

<b>Subject</b>	Low Latency Data Access status report + status of implementation of best practices at NOAA
<b>In response to CGMS action/recommendation</b>	WG-I members are invited to take note and comment on the status of implementation at NOAA of the CGMS Best Practices in support of local and regional processing of LEO direct broadcast data.
<b>HLPP reference</b>	2.3.3
<b>Executive Summary</b>	This paper presents status of implementation at NOAA of the CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data (CGMS/DOC/18/1008274, v1B) for S-NPP, NOAA-20 and NOAA-21
<b>Action/Recommendation proposed</b>	

## 1 INTRODUCTION

This paper describes the implementation status of the Coordination Group for Meteorological Satellites (CGMS) agency best practices in support to local and regional processing of Low Earth Orbiting (LEO) Direct Broadcast (DB) data at the National Oceanic and Atmospheric Administration (NOAA). The Best Practice document is labelled CGMS/DOC/18/1008274, v1C and it is available at:

[https://www.cgms-info.org/documents/CGMS\\_BP\\_LEO\\_DB\\_data\\_-\\_local\\_regional\\_processing.pdf](https://www.cgms-info.org/documents/CGMS_BP_LEO_DB_data_-_local_regional_processing.pdf).

The Best Practices reflect the commitments taken by the CGMS agencies operating DB satellites with respect to the coordination and support provided to the DB user community. By adopting the Best Practices, CGMS Agencies are also increasing user's data access capability, while improving timeliness of satellite data in environmental models, and reducing the overall demands on alternative data distribution systems.

This paper focuses on the Polar Operational Environmental Satellites (POES) legacy missions (NOAA-15, NOAA-18, NOAA-19); Suomi National Polar-orbiting Partnership (S-NPP) mission, NOAA-20 mission and NOAA-21 mission

The Office of Satellite and Product Operations (OSPO), National Environmental Satellite, Data, and Information Service (NESDIS) represents NOAA for this effort.

## 2 STATUS OF OPERATIONAL DIRECT BROADCAST SYSTEMS

Instruments	SNPP	NOAA-20	NOAA21
ATMS	Green	Green	Green
CERES	Green	Green	Green
CrIS	Red	Green	Green
OMPS	Green	Green	Green
VIIRS	Green	Green	Green

### **3 BEST PRACTICES**

#### **3.1 BP.01 Global Specification for Direct Broadcast**

Best Practice BP.01 Description: Operators should implement the agreed CGMS Direct Broadcast Services.

##### **3.1.1 S-NPP, NOAA-20 and NOAA-21**

Compliant. The HRD builds upon a set of applicable Consultative Committee for Space Data Systems (CCSDS) standards as described in the Joint Polar Satellite System 1 (JPSS-1) Spacecraft High Rate Data (HRD) to Direct Broadcast Stations (DBS) Radio Frequency (RF) Interface Control Document (ICD) (2014).

The Mission Data Formatter (MDF) within the Command and Data Processor (CDP) enables CCSDS Channel Access Data Units (CADU) to be generated from CCSDS Advanced Orbiting Systems (AOS) transfer frames provided by the CDP flight software.

The Joint Polar Satellite System (JPSS) Common Data Format Control Book –External (CDFCB-X), Volume VII – Part 1, JPSS Downlink Data Formats is available on the National Environmental Satellite, Data, and Information (NESDIS) website: [JPSS Technical Documents](#).

#### **3.2 BP.02 Timely provision of Space-to-Ground Interface Control Document**

Best Practice BP.02 Description: CGMS operators should provide up-to-date and satellite-specific Space-to-Ground Interface Control Documents in English language at least 3 years before the launch of each satellite, including at least:

- a) Frequency usage
- b) Polarization
- c) Encoding
- d) G/T requirements
- e) Data stream layout and content
- f) Conformance with CCSDS.
- g) Conformance with the CGMS Global Specification (see section 1)

##### **3.2.1 SNPP, NOAA-20, NOAA-21**

Compliant. The Joint Polar Satellite System 1 (JPSS-1) Spacecraft HRD to DBS RF ICD is available to the public at: JPSS Technical Documents

The ICD is listed as a reference on the WMO SATURN webpage titled [JPSS1 Data Access Mechanisms](#)

The NOAA-21 HRD will have some differences compared to the NOAA-20 (JPSS-1) HRD. The JPSS Program briefed HRD users on the differences during an HRD User Group meeting in November 2018. NOAA briefed the changes during the WG-I Intersessional WebEx in March 2019. The JPSS Program posted an updated NOAA-21 Satellite High-Rate Data (HRD) to Direct Broadcast Stations (DBS) Radio Frequency(RF) Interface Control Document (ICD) on the JPSS website in October 2021. The document is available on the JPSS website at: [JPSS Technical Documents](#)

The NOAA-21 HRD differences compared to the NOAA-20 HRD are:

- The modulation type is offset quadrature phase shift keying (OQPSK) (NOAA-20 is QPSK).
- The data rate for NOAA-21 will increase to 25 Mbps (NOAA-20 data rate is 15 Mbps).
- Both missions use Reed-Solomon (RS) block coding. The NOAA-21 HRD interleaves five blocks (I=5) and NOAA-20 interleaves four blocks (I=4).
- The JPSS Program briefed the HRD User Group on the changes on November 8, 2018.

### 3.3 BP.03 Provision of Current Orbit Information

Best Practice BP.03 Description: CGMS operators should ensure timely provision of accurate and up-to-date orbit information based on their operational orbit determination and knowledge of satellite maneuvers. The orbit information should be made available to Direct Broadcast reception station operators:

- a) In TLE format via FTP or HTTP over the Internet
- b) Additionally, if required for the processing and geolocation of the sensor data, in the relevant mission specific format via FTP or HTTP over the Internet and/or via the satellite's Direct Broadcast signal Additionally, if the satellite operator chose to do so, in TLE format via the satellite's Direct Broadcast signal
- c) Additionally, if the satellite operator chose to do so, in TLE format via the satellite's Direct Broadcast signal.

The satellite operator shall document:

- d) The details of how and where the orbit information is made available
- e) For any mission specific format, the format definition and its application

**General Comment:** NOAA no longer uses FTP or HTTP over the Internet and has moved to secure protocols such as HTTPS

### 3.3.1 S-NPP, NOAA-20 and NOAA-21

Compliant with S-NPP, NOAA-20 and NOAA-21. The JPSS Field Terminal Support (FTS) provides Mission Support Data (ancillary data, auxiliary data and Mission Notices) and the necessary hardware and software specifications needed for processing the broadcasts. FTS distributes S-NPP and NOAA-20 (JPSS-1) TLEs, predicted post- maneuver TLEs, and definitive ephemeris files.

Orbital data is also provided on the FTS web portal, to assist the DB community indicating the satellites of interest.

FTS webpage: <https://fieldterminal.nesdis.noaa.gov>

Users can also find S-NPP, NOAA-20 and NOAA-21 TLEs from the following OSPO run webpage: [CelesTrak TLEs](#)

Spacecraft ephemeris and attitude information is included in the HRD broadcast from S-NPP, NOAA-20 and NOAA-21 and it is used for real-time geolocation processing in CSPP.

### 3.4 BP.04 Provision and maintenance of Product Processing software packages

Best Practice BP.04 Description: Each LEO satellite operator should therefore ensure that:

- a) Software packages for the relevant instruments are made available with a test version made available prior to launch and the operational version made available after end of commissioning of the satellite and as soon as feasible for the satellite operator;
- b) To enable deployment of the software packages within organizations not permitting installation of pre-compiled software, source code should be made available;
- c) Global and local product processing shall be harmonized in that brightness temperature products derived from both paths agree within tolerances that are not greater than few tenths (goal is 10%) of the respective performance requirements for bias error at a reference brightness temperature;
- d) User support and maintenance services are available for the duration of the mission;

- e) Notifications for software changes are provided to the user community;
- f) Complete and comprehensive user documentation and S/W release documentation is supplied in English language;
- g) The software installation procedure is designed to be easily executed by an untrained user;
- h) The software package is executable on a standard computer platform, typically Linux/x86-64, providing a performance compatible with the timeliness requirements defined in the Guide to DBNet (CGMS-44-WMO-WP-10);
- i) For reasons of performance, it should be possible to configure the software to process only the instruments and processing levels required locally;
- j) Test data for verifying the installation of the S/W packages are made available

The product processing software is robust against sporadically missing data packets from the instrument or satellite in the sense that the software limits the extent of degraded or lost observations in the generated product(s) to the minimum possible.

### 3.4.1 S-NPP, NOAA-20 and NOAA-21

NOAA's S-NPP, NOAA-20 and NOAA-21 product processor software complies with the elements of BP.04 as follows:

- a) Software packages for the relevant instruments are made available prior to launch. Software is available for download prior to launch. CSPP software processes S-NPP and JPSS data from VIIRS, CrIS, and ATMS. Instructions for downloading CSPP software are on the CSPP Home Page located at: <http://cimss.ssec.wisc.edu/cspp/>
- b) In regards to making source code available, NOAA agrees with the BP.04 wording with a minor condition. For U.S. government agencies, the scope of licensing rights generally depends upon the source of the funding (i.e., government, mixed, or private), the nature of the data (commercial or non-commercial), and any negotiated terms of the contract. Also, NOAA must comply with deemed export control rules. Hence, as long as NOAA has unlimited rights to the source code and complies with all applicable laws, regulations, and policies, then NOAA should be able to make it available.
- c) In regards to harmonizing global and local product processing, the CSPP software is compliant
- d) In regards to user support and maintenance services CSPP is compliant. CSPP is sponsored by the JPSS Program Science Office.
- e) Notifications for CSPP software changes are posted on the CSPP Website.
- f) CSPP Documentation is on the CSPP website: [CSPP](#)
- g) The software installation procedure is designed to be executed by an untrained user.
- h) The CSPP software package is executable on a standard computer platform, typically Linux/x86-64, providing a performance compatible with the

timeliness requirements defined in the Guide to DBNet (CGMS-44-WMOWP-10).

i) The CSPP software enables users to configure the software to process only the instruments and processing levels required locally.

j) Test data for verifying the installation of the CSPP software packages are available from the CSPP program

### **3.5 BP.05 Provision of auxiliary data for instrument product processing.**

Best Practice BP.05 Description: Each operator of instruments requiring auxiliary data for the product processing must make available the necessary auxiliary data on the Internet in a user-friendly and timely manner. Announcements of the availability of new auxiliary data should be issued giving the Direct Broadcast reception station operators sufficient time to update their systems.

#### **3.5.1 S-NPP, NOAA-20 and NOAA-21**

Compliant with S-NPP, NOAA-20 and NOAA-21 auxiliary data are available on FTS. <https://fieldterminal.nesdis.noaa.gov/>

### **3.6 BP.06 Recommendations of channel selection for hyperspectral instruments.**

Best Practice BP.06 Description: Each CGMS operator of hyperspectral instrument is responsible for defining a recommended channel selection scheme for global NWP purposes. The channel selection shall be made available to DB station operators prior to the launch of the first instrument and subsequently whenever the channel selection is modified.

#### **3.6.1 S-NPP, NOAA-20 and NOAA-21**

Compliant. Users are notified of any changes through Environmental Satellite Processing Center (ESPC) Notifications. Contact the ESPC Help Desk to be added to the distribution list: [ESPCOperations@noaa.gov](mailto:ESPCOperations@noaa.gov)

Archive- <https://www.ospo.noaa.gov/Operations/messages.html>

### **3.7 BP.07 Spacecraft and Instrument Operational Status**

Best Practice BP.07 Description: Each CGMS operator to publish and maintain up to date spacecraft and instrument operational status information on the Internet. The CGMS operators should establish a scheme to review on

a regular basis that the published status information is up to date.

### 3.7.1 SNPP, NOAA-20 and NOAA-21

Compliant. S-NPP, NOAA-20, NOAA-21 operational statuses are available at:  
<https://www.ospo.noaa.gov/Operations/JPSS/status.html>

Product maturity level is available at:  
<https://www.star.nesdis.noaa.gov/jpss/AlgorithmOperational.php>

## 3.8 Operational Announcements

Best Practice BP.08 Description: Each CGMS operator to announce planned operations and status changes as well as any observed degradation of the spacecraft and its instruments via e-mail and optionally via other channels.

### 3.8.1 SNPP, NOAA-20 and NOAA-21

Compliant. Environmental Satellite Processing Center (ESPC) Notifications are issued for both and unplanned events. The notifications are also available at: <http://www.ospo.noaa.gov/Operations/messages.html>

## 3.9 BP.09 Satellite Direct Broadcast and Reception Station Performance Requirements

Best Practice BP.09 Description: When planning, designing, and developing satellite direct broadcast (DB) downlink capabilities, the CGMS agencies will strive to minimize, when possible, negative impacts on the DB community by communicating with manufacturers and users; coordinating with the other CGMS agencies; and considering these potential impacts during the CGMS agency's decision-making process.

The performance of the satellite's DB X-Band (7.8 GHz, ITU MetSat Band) downlink should be sufficient for nominal data reception at any reception station within the satellite's footprint at elevations above 5 degrees and a G/T value of at least 22.7 dB/K. The calculation of the satellite DB performance shall include an allocation of at least 8.55 dB for reception station losses, rain and atmospheric losses, and link budget margin. The G/T is defined at the input of the receiver interface, at 5-degree antenna elevation and clear sky conditions.

A reception station operator may be required to establish a reception station with additional performance margin to account for local conditions, including climate, RF interference or the impact of an antenna radome.

### 3.9.1 SNPP, NOAA-20 and NOAA-21

Compliant. The Link Budget in Appendix A.1(SNPP, NOAA-20) and Appendix A.2 (NOAA-21, JPSS-3, JPSS-4) demonstrates a positive margin when assuming Reference Rain and Atmospheric losses and station Reference Performance.

### **3.10 BP.10 Monitoring of the Direct Broadcast Downlink**

Operators of satellites with DB should routinely monitor the quality of the DB downlink and address any anomalies in accordance with each organization's established procedures, and notify users of degraded performance.

Monitoring should include:

- a)** For each satellite, during the six months following DB signal activation, a validation that nominal reception is possible for a DB reception station anywhere within the footprint of the satellite DB antenna by acquiring all passes at an elevation of 5 degrees or more above the local horizon throughout a full satellite ground track repeat cycle. Nominal reception implies a positive link budget margin as well as the signal and data quality parameters defined under d) and e) below, being in their nominal range for a reception station corresponding to the minimum requirements of BP.09
- b)** During at least one pass per day for each satellite, monitoring of the signal quality parameters and the data quality parameters, as defined under d) and e) below respectively, for the part of the pass which is at an elevation of 5 degrees or more above the local horizon;
- c)** During at least one pass per day for each satellite, monitoring of the data quality parameter degradation, attributable to frames or packets discarded or degraded on the spacecraft, prior to transmission to the ground; where
- d)** Signal quality parameters should include receive signal strength, signal to noise ratio, spectral power distribution, and carrier, bit and frame lock statistics; and
- e)** Data quality parameters should include discarded frames and packets (failing error free decoding/reconstruction), missing frames and packets (calculated from measured frame and packet sequence counters), bad lengths (frame or packet out of tolerance length), and sequence errors (frame or packet detected gaps/sequence error) per Virtual Channel Identifier (VCID) for frames and Application Process Identifier (APID) for packets.

#### **3.10.1 SNPP, NOAA-20 and NOAA-21**

a) through e) Compliant with S-NPP, NOAA-20 and NOAA-21. OSPO is responsible for the NPP, NOAA-20 and NOAA-21 HRD broadcasts and OSPO's monitoring capability is based on the JPSS Requirement: L1RDS-2271 "The JPSS Ground System shall monitor the quality of the HRD Direct Broadcast downlinks during at least 3 passes per day for each of the JPSS managed satellites." OSPO routinely schedules HRD contacts at the Svalbard ground station. The Svalbard antenna receives HRD and an HRD Link Monitoring (HLM) report is created in the

JPSS ground system. The HLM is distributed to the FTS so that DB users can retrieve and view the report. OSPO encourages users to report product quality issues that might have been caused by an anomaly on the spacecraft.

The University of Wisconsin – Madison (UW) Space Science and Engineering Center (SSEC)/ Cooperative Institute for Meteorological Satellite Studies (CIMSS) monitors ingest logs and monitors SDR quality using CSPP LEO. SSEC/CIMSS agrees to report any anomalies noted during their normal working hours to OSPO.

The NOAA Direct Broadcast Real Time Network (DBRTN) is NOAA’s contribution to the WMO DBNet. The goal is to deliver advanced infrared and microwave sounder data to NWP centers with low latency for rapid refresh data assimilation. Sounder data are acquired in real-time at NOAA and partner antenna sites, processed centrally at CIMSS/ SSEC to Level 1B, and delivered to NWP centers in BUFR format. UW/SSEC/CIMSS operates 5 DB sites in the DBRTN and 17 partner DB sites are also contributing data to the DBRTN. ATMS and CrIS data from SNPP and NOAA-20 are routinely ingested, processed, converted to BUFR, and then delivered to NOAA for dissemination on GTS. IASI and ATOVS data from Metop- B/C and NOAA-18/19 are also included in the NOAA DBRTN ingest/processing/delivery system. The EUMETSAT NWP-SAF routinely compares the SDRs created from the JPSS HRD with SDRs created from the Stored Mission Data (SMD) and reports any outages or inconsistencies.

#### **4 ACTIONS AND/OR RECOMMENDATIONS FOR CONSIDERATION BY CGMS PLENARY SESSION (OR WORKING GROUP 1)**

WG-I members are invited to take note and comment on the status of implementation at NOAA of the CGMS Best Practices in support of local and regional processing of LEO direct broadcast data.