGATION NAME- MEASUREMENT OF AIR POLLUTION FROM
SATELLITES (MAPS)

NSSDC ID- 81-111A-04 INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
ATMOSPHERIC PHYSICS

PERSONNEL

PI - H.G.	REICHLE, JR.	NASA-LARC
OI - W.L.	CHAMEIDES	GEORGIA INST OF TECH
OI - W.D.	HESKETH	NASA-LARC
OI - C.B.	LUDWIG	PHOTON RESEARCH INC
OI - R.E.	NEWELL	MASS INST OF TECH
OI - L.K.	PETERS	U OF KENTUCKY
OI - W.	SEILER	MPI-CHEMISTRY
OI - J.W.	SWINNERTON	US NAVAL RESEARCH LAB
OI - H.A.	WALLIO	NASA-LARC

BRIEF DESCRIPTION
The Measurement of Air Pollution from Satellites (MAPS) experiment measured for about 35 h the distribution of carbon monoxide in the middle troposphere, upper troposphere, and lower stratosphere over the region from 38 deg N to 38 deg S during both daytime and nighttime. The performance of the MAPS instrument under various temperatures and other orbital conditions indicated the efficiency of using orbiting spacecraft to measure environmental quality. The MAPS equipment consisted of an electro-optical head, an electronics module, a digital tape recorder, and an aerial camera. The core of the MAPS instrument was a nadir-viewing gas filter

radiometer operating at the 4.67-micrometer CO band. The instantaneous field of view was approximately 20 by 22 km. The equipment was coupled to a cold plate and mounted on the experiment pallet shelf. The aerial camera was mounted alongside the MAPS electro-optical head to provide information on cloud cover and the terrain over which the data were gathered.

------- STS-2/OSTA-1, SCHAPPELL--------------------------------

INVESTIGATION NAME- FEATURE IDENTIFICATION AND LOCATION EXPERIMENT (FILE)

NSSDC ID- 81-111A-03

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
EARTH RESOURCES SURVEY

PERSONNEL

PI - R.T.	SCHAPPELL	MARTIN-MARIETTA AEROSP
OI - W.E.	SIVERTSON, JR.	NASA-LARC
OI - J.C.	TIETZ	MARTIN-MARIETTA AEROSP
OI - R.G.	WILSON	NASA-LARC

BRIEF DESCRIPTION

The objective of the Feature Identification and Location Experiment (FILE) was to test a technique for autonomously classifying earth's features into four categories: water, vegetation, bare land, and clouds/snow/ice. The FILE system consisted of a sunrise sensor, two TV cameras, a decision-making electronics unit, a buffer memory, a tape recorder, and a 70-mm Hasselblad camera. This equipment was mounted on the experiment pallet shelf. The sunrise sensor would activate the experiment when the sun was 60 deg from the Space Shuttle's zenith. The two TV cameras were equipped with optical filters for visual red (0.65 micrometer) and near infrared (0.85 micrometer) to determine the ground track. The FILE was a data management technique. Using the ratio between visual red reflectance and near-IR reflectance, it categorized scenes as vegetation, bare ground, water, or snow and clouds. And it would suppress further data acquisition in a certain category after it had acquired a given number of scenes. The FILE experiment operated successfully for several orbits. But only 5 s of classified data were recorded due to a tape recorder malfunction. More description can be found in "Feature Identification and Location Experiment," Science, v. 218, n. 4576, pp. 1031-1033, 1982. The data are available from investigators Eugene Sivertson, Jr. and Gale Wilson, NASA-LaRC.

------- STS-2/OSTA-1, VONNEGUT--------------------------------

INVESTIGATION NAME- NIGHT/DAY OPTICAL SURVEY OF LIGHTNING (NOSL)

NSSDC ID- 81-111A-06

INVESTIGATIVE PROGRAM
CODE EE, APPLICATIONS

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
ATMOSPHERIC PHYSICS

PERSONNEL

PI - B.	VONNEGUT	STATE U OF NEW YORK
OI - M.	BROOK	NM INST OF MINE + TECH
OI - O.H.	VAUGHAN, JR.	NASA-MSFC

BRIEF DESCRIPTION

The objective of the Night/Day Optical Survey of Lightning (NOSL) was to obtain motion picture films and correlated photocell sensor signals of lightning storms. The NOSL equipment consisted of the camera, the attached photocell sensor, and the connected tape recorder. During launch, boost, and reentry, this equipment was secured in storage lockers in the crew compartment. In orbit, the equipment was retrieved and assembled for use in the crew cabin. The motion picture camera was a 16-mm data acquisition camera, a model which has been flight tested on Apollo and Skylab missions. Despite the curtailed duration of the flight and the greatly increased demands on the crew, the crew obtained photographs of lightning at night and excellent motion picture sequences of six large thunderstorm systems during the day. This experiment was reflown twice on later Shuttle missions (STS-4 and STS-6). Data are available from the principal investigator, Dr. Bernard Vonnegut, SUNY at Albany, NY.

Operational Spacecraft and Investigation Descriptions

*******************DMSP 5B/F2-F5, 5C/F1,F2*******************

Spacecraft Name - DMSP 5B/F2-F5, 5C/F1,F2

S/C	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
DMSP 5B/F2	72-018A	03/24/72	98.8	803	885	101.8
DMSP 5B/F3	72-089A	11/09/72	98.8	797	853	101.4
DMSP 5B/F4	73-054A	08/17/73	98.5	795	836	101.2
DMSP 5B/F5	74-015A	03/16/74	99.1	768	860	101.2
DMSP 5C/F1	74-063A	08/09/74	98.6	792	860	101.4
DMSP 5C/F2	75-043A	05/24/75	98.7	795	881	101.7

PM - Space Division Staff USAF Space Division

Brief Description

DMSP (Defense Meteorological Satellite Program) series meteorological satellites were developed and operated by the Air Force. This program, previously known as Data Acquisition and Processing Program (DAPP), was classified until March 1973. The objective of this program was to provide global visual and infrared cloudcover data and specialized environmental data to support Department of Defense requirements for operational weather analysis and forecasting. The program consisted of two satellites in 830-km sun-synchronous polar orbits, with the ascending node of one satellite early in the morning and the other near local noon. The spacecraft, shaped like the frustum of a polyhedron, consisted of four subassemblies: (1) a solar array hat, (2) a base-plate assembly, (3) a sensor AVE (aerospace vehicle electronics) package (SAP), and (4) a data processing system. The primary sensor (SAP) was a four-channel scanning radiometer. Secondary sensors included a vertical temperature profile radiometer (supplementary sensor E -SSE) and an electron spectrograph (supplementary sensor J or J/2 -SSJ or SSJ/2), which were mounted, along with the primary sensor, on the base-plate assembly. Spacecraft stabilization was controlled by a combination flywheel and magnetic control coil system so that the sensors were maintained in the desired earth-looking mode. The data processing system included three tape recorders capable of storing a total of 440 min of data. Either recorded or real-time data were transmitted to ground receiving sites via an S-band transmitter. Recorded data were read out to tracking sites located at Fairchild AFB, Wash., and Loring AFB, Maine, and relayed to Air Force Global Weather Central, Offutt AFB, Nebraska. Real-time data were read out at mobile tactical sites located around the world. For more detailed information, see "Defense Meteorological Satellite Program (DMSP) User's Guide." For information of meteorological data, users may contact SDSD. For the availability of unclassified environmental data, users may direct inquiries to the National Geophysical and Solar-Terrestrial Data Center, NOAA/National Environmental Satellite, Data, and Information Service (NESDIS), Boulder, Colorado 80303.

--------------DMSP 5B/F2-F5, 5C/F1,F2, AFGWC Staff--------------

Investigation Name - Lightning Detector (SSL)

Flown on - DMSP 5B/F5

NSSDC ID - 74-015A-04

PI - AFGWC Staff AFGWC

Brief Description

The lightning detector (Special Sensor L -SSL) was designed to count lightning flashes at night to aid in severe weather detection. The sensor consisted of 12 silicon photodiodes that detected radiation emitted by lightning flashes in the 0.4- to 1.1-micrometer range. The peak response was near 0.8 micrometer. Each photodiode had a nominal field of view of 740 by 740 km on the earth's surface from an altitude of 830 km. The photodiodes were aligned in a 3 by 4 array so that the sensor's field of view was approximately 2200 by 3000 km. The SSL stored the total number of counts and the value of the largest pulse observed by each photodiode during a 1-s sampling interval. Some useful data were collected, but they were never archived for public use.

--------------DMSP 5B/F2-F5, 5C/F1,F2, AFGWC Staff--------------

Investigation Name - Scanning Radiometer (SR)

Flown on - DMSP 5B/F2-F5, 5C/F1,F2

NSSDC ID - 72-018A-01, 72-089A-01, 73-054A-01, 74-015A-01, 74-063A-01, 75-043A-01

PI - AFGWC Staff AFGWC

Brief Description

The four-channel scanning radiometer, designated the sensor AVE (aerospace vehicle electronics) package (SAP), was the primary experiment on the DMSP 5B/5C series. The purpose of this experiment was to provide global, day/night cloud cover and cloud temperature measurements to support Department of Defense requirements for operational weather analysis and forecasting. The radiometer operated in two spectral intervals: (1) visible and near infrared (0.4 to 1.1 micrometers) and (2) infrared (8 to 13 micrometers). The four-channel radiometer was essentially two scanning radiometers driven by a common motor. One radiometer produced high resolution (HR) visual and infrared (IR) data with nadir resolutions of 3.7 and 4.4 km, respectively. The other radiometer produced very high resolution (VHR) visual and infrared (WHR) data with nadir resolutions of 0.63 and 0.67 km, respectively. Onboard recorders had a storage capacity of 210 min of both HR and IR data and a total of 20 min of VHR and WHR data. For direct readout to tactical sites, the experiment was programmed so that VHR and IR data were obtained during the daytime and HR and WHR data were obtained at night. The infrared channels (WHR and IR) covered a temperature range of 210 to 310 deg K with an accuracy of 1 deg K. Electronic circuitry in the sensor converted the sensed infrared energy directly into equivalent black body temperature (as opposed to radiance) prior to transmission to ground sites. The HR channel included a zero resolution sensor which measured solar input and was used to control channel gain, thereby producing an output signal that represents scene albedo. This feature also made it possible to obtain useful visual data at night. The sensor incorporated sunshades and glare suppression devices in conjunction with a long-scan automatic gain control which allowed the HR channel to provide usable data through the day/night terminator. Besides the earth surface/cloud cover imagery at the National Snow and Ice Data Center, Univ. of Colorado, Campus Box 449, Boulder, Colorado 80309, the auroral imagery data are available from the National Geophysical and Solar-Terrestrial Data Center, NOAA/National Environmental Satellite, Data, and Information Service (NESDIS), Boulder, Colorado 80303.

--------------DMSP 5B/F2-F5, 5C/F1,F2, AFGWC Staff--------------

Investigation Name - Vertical Temperature Profile Radiometer (SSE)

Flown on - DMSP 5B/F2,F3,F5, 5C/F1,F2

NSSDC ID - 72-018A-02, 72-089A-02, 74-015A-02, 74-063A-02, 75-043A-02

PI - AFGWC Staff AFGWC

Brief Description

The Special Sensor E (SSE) was a vertical temperature profile radiometer. The objective of this experiment was to obtain vertical temperature and water vapor profiles of the atmosphere to support Department of Defense requirements in operational weather analysis and forecasting. The SSE was an eight-channel sensor with six channels (668.5, 677, 695, 708, 725, and 747 cm-1) in the carbon dioxide 15-micrometer absorption band, one channel (535 cm-1) in a water vapor absorption band, and one channel (835 cm-1) in the 11-micrometer atmospheric window. The experiment consisted of an optical system, a detector and associated electronics, and a scanning mirror. The scanning mirror stepped across the satellite subtrack, allowing the SSE to view 25 separate columns of the atmosphere every 32 s over a cross-track ground swath of 185 km. While the scanning mirror stopped at a scene station, the channel filters were sequenced through the field of view. The surface resolution of the SSE was approximately 37 km at nadir. The carbon dioxide band radiation data were transformed to a temperature profile by a mathematical inversion technique. By a similar technique, this information could be combined with water vapor band data to obtain a water vapor profile. No archival data were produced, due to lack of funds and storage facilities in the operational environment.

--------------DMSP 5B/F2-F5, 5C/F1,F2, Rothwell--------------

Investigation Name - Electron Spectrograph (SSJ)

Flown on - DMSP 5B/F2-F4

NSSDC ID - 72-018A-03, 72-089A-03, 73-054A-03

PI - P.L. Rothwell AFGL

Brief Description

The Special Sensor J (SSJ) was an electron spectrograph with one fixed channel and one stepping channel. The channels detected energetic electrons over ranges of energies associated with visible aurora. The fixed channel was 6 keV and the stepping channel cycled through eight energy thresholds: 54, 98, 219, 600, 1400, 3540, 8200, and 19700 eV. The data sample was taken approximately every second. The field of view was 3 deg by 12 deg.

--------------DMSP 5B/F2-F5, 5C/F1,F2, Rothwell--------------

Investigation Name - Electron Spectrograph (SSJ/2)

Flown on - DMSP 5B/F5, 5C/F1,F2

NSSDC ID - 74-015A-03, 74-063A-03, 75-043A-03

PI - P.L. Rothwell AFGL

Brief Description

The Special Sensor J/2 (SSJ/2) was an improved version of the SSJ. It consisted of an electron spectrograph using a single stepping channel with six energy ranges. Nominal energy steps were 0.3, 0.68, 1.6, 3.5, 7.9, and 18 keV. The sampling rate was 0.0922 second per energy step, and the field of view was a 30-degree anti-earth cone.

-------------DMSP 5B/F2-F5, 5C/F1,F2, Shrum--------------

Investigation Name - Gamma Ray Detector (SSB)

Flown on - DMSP 5B/F4

NSSDC ID - 73-054A-02

PI - J. Shrum AFTAC

Brief Description

The instrument consisted of a four-detector array of cesium iodide scintillators and photomultiplier tubes each surrounded by a tantalum ring shield to provide a directional system. Each detector was positioned so that its most sensitive direction faced 30 deg from the vertical. Pulse-height discriminators were used to provide gamma-ray energy loss thresholds of 0.06, 0.15, and 0.375 MeV. Gamma rays produced in the atmosphere by cosmic rays, precipitating electrons, and other means could be monitored with this instrument.

***********************DMSP 5D-1/F1-F4***********************

Spacecraft Name - DMSP 5D/F1-F4

S/C	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
DMSP 5D-1/F1	76-091A	09/11/76	98.6	806	832	101.3
DMSP 5D-1/F2	77-044A	06/05/77	99.0	787	851	101.3
DMSP 5D-1/F3	78-042A	05/01/78	98.6	802	815	101.1
DMSP 5D-1/F4	79-050A	06/06/79	98.6	806	825	101.2

DMSP 5D-1/F1,F2	PM - J.J. McGlinchey	USAF Space Division
DMSP 5D-1/F3,F4	MG - J. Rivers	USAF Space Division

Brief Description

DMSP 5D-1 series was one of a meteorological satellite series developed and operated by the Air Force. This program, previously known as DAPP (Data Acquisition and Processing Program), was classified until March 1973. The objectives of this program were to provide global visual and infrared cloud cover and specialized environmental data to support Department of Defense requirements for operational weather analysis and forecasting. The program consisted of two satellites in planned 830-km sun-synchronous polar orbits, with the ascending node of one satellite in early morning and the other at local noon. The 5.4-m-long spacecraft was separated into four sections: (1) a precision mounting platform (PMP) for sensors and equipment requiring precise alignment; (2) an equipment support module (ESM) containing the electronics, reaction wheels, and some meteorological sensors; (3) a reaction control equipment (RCE) support structure containing the spent third-stage rocket motor, and supporting the ascent phase reaction control equipment; and (4) a 9.29-sq-m solar cell panel. The Block 5D spacecraft stabilization was controlled by a combination flywheel and magnetic control coil system so sensors could be maintained in the desired "earth-looking" mode. One feature of Block 5D was the precision-pointing accuracy of the primary imager to 0.01 deg provided by a star sensor and an updated ephemeris navigation system. This allowed automatic geographical mapping of the digital imagery to the nearest picture element. The operational linescan system (OLS) was the primary data acquisition system that provided real-time or stored, multi-orbit, day-and-night visual and infrared imagery at 0.6-km resolution for all major land masses, and 2.8-km resolution for complete global coverage. This series also had special meteorological sensors (SSC, SSD, SSH and SSM/T) and other sensors to measure electrons, gamma rays, ionospheric plasma, and X rays. The data processing system, included three high-density tape recorders, each of which could store 400 min of data. Either recorded or real-time data were transmitted to ground-receiving sites via two redundant S-band transmitters. Recorded data were read out to tracking sites located at Fairchild AFB, Wash., and Loring AFB, Maine, and relayed via Satcom to Air Force Global Weather Central, Offutt AFB, Nebraska. Real-time data were read out at mobile tactical sites located around the world. A more complete description of the Block 5D spacecraft can be found in the report, D. A. Nichols, "The Defense meteorological satellite program," Optical Engineering, v. 14, n. 4, July-August 1975. For information on meteorological data, users may contact SDSD. For the availability of unclassified environmental data, users may direct inquiries to the National Geophysical and Solar-Terrestrial Data Center, NOAA/National Environmental Satellite, Data, and Information Service (NESDIS), Boulder, Colorado 80303.

------------------DMSP 5D-1/F1-F4, AFGWC Staff-----------------

Investigation Name - Operational Linescan System (OLS)

Flown on - DMSP 5D-1/F1-F4

NSSDC ID - 76-091A-01, 77-044A-01, 78-042A-01, 79-050A-01

PI - AFGWC Staff AFGWC

Brief Description

The Operational Linescan System (OLS) was the primary experiment on the DMSP Block 5D spacecraft. The purpose of this experiment was to provide global, day/night observations of cloud cover and cloud temperature measurements to support Department of Defense requirements for operational weather analysis and forecasting. The OLS employed a scanning optical telescope driven in an oscillating motion, with optical compensation for image motion, which resulted in near-constant resolution throughout the sensor field of view. The radiometer operated in two ("light" and "thermal infrared") spectral intervals: (1) visible and near infrared (0.4 to 1.1 micrometers) and (2) infrared (8 to 13 micrometers). With DMSP 5D-1/F4, the OLS IR spectral band was changed from 8-13 micrometers to 0.5-12.6 micrometers to improve the sea surface temperature resolution. With onboard processing, the radiometer produced data in four modes: LF (light fine) and TF (thermal fine) data with a resolution of 0.56 km, and LS (light smoothed) and TS (thermal smoothed) data with a resolution of 2.8 km. There were three onboard recorders, and each had a storage capability of 400 min of both LS and TS data or 20 min of LF and TF data. For direct readout to tactical sites, the experiment was programmed so that LF and TS data were obtained at night. The infrared data (TF and TS) covered a temperature range of 210 to 310 deg K with an accuracy of 1 deg K. The LS data mode provided visual data through a dynamic range from full sunlight down to a quarter moon. This mode also automatically adjusted the gain along scan to allow useful data to be obtained across the terminator. Additional information on this experiment is contained in the report, D. A. Nichols, "Primary optical subsystems for DMSP Block 5D," Optical Engineering, v. 14, n. 4, July-August 1975. Besides the earth surface/cloud cover imagery at the National Snow & Ice Data Center, Campus Box 449, Univ. of Colorado, Boulder, Colorado 80309, the auroral imagery is available from the National Geophysical and Solar-Terrestrial Data Center, NOAA/National Environmental Satellite, Data, and Information Service (NESDIS), Boulder, Colorado 80303.

------------------DMSP 5D-1/F1-F4, AFGWC Staff------------------

Investigation Name - Multispectral Filter Radiometer (SSH)

Flown on - DMSP 5D-1/F1-F4

NSSDC ID - 76-091A-02, 77-044A-02, 78-042A-02, 79-050A-02

PI - AFGWC Staff AFGWC

Brief Description

Special Sensor H (SSH), also known as a Vertical Temperature Profile Radiometer (VTPR), was a cross-tracking scanning, multi-channel filter radiometer similar to the HIRS/2 on TIROS-N series. The objective of this experiment was to obtain vertical temperature, water vapor, and ozone profiles of the atmosphere to support Department of Defense requirements in operational weather analysis and forecasting. The SSH was a 16-channel sensor with one channel (1022 cm-1) in the 9.6-micrometer ozone absorption band, one channel (835 cm-1) in the 12-micrometer atmospheric window, six channels (747, 725, 708, 695, 676, 668.5 cm-1) in the 15-micrometer CO2 absorption band, and eight channels (535, 408.5, 441.5, 420, 374, 397.5, 355.4, 353.5 cm-1) in the 18- to 30-micrometer rotational water vapor absorption band. The experiment consisted of an optical system, detector and associated electronics, and a scanning mirror. The scanning mirror was stepped across the satellite subtrack, allowing the SSH to view 25 separate columns of the atmosphere every 32 s over a cross-track ground swath of 2000 km. While the scanning mirror stopped at a scene station, the channel filters were sequenced through the field of view. The surface resolution was approximately 39 km at nadir. Radiance data were transformed into temperature, water vapor, and ozone profiles by a mathematical inversion technique. A more complete description of the experiment can be found in the report, D. A. Nichols, "DMSP Block 5D special meteorological sensor H, optical subsystem," Optical Engineering, v. 14, n. 4, pp. 284-288, July-August 1975. SDSD has the archival data and NSSDC has some ozone data.

------------------DMSP 5D-1/F1-F4, AFGWC Staff------------------

Investigation Name - Microwave Temperature Sounder (SSM/T)

Flown on - DMSP 5D-1/F4

NSSDC ID - 79-050A-06

PI - AFGWC Staff AFGWC

Brief Description

The special sensor microwave/temperature sounder was a seven-channel scanning radiometer which measured radiation in the absorption band of molecular oxygen (50.5, 53.2, 54.35, 54.9, 58.4, 58.825, and 59.4 GHz) to provide data for vertical temperatures from the earth's surface to above 30 km. It was designed to scan in synchronization with the special sensor H package, and it provided temperature soundings at higher altitudes and cloudy regions inaccessible to SSH. By choosing frequencies with different absorption coefficients on the wing of the oxygen absorption band, a series of weighting functions peaking at preselected altitudes was obtained. The radiometer scanned across the nadir track on seven scan positions and two calibration positions (cold sky and 300 deg K). The dwell time for the crosstrack and calibration positions was 2.7 s each. The total scan period was 32 s. The instrument had an instantaneous field of view of 12 deg and scanned plus or minus 36 deg from the nadir. Data are available from SDSD.

------------------DMSP 5D-1/F1-F4, AFGWC Staff------------------

Investigation Name - Snow/Cloud Discriminator (SSC)

Flown on - DMSP 5D-1/F4

NSSDC ID - 79-050A-08

PI - AFGWC Staff AFGWC

Brief Description

The Snow/Cloud Sensor was an experimental unit used in conjunction with the OLS sensor on spacecraft F4. The experiment being performed by the simultaneous in-orbit use of these two sensors is primarily that of proving the proposition that snow/cloud scene discrimination can be obtained through the combination of near IR sensor data and OLS 1-channel (visual) information. The snow/cloud detector was a "push-broom" scan radiometer that depended upon orbital velocity of the spacecraft to provide the along-track scan and a linear array of 48 detector elements at the image plane of a wide lens to provide a 40.2 deg cross-track scan. The sensor measured the reflected solar energy in the 1.51- to 1.63-micrometer spectral band.

------------------DMSP 5D-1/F1-F4, Blake------------------

Investigation Name - GFE-3R Dosimeter (SSJ*)

Flown on - DMSP 5D-1/F1

NSSDC ID - 76-091A-03

PI - J.B. Blake	Aerospace Corp.
OI - S.J. Imamoto	Aerospace Corp.
OI - N. Katz	Aerospace Corp.
OI - W.A. Kolasinski	Aerospace Corp.

Brief Description

The purpose of the GFE-3R dosimeter was to measure the radiation dose in silicon under aluminum shielding of four thicknesses representative of Block 5D DMSP spacecraft. The dosimeter consisted of four separate, single-detector units. These omnidirectional sensors were small, cubical, lithium-drifted, silicon detectors centered under hemispherical shells, and heavily shielded (relative to the hemispherical shell) over the rear 2 pi solid angle. The shielding domes for the four sensors were 35, 75, 125, and 200 mils of aluminum, respectively. The dosimeter directly measured the ionization in the silicon cube caused by natural radiation and served as an electron-proton spectrometer, thus yielding fluxes of energetic electrons and protons encountered in the DMSP orbit, as a function of time. Four integral discriminators, with thresholds corresponding to deposited energy of 25, 75, 300, and 5000 keV, were used to analyze the pulse-height spectrum of signals produced by protons, electrons, and gamma rays entering the detector. Individual pulses from the 25, 300, and 5000 keV channels were counted in scaling registers, which were read out and reset by the telemetry system every 3 s. Pulses, whose amplitudes exceed the gating thresholds of 25 keV and 75 keV, were integrated into 1 MeV equivalent energy pulses (corresponding to a dose of 8.0E-6 rad), which were counted by a cumulative storage register. These registers were read out every 3 s but not reset by the telemetry so that the number of counts read out at any time represented the total energy in MeV deposited in the silicon active volume during the mission life. Maximum accumulated dose storage corresponded to 5.5E5 rad. Additional information can be obtained from Aerospace Corporation publication number TOR-0077(2630)-1, June 1977.

------------------DMSP 5D-1/F1-F4, Mizera------------------

Investigation Name - Remote X-Ray Sensor (SSB/O)

Flown on - DMSP 5D-1/F2

NSSDC ID - 77-044A-06

PI - P.F. Mizera Aerospace Corp.

Brief Description

The investigation was primarily concerned with X rays produced in the atmosphere by precipitating electrons. The instrument consisted of a large-area proportional counter and four circular cadmium-telluride (CdTe) semiconductors embedded in a hemispherical plastic scintillator that was viewed by a photomultiplier tube. The sealed proportional counter had a collimator and was sensitive to X rays from 1.5 to 20.0 keV. The CdTe detectors had discriminators that provided threshold values of 15, 30, 60, and 90 keV.

------------------DMSP 5D-1/F1-F4, Morse------------------

Investigation Name - Atmospheric Density Sensor (SSD)

Flown on - DMSP 5D-1/F4

NSSDC ID - 79-050A-07

PI - F.A. Morse Aerospace Corp.
OI - D. R. Hickman Aerospace Corp.
OI - A.B. Christensen Aerospace Corp.
OI - J.B. Pranke Aerospace Corp.

Brief Description

The SSD was a limb-scanning ultraviolet spectrometer which measured dayglow emissions from O and N2. The wavelengths of primary interest were at 1356 and 3371 A. Energetic photoelectrons were produced by photoionization of neutral molecules by solar EUV radiation. As these fast photoelectrons lost energy through collisions with neutrals, those with energy near 16 eV excited O and N2 to electronic states of energy higher than the ground states. The subsequent decay to the ground state produced emissions monitored by the SSD. The SSD measured light emitted by molecular nitrogen excitation in the LBH and 2d positive bands, and atomic oxygen in the 1356 and 1304 lines. The instrument also had the capability of providing spectral scans from 850 to 1200, from 1100 to 1600, and from 2900 to 3950 A at 4-, 6-, and 12-A resolution, respectively. Light was monitored with narrow collimators that provided a field of view of 0.1 deg x 4 deg. The SSD was mechanically driven to scan vertically through the earth's limb from 80 to 480 km. It provided approximately 50 sets of density profiles on the daylight portion of each orbit.

------------------DMSP 5D-1/F1-F4, Rothwell------------------

Investigation Name - Precipitating Electron Spectrometer (SSJ/3)

Flown on - DMSP 5D-1/F2-F4

NSSDC ID -77-044A-03, 78-042A-03, 79-050A-03

PI - P.L. Rothwell AFGL

Brief Description

The spectrometer consisted of two different-sized cylindrical electrostatic analyzers (ESA) using channeltron electron multipliers. The ESAs pointed toward the zenith in order to measure precipitating electrons. The large ESA had a field of view (FOV) of 1.6 by 8.0 deg with a (delta E)/E of 0.04, while the small one had an FOV of 3.7 by 4.8 deg with a (delta E)/E of 0.072. The large ESA covered the range from 1 to 20 keV and the other one from 50 to 1000 eV. A complete eight-point spectrum from each unit was obtained in 1 s.

------------------DMSP 5D-1/F1-F4, Sagalyn------------------

Investigation Name - Ionospheric Plasma Monitor (SSI/E)

Flown on - DMSP 5D-1/F2,F4

NSSDC ID - 77-044A-05, 79-050A-05

PI - R.C. Sagalyn AFGL

Brief Description

The instrument consisted of one spherical (SEA) and one planar (PEA) electrostatic analyzer. The SEA provided measurements of electron densities from 10 to 1.E6/cc in the temperature range from 200 to 15,000 deg K. The PEA measured ion temperatures in the same range as well as the average ion mass over the range 1 to 35 u. The PEA was oriented in the direction of the positive spacecraft velocity vector, while the SEA was oriented at right angles to this direction and away from the sun to minimize the effect of photoelectrons. The device also provided a measurement of the spacecraft potential.

------------------DMSP 5D-1/F1-F4, Shrum------------------

Investigation Name - Gamma Ray Detector (SSB)

Flown on - DMSP 5D-1/F1,F3

NSSDC ID - 76-091A-04, 78-042A-04

PI - J. Shrum AFTAC

Brief Description

The instrument consisted of a four-detector array of cesium iodide scintillators and photomultiplier tubes each surrounded by a tantalum ring shield to provide a directional system. Each detector was positioned so that its most sensitive direction faced 30 deg from the vertical. Pulse-height discriminators were used to provide gamma-ray energy loss thresholds of 0.06, 0.15, and 0.375 MeV. Gamma rays produced in the atmosphere by cosmic rays, precipitating electrons, and other means could be monitored with this instrument.

------------------DMSP 5D-1/F1-F4, Snyder------------------

Investigation Name - Passive Ionospheric Monitor (SSI/P)

Flown on - DMSP 5D-1/F2,F4

NSSDC ID - 77-044A-04, 79-050A-04

PI - A.L. Snyder AFGL

Brief Description

The instrument consisted of a high-frequency radio receiver connected to a short antenna that swept from 1.3 to 13.9 MHz in 100-kHz steps. The device was used to monitor the ionospheric breakthrough frequency of noise generated by manmade or natural sources below the F2 layer to obtain the critical frequency of this layer (foF2). The foF2 parameter was used in constructing electron-density profiles used in forecasting the state of the ionosphere. The instrument could detect electric fields down to 10 microvolt/m.

**********************DMSP 5D-2/F6-F7**********************

Spacecraft Name - DMSP 5D-2/F6-F7

S/C	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
DMSP 5D-2/F6	82-118A	12/21/82	98.7	817	839	101.4
DMSP 5D-2/F7	83-113A	11/18/83	98.7	810	829	101.3

DMSP 5D-2/F6-F7 MG - S. McElroy USAF Space Division

Brief Description

DMSP 5D-2 series was one of a meteorological satellite series developed and operated by the Air Force. This program, previously known as DAPP (Data Acquisition and Processing Program), was classified until March 1973. The objective of this program was to provide global visual and infrared cloudcover data and specialized environmental data to support Department of Defense requirements for operational weather analysis and forecasting. Operationally, the program consisted of two satellites in planned 830-km, sun-synchronous polar orbits, with the ascending node of one satellite in early morning and the other at local noon. The 6.4-m-long spacecraft was divided into four sections: (1) a precision mounting platform for sensors and equipment requiring precise alignment; (2) an equipment support module containing the electronics, reaction wheels, and some meteorological sensors; (3) a reaction control equipment to support structure containing the spent third-stage rocket motor, and supporting the ascent phase reaction control equipment; and (4) a 9.29-sq-m solar cell panel. The spacecraft stabilization was controlled by a combination flywheel and magnetic control coil system so sensors were maintained in the desired "earth-looking" mode. One feature was the precision-pointing accuracy of the primary imager to 0.01 deg, provided by a star sensor and an updated ephemeris navigation system. This allowed automatic geographical mapping of the digital imagery to the nearest picture element. The operational linescan system was the primary data acquisition system that provided real-time or stored, multi-orbit, day-and-night, visual and infrared imagery. This series also had special meteorological sensors such as the SSH-2 and the SSM/T and other sensors to measure electrons, gamma rays, ionospheric plasma, and X rays. Either recorded or real-time data were transmitted to ground-receiving sites by two redundant S-band transmitters. Recorded data were read out to tracking sites located at Fairchild AFB, Washington, and at Loring AFB, Maine, and relayed by SATCOM to Air Force Global Weather Central, Offutt AFB, Nebraska. Real-time data were read out at mobile tactical sites located around the world. A more complete description of the satellite can be found in the report by D. A. Nichols, "The Defense Meteorological Satellite Program," Optical Engineering, v. 14, n. 4, July-August 1975. For information on meteorological data, users may contact the National Snow and Ice Data Center, CIRES, Campus Box 449, University of Colorado at Boulder, Boulder, CO 80309. For the availability of unclassified environmental data, users may direct inquiries to the National Geophysical and Solar-Terrestrial Data Center, NOAA/National Environmental Satellite, Data and Information Service (NESDIS), Boulder, CO 80303.

------------------DMSP 5D-2/F6-F7, AFGWC Staff-----------------

Investigation Name - Operational Linescan System (OLS)

Flown on - DMSP 5D-2/F6-F7

NSSDC ID - 82-118A-01, 83-113A-01

PI - AFGWC Staff AFGWC

Brief Description

The Operational Linescan System (OLS) was the primary experiment on the DMSP Block 5D spacecraft. The purpose of this experiment was to provide global day and night cloudcover observations and cloud temperature measurements. The OLS employed a scanning optical telescope driven in an oscillating motion, with optical compensation for image motion, which resulted in near-constant resolution throughout the sensor field of view. The radiometer operated in two ("light" and "thermal") spectral intervals: (1) visible and near infrared (0.4 to 1.1 micrometers) and (2) infrared (10.2 to 12.8 micrometers). The radiometer produced, with onboard processing, data in four modes: LF (light fine) and TF (thermal fine) data with a resolution of 0.56 km, and LS (light smoothed) and TS (thermal smoothed) data with a resolution of 2.8 km. There were four onboard recorders, each had a storage capability of 400 min of both LS and TS data or 20 min of LF and TF data. For direct readout to tactical sites, the experiment was programmed so that LF and TS data were obtained at night. The infrared data (TF and TS) covered a temperature range of 190 to 310 deg K with an accuracy of at best 2 deg K. The LS data mode provided visual data through a dynamic range from full sunlight down to a quarter moon. This mode also automatically adjusted the gain along the scan to allow useful data to be obtained across the terminator. Additional information on this experiment is contained in the report by D. A. Nichols, "Primary optical subsystems for DMSP Block 5D," Optical Engineering, v. 14, n. 4, July-August 1975. Data can be obtained through the National Snow & Ice Data Center, Campus Box 449, Univ. of Colorado, Boulder, Colorado 80309.

------------------DMSP 5D-2/F6-F7, AFGWC Staff------------------

Investigation Name - Infrared Temperature Profile Sounder (SSH-2)

Flown on - DMSP 5D-2/F6

NSSDC ID - 82-118A-02

PI - AFGWC Staff AFGWC

Brief Description

The objective of this experiment was to obtain vertical temperature and water vapor profiles of the atmosphere at altitudes from 0 to 30 km. The infrared temperature and moisture sounder, SSH-2, was a 16-channel sensor with one channel (3.7 micrometers) in the 3.7-micrometer window, one channel (11.1 micrometers) in the 12-micrometer window, six channels (13.4, 13.7, 14.1, 14.4, 14.8, 15.0 micrometers) in the 15-micrometer CO2 absorption band, and eight channels (12.5, 18.7, 20.1, 22.7, 23.9, 24.5, 25.2, 28.3 micrometers) in the 22- to 30-micrometer rotational water vapor absorption band. The experiment consisted of an optical system, detector and associated electronics, and a scanning mirror. The scanning mirror was stepped across the satellite groundtrack, allowing the sounder to view 25 separate columns of the atmosphere every 32 s over a crosstrack ground swath of 2204 km. While the scanning mirror was stopped at each of the 25 positions, the channel filters were sequenced through the field of view. The crosstrack surface resolution was approximately 60 km at nadir. The radiance data were transformed into temperature and water vapor profiles by a mathematical inversion technique. The rms error of the temperature was 2.5 to 3 deg K. Archival data are available from SDSD at the National Climatic Data Center (NCDC), Room 100, World Weather Building, Washington, D. C. 20233.

-----------------DMSP 5D-2/F6-F7, AFGWC Staff-----------------

Investigation Name - Microwave Temperature Sounder (SSM/T)

Flown on - DMSP 5D-2/F7

NSSDC ID - 83-113A-03

PI - AFGWC Staff AFGWC

Brief Description

The microwave temperature sounder, SSM/T, was a seven-channel scanning radiometer which measured radiation in the 5- to 6-mm wavelength (50- to 60-GHz) region, (specifically 50.5, 53.2, 54.35, 57.9, 58.4, 58.825, and 59.4 GHz) to provide data on the vertical temperature profile from the earth's surface to above 30 km. The SSM/T provided temperature soundings at higher altitudes and over cloudy regions inaccessible to an infrared temperature and moisture sounder. By choosing frequencies with different absorption coefficients on the wing of the oxygen absorption band, a series of weighting functions peaking at preselected altitudes was obtained. The radiometer scanned across the nadir track on seven scan positions and two calibration positions (cold sky and 300 deg K). The dwell time for the crosstrack and calibration positions was 2.7 s each. The total scan period was 32 s. The instrument had an instantaneous field of view of 12 deg and scanned plus or minus 36 deg from the nadir. Archival data are available from SDSD at the National Climatic Data Center (NCDC), Room 100, World Weather Building, Washington, D. C. 20233.

------------------DMSP 5D-2/F6-F7, AFGWC Staff------------------

Investigation Name - Magnetometer (SSM)

Flown on - DMSP 5D-2/F7
NSSDC ID - 83-113A-06

PI - AFGWC Staff AFGWC

Brief Description

The primary purpose of the magnetometer experiment was to obtain the components of magnetic field transverse to the main geomagnetic field at high latitudes which are associated with auroral field-aligned currents. The instrument consisted of (1) a triaxial fluxgate magnetometer with a fixed Z-axis sensor and adjustable X- and Y-axis sensors and (2) a signal processor to provide data at a 15-nT resolution over the range of 0 to 60,000 nT. Inquiries about data can be directed to Dr. Fred Rich, AFGL, Office PHG, Hanscom AFB, MA 01731.

-----------------DMSP 5D-2/F6-F7, AFGWC Staff-------------------

Investigation Name - Space Radiation Dosimeter (SSJ*)

Flown on - DMSP 5D-2/F7

NSSDC ID - 83-113A-07

PI - AFGWC Staff AFGWC

Brief Description

The primary purpose of the space radiation dosimeter was to measure the radiation dose above desired thresholds in silicon under aluminum shielding of four thicknesses representative of the Block 5D DMSP spacecraft. The instrument consisted of four detectors mounted beneath hemispherical domes of different thicknesses. Each detector was a pin-diffused junction silicon diode. The dosimeter directly measured the ionization in the silicon cube caused by natural radiation and served as an electron-proton spectrometer, thus yielding the fluxes of energetic electrons and protons encountered in the orbit as a function of time. The energy thresholds for measured electrons by different dome sensors were 1.0, 2.5, 5.0 and 10.0 MeV, and those for protons were 20, 35, 51, and 75 MeV. The radiation dose and the energetic electron flux obtained in this experiment may result in an optimization of space radiation-shielding design to protect sensitive electronics components. Inquiries about data can be directed to Ms. S. Gussenhoven at AFGL, Office PHG, Hanscom AFB, MA 01731.

-----------------DMSP 5D-2/F6-F7, Kolasinski------------------

Investigation Name - Scanning X-ray Spectrometer (SSB/A)

Flown on - DMSP 5D-2/F6

NSSDC ID - 82-118A-03

PI - A. Kolasinski Aerospace Corp

Brief Description

The primary objective of the scanning X-ray spectrometer, SSB/A, was to carry out studies in X rays, Lyman-alpha, and locally mirroring electrons. The instrument was composed of a high-energy and a low-energy scanning X-ray sensor, a Lyman-alpha sensor, and Geiger counters for monitoring electron background. The high-energy X-ray sensor consisted of three CdTe crystal detectors to measure X rays in the energy ranges 15 to 30 keV, 30 to 60 keV, 60 to 100 keV, and >100 keV. Each detector had an area of 1 sq cm and a 14-deg field of view. The low-energy X-ray sensor was a 3-atm single-wire proportional counter containing equal amounts of argon and xenon. It measured the flux of X rays in 24 logarithmically spaced energy bands between 1.8 and 78 keV. This sensor had an effective area of 3.7 sq cm and a 5-deg (in track) by 10-deg (crosstrack) field of view. The high- and low-energy X-ray sensors were mounted on separate scanning heads which scanned across the ground track through a 110-deg arc. A complete limb-to-limb scan took 10 s. The Lyman-alpha sensor detected prominent proton events. The two Geiger counters measured electron fluxes above 40 keV and 100 keV. Archival data can be obtained through Dr. David Gorney at the Aerospace Corporation, Space Science Lab, M2/262, P. O. Box 92957, Los Angeles, CA 90009.

-----------------DMSP 5D-2/F6-F7, Rothwell--------------------

Investigation Name - Precipitating Electron/Ion Spectrometer (SSJ/4)

Flown on - DMSP 5D-2/F6-7

NSSDC ID - 82-118A-05, 83-113A-05

PI - P. L. Rothwell USAF Geophys Lab

Brief Description

The primary purpose of the precipitating electron/ion spectrometer was to measure fluxes and energies of electrons and ions precipitated into the upper atmosphere. Particles were separated by an electrostatic analyzer into 20 energy bands from 30 eV to 30 keV: (1) 10 high-energy levels, at

0.948, 1.39, 2.04, 3.00, 4.40, 6.46, 9.48, 13.92, 20.44 and 30.00 keV; and (2) 10 low-energy levels, at 30.0, 44.0, 64.6, 94.9, 139.2, 204.4, 300, 440, 646, and 948 eV. Channeltrons were used to count the impinging electrons and ions in each energy band with particle flux accuracies of 1% and energy flux accuracies of 3.5%. Inquiries about data can be directed to Ms. S. Gussenhoven at the AFGL, Office PHG, Hanscom AFB, MA 01731.

------------------DMSP 5D-2/F6-F7, Sagalyn------------------

Investigation Name - Ionospheric Plasma Monitor (SSI/E)

Flown on - DMSP 5D-2/F6-F7

NSSDC ID - 82-118A-04, 83-113A-04

PI - R. C. Sagalyn USAF Geophys Lab

Brief Description

The instrument consisted of one spherical (SEA) and one planar (PEA) electrostatic analyzer. The SEA provided measurements of electron densities from 10 to 1.E6 electrons/cc in the temperature range from 200 to 15,000 deg K. The PEA measured ion temperatures in the same range as well as the average ion mass over the range 1 to 35 u. The PEA was oriented in the direction of the positive spacecraft velocity. Inquiries about data can be directed to Dr. Fred Rich at AFGL, Office PHG, Hanscom AFB, MA 01731.

------------------DMSP 5D-2/F6-F7, Shrum--------------------

Investigation Name - X-Ray Detector (SSB/S)

Flown on - DMSP 5D-2/F7

NSSDC ID - 83-113A-08

PI - J. Shrum USAF Tech Appl Ctr

Brief Description

The primary purpose of the X-ray detector, SSB/S, was to detect nuclear debris from nuclear detonations. The instrument consisted of three sensors. Two of the sensors were arrays of four 1-cm-diameter CdTe detectors which sensed X rays in the four energy bands >45 keV, >75 keV, >115 keV, and >165 keV. The third sensor was a NaI detector which sensed scintillation. Rotating the sensor assembly caused all three sensors to scan across the ground track.

************************* ESSA 1-9*************************

Spacecraft Name - ESSA 1-9

S/C	Alternate Name	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
ESSA 1	OT 3	66-008A	02/03/66	97.9	702	845	100.4
ESSA 2	OT 2	66-016A	02/28/66	101.0	1356	1418	113.6
ESSA 3	TOS-A	66-087A	10/02/66	101.1	1383	1493	114.6
ESSA 4	TOS-B	67-006A	01/26/67	102.0	1328	1443	113.5
ESSA 5	TOS-C	67-036A	04/20/67	102.0	1361	1423	113.6
ESSA 6	TOS-D	67-114A	11/10/67	102.1	1410	1488	114.8
ESSA 7	TOS-E	68-069A	08/16/68	101.7	1432	1476	115.0
ESSA 8	TOS-F	68-114A	12/15/68	101.9	1410	1473	114.7
ESSA 9	TOS-G	69-016A	02/26/69	101.8	1427	1508	115.3

S/C	PM	PS
ESSA 1	R.M. Rados (Retired) NASA-GSFC	Aero. and Meteo. Div. NASA-GSFC
ESSA 2-9	W.W. Jones (NLA) NASA-GSFC	

Brief Description

ESSA 1-9 (Environmental Science Services Administration) were spin-stabilized operational meteorological spacecraft designed to take daytime cloudcover pictures and solar and terrestrial radiation on a global basis. They were also known as Operational TIROS (OT) and TIROS Operational Satellites (TOS). ESSA 1 had a redundant vidicon camera system. Later odd-number ESSA satellites were equipped with two advanced vidicon camera system (AVCS) cameras. Even-numbered ESSA satellites had two automatic picture transmission (APT) cameras. The AVCS satellites also carried a flat plate radiometer (FPR) system. The satellites had essentially the same configuration as that of the TIROS series, i.e., an 18-sided right prism, 107 cm across opposite corners and 56 cm high, with a reinforced baseplate carrying most of the subsystems and a cover assembly (HAT). Electrical power was provided by approximately 10,000 1- by 2-cm solar cells that were mounted on the cover assembly and by 21 nickel-cadmium batteries. A pair of crossed-dipole command and receiving antennas projected out and down from the baseplate. A monopole telemetry and tracking antenna extended up from the top of the cover assembly. Each satellite was placed in a cartwheel orbital mode, with its spin axis maintained normal to the orbital plane. The satellite spin rate and attitude were determined primarily by a magnetic attitude spin coil (MASC). The MASC was a current-carrying coil mounted in the cover assembly. The magnetic field induced by the current interacted with the earth's magnetic field to provide the necessary torque maintaining a desired spin rate of 9.225 rpm for odd-numbered ESSAs and 10.9 rpm for even-numbered ESSAs. Five small solid-fuel thrusters mounted around the baseplate provided a secondary means of controlling the spacecraft spin rate.

-------------------ESSA 1-9, NESDIS Staff-----------------

Investigation Name - Advanced Vidicon Camera System (AVCS)

Flown on - ESSA 3, 5, 7, 9

NSSDC ID - 66-087A-01, 67-036A-01, 68-069A-01, 69-016A-01

PI - NESDIS Staff NOAA-NESDIS

Brief Description

This system was a camera, tape recorder, and transmitter combination that could record and store a series of remote daytime cloudcover pictures for subsequent playback to a ground data acquisition facility. The cameras and tape recorder system were essentially the same as those on Nimbus 1 and 2. The ESSA AVCS system consisted of two redundant wide-angle cameras with 2.54-cm vidicons. The cameras were mounted 180 deg apart on the side of the spacecraft, with their optical axes perpendicular to the spin axis. The camera optical system employed a 108-deg lens with a focal length of 6.0 mm. Each camera was independently triggered into action only when it came into view of the earth. A video frame consisted of 0.25 s of blanked video followed by 6.25 s of vidicon scan (833 lines) and a final 0.25-s period of blanked video. Concurrent with shutter actuation, a 16-increment gray scale was included at the edge of each picture frame as a contrast check. A four-track tape recorder could store up to 36 pictures. The data could be read out between picture-taking cycles without losing a picture or interrupting a sequence. Six or 12 AVCS pictures per orbit could be programmed. At nominal attitude and altitude (approximately 1450 km), a picture covered a 3100- by 3100-km square with a horizontal resolution of about 3 km at nadir. There was a 50% overlap along the track between successive pictures to ensure complete coverage. The experiment was a success. Data from this experiment are available through SDSD. For an index of available data, see the "Catalog of Meteorological Satellite Data - ESSA 3 Television Cloud Photography," "Catalog of Meteorological Satellite Data - ESSA 3 and ESSA 5 Television Cloud Photography," etc., for sale from the U.S. Superintendent of Documents.

-----------------ESSA 1-9, NESDIS Staff-------------------

Investigation Name - Automatic Picture Transmission (APT)

Flown on - ESSA 2, 4, 6, 8

NSSDC ID - 66-016A-01, 67-006A-01, 67-114A-01, 68-114A-01

PI - NESDIS Staff NOAA-NESDIS

Brief Description

This experiment was a camera and transmitter combination designed to transmit real-time, daylight, slow-scan television pictures of cloud cover to any properly equipped ground receiving station. The camera system consisted of two redundant APT cameras with 2.54-cm-diameter vidicons. Each camera had a 108-deg wide-angle f/1.8 objective lens with a focal length of 5.7 mm. The cameras were mounted 180 deg apart on the side of the spacecraft, with their optical axes perpendicular to the spacecraft spin axis. The cameras were programmed to take four or eight APT pictures per orbit. The actual photography required 8 s and the transmission 200 s. Earth-cloud images retained on the photosensitive surface of the vidicon were read out at four lines per second to produce an 800-line picture. Two 5-W TV transmitters (137.5 MHz) relayed the pictures to local APT stations within communication range. The faceplate of the vidicon had reticle marks that appeared on the picutre format to aid in relating the picture to its geographical position on the earth's surface. At nominal satellite attitude and altitude (approximately 1450 km), a picture covered a 3100- by 3100-km square with a horizontal resolution of about 4 km at nadir. There was a 30% overlap between picutres along the track to ensure complete coverage. APT data were primarily intended for operational use within the local APT acquisition station.

------------------ESSA 1-9, NESDIS Staff------------------

Investigation Name - Vidicon Camera System

Flown on - ESSA 1

NSSDC ID - 66-008A-01

PI - NESDIS Staff NOAA-NESDIS

Brief Description

This system was a camera, tape recorder, and transmitter combination that could record and store a series of remote daytime cloudcover pictures for subsequent playback to a ground data acquisition facility. The system was similar to those flown on previous TIROS missions, consisting of two redundant 500-scan-line TV cameras with 1.27-cm vidicons. The cameras were mounted 180 deg apart on the side of the spacecraft and were canted 75 deg from the spacecraft spin axis. The cameras were triggered into action only when they came into view of the earth. Each tape recorder had two separate channels, one for storing video signals and one for sun-angle data, which served as a time reference. Up to 32 pictures consisting of five levels of gray could be stored for subsequent playback. At nominal attitude and altitude (approximately 1450 km), the cameras covered a 1200- by 1200-km square with a spatial resolution of about 3 km at nadir. The experiment was a success. Data from this experiment are available through SDSD. For a complete index of data, see parts 1 and 2 of the "Catalog of Meteorological Satellite Data - ESSA 1 Television Cloud Photography," for sale from the U.S. Superintendent of Documents.

-----------------------ESSA 1-9, Suomi-----------------------

Investigation Name - Flat Plate Radiometer (FPR)

Flown on - ESSA 3, 5, 7, 9

NSSDC ID - 66-087A-02, 67-036A-02, 68-069A-02, 69-016A-02

PI - V.E. Suomi — U of Wisconsin
OI - R.S. Parent — U of Wisconsin

Brief Description

This experiment was designed to provide a measurement of the global distribution of reflected solar and long-wave radiation leaving the earth. The FPR system was comprised of four infrared sensors, an analog-to-digital converter, a commutator, and a tape recorder. Two pairs of radiometers were mounted on opposite sides of the spacecraft, with their axes perpendicular to the spin axis. A cone shield was employed on two of the radiometers to isolate or reduce any response due to direct solar radiation. The field of view on the other two instruments was unrestricted. Both types of radiometers used a coated (either black or white) aluminum disk as the sensing element. The disk temperature was measured by two thermistors mounted on the back surface of the disk. The black-coated disk responded to the sum of the reflected solar, direct solar, and emitted long-wave radiation. The white disk reflected in the visual range but absorbed in the infrared (7 to 30 micrometers) range. Data from this experiment are available through SDSD.

*************************Gemini 3-12*************************

Spacecraft Name - Gemini 3-12

S/C	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
Gemini 3	65-024A	03/23/65	33.0	160	240	88.6
Gemini 4	65-043A	06/04/65	32.5	162	281	88.8
Gemini 5	65-068A	08/21/65	32.6	197	303	89.4
Gemini 6A	65-104A	12/15/65	28.9	258	271	89.6
Gemini 7	65-100A	12/04/65	28.9	292	298	90.3
Gemini 8	66-020A	03/16/66	28.9	285	298	90.2
Gemini 9	66-047A	06/03/66	28.9	270	272	89.8
Gemini 10	66-066A	07/18/66	28.9	391	400	92.3
Gemini 11	66-081A	09/12/66	28.8	161	280	88.8
Gemini 12	66-104A	11/11/66	28.8	243	310	89.9

PM - W.C. Schneider (Retired) NASA Headquarters
PM - C.W. Mathews (Retired) NASA-JSC

Brief Description

The specific objectives of the Gemini missions were (1) to determine how man performs in the space environment on flights of as much as 2 weeks; (2) to develop the capability to rendezvous with another craft and dock with it; (3) to maneuver the combined vehicles; (4) to provide a platform for scientific, engineering and medical experiments; (5) to develop methods of controlling reentry flight paths to selected landing areas; and (6) to develop astronaut space-flight experience, including extravehicular activity. The experiments conducted during manned flights derived from a variety of disciplines including aeronomy, astronomy, biology, physiology, geography, geology, meteorology, and space physics. The Gemini missions were highly successful and produced some significant experimental results.

----------------------Gemini 3-12, Lowman----------------------

Investigation Name - Synoptic Terrain Photography

Flown on - Gemini 3-12

NSSDC ID - 65-024A-03, 65-043A-01, 65-068A-02, 65-104A-01, 65-100A-01, 66-020A-01, 66-047A-05, 66-066A-02, 66-081A-06, 66-104A-02

PI - P.D. Lowman, Jr. NASA-GSFC

Brief Description

This experiment was designed to take high-quality color photographs of selected land and near-shore areas of the earth by hand-held cameras for geologic, geographic, and oceanographic studies. For the Geminis 3-9, a 70-mm Hasselblad 500C camera with a Zeiss Planar 80-mm f/2.8 lens was used to obtain the photographs. The Gemini 7 had another Zeiss Sonnar 250-mm f/4.5 lens. For the Geminis 9-12, two cameras were used. (Thus, with these two cameras plus the Hasselblad camera mentioned above, Gemini 9 had three cameras.) One camera was a super wide-angle Hasselblad 70-mm with a Zeiss Biogon 38-mm f/4.5 lens, and the other one was a specially designed Maurer camera with a Xenotar 80-mm f/2.8 lens. Haze filters were used on all cameras to reduce the intensity of blue light scattering from the atmosphere. This experiment was not formally scheduled on Gemini 3, but useful pictures were taken by the astronauts. Data from this experiment are available from the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota. The index of photographs can be found in "Earth Photographs from Gemini III, IV, and V" (NASA SP-129) and "Earth Photographs from Gemini 6 through 12" (NASA SP-171).

---------------------Gemini 3-12, Nagler---------------------

Investigation Name - Synoptic Weather Photography

Flown on - Gemini 4-12

NSSDC ID - 65-043A-02, 65-068A-03, 65-104A-02, 65-100A-02, 66-020A-07, 66-047A-06, 66-066A-03, 66-081A-07, 66-104A-03

PI - K. Nagler	NOAA-NMC
OI - S. Soules	NOAA-NWS

Brief Description

The synoptic weather photographs were taken by the same cameras used for the synoptic terrain photography experiment. Photographs were taken when the spacecraft were in a nearly vertical position. The photographs are archived at the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota. The index of photographs can be found in "Earth Photographs from Gemini III, IV, and V" (NASA SP-129) and "Earth Photographs from Gemini 6 through 12" (NASA SP-171).

***********************ITOS 1, NOAA 1-5***********************

Spacecraft Name - ITOS 1, NOAA 1-5

S/C	Alternate Name	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
ITOS 1	TIROS-M	70-008A	01/23/70	102.0	1432	1478	115.0
NOAA 1	ITOS-A	70-106A	12/11/70	101.9	1422	1472	114.8
NOAA 2	ITOS-D	72-082A	10/15/72	101.8	1448	1453	114.9
NOAA 3	ITOS-F	73-086A	11/06/73	102.1	1500	1509	116.1
NOAA 4	ITOS-G	74-089A	11/15/74	101.7	1443	1457	114.9
NOAA 5	ITOS-H	76-077A	07/29/76	102.1	1502	1520	116.2

S/C	PM	PS
ITOS 1, NOAA 1	W.W. Jones (NLA) NASA-GSFC	I.L. Goldberg NASA-GSFC
NOAA 2,3	S. Weiland (Retired) NASA-GSFC	I.L. Goldberg NASA-GSFC
NOAA 4,5	G.A. Branchflower (NLA) NASA-GSFC A. Butera NOAA-NESDIS S. Weiland (Retired) NASA-GSFC	I.L. Goldberg NASA-GSFC

Brief Description

The primary objective of the ITOS 1/NOAAs 1-5 three-axis stabilized, sun-synchronous meteorological satellites was to provide improved operational infrared and visual observations of earth cloud cover, surface/cloud top temperatures, and global atmospheric temperature soundings for weather analysis and forecasting. The secondary objective was to provide solar proton flux data on a regular daily basis. ITOS 1 and NOAA 1 each had five experiments: (1) advanced vidicon camera system (AVCS), (2) automatic picture transmission (APT), (3) scanning radiometer (SR), (4) flat plate radiometer (FPR), and (5) solar proton monitor (SPM). NOAA 2-5 were redesigned to incorporate two instruments and to eliminate the APT and AVCS cameras as well as the FPR. With the addition of the very high resolution radiometer (VHRR) and the vertical temperature profile radiometer (VTPR), NOAA 2-5 entirely relied on scanning radiometers for images and carried an operational instrument capable of obtaining vertical temperature profiles of the atmosphere. The nearly cubical spacecraft measured 1 by 1 by 1.2 m. The spacecraft was equipped with three curved solar panels that were folded during launch and deployed after orbit was achieved. Each panel measured over 4.2 m in length when unfolded and was covered with 3420 solar cells, each measuring 2 by 2 cm. The attitude control system maintained desired spacecraft orientation through gyroscopic principles incorporated into the satellite design. Earth orientation of the satellite body was maintained by taking advantage of the precession induced from a momentum flywheel so that the satellite body precession rate of one revolution per orbit provided the desired "earth looking" attitude. Minor adjustments in attitude and orientation were made by means of magnetic coils and by varying the speed of the momentum flywheel.

----------------ITOS 1, NOAA 1-5, NESDIS Staff----------------

Investigation Name - Advanced Vidicon Camera System (AVCS)

Flown on - ITOS 1, NOAA 1

NSSDC ID - 70-008A-04, 70-106A-04

PI - NESDIS Staff NOAA-NESDIS

Brief Description

The Advanced Vidicon Camera System (AVCS) was a redundant camera and tape recorder combination designed to record a series of wide-angle, high-resolution television pictures of the earth and its cloud cover during daylight. The AVCS operated in three modes: record, playback, and direct readout. The AVCS system was essentially the same as that used on all TOS/ESSA spacecraft (ESSAs 3, 5, 7, and 9). The two major elements of the system were (1) the camera sensor assembly, which contained lens, shutter, grayscale calibrator, vidicon, deflection yoke, camera electronics module, and power circuits, and (2) a preamplifier for converting optical images into electrical signals. The earth-oriented camera used a 108-deg wide-angle lens (5.7-mm focal length) with an f/1.8 aperture and a 2.54-cm-diameter vidicon with 833 scan lines. A video frame consisted of 0.25 s of blanked video, followed by 6.25 s of vidicon scan video (833 lines), and a final 0.25-s period of blanked video. Eleven pictures were taken at 260-s intervals to cover the sunlit portion of the earth (sun elevation greater than 15 deg). The tape recorder could be read out between photographic cycles without losing a picture or interrupting a sequence. At nominal satellite altitude (1450 km), the AVCS pictures covered a 3000- by 3000-km square with a ground resolution of about 3 km at nadir. There was a 50% picture overlap along the track to ensure complete coverage. The recorder could store up to 38 pictures (three orbits of data) in a single start-stop operation. Data are available through SDSD.

-----------------ITOS 1, NOAA 1-5, NESDIS Staff-----------------

Investigation Name - Automatic Picture Transmission (APT)

Flown on - ITOS 1, NOAA 1

NSSDC ID - 70-008A-05, 70-106A-05

PI - NESDIS Staff NOAA-NESDIS

Brief Description

The Automatic Picture Transmission (APT) experiment was designed to automatically take wide-angle, slow scan television pictures of the earth and its cloud cover during daylight. This experiment consisted of two APT subsystems. The photographic operations of APT were controlled by program commands transmitted to the satellite by the command and data acquisition (CDA) stations. A complete APT picture sequence lasted approximately 46 min, during which 11 pictures were taken at 260-s intervals. These pictures were transmitted by 137.62-MHz real-time transmitters to APT-equipped ground stations within communication range of the satellites. The APT subsystem was essentially the same as that used on the TOS/ESSA spacecraft (ESSAs 2, 4, 6, and 8). The major elements of the subsystem were the camera sensor assembly, video amplifier, camera electronics module, and power circuits. The earth-oriented camera used a 108-deg (5.7-mm focal length) wide-angle lens with a maximum aperture of f/1.8 and a 2.54-cm-diameter vidicon with 600 scan lines. At the nominal satellite altitude of 1450 km, each picture covered approximately 3140 km across the track and 2400 km along the track with a ground resolution of about 3 km at nadir. There was an approximate 20% overlap between pictures along the track to ensure complete coverage. APT data were intended primarily for local operational use within an APT acquisition station and generally are not available for distribution.

-----------------ITOS 1, NOAA 1-5, NESDIS Staff-----------------

Investigation Name - Scanning Radiometer (SR)

Flown on - ITOS 1, NOAA 1-5

NSSDC ID - 70-008A-03,70-106A-03, 72-082A-02, 73-086A-02,
74-089A-02, 76-077A-03

PI - NESDIS Staff NOAA-NESDIS

Brief Description

The Scanning Radiometer (SR) experiment consisted of two scanning radiometers, a dual processor, and two recorders. This subsystem permitted the determination of surface temperatures of the ground, the sea, or cloud tops viewed by the radiometers. The radiometer measured reflected radiation from the earth-atmosphere system in the 0.52- to 0.73-micrometer band during the day and emitted radiation from the earth and its atmosphere in the 10.5- to 12.5-micrometer band day and night. The SR on NOAAs 2 and 5 had an additional channel in the 0.50- to 0.94-micrometer region. Unlike a camera, the SR did not take a picture but instead formed an image using a continuously rotating mirror. The mirror scanned the earth's surface perpendicular to the satellite's orbital path at a rate of 48 rpm. As the satellite progressed along its orbital path, each rotation of the mirror provided one scan line of picture. Radiation collected by the mirror was passed through a beam splitter and spectral filter to produce the desired spectral separation. Up to two full orbits of data (145 min) could be stored on magnetic tape for subsequent transmission (1697.5 MHz) to one of the two acquisition stations. The data could also be transmitted in real time to local automatic picture transmission (APT) stations. Once the signal was received by the ground station, a continuous picture was formed by using a facsimile recorder whose scan was in phase with the satellite's forward motion. At nominal spacecraft altitude (approximately 1450 km), the radiometer had a ground resolution of better than 4 km at nadir. The radiometer was capable of yielding radiance temperatures between 185 and 330 deg K to an accuracy of 4 and 1 deg K, respectively. Data from this experiment are available through SDSD.

-----------------ITOS 1, NOAA 1-5, NESDIS Staff-----------------

Investigation Name - Very High-Resolution Radiometer (VHRR)

Flown on - NOAA 2-5

NSSDC ID - 72-082A-03, 74-089A-03, 76-077A-01, 73-086A-03

PI - NESDIS Staff NOAA-NESDIS

Brief Description

The Very High-Resolution Radiometer (VHRR) experiment was designed to continuously measure surface temperatures of the earth, sea, and cloud tops day and night. The data were transmitted in real time to high-resolution picture transmission (HRPT) receiving stations throughout the world for local weather forecasting. In addition, 8 min of data per orbit were programmed for storage in the satellites for later playback to command and data acquisition (CDA) stations. The experiment included two scanning radiometers, a magnetic tape recorder, and associated electronics. The two-channel VHRR operation was similar to that of the scanning radiometer (SR) but with much greater resolution (0.9 km compared to 4 km for the SR at nadir). One VHRR channel measured reflected visual radiation from cloud tops in the spectral range of 0.6 to 0.7 micrometer. This provided more contrast between the earth and clouds than the SR by reducing the effect of haze. The second channel measured infrared radiation emitted from the earth, sea, and cloud tops in the 10.5- to 12.5-micrometer region. This spectral region permitted both daytime and nighttime radiance measurements. The VHRR formed an image by using a scanning mirror technique similar to the SR except that both radiometers operated simultaneously. As the satellite proceeded in its orbit, the 400-rpm revolving mirrors scanned the earth's surface 180 deg out of phase (one mirror at a time) and perpendicular to the orbit path. The visible and infrared data were time-multiplexed so that the scan of the infrared channel transmitted first, followed by the earth scan portion of the visible channel. This process was repeated 400 times per minute (equivalent to the scan rate). If one radiometer failed, the system was still capable of measuring both visible and infrared radiation using only the remaining radiometer. Data from this experiment are presently maintained at SDSD.

------------------ITOS 1, NOAA 1-5, NESDIS Staff------------------

Investigation Name - Vertical Temperature Profile Radiometer (VTPR)

Flown on - NOAA 2-5

NSSDC ID - 72-082A-04 73-086A-04, 74-089A-04, 76-077A-02

PI - NESDIS Staff NOAA-NESDIS

Brief Description

This experiment consisted of two Vertical Temperature Profile Radiometer (VTPR) subsystems. The VTPR sensed the radiance energy from atmospheric carbon dioxide in six narrow spectral regions centered at 15.0, 14.8, 14.4, 14.1, 13.8, and 13.4 micrometers. The atmospheric gross water vapor content was determined from measurements centered at 18.7 micrometers. Measurements were also taken in the 12.0-micrometer spectral region to determine surface/cloud top temperatures. The VTPR consisted of an optical system, a detector and associated electronics, and a scanning mirror. The scanning mirror looked at the earth's surface perpendicular to the satellite orbital path. As each area was scanned, the optical system collected, filtered, and detected the radiation from the earth into the eight spectral intervals. The field of view contributing to one profile was approximately 50 sq km at the ground. The radiometer operated continuously, taking measurements over every part of the earth's surface twice a day. The data were recorded throughout the orbit and played back on command when the satellite was within communication range of a command and acquisition station. Ground personnel used the data to compute temperature-pressure profiles to altitudes as high as 30 km. Data from this experiment are presently maintained at SDSD.

---------------------ITOS 1, NOAA 1-5, Suomi---------------------

Investigation Name - Flat Plate Radiometer (FPR)

Flown on - ITOS 1, NOAA 1

NSSDC ID - 70-008A-02, 70-106A-02

PI - V.E. Suomi U of Wisconsin

Brief Description

The Flat Plate Radiometer (FPR) system was designed to provide a measurement of the global distribution of reflected solar and longwave radiation leaving the earth. The FPR system consisted of four detectors, an analog-to-digital converter, and a tape recorder. The detectors had a hemispheric field of view of 2 pi sr and were mounted on the satellite baseplate facing earth. The detectors used coated aluminum disks as a sensing element. Two of the disks were white and responded only to infrared energy (7 to 30 micrometers) radiated from the earth and its atmosphere. The other two disks were painted black and had a broader band sensitivity (0.3 to 30 micrometers). Two disks (one of each type) had a thermistor bolometer mounted on the back surface to measure the disk temperature. The other two disks used thermopiles. A similar experiment was flown on ESSA 3, 5, 7, and 9. For a full description of the FPR system, see "Studies in Atmospheric Energetics based on Aerospace Probings, Annual Report -1967," pp. 179-189, Dept. Meteorology, University of Wisconsin, March 1968.

--------------------ITOS 1, NOAA 1-5, Williams--------------------

Investigation Name - Solar Proton Monitor

S/C	NSSDC ID	PI	OI
ITOS 1, NOAA 1,2	70-008A-01 70-106A-01 72-082A-01	D.J. Williams APL	
NOAA 3-5	73-086A-01 74-089A-01 76-077A-04	D.J. Williams APL	H.H. Sauer NOAA-ERL

Brief Description

Three solid-state detectors monitored the omnidirectional fluxes of solar protons with energies above 10, 30, and 60 MeV, respectively. Two telescopes, consisting of solid state detectors, each measured directional fluxes of protons in three energy intervals (0.27 - 3.2 MeV, 3.2 - 60 MeV, and above 60 MeV) and of alpha particles between 12.5 and 32 MeV. In the polar cap region, which was of the greatest interest, the telescopes looked parallel to and perpendicular to the local magnetic field direction. An additional solid state detector measured directional fluxes of electrons of energy >140 keV. This detector looked in a direction perpendicular to the orbit plane. Data are available from the National Geophysical and Solar-Terrestrial Data Center, NOAA/National Environmental Satellite, Data, and Information Service (NESDIS), Boulder, Colorado.

****************************Landsat 1-3****************************

Spacecraft Name - Landsat 1-3

S/C	Alternate Name	NSSDC ID	Launch Date	Incl. (deg)	Perig. (km)	Apog. (km)	Per. (min)
Landsat 1	ERTS-A	72-058A	07/23/72	99.1	897	917	103.1
Landsat 2	ERTS-B	75-004A	01/22/75	99.1	907	918	103.3
Landsat 3	Landsat-C	78-026A	03/05/78	99.1	897	914	103.1

S/C	PM	PS
Landsat 1,2	C.M. MacKenzie NASA-GSFC R.K. Browning NASA-GSFC J. Sargent (Retired) NASA-GSFC S. Weiland (Retired) NASA-GSFC	S.C. Freden NASA-GSFC W.P. Nordberg (Deceased) NASA-GSFC
Landsat 3	C.M. MacKenzie NASA-GSFC R.K. Browning NASA-GSFC	S.C. Freden NASA-GSFC

Brief Description

Landsats 1-3 were modified versions of the Nimbus series of meteorological satellites. The near-polar orbiting spacecraft served as a stabilized, earth-oriented platform for obtaining near-global coverage of data on agricultural and forestry resources, geology and mineral resources, hydrology and water resources, geography, cartography, environmental pollution, oceanography and marine resources, and meteorological phenomena. To accomplish these objectives, each spacecraft was equipped with (1) a three- or two-camera return beam vidicon (RBV) to obtain visible and near IR photographic images of the earth, (2) a four- or five-channel multispectral scanner (MSS) to obtain radiometric images of the earth, and (3) a data collection system (DCS) to collect information from remote, individually equipped ground stations and to relay the data to central acquisition stations. Landsat 1-3 carried two wide-band video tape recorders (WBVTR) capable of storing up to 30 min of scanner or camera data. An advanced attitude control system consisting of horizon scanners, sun sensors, and a command antenna combined with a freon gas propulsion system permitted the spacecraft's orientation to be maintained within plus or minus 0.7 deg in all three axes. Spacecraft communications included a command subsystem operating at 154.2 and 2106.4 MHz, and a PCM narrow-band telemetry subsystem. operating at 2287.5 and 137.86 MHz, for spacecraft house-keeping, attitude, and sensor performance data. Video data from the RBV system were transmitted in both real-time and tape-recorder modes at 2265.5 MHz, while information from the MSS was constrained to a 20-MHz bandwidth at 2229.5 MHz. More information can be found in "Landsat Data Users Handbook," available from U.S. Geological Survey, Arlington, Va.

------------------Landsat 1-3, Arluskas, Freden-------------------

Investigation Name - Multispectral Scanner System (MSS)

S/C	NSSDC ID	PI
Landsat 1	72-058A-02	J. Arluskas NASA-GSFC
Landsat 2,3	75-004A-02 78-026A-02	S.C. Freden NASA-GSFC

Brief Description

The Multispectral Scanner (MSS) was designed to provide repetitive daytime acquisition of high-resolution, multispectral data of the earth's surface on a global basis and to demonstrate that remote sensing from space is a feasible and practical approach to efficient management of the earth's resources. In addition to obtaining data for use in earth resource type studies, the MSS system was used to conduct oceanographic and meteorological studies, i.e., to map sea-ice fields, locate and track major ocean currents, monitor both air and water pollution, determine snow cover, investigate severe storm environments, etc. The MSS consisted of a 22.86-cm double reflector-type telescope, scanning mirror, filters, detectors, and associated electronics. The scanner on Landsats 1 and 2 operated in the following spectral intervals: (1) 0.5 to 0.6 micrometer, (2) 0.6 to 0.7 micrometer, (3) 0.7 to 0.8 micrometer, and (4) 0.8 to 1.1 micrometers (these bands were designated as bands 4, 5, 6, and 7, respectively). The Landsat 3 MSS had an additional band in the 10.4- to 12.6-micrometer thermal region (band 8). This thermal band failed on July 11, 1978, and produced little useful data. Incoming radiation was collected by the scanning mirror, which oscillated 2.89 deg to either side of nadir and scanned cross-track swaths 185-km wide. The along-track scan was produced by the orbital motion of the spacecraft. The primary image produced at the image plane of the telescope was relayed by fiber optic bundles to detectors where conversion to an electronic signal was accomplished. Optical filters were used to produce the desired spectral separation. Six detectors were employed in each of the four spectral bands: bands 4 through 6 used photomultiplier tubes as detectors, band 7 used silicon photodiodes. Band 8 on Landsat 3 had two Hg-Cd-Te detectors. A multiplexer included in the MSS system processed the scanner's 24 (26 for Landsat 3) channels of data. The data were time-multiplexed and then converted to a pulse-code modulated signal by an A/D converter. The data were then transmitted (at 2229.5 MHz) directly to an acquisition station or, in the case of remote areas, stored on magnetic tape for subsequent playback the next time the spacecraft came within the communication range of an acquisition station. The ground resolutions were 80 m for bands 4 to 7 and 240 m for band 8. Data from this experiment were handled by the NASA Image Processing Facility, GSFC, Greenbelt, Md. Archival data can be obtained through the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

------------------Landsat 1-3, Weinstein, Freden------------------

Investigation Name - Return Beam Vidicon Camera System

S/C	NSSDC ID	PI	OI
Landsat 1	72-058A-01	O. Weinstein NASA-GSFC	T.M. Ragland (Retired) NASA-GSFC
Landsat 2,3	75-004A-01 78-026A-01	S.C. Freden NASA-GSFC	

Brief Description

The Landsat 1 and 2 Return Beam Vidicon (RBV) camera system contained three independent cameras taking pictures of earth scenes simultaneously during the daytime in three different spectral bands from blue-green (0.47 to 0.575 micrometer) through yellow-red (0.58 to 0.68 micrometer) to near IR (0.69 to 0.83 micrometer). While designed primarily to obtain information for earth resource type studies, the RBV camera system also conducted meteorological studies, i.e., to investigate atmospheric attenuation and to observe mesoscale phenomena, winter monsoon clouds (Japan), snow cover, etc. The three earth-oriented cameras were mounted to a common base, which was structurally isolated from the spacecraft to maintain accurate alignment. Each camera contained an optical lens, a 5.08-cm RBV, a thermoelectric cooler, deflection and focus coils, a mechanical shutter, erase lamps, and sensor electronics. The cameras were similar except for the spectral filters contained in the lens assemblies that provided separate spectral viewing regions. The viewed ground scene, 185 by 185 km in area, was stored on the photosensitive surface of the camera tube, and, after shuttering, the image was scanned by an electron beam to produce a video signal output. Each camera was read out sequentially, requiring about 3.5 s for each of the spectral images. The cameras were operated every 25 s to produce overlapping images along the direction of spacecraft motion. Video data from the RBV were transmitted (at 2265.5 MHz) in both real-time and tape recorder modes. From a nominal spacecraft altitude of 900 km, the RBV had a ground resolution of about 80 m. The Landsat 3 RBV system, consisting of two panchromatic cameras, produced two side-by-side images rather than three overlapping images of the same scene. Each camera had the same spectral band of 0.505 to 0.750 micrometer. The two cameras were aligned to view adjacent 98-km square ground scenes which overlapped slightly so that the total width of the swath was 185 km. The cameras were operated every 12.5 s to produce overlapping images along the direction of spacecraft motion. After shuttering, the image was scanned by an electron beam to produce a video output signal. A 3.5-s offset was introduced between the readouts of the two cameras, permitting sequential readout, and allowing the same tape recorder and communications channel to be used. The Landsat 3 RBV had a better ground resolution of 40 m. Data from this experiment can be obtained through the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

**************************Landsat 4, 5*************************

Spacecraft Name - Landsat 4, 5

S/C	Alternate Name	NSSDC ID	Launch Date	Incl. (deg)	Perig. (km)	Apog. (km)	Per. (min)
Landsat 4	Landsat-D	82-072A	07/16/82	98.3	678	699	98.5
Landsat 5	Landsat-D Prime	84-021A	03/01/84	98.3	683	698	98.6

MG - B.B. Schardt NASA HEADQUARTERS
PM - L. Gonzales NASA-GSFC
PS - V.V. Salomonson NASA-GSFC

Brief Description

The Landsat 4 was an earth resources monitoring system with the new powerful remote-sensing capabilities of the thematic mapper (TM), and provided a transition for both foreign and domestic users from the multispectral scanner (MSS) data to the higher resolution and data rate of the TM. It had a complete end-to-end highly automated data system, which was designed to be a new generation system, and was a major step forward in global remote-sensing applications. The Landsat 4 mission consisted of an orbiting satellite (flight segment) with the necessary wideband data links and support systems, and a ground segment. The Landsat 4 flight segment consisted of two major systems: (1) the instrument module, containing the two sensing instruments together with the mission unique subsystems, such as the solar array and drive, the TDRS (Tracking and Data Relay Satellite) antenna, the wide-band module (WBM), and the global positioning system (GPS); and (2) the multimission modular spacecraft (MMS) that contained the modularized and standardized power, propulsion, attitude control, and communications and data handling subsystems. The flight segment was designed with 3 years nominal life time in orbit and could be extended through in-orbit replacement capability when the shuttle becomes operational. The spacecraft was placed into an orbit having a descending node with equatorial crossing between 9:30 and 10:00 a.m. local time. The spacecraft and attendant sensors were operated through the GSTDN stations before the Tracking And Data Relay Satellite System (TDRSS) became available. Landsat 4 experienced failures of X-band transmission, primary command and data handling computer, and two of its four solar array panels after launch. Landsat 5 was forced to be launched earlier. Landsat 5 was identical to Landsat 4 in all aspects, but with those anomalies repaired.

------------------Landsat 4,5, Salomonson------------------

Investigation Name - Multispectral Scanner System (MSS)

NSSDC ID - 82-072A-02, 84-021A-02

PI - V.V. Salomonson NASA-GSFC

Brief Description

The Multispectral Scanner (MSS) was designed to provide repetitive daytime acquisition of high-resolution, multispectral data of the earth's surface on a global basis and to demonstrate that remote sensing from space is a feasible and practical approach to efficient management of the earth's resources. In addition to earth resource type studies, the MSS system was used to conduct oceanographic and meteorological studies, i.e., to map sea-ice fields, locate and track major ocean currents, monitor both air and water pollution, determine snow cover, investigate severe storm environments, etc. The MSS consisted of a 22.86-cm double reflector-type telescope, scanning mirror, filters, detectors, and associated electronics. The scanner operated in the following spectral intervals: band 1, 0.5 to 0.6 micrometer; band 2, 0.6 to 0.7

micrometer; band 3, 0.7 to 0.8 micrometer; and band 4, 0.8 to 1.1 micrometers (the band numbering was different from Landsats 1-3). The Landsat 4 MSS was similar to the Landsat 1-3 MSS except for changes necessary to accommodate the lower orbital altitude. The swath width of 185 km remained the same by increasing the FOV of the sensors from 11.56 to 14.92 deg. The ground resolution was approximately 83 m for all four bands. The primary image produced at the image plane of the telescope was relayed by use of fiber optic bundles to detectors where conversion to an electronic signal was accomplished. Optical filters were used to produce the desired spectral separation. Six detectors were employed in each of the four spectral channels: bands 1 through 3 used photomultiplier tubes as detectors, band 4 used silicon photodiodes. A multiplexer included in the MSS system processed the scanner's video data. The data were time-multiplexed and then converted to a pulse-code modulated signal by an A/D converter. The data were then transmitted via the Tracking And Data Relay Satellites (TDRS) and/or direct readout to local receiving stations. Data can be obtained through the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

--------------------Landsat 4,5, Barker--------------------

Investigation Name - Thematic Mapper (TM)

NSSDC ID - 82-072A-01, 84-021A-01

PI - J. Barker NASA-GSFC

Brief Description

The Thematic Mapper (TM) was a seven-band, earth-looking, scanning radiometer with a 30-m ground element resolution covering a 185-km ground swath from a 705-km altitude. The instrument consisted of primary imaging optics, scanning mechanism, spectral band discrimination optics, detector arrays, radiative cooler, inflight calibrator, and required operating and processing electronics. The scanning mechanism provided the cross-track scan, while the progress of the spacecraft provided the scan along the track. The optical system imaged the earth's surface on a field stop or a detector sized to define an area on the earth's surface 30-m square. Several lines were scanned simultaneously to permit suitable dwell time for each resolution element. The variation in radiant flux passing through the field stop onto the photo and thermal detectors creates an electrical output that represents the radiant history of the line. Seven spectral bands were used to provide the spectral signature capability of the instrument: band 1, 0.45-0.52 micrometer; band 2, 0.52-0.60 micrometer; band 3, 0.63-0.69 micrometer; band 4, 0.76-0.90 micrometer; band 5, 1.55-1.75 micrometers; band 6, 10.40-12.50 micrometers;, and band 7, 2.08-2.35 micrometers. The information outputs from the detector channels were processed in the TM multiplexer for transmission via the Tracking And Data Relay Satellites (TDRS) and/or direct readout to local receiving stations. Data from this experiment can be obtained through the EROS Data Center, U.S. Geological Survey, Sioux Falls, South Dakota.

*********************SMS 1,2, GOES 1-6**********************

Spacecraft Name - SMS 1,2, GOES 1-6

S/C	Alternate Name	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
SMS 1	SMS-A	74-033A	05/17/74	1.9	32345	35439	1340
SMS 2	SMS-B	75-011A	02/06/75	1.0	35778	35799	1436
GOES 1	GOES-A	75-100A	10/16/75	1.0	34165	36458	1412
GOES 2	GOES-B	77-048A	06/16/77	0.9	35266	36304	1436
GOES 3	GOES-C	78-062A	06/16/78	1.7	35469	36679	1450
GOES 4	GOES-D	80-074A	09/09/80	0.2	35776	35800	1436
GOES 5	GOES-E	81-049A	05/22/81	0.3	35715	35769	1434
GOES 6	GOES-F	83-041A	04/28/83	0.3	35775	35796	1436

S/C	PM	PS
SMS 1, 2	T.J. Karras NOAA-NESDIS A. Butera NOAA-NESDIS D.V. Fordyce (Retired) NASA-GSFC	W.E. Shenk NASA-GSFC
GOES 1-3	G.W. Longanecker NASA-GSFC R.H. Pickard (NLA) NASA-GSFC D.V. Fordyce (Retired) NASA-GSFC	W.E. Shenk NASA-GSFC
GOES 4-6	G.W. Longanecker NASA-GSFC R.H. Pickard (NLA) NASA-GSFC	W.E. Shenk NASA-GSFC

Brief Description

The Synchronous Meteorological Satellite (SMS) and the Geostationary Operational Environmental System (GOES) satellites were geostationary and spaced in longitude over the equator to provide near-continuous, timely, high-quality observations of the earth and its environment. SMS 1 and 2 were developed by NASA, and follow-on spacecraft GOES 1-6 were funded by NOAA. Each spin-stabilized, earth-synchronous spacecraft carried three experiments: (1) a visible infrared spin-scan radiometer (VISSR), or a VISSR atmospheric sounder (VAS), (2) a meteorological data collection system (DCS), and (3) a space environment monitor (SEM) system containing an energetic charged particle monitor, a magnetometer, and a solar X-ray monitor. The cylindrically shaped spacecraft measured

190.5 cm in diameter and 230 cm in length, exclusive of a magnetometer that extended an additional 83 cm beyond the cylinder shell. The primary structural members were a honeycombed equipment shelf and thrust tube. The VISSR telescope was mounted on the equipment shelf and viewed the earth through a special aperture in the spacecraft's side. A support structure extended radially from the thrust tube and was affixed to the solar panels, which formed the outer walls of the spacecraft and provided the primary source of electrical power. Located in the annulus-shaped space between the thrust tube and the solar panels were stationkeeping and dynamics control equipment, batteries, and most of the SEM equipment. The spacecraft spun at approximately 100 rpm with a spin axis nearly perpendicular to the equatorial plane. The spacecraft used both UHF-band and S-band frequencies in its telemetry and command subsystem. A low-power VHF transponder provided telemetry and command during launch and then served as a backup for the primary subsystem once the spacecraft had attained synchronous orbit. The satellites were relocated from time to time to support specific programs or to replace one that was failing. SMS 1 was initially located at 45 deg W to support the Global Atmospheric Research Program (GARP) Atlantic Tropical Experiment (GATE). After completion of the GATE in September of 1974, it was moved to 75 deg W. The follow-on spacecraft joined the SMS 1 to operate at 75 deg W and 135 deg W, which were known as GOES-East and GOES-West, respectively. During the FGGE (First GARP Global Experiment) Operational Year, December 1978 - November 1979, the GOES-East coverage was provided by GOES 2, SMS 1, and SMS 2. The GOES-West coverage was provided by GOES 3. GOES 1 served as the GOES-Indian at 58 deg E during May-August 1979. Beginning 1979, a WEFAX (Weather Facsimile) experimental service was provided by a satellite located at 107 deg W, which was known as GOES-CENTRAL. This service used earlier GOES spacecraft that were no longer suitable for imaging to retransmit GOES image sectors to ground receivers.

--------------SMS 1,2, GOES 1-6, Leinbach, Williams---------------

Investigation Name - Magnetic Field Monitor

Flown on - SMS 1, 2, GOES 1-6

NSSDC ID - 74-033A-04, 75-011A-03, 75-100A-04, 77-048A-04,
78-062A-04, 80-074A-04, 81-049A-04, 83-041A-04

PI - H. Leinbach	NOAA-ERL
PI - D.J. Williams	APL
OI - H.H. Sauer	NOAA-ERL
OI - R.N. Grubb (NLA)	NOAA-ERL
OI - J.C. Joselyn	NOAA-ERL

Brief Description

The biaxial, closed-loop, fluxgate magnetometer had a range of plus or minus 400 nT (without saturation) and a resolution of 0.1 nT over a range of plus or minus 50 nT.

----------------SMS 1,2, GOES 1-6, Leinbach, Williams----------------

Investigation Name - Energetic Particle Monitor

Flown on - SMS 1, 2, GOES 1-6

NSSDC ID - 74-033A-02, 75-011A-01, 75-100A-02, 77-048A-02,
78-062A-02, 80-074A-02, 81-049A-02, 83-041A-02

PI - H. Leinbach	NOAA-ERL
PI - D.J. Williams	APL
OI - H.H. Sauer	NOAA-ERL
OI - R.N. Grubb(NLA)	NOAA-ERL

Brief Description

The energetic particle monitor on SMS 1 and 2, and GOES 1-4 consisted of two detector assemblies, each covering limited regions of the overall energy spectrum. The two detector assemblies monitored protons in seven energy ranges from 0.8 to 500 MeV and alpha particles in six ranges between 4 and 400 MeV. There was also one channel for the measurement of electrons in the energy range >500 keV. The SEM on GOES 5 and 6 had a third detector assembly. The high energy proton and alpha detector (HEPAD) measured protons in four energy ranges above 370 MeV, and alpha particles in two energy ranges above 640 MeV/nucleon.

----------------SMS 1,2, GOES 1-6, Leinbach, Williams----------------

Investigation Name - Solar X-Ray Monitor

Flown on - SMS 1, 2, GOES 1-6

NSSDC ID - 74-033A-03, 75-011A-02, 75-100A-03, 77-048A-03,
78-062A-03, 80-074A-03, 81-049A-03, 83-041A-03

PI - H. Leinbach	NOAA-ERL
PI - D.J. Williams	APL
OI - H.H. Sauer	NOAA-ERL
OI - R.N. Grubb	NOAA-ERL
OI - R.F. Donnelly	NOAA-ERL

Brief Description

The X-ray monitor consisted of ion chamber detectors. The wavelength ranges and useful threshold energy flux sensitivities were 0.5 to 3 A, 1.0E-13 J per sq cm per s; and 1 to 8 A, 1.0E-12 J per sq cm per s; with a dynamic range of 1.0E4.

Investigation Name - Visual Infrared Spin-Scan Radiometer (VISSR)

Flown on - SMS 1,2, GOES 1-3

NSSDC ID - 74-033A-01, 75-011A-04, 75-100A-01, 77-048A-01, 78-062A-01

PI - NESDIS Staff NOAA-NESDIS
OI - W.E. Shenk NASA-GSFC

Brief Description

The Visible Infrared Spin-Scan Radiometer (VISSR) provided day/night observations of cloud cover and earth/cloud radiance temperatures for use in operational weather analysis and forecasting. The two-channel instrument was able to take both full and partial pictures of the earth's disk. The infrared channel (10.5 to 12.6 micrometers) and the visible channel (0.55 to 0.70 micrometer) used a common optics system. Incoming radiation was received by an elliptically shaped scan mirror and collected by a Ritchey-Chretien optical system. The scan mirror was set at a nominal angle of 45 deg to the VISSR optical axis, which was aligned parallel to the spin axis of the spacecraft. The spinning motion of the spacecraft (approximately 100 rpm) provided a west-to-east scan motion when the spin axis of the spacecraft was oriented parallel with the earth's axis. The latitudinal scan was accomplished by sequentially tilting the scanning mirror north to south at the completion of each spin. A full picture took 18.2 min to complete and about 2 min to retrace. During each scan, the field of view on the earth was swept by a linear array of eight visible-spectrum detectors, each with a ground resolution of 0.9 km at nadir. Two Hg-Cd-Te detectors (redundant) sensed the infrared portion of the spectrum with a horizontal resolution of approximately 9 km at nadir. The infrared detectors measured radiance temperatures between 180 and 315 deg K, with a sensitivity of 1.2 deg K at 200 deg K. The VISSR output was digitized and transmitted to the National Oceanic and Atmospheric Administration (NOAA) Command Data Acquisition (CDA) Station, Wallops Island, Va. There the signal was fed into a "line stretcher" where it was stored and time-stretched for transmission back to the satellite at reduced bandwidth for re-broadcast to data utilization stations (DUS). The VISSR data, as with all operational type data, were handled by NOAA, and the majority of data were archived by SDSD. NSSDC also has the data processed by the Image Processing Facilty, NASA-GSFC. A more detailed description can be found in "The GOES/SMS User's Guide," available from NSSDC and SDSD.

Investigation Name - VISSR Atmospheric Sounder (VAS)

Flown on - GOES 4-6

NSSDC ID - 80-074A-01, 81-049A-01, 83-041A-01

PI - NESDIS Staff NOAA-NESDIS
OI - W.E. Shenk NASA-GSFC

Brief Description

The Visible-Infrared Spin-Scan Radiometer Atmospheric Sounder (VAS) operated in three distinct modes to provide parameter flexibility, spectral band selection, geographic location, and signal-to-noise (S/N) ratio. The VAS had the original VISSR imaging capability plus additional thermal bands in H2O and CO2 absorption regions for the determination of water vapor and temperature profiles. The VISSR mode was the same as the VISSR system on board GOES 1-3 except that the FOV for the VAS infrared imaging was 6.9 km. The dwell-sounding mode used up to 12 spectral filters in a wheel covering the range 678.7 per cm (14.74 micrometers) through 2535 per cm (3.94 micrometers) positioned into the optical train while the scanner was dwelling on a single N-to-S scan line. The filter wheel could be programmed so that each spectral band filter could dwell on a single scan line for from 0 to 255 spacecraft spins. Either the 6.9-km or 13.8-km resolution detectors could be selected for the seven filter positions operating in the spectral region 701.6 per cm (14.25 micrometers) through 1487 per cm (6.725 micrometers). For the remaining five spectral bands the 13.8-km resolution detectors were used. Selectable frame size, position and scan direction were also programmable via ground command. For the VAS demonstration, 10-bit reduced resolution (3.5-km) visible data were provided for imaging. In some of the spectral regions, multiple-line data were required to enhance the S/N ratio. Typically, 167 satellite spins at the same N-to-S scan line position were required to obtain the desired sounding data with a 30- x 30-km resolution. The multispectral imaging (MSI) mode could provide either (1) four spectral channel observation (the visible at 0.9-km resolution, the 11-micrometer window at 6.9-km resolution, and any two selected spectral bands at 13.8-km resolution) or (2) five spectral channel observation (the visible at 0.9-km resolution and any four infrared spectral channels at 13.8-km resolution). Unlimited N-to-S frame size and position selection, within the maximum N-to-S FOV scan direction, could be selected. The VAS output was digitized and transmitted to the NOAA Command Data Acquisition (CDA) Station, Wallops Island, Va. There the VISSR data were fed into a "line stretcher," where the data were stored and time-stretched for transmission back to the satellite at reduced bandwidth for rebroadcast to APT user stations. Data can be obtained through SDSD.

***************************** TIROS 1-10************************

Spacecraft Name - TIROS 1-10

S/C	Alternate Name	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
TIROS 1	TIROS-A	60-002B	04/01/60	48.4	693	750	99.2
TIROS 2	TIROS-B	60-016A	11/23/60	48.6	609	742	98.3
TIROS 3	TIROS-C	61-017A	07/12/61	47.9	742	812	100.4
TIROS 4	TIROS-D	62-002A	02/08/62	48.3	712	840	100.0
TIROS 5	TIROS-E	62-025A	06/19/62	58.1	586	972	100.0
TIROS 6	TIROS-F	62-047A	09/18/62	58.3	686	713	98.7
TIROS 7	TIROS-G	63-024A	06/19/63	58.2	621	649	97.4
TIROS 8	TIROS-H	63-054A	12/21/63	58.5	691	765	99.3
TIROS 9	TIROS-I	65-004A	01/22/65	96.4	705	2582	119.2
TIROS 10	TIROS-J	65-051A	07/02/65	98.6	751	837	100.8

S/C	PM	PS
TIROS 1	W.G. Stroud NASA-GSFC	H.I. Butler (Retired) NASA-GSFC
TIROS 2	R.A. Stampf (NLA) NASA-GSFC	Aero. and Meteo. Div. NASA-GSFC
TIROS 3-10	R.M. Rados (Retired)	Aero. and Meteo. Div. NASA-GSFC

Brief Description

TIROS 1-10 (Television and Infrared Observation Satellite) were spin-stabilized meteorological spacecraft designed to test experimental television techniques and infrared equipments. The satellites were in the form of an 18-sided right prism, 48 or 56 cm high and 107 cm in diameter. The top and sides of the spacecraft were covered with approximately 9200 1- by 2-cm silicon solar cells. The TIROS satellites were equipped with a television camera system and an automatic picture transmission system for taking cloudcover pictures, three radiometers (two-channel widefield, omnidirectional, and five-channel scanning) for measuring radiation from the earth and its atmosphere, and an electron temperature probe. The satellite spin rate was maintained between 8 and 12 rpm by the use of five diametrically opposed pairs of small solid-fuel thrusters. TIROS 2-10 were equipped with a magnetic attitude-control device. The first four TIROS were launched into near-circular orbits with an orbit inclination of 48 deg to provide TV coverage of the sunlit portion of the earth between 55 deg N and 55 deg S lat. The orbit inclination on TIROS 5 through 8 was increased to provide TV coverage between 65 deg N to 65 deg S lat. The orbits of TIROS 9 and 10 were intended to be near-polar and sun-synchronous to extend the sensor coverage to the entire sunlit portion of the earth, but only TIROS 10 achieved this desired orbit. A failure in the guidance system placed TIROS 9 in a non-synchronous elliptical orbit. TIROS 1-8 and 10 were designed for a fixed attitude relative to space. TIROS 9 was placed in a cartwheel mode in which the spacecraft spin axis was normal to the orbital plane. With two TV cameras on its rim, the TIROS 9 spacecraft rolled along its near-polar orbit at a rate of 10 revolutions a minute to provide daily global cloud cover on a nearly continuous basis. A more detailed description and performance summary can be found in Schnapf, A., "TIROS: The Television and Infra-red Observation Satellite," J. of British Interplanetary Society, v. 19, pp. 386-409, 1963-64, and Rados, R. M., "The evolution of the TIROS meteorological satellite Operational System," Bull. Amer. Meteor. Soc., v. 48, pp. 326-337, 1967.

------------------TIROS 1-10, Barksdale, Rados----------------

Investigation Name - Scanning Radiometer (SR)

S/C	NSSDC ID	PI	OI
TIROS 2,4	60-016A-02 62-002A-03	J.D. Barksdale NASA-GSFC	
TIROS 3	61-017A-03	R.M. Rados(Retired) NASA-GSFC	J.D. Barksdale NASA-GSFC
TIROS 7	63-024A-02	J.D. Barksdale NASA-GSFC	

Brief Description

This radiometer measured the emitted and reflected radiation of the earth and its atmosphere. The five-channel radiometer scanned the earth and space as the satellite spun about its axis. The radiometer's bi-directional optical axes were inclined to the satellite spin axis at angles of 45 and 135 deg. The sensor used bolometer detectors and filters to limit the spectral response and to provide comprehensive data by measuring radiation intensities in selected portions of the infrared spectrum. The spectral bands of five channels were: (1) 6.0 to 6.5 micrometers (water vapor absorption), (2) 8.0 to 12.0 micrometers (atmospheric window), (3) 0.2 to 6.0 micrometers, (4) 8 to 13 micrometers (TIROS 4 used this channel to transmit a redundant time reference signal), and (5) 0.5 to 0.75 micrometer for reference and comparison with the TV systems. The water vapor absorption band was replaced by a 14- to 16-micrometer carbon dioxide band on TIROS 3. The major limitation of the experiment was the uncertainty in the absolute value of the measurements, resulting from the degradation of the sensors. A more detailed description of the instrument was given in Astheimer, R. W., et al., "Infrared radiometric instruments on TIROS II," J. of Opt. Soc., v. 51, pp. 1386-1393, 1961.

---------------------TIROS 1-10, Brace---------------------

Investigation Name - Electron Temperature Probe

Flown on - TIROS 7

NSSDC ID - 63-024A-03

PI - L.H. Brace	NASA-GSFC
OI - N.W. Spencer	NASA-GSFC

Brief Description

A Langmuir probe was used to measure electron density and temperature. The cylindrical probe consisted of two concentric electrodes. The inner electrode, which was 0.056 cm in diameter and 23 cm long, was used as a collector. The outer electrode served as a guard electrode, and was 0.168 cm in diameter and 10 cm long. The probe was swept through the voltage range from 0 to 1.5 V in 2 s. The current at the collector was measured as the voltage was varied, and the signal was stored on a tape recorder and played back upon interrogation by a ground station. This experiment and the infrared experiment time shared a subcarrier oscillator, and the telemetry format sequence consisted of 18 s of probe data and 12 s of IR data. Although the experiment was designed to allow for computer determination of electron temperature values, this was impractical because of the marginal resolution of the data and the low information rate of the subcarrier; i.e., there were not enough data points per second.

----------------TIROS 1-10, Butler, NESDIS Staff--------------

Investigation Name - Television Camera System

S/C	NSSDC ID	PI	OI
TIROS 1,2	60-002B-01 60-016A-03	H.I. Butler (Retired) NASA-GSFC	
TIROS 3	61-017A-04	NESDIS Staff NOAA-NESDIS	R.M. Rados (Retired) NASA-GSFC
TIROS 4-10	62-002A-04 62-025A-01 62-047A-01 63-024A-04 63-054A-01 65-004A-01 65-051A-01	NESDIS Staff NOAA-NESDIS	

Brief Description

The TV system was developed to obtain cloudcover pictures for operational meteorological use. The experiment consisted of one or two independent camera chains, each containing a television camera, a magnetic-tape recorder and a television transmitter. The two sensor units were capable of concurrent or independent operation. Three different lens systems were used on the TIROS spacecraft. On TIROS 1 and 2, the TV system had one narrow-angle (12-deg) lens and one wide-angle (104-deg) lens. TIROS 3, 7, 9, and 10 had two wide-angle lens systems. TIROS 4, 5 and 6 had one medium-angle (78-deg) lens system and one wide-angle system. TIROS 8 had only one wide-angle lens. Except on TIROS 9, the cameras were mounted on the baseplate of the spacecraft with their optical axes parallel to the spacecraft spin axis. Since the spin axis lay in the orbital plane, the cameras were directed earthward for only approximately one-fourth of each orbit. The two cameras on TIROS 9 were mounted 180 deg apart on the side of the spacecraft and canted 64 deg from the spacecraft spin axis. The cameras were automatically triggered into action only when they came in view of the earth. The TV pictures were transmitted directly to either of two ground receiving stations or stored on magnetic tape for later playback, depending on whether the satellite was within or beyond the communication range of the station. The TV cameras used 500-scan-line, 1.27-cm vidicons. Each recorder could store up to 32 (48 for TIROS 9) frames of pictures. Transmission of the 32-frame sequence was accomplished in 100 s by a 3-W FM transmitter operating at a nominal frequency of 235 MHz. At nominal attitude and altitude (approximately 700 km), a picture taken by the wide-angle camera covered a 1200- by 1200-km square with a spatial resolution of 2.5 to 3.0 km at nadir. The medium-angle camera covered a 725- by 725-km square and had a resolution of 2 km. Data from this experiment are available through SDSD. For a complete index of these data, see "Catalog of Meteorological Satellite Data - TIROS 1 Television Cloud Photography," "Catalog of Meteorological Satellite Data - TIROS 2 Television Cloud Photography," etc.

------------------------TIROS 1-10, Hanel------------------------

Investigation Name - Widefield Radiometer

Flown on - TIROS 2, 3, 4

NSSDC ID - 60-016A-01, 61-017A-02, 62-002A-02

PI - R.A. Hanel NASA-GSFC

Brief Description

The low-resolution, non-scanning, two-channel radiometer measured the thermal and reflected solar radiation from the earth-atmosphere system. The radiometer consisted of two detectors: one black and one white thermistor bolometer. Each of the detectors was mounted in the apex of a highly reflective mylar cone. The black detector responded equally to reflected solar radiation and long-wave terrestrial radiation (0.2 to 50 micrometers). The white detector reflected solar and visible radiation and measured only long-wave thermal radiation (5 to 50 micrometers). The optical axis of each detector was parallel to the satellite spin axis. The field of view (50 deg) of the detectors when viewing the earth directly below the satellite was a circle of 832 km diameter. This area was within the field observed by the wide-angle television camera, and thus a direct measure of the heat balance of the earth-atmosphere system viewed in any of the pictures was provided. The radiation data were recorded on a continuously running endless loop magnetic tape that completed its cycle in about 100 min. Data older than 100 min were erased as newer data were recorded. The experiment performed normally, but the quality of the data was very poor because of decreased sensitivity of the detectors, detector-spacecraft thermal coupling, and less than nominal radiative characteristics. Thus, the collected data were too ambiguous for reduction or analysis. The experiment was described in "The TIROS Low Resolution Radiometer," NASA TN-D-614, 1964.

-----------------------TIROS 1-10, Hunter----------------------

Investigation Name - Automatic Picture Transmission (APT)

Flown on - TIROS 8

NSSDC ID - 63-054A-02

PI - C.M. Hunter NASA-GSFC

Brief Description

This system was a camera and transmitter combination designed to test the feasibility of transmitting local daytime pictures of cloud cover to properly equipped ground receiving stations on a real-time basis. The system consisted of a single camera with a 2.54-cm-diameter vidicon. The camera used a 108-deg wide-angle f/1.8 objective lens with a focal length of 5.7 mm, and was mounted on the satellite baseplate with its optical axis parallel to the spacecraft spin axis. The actual picture taking required 8 s and the transmission 200 s. Earth-cloud images retained on the photosensitive surface of the vidicon were read out at four lines per second to produce an 800-line picture. A 5-W TV transmitter (136.95 MHz) relayed the pictures to local APT stations within communication range. The faceplate of the vidicon had reticle marks that appeared on the picture format to aid in relating the picture to its geographical position on the earth's surface. At nominal satellite attitude and altitude (approximately 700 km), a picture covered a 1200- by 1200-km square with a horizontal resolution of 7.5 km at nadir. The experiment performed normally, and good quality pictures were obtained until the experiment was terminated owing to degradation of the APT camera. The APT experiment successfully demonstrated the feasibility of using weather satellites to provide meteorologists with local cloudcover data on a near real-time basis, requiring only the use of a photofacsimile machine and a relatively inexpensive antenna and receiver. APT data were primarily intended for operational use within the local APT acquisition stations and generally are not available for distribution.

----------------------TIROS 1-10, Suomi-----------------------

Investigation Name - Omnidirectional Radiometer

Flown on - TIROS 3, 4, 7

NSSDC ID - 61-017A-01, 62-002A-01, 63-024A-01

PI - V.E. Suomi U of Wisconsin

Brief Description

This experiment was designed to measure the amount of solar energy absorbed, reflected, and emitted by the earth and its atmosphere. The experiment consisted primarily of two sets of bolometers in the form of hollow aluminum hemispheres, mounted on opposite sides of the spacecraft, whose optical axes were parallel to the spin axis. The bolometers were mounted on mirror surfaces so that the hemispheres behaved very much like isolated spheres in space. One bolometer in each set was painted black, and one was painted white. The black bolometer absorbed most of the incident radiation while the white bolometer was sensitive mainly to radiation with wavelengths longer than approximately 4 micrometers. The reflected and emitted radiation could thus be separated. The sensor temperatures were measured by thermistors fastened to the inside of the hollow hemispheres. The sensor temperatures, taken every 29 s, were an average of the two temperatures from the matched thermistors. A similar experiment was carried on Explorer 7.

************************ TIROS-N, NOAA 6-9************************

Spacecraft Name - TIROS-N, NOAA 6-9

S/C	Alternate Name	NSSDC ID	Launch Date	Incl. (Deg)	Perig. (km)	Apog. (km)	Per. (min)
TIROS-N		78-096A	10/13/78	98.9	846	862	102
NOAA 6	NOAA-A	79-057A	06/27/79	98.7	833	844	101.5
NOAA 7	NOAA-C	81-059A	06/23/81	98.9	845	863	102
NOAA 8	NOAA-E	83-022A	03/28/83	98.8	806	829	101.2
NOAA 9	NOAA-F	84-123A	12/12/84	98.9	841	862	102

S/C	PM	PS
TIROS-N, NOAA 6	G.W. Longanecker NASA-GSFC J. Muller, Jr. NASA-GSFC G.A. Branchflower (NLA) NASA-GSFC	A. Arking NASA-GSFC

NOAA 7-9 | G.W. Longanecker NASA-GSFC | J. Susskind NASA-GSFC
G.A. Branchflower (NLA) NASA-GSFC

Brief Description

The TIROS-N/NOAA series was the third generation of operational polar-orbiting meteorological satellites for use in the National Operational Environmental Satellite System (NOESS), which supported the Global Atmospheric Research Program (GARP) during 1978-84. The spacecraft design provided an economical and stable sun-synchronous platform for advanced operational instruments to be used in making measurements of the earth's atmosphere, its surface and cloud cover, and the near-space environment. Primary sensors included an advanced very high resolution radiometer (AVHRR) and a TIROS operational vertical sounder (TOVS). Secondary experiments consisted of a space environment monitor (SEM) and a data collection system (DCS). The NOAA 7 had an additional contamination monitor to obtain contamination sources, levels, and effects for consideration on future spacecraft. The NOAA 9 carried two other instruments: the earth radiation budget experiment (ERBE), and the solar backscatter ultraviolet radiometer (SBUV/2). Both NOAA 8 and 9 were also equipped with a search and rescue (SAR) system to receive, process, and relay distress signals which were transmitted by beacons carried on civil aircraft and some classes of marine vessels. The spacecraft was based upon the DMSP Block 5D spacecraft bus developed for the U.S. Air Force, and was capable of maintaining an earth-pointing accuracy of better than plus or minus 0.1 deg with a motion rate of less than 0.035 deg/s. For a more detailed description, see Schwalb, A., "The TIROS-N/NOAA A-G satellite series," NOAA Tech. Mem. NESS 95, 1978.

-------------------TIROS-N, NOAA 6-9, Broome------------------

Investigation Name - Earth Radiation Budget Experiment (ERBE)

Flown on - NOAA 9

NSSDC ID - 84-123A-05

PI - G.C. Broome NASA-LaRC

Brief Description

The Earth Radiation Budget Experiment (ERBE) was designed to measure the energy exchange between the earth-atmosphere system and space. The measurements of global, zonal, and regional radiation budgets on monthly time scales helped in climate prediction and in the development of statistical relationships between regional weather and radiation budget anomalies. The ERBE consisted of two instrument packages: the non-scanner (ERBE-NS) instrument and the scanner (ERBS-S) instrument. The ERBE-NS instrument had five sensors, each using cavity radiometer detectors. Four of them were primarily earth-viewing: two wide field-of-view (FOV) sensors viewed the entire disc of the earth from limb to limb, approximately 135 deg; two medium FOV sensors viewed a 10-deg region. The fifth sensor was a solar monitor that measured the total radiation from the sun. Of the four earth-viewing sensors, one wide and one medium FOV sensors made total radiation measurements; the other two measured reflected solar radiation in the shortwave spectral band between 0.2 and 5 micrometers by using Suprasil-W filters. The earth-emitted longwave radiation component was determined by subtracting the shortwave measurement from the total measurement. The ERBE-S instrument was a scanning radiometer which contained three narrow FOV channels. One channel measured reflected solar radiation in the shortwave spectral interval between 0.2 and 5 micrometers. Another channel measured earth-emitted radiation in the longwave spectral region from 5 to 50 micrometers. The third channel measured total radiation with wavelength between 0.2 and 50 micrometers. All three channels were located within a continuously rotating scan drum which scanned the FOV across track sequentially from horizon to horizon. Each channel made 74 radiometric measurements during each scan, and the FOV of each channel was 3 by 4.5 deg that covered about 40 km at the earth's surface. The ERBE-S also viewed the sun for calibration. Additional information can be obtained from "Earth Radiation Budget Experiment (ERBE): An Overview," J. Energy, v. 6, pp. 141-146 (1982), by B. R. Barkstrom and J. B. Hall, Jr.

------------------TIROS-N, NOAA 6-9, Cunningham------------------

Investigation Name - Solar Backscattered Ultraviolet Radiometer (SBUV/2)

Flown on - NOAA 9

NSSDC ID - 84-123A-07

PI - F.G. Cunningham NASA-GSFC

Brief Description

The Solar Backscatter Ultraviolet Radiometer (SBUV/2) was designed to map total ozone concentrations on a global scale, and to provide the vertical distribution of ozone in the earth's atmosphere. The instrument design was based upon the technology developed for the SBUV/TOMS flown on Nimbus 7. The SBUV/2 instrument measured backscattered solar radiation in an 11.3-deg field of view in the nadir direction at 12 discrete, 1.1-nm wide, wavelength bands between 252.0 and 339.8 nm. The solar irradiance was determined at the same 12 wavelength bands by deploying a diffuser which reflected sunlight into the instrument's field of view. The SBUV/2 also measured the solar irradiance or the atmospheric radiance with a continuous spectral scan from 160 to 400 nm in increments of 0.148 nm. The SBUV/2 had another narrowband filter photometer channel, called the cloud cover radiometer (CCR), which continuously measured the earth's surface brightness at 380 nm. The CCR field of view was 11.3 deg.

--------------------TIROS-N, NOAA 6-9, Leinbach-------------------

Investigation Name - Space Environmental Monitor (SEM)

Flown on - TIROS-N, NOAA 6-9

NSSDC ID - 78-096A-04, 79-057A-04, 81-059A-04, 83-022A-04
84-123A-04

PI - H. Leinbach	NOAA-ERL
PI - D.J. Williams	APL
OI - H.H. Sauer	NOAA-ERL
OI - R.N. Grubb (NLA)	NOAA-ERL
OI - D.S. Evans	NOAA-ERL
OI - R. Seale	NOAA-ERL
OI - C.O. Bostrom	APL

Brief Description

This experiment was an extension of the solar proton monitoring experiment flown on the ITOS series spacecraft. The experiment package consisted of three detector systems and a data processing unit. The total energy detector (TED) measured the energetic particle energy from 0.3 keV to 20 keV in 11 bands. The medium energy proton and electron detector (MEPED) measured proton flux above 16, 30 and 80 keV; electron flux above 30, 100 and 300 keV; and the intensity of protons and electrons (inseparable) above 6 MeV. The high-energy proton and alpha telescope (HEPAT) had a 48-deg viewing cone, viewed in the anti-earth direction, and measured energy of protons above 370 MeV and alpha particles above 640 and 850 MeV/n.

------------------TIROS-N, NOAA 6-9, NESDIS Staff-----------------

Investigation Name - Advanced Very High Resolution Radiometer (AVHRR)

Flown on - TIROS-N, NOAA 6-9

NSSDC ID - 78-096A-01, 79-057A-01, 81-059A-01, 83-022A-01,
84-123A-01

PI - NESDIS Staff	NOAA-NESDIS
OI - W.E. Shenk	NASA-GSFC

Brief Description

The Advanced Very High Resolution Radiometer (AVHRR) was a four- or five-channel scanning radiometer capable of providing global daytime and nighttime sea-surface temperature and information about ice, snow, and clouds. These data were obtained on a daily basis for use in weather analysis and forecasting. On TIROS-N and NOAAs 6 and 8, the radiometer measured emitted and reflected radiation in the following spectral intervals: channel 1, 0.55 to 0.9 micrometer (visible); channel 2, 0.725 to 1.1 micrometers (near IR); channel 3, 3.55 to 3.93 micrometers (IR window); and channel 4, 10.5 to 11.5 micrometers (IR window). The AVHRR on NOAA 7 and 9 had a fifth channel in the 11.5- to 12.5-micrometer (IR window) region. All channels had a spatial resolution of 1.1 km at nadir, and the IR-window channels had a thermal resolution of 0.12 deg K at 300 deg K. The AVHRR was capable of operating in both real-time or recorded modes. Direct readout data were transmitted to ground stations of the automatic picture transmission (APT) class at low resolution (4-km) and to ground stations of the high-resolution picture transmission (HRPT) class at high resolution (1-km). Data recorded on board were available for processing in the NOAA Central Computer Facility. They included global area coverage (GAC) data, with a resolution of 4 km, and local area coverage (LAC) data which were from selected portions of each orbit with a 1-km resolution. Archival data are available from SDSD.

------------------TIROS-N, NOAA 6-9, NESDIS Staff-----------------

Investigation Name - TIROS Operational Vertical Sounder (TOVS)

Flown on - TIROS-N, NOAA 6-9

NSSDC ID - 78-096A-02, 79-057A-02, 81-059A-02, 83-022A-02, 84-123A-02

PI - NESDIS Staff NOAA-NESDIS

Brief Description

The TIROS Operational Vertical Sounder (TOVS) consisted of three instruments designed to provide temperature and humidity profiles of the atmosphere from the surface to the stratosphere (approximately 1 mb). The first instrument was the second version of the high-resolution infrared spectrometer (HIRS/2). The HIRS was originally tested onboard the Nimbus 6. The HIRS/2 had 20 channels in the following spectral intervals: channels 1 through 5 , the 15-micrometer CO2 bands (15.0, 14.7, 14.5, 14.2, and 14.0 micrometers); channels 6 and 7, the 13.7- and 13.4-micrometer CO2/H2O bands; channel 8, the 11.1-micrometer window region; channel 9, the 9.7-micrometer ozone band; channels 10, 11, and 12, the 6-micrometer water vapor bands (8.3, 7.3, and 6.7 micrometers); channels 13 and 14, the 4.57- and 4.52-micrometer N2O bands; channels 15 and 16, the 4.46- and 4.40-micrometer CO2/N2O bands; channel 17, the 4.24-micrometer CO2 band; channels 18 and 19, the 4.0- and 3.7-micrometer window bands; and channel 20, the 0.7-micrometer window region. The HIRS/2 provided data for calculations of temperature profiles from the surface to 10 mb, water vapor content at three levels of the atmosphere, and total ozone content. The second instrument, the stratospheric sounding unit (SSU), was provided by the British Meteorological Office and was similar to the pressure-modulated radiometer (PMR) flown on Nimbus 6. The SSU operated at three 15.0-micrometer channels using selective absorption, passing the incoming radiation through three pressure-modulated cells containing CO2. The SSU provided temperature information in the stratosphere. The third instrument, the microwave sounding unit (MSU), was similar to the scanning microwave spectrometer (SCAMS) flown on Nimbus 6. The MSU had one channel in the 50.31-GHz window region and three channels in the 55-GHz oxygen band (53.73, 54.96, 57.95 GHz) to obtain temperature profiles which were free of cloud interference. The instruments were cross-course scanning devices utilizing a step scan to provide a traverse scan, while the orbital motion of the satellite provided scanning in the orthogonal direction. The HIRS/2 had a field of view (FOV) 30 km in diameter at nadir, whereas the MSU had an FOV of 110 km in diameter. The HIRS/2 sampled 56 FOVs in each scan line about 2250 km wide, and the MSU sampled 11 FOVs along the swath with the same width. Each SSU scan line had 8 FOVs with a width of 1500 km. For a more detailed description, see Smith, W. L., "The TIROS-N operational vertical sounder," Bull. Am. Meteorol. Soc., v. 60, pp. 1177-1187, 1979. Archival data are available from SDSD.

------------------TIROS-N, NOAA 6-9, NESDIS staff-----------------

Investigation Name - Data Collection System (DCS)

Flown on - TIROS-N, NOAA 6-9

NSSDC ID - 78-096A-03, 79-057A-03, 81-059A-03, 83-022A-03,
84-123A-03

PI - NESDIS Staff — NOAA-NESDIS
CNES

Brief Description

The Data Collection System (DCS), also known as the Data Collection and Platform Location System (DCPLS) and ARGOS, was designed to receive low-duty-cycle transmissions of meteorological observations from free-floating balloons, ocean buoys, other satellites, and fixed ground-based sensor platforms distributed around the globe. These observations were organized on board the spacecraft and retransmitted when the spacecraft came within range of a command and data acquisition (CDA) station. For free-moving balloons, the Doppler frequency shift of the transmitted signal was observed to calculate the location of the balloons. The DCS was expected, for a moving sensor platform, to have a location accuracy of 5 to 8 km rms, and a velocity accuracy of 1 to 1.6 m/s. This system had the capability of acquiring data from as many as 2000 platforms per day. Identical experiments were flown on other spacecraft in the TIROS-N/NOAA series. Processing and dissemination of data were handled by CNES of Toulouse, France.

-------------------TIROS-N, NOAA 6-9, NESDIS Staff-------------------

Investigation Name - Search and Rescue (SAR)

Flown on - NOAA 8, NOAA 9

NSSDC ID - 83-022A-05, 84-123A-06

PI - NESDIS Staff NESDIS

Brief Description

The search and rescue (SAR) instruments, also known as the Search and Rescue Satellite Aided Tracking (SARSAT) instruments, had the capability of detecting and locating existing emergency transmitters in a manner independent of the environmental data. Data from the 121.5-MHz emergency locator transmitters (ELT), the 243-MHz emergency position indicating radio beacons (EPIRB), and the experimental 406-MHz ELTs/EPIRBs were received by the search and rescue repeater (SARR) and broadcasted in real time on an L-band frequency (1544.5 MHz). Real-time data were monitored by local user terminals operated in the United States, Canada, and France. The 406-MHz data were also processed by a search and rescue processor (SARP) and stored on the spacecraft for later transmittal to the CDA stations in Alaska and Virginia, thus providing full global coverage. The distress signals were forwarded to Mission Control Centers located in each country for subsequent relay to the appropriate Rescue Coordination Center.

Geodetic Tracking Spacecraft

The geodetic tracking data sets are part of a data exchange in which approved individuals or organizations submit tracking data and can then request the data submitted by other organizations. The approved list of requesters is controlled by the Geodynamics Program, Code EEG, at NASA Headquarters. Experiments involved are the optical camera tracking, the optical beacon system, the laser reflectors, the Doppler system, the Minitrack beacon, the radio range system, the S-band transponder, and the C-band transponder on the following satellites:

BE-B
BE-C
Diademe 1
Diademe 2
Echo 1
Echo 2
GEOS 1
GEOS 2
GEOS 3
LAGEOS
PAGEOS
Seasat 1
Starlette

For further information about these restricted satellite data sets, please contact:

Henry G. Linder
Code 634
Data Manager, Crustal Dynamics Project
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

Telephone: (301) 344-9537
Telex No.: 89675
TWX No.: 7108289716

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Appendixes

APPENDIX A - DEFINITIONS

Investigation Discipline -	The subject to which an investigation pertains. The possible entries are limited, and the NSSDC information files can be searched using this field.
Investigation Program -	Code of the cognizant NASA Headquarters office, or name of other sponsoring agency program. "CO-OP" added to a code indicates a cooperative effort with another agency or a foreign country. Investigation program categories include the following: CODE EB (Life Sciences) CODE EC (Communications) CODE EE (Earth & Science Applications) CODE EL (Solar System Exploration) CODE EN (Materials Processing) CODE EZ (Astrophysics) CODE RS (Space Systems)
MG -	Program Manager. For NASA missions, "program" usually refers to the NASA Headquarters level.
NLA -	No longer affiliated. Used in the spacecraft personnel section to indicate that the person had the specified affiliation at the time of his participation in the project, but is no longer there. Used in the investigation personnel section to indicate that the affiliation shown is the last known scientific affiliation and that the given person is no longer there.
NSSDC ID -	An identification code used in the NSSDC information system. In this system, each successfully launched spacecraft and experiment is assigned a code based on the launch sequence of the spacecraft. Subsequent to 1962, this code (e.g., 66-008A for the spacecraft ESSA 1) corresponds to the COSPAR international designation. The experiment codes are based on the spacecraft code. For example, the experiments carried aboard the spacecraft 66-008A are numbered 66-008A-01, 66-008A-02, etc. Each prelaunch spacecraft and experiment are also assigned an NSSDC ID code based on the name of the spacecraft. Prior to launch, for example, the approved NASA launch, Earth Radiation Budget Satellite, was coded ERBS. The experiments carried aboard this spacecraft were coded ERBS -01 and ERBS -02. Once it was launched, its prelaunch designation was changed to a postlaunch one: 84-108B.

OI - Other Investigator.

PI - Principal Investigator.

PM - Project Manager. If a spacecraft has had several project managers, the initial and latest project managers are both indicated in the spacecraft personnel section. For NASA missions, "project" usually refers to the NASA field center (e.g., GSFC) level. For international programs, there is usually a project manager in each of the two or more participating nations. The current or more recent PM is listed first.

PS - Project Scientist. The above comments for project managers also apply to project scientists.

SC - Program Scientist. For NASA missions, "program" usually refers to the NASA Headquarters level.

TL - Team Leader.

TM - Team Member.

APPENDIX B - ABBREVIATIONS AND ACRONYMS

A	angstrom; ampere
ac	alternating current
A/D	analog to digital
AEM	Applications Explorer Missions (NASA)
AFB	Air Force Base
AFGL	Air Force Geophysics Laboratory (AFSC)
AFGWC	Air Force Global Weather Central
AFSC	Air Force Systems Command
AFTAC	Air Force Technical Application Center
ALT	altitude; radar altimeter
AM	amplitude modulation
a.m.	ante meridiem
APL	Applied Physics Laboratory of Johns Hopkins University
apog	apogee
APT	automatic picture transmission
ARC	Ames Research Center (NASA)
ASTP	Apollo-Soyuz Test Project (USA & USSR)
atm	atmosphere
ATS	Applications Technology Satellite (NASA)
b	bar; barn
B	bel; magnetic field strength
BE	Beacon Explorer (satellite, NASA)
B/W	black and white
C	degree Celsius; coulomb
CaF2	CaF_2
cc	cubic centimeter
CCD	charge-coupled device
CH4	CH_4
cm	centimeter
CNES	Centre National d'Etudes Spatiales (French space agency)
CNRS	Centre National de la Recherche Scientifique (France)
CO2	CO_2
COSPAR	Committee on Space Research
d	day
DAPP	Defense Aquisition and Processing Program (DOD; now called DMSP)
dB	decibel
deg	degree
DFVLR	Deutsche Forschungs- und Versuchsanstalt fur Luft- und Raumfahrt (Research Laboratory for Aeronautics and Astronautics, Federal Republic of Germany)
DMSP	Defense Meteorological Satellite Program (USAF)
DOD	Department of Defense

ERBE	earth radiation budget experiment
ERBS	Earth Radiation Budget Satellite (NASA)
ERL	Environmental Research Laboratory (NOAA)
EROS	Earth Resources Observation System (Dept. of the Interior)
ESA	European Space Agency
ESRO	European Space Research Organization (now ESA)
ESSA	Environmental Science Services Administration (now NOAA; also satellite series, ESSA-NASA)
eV	electron volt
FM	frequency modulation
FOV	field of view
ft	foot or feet
g	gram
GARP	Global Atmospheric Research Program
GATE	GARP Atlantic Tropical Experiment
GEOS	Geodynamics Experimental Ocean Satellite
GHz	gigahertz
GOES	Geostationary Operational Environmental Satellite (NASA-NOAA)
GSFC	Goddard Space Flight Center (NASA)
GSTDN	ground spaceflight tracking and data network (GSFC)
GVHRR	geosynchronous very high resolution radiometer
h	hour
H2O	H_2O
HCMM	Heat Capacity Mapping Mission (satellite, NASA)
Hz	hertz (cycles per second)
in.	inch
incl	inclination
IR	infrared
ITOS	Improved TIROS Operational Satellite (NOAA)
J	joule
JPL	Jet Propulsion Laboratory (NASA)
JSC	Johnson Space Center (NASA)
K	Kelvin
kbs	kilobits per second
keV	kiloelectron volt
kg	kilogram
kHz	kilohertz
km	kilometer
KSC	Kennedy Space Center (NASA)

LAGEOS	Laser Geodetic Earth-Orbiting Satellite (NASA)
LaRC	Langley Research Center (NASA)
LeRC	Lewis Research Center (NASA)
lat.	latitude
LOGACS	Low-G Accelerometer Calibration System (USAF)
m	meter; milli- (prefix)
mb	millibar
MeV	megaelectron volts
MgF2	MgF_2
MHz	megahertz
min	minute
MIT	Massachusetts Institute of Technology
mm	millimeter
MPI	Max Planck Institute (Federal Republic of Germany)
mrad	milliradian
MSFC	Marshall Space Flight Center (NASA)
mW	milliwatt
N	north; newton; nucleon
N2	N_2
N2O	N_2O
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research (NSF)
NCDC	National Climatic Data Center (NOAA; formerly NCC)
NESDIS	National Environmental Satellite, Data, and Information Service (NOAA)
NESS	National Environmental Satellite Service (NOAA; now NESDIS)
nm	nanometer
NMC	National Meteorological Center (NOAA)
NO2	NO_2
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Air Defense Command
NOS	National Ocean Survey (NOAA)
NRC	National Research Council (National Academy of Sciences)
NRL	Naval Research Laboratory
NSF	National Science Foundation
NSSDC	National Space Science Data Center
nT	nanotesla
NWS	National Weather Service
O2	O_2
OMSF	Office of Manned Space Flight (NASA; now part of the Office of Space Flight)
OSS	Office of Space Science (NASA; now OSSA)
OSSA	Office of Space Science and Applications (NASA)
OSTA	Office of Space and Terrestrial Applications (NASA; now part of OSSA)

Pa	pascal
PAGEOS	Passive Geodetic Earth-Orbiting Satellite (NASA)
PCM	pulse-coded modulation
per	orbit period
perig	perigee
p.m.	post meridiem
PMEL	Pacific Marine Environmental Laboratory (NOAA)
rad	radian
rms	root mean square
rpm	revolutions per minute
s	second
S	south
SAGE	Stratospheric Aerosol and Gas Experiment (NASA; S/C or Experiment)
SAM	Stratospheric Aerosol Measurement
SAO	Smithsonian Astrophysical Observatory (Smithsonian Institution)
SAR	synthetic aperture radar; search and rescue
SARSAT	Search and Rescue Satellite Aided Tracking
SAS	Soviet Academy of Science
SASS	SEASAT-A satellite scatterometer
S/C	spacecraft
SDSD	Satellite Data Services Division (NOAA)
SEASAT	Ocean Dynamics Satellite (NASA)
SMS	Synchronous Meteorological Satellite (NASA)
S/N	signal to noise
sq	square
sr	steradian
STS	Space Transportation System (NASA)
STDN	Spaceflight Tracking and Data Network (NASA)
TDRS	Tracking and Data Relay Satellite (NASA)
TDRSS	Tracking and Data Relay Satellite System (NASA)
TIROS	Television and Infrared Observations Satellite (NASA)
TOS	TIROS Operational Satellite or System (NASA)
TRF	technical reference file (NSSDC)
u	atomic mass unit
U	University
UHF	ultra-high frequency
U.K.	United Kingdom
U.S.	United States
USA	United States of America
USAF	United States Air Force
USSR	Union of Soviet Socialist Republics
UT	universal time
UV	ultraviolet

V	volt
VHF	very high frequency
VIS	visual imaging spectrometer; visible
W	watt; west
WDC	World Data Center
WDC-A-R&S	World Data Center A for Rockets and Satellites
WEFAX	weather facsimile
WFC	Wallops Flight Center (NASA)
WFF	Wallops Flight Facility (NASA)
WMO	World Meteorological Organization
WWW	World Weather Watch (WMO)
yr	year

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

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- ☐ Use in publication
- ☐ Other: ______________________

DOCUMENT DISTRIBUTION CATEGORIES

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☐ Documents Describing the Operation of NSSDC and WDC-A-R&S

Documents Describing the Availability of Satellite Experiment Data

- ☐ NSSDC Data Listing
- ☐ Astronomy
- ☐ Geodesy and Gravimetry
- ☐ Ionospheric Physics
- ☐ Meteorology
- ☐ Particles and Fields
- ☐ Planetary Atmospheres
- ☐ Planetology
- ☐ Solar Physics
- ☐ Earth Resources Survey

☐ Report on Active and Planned Spacecraft and Experiments

☐ Spacecraft Program Bibliographies

☐ Reports on Models of the Near-Earth Environment

☐ World Data Center A for Rockets and Satellites Launch Summaries

☐ SPACEWARN Bulletins

☐ Satellite Situation Center (SSC) Reports

633-82 (4/85)

SPECIFIC DOCUMENTS

ORDER NUMBER	PUBLICATION TITLE

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

NSSDC/WDC-A-R&S DOCUMENT REQUEST FORM

Researchers WITHIN the United States send order to:	Researchers OUTSIDE the United States send order to:
NATIONAL SPACE SCIENCE DATA CENTER CODE 633.4 GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND 20771	WORLD DATA CENTER A ROCKETS AND SATELLITES CODE 630.2 GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND 20771 U.S.A.

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REQUESTER INFORMATION (Please print)

NAME (First, Middle Initial, Last)	TITLE/POSITION (Dr., Prof., Mr., Ms., Graduate Student, Research Associate, etc.)
DIVISION/BRANCH/DEPARTMENT	MAIL CODE
ORGANIZATION	
ADDRESS	
CITY	STATE
ZIP CODE OR COUNTRY	TELEPHONE (Area Code) (Number) (Extension)
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633-28 (2/85)

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Additional Specifications (Negatives, Positives, Paper Prints, etc.)

*If requesting data on magnetic tape, please supply the necessary information below.

Density	Mode		No. of Tracks	Computer	
☐ 800 bpi	☐ BIN	☐ EBCDIC	☐ 7	(Type/Model)	☐ New tapes will be supplied prior to processing.
☐ 1600 bpi	☐ BCD	☐ ASCII	☐ 9		☐ Original NSSDC tapes will be returned.
☐ 6250 bpi		Maximum block size	________	________	☐ I shall pay for new tapes.

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