National Aeronautics and Space Administration

# The Wind Mission

## The First U.S. Mission in the International Global Geospace Science Physics Program

Press Kit

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Understanding the Solar Wind's effects
on Earth's Atmosphere

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NASA'S WIND SATELLITE WILL STUDY SOLAR WIND AND CARRY FIRST RUSSIAN INSTRUMENT TO FLY ON A U.S. SPACECRAFT

After its November 1, 1994, launch, NASA's Wind satellite will take up a vantage point between the Sun and the Earth, giving scientists a unique opportunity to study the enormous flow of energy and momentum known as the solar wind.

The Wind spacecraft will be in position to measure the basic properties of one of the most important interactions in the Solar System by observing the solar wind immediately before it collides with the Earth's magnetic field and atmosphere. The solar wind emanates continuously from the solar atmosphere (or corona) and consists of electrically charged particles, mostly positively-charged protons and negatively-charged electrons.

The interplay of forces resulting from the continual collision is responsible for dramatic global effects. One spectacular example of the effects of this interplay is in the Earth's polar atmospheres. The spectacular Northern and Southern lights, or auroras, are produced as a result of the complicated interplay of forces. Other more indirect effects of the solar wind may be highly disruptive, such as electrical power system failures, radio communication disruptions and diminished performance and reliability of spacecraft in Earth orbit.

The main scientific goal of the mission is to measure the mass, momentum and energy of the solar wind that somehow is transferred into the space environment around the Earth. Although much has been learned from previous space missions about the general nature of this huge transfer, it is necessary to gather a great deal of detailed information from several strategic regions of space around the Earth before scientists understand the ways in which the planet's atmosphere responds to changes in the solar wind.

The mission -- part of a comprehensive effort to understand the Sun, the solar wind and their effects on the Solar System -- may eventually yield long-range benefits such as predicting when dangerous conditions will occur in the solar wind or on the Sun. The predictions could provide just the kind of early warning needed to help minimize damage to susceptible systems. An Air Force research program will use Wind data in an effort to develop ways to forecast so-called space weather conditions so that multi-million dollar spacecraft can be safeguarded, such as altering their operations in advance of an approaching solar storm.

The launch also marks the first time a Russian instrument will fly on an American spacecraft. The Konus Gamma-Ray Spectrometer instrument, provided by the Ioffe Institute, Russia, is one of two instruments on Wind which will study cosmic gamma-ray bursts, rather than the solar wind.

"The historic first flight of a Russian instrument on an American spacecraft is the vanguard of more ambitious space science cooperation with Russia in the future," said Dr. Wesley T. Huntress, Jr., NASA's Associate Administrator for Space Science.

"In addition to Konus, a French instrument and six U.S. instruments are flying on Wind, highlighting the international cooperation involved in most of our science missions," Huntress continued. "Wind's international scientific team hopes to significantly advance our understanding of the solar wind's effects on the Earth, and ultimately everyone on this planet will benefit because of their efforts."

## Mission Description

Immediately after launch, Wind will measure the solar wind particles and electromagnetic fields in the turbulent area between the Earth and the Sun where particles of the solar wind encounter the Earth's magnetic field (also called the geomagnetic field or magnetosphere).

The solar wind is ejected from the Sun at tremendous velocities, and as it approaches the Earth, its momentum compresses the outward extension of the geomagnetic field on the dayside of the Earth and greatly elongates it on the nightside to form the magnetosphere. At a certain distance 'upstream' from Earth, the incoming solar wind flow is slowed and deflected by the dayside geomagnetic field, forming a supersonic shock wave located in front of the magnetosphere. This shock wave is known as the bow shock because of its similarity to the wave at the bow of a moving ship.

In the early stages of the mission, Wind will be ideally located to measure solar wind particles reflected from the bow shock. At first, the satellite will have a figure-eight orbit around the Earth with the assistance of the Moon's gravitational field. Its furthest point from the Earth will be up to 990,000 miles (1,600,000 kilometers), and its closest point will be at least 18,000 miles (29,000 kilometers).

Later in the mission, the Wind spacecraft will be inserted into a special halo orbit in the solar wind upstream from the Earth, at the unique distance which allows Wind to always remain between the Earth and the Sun (about 930,000 to 1,050,000 miles, or 1,500,000 to 1,690,000 kilometers, from the Earth).

- more -

Here, Wind will observe the solar wind before it intercepts the magnetosphere. Such observations are of central importance to determine how conditions in the solar wind cause or relate to the subsequent major dynamic changes -- such as greatly enhanced electrical currents and large temporal changes in the geomagnetic field itself -- that take place in the magnetosphere.

The Wind spacecraft is a spin-stabilized, cylinder-shaped spacecraft measuring 7.87 feet (2.4 meters) in diameter and 5.91 feet (1.8 meters) in height. The spacecraft weighs 1,973 pounds (895 kilograms) without fuel, and holds 662 pounds (300 kilograms) of hydrazine propellant for attitude control. The minimum design life of Wind is three years. Wind was built for NASA by Martin Marietta Astro-Space, East Windsor, NJ.

Wind, set for lift-off from Cape Canaveral Air Station in Florida, will have a five minute launch window which opens at 4:31 a.m. Tuesday, Nov. 1. The launch vehicle is a McDonnell Douglas Delta 7925-10 rocket. It will be the 227th Delta flight.

- end of general release -

## THE WIND MISSION

### International Study of the Sun-Earth Connection

The Wind spacecraft is the first of two U.S. missions of the Global Geospace Science (GGS) initiative, which is part of a worldwide collaboration called the International Solar-Terrestrial Physics (ISTP) program. The aim of ISTP is to understand the physical behavior of the solar-terrestrial system in order to predict how the Earth's magnetosphere and atmosphere will respond to changes in solar wind.

Wind plays a crucial role -- essentially that of a scout and sentry -- in the fleet of ISTP satellites. The task of Wind is to measure crucial properties of the solar wind before it impacts the Earth's magnetic field and alters the Earth's space environment (which contains charged particles, electric and magnetic fields, electric currents and radiation) and upper atmosphere in a direct manner.

The other ISTP satellites will operate in special orbits and locations to measure the principal responses -- sometimes dramatic changes or disruptions from typical behavior -- of the Earth's space environment to the impact of solar wind.

The second GGS satellite, Polar, is scheduled for launch in 1995 to measure the flow of plasma -- a solar wind of electrified particles -- to and from the Earth's ionosphere. The Wind and Polar missions will perform simultaneous and closely coordinated measurements of the key regions of Earth's nearby space environment, called geospace. Data will be provided from other ISTP missions in equatorial orbits. Complementing ground-based and theoretical investigations also will be conducted.

In addition to GGS, another element of ISTP is the Collaborative Solar-Terrestrial Research (COSTR) program. As part of COSTR, NASA is collaborating with Japan and the European Space Agency (ESA) on two additional solar-terrestrial missions. The first was the Geotail satellite, provided by the Japanese Institute of Space and Astronautical Science (ISAS) launched in July 1992 to explore the tail of the magnetosphere, the region around the planet dominated by the Earth's magnetic field. Geotail will be followed by future launches of the Solar and Heliospheric Observatory (SOHO) and the four-spacecraft Plasma Turbulence Laboratory (CLUSTER) mission, in collaboration with ESA.

The United States contribution to ISTP is managed by NASA's Goddard Space Flight Center (GSFC), Greenbelt, MD, for the Office of Space Science at NASA Headquarters, Washington, DC.

## SOLAR WIND BACKGROUND

The Sun is the dominant source of energy and force in the solar system. In addition to electromagnetic energy (which includes life-sustaining light and heat, x-rays and even gamma rays) the Sun continually radiates a stream of electrically charges particles into space known as the solar wind.

On the Earth, the prevailing winds generally are horizontal to the surface. On the Sun, however, the upper atmosphere of the Sun achieves such enormous temperatures -- about two million degrees in the solar corona -- that the solar wind is essentially a vertical flow that blows away from the Sun in all directions and actually drags along with it the solar magnetic field.

## GGS SPACECRAFT ORBIT GRAPHIC

The solar wind accelerates rapidly near the Sun and expands at supersonic speeds through the interplanetary space far beyond the orbit of the outermost planets. At the orbit of the Earth, the solar wind speed is typically about one million miles per hour (400 kilometers per second).

Although it is electrically neutral, the solar wind consists almost exclusively of charged particles and is an excellent electrical conductor. The particles in the solar wind are predominately electrons (negative charge) and protons (positive charge).

The solar wind is ubiquitous in the Solar System, occupying all of interplanetary space and controlling the space environments of most, if not all, objects within it. For non-magnetic bodies, such as Earth's Moon, the solar wind impacts the surface directly. For magnetized bodies, such as the Earth, the solar wind and the magnetic field interact to form an astrophysical configuration of great importance known as a magnetosphere.

A typical planetary magnetosphere is essentially a three-dimensional magnetic cavity carved out of the solar wind. A planet's dayside magnetosphere is highly compressed in the direction of the Sun by the approaching solar wind and greatly elongated on the nightside (called the antisolar direction). The Earth's magnetosphere contains its internal magnetic field plus the magnetic distortions created by the solar wind. The boundary of the magnetosphere is called the magnetopause, which is located on the dayside where the magnetic pressure of the Earth's internal field is equal to the net flow pressure of the impinging solar wind.

The unadulterated solar wind does not impinge directly on the magnetopause. The reason for this is that the Earth's magnetic field is essentially an impenetrable obstacle to the solar wind because of its large electrical conductivity. The supersonic wind must, therefore, slow down and deflect from its original direction in order to flow around the magnetic obstacle ahead. As a result of the required adjustment, a bow-shaped shock wave forms at a fixed stand-off distance from the dayside magnetopause.

Along the Earth-Sun line, the solar wind slows to subsonic speeds in crossing the bow shock wave. The space outside the magnetopause and inside the bow shock wave is called the magnetosheath, that is, the magnetosheath contains the deflected solar wind that crosses the bow shock wave and moves downstream outside the magnetopause.

## WIND INSTRUMENT GRAPHIC

### Wind Instruments

Radio and Plasma Waves (Waves)
Principal Investigator: Dr. J. Bougeret, Paris Observatory

The Sun and the Earth emit radio waves that affect particles in the interplanetary plasma and carry some of the energy flowing there. The Radio and Plasma Waves instrument will measure the properties of these waves and other wave modes of the plasma over a very wide frequency range.

Solar Wind Experiment (SWE)
Principal Investigator: Dr. K. Ogilvie, NASA/Goddard Space Flight Center

SWE will measure ions and electrons in the solar wind and the foreshock regions at a rate of once per minute for ions and 20 times per minute for electrons. Measurements made in the foreshock are important for understanding the structure of the bow shock. From these measurements, the solar-wind velocity, density, temperature and heat flux can be deduced. Electron and ion velocity distributions should reveal properties of the flowing plasmas and their pivotal role in the transfer of mass, momentum and energy from the Sun to the Earth. Because the solar wind is an extension of the corona, from which it is accelerated, these measurements also assist in studies of the Sun.

Magnetic Fields Investigation (MFI)
Principal Investigator: Dr. R. Lepping, NASA/Goddard Space Flight Center

MFI will investigate the structure, intensity and fluctuations of the interplanetary magnetic field, which influence the transport of energy and the acceleration of particles in the solar wind. The magnetic field measurements from MFI are especially important to the interpretation of other data from Wind.

Energetic Particle Acceleration, Composition, and Transport (EPACT)
Principal Investigator: Dr. T. von Rosenvinge, NASA/Goddard Space Flight Center

The EPACT investigation will measure properties of high-energy ions in the solar wind. This direct sampling of solar matter is a way to study events on the solar surface and the incorporation of solar material into the solar wind. Because of their distinctive high charge, solar-wind ions can be used as tracers for the transfer and flow of particles from the solar wind into the magnetosphere. EPACT will also provide information on shock waves in the interplanetary medium.

Solar Mass Sensor (SMS)
Principal Investigator: Dr. G. Gloeckler, University of Maryland

This investigation will determine the abundance, velocity, spectra, temperature and thermal speeds of solar-wind ions. The SMS instruments will enable the isotopes of many elements to be studied. These ion studies, along with the EPACT and other plasma investigations, will provide another analysis of the events on the solar surface. This investigation will add to our knowledge of how the solar wind is formed and accelerated from the solar surface into the interplanetary medium.

Three-Dimensional Plasma Analyzer (3-D Plasma)
Principal Investigator: Dr. R. Lin, University of California at Berkeley

This investigation will measure ions and electrons with energies above that of the solar wind and into the energetic particle range. It will study particles upstream of the bow shock and in the foreshock region, as well as the transient particles emitted by the Sun during solar particle events following solar flares. In addition, this instrument will cover the energy gap between the SWE and EPACT instruments.

Transient Gamma Ray Spectrometer (TGRS)
Principal Investigator: Dr. B. Teegarden, NASA/Goddard Space Flight Center

TGRS will observe transient gamma-ray events. It will make the first high-resolution spectroscopic survey of cosmic gamma-ray transients and measurements of gamma-ray lines in solar flares. The cause of the transient events, which occur at great distances from the Earth, represent one of the intriguing mysteries of present-day astrophysics.

Gamma Ray Spectrometer (Konus)
Principal Investigator: Dr. E. Mazets, Ioffe Institute, Russia and T. Kline, NASA/Goddard Space Flight Center

Konus will perform gamma-ray burst studies similar to the TGRS studies, but at lower resolution with broader coverage. When their data are combined, they provide coverage of the full sky. Konus also will perform event detection and measure time history. The Konus investigation is the first Russian instrument to fly on an American satellite.

LAUNCH VEHICLE GRAPHIC

## Launch Vehicle and Upper Stages

The Wind spacecraft will be placed into an orbit 99.8 x 242,820 nautical miles by a 7925-10 version of the Delta II expendable launch vehicle. Delta 227 will use a 10-foot diameter fairing.

Built by McDonnell Douglas Aerospace of Huntington Beach, CA, the Delta II 7925 has made 23 flights, all of which were successful.

The three-stage Delta II carrying the Wind spacecraft consists of five major assemblies: the first stage, including nine strap-on solid rocket motors; the interstage; the second stage; the third or upper stage; and the 10-foot diameter payload fairing. The rocket is 125.2 feet tall and eight feet in diameter.

Manufactured by Rocketdyne Division of Rockwell International, the RS-27A main engine operates on a combination of liquid oxygen and RP-1 (kerosene).

The RS-27 has a liftoff thrust of 207,000 pounds, and each of the nine solid strap-on motors has a sea-level thrust of 97,070 pounds. The main engine and six of the nine solids, when burning at liftoff, provide a total liftoff thrust of 789,420 pounds. The last three solid strap-on motors are ignited at altitude during the first-stage burn. The solids are graphite epoxy motors, made by Hercules

Aerospace.

The second stage uses an Aerojet AJ10-118K engine that burns Aerozine-50 and nitrogen tetroxide oxidizer.  It is ignited at altitude and has a vacuum-rated thrust level of 9,645 pounds.  The third stage uses a Thiokol Corp. Star-48B solid rocket motor.

The Delta flight path for the Wind launch will be a launch azimuth of 95 degrees.  The second stage will fly over Africa and go into a parking orbit, with the third stage putting the payload into the highly elliptical orbit.  The time from launch until spacecraft separation is approximately 1 hour and 21 minutes.

Orbit parameters include an apogee altitude of 242,820 nautical miles and perigee altitude of 99.8 nautical miles.

The Rocketdyne Division of Rockwell International in Canoga Park, CA, is responsible for the first stage main engine; Aerojet, Sacramento, CA, builds the second stage engine; Hercules Aerospace, Magna, UT, manufactures the solid rocket boosters; Delco Systems of Goleta, CA, produces the guidance computer on the second stage; and Thiokol Corp., Ogden, UT, provides the Star-48 motor for the third stage.

The Orbital Launch Services (OLS) Project at GSFC provides and operates versatile small through medium-class ELV services for NASA users.  The Delta vehicle was selected for medium expendable launch vehicle (MELV) services in the mid-1990s.  Since 1960 the DELTA/OLS Project has provided management for 226 Delta launches, 216 of which were successful.  The success rate for Delta is 98.9 percent in the last 17 years and 100 percent for the last 48 launches.

Vehicle characteristics:

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| Size: | 125 feet high by 8 feet in diameter |
| Liftoff weight: | 511,190 pounds |
| Liftoff thrust: | 699,250 pounds |
| Prime contractor: | McDonnell Douglas Aerospace |

## MISSION OPERATIONS

Mission operations will be conducted from GSFC for the Wind spacecraft using NASA institutional and project-unique support facilities.  These facilities provide command and control, command management, orbit and attitude computation, mission analysis, data capture and processing, and science operations.  Tracking, command, and data acquisition support will be provided by the JPL/DSN.

A Flight Operations Team (FOT) will conduct and coordinate all aspects of mission operations.  This FOT will be responsible for the health and safety of the instruments and spacecraft, the evaluation of spacecraft performance, command management, and maintenance of spacecraft-related data bases.

The FOT will also be responsible for coordinating JPL/DSN scheduling (including resolution of scheduling conflicts), data acquisition management, control of the spacecraft and instruments, science and spacecraft operations coordination, and for implementing scientific instrument operations plans.

A Science Planning Operational Facility (SPOF) for Wind instruments will provide support for the FOT for planning their science operations.  These facilities will prepare science instrument operations schedules and command sequences, which will be forwarded to the CMS for implementation.

GROUND SEGMENT

The ground segment of the GGS Project will use both existing and Project-unique facilities for overall data acquisition and analyses.  The institutional support elements of the ground segment are:

* Generic Data Capture Facility (GDCF).
* Data Distribution Facility (DDF).
* NASA Communications Network (NASCOM).
* Project Operations Control Center (POCC).
* Flight Dynamics Facility (FDF).
* Jet Propulsion Laboratory/Deep Space Network (JPL/DSN).
* NASA Science Internet (NSI).
* National Space Science Data Center (NSSDC).
* Command Management System (CMS).

The GGS-unique elements of the ground system include:

* Central Data Handling Facility (CDHF).
* Remote Data Analysis Facilities (RDAFs).
* Science Planning and Operations Facility (SPOF).

Jet Propulsion Laboratory/ Deep Space Network (JPL/DSN)

The JPL/DSN sites at Canberra, Australia; Madrid, Spain; and Goldstone, California will provide support for the Wind spacecraft on a scheduled basis to provide telemetry, tracking, and command (TT&C) communications between the spacecraft and GSFC using NASCOM.  The nominal JPL/DSN support requirements include Wind for approximately 2 hours per day.  The spacecraft will be compatible with the JPL/DSN S-band communications system for both command uplink and telemetry downlink.

Payload Operations Control Center (POCC)

The GSFC will provide POCC support for Wind spacecraft operations.  The POCC will be the focal point for all command and control operations associated with the spacecraft.  The

POCC will provide spacecraft health and safety monitoring; spacecraft operations and control; spacecraft resource management; and spacecraft engineering data trend analysis.

Flight Dynamics Facility (FDF)

The FDF, located at GSFC, will provide mission analysis, attitude sensor calibration, attitude determination, maneuver planning, maneuver operations, and orbit determination support for the Wind mission. This support will be provided from pre-launch planning and analysis through mission operations phases.

Generic Data Capture Facility (GDCF)

The GDCF, located at GSFC, will capture real-time and tape recorder playback data for the Wind mission. Output will be chronologically ordered, time-annotated, and quality-checked data products and forwarded as level-0 data to the CDHF for further processing and distribution.

Central Data Handling Facility (CDHF)

The CDHF, located at GSFC, is the central location in the ISTP Science Initiative where measurements from the wide variety of geospace instrumentation, ground-based instrumentation, and theoretical studies are brought together and analyzed. Subsequently, these data will be distributed, along with ancillary data, in a unified fashion to the Principal Investigator (PI) and Co-Investigator (Co-I) teams for further analysis on local data analysis systems. The facility also provides a number of on-line data services for the ISTP Science Initiative community of investigators.

The CDHF outputs unified key parameter data sets, decommutated telemetry, and associated ancillary data to the ISTP Science Initiative community over computer networks (e.g., NASA Science Internet). The CDHF also provides on-line storage and investigator electronic access to the most recent 8 days of telemetry data through NSI; receives command history files from the CMS; and provides level-0 data, orbit and attitude files, key parameter files, and command history files to the DDF.

Remote Data Analysis Facilities (RDAFs)

The RDAFs will be used by the various U.S. PIs and Co-Is. The primary functions of the RDAFs are to develop key parameter and data reduction software; generate instrument command lists and schedules; process production data (event data); retrieve key parameters, attitude, orbit, and telemetry data electronically from the CDHF and the NSSDC archives; and transmit event data to the CDHF and NSSDC for archiving.

NASA Science Internet (NSI)

The NSI will provide the principal electronic communications media for exchange of scientific, ancillary, and mission planning data among the PIs and within the GGS ground system.

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