Joint Polar Satellite System (JPSS) Program

Level 1 Requirements Document – Preliminary

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Change Log

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Revision	Date	Sections Changed	Author
4.6	May15, 2011	2.5 – Clarification on NOAA procuring CERES instruments	C. Baker
4.6	May 15, 2011	5.1.18 NOAA JPSS program shall support hardware and software modifications to NOAA's CLASS archive to accommodate the archiving of NPP/JPSS data.	C. Baker
4.6	June 24, 2011	Appendix A – Addition of definition of CLASS	D. Brauer
4.6	Sept 14, 2011	2.1 – Clarification of NOAA's acquisition strategy relating to JPSS sensors for EUMETSAT.	D.Brauer
4.6	Sept 14, 2011	5.1.2.1 – Inserted language clarifying transition from cal/val to long-term monitoring	D.Brauer
4.6	Sept 14, 2011	5.1.11 and 5.1.11.1 – Clarification of differences between GCOM-C and –W and mission of GCOM-C	D.Brauer
4.6	Sept 14, 2011	5.1.18 – Clarification that the DWSS data stream will be part of JPSS System for archiving of data for CLASS.	D.Brauer
4.6	Sept 14, 2011	8 – Insertion of language that the reference documents will be available from the NOAA JPSS Office	D.Brauer
4.7	Sept 22, 2011	3 - Insertion of launch readiness dates for JPSS-1/2	D.Brauer
4.7	Sept 22, 2011	4 – Deletion of references to CERES Follow-on	D.Brauer
4.7	Sept 22, 2011	4 – Deletion of reference to SEM-N flying on JPSS-2	D.Brauer
4.7	Sept 22, 2011	5.3.5 Deletion of CERES Follow-on 5.3.5.1 – insertion that CERES Follow-on is objective for JPSS-2	D.Brauer

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1 DOCUMENT PURPOSE AND SCOPE

Requirements definition is an initial step in the NOAA program management process as per NOAA Administrative Order 216-108 "Requirements Management." NOAA's Level 1 requirements are primarily top-level, user-driven requirements for environmental observing capability (data, products) needed to achieve NOAA's mission and may also include program responsibilities as decreed by management decisions. They represent a subset of the NOAA Consolidated Observing Requirements List (CORL) that can be satisfied by a realistically executable observing program.

User requirements will flow through the NOAA Observing Systems Council (NOSC) to Deputy Under Secretary of Commerce for Operations (DUS-O) for approval. Interagency input and review are provided by NOAA Goal Teams, NOAA Line Offices, and interagency environmental satellite coordinating organizations.

If substantive changes in the program requirements are needed, this document must be updated, coordinated through the NOSC, and presented to the DUS-O before changes are approved and implemented.

This document defines the preliminary Level 1 performance requirements to govern the NOAA Joint Polar Satellite System (JPSS) program through its transition and formulation period. The JPSS Level 1 requirements have been defined collaboratively by a team of current and future polar satellite users in coordination with National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD).

The JPSS Program is NOAA's portion of the restructured National Polar-orbiting Operational Environmental Satellite System (NPOESS) program. The JPSS will provide operational continuity of satellite-based observations and products for NOAA Polar-orbiting Operational Environmental Satellites (POES) and the NPOESS Preparatory Project (NPP) satellite and ground systems.

The purposes of this Level 1 Requirements Document (L1RD) are to:

- Provide the high-level definition and concept for the program;
- Provide the high level performance requirements*
- Define key program stakeholders and their high-level roles and responsibilities;
- Define program success criteria.

*High-level cost and schedule requirements are currently captured in the Formulation Authorization Document (FAD) and will be updated in this document when the baseline is established at Key Decision Point I.

Because the JPSS will be developed using considerable material investments from NPOESS, many procurement decisions have already been made and will be reflected in this document. However, latitude will be given to allow cost effective acquisition decisions to be made by the JPSS Program. Important information is contained in Appendix A to clarify assumptions and limitations.

The JPSS Program has the latitude to satisfy some requirements through partner assets, including, but not limited to the DOD meteorological satellites, European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Meteorological Operational (Metop) satellites and Japanese Aerospace Exploration Agency (JAXA) Global Change Observation Mission (GCOM) satellites.

The Supplement to this document provides further technical elaboration of the requirements contained herein. The Supplement will be reviewed by NOAA and NASA and approved by the NOSC Co-Chairs.

2 PROGRAM DEFINITION

In Fiscal Year (FY) 2010, the Administration directed NOAA, NASA and DOD to restructure the NPOESS program and assigned responsibility to NOAA and DOD to manage complementary polar observing programs. NOAA, through NASA as its acquisition agent, will procure the afternoon orbit assets that support its civil weather and climate requirements and develop a shared common ground system. DOD will independently procure assets for the early morning orbit environmental satellite mission. Both agencies will continue to share environmental data made by the systems and support the operations of a shared common ground system.

2.1 JPSS Heritage

The JPSS will implement NOAA's requirements to provide global environmental data primarily from low Earth-orbiting satellites in support of NOAA's mission to understand and predict changes in weather, climate, oceans and coasts, and the space environment which support the Nation's economy, and protect lives and property.

The JPSS Program will help ensure the continuation into the future of NOAA's ongoing polar satellite cooperation with EUMETSAT. An agreement between NOAA and EUMETSAT on an Initial Joint Polar-orbiting Satellite System (IJPS) was signed on November 19th, 1998. The primary mission of the IJPS is to collect and exchange environmental data from polar orbit between NOAA and EUMETSAT and to disseminate the data to users in support of operational meteorological and environmental forecasting and global climate monitoring. The IJPS satellites include NOAA-18, NOAA-19, and Metop-1, -2. In addition, the Agreement between NOAA and EUMETSAT on Joint Transition Activities regarding Polar-orbiting Operational Environmental Satellite Systems, signed on June 24, 2003, and amended January 20, 2005 and February 16, 2006, extended this cooperation to include the NPOESS satellites and Metop-3.

NOAA and EUMETSAT have entered into discussions on a Joint Polar System (JPS). It is envisioned that JPSS capabilities will be the NOAA contribution to JPS and the Metop follow-on polar-orbiting satellite capabilities, known as the EUMETSAT Polar

System Second Generation (EPS-SG), will be EUMETSAT's contribution to JPS. The NOAA acquisition strategy will include the potential for EUMETSAT-funded options for additional sensors.

2.2 *Objectives*

The overarching program objective is to sustain continuity of and enhance NOAA's Earth observation analysis, forecasting and climate monitoring capabilities from global polar-orbiting observations.

2.3 Needs

NOAA's Mission: Science, Service, and Stewardship to understand and anticipate changes in climate, weather, oceans, and coasts; share that knowledge and information with others, and to conserve and manage marine resources. NOAA's long-term goals are:

- Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts.
- Weather-Ready Nation: Society is prepared for and responds to weather-related events.
- Healthy Oceans: Marine fisheries, habitats, and biodiversity are sustained within healthy and productive ecosystems.
- Resilient Coastal Communities and Economies: Coastal and Great Lakes communities are environmentally and economically sustainable.

Polar-orbiting satellites meet many current and near-term national operational environmental sensing requirements for continuous observation of Earth's environment. To meet these requirements and accomplish its mission, the polar orbiting environmental satellite program performs four major functions:

- Provides environmental sensing from polar sun-synchronous orbit.
- Provides Data Collection Service capability.
- Provides broadcast of environmental data to distributed users
- Provides relay of distress signals from aircraft or marine vessels to search and rescue ground stations.

2.4 Stakeholders

There are three primary categories of JPSS stakeholders:

<u>Users</u> –This category includes current and future internal and external worldwide users of operational Low-Earth Orbiting (LEO) environmental satellite data and services. The user community includes all components of NOAA that perform analysis and forecasting of weather, climate, oceans and coasts, as well as interagency, international and private

users. Users are the immediate recipients of JPSS data that develop value-added products and services for others.

Data Providers – This category includes the organization(s) that will influence the JPSS Program and play a major role in providing data and services to the users. These stakeholders are primarily within NOAA organizations. This category also includes the DOD, NASA, EUMETSAT, and the Japanese Aerospace Exploration Agency (JAXA). Data providers are peer entities that also provide environmental data and services to Users.

Program Management and Oversight – This category is represented by the NOAA and NASA Program Management Councils (PMCs) and their designees. The NOAA Administrator has program management oversight authority and the NOAA PMC provides the forum for regular reviews and assessments of the JPSS Program. The DUS-O is the chair of the PMC and provides primary oversight on an ongoing basis.

2.5 Organizational Relationships and Responsibilities

The JPSS is a NOAA program that will be predominately acquired through NASA. As such, NOAA defines requirements and provides funding and requirements to NASA which is responsible for acquiring and integrating the system. The JPSS Program will be jointly managed by the NOAA and NASA requiring thorough integration and communication between the two agencies. The JPSS Program will transfer to NOAA responsibility for the JPSS satellites and ground systems operations after the launch, early orbit and activation phase, nominally 90 days after each launch.

The JPSS Program will assume accountability for the execution of the NPP responsibilities that formerly existed within the NPOESS Program. In accordance with the Final Implementation Agreement for NPP signed 17 September 2004, the NPOESS program provided the Cross-Track Infrared Sounder (CrIS), Visible Infrared Imager/Radiometer Suite (VIIRS), and Ozone Mapping Profiler Suite (OMPS), mission operations, and the ground data processing. NASA provided the spacecraft, the Advanced Technology Microwave Sounder (ATMS), Clouds and the Earth's Radiant Energy System (CERES), Mission Integration, and launch. NASA and NOAA provided funding for the integration and test of the OMPS (Limb) sensor which was delivered as part of the OMPS suite. NOAA will provide the data archive.

The JPSS Program will acquire for the JPSS satellites two each of the Advanced Technology Microwave Sounder (ATMS), Cross-track Infrared Sounder (CrIS), Visible Infrared Imager/Radiometer Suite (VIIRS), and OMPS Nadir (OMPS-N) sensor, with contract options to acquire additional units.

In order to simplify management of instrument development, the JPSS Program will acquire one each of the Clouds and the Earth's Radiant Energy System (CERES) and CERES Follow-on, two Total and Spectral Solar Irradiance Sensors (TSIS), and the OMPS-L using NOAA Climate Sensor Project funding rather than have NOAA procure the instruments. JPSS will integrate Climate Sensors onto the appropriate satellite platforms and produce satellite data products.

Two Advanced Data Collection System (A-DCS) and Search & Rescue Satellite Aided Tracking (SARSAT) systems will be provided to the JPSS Program under international agreements managed by NOAA. The A-DCS and SARSAT instruments will be supplied to the JPSS Program by the French and Canadian governments, respectively. The JPSS Program will maintain insight during the development phases of the SARSAT instruments and A-DCS. The JPSS Program will procure necessary receive/transmit antennas and ensure these, along with the A-DCS and SARSAT payloads are integrated on to suitable satellite platforms.

The JPSS Command, Control, and Communication Segment (C3S) will perform satellite operations for NPP, JPSS, and Defense Weather Satellite System (DWSS), with the Mission Management Center (MMC) being located at the NOAA Satellite Operations Facility (NSOF). The JPSS Program will install and upgrade the MMC as required for NPP, JPSS, and DWSS. NASA will operate and evaluate the JPSS satellites through launch and early orbit operations.

The JPSS Program will provide a backup command, control and communications capability, termed the Alternate Mission Management Center (AMMC), at a geographically distinct location from the MMC to meet mission operational availability requirements. The location of the AMMC will be consistent with NOAA's enterprise backup requirements. The JPSS budget will include NOAA's operations and sustainment costs for satellite operations at the AMMC for the life of the JPSS Program.

Additionally, the JPSS Program will upgrade the McMurdo Ground Station capabilities to receive stored mission data transmissions from the Defense Meteorological Satellite Program (DMSP) and Metop satellites. This will substantially reduce data latency.

The JPSS will provide data processing capabilities at four operational processing centers: National Environmental Satellite Data and Information Service (NESDIS), Air Force Weather Agency (AFWA), Fleet Numerical Meteorology and Oceanography Center (FNMOC), and Naval Oceanographic Office (NAVO). These four processing centers will be called Centrals throughout this document.

The JPSS Program will deliver an Interface Data Processing Segment (IDPS) with equipment at the four Centrals to ingest mission data from the C3S, generate data products and make them available to the users and NOAA archive. Responsibilities for the Interface Data Processing equipment and communications will be in accordance with the NOAA – Defense Meteorological Satellite Group Memorandum of Agreement for Common Ground System signed fall 2010. NOAA will assume sustainment of the JPSS ground system one year after the launch of JPSS-1. DOD will assume operations of IDPs at the DOD Centrals one year after launch of NPP, or at installation of the IDPs at the DOD Centrals, whichever is later. DOD will assume sustainment of the IDPs at the DOD Centrals at the launch of JPSS-1 plus one year.

The JPSS Program is not responsible for developing or deploying any direct readout field terminals. However, the JPSS will provide the Direct Readout community with software, documentation, and periodic updates to enable civilian and military agencies to use their own hardware to receive the JPSS High Rate Data (HRD) and Low Rate Data (LRD) broadcasts and produce data products from JPSS.

Responsibility for algorithm development, maintenance, and validation resides within the Common Ground System. NOAA will lead algorithm development and calibration/validation (cal/val) activities with assistance from NASA and other organizations as deemed necessary. The JPSS Program will coordinate with the DOD to ensure JPSS serves national needs.

Further description of the organizational roles and responsibilities will be documented in the JPSS Program Plan/Management Control Plan.

3 SYSTEM CONCEPT

The overarching concept of the JPSS is the continuation of polar-orbiting environmental satellite observations required to understand and predict changes in weather, climate, oceans and coasts, and the space environment. The JPSS will succeed NPP and NOAA POES satellites and ground systems. It will deliver an operational polar-orbiting satellite system that will equal or exceed NPP and NOAA POES capabilities in terms of quality, volume, accuracy and timeliness of environmental data products and services. The JPSS will avoid as much as possible gaps with existing POES and NASA Earth Observing System (EOS) capabilities of similar environmental data. The launch readiness dates for JPSS-1 and JPSS-2 are first quarter FY2017 and first quarter FY2022 respectively.

JPSS will provide a variety of environmental observations from the 1330 Local Time of the Ascending Node (LTAN) orbit. Together with satellites from the EUMETSAT in the 0930 orbit and DOD in the 1730 orbit, many observations can be refreshed at four-hour intervals. Additionally, the JPSS will acquire and process data from JAXA's Global Change Observation Mission (GCOM) as defined in Appendix B. The JPSS may also acquire data from other satellites to meet Program requirements.

NOAA and the DOD will plan for NOAA to continue operation of the DMSP follow-on environmental satellites, known as the DWSS, under a separate agreement.

JPSS Program will provide all data in accordance with Appendix B to the NOAA archive via the NESDIS IDP for long term storage where it can be accessed for broader off-line processing (or reprocessing) including the generation of CDRs and Climate Information Records (CIRs).

4 SYSTEM ARCHITECTURE

The JPSS will consist of satellites in the 1330 LTAN polar orbit sharing a Common Ground System (CGS) with the DWSS environmental satellites in the 1730 LTAN orbit. Elements of the CGS will also be used to collect, but not process, mission data from DMSP and Metop satellites received at the McMurdo Ground Station. Subject to the conclusion of an agreement with JAXA, the JPSS CGS will receive and process data from the GCOM satellites. The overall JPSS system architecture is shown schematically in Figure 1.

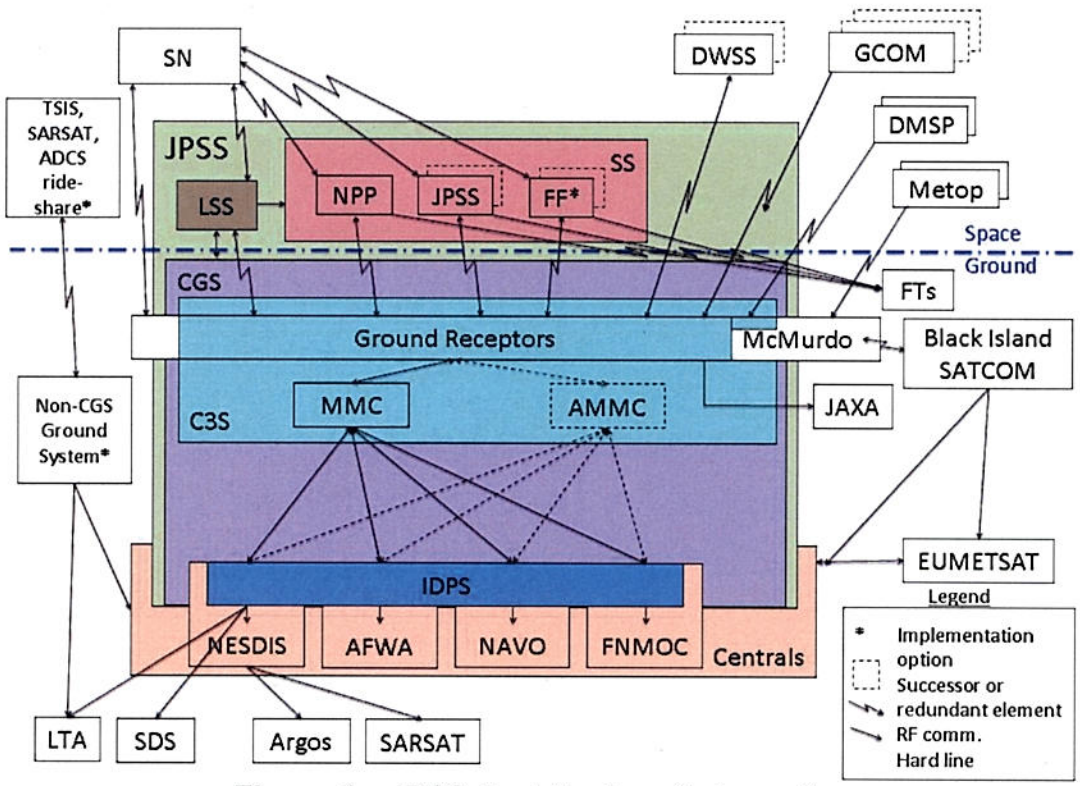

Figure 1: JPSS Architecture Schematic.
(Acronyms are defined in the text and in Appendix E.)

The JPSS will be comprised of four segments: the Launch Support Segment (LSS), the Space Segment (SS), the Command, Control and Communications Segment (C3S), and the Interface Data Processing Segment (IDPS). The CGS will be comprised of the C3S and the IDPS.

The LSS will consist of the launch services procured or obtained by the JPSS Program to place JPSS satellites in orbit.

The SS will consist primarily of the satellites carrying the ATMS, CrIS, VIIRS, OMPS, and CERES. This will be accomplished first by the use of NPP into the JPSS operational system following on-orbit acceptance, approximately 90 days after the NPP launch. To help ensure adequate continuity of environmental data collection from the

1330 LTAN orbit, NPP will be followed by an essentially identical satellite, designated JPSS-1. JPSS-1 will be followed, in turn, by JPSS-2 that will carry a similar instrument payload. These spacecraft operations may overlap. Four additional instruments and services (SEM-N, TSIS, SARSAT instruments, and A-DCS) were planned for the NPOESS 1330 LTAN orbits. SEM-N will be flown on the DWSS satellites. The JPSS Program and NOAA will conduct mission trade studies to determine the most efficient launch options for TSIS, SARSAT, and A-DCS. Study options include development and launch of a separate Free Flyer (FF) satellite optimized to accommodate TSIS, SARSAT instruments and A-DCS, or by utilizing ride-share opportunities on other satellites. JPSS-1, JPSS-2, and the Free Flyers are referred to as the JPSS satellites. These options are represented in Fig. 1 by asterisk. Instruments or services that fly on platforms other than NPP, JPSS-1, JPSS-2, or the FF satellites will be considered to be outside the JPSS since their launch services, spacecraft bus, and ground system would all be independent of the rest of the JPSS. However, the JPSS Program will be responsible for sensor accommodation of these payloads on suitable satellite missions and data retrieval from these payloads. The SS will nominally communicate at radio frequencies with the CGS, with Field Terminal (FT) users, and with the Global Positioning System (GPS). The SS will also communicate via the Tracking and Data Relay Satellite System (TDRSS) through the NASA Space Network (SN) during satellite launches and anomalies.

The C3S will consist of all components required to evaluate, sustain, command and control, and monitor the health and welfare of the satellites controlled by the CGS including all of their instrument/sensor payloads; receive mission data from the satellites; and deliver it to the IDPS. C3S elements consist of the MMC at Suitland, MD and the AMMC; elements of the Svalbard, Norway ground station; connections to the NASA SN; ground receptors; and the communications required to network all CGS components. The C3S will include an upgrade to the McMurdo Ground Station (MGS), Antarctica to enable receipt of mission data from DMSP and Metop satellites and relay of that data through the Black Island to Australia satellite communication link. Metop data will be relayed to EUMETSAT and DMSP data will be relayed to the DOD.

JPSS data requirements focus on the delivery of Raw Data Records (RDRs), Sensor Data Records (SDRs), Temperature Data Records (TDRs), Application Related Products (ARPs), Intermediate Products (IPs), and Environmental Data Records (EDRs) to the users. These data are collectively called xDRs and form the basis of the data processing products. Definitions of these products can be found in Appendices B and D. RDRs are processed (or reprocessed) outside the JPSS into Climate RDRs and, ultimately, into CDRs and CIRs that are core NOAA climate products.

The IDPS will consist of data processing equipment and software installed at the four Centrals. The IDPS will deliver observational data products to the Centrals. Each IDP unit will be user configurable to produce all or any subset of RDRs, SDRs, TDRs, ARPs, IPs, and EDRs. The IDP unit installed at NESDIS will also deliver data products to the archive and to the NASA Science Data System (SDS).

5 PERFORMANCE REQUIREMENTS

Performance requirements are defined in this section. In some cases both "threshold" and "objective" requirements are specified. Threshold requirements represent the minimally acceptable level of performance that must be achieved. Objective requirements represent an improved performance level above and beyond the threshold requirements that would better meet user needs and which are realistically achievable with current technology. If not explicitly specified, a performance requirement should be considered a threshold requirement.

Key Performance Parameters (KPPs) are system attributes that represent those minimum capabilities or characteristics considered most essential to achieve an effective system. The KPPs for the JPSS are included as part of the System Success Criteria (Section 7).

5.1 General and System Requirements

5.1.1 The JPSS shall have a total mission life cycle of twelve years, beginning when the first JPSS satellite is available for launch.

5.1.2 The JPSS shall deliver the observational data listed in Appendix B to the Centrals and NOAA archive service delivery point at NSOF. The JPSS L1RD Supplement provides clarification and elaboration of Appendix B.

5.1.2.1 The JPSS Program shall routinely provide and update, detailed characterization of the sensors and data processing performance. The JPSS Program will transition from an intensive calibration/validation period to long-term monitoring nominally between 6-12 months from launch. Long-term monitoring will consist of trending of instrument performance parameters which are part of the real-time data stream, and intercomparing sensors with other sensors. The JPSS shall deliver metadata to include, at a minimum, information on satellite status, associated algorithm packages, telemetry, calibration, navigation, and other information necessary for off-line reprocessing and for off-line climate data processing.

5.1.2.2 The JPSS shall deliver RDRs and metadata to the NASA SDS service delivery point at the NSOF.

5.1.3 Data latency shall be within 80 minutes from the JPSS-1 mission and within 30 minutes from the JPSS-2 (Objective: 15 minutes) unless a longer latency is stated in the L1RD Supplement for specific EDRs.

5.1.3.1 Data latency requirements shall be met at least 95% (Objective: 98%) of the time on a monthly basis for EDRs and ARPs from data collected by the operational sensors on each JPSS satellite.

5.1.3.2 A-DCS data latency shall be consistent with requirements for JPSS data.

5.1.4 The JPSS shall maintain a Mission Operational Availability of greater than or equal to 70% averaged over the mission lifetime.

5.1.5 On a monthly basis, at least 99% (Objective: 100%) of the data collected by operational sensors on each JPSS satellite shall be delivered to the IDPS.

5.1.6 Each xDR shall conform to the technical requirements as indicated in Appendix B.

5.1.7 When commanded by the MMC or AMMC, the JPSS shall ensure that only authorized recipients are provided U.S. environmental sensor data from the DWSS satellites. This does not apply to JPSS satellites.

5.1.8 JPSS-1 and JPSS-2 shall provide real-time X-band direct broadcast (i.e., High Rate Data (HRD)) with all JPSS instrument data to the direct readout community.

5.1.9 JPSS-2 (as Threshold) and additionally JPSS- 1 (as objective) shall provide real-time L-band direct broadcast (i.e., Low Rate Data (LRD)) to the direct readout community.

5.1.9.1 LRD broadcasts shall be programmable on-orbit to provide a subset of data from any JPSS instrument for transmission in the L-band broadcast including A-DCS data.

5.1.10 The JPSS shall deliver a complete set of data products from the Operational NPP, JPSS and DWSS Satellites in accordance with paragraph 5.1.2.

5.1.10.1 The JPSS shall deliver additional products from secondary operational NPP, JPSS or DWSS satellites on a best efforts basis.

5.1.11 The JPSS shall provide xDRs from each JAXA GCOM-W (W for Water monitoring) satellite with threshold performance as indicated in Appendix B.

5.1.11.1 (Objective) The JPSS shall deliver GCOM-C (C for Climate monitoring) xDRs as indicated in Appendix B. GCOM-C will provide advanced land and ocean measurements, including ocean color. The major enhancement over current capabilities will be monitoring ocean color from the mid morning orbit and thereby providing improved temporal coverage. The JPSS shall produce xDRs as detailed in the Appendix B for sensors flown on DWSS satellites.

5.1.12 The JPSS shall provide a sub-set of Intermediate Products (IPs) to the Centrals as specified in Appendix B.

5.1.13 The NESDIS IDP shall deliver all xDRs and associated descriptive information (e.g., metadata) to the NOAA archive service delivery point at NSOF for long-term archive/storage, internal management, and data quality monitoring.

5.1.14 By the launch of the JPSS-1 satellite, the JPSS shall be compliant with requirements for High Impact Systems pursuant to National Institute of Standards and Technology (NIST) 800-53 and related documents.

5.1.15 The Common Ground System shall be capable of a minimum 200% memory and network capacity increase relative to the required capacity predicted at NPOESS Critical Design Review to command, control, communicate, acquire and process data from the operational satellites.

5.1.16 The JPSS Program shall support infrastructure modifications to NOAA facilities required to accommodate growth of the Common Ground System since NPOESS CDR.

5.1.17 The NOAA JPSS program shall support hardware and software modifications to NOAA's CLASS archive to accommodate the archiving of data from NPP and the JPSS system.

5.2 Launch Segment

The launch segment consists of services procured or obtained by the JPSS Program to meet the following requirements:

5.2.1 The JPSS-1 and JPSS-2 missions shall be launched on expendable launch vehicles of risk category 2 or higher, per NASA Policy Directive (NPD) 8610.7.

5.2.2 The TSIS and ADCS/SARSAT missions shall be launched on expendable launch vehicles of risk category 2 or higher, per NPD 8610.7.

5.2.3 JPSS shall provide necessary launch services for JPSS satellites including:

5.2.3.1 The launch vehicle and its associated facilities, support equipment, and services required to insert the satellite into the proper mission orbit.

5.2.3.2 The launch site payload processing facilities required to process, service, sustain, and test the satellite and its ground support equipment at the launch site prior to the launch.

5.2.4 The JPSS-1 and JPSS-2 satellites shall be launched and operated in a polar sun-synchronous orbit and shall have the following characteristics: nominal altitude of 824 +/- 17 kilometers, ground track repeat accuracy of 20 km at the Equator with a repeat cycle less than 20 days, and nominal ascending equator crossing time of 1330 +/- 10 minutes.

5.2.5 The JPSS A-DCS and SARSAT instruments shall be accommodated on satellite(s) that provide global coverage, an area revisit time of at least twice per 24 hours, and exclude the 06:30 to 12:30 LTAN window.

5.2.6 The JPSS TSIS instrument shall be accommodated on a satellite that provides at least 12 periods of solar observing, each lasting at least 40 minutes, every 24 hours.

5.3 Space Segment

Instruments and communications descriptions are contained in Appendix D and detailed in the L1RD Supplement.

5.3.1 The JPSS-1 and JPSS-2 missions shall be Category 1 per NASA Procedural Requirements (NPR) 7120.5 and the risk classification shall be B per NPR 8705.4.

5.3.2 The TSIS and ADCS/SARSAT missions shall be Category 2 per NPR 7120.5 and the risk classification shall be C per NPR 8705.4.

5.3.3 All JPSS launches and satellites shall strive to limit orbital debris generation per the U.S. National Space Policy of 2010 and NASA Procedural Requirements for Limiting Orbital Debris dated May 14, 2009.

5.3.4 The JPSS-1 payload shall include the ATMS, CrIS, VIIRS, OMPS-N, and CERES instruments.

5.3.5 The JPSS-2 payload shall include the ATMS, CrIS, VIIRS, OMPS-N, and OMPS-L instruments.

5.3.5.1 (Objective) The JPSS-2 payload shall include a CERES Follow-on instrument.

5.3.6 The JPSS Program shall accommodate TSIS, SARSAT instruments, and A-DCS on other spacecraft if they are not accommodated on JPSS-1 and JPSS-2 and ensure these sensors are operated as designed.

5.4 Command, Control, Communications Segment: Spacecraft Operations and Data Acquisition

5.4.1 The C3S shall monitor, assess, maintain, and command and control all components of the NPP, JPSS and DWSS from the MMC and AMMC.

5.4.2 The C3S shall receive NPP, JPSS, and DWSS satellite telemetry and relay it to the MMC and AMMC.

5.4.3 The JPSS shall ensure A-DCS, SARSAT instruments, and TSIS telemetry are monitored.

5.4.4 The C3S shall receive NPP, JPSS, and DWSS satellite data and relay it to the IDPS.

5.4.5 The C3S shall acquire sensor science data from the GCOM-W satellites and relay it to the Centrals and JAXA.

5.4.5.1 (Objective) The JPSS shall acquire sensor science data from GCOM-C satellites and relay it to NESDIS and JAXA.

5.4.6 The C3S shall transfer Metop data from the NASA-Metop interface at McMurdo Ground Station (MGS) to the Metop Service Delivery Point.

5.4.7 The C3S shall collect DMSP data at McMurdo and relay to the DMSP Service Delivery Point.

5.4.8 The C3S shall have at least 100% built-in margin relative to the required processing, throughput, memory, and storage capacity predicted at NPOESS Critical Design Review.

5.5 Interface Data Processing Segment:

5.5.1 The NESDIS IDP shall deliver all NPP RDRs and associated metadata to the NASA SDS and the NOAA archive Service Delivery Points at NSOF.

5.5.2 The NESDIS IDP shall have at least 100% built-in margin relative to the required processing, throughput, memory, and storage capacity predicted at NPOESS Critical Design Review.

5.5.3 The JPSS shall deliver data quality monitoring capability to the Centrals.

5.5.4 The IDP's at each Central shall store satellite and ancillary data for 24 hours.

5.6 Sustainment and Operations

5.6.1 The JPSS shall be compliant with NOAA and NESDIS information technology security policies and procedures (NOAA Administrative Order 212-13 "Information Technology Security Policy") for all space and ground components.

5.6.2 The JPSS Program shall transfer to NOAA responsibility for the NPP satellite and ground systems operations after operability has been demonstrated, nominally 9 months after launch.

5.6.2.1 The JPSS Program shall conduct an Operations Handover Review to present the operational readiness of the NPP satellite and ground systems, at which time NOAA will make a determination on the operational acceptance of the NPP satellite and ground systems.

5.6.3 The JPSS Program shall transfer to NOAA responsibility for the JPSS satellites and ground systems operations after the launch, early orbit and activation phase, nominally 90 days after each launch.

5.6.3.1 The JPSS Program shall conduct an Operations Handover Review to present the operational readiness of each JPSS satellite and the ground systems, at which time NOAA will make a determination on the operational acceptance of the satellite and ground systems.

5.7 A-DCS and SARSAT Ground Processing:

5.7.1 The JPSS shall relay Argos beacon and housekeeping data to the NESDIS Central. NESDIS will provide the data to the NOAA archive and the two Argos Global Processing Centers in Largo, Maryland and Toulouse, France.

5.7.2 The JPSS shall provide A-DCS housekeeping data to the NESDIS Central in engineering Units.

5.7.3 The JPSS shall provide SARSAT telemetry to the US Mission Control Center in Suitland, Maryland.

6 PROGRAM MANAGEMENT REQUIREMENTS

6.1 The JPSS Program shall be executed in accordance with the NASA Program and Project Management Processes and Requirements (NPR 7120.5). Tailoring of the 7120.5 procedures and processes for the implementation, development and execution of the JPSS Program will be documented in the JPSS Program Plan/Management Control Plan (MCP). The MCP will be approved by NOAA and NASA.

6.2 The JPSS Program shall establish a JPSS configuration control process, to include DOD partners with respect to the common ground system, to facilitate changes to the system. The configuration control process will ensure functionality of the JPSS while providing a means to introduce new or improved products, services, and capabilities.

6.3 NOAA shall negotiate for global data receptor sites and frequency filing coordination.

7 SYSTEM SUCCESS CRITERIA

Mission success of the JPSS requires all five performance attributes identified as KPPs in Appendix B and listed below have been met. Failure to meet all KPP is regarded as mission failure.

<u>Parameter</u>
- Atmospheric Moisture Profile
- Atmospheric Temperature Profile
- Imagery
- Sea Surface Temperature
- Data Latency

NOAA will declare that the JPSS has attained Full Operational Capability when all threshold requirements have been met or exceeded.

Changes to the Key Performance Parameters require an update or waiver to the L1RD. Performance criteria for non-KPP requirements listed in the L1RD Supplement can be approved by the NOSC.

8 REFERENCES

1. Executive Office of the President, Office of Science and Technology Policy, Memorandum to DoD, NOAA and NASA, March 2, 2010.
2. Under Secretary of Defense, Acquisition, Technology, and Logistics (USD AT&L) Memorandum dated March 17, 2010, "Acquisition Decision Memorandum (ADM), NPOESS Program Restructure."
3. USD AT&L Memorandum, June 22, 2010, "ADM, for the Department of Defense responsibilities under the restructure of NPOESS."
4. NPOESS Joint Agency Requirements Group, December 10, 2001, "NPOESS Integrated Operational Requirements Document (IORD) II."
5. National Polar-orbiting Operational Environmental Satellite System (NPOESS), Capabilities Production Document (CPD) draft dated 2009.
6. NAO 212-15, "Management of Environmental and Geospatial Data and Information." March 9, 2010 (pending approval).
7. "National Space Policy of the United States of America" June 28, 2010.
8. The International Cospas-Sarsat Programme Agreement between Canada, France, the former USSR and the USA (document C/S P.001), July 1, 1988.
9. Argos Data Collection Systems (Argos DCS) Statement adopted July 8, 1998.
10. NASA Program and Project Management Processes and Requirements (NPR 7120.5) March 06, 2007
11. NASA Agency Risk Management Procedural Requirements (NPR 8000.4) December 16, 2008.
12. NASA Policy for Safety and Mission Success (NPD 8700.1) October 28, 2008.

These documents are available through the NOAA JPSS Office.

9 APPROVAL

SEP 2 2 2011

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Deputy Under Secretary of Commerce for
Oceans and Atmosphere for Operations

10 CONCURRENCES

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8/11/11

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Center Director, NASA Goddard Space Flight Center

3-10-11

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Program Manager, Joint Polar Satellite System

APPENDICES

A. Clarifications and Limitations

NOAA's Climate Sensor Project

NOAA has a separately funded project to acquire climate sensors. The NOAA Climate Sensor Project will fund climate sensors (TSIS, CERES/CERES Follow-on, and OMPS-L) for use in the JPSS. The JPSS Program will ensure that the sensors provided by the Climate Sensor Project are flown on either a JPSS satellite or another spacecraft and in a manner that meets the climate community needs. Despite the "climate sensor" terminology, all sensors flown or accommodated by JPSS are used for NOAA climate products and services. Similarly, data from JPSS "climate sensors" are also used to produce near real-time environmental data records as identified in Appendix B and detailed in the L1RD Supplement and provided to the NOAA archive.

NOAA's Climate Data Record Program

NOAA has a separately funded program to develop and generate climate products and information. The NOAA Climate Data Records (CDR) Program (CDRP) will acquire algorithms and associated Information Technology (IT) infrastructure to generate climate data products (C-RDRs, CDRs and CIRs) in near- and non-real-time configurations. In most cases, the CDRP will use RDRs in the NOAA archive as its JPSS source data. The CDRP will also assess data quality from the climate product perspective from the JPSS sensors that it uses. Program also uses non-JPSS source data, including that from heritage NOAA and DOD operational programs.

NOAA Comprehensive Large Array-data Stewardship System (CLASS)

CLASS is an IT system that supports the NOAA Data Center's mission from its polar and geostationary satellites and from in situ sources. In the context of JPSS, the CLASS mission is to provide the system interface for IDPS to transfer JPSS xDRs and associated data to the NOAA Data Centers for archive (following the Open Archive Information System Reference Model ISO 14721:2003). All JPSS system components (for example source code, documentation, prelaunch calibration coefficients) used in product generation will also be archived through CLASS to support future reprocessing and research. The JPSS Ground Project is responsible for delivering the data to the CLASS ingest point.

NOAA NCDC is responsible for project management of CLASS infrastructure, with oversight provided by the CLASS Operations Planning Board. The CLASS system owner, through the CLASS Operations Planning Board, is responsible for ensuring the upgrades meet NOAA archive requirements. The NOAA JPSS Program is responsible for funding the systems upgrades necessary to archive JPSS data and provide user access. The NOAA JPSS Program approves the budget based on recommendations from the CLASS Operations Planning Board.

NOAA's NPOESS Data Exploitation (NDE) Project:

NOAA has a separate funding line for NDE. NOAA's NDE is responsible for the development, management, and evaluation of the near real-time and NOAA-unique product generation of NPP and JPSS satellite data for dissemination to the NOAA community. NDE will transition from development to operations and become part of the NSOF Environmental Satellite Processing Center (ESPC). The JPSS will make all NPP and JPSS data available to NDE via the NESDIS IDP according to Appendix B and detailed in the Supplement.

SARSAT and A-DCS:

Search & Rescue Satellite Aided Tracking (SARSAT) and Advanced Data Collection System (A-DCS) instruments will be provided to the JPSS Program under international agreements. The JPSS Program will ensure SARSAT and A-DCS instruments are flown on either a JPSS satellite or another spacecraft that meets the appropriate user community needs. The A-DCS instrument data will be archived by NOAA. The NOAA Central will make the data available to the appropriate agencies.

The NOAA Low Earth Orbiting (LEO) satellites with Search and Rescue payloads provide the operational component in the international Cospas-SARSAT Programme. The Search and Rescue Repeater, provided by Canada, and the Search and Rescue Processor, provided by France, along with associated antennas comprise the satellite-born SARSAT instruments. With the LEO contributions of EUMETSAT, Russia, and the United States, the Programme is able to maintain a global satellite search and rescue capability. International planning requires four LEO satellites with a search and rescue capability in order to meet our operational requirements on timeliness of detection. Without the planned contribution of the United States on the JPSS satellites, the Cospas-SARSAT Programme would not be able to meet its commitments and a degradation of service would occur which would put the safety of the users at risk.

The A-DCS payload is a component of the Argos international global tracking and surface data collection system that is jointly managed by the French Centre Nationale d'Etudes Spatiales (CNES) and NOAA NESDIS. A-DCS is used to support global environmental data collection by relaying weather conditions from remote sites (meteorological and oceanographic applications), free-floating and moored ocean buoys and subsurface floats, and fishing vessels (for resource management), and wildlife migration paths. The A-DCS instrument is supplied to the JPSS Program by the French government under the following implementing agreement: *The National Oceanic And Atmospheric Administration Of The United States Of America And The Centre National D'etudes Spatiales Of France On The Argos Data Collection System* signed November 2008.

DOD's Environmental Satellite:

According to the Under Secretary of Defense, Acquisition, Technology, and Logistics, Acquisition (USD AT&L) Decision Memorandums (ADM) dated March 17, 2010, the DOD will take primary responsibility for environmental monitoring from the morning (1730 LTAN) orbit, will plan to share data with NOAA across a common ground system, and will continue support arrangements with NOAA for the operation of DMSP. The USD AT&L ADM dated June 22, 2010 directed the establishment of the DWSS program and, initiation of action to launch the first DWSS in 2018 with a sensor complement consisting of VIIRS, SEM-N, and a microwave sensing capability. The NPOESS program had been developing the Microwave Imager/Sounder (MIS) to meet program requirements. Should DOD elect not pursue this course of action, the JPSS Program will not be responsible for providing those deferred capabilities.

European Polar-orbiting Satellite:

Should plans for a successor to the EUMETSAT Metop polar-orbiting satellite not be realized as planned, the JPSS Program is not responsible for providing those capabilities from the 0930 orbit.

JAXA's GCOM Program

The Japanese Aerospace Exploration Agency (JAXA) plans to launch a series of low-earth-orbiting spacecraft called the Global Change Observation Mission (GCOM). Plans call for a series of two satellites called GCOM-Water (GCOM-W) which will carry the Advanced Microwave Scanning Radiometer (AMSR) sensor on both GCOM-W1 and GCOM-W2. NOAA is investigating the possibility of providing a Dual-Frequency Scatterometer (DFS) for GCOM-W2. The GCOM-Climate (GCOM-C) series will host the Second Generation Global Imager (SGLI) instrument.

Subject to the conclusion of an agreement with JAXA, NOAA plans to provide data retrieval and relay of raw data from GCOM-W satellite series to JAXA. NOAA also plans to generate and archive environmental data products from the GCOM-W raw data. Funding for these processes were included in the budget estimate and request submitted for JPSS. NOAA expects the JPSS Program to implement capabilities to meet the requirements in this L1RD with respect to the GCOM missions subject to availability of budgeted funding. Plans and funding for recovery, transmission, processing, and archival of GCOM-C data have not yet been approved and are shown as objectives in this L1RD. Should plans for the JAXA GCOM missions not be realized, the JPSS Program is not responsible for providing these capabilities.

NASA's Science Data Segment (SDS)

The NASA SDS is a key component of NPP as a research and validation tool to ensure the quality and performance of NPP products for climate studies. It is envisioned that the JPSS Program will continue to use NASA SDS to support development of JPSS capabilities. NOAA supports the continuation of the NASA SDS but JPSS will not provide sustainment funding for NASA SDS.

B. Observational Data

The Observational Data listed in Appendix B have been categorized into:

- Category 1: Data from JPSS Core sensors (VIIRS, ATMS, CrIS, OMPS-N, OMPS-L) which includes data from core sensors are flown on DWSS.
- Category 2: Data from GFE sensors for which the JPSS Program must have integrated on suitable satellites and retrieve data (TSIS, CERES and CERES Follow-on)
- Category 3: Data from GCOM sensors (AMSR-2, AMSR-3, DFS and SGLI)
- Category 4: Data from DWSS-unique sensors that will be processed within the JPSS Program (MIS and SEM-N)

JPSS observational data requirements focus on the delivery of Raw Data Records (RDRs), Sensor Data Records (SDRs), Temperature Data Records (TDRs), Application Related Products (ARPs), Intermediate Products (IPs), and Environmental Data Records (EDRs) to the end user. These data records are collectively called xDRs and form the basis of the JPSS data processing architecture. Unless otherwise stated, all xDRs are required to be delivered to the Centrals and archive. Data product definitions are provided in Appendix D. Requirements for NPP data are specified in NPP documentation. The JPSS L1RD Supplement provides clarification and elaboration of Appendix B.

Tables 1 through 4 capture the Threshold (T) and Objective (O) parameters for each category of satellites/sensors. Application related products (ARP) and Intermediate Products (IP) are shown as appropriate.

Table 1: JPSS Core Sensor Data Products

(Requirements apply to JPSS-1 (J-1), JPSS-2 (J-2) and core sensors on DWSS)

Parameter	VIIRS	CrIMSS (CrIS & ATMS)	ATMS	OMPS-N	OMPS-L
Active Fires (ARP)	T				
Aerosol Optical Thickness	T				
Aerosol Particle Size	T				
Albedo (Surface)	T				
Atmospheric Vertical Moisture Profile		T	O		
Atmospheric Vertical Temperature Profile		T	O		
Cloud Base Height	T				
Cloud Coverage/Layers	T				
Cloud Effective Particle Size	T				
Cloud Ice Water Path			O		
Cloud Liquid Water			O		
Cloud Mask (IP)	T				
Cloud Optical Thickness	T				
Cloud Top Height	T				
Cloud Top Pressure	T				
Cloud Top Temperature	T				
Green Vegetative fraction	O				
Ice Surface Temperature	T				
Imagery	T		O		
Infrared Ozone Profile (IP)		T			
Land Surface Emissivity			O		
Land Surface Temperature	T				
Net Heat Flux	T				
Ocean Color/Chlorophyll	T				
Ozone Profile (ARP)				T	O (J-1) T (J-2)
Ozone Total Column				T	O (J-1) T (J-2)
Polar Winds	O				
Precipitable Water			O		
Precipitation type/rate			O		
Quarterly Surface Type (IP)	T				
Raw Data Record	T	T		T	O (J-1) T (J-2)
Sea Ice Characterization	T				
Sea Ice Concentration			O		
Sea Surface Temperature	T				
Sensor Data Record	T	T		T	O (J-1) T (J-2)
Snow Cover	T		O		
Snow Water Equivalent			O		
Surface Type	T				
Suspended Matter	T				
Temperature Data Record		T	O		
Vegetation Index	T				

Table 2: GFE Sensor Data Products

Parameter	TSIS	CERES	CERES Follow-on
Downward Long Wave Radiance at the Surface		T	T
Downward Short Wave Radiance at the Surface		T	T
Net Solar Radiation		T	T
Outgoing Long Wave Radiance		T	T
Raw Data Record	T	T	T
Sensor Data Record	T	T	T
Spectral Solar Irradiance	T		
Total Solar Irradiance	T		

Table 3: GCOM Sensor Data Products

Parameter	AMSR2	AMSR3	DFS	SGLI
Active Fires (ARP)				O
Aerosol Optical Thickness				O
Albedo (Surface)				O
Atmospheric Vertical Moisture Profile		O		
Atmospheric Vertical Temperature Profile		O		
Cloud Base Height				O
Cloud Coverage/Layers				O
Cloud Effective Particle Size				O
Cloud Liquid Water	T	T		
Cloud Optical Thickness				O
Cloud Top Height				O
Cloud Top Pressure				O
Cloud Top Temperature				O
Green Vegetation Fraction				O
Ice Surface Temperature				O
Imagery	T	T	O	O
Land Surface Emissivity	O	O		
Land Surface Temperature				O
Ocean Color/Chlorophyll				O
Polar Winds				O
Precipitable Water	T	T		
Precipitation (Type/Rate)	T	T		
Raw Data Record	T	T	O	O
Sea Ice Characterization	T	T	O	O
Sea Surface Stress			O	
Sea Surface Temperature	T	T		O
Sea Surface Wind Direction			O	
Sea Surface Wind Speed	T	T	O	
Sensor Data Record	T	T	O	O
Snow Cover				O
Snow Cover/Depth	T	T		
Snow Water Equivalent	T	T		
Soil Moisture	T	T	O	
Surface Type	T	T		O
Suspended Matter				O
Temperature Data Record	T	T		
Vegetation Index				O

Table 4: DWSS-Unique Sensor Data Products
(Other than VIIRS, data from sensors on the DWSS satellites not shown on this table shall be treated as "Objective" requirements)

Parameter	MIS	SEM-N
Atmospheric Vertical Moisture Profile	T	
Atmospheric Vertical Temperature Profile	T	
Auroral Boundary		T
Auroral Energy Deposition		T
Cloud Ice Water Path	T	
Cloud Liquid Water	T	
Energetic Ions		T
Imagery	T	
Land Surface Temperature	T	
Medium Energy Charged Particles		T
Precipitable Water	T	
Precipitation (Type/Rate)	T	
Pressure Profile	T	
Raw Data Record	T	T
Sea Ice Characterization	T	
Sea Surface Temperature	T	
Sea Surface Wind Direction	O	
Sea Surface Wind Stress	O	
Sea Surface Wind Speed	T	
Sensor Data Record	T	T
Snow Cover/Depth	T	
Soil Moisture	T	
Supra-Thermal-Auroral Properties		T
Surface Type	T	
Temperature Data Record	T	
Total Water Content	T	

Key Performance Parameters (KPPs) are system attributes that represent those minimum capabilities or characteristics considered most essential to achieve an effective system. The JPSS EDRs containing KPPs are listed in the following sections.

1. Atmospheric Vertical Moisture Profile (AVMP)

Atmospheric profiles of moisture provide critical information for weather forecasting. Moisture profiles are used to determine the vertical and horizontal extent of clouds, to initialize cloud analysis and numerical weather prediction models, and to determine atmospheric stability for forecasting events such as severe weather and contrail formation.

AVMP includes performance attributes that are identified as KPPs. The attribute performance requirements are shown in the following table:

Table 5: Atmospheric Vertical Moisture Profile

EDR Attribute (KPP in bold)	Threshold (NS = Not Specified)	Objective
a. Horizontal Cell Size		
1. Clear Nadir	15 km @ nadir (1)	1 km @ Nadir
2. Cloudy Nadir	30 km @ nadir (2)	1 km @ Nadir
b. Vertical Reporting Interval		
1. Surface to 850 mb	20 mb	5 mb
2. 850 mb to 100 mb	50 mb	10 mb
c. Mapping Uncertainty, 3 Sigma (3)	5 km	0.5 km
d. ***Measurement Uncertainty** (expressed as a percent of average mixing ratio in 2 km layers)		
1. * Clear, Surface to 600 mb	**Greater of 20 % or 0.2 g kg^{-1}**	10%
2. Clear, 600 mb to 300 mb	Greater of 35 % or 0.1 g kg^{-1}	10%
3. Clear, 300 mb to 100 mb	Greater of 35 % or 0.1 g kg^{-1}	10%
4. *Cloudy, Surface to 600 mb	**Greater of 20 % or 0.2 g kg^{-1}**	10%
5. Cloudy, 600 mb to 400 mb	Greater of 40 % or 0.1 g kg^{-1}	10%
6. Cloudy, 400 mb to 100 mb	Greater of 40 % or 0.1 g kg^{-1}	NA
e. ***Latency**	**80 min. for JPSS-1; 30 min. for JPSS-2**	15 min
f. Refresh	17.2 hrs (4)	3 hrs
g. Long-term Stability (5)	2%	1%

Notes:

1. JPSS will require up to 9 soundings per FOR to meet this requirement. (Initially, NPP will only process one sounding per FOR for a clear resolution of 46 km at Nadir.)
2. Cloudy HCS based on the ATMS G Band FOV for JPSS. (Cloudy HCS for NPP is 46 km.)
3. "Accuracy" was changed to "Uncertainty, 3 sigma" in accordance with user desires as expressed through the OATS and JARG.
4. IORD threshold was 6 hours. The 17.2 hour refresh results from flying the CrIMSS in the 1330 JPSS orbit only. In the JPSS era, users can improve the 17.2 hour refresh by utilizing the JPSS CrIMSS and Metop IASI, AMSU, and MHS data, although it is understood that, in most cases, the Metop data does not have the latency of CrIMSS data and is not processed in the IDPS.
5. Long Term Stability is not used operationally, but is important for Climate Research. This element specification only applies to measurements from CrIS and ATMS.

2. Atmospheric Vertical Temperature Profile (AVTP)

Atmospheric Vertical Temperature Profiles are a set of estimates of the average atmospheric temperature in three-dimensional cells throughout the atmosphere centered on specified points along a line-of-sight. Sampling of temperature at stated intervals throughout the atmosphere is used to predict a variety of weather elements such as thunderstorms, cloud cover, and winds. Numerical prediction model output is used as the basis for regional forecasts. NOAA's weather forecast offices use AVTP information to help predict severe weather events.

AVTP includes performance attributes that are identified as KPPs. The attribute performance requirements are shown in the following table:

Table 6: Atmospheric Vertical Temperature Profile

EDR Attribute (KPP in bold)	Threshold (NS = Not Specified)	Objective
a. Horizontal Cell Size		
1. Clear, Nadir	18.5 km (1)	1 km
2. Clear, worst case	100 km	1 km
3. Cloudy, Nadir	46 km (2)	1 km
4. Cloudy, worst cast	170 km (3)	1 km
b. Vertical Reporting Interval		
1. Surface to 850 mb	20 mb	10 mb
2. 850 mb to 300 mb	50 mb	10 mb
3. 300 mb to 100 mb	25 mb	10 mb
4. 100 mb to 10 mb	20 mb	10 mb
5. 10 mb to 1.0 mb	2 mb	1 mb
6. 1.0 mb to 0.5 mb (3)	0.2 mb	0.1 mb
7. 0.05 mb to 0.01 mb	No Capability (4)	N/A
c. Mapping Uncertainty, 3 Sigma (5)	5 km	0.5 km
d. *Measurement Uncertainty (expressed as an error in layer verage temperature) (6, 7)		
1. * Clear, Surface to 300 mb	**1.6 K per 1 km Layer (8)**	0.5 K per 1 km layer
2. Clear, 300 mb to 30 mb	1.5 K per 3 km layer	0.5 K per 3 km layer
3. Clear, 30 mb to 1 mb	1.5 K per 5 km layer	0.5 K per 5 km layer
4. Clear, 1 mb to 0.5 mb (3)	3.5 K per 5 km layer	0.5 K per 5 km layer
5. *Cloudy, Surface to 700 mb	**2.5 K per 1 km layer**	0.5 K per 1 km layer
6. Cloudy, 700 mb to 300 mb	1.5 K per 1 km layer	0.5 K per 1 km layer
7. Cloudy, 300 mb to 30 mb	1.5 K per 3 km layer	0.5 K per 3 km layer
8. Cloudy, 30 mb to 1 mb	1.5 K per 5 km layer	0.5 K per 5 km layer
9. Cloudy, 1 mb to 0.5 mb (3)	3.5 K per 5 km layer	0.5 K per 5 km layer
e. * Latency	**80 min. for JPSS-1; 30 min. for JPSS-2**	15 min
f. Refresh	17.2 hrs (9)	3 hrs
g. Long-term Stability (10)		
1. Trop. Mean	0.05 K	0.03 K
2. Strat. Mean	0.10 K	0.05 K

Notes:

1. JPSS will require up to 9 soundings per FOR to meet this requirement. (Initially, NPP will only process one sounding per FOR for a clear resolution of 46 km at Nadir.)
2. ATMS provides the Cloudy AVTP EDR. The IORD threshold for AVMP HCS (3. Cloudy, Nadir) is 40 km. The ATMS FOV is 46 km which limits the HCS for Cloudy conditions.
3. The IORD threshold for AVTP HCS (3. Cloudy, worst case) is 50 km. The cloudy 170 km Edge of Swath dimension is driven by the geometric expansion of the ATMS 46 km Nadir horizontal cell size. The user community via the NPOESS Joint Agency Requirements Group (JARG) deemed this to be acceptable during restructure due to the horizontal homogeneity of layer temperature at this length scale.
4. CrIMSS does not provide measurements at atmospheric pressures below 0.5 mb. MIS is required to provide AVTP measurement capability from 0.5 to 0.01 mb (the IORD requirement). This applies to the Vertical Reporting Interval and Measurement Uncertainty parameters.
5. "Accuracy" was changed to "Uncertainty, 3 sigma" in accordance with user desires as expressed JARG.
6. Measurement Uncertainty shall be referenced to the Cloudy Horizontal Cell Size thresholds and objectives as listed under Items a(3) & a(4).
7. DMSP measures at mandatory levels in the atmosphere, not per "x" km layers.
8. CrIMSS meets the IORD threshold of 1.6 K per 1 km layer over ocean and thus meets the Global average. Over land and ice mass, the Uncertainty degrades to 1.7 K due to the state of the science of the land emissivity knowledge within the temperature sounding algorithm.
9. IORD threshold was 6 hours. The 17.2 hour refresh results from flying CrIMSS in the 1330 JPSS orbit only. In the JPSS era, users can improve the 17.2 hour refresh by utilizing the JPSS CrIMSS and Metop IASI, AMSU and MHS data, although it is understood that, in most cases, the Metop data does not have the latency of CrIMSS data and is not processed in the IDPS.
10. Long Term Stability is not used operationally, but is important for Climate Research. This element specification only applies to measurements from CrIS and ATMS.

3. Imagery

Imagery enables weather forecasters to discern environmental phenomena (by either manual analysis or automated algorithms) within the visible, near-infrared, infrared, and microwave portions of the spectrum. Imagery is also used as digital input to remote sensing algorithms which produce other environmental measurements, although this doesn't replace the explicit requirement for retrieval of individual parameters described elsewhere in this document. Imagery is required by meteorologists to verify the validity and accuracy of numerical weather prediction analyses and forecasts.

The Imagery EDR includes performance attributes that are identified as KPPs. The attribute performance requirements are shown in the following table:

Table 7: Imagery

EDR Attribute (KPP in bold)	Threshold (NS = Not Specified)	Objective
a. *Horizontal Spatial Resolution		
1. *Nadir	**0.4 km**	0.1 km
2. Edge of Swath, clear	0.8 km	0.1 km
3. Night-time visual, clear	2.6 km	0.65 km
4. All Weather	See Note 9	
b. Mapping Uncertainty, 3 Sigma (1)		
1. Nadir, clear	1 km	NS
2. Edge of Swath, clear	3 km	0.5 km
3. All weather	Note 9	1 km (2)
c. Refresh for Visible and IR Bands, Clear (10)		
1. Average revisit at any location	**≤12 hrs. (3,4,5)**	1 hr.
2. Maximum revisit at any location	**≤ 12 hrs. (3,4, 11)**	1 hr.
3. At least 56% of the revisit times will be 4 hours or less (6)	**At least 56% of the revisit times will be 4 hours or less (3, 4, 7, 10)**	1 hr.
d. *Latency	**80 min. for JPSS-1; 30 min. for JPSS-2**	15 minutes

Notes:

1. "Accuracy" was changed to "Uncertainty, 3 sigma" in accordance with user desires as expressed through the NPOESS JARG.
2. This value is an "Objective" based upon the original CMIS Sensor Requirements Document (SRD) Objective.
3. JPSS alone cannot meet the original < 4 hour average "refresh" intent of the IORD.
4. The Maximum Revisit shown at IOC is based upon having only the VIIRS available in the 1330 JPSS orbit.
5. IORD required ? 4 hours for Average Revisit. However, users can improve the 12 hour average revisit by utilizing the JPSS and DWSS VIIRS and Metop AVHRR data, although it is understood that, in most cases, the Metop data does not have the resolution (0.4 km HSR) or latency of VIIRS data and is not processed in the IDPS.
6. Editing changes during several "pre-release" versions of IORD-I condensed (and confused) the refresh requirement. This confusion was carried into IORD-II. The intent of the original IORD requirement was that "at least 75% of the revisit times shall be 4 hours or less", not necessarily "at any location". The May, 2008 NPOESS Senior Users Advisory Group (SUAG) recommended to the NPOESS Joint Agency Requirments Council (JARC) that this requirement be changed to read "at least 56% of the revisit times shall be 4 hours or less" based upon legacy performance.
7. IORD required "at least 75%" of the revisit times ? 4 hours". Again, users can increase the number of revisits in less than 4 hours by utilizing the JPSS and DWSS VIIRS and Metop AVHRR data.
8. Reserved
9. The "All weather" attribute can only be fulfilled by an instrument such as MIS.
10. If the POES and DMSP planes are combined (best 3 satellite combination is 2 POES and 1 DMSP), the best Avg. Revisit becomes ? 4 hrs.; the best Max. Revisit ~ 6.1 hrs.; and ~ 56% of the points have a revisit of 4 hours or less.
11. IORD required ? 6 hrs for Max Revisit. Users can improve the 12 hour max revisit by utilizing the JPSS, DWSS and Metop data.

4. Sea Surface Temperature (SST)

SST has two major applications: 1) sea surface phenomenology, and 2) use in the infrared cloud/no cloud decision for processed cloud data. Analyses require high resolution SSTs as input to global weather prediction models and to determine temperature, water masses, and circulation supporting safety at sea. Measurements are also required to distinguish low clouds and fog from open water. Improvements in SST resolution and accuracy beyond legacy to JPSS threshold values will enable improved weather forecasts and directly support various other mission areas including crew safety/ditching at sea, tropical storm movement forecasts, and coastal zone management.

SST includes performance attributes that are identified as KPPs. The attribute performance requirements are shown in the following table:

Table 8: Sea Surface Temperature

EDR Attribute (KPP in bold)	Threshold (NS = Not Specified)	Objective
a. *Horizontal Cell Size		
1. *Nadir, Clear	**1 km**	0.25 km
2. Worst case, Clear	1.3 km	NS
3. All weather	Note 8	
b. Mapping Uncertainty, 3 Sigma (1)		
1. Nadir, Clear	1 km	1.0 km
2. Worst case, Clear	1.5 (2)	NS
3. All weather	Note 8	1 km
c. Measurement Range	271 K to 313 K (3)	271 K to 313 K (3)
d. Measurement Accuracy, Skin & Bulk (5)		
1. Clear	0.1 K (4)	0.1 K
2. All weather	Note 11	0.5 K
e. *Measurement Uncertainty		
1. *Clear	**0.5 K** (5)	0.1 K
2. All weather	0.64 K Globally (10)	0.5 K
f. Refresh	< 12 hrs. (6)	3 hrs
g. Long-term Stability (9)	0.1 K	0.05 K
h. Latency	80 min. for JPSS-1; 30 min. for JPSS-2	15 min
i. Geographic Coverage	Global Oceans	Global Oceans

Notes:

1. "Accuracy" was changed to "Uncertainty, 3 sigma" in accordance with user desires as expressed through the JARG.
2. The IORD required 1.3 km. The 1.5 km, 3 sigma Mapping Uncertainty value at the Edge of Scan is consistent with the VIIRS imagery mapping uncertainty requirement.
3. For All Weather SST, 307K is the realisitc upper limit. For bulk SST, 308K is the realistic upper limit.
4. IORD requirement was Measurement "Precision". By consensus agreement, the SST TIM (1/25/07) recommended that the SST Measurement Precision requirement (0.2 K, clear) be removed and replaced by a 0.1 K Measurement Accuracy (Skin & Bulk) requirement.
5. By consensus agreement, the key SST user agencies, the government, and the vendor team participating in the SST TIM (1/25/07) recommended that the Skin and Bulk Measurement Uncertainty beyond 40 degrees satellite Zenith angle be set at 0.7 K. The degradation is driven by the path length through the atmosphere. (The request was for 1 K. Based upon limited data, heritage appears to be 0.5 K.)
6. The IORD required < 6 hrs. Users can improve the 12 hour refresh by utilizing the JPSS, DWSS (VIIRS) and Metop (AVHRR) data, although it is understood that, in most cases, the Metop data does not have the resolution or latency of VIIRS data and is not processed in the IDPS.
7. Reserved
8. The "All weather" attribute can only be acheived with an instrument such as MIS. 58 km is the SSMIS legacy value for Horizontal Cell Size and 7 km is SSMIS for mapping
9. Long Term Stability is not used operationally, but is important for Climate Research. This element specification only applies to measurements from VIIRS.
10. MIS expects to achieve 0.64 K Globally when using a 25 km HCS.
11. The all weather IORD measurement "Precision" requirement was 0.3K. 1K is the expected MIS spec for all stratifications.

Other data product requirements include:

(Attribute tables for the following data products are included in the L1RD Supplement)

1. **Active Fires (Application Related Product (ARP)):** Active Fires is an ARP of Surface Type being delivered by the JPSS as an Intermediate Product at the request of the user community. Active surface fires are natural or anthropogenic fires. This deliverable ARP provides the geolocation of the pixels in which active fires are detected. It includes the attributes "Fire Radiative Power" and "Area of Active Fires" as performance objective. The products for this application are desired during both day and night time for clear-sky conditions and within clear areas under conditions of broken clouds.

2. **Aerosol Optical Thickness (AOT):** Aerosols affect visibility and are a detriment to satellite measurements of some environmental quantities. Aerosol concentration measurements are required for aviation safety (to include space launch, tracking and recovery), ship navigation, and ship and air operations.

3. **Aerosol Particle Size (APS):** Atmospheric aerosols affect the radiation regime of the atmosphere directly by absorption and scattering. APS information is also useful to numerical weather prediction (NWP) and aerosol dispersion models. Some of the original attributes for this EDR (particularly climate elements) could only be produced by the Aerosol Polarimetry Sensor (APS) which is not flown on JPSS. Consequently, this EDR is produced from VIIRS data only.

4. **Albedo (Surface):** Both narrow- and broad-band albedo are important variables in determining the radiative balance at the surface (how much incident energy goes toward surface heating versus how much is reflected back to space). Albedo is required to determine surface emissivity for retrieval of satellite-derived temperature and moisture soundings, and as an input to automated cloud analyses using visible data. Albedo is also of use in determining surface type and as a background against which to detect and screen out clouds.

5. **Auroral Boundary:** The auroral boundaries are the loci of points representing the equatorward and poleward edges of the auroral zones. The requirement is the specification of the equatorward auroral boundary presented as the set of geographic latitudes and longitudes for the boundary referenced to an altitude of 110 km above sea level.

6. **Auroral Energy Deposition (AED):** AED refers to the energy flux into the ionosphere from precipitating auroral particles. These data are used to estimate the total auroral heat input into each hemisphere. The hemispheric power input can be determined from direct auroral particle measurements or auroral imagery. In-situ measurements of precipitating ion and electron fluxes may be combined with statistical models of auroral activity to provide an estimate of the hemispheric power

input. The total heat input can also be derived from ultraviolet (UV) and / or X-ray auroral imagery.

7. **Cloud Base Height (CBH):** Cloud base height is defined as the height above sea level where cloud bases occur. Cloud Base Height is used to support aviation operations.

8. **Cloud Cover/Layers (CCL):** Cloud cover is the fraction of a given area of the earth's horizontal surface that is masked by the vertical projection of clouds. Cloud cover data is a critical input to general forecasting, albedo measurements, and other meteorological applications.

9. **Cloud Effective Particle Size (CEPS):** These data are required in global NWP models and in hurricane forecasting. Cloud optical depth and other cloud radiative properties vary substantially with CEPS. Uncertainties in the CEPS can generate large differences among Ice Water Content retrievals with remote sensing techniques. IWC has become the key variable used in models to characterize cloud radiative, dynamical, and hydrological properties.

10. **Cloud Ice Water Path:** Cloud ice water path is defined as the equivalent amount of water within cloud ice particles in a specified segment of a vertical column of the atmosphere.

11. **Cloud Liquid Water (CLW):** CLW is defined as the equivalent amount of water within cloud in a specified segment of a vertical column of the atmosphere.

12. **Cloud Mask (Intermediate Product (IP)):** A VIIRS Cloud Mask (VCM) classifies pixels as Confidently Clear, Confidently Cloudy, Probably Clear, and Probably Cloudy. It is used to generate the CCL EDR and several other user applications. CCL is produced using only pixels marked as Confidently Cloudy by the VIIRS Cloud Mask (and the Binary Cloud Map), which are included in the cell.

13. **Cloud Optical Thickness (COT):** COT is defined as the extinction (scattering plus absorption) per unit length, integrated over each and every distinguishable cloud layer and all distinguishable cloud layers in aggregate, in a vertical column of the atmosphere. These data are required in global numerical weather prediction (NWP) models and in hurricane forecasting.

14. **Cloud Top Height (CTH):** Cloud top data are of particular interest to forecasters providing weather support to aircraft operations. These data are vital as inputs to both NWP and specialized cloud analysis/forecast models, particularly for severe weather forecasting, aircraft routing, and determining visibility at altitude for aerial refueling missions. CTH observations will help the forecaster predict rime and mixed icing in stratiform clouds from 3000-6000 feet; and clear or mixed icing in cumuliform clouds from 3000-20000 feet. Cloud top data are also needed in

mesocale studies and climatological analyses, particularly those focused on the radiative balance of the atmosphere.

15. **Cloud Top Pressure (CTP):** Cloud top pressure is defined for each cloud-covered earth location as the set of atmospheric pressures at the tops of the cloud layers overlying the location. Operational measurements of CTP are needed to improve operational numerical weather prediction.

16. **Cloud Top Temperature (CTT):** Cloud top temperature data are used for operational forecasting. Determination of cloud top temperature offers weather forecasters a means to discriminate convective vs. non-convective clouds, intensity change (cooling vs. warming), and distribution/intensity of convective elements along a squall line. These data are used in global NWP models, and have application to aviation guidance forecasting and hurricane forecasting.

17. **Downward Long Wave Radiance at the Surface:** Radiation from 5.0 to 100 µm. This is an instantaneous, not a time-averaged measurement.

18. **Downward Short Wave Radiance at the Surface:** The irradiance at wavelengths less than 4 µm incident downward at the surface of the earth. This is an instantaneous, not a time-averaged measurement.

19. **Energetic Ions:** Measurements of energetic ions within this energy range required as input to models of the auroral ionosphere, especially D-region and to determine the polar cap boundary. These data are also used in assessments of satellite anomalies, semiconductor and solar-cell radiation damage, and radiation hazard to astronauts and aircraft personnel. The requirement is a measurement of the ion characteristics, including the energy spectrum and particle pitch angle.

20. **Green Vegetation Fraction (Objective):** Green Vegetation Fraction (GVF) is defined as the fraction of a vertically viewed scene that is covered by active green vegetation. The real-time weekly GVF provides an excellent characterization of the surface in the NOAA land-surface model (LSM). The LSM is a component of all operational numerical weather prediction models and GVF helps improve near-surface winds, temperature and humidity forecasts.

21. **Ice Surface Temperature**: Remotely-sensed ice surface temperatures will be an invaluable daily, large scale, and reliable data set used to estimate sea ice growth and decay. IST is the temperature at the ice surface. As a threshold, the temperature of the surface of ice over land or water is required.

22. **Infra-Red Ozone profile (IP):** Ozone profile derived primarily from the CrIS instrument.

23. **Land Surface Emissivity**: Emissivity of a material is the relative ability of its surface to emit energy by radiation. It is the ratio of energy radiated by a particular material to energy radiated by a black body at the same temperature. Emissivity is most widely used in NWP models.

24. **Land Surface Temperature (LST) (Objective):** Surface temperature information is needed for NWP and hydrological modeling, automated cloud analysis, and for general forces operations (i.e., wind chill temperatures and heat stress factors). LST is also used to support rescue operations and land/sea assault operations.

25. **Medium Energy Charged Particles:** Measurements of particles in this energy range are required to serve as inputs to models of the auroral ionosphere, determine the boundaries and extent of the polar cap, and provide inputs to magnetospheric models. These data are also used in the analysis of satellite anomalies involving surface charging and, at the higher energies, deep-dielectric charging and radiation damage.

26. **Net Heat Flux:** Knowledge of net heat flux is essential to the correct physical modeling of natural phenomena occurring at the air/sea interface for both numerical meteorological and oceanographic prediction models.

27. **Net Solar Radiation:** Incident minus reflected solar radiation (Top of atmosphere). This is an instantaneous, not a time-averaged measurement.

28. **Ocean Color/Chlorophyll (OC/C):** OC/C is used is used to quantify water-leaving radiances to quantify various pigments in the water in order to determine chlorophyll concentrations, turbidity, and other changing optical conditions and provides continuity from previous ocean color missions (MODIS and SeaWiFS).

29. **Outgoing Long Wave Radiance:** Outgoing longwave radiation (5.0 to 100 μm). This is an instantaneous, not a time-averaged measurement.

30. **Ozone Profile (ARP):** Ozone profile can be generated from OMPS-nadir data. When OMPS-L data is used in conjunction with the OMPS-Nadir sensor, the ARP provides global ozone observations at high vertical resolution (< 3 km). The detailed vertical structure of stratospheric ozone (12 – 25 km altitude region) has been shown to be a useful contributor to extended range (beyond 1 week) forecast skill in global models.

31. **Ozone Total Column:** Ozone Total Column (also called Atmospheric Ozone) is defined as the amount of ozone in a vertical column of the atmosphere measured in Dobson Units (milli-atm-cm). Operational measurements of stratospheric ozone are needed to improve operational numerical weather prediction and to support requirements for depiction of the upper atmosphere. This information also has relevance to human health.

32. **Polar Winds (Objective):** Polar wind observations provide atmospheric wind speed, direction, and height data. These data are used primarily in operational numerical weather prediction systems. Satellite-derived winds over the polar regions have been shown to have a positive impact on weather forecasts, not just at high latitudes, but globally. Over oceans and at high latitudes, in situ wind information is sparse. Polar wind measurements from space therefore fill a critical gap.

33. **Precipitable Water (PW):** Precipitable Water (PW) is the total equivalent water of unit cross-sectional area between any two specified levels, including the total atmospheric column. This EDR is derived from imagery, atmospheric sounding data, and microwave observations.

34. **Precipitation (Type/Rate):** The required data products for this EDR are precipitation rate (mm/hour) and identification of type as rain or ice. Numerical forecast models use precipitation data to determine the latent heat released due to moisture condensation.

35. **Pressure (Surface/Profile):** A pressure profile is a set of estimates of the atmospheric pressure at specified altitudes above the Earth's surface. Pressure (Surface/Profile) information is required as an input to numerical weather prediction models.

36. **Quarterly Surface Type (IP):** Quarterly surface type is used in the generation of the Surface Type EDR and several use applications.

37. **Sea Ice Characterization:** Sea Ice Characterization constitutes the sea ice properties derived from all weather imagery. Sea ice age is defined as the time that has passed since the formation of the surface layer of an ice covered region of the ocean. The content of the sea ice age EDR is the typing of areas of sea ice by age. The National Ice Center monitors sea ice globally to estimate sea ice growth and decay. This information is used to protect mariners, support military and civilian operations, and assess potential global climate changes since polar regions are more likely to exhibit early signs of global warming.

38. **Sea Surface Winds (SSW):** Sea Surface Winds (SSW) is the measure of atmospheric wind speed/direction at the sea/atmosphere interface in clear sky and cloudy conditions. Winds indicate global and local circulation patterns, force ocean surface circulation (surface currents), determine sea state, influence water levels along the coast, help to determine surface height, produce storm surge, and drive the motion of the lower layers of the atmosphere.

    Sea Surface Winds (SSW) from AMSR2 is the measure of atmospheric wind speed only at the sea/atmosphere interface in clear sky and cloudy conditions. Winds indicate global and local circulation patterns, force ocean surface circulation (surface currents), determine sea state, influence water levels along the coast, help to determine surface height, produce storm surge, and drive the motion of the lower layers of the atmosphere.

39. **Sea Surface Wind Stress (Objective):** Sea Surface wind stress is defined as the magnitude of the frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves. Sea Surface Wind Stress is a parameter derived from Sea Surface Wind Speed and Direction as well as air-sea temperature difference. The sea surface wind stress from a polar-orbiting satellite is needed to construct quality analyses of ocean currents.

40. **Snow Cover:** Snow cover data at specified values are required to determine background conditions for electro-optical sensors. Forecasts of weather, trafficability, river stage, flood, air rescue conditions, and other phenomena also utilize snow cover information.

41. **Snow Cover/Depth:** The snow "Depth" and "All Weather" attributes of this EDR are provided by conical microwave sensors (e.g., AMSR2 and MIS). Snow cover data at specified values are required to determine background conditions for electro-optical sensors.

42. **Snow-Water Equivalent (SWE):** the product of snow depth and snow relative density (with respect to the density of liquid water), a measure of the amount of water stored in a snowpack per unit area; it is expressed in units of length (e.g., cm or inches), being a quantity of type surface density, normalized by water density. SWE is extremely useful to the hydrological community to estimate runoff and stored water.

43. **Soil Moisture (SM):** Soil Moisture is moisture in the soil within the zone of aeration, including water vapor present in soil pores. National Weather Service weather model requires soil moisture to properly calculate the energy fluxes at the surface. Soil moisture measurements are needed to derive trafficability information useful for support of the deployment of amphibious and ground forces.

44. **Spectral Irradiance:** The TSIS instrument is capable of producing a power per unit area per unit wavelength measurement of solar irradiance. This was a planned NPOESS baseline product delivered as part of solar irradiance EDR.

45. **Supra-Thermal-Auroral Properties (STAP):** STAP are in-situ measurements of moderately energetic (< 50 keV) electrons and ions, primarily in the auroral regions. These measurements are input to space environment models and are useful to satellite anomaly assessments (surface charging).

46. **Surface Type:** Surface type information is required as input to agricultural and hydrological models supporting various U.S. Government customers.

47. **Suspended Matter:** Suspended matter, such as sand, dust, and volcanic ash, can damage many different systems. Aircraft flying through these materials can suffer similar damage on cockpit canopies or windscreens. Additionally, aircraft engines suffer extremely high wear in the presence of suspended matter, leading to increased sustainment or engine failure. Volcanic ash plumes are a threat to military and civil aviation. DOC participates in a civil aviation warning system for volcanic ash hazards by monitoring these plumes in satellite imagery. DOC also monitors smoke from large scale fire events to provide information to the relevant agencies and the public.

48. **Total Solar Irradiance:** Total Solar Irradiance is defined as the radiated power per unit area incident on a plane surface at the top of the atmosphere that is normal to the direction from the Sun. Solar Spectral Irradiance is power per unit area per unit wavelength interval. Solar Irradiance is used as a component for monitoring the current state and variability of the climate system. Precision, measurement accuracy, and refresh threshold requirements are based on variations of solar irradiance over the solar cycle and its impact on global climate change as documented by National Research Council, 1994: Solar Influences on Global Change.

49. **Total Water Content (TWC)**: TWC is defined as the water vapor, cloud liquid water, and cloud ice liquid equivalent in specified segments of a vertical column of the atmosphere.

50. **Vegetation Index:** Vegetation/surface type data are required as input to agricultural and hydrological analysis models Vegetation Index is used in numerical weather forecast models as one aspect of specifying surface boundary conditions. USDA is one of the largest users of global vegetation index information for assessing crop conditions and yield. It is also used for monitoring drought, flooding, and general vegetation conditions.

Additionally, the L1RD Supplement contains a list of products at an objective level from the NPOESS IORD Preplanned Product Improvement set. Although these products are beyond the scope of the JPSS program, they represent valid user needs and are provided as potential candidates for improvements to the system.

C. Requirements Working Group Participants

The following individuals were designated by their organization to participate on the team as user representatives and have contributed to the development of this user requirements document. The team was led and coordinated by the JPSS Requirements Working Group authorized by the NOAA Observing Systems Council.

Name	**Role**	**Organization**
Michael Bonadonna	Co-Chair	NOAA; JPSS Requirement Lead
Michael Johnson	Co-Chair	National Weather Service
Jeff Privette	Co-Chair	National Climatic Data Center
Argelia Gonzalez	Executive Secretary	NPOESS Program Executive Office
David Benner	Participant	LOR WG: Satellite Services
Chris Brown	Participant	NESDIS /STAR
Lt Col Chris Cantrel	Participant	Air Force Directorate of Weather
William Denig	Participant	National Geophysical Data Center
Frank Eastman	Participant	NPOESS Integrated Program Office
Ralph Ferraro	Participant	NESDIS / STAR
James Gleason	Participant	JPSS Project Office
Brent Gordon	Participant	National Weather Service
James Heil	Participant	National Weather Service
David Hermreck	Participant	NESDIS
Ken Knapp	Participant	National Climatic Data Center
Richard Krasner	Observer	Dept. of Commerce Inspector General
CDR Andrew Lomax	Participant	Chief Naval Operations Staff
Ajay Mehta	Participant	NESDIS
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Joe Mulligan	Participant	NPOESS Integrated Program Office
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Selina Nauman	Participant	NESDIS
Peggy O'Neill	Participant	NASA Goddard Space Flight Center
Shanna Pitter	Participant	LOR WG: Weather and Water Goal
Tom Schott	Participant	LOR WG: Chair
Kevin Schrab	Participant	National Weather Service
Lei Shi	Participant	LOR WG: Climate
Bill Sjoberg	Participant	National Weather Service
Karen St Germain	Participant	NPOESS Integrated Program Office
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Xuepeng Zhao	Participant	National Climatic Data Center

D. Glossary of Terms

A-DCS: The Advanced Data Collection System will be similar to the Argos-2 payload which resides on NOAA's current POES and measures environmental factors such as atmospheric temperature and pressure, and the velocity and direction of the ocean and wind currents. A-DCS will also collect a variety non-environmental data from Argos platforms.

Application Related Product (ARP): Data product generated by an application using an EDR input.

ATMS and CrIS: The Cross-track Infrared Sounder (CrIS) combined with the Advanced Technology Microwave Sounder (ATMS) globally produces atmospheric temperature, moisture and pressure profiles from space. The combined ATMS / CrIS sensor suite is call the Cross-track Infrared and Microwave Sounder Suite.

Baseline: Operational Baseline refers to an operationally significant performance level between the threshold and objective that is expected to be delivered by the program. The System Baseline refers to capabilities on contract.

C^3 Segment: The system segment responsible for Command, Control, and Communications.

Centrals: Primary processing centers that use JPSS xDRs and other data to produce environmental products for their customers. The processing, archiving, and dissemination of these data are their responsibility. For JPSS, the following are Centrals: Air Force Weather Agency (AFWA), Fleet Numerical Meteorology and Oceanography Center (FNMOC), the Naval Oceanographic Office (NAVO), and the National Environmental Satellite Data and Information Services (NESDIS).

CERES and CERES Follow-on: The Clouds and the Earth's Radiant Energy System. Part of NASA's EOS, CERES products include both solar-reflected and Earth-emitted radiation from the top of the atmosphere to the Earth's surface. Cloud properties are determined using simultaneous measurements by other EOS instruments such as the Moderate Resolution Imaging Spectroradiometer (MODIS).

Comprehensive Large Array-data Stewardship System (CLASS): CLASS is an IT system that supports the NOAA Data Center's mission from its polar and geostationary satellites and from in situ sources.

Climate Data Record (CDR): A CDR is a time series of measurements (e.g., sea surface temperature) of sufficient length, consistency, and continuity to determine climate variability and change [National Research Council, 2004]. In practice, NOAA will use JPSS data together with heritage and other data sets to provide climate records typically covering multiple decades in time.

Climate Information Record (CIR): -- A CIR is a time series derived from CDRs and related long-term measurements that provides specific information about complex environmental phenomena of importance to science and society (e.g., drought area, Arctic sea ice extent, hurricane trends) in a manner useful to a variety of applications and user communities.

Data Availability to Centrals: Data Availability is the percentage of data collected by operational sensors on each JPSS satellite that is delivered to the IDPS across the four Centrals. Data availability is calculated on a monthly basis.

Data Latency: EDR latency is defined as the period from the time of observation of all requisite data by the satellite until the EDR produced by those data are available at the IDPS/Central interface.

Development: The creation of a new system, or the system modifications necessary to add completely new functionality to an existing baseline system to comply with mission requirements. The testing, fielding, and verification of these new capabilities (with support from the receiving organization at the installation site.)

Engineering Units: A term used to describe spacecraft telemetry in terms of volts, amps, deg C, deg of rotation, etc. Engineering units are usually derived from raw "counts" by applying a calibration curve. Science data has to be further reduced to convert those "engineer units" into raw science units (e.g. flux) by applying on-orbit or ground calibration data.

Environmental Data: Environmental data as used in this document is also termed mission data and refers to all data (atmospheric, oceanographic, terrestrial, space environmental and climatic) being sensed and collected by the spacecraft.

Environmental Data Record (EDR): Data record produced when an algorithm is used to convert Sensor or Temperature Data Records (SDRs, TDRs) to geolocated geophysical parameters (including ancillary parameters, e.g., cloud cleared radiation, etc.).

Field Terminals: Field Terminals include the various receivers used by deployed/remote units to obtain environmental data in real time.

Ground Receptors: An element of the JPSS C3S, ground receptors may include unattended globally distributed satellite data receiving sites or other facilities as provided by JPSS to collect stored mission data from the JPSS and DWSS satellites.

High Rate Data (HRD) Broadcast: The JPSS satellites will broadcast data to the Direct Broadcast Users' field terminals via a near continuous, X-Band, transmission. The HRD broadcast is expected to include virtually all collected mission data.

Imagery: Two-dimensional array of numbers, in digital format, each representing the brightness of a small elemental area.

Interface Data Processing Segment (IDPS): The ground processing capability located at the four Centrals. The IDPS receives raw data from the Space or C^3 segment, temporarily stores RDRs, converts RDRs into EDRs then pushes all required data into the Central's computers. The IDPS equipment at any one location is referred to as the Interface Data Processor (IDP) for that site. The IDP algorithms residing within the field terminals perform similar functions.

Intermediate Product (IP): Data product generated for temporary use within the IDPS to generate xDRS.

Key Performance Parameter: A parameter so significant to the user community that all designated requirements must be met to achieve minimal mission success.

Low Rate Data (LRD) Broadcast: The JPSS-2 satellite will broadcast data to the Direct Broadcast Users' field terminals via a near continuous, L-Band, transmission. The LRD broadcast is expected to include a user selectable subset of collected mission data.

Mission Sensors: Any sensor on the spacecraft directly used to satisfy any of the environmental data requirements.

Objective: Objectives represent an improved performance level above and beyond the threshold requirements that would better meet user needs and which are realistically achievable with current technology.

OMPS: Ozone Mapping and Profiler Suite collects data to permit the calculation of the vertical and horizontal distribution of ozone in the Earth's atmosphere. OMPS consists of separate nadir and limb sensors. The OPMP Nadir sensor consists of Mapper and Profiler components.

Operational Availability (A_o): The measure of the probability that a system is operationally capable (ready for tasking) of performing an assigned mission (delivering a KPP) at any given time Once on orbit, the JPSS satellites are required to operate 24/7, 365 days per year for the mission lifetime. The System Operational Availability for JPSS is a composite value that includes the Command, Control, and Communications Segment (to/from the Space Segment including MMC equipment); a single Space Segment orbital plane; and an IDP system at a single Central site. The availability criteria include the reliability for each of the segments of the system, redundancy, and planned outages (downtime for spacecraft maneuvers and calibration and ground system sustainment).

Operations: The staff necessary to operate a system and the recurring costs necessary to keep the operation active (facilities, networks, utilities, etc.)

Operational Satellite: A spacecraft providing useful data to meet observational data or service requirements. Primary operational status is declared when a NOAA satellite is tasked to provide data to meet mission success criteria. These satellites have priority for data collection and processing. Secondary operational satellites provide data to supplement the primary source to increase temporal or spatial coverage. Data from the secondary operational satellites have lower priority than Primary operational satellites.

Payload: Mission sensors and on-board processor.

Program Plan/Management Control Plan: A document authorized by a Memorandum of Understanding between NOAA and NASA which establishes the business processes, management controls, and organizational structure of the program. The MCP forms the basis for the Project Plans of the Flight and Ground Segment Projects.

Raw Data Record (RDR): Full resolution digital sensor data, time referenced and earth located, with absolute radiometric and geometric calibration coefficients available, but not applied, to the data. Aggregates (sums or weighted averages) of detector samples are considered to be full resolution data if the aggregation is normally performed to meet resolution and other requirements. Sensor data must be unprocessed with the following exceptions: time delay and integration, detector array non-uniformity correction (i.e., offset and responsivity equalization), and data compression are allowed. Lossy data compression is allowed only if the total measurement error is dominated by error sources other than the data compression algorithm. All calibration data will be retained and communicated to the ground without lossy compression.

Refresh: Refresh is the time interval between successive collections of measurements of the same parameter from the same geographical point on, or above, the surface of the earth.

SARSAT: The Search and Rescue Satellite Aided Tracking system (SARSAT) uses NOAA satellites in low-Earth and geostationary orbits to detect and locate aviators, mariners, and land-based users in distress. The satellites relay distress signals from emergency beacons to a network of ground stations and ultimately to the U.S. Mission Control Center (USMCC) in Suitland, Maryland as well as the Canadian and French MCCs. The MCCs processes the data and alerts the appropriate search and rescue authorities.

SEM-N: The Space Environment Monitor will be carried on DWSS satellites and provide five Environmental Data Records. These data provide information about the space environment necessary to ensure reliable operations of current space-based and ground-based systems, to facilitate the analysis of system anomalies that may be the result of space environmental effects, and to guide the design and efficient operations of future systems that may be affected by the space environment.

Sensor Data Record (SDR): Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to geolocated calibrated brightness temperatures, radiances, or reflectances with associated ephemeris data.

Service Delivery Point: The functional location or locations where the JPSS must provide data or services.

Space Segment: The spacecraft including its associated sensors, subsystems, equipment, and processors.

Sustainment: The work required to keep a baseline system architecture functioning as technology and security requirements evolve, and the effort necessary to fix problems identified in the system during operations. System refresh as required.

Threshold: Threshold requirements represent the minimally acceptable level of performance that must be achieved.

Temperature Data Records (TDRs): Data records that are geolocated antenna temperatures with all relevant calibration data counts and ephemeris data to revert from T-sub-a into counts. The existence of the SDRs provides reversible data tracking back from the EDRs to the Raw data.

TSIS: The Total and Spectral Solar Irradiance Sensor (TSIS) is a combination of two solar irradiance instruments to monitor the solar energy incident at the top of the Earth's atmosphere. The Total Irradiance Monitor (TIM) measures total solar irradiance (TSI). This TSI record is used both to determine solar forcing on the Earth's climate and to establish correlations with long duration proxies of solar activity, allowing estimates of past solar influences on the Earth. The Spectral Irradiance Monitor (SIM) measures the solar spectral irradiance useful in determining the response of different layers in the Earth's atmosphere to solar variations and in diagnosing the solar causes of irradiance variations.

VIIRS: The Visible Infrared Imager/Radiometer Suite collects visible and infrared radiometric data of the Earth's atmosphere, ocean, and land surfaces. Data types include atmospheric parameters, clouds, Earth radiation budget, land/water and sea surface temperature, ocean color, and low light imagery.

E. Acronyms

A-DCS	Advanced Data Collection System
AF A3O-W	Air Force Directorate of Weather
AFWA	Air Force Weather Agency
AMMC	Alternate Mission Management Center
AMSR	Advanced Microwave Scanning Radiometer
ARP	Application Related Product
ATMS	Advanced Technology Microwave Sounder
C3S	Command, Control and communications Segment
CIR	Climate Information Record
Cal/Val	Calibration/Validation
CERES	Clouds and the Earth's Radiant Energy System
CDR	Climate Data Record
CGS	Common Ground System
CORL	NOAA Consolidated Observing Requirements List
CPD	NPOESS Capabilities Production Document
CLASS	Comprehensive Large Array-Data Stewardship System
CNES	Centre Nationale d'Etudes Spatiales (CNES), France
CrIS	Cross-track Infrared Sounder
CrIMSS	Cross-track Infrared and Microwave Sounder Suite
DFS	Dual Frequency Scatterometer
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
DUS-O	Deputy Under Secretary of Commerce for Oceans and Atmosphere for Operations
DWSS	Defense Weather Satellite System
EDR	Environmental Data Record
EOS	NASA Earth Observing System
EPS-SG	European Polar System-Second Generation
ESPC	Environmental Satellite Processing Center
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FNMOC	Fleet Numerical Meteorology and Oceanography Center
FF	Free Flyer satellite
FT	Field Terminal
FY	Fiscal Year
GCOM	Global Change Observation Mission
GFE	Government Furnished Equipment
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
HRD	High Rate Data
IDP	Interface Data Processor
IDPS	Interface Data Processing Segment
IORD–II	NPOESS Integrated Operational Requirements Document - 2
IP	Intermediate Product
IPO	Integrated Program Office
JAXA	Japanese Aerospace Exploration Agency
JPS	NOAA – EUMETSAT Joint Polar System
JPSS	Joint Polar Satellite System
KPP	Key Performance Parameter
L1RD	Level 1 Requirements Document
LEO	Low-Earth orbiting or orbit
LOR WG	Low Earth-orbiting Requirements Working Group
LRD	Low Rate Data
LSS	Launch Support Segment
LST	Local Solar Time
LTAN	Local Time Ascending Node
MCP	Program Plan/Management Control Plan
MGS	McMurdo Ground Station
MMC	Mission Management Center
Metop	EUMETSAT Meteorological Operational satellites
MIS	Microwave Imager/Sounder
NASA	National Aeronautics and Space Administration

NAVO	Naval Oceanographic Office
NCDC	National Climatic Data Center
NDE	NOAA's NPOESS Data Exploitation program
NESDIS	NOAA Satellite and Information Service
NGDC	National Geophysical Data Center
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOSC	NOAA Observing Systems Council
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NSA	National Security Agency
NSOF	NOAA Satellite Operations Facility
NWS	National Weather Service
OMPS	Ozone Mapping and Profiler Suite
PEO	Program Executive Office
PMC	Program Management Council
POES	NOAA Polar-orbiting Operational Environmental Satellites
RDR	Raw Data Record
SARSAT	Search and Rescue Satellite Aided Tracking
SEM-N	Space Environment Monitor-NPOESS
SDR	Sensor Data Record
SDS	Science Data Segment
SGLI	Second Generation Global Imager
SN	NASA Space Network
SS	Space Segment
STAR	NOAA's Center for Satellite Applications and Research
TDR	Temperature Data Record
TDRSS	Tracking and Data Relay Satellite System
TSIS	Total and Spectral Solar Irradiance Sensor
USAF	United States Air Force
USD AT&L	Under Secretary of Defense, Acquisition, Technology, and Logistics
USG	United States Government
VIIRS	Visible Infrared Imager/ Radiometer Suite
xDR	Data Record