

**Working Draft**

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# Purpose Statement

This booklet provides reference information about Earth and Earth-Sun spacecraft with a NASA affiliation.

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## ***The NASA Vision***

To improve life here,  
To extend life to there,  
To find life beyond.

## ***The NASA Mission***

To understand and protect our home planet,  
To explore the universe and search for life,  
To inspire the next generation of explorers...  
as only NASA Can

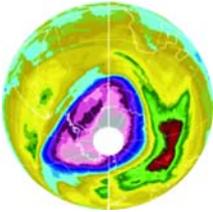
[www.nasa.gov](http://www.nasa.gov)

# **Science Mission Directorate**

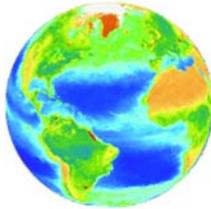
## **Earth Science Division**

### **Focus Areas**

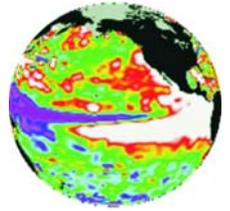
The NASA Earth Science Division seeks to develop a scientific understanding of the Earth-Sun system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations.



**Atmospheric  
Composition**



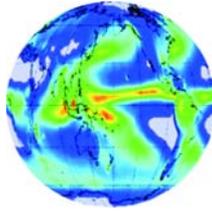
**Carbon Cycle  
& Ecosystems**



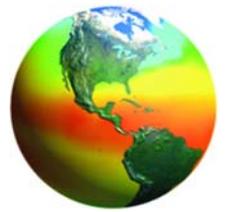
**Climate Variability  
& Change**



**Earth Surface  
& Interior**



**Water & Energy  
Cycle**



**Weather**



**Sun Solar System**

# Research Strategy

NASA's Earth Science Division is developing a scientific understanding of the Earth-Sun interactions and its responses to natural and human-induced changes to enable improved prediction capability for climate, weather, and natural hazards. The Earth Science Division has an end-to-end strategy to ensure that all the information, understanding, and capabilities derived from its research program achieve maximum usefulness for the scientific and decision-making communities. Increasing our knowledge of the Earth system is the goal of the Earth Science Division's Research Program.

The Earth Science Division has defined its research strategy around a hierarchy of scientific questions. At the highest level, the Earth Science Division is attempting to provide an answer to one overarching question:

## **How is the Earth changing and what are the consequences for life on Earth?**

The magnitude and scope of this question are too large to allow a simple answer, requiring a lower tier of questions that provide the conceptual approach that the Earth-Sun System Division is taking to improve our knowledge of the Earth system:

**Variability:** How is the global system changing?

**Forcing:** What are the primary forcings of the Earth system?

**Response:** How does the Earth system respond to natural and human-induced changes?

**Consequence:** What are the consequences of change in the Earth system for human civilization?

**Prediction:** How will the Earth system change in the future, and how can we improve predictions through advances in remote sensing observations, data assimilation and modeling?

# Specific Science Questions

Variability	Forcing	Response	Consequence	Prediction
Precipitation, evaporation & cycling of water changing?	Atmospheric constituents & solar radiation on climate?	Clouds & surface hydrological processes on climate?	Weather variation related to climate variation?	Weather forecasting improvement?
Global ocean circulation varying?	Changes in land cover & land use?	Ecosystems, land cover and biogeochemical cycles?	Consequences of land cover & land use change?	Improve prediction of climate variability and change?
Global ecosystems changing?	Motions of the Earth and the Earth's interior transformation?	Changes in global ocean circulation?	Coastal region impacts?	Ozone, climate and air quality impacts of atmospheric composition?
Atmospheric composition changing?		Atmospheric trace constituent responses?	Regional air quality impacts?	Carbon cycle and ecosystem change?
Ice cover mass changing?		Sea level affected by Earth system changes?		Change in water cycle dynamics?
Earth surface transformation?				Predict and mitigate natural hazards from Earth surface change?

# Applications of National Priority



Agricultural Efficiency



Air Quality



Aviation



Carbon Management



Coastal Management



Ecological Forecasting



Disaster Management



Energy Management



Homeland Security



Invasive Species



Public Health



Water Management

The NASA Applied Research and Technology Program Office mission is to expand and accelerate the realization of economic and societal benefits from Earth science, information, and technology. The overarching goal is to bridge the gap between Earth system science research results and the adoption of observations and prediction capabilities for reliable and sustained use in decision support.

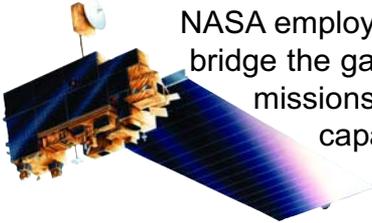


# Earth-Sun System

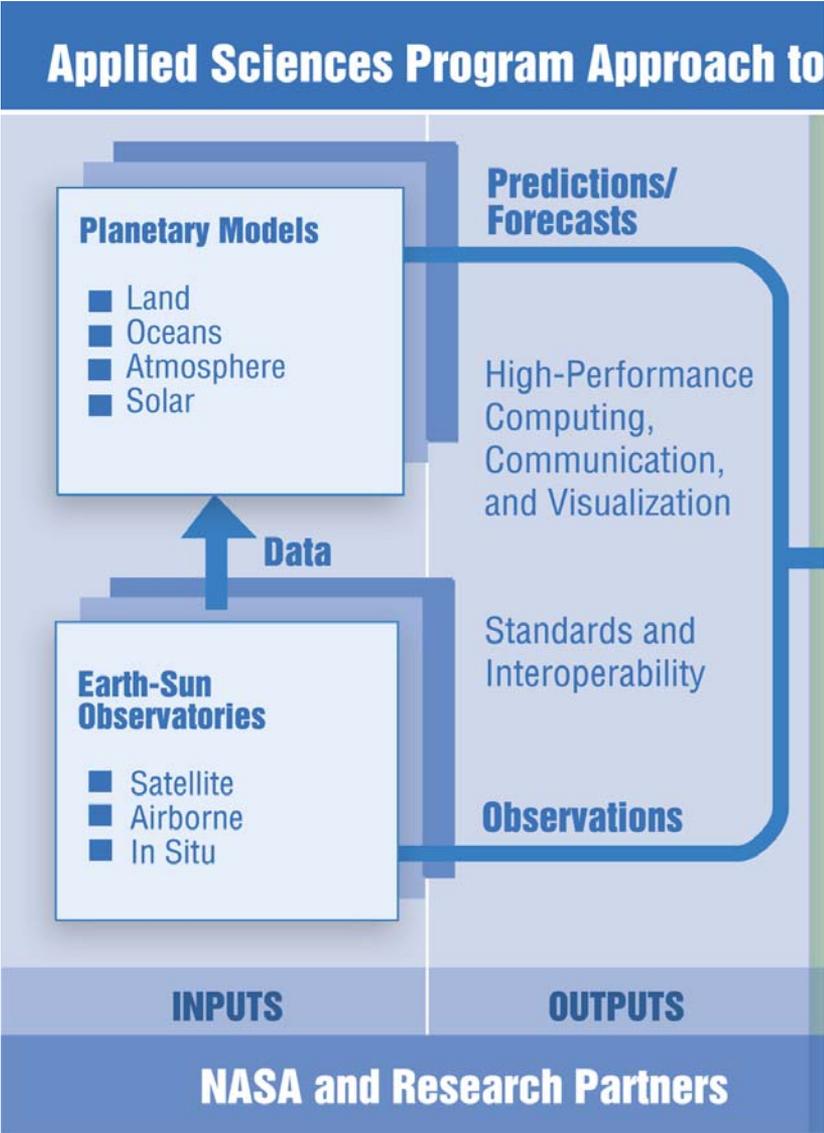
To understand and protect our home planet



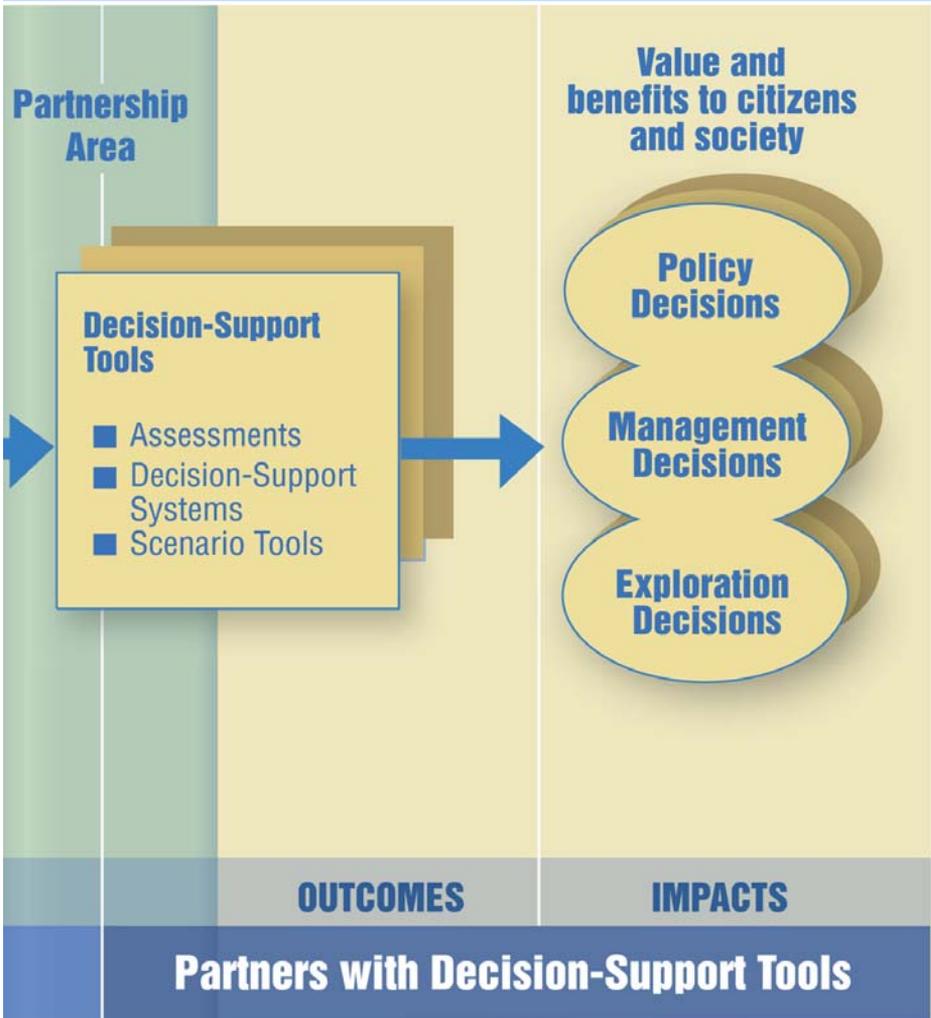
# Integrated System Solutions Architecture



NASA employs a systems engineering approach to bridge the gap between Earth-Sun system science missions and models. The data and prediction capabilities are adopted for reliable and sustained use in decision support.



# Integrated System Solutions



**Deployed  
NASA-Led Earth  
Missions**

# Aqua

Aqua is designed to acquire precise atmospheric and oceanic measurements to provide a greater understanding of their role in the Earth's climate and its variations. The satellite's instruments provide regional to global land cover, land cover change, and atmospheric constituents.

## Sensors:

MODIS - Moderate Resolution Imaging Spectroradiometer

AIRS - Atmospheric Infrared Sounder

AMSU-A - Advanced Microwave Sounding Unit-A

CERES - Clouds and the Earth's Radiant Energy System

HSB - Humidity Sounder for Brazil

AMSR-E - Advanced Microwave Scanning Radiometer-EOS

## Links:

<http://aqua.nasa.gov>

## Applications



## VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: May 4, 2002
- Design Life: 5 years
- Measurements:  
Vegetation dynamics

## OWNER

- Brazil, INPE
- Japan, JAXA (formerly NASDA)
- U.S., NASA

# Aura

Aura's mission is designed to observe the atmosphere to answer the following three high-priority environmental questions: Is the Earth's ozone layer recovering? Is air quality getting worse? How is the Earth's climate changing? Aura's new objective over previous atmospheric research missions is also to probe the Earth's troposphere.

## Sensors:

HIRDLS - High Resolution Dynamics Limb Sounder

MLS - Microwave Limb Sounder

OMI - Ozone Monitoring Instrument

TES - Tropospheric Emission Spectrometer

**Links:** (opens a new browser window)

<http://aura.gsfc.nasa.gov/>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: July 15, 2004
- Design Life: 5 years
- Measurements:  
Stratospheric and tropospheric ozone

### OWNER

- U.K., Meteorological Office
- U.S., NASA

### Earth Radiation Budget Satellite

The ERBS mission is to investigate how energy from the Sun is absorbed and re-emitted by the Earth. Observations from ERBS are also used to determine the effects of human activities (such as burning fossil fuels and the use of chlorofluorocarbons) and natural occurrences (such as volcanic eruptions) on the Earth's radiation balance. This system is only partially operational.

#### SENSORS:

SAGE II - Stratospheric Aerosol and Gas Experiment II

ERBE Nonscanner - Earth Radiation Budget Experiment Nonscanner

ERBE Scanner - Earth Radiation Budget Experiment Scanner

#### LINKS:

<http://asd-www.larc.nasa.gov/erbe>

[http://eosweb.larc.nasa.gov/EDDOCS/Erb\\_Satellite.html](http://eosweb.larc.nasa.gov/EDDOCS/Erb_Satellite.html)

### Applications



#### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 585 km
- Inclination: 57°
- Launch Date: October 5, 1984
- Design Life: 1-2 years (exceeded)
- Measurements: Regional and global coverages of solar irradiance, radiance, and albedo vertical distributions of aerosols, ozone, and CO<sub>2</sub>

#### OWNER

- U.S., NASA

# GRACE

## Gravity Recovery and Climate Experiment

GRACE is a cooperative mission with Germany to obtain an accurate global and high-resolution determination of both the static and the time-variable components of the Earth's gravity field. Changes in the distance between the twin satellites are used to make gravitational field measurements.

### SENSORS:

GPS Receiver - Global Positioning System Receiver

LRA - Laser Retroreflector Array

KBR or HAIRS - K-Band Ranging System or High Accuracy Inter-satellite Ranging System

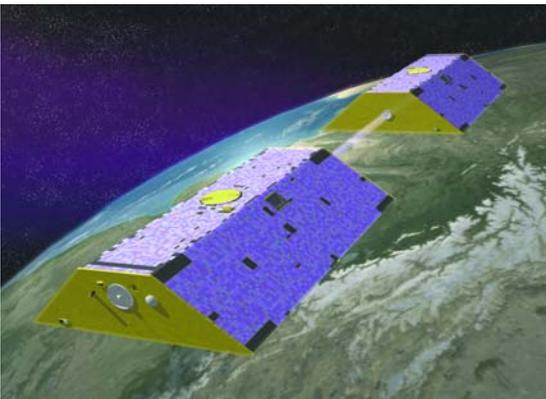
SCA - Star Camera Assembly

SuperSTAR - SuperSTAR Accelerometer

### LINKS:

<http://www.csr.utexas.edu/grace/>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 400 km
- Inclination: 89°
- Launch Date: March 15, 2002
- Design Life: 5 years
- Measurements:  
Gravitational field (to improve understanding of geodesy, glaciology, hydrology, oceanography, and solid earth sciences)

### OWNER

- U.K., Meteorological Office
- U.S., NASA

# ICESat

## Ice, Clouds, and Land Elevation Satellite

ICESat is a benchmark EOS mission to achieve the ESE/EOS requirements for measuring ice sheet mass balance, cloud and aerosol heights, atmospheric optical densities, and vegetation and land topography. It will provide cloud property information not otherwise available from passive sensors by processing the altimeter data throughout its orbit.

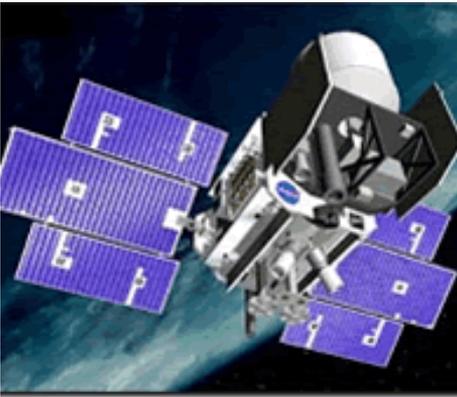
### SENSORS:

GLAS - Geo-science Laser Altimeter System  
GPS Receiver - Global Positioning System Receiver

### LINKS:

<http://icesat.gsfc.nasa.gov>

## Applications



### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 600 km
- Inclination: 94°
- Launch Date: January 12, 2003
- Design Life: 4 years
- Measurements: Land, ice, and sea ice topography; ice sheet mass balance

### OWNER

- U.S., NASA

# LAGEOS I

## Laser Geodynamics Satellite I

LAGEOS is the first NASA satellite dedicated wholly to laser ranging: science is performed by reflecting laser light from the vehicle's 426 cube-corner retroreflectors. It was designed to act as a permanent reference point so that the Earth's progress could be tracked relative to the satellite.

### SENSORS:

LRA - Laser Retroreflector Array

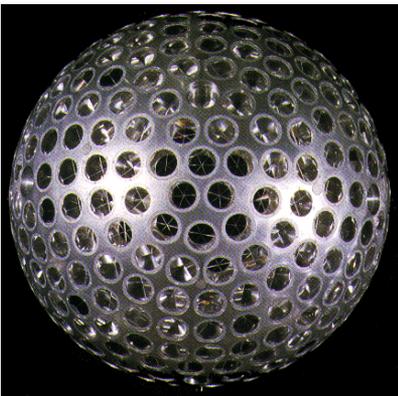
SLR2000 - Satellite Laser Ranging 2000 Station

### LINKS:

[http://ilrs.gsfc.nasa.gov/satellite\\_missions/list\\_of\\_satellites/lageos.html](http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/lageos.html)

<http://www.earth.nasa.gov/history/lageos/lageos1.html>

## Applications



### VITAL FACTS

- Orbit Type: Non-Sun Synchronous
- Altitude: 6000 km
- Inclination: 110°
- Launch Date: May 4, 1976
- Design Life: 40 years
- Measurements: Earth dynamics: crust motion and rotation changes

### OWNER

- Italy, ASI
- U.S., NASA

# LAGEOS II

## Laser Geodynamics Satellite II

LAGEOS is the first NASA satellite dedicated wholly to laser ranging: science is performed by reflecting laser light from the vehicle's 426 cube-corner retroreflectors. It was designed to act as a permanent reference point so that the Earth's progress could be tracked relative to the satellite.

### SENSORS:

LRA - Laser Retroreflector Array

SLR2000 - Satellite Laser Ranging 2000 Station

### LINKS:

<http://www.earth.nasa.gov/history/lageos/lageos1.html>

[http://ilrs.gsfc.nasa.gov/satellite\\_missions/list\\_of\\_satellites/lageos.html](http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/lageos.html)



### VITAL FACTS

- Orbit Type: Non-Sun Synchronous
- Altitude: 5900 km
- Inclination: 52°
- Launch Date: October 22, 1992
- Design Life: 40 years
- Measurements: Earth dynamics: crust motion and rotation changes

### OWNER

- Italy, ASI
- U.S., NASA

# NMP EO-1

## New Millennium Program Earth Observing 1

EO-1 is designed to demonstrate and validate advanced instruments, spacecraft systems, and mission concepts in flight. It has returned scientific data as a by-product of its testing to support land cover change and atmospheric constituents.

### SENSORS:

ALI - Advanced Land Imager

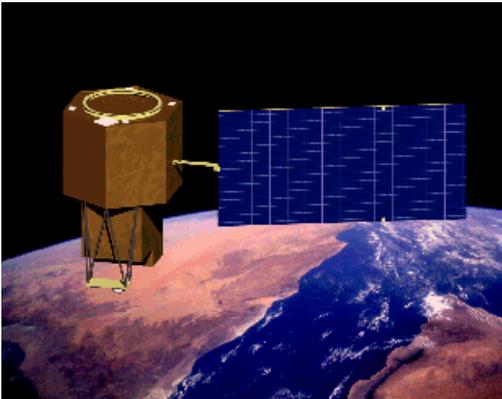
Hyperion - Hyperspectral Imager

LAC - Linear Etalon Imaging Spectrometer (LEISA) Atmospheric Corrector

### LINKS:

<http://eo1.gsfc.nasa.gov>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: November 21, 2000
- Design Life: 2 years
- Measurements: Land cover and use change

#### OWNER

- U.S., NASA

# QuikSCAT

## Quick Scatterometer

QuikSCAT, a "quick recovery" mission to fill the gap created by the loss of data from NSCAT, is benchmarked with the National Oceanic and Atmospheric Administration (NOAA)/National Environmental Satellite, Data, and Information Service (NESDIS) Office of Research and Applications. QuikSCAT is currently intended to record sea-surface wind speed and direction data for global climate research and operational weather forecasting and storm warning.

### SENSORS:

SeaWinds - SeaWinds

### LINKS:

<http://winds.jpl.nasa.gov/missions/quikscat/index.cfm>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 803 km
- Inclination: 98.6°
- Launch Date: June 19, 1999
- Design Life: 6 years
- Measurements: sea surface wind velocity and wind direction

### OWNER

- U.S., NASA

# SORCE

## Solar Radiation and Climate Experiment

SORCE is a NASA-sponsored project with the University of Colorado's Laboratory for Atmospheric and Space Physics in Boulder. SORCE provides total irradiance measurements and the full spectral irradiance measurements required by climate studies to understand the role of the Sun's variations on the Earth's climate.

### SENSORS:

XPS - Extreme Ultraviolet (XUV) Photometer System

TIM - Total Irradiance Monitor

SIM - Spectral Irradiance Monitor

SOLSTICE - Solar Stellar Irradiance Comparison Experiment A&B

### LINKS:

<http://lasp.colorado.edu/sorce/>

## Applications



### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 640 km
- Inclination: 40°
- Launch Date: January 25, 2003
- Design Life: 5 years
- Measurements: Solar spectral irradiance

### OWNER

- U.S., NASA

# SRTM

## Shuttle Radar Topography Mission

The goal of the Shuttle Radar Topography Mission (SRTM), a joint project of NASA, the National Geospatial-Intelligence Agency, and the German and Italian space agencies, was to map the world in three dimensions. In its 11-day mission on STS-99 in February 2000, SRTM collected an unprecedented 8.6 Terabytes of interferometric C-band Synthetic Aperture Radar (SAR) data (equivalent to about 14,317 CDs).

### SENSORS:

SIR-C - Spaceborne Imaging Radar-C

X-SAR - X-Band Synthetic Aperture Radar

### LINKS:

<http://www.jpl.nasa.gov/srtm/>

## Applications



### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 233 km
- Inclination: 57°
- Launch Date: February 11, 2000
- Design Life: 11-day STS mission
- Measurements: Gridded heights of 80% of the Earth's surface

### OWNER

- U.S., NASA

# Terra

## Solar Radiation and Climate Experiment

The Terra satellite provides global data on the state of the atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another. Japan, Canada, and the U.S. have provided instruments for this mission.

### SENSORS:

MODIS - Moderate Resolution Imaging Spectroradiometer

CERES - Clouds and the Earth's Radiant Energy System

MOPITT - Measurements of Pollution in the Troposphere

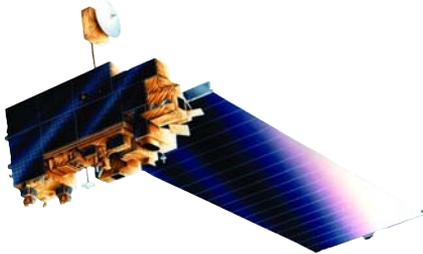
MISR - Multi-angle Imaging Spectro-Radiometer

ASTER - Advanced Spaceborne Thermal Emission and Reflection Radiometer

### LINKS:

<http://terra.nasa.gov>

## Applications



### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 720 km
- Inclination: 98.2°
- Launch Date: December 18, 1999
- Design Life: 5 years
- Measurements: Surface bi-directional reflectance distribution function

### OWNER

- U.S., JPL
- U.S., NASA

# TOMS-EP

## Total Ozone Mapping Spectrometer - Earth Probe

The Total Ozone Mapping Spectrometer-Earth Probe (TOMS-EP) provides global measurements of total column ozone and its variation on a daily basis. Together with the TOMS aboard Nimbus-7 and Meteor-3, TOMS-EP provides a long-term dataset of daily ozone covering about two decades.

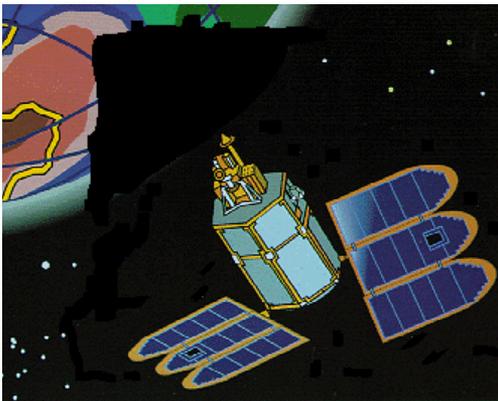
### SENSORS:

TOMS - Total Ozone Mapping Spectrometer

### LINKS:

<http://toms.gsfc.nasa.gov>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 740 km
- Inclination: 98.385°
- Launch Date: July 2, 1996
- Design Life: 2 years (exceeded)
- Measurements: Aerosol index

### OWNER

- U.S., NASA

### Topographic Experiment/Poseidon

TOPEX/Poseidon is a joint mission between France and the U.S. to monitor global ocean circulation, to improve global climate predictions, and to monitor events such as El Niño Southern Oscillation conditions and ocean eddies.

#### SENSORS:

GPS Receiver - Global Positioning System Receiver

LRA - Laser Retroreflector Array

TMR - TOPEX Microwave Radiometer

SSALT - Solid State Radar AlTimeter

DORIS - Doppler Orbitography and Radiopositioning Integrated by Satellite

NRA - NASA Radar Altimeter

#### LINKS:

<http://topex-www.jpl.nasa.gov/>

### Applications



#### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 1,336 km
- Inclination: 66°
- Launch Date: August 10, 1992
- Design Life: 5 years
- Measurements: Ocean topography

#### OWNER

- France, CNES
- U.S., NASA

# TRMM

## Tropical Rainfall Measuring Mission

TRMM is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) of Japan to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation shaping both weather and climate around the globe.

### SENSORS:

CERES - Clouds and the Earth's Radiant Energy System

LIS - Lightning Imaging Sensor

TMI - TRMM Microwave Imager

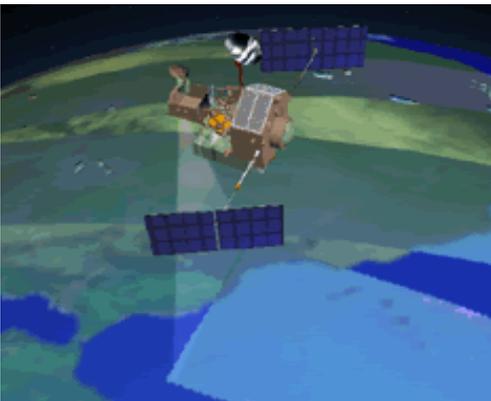
VIRS - Visible Infrared Scanner

PR - Precipitation Radar

### LINKS:

<http://trmm.gsfc.nasa.gov>

## Applications



### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 402 km
- Inclination: 35°
- Launch Date: November 27, 1997
- Design Life: 3 years (exceeded)
- Measurements: Earth's radiation budget and atmospheric radiation

### OWNER

- Japan, JAXA (formerly NASDA)
- U.S., NASA

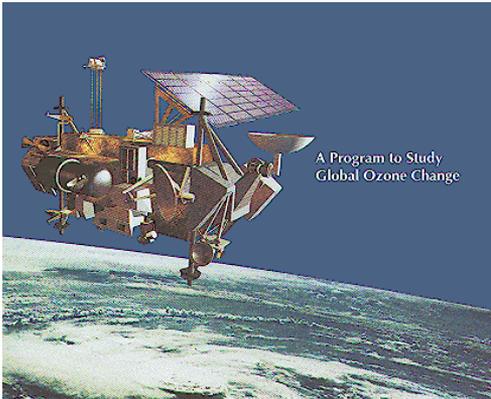
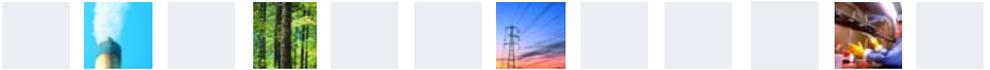
### Upper Atmosphere Research Satellite

UARS is the first NASA mission that carries out a systematic, comprehensive study of the stratosphere and furnishes important new data on the mesosphere and thermosphere. The United Kingdom and Canada provided some of the instruments for this mission.

#### SENSORS:

MLS - Microwave Limb Sounder  
 SOLSTICE - Solar Stellar Irradiance Comparison Experiment A&B  
 ISAMS - Improved Stratospheric and Mesospheric Sounder  
 HALOE - Halogen Occultation Experiment  
 HRDI - High Resolution Doppler Imager  
 WINDII - Wind Imaging Interferometer  
 SUSIM - Solar Ultraviolet Spectral Irradiance Monitor  
 CLAES - Cryogenic Limb Array Etalon Spectrometer  
 ACRIM II - Active Cavity Radiometer Irradiance Monitor II  
 HEPS - High-Energy Particle Spectrometer  
 MEPS - Medium-Energy Particle Spectrometer  
 AXIS - Atmospheric X-ray Imaging Spectrometer  
 VMAG - Vector Magnetometer

#### Applications



#### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 585 km
- Inclination: 57°
- Launch Date: September 15, 1991
- Design Life: 2 years (exceeded)
- Measurements: Energetic electron atmospheric energy input

#### OWNER

- U.S., NASA
- Canada, CSA
- U.K. Meteorological Office

#### LINKS:

<http://umpgal.gsfc.nasa.gov/>

# CALIPSO

## Cloud-Aerosol LIDAR and Infrared Pathfinder Satellite Observations

CALIPSO will provide key measurements of aerosol and cloud properties needed to improve climate predictions. CALIPSO will fly a 3-channel LIDAR with a suite of passive instruments to obtain coincident observations of radiative fluxes and atmospheric conditions. CALIPSO will fly in orbital formation along with Aqua, CloudSAT, PARASOL, and Aura to provide a comprehensive characterization of the structure and composition of clouds and their effects on climate under all weather conditions.

### SENSORS:

IIR - Imaging Infrared Radiometer

WFC - Wide Field Camera

CALIOP - Cloud-Aerosol Lidar with Orthogonal Polarization

### LINKS:

<http://www-calipso.larc.nasa.gov/>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: April 28, 2006
- Design Life: 3 years
- Measurements: Aerosol and cloud properties

### OWNER

- France, CNES
- U.S., NASA

# CloudSAT

CloudSat, a cooperative mission with Canada, will use advanced radar to "slice" through clouds to see their vertical structure, providing a completely new observational capability from space. CloudSat will look at the structure, composition, and effects of clouds and will be one of the first satellites to study clouds on a global basis.

## SENSORS:

CloudSat CPR - Cloud Profiling Radar

## LINKS:

<http://cloudsat.atmos.colostate.edu>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: April 20, 2005
- Design Life: 2 years
- Measurements: Cloud vertical structure and properties

### OWNER

- U.S., NASA

**Deployed  
NASA-Led  
Solar Missions**

# ACE

## Advanced Composition Explorer

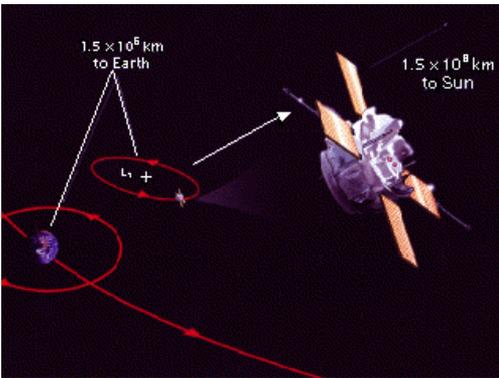
The ACE spacecraft, carrying six high-resolution sensors and three monitoring instruments, samples low-energy particles of solar origin and high-energy galactic particles.

### SENSORS:

CRIS - Cosmic Ray Isotope Spectrometer  
SIS - Solar Isotope Spectrometer  
ULEIS - Ultra Low Energy Isotope Spectrometer  
SEPICA - Solar Energetic Particle Ionic Charge Analyzer  
EPAM - Electron, Proton, and Alpha Monitor  
SWIMS - Solar Wind Ion Mass Spectrometer  
SWICS - Solar Wind Ion Composition Spectrometer  
SWEPAM - Solar Wind Electron, Proton, and Alpha Monitor  
MAG - Magnetometer

### LINKS:

[http://www.srl.caltech.edu/ACE/ace\\_mission.html](http://www.srl.caltech.edu/ACE/ace_mission.html)



### VITAL FACTS

- Orbit Type: Earth-sun Libration Point (L1)
- Altitude: 1.5 million km
- Inclination:
- Launch Date: August 25, 1997
- Design Life: 2 years (exceeded)
- Measurements: Isotopic and elemental composition of solar corona, interplanetary medium, local interstellar medium, and Galactic matter

### OWNER

- U.S., NASA

# FAST

## Fast Auroral Snapshot

The FAST satellite is designed to carry out in situ measurements of acceleration physics and related plasma processes associated with the Earth's aurora.

### SENSORS:

ESA - Electrostatic Analyzers

TEAMS - Time-of-flight Energy Mass Angle Spectrograph

MFI - Magnetic Field Instrument

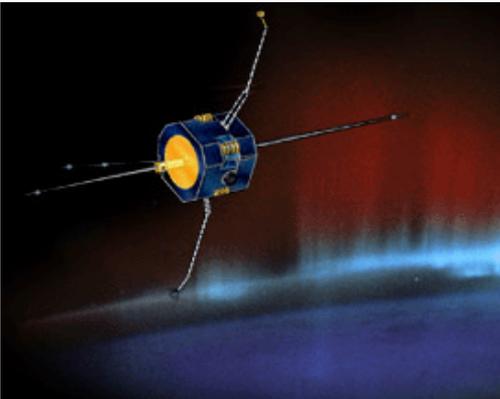
EF/LPI - Electric Field/Langmuir Probe Instrument

EFI - Electric Field Instrument

### LINKS:

<http://sunland.gsfc.nasa.gov/smex/fast/mission/>

<http://sprg.ssl.berkeley.edu/fast/>



### VITAL FACTS

- Orbit Type: elliptical near-polar
- Altitude: 350 km x 4175 km
- Inclination: 83°
- Launch Date: August 21, 1996
- Design Life: 1 year (exceeded)
- Measurements: Magnetic fields

### OWNER

- U.S., NASA

# IMAGE

## Imager for Magnetopause to Aurora Global Exploration

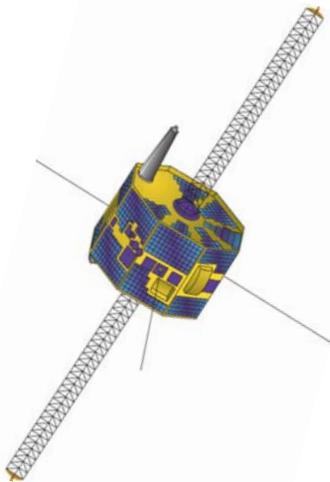
The IMAGE observatory is a spin-stabilized spacecraft that addresses broad science questions to understand the geospace environment and its response to the solar wind.

### SENSORS:

LENA - Low-Energy Neutral-Atom Imager  
MENA - Medium-Energy Neutral-Atom Imager  
HENA - High-Energy Neutral-Atom Imager  
EUV - Extreme Ultraviolet Imager  
WIC - Wideband Imaging Camera  
SI - Spectrographic Imager  
GEO - Geocorona Photometer  
RPI - Radio Plasma Imaging

### LINKS:

<http://image.gsfc.nasa.gov/>  
<http://pluto.space.swri.edu/IMAGE/index.html>



### VITAL FACTS

- Orbit Type: Elliptical polar orbit
- Altitude: 1000 km x 45,922 km
- Inclination:
- Launch Date: March 25, 2000
- Design Life: 2-5 years
- Measurements: Radio sounding

### OWNER

- U.S., NASA

# Polar

The Polar science team measures and studies how the solar wind plasma energy enters into the magnetosphere through the polar cusp on the day side of the magnetosphere by obtaining data from both high- and low-altitude perspectives of the Earth's polar regions.

## **SENSORS:**

PWI - Plasma Waves Investigation

MFE - Magnetic Field Experiment

TIMAS - Toroidal Imaging Mass-Angle Spectrograph

EFI - Electric Field Instrument

TIDE/PSI - Thermal Ion Dynamics Experiment/Plasma Source Instrument

UVI - Ultraviolet Imager

VIS - Visible Imaging System

PIXIE - Polar Ionospheric X-Ray Imaging Experiment

CAMMICE - Charge and Mass Magnetospheric Ion Composition Experiment

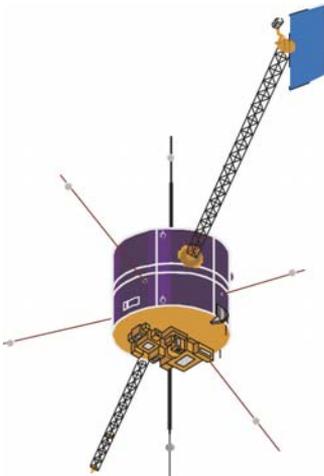
CEPPAD - Comprehensive Energetic-Particle Pitch-Angle Distribution

SEPS - Source/Loss Cone Energetic Particle Spectrometer

HYDRA - Hot Plasma Analyzer

## **LINKS:**

<http://www-istp.gsfc.nasa.gov/istp/polar/>



## **VITAL FACTS**

- Orbit Type: elliptical geocentric orbit
- Altitude: 11500 x 56500 km
- Inclination: 90°
- Launch Date: February 24, 1996
- Design Life: 3 years (exceeded)
- Measurements: Electric fields

## **OWNER**

- U.S., NASA

# RHESSI

## Reuven Ramaty High Energy Solar Spectroscopic Imager

RHESSI, Reuven Ramaty High Energy Solar Spectroscopic Imager, uses a sun-pointed, spin-stabilized spacecraft to investigate the physics of particle acceleration and energy release in solar flares.

### SENSORS:

RHESSI - Reuven Ramaty High Energy Solar Spectroscopic Imager

### LINKS:

<http://www.specastro.com/ProgramsProducts/Hessi.asp>

### VITAL FACTS

- Orbit Type: Circular
- Altitude: 600 km
- Inclination:
- Launch Date: February 5, 2002
- Design Life: 2 Years (exceeded)
- Measurements: Imaging of solar flares

### OWNER

- U.S., NASA

# TIMED

## Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics

The TIMED (Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics) mission will study the influences of the sun and humans on the Mesosphere and Lower Thermosphere/Ionosphere.

### SENSORS:

GUUVI - Global Ultraviolet Imager

SABER - Sounding of the Atmosphere using Broadband Emission Radiometry

SEE - Solar Extreme Ultraviolet Experiment

TIDI - TIMED Doppler Interferometer

### LINKS:

<http://stp.gsfc.nasa.gov/missions/timed/links.htm>

<http://www.timed.jhuapl.edu/mission2/index.html>



### VITAL FACTS

- Orbit Type: Circular
- Altitude: 625 km
- Inclination:
- Launch Date: December 7, 2001
- Design Life: 2 Years (exceeded)
- Measurements: Solar ultraviolet radiation

### OWNER

- U.S., NASA

# TRACE

## Transition Region and Coronal Explorer

The Transition Region and Coronal Explorer is a NASA Small Explorer (SMEX) mission to image the solar corona and transition region at high angular and temporal resolution.

### SENSORS:

TRACE - Transition Region and Coronal Explorer

### LINKS:

<http://sunland.gsfc.nasa.gov/smex/trace/index.html>



### VITAL FACTS

- Orbit Type: Sun-synchronous
- Altitude: 600 x 650 km
- Inclination:
- Launch Date: April 2, 1998
- Design Life: 1 year (exceeded)
- Measurements: Temporal evolution of the magnetic field

### OWNER

- U.S., NASA

# VOYAGER I & II

Traveling through space over 27 years, the Voyager 1 spacecraft has reached 90 astronomical units (AU) from the Sun. It is the only spacecraft to have made measurements in the solar wind from such a great distance from the source of the dynamic solar environment. NASA placed a message aboard Voyager 1 and 2, intended to communicate a story of our world to extraterrestrials.

## SENSORS:

LECP - Low energy charged particle investigation

MAG - Magnetic Field Investigation

UVS - Ultraviolet Spectrometer

CRS - Cosmic Ray Investigation

PWS - Plasma Wave Investigation

PRA - Planetary Radio Astronomy Subsystem

PLS

## LINKS:

<http://voyager.jpl.nasa.gov/>



## VITAL FACTS

- Orbit Type:
- Altitude: 90 AU
- Inclination:
- Launch Date: September 5, 1977
- Design Life: 43 years
- Measurements: Interstellar cosmic rays

### OWNER

- U.S., NASA

# Wind

Wind is the first of two NASA spacecraft in the Global Geospace Science initiative and part of the ISTP Project.

## SENSORS:

SWICS - Solar Wind Ion Composition Spectrometer

WAVES - Radio and Plasma Wave Experiment

EPACT - Energetic Particle Acceleration, Composition, and Transport

SWE - Solar Wind Experiment

MASS - High Mass Resolution Spectrometer

STICS - Suprathermal Ion Composition Spectrometer

MFI - Magnetic Field Investigation

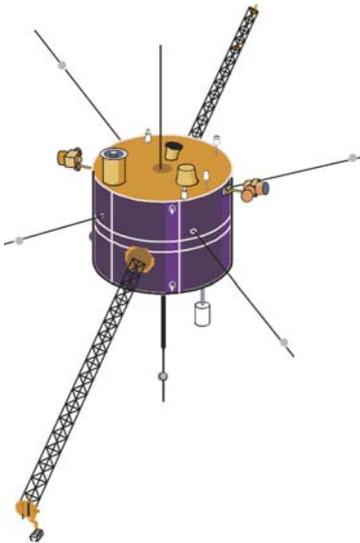
3D PLASMA - 3-D Plasma and Energetic Particle Analyzer

TGRS - Transient Gamma-Ray Spectrometer

KONUS - Gamma Ray Burst Studies

## LINKS:

<http://pwg.gsfc.nasa.gov/istp/wind/>



## VITAL FACTS

- Orbit Type: Variable (double lunar swing-by and Lagrangian point - halo)
- Altitude:
- Inclination:
- Launch Date: November 1, 1994
- Design Life: 3 years (exceeded)
- Measurements: Plasma processes in the near-Earth solar wind

## OWNER

- U.S., NASA

# **NASA-Led Earth Missions In Development**

# Aquarius

Aquarius is a focused satellite mission to measure global Sea Surface Salinity (SSS). Scientific progress is limited because conventional in situ SSS sampling is too sparse to give the global view of salinity variability that only a satellite can provide. Aquarius will resolve missing physical processes that link the water cycle, the climate, and the ocean.

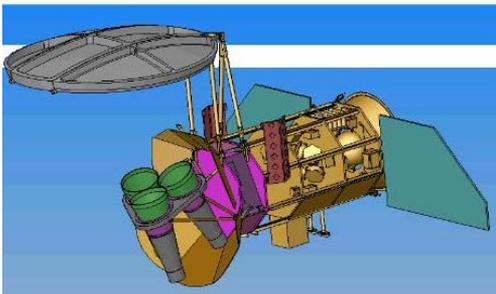
## SENSORS:

Aquarius Radiometer - Aquarius Radiometer/Scatterometer

## LINKS:

<http://aquarius.gsfc.nasa.gov>

## Applications



## VITAL FACTS

- Orbit Type: Sun-synchronous
- Altitude: 600 km
- Inclination:
- Launch Date: January 1, 2008
- Design Life: 3 years
- Measurements: Global and synoptic sea surface salinity

## OWNER

- Argentina, CONAE
- U.S., NASA

# Mission In Development

## Deep Space Climate Observatory

DSCOVER (formerly Triana) is a cooperative project between the NASA offices of Earth and Space science. It was designed to measure how solar radiation affects climate by using the Sun-Earth Lagrangian points (1.5 million km away from Earth) to make full Earth observations continuously.

### SENSORS:

EPIC - Earth Polychromatic Imaging Camera

NISTAR - National Institute of Standards and Technology Advanced Radiometer

Plasma-Mag - Plasma-Magnetometer

### LINKS:

<http:// triana.gsfc.nasa.gov/home/>

<http://www-pm.larc.nasa.gov/triana.html>

## Applications



### VITAL FACTS

- Orbit Type: L1, Lagrange neutral gravity point between the Earth and the Sun
- Altitude: 1,507,000 km
- Inclination:
- Launch Date: January 1, 2008
- Design Life: 4 years
- Measurements: Early warning of solar events

#### OWNER

- U.S., NASA

# Glory

Glory will monitor the concentration and nature of both natural and anthropogenic aerosols with accuracy and coverage sufficient for quantification of the aerosol effect on climate, the anthropogenic component of this effect, and the long-term change of this effect caused by natural and anthropogenic factors. Glory will also monitor the total solar irradiance.

## **SENSORS:**

TIM - Total Irradiance Monitor

APS - Aerosol Polarimetric Sensor

## **LINKS:**

<http://glory.giss.nasa.gov/>

## **VITAL FACTS**

- Orbit Type: Sun-synchronous
- Altitude: 824 km
- Inclination: 98.2°
- Launch Date: December 2007
- Design Life: 3 years
- Measurements: Global distribution of natural and anthropogenic aerosols

## **OWNER**

- U.S., NASA

# Mission In Development

# GPM

## Global Precipitation Measurement

GPM is a joint mission with the Japan Aerospace Exploration Agency (JAXA) of Japan and other international partners. Building upon the success of the Tropical Rainfall Measuring Mission (TRMM), GPM will initiate global precipitation measurement. Its science objectives are to improve ongoing efforts to predict climate by providing near-global measurement of precipitation, its distribution, and physical processes, and to improve the accuracy of weather and precipitation forecasts through more accurate measurement of rain rates and latent heating.

### SENSORS:

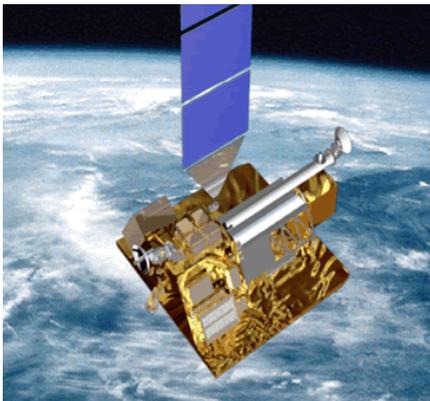
DPR - Dual-frequency Precipitation Radar

GMI - GPM Microwave Imager

### LINKS:

<http://gpm.gsfc.nasa.gov>

## Applications



### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 600 km
- Inclination: 98.6°
- Launch Date: 1/01/2010
- Design Life: 3 years
- Measurements: Global precipitation

### OWNER

- Japan, JAXA (formerly NASDA)
- U.S., NASA

## Mission In Development

### Hydrosphere State

HYDROS will provide the first global views of Earth's changing soil moisture and land surface freeze/thaw conditions, leading to breakthroughs in weather and climate prediction and in the understanding of processes linking water, energy, and carbon cycles.

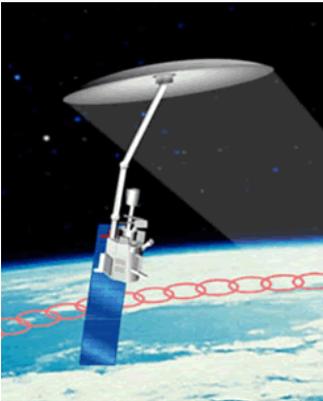
**SENSORS:**

HYDROS - Hydros Radar/Radiometer

**LINKS:**

<http://hydros.gsfc.nasa.gov/>

### Applications

**VITAL FACTS**

- Orbit Type: Sun-synchronous
- Altitude: 670 km
- Inclination:
- Launch Date: 9/1/2010
- Design Life: 4 years
- Measurements: Soil Moisture, hydroclimatology, hydrometeorology, freeze/thaw conditions

**OWNER**

- U.S., NASA

# NPP

## NPOESS Preparatory Project

The NPP is a cooperative project with DoD and NOAA to extend key measurements in support of long-term monitoring of climate trends and of global biological productivity. It extends the measurement series being initiated with EOS Terra and EOS Aqua by providing a bridge between NASA's EOS missions and the National Polar-orbiting Operational Environmental Satellite System (NPOESS).

### SENSORS:

CrIS - Cross-track Infrared Sounder

OMPS - Ozone Mapping and Profiler Suite

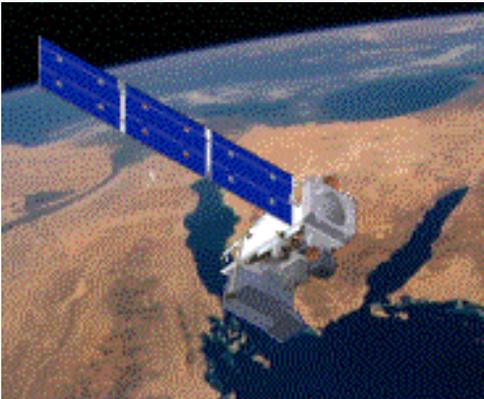
ATMS - Advanced Technology Microwave Sounder

VIIRS - Visible/Infrared Imager/Radiometer Suite

### LINKS:

<http://jointmission.gsfc.nasa.gov/>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 824 km
- Inclination:
- Launch Date: October 31, 2006
- Design Life: 5 years
- Measurements: Atmospheric temperature and water vapor profiles

### OWNER

- U.S., NASA
- U.S., NOAA

# Mission In Development

# OCO

## Orbiting Carbon Observatory

The OCO will provide space-based observations of atmospheric carbon dioxide (CO<sub>2</sub>), the principal anthropogenic driver of climate change. This mission uses mature technologies to address NASA's carbon cycle measurement requirement. OCO generates the knowledge needed to improve projections of future atmospheric CO<sub>2</sub>.

### SENSORS:

OCO Spectrometers - Orbiting Carbon Observatory Spectrometers

### LINKS:

<http://essp.gsfc.nasa.gov/oco/index.html>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 705 km
- Inclination:
- Launch Date: December 2007
- Design Life: 2 years
- Measurements: Maps of column-integrated CO<sub>2</sub> dry air mole fraction

### OWNER

- U.S., NASA

# Mission In Development

**NASA-Led  
Solar Missions  
In Development**

# AIM

## Aeronomy of Ice in the Mesosphere

The AIM satellite mission will explore Polar Mesospheric Clouds (PMCs), also called noctilucent clouds, to find out why they form and why they are changing. Results from this mission will provide the basis for study of long-term variability in the mesospheric climate.

### SENSORS:

CIPS - Cloud Imaging and Particle Size Experiment

SOFIE - Solar Occultation For Ice Experiment

CDE - Cosmic Dust Experiment

### LINKS:

<http://aim.hamptonu.edu/>

### VITAL FACTS

- Orbit Type: Polar
- Altitude: 482.8032 km
- Inclination:
- Launch Date: September 29, 2006
- Design Life: 6 years
- Measurements: PMC abundances, spatial distribution, particle size distributions, gravity wave activity, cosmic dust influx to the atmosphere, and vertical profile measurements of temperature, H<sub>2</sub>O, OH, CH<sub>4</sub>, O<sub>3</sub>, CO<sub>2</sub>, NO, and aerosols

### OWNER

- U.S., Hampton University
- U.S., LASP
- U.S., NASA

## Mission In Development

# MMS

## Magnetosphere Multiscale

MMS employs 5 identical spacecraft in a variably spaced tetrahedron. These spacecraft will study how small-scale processes control large-scale phenomenology, such as magnetotail dynamics, plasma entry into the magnetosphere, and substorm initiation.

### LINKS:

<http://stp.gsfc.nasa.gov/missions/mms/mms.htm>

### VITAL FACTS

- Orbit Type:
- Altitude:
- Inclination:
- Launch Date: January 2010
- Design Life: 2 years
- Measurements: Magnetic and electric fields

### OWNER

- U.S., NASA

## Mission In Development

# SDO

## Solar Dynamics Observatory

SDO is being designed to help us understand the Sun's influence on Earth and Near-Earth space by studying the solar atmosphere on small scales of space and time and in many wavelengths simultaneously.

### SENSORS:

HMI - Helioseismic and Magnetic Imager

AIA - Atmospheric Imaging Assembly

EVE - Extreme Ultraviolet Variability Experiment

### LINKS:

<http://sdo.gsfc.nasa.gov/>

### VITAL FACTS

- Orbit Type: Inclined Geosynchronous
- Altitude: 35,000 km
- Inclination: 28.5°
- Launch Date: April 1, 2008
- Design Life: 5 years
- Measurements: Radiation levels of solar output

### OWNER

- U.S., NASA

## Mission In Development

# STEREO

## Solar Terrestrial Relations Observatory

The STEREO mission will use two identically equipped spacecraft to provide revolutionary 3-D imaging of coronal mass ejections. The STEREO mission is a multilateral international collaboration involving participants from France, Germany, the United States, and United Kingdom.

### LINKS:

<http://stp.gsfc.nasa.gov/missions/stereo/stereo.htm>

<http://stereo.jhuapl.edu/mission/overview/overview.html>

### VITAL FACTS

- Orbit Type: Heliocentric Elliptical
- Altitude: 149598000 km
- Inclination:
- Launch Date: February 11, 2006
- Design Life: 2 years
- Measurements: 3-D images of the structure of coronal mass ejections

### OWNER:

- France, CNRS
- U.S., JHU/APL
- U.S., NASA
- U.S., NRL

## Mission In Development

# ST5

## Science Technology 5

Space Technology 5 (ST5) is the fourth deep space mission in NASA's New Millennium Program. During flight validation of its technologies, ST5 will measure the effect of solar activity on the Earth's magnetosphere, the region of upper atmosphere that surrounds our planet. ST5's objective is to demonstrate and flight qualify several innovative technologies and concepts for application to future space missions.

### LINKS:

<http://nmp.jpl.nasa.gov/st5/index.html>

### VITAL FACTS

- Orbit Type: Elliptical Geocentric
- Altitude: 3,000 km
- Inclination:
- Launch Date: February 28, 2006
- Design Life: TBD
- Measurements: The effect of solar activity on the Earth's magnetosphere

### OWNER

- U.S., NASA

## Mission In Development

# THEMIS

## Time History of Events and Macroscale Interactions During Substorms

THEMIS consists of five identical probes. These probes will answer fundamental outstanding questions regarding the magnetospheric substorm instability, a dominant mechanism of transport and explosive release of solar wind energy within Geospace. THEMIS will also address questions in radiation belt physics and solar wind/magnetosphere energy coupling.

### SENSORS:

FGM - Fluxgate Magnetometer

ESA - Electrostatic Analyzers

EFI - Electric Field Instrument

SST - Solid State Telescope

### LINKS:

<http://sprg.ssl.berkeley.edu/themis/about/about.htm>

### VITAL FACTS

- Orbit Type: Elliptical, High-Earth
- Altitude: 63780 x 191340 km
- Inclination:
- Launch Date: Oct. 19, 2006
- Design Life: 2 years
- Measurements: Particles and fields on orbits which optimize tail-aligned conjunctions over North America.

### OWNER

- U.S., NASA
- U.S., Canadian Space Agency

## Mission In Development

# **Interagency Partnerships**

## GOES 8-12

### Geostationary Operational Environmental Satellites

The GOES series is a reimbursable project for NOAA. GOES-M (also known as GOES-12) provides weather imagery and quantitative sounding data used to support weather forecasting, severe storm tracking, and meteorological research.

#### SENSORS:

GOES Imager - Geostationary Operational Environmental Satellite Imager

SEM-2 - Space Environment Monitor, Generation 2

GOES Sounder - Geostationary Operational Environmental Satellite - Sounder

SXI - Solar X-ray Imager

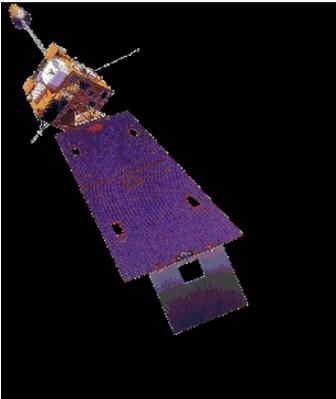
SARSAT - Search And Rescue Satellite Aided Tracking

#### LINKS:

<http://www.oso.noaa.gov/goes/>

<http://rsd.gsfc.nasa.gov/goes/text/goesmstatus.html>

<http://goespoes.gsfc.nasa.gov/aboutgoes/current.htm>



#### VITAL FACTS

- Orbit Type: Geostationary
- Altitude: 36000 km
- Inclination: Longitude: 75° W or 135° W°
- Launch Date: July 23, 2001
- Design Life: 5 years
- Measurements: Solar X-ray flux

#### OWNER

- U.S., NOAA

## Landsat 5

The fifth in a series of Earth observation platforms, Landsat 5 continued the Thematic Mapper archive started in 1982. Current transmissions are by direct downlink only, as there is no recording capability.

### SENSORS:

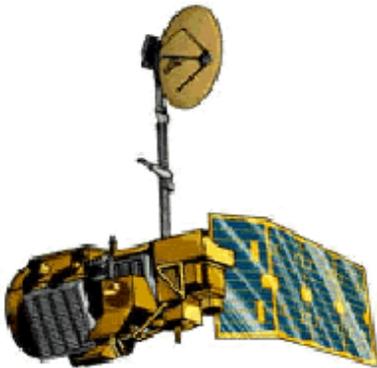
TM - Thematic Mapper

MSS - Multispectral Scanner

### LINKS:

<http://geo.arc.nasa.gov/sge/landsat/landsat.html>

<http://www.earth.nasa.gov/history/landsat/landsat5.html>



### VITAL FACTS

- Orbit Type: Sun-synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: March 1, 1984
- Design Life: 5 years (exceeded)
- Measurements: Ground cover and land use imagery

### OWNER

- U.S., NASA
- U.S., NOAA
- U.S., USGS

# Landsat 7

NASA's Landsat provides well-calibrated, multispectral, moderate resolution, substantially cloud-free, sunlit digital images of the Earth's continental and coastal areas with global coverage on a seasonal basis using the Enhanced Thematic Mapper Plus instrument. Operations were transferred to the U.S. Geological Survey in 2000.

## SENSORS:

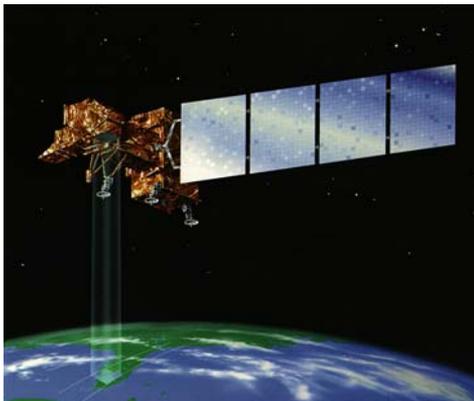
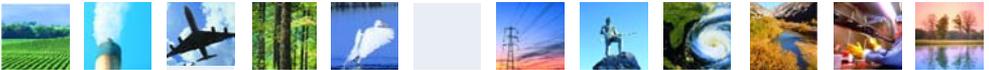
ETM+ - Enhanced Thematic Mapper Plus

## LINKS:

<http://landsat7.usgs.gov/>

<http://landsat.gsfc.nasa.gov/>

## Applications



## VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: April 15, 1999
- Design Life: 5 years
- Measurements: Land cover and land use change

## OWNER

- U.S., NASA
- U.S., USGS

## POES 15-17

### Polar-orbiting Operational Environmental Satellite, NOAA K-M

NOAA-M POES (National Oceanic and Atmospheric Administration Polar-orbiting Operational Environmental Satellites) provides global coverage of numerous atmospheric and surface parameters for weather forecasting and meteorological research, as well as space environment monitors and an aircraft and maritime emergency beacon system. This is a reimbursable project for NOAA. NASA builds and launches the satellites.

#### SENSORS:

AMSU-A - Advanced Microwave Sounding Unit-A  
SBUV-2 - Solar Backscatter Ultraviolet Radiometer 2  
AVHRR - Advanced Very High Resolution Radiometer 3  
HIRS - High Resolution Infrared Radiation Sounder  
SEM-2 - Space Environment Monitor, Generation 2  
SARSAT - Search And Rescue Satellite Aided Tracking  
A-DCS - ARGOS Data Collection System  
AMSU-B - Advanced Microwave Sounding Unit-B

#### LINKS:

<http://goespoes.gsfc.nasa.gov/>

#### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 833 km
- Inclination: 98.8°
- Launch Date: June 24, 2002
- Design Life: 2 years
- Measurements: Global atmospheric temperature and humidity profiles

#### OWNER

- U.S., NOAA

**Interagency  
Partnerships  
In Development**

# GOES N-P

## Geostationary Operational Environmental Satellites N - P

The GOES series N-P will be a vital contributor to weather, solar, and space operations and science. The GOES N-P series will aid activities ranging from severe storm warnings to resource management and advances in science. GOES N-P data will add to the global community of knowledge, embracing many civil and government environmental forecasting organizations.

### SENSORS:

- AMSU-A - Advanced Microwave Sounding Unit-A
- SBUV-2 - Solar Backscatter Ultraviolet Radiometer 2
- AVHRR - Advanced Very High Resolution Radiometer 3
- HIRS - High Resolution Infrared Radiation Sounder
- SEM-2 - Space Environment Monitor, Generation 2
- MHS - Microwave Humidity Sounder
- SARSAT - Search And Rescue Satellite Aided Tracking

### LINKS:

<http://projects.osd.noaa.gov/IJPS/characteristic.htm>

### VITAL FACTS

- Orbit Type: Geostationary
- Altitude:
- Inclination: Longitude: 135° W and 75° W°
- Launch Date: April 1, 2006
- Design Life: 2 years
- Measurements: Spectral solar irradiance

### OWNER

- U.S., NOAA

## Mission In Development

# GOES R

## Geostationary Operational Environmental Satellite R

The multi-mission GOES series is a vital contributor to weather, solar, and space operations and science. The GOES R series is still in planning.

### SENSORS:

### LINKS:

[http://goes2.gsfc.nasa.gov/spacecraft/goes\\_r\\_spacecraft.htm](http://goes2.gsfc.nasa.gov/spacecraft/goes_r_spacecraft.htm)

## Applications



### VITAL FACTS

- Orbit Type: Geostationary
- Altitude:
- Inclination: Longitude: 135° W and 75° W°
- Launch Date: 2012
- Design Life: 5 years
- Measurements: Solar activity, the charged particle environment, and the Earth's magnetic field

### OWNER

- U.S., NOAA

## Mission In Development

# NPOES-1

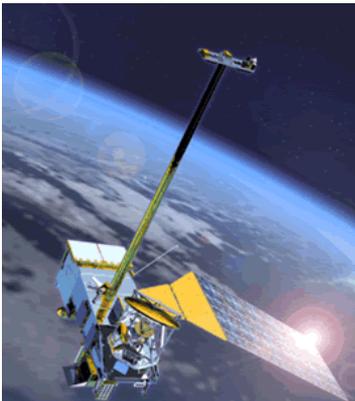
## National Polar-orbiting Operational Environmental Satellite System

NPOESS will provide the U.S. with an enduring capability to measure atmospheric, land, and oceanic environmental parameters globally. The system will provide timely and accurate weather and environmental data to weather forecasters, military commanders, civilian leaders, and the scientific community. The current plan is for the NPOESS constellation to consist of three polar-orbiting satellites.

### SENSORS:

TIM - Total Irradiance Monitor  
CMIS - Conical Microwave Imager/Sounder  
CrIS - Cross-track Infrared Sounder  
GPSOS - Global Positioning System Occultation Sensor  
OMPS - Ozone Mapping and Profiler Suite  
OLI - Operational Land Imager  
SESS - Space Environment Sensor Suite  
ATMS - Advanced Technology Microwave Sounder  
VIIRS - Visible/Infrared Imager/Radiometer Suite  
APS - Aerosol Polarimetric Sensor  
SSALT-2 - Solid State Radar ALTimeter  
SARSAT - Search And Rescue Satellite Aided Tracking  
A-DCS - ARGOS Data Collection System  
ERBS - Earth Radiation Budget Sensor  
TSIS - Total Solar Irradiance Sensor  
Black Jack GPS - Black Jack GPS Occultation

### Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 833 km
- Inclination: 98.75°
- Launch Date: Sept. 1, 2010
- Design Life: 2 years
- Measurements: Atmospheric temperature, water vapor profiles, and auroral boundary traits

### OWNER

- U.S., NASA

### LINKS:

<http://www.ipo.noaa.gov/index2.html>

## Mission In Development

# POESN-N'

## Polar-orbiting Operational Environmental Satellites N - N'

The NOAA POES satellites N and N' provide global coverage of numerous atmospheric and surface parameters for weather forecasting and meteorological research, as well as space environment monitors and an aircraft and maritime emergency beacon system. This is a reimbursable project for NOAA. NASA builds and launches the satellites.

### SENSORS:

AMSU-A - Advanced Microwave Sounding Unit-A  
SBUV-2 - Solar Backscatter Ultraviolet Radiometer 2  
AVHRR - Advanced Very High Resolution Radiometer 3  
HIRS - High Resolution Infrared Radiation Sounder  
SEM-2 - Space Environment Monitor, Generation 2  
MHS - Microwave Humidity Sounder  
SARSAT - Search And Rescue Satellite Aided Tracking

### LINKS:

<http://projects.osd.noaa.gov/IJPS/characteristic.htm>

### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 870 km
- Inclination: 98.8°
- Launch Date: March 2005 (N)
- Design Life: 2 years
- Measurements: Spectral solar irradiance

### OWNER

- U.S., NOAA

## Mission In Development

**Interagency  
Partnerships In  
Development-Solar**

# CINDI

## Coupled Ion-Neutral Dynamics Investigation

CINDI seeks to discover how the neutral gas motions and the charged particle motions are related. The CINDI investigation is carried out as an enhancement to the science objectives of the Communication/Navigation Outage Forecast System (C/NOFS).

### SENSORS:

IVM - Ion Velocity Meter

NWM - Neutral Wind Meter

### LINKS:

<http://129.110.7.63/heelis/cindi.html>

### VITAL FACTS

- Orbit Type: Low-Earth
- Altitude: 400-700 km
- Inclination: 13°
- Launch Date: January 1, 2007
- Design Life: 3 years
- Measurements: Ion drift velocity vector from 400 to 700 km

### OWNER

- U.S., NASA

# Mission In Development

# TWINS

## Two Wide-angle Imaging Neutral-atom Spectrometers

The TWINS mission provides a new capability for stereoscopically imaging the magnetosphere. By imaging the charge exchange of neutral atoms over a broad energy range using two identical instruments on two widely spaced high-altitude, high-inclination spacecraft, TWINS will enable the 3-dimensional visualization and the resolution of large scale structures and dynamics within the magnetosphere.

### SENSORS:

TEI - TWINS ENA (Energetic Neutral Atom) Imager  
Lyman-alpha Detector

### LINKS:

<http://nis-www.lanl.gov/nis-projects/twins/>

### VITAL FACTS

- Orbit Type: Elliptical Earth (Molniya orbit)
- Altitude: 300-46000 km
- Inclination: 63.4°
- Launch Date: January 1, 2007
- Design Life: TBD
- Measurements: Earth's magnetic field

### OWNER

- U.S., NASA

## Mission In Development

# **International Partnerships**

# CHAMP

## Challenging Mini-Satellite Payload

CHAMP is a cooperative project between the U.S. and Germany. It is designed to map the Earth's global long- to medium-wavelength gravity field and the Earth's global magnetic field and temporal variations. CHAMP is also designed to perform atmosphere/ionosphere sounding.

### SENSORS:

GPS Receiver - Global Positioning System Receiver

LRA - Laser Retroreflector Array

OVM - Overhauser Magnetometer

FGM - Fluxgate Magnetometer

DIDM - Digital Ion Drift Meter

STAR - Space Three-axis Accelerometer for Research

ASC - Advanced Star Compass

Black Jack GPS - Black Jack GPS Occultation

### LINKS:

<http://op.gfz-potsdam.de/champ/>

## Applications



### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 450 km
- Inclination: 87.27°
- Launch Date: July 15, 2000
- Design Life: 5 years
- Measurements: Temporal variance in the Earth's gravity and magnetic fields

### OWNER

- Germany, GFZ

# ERS I/II

## European Remote Sensing I/II

The European Remote Sensing (ERS) satellites earth observation mission has been operating for over 10 years. The ERS satellites carry a suite of instruments to provide data for scientific and commercial applications. ERS-2 was launched in 1995 and is the current operational satellite. ERS-2 continues to provide excellent data, far exceeding its nominal lifetime.

### SENSORS:

LRA - Laser Retroreflector Array

ATSR - Along Track Scanning Radiometer

GOME - Global Ozone Monitoring Experiment

RA-1 - Radar Altimeter-1

AMI/WS - Active Microwave Instrument/Wind Scatterometer

MWR - Microwave Radiometer

### LINKS:

<http://earth.esa.int/ers/>



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 780 km
- Inclination: 98.52°
- Launch Date: July 17, 1991
- Design Life: 2 years
- Measurements: Provides all-weather images of ocean, ice, and land surfaces.

### OWNER

- Europe, ESA

# FedSat

## Federation Satellite

FedSat is the first Australian-built satellite in over 30 years. It has been delivering scientific data to its ground station in Adelaide almost daily. This information is used by Australian and international researchers to study space weather, to help improve space computers, communication systems and other satellite technology, and to support research on navigation and satellite tracking.

### SENSORS:

GPS Receiver - Global Positioning System Receiver

CPE - Communications Payload Experiment

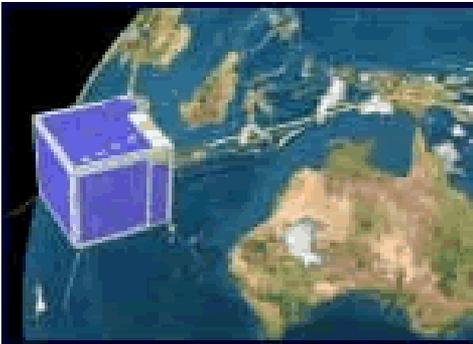
HPCE - High Performance Computer Experiment

NewMag - New Magnetometer Experiment

### LINKS:

<http://www.crcss.csiro.au/fedsat/default.htm>

<http://www.auspace.com.au/projects/fedsat.htm>



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 802.9 km
- Inclination: 98.67°
- Launch Date: December 14, 2002
- Design Life: 3 years
- Measurements: Electrical currents and perturbations in the Earth's magnetic field, tests mobile communications

### OWNER

- Australia, CSIRO

# Jason-1

Jason-1 is a joint mission between France and the U.S. to monitor global ocean circulation, to improve global climate predictions, and to monitor events such as El Niño Southern Oscillation conditions and ocean eddies.

## SENSORS:

GPS Receiver - Global Positioning System Receiver

LRA - Laser Retroreflector Array

JMR - Jason-1 Microwave Radiometer

SSALT-2 - Solid State Radar Altimeter

DORIS - Doppler Orbitography and Radiopositioning Integrated by Satellite

## LINKS:

<http://sealevel.jpl.nasa.gov>

<http://topex-www.jpl.nasa.gov/mission/jason-1.html>

## Applications



## VITAL FACTS

- Orbit Type: Non Sun-Synchronous Circular
- Altitude: 1,336 km
- Inclination: 66°
- Launch Date: December 7, 2001
- Design Life: 5 years
- Measurements: Brightness temperature

## OWNER

- France, CNES
- U.S., NASA

# SAC-C

## Satelite de Aplicaciones Cientificas

SAC-C will provide multispectral imaging of terrestrial and coastal environments. The spacecraft will study the structure and dynamics of the Earth's atmosphere, ionosphere and geomagnetic field. SAC-C will seek to measure the space radiation in the environment and its influence on advanced electronic components.

### SENSORS:

- MMRS - Multispectral Medium Resolution Scanner
- ICARE - Influence of Space Radiation on Advanced Components
- INES - Italian Navigation Experiment
- GOLPE - GPS Occultation and Passive Reflection Experiment
- HRTC - High Resolution Technological Camera
- WTE - Whale Tracker Experiment
- IST - Italian Star Tracker
- HSC - High Sensitivity Camera
- SHM - Scalar Helium Magnetometer

### LINKS:

[http://www.gsfc.nasa.gov/gsfcservice/gallery/fact\\_sheets/spacesci/sac-c.htm](http://www.gsfc.nasa.gov/gsfcservice/gallery/fact_sheets/spacesci/sac-c.htm)



### VITAL FACTS

- Orbit Type: Sun-synchronous
- Altitude: 702 kilometers
- Inclination: 98.2°
- Launch Date: November 21, 2000
- Design Life: 4 years
- Measurements: High energy radiation environment, trapped particle intensities and energy distribution

### OWNER

- Argentina, CONAE
- Brazil, INDPE
- Denmark, DSRI
- France, CNES
- Italy, ASI
- U.S., NASA

## Stratospheric Aerosol and Gas Experiment III

SAGE III is a joint mission between NASA and the Russian Space Agency that is one of nine experiments on the Russian Meteor-3M spacecraft.

### SENSORS:

SAGE III - Stratospheric Aerosol and Gas Experiment III

### LINKS:

<http://www-sage3.larc.nasa.gov/>

## Applications



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 1020  $\pm$ 20 km
- Inclination: 99.64°
- Launch Date: December 10, 2001
- Design Life: 5 years
- Measurements: Aerosol extinction

### OWNER

- Russia, RSA
- U.S., NASA

# **International Partnerships In Development**

# OSTM

## Ocean Surface Topography Mission

OSTM will provide research quality oceanographic sea surface height data into an operational mode for continued climate forecasting research and science. It will continue and extend measurements conducted by the TOPEX/Poseidon and Jason-1 missions.

### SENSORS:

GPS Receiver - Global Positioning System Receiver

LRA - Laser Retroreflector Array

SSALT - Solid State Radar Altimeter

JMR - Jason-1 Microwave Radiometer

DORIS - Doppler Orbitography and Radiopositioning Integrated by Satellite

WSOA - Wide Swath Ocean Altimeter

AMR - Advanced Microwave Radiometer

### LINKS:

<http://topex-www.jpl.nasa.gov/mission/ostm.html>

## Applications



### VITAL FACTS

- Orbit Type: Non Sun-Synchronous
- Altitude: 1336 km
- Inclination: 66°
- Launch Date: April 2008
- Design Life: 5 years
- Measurements: Climate monitoring

### OWNER

- France, CNES
- U.S., NASA

## Mission In Development



**International  
Partnerships  
Solar**

## Cluster

Cluster II is part of an international collaboration to investigate the physical connection between the Sun and Earth. Flying in a tetrahedral formation, the four spacecraft collect data on small-scale changes in near-Earth space and the interaction between the charged particles of the solar wind and Earth's atmosphere.

### SENSORS:

EDI - Electron Drift Instrument

ASPOC - Active Spacecraft Potential Control

STAFF - Spatio-Temporal Analysis of Field Fluctuation

EFW - Electric Field and Wave

DWP - Digital Wave Processing

WHISPER - Waves of High frequency and Sounder for Probing of Electron density by Relaxation

WBD - Wide Band Data

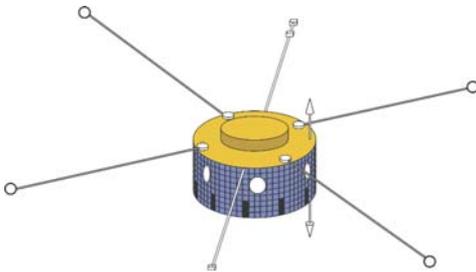
PEACE - Plasma Electron And Current Experiment

CIS - Cluster Ion Spectrometry

RAPID - Research with Adaptive Particle Imaging Detectors

### LINKS:

<http://clusterlaunch.esa.int/science-e/www/area/index.cfm?fareaid=8>



### VITAL FACTS

- Orbit Type: Elliptical polar orbit
- Altitude: 19,000 to 119,000 km
- Inclination:
- Launch Date: July 16, 2000 and August 9, 2000
- Design Life: 5 years
- Measurements: Electrical potential

### OWNER

- Europe, ESA

# Geotail

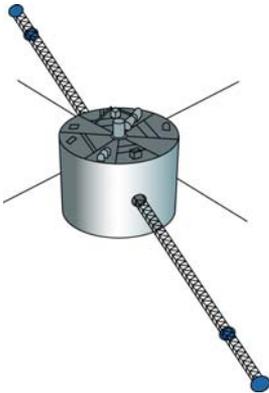
The GEOTAIL mission is a collaborative project undertaken by the Institute of Space and Astronautical Science (ISAS) and the National Aeronautics and Space Administration (NASA). Its primary objective is to study the dynamics of the Earth's magnetotail. Geotail is a spin-stabilized spacecraft utilizing mechanically despun antennas.

## SENSORS:

CPI - Comprehensive Plasma Instrument  
EFD - Electric Field Detector  
EPIC - Energetic Particles and Ion Composition  
HEP - High Energy Particles  
LEP - Low Energy Particles  
MGF - Magnetic Fields Measurement  
PWI - Plasma Wave Investigation

## LINKS:

<http://www.isas.ac.jp/e/enterp/missions/geotail/index.shtml>  
<http://www-istp.gsfc.nasa.gov/istp/geotail/>



## VITAL FACTS

- Orbit Type: Variable (double lunar swingby and low inclination orbit)
- Altitude: Variable
- Inclination:
- Launch Date: July 24, 1992
- Design Life: ~4 years (exceeded)
- Measurements: Global energy flow and transformation in the magnetotail

## OWNER

- Japan, ISAS
- U.S., NASA

# SOHO

## Solar and Heliospheric Observatory

SOHO, the Solar and Heliospheric Observatory, is a project of international cooperation between ESA and NASA to study the Sun, from its deep core to the outer corona, and the solar wind. SOHO is a three-axis stabilized spacecraft that constantly faces the Sun.

### SENSORS:

CDS - Coronal Diagnostic Spectrometer

CELIAS - Charge, Element, and Isotope Analysis System

EIT - Extreme Ultraviolet Imaging Telescope

GOLF - Global Oscillations at Low Frequencies

LASCO - Large Angle and Spectrometric Coronagraph

MDI/SOI - Michelson Doppler Imager/Solar Oscillations Investigation

SUMER - Solar Ultraviolet Measurements of Emitted Radiation

SWAN - Solar Wind Anisotropies

UVCS - Ultraviolet Coronagraph Spectrometer

VIRGO - Variability of Solar Irradiance and Gravity Oscillations

COSTEP - Comprehensive Suprathermal and Energetic Particle Analyzer

ERNE - Energetic and Relativistic Nuclei and Electron Experiment

### LINKS:

<http://sohowww.nascom.nasa.gov/>



### VITAL FACTS

- Orbit Type: Earth-sun Libration Point (L1)
- Altitude: 1.5 million km
- Inclination:
- Launch Date: December 2, 1995
- Design Life: 2 years (exceeded)
- Measurements: Solar wind

### OWNER

- Europe, ESA
- U.S., NASA

# Ulysses

Ulysses, with an array of sensors for gauging the invisible winds, atoms, dust grains, and magnetic fields that permeate space around the Sun, is contributing to a better understanding of the Sun and its heliosphere.

## **SENSORS:**

SWICS - Solar Wind Ion Composition Spectrometer

COSPIN - Cosmic-ray and Solar Particle Investigation

GRB - Gamma-Ray Burst Experiment

DUST - Cosmic Dust Experiment

EPAC/GAS - Energetic Particle Composition /Interstellar Neutral Gas Experiment

FGM/VHM - Fluxgate Magnetometer/ Vector Helium Magnetometer

HI-SCALE - Heliosphere Instrument for Spectra Composition and Anisotropy at Low Energies

SWOOPS - Solar Wind Observations Over the Poles of the Sun

URAP - Unified Radio and Plasma-Wave Experiment

GWE - Gravitational Wave Experiment

GLG/SWICS

SCE

## **LINKS:**

[http://www.esa.int/export/esaSC/120395\\_index\\_0\\_m.html](http://www.esa.int/export/esaSC/120395_index_0_m.html)

## **VITAL FACTS**

- Orbit Type: Heliocentric
- Altitude: 807829200 x 194477400 km
- Inclination:
- Launch Date: October 6, 1990
- Design Life: 5 years (exceeded)
- Measurements: Dust and gas

## **OWNER**

- Europe, ESA
- U.S., NASA

**International  
Partnerships  
In Development-  
Solar**

## Solar B

Solar-B will determine the solar origins of space weather and global change, providing a comprehensive study of stellar magnetic fields and a new view into the magnetic dynamics of the plasma universe.

### SENSORS:

EIS - Extreme Ultraviolet Imaging Spectrometer

XRT - X-Ray Telescope

SOT - Solar Optical Telescope

### LINKS:

<http://stp.gsfc.nasa.gov/missions/solar-b/solar-b.htm>

### VITAL FACTS

- Orbit Type: Sun-synchronous
- Altitude: 600 km
- Inclination: 97.7°
- Launch Date: September 2006
- Design Life: 3 years
- Measurements: Modulation of the Sun's Luminosity

### OWNER

- Japan, JAXA
- U.K., PPARC
- U.S., NASA

## Mission In Development

# **Commercial Partnerships**

# OrbView-1

ORBIMAGE's OrbView-1 was the world's first commercial imaging satellite. The satellite's miniaturized camera provided daily severe weather images and global lightning information during day and night operations. Its atmospheric monitoring instrument provided global meteorological data useful for improving long-term weather forecasts.

## **SENSORS:**

OTD - Optical Transient Detector

GPS Receiver - Global Positioning System Receiver

## **LINKS:**

[http://www.orbimage.com/corp/orbimage\\_system/ov1/](http://www.orbimage.com/corp/orbimage_system/ov1/)



## **VITAL FACTS**

- Orbit Type: Sun-synchronous
- Altitude: 740 km
- Inclination: 70°
- Launch Date: April 3, 1995
- Design Life: 2 years (exceeded)
- Measurements: Broad-area cloud-to-cloud lightning imagery, severe weather patterns

## **OWNER**

- U.S., ORBIMAGE

# OrbView-2

## OrbView- 2/Sea-viewing Wide Field-of-view Sensor

The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project provides quantitative data on global ocean bio-optical properties to the Earth science community. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants). The SeaWiFS Project will develop and operate a research data system that will process, calibrate, validate, archive, and distribute data received from an Earth-orbiting ocean color sensor.

### SENSORS:

SeaWiFS - Sea-viewing Wide Field-of-View Sensor

### LINKS:

<http://seawifs.gsfc.nasa.gov/SEAWIFS.html>

[http://www.orbimage.com/corp/orbimage\\_system\\_ov2/](http://www.orbimage.com/corp/orbimage_system_ov2/)



### VITAL FACTS

- Orbit Type: Sun-Synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: August 1, 1997
- Design Life:
- Measurements: Ocean color for monitoring plankton and sedimentation levels in the oceans and for assessing the health of land-based vegetation on a global basis.

OWNER  
• U.S., NASA



*Science Mission Directorate  
Earth-Sun System Division*



This booklet is part of a series of three booklets. Please read the Models & Analysis Systems booklet for more information on the individual Models and the Decision Support Tools booklet for more information on support tools.

These booklets are derived from the **Earth-Sun Science System Components Knowledge Base** which is available on-line at <http://www.asd.ssc.nasa.gov/m2m>

For more information please e-mail us at: [EarthScience@ssc.nasa.gov](mailto:EarthScience@ssc.nasa.gov)

<http://science.hq.nasa.gov>