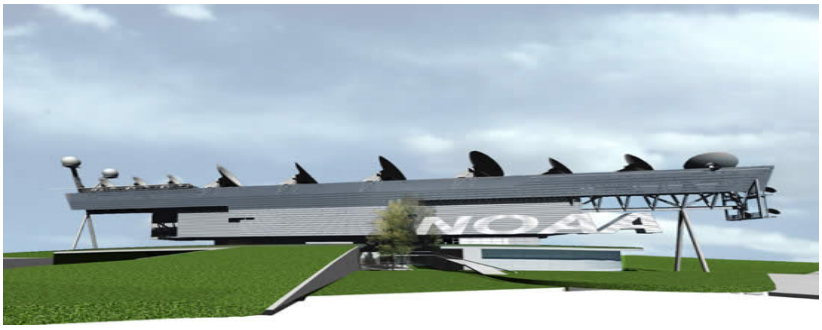
Environmental Satellite Processing Center (ESPC)



NOAA Unique Combined Atmospheric Product System (NUCAPS) External Users Manual (EUM)

Version 5.0, April 13, 2017

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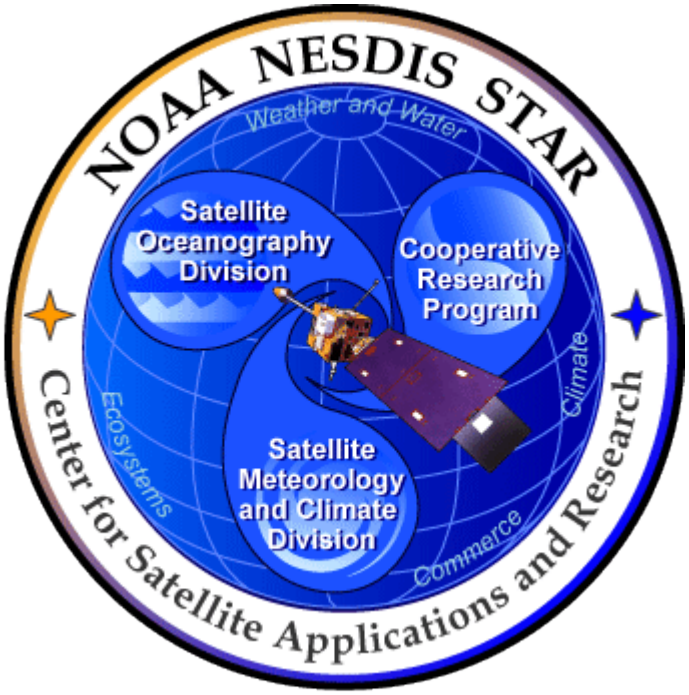
Version 2.0 Modified by: Letitia Soulliard and Thomas King (IMSG)

Version 3.0 Updated by: Awdesh Sharma, NOAA/NESDIS, Oleg Roytburd, SGT

Version 4.0 and 5.0 Letitia Soulliard and Thomas King (IMSG)

For the: U.S. Department of Commerce
National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)
Office of Satellite Products and Operations (OSPO)
Environmental Satellite Processing Center (ESPC)



NOAA NESDIS
CENTER for SATELLITE APPLICATIONS and RESEARCH

The NOAA Unique Combined Atmospheric Product System
External Users Manual

Approval Page

Environmental Satellite Processing Center (ESPC)

The NOAA Unique Combined Atmospheric Product System
External Users Manual (EUM)

Version 5.0, April 2017
WR000224

PROGRAM: Atmosphere	DOCUMENT RELEASE DATE: April 2017
APPROVALS	
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Document History

The Document History identifies the document origination and the series of revisions to the document that may occur at any point after the baseline release. This page will become a permanent part of this document.

Version Number	Date	Description of Change/Revision	Section/Pages Affected	Changes Made by Name/Title/ Organization
1.0	12/1/2011	Origination; Document was released for Phase 1 SDR products.	All	Chen Zhang (Dell) Thomas S King (IMSG) Letitia Soulliard (IMSG)
2.0	10/01/2012	The entire document was revised for Phase 2 EDR products	All	Letitia Soulliard and Thomas King
3.0	05/29/2014	Modified by A.K. Sharma		
3.0	06/12/2014	Technical Edit	WR000224	Janice Olfus-Carter, ETDT/SSAI
3.0	6/12/2014	Quality Assessment by Marilyn Gross	WR000224	Marilyn Gross, ETDT/SGT
3.0	6/17/2014	Minor Edits	1.1.3	A.K. Sharma
4.0	6/8/2015	Updated for Phase 3	All	Letitia Soulliard and Thomas King
4.1	9/10/2015	Updated for Phase 3	All	Thomas King
5.0	4/13/2017	Updated for Phase 4	All	Thomas King and Letitia Soulliard

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Page

LIST OF ACRONYMS

AMSU-A	Advanced Microwave Sounder Unit - A
ASCII	American Standard Code for Information Interchange
ATBD	Algorithm Theoretical Basis Document
ATMS	Advanced Technology Microwave Sounder
BUFR	Binary Universal Form for the Representation of meteorological data
CCR	Cloud-Cleared Radiances
CDL	Common Data Language
CDR	Critical Design Review
CLASS	Comprehensive Large Array-data Stewardship System
CPU	Central Processing Unit
CrIS	Cross-track Infrared Sounder
DAP	Delivered Algorithm Package
DEM	Digital Elevation Model
DDS	Data Distribution Server
DHS	Data Handling System
DOD	Department of Defense
EDR	Environmental Data Record
EPL	Enterprise Product Lifecycle
ESPC	Environmental Satellite Processing Center
EUMETSAT	European Organization for the Exploitation Meteorological Satellites
FOR	Field Of Regard
FOV	Field of View
GB	Gigabyte
GFS	Global Forecast System
GMAO	Global Modeling and Assimilation Office
GMT	Greenwich Mean Time
GRIB	Gridded Binary format
IASI	Infrared Atmospheric Sounding Interferometer
ICD	Interface Control Document
IDPS	Interface Data Processing Segment
IP	Intermediate Product
IPD	NOAA’s Internal Processing Division
IPT	Integrated Product Team
NDE	NPOESS Data Exploitation
NGDC	National Geophysical Data Center
NCDC	National Climate Data Center
NCEP	National Center for Environmental Prediction

NESDIS	National Environmental Satellite, Data, and Information Service
netCDF4	network Common Data Format version 4
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NRL	Naval Research Lab
NSOF	NOAA Satellite Operations Facility
NUCAPS	NOAA Unique Combined Atmospheric Product System
NWP	Numerical Weather Prediction
OLR	Outgoing Longwave Radiances
OSPO	Office of Satellite & Product Operations
PBR	Project Baseline Report
PCF	Process Control File
PCS	Principal Components
PDA	Product Distribution and Access
PGAI	Product Generation Application Interface
PGM	Product Generation Manager
PSF	Process Status File
RAD	Requirements Allocation Document
RR	Reconstructed Radiances
RSE	Remote Sensing Extension
SADIE	Science Algorithm Development and Integration Environment
SAN	Storage Area Network
SDR	Sensor Data Record
SFS	Shared File System
SMCD	Satellite Meteorology and Climate Division
SPSRB	Satellite Products and Services Review Board
STAR	Center for Satellite Applications and Research
SWA	Software Architecture Document
VIIRS	Visible Infrared Imager Radiometer Suite
VVP	Verification and Validation Plan
WMO	World Meteorological Organization
XML	eXtensible Markup Language

1. PRODUCTS

This is an external user's manual document describing the NOAA Unique Combined Atmospheric Product System (NUCAPS) products and output files. The NUCAPS was developed at the Center for Satellite Applications and Research (STAR). It has been delivered to the NPOESS Data Exploitation (NDE) team and integrated into the NDE Data Handling System (DHS) where it is run in operationally.

The intended users of the External Users Manual (EUM) are end users of the output products and files, and the product verification and validation (V&V) teams. The purpose of the EUM is to provide product users with information that will enable them to acquire the product, understand its features, and use the data. External users are defined as those users who do not have direct access to the processing system (those outside of the NESDIS). The output files are defined as those leaving the NDE system. NUCAPS does output some files for tailoring into BUFR within NDE. Those tailored files are described in a separate EUM.

1.1. Product Overview

1.1.1. Product Requirements

All NUCAPS basic and derived requirements are available in the NUCAPS Requirements Allocation Document (RAD). These requirements identify the users and their needs with respect to file content, format, latency, and quality.

1.1.2. Product Team

The NUCAPS Development product team consists of members from STAR and OSPO. The roles and contact information for the different product team members are identified in Table 1-1.

Table 1-1 Product Team Members

Team Member	Organization	Role	Contact Information
Walter Wolf	STAR	STAR Product Lead	5830 University Research Court College Park, MD. 20740 Phone: 301-683-1314 Email: Walter.Wolf@noaa.gov

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William P. O'Connor	OSPO	Secondary Maintenance Programmer	5830 University Research Court College Park Maryland 20740 Phone: 301-683-3280 FAX: 301-683-3297 Email: william.oconnor@noaa.gov
Tony Reale	STAR	STAR Scientist	NSOF 4231 Suitland Rd Suitland MD 20746 Email: tony.reale@noaa.gov
Donna McNamara	OSPO	Data Distribution	NSOF 1372 4231 Suitland Rd Suitland MD 20746 Phone: (301)817-3803 Email; donna.mcnamara@noaa.gov

1.1.3. Product Description

The NOAA Unique Combined Atmospheric Product System (NUCAPS) was developed to generate (1) spectrally thinned radiances, (2) retrieved products such as profiles of temperature, moisture, trace gases and cloud-cleared radiances, (3) outgoing longwave radiation, and (4) globally gridded validation products. The thinned radiance products are not external outputs of NDE. After they are produced in NUCAPS, they are tailored into BUFR by the Reformatter Toolkit (N4RT) system that also runs within NDE. Therefore, the only external outputs are the retrieved and the validation products. Details on the content of all NUCAPS external output files are shown in section 1.3.

1.2. Product History

NUCAPS was made operational in several phases. Phase 1 went operational in April 2012 with thinned radiances, principal components, and SDR validation products. Phase 2 went operational in October 2013 adding temperature, moisture, and trace gases profiles along with global EDR validation products (grids). Phase 3 was made operational in October 2015. It included VIIRS/CrIS collocation to include VIIRS cloud products for the CrIS SDR BUFR, updates and bug fixes to the preprocessor and retrieval codes, ILS correction, and a port from IBM to Linux GNU compilers. Phase 4 implemented the use of CrIS full spectrum data and JPSS Enterprise cloud products.

1.3. Product Access

All NUCAPS output data files are made available by NDE on the Product Distribution and Access (PDA) server. For access to this server, information about data files, and associated documentation, the NUCAPS PAL should be contacted (see Table 1-1).

The NESDIS' Policy on Access and Distribution of Environmental Data and Products is provided at: http://www.ospo.noaa.gov/Organization/About/access.html.
Users need to fill out the Data Access Request Form located on this site and submit to the PAL with a copy to nesdis.data.access@noaa.gov. This address provides the OSPO Data Access Team a copy of the correspondence. The process is defined in the following diagram. Once the request is approved by the OSPO management the data will be delivered by the Data Distribution System (DDSProd) currently distributing the ESPC data products and later by the Product Distribution and Access (PDA) system. The ESPC Data Distribution Manager, Donna McNamara (donna.mcnamara@noaa.gov) should be contacted for any data accessibility and data distribution problems.

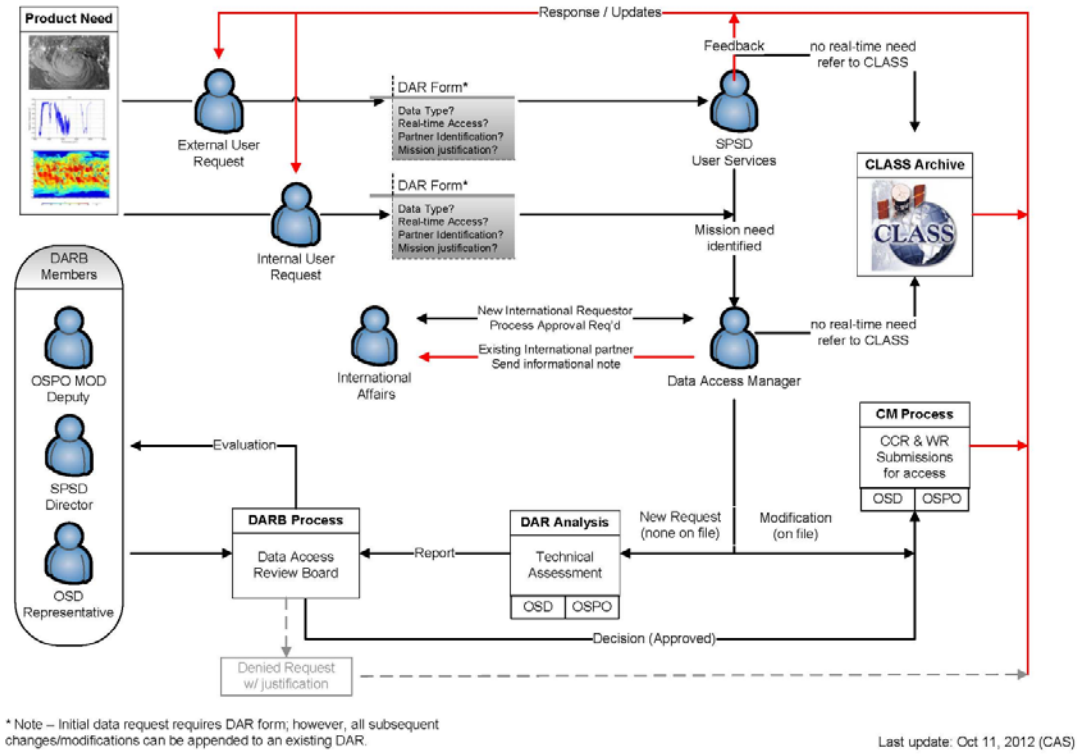

Figure 1-1 NDE Data Access Process

In order to obtain the near real time data, the user needs to fill out the Data Access Request Form located on http://www.ospo.noaa.gov/Organization/About/access.html and submit it to the PAL with a copy to nesdis.data.access@noaa.gov. CLASS archives the NUCAPS Environmental Data Record (EDR) retrieval product, the Cloud-Cleared Radiance (CCR) product, and the Outgoing Longwave Radiation (OLR) product for the non-real time users. These files are CF-compliant netCDF4 files containing metadata. PDA pushes the data to CLASS.

Table 1-2 lists all NUCAPS files distributed outside of the NDE system to external users. The BUFR and AWIPS files are not produced inside the NUCAPS software, but are produced elsewhere downstream within the NDE system. Each global grid includes two binary data files, which are ascending orbital data file (ASC) and descending orbital data file (DSC). Table 1-3 ~ Table 1-6 shows the detailed content of each output files listed in Table 1-2.

Table 1-2 NUCAPS Output Files

File	Description	Format	Size/file
NUCAPS-EDR_v2r0_npp_s????????????_e????????????_c??????????????.nc	This is the granule output file containing all the retrieval (profile) products.	netCDF4	3.1 MB/file 2700 files/day
NUCAPS-CCR-AR_v2r0_npp_s????????????_e????????????_c??????????????.nc	This is the granule output file containing cloud-cleared radiance product data.	netCDF4	1.3 MB/file 2700 files/day
NUCAPS-OLR_v2r0_npp_s????????????_e????????????_c??????????????.nc	This is the granule output file containing the outgoing longwave radiance product data.	netCDF4	0.063 MB/file 2700 files/day
NUCAPS-GG-EDR-GRIDS-?SC_v2r0_npp_s????????????_e????????????_c??????????????.bin	CrIS/ATMS retrievals on a daily global grid at 0.5X2 degree resolution.	Gridded direct-access binary	726 MB/file 2 files/day
NUCAPS-GG-OLR-GRIDS-?SC_v2r0_npp_s????????????_e????????????_c????????????.bin	Outgoing Longwave Range CrIS radiances on a daily global grid at	Gridded direct-access binary	2.9 MB/file 2 files/day
NUCAPS-PCS-MONITORING_v2r0_npp_s???????????????_e????????????_c????????????.txt	This is the PCS statistics monitoring file. This is to be distributed for SDR monitoring at OSPO.	Text file	0.0015 MB/file 2700 files/day
NUCAPS-EDR-MONITORING_v2r0_npp_s????????????_e????????????_c????????????.txt	This is the retrieval monitoring output file.	Text file	0.078 MB/file 2700 files/day
NUCAPS_EDR_IUTN06_KNES_npp_$.nc.wmo	NUCAPS EDR for AWIPS for 9 sectors	netCDF4	0.215 MB/file 1648 files/day
NUCAPS-C0431_v2r0_npp_s?????????????_e????????????_c?????????????.bufr	The output CrIS 431-channel full spatial resolution BUFR file converted from NUCAPS netCDF4.	BUFR	1.0 MB/file 2700 files/day

NUCAPS-C2211_v2r0_npp_s????????????? ?_e??????????????_c?????????? ?????.bufr	The output CrIS 2211-channel full spatial resolution BUFR file converted from NUCAPS netCDF4.	BUFR	4.8 MB/file 2700 files/day

Table 1-3 NUCAPS EDR File

Variable	Type	Description	Dim	Units	Range
CrIS_FORs	Long	CrIS Fields of Regard per granule	120	None	1 to 120
Time	Double	UTC Milliseconds since Jan 1, 1970	120	Milliseconds	950000000000 to 2500000000000
Latitude	Float	Latitude of the center of the FOR	120	Degrees	-90 to 90
Longitude	Float	Longitude of the center of the FOR	120	Degrees	-180 to 180
View_Angle	Float	Viewing angle of the sensor from the satellite	120	Degrees	-60 to 60
Satellite_Height	Float	Satellite height above the FOR	120	km	800 to 900
Mean_CO2	Float	Column averaged CO2 of the FOR	120	ppm	0 to 1000
Solar_Zenith	Float	Solar zenith angle	120	Degrees	0 to 180
Ascending_Descending	Short	Orbital status	120	None	0 to 1
Topography	Float	Surface height	120	Meters	0 to 10000
Land_Fraction	Float	Land fraction	120	None	0 to 1
Surface_Pressure	Float	Surface air pressure	120	mb	0 to 10000
Skin_Temperature	Float	Surface temperature	120	Kelvin	0 to 1000
MIT_Skin_Temperature	Float	Surface temperature from MIT retrieval	120	Kelvin	0 to 1000

FG_Skin_Temperature	Float	Surface temperature from the first guess	120	Kelvin	0 to 1000
MW_Surface_Class	Short	Microwave surface class	120	None	0 to 10
MW_Surface_Emis	Float	Microwave surface emissivity	120	None	0 to 1
N_Smw_Per_FOV	Long	Number of MW spectral points	120	None	1 to 16
nemis_Per_FOV	Long	Number of surface emis hinge points	120	None	1 to 100
ncemis_Per_FOV	Long	Number of cloud emis hinge points	120	None	1 to 100
ncld_Per_FOV	Long	Number of cloud layers	120	None	1 to 8
Quality_Flag	Long	Quality flags for retrieval	120	None	0 to 31
Ispare_Field	Long	Ispare diagnostics array from retrieval	129X120	None	N/A, see NUCAPS SMM
Rspare_Field	Float	Rspare diagnostics array from retrieval	258X120	None	N/A, see NUCAPS SMM
Cloud_Top_Pressure	Float	Cloud top air pressure	8X120	mb	0 to 10000
Cloud_Top_Fraction	Float	Cloud top fractional coverage	8X120	None	0 to 1
Pressure	Float	Air pressure	100X120	mb	0 to 2000
Effective_Pressure	Float	Effective Air pressure	100X120	mb	0 to 2000
Temperature	Float	Air temperature	100X120	Kelvin	0 to 1000
MIT_Temperature	Float	Air temperature from MIT retrieval	100X120	Kelvin	0 to 1000
FG_Temperature	Float	Air temperature from the first guess	100X120	Kelvin	0 to 1000
H2O	Float	Water vapor layer column density	100X120	molecules/cm2	0 to 100000000

MIT_H2O	Float	Water vapor layer column density from MIT retrieval	100X120	molecules/cm2	0 to 100000000
FG_H2O	Float	Water vapor layer column density from the first guess	100X120	molecules/cm2	0 to 100000000
H2O_MR	Float	Water vapor mixing ratio	100X120	g/g	0 to 100000000
MIT_H2O_MR	Float	Water vapor mixing ratio from MIT retrieval	100X120	g/g	0 to 100000000
FG_H2O_MR	Float	Water vapor mixing ratio from the first guess	100X120	g/g	0 to 100000000
O3	Float	Ozone layer column density	100X120	molecules/cm2	0 to 100000000
FG_O3	Float	Ozone layer column density from first guess	100X120	molecules/cm2	0 to 100000000
O3_MR	Float	Ozone mixing ratio	100X120	ppb	0 to 100000000
FG_O3_MR	Float	Ozone mixing ratio from first guess	100X120	ppb	0 to 100000000
Liquid_H2O	Float	Liquid water layer column density	100X120	molecules/cm2	0 to 100000000
Liquid_H2O_MR	Float	Liquid water mixing ratio	100X120	g/g	0 to 100000000
Ice_Liquid_Flag	Short	Ice liquid flag	100X120	None	0 to 1
CO	Float	Carbon monoxide layer column density	100X120	molecules/cm2	0 to 100000000
CO_MR	Float	Carbon monoxide mixing ratio	100X120	ppb	0 to 100000000
CH4	Float	Methane layer column density	100X120	molecules/cm2	0 to 100000000
CH4_MR	Float	Methane mixing ratio	100X120	ppb	0 to 100000000

CO2	Float	Carbon dioxide dry mixing ratio	100X120	ppm	0 to 1000
HNO3	Float	Nitric Acid layer column density	100X120	molecules/cm2	0 to 100000000
HNO3_MR	Float	Nitric Acid mixing ratio	100X120	ppb	0 to 100000000
N2O	Float	Nitrous Oxide layer column density	100X120	molecules/cm2	0 to 100000000
N2O_MR	Float	Nitrous Oxide mixing ratio	100X120	ppb	0 to 100000000
SO2	Float	Sulfur Dioxide layer column density	100X120	molecules/cm2	0 to 100000000
SO2_MR	Float	Sulfur Dioxide mixing ratio	100X120	ppb	0 to 100000000
MW_Frequency	Float	Microwave frequency	16X120	cm-1	0 to 10000
MW_Emis	Float	Microwave emissivity	16X120	None	0 to 1
MIT_MW_Emis	Float	Microwave emissivity from MIT retrieval	16X120	None	0 to 1
IR_Emis_Freq	Float	IR emissivity hinge point frequencies	100X120	cm-1	0 to 10000
FG_IR_Emis_Freq	Float	IR emissivity hinge point frequencies from the first guess	100X120	cm-1	0 to 10000
IR_Surface_Emis	Float	IR surface emissivity	100X120	None	0 to 1
FG_IR_Surface_Emis	Float	IR surface emissivity from the first guess	100X120	None	0 to 1
IR_Surface_Refl	Float	IR surface reflectance	100X120	percent	0 to 100
Stability	Float	Stability parameters	16X120	Varying	0 to 1000000
Cloud_Freq	Float	Cloud IR frequencies	100X8X120	cm-1	0 to 10000

Cloud_Emis	Float	Cloud IR emissivity	100X8 X120	None	0 to 1
Cloud_Refl	Float	Cloud IR reflectivity	100X8 X120	percent	0 to 100
quality_information	Char	Empty variable, containing a collection of attributes describing quality information metadata	0	N/A	N/A

Table 1-4 NUCAPS CCR Archive File

Variable	Type	Description	Dim	Units	Range
CrIS_Channels	Long	Channel number for the CrIS radiance data	1317	None	1 to 1317
CrIS_Frequencies	Float	Frequency at which the CrIS radiances are observed	1317	cm-1	1 to 10000
Subset_CrIS_FORs	Long	The index of the CrIS fields of regard to subset	120	None	1 to 120
Subset_CrIS_FOVs	Long	The index of the CrIS fields of view to subset	1	None	1 to 9
Scan_Line	Long	The number of the current scan line in the granule	120	None	1 to 4
CrIS_FORs	Long	CrIS Fields of Regard per granule	120	None	1 to 120
CrIS_FOVs	Long	CrIS Fields of View per FOR	120	None	1 to 9
Quality_Flag	Byte	CrIS quality flag	120	None	0 to 31
Time	Double	UTC Milliseconds since Jan 1, 1970	120	Milliseconds	950000000000 to 2500000000000
CrIS_Latitude	Float	CrIS Latitude values for each FOV	120	Degrees	-90 to 90
CrIS_Longitude	Float	CrIS Longitude values for each FOV	120	Degrees	-180 to 180
CrIS_Radiances	Float	CrIS Cloud-Cleared Radiances (CCR) for each FOV	1317 X120	mW/(m2 sr cm-1)	-5 to 150
CrIS_View_Angle	Float	CrIS View Angles for each FOV	120	Degrees	-60 to 60
Satellite_Height	Float	Satellite height above each FOV	120	km	800 to 900

Solar_Zenith	Float	Solar zenith angles for each FOV	120	Degrees	0 to 180
Ascending_ Descending	Short	Orbital status for each FOV	120	None	0 to 1
quality_information	Char	Empty variable, containing a collection of attributes describing quality information metadata	0	N/A	N/A

Table 1-5 NUCAPS OLR File

Variable	Type	Description	Dim	Units	Range
LAT	Float	CrIS Latitude values for each FOV	4x30x9	Degrees	-90 to 90
LON	Float	CrIS Longitude values for each FOV	4x30x9	Degrees	-180 to 180
TIME	Double	UTC time as milliseconds from 01/01/1970	4x30x9	msec	
SATZEN	Float	Solar zenith angles for each FOV	4x30x9	Degrees	0 to 180
SATHEIGHT	Float	SATELLITE HEIGHT for each FOV	4x30x9	km	0 to 180
VIEWANG	Float	CrIS View Angles for each FOV	4x30x9	Degrees	-49 to 49
FLUX	Float	CrIS OLR at top-of-atmosphere	4x30x9	Wm-2	0 to 500
QA	Short	CrIS level1c radiance quality flag	4x30x9	None	0 to 1
AD	Short	CrIS level1c AD flag	4x30x9	None	0 to 1

Table 1-6 NUCAPS EDR 0.5X2 Global Grids File

Variable	Type	Description	Dim	Units	Range
YearMonthDay	Float	Calendar date	720X91	MMDDYY	010100 to 123199
Time	Float	Hours.Fractional_Minutes	720X91	Hours	0 to 24
Grid_Latitude	Float	Latitude locations of the grid points	720X91	Degrees	-90 to 90
Grid_Longitude	Float	Longitude locations of the grid points	720X91	Degrees	-180 to 180
Instrument_Latitude	Float	Latitude of the actual observations	720X91	Degrees	-90 to 90
Instrument_Longitude	Float	Longitude of the actual observations	720X91	Degrees	-180 to 180
View_Angle	Float	Viewing angle of the sensor from the satellite	720X91	Degrees	-60 to 60
Satellite_Height	Float	Satellite height	720X91	km	800 to 900
Mean_CO2	Float	Column averaged CO2 of the FOR	720X91	ppm	0 to 1000
Solar_Zenith	Float	Solar zenith angle	720X91	Degrees	0 to 180
Topography	Float	Surface height	720X91	Meters	0 to 10000
Land_Fraction	Float	Land fraction	720X91	None	0 to 1
Surface_Pressure	Float	Surface air pressure	720X91	mb	0 to 10000
Skin_Temperature	Float	Surface temperature	720X91	Kelvin	0 to 1000
MW_Surface_Class	Float	Microwave surface class	720X91	None	0 to 10
MW_Surface_Emis	Float	Microwave surface emissivity	720X91	None	0 to 1

N_Smw_Per_FOV	Float	Number of MW spectral points	720X91	None	1 to 16
nemis_Per_FOV	Float	Number of surface emis hinge points	720X91	None	1 to 100
ncemis_Per_FOV	Float	Number of cloud emis hinge points	720X91	None	1 to 100
ncld_Per_FOV	Float	Number of cloud layers	720X91	None	1 to 8
Quality_Flag	Float	Quality flags for retrieval	720X91	None	0 to 31
Cloud_Top_Pressure	Float	Cloud top air pressure	720X91X8	mb	0 to 10000
Cloud_Top_Fraction	Float	Cloud top fractional coverage	720X91X8	None	0 to 1
Pressure	Float	Air pressure	720X91X100	mb	0 to 2000
Effective_Pressure	Float	Effective aire pressure	720X91X100	mb	0 to 2000
Temperature	Float	Air temperature	720X91X100	Kelvin	0 to 1000
H2O	Float	Water vapor layer column density	720X91X100	molecules/cm2	0 to 100000000
H2O_MR	Float	Water vapor mixing ratio	720X91X100	g/g	0 to 100000000
O3	Float	Ozone layer column density	720X91X100	molecules/cm2	0 to 100000000
O3_MR	Float	Ozone mixing ratio	720X91X100	ppb	0 to 100000000
Liquid_H2O	Float	Liquid water layer column density	720X91X100	molecules/cm2	0 to 100000000
Liquid_H2O_MR	Float	Liquid water mixing ratio	720X91X100	g/g	0 to 100000000
Ice_Liquid_Flag	Float	Ice liquid flag	720X91X100	None	0 to 1
CO	Float	Carbon monoxide layer column density	720X91X100	molecules/cm2	0 to 100000000
CO_MR	Float	Carbon monoxide mixing ratio	720X91X100	ppb	0 to 100000000
CH4	Float	Methane layer column density	720X91X100	molecules/cm2	0 to 100000000

CH4_MR	Float	Methane mixing ratio	720X91X100	ppb	0 to 100000000
CO2	Float	Carbon dioxide dry mixing ratio	720X91X100	ppm	0 to 1000
N2O	Float	Nitrous Oxide layer column density	720X91X100	molecules/cm2	0 to 100000000
N2O_MR	Float	Nitrous Oxide mixing ratio	720X91X100	ppb	0 to 100000000
SO2	Float	Sulfur Dioxide layer column density	720X91X100	molecules/cm2	0 to 100000000
SO2_MR	Float	Sulfur Dioxide mixing ratio	720X91X100	ppb	0 to 100000000
HNO3	Float	Nitric Acid layer column density	720X91X100	molecules/cm2	0 to 100000000
HNO3_MR	Float	Nitric Acid mixing ratio	720X91X100	ppb	0 to 100000000
MW_Frequency	Float	Microwave frequency	720X91X16	cm-1	0 to 10000
MW_Emis	Float	Microwave emissivity	720X91X16	None	0 to 1
IR_Emis_Freq	Float	IR emissivity hinge point frequencies	720X91X100	cm-1	0 to 10000
IR_Surface_Emis	Float	IR surface emissivity	720X91X100	None	0 to 1
IR_Surface_Refl	Float	IR surface reflectance	720X91X100	percent	0 to 100
CrIS_FORs	Float	CrIS Fields of Regard	720X91	None	1 to 120
FG_Temperature	Float	Air temperature from the first guess	720X91X100	Kelvin	0 to 1000
FG_H2O_MR	Float	Water vapor mixing ratio from the first guess	720X91X100	g/g	0 to 100000000
FG_O3_MR	Float	Ozone mixing ratio from the first guess	720X91X100	ppb	0 to 100000000

Table 1-7 NUCAPS OLR 0.5X2 Global Grids File

Variable	Type	Description	Dim	Units	Range
YearMonthDay	Real	Year/Month/Day string given as YYYYMMDD.	720X91	MMDDYY	010100 to 123199
Time	Real	Hours.Fractional_Minutes	720X91	Hours	0 to 24
Grid_Latitude	Real	Lat locations of the grid points (± 90 degrees)	720X91	Degrees	-90 to 90
Grid_Longitude	Real	Lon locations of the grid points (± 90 degrees)	720X91	Degrees	-180 to 180
Instrument_Latitude	Real	Lat locations of the actual observations (± 90 degrees)	720X91	Degrees	-90 to 90
Instrument_Longitude	Real	Lon locations of the actual observations (± 90 degrees)	720X91	Degrees	-180 to 180
View_Angle	Real	The view angle of the current CrIS FOV (± 90 degrees)	720X91	Degrees	-60 to 60
Satellite_Zenith	Real	The satellite zenith of each matched CrIS FOV (0 - 90 degrees).	720X91	Degrees	0 to 70
Satellite_Height	Real	The satellite height of each matched CrIS FOV (km).	720X91	km	800 to 900
Flux	Real	Outgoing Longwave Radiation Flux	720X91	Wm^{-2}	0 to 500
Quality_Flag	Real	OLR quality flag	720X91	None	0 to 1

2. ALGORITHM

2.1. Algorithm Overview

The NUCAPS profile products and cloud-cleared radiances are generated using a retrieval algorithm whereas the thinned radiances and global products do not require a science algorithm and can be conceived of as a reorganization of the data. The Outgoing Longwave Radiances are generated using a separate code. The retrieval algorithm runs inside a system of supporting software. This system was developed during the Aqua mission to use data from the AIRS/AMSU/MODIS instruments, but was designed to be flexible to use IASI/AMSU-A/MHS/AVHRR and CrIS/ATMS. The NUCAPS retrieval algorithm has a flexible modular design that allows the types of instruments, the amount of diagnostics, and the activation of various retrieval process steps to be turned on or off via a set of input name-lists. This flexibility allows the system to be used for research or in a faster and more efficient operational manner. For information about the NUCAPS algorithm, see the NUCAPS Algorithm Theoretical Basis Document (NESDIS/STAR, 2009). The output files are described earlier in section 1.3. This section describes the input files.

2.2. Input Satellite Data

2.2.1. Satellite Instruments

NUCAPS is a product system operated within the NDE DHS by OSPO. NUCAPS uses data from the Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) instruments on the NPOESS Preparatory Project (NPP) platform. NPP launched on October 28, 2011. It is in a sun synchronous circular orbit with a 10:30am descending-node orbit at an altitude of 824 km.

CrIS is a Michelson Interferometer with 2211 channels measuring in the Infrared (IR) portion of the spectrum. It has the following spectral characteristics:

CrIS spectral bands:
LWIR Band 650-1095 cm^{-1}
MWIR Band 1210-1750 cm^{-1}
SWIR Band 2155-2550 cm^{-1}

CrIS full-spectral resolution:
LWIR Band < 0.625cm^{-1}
MWIR Band < 0.625cm^{-1}

SWIR Band < 0.625cm^{-1}

The CrIS instrument starts a new Earth scan every 8 seconds. Each scans contains 30 Fields of Regard (FOR) viewed on the Earth's surface with a scan width of ±50˚. Each FOR contains a simultaneously measured 3X3 set of Fields of View (FOVs). The CrIS FOVs are circular and have a diameter of 14 km at nadir.

ATMS is a cross-track scanning 22-channel passive microwave radiometer. The channels are bands from 23 GHz through 183 GHz making its measurement capabilities similar to that of the Advanced Microwave Sound Unit (AMSU) and the Microwave Humidity Sounder (MHS). ATMS makes three scans (a scan set) every eight seconds. Each scan contains a single row of 96 FOVs. The FOV coverage sizes vary for each ATMS channel. ATMS scan sets are synchronized with those of the CrIS instrument. With each scan, the ATMS FOV coverage extends over each end of the associated CrIS scans. This is done to allow for footprint resampling of the smaller ATMS FOVs into larger AMSU-A like footprints (~40km at nadir). The resampled ATMS radiances can be used as input into existing retrieval algorithms like that in NUCAPS.

Both the CrIS and ATMS instruments are scheduled to fly on the JPSS J1 and J3 platforms as well. Additional details about these instruments can be found at:

http://jointmission.gsfc.nasa.gov/cris.html

2.2.2. Pre-Processing Steps

The Raw Data Records (RDR) CrIS and ATMS instrument packet data are transmitted from the satellite to the ground stations and are then sent to the Internal Data Processing Segment (IDPS) at the NOAA Satellite Operations Facility (NSOF). The IDPS applies the instrument calibration and geolocation to generate the Science Data Records (SDR) and Temperature Data Record (TDR) files required by NUCAPS. The SDR and TDR are distributed from the IDPS and made available to NDE as 32 second granule files in HDF5 format. When NDE has the inputs required to process a CrIS and ATMS granule set (based on the NUCAPS production rules), it executes the job to produce the output file described in this document.

Format information on the CrIS and ATMS SDR and TDR files is described in the NPOESS Common Data Format Control Book – External, Volume III – SDR/TDR Formats. The most recent versions of all the CDFCB documents can be obtained from the JPSS Program Office or from the NASA NPP site:

http://npp.gsfc.nasa.gov/documents.html

http://www.nasa.gov/mission_pages/NPP/main/index.html

Information about the GFS forecast files can be found at:
http://www.nco.ncep.noaa.gov/pmb/products/gfs/

Within NUCAPS, there is additional pre-processing required to get the CrIS, ATMS, and GFS data into an input format that can be directly read by the retrieval code. That internal NUCAPS preprocessing is disc**u**ssed in the NUCAPS SMM (NESDIS/STAR, 2017).

NDE Data Handling System (DHS) ingests the CrIS SDR and ATMS TDR data from IDPS. The NUCAPS software units generate the products running within NDE system and the output products are distributed by the NDE distribution system.

CrIS is a Michelson interferometer based on the principle of Fourier Transform and designed to measure with high resolution and high spectral accuracy the emission of infrared radiation from the atmosphere in three bands in the spectral range from 3.9 to 15.4 μm (650 – 2550 cm^{-1}). The core of the instrument is a Fourier transform spectrometer which measures in one sweep the spectral features of the atmosphere with high spectral resolution and throughput. The spectrometer transforms the incoming spectral radiance, i.e. the spectrum, into a modulated signal, the interferogram, where all infrared wavenumbers in the band of interest are present simultaneously. The output from the spectrometer consists of one such interferogram for each observed scene.

The ground segment algorithms are required to transform raw instrument records (RDR) into sensor data records (SDR), which are essentially calibrated spectra. Auxiliary data will also be used in conjunction with several indicators to address the accuracy of the data. The SDR Algorithm system mathematically retransforms the scene interferograms from the CrIS instrument into spectral information useful for retrieving the atmospheric parameters,

The incoming data may be acquired during deep space, internal calibration blackbody, and scene atmospheric measurements of the CrIS sensor. Each of these three types of incoming data therefore needs to be processed differently. Once combined together they will ultimately generate calibrated spectra with small residual errors.

The main objectives of the SDR Algorithms are:

Pre-process incoming data packets

Load and sort data

Convert interferograms to spectra

Convert scene measurements into calibrated spectra

Compute *spectral calibration*, using metrology wavelength measurements

» Characterize metrology using neon lamp reference measurements
» Monitor metrology drift using laser diode parameters measurements
» Perform alias unfolding and spectral labeling
» Map spectral channels to a fixed wavenumber grid

Compute *radiometric calibration*, using reference calibration measurements

» Average warm calibration target data, average cold calibration target data
» Subtract sensor background radiance
» Remove sensor induced phase dispersion
» Correct for fringe count errors
» Perform non-linearity correction
» Correct for off-axis self-apodization on each FOV
» Correct for polarization errors
» Remove orthogonal noise components

Compute *geometric calibration*, using LOS position and ephemeris data

Evaluate the associated error

Check for data quality and maintain quality controls

Compute NEdN estimates

2.3. Input Ancillary Data

2.3.1. Digital Elevation Model

There is one Digital Elevation Model (DEM) file: *Global_DEM.bin*

It contains the following fields: latitude, longitude, topography (elevation in meters), land fraction, and land/sea mask. The values in the file apply to the center of a grid cell. The

DEM is a global file with a resolution of 21600 latitude points X 43200 longitude points. This provides a grid resolution of 0.0083° X 0.0083°. This file is static and is delivered as part of the system which is why the DEM resides in the system file directory. The file is used in the L1C Subsetter and L1B Processing units. In these units, the preprocessing for level2 adds the DEM information. The downstream Level 2 Processing unit code requires this surface information for the retrieval.

2.3.2. Retrieval System Files

There are a number of static retrieval system files. These are inputs to the NUCAPS retrieval, but unlike data files, they are static and are only updated with a delivery of the system.

Table 2-1 contains the file name in the first column and the second column contains a brief description of the file.

Table 2-1 Retrieval System Files

File	Description
jpl_100.inp	Ensemble error estimate of climatology
airs_olr.dat	Radiative transmittance coefficients to compute Outgoing Longwave Radiation
L2.M.weight.hsb.v1.0.0.anc	HSB weighting file
L2.M.ecof_705.v1.0.0.anc	Microwave retrieval error covariance file
L2.M.cov100av.v1.0.0.anc	Microwave retrieval error covariance file
L2.uars_clim.v1.0.3.anc	UARS climatology file for upper atmosphere
ncep_clim.bin	NCEP climatology file for Temperature and water vapor.
L2.masuda.v2.0.0.anc	Coefficients for the Masuda surface emissivity model for ocean
RTA_atms_20111107.bin	The ATMS RTA file
170214_hr_cris_tuning_mask_guard.asc	The CrIS hi-res (hr) tuning mask file.
Tuning_mask_cris_nsr_atms_20150213.asc	The CrIS low res (nsr) tuning mask file.

File	Description
cris_fsr_wavenumber.asc cris_nsr_wavenumber.asc	The CrIS frequency list for hi-res (fsr) and low-res (nsr).
cris_solar_v11a.txt cris_solar_v10a.txt	The solar irradiance files for hi-res (v11a) and low-res (v10a).
RTA_cris_fsr_v11a_20161222.bin RTA_cris_nsr_v10a_20110218.bin	The CrIS RTA files for hi-res (V11a) and low-res (V10a).
161101cris_fsr_guard.dat	The IR noise files for hi-res mode.
tobin120120.dat	The IR noise files for low-res mode.
cris_888g.t1	The cloud averaging table for hi-res mode.
cris_v10a.t1	The cloud averaging table for low-res mode.
170211_cris_irv11_tdr.asc	The CrIS hi-res tuning coefficient files for both IR+MW and IR-only modes
Tuning_cris_nsr_atms_20120515_20150213.asc	The CrIS low-res tuning coefficient file for IR+MW mode.
Tuning_cris_nsr_atms_v1.7.asc	The CrIS low-res tuning coefficient file for IR-only mode.
reg_eigenvec_cris_fsr_20150115_20170224.asc	The CrIS hi-res IR regression eigenvector file for both IR+MW and IR-only modes.
reg_eigenvec_cris_nsr_20150512.asc	The CrIS low-res IR regression eigenvector file for IR+MW mode.
reg_eigenvec_cris_nsr_noatms_20161026.asc	The CrIS low-res IR regression eigenvector file for IR-only mode.
reg_coef_ccr_cris_fsr_20170226.asc	Static
reg_coef_ccr_cris_fsr_noatms_20170314.asc	The CrIS hi-res (fsr) IR CCR regression file for the IR-only mode.
reg_coef_ccr_cris_nsr_20150514.asc	The CrIS low-res (nsr) IR CCR regression file for the IR+MW mode.
reg_coef_ccr_cris_nsr_noatms_20161103.asc	The CrIS low-res (nsr) IR CCR regression file for the IR-only mode.
reg_coef_all_cris_fsr_20170225.asc	The CrIS hi-res (fsr) IR all-sky regression file for the IR+MW mode.
reg_coef_all_cris_fsr_noatms_20170310.asc	The CrIS hi-res (fsr) IR all-sky regression file for the IR-only mode.
reg_coef_all_cris_nsr_20150512.asc	The CrIS low-res (nsr) IR all-sky regression file for the IR+MW mode.
reg_coef_all_cris_nsr_noatms_20161026.asc	The CrIS low-res (nsr) IR all-sky regression file for the IR-only mode.

File	Description
170211_rtaerr_irv11_tdr.asc	The RTA error file for both the hi-res IR+MW and IR-only modes.
cris_rtaerr_v10a.asc	The RTA error file for the low-res IR+MW mode.
cris_rtaerr_irv10_tdr_v1.7.asc	The RTA error file for the low-res IR-only mode.
atms_20141212.dat	The microwave noise file for the hi-res IR+MW, hi-res IR-only, and the low-res IR-only mode.
atms_1.dat	The microwave noise file for the low-res IR+MW mode.
hr_irmw_clouds_cris.nl hr_iro_clouds_cris.nl lr_irmw_clouds_cris.nl lr_iro_clouds_cris.nl	Cloud files name lists for hi-res (hr) and low-res (lr) IR+MW and IR-only processing modes.
hr_irmw_io_cris.nl hr_iro_io_cris.nl lr_irmw_io_cris.nl lr_iro_io_cris.nl	Input/Output name lists for hi-res (hr) and low-res (lr) IR+MW and IR-only processing modes.
hr_irmw_microw_cris.nl hr_iro_microw_cris.nl lr_irmw_microw_cris.nl lr_iro_microw_cris.nl	Microwave file name lists for hi-res (hr) and low-res (lr) IR+MW and IR-only processing modes.
hr_irmw_ozone_cris.nl hr_iro_ozone_cris.nl lr_irmw_ozone_cris.nl lr_iro_ozone_cris.nl	Ozone file name lists for hi-res (hr) and low-res (lr) IR+MW and IR-only processing modes.
hr_irmw_pro_cris.nl hr_iro_pro_cris.nl lr_irmw_pro_cris.nl lr_iro_pro_cris.nl	Profile file name lists for hi-res (hr) and low-res (lr) IR+MW and IR-only processing modes.
hr_irmw_temp_cris.nl hr_iro_temp_cris.nl lr_irmw_temp_cris.nl lr_iro_temp_cris.nl	Temperature file name lists for hi-res (hr) and low-res (lr) IR+MW and IR-only processing modes.
hr_irmw_water_cris.nl hr_iro_water_cris.nl lr_irmw_water_cris.nl lr_iro_water_cris.nl	Water vapor file name lists for hi-res (hr) and low-res (lr) IR+MW and IR-only processing modes.

2.3.3. GFS Forecast Files

These are forecast files generated by NCEP and pushed (by NCEP) to the ESPC/DDS. These files are needed for the NUCAPS EDR generation.

The files have the following name structure:

gfs.t${Hour}z.pgrbf${Forecast}

where:
${Hour} = the time for which the forecast is run (00Z, 06Z, 12Z, and 18Z)
${Forecast} = the forecast projection time (in hours = 00, 03, 06, 09, and 12)

00, 03, 06, 09, and 12 hour forecasts are run every six hours. The files are GRIB2 format files and are read with the *wgrib2* reader which is freely available from NCEP. The header content of any GRIB2 file can viewed by running *wgrib2* and supplying the file name as an argument to the command.

The forecast file preprocessor in the EDR Processing unit uses these files to extract only the surface pressure. The retrieval uses the surface pressure to anchor its solution to the surface. The following forecast variables are extracted from 91 levels and used by this processing:

Run Hour
Forecast Hour
Forecast Latitude
Forecast Longitude
Pressure
Temperature
Water Vapor
Ozone
2 meter Dew Point
2 meter Temperature
Skin Temperature
Surface Pressure
Precipitable Water Content
Total Column Ozone
Sea Surface Temperature
Land Fraction
Temperature of the 30 mb to 0 mb layer

2.3.4. Eigenvector Files

There are three of these files, one for each of the three bands. These are text files shown here:

eigvec.cris_HSR_713_band1.${Day}${Month}${Year}
eigvec.cris_HSR_865_band2.${Day}${Month}${Year}
eigvec.cris_HSR_633_band3.${Day}${Month}${Year}

where:
${Year} = 2-digit year
${Month} = 2-digit month
${Day} = 2-digit day
713 = LW band
865 = MW band
633 = SW band
HSR = CrIS Hi-spectral resolution

The date string indicates when the file was generated. This file contains the eigenvector coefficients required for principal component radiance reconstructions. It is a file that will need to be updated about once every six months or if there are major changes to the calibration of the instrument.

2.3.5. OLR Boxcar files

The OLR code uses a number of boxcar static files that are provided with the system. These files are called:
airs_17boxcar_01.txt
airs_17boxcar_02.txt
airs_17boxcar_03.txt
airs_17boxcar_04.txt
airs_17boxcar_05.txt
airs_17boxcar_06.txt
airs_17boxcar_07.txt
airs_17boxcar_08.txt
airs_17boxcar_09.txt
airs_17boxcar_10.txt
airs_17boxcar_11.txt
airs_17boxcar_12.txt

airs_17boxcar_13.txt
airs_17boxcar_14.txt
airs_17boxcar_15.txt
airs_17boxcar_16.txt
airs_17boxcar_17.txt
airs_17boxcar.txt
cris_17boxcar_01.txt
cris_17boxcar_02.txt
cris_17boxcar_03.txt
cris_17boxcar_04.txt
cris_17boxcar_05.txt
cris_17boxcar_06.txt
cris_17boxcar_07.txt
cris_17boxcar_08.txt
cris_17boxcar_09.txt
cris_17boxcar_10.txt
cris_17boxcar_11.txt
cris_17boxcar_12.txt
cris_17boxcar_13.txt
cris_17boxcar_14.txt
cris_17boxcar_15.txt
cris_17boxcar_16.txt
cris_17boxcar_17.txt
cris_17boxcar.txt
olr_reg_coef_cv005_17boxcar_2.asc
rad_corr_reg_coef_17boxcar_airsv10ab_2.asc

2.3.6. VIIRS collocation LUT Files

The CrIS-VIIRS collocation code uses a set of look up tables to more quickly collocate the two instruments. These files are called:
CrIS_VIIRS_MOD.dat
CrIS_VIIRS_MOD_HEI.dat
CrIS_VIIRS_WGT.dat
CrIS_VIIRS_WGT_HEI.dat

2.3.7. Template Files

The system uses a number of template files. These are all static files that will only change with a new delivery of the system. They are never modified by the scripts and programs

that use them. Scripts will only copy these files to a local directory or create soft links to them

2.3.7.1. CDL Template Files

These are template parameter files used for generating the NUCAPS SDR and NUCAPS EDR granule subsets. These files contain the lists of channels and footprints to be extracted for each type of subset. They also contain the variable lists, array sizes and array dimensions for each NetCDF output file. Each file can be converted into a NetCDF file using the *ncgen* NetCDF4 library utility. This file will have a complete header based on that of the CDL template, but contains no instrument data values, only fill (missing) values. These files are then populated with instrument data values by the subsetter code. There is a different template file for each type of subset.

The following NUCAPS CDL template files shown in Table 2-2 are present in the current build:

Table 2-2 NUCAPS CDL Files

CDL Template Name	Description
nucaps_all_HR.cdl	A netCDF4 template for the all-FOV, 2211 channel radiance file.
nucaps_c0300_allfovs_HR.cdl	A netCDF4 template for the all-FOV, 431 channel radiance file.
nucaps_ccr_archive_HR.cdl	A template CCR granule product archive file which also contains static metadata.
nucaps_l2.cdl	A template for the CrIS EDR granule profile product file which also contains static metadata.
nucaps_olr.cdl	A template for the CrIS OLR granule product file which also contains static metadata.

3. PERFORMANCE

3.1. Product Testing

3.1.1. Test Data

Description of all NUCAPS test data (input, output, and intermediate) used in unit and system tests is provided in the NUCAPS Algorithm Readiness Review documents for Phases 1-4. These are available by contacting the NUCAPS Product Area Lead (PAL) at OSPO.

3.1.2. Test Plans

Description of all NUCAPS test plans used in unit and system tests is provided in the NUCAPS Algorithm Readiness Review documents for Phases 1-4. These are available by contacting the NUCAPS Product Area Lead (PAL) at OSPO.

3.2. Product Accuracy

3.2.1. Test Results

Description of all NUCAPS test results from the unit and system tests is provided in the NUCAPS Algorithm Readiness Review documents for Phases 1-4. These are available by contacting the NUCAPS Product Area Lead (PAL) at OSPO.

3.2.2. Product Accuracy

The Retrieval algorithm product accuracy validation is provided in the NUCAPS Algorithm Readiness Review documents for Phases 1-4. Accuracy and precision requirements are document in the NUCAPS Requirements Document and are derived from the JPSS L1RD Supplement and the JERD.

There are no accuracy requirements for the thinned radiance products or validation products. Validation products are for validation and quality monitoring and therefore do not have any accuracy requirements.

3.3. Product Quality

All the CrIS and ATMS thinned radiance and validation output data files contain the following 6 CrIS quality flags and 2 ATMS quality flags.

CrIS_QF1 = QF1_SCAN_CRISSDR of the CrIS SDR input data.
CrIS_QF2 = QF2_CRISSDR of the CrIS SDR input data.
CrIS_QF3 = QF3_CRISSDR of the CrIS SDR input data.
CrIS_QF4 = QF4_CRISSDR of the CrIS SDR input data.
CrIS_QF5 = QF1_CRISSDRGEO of the CrIS SDR Geolocation input data.
CrIS_QF6 = NUCAPS Aggregate quality flag

ATMS_QF1 = ATMS Aggregate quality flag (0 = good, 1 = bad if any relative quality flags in the ATMS TDR and Geolocation input data are not equal to zero)
ATMS_QF2 = ATMS Aggregation qulatiy flag (0 = good, 1 = bad if there is an error occurred during the ATMS resampling process)

The CrIS flags, except for CrIS_QF6 are bit fields. CrIS_QF1 – CrIS_QF5 are defined in the JPSS Common Data Format Control Books Volume III. CrIS_QF6 is created by the NUCAPS code and is a summary of all the bit field flags. A CrIS_QF6 = 0 indicates all the other bit fields within all the other quality flags are indicating good data. A non-zero flag indicates a problem and therefore the user should interrogate the other flags for details.

The NUCAPS CrIS OLR Quality_Flag is defined at:

0 – good
1 – rejected
-9999 – missing

The NUCAPS retrieval output data files (CCR archive and EDR) contain Quality_Flag with following value settings:

0 – good
1 – rejected by physical
2 – rejected by MIT file
4 – rejected by NOAA (regression) file
8 – rejected by internal MIT
9 – rejected by physical and internal MIT
16 – rejected by internal NOAA
17 – rejected by physical and internal NOAA
24 – rejected by internal MIT and internal NOAA
25 – rejected by physical, internal MIT, and internal NOAA
-9999 – missing

3.4. Analysis Tools

No external product tools are supplied. The NUCAPS output files are plain text files, binary files, or netCDF4 files. External users can choose their own tools to display and analyze these output files.

4. PRODUCT STATUS

4.1. Operations Documentation

Operational logs contain the information regarding the changes made to science, instruments, and systems. Basically the Configuration Management system will have the detailed information about these changes, but operational logs keep the high level description of these changes.

NESDIS/STAR (2013), NUCAPS Algorithm Theoretical Basis Document, Version 1.0.

NESDIS/STAR (2017), NUCAPS System Maintenance Manual, Version 5.0.

4.2. Maintenance History

The System Maintenance Manual (SMM) has been been updated to reflect the changes that will be required to maintain the NUCAPS system within the ESPC environment. Information regarding the changes to the products is tracked by the Operational logs and will be available to users on request. Product metadata will be updated as per the changes required in the product including the version number, quality flags etc.

END OF DOCUMENT