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Status of the Current and Future NOAA Satellite Systems

In response to CGMS permanent action 06

The National Oceanic and Atmospheric Administration (NOAA) manages a constellation of four geostationary and eleven polar orbiting meteorological spacecraft, including six military satellites, from the Satellite Operations Control Center (SOCC) in Suitland, Maryland. These satellites provide continuous observations of weather conditions and environmental features of the western hemisphere, monitor global climate change, verify ozone depletion and land surface change, monitor the critical space environmental parameters, and support search and rescue efforts across the globe. This document briefly addresses the status of the geosynchronous and low-earth-orbiting spacecraft constellations as of October 12, 2012.

Polar Operational Environmental Satellite (POES)
Geostationary Operational Environmental Satellite (GOES)

1 INTRODUCTION

The working paper provides a status of NOAA's geostationary and polar-orbiting satellite constellations. The current geostationary configuration takes in to account the changes in the geostationary operations in the Pacific region and the interim activities associated with the anomalies with the Imager and Sounder in the Atlantic region, and the continuous operation of GOES-12 to support the Caribbean And South America at 60^{o}W.

The current polar-orbiting spacecrafts continue to function and provide support for the direct readout communities.

The launch schedules for the future geostationary and polar-orbiting constellations have been revised to reflect a more robust support and implementation plan.

2 CURRENT SATELLITE SYSTEMS

CURRENT POLAR-ORBITING SATELLITES COORDINATED WITHIN CGMS
(as of 11 October 2012)

Orbit type **(equatorial crossing times)**	**Satellites in orbit** (+operation mode) P=Pre-operational Op=operational B=back-up L=limited availability	**Operator**	**Crossing Time** A=Northw D=Southw +Altitude	**Launch date**	**Status**
Sun-synchr. "Morning" (6:00 – 12:00) (18:00 – 24:00)	NOAA-17 (B)	NOAA	19:13 (A) 810 km	6/02	Functional. 10/28/2003 – AMSU-A1 Failed. 2/15/2003 – DTR5 Failed. 2/14/2008 – STX3 output power degraded to inoperable level. STX1 diminished performance. AMSU-B channels 18-20 inoperative. AVHRR scan motor stalled on October 15, 2010.

Orbit type **(equatorial crossing times)**	**Satellites in orbit** (+operation mode) P=Pre-operational Op=operational B=back-up L=limited availability	**Operator**	**Crossing Time** A=Northw D=Southw +Altitude	**Launch date**	**Status**
	NOAA-15 (B)	NOAA	16:42(A) 807 km	05/98	Functional. AVHRR provides images with degraded navigation. AMSU-B scan motor stalled on March 28, 2011 & HIRS/Filter wheel failed on June 6, 2009) AMSU-A1 channels 11 & 14 inoperative and AMSU-B scan motor stalled on March 28, 2011.
	DMSP-F18 (Op)	NOAA	20 :08 (A) 850 km	10/09	Defense satellite. SSMIS. Data available to civilian users through NOAA.
	DMSP-F16 (B)	NOAA	18 :51 (A) 850 km	10/03	Defense satellite. SSMIS. Data available to civilian users through NOAA.
	DMSP-F15 (B)	NOAA	17 :06 (A) 850 km	12/99	Defense satellite. SSMT2 (microwave water vapor sounder) non-functional. Data available to civilian users through NOAA.
	DMSP-F14 (B)	NOAA	15 :47 (A) 852 km	04/97	Defense satellite. SSMI (microwave imager), SSMT1 (microwave temperature sounder) non-functional and SSMT2 non-functional. No functional onboard recorder.
	DMSP-F12 (L)	NOAA	15:35 (A) 850 km	8/94	Defense Satellite. Satellite decommissioned on 10/12/08
Sun-synchr. "Afternoon" (12:00 – 16:00) (00:00 – 04:00)	Suomi National Polar-orbiting Partnership (Suomi NPP)	NOAA/NASA	13:30 (A) 833 km	10/11	Sensors performing nominally. Data records in beta phase.
	NOAA-19 (Op)	NOAA	13:33 (A) 870 km	2/09	Functional. Noise on MHS Channel H3. Noise on AMSU-A1 channel 8.

Orbit type **(equatorial crossing times)**	**Satellites in orbit** (+operation mode) P=Pre-operational Op=operational B=back-up L=limited availability	**Operator**	**Crossing Time** A=Northw D=Southw +Altitude	**Launch date**	**Status**
	NOAA-18 (B)	NOAA	14:51 (A) 854 km	5/05	Functional. Noise on HIRS long wave channels. SBUV chopper motor intermittent seizures, but self-corrected via macros. 6/7/2009 – MIMU-2 failure (loss of redundancy).
	NOAA-16 (B)	NOAA	20:29 (A) 849 km	09/00	Functional, no APT. Intermittent problems with AVHRR.
Sun-synchr. “Early morning” (4:00 - 6:00) (16:00 – 18:00)	DMSP-F13 (B)	NOAA	18:05 (A) 850 km	03/95	Defense satellite. Data available to civilian users through NOAA. No functional recorders on board
	DMSP-F17 (Op)	NOAA	17:37 (A) 850 km	11/07	Defense satellite. SSMIS. Data available to civilian users through NOAA.

CURRENT GEOSTATIONARY SATELLITES COORDINATED WITHIN CGMS

(as of 11 October 2012)

SECTOR	**Satellites currently in orbit (+type)** P: Pre-operational Op: Operational B: Back-up L: Limited availability	**Operator**	**Loca-tion**	**Launch date**	**Status**
WEST - PACIFIC (180°W-108°W)	GOES-11 (Op)	NOAA		05/00	Decommissioned December 16, 2011
EAST-ATLANTIC (108°W-36°W)	GOES-12 (B)	NOAA	60°W	7/ 01	Supports South America. SXI failed 4/12/2007 X-Ray Positioner Failed 4/12/2007 No fuel remaining for inclination control.
	GOES-13 (B)	NOAA	75°W	5/16/2006	In standby mode, analysis of Imager and Sounder anomaly since 9/232012. XRS/EUV inoperable.
	GOES-14 (O)	NOAA	104.86° W	6/27/2009	Operational, providing GOES east support Drifting 0.90° east towards GOES-13.
	GOES-15 (0)	NOAA	135°W	3/04/2010	Operational GOES-West on December 14, 2011.

2.1 Status of current GEO satellite systems

The current primary geostationary satellites, GOES-14 and GOES-15, are stationed over the east and west coasts of the United States. These satellites are used to provide simultaneous images and soundings of the Western Hemisphere.

GOES-15 replaced GOES 11 as the operational West satellite on 14 December 2011. GOES-11 was decommissioned on 16 December 2011. The GOES-13 satellite has been placed into standby mode to diagnose issues with the imager and sounder instruments. GOES-14 located at 105^o W was taken out of standby mode to provide east coverage while the GOES-13 anomalies are being analyzed. Since 1 October 2012, GOES-14 has been drifting 0.90^o east per day towards GOES-13. GOES-12 located at 60^o W continues to support coverage of the Caribbean and South America ever since May 2010.

2.1.1 Mission objectives, payload/instruments, products

The goals of the Geostationary Operational Environmental Satellite (GOES) system program are to:

- Maintain reliable operational, environmental, and storm warning systems to protect life and property
- Monitor the earth's surface and space environmental conditions
- Introduce improved atmospheric and oceanic observations and data dissemination capabilities
- Develop and provide new and improved applications and products for a wide range of federal agencies, state and local governments, and private users.

The primary instrument payload for the current series of GOES spacecraft consists of:

- The Imager, a multi-channel instrument designed to sense radiant and solar reflected energy. The GOES-13 spacecraft has 5 channels: one visible and four IR channels. The 13.3 micron IR channel is 8 km resolution and the other three IR have 4 km resolution.
- The Sounder, which provides data for atmospheric temperature and moisture profiles, surface and cloud top temperature and ozone distributions.

The newer GOES NOP spacecraft use star trackers for navigation for improved Image Navigation and Registration (INR). The spacecraft can apply compensation signals to the instrument servo motors to compensate for repeatable long-term orbit and attitude effects.

The GOES spacecraft also have Space Environmental Monitor (SEM) systems to measure magnetic fields, solar x-ray flux and high energy electrons, protons and alpha particles. GOES-13, GOES-14 and GOES-15 have the Solar X-Ray Imager (SXI) instrument to provide real-time images (once per minute) of the sun in the X-Ray band.

A data collection system on the GOES spacecraft receives and relays environmental data sensed by widely dispersed surface platforms such as river and rain gauges, seismometers, tide gauges, buoys, ships and automatic weather stations. Platforms transmit sensor data to the satellite at regular or self-timed intervals, upon interrogation by the satellite, or in an emergency alarm mode whenever a sensor receives information exceeding a preset level.

The GOES system produces a large number of primary data products. They include:

- Basic day/night cloud imagery and low level cloud and fog imagery.
- Upper and lower tropospheric water vapor imagery.
- Observations of land surface temperature data with strong diurnal variation.
- Sea surface temperature data.
- Winds from cloud motions at several levels and hourly cloud-top heights and amounts.
- Albedo and infrared radiation flux to space, important for climate monitoring and climate model validation.
- Detection and monitoring of forest fires resulting from natural causes and/or manmade causes and monitoring of smoke plumes.
- Precipitation estimates.

Data Product Usage: These data products enable users to accurately monitor severe storms, determine winds from cloud motion, and when combined with data from conventional meteorological sensors, produce improved short-term weather forecasts. The major operational use of 1 km resolution visible and 4 km resolution infrared multi-spectral imagery is to provide early warnings of threatening weather. Forecasting the location of probable severe convective storms and the landfall position of tropical cyclones and hurricanes is heavily dependent upon GOES infrared and visible pictures. The quantitative temperature and moisture and wind measurements are useful for isolating areas of potential storm development.

Major Users: GOES data products are used by a wide variety of both operational and research centers. The NWS's extensive use of multi-spectral imagery provides early warnings of threatening weather and is central to its weather monitoring and short-term forecast function. Most nations in the Western Hemisphere depend on GOES imagery for their routine weather forecast functions as well as other regional applications. GOES data products are also used by commercial weather users, universities, the Department of Defense, and the global research community, particularly the International Satellite Cloud Climatology Project, through which the world's cloud cover is monitored for the purpose of detecting change in the Earth's climate. Users of GOES data products are also found in the air and ground traffic control, ship navigation, agriculture, and space services sectors.

2.1.2 Status of spacecraft

The primary instrument payload and subsystem status for the current series of GOES spacecraft is provided in table 1.

Spacecraft	GOES-15	GOES-14	GOES-13	GOES-12
Launch Date	4 Mar 2010	27 Jun 2009	25 May 2006	23 Jul 2001
Operational Date	6 Dec 2011	9 Sep 2012	14 Apr 2011	1 Mar 2003
Mission Data Category	Operational (W)	Standby	Operational (E)	South America
Payload Instruments				
IMAGER	G	G	G	Y
SEM	G	G	Y	Y
SOUNDER	Y	G	G	Y
SXI	G	G	G	R
Spacecraft Subsystems				
TANDC	G	G	G	G
ACS	G	G	G	G
POWER	G	G	G	G
Thermal	G	G	G	G
GVAR	G	G	G	G
LRIT	G	G	G	G
EMWIN	Y	G	G	G
DCS	G	G	G	G

Operational GG	G	Spacecraft Issue but No User Impact	S/C
Operational with Limitation	Y	Operational with Degradation	O
Non-Operational	RR	Not Applicable	N/A

Table 1: Geostationary Operational Environmental Satellite (GOES) Performance Status *(as of 12 October 2012)*

Current Activities

The GOES-13 spacecraft, which had its sounder and imager instruments taken out of service because of technical trouble in late September 2012, will returned to full operations on October 18, 2012, as NOAA's GOES East satellite. The trouble stemmed from a motor vibration, which caused a lubricant buildup that obstructed the spinning motion of the filter wheel in the sounder. A team of engineers from NOAA, Boeing and ITT suppressed the vibration, the filter wheel restarted and is running smoothly, with improved performance. NOAA turned off the two instruments on September 23, and immediately configured GOES-15, the West Coast satellite, to provide additional coverage of the eastern United States and part of the Atlantic Ocean. Within a few hours, NOAA activated its on-orbit spare satellite, GOES-14, for full service.

And as a team of engineers from NOAA, Boeing and ITT continued to pinpoint the cause of the problem, NOAA began moving GOES-14 towards the position where GOES-13 was situated. GOES-14 will return to its earlier status as the on-orbit spare. GOES-13 had been NOAA's geostationary satellite, providing coverage of the U.S. East Coast, since April 14, 2010.

At 14:44z on 18 October, NOAA engineers restored the GOES-13 imager and sounder operations. GOES-13 data was inserted back into the GOES-13 GVAR data stream, replacing the GOES-14 data stream. GOES-13 is now fully functioning as GOES-East.

GOES-14 will be placed in standby mode at 95^{o} west.

2.1.3 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

1. Date and Universal Time of the anomaly	**2. Fully specified location of the anomaly** (spacecraft location)	**3. Velocity or orbital elements at time of the anomaly**	4. Eclipse state of the vehicle (full, penumbra, partial, none)	5. Vector to Sun in spacecraft coordinates	6. Velocity vector of spacecraft in spacecraft coordinates	7. Initial guess at type of anomaly (See taxonomy below)	8. Estimated confidence of that guess	9. Anomaly category (e.g., affected system or kind of disruption)	10. Vehicle identity	11. Notes (e.g. unusual operational states or recent changes to operations (recent commands, attitude scheme, etc.)
None										

Taxonomy of Satellite Anomalies Caused by In Situ Charged Particle Environment (to be used for column 7):

1. Electrostatic discharge (charging)
    1.1 Surface charging
        1.1.1 Plasma sheet (subauroral)
        1.1.2 Auroral
    1.2 Internal charging
        1.2.1 Subsurface charging (e.g., beneath blanket)
        1.2.2 Deep charging (e.g., inside a box)
2. Single-Event Effects
    2.1 Protons
        2.1.1 Solar proton event
        2.1.2 Geomagnetically trapped protons
    2.2 Heavy ions
        2.2.1 Galactic Cosmic Rays
        2.2.2 Solar energetic particles
        2.2.3 Geomagnetically trapped heavy ions
3. Total Dose
    3.1 Long-term dose accumulation (multiple causes combined)
    3.2 Short-term (days or less) dose accumulation
        3.2.1 Solar protons
        3.2.2 Geomagnetically trapped protons
        3.2.3 Geomagnetically trapped electrons

2.1.4 Ground segment matters

N/A

2.1.5 Data transmission

Data from the GOES spacecrafts are transmitted via:

- Low-Rate Information Transmission (LRIT),
- GOES Variable Format (GVAR) data transmission,
- GOES Data Collection service (DCS) and
- the Emergency Manager's Weather and Information Network (EMWIN).

2.1.6 Projects, services

N/A

2.1.7 User statistics*

- LRIT - 615 stations**
- GVAR - 720 stations**
- GOES DCS - 22,500 platforms**
- EMWIN - 5500 users

* The actual number of reception stations is assumed to be much higher since NOAA does not require users to register their stations and manufacturers do not disclose clients information.

** The number of user per station/platform is unknown.

2.2 Status of current LEO satellite systems

2.2.1 Polar Orbiting Meteorological Satellite Systems (POES)

The POES spacecraft constellation includes one primary, three backups, and one secondary spacecraft. These spacecraft are in circular orbits inclined at approximately 98 degrees (retrograde). On September 17, 2012, the European Meteorological Operational (METOP)-B spacecraft was aboard a Soyuz launch vehicle that launched from Baikonur Cosmodrome in Kazakhstan. MetOp-B is the second of three European Space Agency (ESA) and European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) weather satellites.

The instrument payload includes: the Advanced Scatterometer (ASCAT), the Microwave Humidity Sounder (MHS), the Global Navigation Satellite System Receiver for Atmospheric Sounding (GRAS), the Global Ozone Monitoring Experiment -2 (GOME-2), the Infrared Atmospheric Sounding Interferometer (IASI) as well as the NOAA-provided; Advanced Microwave Sounding Unit (AMSU)-A1 and AMSU-A2, the Advanced Very High Resolution Radiometer (AVHRR), the High Resolution Infrared Radiation Sounder (HIRS) and the Space Environment Monitor (SEM). In addition, METOP-B carries instruments to support the Argos data collection service and the international COSPAS-SARSAT Search and Rescue program.

After a six month checkout period, METOP-B is scheduled to replace METOP-A as the primary morning spacecraft.

2.2.2 Mission objectives, payload/instruments, products

The primary mission of the POES system is to provide daily global observations of weather patterns and environmental measurements of the Earth’s atmosphere, its surface and cloud cover, and the proton and electron flux at satellite altitude; and to establish long-term data sets for climate monitoring and assessment and climate change predictions. Since the beginning of the POES program, environmental data and products acquired by its satellites have been provided to users around the globe.

Data from the POES series supports a broad range of environmental monitoring applications including weather analysis and forecasting, climate research and prediction, global sea surface temperature measurements, atmospheric soundings of temperature and humidity, ocean dynamics research, volcanic eruption monitoring, forest fire detection, global vegetation analysis, search and rescue, and many other applications.

The POES instruments are:

- Advanced Very High Resolution Radiometer (AVHRR/3),
- High Resolution Infrared Radiation Sounder (HIRS/4),
- Advanced Microwave Sounding Unit (AMSU-A and B),
- Solar Backscatter Ultraviolet Spectral Radiometer (SBUV/2),
- Microwave Humidity Sounder (MHS),
- Space Environment Monitor (SEM),
- Search and Rescue Satellite Aided Tracking System (SARSAT) and
- Advanced Data Collection System (A-DCS)

2.2.3 Status of spacecraft

Table 2 provides the current status of the instruments, subsystems and services on the NOAA POES spacecrafts.

Spacecraft	METOP-A	NOAA-19	NOAA-18	NOAA-17	NOAA-16	NOAA-15
Launch Date	Oct 2006	Feb 2009	May 2005	Jun 2002	Sep 2000	May 1998
Operational Date	May 2007	Jun 2009	Aug 2005	Oct 2002	Mar 2001	Dec 1998
Mission Data Category	Primary (AM)	Primary (PM)	Backup (PM)	Backup (AM)	Backup (PM)	Secondary (AM)
Payload Instruments						
AVHRR	G	G	G	R	Y	Y
HIRS	G	G	R	G	Y	R
AMSU-A1	G	G	G	R	Y	Y
AMSU-A2	G	G	G	G	G	
AMSU-B	N/A	N/A	N/A	O	G	R
MHS	G	Y	G	N/A	N/A	N/A
SEM	G	G	G	G	G	G
SBUV	N/A	S/C	G	G	Y	N/A
Spacecraft Subsystems						
Telemetry, Command & Control	G	G	G	G	G	G
ADACS	G	G	G	G	Y	Y
EPS	G	G	G	Y	G	G
Thermal Control	G	G	G	G	G	Y
HRPT/AHRPT	Y	G	G	G	G	Y
APT/LRPT	R	G	G	G	R	G
SAR	G	G	G	G	Y	Y

Operational GG	G	Spacecraft Issue but No User Impact	S/C
Operational with Limitation	Y	Operational with Degradation	O
Non-Operational	RR	Not Applicable	N/A

Table 2: Polar-orbiting Operational Environmental Satellite (POES) Performance Status *(as of 11 October 2012)*

2.3 Current Status of Jason-2 and Activities for the Jason-3 Program

The OSTM/Jason-2 and Jason-3 missions are a joint collaboration among four organizations: National Oceanic and Atmospheric Administration (NOAA), National Aeronautics & Space Administration/Jet Propulsion Laboratory (NASA/JPL), Centre Nationale d'Etudes Spatiales (CNES) and European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). These missions were established through a Memorandum of Understanding (MOU) among the partners.

The Jason-2 satellite was launched in June 2008, with a design lifetime of three years and an extended lifetime of two additional years.

The OSTM/Jason-2 ground segment consists of satellite command & control and near real-time data activities since its June 2008 launch. The OSTM space segment, the Jason-2 satellite consists of the satellite-bus, the payload module, and the payload instruments. CNES provides the satellite-bus (the PROTEUS platform) and the payload module. CNES and NASA jointly provide the payload instruments. Jason-2 has a required mission life of three with a design life goal of five years. It is in an orbit with 66 degrees inclination, with apogee of 1,380 km and perigee of 1,328 km. Its orbital period is 112 minutes which provides for a repeat cycle of 9.9156 days. In June, 2011, Jason-2 achieved a major milestone. Jason-2 satellite mission met its 3 years required design life and continues to perform well.

For Jason-3, multiple design reviews have been successfully completed and the development for the instruments is nearing completion and scheduled to be delivered for integration in February 2013. The SpaceX Falcon9 has been selected as the launch vehicle. The ground system upgrades have been implemented and initial testing with the partners has already started.

2.3.1 Mission objectives, payload/instruments, products

The OSTM/Jason-2 mission provides service continuity for the predecessor research missions TOPEX/Poseidon and Jason-1. The Jason-2 instruments collect sea surface height measurements as well measurement of significant wave height and wind speed at ocean surface using a satellite mounted radar altimeter. The sea surface height measurements are used for Ocean Climatology and Ocean Weather applications.

For NOAA, the Jason-2 system implementation leverages and augments the existing NOAA operational polar satellite ground segment.

Jason-3 will continue to provide the data continuity. Jason-3 will have a similar instrument suite and the same orbital characteristics as OSTM/Jason-2. The Jason-2 ground system will be upgraded to support dual Jason-2 and Jason-3 satellite operations.

The Jason-2 spacecraft core instruments are presented below:.

Type	Instrument	Description
Core Mission	Poseidon-3 Radar Altimeter	This is the mission's main instrument. It measures sea-level height, wave height, and wind speed.
	Advance Microwave Radiometer (AMR)	The AMR measures *water vapor* content in the atmosphere. It is used to correct for delays in the *radar* signal propagation due to atmospheric water vapor content.
Location System	Doris Tracking Receiver	This receiver locates the on orbit satellite in real time, information essential for providing *altimetry* data in near real time or offline.
	Laser Reflector Array (LRA)	The LRA is a totally passive reflector designed to reflect laser pulses back to their point of origin on Earth, allowing the OSTM spacecraft to be tracked with centimeter accuracy by 40 satellite laser ranging stations.
	GPS Payload receiver (GPSP)	This tracking system uses the GPS constellation of satellites to determine the exact position of a transmitter. It also provides backup precise orbit determination.

The Jason-2 Ground System for the OSTM is made up of NOAA, NASA, CNES, and EUMETSAT ground segments. The NOAA Satellite Operations Control Center (SOCC) is the primary mission operations center. NOAA operates and controls the Jason-2 satellite with support from CNES and NASA/JPL for mission planning, satellite, and instrument monitoring. NOAA schedules and conducts satellite operations through the NOAA Command & Data Acquisition Stations (CDASs) at Wallops and Fairbanks and remotely through the Usingen Earth Terminal (ET) for satellite telemetry collection and commanding.

NOAA and EUMETSAT receive and store the satellite telemetry and instrument data at their respective ground stations (CDASs, ET), process the near-real-time (NRT) science data and

generate products, and make them available to the four mission partners and science users. EUMETSAT and NOAA produce and exchange Operational Geophysical Data Records (OGDRs) products. The OGDRs are made available within 3 to 5 hours of observation.

CNES produces and distributes off-line products: the altimetry science products called Geophysical Data Records (GDRs). The GDR is a fully validated product that uses a precise orbit and the best environmental/geophysical corrections. This product is available per repeat cycle with a latency of 60 days. The GDRs are disseminated to users as they become available, and are ingested in the two mission archives at CNES and NOAA.

2.3.2 Jason-3 Mission and Systems Overview

With a planned launch date in 2014, the Jason-3 mission will ensure the continuity of the 20 plus year sea surface height data record. NOAA and EUMETSAT are the lead agencies for the program. CNES will act as the system coordinator at the technical level, and NASA will support science team activities.

The Jason-2 ground system will be upgraded to support dual Jason-2 and Jason-3 operations.

The accuracy requirements for Jason-3 sea surface height, wind speed, and significant wave height data are identical to OSTM/Jason-2.

Major responsibilities of the organizations are described below:

NOAA will provide the Advanced Microwave Radiometer (AMR) and its antenna, a laser retroreflector array (LRA), and a Global Positioning System Payload (GPSP) receiver package. NOAA will also provide the launch vehicle and launch services. NOAA will be responsible for the operation of the satellite and the generation of near-real-time products from the data collected at the CDASs. NOAA will archive and disseminate all near-real-time and off-line data products.

EUMETSAT and CNES will jointly provide the PROTEUS platform, the Poseidon dual-frequency radar altimeter and antenna, and the Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) receiver package, the payload module and its integration, the command and control center for the satellite, and a second European Earth Terminal (EET) at Usingen. EUMETSAT will be responsible for generation of near-real-time products from the data collected at the EET. CNES will archive and disseminate all near-real-time and off-line data products.

2.2.3 Conclusions

The operational OSTM/Jason-2 mission has demonstrated that a research project can be successfully transitioned to an operational system that provides continuity of data to the international oceanic/scientific community. It has also demonstrated that international cooperation for an operational mission can provide benefits to the entire scientific community. The major benefits derived from the mission data and products are:

- Altimetry assimilation into global and regional ocean models
- Monitoring sea level rise, global climate change
- Monitoring high seas wind and wave conditions
- Forecasting hurricane intensification
- Hazard monitoring

Jason-3 will continue the international cooperation and will extend the continuity of more than 20-years of sea surface height measurements for Ocean Climatology and Ocean Weather.

2.4. Current Status of the Deep Space Climate Observatory (DSCOVR)

The DSCOVR program started in late 2011 when funding began. Launch is targeted for June 2014. The DSCOVR satellite was originally designed for 2 a year mission life. Based on the long life of spacecraft built on the same bus (Small Mission Explorer Lite – SMEX-Lite), the DSCOVR spacecraft will have expendables (e.g. propellant) for at least 5 years of mission duration. DSCOVR a joint program between three agencies: NOAA, USAF, and NASA. NOAA is funding a reimbursable project at NASA Goddard Space Flight Center (GSFC) to refurbish the spacecraft and build the ground system. NOAA is also providing satellite operations, product processing, archive, and forecast products. NASA is providing the DSCOVR spacecraft, in addition to reimbursable activities. The USAF is providing launch service. The international RTSWnet will continue to take down realtime solar wind data from DSCOVR.

Funding for DSCOVR and implementation are in progress. NOAA was appropriated $2 million in Fiscal Year (FY) 2011 for program startup and systems engineering. NOAA and NASA signed an initial Interagency Agreement (IAA) in November 2011. NOAA received a further $30 million appropriation in FY2012 that is being transferred to NASA to fund refurbishment activities. USAF received a $134 million appropriation in FY2012 for the Orbital-Suborbital small and medium space lift program (OSP-3) that will procure a launch for DSCOVR. OSP-3 contract award is expected in December 2012.

The NASA DSCOVR project passed a Rebaseline Review in June 2012 for a June 2014 launch readiness date. NASA's refurbishment of the spacecraft is well underway. The spacecraft has been disassembled and components are undergoing refurbishment in preparation for re-assembly, integration, and test.

The DSCOVR program received direction the White House Office of Management and Budget (OMB) to prepare the legacy Earth science instruments for operations, in addition to the solar wind instruments. The program will be rephased in September 2012 to include the Earth science instruments without additional funding until FY2015.

2.5 Current Status of Cosmic-2 and Plan to Increase GPS-RO Global Coverage

The United States and Taiwan, through an Agreement signed in May 2010, have agreed to jointly develop a satellite program to deliver next-generation global navigation satellite system (GNSS) radio occultation (RO) data to users around the world. This Program, known as FORMOSAT-7/COSMIC-2, is a follow-on to the FORMOSAT-3/COSMIC mission, which was a joint US-Taiwan 6-satellite constellation demonstration mission launched in April 2006. The COSMIC mission was the world's first operational GPS radio occultation (GPS-RO) mission for global Earth weather forecast; climate monitoring; atmospheric, ionospheric, and geodetic research. The GPS-RO data from COSMIC has been extremely valuable to the climate, meteorology, and space weather communities, including real-time forecasting users as well as U.S. and international research communities. Unfortunately, COSMIC reached the end of its design life in 2011 and the critical real-time satellite observing capability has begun to significantly degrade as satellites become no longer operational.

The National Oceanic and Atmospheric Administration (NOAA) and Taiwan's National Space Organization (NSPO) have both experienced difficulties in the past two years with respect to the FORMOSAT-7/COSMIC-2 Program; however, significant progress on the Program has occurred – particularly in the past 6 months. The US partnership for COSMIC-2 now consists of a partnership with the US Air Force. The Air Force through their Space and Missile Center in Los Angeles, CA is now on contract to provide the first six COSMIC-2 primary payloads and the launch vehicle for the first 6 COSMIC-2 satellites. This new partnership has also allowed Taiwan's NSPO to proceed with their spacecraft award which was made to Surrey Satellite Technology Limited (SSTL) UK in July 2012. In August 2012, the US team initiated a ground architecture study team that is examining the use of existing infrastructure domestically and internationally to capture the RO data from COSMIC-2 to meet operational data latencies. Active discussions have begun with NOAA's international partners in Brazil, France and Australia. The study team anticipates initial findings by Dec 2012. NOAA and the NSPO are poised to finalize spacecraft and system designs over the next 12 months.

2.6 Report on the Current Defense Meteorological Satellite Program (DMSP)

Similar to the civilian POES program, the DMSP program designs, launches, and maintains several near polar orbiting, sun synchronous satellites monitoring the meteorological, oceanographic, and solar-terrestrial physics environments. The visible and infrared sensors collect images of global cloud distribution across a 3,000-kilometer swath during both daytime and night time conditions. The current DMSP constellation consists of two primary, two secondary, and two backup operational spacecraft.

2.7 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

1. Date and Universal Time of the anomaly	**2. Fully specified location of the anomaly** (spacecraft location)	**3. Velocity or orbital elements at time of the anomaly**	4. Eclipse state of the vehicle (full, penumbra, partial, none)	5. Vector to Sun in spacecraft coordinates	6. Velocity vector of spacecraft in spacecraft coordinates	7. Initial guess at type of anomaly (See taxonomy below)	8. Estimated confidence of that guess	9. Anomaly category (e.g., affected system or kind of disruption)	10. Vehicle identity	11. Notes (e.g. unusual operational states or recent changes to operations (recent commands, attitude scheme, etc.)
None										

Taxonomy of Satellite Anomalies Caused by In Situ Charged Particle Environment (to be used for column 7):

1. Electrostatic discharge (charging)
    - 1.1 Surface charging
        - 1.1.1 Plasma sheet (subauroral)
        - 1.1.2 Auroral
    - 1.2 Internal charging
        - 1.2.1 Subsurface charging (e.g., beneath blanket)
        - 1.2.2 Deep charging (e.g., inside a box)
2. Single-Event Effects
    - 2.1 Protons
        - 2.1.1 Solar proton event
        - 2.1.2 Geomagnetically trapped protons
    - 2.2 Heavy ions
        - 2.2.1 Galactic Cosmic Rays
        - 2.2.2 Solar energetic particles
        - 2.2.3 Geomagnetically trapped heavy ions
3. Total Dose
    - 3.1 Long-term dose accumulation (multiple causes combined)
    - 3.2 Short-term (days or less) dose accumulation
        - 3.2.1 Solar protons
        - 3.2.2 Geomagnetically trapped protons
        - 3.2.3 Geomagnetically trapped electrons

2.7.1 Ground segment matters

N/A

2.7.2 Data transmission

Current transmission services on the POES spacecrafts includes:

- GAC (Global Area Coverage) Playback - Reduced resolution AVHRR data (4 km) plus stored TIP data at full resolution soundings. GAC data is derived on-board the NOAA satellite by subsampling and averaging the nominal 1 km AVHRR imagery. It provides daily global coverage recorded on-board and transmitted to a NOAA ground station. About 115 minutes of GAC data can be stored on-board.

- LAC (Local Area Coverage) - LAC is nominally 1 km resolution AVHRR imagery (which is normal or `high' resolution data) recorded with the on-board tape recorder for subsequent transmission to a NOAA ground station. About 11 minutes of LAC data can be accommodated on a recorder. LAC imagery can only be obtained from NOAA/NESDIS.

- HRPT (High Resolution Picture Transmission) - Full resolution AVHRR & TIP data, Frequency: 1698 or 1707 MHz, data rate = 665.4 kbit/s, split phase PSK. The imagery is available in a format defined by the ground receiving station.

- APT (Automatic Picture Transmission) - Reduced resolution geometrically corrected analog video from two channel of AVHRR, selected by user command. Frequency: 137.50 or 137.62 MHz

- DSB Direct Sounder Broadcasting) - A VHF beacon to users who don't have S-band reception. Data content: HIRS, SEM, DCS, SBUV, & Eph

2.7.3 Projects, services

N/A

2.7.4 User statistics *

- GAC - Unknown
- LAC – Unknown
- HRPT – 536 stations**
- APT – >5000 stations**
- DSB – Unknown

* The actual number of reception stations is assumed to be much higher since NOAA does not require users to register their stations and manufacturers do not disclose clients information.

** The number of user per station/platform is unknown.

2.8 Status of current HEO [or other] satellite systems

N/A

2.8.1 Mission objectives, payload/instruments, products

N/A

2.8.2 Status of spacecraft

N/A

2.8.3 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

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2. Single-Event Effects
    - 2.1 Protons
        - 2.1.1 Solar proton event
        - 2.1.2 Geomagnetically trapped protons
    - 2.2 Heavy ions
        - 2.2.1 Galactic Cosmic Rays
        - 2.2.2 Solar energetic particles
        - 2.2.3 Geomagnetically trapped heavy ions
3. Total Dose
    - 3.1 Long-term dose accumulation (multiple causes combined)
    - 3.2 Short-term (days or less) dose accumulation
        - 3.2.1 Solar protons
        - 3.2.2 Geomagnetically trapped protons
        - 3.2.3 Geomagnetically trapped electrons

2.8.4 Ground segment matters

N/A

2.8.5 Data transmission

N/A

2.8.6 Projects, services

N/A

2.8.7 User statistics

N/A

2.9 Status of current R&D satellite systems

N/A

2.9.1 Mission objectives, payload/instruments, products

N/A

2.9.2 Status of spacecraft

N/A

2.9.3 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

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N/A										

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        - 3.2.3 Geomagnetically trapped electrons

2.9.4 Ground segment matters

N/A

2.9.5 Data transmission

N/A

2.9.6 Projects, services

N/A

2.9.7 User statistics

N/A

3 FUTURE SATELLITE SYSTEMS

FUTURE POLAR-ORBITING SATELLITES COORDINATED WITHIN CGMS
(as of 11 October 2012)

Orbit type (equatorial crossing times)	Future Additional Satellites	Operator	Planned launch date	Other information
Sun-synchr. "Morning" (6:00 – 12:00) (18:00 – 24:00)	DMSP F-20	NOAA	2014	(SSMI/S)
Sun-synchr. "Afternoon" (12:00 – 16:00) (00:00 – 04:00)	JPSS-1	NOAA	2Q FY2017	(833 km) (13:30 A) HRD
	JPSS-1	NOAA	1Q FY2022	(833 km) (13:30 A) HRD
	Free Flyer-1	NOAA	4Q FY2016 (LRD)	(833 km) (13:30 A) HRD
	Free Flyer-2	NOAA	3Q FY2021 (LRD)	(833 km) (13:30 A) HRD

FUTURE GEOSTATIONARY SATELLITES COORDINATED WITHIN CGMS
(as of 11 October 2012)

Sector	Future additional satellites	Operator	Launch Readiness	(Planned location) Other remarks
EAST PACIFIC (180°W-108°W) AND WEST-ATLANTIC (108°W-36°W)	GOES-R	USA/NOAA	10/2015	137° W or 75° W
	GOES-S	USA/NOAA	02/2017	137° W or 75° W
	GOES-T	USA/NOAA	04/2019	137° W or 75° W
	GOES-U	USA/NOAA	10/2024	137° W or 75° W

3.1 Status of future GEO satellite systems

NOAA-WP-09 provides a status and an overview of NOAA's future GOES satellite system, the GOES-R Series. Steady progress on the development of the GOES-R Program continued throughout 2011 and, to date, in 2012. All the GOES-R instruments are nearing completion of their first flight models and will begin environmental testing in late 2012 and early 2013. Delivery of the instruments for integration on the GOES-R spacecraft is expected in mid-to-late 2013. In addition to progress on the instruments, the GOES-R Program continued development of the spacecraft and ground system.
The new GOES-R series of satellites will advance operational environmental remote sensing technology by several decades. The technological advances will provide environmental information over a greater geographical location in less time, at higher resolutions, and with higher spectral content.

3.1.1 Mission objectives, spacecraft, payload/instruments, products

GOES-R Mission Objectives:

- To maintain GOES mission continuity and quality in environmental observations in the 2015-2028 timeframe
- To provide enhanced environmental data products
- To improve services and data being provided to Users

- To be responsive to technology infusion to meet evolving User needs.

GOES-R instrument payload includes:

- Advanced Baseline Imager (ABI)
- Space Environmental In-Situ Suite (SEISS
- Solar Ultra Violet Imager (SUVI)
- Extreme Ultra Violet / X-Ray Irradiance Sensor (EXIS)
- Geostationary Lightning Mapper (GLM)
- Magnetometer (MAG)

For a list of the GOES-R products, see http://www.goes-r.gov/products/baseline.html.

3.1.2 Ground segment matters

For an overview and status of the GOES-R ground segment please see http://www.goes-r.gov/ground/overview.html.

3.1.3 Data transmission

GOES-R continues to develop and improved direct services, such as GOES-R Re-Broadcast (GRB), Search and Rescue (SAR), Data Collection System (DCS), Emergency Managers Weather Information Network (EMWIN) and High Rate Information Transmission (HRIT). Each of these systems are progressing well in their fabrication phases. Please see NOAA-WP-28 for additional information.

3.2 Status of future LEO satellite systems

The development and implementation plans for JPSS are continuing as scheduled. Spacecraft will be launched into an orbital plane to provide significantly improved operational capabilities and benefits to satisfy the critical civil and national security requirements for space-based, remotely sensed environmental data. The advanced technology visible, infrared, and microwave imagers and sounders that are being developed will deliver higher spatial and resolution atmospheric, oceanic, terrestrial, and solar-geophysical data enabling more accurate short-term weather forecasts and significantly improved long range numerical weather forecasts as well as serving the data continuity requirements for improved global climate change assessment and prediction. The program is on the path to creating a high performance, polar-orbiting satellite system that will be more responsive to user requirements and provide sustained, space-based measurements as a cornerstone of an Integrated Global Observing System. These activities represent a sound beginning for achieving the planned national and international operational satellite programs that will ensure continuous support to a variety of users.

3.2.1 Mission objectives, spacecraft, payload/instruments, products

JPSS will provide continuity of critical observations for accurate weather forecasting, reliable severe storm outlooks, global measurements of atmospheric and oceanic conditions such as sea surface temperatures, ozone, and more. JPSS will also monitor rescue beacons to help save lives through the international SARSAT program and continue support for the French provided Advanced Data Collection System (ADCS).

The JPSS instrument payload includes:

- Visible/Infrared Imager/Radiometer Suite (VIIRS)
- Cross-track Infrared Sounder (CrIS)
- Advanced Technology Microwave Sounder (ATMS)
- Ozone Mapping and Profiler Suite (OMPS)
- Cloud and Earth Radiant Energy System (CERES)
- Total Solar Irradiance Sensor (TSIS)

The JPSS spacecraft will capable of providing 30 Environmental Data Records (EDRs) including four Key Performance Parameters (KPPs);

- Imagery
- Atmospheric Vertical Temperature Profile
- Atmospheric Vertical Moisture Profile
- Sea Surface Temperature

For additional information, see www.star.nesdis.noaa.gov/jpss/ or www.nesdis.noaa.gov/jpss/.

3.2.2 Ground segment matters

See www.nesdis.noaa.gov/jpss/.

3.2.3 Data transmission

See NOAA-WP-28.

3.3 Status of future HEO [or other] satellite systems

N/A

3.3.1 Mission objectives, spacecraft, payload/instruments, products

N/A

3.3.2 Ground segment matters

N/A

3.3.3 Data transmission

N/A

3.4 Status of future R&D satellite systems

N/A

3.4.1 Mission objectives, spacecraft, payload/instruments, products

N/A

3.4.2 Ground segment matters

N/A

3.4.3 Data transmission

N/A

4 ACTIONS AND/OR RECOMMENDATIONS FOR CONSIDERATION BY CGMS PLENARY SESSION

None.

5 CONCLUSIONS

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