Fact Sheet

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GeoSat Follow-On METOC Satellite

The GeoSat Follow-On Satellite

The U.S. Navy's Space and Naval Warfare Systems Command launched the GeoSat Follow-On satellite (known as GFO) in February 1998 from Vandenberg Air Force Base in Santa Barbara County California aboard an Orbital Sciences Taurus launch vehicle.

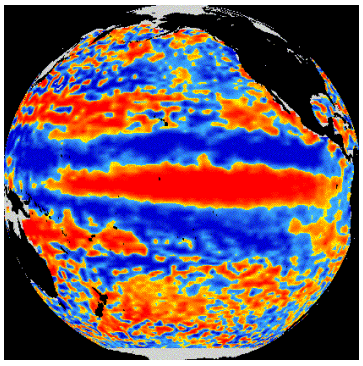
The GeoSat Follow-On program marks the beginning of a new era for low cost access to space by the Navy. This is the Navy's initiative to develop an operational series of radar altimeter satellites to maintain continuous ocean observation from the GeoSat-A exact repeat orbit and exact repeat mission flight.

Evolving from GeoSat-A, a research satellite built for the Navy by the Johns Hopkins Applied Research Lab, GeoSat Follow-On becomes the first Navy operational SmallSat with a cost of less than $100 Million. The technology developed in GeoSat-A transferred to industry as intended.

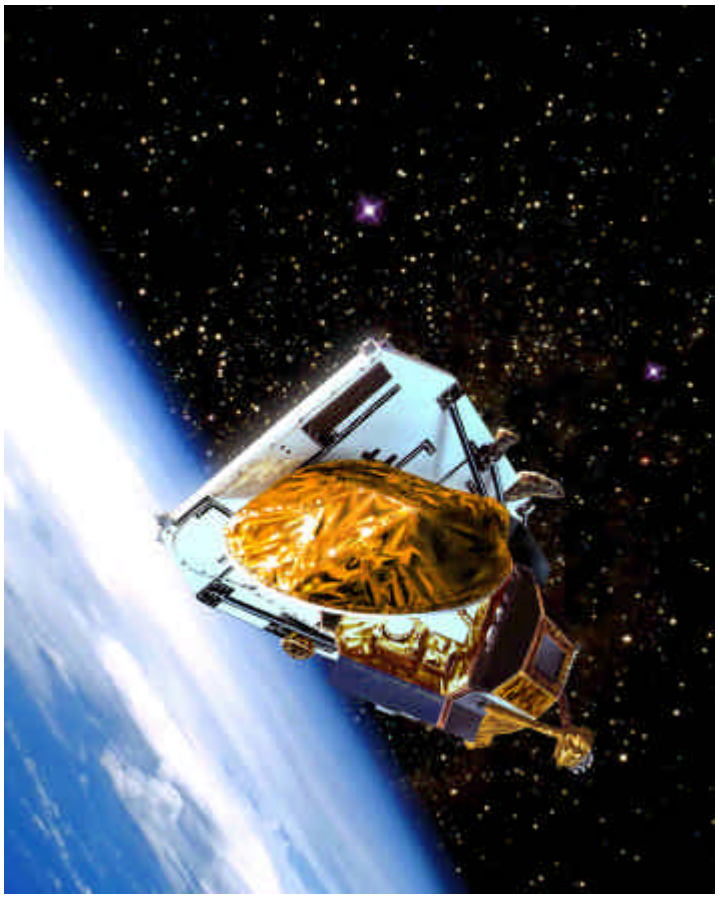
The U.S. Navy operates ships around the globe and requires up-to-date weather and oceanographic information. Weather data is provided through a variety of sources to ships at sea, but precise, current, METOC (meteorological/ oceanographic) information is provided by space-based radar altimeters.

The Navy's first operational altimetry satellite, GeoSat-A, provided data from March 1985 until January 1990. The five-year Geodetic/ Geo-physical (GeoSat-A) mission and its extensive data validation program demonstrated the ability of the radar altimeter to measure the dynamic topography of the Western Boundary currents and their associated rings and eddies. The satellite provided sea surface height data for assimilation into numerical models and mapping the progression of El Niño in the equatorial Pacific.

The GeoSat altimeter was the only satellite to capture the sea level changes associated with the 1987 El Niño (shown in the color bands in the image below). A significantly improved version of the GeoSat data was released in June 1997 and is available from the NOAA National Oceanographic Data Center.



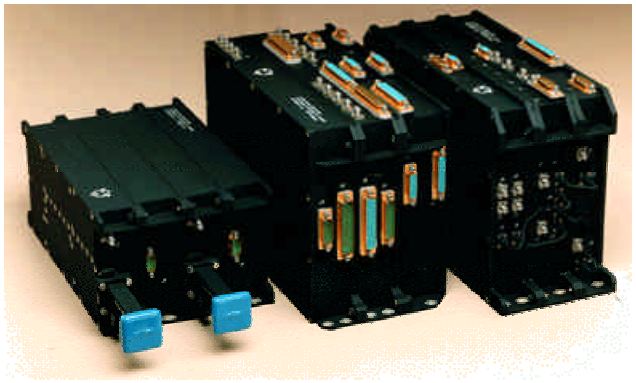
The METOC Systems Program Office (PMW-185) of the Space and Naval Warfare Systems Command in San Diego has overall responsibility for executing the



procurement of the Navy's environmental sensor satellite known as GFO. Competitive procurement in 1992 resulted in the selection of Ball Aerospace & Technologies Corp. to build the GeoSat Follow-On and place it in orbit. The GFO contract is an innovative implementation of acquisition reform.

The Navy issued contract performance objectives and goals which allowed the contractor latitude in choosing commercial off-the-shelf components for the satellite and in selecting the commercial launch vehicle for lift to orbit. The Navy reduced its cost of getting to orbit by acquiring commercial launch services -- the lift capacity for the payload -- rather than buying an entire launch vehicle. This reduced costs to the Navy by accommodating multiple payloads.

Ball Aerospace & Technologies Corp. built the spacecraft bus, procured the payload and launch services and supplied the GFO system software and hardware for the mission's two ground support stations. The company provided the integrated antenna for the payload's altimeter and radiometer as well as the global positioning system and



Raytheon altimeter

communications antennas. Subcontractors to BATC include: Raytheon E-Systems Division (manufacturer of the altimeter shown above), AIL Systems Inc. (manufacture of the microwave radiometer), AOA Inc. (formerly known as Allan Osborne Associates Inc. and manufacturer of the onboard GPS receivers), and Orbital Sciences Corporation (launch vehicle manufacture and launch operations).

The Mission of the Satellite

The Navy requirements for geodetic and oceanographic information have been a driving force through the history of satellite radar altimetry. The Navy's collection of geodetic information was initially acquired by ship surveys and buoy drops that were slow, expensive, and incomplete. Now, space-borne altimeters provide a much more efficient method of collecting the necessary information to support weather and environmental predictions and enhance naval warfighting capability.

U.S. Navy applications of GFO information will include use of altimeter data in coastal ocean-ography, in mapping mesoscale fronts and eddies, and, in using basin-scale data for generating eddy-resolving global ocean models. The length and time scales of these processes are too large for conventional in-the-water oceanographic instrumentation configurations to measure. Satellite altimetry is the only known method by which oceanographers can precisely measure sea surface topography. The shape of the sea surface is the only physical variable directly measurable from space that is directly and simply connected to the large-scale movement of water and the total mass and volume of the ocean.

The GFO mission will support U.S. Navy, NOAA, NASA, and University ocean science and ocean monitoring. It is believed that ocean circulation may be a major cause of decadal climate change. New scientific evidence indicates that dramatic, even catastrophic climate changes can occur over the space of only a few years. Recent ice core samples support several models where shifts of as much as 10 degrees Celsius occur in as short a time as 3-5 years. By comparison, the "little ice age" of 750 years ago resulted from a climate change of only 2 degrees Celsius.

Technical Information on the Satellite

GeoSat Follow-On (GFO) is a unique graphite composite satellite with surface-mounted electronics that is both compact and lightweight. The graphite composite honeycomb fabrication features great strength and resilience to temperature extremes while being comparatively lightweight. Weighing 346 kg (761 pounds) unfueled (369 kg fueled with hydrazine) and approximately 10 feet tall, the GFO satellite has a design life of eight years.

GFO employs a modernized, all solid state radar altimeter built by Raytheon E-Systems as its primary payload. An on-board water vapor radiometer corrects the altimeter measurements based on the amount of moisture in the atmospheric column. The GFO Radar Altimeter measures sea surface conditions over the world's oceans under all weather conditions. It also provides essential, near real-time data on ocean surface topography for determining thermal fronts, eddies, ice edge locations, surface wind speeds and significant wave heights. This data provides dynamic input for constructing ocean models that contribute to understanding changes in global climate, long-range weather forecasting and the balance of planetary energy. The Raytheon Radar Altimeter provides the information necessary to ensure a more productive use of the ocean's resources and safer marine navigation.

Global Positioning System (GPS) receivers provide data to a Precision Tracking System designed to measure satellite altitude to within a few centimeters. Ground system software combines this precisely measured satellite altitude with the altimeter measurements to calculate the ocean surface height. Four GPS receivers are included on the GFO for reliability.

Launch of the Satellite

Orbital Sciences Corporation launched GFO from Vandenberg AFB, Calif., at 5:20 a.m. Tuesday, February 10, 1998, on the second of their Taurus series of launch vehicles and first Taurus Rocket commercial launch. The GeoSat Follow-On satellite was released from the Taurus payload fairing about 14 minutes 30 seconds into the flight. Orbital's Taurus rocket is a ground-launched vehicle built on Orbital's experience with their aircraft-launched Pegasus launch vehicle and operational space systems. The first Taurus launch occurred in March 1994 and placed two U.S. Department of Defense satellites into their desired orbits. Since then, Orbital has developed

an upgraded Taurus vehicle to meet the need for greater performance and payload volume. The Taurus vehicle can deliver satellites of up to 3,000 pounds into low-Earth orbit. This launch also carried three commercial payloads which reduced the Navy's cost of lift to orbit.

The Taurus launch vehicle used a Thiokol CASTOR 120® initial stage followed by three additional stages to insert the GFO satellite into orbit. The CASTOR 120 motor weighs approximately 116,000 pounds of which 107,000 pounds is propellant.

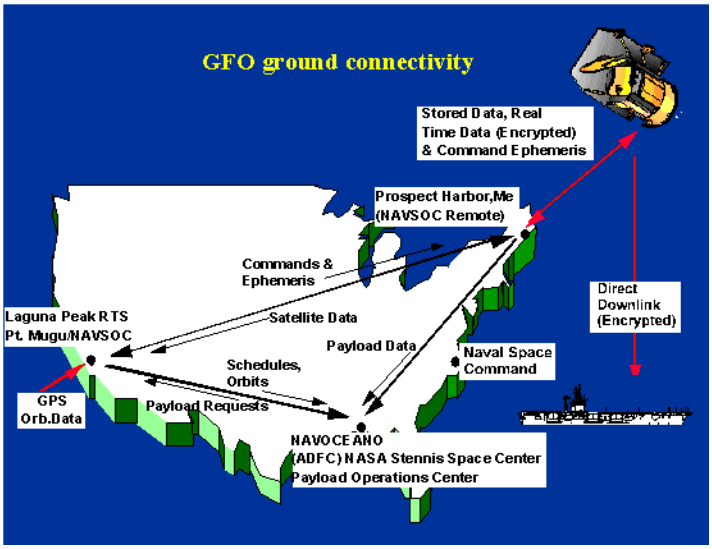
Technological advances on the motor include the use of a high-strength Thiokol TCR® resin for the case material, a low-cost and high-performance thrust vector control system, and class 1.3C HTPB propellant, providing excellent mechanical properties and highly predictable ballistic performance during the 79 second burn time. The CASTOR 120 solid rocket motor now serves as the basic building block of the ground-based U.S. small launch vehicles fleet, providing boost propulsion for not only Orbital's Taurus launch vehicle but for Lockheed Martin's Athena family of launch vehicles.

After payload separation from the launch vehicle, Ball Aerospace & Technologies Corp. conducted post-launch operations from the Naval Satellite Operations Center using telemetry data collected from ground stations in Maine and California. These operations tested all satellite functions and operational procedures and moved the satellite into the operating orbit. When GFO checkout has been successfully completed, Ball Aerospace & Technologies Corp. will turn the satellite over to the Navy for operation.

Operation of the Satellite

The Naval Space Command's Naval Satellite Operations Center (NAVSOC) will operate GeoSat Follow-On. The Naval Satellite Operations Center operates assigned spacecraft and provides on-orbit support for naval communications satellites from its headquarters at Point Mugu, Calif.

The GFO ground segment will include two Naval Satellite Operations Center remote tracking sites at Prospect Harbor, Maine, and Pt. Mugu, California. Satellite payload and engineering data will be relayed to the Satellite Operations Center at NAVSOC Headquarters with payload data sent directly to the Payload Operations Center. The Satellite Operations Center will provide all system and satellite operations with remote commanding via the Maine and California sites.



The Naval Meteorology and Oceanography Command's Naval Oceanographic Office at the Stennis Space Center near Bay St. Louis, Mississippi, will process this data at their Payload Operations Center. GFO will be the first altimetry satellite with direct downlink to ships and regional Meteorology and Oceanography (METOC) Centers equipped with AN/SMQ-11 Tactical Terminals. This capability will put real-time altimetry data in the forward-deployed tactical decision makers' hands for the first time. The Naval Meteorology and Oceanography Command's mission is to collect, interpret and apply global data and information for safety at sea, strategic and tactical warfare, and weapons system design, development and deployment. The command provides meteorological, oceanographic, and mapping, charting and geodesy services to increase the effectiveness of our Navy in both peacetime and in war.

The GeoSat Follow-On satellite follows the same exact repeat orbit as GeoSat-A. The GeoSat exact repeat orbit follows the same ground track every 17 days. The GeoSat, at an altitude of 800 kilometers with an inclination of 108 degrees, 0.008 eccentricity, and a 100-minute period, covers latitudes up to +/- 72 degrees and all longitudes. This 17-day exact repeat orbit will retrace the ground track to +/-1 km. As with the original GeoSat, the data will be available for ocean science through NOAA. Oceanographers will be able to compare current GeoSat Follow-On data to historic data from GeoSat-A.

All payload data will be provided on an encrypted, continuously operating tactical downlink to AN/SMQ11-equipped Navy ships and facilities. The payload data will be downloaded approximately four times per day and sent to the NAVOCEANO Altimeter Data Fusion Center for processing. Sea surface topography derived from the altimeter data will be used for tactical environmental aids and for boundary conditions for ocean models.

Support to NOAA by the Satellite

NOAA is particularly interested in GFO because of the demonstrated ability of altimeter data to improve El Niño forecasts. By monitoring patterns of sea level change, the altimeter provides estimates of the varying heat content of the ocean--a critical parameter in ocean models. NOAA presently derives its operational altimeter data from the Topex/Poseidon satellite launched in 1992. GFO will not only double the amount of data available for NOAA's model, it will also provide a reliable backup should Topex/Poseidon fail.

The People Behind the Satellite

Since the 1960s, scientists working for the U.S. Navy, colleges and universities and the aerospace industry have developed and refined the science of space-based meteorology with new sensors and communications systems. The GeoSat Follow-On mission participants have honored two members of the team who passed away prior to the launch and operation of this spacecraft.

An aluminum "foil" plaque (represented here in false color) was attached to the GFO satellite to honor Jimmy L. Mitchell and Vincent Noble for their many contributions to the US Navy's satellite oceanography program.

Related Information Sources and Web Sites

The Oceanographer of the Navy
http://oceanographer.navy.mil/main.html
United States Naval Observatory, 3450 Massachusetts Avenue, NW, Bldg. 1, Washington, DC 20392-5421.

The Naval Meteorology and Oceanography Command
http://pao.cnmoc.navy.mil/pao.htm
https://www.cnmoc.navy.mil/
Naval Meteorology and Oceanography Command, 1100 Balch Boulevard, Stennis Space Center, MS 39529

The Naval Oceanographic Office
http://www.navo.navy.mil/newpage/index4.htm
1002 Balch Blvd, John C. Stennis Space Center, Bay St. Louis, Mississippi

The Naval Space Command
http://www.navspace.navy.mil/
Naval Surface Warfare Center, Dahlgren Division, Dahlgren, Va.

Navy GeoSat Follow-On Altimeter Mission Web Page
http://gfo.bmpcoe.org/Gfo/

The Applied Research Laboratory (ARL) at Penn State
http://www.arl.psu.edu/

NOAA Laboratory for Satellite Altimetry
http://ibis.grdl.noaa.gov/SAT

GeoSat Data on CD-ROM
http://ibis.grdl.noaa.gov/SAT/gdrs/geosat.html

Orbital Sciences Corporation
http://www.orbital.com/Template.php3?Section=News&NavMenuID=32&template=PressReleaseDisplay.php3&PressReleaseID=196

Ball Aerospace & Technologies Corp.
http://www.ball.com/aerospace/gfohome.html

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