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# Press Kit

Project GMS (Japan)

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(NASA-News-Release-77-110) FIRST JAPANESE WEATHER SATELLITE TO BE LAUNCHED (National Aeronautics and Space Administration) 19 p

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RELEASE NO: 77-110

## FIRST JAPANESE WEATHER SATELLITE TO BE LAUNCHED

An American rocket, NASA's Delta 2914, will launch the Japanese Government's first meteorological satellite into synchronous orbit from Cape Canaveral, Fla., no earlier than July 14, 1977.

The Geogynchronous Meteorological Satellite (GMS) weighs 281 kilograms (620 pounds) and represents a major scientific attempt to improve weather predictions over millions of square miles in the Western Pacific Ocean.

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GMS is a satellite program under the direction of the National Space Development Agency of Japan (NASDA). The Delta launch vehicle project is managed for NASA's Office of Space Flight by the Goddard Space Flight Center, Greenbelt, Md.

From its "meteorological arena" 35,800 kilometers (22,250 miles) in space, GMS will identify, pinpoint and photograph every major weather pattern from Hawaii to Pakistan. The satellite's "cameras" will take a cloud cover photo of approximately one third of the world every 30 minutes, 24 hours a day to help alert meteorologists to potential perilous storms over the Pacific. The satellite will be positioned over the equator directly south of Tokyo at 140 degrees East longitude.

Mission objectives of the GMS are to observe cataclysmic events such as hurricanes, typhoons and regional weather phenomena; day and night observation of regional weather; relay meteorological observation data from surface collection points (ships, buoys and weather stations) to the central processing center in Japan; and to transmit processed imaging data for facsimile reproduction at distribution points in the Western Pacific area.

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On board GMS is a Visable Infrared Spin Scan Radiometer (VISSR), capable of making highly accurate pictures of the Earth's cloud cover in daylight and in total darkness. The images, which can be transmitted to Earth every 30 minutes, will enable meteorologists to identify, monitor and track severe storms, heavy rainfall or cloudbursts, floods and typhoons.

GMS also will carry a Space Environment Monitor (SEM) to monitor energetic particle activity emanated by the Sun. Extreme solar activity can affect Earth communications. The SEM monitors solar protons, alpha particles and solar electrons.

A solid motor attached to the GMS spacecraft will be fired about 27 hours after lift-off to inject the spacecraft into its final position above the equator.

The NASDA ground station at Okinawa and NASA's Space Tracking and Data Network (STDN) station at Rosman, N.C., will provide near-continuous transfer orbit monitoring of the spacecraft.

The NASDA ground station at Masuda, Japan, plus other stations in the NASA STDN network (Orroral Valley, Australia and Santiago, Chile) provide backup capability in monitoring the transfer orbit.

After GMS goes into its preliminary orbit from Cape Canaveral, all control and monitoring functions will be performed from the GMS Mission Control Center at Hughes Aircraft Company, El Segundo, Calif.

The cylindrically-shaped weather satellite is the first of several "weather watchers" to be launched by several countries in an attempt to improve weather predictions for extended periods on a global basis. This international weather satellite program is a major part of the Global Atmospheric Research Project (GARP). GARP is sponsored by the International Council of Scientific Unions and the World Meteorological Organization.

Other countries contributing weather satellites to the GARP Program include the European Space Agency (ESA), the Soviet Union and the U.S.

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Members of the European Space Agency are Belgium, Denmark, France, Italy, Netherlands, Spain, Sweden, Switzerland, West Germany, the United Kingdom and Ireland.

Under the GARP Program, five geostationary meteorological satellites (two from the U.S., one each from Japan, the Soviet Union and the European Space Agency) will be placed in orbit. Additionally, the U.S. and the Soviet Union plan to launch two satellites each into polar orbit. The mission of these satellites is to:

- Collect and disseminate observation data on cloud formations and Earth surface temperatures.
- Collect and disseminate meteorological observations data from ships, buoys and unmanned observatories.
- Observe solar protons by space environment monitor.

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In addition to those countries participating in the satellite portion of GARP, approximately 145 countries also will make contributions to the world-wide weather effort by taking daily surface and atmospheric measurements in their respective areas.

All of the data will be sent to Central Data Centers in Moscow and Washington, D.C. Current planning calls for the program to be in full operation by December of 1978.

The Delta rocket is managed for NASA's Office of Space Flight by the Goddard Space Flight Center. NASA's Kennedy Space Center, Fla., Expendable Launch Vehicles Division is responsible to Goddard for management of launch operations. GMS is a meteorological satellite program of the National Space Development Agency of Japan (NASDA). NASDA is responsible for the satellite's procurement, launch and initial checkout.

Later, NASDA will share joint responsibility with the Japanses Meteorological Agency for control and use of the GMS during its planned five-year mission lifetime.

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GMS has been designed, developed and manufactured by Hughes Aircraft Co. under subcontract to the Nippon Electric Co., Ltd. of Japan. Hughes also developed the satellite's camera system. The SEM was designed and built by Nippon Electric Co. Prime contractor for the Delta launch vehicle is McDonnell Douglas Astronautics Co. Huntington Beach, Calif.

The U.S. is reimbursed by the Japanese Government for costs associated with providing Delta launch support.

(END OF GENERAL RELEASE. BACKGROUND INFORMATION FOLLOWS.)

SPACECRAFT (GMS) CHARACTERISTICS

GMS is cylindrical in shape, 3 meters (9 feet) tall, weighs 280 kilograms (620 pounds) in synchronous orbit and has a designed lifetime of more than five years. Lifetime is limited primarily by the amount of hydrazine fuel that can be carried aboard to provide control in orbit. Full redundancy of all mission-critical functions is provided to ensure electronics lifetimes significantly in excess of five years. The solar panel power of 225 watts includes approximately 30 watts margin at the end of five years.

Dominant features of the spacecraft are a large sunshade for the VISSR camera aperture, a 216-cm (7.1 ft.) diameter cylindrical solar array and an S band/UHF despun antenna.

Image capability of the satellite is provided by the VISSR, which is derived from the space-proved United States Synchronous Meteorological Satellite instrument already in orbit. The VISSR provides simultaneous operation of four visible light detectors and one infrared detector.

The SEM instrument, designed and constructed by Nippon Electric Co., is a new design containing five detectors for multi-mode solar particle counting.

Microminiaturization of electronics for the communications sub-system repeater design for S band and UHF operation is achieved by using the latest microwave integrated circuit design techniques.

A unique three channel noncontacting rotary joint couples signals for the spinning spacecraft electronics to the Earth-pointed (despun) antennas. The UHF helix antenna combines high gain and lightweight construction. The S-band parabolic reflector antenna features a specially designed rim and defocused feed to maximize performance.

Design of the VHF communication subsystem for telemetry and command monitoring is compatible with the Goddard Range and Range Rate (GRARR) system, which allows use of NASA's STDN (worldwide tracking network) telemetry, tracking and command stations during launch and transfer orbit.

The control subsystem is similar to the flight-proven Intelsat-IV control subsystem but with very low jitter, to achieve precision images for the VISSR mission.

In addition, flight-proven space qualified design approaches have been used throughout the various other subsystems to enhance system reliability and assure confidence in meeting the satellite objectives.

## VISSR MISSION

The Visible Infrared Spin Scan Radiometer (VISSR) aboard the GMS is used to image the Earth in both visible and infrared spectra. Visible spectrum information consists of reflected sunlight measurements obtained when the Earth's surface visible to the VISSR is illuminated by the Sun. This information is valuable for determining cloud cover, wind velocity and other information deduced from these parameters.

The infrared spectrum is scanned in the long wave infrared region (10 to 12 microns), where the information obtained from the Earth is the amount of heat radiation below the principal energy spectrum of the Sun. Since it contains very little reflected radiation, the infrared information is available day and night. The infrared response to various Earth atmospheric conditions differs significantly from the visible response and thus is a valuable tool for meteorological analysis.

Extremely sensitive infrared detectors are provided which operate at temperatures about 95 degrees K (-178 degrees C). A unique radiation cooler cools the detectors by radiating heat into cold space.

The GMS VISSR generates an Earth image by using the spinning motion of the satellite for scanning from west to east and using motor-actuated mirror stepping for scanning north to south. Since each north-south scan step is 140 microradians, 2,500 steps are required to scan a region 20 degrees in elevation. A 20-degree window of azimuth and elevation (the Earth subtends an angle of approximately 17.5 degrees) can be scanned in approximately 25 minutes. Resolution to 5 km (16,000 ft.) is provided by an optical telescope with approximately 140 microradians instantaneous field of view (IFOV). The four visible channels are scanned simultaneously with each infrared scan, which provides 1.25 km (4,100 ft.) resolution in the visible channels.

As the satellite spins, both infrared detectors and the two sets of visible detectors are swept over the same Earth track, providing redundant signals, increasing reliability and permitting correlation of infrared and visible image data. The relative arrangement of the infrared and visible spectrum detectors in the VISSR focal plane, where the image of the Earth is formed, is shown in the figures.

Detector signals pass through the full redundant VISSR electronics to the two VISSR multiplexermodulators. Either redundant VISSR multiplexermodulator may be commanded to encode either of the VISSR electronics redundant signals for transmission to Earth by way of the redundant communication channels. Ground processing of the data provided the weather picture.

## GMS LAUNCH PROFILE

The first two stages of the Delta 2914 place the spacecraft in a low altitude parking orbit 174 km (108 mi.) at 27.2 degrees inclination near the first equatorial crossing. Spinup to 50 rpm, followed by injection into a transfer orbit using the Delta third stage, occurs after a few minutes in parking orbit.

If spacecraft operation is normal, the GMS will be boosted into synchronous orbit when the spacecraft apogee motor is fired at the third apogee (approximately 27 hours after lift-off). For a nominal transfer orbit, the subsatellite longitude at this time is 141 degrees E, that is, only 1 degree from the final orbital station.

Following burnout of the Delta third stage and spacecraft separation, the GMS will be in transfer orbit. Transfer orbit is a highly elliptical, inclined (27.2 degrees) orbit, with a perigee altitude of 174 km (108 mi.) and an apogee of 870 km (540 mi.) above synchronous altitude. When the spacecraft motor is fired at apogee, the orbit will be circularized and the launch inclination removed. The transfer orbit third apogee occurs nearest the spacecraft's final orbit position of 140 degrees E longitude (north of Australia) and, for this reason, is the optimum time for apogee motor firing, to minimize time and expenditure of hydrazine ($N_2H_4$) propellant necessary to arrive on final station.

During transfer orbit the spacecraft with apogee motor attached is unstable about its principal (spin) axis. To minimize nutation buildup about this spin axis, an active nutation control system is turned on when the spacecraft separates from the Delta third stage. Precise control of thruster firings by this active nutation control system maintains spacecraft stability about the spin axis.

Before apogee motor firing, the spacecraft spin axis must be reoriented to the correct attitude. Re-orientation will be started as soon as possible after determination of injection attitude and subsequent apogee motor firing attitude. Apogee motor firing attitude will be aligned to inject the spacecraft into near-synchronous drift orbit for arrival on station in less than two weeks.

## DELTA LAUNCH VEHICLE

### First Stage

The first stage is a McDonnell Douglas modified Thor booster incorporating nine Castor II strap-on Thiokol solid fuel rocket motors. The booster is powered by a Rocketdyne 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).

### Second Stage

The second stage is powered by a TRW liquid-fuel, pressure-fed engine that also is gimbal-mounted to provide pitch and yaw control through the second stage burn. A nitrogen gas system uses eight fixed nozzles for roll control during powered and coast flight, as well as pitch and yaw control during coast and after second stage cutoffs. Two fixed nozzles, fed by the propellant tank, helium pressurization system, provide retrothrust after third stage separation. Fifty-four minutes after spacecraft separation, the second stage will be reignited for a 10-second burn. Data on this burn will be collected for studies related to future Delta missions.

### Third Stage

The third stage is the TE-3-64-4 spin-stabilized, solid propellant Thiokol motor. It is secured in the spin table mounted to the second stage. The firing of eight solid propellant rockets fixed to the spin table accomplishes spinup of the third stage spacecraft assembly.

### Injection Into Synchronous Orbit

The Delta vehicle will inject GMS into a transfer orbit having an apogee of 36,655 km (22,776 mi.), a perigee of 174 km (108 mi.) and inclination of 27.2 degrees. NASA's Spaceflight Tracking and Data Network will provide telemetry, tracking and ranging support until the spacecraft is placed in its final synchronous orbit at 140 degrees E. Command, control, tracking and data analysis are the responsibilities of NASDA and Hughes Aircraft Co.

## STRAIGHT EIGHT DELTA FACTS AND FIGURES

Height: 35.4 m (116 ft.) including shroud

Maximum Diameter: 2.4 m (8 ft.) without attached solids

Liftoff Weight: 131,895 kg (293,100 lb.)

Liftoff Thrust: 1,765,315 newtons (396,700 lb.) including strap-on solids

### First Stage

(Liquid Only) consists of an extended long-tank Thor, produced by McDonnell Douglas. The RS-27 engines are produced by the Rocketdyne Division of Rockwell International. The stage has the following characteristics:

Diameter: 2.4 m (8 ft.)

Height: 21.3 m (70 ft.)

Propellants: RJ-1 kerosene as the fuel and liquid oxygen (LOX) as the oxidizer

Thrust: 912,000 N (205,000 lb.)

Burning Time: About 3.48 minutes

Weight: About 84,600 kg (185,000 lb.) excluding strap-on solids

Strap-on solids consist of nine TMX-354-5/Castor II solid-propellant rockets produced by the Thiokol Chemical Corp., with the following features:

Diameter: 0.8 m (31 in.)

Height: 7 m (23.5 ft.)

Total Weight: 40,300 kg (88,650 lb.) for nine
4,475 kg ( 9,850 lb.) for each

Thrust: 2,083,000 N (468,000 lb.) for nine
231,400 N ( 52,000 lb.) for each

Burning Time: 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, Teledyne and Delco.

Propellants: Liquid, consists of Aerozene 50 for the fuel and nitrogen tetroxide ($N_2O_4$) for the oxidizer.

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

Height: 6.4 m (21 ft.)

Weight: 6,118 kg (13,596 lb.)

Thrust: About 42,943 N (9,650 lb.)

Total Burning Time: 335 seconds

Third Stage

Thiokol Chemical Corp. TE-364-4 motor.

Propellant: Solid

Height: 1.4 m (4.5 ft.)

Diameter: 1 m (3 ft.)

Weight: 1,152 kg (2,560 lb.)

Thrust: 61,855 N (13,900 lb.)

Burning Time: 44 seconds

## LAUNCH OPERATIONS

The Kennedy Space Center's Expendable Vehicles Directorate plays a key role in the preparation and launch of the thrust-augmented Delta rocket carrying GMS.

Delta 132 will be launched from Pad B, southernmost of the two launch pads at Complex 17, Cape Canaveral Air Force Station, Fla.

The Delta first stage and interstage are scheduled to be erected on Pad B June 18. The nine solid strap-on rocket motors will be mounted in place around the base of the first stage June 20. The second stage will be erected June 21.

The GMS spacecraft was received by KSC June 7 and underwent initial processing in Building AE. Later it will be moved to the Delta Spin Test Facility and mated with the Delta third stage July 1. The third stage/spacecraft assembly will be moved to Pad B and mated with Delta 132 July 6. The payload fairing, to protect the spacecraft on its flight through the atmosphere, is to be put in place July 11.

## TYPICAL LAUNCH SEQUENCE FOR GMS/DELTA 132

| Event | Time | Altitude Kilometers | Altitude Miles | Velocity Km/Hr | Velocity Mph |
|---|---|---|---|---|---|
| Liftoff | 0 sec. | 0 | 0 | 0 | 0 |
| Six Solid Motor Burnout | 38 sec. | 6 | 4 | 1,380 | 857 |
| Three Solid Motor Ignition | 39 sec. | 6 | 4 | 1,380 | 857 |
| Three Solid Motor Burnout | 1 min. 17 sec. | 21 | 13 | 2,888 | 1,795 |
| Nine Solid Motor Jettison | 1 min. 27 sec. | 26 | 16 | 3,166 | 1,968 |
| Main Engine Cutoff (MECO) | 3 min. 48 sec. | 92 | 57 | 17,871 | 11,104 |
| First/Second Stage Separation | 3 min. 56 sec. | 98 | 61 | 17,897 | 11,120 |
| Second Stage Ignition | 4 min. 1 sec. | 101 | 63 | 17,873 | 11,106 |
| Fairing Jettison | 4 min. 45 sec. | 125 | 78 | 18,612 | 11,565 |
| Second Stage Cutoff (SECO-1) | 8 min. 57 sec. | 160 | 99 | 26,753 | 16,624 |
| Restart Second Stage | 21 min. 17 sec. | 169 | 105 | 26,731 | 16,610 |
| Second Stage Cutoff (SECO-II) | 21 min. 24 sec. | 169 | 105 | 27,103 | 16,841 |
| Third Stage Spinup | 22 min. 14 sec. | 171 | 106 | 27,095 | 16,836 |
| Second/Third Stage Separation | 22 min. 16 sec. | 171 | 106 | 27,095 | 16,836 |
| Third Stage Ignition | 22 min. 58 sec. | 173 | 107 | 27,085 | 16,830 |
| Third Stage Burnout | 23 min. 42 sec. | 174 | 108 | 35,481 | 22,047 |
| Third Stage/Spacecraft Separation | 24 min. 55 sec. | 197 | 122 | 35,405 | 22,000 |

## DELTA 132/GMS TEAM

### NASA Headquarters

| | |
|---|---|
| John F. Yardley | Associate Administrator for Space Flight |
| Joseph B. Mahon | Director of Expendable Launch Vehicle Programs |
| Peter T. Eaton | Manager, Delta Program |

### Goddard Space Flight Center

| | |
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| Dr. Robert S. Cooper | Director |
| Dr. William C. Schneider | Director of Project Management |
| Charles R. Gunn | Delta Project Manager |
| William R. Russell | Deputy Delta Project Manager, Technical |
| Robert Goss | Chief, Mission Analysis and Integration Branch, Delta Project Office -- NASA Manager for GMS |
| William R. Burrowbridge | Delta Mission Integration Manager |
| Edward Lowe | Network Support Manager |
| John Walker | Network Operations Manager |

### Kennedy Space Center

| | |
|---|---|
| Lee R. Scherer | Director |
| Dr. Walter J. Kapryan | Director, Space Vehicles Operations |
| George F. Page | Director, Expendable Vehicles |
| Hugh A. Weston, Jr. | Chief, Delta Operations Division |
| Bert L. Grenville | Complex 17 Operations Manager |
| Edmund Chaffin | Spacecraft Coordinator |

NASDA

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| Hideo Shima | President |
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| Akira Kubozono | System Planning Department |
| Yoshitaha Kurihara | Applications Satellite Design Group |
| Kazuo Watanabe | GMS Project Manager |

CONTRACTORS

| | |
|---|---|
| McDonnell Douglas Astronautics Co. Huntington Beach, Calif. | Delta launch vehicle |
| Nippon Electric Co., Ltd. Yokohama, Japan | Spacecraft and SEM |
| Hughes Aircraft Co. Los Angeles, Calif. | Spacecraft and camera systems |

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