National Aeronautics and Space Administration

Glory

Revealing the Effects of Aerosols and Solar Irradiance on Climate.

The Glory mission will facilitate the monitoring of key climate forcings with accuracy unattainable by other existing instruments.

www.nasa.gov/glory

Why Glory?

The Sun provides a constant source of energy to our planet. However, only about one-half of the sunlight that reaches the Earth directly results in heating of its surface. The remaining energy is either reflected back into space by the Earth's surface and atmosphere or is absorbed in the atmosphere and later re-emitted. This energy budget of "energy in" versus "energy out" directly influences the Earth's short-term and long-term climate trends.

Data from the Glory mission will allow scientists to better understand how the sun and tiny atmospheric particles called aerosols affect Earth's climate. Both aerosols and solar energy influence the planet's energy budget – the amount of energy entering and exiting Earth's atmosphere. An accurate measurement of these impacts is important in order to anticipate future changes to our climate, and how they may affect human life.

Observatory

The Glory Observatory uses Orbital Sciences Corporation's LEOStar 1 bus design, with twin articulated deployable solar panels, 3-axis stabilization, and X-band/S-band Radio Frequency communications capabilities. The bus structure consists of an octagonal aluminum space frame outfitted with hydrazine propulsion system containing sufficient fuel for at least 36 months of on-orbit service. The bus also provides payload power; command, telemetry, and science data interfaces, including onboard storage of data; and an attitude control subsystem to support instrument pointing requirements.

Instruments

The Glory science mission is accomplished through the deployment of two science instruments: the Aerosol Polarimetry Sensor (APS), complimented by two Cloud Cameras, and the Total Irradiance Monitor (TIM)

Total Irradiance Monitor

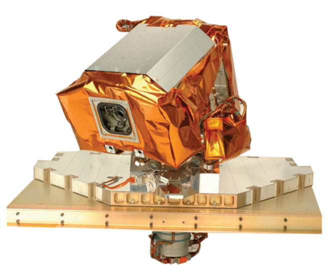
The TIM instrument is built by the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) in Boulder, Colorado. The instrument measures the amount of solar energy that enters the Earth's atmosphere. This information will help researchers understand any long-term changes in the amount of energy coming from the Sun and how those changes affect Earth's climate. The accuracy of Glory's TIM instrument is expected to be better than that of any other solar irradiance instrument currently in space. It will follow a record of observations made by an earlier TIM instrument flown on the NASA SOlar Radiation and Climate Experiment (SORCE) mission, and will continue an uninterrupted series of space-based, solar observations that span the past 30+ years.

The TIM instrument will monitor the Sun during the daylight portion of each Glory orbit. Data acquired in 50-second intervals will track changes in the total solar energy, which will then be averaged to provide both 6-hourly and daily values. The mission of the Glory TIM instrument will help diagnose short-term solar mechanisms causing energy budget changes and will contribute to the vital long-term solar record.

Aerosol Polarimetry Sensor

The Aerosol Polarimetry Sensor (APS) instrument is built by Raytheon, Inc. in El Segundo, California. This instrument will measure the size, quantity, refractive index, and shape of aerosols. For the purposes of the APS science mission, an aerosol is characterized as any particle, whether natural or human-caused, that is suspended in Earth's atmosphere. This is the first space-based instrument to be able to identify different aerosol types, which will help researchers distinguish the relative influence of these aerosols on our global climate. The aerosol characterization capabilities of APS, coupled with the cloud identification function performed by the two on-board Cloud Cameras, will allow scientists to determine, with very high accuracy, the global distribution of aerosols and cloud properties. The two Glory Cloud Cameras are built by Ball Aerospace and Technologies Corporation (BATC) in Boulder, Colorado.

APS Instrument



TIM Instrument

Launch Service

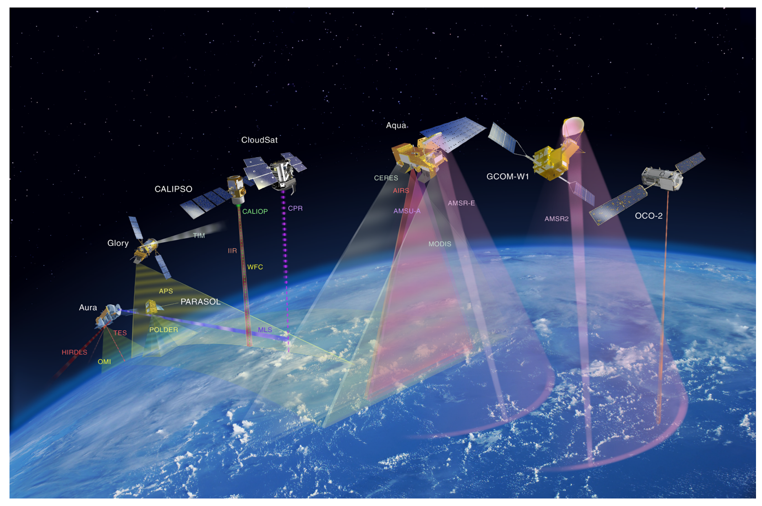
The Glory Observatory is scheduled for launch in early 2011 on a Taurus XL launch vehicle from the Vandenberg Air Force Base, located on the central coast of California. The Taurus XL launch service is provided by Orbital Sciences Corporation's Launch Systems Group (LSG) under the management of NASA Kennedy Space Center's Launch Services Program (LSP).

Mission Orbit

Following the successful launch and commissioning of the Glory Observatory, the mission will operate as part of the Afternoon Constellation, also known as the A-Train. The A-Train is a series of Earth-observing satellites flying in close formation to enable co-observation between the various science instruments within the A-Train . The A-Train satellites fly in a near-circular, sun-synchronous orbit characterized by the following parameters:

Altitude: 705 km
Inclination: 98.2 degrees
Orbital Period: 99 minutes

The A-Train satellites fly a repeating pattern of 233 orbit ground tracks every 16 days. The reference system used to chart their positions relative to the surface of the Earth is known as the Worldwide Reference System 2 (WRS-2). The 233 fixed WRS-2 paths provide a reference to which Earth observing missions can maintain their ground tracks. Such complete, repeatable coverage of the Earth will help scientists learn about aerosols and their impacts across the globe.



The A-Train Satellites

Mission Lifetime: 3-year mission requirement with a 5-year mission goal

Glory Science Objectives

Scientists who study the Earth's energy balance consider the difference between energy entering and energy leaving the lowest layer of Earth's atmosphere (generally, energy entering has a warming effect while energy leaving has a cooling effect). Specifically, the Glory mission is intended to achieve the following two scientific objectives:

1) Collect data on the properties of natural and human-caused aerosols in the Earth's atmosphere.
2) Measure solar energy entering the Earth's atmosphere to determine its long-term effects on the Earth's climate record.

The Sun Factor

The primary input to the Earth's energy budget comes from a natural source – our Sun. To find the contribution of this giant space heater to the Earth's energy budget, scientists measure the amount of energy that reaches the Earth's atmosphere over a given period of time. The solar energy input to the Earth is approximately 1,361 watts per square meter. That's enough energy to continuously power nearly half a million 60-watt light bulbs for every person on Earth. Satellite-based sensors have established a data record of the Sun's input spanning the past 30+ years, but these measurements of contain slight offsets due to instrument calibration differences. That's one reason why scientists must maintain a continuous solar measurement record. Glory will provide continuity of this measurement.

Another reason to continue solar measurements is that the energy from the Sun fluctuates depending on solar changes, and these changes can affect Earth's climate. While it is easy to recognize that the Sun contributes to the "heat in" portion of the Earth's energy budget, it is not so simple to determine the subtle climate effects that changes in the Sun's intensity can cause. The data from the TIM instrument on Glory will help answer some of these questions.

Particle Puzzles

A second factor affecting the Earth's energy balance is the influence of aerosols, which are tiny particles, suspended in the atmosphere. Aerosols come from both natural sources, such as volcanoes, fires and desert dust, and from human sources, such as the burning of fossil fuels. Aerosols impact the Earth's energy balance by either absorbing or reflecting solar energy. Black carbon aerosols, for example, absorb sunlight which warms them up and this energy is therefore retained as "heat in". Non-absorbing aerosols, such as sulfates, reflect the energy of the Sun back into space causing cooling, or "heat out." In addition, aerosols can also indirectly impact atmospheric cooling by changing the properties of clouds and altering precipitation patterns.

Both natural and human-caused aerosols have an impact on global temperatures. Over the past century, the average temperature of the Earth has increased by approximately 1.3 degrees F (0.7 degrees C). Accurately attributing this increase and the accompanying climate change to natural events, human sources, or a combination of both is of primary importance to scientists and policy makers. The aerosol sensor on Glory will provide scientists with accurate measurements of aerosols in our atmosphere and will help scientists better understand how they influence the climate.

The impact of solar variability and aerosols on the Earth's climate is believed to be comparable to the impact posed by greenhouse gases. Still, aerosols remain poorly measured and may represent the largest uncertainty in our understanding of climate changes. The root of the problem is that the land, ocean, and atmosphere of the Earth interact in complex and sometimes unpredictable ways, which leads to large uncertainties in simulations that scientists use to describe and understand this system. The objective of the Glory mission is to reduce these uncertainties.

Key Players

The fabrication and operation of the Glory observatory requires the close collaboration of numerous organizations located across the United States

+ NASA Goddard Space Flight Center (GSFC) *[Greenbelt, Maryland]*
+ Orbital Sciences Corporation *[Dulles, Virginia]*
+ The Laboratory for Atmospheric and Space Physics (LASP) *[Boulder, Colorado]*
+ The Goddard Institute for Space Studies (GISS) *[New York City]*
+ NASA Kennedy Space Center (KSC) *[Cape Canaveral, Florida]*
+ Raytheon Space and Airborne Systems *[El Segundo, California]*
+ Ball Aerospace and Technologies Corporation (BATC) *[Boulder, Colorado]*

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