Nimbus To Now The History Of Nasa Earth Observing Missions

Abstract:

-NASA has a long and successful history of developing, launching, and operating Earth-observing missions that have contributed significantly to our understanding of the planet.

-This challenge is create an engaging multimedia depiction of all NASA's Earth-observing missions that also demonstrates how the mission set evolved over time to include new technologies and meet science-driven needs.

Introduction:

-I will talk about all the missiles launched by NASA in the following details

-Satellite launch date from oldest to newest(1997-2031):

-This challenge will be divided into:

-Statue:

1. completed
2. Current, Extended Mission
3. Future, Implementation
4. Future, Formulation
5. Current, Prime Mission
6. Launch Failure
7. Eliminated
8. Current

-Mission Category

-Launch Date

-Launch Location

-Designed Life

-Actual Completion Date

-Project goals

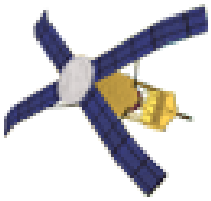
-Instruments

-Relevant Science Focus Areas

-Science Goals

Analyses:

Sea-viewing Wide Field-of-view Sensor (SeaWiFS) 1/8/1997



Status: Completed
Mission Category: Other
Launch Date: August 1, 1997
Launch Location: Vandenberg Air Force Base, CA
Designed Life: August 1, 2012
Actual Completion Date: December 11, 2010

Project goals:

The purpose of the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) mission was to provide quantitative data on global ocean bio-optical properties to the Earth science community. OrbView-2 (OV-2—formerly known as SeaStar) was the satellite system, developed by Orbital Science Corporation, that carried SeaWiFS. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications.

Instruments:

SeaWiFS (Sea-viewing Wide Field-of-view Sensor)

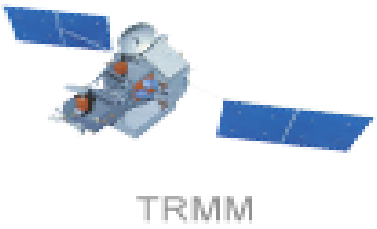
Relevant Science Focus Areas:

- Carbon Cycle, Ecosystems, and Biogeochemistry
- Climate Variability and Change
- Water and Energy Cycles

Science Goals:

The purpose of SeaWiFS data is to examine oceanic factors that affect global change and to assess the oceans’ role in the global carbon cycle, as well as other biogeochemical cycles. The SeaWiFS project aims to obtain accurate ocean color data from the world’s oceans, to process these data in conjunction with ancillary data into meaningful biological parameters, such as photosynthesis rates, and to make these data readily available to researchers.

Tropical Rainfall Measuring Mission (TRMM) 27/11/1997



Status: Completed
Mission Category: Precipitation Missions
Launch Date: November 27, 1997
Launch Location: Tanegashima Space Center, Japan
Designed Life: November 27, 2000

Project goals:

The Tropical Rainfall Measuring Mission (TRMM) is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA). It was designed 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.

Instruments:

- CERES (Clouds and Earth's Radiant Energy System)
- LIS (Lightning Imaging Sensor)
- PR (Precipitation Radar)
- TMI (TRMM Microwave Imager)
- VIRS (Visible and Infrared Scanner)

Relevant Science Focus Areas:

- Climate Variability and Change
- Water and Energy Cycles
- Weather

Science Goals:

- Obtain and study multiyear science data sets of tropical and subtropical rainfall measurements.
- Understand how interactions between the sea, air, and land masses produce changes in global rainfall and climate.
- Improve modeling of tropical rainfall processes and their influence on global circulation in order to predict rainfall and its variability at various periods of time.
- Test, evaluate, and improve satellite rainfall measurement techniques.

LANDSAT 7 15/4/1999

Status: Current, Extended Mission

Mission Category: Earth Observing System (EOS)

Launch Date: April 15, 1999

Launch Location: Vandenberg Air Force Base, CA

Project goals:

July 23, 2012, was the 40th anniversary of the launch of the first of a series of Landsat satellites that have continuously supplied the world with global land surface images. Landsat 5, launched in 1984, continues to provide important observations of the landmass of the planet and has established a record for reliability in the civilian satellite fleet. Landsat 7 joined Landsat 5 in April 1999. Both Landsat 5 and Landsat 7 provide data for remote sensing and Geographic Information System (GIS) science and applications around the world. NASA was responsible for the development and launch of Landsat 7 and the development of the ground system. The United States Geological Survey (USGS) is responsible for operating the satellite, distributing the data, and maintaining an archive of Landsat 7 and other remotely sensed data.

Instruments:

ETM+ (Enhanced Thematic Mapper Plus)

Relevant Science Focus Areas:

- Carbon Cycle, Ecosystems, and Biogeochemistry
- Earth Surface and Interio

Science Goals:

- Acquire sunlit, essentially cloud-free global seasonal coverage of Earth’s land masses.
- Provide well-calibrated radiometric and geometric data.
- Meet requirements for global-change research by providing imagery that are consistent with the acquisition geometry, spatial resolution, spectral characteristics, and calibration of previous Landsat data.

QUICK SCATTEROMETER (QUIKSCAT) 19/6/1999

QuikSCAT

Status: Completed
Mission Category: Earth Observing System (EOS)
Launch Date: June 19, 1999
Launch Location: Vandenberg Air Force Base, CA
Designed Life: June 19, 2002
Actual Completion Date: November 23, 2009

Project goals:

The Quick Scatterometer (QuikSCAT) acquired accurate, high-resolution, continuous, all-weather measurements of global (land, ice, and ocean) radar cross-sections and near-surface vector winds over the ice-free global oceans. The wind measurements are used for research investigations as well as in operational weather prediction. Radar cross-sections from land and ice-covered regions are used for vegetation classification/monitoring, cryospheric investigations, and operational ice-edge and iceberg detection and monitoring.

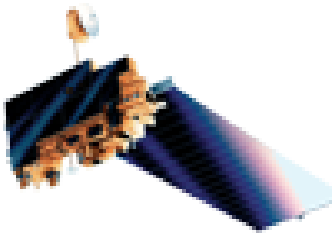
Instruments:

SeaWinds (Microwave Radar Instrument)

Relevant Science Focus Areas:

- Climate Variability and Change
- Weather

TERRA 18/12/1999



Terra

Status: Current, Extended Mission
Mission Category: Earth Observing System (EOS)
Launch Date: December 18, 1999
Launch Location: Vandenberg Air Force Base, CA
Designed Life: December 18, 2005

Project goals:

The Terra (formerly called EOS AM-1) satellite is the flagship of NASA's Earth Science Missions. Terra is the first EOS (Earth Observing System) platform and provides global data on the state of the atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another.

Instruments:

- ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer)
- CERES (Clouds and Earth's Radiant Energy System)
- MISR (Multiangle Imaging Spectroradiometer)
- MODIS (Moderate-Resolution Imaging Spectroradiometer)
- MOPITT (Measurements of Pollution in the Troposphere)

Relevant Science Focus Areas:

- Atmospheric Composition

- Carbon Cycle, Ecosystems, and Biogeochemistry
- Climate Variability and Change
- Earth Surface and Interior
- Water and Energy Cycles
- Weather

Science Goals:

- Provide the first global and seasonal measurements of the Earth system, including those of snow and ice, surface temperature, clouds, water vapor, land cover, and land and ocean biological productivity.
- Improve our ability to detect human impacts on the Earth system and climate, identify the ’fingerprint’ of human activity on climate, and predict climate change by using the new global observations in climate models.
- Help develop technologies for disaster prediction, characterization, and risk reduction from wildfires, volcanoes, floods, and droughts.
- Start long-term monitoring of global climate change and environmental change.

Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSAT) s20/12/1999

Status: Completed

Mission Category: Earth Observing System (EOS)

Launch Date: December 20, 1999

Launch Location: Vandenberg Air Force Base, CA

Project goals:

The Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSAT) was launched on December 20, 1999, as a secondary payload on a Taurus launch vehicle and carries the Active Cavity Radiometer Irradiance Monitor 3 (ACRIM3) instrument. The science mission began on April 5, 2000, following a period of on-orbit adjustment of the solar-pointing software on ACRIMSAT. The purpose of ACRIM3 is to study Total Solar Irradiance (TSI). ACRIM3, the third in a series of ACRIM solar-monitoring experiments built for NASA by the Jet Propulsion Laboratory (JPL), extends the database begun by ACRIM1, launched in 1980 on the Solar Maximum Mission (SMM) spacecraft, and continued by ACRIM2, launched on the Upper Atmosphere Research Satellite (UARS) in 1991. ACRIMSAT/ACRIM3 completed its five-year Minimum Mission in 2005.

NOTE :

In December 2013, ACRIMSAT suffered a mission-ending failure when its degrading batteries could no longer sustain operations. The spacecraft has not responded to ground commands since December 14, 2013. After several unsuccessful recovery attempts and extensive failure analysis, the mission was determined to be unrecoverable and officially terminated July 30, 2014.

Instruments:

ACRIM3 (Active Cavity Radiometer Irradiance Monitor)

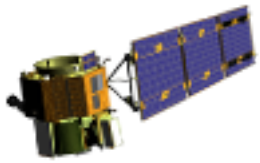
Relevant Science Focus Areas:

- Climate Variability and Change
- Weather Water and Energy Cycle

Science Goals:

- Extend the TSI observational database with maximum precision and traceability.
- With ACRIM3 results, relate past and future TSI databases using comparisons with the UARS/ACRIM2 experiment, the Solar Heliospheric Observatory (SOHO)/Variability of Solar Irradiance and Gravity Oscillations (VIRGO) experiment, and the Solar Radiation and Climate Experiment (SORCE)/Total Irradiance Monitor (TIM) experiment.
- Develop a composite TSI time series incorporating results from satellite TSI observations since 1978.
- Investigate the multidecadal upward TSI trend during solar cycles 21-23 using ACRIM3 observations of the solar activity minimum preceding cycle 24.
- Provide a redundant monitoring capability to prevent catastrophic loss of the TSI longterm database in the event of a SORCE/TIM experiment failure.

EARTH OBSERVING-1 (EO-1) 21/11/2000



EO-1

Status: Completed

Mission Category: Other

Launch Date: November 21, 2000

Launch Location: Vandenberg Air Force Base, CA

Actual Completion Date: March 30, 2017

Project goals:

The Earth Observing (EO-1) satellite was a one-year technology validation/demonstration mission designed to demonstrate new technologies and strategies for improved Earth observations; however, it has been extended beyond one year and still collects data. The satellite contains three observing instruments supported by a variety of newly developed space technologies.

Instruments:

- ALI (Advanced Land Imager)
- Hyperion (Hyperspectral Instrument)
- AC (Linear Etalon Imaging Spectral Array (LEISA) Atmospheric Corrector)

Relevant Science Focus Areas:

- Carbon Cycle
- Ecosystems
- Biogeochemistry
- Earth Surface and Interior

Science Goals:

- Validate and test new technologies that could provide significant cost reductions and improved performance for future Landsat missions.
- Provide a science-grade space-borne hyperspectral instrument, thus providing a new class of Earth observation data for improved Earth surface characterization.
- Provide the first space-based test of an onboard atmospheric corrector for increasing the accuracy of surface reflectance estimates.

JASON-1 7/12/2001

Status: Completed

Mission Category: Earth Observing System (EOS)

Launch Date: December 7, 2001

Launch Location: Vandenberg Air Force Base, CA

Actual Completion Date: July 1, 2013

Project goals:

The Jason spacecraft mapped ocean surface topography. The data collected provide information on ocean surface current velocity and heights which, when combined with ocean models, can lead to a four-dimensional description of ocean circulation. Data from Jason have also extended ocean surface topography into the 21st century, providing a 5-year view of global ocean surface topography, increasing understanding of ocean circulation, improving forecasting of climate events, and measuring global sea-level change.

Instruments:

- DORIS (Doppler Orbitography and Radio-positining Integrated by Satellite)
- GPSP (Global Positioning System Payload))/TRSR (Turbo Rogue Space Receiver)
- JMR (Jason Microwave Radiometer)
- LRA (Laser Retroreflector Array)
- Poseidon-2 altimete

Relevant Science Focus Areas:

- Climate Variability and Change
- Water and Energy Cycles

Science Goals:

- Determine general ocean circulation and understand its role in Earth's climate, particularly how ocean circulation impacts Earth's hydrological and biogeochemical cycles.
- Study the variation of ocean circulation, on time scales ranging from seasonal and annual to decadal, and how this variation impacts climate change.
- Collaborate with other global ocean-monitoring programs to produce routine models of the global ocean for scientific and operational applications.
- Study large-scale ocean tides.
- Study geophysical processes and their effects on ocean surface topography.

Stratospheric Aerosol and Gas Experiment-III Meteor-3M (SAGE-III) 12/10/2001

Status: Completed

Mission Category: Earth Observing System (EOS)

Launch Date: December 10, 2001

Launch Location: Baikonur Cosmodrome, Russia

Actual Completion Date: March 6, 2006

Project goals:

The third Stratospheric Aerosol and Gas Experiment (SAGE III) Meteor-3M was the EOS component of the Russian Meteor-3M mission. SAGE III provided accurate, long-term measurements of ozone, aerosols, water vapor, and other key parameters of Earth's atmosphere. Due to a power supply system failure, communication with the satellite was lost on March 6, 2006 and the SAGE III and Meteor-3M missions were terminated.

Instruments:

- SAGE III (Stratospheric Aerosol and Gas Experiment)

Relevant Science Focus Areas:

- Atmospheric Composition
- Climate Variability and Change

Science Goals:

- SAGE III provided global, long-term measurements of key components of Earth's atmosphere. It also provided measurements of temperature in the stratosphere and mesosphere. Through profiles of trace gases, such as water vapor and nitrogen dioxide, SAGE III investigated the significant role of these gases in atmospheric radiative and chemical processes.

GRAVITY RECOVERY AND CLIMATE EXPERIMENT (GRACE) 17/3/2002

Status: Completed
Mission Category: Earth System Science Pathfinder Program

Launch Date: March 17, 2002

Launch Location: Plesetsk Cosmodrome, Russia

Actual Completion Date: October 7, 2017

Project goals:

The Gravity Recovery and Climate Experiment (GRACE) mission enabled the most precise measurements of Earth's mean and time-variable gravity field ever obtained and has led to advances in the fields of hydrology (continental and regional water balance, monitoring changes in aquifers), oceanography (studying ocean currents, ocean heat flux, ocean bottom pressure, sea-level rise), and solid-Earth sciences.

Instruments:

- GPS (Black-Jack Global Positioning System Receiver)
- HAIRS (High-Accuracy Inter-satellite Ranging System)
- SCA (Star Camera Assembly)
- SSA (SuperStar Accelerometer)
- USO (Ultra Stable Oscillator)

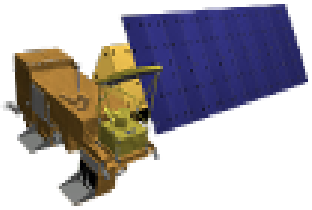
Relevant Science Focus Areas:

- Climate Variability and Change
- Earth Surface and Interior
- Water and Energy Cycles

Science Goals:

- Primary goal: Provide global, high-resolution estimates of the constant and time-variable part of Earth's gravity field, with unprecedented accuracy.
- Secondary goal: Measure several hundred global atmospheric profiles per day to determine how GPS measurements are distorted by Earth's atmosphere and ionosphere.

AQUA 4/5/2002



Aqua

Status: Current, Extended Mission

Mission Category: Earth Observing System (EOS), A-Train

Launch Date: May 4, 2002

Launch Location: Vandenberg Air Force Base, CA

Designed Life: May 4, 2008

Project goals:

Aqua is a major international Earth Science satellite mission centered at NASA. Launched on May 4, 2002, the satellite has six differrent Earth-observing instruments on board and is named for the large amount of information it collects about water in the Earth system. Aqua gathers this information from its stream of approximately 89 Gigabytes of data a day. The water variables being measured include almost all elements of the water cycle and involve water in its liquid, solid, and vapor forms. Additional variables being measured include radiative energy fluxes, aerosols, vegetation cover on the land, phytoplankton and dissolved organic matter in the oceans, and air, land, and water temperatures.

Instruments:

- AIRS (Atmospheric Infrared Sounder)
- AMSR-E (Advanced Microwave Scanning Radiometer for the Earth Observing System)
- AMSU-A (Advanced Microwave Sounding Unit-A)

- CERES (Clouds and the Earth's Radiant Energy System)
- HSB (Humidity Sounder for Brazil)
- MODIS (Moderate-Resolution Imaging Spectroradiometer)

Relevant Science Focus Areas:

- Atmospheric Composition
- Carbon Cycle, Ecosystems, and Biogeochemistry
- Climate Variability and Change
- Water and Energy Cycles
- Weather

Science Goals:

- Enhanced understanding of water in the Earth's climate system and the global water cycle.
- Enhanced understanding of additional components of the Earth's climate system and their interactions.
- Improved weather forecasting

SeaWinds on the Advanced Earth bserving Satellite II (ADEOS II) (SeaWinds) 13/12/2002

Status: Completed

Mission Category: Other

Launch Date: December 14, 2002

Launch Location: Tanegashima Space Center, Japan

Actual Completion Date: October 24, 2003

Project goals:

The SeaWinds scatterometer flew onboard the ADEOS II spacecraft. ADEOS II was an international satellite mission led by the Japan Aerospace Exploration Agency (JAXA) - formerly the National Space Development Agency (NASDA) of Japan - with U.S. (NASA) and French Centre Nationale d'Etudes Spatiales (CNES) participation. Midori-II is the Japanese name for the mission.

Instruments:

- AMR (Advanced Microwave Radiometer)
- GLI (Global Imager)
- ILAS II (Improved Limb Atmospheric Spectrometer II)
- POLDER (Polarization and Directionality of the Earth's Reflectance)
- SeaWinds (Microwave Radar Instrument)

Relevant Science Focus Areas:

- Climate Variability and Chang
- Weathe

Science Goals:

- Monitor the water and energy cycle as a part of the global climate system.
- Quantitatively estimate the biomass and fundamental productivity as a part of the carbon cycle, which plays an important role in global warming.
- Detect trends in long-term climate change as a result of continuing the observations started by ADEOS-I.

ICE, CLOUD, AND LAND ELEVATION SATELLITE (ICESAT)
12/1/2003

Status: Completed

Mission Category: Earth Observing System (EOS)

Launch Date: January 12, 2003

Launch Location: Vandenberg Air Force Base, CA

Actual Completion Date: August 14, 2010

Project goals:

ICESat (Ice, Cloud,and land Elevation Satellite) is the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics. From 2003 to 2009, the ICESat mission provided multi-year elevation data needed to determine ice sheet mass balance as well as cloud property information, especially for stratospheric clouds common over polar areas. It also provided topography and vegetation data around the globe, in addition to the polar-specific coverage over the Greenland and Antarctic ice sheets.

Relevant Science Focus Areas:

- Climate Variability and Change
- Earth Surface and Interior
- Water and Energy Cycles

Science Goals:

- Provide repeated, precision, polar ice sheet elevations through time for improved mass-balance measurements
- Provide atmosphere-cloud heights and aerosol distribution data
- Provide land topography and vegetation cover data

Solar Radiation and Climate Experiment (SORCE) 25/1/2003

Status: Completed

Mission Category: Earth Observing System (EOS)

Launch Date: January 25, 2003

Launch Location: Kennedy Space Center, Florida

Project goals:

Observations from the Solar Radiation and Climate (SORCE) satellite are improving our understanding of the Sun by generating new inquiry regarding how and why solar variability occurs and how it affects our atmosphere and climate. This knowledge is used to estimate past and future solar behavior and climate response.

Instruments:

- SIM (Spectral Irradiance Monitor)
- SOLSTICE (Solar Stellar Irradiance Comparison Experiment)
- TIM (Total Irradiance Monitor)
- XPS (XUV Photometer System)

Relevant Science Focus Areas:

- Atmospheric Composition
- Climate Variability and Change
- Water and Energy Cycles

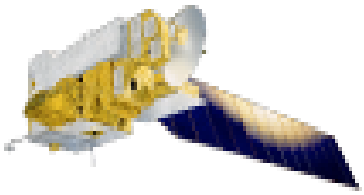
Science Goals:

- SORCE is part of the NASA Earth Observing System of satellites, a series of satellite missions designed to monitor the Earth system from space. These sustained and comprehensive observations include the measurement of solar irradiance as the dominant direct energy input to land, ocean, and atmosphere. As an integral part of this, the SORCE mission aims to:
- Make precise and accurate measurements of the total solar irradiance (TSI). These observations are connected to previous TSI measurements to form a long-term record of solar influences on Earth.
- Establish a precise data set of visible and near infrared solar spectral irradiance (SSI) measurements suitable for future climate studies.
- Compare daily measurements of solar ultraviolet irradiance with bright, early-type stars for in-flight calibration and correction of possible changes in the instrument responsivity.

AURA 15/7/2004

Status: Current, Extended Mission

Mission Category: Earth Observing System (EOS), A-Train



Aura

Launch Date: July 15, 2004

Launch Location: Vandenberg Air Force Base, CA

Designed Life: July 15, 2010

Project goals:

Aura's four instruments study the atmosphere's chemistry and dynamics. Aura's measurements enable us to investigate questions about ozone trends, air-quality changes and their linkage to climate change. Aura's measurements also provide accurate data for predictive models and useful information for local and national agency decision-support systems.

Instruments:

- HIRDLS (High-Resolution Dynamics Limb Sounder)
- MLS (Microwave Limb Sounder)
- OMI (Ozone Monitoring Instrument)
- TES (Tropospheric Emission Spectrometer)

Relevant Science Focus Areas:

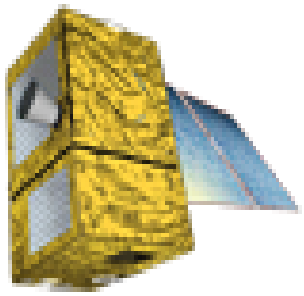
- Atmospheric Composition

- Climate Variability and Change
- Weather

Science Goals:

- The Aura mission seeks to answer three main science questions: Is the stratospheric ozone layer recovering? What are the processes controlling air quality? How is Earth's climate changing?

Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar (PARASOL) 4/12/2004



PARASOL

Status: Completed

Mission Category: A-Train

Launch Date: December 4, 2004

Launch Location: Kourou, French Guiana

Designed Life: December 4, 2006

Actual Completion Date: December 18, 2013

Project goals:

The French Space Agency CNES launched the Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar (PARASOL) spacecraft into the A-Train orbit in December 2004. Originally designed to be a 2-year mission, PARASOL flew within ~30 seconds of the CALIPSO and CloudSat satellites. In early December 2009, the PARASOL satellite orbit was lowered under the A-train, which enabled it to keep sharing data periodically with the A-train members. On November 16, 2011, PARASOL was lowered to 9.5 km under the A-Train and continues its nominal mission observing clouds and aerosols. PARASOL fully exited the A-Train and ceased operation on December 18, 2013. PARASOL made measurements of the total and polarized light in several wavelengths and at several different viewing angles. PARASOL's Polarization and Directionality of the Earth's Reflectances (POLDER) instrument cycled through eight narrow wavelength bands and, for certain wavelengths, sampled three distinct polarizations. All of these data are combined to

provide a thorough assessment of the state of the light reflected by the coupled surface-atmosphere system.

Instruments:

- POLDER (Polarization and Directionality of the Earth's Reflectance)

Relevant Science Focus Areas:

- Atmospheric Composition
- Carbon Cycle, Ecosystems, and Biogeochemistry
- Climate Variability and Change
- Water and Energy Cycles

CloudSat 27/4/2006

CloudSat

Status: Current, Extended Mission

Mission Category: Earth System Science Pathfinder Program, A-Train

Launch Date: April 28, 2006

Launch Location: Vandenberg Air Force Base, CA

Designed Life: April 28, 2009

Project goals:

CloudSat is studying clouds in detail to better characterize the role they play in regulating Earth's climate. CloudSat is providing the first direct, global survey of the vertical structure and overlap of cloud systems and their liquid and ice-water contents. Data returned should lead to improved cloud representations in atmospheric models, which should help improve the accuracy of weather forecasts and climate predictions made using these models.

Instruments:

- CPR (Cloud Profiling Radar)

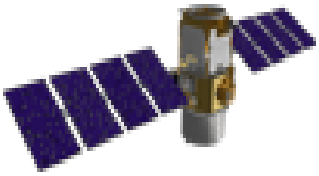
Relevant Science Focus Areas:

- Climate Variability and Change
- Weather Water and Energy Cycle

Science Goals:

- Profile the vertical structure of clouds: Understanding the vertical structure of clouds is fundamentally important to improving our understanding of how clouds affect both the local and large-scale environment.
- Measure the profiles of cloud liquid water and ice water content: These two quantities-predicted by cloud process and global scale models alike-determine practically all other cloud properties, including precipitation and cloud optical properties.
- Measure profiles of cloud optical properties: These measurements, when combined with water and ice content information, provide critical tests of key cloud process parameterizations and enable the estimation of flux profiles and radiative heating rates through the atmospheric column.

Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) 27/4/2006



CALIPSO

Status: Current, Extended Mission

Mission Category: Earth System Science Pathfinder Program, A-Train

Launch Date: April 28, 2006

Launch Location: Vandenberg Air Force Base, CA

Project goals:

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) spacecraft is a joint U.S. (NASA) / French (Centre National d'Etudes Spatiales/CNES) mission. Observations from spaceborne lidar, combined with passive imagery, will lead to improved understanding of the role aerosols and clouds play in regulating the Earth's climate, in particular, how aerosols and clouds interact with one another.

Relevant Science Focus Areas:

- Atmospheric Composition
- Climate Variability and Change
- Water and Energy Cycles
- Weather

Ocean Surface Topography Mission/Jason-2 (OSTM/Jason-2) 20/6/2008

OSTM/Jason-2

Status: Completed

Mission Category: Other

Launch Date: January 20, 2008

Launch Location: Vandenberg Air Force Base, CA

Actual Completion Date: October 1, 2019

Project goals:

The Ocean Surface Topography Mission (OSTM), a continuation of the TOPEX/Poseidon and Jason missions, is based on the science and pre-operational returns of these two missions and will support global and regional operational applications. Like its predecessors, OSTM will map ocean surface topography and the data collected will provide information on ocean surface current velocity and heights which, when combined with ocean models, can lead to a four-dimensional description of ocean circulation. Data from OSTM will extend the time series of ocean surface topography measurements for detecting previously unknown changes on decadal scales, increase understanding of ocean circulation, improve forecasting of climate events, and measure global sea level change.

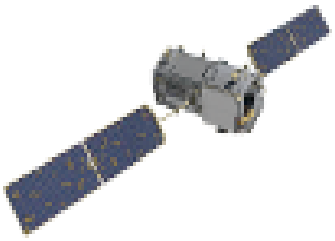
Relevant Science Focus Areas:

- Climate Variability and Change
- Water and Energy Cycles

Science Goals:

- OSTM will continue to meet the following science goals of the ocean surface topography effort:
- Determine general ocean circulation and understand its role in Earth's climate, particularly how ocean circulation impacts Earth's hydrological and biogeochemical cycles.
- Study the variation of ocean circulation on time scales ranging from seasonal and annual to decadal and examine how this variation impacts climate change.
- Collaborate with other global ocean-monitoring programs to produce routine models of the global ocean for scientific and operational applications.
- Study large-scale ocean tides.
- Study geophysical processes and their effects on ocean surface topography.

Orbiting Carbon Observatory (OCO) 24/2/2009



OCO

Status: Other

Mission Category: Earth System Science Pathfinder Program

Launch Date: February 24, 2009

Launch Location: Vandenberg Air Force Base, CA

Actual Completion Date: February 24, 2009

Project goals:

The Orbiting Carbon Observatory (OCO) was designed to provide space-based global measurements of atmospheric carbon dioxide (CO2) with the precision and resolution needed to identify and characterize the processes that regulate this important greenhouse gas. With its three high-resolution grating spectrometers, data collected by OCO could be combined with meteorological observations and ground-based CO2 measurement to help characterize CO2 sources and sinks on regional scales at monthly intervals for 2 years.

Instruments:

- Three high-resolution grating spectrometers

Relevant Science Focus Areas:

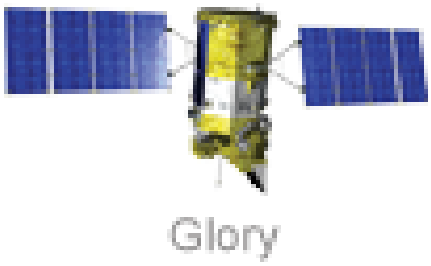
- Atmospheric Composition

- Carbon Cycle, Ecosystems, and Biogeochemistry

Science Goals:

- Improve our understanding of the geographic distribution of CO2 sources and sinks (surface fluxes) and the processes controlling their variability on seasonal time scales. Validate a passive spectroscopic measurement approach and analysis concept that is well suited for future systematic CO2 monitoring missions.
- Validate a passive spectroscopic measurement approach and analysis concept that is well suited for future systematic CO2 monitoring missions.

GLORY 4/3/2011



Status: Other

Mission Category: A-Train

Launch Date: March 4, 2011

Launch Location: Vandenberg Air Force Base, CA

Actual Completion Date: March 4, 2011

Project goals:

The Glory satellite consists of a spacecraft bus and three instruments and will be launched from the Vandenberg Air Force Base aboard a Taurus 2110 launch vehicle. Glory's remote sensing mission is designed to:

1) collect data on the optical, microphysical, and chemical properties, and spatial and temporal distributions of aerosols and clouds; and

2) continue the long-term total solar irradiance climate record.

Instruments:

- APS (Aerosol Polarimetry Sensor)
- CC (Cloud Camera)
- TIM (Total Irradiance Monitor)

Relevant Science Focus Areas:

- Atmospheric Composition
- Carbon Cycle, Ecosystems, and Biogeochemistry
- Climate Variability and Change
- Water and Energy Cycle

Science Goals:

- Use data collected on the optical, microphysical, and chemical properties of aerosols and clouds to analyze aerosols and aerosol-cloud interactions.
- Measure total solar irradiance for long-term climate studies.

AQUARIUS 10/6/2011

Aquarius

Status: Completed

Mission Category: Earth System Science Pathfinder Program

Launch Date: June 10, 2011

Launch Location: Vandenberg Air Force Base, CA

Actual Completion Date: June 8, 2015

Project goals:

The Aquarius/Satélite de Aplicaciones Científicas (SAC)-D satellite observatory, was an international collaboration between NASA and Argentina's space agency, Comisión Nacional de Actividades Espaciales (CONAE), with participation from Brazil, Canada, France and Italy.

The mission ended June 8 when an essential part of the power and attitude control system for the SAC-D spacecraft, which carries NASA's Aquarius instrument, stopped operating. The Aquarius instrument successfully achieved its science objectives and completed its primary three-year mission in November 2014.

Aquarius was a pathfinder mission to demonstrate that accurate, scientifically-significant measurements of salinity could be made from space. It was also the first mission to combine use of passive (radiometer) and active (radar) measurements at L-band.

The instrument's surface salinity measurements are contributing to a better understanding of ocean dynamics and advancing

climate and ocean models, both from season to season and year to year. These models still are improving El Niño prediction. Aquarius global salinity maps are revealing how freshwater plumes coming from the mouth of large rivers and the precipitation and evaporation over the oceans affect the salinity structure of the ocean.

Salinity information is critical to improving our understanding of two major components of Earth's climate system: the water cycle and ocean circulation. By measuring ocean salinity from space, Aquarius provided new insights into the massive natural exchange of freshwater between the ocean, atmosphere and sea ice, which – in turn – influences ocean circulation, weather and climate.

Data from Aquarius revealed how extreme floods impact our seas and how low-salinity river plumes affect hurricane intensity. Aquarius data also were integral to the Salinity Processes in the Upper Ocean Regional Study (SPURS), a year-long international field study of the oceanographic processes that sustain the maximum surface salinities in the central subtropical North Atlantic, and influence global ocean circulation.

Instruments:

- L-band radiometer
- L-band scatterometer

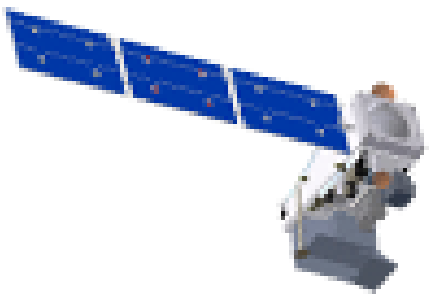
Relevant Science Focus Areas:

- Climate Variability and Change
- Water and Energy Cycles

Science Goals:

- Observe and model the processes that relate salinity variations to climatic changes in the global cycling of water.
- Understand how these salinity variations influence the general ocean circulation.

Suomi National Polar-orbiting Partnership (Suomi NPP) 28/10/2011



Suomi NPP

Status: Current, Extended Mission

Mission Category: Inter-Agency Partnerships

Launch Date: October 28, 2011

Launch Location: Vandenberg Air Force Base, CA

Project goals:

The Suomi National Polar-orbiting Partnership (Suomi NPP) is a joint mission to extend key measurements in support of long-term monitoring of climate trends and of global biological productivity. It extends the measurement series initiated with EOS Terra and AQUA by providing a bridge between NASA's EOS missions and the Joint Polar Satellite System (JPSS). JPSS is the civilian component of the former National Polar-orbiting Operational Environmental Satellite System (NPOESS), which was reorganized by the administration in 2010.

The Suomi NPP mission will provide operational agencies early access to the next generation of sensors, thereby greatly reducing the risks incurred during the transition. This will permit testing of the advanced ground operations facilities and validation of sensors and algorithms while the current operational systems are still in place. This new system will provide nearly an order of magnitude more data than the current operational system.

JPSS will provide long-term systematic measurements of key environmental variables beginning about 2016. In preparation for

this system, Suomi NPP will provide risk reduction for this future operational system and it will maintain continuity of certain environmental data sets that were initiated with NASA's Terra and Aqua satellites. These measurements will be taken by five different sensors; Visible Infrared Imaging spectroRadiometer Suite (VIIRS), Crosstrack Infrared Sounder (CrIS), and Advanced Technology Microwave Sounder (ATMS), Ozone Mapping and Profiling Suite (OMPS) and the Clouds and the Earth's Radiant Energy System (CERES). These sensors will collect data on atmospheric and sea surface temperatures, humidity soundings, land and ocean biological productivity, cloud and aerosol properties, ozone and ozone profiles, and Earth radiation budget measurements. This data will be used for long-term climate and global change studies.

NASA announced on January 25 at the American Meteorological Society annual meeting that the NPP mission has been renamed the Suomi National Polar-orbiting Partnership, or Suomi NPP, in honor of the late Verner Suomi, a pioneer of satellite meteorology.

Instruments:

- ATMS (Advanced Technology Microwave Sounder)
- CERES (Clouds and Earth's Radiant Energy System)
- CrIS (Cross-Track Infrared Sounder)
- OMPS (Ozone Mapping and Profiler Suite)
- VIIRS (Visible/Infrared Imager/Radiometer Suite)

Relevant Science Focus Areas:

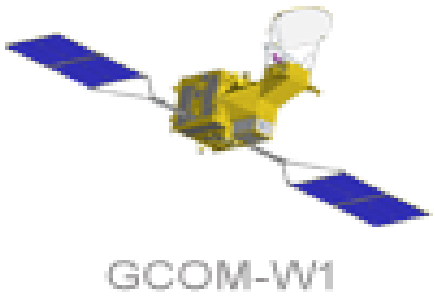
- Atmospheric Composition
- Carbon Cycle, Ecosystems, and Biogeochemistry
- Climate Variability and Change
- Water and Energy Cycle
- Weather

Science Goals:

- Suomi NPP will provide NASA with continuation of a set of global-change observations initiated by the EOS Terra, Aqua, and Aura missions. The observations will contribute to the Systematic Measurements element of NASA's Earth Science Enterprise (ESE). Research Strategy for 2000-2010. The

systematic measurements will be used in the development of consistent, long-term data records from multi-instrument, multi-platform, and multi-year observations, with due attention to calibration and validation. In that context, Suomi NPP's Environmental Data Records (EDRs), similar to EOS Level 2 swath products, will be generated in near-real time in NPOESS production facilities. NASA will help validate and enhance the algorithms, driving them toward science-grade quality where possible. NPP also serves as a risk-reduction demonstration for key aspects of NPOESS, the nation's future polar-orbiting operational satellite system. Together, Suomi NPP's objectives will allow NASA science programs to transition their systematic observation requirements from research grade missions to NPOESS and other operational missions.

The Global Change Observation Mission-Water (GCOM-W1) 18/5/2012



Status: Current

Mission Category: A-Train

Launch Date: May 18, 2012

Project goals:

Japan Aerospace Exploration Agency (JAXA) mission (No NASA contribution)

The “Global Change Observation Mission” (GCOM) aims to construct, use, and verify systems that enable continuous global-scale observations (for 10 to 15 years) of effective geophysical parameters for elucidating global climate change and water circulation mechanisms.

Water circulation changes will be observed by a microwave radiometer onboard the GCOM-W (Water) satellite (scheduled to be launched in Japan Fiscal Year 2012). The GCOM-W will observe precipitation, vapor amounts, wind velocity above the ocean, sea water temperatures, water levels on land areas and snow depths.

Instruments:

- AMSR2 (Advanced Microwave Scanning Radiometer 2)

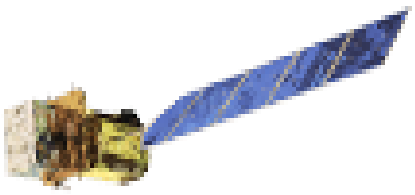
Relevant Science Focus Areas:

- Atmospheric Composition
- Climate Variability and Change
- Water and Energy Cycle
- Weather

Science Goals:

- Enhanced understanding of water in the Earth's climate system and the global water cycle.
- Enhanced understanding of additional components of the Earth's climate system and their interactions.
- Improved weather forecasting.

LANDSAT 8 11/2/2013



Landsat 8

Status: Current, Extended Mission

Mission Category: Earth Systematic Missions Program, Inter-Agency Partnerships

Launch Date: February 11, 2013

Launch Location: Vandenberg Air Force Base, CA

Designed Life: February 11, 2018

Project goals:

Landsat 8 (previously named the Landsat Data Continuity Mission) is a joint NASA/U.S. Geological Survey (USGS) mission and is the eighth satellite in the Landsat series. The observatory consists of the spacecraft bus and its play load of two Earth-observing sensors, the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). OLI and TIRS collect data jointly to provide coincident images of the global and surface including coastal regions, polar ice, islands, and the continental areas. In addition, Landsat 8 follows the same sequence of fixed ground tracks as the Landsat 4, Landsat 5, and Landsat 7 satellites. This allows all the science data from Landsat 8 to be referenced to the same coordinate system, continuing the decades-long data record. The Landsat Program provides repetitive acquisition of high resolution multispectral data of the Earth's surface on a global basis. The data from the Landsat spacecraft constitute the longest record of the Earth's continental surfaces as seen from space. It is a record unmatched in quality, detail, coverage, and value. NASA and the USGS jointly manage the Landsat Program.

Instruments:

- Operational Land Imager
- Thermal Infrared Sensor

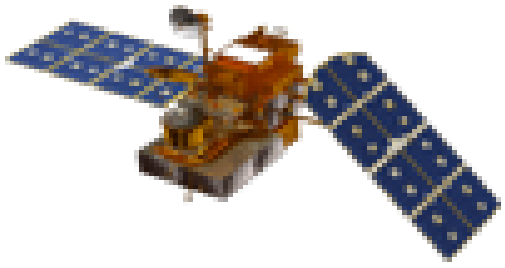
Relevant Science Focus Areas:

- Carbon Cycle, Ecosystems, and Biogeochemistry
- Earth Surface and Interior

Science Goals:

- Characterize and monitor land-cover use and change over time for global climate research, polar studies, land use and land cover change, and the impacts of natural events as well as human activities on Earth's surface.

Global Precipitation Measurement Core Observatory (GPM Core) 27/2/2014



GPM Core

Status: Current, Extended Mission

Mission Category: Precipitation Missions

Launch Date: February 27, 2014

Launch Location: Tanegashima Space Center, Japan

Designed Life: February 27, 2017

Project goals:

The Global Precipitation Measurement (GPM) mission is an international partnership co-led by NASA and the Japan Aerospace Exploration Agency (JAXA). The mission centers on the deployment of the GPM Core Observatory and consists of a network, or constellation, of additional satellites that together will provide next-generation global observations of precipitation from space. The GPM Core mission builds on the success of the Tropical Rainfall Measuring Mission (TRMM) and provides more accurate, frequent (3-hourly), global, high spatial resolution, and microphysically detailed measurements of precipitation. The GPM Core Observatory improves upon the capabilities of its predecessor, the TRMM satellite, with advanced precipitation instruments and expanded coverage of Earth's surface. The GPM Core carries two instruments: the GPM Microwave Imager (GMI) and Dual-frequency Precipitation Radar (DPR). These instruments collect improved observations that allow scientists to better "see" inside clouds. The GMI has the capability to measure the amount, size, intensity and type of precipitation, from heavy-to-moderate rain to light rain and snowfall. The DPR returns three-dimensional profiles and intensities of liquid and solid precipitation. These data allow scientists to see the internal structure of storms within and below clouds.

Instruments:

- DPR (Dual-frequency Precipitation Radar)
- GMI (GPM Microwave Imager)

Relevant Science Focus Areas:

- Climate Variability and Change
- Water and Energy Cycles
- Weather

Science Goals:

- Climate Prediction-Improve climate prediction through progress in quantifying space-time variability of precipitation along with improvements in achieving water budget closure, plus focused research on relationships between precipitation and climate variations.

- Weather Prediction-Improve the accuracy of global and regional numerical weather prediction models through accurate and precise measurements of instantaneous rain rates, made frequently and with global distribution, plus focused research on more advanced techniques in satellite rainfall data assimilation.
- Flood/Fresh Water Resource Prediction-Improve flood and fresh water resource prediction through frequent sampling and complete Earth coverage of high-resolution precipitation measurements, plus focused research on more innovative designs in hydro-meteorological modeling.

Orbiting Carbon Observatory 2 (OCO-2) 2/7/2014

Status: Current, Extended Mission

Mission Category: Earth System Science Pathfinder Program, A-Train

Launch Date: July 2, 2014

Launch Location: Vandenberg Air Force Base, CA

Designed Life: July 2, 2019

Project goals:

The second Orbiting Carbon Observatory (OCO-2) mission is designed to provide space-based global measurements of atmospheric carbon dioxide with the precision and resolution needed to identify and characterize the processes that regulate this important greenhouse gas. With its three high-resolution grating spectrometers, data collected by OCO-2 could be combined with meteorological observations and ground-based carbon dioxide measurement to help characterize carbon dioxide sources and sinks on regional scales at monthly intervals for 2 years.

Instruments:

- Three high-resolution grating spectrometers

Relevant Science Focus Areas:

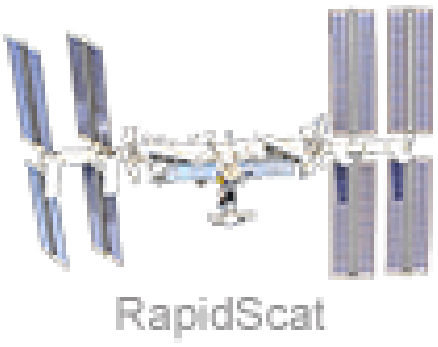
- Carbon Cycle, Ecosystems, and Biogeochemistry

- Earth Surface and Interior

Science Goals:

- Improve our understanding of the geographic distribution of CO2 sources and sinks (surface fluxes) and the processes controlling their variability on seasonal time scales.
- Validate a passive spectroscopic measurement approach and analysis concept that is well suited for future systematic CO2 monitoring missions.

ISS-RAPID SCATTEROMETER (ISS-RAPIDSCAT) 20/9/2014



Status: Completed

Mission Category: Other

Launch Date: September 21, 2014

Launch Location: Cape Canaveral Air Force Station

Actual Completion Date: October 17, 2016

Project goals:

The primary goal of the Rapid Scatterometer (RapidScat) was to provide a gap-filler ocean vector winds measurement capability to mitigate the loss of the NASA Quick Scatterometer (QuikSCAT). Scatterometers are radar instruments that can measure near-surface wind speed and direction over the ocean, and have proved to be extremely valuable for weather forecasting, including hurricane monitoring, and for monitoring large-scale changes in the Earth's climate, such as El Niño. The RapidScat instrument was be mounted on the International Space Station (ISS) and provided wind measurements that enhance the international scatterometer constellation, providing unique cross-calibration capabilities to extend the climate data record initiated by the QuikSCAT satellite. In addition, because of the unique orbit characteristics of the ISS, RapidScat enabled the first measurements of the systematic diurnal changes of winds over the ocean.

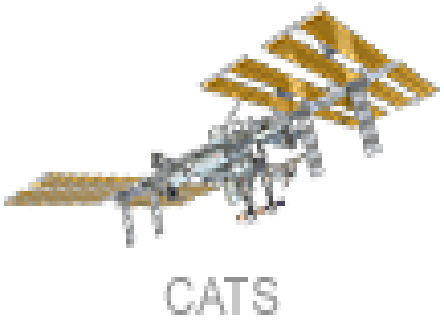
Instruments:

- Rapid Scatterometer

Science Goals:

- To provide ocean vector wind data for a period of two years to mitigate the loss of QuikSCAT to scientists and weather forecasters.
- To serve as a calibration standard to the international scatterometer constellation, enabling the continuation of the QuikSCAT data record, and enabling monitoring of climate variability and change over multiple decades.
- To study the systematic variation of ocean winds as a function of time of day. These variations are important in understanding the dynamics and interactions of the ocean and atmosphere in the tropics, where current climate models still exhibit shortcomings, and which play a significant role in governing the Earth's energy and water budgets.

Cloud-Aerosol Transport System on ISS (CATS on ISS) 10/1/2015



Status: Completed

Mission Category: Other

Launch Date: January 10, 2015

Launch Location: NASA's Kennedy Space Center

Designed Life: January 10, 2018

Actual Completion Date: November 14, 2017

Project goals:

The Cloud-Aerosol Transport System (CATS) investigation used a remote sensing, light detection and ranging (LiDAR), instrument designed to provide measurements of the particulate contents within the atmosphere including clouds and aerosols. The CATS instrument used a laser to provide data on the location, composition, and distribution of atmospheric constituents which impact the climate on a global scale. Obtaining a better understanding of cloud and aerosol coverage and properties is critical for understanding and modeling of the Earth system and associated climate feedback processes.

CATS was an attached payload on the Japanese Experiment Module Exposed Facility, or JEM-EF onboard the International Space Station (ISS). The CATS project was not a "business as usual" project - it was specifically intended to demonstrate a low-cost, streamlined approach to developing ISS science payloads.

The CATS instrument was funded by the International Space Station NASA Research Office with supplemental funding for research from NASA's Earth Science Division.

Instruments:

- LIDAR

Science Goals:

- Provide near-real-time measurements of clouds and aerosols that can be assimilated into aerosol transport models
- Provide on-orbit tech demo for high rep-rate laser, photon-counting detection, and 355 nm laser operation in-space
- Provide risk reduction for future Earth Science missions
- Provide long-term (6 months to 3 years) operational science from ISS

Soil Moisture Active-Passive (SMAP) 31/1/2015

Status: Current, Extended Mission

Mission Category: Earth Systematic Missions Program, Decadal Survey 2007

Launch Date: January 31, 2015

Launch Location: Vandenberg Air Force Base

Designed Life: May 31, 2018

Project goals:

The Soil Moisture Active-Passive (SMAP) mission uses a combined radiometer and high-resolution radar to measure surface soil moisture and freeze-thaw state. Direct measurements of soil moisture and freeze/thaw state are needed to improve our understanding of regional water cycles, ecosystem productivity, and processes that link the water, energy, and carbon cycles. Soil moisture information at high resolution enables improvements in weather, flood, and drought forecasts, and predictions of agricultural productivity and climate change.

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO) has developed a tri-agency set of requirements for the next generation of polar-orbiting operational environmental satellites. A novel approach combining radar-radiometer and L-band mapping of global soil moisture will allow SMAP to far exceed the NPOESS soil moisture threshold (minimum performance) requirements for sensing depth and spatial resolution.

With “fast-track” development, it is possible that SMAP could provide critical gap-filling soil moisture measurements for NPOESS, which were lost when the Conical Microwave Imager/Sounder was cancelled from the first NPOESS platform.

Instruments:

- L-band Radar
- L-band radiometer

Deep Space Climate Observatory (DSCOVR) 11/2/2015

DSCOVR

Status: Current, Extended Mission

Mission Category: Inter-Agency Partnerships

Launch Date: February 11, 2015

Launch Location: Cape Canaveral Air Force Station

Designed Life: February 11, 2017

Project goals:

The Deep Space Climate Observatory, or DSCOVR, is a spacecraft which will orbit between Earth and the sun, observing and providing advanced warning of particles and magnetic fields emitted by the sun (known as the solar wind) which can affect power grids, communications systems, and satellites close to Earth. From its post at the Lagrange point 1 (or L1), approximately one million miles from Earth. DSCOVR will also observe our planet and provide measurements of the radiation reflected and emitted by Earth and images of the sunlit side of Earth for science applications.

The DSCOVR mission is a partnership between NOAA, NASA and the U.S. Air Force and will be operated by NOAA.

NASA, using NOAA funds, refurbished the DSCOVR satellite and instruments, which had been in storage for several years. NASA is

also developing the ground system to be used to operate the DSCOVR satellite. The U.S. Air Force is providing the SpaceX Falcon 9 launch vehicle for DSCOVR mission.

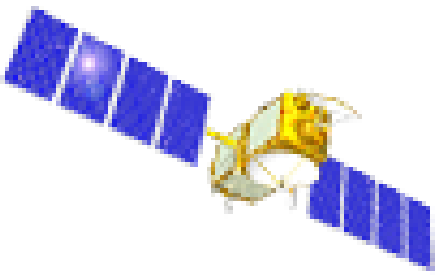
Instruments:

- Plasma-Magnetometer (PlasMag)
- National Institute of Standards and Technology Advanced Radiometer (NISTAR)
- Earth Polychromatic Imaging Camera (EPIC)

Relevant Science Focus Areas:

- Solar wind activity
- Reflected and emitted radiation from the entire sunlit face of the Earth
- Ozone amounts, aerosol amounts, cloud height and phase, vegetation properties, hotspot land properties and UV radiation estimates at Earth's surface

JASON-3 17/1/2016



Jason-3

Status: Current

Mission Category: Inter-Agency Partnerships

Launch Date: January 17, 2016

Launch Location: Vandenberg Air Force Base, CA

Project goals:

Jason-3 is the fourth mission in U.S.-European series of satellite missions that measure the height of the ocean surface. Launched on January 17, 2016, the mission will extend the time series of ocean surface topography measurements (the hills and valleys of the ocean surface) begun by the TOPEX/Poseidon satellite mission in 1992 and continuing through the Jason-1 (launched in 2001) and the currently operating OSTM/Jason-2 (launched in 2008) missions. These measurements provide scientists with critical information about circulation patterns in the ocean and about both global and regional changes in sea level and the climate implications of a warming world.

The primary instrument on Jason-3 is a radar altimeter. The altimeter will measure sea-level variations over the global ocean with very high accuracy (as 1.3 inches or 3.3 centimeters, with a goal of achieving 1 inch or 2.5 centimeters). Continual, long-term, reliable data of changes in ocean surface topography will be generated and will be used by

scientists and operational agencies (NOAA, European weather agencies, marine operators, etc.) for scientific research and operational oceanography for the benefit of society.

TOPEX/Poseidon and Jason-1 were cooperative missions between NASA and the French space agency, CNES. Additional partners in the Jason-2 mission included NOAA and Eumetsat. Jason-3 continues the international cooperation, with NOAA and Eumetsat leading the efforts, along with partners NASA and CNES.

Instruments:

- Altimeter
- Microwave radiometer
- DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite)
- Laser Retroreflector Array (LRA)
- Global Positioning System (GPS) receiver

Relevant Science Focus Areas:

- Climate Variability and Change

- Water and Energy Cycles

Science Goals:

- Jason-3 will continue to meet the following science goals of the ocean surface topography effort
- Determine general ocean circulation and understand its role in Earth's climate, particularly how ocean circulation impacts Earth's hydrological and biogeochemical cycles.
- Study the variation of ocean circulation on time scales ranging from seasonal and annual to decadal and examine how this variation impacts climate change.
- Collaborate with other global ocean-monitoring programs to produce routine models of the global ocean for scientific and operational applications.
- Study large-scale ocean tides.
- Study geophysical processes and their effects on ocean surface topography.

Stratospheric Aerosol and Gas Experiment III on ISS (SAGE III-ISS) 19/2/2017

ISS-SAGE III

Status: Current, Prime Mission

Mission Category: Earth Systematic Missions Program

Launch Date: February 19, 2017

Launch Location: Cape Canaveral Air Force Station

Project goals:

The SAGE III instrument is used to study ozone, a gas found in the upper atmosphere that acts as Earth's sunscreen. More than 25 years ago, scientists realized there was a problem with Earth's thin, protective coat of ozone...it was thinning. The SAGE family of instruments was pivotal in making accurate measurements of the amount of ozone loss in Earth's atmosphere. SAGE has also played a key role in measuring the onset of ozone recovery resulting from the internationally mandated policy changes that regulated chlorine-containing chemicals, the Montreal Protocol, which was passed in 1987.

Today, the SAGE technique is still the best for the job, and NASA scientists are preparing to send the third generation of the instrument into space. However, not just any spacecraft will do for SAGE III. Scientists have been keeping it safe, waiting for the day that it could go where no continuous Earth-observing instrument has gone before – the International Space Station (ISS).

Instead of flying on an un-manned satellite, SAGE III will be mounted to the ISS where it will operate alongside experiments from all over the world in the space-based laboratory. The orbital path of ISS will help maximize the scientific value of SAGE-III observations while proving that atmospheric science instruments do have a place on the space station.

Instruments:

- SAGE III (Stratospheric Aerosol and Gas Experiment)

Relevant Science Focus Areas:

- Atmospheric Composition
- Climate Variability and Change

Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) 22/5/2018

Status: Current, Prime Mission

Mission Category: Earth Systematic Missions Program, Decadal Survey 2007

Launch Date: May 22, 2018

Launch Location: Vandenberg Air Force Base

Project goals:

Changes in how mass is distributed within and between Earth's atmosphere, oceans, groundwater and ice sheets are fundamental indicators of the large-scale dynamics of the planet. For more than 15 years, NASA's Gravity Recovery and Climate Experiment (GRACE) mission monitored mass changes every month with far-reaching impact on our understanding of the Earth system and how it is evolving. GRACE Follow-On (GRACE-FO) continues the legacy of GRACE, tracking Earth's water movement and surface mass changes across the planet. Monitoring changes in ice sheets and glaciers, near-surface and underground water storage, the amount of water in large lakes and rivers, as well as changes in sea level and ocean currents provides an integrated global view of how Earth's water cycle and energy balance are evolving—measurements that have important applications for everyday life.

on the space station.

Instruments:

- GRACE-FO uses a Microwave Instrument (MWI), which is a microwave ranging system based on global positioning system (GPS) technology, and a very sensitive accelerometer (an instrument that measures the forces on the satellites besides gravity).GRACE-FO will also have an experimental instrument called the Laser Ranging Interferometer (LRI).

Relevant Science Focus Areas:

- Climate Variability and Change
- Earth Surface and Interior
- Water and Energy Cycles

ECOSYSTEM SPACEBORNE THERMAL RADIOMETER EXPERIMENT ON SPACE STATION (EVI-2) (ECOSTRESS) 29/6/2018

Status: Current, Extended Mission

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Instrument

Launch Date: June 29, 2018

Project goals:

The ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) will address critical questions on plant–water dynamics and future ecosystem changes with climate through an optimal combination of thermal infrared (TIR) measurements over the diurnal cycle for a wide range of biomes with high spatiotemporal resolution from the International Space Station. ECOSTRESS will fill a key gap in our observing capability, advance core NASA and societal objectives, and allow us to address the following science objectives:

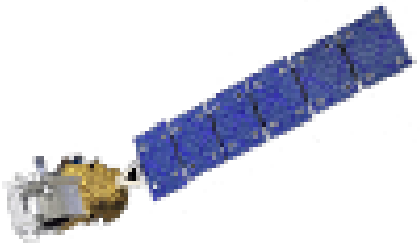
1. Identify critical thresholds of water use and water stress in key climate sensitive biomes;
2. Detect the timing, location, and predictive factors leading to plant water uptake decline and/or cessation over the diurnal cycle; and,
3. Measure agricultural water consumptive use over the contiguous United States (CONUS) at spatiotemporal scales applicable to improve drought estimation accuracy.

The ECOSTRESS mission will acquire data for 1 year, measuring TIR, evapotranspiration (ET), Water Use Efficiency (WUE), and the Evaporative Stress Index drought indicator for selected regions of the globe and the entire CONUS.

Instruments:

- IR Radiometer

Ice, Cloud, and land Elevation Satellite-2 (ICESat-2) 15/9/2018



ICESat-2

Status: Current, Prime Mission

Mission Category: Earth Systematic Missions Program, Decadal Survey 2007

Launch Date: September 15, 2018

Launch Location: Vandenberg Air Force Base

Designed Life: September 15, 2021

Project goals:

The Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2) mission is one of the first four missions recommended for launch by NASA by the U.S. National Research Council (NRC) within Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond. The ICESat-2 mission will provide elevation measurements over the Greenland and Antarctica ice sheets to quantify changes in ice-sheet mass, the mechanisms that drive that change (variations in accumulation, changes in ice melt, or ice flow acceleration/deceleration), and the impact of these changes on future global sea level; monitor changes in sea-ice thickness to examine ice-ocean-atmosphere exchanges of energy, mass, and moisture; and measure vegetation canopy height as a basis for estimating large-scale biomass and biomass change.

Instruments:

- ATLAS (Advanced Topographic Laser Altimeter System)
- GPSP (Global Positioning System Payload)

Relevant Science Focus Areas:

- Climate Variability and Change
- Earth Surface and Interior
- Water and Energy Cycles

Science Goals:

- Quantify how much melting ice sheets in Greenland and Antarctica contribute to sea level changes.
- Quantify how ice sheets, glaciers, and more are gaining or losing mass at a regional level, to help researchers understand the mechanisms behind those changes.
- Estimate the thickness of sea ice and monitor any changes.
- Measure the height of vegetation in forests and other ecosystems worldwide.

Global Ecosystem Dynamics Investigation Lidar (EVI-2) (GEDI on ISS) 5/12/2018

Status: Current, Prime Mission

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Instrument

Launch Date: December 5, 2018

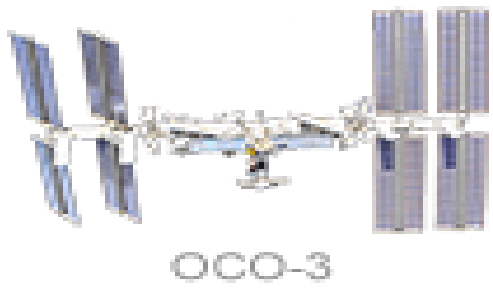
Launch Location: Cape Canaveral

Designed Life: December 5, 2020

Project goals:

Launched December 5, 2018, the scientific goal of the Global Ecosystem Dynamics Investigation Lidar (GEDI) is to characterize the effects of changing climate and land use on ecosystem structure and dynamics to enable radically improved quantification and understanding of the Earth's carbon cycle and biodiversity. Focused on tropical and temperate forests from its vantage point on the International Space Station (ISS), GEDI uses lidar to provide the first global, high-resolution observations of forest vertical structure. GEDI addresses three, core science questions: (Q1) What is the aboveground carbon balance of the land surface? (Q2) What role will the land surface play in mitigating atmospheric carbon dioxide in the coming decades? (Q3) How does ecosystem structure affect habitat quality and biodiversity? Answering these questions is critical for understanding the future path of global climate change and the Earth’s biodiversity.

Orbiting Carbon Observatory 3 (ISS-OCO-3)) 4/5/2019



Status: Current, Prime Mission

Mission Category: Earth System Science Pathfinder Program, Other

Launch Date: May 4, 2019

Project goals:

The third Orbiting Carbon Observatory (OCO-3) is a future space instrument designed to investigate important questions about the distribution of carbon dioxide on Earth as it relates to growing urban populations and changing patterns of fossil fuel combustion. NASA plans to develop and assemble the instrument using spare materials from the successful development and launch of the Orbiting Carbon Observatory 2 in 2014 and host the instrument on the International Space Station (ISS) for location on the Japanese Experiment Module Exposed Facility (JEM-EF).

Sentinel-6 Michael Freilich 21/11/2020

Sentinel-6 Michael Freilich

Status: Current, Prime Mission

Mission Category: Earth Systematic Missions Program, Inter-Agency Partnerships

Launch Date: November 21, 2020

Launch Location: Vandenberg

Project goals:

Sentinel-6 Michael Freilich aims to continue high precision ocean altimetry measurements in the 2020–2030 time-frame using two successive, identical satellites, Sentinel-6A Michael Freilich and Sentinel-6B.

A secondary objective of Sentinel-6 Michael Freilich is to collect high resolution vertical profiles of temperature, using the GNSS Radio-Occultation sounding technique, to assess temperature changes in the troposphere and stratosphere and to support Numerical Weather Prediction.

Instruments:

- AMR-C - AMR-C Climate-quality microwave radiometer DORIS-NG - Doppler Orbitography and Radio-positioning Integrated by Satellite-NG GNSS POD Receiver - GNSS POD Receiver LRA (Sentinel-6) - Laser Retroreflector Array (Sentinel-6) Poseidon-4 Altimeter - Poseidon-4 SAR Radar Altimeter TriG - TriG Receiver for Radio Occultation

Relevant Science Focus Areas:

- Measurements of global sea surface height

LANDSAT 9 27/9/2021

Landsat 9

Status: Current, Prime Mission

Mission Category: Earth Systematic Missions Program, Inter-Agency Partnerships

Launch Date: September 27, 2021

Launch Location: Vandenberg Space Force Base

Designed Life: September 27, 2026

Project goals:

The President's fiscal year 2016 budget calls for initiation of a Landsat 9 spacecraft as an upgraded rebuild of Landsat 8, as well as development of a low-cost thermal infrared (TIR) free-flying satellite to reduce the risk of a data gap in this important measurement. The TIR free flyer will ensure data continuity by flying in formation with Landsat 8. The budget also calls for the exploration of technology and systems innovations to provide more cost effective and advanced capabilities in future land-imaging missions beyond Landsat 9, such as finding ways to miniaturize instruments to be launched on smaller, less expensive satellites.

Instruments:

- Operational Land Imager-2 (OLI-2)
- Thermal Infrared Sensor-2 (TIRS-2)

Earth Surface Mineral Dust Source Investigation (EVI-4) (EMIT on ISS) 2022

EMIT

Status: Future, Formulation

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Instrument

Launch Date: 2022

Project goals:

The Earth Surface Mineral Dust Source Investigation (EMIT) will use a sensor mounted to the exterior of the International Space Station (ISS) to determine the mineral composition of natural sources that produce dust aerosols around the world. By measuring in detail which minerals make up the dust, EMIT will help to answer the essential question of whether this type of aerosol warms or cools the atmosphere. Robert Green of JPL is the principal investigator. EMIT's hyperspectral instrument will measure the different wavelengths of light emitted by minerals on the surface of deserts and other dust sources to determine their composition. The EMIT sensor is based in part on NASA's Moon Mineralogy Mapper instrument aboard the Indian Space Research Organization's Chandrayaan-1 spacecraft.

The EMIT team brings together broad expertise that covers mineral measurements, soil science, remote sensing of surface properties and Earth system modeling. The project's modeling component will use the data collected to advance our understanding of the role of atmospheric dust in Earth's climate and better predict how it can be expected to change in the future.

Instruments:

- hyperspectral instrument

Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (EVI-3) (TROPICS) 2022

Status: Future, Formulation

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Instrument

Launch Date: 2022

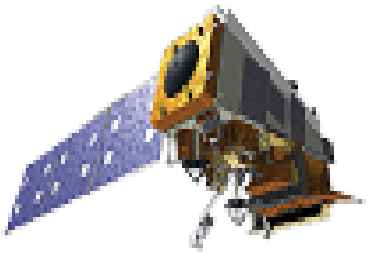
Project goals:

The Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) mission will provide rapid-refresh microwave measurements (median refresh rate of 21 minutes for the baseline mission, 31 minutes for the threshold mission) over the tropics that can be used to observe the thermodynamics of the troposphere and precipitation structure for storm systems at the mesoscale and synoptic scale over the entire storm lifecycle. TROPICS comprises 12 CubeSats (fully compliant 4.0 kg 3U) in three low-Earth orbital planes. Each CubeSat will host a high-performance radiometer scanning across the satellite track at 30 RPM to provide temperature profiles using seven channels near the 118.75 GHz oxygen absorption line, water vapor profiles using 3 channels near the 183 GHz water vapor absorption line, imagery in a single channel near 90 GHz for precipitation measurements, and a single channel at 206 GHz for cloud ice measurements. (Picture credit: MIT Lincoln Laboratory)

Science Goals:

- Relate precipitation structure evolution, including diurnal cycle, to the evolution of the upper-level warm core and associated intensity changes
- Relate the occurrence of intense precipitation cores (convective bursts) to storm intensity evolution
- Relate retrieved environmental moisture measurements to coincident measures of storm structure (including size) and intensity
- Assimilate microwave radiances and/or retrievals in mesoscale and global numerical weather prediction models to assess impacts on storm track and intensity

Joint Polar Satellite System-2 (JPSS-2) 2022



JPSS-2

Status: Future, Implementation

Mission Category: Inter-Agency Partnerships

Launch Date: 2021

Project goals:

The Joint Polar Satellite System (JPSS) is the restructured civilian portion of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) that will make afternoon observations as it orbits Earth. The system includes the satellites and sensors supporting civil weather and climate measurements and a shared ground infrastructure with the Department of Defense weather satellite system.

NOAA is responsible for the JPSS program. NASA is the program's procurement agent, and the agency's Goddard Space Flight Center in Greenbelt, Md., is the lead for acquisition. Data and imagery obtained from JPSS will increase the timeliness, accuracy and cost-effectiveness of public warnings and forecasts of climate and weather events, reducing the potential loss of human life and property.

Polar-orbiting satellites observe Earth from space and collect and disseminate data on Earth's weather, atmosphere, oceans, land, and near-space environment and are able to monitor the entire planet and provide data for long-range weather and climate forecasts.

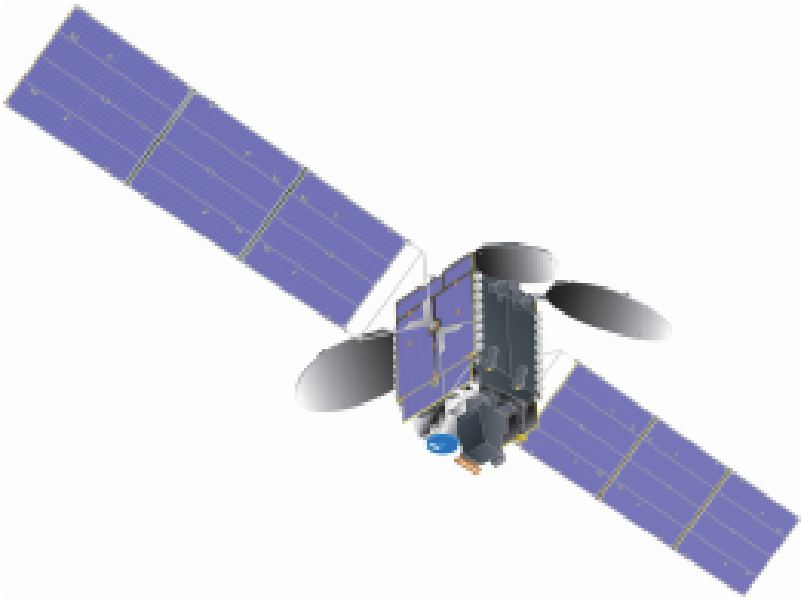
Instruments:

- ATMS (Advanced Technology Microwave Sounder)
- CERES (Clouds and Earth's Radiant Energy System)
- CrIS (Cross-Track Infrared Sounder)
- OMPS (Ozone Mapping and Profiler Suite)
- VIIRS (Visible/Infrared Imager/Radiometer Suite)
- RBI (Radiation Budget Instrument)

Relevant Science Focus Areas:

- Weather

Tropospheric Emissions: Monitoring of Pollution (EVI-1) (TEMPO) 2022



Status: Future, Formulation

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Instrument

Launch Date: 2022

Project goals:

The Tropospheric Emissions: Monitoring of Pollution (TEMPO) mission will measure atmospheric pollution covering most of North America, from Mexico City to the Canadian tar/oil sands, and from the Atlantic to the Pacific hourly and at high spatial resolution. TEMPO's measurements from geostationary orbit (GEO) of tropospheric ozone, ozone precursors, aerosols, and clouds will create a revolutionary dataset that provides understanding and improves prediction of air quality (AQ) and climate forcing.

TEMPO spectroscopic measurements in the ultraviolet and visible provide a tropospheric measurement suite that includes the key elements of tropospheric air pollution chemistry. Measurements are from geostationary orbit, to capture the inherent high variability in the diurnal cycle of emissions and chemistry. A small product spatial footprint resolves pollution sources at sub-urban scale. Together, this temporal and spatial resolution improves emission inventories, monitors population exposure, and enables effective emission-control strategies.

Maxar Technologies and Intelsat recently agreed to partner to host NASA's Tropospheric Emissions: Monitoring of Pollution (TEMPO) instrument onboard the Intelsat 40e mission. In 2019, NASA selected Maxar to host the TEMPO instrument utilizing the U.S. Air Force Hosted Payload Solutions (HoPS) contract vehicle. Intelsat 40e is based on Maxar's 1300-class satellite platform and will provide commercial satellite communications for Intelsat customers in North and Central America. The satellite is scheduled to launch into geostationary orbit 22,236 miles (35,786 km) above Earth's equator in 2022.

This instrument will measure the spectra required to retrieve ozone (O3), nitrogen dioxide (NO2), sulfur dioxide (SO2), formaldehyde (H2CO), glyoxal (C2H2O2), aerosols, cloud parameters, and UV-B radiation. TEMPO thus measures the major elements, directly or by proxy, of the diurnal tropospheric ozone chemistry cycle. Multi-spectral observations provide sensitivity to ozone in the lowermost troposphere. TEMPO will also quantify the daytime temporal evolution of aerosol loading.

TEMPO will be part of a constellation of instruments measuring air quality over the Northern Hemisphere that will also include the European Space Agency's Sentinel-4, currently in development, and South Korea's Geostationary Environment Monitoring Spectrometer.

Instruments:

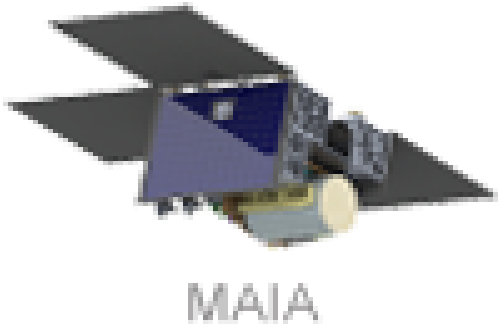
- UV and Visible Offner Grating spectrometer

Science Goals:

- Collect simultaneous high temporal and spatial resolution measurements of pollutants over Greater North America.
- Measure the key elements in tropospheric ozone chemistry and aerosol cycles.

- Observe aerosols and gases for quantifying and tracking evolution of pollution.
- Integrate observations from TEMPO and other platforms into models to improve representation of processes.
- Serve as the North American geostationary component of an international constellation for air quality monitoring.
- Determine the diurnal instantaneous radiative forcings associated pollutants and other climate agents on the continental scale.

Multi-Angle Imager for Aerosols (EVI-3) (MAIA) 2022



Status: Future, Formulation

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Instrument

Launch Date: 2022

Project goals:

Currently in development, Multi-Angle Imager for Aerosols (MAIA) uses a twin-camera instrument that will make radiometric and polarimetric

measurements needed to characterize the sizes, compositions and quantities of particulate matter in air pollution. As part of the MAIA investigation, researchers will combine MAIA measurements with population health records to better understand the connections between aerosol pollutants and health problems such as adverse birth outcomes, cardiovascular and respiratory diseases and premature deaths.

The MAIA instrument measures the radiance and polarization of sunlight scattered by atmospheric aerosols, from which the abundance and characteristics of ground-level particulate matter (PM) are derived. The instrument contains two pushbroom spectropolarimetric cameras on a two-axis gimbal for multiangle viewing, frequent target revisits, and inflight calibration.

Instruments:

- Two pushbroom spectropolarimetric cameras

Geostationary Carbon Cycle Observatory (EVM-2) (GeoCarb) 2024

Status: Future, Formulation

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Mission

Launch Date: 2022

Project goals:

NASA has selected a first-of-its-kind Earth science mission that will extend our nation's lead in measuring key greenhouse gases and vegetation health from space to advance our understanding of Earth's natural exchanges of carbon between the land, atmosphere and ocean. The Geostationary Carbon Observatory (GeoCarb), targeted for launch in the early 2020s, will build on the success of NASA's Orbiting Carbon Observatory-2 (OCO-2) mission by placing a similar instrument on a hosted satellite flying in geostationary orbit. Perched 22,236 miles (35,786 kilometers) above the Americas, GeoCarb will collect 10 million daily observations of the concentrations of carbon dioxide, methane, carbon monoxide and solar-induced fluorescence (SIF) at a spatial resolution of about 3 to 6 miles (5 to 10 kilometers). The primary goals of GeoCarb, led by Berrien Moore of the University of Oklahoma in Norman, are to monitor plant health and vegetation stress throughout the Americas, and to probe, in unprecedented detail, the natural sources, sinks and exchange processes that control carbon dioxide, carbon monoxide and methane in the atmosphere. The NASA-directed mission will launch on a hosted satellite to make observations over the Americas from an orbit of approximately 22,000 miles (35,800 kilometers) above the equator.

The GeoCarb instrument views reflected light from Earth through a narrow slit. When the slit is projected onto Earth's surface, it sees an area measuring about 1,740 miles (2,800 kilometers) from north to south and about 3.7 miles (6 kilometers) from east to west. In comparison, OCO-2's swath is about 6.2 miles (10 kilometers) wide. GeoCarb stares at that area for about 4-1/2 seconds, then the slit is moved half a slit width -- 1.9 miles, or 3 kilometers -- to the west, allowing for double sampling. With this technique, GeoCarb can scan the entire continental United States in about 2-1/4 hours, and from Brazil to South America's West Coast

in about 2-3/4 hours. It is not designed to observe the oceans, as reflectivity over the oceans is too low to provide useful data. The mission was competitively selected from 15 proposals submitted to the agency's second Earth Venture - Mission announcement of opportunity for small orbital investigations of the Earth system. GeoCarb is the second space-based investigation in the Earth Venture - Mission series of rapidly developed, cost-constrained projects for NASA's Earth Science Division.

Multi-Angle Imager for Aerosols (EVI-3) (MAIA) 2023

Status: Future, Formulation

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Instrument

Launch Date: 2023

Project goals:

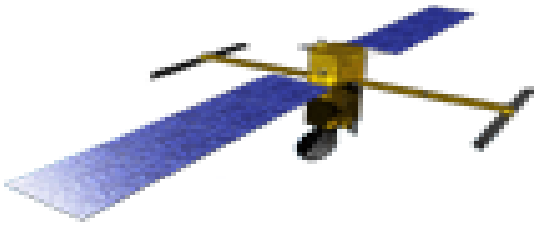
The Polar Radiant Energy in the Far Infrared Experiment (PREFIRE) will fly a pair of small CubeSat satellites to probe a little-studied portion of the radiant energy emitted by Earth for clues about Arctic warming, sea ice loss, and ice-sheet

melting. PREFIRE will fly miniaturized thermal infrared spectrometers on two CubeSat satellites, each about the size of a loaf of bread. The sensors are based on technology previously flown on the Mars Climate Sounder, an instrument on NASA's Mars Reconnaissance Orbiter. The CubeSats will orbit Earth's poles to measure far-infrared emissions and how they change throughout the day and over seasons. The observations will allow scientists to assess how changes in thermal infrared emissions at the top of Earth's atmosphere are related to changes in cloud cover and surface conditions below, such as the amount of sea ice and meltwater on the surface of the ice. Tristan L'Ecuyer of the University of Wisconsin, Madison, is the principal investigator.

Instruments:

- Miniaturized thermal infrared spectrometers on two CubeSat satellites

Surface Water Ocean Topography (SWOT) 2023



Status: Future, Formulation

Mission Category: Earth Earth Systematic Missions Program, Decadal Survey 2007

Launch Date: 2023

Project goals:

The Surface Water Ocean Topography (SWOT) mission is a proposed NASA mission to make the first global survey of Earth's surface water.

SWOT is being developed by an international group of hydrologists and oceanographers to provide a better understanding of the world's oceans and its terrestrial surface waters. It will give scientists their first comprehensive view of Earth's freshwater bodies from space and much more detailed measurements of the ocean surface than ever before.

SWOT is a collaboration between NASA and the French space agency, CNES. It builds on the very successful 25-year partnership between the two agencies to use radar altimetry to measure the surface of the ocean. This partnership began with the TOPEX/Poseidon mission.

The SWOT mission is based on a new type of radar called Ka-band radar interferometry. The satellite will fly two radar antennae at either end of a 10-meter (33-foot) mast, allowing it to measure the elevation of the surface along a 120 - kilometer (75-mile)-wide swath below. The new radar system is smaller but similar to the one that flew on NASA's Shuttle Radar Topography Mission, which made high-resolution measurements of Earth's land surface in 2000.

Instruments:

- Ka- or Ku-Band Radar

- Ku-Band Altimeter
- MWR (Microwave Radiometer)

Science Goals:

- Provide sea surface heights (SSH) and terrestrial water heights over a 120 km wide swath with a +/-10 km gap at the nadir track.
- Over the deep oceans, provide SSH within each swath with a posting every 2 km x 2 km, and a precision not to exceed 0.5 cm when averaged over the area.
- Over land, download the raw data for ground processing and produce a water mask able to resolve 100-m rivers and 1-km2 lakes, wetlands, or reservoirs. Associated with this mask will be water level elevations with an accuracy of 10 cm and a slope accuracy of 1 cm/1 km.
- Cover at least 90 percent of the globe. Gaps are not to exceed 10 percent of Earth's surface
- other climate agents on the continental scale.

NASA-ISRO Synthetic Aperture Radar (NI-SAR) 2023

Status: Future, Formulation

Mission Category: Earth Systematic Missions Program

Launch Date: 2023

Project goals:

Using advanced radar imaging that will provide an unprecedented, detailed view of Earth, the NASA-Indian Space Research Organisation (ISRO) Synthetic Aperture Radar, or NISAR, satellite is designed to observe and take measurements of some of the planet's most complex processes, including ecosystem disturbances,

ice-sheet collapse, and natural hazards such as earthquakes, tsunamis, volcanoes and landslides.

Data collected from NISAR will reveal information about the evolution and state of Earth's crust, help scientists better understand our planet's processes and changing climate, and aid future resource and hazard management. The mission is a partnership between NASA and the Indian Space Research Organization.

Instruments:

- L-band (24-centimeter wavelength) Polarimetric Synthetic Aperture Radar
- S-band (12-centimeter wavelength) Polarimetric Synthetic Aperture Radar

Climate Absolute Radiance and Refractivity Observatory Pathfinder (CLARREO Path.) 2023

Status: Future, Formulation

Mission Category: Earth Systematic Missions Program

Launch Date: 2023

Project goals:

CLARREO Pathfinder (CPF) will have a Reflected Solar spectrometer on the International Space Station (ISS) starting in 2021 that will detect the complete spectrum of radiation from the Sun reflected by Earth. CLARREO Pathfinder (CPF) provides a crucial step toward informing strategic planning by government agencies (e.g. DoD and DOE), the operation and sustainment of key national assets (e.g. coastal military installations), and risk assessment by the reinsurance industry in response to hazards such as flooding and inundation.

Instruments:

- IR Spectrometer
- RS Spectrometer

Total and Spectral Solar Irradiance Sensor -2 (TSIS-2) 2024

Status: Future, Formulation

Mission Category: Earth Systematic Missions Program

Launch Date: 2024

Project goals:

We live on a solar-powered planet. The Sun provides almost all of the energy that fuels life and drives the Earth's ocean currents, seasons, weather, and climate. For scientists who study changes in Earth's climate, energy from the Sun is a factor that they can't ignore.

NASA's Total and Spectral Solar Irradiance Sensor – 2, or TSIS-2, will measure the Sun's energy input to Earth. Since 1978, various satellites have measured the Sun's brightness above Earth's atmosphere. TSIS-2 will add solar irradiance measurements to four decades of continuous data records. Unlike its predecessor TSIS-1, which operates from the International Space Station, TSIS-2 will ride on a free-flying spacecraft.

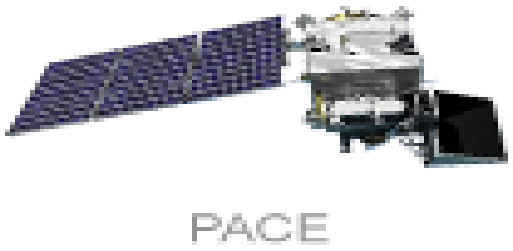
Measurements of Earth's solar energy input is simply a measurement of the Sun's brightness at the top of Earth's atmosphere. TSIS-2 measures the brightness of the sun that reaches the earth, called total irradiance, as well as the distribution of that energy over ultraviolet, visible, and infrared wavelengths, called spectral irradiance.

TSIS-2 comprises two instruments, the Total Irradiance Monitor (TIM), and the spectral Irradiance Monitor (SIM). TIM measures total brightness and SIM measures spectral irradiance over a wavelength range that includes 96% of the energy in the solar spectrum. Both instruments are similar to those used for the TSIS-1 mission. Decades of measurements have shown the Sun's brightness fluctuates up and down by a small, but important ~0.1 percent over an 11-year solar cycle. While Earth's upper atmosphere is sensitive to these changes in sunlight, this variation in total irradiance is too small to explain recent trends in global surface temperature rise.

Scientist who study the Earth's atmosphere, for example to predict ozone layer recovery or to provide air quality forecasts, use computer models that need accurate measurements of the different wavelength bands of sunlight—spectral solar irradiance—reaching Earth. Particles and gasses inside Earth's atmosphere react differently to individual wavelengths of light. For example, ozone blocks the most harmful ultraviolet rays, clouds absorb and emit heat radiation, and reflect visible light, and water vapor absorbs heat.

NASA's Goddard Space Flight Center (GSFC) has overall responsibility for the development and operation of TSIS-2 as part of the Earth Systematic Missions (ESM) program. The Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado, Boulder, under contract with NASA, is building the TIM and SIM instruments to ensure the availability of this data to the scientific community. NASA plans to launch TSIS-2 in 2023.

Climate Absolute Radiance and Refractivity Observatory Pathfinder (CLARREO Path.) 2024



Status: Future, Formulation

Mission Category: Earth Systematic Missions Program

Launch Date: 2024

Project goals:

The Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission will make global ocean color measurements to provide extended data records on ocean ecology and global biogeochemistry (e.g., carbon cycle) along with polarimetry measurements to provide extended data records on clouds and aerosols. Understanding of impacts and feedbacks of the Earth system to climate are critical importance.

Instruments:

- Ocean color spectrometer
- Polarimeter (TBD)

SENTINEL-6B 2026

Status: Future

Mission Category: Inter-Agency Partnerships

Launch Date: 2026

Project goals:

The Jason Continuity of Service (Jason-CS) mission on the Sentinel-6 spacecraft is an international partnership between the U.S. and Europe. Jason-CS/Sentinel-6 includes two identical satellites with the first launched November 21, 2020 (Sentinel-6 Michael Freilich) and the second scheduled for launch in 2025 (satellite B).

Jason-CS/Sentinel-6 will ensure continuity of sea level observations into a fourth decade. Like their predecessors, these satellites will provide ongoing measurements of global sea level rise – one of the most important indicators of human-caused climate change. The data will also support operational oceanography through improved forecasts of ocean currents as well as wind and wave conditions. This data will allow improvements in both short-term forecasting for weather predictions in the two- to four-week range (e.g. hurricane intensity predictions), and long-term forecasting for seasonal conditions (e.g. El Niño, La Niña).

With a new experiment: Global Navigation Satellite System Radio Occultation (GNSS-RO), Jason-CS/Sentinel-6 will also aid weather prediction. Watching GNSS satellites as they disappear over the horizon will provide detailed information about the layers in the atmosphere. This information will contribute to computer models that predict the weather and enhance forecasting capabilities.

Since 1992, high-precision satellite altimeters have been essential in helping scientists understand how the ocean stores and redistributes heat, water, and carbon in the climate system. The Jason-CS/Sentinel-6 satellites will extend this legacy through at least 2030, providing a nearly 40-year record of sea level rise, along with changes in ocean currents and conditions.

Instruments:

- The satellite will carry several instruments to support science goals. A Radar Altimeter will bounce signals off the ocean surface. Sea surface height will be determined based on the time it takes each pulse to travel from the satellite to the ocean and back again. An Advanced Microwave Radiometer (AMR) will retrieve the amount of water vapor between the satellite and ocean, which affects the travel speed of radar pulses. Radio Occultation Antennas will measure the delay of radio signals between Jason-CS and global navigation satellites (GPS) as they slice through different layers of the atmosphere. Other onboard instruments will be used to precisely determine the satellite's position (DORIS, Laser Retroreflector Array), perform data downlinks (S-band and X-band antennas), and supply power (Solar Array).

Geosynchronous Littoral Imaging and Monitoring Radiometer (EVI-5) (GLIMR) 2026

Status: Future , Formulation

Mission Category: Earth Venture Class, Earth Venture-Instrument

Launch Date: 2026

Project goals:

The selected Geosynchronous Littoral Imaging and Monitoring Radiometer (GLIMR) instrument, led by principal investigator Joseph Salisbury at the University of New Hampshire, Durham, will provide unique observations of ocean biology, chemistry, and ecology in the Gulf of Mexico, portions of the southeastern United States coastline, and the Amazon River plume – where the waters of the Amazon River enter the Atlantic Ocean.

The instrument was competitively selected from eight proposals considered under NASA's fifth EVI solicitation released in 2018, with an award of $107.9 million. This is the largest NASA contract award in the history of the University of New Hampshire. Salisbury and his team have proposed the instrument as a hosted payload, for which NASA will provide access to space.

Coastal ecosystems support humanity in many ways, but they are under increasing pressure from the effects of land use activities, population growth, extreme weather events, and climate change. These pressures can give rise to more frequent, expansive and harmful algal blooms, as well as create areas where dissolved oxygen is severely depleted – both of which are detrimental to tourism, fisheries, and human health.

GLIMR will be integrated on a NASA-selected platform and launched in the 2026-2027 timeframe into a geosynchronous orbit where it will be able to monitor a wide area, centered on the Gulf of Mexico, for up to 15 hours a day. From this vantage point, the hyperspectral ocean color radiometer will measure the

reflectance of sunlight from optically complex coastal waters in narrow wavebands. GLIMR will be able to gather many observations of a given area each day, a critical capability in studying phenomena such as the lifecycle of coastal phytoplankton blooms and oil spills in a way that would not be possible from a satellite in a low-Earth orbit. Given its unique spatial and temporal resolution, GLIMR will be highly complementary to other low-Earth orbit satellites that observe the ocean.

Investigation of Convective Updrafts (EVM-3) (INCUS) 2027

Status: Future , Formulation

Mission Category: Earth System Science Pathfinder Program, Earth Venture Class, Earth Venture-Mission

Launch Date: 2027

Project goals:

The Investigation of Convective Updrafts (INCUS) mission will be a collection of three SmallSats, flying in tight coordination. INCUS aims to directly address why convective storms, heavy precipitation, and clouds occur exactly when and where they form. The investigation stems from the 2017 Earth Science Decadal Survey by the National Academies of Sciences, Engineering, and Medicine, which lays out ambitious, but critically necessary, research and observation guidance. NASA selected INCUS through the agency's Earth Venture Mission-3 (EVM-3) solicitation that sought complete, space-based investigations to address important science questions and produce data of societal relevance within the Earth science field.

JPSS-3 2027

Status: Future

Mission Category: Inter-Agency Partnerships

Launch Date: 2027

Project goals:

The Joint Polar Satellite System (JPSS) is the Nation's new generation polar-orbiting operational environmental satellite system. JPSS is a collaborative program between the National Oceanic and Atmospheric Administration (NOAA)

and its acquisition agent, NASA. This interagency effort is the latest generation of U.S. polar-orbiting, non-geosynchronous environmental satellites.

JPSS-3 is the third spacecraft in the JPSS series. JPSS-3 will carry: VIIRS, CrIS, ATMS, and OMPS-N.

Historical Note: The Joint Polar Satellite System (JPSS) is a collaborative program between NOAA and NASA. JPSS is the civilian component of the former National Polar-orbiting Operational Environmental Satellite System

(NPOESS), which was reorganized in 2010.

Instruments:

- ATMS (Advanced Technology Microwave Sounder) CrIS (Cross-Track Infrared Sounder) OMPS (Ozone Mapping and Profiler Suite) VIIRS (Visible/Infrared Imager/Radiometer Suite)

JPSS-4 2031

Status: Future

Mission Category: Inter-Agency Partnerships

Launch Date: 2031

Project goals:

The Joint Polar Satellite System (JPSS) is the Nation's new generation polar-orbiting operational environmental satellite system. JPSS is a collaborative program between the National Oceanic and Atmospheric Administration (NOAA)

and its acquisition agent, NASA. This interagency effort is the latest generation of U.S. polar-orbiting, non-geosynchronous environmental satellites.

JPSS-4 is the fourth and final spacecraft in the JPSS series. JPSS-4 will carry the latest versions of: VIIRS, CrIS, ATMS, and OMPS-N.

Historical Note: The Joint Polar Satellite System (JPSS) is a collaborative program between NOAA and NASA. JPSS is the civilian component of the former National Polar-orbiting Operational Environmental Satellite System

(NPOESS), which was reorganized in 2010.

Instruments:

- ATMS (Advanced Technology Microwave Sounder) CrIS (Cross-Track Infrared Sounder) OMPS (Ozone Mapping and Profiler Suite) VIIRS (Visible/Infrared Imager/Radiometer Suite)

Result:

We will know about each missile, the tools used in it, the importance of each missile, and its purpose

The Reviewer:

https://eospso.nasa.gov/content/all-missions