Raytheon

Glory Aerosol Polarimetry Sensor

Central to NASA's Glory Climate Mission

The Glory Aerosol Polarimetry Sensor will increase our understanding of the impact of aerosols on global climate change.

Benefits

- Distinguishes between various types of aerosols in Earth's atmosphere
- Reveals effects on aerosols of seasonal and regional trends and transient climate events
- Measures global distribution of aerosols with high accuracy
- Provides key data for developing environmental policies

NASA's Glory Mission

Raytheon's Aerosol Polarimetry Sensor (APS) was designed to collect global aerosol data for climate scientists during NASA's Glory mission. The three-year mission, scheduled to begin in 2009, aims to ascertain the ratios of different species of short-lived aerosols in Earth's atmosphere to further understand their role in global and regional climate change (also called "climate forcing"). The APS will measure reflected sunlight that traverses Earth's atmosphere and interacts with aerosols. An onboard cloud camera used in conjunction with the APS will distinguish between clear and cloudy skies to ensure the highest possible fidelity of the polarimetric data.

Since 1989, the U.S. Global Change Research Program has been studying the causes — and the implications for society — of worldwide climate change. In 2001 the Climate Change Research Initiative was commissioned to focus on areas of uncertainty, with research on the effects of atmospheric aerosols specifically identified as a top priority. Since black carbon aerosols generally contribute to warming, and sulfate aerosols to cooling, the concentrations of these aerosols must be determined before accurate climate models can be developed. NASA's Glory mission contributes to this research.

The Space Vantage Point

While atmospheric aerosols are short-lived (unlike greenhouse gases), they are constantly being replenished — making them significant contributors to global heating and cooling. Because they are transported over long distances by winds, their effects on climate are best studied through space-based observations.

One goal of the Glory mission is to determine whether absorption measurements for black carbon and dust can be improved to obtain more accurate data. The APS will support this and other mission goals with its superior ability to differentiate these man-made aerosols from natural ones — such as smoke, volcanic ash and sea spray — and measure their distribution with greater precision. Collected data showing the global distribution and variety of aerosols will provide clues to their microphysics and impact on atmospheric radiation and cloud coverage.

Unique APS Capabilities

Raytheon's APS is the only instrument able to distinguish between the various aerosols in Earth's atmosphere and measure them accurately from space. The 161 optical elements in its optics and detector module include six precision-aligned telescopes that analyze light of varying wavelengths, from visible to shortwave infrared, into four polarization orientations.

On orbit, the APS will make comprehensive measurements from multiple viewing angles in multiple spectral bands. Its innovative optical design enables the sensor to simultaneously collect spectral and polarimetric data while scanning the Earth's surface.

Highly Accurate Data

The APS design incorporates both polarized and unpolarized references to assure high accuracy under the full range of operating conditions. These references allow incoming APS imagery and data to be compared to known polarization profiles and spectral content similar to that of the scenes of interest being surveyed. Polarization characteristics can then be collected on orbit with high confidence in the resulting data.

The Glory APS' radiometric and polarimetric performance is characterized using a number of calibration methods. This allows cross-checking for maximum accuracy. In addition, a space-grade Spectralon® panel in the APS solar reference assembly serves as an on-orbit source for absolute radiometric calibration. Lunar calibrations will be used to track the calibration's stability.

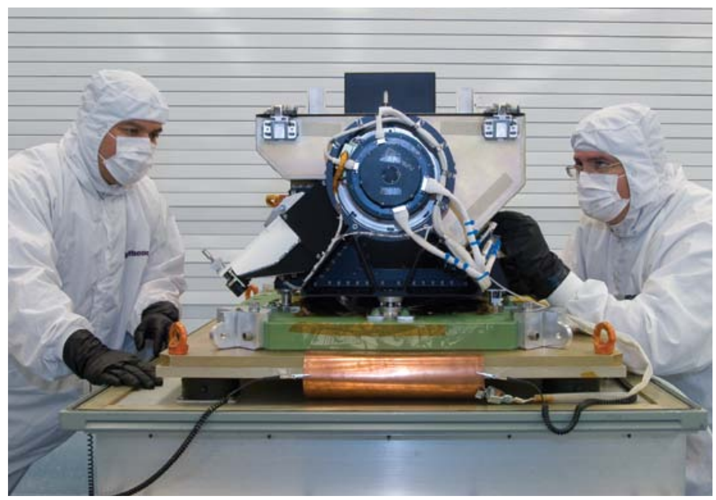
Driving Better Decisions

Information developed by NASA's Glory mission will help climate scientists determine the man-made or natural origin of atmospheric aerosols, establish their persistence and distribution, and evaluate their impact on climate. This new information will enable policy makers to formulate responses to climate change based on a more complete understanding of the global processes that contribute to it.

Spectral Bands and Required Accuracies

Band	Wavelength (nm)	Bandwidth (nm)	Radiometric Accuracy	Polarization Accuracy*	SNR**
1	412	20	5%	0.2% – 0.5%	235
2	443	20	5%	0.2% – 0.5%	235
3	555	20	5%	0.2% – 0.5%	235
4	672	20	5%	0.2% – 0.5%	235
5	865	39	5%	0.2% – 0.5%	235
6	910	20	5%	0.2% – 0.5%	94
7	1378	35	8%	0.2% – 0.5%	141
8	1610	60	5%	0.2% – 0.5%	235
9	2250	75	5%	0.2% – 0.5%	235

*Function of polarization value (q or u)
**Signal to noise ratio



Raytheon's APS, delivered to NASA in March 2009, will give policy makers a wealth of highly accurate data for global climate monitoring.

Technical Specifications

Orbit	705 km, 1:30 pm ascending node, sun-synchronous, circular
Scan Rate	40 rpm, along-track
Field of View (FOV)	+50/–60 degrees (fore-to-aft)
Instantaneous Field of View (IFOV)	8 mrad
Telescopes	6 total, 4 VNIR and 2 SWIR
Size	0.8 x 1.1 x 0.54 m
Mass	69 kg
Power	55 W (orbital average)
Data Rate	160 kbps
Quantization	16 bits
Design Life	3-year requirement

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