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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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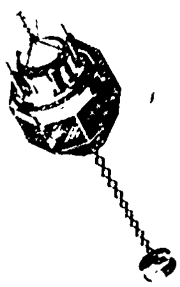
FOR RELEASE:
IMMEDIATE

RELEASE NO: 75-88

PROJECT: GEOS-C

PRESS KIT



contents

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FOR RELEASE:
Immediate

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NEW SATELLITE TO MEASURE OCEAN SURFACE TOPOGRAPHY AND SEA STATE

An Earth-orbiting spacecraft designed to measure precisely the topography of the ocean surface and the sea state--wave height, period, and direction--is being prepared by NASA for launch no earlier than April 9.

The new oceanographic-geodetic satellite, designated Geodynamics Experimental Ocean Satellite-C (GEOS-C), is the third in a series of spacecraft designed to gain knowledge of Earth's shape and dynamic behavior.

- more -

March 31, 1975

The 340-kilogram (750-pound) satellite will be launched aboard a Delta rocket from the Western Test Range near Lompoc, California, into a circular orbit at an altitude of 843 kilometers (523 statute miles) where it will circle Earth every 101.8 minutes on a path inclined 65 degrees retrograde to the equator.

GEOS-C will be used to compare several new and established geophysical measuring systems including a radar altimeter and satellite-to-satellite tracking as well as a radar, laser, and doppler tracking.

The spacecraft will demonstrate the feasibility and the utility of satellite altimeters for measuring the geometry of the oceans and mapping the topography of the ocean surfaces to within a precision to 1 to 2 meters (about 40 to 80 inches). Radar pulses will be beamed to the ocean surface from the satellite and their return timed to measure the satellite altitude from the sea surface, thus providing mean sea level determinations--important in the determination of Earth's gravity field and in the detection of global ocean circulation patterns. The general shape or characteristics of the returned pulses as reflected from the sea surface will provide a measure of the sea state in the areas surveyed--important in detecting rough sea conditions or the effect of storms.

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The altimeter data are expected to contribute to the refinement of present knowledge of the geoid--that is, the level that would be assumed by the ocean surface in the absence of winds, currents, and tides. They will also provide a description of the behavior of the ocean's surface that varies with time due to currents and winds. Thus the radar altimeter will contribute to technology leading to highly accurate operational satellite altimetry.

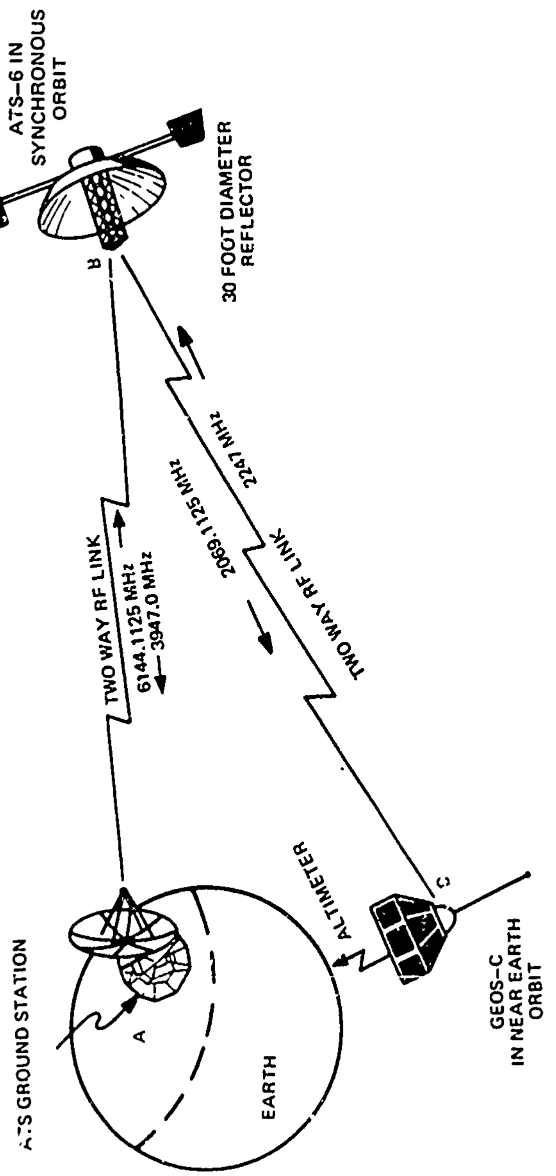
The orbit of GEOS-C must be accurately known so that the height above sea level measured by the altimeter can be accurately calibrated. To do this, GEOS-C will be tracked from the ground by laser, radio doppler, C-band radar, and S-band radar, as well as being tracked by Applications Technology Satellite-6 (ATS-6), launched last year, thus making GEOS-C the best tracked spacecraft ever launched by NASA.

In addition to altimeter calibration, the precision tracking will yield improved gravity field information and will make possible more precise position location of ground tracking stations. These data will be useful in such studies of Earth dynamics as tectonic plate motion, Earth rotation, polar motion, and continental drift theory.

The satellite-to-satellite tracking experiment by GEOS-C and ATS-6, the first of this kind, is expected to provide more precise orbit information on the observed satellite than is now obtainable by the less constant observations of ground stations.

From its geosynchronous altitude, ATS-6 can observe GEOS-C for more than half its orbit. ATS-6 will track and GEOS-C will radio ranging signals through its S-band transponder to ATS-6, which in turn will relay the data to ground stations.

GEOS-C will carry an array of quartz reflectors for laser ranging. The ring of reflectors around the satellite has been designed to permit measurements to accuracies of 10 centimeters (4 inches), which has not been possible in lasar tracking of previous satellites. A laser beam will be sent to the satellite and the reflected signal received at the same ground site. A network of ground laser ranging stations will be used to track GEOS-C during its mission lifetime.



Satellite-to-Satellite Experiment Configuration

ORIGINAL PAGE IS
OF POOR QUALITY

Powered by panels of solar cells, the 132 centimeter (52 inch) diameter GEOS-C will be fixed in orbit with its antennas pointed Earthward by means of an extremely precise gravity-gradient stabilization system employing a scissors type boom with a 45-kilogram (100-pound) end mass. The mass at the end of the boom swings outward as the spacecraft circles the globe in its fixed orbital path, like a ball twirled on a string, keeping the antennas at the opposite end aimed always at Earth. A momentum wheel, like a gyroscope, augments the gravity gradient boom to provide full three-axis stabilization.

The GEOS-C is considered a bridging step between the NGSP and the emerging NASA Earth and Ocean Physics Applications Program.

The GEOS-C Program is under the management of NASA's Office of Applications. The NASA Wallops Flight Center has project management responsibility for GEOS-C. Mission operations are managed by the NASA Goddard Space Flight Center, which also manages the Delta launch vehicle project. The spacecraft was designed and fabricated by the Applied Physics Laboratory of the Johns Hopkins University. Launch site operations are managed by the NASA Kennedy Space Center Unmanned Launch Operations Directorate.

The GEOS-C spacecraft and instruments cost about $12.5 million; the Delta launch vehicle, about $4.5 million.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

BACKGROUND

Since the advent of satellites, man has made much progress in refining his knowledge of the size and shape of Earth. The second U.S. satellite (Vanguard-1, March 17, 1958) determined the famous pear-shaped component of Earth during the International Geophysical Year (IGY).

The particular objectives of the NASA program in satellite geodesy have been to provide a precise measurement of Earth's surface and a mathematical description of Earth surface and its gravity field. These objectives formed the basis of the National Geodetic Satellite Program (NGSP) initiated in 1964. Under NASA management, the NGSP was a joint venture of the Departments of Defense and Commerce, with participation by several universities and international organizations, to meet some of the geodetic needs of the U.S.

The first objective of the Geodetic Satellite Program was to generate a unified world survey network with an accuracy of 10 meters. Such a unified world survey network provides necessary points for geophysicists to obtain a basic reference for the physical measurements of Earth. These common reference points have been a very important contribution of the space program. One of the first accomplishments in space in 1959 was the generation of a Mercury datum used as a basis for the Mercury tracking network.

The second objective of the NGSP was to develop a more precise mathematical model of Earth's gravitational field. This information revealed details about Earth's dynamics and structure. It also has had significant space application in improving orbital prediction capability and made possible missions that require high-precision position determination.

The following is a brief flight history of the NASA satellite geodesy program:

- Explorer-22 (Beacon Explorer-B), launched October 10, 1964. In addition to ionospheric studies, this satellite provided the first instance of ground-based laser tracking for use in tracking and geodetic studies.
- Explorer-27 (Beacon Explorer-C), launched April 29, 1965. With geodetic objectives primary, this mission carried ultra-stable oscillators for precise Doppler tracking of orbital irregularities for gravity field determination. Laser tracking experiments and ionospheric studies were continued.

- GEOS-1 (Explorer-29), launched November 6, 1965. This mission contained basic instrumentation from several participating agencies: a U.S. Navy Doppler system, U.S. Army electronic ranging system SECOR, U.S. Air Force optical beacons, and NASA laser reflectors, and range and range-rate system. This combination of instruments accomplished two important objectives: (1) most of the observation capability of the U.S. could be focused on one satellite; and (2) errors in a particular system could be discovered and corrected by reference to other systems.

- PAGEOS-1 (PAssive GEOS), launched July 1, 1966. This mission consisted of the use of an ECHO-1 type, aluminized Mylar balloon for optical sighting by sunlight reflected from the satellite. By observing PAGEOS-1 against the star background, stations determined their orientation to one another.

- GEOS-2 (Explorer 36), launched January 11, 1968. This mission was nearly identical to GEOS-1 with additional laser equipment and a new radar system.

- Skylab, launched May 14, 1973. This manned orbiting laboratory was equipped with an Earth Resources Experiment Package (EREP) that included an earlier version of the GEOS-C radar altimeter. The data obtained from the altimeter provided "proof of concept" for the GEOS-C instrument and supplied localized samples of sea surface topography data.

In addition to the data from these satellites, considerable information has been acquired from many other satellites whose orbit characteristics and systems have contributed to solutions in geodesy.

PROJECT DESCRIPTION

The purpose of the GEOS-C Project is to design, develop, and launch an oceanographic/geodetic satellite and to perform experiments in support of the NASA Earth and Ocean Physics Applications Program (EOPAP). The GEOS-C Project will apply satellite techniques to geoscience investigations--oceanography and solid-Earth physics--to:

1. Demonstrate the feasibility and utility of satellite altimeters for measuring the geometry of the ocean surface. With sufficient accuracy in the determination of the geocentric position of the spacecraft and with suitable altimetry, the geometry of the ocean surface can be described and sea level determinations can be made. This, in turn will contribute to refinement of the present knowledge of the geoid (that is, the level that would be assumed by the ocean surface in the absence of winds, currents, and tides) and to the initial description of the time-varying behavior of the ocean's surface and the larger quasi-steady state departures of the sea surface from the geoid--sea surface slopes, tides, geological effects on the ocean's surface, etc. The mission will provide data for the detection and measurement of oceanographic features such as sea state, wave heights, and major current systems.

2. Contribute to the calibration, data accuracy determination, and improvement of candidate ground-based and satellite-borne tracking systems. The improvement in ground tracking accuracy, especially the laser tracking, coupled with the altimeter data will contribute to the solution of such problems as detection and measurement of local gravity anomalies and the temporal variation of the gravity field; the verification of continental drift theory, polar motion, tectonic motions (changes in the structure of Earth's crust), fault motions, and Earth rotation.

3. Compare and correlate results obtained and make available both the observational data and the results of analyses.

The GEOS-C mission activities are presently scheduled for approximately a one-year period, although the altimeter and sea-surface topography feasibility objectives can be satisfied in about six months. Data will be provided to refine the geodetic and geophysical results of the National Geodetic Satellite Program (NGSP) and furnish a test bed for new systems and techniques that are expected to contribute heavily toward the objectives of EOPAP and particularly to the development of SEASAT, a new oceanographic satellite being planned for launch in 1978. This mission will also contribute to fulfilling the Department of Defense C-band radar calibration requirements and the altimeter requirements of both the Departments of Defense and Commerce.

A broad spectrum of oceanographic and science and engineering information will result from the analysis of data obtained from GEOS-C. For example, 41 investigators or investigating teams from government, university, and industrial organizations were selected from proposals submitted in response to a call for space flight data investigations issued in October 1972. Analysis of the first quick-look data will begin about two weeks after the satellite has been turned on in orbit, and arrangements have been made to provide appropriate data to each investigator on a routine basis.

MISSION OBJECTIVES

The GEOS-C mission objectives in order of priority at launch are:

1. To perform an in-orbit satellite altimeter experiment to: (a) determine the feasibility and utility of a space-borne radar altimeter to map the topography of the ocean surface with an absolute accuracy of plus or minus 5 meters (16 1/2 feet) and with a relative accuracy of 1 to 2 meters (40 to 80 inches), (b) determine the feasibility of measuring the deflection of the vertical at sea, (c) determine the feasibility of measuring wave height, and (d) contribute to the technology of future altimeter-satellite systems with a 10-centimeter (4-inch) measurement capability.

2. To support further the calibration of NASA and other agencies' ground C-band radar systems by providing a space-borne coherent C-band transponder system, to assist in locating these stations in the unified Earth-centered reference system, and to provide tracking coverage in support of the radar-altimeter experiment.

3. To perform a satellite-to-satellite tracking experiment with the Applications Technology Satellite-6 (ATS-6) using an S-band transponder system to directly measure the short period accelerations imparted to the spacecraft by the gravity field and to determine the position of the spacecraft. The satellite-to-satellite tracking system will also be used for relaying altimeter-data through ATS-6.

4. To support further the intercomparison of new and established geodetic and geophysical measuring systems, including the radar altimeter, satellite-to-satellite tracking, and C-band, S-band, laser, and Doppler tracking systems.

5. To investigate solid-Earth dynamic phenomena such as polar motion, fault motion, Earth rotation, Earth tides, and continental drift theory with precision satellite tracking systems such as the laser and Doppler systems.

6. To refine further orbit-determination techniques, the determination of interdatum ties, and gravity models with a spacecraft equipped with laser retroreflectors, C-band transponders, S-band transponders, and Doppler beacons.

7. To support the calibration of the S-Band sites in NASA's Space Tracking and Data Network (STDN) by furnishing a space-borne S-Band transponder to assist in positioning the network stations in the world reference tracking system, and to assist in evaluating the unified S-Band system as a tool for geodesy and precision orbit determination.

SPACECRAFT

GEOS-C is a densely packed, 340-kilogram (750-pound) satellite with an eight-sided aluminum shell topped by a truncated pyramid. It is 132 centimeters (53 inches) wide and 81 centimeters (32 inches) high. Its structure is basically the same as that of GEOS-2, which was launched January 11, 1968, with the substitution of heavier trusses to accommodate the additional weight.

GEOS-C's main purpose is to perform experiments in support of the application of geodetic satellite techniques to geosciences, i.d., solid Earth physics and oceanography. The experiments GEOS-C carries to achieve its objectives are:

- A radar altimeter--the first to be carried on an unmanned spacecraft--to demonstrate the feasibility and utility of using an on-board altimeter to detect and measure oceanographic features such as sea state, wave heights, and major current systems.

- Two C-band transponders to support the altimeter and C-band system calibration as well as for experimentation to determine the accuracy of the system for geometric and gravimetric geodesy investigations.

- One S-band transponder for satellite-to-satellite tracking and for Earth tracking experiments to measure more precisely the satellite orbit and the gravity field.

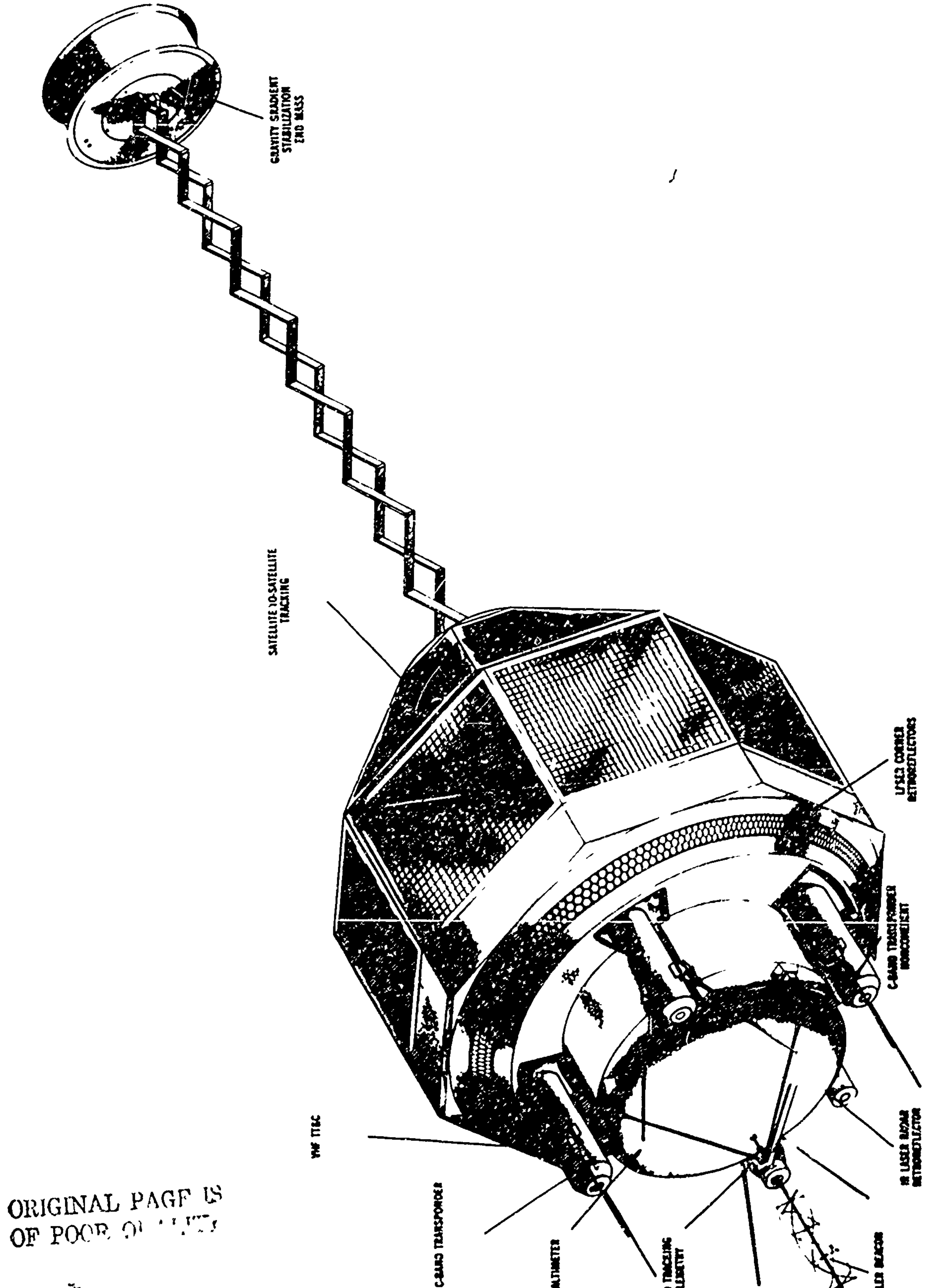
- Laser retroreflectors for measuring the satellite range at optical frequencies.

- A radio Doppler system that transmits on two coherent frequencies used to obtain precision satellite range rate data.

The radar altimeter, laser retroreflectors, and the various antennas are mounted on a platform at the Earth-facing end of the satellite.

The spacecraft's outer surfaces carry panels of solar cells. The solar cell arrays are designed to provide maximum solar cell power output and minimum daily average fluctuations in the satellite's exposure to sunlight as it orbits Earth. Digital solar attitude sensors are mounted below three equatorial solar cell panels. These sensors provide information on the satellite's orientation relative to the Sun.

The C-band and S-band transponders and the Doppler system are mounted in the satellite. Also included in the satellite are the command system, the telemetry system, and the battery which is wired to the solar cell array. A three-axis vector magnetometer for measuring the satellite orientation with respect to Earth's magnetic field and an electromagnet for stabilizing the satellite magnetically are also mounted in the satellite.


GRAVITY GRADIENT STABILIZATION END MASS
SATELLITE TO-SATELLITE TRACKING
LASER CORNER RETROREFLECTORS
C-BAND TRANSPONDER NONCOHERENT
VHF TT&C
C-BAND TRANSPONDER
RADAR ALTIMETER
S BAND TRACKING & TELEMETRY
DOPPLER BEACON
IR LASER RADAR RETROREFLECTOR

A 600-centimeter scissor type boom extends from a housing in the pyramid end of the spacecraft to provide gravity gradient stabilization of the satellite after it is magnetically stabilized, so that the altimeter, antennas, and laser reflectors will point Earthward at all times. The boom can be retracted or extended to different lengths by means of a motor located inside the satellite. Also in the satellite is a constant-speed momentum wheel which provides full three-axis stabilization.

INVESTIGATIONS

The GEOS-C mission will conduct investigations in 13 specific categories:

Ocean Geoid Determination

This category includes all investigations for the determination of the geometry of mean sea level using altimetry data alone or in combination with other data types.

The satellite altimeter observations provide measurements of the satellite height above the ocean surface. This data can be used directly to estimate the ocean geoid, provided the satellite position can be determined with sufficient accuracy and/or errors in satellite position corrected.

Investigations in this category may call for the combination of altimeter information with geoid information obtained from existing surface gravimetry, satellite gravity field information, and geocentric station position.

One of the important results expected to be obtained from the GEOS-C altimeter is improved definition of the ocean geoid. At present, worldwide knowledge of the ocean geoid is available only from satellite gravity field data which, at best, defines variations with widths of the order of 1500 kilometers (about 900 miles) or larger. The satellite altimeter, with precision and/or accuracy of 1 to 2 meters (40 to 80 inches), has the potential for greatly increasing knowledge of the ocean geoid in those substantial parts of the ocean where no detailed surface gravity data exists, as well as contributing to increased accuracy in those areas where surface gravity and other types of gravity data exist.

Ocean Tides

At present most measurements of ocean tides are made at coastal stations where the tidal effects are strongly influenced by local bathymetric effects. Although several theories exist that permit theoretical computation of deep ocean tides, only limited numbers of measurements of deep ocean tides have been made utilizing bottom tide meters.

The GEOS-C altimeter has the potential for rapid global determination of ocean tides. GEOS-C should allow evaluation of various techniques for recovery of tide data from satellite altimeter measurements. To aid in this evaluation, the tidal analyses of GEOS-C altimeter data will be carried out on data collected in areas where ground truth in the form of bottom tide meter data is available.

Sea State Determination

In addition to giving the distance between the spacecraft and the ocean surface, the GEOS-C altimeter data, through analysis of the characteristics of the return pulse, is expected to provide information on the sea state. In particular, information on mean wave height, wave period, and wave propagation direction may be determinable.

Although theoretical studies and aircraft radar altimeter data analyses have been carried out, considerable effort is needed to determine the degree to which various types of sea state data can be extracted from a satellite altimeter and to identify the best methods for carrying out extraction of the information. Most of the investigations planned for GEOS-C for sea state determination analyses are aimed at evaluation of feasibility and identification of best methods through comparison of results obtained from the GEOS-C altimeter with ground truth information on sea state and with data obtained from aircraft-borne radar instruments.

In addition to analysis of GEOS-C data in terms of sea state parameters, the objectives of these investigations include development of information for use in the design of future satellite radar altimeters and determination of potential bias introduced into altimeter sea surface topography determinations due to sea state.

Quasi-Stationary Departures from the Marine Geoid

This category includes all altimeter data analyses designed to investigate nonperiodic deviations of sea level from the expected values based on present knowledge of the gravity field. It also includes analyses of altimeter data to determine sea slopes associated with such phenomena as currents and wind setup.

The sea surface topography that will be measured by the GEOS-C altimeter is a function primarily of variation of the force of gravity over Earth's surface, changes in atmospheric pressure from point to point on the ocean surface, density structure of the water column, surface wind effects, dynamic effects due to ocean currents, and tidal effects. If only gravitational forces (including rotation) were present, the sea surface topography would coincide with the geoid.

The effects of atmospheric pressure variations, wind forces, and tides are time-variable with a reasonably high temporal frequency. The effects of density structure of the water column and currents are usually considered to be quasi-stationary departures from the geoid, even though the effects of currents do shift over restricted areas of the surface.

One of the primary aims of NASA's Earth and Ocean Physics Applications Program (EOPAP) is to determine, from altimeter measurements, departures of sea surface topography from the marine geoid due to water motion. The reason for this interest lies in the fact that the velocity and volume of water in motion can be inferred from these departures.

Gravity Model Improvement

This category includes all analyses of GEOS-C altimeter and tracking data which have the ultimate objective of determining an improved Earth gravity field model. These include both normal perturbation analyses combining GEOS-C tracking data with data from other satellites and analyses in which the altimeter geoid height information, satellite-to-satellite tracking experiment rate information, or other tracking data are combined with existing information for gravity field model improvement.

Improvement of the existing gravity models is required to achieve EOPAP goals from three viewpoints. First, satisfaction of a number of EOPAP goals requires improved satellite orbit determination which, to a large extent, depends on an improved gravity model. Second, determination of effects of ocean currents on sea surface topography requires high accuracy in geoids with which altimeter-derived sea surface topography can be compared. Increased geoid accuracy requires increased accuracy in knowledge of the gravity field. Finally, interpretation of an improved gravity field offers the potential of increased understanding of plate tectonics and, therefore, of the mechanisms producing earthquakes.

Gravity field information can be derived from GEOS-C data in three ways: (1) by combining information on the perturbations of GEOS-C from tracking data with data from other satellites in a general perturbation analysis; (2) by analysis of satellite-to-satellite tracking data in the same manner as Lunar Orbiter and Apollo data were analyzed to obtain residual line-of-sight accelerations or compatible gravity anomaly information; and (3) by transforming altimeter geoid height data to gravity anomaly information. The investigations also include the combination of GEOS-C data with gravity field information from other sources.

Geological Investigations

One important use of the geoid results to be derived from the GEOS-C altimeter data is interpretation in terms of the geological and geophysical significance of the results. The GEOS-C altimeter results can be of particular value in extending information to areas in which little or no surface gravity information presently exists.

Solid-Earth Dynamics

This category includes all analyses involving the determination of Earth tides, polar motion, and changes in rotation rate of Earth. It also includes determination of very precise positions on Earth's surface using GEOS-C tracking data for such purposes as determination of fault motion and crustal plate motion.

High precision tracking of the GEOS-C satellite, particularly by the submeter precision laser systems, allows derivation of improved information on the dynamics of the solid Earth. Determinations can be made of the effects of solid Earth tides and of the motions of Earth's pole including Chandler motion, yearly motion, and the diurnal wobble.

Intercomparison, Evaluation, and Calibration of Instrumentation Systems

This category includes all investigations whose objective is the evaluation and calibration of altimeter, satellite-to-satellite tracking, and ground tracking instrumentation to be used with the GEOS-C mission. Evaluations of the on-board instrumentation and the ground systems are included. All instrument intercomparison investigations and studies related to instrumentation technology are in this category.

Since the satellite-to-satellite experiment involves new instrumentation, special emphasis will be given to evaluation and calibration of these results.

Ground Truth Determination

This category includes all investigation whose objective is the collection of data from ground, ship, and aircraft based systems and the use of this data to evaluate satellite system characteristics.

Tracking Station Location Improvement

This category includes all investigations to determine the location of tracking stations where the objective is geodetic in nature and not for Earth dynamic purposes.

Several types of tracking data taken using the GEOS-C satellite can be used to provide improved station location information that will be useful in support of altimeter calibration and to support other project objectives. GEOS-C will provide data from new stations, data of higher accuracy than previously available, and data from new instrumentation types such as very long baseline interferometer (VLBI) measurements.

Orbit Determination Improvement

Indirectly, GEOS-C can be expected to support improved orbit determination by providing improved gravity field information. However, this category will emphasize new types of tracking information such as the satellite-to-satellite tracking experiment and altimeter data and its capability to support improved orbit determination.

Data Management/Information Processing

This category includes investigations whose objective is the development of methods and techniques for managing and processing the data taken by the various instrumentations on the GEOS-C spacecraft. This includes the development of data editing and preprocessing techniques. Specifically, investigations are directed toward those systems expected to be most useful in future Earth and ocean physics applications activities and involve advanced techniques applicable to future activities.

Unique System Investigations

Three GEOS-C investigations are uniquely associated with a particular instrumentation and do not fit into any of the preceding 12 categories. One investigation deals with atmospheric studies utilizing satellite-to-satellite tracking experiment data taken through the atmosphere while the other two relate to altimeter and to the C-Band system.

PRINCIPAL INVESTIGATORS

GEOS-C investigations will be conducted by many members of the scientific community. Principal investigations are listed by investigational category.

Ocean Geoid

Black, Dr. H. D.	Johns Hopkins University, Applied Physics Laboratory
Chovitz, B. H.	National Oceanic and Atmospheric Administration (NOAA)
Dohler, G. C.	Department of the Environment, Ottawa, Canada
Gaposchkin, Dr. E. M.	Smithsonian Astrophysical Observatory
Hadgigeorge, G.	Air Force Cambridge Research Laboratory
Jordan, Dr. S. K.	The Analytic Sciences Corporation
Lambeck, Dr. K.	Observatorie de Paris, Mendon, France
Mather, Dr. R. S.	University of New South Wales, Australia
Siry, Dr. J. W.	NASA Goddard Space Flight Center
Tolson, R. R.	NASA Langley Research Center

Ocean Tides

Dohler, G. C.	Department of the Environment Ottawa, Canada
Hendershott, Dr. M. C.	Scripps Institute of Oceanography
Kuo, Dr. J. T.	Lamont-Doherty Geological Observatory
Mofjeld, Dr. H. O.	NOAA
Siry, Dr. J. W.	NASA Goddard Space Flight Center

Sea State

Barrick, Dr. D. E.	NOAA
Blac, P. G.	NOAA
Gower, Dr. J. F. R.	Marine Sciences Directorate, Victoria, B.C., Canada
Miller, Dr. L. S.	Applied Science Associates, Inc.
Pierson, Dr. W. J.	University Institute of Oceanography
Ross, D.	NOAA
Walsh, Dr. E. J.	NASA Wallops Flight Center
Wells, Dr. W. T.	Wolf Research and Development Corporation
Whitlock, C. H.	NASA Langley Research Center

Quasi-Stationary Departures from the Marine Geoid

Apel, Dr. J. R.	NOAA
Leitao, C. D.	NASA Wallops Flight Center

Gravity Model Improvement

Chovitz, B. H.	NOAA
Khan, Dr. M. A.	Computer Sciences Corporation
Rapp, Dr. R. H.	Ohio State University
Siry, Dr. J. W.	NASA Goddard Space Flight Center
Sjogren, W. L.	Jet Propulsion Laboratory
Wong, L.	The Aerospace Corporation

Geological Investigations

Kaula, Prof. W. M.	University of California
Talwani, Dr. M.	Lamont-Doherty Geological Observatory

Solid Earth Dynamics

Bower, Dr. D. R.	Department of Energy, Mines and Resources, Ottawa, Canada
Douglas, B. C.	NOAA
Smith, Dr. D. E.	NASA Goddard Space Flight Center
Tapley, Dr. B. D.	University of Texas

Intercomparison, Evaluation and Calibration

Berbert, J. H.	NASA Goddard Space Flight Center
Bryan, J. W.	NASA Goddard Space Flight Center
Dooley, Dr. R. P.	Technology Service Corporation
Lutz, G.	DFVLR Mobile Raketenbasis, Federal Republic of Germany
Martin, Dr. C. F.	Wolf Research and Development Corporation
Godbey, T. W.	General Electric Company

Ground Truth

Mourad, A. G.	Battelle Memorial Institute
Pierson, Dr. W. J.	University Institute of Oceanography

Tracking Station Location

Fisher, D.	Tel-Aviv University, Tel-Aviv, Israel
Krabill, W. B.	NASA Wallops Flight Center
Marsh, J. G.	NASA Goddard Space Flight Center
Muller, P. M.	Jet Propulsion Laboratory
Schneider, Prof, Dr. M.	Technischen Universitat, Munchen, Federal Republic of Germany

Orbit Determination

Balmino, Dr. G.	Centre National D'Etudes Spatiales, France
Black, H. D.	Johns Hopkins University, Applied Physics Laboratory

Data Management/Information Processing

Godbey, T. W.	General Electric Company

Unique System Investigations

Hofmeister, Dr. E. L.	General Electric Company
Jackson, E. B.	NASA Wallops Flight Center
Liu, A. S.	Jet Propulsion Laboratory

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DELTA LAUNCH VEHICLE

GEOS-C will be launched from SLC-2W at the Western Test Range, Ca., by a two-stage Delta launch vehicle. The vehicle is approximately 32 meters (106 feet) long, with a maximum body diameter of 2.4m (8 feet). The Delta has been launched successfully 90 per cent of the time for the past 14 years.

First Stage

The first stage is a McDonnell Douglas modified Thor booster incorporating four strap-on Thiokol Castor II solid-fuel rocket motors. The booster is powered by a Rocketdyne MB-III B engine using liquid oxygen and liquid hydrocarbon propellants. The main engine is gimbal-mounted to provide pitch and yaw control from liftoff to main engine cutoff (MECO). Two liquid-propellant vernier engines provide roll control throughout first stage operation and pitch and yaw control from MECO to separation of the first and second stages.

Second Stage

The second stage is powered by a TRW liquid-fuel pressure-fed TR-201 engine that also is gimbal-mounted to provide pitch and yaw control through second stage burn. A nitrogen gas system using eight fixed nozzles provides roll control during powered and coast flight as well as pitch and yaw control during coast and after second stage cutoff. Two fixed nozzles, fed by the propellant-tank helium pressurization system, provide retro-thrust after spacecraft separation.

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DELTA FACTS AND FIGURES

The Delta launch vehicle project is under the technical management of the Goddard Space Flight Center, Greenbelt, Md.; McDonnell Douglas Astronautics Co., Huntington Beach, Calif., is the prime contractor. The two-stage Delta has the following general characteristics:

Height 32 meters (106 feet) including shroud;
Maximum diameter 2.4 m (8 ft.) without attached solids;
Liftoff weight 110,165 kg (243,190 lbs.)
Liftoff thrust 1,375,000 Newtons (307,000 lbs.), including four strap-on solids.

First Stage (liquid only) consists of an extended long tank Thor, produced by McDonnell Douglas Astronautics Co, with MB-III B engines, produced by the Rocketdyne Division of Rockwell International, and has the following characteristics:

A diameter of 2.4 m (8 feet);
A height of 18 m (60 feet)
Propellants of RP-1 kerosene as the fuel and liquid oxygen (LOX) as the oxidizer;
A thrust of 780,000 N (175,000 lbs.);
A burning time of about three minutes and 48 seconds;
A weight of about 84,600 kg (186,000 lbs.) excluding strap-on solids.

Strap-on solids consist of four Castor II solid propellant rockets produced by the Thiokol Chemical Corp., with the following features:

A diameter of 0.8 m (31 in.);
A height of 7 m (23.6 feet);
A total weight of 17,900 kg (39,400 lbs.) for four 4,475 kg (9,850 lbs.) each
A maximum thrust of 925,600 N (208,000 lbs.) for four 231,400 N (52,000 lbs., each
A burning time of 38 seconds

Second Stage: Produced by McDonnell Douglas Astronautics Co., using a TRW TR-201 rocket engine; major contractors for the vehicle inertial guidance system located on the second stage are Hamilton Standard and Teledyne.

Propellants: Liquid--Aerozene 50 for the fuel and Nitrogen Tetroxide (N_2O_4) for the oxidizer.

Diameter: 1.5 m (5 feet) plus 2.4 m (8 feet) attached ring.

- more -

Height: 6.4 m (21 feet)

Weight: 61,800 kg (136,000 lbs.)

Thrust: About 42,300 N (9,500 lbs.)

Total Burning Time: 335 seconds.

- more -

LAUNCH OPERATIONS

NASA launch operations from its West Coast facility are conductedby the Kennedy Space Center's Unmanned Launch Operations, Western Launch Operations Division (WLOD). This facility is located at Vandenberg Air Force Base, near Lompoc, California, approximately 125 miles northwest of Los Angeles and 280 miles south of San Francisco. Launch facilities are located on a promontory which juts into the Pacific Ocean near Point Arguello. This makes it possible to launch to the south and place payloads in polar and near-polar orbits without overflying populated areas.

GEOS-C will be launched by Delta 110 from Space Launch Complex 2 West, which has been extensively updated over the years to accept the various Delta configurations, including the powerful new version now in use. The GEOS-C mission will be the second launch this year from this complex. Delta 107 was successfully launched on January 22 to place LANDSAT-2 in a near polar, sun-synchronous orbit at an altitude of 920 kilometers (570 statute miles).

Preparations for the launch of GEOS-C began in late January with the arrival of the Delta 110 first and second stages at WLOD for preliminary checkout and erection. The GEOS-C spacecraft was shipped from the Johns Hopkins Applied Physics Laboratory in mid-February and arrived at KSC/WLOD during the third week of February.

GEOS-C LAUNCH EVENTS

EVENT	TIME (SEC.)	ALTITUDE (KM)	ALTITUDE (MILES)	VELOCITY (METERS/SEC.)	VELOCITY (FT./SEC.)
Liftoff	0	0	0	0	0
Four Solid Motor Burnout	9	4.4	2.7	448	1494
Four Solid Motor Jettison	120	26	16	475	1584
Main Engine Cutoff	272	96	60	4179	13931
First/Second Stage Separation	280	104	64	4174	13914
Second Stage Ignition	285	109	68	4164	13879
Fairing Jettison	305	126	78	4267	14224
Second Stage First Cut-Off	576	185	115	7854	26180
Second Stage Restart	3419	842	522	7140	23799
Second Stage Second Cut-off	3426	842	522	7314	24381
Spacecraft Separation	3501	840	521	7315	24382

- more -

GEOS-C MANAGEMENT

NASA Headquarters

Charles W. Mathews	Associate Administrator for for Applications
Francis L. Williams	Director of Special Programs
Dick S. Diller	GEOS-C Program Manager
James P. Murphy	GEOS-C Program Scientist
Noel W. Hinners	Associate Administrator for Space Science
Joseph B. Mahon	Director of Launch Vehicle and Propulsion Program
I.T. Gillam IV	Small Launch Vehicle and International Programs Manager
P.T. Eaton	Delta Program Manager

Wallops Flight Center

Robert L. Krieger	Director
Laurence C. Rossi	Project Manager
H. Ray Stanley	Project Scientist
Frank M. Boykin	Spacecraft Systems Manager

Goddard Space Flight Center

Dr. John F. Clark	Director
Robert N. Lindley	Director of Projects
John B. Zegalia	Mission Operations Systems Manager and Mission Support Manager
Richard H. Sclafford	Network Support Manager

Goddard Space Flight Center (con't.)

Robert C. Baumann	Associate Director of Projects for Delta
Francis J. Lawrence	Delta Mission Integration Engineer

Kennedy Space Center

Lee R. Scherer	Director
John J. Neilon	Director, Unmanned Launch Operations
Henry R. Van Goey	Manager, KSC Western Launch Operations Division
Wilmer "Bud" Thacker	Chief, Delta Operations, Launch Vehicle Engineering Branch
Carl Latham	GEOS-C Spacecraft Coordinator

Experiment Managers

C. L. Purdy	Radar Altimeter Experiment Systems Manager, NASA Wallops Flight Center
E. B. Jackson	C-Band Experiment System Manager, WFC
B. J. Trudell	Satellite-to-Satellite Experiment System Manager, GSFC
C. C. Stephanides	Laser Experiment System Manager, GSFC
D. Anderle	Doppler System Manager, NWL
I. M. Salzberg	S-Band Experiment System Manager, GSFC

- more -

Support Organizations

Spacecraft and Experiment Hardware Contractor: Applied Physics Laboratory, Johns Hopkins University

Launch Vehicle Contractor: McDonnell Douglas Aircraft Corporation

Launch Site: Air Force Western Test Range, Vandenberg Air Force Base, Calif.

ATS-6 Project: Dr. James E. Kupperian, Jr., Project Manager, GSFC

Ground Truth: National Oceanic and Atmospheric Administration--Lt. L. Goodman

Naval Research Laboratory--Ben Yaplee

CONTRACTORS

HARDWARE

GEOS-C Spacecraft	Applied Phys.cs Lab
Delta Launch Vehicle	McDonnell Douglas Aircraft Corp.
Altimeter	General Electric
S-Band Transponder	Motorola
C-Band Transponder	Vega Precision Labs
Laser Cubes	Zygo Corp.
Doppler	Applied Physics Lab

SUPPORT

Computer Sciences Corp.

Wolf Research and Development Corp.

Applied Sciences Associates

RCA Corp.

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