

# NASA News

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## HIGHLIGHTS OF 1980 ACTIVITIES



Voyager 1's flyby of Saturn, one of the most spectacular planetary encounters in space history, highlighted the 1980 space exploration activities of the National Aeronautics and Space Administration.

Of the space agency's seven launch efforts during 1980, six were successful. The unsuccessful effort was the attempted launch of NOAA-B, an environmental monitoring satellite on May 29. A booster failure put the satellite into the wrong orbit, causing mission failure.

Of the total, six of the launches, including the failure, were reimbursable for which NASA is paid for the launch and launch support costs.

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The overwhelming success of the Saturn encounter was summed up by Dr. Bradford Smith of the University of Arizona, team leader of the Voyager imaging team, when he stated: "We learned more about Saturn in one week than in the entire span of human history."

The Voyager spacecraft flew within 123,600 kilometers (77,000 miles) of the planet on Nov. 12, climaxing its 38-month journey through space.

As the year came to its end, work was intensifying on the Space Shuttle. Scheduled for its first orbital flight test in March, the Shuttle is expected to be one of the highlights of 1981.

1980 YEAR-END RELEASE

Space Transportation Systems

As 1980 drew to a close, the Space Shuttle Columbia was being prepared for rollout to Launch Pad 39A at the Kennedy Space Center, Fla. The rollout is the final phase of prelaunch preparations for the initial launch of the Columbia.

The orbiter was moved from the Orbiter Processing Facility to the Vehicle Assembly Building on Nov. 24 after spending more than a year undergoing Thermal Protection System tile installation and final systems integration and testing. Upon arrival at the Vehicle Assembly Building, the orbiter was stacked with the external tank and solid rocket boosters.

More than half of the nearly 32,000 tiles were rebonded to the Columbia's exterior after it was determined that earlier bonding techniques did not meet revised specifications. The tougher standards are to insure the Thermal Protection System tile will not work loose during severe vibro-acoustical stress encountered during launch of the Space Shuttle.

Testing of the tiles and the bonding technique was conducted in the laboratory and aboard NASA high-performance aircraft during 1980.

Space Shuttle main engine testing continued at the National Space Technology Laboratories near New Orleans and at Rockwell International's Rocketdyne Div. facility at Canoga Park, Calif.

A third series of ground tests leading to Preliminary Flight Certification of the main engine at rated power level, was completed at NSTL in September. The fourth and final series was completed Dec. 2.

The Columbia's flight engines were returned to NSTL during the fall and recertified with 520-second firings. Following the tests, the engines were returned to the Kennedy Space Center and reinstalled on the orbiter.

During the year, a fuel preburner burn-through problem was identified and resolved by a modification to the preburner. In addition, several engine fatigue failures occurred, but they pose no problems to the first Shuttle mission.

Two more main propulsion test firings are required in addition to the three successful test firings conducted during 1980.

More than 87,500 seconds of firing time had been logged since the test program began.

Construction of Orbiter Challenger continued at Palmdale, Calif. Challenger is scheduled for completion in late 1982.

As the Columbia was being prepared for its initial launch in March 1981, the prime crew of John Young and Robert Crippen continued training at the Johnson Space Center in Houston.

Nineteen new astronaut candidates reported to Johnson in July to begin an intensive training course. Eight pilot candidates and 11 mission specialist candidates will undergo a year of training before qualifying for the astronaut corps. Of the eight pilot candidates, one is black. Two women and one Hispanic are in the select group of trainees. One candidate, William Fisher, is the husband of Dr. Anna Fisher, a qualified mission specialist astronaut, who was selected in 1978.

### Advanced Plans

Studies of new space initiatives continued in 1980. Prime targets for eventual development include a Solar Electric Propulsion System, 25-Kilowatt Power Station, Space Operations Center and an Orbital Transfer Vehicle.

The Solar Electric Propulsion System would be used to provide propulsion necessary for long duration interplanetary missions or low acceleration movement of large space structures in Earth orbit.

During the year parallel contracts were awarded for design definition studies for a 25-Kilowatt Power Station. The system would provide electrical power from a solar array to augment Space Shuttle/Spacelab missions as well as support large payloads left in space.

Definition studies were begun in 1980 on a Space Operations Center designed for long duration in-orbit operations. Up to 12 persons could man the center.

Following the completion of definition studies, planners are now assessing the next logical step in the development of an Interim Orbiter Transfer Vehicle and a follow-on manned Orbital Transfer Vehicle.

NASA is in the process of defining a cooperative program with Italy for the development of a tethered scientific satellite flight program.

### Space Transportation Operations

NASA's newest program office, the Office of Space Transportation Operations, was set up in October 1979 with the primary job of organizing and ultimately conducting Space Shuttle operations. Target date for the start of the formal operation of the Space Shuttle -- following four orbital test flights -- is the fifth flight of the Columbia in September 1982, when the first Tracking and Data Relay Satellite will be launched.

The new office has two other major responsibilities. These are management of the expendable launch vehicle program which will play a key role in the early 1980s in meeting NASA's satellite launch obligations during the transition period to full-scale Space Shuttle operations, and the Spacelab program, a joint European Space Agency/NASA undertaking.

The Space Shuttle operational schedule during the first four years calls for 74 flights, of which 64 will be from the Kennedy Space Center, Fla., and 10 from Vandenberg Air Force Base, Calif. About one-third of the flights will carry NASA, civilian U.S. government and European Space Agency payloads; one-third will be for non-U.S. government payloads (primarily geosynchronous communications satellites); and one-third will be Department of Defense payloads.

The long-range Space Shuttle operational schedule calls for 487 flights through the mid-1990s.

In addition to the first Space Shuttle Orbiter, the Columbia, three other orbiters will comprise the Space Shuttle fleet. These are the Challenger with its first flight scheduled for November 1982, the Discovery scheduled to fly in December 1983 and the Atlantis which will make its maiden flight in March 1985.

Highlights of the first year of activities for the Office of Space Transportation Operations included:

- o Signing of launch services agreements with four users of the Space Shuttle or expendable launch vehicles: the International Telecommunications Satellite Organization (INTELSAT); Satellite Business Systems; the Government of India; and the Republic of Indonesia.

- o Appointment in July of Dr. Stanley I. Weiss, former Deputy Assistant Secretary of the Department of Energy and executive of the Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif., to be NASA Associate Administrator for Space Transportation Operations.

- o Start of development of the updated Delta launch vehicle -- the 3920 -- which will be launched in 1982.

- o Seven satellite launchings conducted using the Atlas Centaur, the Delta and the Atlas F launch vehicles (see attached NASA Launch Record).

- o Meetings with Space Shuttle users at the Kennedy Space Center in May and at NASA Headquarters in Washington in October to keep them up to date on the latest Space Shuttle test flight and operational planning developments.

- o Signing in January of a \$183,960,000 contract with the European Space Agency for the manufacture and delivery in 1984 of

second Spacelab.

- o Acceptance on Nov. 28 of the first Spacelab engineering model which will be used at the Kennedy Space Center for ground systems checkout and crew training.

- o Selection for the Space Shuttle program of eight pilot and 11 mission specialist astronaut candidates -- including a Hispanic, a black and two women -- who reported in July for training at Johnson Space Center in Houston.

- o Publication of a reimbursement guide for civilian U.S. Government and non-U.S. Government users of the Space Shuttle system.

### Space Science

Voyager 1 was 48 million kilometers (30 million miles) past Saturn and headed into the cosmos as 1980 came to a close, leaving behind one of the most spectacular planetary encounters in space history.

The week of photographs and other measurements taken in early November as Voyager flew within 123,600 km (77,000 mi.) of the planet marked the climax of a 38-month, 1.5-billion km (932 million mi.) journey by the instrument-laden robot spacecraft.

"We learned more about Saturn in one week than in the entire span of human history," said Dr. Bradford Smith of the University of Arizona, team leader of the Voyager imaging team. At the same time, the data radioed back to Earth by Voyager raised almost as many questions as it answered about the giant planet, its rings and its moons.

Here are some of the scientific surprises encountered at Saturn:

- o Saturn's rings are far more numerous than had been previously believed -- numbering in the hundreds -- and far more complex. At least two rings are "out-of-round" (elliptical) and three others appear braided.

- o Mysterious dark fingers of material stretch across the brightest parts of the rings. Long radial spoke-like features in one of the major rings (the B ring) are dark when viewed from above the ring plane, and bright when observed from below the plane, indicating that they have a strong forward-scattering property.

- o Voyager confirmed the existence of a D ring stretching about 17,600 km (11,000 mi.) from Saturn's cloud tops to the edge of the other five major rings, and a new ring was discovered beyond the others, about 89,600 km (56,000 mi.) out from Saturn.

o Voyager 1 photographed six new Saturnian moons, some that had never been seen before, and some that had been reported as moons but not confirmed.

o Closeup observations of Saturn's smaller moons show that they consist of dirty ice. Some are pockmarked by meteoritic craters collected over eons, but others are smoother and therefore younger.

o Titan, largest of Saturn's 15 known moons, has an atmosphere composed largely of nitrogen, not methane as had been previously believed. In many ways, the Titanic atmosphere resembles that of the primitive Earth before it evolved to its present state.

o Titan is not the largest natural satellite in our solar system, as previously believed, but seemed largest. Titan's actual diameter, obscured by thick layers of atmosphere, is no more than 5,120 km (3,175 mi.), compared with the Jovian satellite Ganymede, which measures 5,240 km (3,275 mi.) across.

o At Saturn's equator, winds whirl around the planet at a speed of 1,000 miles an hour, four times faster than the strongest winds observed by Voyager at Jupiter.

o The mechanism that drives the high velocity zonal wind is the cyclic rising and subsidence of massive, extremely cold clouds of ammonia that are thought to be the major constituent of Saturn's atmosphere.

o The rings are made up of particles whose sizes cover a wide range, from microns to meters. The distinct differences between the materials in the rings suggest that the rings formed at different times, from different sources.

Voyager 1 is now headed for the outer reaches of the solar system, and will be considered to have left the solar system when it crosses the orbit of Pluto about 1990. The spacecraft will then begin a virtually endless journey among the stars.

A sister craft, Voyager 2, will encounter Saturn on Aug. 25, 1981, and then proceed to Uranus for man's first closeup look at that planet in 1986. If all is still well, the spacecraft could be sent on to Neptune for a 1989 rendezvous.

Voyager is the last approved planetary mission of NASA until 1984, when Space Shuttle launches will send a Galileo orbiter and a probe to Jupiter for a detailed, long-term scientific examination of that planet and its atmosphere.

On Feb. 14, 1980, atop a Delta rocket, NASA launched the first spacecraft designed specifically for the study of solar flares. Operating in a circular orbit 579 km (360 mi.) above the equator, the Solar Maximum Mission observatory represents a major

step toward a better understanding of the violent nature of the Sun and its effects on Earth.

The mission was planned to coincide with the solar maximum period, the peak of an 11-year sunspot cycle when particularly explosive activity disrupts the Sun's surface. The satellite, carrying seven instruments provided scientists with observations of hundreds of solar flares -- violent eruptions on the Sun's surface -- over a wide band of wavelengths in the ultraviolet, X-ray, and gamma ray regions of the spectrum. Through coordinated observations at many different wavelengths, scientists have obtained many clues about the complex nature of solar flares and how they might be predicted.

Integration of OSTA-1, the first science and technology payload to be carried aboard the Space Shuttle, was scheduled for May 1981, with launch of Orbital Flight Test 4 (OFT-4) planned for late summer.

Work continued during 1980 on several other important space science projects; among them, Space Telescope, scheduled for launch in 1983; International Solar Polar Mission, 1983; Infrared Astronomy Satellite, 1982; and Gamma Ray Observatory Mission, 1985. Three space science satellites are scheduled for launch in 1981: Cosmic Ray Isotope Experiment, first half of 1981; Dynamic Explorer, July; and Solar Mesospheric Explorer, September.

Excellent data continued to be received during 1980 from NASA's two Earth-orbiting High Energy Astronomy Observatories (HEAO-2 and HEAO-3), developed by the Marshall Space Flight Center. Processing and detailed analysis of data from the two satellites, as well as from HEAO-1 (which reentered the atmosphere in 1979), will require years of work by astrophysicists. HEAO-2 has already detected X-ray sources 1,000 times fainter than any previously observed, and 10 million times fainter than the first X-ray stars observed. Scientists studying data from HEAO-2 have also confirmed the emission of X-rays from Jupiter -- the only planet other than Earth known to produce such rays.

Orbiting Astronomical Observatory 3 (OAO-3) ended its scientific operations in space on Dec. 30 after eight years. Primary objective of OAO-3 was to obtain high-resolution spectra of a number of stars and to investigate the nature of interstellar matter -- the material in the space between the stars. Among the experiments carried by the satellite were an 80-centimeter (32-inch) Cassegrain telescope and photoelectric spectrometer and an X-ray telescope package. Data analysis will continue until 1983.

### Aeronautics

NASA aeronautical research and technology programs made major progress towards improving the energy efficiency, environmental compatibility, safety and performance of future civil,



military and general aviation aircraft.

The Aircraft Energy Efficiency Program is developing advanced technologies that could reduce fuel consumption by up to 50 percent in future generation aircraft. Significant progress was realized during 1980 on all six major elements of the program. One element, the Engine Component Improvement Program, is already providing fuel-saving technology advancements for engines now being produced by the U.S. industry.

In general aviation, some of NASA's major efforts included flight research into causes of stall/spin behavior of light aircraft; research and testing of energy-absorbing structures and crash-impact load-limiting seats; development and demonstration of an Automated Pilot Advisory System for small airports without traffic control towers; and improvement of fuel efficiency of engines and the flight efficiency of aircraft designs.

The Quiet, Clean General Aviation Turbine Engine program was completed with the resulting research engines producing from 50 to 60 percent less noise than the quietest current business jets and significant reductions in engine pollution emissions.

Combining the desired flight qualities of both the helicopter and the conventional airplane, the NASA/Army Tilt Rotor Research Aircraft, as a concept, could lead to significant future improvements in the national air transportation system and in military operations.

The Tilt Rotor Aircraft, in flight research this year, demonstrated about twice the speed and range of present day helicopter systems using the same amount of fuel. The aircraft reached speeds of 560 kilometers per hour (350 miles per hour).

Research on the Quiet Short-Haul Research Aircraft, demonstrating propulsive lift technology in which engine exhaust flow is employed to aid normal aerodynamic lift, is aimed at future short-haul transports capable of quiet operations from close-to-city air terminals with short runways. Flight research this year demonstrated the effectiveness of this technology to reduce aircraft noise in the communities surrounding airports and also demonstrated the outstanding capability of this short take-off and landing concept to operate in the Navy shipboard environment without catapults and arresting gear.

A joint NASA/Air Force flight research vehicle called HiMAT, for Highly Maneuverable Aircraft Technology, is demonstrating several advanced technologies for future military fighters. The combined technologies are designed to double the maneuverability at transonic and supersonic speeds of U.S. fighter aircraft of the 1990s. This year HiMAT achieved near-maximum design maneuverability at sustained speeds approaching supersonic.

## Energy Programs

NASA energy work, sponsored by the Department of Energy and other agencies, encompasses a variety of projects including solar cell power systems, automotive power systems, industrial gas turbine development, solar heating and cooling, wind turbine generators, solar thermal electric conversion, energy storage and advanced coal extraction and processing.

Other efforts include satellite power systems, nuclear waste isolation in space, fuel cell systems and magnetohydrodynamics.

The fourth and final 200-kilowatt experimental wind turbine electric generator began operating in May on the island of Oahu in Hawaii. Performance has been outstanding because of consistently high wind velocities and a minimum of machine problems. Modifications to the 2-megawatt wind turbine at Boone, N.C., to reduce television interference and low-frequency noise have been made and the turbine is being readied for turnover to the local utility company. The 2.5-megawatt wind turbine at Goodnoe Hills, Wash., has begun operations. Two additional machines at Goodnoe Hills will follow in three-month intervals. In moderate production runs, NASA believes this 2.5-megawatt machine will provide power for less than 4 cents per kilowatt hour.

Progress has been made in applying ceramics technology in automotive gas turbine engines that will result in significantly increased fuel efficiency. Ceramic components have been successfully operated at 1,900 degrees Fahrenheit in a test engine. Additionally, ceramic components have been successfully operated in a truck to verify that the design methods adequately account for the stresses imposed in roadway operations.

The Satellite Power Systems Concept Development and Evaluation Program, a joint DOE/NASA study, has been completed, and reports and recommendations are being prepared. The concept seems to have merit as an electric power option for the post-2000 era, a judgment that is qualified by uncertainties in costs, technology and environmental acceptability. As a result, there are no plans to commit to a full development program. Instead, a program of research into critical areas and studies of improved concepts is being considered.

NASA work on electric car propulsion systems, begun in 1975, is approaching the commercialization phase. NASA plans to invite private companies to submit competitive proposals on the commercialization of an electric vehicle propulsion system which is expected to result in the startup of a government/industry cost-shared venture by late 1981.

The DOE/NASA Solar Federal Buildings Program began this year to provide solar systems for 843 installations in all 50 states and the District of Columbia. Design and construction are expected to be completed in the next 12 months, providing at least

part of the buildings' energy needs, committing the federal government to the use of solar equipment, and stimulating the solar industry.

A unique energy-storage system developed by NASA promises major cost reductions in storing electrical energy, as well as offering long-term reliability and minimal environmental impact. Called Redox, the system could help speed the growth of solar-electric and wind-energy systems where the potential cost of energy storage has been an important consideration. New component developments this year have made the Redox system technologically feasible for wide-scale prototype development.

### Space Tracking and Data Systems

NASA's Office of Space Tracking and Data Systems provides the communications, command, data acquisition and data processing support needed for NASA's flight programs, including Earth orbital science and applications, planetary and interplanetary exploration, aeronautical research and the sounding rocket program.

During the year, NASA's worldwide tracking and data acquisition operations supported daily an average of 30 satellite and space probe missions through the Spaceflight Tracking and Data Network (STDN), for Earth orbiting satellites and, the Deep Space Network (DSN), managed for NASA by the Jet Propulsion Laboratory, Pasadena, Calif., which is responsible for supporting space probe missions.

A highlight of the year for NASA "trackers" was the remarkable success of the Voyager 1 encounter with the planet Saturn, over a billion kilometers from Earth. Millions of bits of data -- including vivid images of the planet, its rings and moons -- were transmitted across the solar system from a Voyager signal that was equivalent to the energy radiated by an automobile dome light. Signal transmission time to and from the spacecraft took just under three hours traveling at the speed of light.

Other major activities of the Office included preparations for coverage of the Space Shuttle orbital test flights scheduled to begin next year, and continuing work on the Tracking and Data Relay Satellite System (TDRSS).

In November, a final design review of the Tracking and Data Relay Satellite was held. Current plans call for the two-satellite tracking system to be in operation in geosynchronous orbit late in 1982. When in place, the new system, with its single ground station at White Sands, N.M., will be the primary tracking and data acquisition system for the Space Shuttle as well as low Earth-orbiting satellites, replacing ground stations of the Spaceflight Tracking and Data Network. In anticipation of this, the tracking station at Winkfield, England, was closed in October and the Rosman, N.C., facility will be closed early in 1981. Most stations in the Network will be closed or consolidated with the

### Space Research and Technology

NASA space research and technology development programs are advancing the usefulness, performance, reliability and efficiency, and reducing the cost of space vehicles and space operations, and are providing a reservoir to stimulate fresh concepts and capabilities for future missions.

Planetary return or stopover missions could be less costly if on-site propellant production were developed. This year, methods for producing liquid oxygen from a simulated Martian atmosphere, using electrolytic techniques, were successfully demonstrated.

NASA achieved the first solar pumping of a laser in October in a research program on the transmission of energy in space for use in electrical, thermal or propulsive applications. The laser output was measured at approximately 0.5 watt. The NASA program encompasses work in beam generation, receiver-conversion and related fundamental research.

The first demonstration was completed of autonomous "hand-eye" machine coordination necessary for robotic techniques in space assembly, inspection and repair. The system picked up a single-crystal solar cell, inspected it for defects and successfully placed it onto the solar cell panel array with the proper conductor-pattern orientation.

And during the past year, the operational lifetime of nickel-cadmium batteries was doubled by development of a technique of deep-discharge reconditioning. Since more than 95 percent of NASA Earth-orbiting spacecraft use these batteries, doubling the operational lifetime will be a key factor in reducing future spacecraft power problems.

### Applications and Technology Utilization

The Office of Space and Terrestrial Applications programs continued to make meaningful advances in bringing space technology to broaden and strengthen the nation's economic base.

Landsats 1 and 2 continued to monitor and map the Earth's resources from polar orbit 920 km (570 mi.) above the Earth. There are now 14 Landsat ground stations in 11 nations (including the United States) around the world. Here in the United States, Landsat data use continues to grow. Some 37 states now have programs which use Landsat data. A new multi-agency program, AgRISTARS, was initiated to determine the usefulness, cost and extent to which aerospace remote sensing data can be useful in crop forecasting and management systems.

The NASA Magnetic Field Satellite, Magsat, launched Oct. 30,

1979, specifically to map the magnetic field near the Earth returned to Earth June 11, 1980. The mission yielded a complete survey of the Earth's magnetic field and vector field measurements. The U.S. Geological Survey will use the Magsat data to update magnetic field charts and maps for navigation and geological use. Magsat data may provide important clues to geologists in search of new mineral and petroleum deposits.

The Heat Capacity Mapping Mission satellite data continues to be analyzed with gratifying results. U.S. Geological Survey geologists report delineations of new geologic structures and units which may be related to the mineralization in the Rocky Mountains and Great Plains. Scientists in South Dakota report delineations -- not extractable from Landsat or Seasat data -- of shallow ground-water aquifers, which are important to agriculture and land development in the midwest.

The Materials Processing in Space program continues to move forward in all its elements: science, operations, hardware and planning. A strong base has been formed which will serve as a foundation for future Space Transportation System and Spacelab flight operations. The first Joint Endeavor Agreement between NASA and the McDonnell Douglas Astronautics Co., is proceeding well with the first flight expected in 1982 on the Space Transportation System mid-deck.

The Environmental Observation programs activity continued with research in the areas of atmosphere, ocean surfaces and climate. Since immediately after the Mount St. Helens volcanic eruption, NASA has been working closely with scientists from other agencies and universities to assess the impact of the eruptions on local, regional and world climate patterns.

Plans are moving ahead for the operational demonstration of a National Oceanic Satellite System, a tri-agency effort (Department of Defense, Department of Commerce and NASA) to demonstrate the feasibility of continuous spacecraft observation of the Earth's ocean surface winds, sea state, surface water temperature, wave height, ice and other geophysical measurements.

The NASA Technology Utilization program of bringing space technology to the non-aerospace private and public sectors was sharply enhanced with the passage of the Small Business Act of 1980. The new law authorizes the Small Business Administration and NASA to significantly increase technical and management assistance to the small business sector.

In the field of satellite communications, NASA has undertaken a new research and development program to develop the technology that will assure the availability of adequate and affordable satellite communications beyond the year 1990. Called the 30/20 GHz Program, these efforts are aimed at an expansion of capacity through the use of the allocated 30/20 GHz band and the development of the technology for achieving more effective and

efficient use of the frequency spectrum. Examples of the technology being developed include multiple beam satellite antennas, satellite switching and/or call routing systems, high-frequency, high-power systems, and low-cost Earth stations for providing service to customer premises.

### International Affairs

A milestone in European-American space cooperation occurred Nov. 28, 1980, when the Spacelab engineering model was accepted by NASA in a rollout ceremony in Bremen, West Germany.

Spacelab is to be a major element in the NASA Space Transportation System and will have facilities and equipment similar to laboratories on Earth but adapted for zero gravity.

The engineering model is a prototype of the flight unit but is not intended for flight on board the Space Shuttle. It will be used by NASA to prepare for processing the flight unit, including verification of the interface of the space laboratory with ground equipment at the Kennedy Space Center, Fla., launch site. The engineering model arrived at Kennedy on Dec. 13.

The delivery of the engineering model constitutes the first major transfer of Spacelab hardware to NASA under the European Space Agency/NASA memorandum of understanding signed in 1973. It will be followed by the delivery of the first Spacelab flight unit in 1981. Under the terms of the memorandum of understanding, NASA ordered a second flight unit this year for delivery in 1982-83.

Work will be completed early in 1981 on the Shuttle Remote Manipulator System, another element of the Space Transportation System which is being developed by Canada.

In July 1980, NASA and the European Space Agency announced that two European scientists would enter NASA's Mission Specialist training program at the Johnson Space Center, Houston.

NASA agreed to train the scientists nominated by the European Space Agency in recognition of the substantial contribution ESA is making to the Space Transportation System by funding development of Spacelab. ESA will reimburse NASA for the costs of training the two European scientists.

Claude Nicollier, a Swiss astronomer, and Wubbo Ockels, a Dutch physicist were the two Europeans selected for training. They are now both ESA employees and also Spacelab Payload Specialist candidates.

During 1980, NASA signed separate Launch Services Agreements with Intelsat, India and Indonesia for the launch of communications satellites.

Italy's National Research Council has forwarded earnest money for launch on the Space Transportation System of Italy's planned interim research stage, a small upper stage similar to the Spinning Solid Upper Stage.

In addition, discussions have been underway with the Federal Republic of Germany for the first of two reimbursable German Spacelab missions. The first German Spacelab mission, designated D-1, will contain life sciences and materials processing experiments. The second German Spacelab mission, designated D-4, will carry astrophysics experiments.

Japan has initiated preliminary discussions in planning for its first Spacelab mission, currently envisioned as a partial payload dedicated to materials processing and life science investigations in 1986.

Four new sites for the establishment of NASA air-to-ground voice communications facilities for the Space Shuttle were selected this year. Agreements have been concluded or are being negotiated for the establishment of these facilities in Botswana, Indian Ocean area, western Australia and western Africa. These new facilities will provide voice contact between the NASA ground flight controller and the Space Shuttle astronauts in portions of the Shuttle orbit not covered by existing stations.

The Solar Maximum Mission that was launched in February 1980 has significant foreign contribution. The Solar Maximum Mission is studying the Sun during the peak of its 11-year cycle, when solar flares occur most frequently, and helping us gain a better understanding of its effect on Earth. Several foreign scientific instruments valued at around \$10 million have been contributed to this mission. The Solar Maximum Mission's hard X-ray imaging spectrometer is being provided by a Dutch investigator with British participation; British scientists are collaborating with a U.S. investigator on the X-ray polychromator experiment; and a German scientist is participating with a U.S. investigator on a gamma ray spectrometer.

During 1980, progress continued on the following space science projects with major international involvement: Galileo, an orbiter and probe mission with Germany which will conduct comprehensive investigations of Jupiter; the International Solar Polar Mission, a two-spacecraft mission with the European Space Agency that will investigate the Sun; the Infrared Astronomical Satellite, a cooperative effort with the Netherlands to carry out a comprehensive all-sky survey to detect infrared sources and obtain spectral information; and the Space Telescope, with important ESA involvement, which will operate above the atmospheric veil surrounding the Earth and will increase by several hundred-fold the volume of space we can observe.

During 1980, the U.S., Canadian and French agencies participating in a project to evaluate a Satellite-Aided Search and Res-

cue System formally confirmed an Understanding with the Soviet Union regarding cooperation between SARSAT and a similar Soviet system called COSPAS. Under the terms of the Understanding, the two systems will be interoperable. This cooperative effort will allow a more effective demonstration and evaluation of this concept than would have been possible with either system alone.

Norway has requested to join the SARSAT experiment and has been approved in principle. An understanding between Norway and the SARSAT parties (United States, Canada and France) is under discussion. Brazil, Italy, Japan and Sweden are evaluating joining the project and Bulgaria, the German Democratic Republic and Poland are evaluating joining the Soviet segment. The presently approved system will utilize both Soviet and U.S. satellites. The demonstration is to begin in 1982 and last at least 15 months.

NASA and the Soviet Academy of Sciences continued discussions and planning during the past year for U.S. participation in the 1982 Soviet biosatellite mission, the first such Soviet mission to include primates. NASA would provide instruments to monitor cardiovascular functions, biorhythms and motor activity of two rhesus monkeys and would also assist the Soviets in data analyses of biomedical data from the flight.

During 1980, NASA and the Chinese Aeronautical Establishment exchanged visits of aeronautics delegations. The purpose of this exchange was to become familiar with each other's civil aeronautics research and development activities to assess prospects for NASA/Chinese cooperation in this field.

In the past 12 months Landsat ground stations have become operational in Japan, India, Australia, Argentina and South Africa, joining stations in Canada, Brazil, Italy and Sweden. Agreements were signed with the People's Republic of China in early 1980; the Republic of South Africa in September 1980; and with Thailand in 1979 calling for establishment of facilities for direct access to Landsat data.

Considerable progress was made on implementation of the potential cooperative projects recommended by the U.S./Japanese Joint Study Group last year. Letter agreements have been concluded with cooperating Japanese agencies to establish 10 different projects, data exchanges and joint analyses or feasibility studies. For example, Japan will modify an existing 26-meter (85-foot) antenna to participate in crustal plate motion studies, and has agreed to data exchanges and joint analyses for studies of ocean dynamics, winds and waves associated with typhoons, cloud height measurements and use of remotely-sensed data to study snow properties and evaporation. A feasibility study is also underway for possible contribution by Japan of science packages for probes of the planned Saturn Orbiter Dual Probe mission that might be undertaken later this decade.



Senior officials from Italy's Ministry for Scientific and Technological Research visited NASA Headquarters and centers at mid-year for broad-ranging discussions on a variety of potential areas of mutual interest and joint activity. Several specific potential projects, such as joint development of a tethered satellite system for the Shuttle, are under active consideration and preliminary definition studies are continuing.

NASA and the Brazilian Institute for Space Research have established an informal working group to identify new areas of cooperation. The first meeting was held in Brazil in June 1980. Potential future cooperative projects were identified in the areas of remote sensing, meteorology and Space Transportation System use.

1980 NASA LAUNCH RECORD

Date	Payload	Launch Vehicle	Launch Site	Mission Remarks
January 17	FLTSATCOM-C	Atlas Centaur	ESMC*	Part of worldwide armed forces communications system
February 14	SMM - Solar Maximum Mission	Delta	ESMC	Scientific studies of solar flare mechanisms -- part of international solar year activities.
May 29	NOAA-B	Atlas-F	WSMC**	Environmental monitoring satellite -- booster failure put satellite into wrong orbit causing mission failure.
September 9	GOES-D	Delta	ESMC	Weather observation.
October 30	FLTSATCOM-D	Atlas Centaur	ESMC	Part of worldwide armed forces communications system
November 15	SBS-A	Delta	ESMC	Satellite Business Systems advanced communications satellite.
December 6	Intelsat V-A	Atlas Centaur	ESMC	Largest commercial communications satellite.

\* ESMC - Eastern Space and Missile Center, Cape Canaveral, Fla.

\*\* WSMC - Western Space and Missile Center, Vandenberg Air Force Base, Calif.

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