



Preparation for the Full Resolution CrIS Hyperspectral Radiance Data in BUFR Format



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Abstract

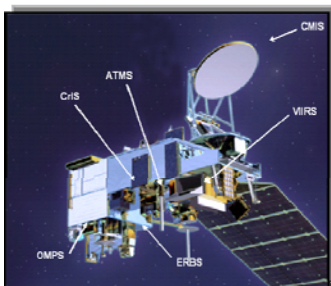
NOAA/NESDIS is currently creating and distributing Cross-track Infrared Sounder (CrIS) radiances from the Suomi National Polar-orbiting Partnership (S-NPP) satellite in Binary Universal Form for the Representation of meteorological data (BUFR) format to the global Numerical Weather Prediction (NWP) centers. Two BUFR files are currently being made available, the truncated resolution set of 1305 channels and a representative set containing 399 channels. For the next CrIS instrument on the J1 satellite, the full resolution channel set containing 2211 channels will be downlinked. To prepare for this larger data set, NOAA/NESDIS/STAR will be making upgrades to the CrIS processing system running in NESDIS operations and to the distributed BUFR files. STAR will also be implementing a new representative channel subset to replace the 399 channel BUFR file. When the S-NPP downlink is changed to bring down the full resolution CrIS channel set, these updates to the BUFR files will be implemented for S-NPP as well. The updates to the CrIS processing system, the channel subset, and the BUFR files shall be presented.

Development Timeline

- Jul 15: Begin requirements development
- Jul 15: Begin product development
- Aug 15: Update NUCAPS and BUFR Toolkit
- Sep 15: Begin CrIS BUFR processing for JSCDA
- Sep 15: Finalize updated CrIS BUFR table
- Oct 15: Add JPSS Risk Reduction VIIRS clouds
- Nov 15: Make sample CrIS BUFR available to users
- Dec 15: Critical Design Review
- Dec 15: Update subset channel selection
- Feb 16: Complete unit testing
- Mar 16: Software Review
- Apr 16: Deliver preliminary DAP for NDE 1.0 & 2.0
- Apr 16: Algorithm Readiness Review
- Apr 16: Deliver Final DAP to NDE
- May 16: System Baseline
- Jun 16: Operational Readiness Review
- Jun 16: S-NPP full-res SDRs available from IDPS
- Jun 16: Product declared operational in NDE 1.0

Necessary Updates

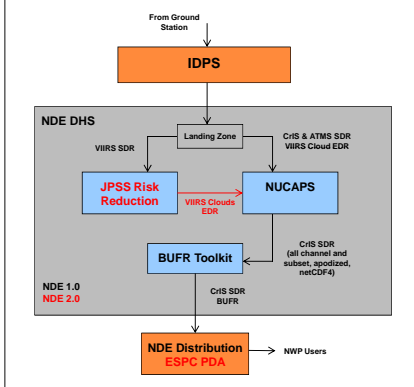
- NUCAPS Updates:**
 - Code updates to the NUCAPS preprocessor reader routines to accommodate the new full-res files with the additional channels.
 - Code updates to use the collocated JPSS Risk Reduction Cloud Mask and Cloud Top Height (Highest cloud) in the CrIS BUFR. Initially, NUCAPS will also need to be able to continue to use the currently available VIIRS cloud products from IDPS until the JPSS Risk Reduction clouds are available in the fall of 2016.
 - Update to the NUCAPS subsetter to extract the new subset channel set.
 - Update the NUCAPS radiance eigenvectors for quality monitoring of radiances.
 - Subset channel selection.
- BUFR/GRIB2 Toolkit Updates:**
 - Update to the CrIS SDR BUFR table.
 - Update to BUFR Toolkit code to handle writing the new table.
- JPSS Risk Reduction Updates:**
 - Integration of GOES-R cloud algorithms into the AIT Framework. This work is already complete. However, this package will run inside NDE 2.0 which doesn't become operational until fall of 2016.



CrIS Full-Resolution BUFR Product Information

- The CrIS all-channel BUFR will contain 2211 channels.
- The new CrIS BUFR files will continue to contain 32 seconds of data (4 CrIS scans).
- Only WMO-approved descriptors are used in the current and updated CrIS BUFR tables.
- The subset will contain ~400 channels. These are yet to be determined.
- The channel subset will be selected by Jim Jung at JCSDA and Antonia Gambaocota funded through the JPSS Project.
- The 12 CrIS guard channels (2 at the beginning and end of each of the 3 bands) will be stored in a separate array within the BUFR file.
- Hamming apodization will be applied (as is currently done). This type of apodization (which is reversible) and the availability of the guard channels will allow users the ability to de-apodize the radiance data in the all-channel 2211 BUFR file.
- A flag is present in the table to differentiate it from the currently generated lower-resolution CrIS BUFR data. This is necessary because many of the channels have the same central wavenumber, but different spectral widths.
- The CrIS BUFR currently contains the VIIRS EDR cloud fraction and height (from IDPS) collocated to the CrIS FOVs. These will be replaced with the VIIRS cloud products from the JPSS Risk Reduction product suite which are higher resolution for cloud height.
- Latency will not be impacted by the switch to the new VIIRS cloud products. If VIIRS cloud data are not available within 10 minutes, the CrIS BUFR is generated without the cloud information.
- Currently, 93% of the VIIRS data is available within 10 minutes.
- The VIIRS cloud fraction is averaged over each CrIS FOV.
- The cloud height is the height of the highest VIIRS cloud in each CrIS FOV.

NESDIS CrIS BUFR Data Processing



Data Processing System

- The NDE Data Handling System (DHS):**
 - NDE is the enterprise processing system for generating S-NPP and JPSS NOAA-unique and tailored products.
 - CrIS SDR BUFR generation within the NDE DHS requires processing through the NOAA Unique CrIS ATMS Processing System (NUCAPS), JPSS Risk Reduction, and the BUFR Toolkit packages.
 - The NDE DHS ingests CrIS SDR and VIIRS SDR and EDR data from the Interface Data Processing Segment (IDPS).
 - The NDE system schedules, manages, and monitors all operational science data processing.
 - The NUCAPS package reads the CrIS SDR and VIIRS cloud product EDR. Its output is converted to BUFR by the BUFR Toolkit package. NUCAPS will initially use the VIIRS cloud EDR from IDPS and later the VIIRS cloud EDR from JPSS Risk Reduction (see figure above).
 - NDE version 1.0 will distribute to the current NDE distribution server. For NDE 2.0, the ESPC Product Distribution Area (PDA) will handle all ESPC operational product distribution.
- NUCAPS Data Handling:**
 - NUCAPS preprocessor: Extracts file headers for instrument mode and maneuver checks, conducts range checks of data, performs leap second correction, collocates CrIS, ATMS, and VIIRS data onto the same fields of view, performs the apodization on the CrIS radiances, applies a digital elevation model, and reformats all the output for the downstream processing units.
 - NUCAPS subsetter: Generates CrIS thinned radiances and principal component products. Reformats CrIS products for downstream tailoring into BUFR.
- BUFR/GRIB2 Toolkit:**
 - Reads in netCDF4 files from NUCAPS and encodes the output into BUFR.
- JPSS Risk Reduction Data Handling:**
 - Reads in the VIIRS SDR and generates VIIRS EDR products for clouds (also cryosphere, aerosol and volcanic ash).
 - Cloud products are output to netCDF4.

System Information

- Hardware and System:**
 - 8 Dual socket Intel Xeon X5660, 2.8GHz, Red Hat Enterprise Linux
 - GNU gfortran and C/C++ 4.7 compilers, Perl (version 5.8 or higher)
 - Libraries and utilities: netCDF4, HDF5, BUFR, wgrib2
 - Separate machines for development (at STAR) and test and production (at ESPC).
- Code:**
 - All data handling and algorithms are written in Fortran 90.
 - Perl scripts wrap the Fortran 90 main programs to manage the interface with the NDE DHS.
- Testing and Quality Assurance:**
 - The STAR CrIS SDR Cal/Val lead, Yong Han, has provided over a year's worth of CrIS full-resolution SDR files for development, testing, and reprocessing. These files are generated continuously offline from full-resolution RDR files using the Algorithm Development Library (ADL).
 - JPSS Risk Reduction VIIRS cloud products will be generated at STAR on a Linux cluster. These will be available in netCDF4 for use in the NUCAPS and Toolkit development effort.
 - Additional JPSS datasets will be available from the STAR Collaborative Data Repository (SCDR).
 - These long term data sets allow for system testing of all the code and hardware to ensure it is robust, can handle the data volumes, and can meet the product latencies.
 - CrIS full-resolution BUFR files are being made available to JCSDA and EMC at: http://ftp2.star.nesdis.noaa.gov/smcd/letitias/CrIS_HR_BUFR/
 - Ingest of full-res all-channel CrIS BUFR are currently being tested by Dennis Keyser at EMC.
 - BUFR table developed by STAR and approved by the NESDIS WMO representative (Jeff Afor).
 - Test data, procedures, and test results are made available to NDE and OSPO as part of the Delivered Algorithm Package (DAP).
 - All software requirements, design, standards, and security is reviewed as part of the Satellite Product Services Review Board (SPSRB) review process.
 - All code is checked using code checking and profiling tools.
 - CrIS principal component radiances reconstruction scores will be calculated for each of the 3 CrIS bands for each of the 9 CrIS FOVs. This is done now on the current CrIS SDR data.
 - The reconstruction scores will be monitored by the OSPO Product Monitoring System and scores exceeding defined thresholds will trigger alerts.
 - The NUCAPS retrieval product will provide another mechanism for monitoring the quality of the CrIS SDR.

NOAA-Unique CrIS SDR Products

Products	Format	Users
CrIS SDR radiances (~400 channels, all FOVs/FORS)	BUFR	NCEP, JCSDA, GMAO
CrIS SDR Radiances (2211 channels, all FOVs/FORS)	BUFR	EUMETSAT (ECMWF, UKMet, DWD, Meteo France, CMC)

FOV = Field of View; FOR = Field of Regard

Full Spectrum CrIS Radiance BUFR Table Entries

Satellite ID	Solar Azimuth	Starting Wavenumber (per band)
ID of Originating Center	Ascending/Descending Flag	Ending Wavenumber (per band)
Satellite Instrument	Scan Line Number	Start Channel (per band)
Year	Field of Regard	End Channel (per band)
Month	Field of View	Calibration Quality Flags
Day	Orbit Number	Field of View Quality Flags
Hour	Height of Land Surface	GeoLocation Quality
Minute	Satellite Height	NUCAPS Quality
Second	Land Fraction	Channel Number
Location of Platform	Land/Sea Qualifier	Channel Radiance
Latitude	Cloud Cover	Measure Type
Longitude	Height of Cloud Top	Guard Channel Number
Satellite Zenith Angle	Radiance Type Flags	Guard Channel Radiance
Satellite Azimuth	Scan-Level Quality Flags	
Solar Zenith	Type of Band	