National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)
Office of Satellite Products and Operations (OSPO)

The NOAA JPSS Risk Reduction System External User Manual (EUM)

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1. PRODUCTS

This is an external user's manual document describing the Joint Polar Satellite System (JPSS) Risk Reduction (RR) products and output files. The JPSS Risk Reduction product system was developed at the Center for Satellite Applications and Research (STAR) and will be implemented into operations at the NOAA NPOESS Data Exploitation (NDE).

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 and product testers 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.

1.1. Product Overview

The NOAA JPSS RR System produces a total of 26 products in four different product areas: Clouds, Aerosol, Cryosphere, and Land Surface. The products generated from the Suomi NPP (National Polar Orbiting Partnership) Visible Infrared Imaging Radiometer Suite (VIIRS) Scientific Data Records (SDR) will be used as risk reduction assessment for a cost effective implementation of common NESDIS algorithms for the JPSS program. The output products are intended for operational and scientific users.

1.1.1. Product Requirements

The requirements are to develop a production system to demonstrate that common algorithm approach for new NPP VIIRS satellite products created from upgraded GOES-R algorithms. It is expected to demonstrate a cost effective algorithm development, implementation, transition to operations, and maintenance process for NOAA JPSS products on future JPSS satellites.

1.1.2. Product Team

The VIIRS JPSS RR Development product team consists of members from STAR. 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
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Sid Boukabara	JCSDA	User Team	
Carven Scott	NWS	User Team	

1.1.3. Product Description

The NOAA JPSS RR products will be used as a risk reduction assessment for a cost effective implementation of common NESDIS algorithms for the JPSS system. The system was designed to run within the NPOESS Data Exploitation (NDE) production environment.

The output products are intended for operational and scientific users. Table 1-2 provides information on the algorithms and products.

Table 1-2: JPSS RR Algorithms and Products

Product Category	Algorithm	Product
Cloud	- Cloud Mask	Cloud Mask
	- Cloud Phase	Cloud Top Phase Cloud Type
	- Cloud Height	Cloud Top Height Cloud Cover Layers Cloud Top Temperature Cloud Top Pressure
	- Daytime Cloud Optical and Microphysical Properties (DCOMP)	Cloud Optical Depth Cloud Particle Size Distribution Cloud Liquid Water Path Cloud Ice Water Path
	- Nighttime Cloud Optical and Microphysical Properties (NCOMP)	Cloud Optical Depth Cloud Particle Size Distribution Cloud Liquid Water Path Cloud Ice Water Path
	- Cloud Base	Cloud Base Height Cloud Base Pressure
Aerosol	- Aerosol Detection	Aerosol Detection
	- Aerosol Optic al Depth	Aerosol Optical Depth Aerosol Particle Size
	- Volcanic Ash	Volcanic Ash Mass Loading Volcanic Ash Height
Cryosphere	- Snow Cover	Snow Cover Snow Fraction
	- Ice Concentration	Ice Concentration and Cover Ice Surface Temperature
	- Ice Thickness and Age	Ice Thickness/Age

Land Surface	- Land Surface Temperature - Land Surface Albedo	Land Surface Temperature Primary Clear Albedo (IP) Improved Albedo (EDR)

1.1.4. Product History

The algorithms in the JPSS products are modified or upgraded versions of GOES-R algorithms adapted to run on S-NPP VIIRS (except for Snow Cover which is GOES heritage). The result of this implementation is to have just one set of algorithm software that will need to be maintained for generating products from both the GOES-R Advanced Baseline Imager and the JPSS VIIRS instruments. It is expected that instruments onboard future VIIRS satellites will also use these algorithms. This risk reduction project supports the common algorithm approach for new satellite products.

1.2. Product Characteristics

VIIRS is a 22-band imaging radiometer that, in terms of features, is a cross between MODIS and AVHRR, with some characteristics of the Operational Linescan System (OLS) on Defense Meteorological Satellite Program (DMSP) satellites. Several unique characteristics of VIIRS will impact the VIIRS JPSS RR products, which include

- a wider swath,
- high spatial resolution,
- constrained pixel growth: better resolution at edge of swath,
- a visible day-night band (DNB).

1.3. Product Access

All JPSS RR output data files will be made available by the NDE DHS on the NDE data distribution server at ESPC in a near real time manner. For access to this server, information about data files, and associated documentation, the JPSS 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.

The products are in netCDF format and undergo compression while being processed. Table 1-3 lists the JPSS RR output files and their formats. Tables 1-4 to 1-14 show the detailed content of the output files.

Table 1-3: JPSS RR Output File Names: NetCDF4

JPSS RR Product Algorithm Names	***NetCDF4JPSS RR product filenames***
Aerosol Detection	JRR-ADP_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Aerosol Optical Depth	JRR-AOD_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Volcanic Ash	JRR-VolcanicAsh_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Cloud Mask	JRR-CloudMask_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Cloud Height	JRR-CloudHeight_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Cloud Phase	JRR-CloudPhase_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Daytime Cloud Optical and Microphysical Properties (DCOMP)	JRR-CloudDCOMP_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Nighttime Cloud Optical and	JRR-

Microphysical Properties (NCOMP)	CloudNCOMP_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Cloud Base	JRR-CloudBase_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Ice Thickness and Age	JRR-IceAge_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Ice Concentration	JRR-IceConcentration_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Snow Cover	JRR-SnowCover_v1r2_npp_sYYYYMMDDHHMMSS0_eYYYYMMDDHHMMSS0_cYYYYMMDDHHMMSS0.nc
Land Surface Temperature	LST_v1r4_npp_sYYYYMMDDHHMMSSS_eYYYYMMDDHHMMSSS_cYYYYMMDDHHMMSSS.nc LST_v1r4_j01_sYYYYMMDDHHMMSSS_eYYYYMMDDHHMMSSS_cYYYYMMDDHHMMSSS.nc
Land Surface Albedo	SURFRAD_v1r4_npp_sYYYYMMDDHHMMSSS_eYYYYMMDDHHMMSSS_cYYYYMMDDHHMMSSS.nc SURFRAD_v1r4_j01_sYYYYMMDDHHMMSSS_eYYYYMMDDHHMMSSS_cYYYYMMDDHHMMSSS.nc

Where,
v1r2, v1r4 – version number
npp – satellite name is NPP
j01 – satellite name is JPSS01(NOAA20)
YYYY – 4 digit year
MM – 2 digit month
DD – 2 digit day
HH – 2 digit hour
MM – 2 digit minute
SS – 2 digit second
SSS – Decimal seconds to the 1/10 precision (e.g. “103” = 10.3 seconds)
s – start
e – end
c – creation time

Note that the *.nc product data files undergo level 2 compression. While the other JPSS products have the ‘JRR’ prefix, land surface file names begin with the product names. The land surface products version number is v1r4, while the other JPSS RR products are v1r2.

In addition to the ancillary products required to generate the JPSS RR products, the land surface temperature and albedo products also require offline components (albedo and emissivity) that are determined separately outside of the framework. Brief descriptions of the offline components can be found among the ancillary products in section 2.3.16.

The file contents are shown in Table 1-4 to Table 1-14.

Table 1-4: Aerosol Detection Output File

Variable	Type	Description	Dim	Units	Range
Ash	Byte	Volcanic Ash Flag: 1 = yes, 0 = No	2	1	0,1
AshConfidHighPct	Float	Percent of high confidence ash	0	Percent	0, 100
AshConfidLowPct	Float	Percent of low confidence ash	0	Percent	0, 100
AshConfidMediumPct	Float	Percent of medium confidence ash	0	Percent	0, 100
AshPct	Float	Percent of good ash retrieval	0	Percent	0, 100
Byte1	Byte	Quality Flag Byte 1	2	1	-128,127
Byte2	Byte	Quality Flag Byte 2	2	1	-128,127
Byte3	Byte	Quality Flag Byte 3	2	1	-128,127
Byte4	Byte	Quality Flag Byte 4	2	1	-128,127
Byte5	Byte	Quality Flag Byte 5	2	1	-128,127
Cloud	Byte	Cloud Flag: 1 yes, 0 no	2	1	0,1
DAII	Float	Dust Aerosol Index	2	1	
Dust	Byte	Deep blue dust flag: 1 yes, 0 no	2	1	0,1
DustConfidHighPct	Float	Percent of high confidence dust	0	Percent	0, 100
DustConfidLowPct	Float	Percent of low confidence dust	0	Percent	0, 100
DustConfidMediumPct	Float	Percent of medium confidence dust	0	Percent	0, 100
DustPct	Float	Percent of good dust retrieval	0	Percent	0, 100
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90., 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180., 180.
NDAI	Float	No Dust Aerosol Index	2	1	

NUC	Byte	None, Unknown, Clear_sky Flag: 1 Yes, 0 No	2	1	0, 1
NUCConfidHighPct	Float	Percent of high confidence NUC	0	Percent	0, 100
NUCConfidLowPct	Float	Percent of low confidence NUC	0	Percent	0, 100
NUCConfidMediumPct	Float	Percent of medium confidence NUC	0	Percent	0, 100
NUCPct	Float	Percent of good NUC retrieval	0	Percent	0, 100
NoAshPct	Float	Percent of ash not determined (bad)	0	Percent	0, 100
NoDustPct	Float	Percent of dust not determined (bad)	0	Percent	0, 100
NoNUCPct	Float	Percent of NUC not determined (bad)	0	Percent	0, 100
NoSmokePct	Float	Percent of smoke not determined (bad)	0	Percent	0, 100
NumOfGoodAshRetrieval	Long	Number of Good Ash Retrievals	0	1	
NumOfGoodDustRetrieval	Long	Number of Good Dust Retrievals	0	1	
NumOfGoodNUCRetrieval	Long	Number of Good NUC Retrievals	0	1	
NumOfGoodSmokeRetrieval	Long	Number of Good Smoke Retrievals	0	1	
NumOfQualityFlag	Long	Number of quality flag	0	1	
NumOfSatZenAngLess60	Long	Number of pixel with satellite zenith angle less 60 degree	0	1	
NumOfSolZenAngLess60	Long	Number of pixel with solar zenith angle less 60 degree	0	1	
Smoke	Byte	Deep Blue Smoke Flag: 1 Yes, 0 No	2	1	0, 1
SmokeCon	Float	Smoke Concentration	2	ug/m^3	
SmokeConfidHighPct	Float	Percent of high confidence smoke	0	Percent	0, 100
SmokeConfidLowPct	Float	Percent of low confidence smoke	0	Percent	0, 100
SmokeConfidMediumPct	Float	Percent of medium confidence smoke	0	Percent	0, 100
SmokePct	Float	Percent of good	0	Percent	0, 100

		smoke retrieval			
SnowIce	Byte	Snow Ice Flag: 1 Yes, 0 No	2	1	0, 1
StartColumn	Long	Start column index	0		
StartRow	Long	Start row index	0		
TotalPixel	Long	Total number of pixels where retrievals are attempted	0	1	

Table 1-5: Aerosol Optical Depth Output File

Variable	Type	Description	Dim	Units	Range
AOD550	Float	Aerosol optical depth at 550 nm	2	1	-0.05, 5.0
AOD550LndMdl	Float	Retrieval AOD550 for each land aerosol model: dust, generic, urban, smoke	3	1	-0.05,5
AOD_channel	Float	Aerosol optical depth in selected channels	3	1	0, 12
AerMdl	Byte	Aerosol model: 0-oceanic, 1-dust, 2-generic, 3-urban, 4-heavy smoke	2	1	0, 4
AngsExp1	Float	Angstrom exponent for M4 vs M7 over ocean	2	1	-1, 3
AngsExp2	Float	Angstrom exponent for M7 vs M10 over ocean	2	1	-1, 3
CoarseMdlIdx	Byte	Retrieved coarse aerosol model index over ocean	2	1	1,5
FineMdlIdx	Byte	Retrieved fine aerosol model index over ocean	2	1	1,4
FineModWgt	Float	Retrieved ratio of fine mode optical depth at 0.55 micron over ocean	2	1	0,1

HighQualityPct	Float	Percent of high quality retrievals	0	Percent	0, 100
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90., 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180., 180.
MeanAOD	Float	Mean AOD at 550 nm	0	1	-1, 5
QCall	Byte	Retrieval quality: 0: no retrieval; 1:low; 2:medium; 3:high	2	1	0, 4
QCExtn	Byte	External flags from input masks: bit 0&1: cloud (0-confClr/1-probClr/2-probCld/3-confCld); bit 2: snow (0-No/1-Yes); bit 3: cloud shadow; bit 4: fire; bit 5: sun glint; bit 6: Heavy aerosol	2	1	-128,127
QCInput	Byte	Flags for input data (0-valid/1-invalid): bit 0: geolocation; bit 1: geometry; bit 2: ancillary model data; bit 3: reflectance	2	1	0, 15
QCPath	Byte	Flags for retrieval path (0-No/1-Yes): bit 0: retrieval over water; bit 1: over bright land; bit 2: over glint water; bit 3: retrieval with SW scheme over land; bit 4: retrieval with SWIR scheme over land; bit 5: retrieval over bright-land algorithm	2	1	0,31
QCRet	Byte	Flags for retrieval (0-No/1-Yes): bit 0: retrieval failed; bit 1: low sun; bit 2: dark barren land surface type; bit 3: extrapolation involved; bit 4:	2	1	-128,127

		retrieval residula out of range; bit 5: dark land NDVI out of range; bit 6: dark land redness ratio out of range; bit 7: adjacent to cloud or snow			
QCTest	Byte	Flags for internal tests (0-No/1-Yes): bit 0: cloudy; bit 1: cirrus; bit 2: thin cirrus; bit 3: inhomogeneous; bit 4: snow/ice; bit 5: ephemeral water; bit 6: shallow water; bit 7: heavy aerosol	2	1	-128,127
ResLndMdl	Float	Retrieval residual for each land aerosol model: dust, generic, urban, smoke	3	1	0,999
Residual	Float	Retrieval residual of the best solution	2	2	0,999
RetrievalPct	Float	Percent of AOD retrievals	0	Percent	0,100
SfcRefl	Float	surface reflectance in selected channels	3	1	0, 1
SpaStddev	Float	Inhomogeneity TOA reflectance standard deviation: M1 over land, M11 over ocean	2	1	0, 1
StartColumn	Long	Start column index	0		
StartRow	Long	Start row index	0		

Table 1-6: Volcanic Ash Output File

Variable	Type	Description	Dim	Units	Range
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90., 90.
Longitude	Float	Pixel longitude in	2	Degrees	-180., 180.

		field longitude		east	
AshConfidence	Float	Ash Confidence	2	None	NA
AshConfidenceMulti	Float	Ash Confidence Multi	2	None	NA
AshDetectionQPI	Byte	Ash Detection Product Quality Information	3	None	-128, 127
AshDetectionQF	Byte	Ash Detection Quality Flag	2	None	-128, 127
CldB1112_TotLRC	Float	Cloud B1112 Total LRC	2	None	NA
CldB1112_Tot	Float	Cloud B1112 Total	2	None	NA
CldB8511_TotLRC	Float	Cloud B8511 Total LRC	2	None	NA
CldB8511_Tot	Float	Cloud B8511 Total	2	None	NA
EmissCh14_Tot	Float	Emissions Ch14 Total	2	None	NA
EmissCh11_Tot	Float	Emissions Ch11 Total	2	None	NA
AshTopTemp	Float	Ash Top Temperature	2	Kelvin	180, 340
AshTopPress	Float	Ash Top Pressure	2	hPa	0, 1100
AshTopHeight	Float	Ash Top Height	2	Meters	0, 30000
AshEmiss	Float	Ash Emissivity at 11um	2	None	NA
AshEffRad	Float	Ash Effective Particle Size	2	Microns	1, 20
AshOD_VIS	Float	Ash visible optical depth	2	None	1, 100
AshOD_IR	Float	Ash infrared optical depth	2	None	1, 100
AshMassLoading	Float	Ash Mass Loading	2	Tons/km^2	0, 70
AshBeta	Float	Beta value for 11 and 12 microns	2	None	NA
AshTempErr	Float	Estimated error in ash temperature	2	Kelvin	NA
AshPressErr	Float	Estimated error in ash pressure	2	hPa	NA
AshHgtErr	Float	Estimated error in Ash Height	2	Meters	NA
Ash_QF	Byte	Ash Retrieval Quality Flag	3	None	-128, 127
Ash_PQI	Byte	Ash Retrieval Product Quality Information	3	None	-128, 127
TotMassVolAsh	Float	Total Ash Loading	0	tons/km^	NA

		Mass for Overall Highest Quality Pixels		2	
MassLoadingMax	Float	Maximum Ash Loading for Overall Highest Quality Pixels	0	tons/km^ 2	NA
MassLoadingMin	Float	Minimum Ash Loading for Overall Highest Quality Pixels	0	tons/km^ 2	NA
MassLoadingMean	Float	Mean Mass Loading for Overall Highest Quality Pixels	0	tons/km^ 2	NA
MassLoadingStdDev	Float	Standard Deviation of Mass Loading for Overall Highest Quality Pixels	0	tons/km^ 2	NA
AshCldHgtMax	Float	Maximum Ash Cloud Height for Overall Highest Quality Pixels	0	Meters	NA
AshCldHgtMin	Float	Minimum Ash Cloud Height for Overall Highest Quality Pixels	0	Meters	NA
AshCldHgtMean	Float	Mean Ash Cloud Height for Overall Highest Quality Pixels	0	Meters	NA
AshCldHgtStdDev	Float	Standard Deviation of Ash Cloud Height for Overall Highest Quality Pixels	0	Meters	NA
DetQF_OverallPerc	Float	Percent of High Quality Overall pixels for detection	0	Percent	NA
DetQF_InvDatPerc	Float	Percent of High Quality Invalid data pixels for detection	0	Percent	NA
DetQF_SatZenPerc	Float	Percent of High Quality Satellite Zenith pixels for detection	0	Percent	NA
DetQF_SingLyrPerc	Float	Percent of High Quality Single Layer pixels for detection	0	Percent	NA
DetQF_MultLyrPerc	Float	Percent of High	0	Percent	NA

		Quality Multiple Layer pixels for detection			
RetQF_OverallPerc	Float	Percent of High Quality Overall pixels for retrieval	0	Percent	NA
RetQF_TcldPerc	Float	Percent of High Quality Cloud Temperature pixels for retrieval	0	Percent	NA
RetQF_EcldPerc	Float	Percent of High Quality 11 micron emissivity at nadir pixels for retrieval	0	Percent	NA
RetQF_BcldPerc	Float	Percent of High Quality beta ratio for 11 and 12 micron pixels for retrieval	0	Percent	NA
TotAttemptedRet	Long	Total Attempted Retrievals	0	None	NA
StartColumn	Long	Start column index	0		
StartRow	Long	Start row index	0		

Table 1-7: Cloud Height Output File

Variable	Type	Description	Dim	Units	Range
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90., 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180., 180.
CldTopTemp	Float	Cloud Top Temperature	2	Kelvin	180, 340
CldTopPres	Float	Cloud Top Pressure	2	hPa	0, 1100
CldTopHght	Float	Cloud Top Height	2	Meter	-300, 20000
CldHgtFlag	Byte	Cloud Height Processing Flag	3	None	0, 6
CldPackedFlag	Byte	Cloud Height Diagnostic Flag	3	None	-128, 127
CloudHgtQF	Byte	Cloud Height Quality Flag	2	None	0, 6
Conv_Cld_Prob	Float	Convective Cld Prob	2	1	0, 1
CloudLayer	Byte	Cloud Layer	2	None	0, 3
InverFlag	Byte	Inversion Flag	2	None	0, 1
TcError	Float	Tc Error	2	None	NA
PcError	Float	Pc Error	2	None	NA

ZcError	Float	Zc Error	2	None	NA
Cost	Float	Cost	2	None	NA
Cloud_Layer	Byte	Cloud Layer	2	None	NA
Total_Cloud_Fraction	Float	Total Cloud Fraction	2	None	NA
Total_Cloud_Fraction_Uncer	Float	Total Cloud Fraction Uncertainty	2	None	NA
High_Cloud_Fraction	Float	High Cloud Fraction	2	None	NA
Mid_Cloud_Fraction	Float	Mid Cloud Fraction	2	None	NA
Low_Cloud_Fraction	Float	Low Cloud Fraction	2	None	NA
Shadow_Mask	Byte	Shadow Mask	2	None	NA
MinCldTopTemp	Float	Minimum of cloud top temperature	0	Kelvin	NA
MaxCldTopTemp	Float	Maximum of cloud top temperature	0	Kelvin	NA
MeanCldTopTemp	Float	Mean of cloud top temperature	0	Kelvin	NA
StdDevCldTopTemp	Float	Std Dev of cloud top temperature	0	Kelvin	NA
MinCldTopPres	Float	Minimum of cloud top pressure	0	hPa	NA
MaxCldTopPres	Float	Maximum of cloud top pressure	0	hPa	NA
MeanCldTopPres	Float	Mean of cloud top pressure	0	hPa	NA
StdDevCldTopPres	Float	Std Dev of cloud top pressure	0	hPa	NA
MinCldTopHeight	Float	Minimum of cloud top Height	0	Meter	NA
MaxCldTopHeight	Float	Maximum of cloud top Height	0	Meter	NA
MeanCldTopHeight	Float	Mean of cloud top Height	0	Meter	NA
StdDevCldTopHeight	Float	Std Dev of cloud top Height	0	Meter	NA
NumOfQualityFlag	Long	Number of quality flag	0	None	NA
TotalCloudPixel	Long	Total Number of detected cloud pixels	0	None	NA
TerminatorPixPct	Float	Percent of terminator pixels	0	Percent	0, 100
ValidRetrPct	Float	Valid, good converged retrieval	0	Percent	0, 100
InvalidRetrSpaceViewPct	Float	Invalid pixel due to space view	0	Percent	0, 100
InvalidRetrSatZenPct	Float	Invalid pixel due to being outside of	0	Percent	0, 100

		sensor zenith range			
InvalidRetrBadDataPct	Float	Invalid earth pixel due to bad data: bad or missing 11 um BT or bad missing clear sky 11 um BT	0	Percent	0, 100
InvalidRetrCldMaskPct	Float	Invalid due to cloud mask being clear or probably clear	0	Percent	0, 100
InvalidRetrMissCldTypePct	Float	Invalid due to missing cloud type	0	Percent	0, 100
InvalidRetrFailedPct	Float	Failed Retrieval	0	Percent	0, 100
DayTimePixPct	Float	Percent of daytime pixels	0	Percent	0, 100
NightTimePixPct	Float	Percent of nighttime pixels	0	Percent	0, 100
ProcOrder	Byte	Processing order	2	None	0, 4
ChanOn	Byte	Channel On info	1	None	NA
AchaMode	Long	Acha Mode	0	None	None
CldTopEmss	Float	Cloud Top Emissivity	2	1	0,1
InverFlag	Byte	Inversion Flag	2	1	0, 1
SC_Cld_Prob	Float	Supercooled Cld Prob	2	1	0,1
Shadow_Mask	Byte	Shadow Mask	2	1	0,1
TerminatorPixPct	Float	Percent of terminator pixels	0	Percent	0, 100

Table 1-8: Cloud Mask Output File

Variable	Type	Description	Dim	Units	Range
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90., 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180., 180.
CloudMask	Byte	Cloud Mask	2	None	0, 3
CloudMaskBinary	Byte	Cloud Mask Binary	2	None	0, 1
CloudMaskPacked	Byte	Diagnostic Cloud Mask	3	Noner	-128, 127
CloudMaskFlag	Byte	Cloud Mask Test	3	None	0, 6
Smoke_Mask	Byte	Smoke Mask	2	None	0, 3
Fire_Mask	Byte	Fire Mask	2	None	0, 3

Dust_Mask	Byte	Dust Mask	2	None	0, 3
CloudMaskQualFlag	Byte	Cloud Mask Quality Flag	2	None	0, 3
CloudProbability	Float	Cloud Probability	2	None	0, 1
ClearProbClear	Float	Percent of Clear and Probably Clear	0	Percent	0, 100
NumOfQualityFlag	Long	Number of quality flag	0	None	NA
Cloudy	Float	Percent of Pixels that passed a test for cloud and failed a test for cloud edge	0	Percent	0, 100
ProbCloudy	Float	Percent of Pixels that passed a test for cloud and passed a test for cloud edge	0	Percent	0, 100
ProbClear	Float	Percent of Pixels that passed no test for cloud but passed tests for spatial heterogenity	0	Percent	0, 100
Clear	Float	Percent of Pixels that passed no test for cloud and failed a test for spatial heterogenity	0	Percent	0, 100
TotalPixel	Long	Total Number of pixels	0	None	NA
TerminatorPixPercent	Float	Percent of terminator pixels	0	Percent	0, 100
TotalCloudMaskPixel	Long	Total Number of cloud Mask pixels	0	None	NA
MinClrSkyOBS_RTM	Float	Minimum observation - RTM for Clear Sky IR Channel 07 to 16	1	Kelvin	NA
MaxClrSkyOBS_RTM	Float	Maximum observation - RTM for Clear Sky IR Channel 07 to 16	1	Kelvin	NA
MeanClrSkyOBS_RTM	Float	Mean observation - RTM for Clear Sky IR Channel 07 to 16	1	Kelvin	NA
StdDevClrSkyOBS_RTM	Float	Std Dev observation - RTM for Clear Sky IR Channel 07 to 16	1	Kelvin	NA
MinAllSkyOBS_RTM	Float	Minimum	1	Kelvin	NA

		observation - RTM for All Sky IR Channel 07 to 16			
MaxAllSkyOBS_RTM	Float	Maximum observation - RTM for All Sky IR Channel 07 to 16	1	Kelvin	NA
MeanAllSkyOBS_RTM	Float	Mean observation RTM for All Sky IR Channel 07 to 16	1	Kelvin	NA
StdDevAllSkyOBS_RTM	Float	Std Dev observation - RTM for All Sky IR Channel 07 to 16	1	Kelvin	NA

Table 1-9: Daytime and Nighttime Cloud Microphysics Output File

Variable	Type	Description	Dim	Units	Range
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90, 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180, 180.
CloudMicroVisOD	Float	Cloud optical depth	2	None	0, 100
CloudMicroVisODMD6	Float	Cloud optical depth	2	None	0, 100
CloudMicroEffRad	Float	Cloud effective radius	2	Micron	0, 100
CloudMicroEffRadMD6	Float	Cloud effective radius	2	Micron	0, 100
CloudMicroLWP	Float	Cloud liquid water path	2	g/m2	0, 5000
CloudMicroIWP	Float	Cloud ice water path	2	g/m2	0, 5000
CloudMicro_Mode	Long	Cloud micro algorithm mode	0	None	1, 3
CloudMicroFlag	Byte	Cloud Micro Flag	3	None	-128, 127
ProcessingFlag	Byte	Cloud micro processing flag	3	None	-128, 127
QualityFlag	Byte	Cloud micro quality flag	2	None	0, 6
DayNightFlag	Long	Day night flag	0	None	NA
MinOpticalDepth	Float	Minimum of optical depth	0	None	0, 100
MaxOpticalDepth	Float	Maximum of optical depth	0	None	0, 100

meanOpticalDepth	Float	Mean of optical depth	0	None	0, 100
StdDevOpticalDepth	Float	Std Dev of optical depth	0	None	0, 100
MinParticalSize	Float	Minimum of particle size	0	Micron	0, 100
MaxParticalSize	Float	Maximum of particle size	0	Micron	0, 100
MeanParticalSize	Float	Mean of particle size	0	Micron	0, 100
StdDevParticalSize	Float	Std dev of particle size	0	Micron	0, 100
NumOfQualityFlag	Long	Number of quality flag	0	None	NA
ValidRetrPct	Float	Valid, good quality converged retrieval	0	Percent	0, 100
ValidDegradedSnowPct	Float	Valid, quality may be degred due to snow or sea ice surface	0	Percent	0, 100
ValidDegradedTwilightPct	Float	Valid, but degraded quality due to twilight conditions: solar zenith bwtween 65 and 82 degree	0	Percent	0, 100
InvalidCloudFreePct	Float	Invalid due to cloud-free condition	0	Percent	0, 100
InvlidOutsideRangePct	Float	Invalid pixel due to being outside of observation range	0	Percent	0, 100
InvalidMissPct	Float	Invalid pixel due to missing data	0	Percent	0, 100
InvalidFaliedPct	Float	Invalid pixel, DCOMP attempted but failed retrieval	0	Percent	0, 100
TotalCloudPixel	Float	Total Number of detected cloud pixels	0	Percent	0, 100
DayTimePixPct	Float	Percent of daytime pixels	0	Percent	0, 100
NightTimePixPct	Float	Percent of nighttime pixels	0	Percent	0, 100
TerminatorPixPct	Float	Percent of terminator pixels	0	Percent	0, 100
NitCat00Pct	Float	Good retrieval	0	Percent	0, 100
NitCat01Pct	Float	Space mask	0	Percent	0, 100
NitCat02Pct	Float	Day	0	Percent	0, 100
NitCat03Pct	Float	Cloud type indicates it is not a cloud	0	Percent	0, 100

NitCat04Pct	Float	Cloud type has an unknown value	0	Percent	0, 100
NitCat05Pct	Float	Unrealistic cloud temperature	0	Percent	0, 100
NitCat06Pct	Float	No retrieval: minimum error model for water = 0	0	Percent	0, 100
NitCat07Pct	Float	No retrieval: minimum error model for ice = 0	0	Percent	0, 100

Table 1-10: Cloud Phase Output File

Variable	Type	Description	Dim	Units	Range
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90, 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180, 180.
CloudPhase	Byte	Cloud phase	2	None	0, 5
CloudType	Byte	Cloud type	2	None	0, 8
CloudTypePacked	Byte	Cloud type diagnostic flag	3	None	-128, 127
CloudPhaseFlag	Byte	Cloud phase and type quality flag	3	None	0, 1
NumberofCloudPhase	Long	Number of cloud phase categories	0	None	NA
LiquidWaterPct	Float	Percent of liquid water cloud with an opaque cloud temperature greater than 273k	0	Percent	0, 100
SuperCooledLiquidWaterPct	Float	Percent of liquid water topped cloud with an opaque cloud temperature less than 273K	0	Percent	0, 100
MixedPhasePct	Float	Percent of cloud high probability of containing liquid water and ice near cloud top	0	Percent	0, 100
IcePct	Float	Percent of all ice topped clouds	0	Percent	0, 100
NumberofQualFlagVals	Long	Number of quality	0	None	NA

		flag values			
NumberofLowQuality	Long	Number of low quality	0	None	NA
NumberofHighQuality	Long	Number of high quality	0	None	NA
TotalCloudPixels	Long	Total number of detected cloud pixels	0	None	NA
TerminatorPixPct	Float	Percent of terminator pixels	0	Percent	0, 100
TermPixCnt	Long	Terminator pixel count	0	None	NA
TotPixAtpt	Long	Total pixel number attempted	0	None	NA
ChanOn	Byte	Channel On info	1	None	NA
AchaMode	Long	Acha Mode	0	None	NA

Table 1-11: Ice Age Output File

Variable	Type	Description	Dim	Units	Range
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90, 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180, 180.
IceAge	Short	Ice Age classification numbers(1-8)	2	None	0, 8
IceThickness	Float	Ice thickness	2	Meter	0, 9999
QCFlags	Short	QC flags	2	None	NA
ProdQualInfo	Long	Product qualiity information	2	None	NA
NumOfQACategories	Long	Number of QA flag values	0	None	NA
Tot_QACat01	Long	Total number of pixels with QA category 1 (normal or optimal)	0	None	NA
Tot_QACat02	Long	Total number of pixels with QA category 2 (uncertain or suboptimal)	0	None	NA
Tot_QACat03	Long	Total number of pixels with QA	0	None	NA

		category 3 (bad or missing)			
Tot_QACat04	Long	Total number of pixels with QA category 4 (non-retrievable)	0	None	NA
TotWaterPixs	Long	Total number of pixels w. water surface	0	None	NA
TotRetrPixs	Long	Total number of valid ice thickness and age retrievals	0	None	NA
TermntPixPct	Float	% of terminated ice thickness and age retrievals of all processed pixels	0	Percent	0, 100
TotDaytimePixs	Long	Total number of daytime valid retrievals	0	None	NA
TotNighttimePixs	Long	Total number of nighttime valid retrievals	0	None	NA
MeanIceThk	Float	Mean ice thickness retrieval	0	Meter	NA
MaxIceThk	Float	Max ice thickness retrieval	0	Meter	NA
MinIceThk	Float	Min ice thickness retrieval	0	Meter	NA
STDIceThk	Float	Standard deviation of ice thickness retrievals	0	Meter	NA

Table 1-12: Ice Concentration Output File

Variable	Type	Description	Dim	Units	Range
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90, 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180, 180.
IceMap	Short	Ice Cover map codes numbers(1-8)	2	None	-2, 2
IceConc	Float	Ice concentration	2	Percent	0, 100
IceSrfTemp	Float	Ice surface temp	2	Kelvin	100, 390
QCFlags	Long	Quality control flags	2	None	NA

SearchWindowSize	Long	Pixel size of search window to determine tie-point	0	None	NA
TotWaterPixs	Long	Total number of pixels w. water surface	0	None	NA
TotIceRetrvls	Long	Total number of valid ice cover and concentration retrievals	0	None	NA
IceRetrPct	Float	% of valid ice cover and concentration retreivals of all water pixels	0	Percent	0, 100
TotIceTermnt	Long	Total number of terminated ice cover and concentration retrievals	0	None	NA
IceTermntPct	Float	% of terminated ice cover and concentration retrievals of all processed pixels	0	Percent	0, 100
TotDaytimePixs	Long	Total number of daytime valid retrievals	0	None	NA
TotNighttimePixs	Long	Total number of nighttime valid retrievals	0	None	NA
MeanIceConc	Float	Mean ice concentration retrieval	0	Percent	0, 100
MaxIceConc	Float	Max ice concentration retrieval	0	Percent	0, 100
MinIceConc	Float	Min ice concentration retrieval	0	Percent	0, 100
STDIceConc	Float	Standard deviation of ice concentration retrievals	0	Percent	0, 100
NumOfQACategories	Long	Number of QA flag values	0	None	NA
Tot_QACat01	Long	Total number of pixels with QA category 1 (normal or optimal)	0	None	NA
Tot_QACat02	Long	Total number of	0	None	NA

		pixels with QA category 2 (uncertain or suboptimal)			
Tot_QACat03	Long	Total number of pixels with QA category 3 (non-retrievable)	0	None	NA
Tot_QACat04	Long	Total number of pixels with QA category 4 (bad data)	0	None	NA

Table 1-13: Snow Cover Output File

Variable	Type	Description	Dim	Units	Range
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90, 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180, 180.
SnowMask	Byte	Snow mask	2	None	NA
SnowMaskQuality	Byte	Snow mask quality	2	None	NA
SnowFraction	Byte	Snow fraction	2	None	NA
SnowFractionQuality	Byte	Snow mask binary	2	None	NA
SnowProbability	Short	Snow probability	2	None	NA
MinReflectance	Float	Min reflectance in bands 1 and 2 to perform snow identification	0	None	NA
MaxReflectance	Float	Max reflectance in bands 1 and 2 to perform snow identification	0	None	150, 250
MinBrightTemp	Float	Min temperature in bands 4 and 5 to perform snow identification	0	Kelvin	NA
MaxBrightTemp	Float	Max temperature in bands 4 and 5 to perform snow identification	0	Kelvin	350, 450
MaxSolarZenith	Float	Max solar zenith angle to perform snow identification	0	Degrees	80, 87

MaxSnowTemp	Float	Snow max temperature threshold	0	Kelvin	280, 293
MinVisibleReflect	Float	Snow min visible reflectance threshold	0	None	5, 15
MaxSwirReflect	Float	Snow max shortwave IR reflectance threshold	0	None	10, 30
MaxMirReflect	Float	Snow max midIR reflectance	0	None	4, 6
MinNdvi	Float	Snow min ndvi threshold value	0	None	-0.5, 0
R1ObservGeomCorrCoeff 1	Float	r1 observation geometry correction coefficient 1	0	None	NA
R1ObservGeomCorrCoeff 2	Float	r1 observation geometry correction coefficient 2	0	None	NA
R1ObservGeomCorrCoeff 3	Float	r1 observation geometry correction coefficient 3	0	None	NA
R1TempCorrCoeff1	Float	r1 correction coefficient 1 for surface temperature	0	None	NA
R1TempCorrCoeff2	Float	r1 correction coefficient 2 for surface temperature	0	None	NA
R1TempCorrCoeff3	Float	r1 correction coefficient 3 for surface temperature	0	None	NA
R1NdviCorrCoeff1	Float	r1 correction coefficient 1 for ndvi	0	None	NA
R1NdviCorrCoeff2	Float	r1 correction coefficient 2 for ndvi	0	None	NA
R1NdviCorrCoeff3	Float	r1 correction coefficient 3 for ndvi	0	None	NA
SnowClimTestFlag	Long	Flag to turn on/off the snow climatology test	0	None	NA
LstClimTestFlag	Long	Flag to turn on/off the lst climatology test	0	None	NA
SpatConsTestFlag	Long	Flag to turn on/off the spatial consistency test	0	None	NA
TempUnifTestFlag	Long	Flag to turn on/off the lst spatial variation test	0	None	NA

TempOffset	Float	Temperature offset for LST climatology test	0	None	NA
WinSizeSpatCons	Long	Sliding window size for spatial consistency test	0	None	NA
WinSizeTempUnif	Long	Sliding window size for temperature uniformity test	0	None	NA
MaxFracClearPix	Float	Max fraction (%) of clear pixels within the window for consistency test	0	Percent	0, 100
PixElevThresh	Float	Pixel elevation threshold to apply temperature uniformity test	0	None	NA
FracWarmerPix	Float	Fraction (%) of warmer pixels to reject snow with a temperature uniformity test	0	Percent	0, 100
TempUnifOffset	Float	Temperature difference to identify warmer pixels to reject snow with a temperature uniformity test	0	Kelvin	NA
NumTiePoints	Long	Number of tie points in NDVI/NDSI threshold test	0	None	1, 10
NdviNdsiTiePoints	Byte	Tie-point values for NDVI/NDSI test	0	None	NA
NumPixFlags	Long	Number of pixel flags	0	None	NA
SnowFreeLandFlagVal	Byte	Snow-free land pixel flag value	0	None	NA
SnowFlagVal	Byte	Snow-covered land pixel flag value	0	None	NA
WaterFlagVal	Byte	Water pixel flag value	0	None	NA
CloudFlagVal	Byte	Cloudy pixel flag value	0	None	NA
UndetermFlagVal	Byte	Undetermined pixel flag value	0	None	NA
UnclassFlagVal	Byte	Unclassified pixel flag value	0	None	NA

DarkPixFlagVal	Byte	Dark (insufficient daylight) pixel flag value1	0	None	NA
BadDataFlagVal	Byte	VIIRS bad pixel data flag value	0	None	NA
FillValueFlag	Byte	No VIIRS coverage pixel flag value (fill value)	0	None	NA
RejSnowFlagVal1	Byte	Rejected snow pixel (snow climatology) flag value	0	None	NA
RejSnowFlagVal2	Byte	Rejected snow pixel (temperature climatology) flag value	0	None	NA
RejSnowFlagVal3	Byte	Rejected snow pixel (spatial consistency) flag value	0	None	NA
RejSnowFlagVal4	Byte	Rejected snow pixel (temperature uniformity) flag value	0	None	NA
RejSnowFlagVal5	Byte	Rejected snow pixel spare	0	None	NA
NumTotalPix	Long	Total number of pixels processed	0	None	NA
NumMissPix	Long	Number of data pixels with unavailable SDR	0	None	NA
NumBadPix	Long	Number of data pixels with corrupted/invalid SDR	0	None	NA
NumWaterPix	Long	Number of water pixels	0	None	NA
NumDarkPix	Long	Total number of dark pixels	0	None	NA
NumCloudPix	Long	Number of cloudy pixels	0	None	NA
NumClearPix	Long	Number of cloud-clear land pixels	0	None	NA
NumLandPix	Long	Number of land pixels	0	None	NA
NumUndetermPix	Long	Number of undetermined pixels	0	None	NA
NumUnclassPix	Long	Number of unclassified pixels	0	None	NA
NumSnowPix	Long	Number of snow-covered pixels	0	None	NA

NumNoSnowPix	Long	Number of snow-free land pixels	0	None	NA
NumGoodPix	Long	Number of good land pixels where snow cover identification was attempted	0	None	NA
NumConfSnowPix	Long	Total number of confirmed snow pixels	0	None	NA
NumRejSnowPix	Long	Total number of rejected snow pixels	0	None	NA
NumRejSnowClimPix	Long	Number of snow pixels rejected by the snow climatology test	0	None	NA
NumRejLstClimPix	Long	Number of snow pixels rejected by the lst climatology test	0	None	NA
NumRejSpatConsPix	Long	Number of snow pixels rejected by spatial consistency test	0	None	NA
NumRejTempUnifPix	Long	Number of snow pixels rejected by temperature uniformity test	0	None	NA
FractionLandPix	Float	Fraction of land pixels of all pixels in the granule	0	None	0, 1
FractionSnowPix	Float	Fraction of snow pixels of all pixels in the granule	0	None	0, 1
FractionValidPix	Float	Fraction of valid SDR pixels	0	None	0, 1
FractionCloudPix	Float	Fraction of cloud pixels of all pixels in the granule	0	None	0, 1
FractionNoDataPix	Float	Fraction of pixels with no valid SDR of all pixels in the granule	0	None	0, 1
FractionWaterPix	Float	Fraction of water pixels in the granule	0	None	0, 1
FractionDarkPix	Float	Fraction of pixels with solar zenith angle above the limit	0	None	0, 1

FracMax	Float	Max snow cover fraction	0	None	0, 1
FracMean	Float	Mean snow cover fraction	0	None	0, 1
FracMin	Float	Min snow cover fraction	0	None	0, 1
FracStdDev	Float	Standard deviation of snow cover fraction	0	None	0, 1
FracRtrvdPct	Float	Fraction of pixels for which show fraction was retrieved	0	Percent	0, 100
FracRtrvdTtl	Float	Total number of pixels for which snow fraction was retrieved	0	1	NA
NDSIFracMax	Float	NDSI max snow cover fraction	0	None	0, 1
NDSIFracMean	Float	NDSI mean snow cover fraction	0	None	0, 1
NDSIFracMin	Float	NDSI min snow cover fraction	0	None	0, 1
NDSIFracRtrvdPct	Float	NDSI fraction of pixels for which snow fraction was retrieved	0	None	0, 1
NDSIFracRtrvdTtl	Float	NDSI total number of pixels for which snow fraction was retrieved	0	1	NA
NDSIFracStdDev	Float	NDSI standard deviation of snow cover fractions	0	None	NA
NDSISnowFraction	Float	NDSI-based snow fraction	2	None	0, 1
NDSISnowFractionQuality	Byte	NDSI-based snow fraction quality	2	None	0, 1

Table 1-14: Cloud Base

Variable	Type	Description	Dim	Units	Range
CldBaseHght	Float	Cloud Base Height	2	Meter	-300.0, 20000.0

CdBasePres	Float	Cloud Base Pressure	2	HPa	0.0, 1100.0
CldBaseQF	Byte	Cloud Base Quality Flag	2	None	0, 6
CldTopHght	Float	Cloud Top Height	2	Meter	-300.0, 20000.0
CldTopPres	Float	Cloud Top Pressure	2	HPa	0.0, 1100.0
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90, 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180, 180.
StartColumn	Long	Starting Column	0	None	NA
StartRow	Long	Starting Row	0	None	NA

Table 1-15: Land Surface Temperature

Variable	Type	Description	Dim	Units	Range
DefaultValue	Float	Default value of LST	0	K	NA
Emis_Quality_Flag	Byte	Emissions quality flag	2	None	NA
EmissChnMap	Long	Emissions channel mapping	1	None	NA
EmissResKey	Long	Emissions Res Key	0	None	NA
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90, 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180, 180.
MaxLST*	Float	Maximum LST within valid LST range	0	K	213, 343
MeanLST*	Float	Mean LST within valid LST range	0	K	213, 343
MinLST*	Float	Minimum LST within valid LST range	0	K	213, 343
PercentOutRange*	Float	Percentage of out of range LST	0	Percent	[0,100]
PercentHighQuality*	Float	Percentage of high quality retrievals	0	Percent	[0,100]
PercentLandPixels*	Float	Percentage of land pixels among pixels	0	Percent	[0,100]

		retrieved			
PercentClearPixels*	Float	Percentage of clear pixels among pixels retrieved	0	Percent	[0,100]
PercentLargeAnglePixels*	Float	Percentage of large angle pixels among pixels retrieved	0	Percent	[0,100]
Pixels_Clear*	Long	Total pixels under confidently clear or probably clear	0	1	NA
Pixels_High_Quality*	Long	Number of high quality retrievals	0	1	NA
Pixels_Invalid*	Long	Number of invalid pixels	0	1	NA
Pixels_Land*	Long	Total land pixels	0	1	NA
Pixels_LargeAngle*	Long	Total pixels with large view angle	0	1	NA
Pixels_Low_Quality*	Long	Number of low quality retrievals	0	1	NA
Pixels_Medium_Quality*	Long	Number of medium quality retrievals	0	1	NA
Pixels_Retrieved*	Long	Total pixels with LST retrieval	0	1	NA
SatID	Long	Satellite ID	0	None	NA
SfcEmiss	Float	Surface Emissions	3	?	NA
StartColumn	Long	Starting Column	0	None	NA
StartRow	Long	Starting Row	0	None	NA
StdDev_LST*	Float	Standard deviation of LST within valid LST range	0	1	NA
TotalChns	Long	Total number of channels	0	None	NA
VLST	Float	VIIRS land surface temperature	2	K	213, 343
VLST_Quality_Flag	Short	VIIRS LST quality flag	2	None	0, 32767
emis_bbe	Float	Emissions	2	?	NA
emis_m15	Float	Ch15 emissions	2	?	NA
emis_m16	Float	Ch16 emissions	2	?	NA

* Product level monitoring metadata

Table 1-16: Land Surface Albedo

Variable	Type	Description	Dim	Units	Range
AlbOff	Float	VIIRS LSA Albedo offset	0	None	NA
AlbScl	Float	VIIRS LSA Albedo Scale Factor	0	None	NA
CldCnfCld	Long	VIIRS LSA Cloud Condition: Confidently Cloudy	0	None	NA
CldCndClr	Long	VIIRS LSA Cloud Condition: Confidently Clear	0	None	NA
CldProbCld	Long	VIIRS LSA Cloud Condition: Probably Cloudy	0	None	NA
CldProbClr	Long	VIIRS LSA Cloud Condition: Probably Clear	0	None	NA
DataQualityFlag	Byte	VIIRS LSA 2-bit High-Quality Flag	2	None	0, 2
Latitude	Float	Pixel latitude in field latitude	2	Degrees north	-90, 90.
Longitude	Float	Pixel longitude in field longitude	2	Degrees east	-180, 180.
OnFltFltd	Long	VIIRS LSA Online Filter: Online Filtered	0	None	NA
OnFltNoFlt	Long	VIIRS LSA Online Filter: No Online Filter	0	None	NA
OvQltyHghQltyRtr	Long	VIIRS LSA Overall Quality: High Quality Retrieval	0	None	NA
OvQltyNoRtr	Long	VIIRS LSA Overall Quality: No Retrieval	0	None	NA
OvQltyRtr	Long	VIIRS LSA Overall Quality: Retrieval	0	None	NA
ProductQualityInformation	Short	VIIRS LSA 2-byte Quality Flag	2	None	0, 32767
RtrPthDst	Long	VIIRS LSA Retrieval Path: Desert	0	None	NA
RtrPthGen	Long	VIIRS LSA Retrieval Path: Generic	0	None	NA
RtrPthNoRtr	Long	VIIRS LSA Retrieval Path: No Retrieval	0	None	NA
RtrPthSI	Long	VIIRS LSA Retrieval	0	None	NA

		Path: Sea Ice			
RtrPthSnw	Long	VIIRS LSA Retrieval Path: Snow	0	None	NA
SZAFav	Long	VIIRS LSA Solar Zenith Angle: Favorable SZA	0	None	NA
SZALge	Long	VIIRS LSA Solar Zenith Angle: Very Large SZA	0	None	NA
TFDegRtr	Long	VIIRS LSA Temporal Filter Flag: Degraded Retrieval	0	None	NA
TFHghRtr	Long	VIIRS LSA Temporal FilterFlag: High-Quality Retrieval	0	None	NA
TFNoRtr	Long	VIIRS LSA Temporal FilterFlag: No Retrieval	0	None	NA
VIIRS_Albedo_EDR	Short	Improved VIIRS Land Surface Albedo	2	None	0, 10000
VIIRS_Albedo_IP	Short	Primary VIIRS Land Surface Albedo Clear	2	None	0, 10000
VZAFav	Long	VIIRS LSA View Zenith Angle: Favorable VZA	0	None	NA
VZALge	Long	VIIRS LSA View Zenith Angle: Very Large LZA	0	None	NA
MaxLSA*	Float	Max LSA	0	None	NA
MinLSA*	Float	Min LSA	0	None	NA
MeanLSA*	Float	Mean LSA	0	None	NA
StdLSA*	Float	Std. deviation of LSA	0	None	NA
PercentHighQuality*	Float	Percentage of high quality retrievals over all valid retrievals	0	Percent	[0,100]
PercentFilteredPixel*	Float	Percentage of filtered pixels over all valid retrievals	0	Percent	[0,100]
PercentLandPixels*	Float	Percentage of land pixels	0	Percent	[0,100]
PercentSeaicePixels*	Float	Percentage of seaice pixels	0	Percent	[0,100]
PercentClearPixels*	Float	Percentage of clear	0	Percent	[0,100]

		pixels			
PercentLargeVZAPixels*	Float	Percentage of large view zenith angle pixels	0	Percent	[0,100]
PercentLargeSZAPixels*	Float	Percentage of large solar zenith angle pixels	0	Percent	[0,100]

* Product level monitoring metadata

Note that four additional nc files will be generated along with the Cloud Mask output files. These files, one navigation and three L1b channel band files, will be used as input for the VIIRS polar wind product suite.

Lastly, all JPRR RR product output files contain three types of NDE-required metadata. The first type is collection-level metadata, which is static with respect to each NUP NOAA Unique Product). The second type is granule-level metadata that is granule-dependent and thus is dynamic with respect to the observations. The third type is swath geographic metadata, which is the satellite's native geolocated observation. The NDE metadata can be found in the global-attributes section of the output files. A list of metadata variables is shown in Table 17.

Table 17 - NDE Level Metadata

Collection Level Metadata		
Attribute Name	**Data Type**	**Description / Value**
Conventions	string	"CF-1.5"
Metadata_Conventions	string	"CF-1.5, Unidata Dataset Discovery v1.0"
standard_name_vocabulary	string	"CF standard Name Table(version 17, 24 March 2011)
project	string	"S-NPP Data Exploitation"
institution	string	"DOC/NOAA/NESDIS/NDE -> S-NPP Data Exploitation, NESDIS, NOAA, U.S. Department of Commerce"
naming_authority	string	"gov.noaa.nesdis.nde"
satellite_name	string	"NPP"
instrument_name	string	"VIIRS"

title	string	Set to the NUP product short name (SURFRAD / LST)
summary	string	Brief description of the product
history	string	Provides the algorithm name and version used to produce the NUP (v1r0)
processing_level	string	“NOAA Level 2”
references	string	Published or web-based references describing the data or methods used to produce the product
Granule Level Metadata		
Attribute Name	**Data Type**	**Description**
id	string	Each product team can implement a unique identifier, approved by NESDIS data center representative
metadata_link	string	This attribute lists the unique NUP product file name
start_orbit_number	int	This attribute is a sequential whole number set by the S-NPP / JPSS Ground System in the xDR metadata. Orbits are incremented on the northward equatorial node.
end_orbit_number	int	This attribute is a sequential whole number set by the S-NPP / JPSS Ground System in the xDR metadata. Orbits are incremented on the northward equatorial node.
day_night_data_flag	string	This attribute should be set to “day”, “night”, or “both” depending on sunlight conditions for observation
ascend_descend_data_flag	int	This attribute indicates whether the sateelite is moving northward or southward. The center time of an observation is used. This attribute should be set to 0 (ascending or northward) or 1 (descending or southward)
time_coverage_start	string	This attribute is set to the UTC start time of an observation as “YYYY-MM-DDTh:mm:ssZ”, where YYYY is the four digit year, MM is the two digit month, DD is the two digit day, hh is the UTC hour, mm is the UTC minute, and ss is the UTC second
time_coverage_end	string	This attribute is set to the UTC end time of an observation as “YYYY-MM-DDTh:mm:ssZ”, where YYYY is the four digit year, MM is the two digit month, DD is the two digit day, hh is the UTC hour, mm is the UTC minute, and ss is the UTC second
date_created	string	This attribute is set to the UTC time the NUP file was created as “YYYY-MM-DDTh:mm:ssZ”, where YYYY is the four digit year, MM is the two digit month, DD is the two digit day, hh is the UTC hour, mm is the UTC minute, and ss is the UTC second
Swath Geographic Metadata		
Attribute Name	**Data Type**	**Description**
cdm_data_type	string	This attribute describes the geographic category the NUP data represents. This should be “swath” for native 2-D satellite swath data

geospatial_first_scanline_first_fov_lat	float	These attributes describes the four point geolocated latitude and longitude (polygon) that describes the geographic context for the NUP observation. Latitude values include -90 (south) to 90 (north) degrees and longitude values include -180 (west) to 180 (east).
geospatial_first_scanline_first_fov_lat	float	
geospatial_first_scanline_last_fov_lat	float	
geospatial_last_scanline_first_fov_lat	float	
geospatial_last_scanline_last_fov_lat	float	
geospatial_first_scanline_first_fov_lon	float	
geospatial_first_scanline_last_fov_lon	float	
geospatial_last_scanline_first_fov_lon	float	
geospatial_last_scanline_last_fov_lon	float	
geospatial_lat_units	string	This attribute should be "degrees_north"
geospatial_lon_units	string	This attribute should be "degrees_east"
geospatial_bounds	string	This attribute describes a closed polygon of N (N>3) latitude and longitude vertices. The last latitude/longitude pair must be identical to the first pair. Latitude values include -90 (south) to 90 (north) degrees and longitude values include -0 (west) to 180 (east). This should be "POLYGON((lon1 lat1, lon2 lat2, …, lonN latN, lon1 lat1))

2. ALGORITHM

2.1. Algorithm Overview

The JPSS RR products are generated from the Cloud, Aerosol, Cryosphere, and Land Surface algorithms located within the framework. The Cloud algorithms include Cloud Mask, Cloud Phase, Cloud Height, Daytime Cloud Optical and Microphysical Properties (DCOMP), and Nighttime Cloud Optical and Microphysical Properties (NCOMP). The Aerosol algorithms include Aerosol Detection, Aerosol Optical Depth, and Volcanic Ash. The Cryosphere algorithms include Snow Cover, Ice Concentration, and Ice Thickness and Age. The land surface products include the Land Surface Temperature and Albedo.

These algorithms run inside a system of supporting software. This is the AIT-Framework system or the GOES-R Algorithm Working Group (AWG) Product Processing System Framework. The Framework has been developed to be plug-and-play system for GOES-R and VIIRS scientific algorithms enabling the development and testing of the Level 2 GOES-R and VIIRS products within a single system. Many of the VIIRS products originated as GOES-R products but have been adapted for the VIIRS satellites. The system has been created to run products and store them in memory to be used as inputs for other products: i.e. product precedence. Common ancillary data has been used by the algorithms and the ancillary data is also stored in memory and treated as precedence for the products. Within the Framework system, the RR algorithms have flexible interface designs that allow the different types of instruments/satellite data sets. Therefore the RR algorithms are the same for GOES-R products and corresponding JPSS RR products.

2.1.1 Pre-Processing Steps

For JPSS RR, there are two steps in order to generate the VIIRS products: The pre-processing step and main-processing step. The main purposes of the preprocessing are to do the data gap filling and HDF5-to-NetCDF4 conversion.

During Preprocessing steps, JPSS RR software first reads in the system PCF file. Next JPSS software converts the HDF5 format VIIRS data to NetCDF4 format and performs data gap filling, then generates/writes out Framework output of SDR data and ancillary products by calling the Framework program. For detailed information about the preprocessing steps, please refer JPSS RR System Maintenance Manual.

2.2. Input Data Files

This section describes the input data files required by the JPSS RR system, including the satellite data, the ancillary data required by the AIT-framework to generate the products, as well as the algorithm specified coefficient files, etc. All of these files are defined in the system PCF files through the File-Handle-Name (the left side of the equal sign in the PCF file).

The JPSS RR system requires AIT-framework configuration files (CFG) and process control files (PCF) in text format.

An AIT-framework CFG file is required to run the AIT-framework program and in the CFG file, a number of AIT-framework PCF files are specified. The data is passed to the AIT-framework program through the Framework-CFG and Framework-PCF files by specifying the data files in these Framework-CFG and PCF.

2.2.1. Satellite Data Files

To generate JPSS RR products, VIIRS satellite pixel files in NetCDF4 format are required.

It only uses whichever I or M band data is required to run the JPSS RR system. They are VIIRS Science Data Records (SDR) Moderate Resolution Band 01 -16 SVM01-16, Terrain Corrected Geolocation data GMCTO, VIIRS SDR Imagery Bands 01-05 SVI01-05, and VIIRS Image Bands SDR Terrain Corrected Geolocation data GICTO. The Bayseian CloudMask algorithm uses I band 1/4/5 resolution to produce the dust mask. These data files are the VIIRS input to the JPSS RR system. All of these files are in HDF5 format and are generated by the IDPS system at NDE. The details of the File-Handle-Name in the system's PCF and the corresponding satellite data files are listed in JPSS RR System Maintenance Manual.

2.3. Ancillary Data Files Required by AIT-framework

The ancillary files are in NetCDF format, except for the CRTM coefficient files, which are in binary format. Each of the three product categories requires some ancillary files. The Cloud products require NWP GFS data, NWP Snow Mask, 1km NASA Land Mask, 1km NASA Coast Mask, Desert Mask, AVHRR Surface Type, 1km Surface Elevation, Seebor Surface Emissivity, Surface Albedo Composite, Pseudo Emissivity, OISST, and CRTM. The Aerosol products require 1km NASA Land Mask, Desert Mask, NWP GFS data, and NWP Snow Mask. The Cryosphere products require Land Mask, Surface Elevation, and Climatic LST. In addition, all of the products require ancillary data for the VIIRS SDR reader. These ancillary products are described below. The land surface products require the land surface emissivity, which is currently being calculated offline and treated as an ancillary product.

2.3.1. Land Mask

The land mask is derived from the NASA EOS project supplied static dataset as well as World Vector Shoreline data and DTED DEM data provided by NIMA (then DMA) and bathymetric data provided by the oceanographic community.
The original global binary file, version 3, produced in 2003 by Robert Wolfe, was converted to NetCDF and HDF for usage in the framework. Resolution: The land/ocean mask is stored in a 1 km geographic (geodetic) projection.
Filename: lw_geo_2001001_v03m.nc
Origin: Created by SSEC/CIMSS based on NASA MODIS collection 5
Size: 890 MB.
Static/Dynamic: Static
Values:

- 0 = Shallow ocean
- 1 = Land (Nothing else but land)
- 2 = Ocean coastlines and lake shorelines
- 3 = Shallow inland water
- 4 = Ephemeral water
- 5 = Deep inland water
- 6 = Moderate or continental ocean
- 7 = Deep ocean

2.3.2. Coast Mask

The coast mask is created from the land/water mask and differentiates coast at resolutions ranging from 1 – 10 km. It is produced by searching for heterogeneity in concentric boxes 3x3 (1 km) up to 21x21 (10 km) of pixels centered on any given pixel.
Resolution: The coast mask is stored in a 1 km geographic (geodetic) equal area projection.
Filename: coast_mask_1km.nc
Origin: Created by SSEC/CIMSS based upon NASA MODIS collection 5.
Size: 890 MB.
Static/Dynamic: Static
Values: A value of 1 means that the pixel 1km away is a water/land transition or is a water/land transition. 0 is considered the fill value of the coast mask.

2.3.3. NWP Snow Mask

The NWP Snow Mask ancillary algorithm generates the Snow Mask from the following ancillary products: GFS NWP Data (section 2.3.10), Land Mask (section 2.3.1), and OISST Daily Data (section 2.3.11).

Note that the LST algorithm will switch to a snow cover mask ancillary dataset in a future update.

2.3.4. Calculated Desert Mask

The Calculated Desert Mask uses two ancillary products to generate the desert mask: Land Mask (section 2.3.1), and Surface Type (section 2.3.7). A value of 0 means no desert, 1 is wooden grass, closed shrubs, open shrubs, grasses, or cropland, and 2 is bare surface.

2.3.5. Surface Elevation Mask

The digital surface elevation is Global Land One-km Base Elevation (GLOBE) Project 1km database global file converted into a file format readable by the framework.
Resolution**:** The surface elevation is stored as meters in a Plate Carrée projection at 30 arc-second (1km) resolution.
Filename: GLOBE_1km_digelev.nc
Origin: NGDC
Size: 1843.2 MB
Static/Dynamic: Static

2.3.6. Climatic LST

The Climatic Land Surface Temperature (LST) product is monthly-averaged mean surface temperatures over the globe at 2.5 degree resolution. The data is from the International Satellite Cloud Climatology Project (ISCCP). Data is interpolated between two consecutive months to arrive at an average of the date of the satellite data. The temperature is in degrees K, and the twelve input NetCDF datasets are in the following format: climatic_lst_month_XX.nc, where XX is the two digit number of the month (01 to 12). Each file is 47 K in size.

2.3.7. Surface Emissivity SEEBOR

The surface IR emissivity for ABI bands from UW-Madison baseline fit database. This is a global database of monthly (001-031, 032-059, etc.) IR land surface emissivity derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) operational land surface emissivity product (MOD11). Emissivity is available globally at ten wavelengths (3.6, 4.3, 5.0, 5.8, 7.6, 8.3, 9.3, 10.8, 12.1, and 14.3 μm). Monthly emissivities have been integrated into the ABI spectral response functions to match the ABI bands. The SEEBOR emissivity training set was interpolated over the spectral response function for a given channel at each data point. These are then output to a static file for usage in the framework. For the production of the test dataset, the ABI SRFs, provided by the Imagery AWG, were used to produce the static emissivity dataset.
Resolution: 0.05 degree (5km) spatial resolution
Filename: global_emiss_intABI_YYYYDDD.nc where**,** YYYYDDD = year plus Julian day
Origin: UW Baseline Fit, Seeman and Borbas (2006).
Size: 693 MB x 12
Static/Dynamic: Dynamic
Values: The emissivities are fractional values scaled with a scale factor of 0.001 and have fill value of -9999. Generally, the data points that are the fill value are ocean or water pixels.

Surface emissivity at 5km resolution (climatologically monthly), required by AIT Framework is listed in Table 2-1.

Table 2-1: Surface Emissivity Data

File Name	Description	Size (MB)
global_emiss_intABI_2005001.nc	SEEBOR data for January	693
global_emiss_intABI_2005032.nc	SEEBOR data for February	693
global_emiss_intABI_2005060.nc	SEEBOR data for March	693
global_emiss_intABI_2005091.nc	SEEBOR data for April	693
global_emiss_intABI_2005121.nc	SEEBOR data for May	693
global_emiss_intABI_2005152.nc	SEEBOR data for June	693
global_emiss_intABI_2005182.nc	SEEBOR data for July	693
global_emiss_intABI_2005213.nc	SEEBOR data for August	693
global_emiss_intABI_2005244.nc	SEEBOR data for September	693
global_emiss_intABI_2005274.nc	SEEBOR data for October	693

global_emiss_intABI_2005305.nc	SEEBOR data for November	693
global_emiss_intABI_2005335.nc	SEEBOR data for December	693

2.3.8. Surface Type Mask

A global land cover classification collection created by The University of Maryland Department of Geography. Imagery from the AVHRR satellites acquired between 1981 and 1994 was used to distinguish fourteen land cover classes and was updated in 2001. The original binary file is available at:

Resolution**:** This product is available at 1 km resolution in a 1 km geographic (geodetic) equal area projection.
The data are arranged with the upper left hand corner having a latitude/longitude of 90.0, -180.0 and lower right corner with a latitude/longitude of 90S, 180.0.

Filename: gl-latlong-1km-landcover.nc
Origin: University of Maryland
Size: 890 MB
Static/Dynamic: Static
Values:

0 = Water
1 = Evergreen Needleleaf Forest
2 = Evergreen Broadleaf Forest
3 = Deciduous Needleleaf Forest
4 = Deciduous Broadleaf Forest
5 = Mixed Forests
6 = Woodland
7 = Wooded Grassland
8 = Closed Shrubland
9 = Open Shrubland
10 = Grasslands
11 = Cropland
12 = Bare Ground
13 = Urban and Built-Up

2.3.9. CRTM Coefficients

CRTM coefficient files for VIIRS data, required by AIT Framework, are shown in Table 2-2. Note that the coefficient files are for CRTM v2.1.3, and not v2.0.2 which was previously used by the framework.

Table 2-2: CRTM Coefficient Data

File Name	Description	Size (MB)
AerosolCoeff.bin	Aerosol Coeff data for CRTM	5.5
CloudCoeff.bin	Cloud Coeff data for CRTM	1.6
EmisCoeff.bin	Emissivity Coeff data for CRTM	1.9
viirs-m_npp.SpcCoeff.bin	Space Coeff data for NPP VIIRS-M	472 Bytes
viirs-m_npp.TauCoeff.bin	Tau Coeff data for NPP VIIRS-M	104 KB

2.3.10. Ancillary Data for VIIRS SDR Reader

These two files contain NPP VIIRS 16 M-band and I-band channel information, Planck coefficients and spectral ranges. It is used by the framework SDR Data Readers.

File Name: npp_viirs_ancil.Ibands.nc
Size: 2240 KB

File Name: npp_viirs_ancil.Mbands.nc
Size: 2258 KB

Ancillary data contains information such as channel mapping.

File Name: npp_viirs_ancil.nc

Size: 2312 KB

2.3.11. NWP Data - GFS GRIB2 Forecast Files

These are GFS 6-hour global forecast data files at 0.5 degree resolution in GRIB2 format from NCEP.

File Name: *gfs.t${Hour}z.pgrbf${Forecast}.YYYYMMDD*
Size: 51~52 MB

2.3.12. Desert Mask

The desert mask uses the NASA 1km land mask and 1km surface type ancillary algorithms to calculate the desert mask. A value of ‘0’ denotes no desert, ‘1’ refers to wooden grass, closed shrubs, open shrubs, grasses, or croplands, and ‘2’ is desert. There are no external files associated specifically with this algorithm.

2.3.13. Surface Albedo Composite

The surface albedo (***not to be confused with the JPSS RR land surface albedo product***) provides a global estimate of the cloud-clear white sky reflectance from 2004 MODIS data. This product is used for the Clouds products. The albedo is an averaged value over a seventeen day period. There are three wavelengths, 0.659 um, 1.64 um, and 2.13 um.

Filenames:
AlbMap.WS.c004.v2.0.2004.DDD.0.659_x4.nc
AlbMap.WS.c004.v2.0.2004.DDD.1.64_x4.nc
AlbMap.WS.c004.v2.0.2004.DDD.2.13_x4.nc

Where DDD is the Julian day of the year, which ranges from 001 to 353 in increments of 17. There are a total of 66 files. Each file is 28 MB in size.

2.3.14. Pseudo Emissivity

The pseudo emissivity uses the Plank function to calculate the channel 7 emissivity. There are no external files associated with this algorithm.

2.3.15. OISST Daily Data

It is the Reynolds OISST daily analysis at 0.25 degree resolution from NCDC

File Name: avhrr-only-v2.YYYYMMDD_preliminary.nc
Size: 8.0 MB

2.3.16. Offline Land Surface Emissivity and Albedo

The offline land surface emissivity and albedo are not technically ancillary products, but are included here because they are used for the online LST and LSA products, respectively. More information for both offline products can be found in the JRR ARR (Algorithm Readiness Review) documentation (2018). Table 2-3 shows information about the output offline LSE and LSA products that are used by their online counterparts.

The LST EDR algorithm processing requires dynamic emissivity data. The daily offline LSE algorithm implementation produces high-resolution gridded global emissivity data using near real-time vegetation fraction and snow fraction data. The gridded LSE data is interpolated to VIIRS pixel level to be used in the retrieval of LST EDR processing. Offline LSE output is used as online LST EDR processing for the next day.

The VIIRS LSA EDR algorithm processing requires a dynamic global albedo map. This is achieved using the daily offline LSA algorithm implementation at NDE which produces the gridded temporal filtered global LSA tiles. The filtered LSA tiles are used in the retrieval of the improved LSA EDR product – VIIRS Albedo EDR. As the offline processing is very time consuming, filtered LSA tiles from 2 days ago are utilized in LSA EDR processing.

Table 2-3 - LSE and LSA Offline Output Products

Interface Item	Notes	Format	Source	Description
VIIRS gridded Land Surface Emissivity (LSE)	4 variables, each of grid (xsize=40000, ysize=20000)	NetCDF4	VLPS	VIIRS LSE offline product file containing (8 – 13.5 um) broadband emissivity, M15, M16 emissivities, and quality flag S-NPP.VIIRS.LSE.yyyymmdd.v2p1.nc

Filtered LSA Tiles	~2400 files per day	NetCDF4	NDE	Filtered LSA Tiles for (day+2) LSA processing H??v??_yyyyjjj_FLT.nc

where yyyy is the year and jjj is the Julian date.

3. PERFORMANCE

3.1. Product Testing

3.1.1. Test Data

Description of all JPSS RR test data (input, output, and intermediate) used in unit and system tests is provided in the JPSS RR Algorithm Readiness Review and Test Readiness Document (NESDIS/STAR, 2015). These are available by contacting the JPSS RR Product Area Lead (PAL) at OSPO.

3.1.2. Test Plans

Description of all JPSS RR test plans used in unit and system tests is provided in the JPSS RR Algorithm Readiness Review and Test Readiness Document (NESDIS/STAR, 2014). These are available by contacting the JPSS RR Product Area Lead (PAL) at OSPO.

3.2. Product Accuracy

3.2.1. Test Results

Description of all JPSS RR test results from the unit and system tests is provided in the JPSS RR Algorithm Readiness Review and Test Readiness Document (NESDIS/STAR 2014). These are available by contacting the JPSS RR Product Area Lead (PAL) at OSPO.

3.2.2. Product Accuracy

JPSS RR products have been validated against observations. The accuracy and precision of the JPSS RR products fall well within the accuracy and precision specifications. The detailed validations are available at Algorithm Readiness Review by contacting the JPSS RR Product Area Lead (PAL) at OSPO.

3.3. Product Quality

Quality flags are expected to be zero, which means no error.
Each failure is associated with a unique "flag" value that is saved in the JPSS RR output files. These values are shown in Table 3-1 to Table 3-15 for the algorithms.

Table 3-1: Cloud Mask Failure Codes.

Cloud Mask Quality Control Codes	
QC_Flag	**Definition**
0	Good
1	Invalid pixel due to space view
2	Invalid pixel due to being outside of sensor zenith range
3	Invalid earth pixel due to bad data (bad or missing 11mm BT or bad/missing clear sky 11 mm BT)
4	Reduced quality Cloud mask (bad 3.9mm pixel)
5	Reduced quality 0.64mm tests
6	Reduced quality due to other bad channels (excluding 0.64, 3.9, or 11 mm)

Table 3-2: Cloud Phase/Type Quality Flags

Cloud Phase/Type Quality Control Codes		
Bit	**Definition**	**Bit Interpretation**
1	**Overall cloud phase product quality flag** – the overall quality will be set to "low quality" if any of the more specific quality flags listed below are set to "low quality"	0 = high quality 1 = low quality
2	**L1b quality flag** – this will be set to "low quality" if any of the spectral data used in the algorithms is of low quality, based on L1b calibration flags	0 = high quality spectral data 1 = low quality spectral data
3	**Beta quality flag** – this will be set to "low quality" if $\beta_{stropo}(12/11\mu m)$, $\beta_{sopaque}(12/11\mu m)$, $\beta_{stropo}(8.5/11\mu m)$, **or** $\beta_{sopaque}(8.5/11\mu m)$ fall outside of the 0.1 – 10.0 range	0 = high quality beta calculation 1 = low quality beta calculation

4	**Ice cloud quality flag** – this will be set to “low quality” if the cloud phase was determined to be ice and the $\varepsilon_{stropo}(11\mu m) < 0.05$	0 = ice cloud determination based on strong radiative signal 1 = ice cloud determination based on weak radiative signal (low quality)
5	**Surface emissivity quality flag** – this will be set to “low quality” if the result of the Low Surface Emissivity (LSE) Test is TRUE and the result of the Overall Opaque Cloud (OOC) Test is FALSE	0 = surface emissivity does NOT significantly impact product quality 1 = surface emissivity significantly impacts product quality (low quality)
6	**Satellite zenith angle quality flag** – this will be set to “low quality” if the cosine of the satellite zenith angle is less than 0.15 (~82 degrees)	0 = satellite zenith angle does NOT significantly impact product quality 1 = satellite zenith angle significantly impacts product quality (low quality)

Table 3-3: Cloud Height Failure Codes

Cloud Height Quality Control Codes	
QC_Flag	**Definition**
0	Good
1	Invalid pixel due to space view
2	Invalid pixel due to being outside of sensor zenith range
3	Invalid earth pixel due to bad data (bad or missing 11mm BT or bad/missing clear sky 11 mm BT)
4	Invalid due to cloud mask being clear or probably clear
5	Invalid due to missing cloud type
6	Failed retrieval

Table 3-4: DCOMP Quality Flag Specification

Aerosol Quality Control Codes

Quality Flag Name	Bit	F_1	Description
DCOMP_PRCS_FLAG	0	1	0 - not processed; - processed
DCOMP_QF_COD_VALID	1	2	0 – valid retrieval; 1 – not valid
DCOMP_QF_REF_VALID	2	4	0 – valid retrieval; 1 – not valid
DCOMP_QF_COD_DEGRADED	3	8	0 – no; 1 - degraded
DCOMP_QF_REF_DEGRADED	4	16	0 – no; 1 - degraded
DCOMP_QF_CONVERGENCY	5	32	0 – convergent; 1 - not
DCOMP_QF_GLINT	6	64	0 – no glint; 1 - glint

Table 3-5: DCOMP Failure Codes

DCOMP Quality Control Codes	
QC_Flag	**Definition**
0	Valid, Quality may be degraded due to snow or sea-ice
1	Valid, Quality may be degraded due to twilight conditions
2	Valid, but degraded quality due to twilight conditions (solar zenith between 65 and 82 degree)
3	Invalid due to cloud-free condition
4	Invalid pixel due to being outside of observation range
5	Invalid pixel due to missing input data
6	Invalid pixel, DCOMP attempted but failed retrieval

Table 3-6: Cloud Phase/Type Quality Flags

NCOMP Control Codes		
Bit	**Quality Flag Name**	**Cause and effect**
Angle restriction flags		
1	QC_CYCLE_VZA	Viewing Zenith Angle >= 72.0
2	QC_CYCLE	Solar Zenith Angle < 82.0
Ancillary Data Flags		
3	QC_CYCLE_NOCLOUD	Cloud Type indicates it is not a cloud

4	QC_CYCLE_CLOUDTYPE	Cloud Type has an unknown value
5	QC_CYCLE_TCLOUD	Cloud Temperature is < 0.0
No Retrieval Flags		
6	QC_MINERR_WATER_0	No retrieval: Minimum error model for water = 0
7	QC_MINERR_ICE_0	No retrieval: Minimum error model for ice = 0
Valid Retrieval Flags		
8	QC__TWILIGHT_	82.0 <= Solar Zenith Angle < 90.0
9	QC_CTWATER_NCOMPICE	Cloud Type = water, NCOMP preferred phase = ice
10	QC_CTICE_NCOMPWATER	Cloud Type = ice, NCOMP preferred phase = water
11	QC_CTMIX_NCOMPWATER	Cloud Type = mixed, NCOMP preferred phase = water
12	QC_CTMIX_NCOMPICE	Cloud Type = mixed, NCOMP preferred phase = ice
13	QC__NCOMPWATER	Cloud Type = supercooled, NCOMP preferred phase = water
14	QC__NCOMPICE	Cloud Type = supercooled, NCOMP preferred phase = ice

Table 3-7: Cloud Base Quality Flag

Cloud Base Quality Control Codes	
QC_Flag	**Definition**
0	Valid retrieval
1	Invalid due to the upstream input being invalid or clear
2	Out of range due to CBH lower than terrain (set to TBH = terrain)
3	Out of range due to CBH < minCBH (0 km) or CBH > maxCBH (20 km)
4	Invalid due to CBH >= CTH

Table 3-8: Aerosol Detection Failure Codes

Aerosol Detection Quality Control Codes				
Byte/Bit	**Quality flag name**	**Meaning**		
		1bit: 0 (default)	**1**	
		2bit: 00 (default)	**01**	**11**
0	QC_SMOKE_DETECTION	Determined (good)	not Determined(bad)	
1	QC_DUST_DETECTION	Determined(good)	not Determined(bad)	
2-3	QC_SMOKE_CONFIDENCE	Low	Medium	High
4-5	QC_DUST_CONFIDENCE	Low	Medium	High
6	SPARE			
7	SPARE			

Table 3-9: Aerosol Quality Flags

Aerosol Quality Control Codes			
Quality Flag Name	**Variable Type**	**Value**	**Definition**
QC_EXT_SNOW	LONG	2	External input mask for snow
QC_EXT_SHADOW	LONG	3	External input mask for cloud shadow
QC_EXT_FIRE	LONG	4	External input mask for fire
QC_EXT_GLINT	LONG	5	External input mask for the glint angle
QC_EXT_HVYAER	LONG	6	External input mask for heavy aerosols
QC_INPUT_LOC	LONG	0	Input mask for loc
QC_INPUT_GEO	LONG	1	Input mask for geo
QC_INPUT_ANC	LONG	2	Input mask for ancillary
QC_INPUT_REF	LONG	3	Input mask for reference
QC_CLOUDY	LONG	0	Cloud – fail reflectance test
QC_CIRRUS	LONG	1	Cirrus test
QC_THIN_CIRRUS	LONG	2	Thin cirrus test
QC_INHOMO	LONG	3	Spatially inhomogeneous test
QC_SNOWICE	LONG	4	Snow/ice test

QC_EPHEMERAL_WATER	LONG	5	Over land only test
QC_SHALLOW_WATER	LONG	6	Over water only test
QC_HVYEAR	LONG	7	Heavy aerosols test
QC_RET_WATER	LONG	0	Retrieval water path
QC_OVER_BRIGHT_LAND	LONG	1	Retrieval path over bright land
QC_OVER_GLINT_WATER	LONG	2	Retrieval path over glint water
QC_LAND_SW	LONG	3	Retrieval path over short-wave land
QC_LAND_SWIR	LONG	4	Retrieval path over land short-wave IR
QC_LAND_BRT	LONG	5	Retrieval path over land brightness temp
QC_FAILED	LONG	0	Failed retrieval
QC_LOWSUN	LONG	1	Low sun angle retrieval
QC_DARK_BARREN	LONG	2	Dark barren land retrieval
QC_EXTRP	LONG	3	Extrapolation retrieval
QC_RESIDUAL	LONG	4	Residual retrieval
QC_NDVI	LONG	5	NDVI retrieval
QC_REDR	LONG	6	REDR retrieval
QC_ADJ	LONG	7	ADJ retrieval
QC_HIGH	LONG	0	Overall quality high
QC_MEDIUM	LONG	1	Overall quality medium
QC_LOW	LONG	2	Overall quality low
QC_NORET	LONG	3	Overall quality no return

Table 3-10: Aerosol Optical Depth Failure Codes

Aerosol Optical Depth Quality Control Codes			
Byte	**Bits**	**Quality Flag Name**	**Meaning**
1: Input Geometry Quality Flag	0	QC_INPUT_LON	0: valid longitude (-180 - 180°) 1: out-of-range longitude
	1	QC_INPUT_LAT	0: valid latitude (-90 - 90°) 1: out-of-range latitude
	2	QC_INPUT_ELEV	0: valid elevation (-2 – 10 km) 1: out-of-range elevation

	3	QC_INPUT_SOLZEN	0: valid solar zenith (0 - 90°) 1: out-of-range solar zenith
	4	QC_INPUT_SATZEN	0: valid satellite zenith (0 - 90°) 1: out-of-range satellite zenith
	5	QC_INPUT_SOLAZI	0: valid solar azimuth (0 - 180°) 1: out-of-range solar azimuth
	6	QC_INPUT_SATAZI	0: valid satellite azimuth (0 - 180°) 1: out-of-range satellite azimuth
2: Input Ancillary Data Flag	0 1	QC_INPUT_TPW	00: constant TPW data (2.0 cm) 01: valid TPW data from ABI retrieval (0-20 cm) 10: valid TPW data from model (0-20 cm)
	2 3	QC_INPUT_OZONE	00: constant ozone data (0.35 atm-cm) 01: valid ozone data from ABI retrieval (0.0 – 0.7 atm-cm) 10: valid ozone data from model (0.0 – 0.7 atm-cm)
	4	QC_INPUT__PRES	0: valid model surface pressure (500 – 1500 mb) 1: constant surface pressure (1013 mb)
	5	QC_INPUT_HGT	0: valid model surface height (-2 – 10 km) 1: constant surface height (0 km)
	6	QC_INPUT_WSP	0: valid model surface wind speed (0 – 100 m/s) 1: constant surface wind speed (6 m/s)
	7	QC_INPUT_WDR	0: model surface wind direction (0° - 360°) 1: fixed surface wind direction (90°)
3: Input Reflectance Data Flag	0	QC_INPUT_REFL_CH1	0: valid ABI reflectance in band 1 (0 – 1) 1: out-of-range ABI reflectance in band 1
	1	QC_INPUT_REFL_CH2	0: valid ABI reflectance in band 2 (0 – 1) 1: out-of-range ABI reflectance in band 2
	2	QC_INPUT_REFL_CH3	0: valid ABI reflectance in band 3 (0 – 1) 1: out-of-range ABI reflectance in band 3
	3	QC_INPUT_REFL_CH5	0: valid ABI reflectance in band 5 (0 – 1) 1: out-of-range ABI reflectance in band 5
	4	QC_INPUT_REFL_CH6	0: valid ABI reflectance in band 6 (0 – 1) 1: out-of-range ABI reflectance in band 6
4: Critical Path Flag	0	QC_CLOUD_MASK	0: clear sky 1: cloudy sky
	1	QC_RET_SCENE	0: over-land algorithm is used 1: over-water algorithm is used
	2	QC_LAND_TYPE	0: vegetation 1: soil
	3	QC_LAND_BRISFC	0: dark surface 1: bright surface
	4	QC_LAND_SNOW	0: no snow contamination 1: with snow contamination
	5	QC__WATER_GLINT	0: no sunglint contamination 1: with sunglint contamination
5: AOD Product	0	QC_RET	0: AOD is retrieved 1: AOD is not retrieved
	1	QC_RET_EXTRP	0: interpolation within LUT AOD range

Quality Flag			1: extrapolation of AOD used
	2	QC_OUT_SPEC	0: within F&PS specification range 1: out of F&PS specification range
	3	QC_LOWSUN	0: solar zenith angle not larger than 80° 1: solar zenith angle larger than 80°
	4	QC_LOWSAT	0: local zenith angle not larger than 60º 1: local zenith angle larger than 60º

Table 3-11: Volcanic Ash Detection Quality Flags

Volcanic Ash Detection Quality Control Codes			
Byte	**Bit**	**Name**	**Values**
1	**1**	Overall QF	0 – High Quality **1 – Low Quality**
1	**2**	Invalid Data QF	0 – High Quality **1 – Low Quality**
1	**3**	Local Zenith Angle QF	**0 – High Quality** 1 – Low Quality
1	**4-6**	Ash Single Layer Confidence QF	0 – High 1 – Moderate 2 – Low 3 – Very Low **4 – Not-Ash**
1	**7-8**	Spare	n/a
2	**1-3**	Ash Multi Layer Confidence QF	0 – High 1 – Moderate 2 – Low 3 – Very Low **4 – Not-Ash**

Table 3-12: Volcanic Ash Retrieval Quality Flags

Volcanic Ash Retrieval Quality Control Codes			
Byte	**Bit**	**Name**	**Values**
1	**1-2**	Retrieval Status	0 - Successful 1 - Failed 2 - Not Attempted
1	**3-4**	T_{cld} QF	0 – High Quality 1 – Medium Quality 2 – Low Quality
1	**5-6**	ε_{cld} QF	0 – High Quality 1 – Medium Quality

			2 – Low Quality
1	**7-8**	β(12/11μm) QF	0 – High Quality 1 – Medium Quality 2 – Low Quality
2	**1-4**	Ash Particle Size	0 – < 2 μm 1 – ≥2 – < 3 μm 2 – ≥3 – < 4 μm 3 – ≥4 – < 5 μm 4 – ≥5 – < 6 μm 5 – ≥6 – < 7 μm 6 – ≥7 – < 8 μm 7 – ≥8 – < 9 μm 8 – ≥9 – < 10 μm 9 – ≥ 10 μm 10 - invalid

Table 3-13: Snow Cover Retrieval Quality Flags

Snow Cover Retrieval Quality Control Codes	
Bit	**Name** **Values**
0	no-data value in band data
1	missing data in band data
2	modeled cloudy
3	water
4	solar zenith angle less than 0 or greater than MAX_SOLAR_ZENITH_ANGLE
5	sensor zenith angle less than 0.0 or greater than MAX_SENSOR_ZENITH_ANGLE
6	bad metadata or ancillary data
7	N/A

Table 3-14: Ice Concentration Retrieval Quality Flags

Ice Concentration Retrieval Quality Control Codes		
Quality Flag Name	**Variable Type**	**Definition**
QC_Flags	LONG	Quality Control Flags
Tot_QACat01	LONG	Total number of pixels with QA category 1

		(Normal or optimal)
Tot_QACat02	LONG	Total number of pixels with QA category 2 (Uncertain or suboptimal)
Tot_QACat03	LONG	Total number of pixels with QA category 3 (Non-retrievable)
Tot_QACat04	LONG	Total number of pixels with QA category 4 (Bad data)

Table 3-15: Ice Thickness And Age Retrieval Quality Flags

Ice Thickness And Age Retrieval Quality Control Codes		
Quality Flag Name	**Variable Type**	**Definition**
QC_Flags	LONG	Quality Control Flags
Tot_QACat01	LONG	Total number of pixels with QA category 1 (Normal or optimal)
Tot_QACat02	LONG	Total number of pixels with QA category 2 (Uncertain or suboptimal)
Tot_QACat03	LONG	Total number of pixels with QA category 3 (bad or missing)
Tot_QACat04	LONG	Total number of pixels with QA category 4 (Non-retrievable)

Table 3-16 - VIIRS LST Quality Flags

LST Algorithm Quality Flags (2 bytes)			
bit	**Flag**	**Source**	**Description**
0-1	LST quality	LST	00=high, 01=medium, 10=low, 11=no retrieval
2-3	Cloud condition	Cloud mask	00=confidently clear, 01=probably clear, 10=probably cloudy, 11=confidently cloudy
4	SDR quality	SDR	0=normal, 1=bad data (bad quality or missing or out of space)
5	Aerosol optical thickness at 550nm (slant path)	AOD	0=within range (AOD<=1.0), 1=outside range (AOD>1.0)

6-7	Land surface cover	Land/sea mask snow/ice mask	00=land, 1=snow/ice, 10=inland water, 11=coastal
8-9	Water vapor condition	TPW input	00=very dry atmosphere (wv<1.5g/cm^2), 01=dry (1.5,3), 10=moist atmosphere (3,4.5), 1=very moist (4.5+)
10	Emissivity quality	Emissivity	0=within LSE uncertainty, 1=beyond LSE uncertainty requirement (0.015)
11	Degradation by large viewing angle	SDR	0=no degradation, 1=large view degradation (VIIRS <= 40 deg, ABI <= 55 deg)
12	Day/night flag	SDR	0=night (solar zenith angle > 85 deg), 1=day
13	Thin cirrus	Cloud mask	0=no thin cirrus, 1=thin cirrus (only available for daytime)
14	Fire contamination flag	Cloud mask	0=no, 1=yes
15	Reserved for future use		

Table 3-17 - VIIRS LSA Quality Flags (2 bytes)

byte	bit	Flag description	Meaning
0	0-1	Overall quality of product	00=high quality retrieval, 01=retrieval, 10=no retrieval
	2-3	Cloud condition	00=confidently clear, 01=probably clear, 10=probably cloudy, 11=confidently cloudy
	4	SDR quality	0=normal, 1=bad data (VIIRS bad, missing, or not calibrated) (GOES bad, missing, or out of space)
	5	Solar zenith angle flag	0=favorable SZA, 1=SZA larger than 60 deg
	6	View zenith angle flag	0=favorable VZA, 1=VZA larger than 60 deg
	7	Spare	
1	0-2	Retrieval path	000=generic, 001=desert, 010=snow, 011=sea ice, 100=no retrieval

	3-4	Temporal filter quality flag	00=high-quality retrieval, 01=degraded retrieval, 10=no retrieval
	5	Online filter flag	0=non filtered, 1=filtered
	6-7	Spare	

No external product tools are supplied. External users can choose their own tools to display and analyze these output files.

4. PRODUCT STATUS

4.1. Operations Documentation

NESDIS/STAR (2018), Enterprise Land Surface Emissivity Algorithm Theoretical Basis Document (ATBD)

NESDIS/STAR (2018), VIIRS NDE Surface Albedo Algorithm Theoretical Basis Document (ATBD)

NESDIS/STAR (2016), JPSS Risk Reduction: Uniform Multi-Sensor Land Surface Temperatur and Suface Albedo for Consistent Products Critical Design Review (CDR)

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NPOESS(2009), NPOESS Common Data Format Control Book, Version D.

NESDIS/STAR (2015), JPPS RR System Maintenance Manual, Version 1.0.

4.2. Maintenance History

5. APPENDIX A: Algorithm Status

Table 5-1 – JPSS RR Algorithm Status

NOTE: the following chart is out-of-date.

JPSS RR Algorithm Status

last update: 03/17/2015

JPSS RR Algorithms	Algorithm Code is integrated in Framework?	Algorithm is hooked up w. Bayesian CM and bit flags?	NDE Metadata is added?	Ready to run in NRT?	Integrator		Has been set up in NR run*? (by Hua)
Cloud Mask	Yes	N/A	Yes	Yes	*Roy*		Yes
Cloud Phase	Yes	Yes	No	Yes	*Roy*		Yes
Cloud Height	Yes	Yes	Yes	Yes	*Roy*		Yes
NCOMP	Yes	Yes	No	Yes	*Roy*		Yes
DCOMP	Yes	N/A	Yes	Yes	*Mike*		Yes
AOD	Yes	No	No	No	*Roy*		Yes
ADP	Yes	Yes	Yes	No	*Tianxu*		No
VolAsh	Yes	N/A	Yes	Yes	*Mike*		No
Ice Concentration	Yes	Yes	Yes	Yes	*Alex/Aiwu*		Yes
IceAge	Yes	Yes	Yes	Yes	*Alex/Aiwu*		Yes
SnowCover /Fraction	Yes	Yes	Yes	Yes	*Alex*		No
SnowFraction (Refl)	Yes	Yes	Yes	Yes	*Alex*		No

END OF DOCUMENT