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**Joint Polar Satellite System (JPSS)  
Operational Algorithm Description  
(OAD)  
Document for VIIRS Sea Surface  
Temperature (SST) Environmental  
Data Record (EDR) Software**

**For Public Release**

The information provided herein does not contain technical data as defined in the International Traffic in Arms Regulations (ITAR) 22 CFC 120.10. This document has been approved For Public Release to the NOAA Comprehensive Large Array-data Stewardship System (CLASS).



National Aeronautics and  
Space Administration

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**Goddard Space Flight Center  
Greenbelt, Maryland**

**Joint Polar Satellite System (JPSS)  
Operational Algorithm Description (OAD) Document for  
VIIRS Sea Surface Temperature (SST) Environmental Data  
Record (EDR) Software  
JPSS Electronic Signature Page**

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## Preface

This document is under JPSS Ground Algorithm ERB configuration control. Once this document is approved, JPSS approved changes are handled in accordance with Class I and Class II change control requirements as described in the JPSS Configuration Management Procedures, and changes to this document shall be made by complete revision.

Any questions should be addressed to:

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## Change History Log

| Revision   | Effective Date | Description of Changes<br>(Reference the CCR & CCB/ERB Approve Date)  |
|------------|----------------|---|
| Original   | 05/20/2011     | <b>474-CCR-11-0077:</b> This version baselines D36815, Operational Algorithm Description Document for VIIRS Sea Surface Temperature (SST) EDR, Rev B, dated 05/19/2010, as a JPSS document version Rev -. This is the version that was approved for NPP launch. Per NPOESS CDFCB - External, Volume V – Metadata, doc number D34862-05, this has been approved for Public Release into CLASS. This CCR was approved by the JPSS Algorithm ERB on May 20, 2011.  |
| Revision A | 01/18/2012     | <b>474-CCR-11-0255:</b> This version baselines 474-00061, Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for VIIRS Sea Surface Temperature (SST) Environmental Data Record (EDR) Software, for the Mx 6 IDPS release. This CCR was approved by the JPSS Algorithm ERB on January 18, 2012.  |
| Revision B | 05/14/2013     | <b>474-CCR-13-0948:</b> This version authorizes 474-00061, JPSS OAD Document for VIIRS SST EDR Software, for the Mx 7.0 IDPS release. Includes <b>ECR-ALG-0037</b> , which contains Raytheon PCR031522; OAD: Update to SST algorithm to clarify conditions for degraded quality flags (DR4845) in Section 2.1.2.5. Includes Raytheon PCR032720; 474-CCR-13-0916/ECR-ALG-0037: Update applicable OAD filenames/template/Rev/etc. for Mx7 Release.  |
| Revision C | 01/29/2014     | <b>474-CCR-14-1517:</b> This version authorizes 474-00061, JPSS OAD Document for VIIRS SST EDR Software, for the Mx 8.1 IDPS release. Includes Raytheon PCR035709; OAD: PRO: 474-CCR-13-1077: Change Forms of SST Equations - DR 4807 - Code Change, in Sections 2.0 & 2.1.2.4, Tables 5 & 7, and Figure 4. Also includes Raytheon PCR035716; OAD: PRO: 474-CCR-13-1137: Remove Bulk and Add First Guess Skin Temp in SST Product - DR7098, DR496, in Tables 1, 3, 7-11 & 13, Sections 2.0, 2.1.1.2, 2.1.2 & 2.1.2.4, 2.1.2.5, 2.1.4, 2.1.7 & 2.1.8.2, and Figures 1 & 2. Also includes Raytheon PCR036418; CHILD: PRO: OAD: 474-CCR-13-1298: Update SST OAD & CDFCB As a Result of 474-CCR-13-1077/1137 (DR 7385), in Table 9. |
| Revision D | 06/25/2014     | <b>474-CCR-14-1856:</b> This version authorizes 474-00061, JPSS OAD Document for VIIRS SST EDR Software, for the Mx 8.5 IDPS release. Includes Raytheon PCR038790; Child: OAD: Implement 474-CCR-14-1691 (Issue With the  |

|  |  |  |
|--|--|--|
|  |  | New Product Definition of SST Changed in CCR 1137) (ADR 7593), in Table 7. |
|  |  |  |



**NATIONAL POLAR-ORBITING  
OPERATIONAL ENVIRONMENTAL  
SATELLITE SYSTEM (NPOESS)  
OPERATIONAL ALGORITHM DESCRIPTION  
DOCUMENT FOR SEA SURFACE  
TEMPERATURE (SST)**

**SDRL No. S141  
SYSTEM SPECIFICATION SS22-0096**

**RAYTHEON COMPANY  
INTELLIGENCE AND INFORMATION SYSTEMS (IIS)  
NPOESS PROGRAM  
OMAHA, NEBRASKA**

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**Engineering & Manufacturing Development (EMD) Phase  
 Acquisitions & Operations Contract**

**CAGE NO. 11982**

**Operational Algorithm Description Document  
 VIIRS Sea Surface Temperature (SST) EDR**

**Document Date: Sep 27, 2011**

**Document Number: D36815  
 Revision: C6**

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**Contract No. F04701-02-C-0502**

This document has been identified per the NPOESS Common Data Format Control Book – External Volume 5 Metadata, D34862-05, Appendix B as a document to be provided to the NOAA Comprehensive Large Array-data Stewardship System (CLASS) via the delivery of NPOESS Document Release Packages to CLASS.

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| ---  | 3-31-03            | Initial Release.   | All                  |
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| A2   | 9-24-03            | Added cover sheet; Added ITAR Markings.  | All                  |
| A3   | 10-13-03           | Finalized for ACCB review.   | All                  |
| A4   | 1-5-04             | Updated to list units in input and output tables.  | 4,5                  |
| A5   | 1-30-04            | ERB updates.   | All                  |
| A6   | 5-5-04             | Replaced most of PDL, updated inputs, small misc. corrections.   | 3-14                 |
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| A12  | 9-12-08            | New cover sheet, update references, acronym list, prepare for peer review. Delivered to NGST. Accepted all changes after delivery.   | All                  |
| A13  | 01-18-09           | Prepared for TIM.  | All                  |
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| B1   | 09-28-09           | Updated Table 7 for PCR 21384  | 7                    |
| B2   | 12-01-09           | Updated for RFA Nos. 235 and 631, updated Subcontract number.  | Title pg. & 5-7      |

|  |          |   |               |
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| C2   | 8-27-10  | ECR1061/PCR024068 update output product ranges  | Table 7       |
| C3   | 10-20-10 | Implemented Tech Memo 2010.510.0074 as a part of the document convergence (RFA007)  | All           |
| C4   | 06-29-11 | Updated due to ECR-ALG-0007 VIIRS SST_Drop 4.6.1  | All           |
| C5   | 09-21-11 | Updated for PCR027399   | 14-15         |
| C6   | 09-27-11 | Updated OAD for PCR026625.  | All           |

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**1.0 INTRODUCTION**

**1.1 Objective**

The purpose of the Operational Algorithm Description (OAD) document is to express, in computer-science terms, the remote sensing algorithms that produce the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) end-user data products. These products are individually known as Raw Data Records (RDRs), Temperature Data Records (TDRs), Sensor Data Records (SDRs) and Environmental Data Records (EDRs). In addition, any Intermediate Products (IPs) produced in the process are also described in the OAD.

The science basis of an algorithm is described in a corresponding Algorithm Theoretical Basis Document (ATBD). The OAD provides a software description of that science as implemented in the operational ground system -- the Data Processing Element (DPE).

The purpose of an OAD is two-fold:

1. Provide initial implementation design guidance to the operational software developer.
2. Capture the “as-built” operational implementation of the algorithm reflecting any changes needed to meet operational performance/design requirements.

An individual OAD document describes one or more algorithms used in the production of one or more data products. There is a general, but not strict, one-to-one correspondence between OAD and ATBD documents.

This particular document describes operational software implementation for the Visible/Infrared Imager/Radiometer Suite (VIIRS) Sea Surface Temperature (SST) Environmental Data Record (EDR).

**1.2 Scope**

The scope of this document is limited to the description of the core operational algorithm(s) required to create the VIIRS Sea Surface Temperature (SST) EDR. The theoretical basis for this algorithm is described in Section 3.3 of the VIIRS Sea Surface Temperature Algorithm Theoretical Basis Document (ATBD), 474-00048.

**1.2.1 Document References**

The science and system engineering documents relevant to the algorithms described in this OAD are listed in Table 1.

**Table 1. Reference Documents**

| Document Title  | Document Number/Revision | Revision Date |
|---|--------------------------|---------------|
| VIIRS Sea Surface Temperature Algorithm Theoretical Basis Document (ATBD) | 474-00048                | Latest        |
| JPSS Environmental Data Record (EDR) Production Report (PR) for NPP       | 474-00012                | Latest        |
| NPOESS System Specification   | SY15-0007 Rev L          | 10 Sep 07     |
| JPSS Environmental Data Record (EDR) Interdependency Report (IR) for NPP  | 474-00007                | Latest        |

| Document Title   | Document Number/Revision  | Revision Date |
|--|---|---------------|
| NPP Mission Data Format Control Book and App A (MDFCB)                                   | 429-05-02-42_MDFCB  | Latest        |
| JPSS Common Data Format Control Book - External - --Block 1.2.2 (All Volumes)            | 474-00001-01-B0122<br>CDFCB-X Vol I<br>474-00001-02-B0122<br>CDFCB-X Vol II<br>474-00001-03-B0122<br>CDFCB-X Vol III<br>474-00001-04-01-B0122<br>CDFCB-X Vol IV Part 1<br>474-00001-04-02-B0122<br>CDFCB-X Vol IV Part 2<br>474-00001-04-03-B0122<br>CDFCB-X Vol IV Part 3<br>474-00001-04-04-B0122<br>CDFCB-X Vol IV Part 4<br>474-00001-05-B0122<br>CDFCB-X Vol V<br>474-00001-06-B0122<br>CDFCB-X Vol VI<br>474-00001-08-B0122<br>CDFCB-X Vol VIII | Latest        |
| JPSS Common Data Format Control Book - External - Block 1.2.3 (All Volumes)              | 474-00001-01-B0123<br>CDFCB-X Vol I<br>474-00001-02-B0123<br>CDFCB-X Vol II<br>474-00001-03-B0123<br>CDFCB-X Vol III<br>474-00001-04-01-B0123<br>CDFCB-X Vol IV Part 1<br>474-00001-04-02-B0123<br>CDFCB-X Vol IV Part 2<br>474-00001-04-03-B0123<br>CDFCB-X Vol IV Part 3<br>474-00001-04-04-B0123<br>CDFCB-X Vol IV Part 4<br>474-00001-05-B0123<br>CDFCB-X Vol V<br>474-00001-06-B0123<br>CDFCB-X Vol VI<br>474-00001-08-B0123<br>CDFCB-X Vol VIII | Latest        |
| NPP Command and Telemetry (C&T) Handbook   | D568423 Rev. C  | 30 Sep 2008   |
| JPSS CGS Data Processor Inter-subsystem Interface Control Document (DPIS ICD) Vol I - IV | IC60917-IDP-002   | Latest        |
| Joint Polar Satellite System (JPSS) Program Lexicon                                      | 470-00041   | Latest        |
| NGST/SE technical memo – VIIRS SST QF Memo   | NP-EMD.2005.510.0023  | 21 Feb 2005   |
| NGST/SE technical memo – MS Engineering Memo_SST OAD Update.doc                          | NP-EMD.2005.510.0073  | Jun 2005      |
| NGST/SE technical memo – NPP_VIIRS_SST_OAD_Update_Drop46.doc                             | NP.EMD.2007.610.0002  | 09 Aug 2007   |
| NGST/SE technical memo – Granule-Level Summary Exclusion Flag Definition Rev. C.doc      | NP.EMD.2010.510.0005.Rev-C  | 02 Mar 2010   |
| NGST/SE technical memo – Instructions to Update the OAD for the VIIRS Sea Surface        | NP.EMD.2010.510.0074  | 16 Sep 2010   |

| Document Title  | Document Number/Revision | Revision Date |
|---|--------------------------|---------------|
| Temperature   |                          |               |
| Joint Polar Satellite System (JPSS) Common Ground System (CGS) IDPS PRO Software User's Manual Part 2 | UG60917-IDP-026          | Latest        |

**1.2.2 Source Code References**

The science and operational code and associated documentation relevant to the algorithms described in this OAD are listed in Table 2.

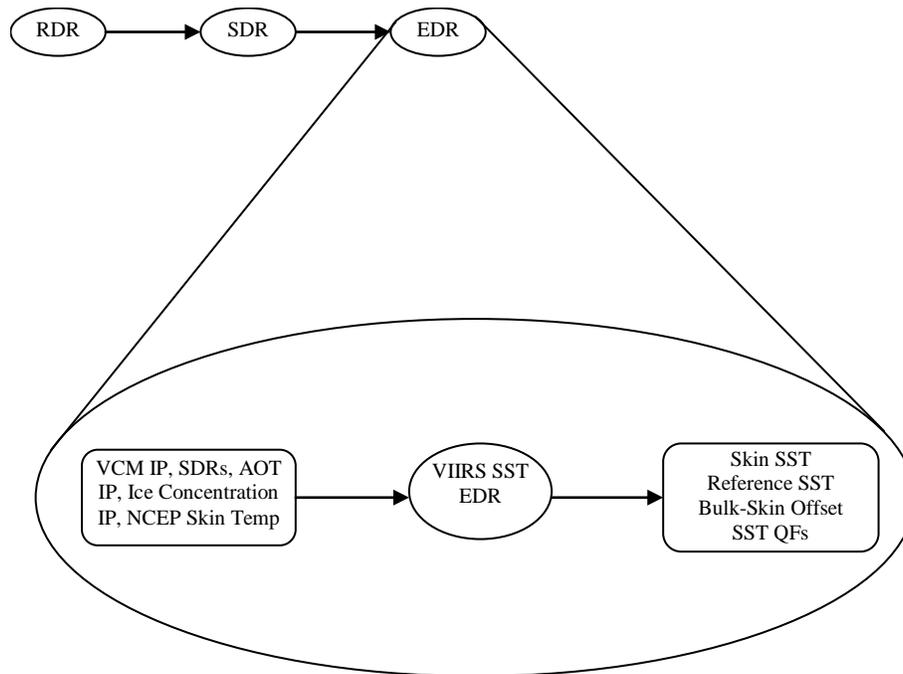
**Table 2. Source Code References**

| Reference Title   | Reference Tag/Revision                               | Revision Date                   |
|---|--|---------------------------------|
| VIIRS SST science-grade software                                    | ISTN_VIIRS_NGST_4.6                                  | 19 Nov 2007                     |
| VIIRS SST operational software                                      | 11.3.0.14  | 28 Jun 2005                     |
| NGST/SE technical memo – VIIRS SST QF Memo                          | NP-EMD.2005.510.0023                                 | 21 Feb 2005                     |
| OAD – VIIRS SST Rev A   | Build 1.5.x.1-B<br>(PCRs 15068 & 16178)              | 16 Apr 08 & 24 Mar 08           |
| PCR 21384 (no code changes)   | (OAD Rev B1)   | 28 Sep 2009                     |
| PCR 22882 [TM 2010.510.0005.Rev-C ] (No OAD update required)        | Build Sensor<br>Characterization SC-09               | 14 Apr 2010                     |
| ACCB  | OAD Rev B  | 19 May 2010                     |
| ECR1061/PCR024068 update output product ranges                      | (OAD Rev C2)   | 27 Aug 2010                     |
| Implemented TM 2010.510.0074 (No code update)(PCR024726)            | (OAD Rev C3)   | 20 Oct 2010                     |
| VIIRS SST science-grade software                                    | ISTN_VIIRS_NGST_4.6.1                                | 13 Jan 2011                     |
| VIIRS SST operational software (PCRs 025921 & 026165)               | ECR-A0007 Maintenance<br>Build 1.5.05.E (OAD Rev-C4) | 09 Mar 2011 & 29 Jun 2011 (OAD) |
| PCR027399 (OAD-no code updates)                                     | (OAD Rev-C5)   | 21 Sep 2011                     |
| PCR0226625 (OAD update for ADL)                                     | (OAD Rev-C6)   | 27 Sep 2011                     |
| OAD transitioned to JPSS Program – this table is no longer updated. |  |                                 |

## 2.0 ALGORITHM OVERVIEW

This algorithm is a statistical retrieval that employs linear regression techniques to derive skin SST from VIIRS infrared bands. Separate regression algorithms are used for day and night.

Figure 1 depicts the basic processing flow of the SST algorithm. Inputs are the aforementioned VIIRS Sensor Data Records (SDR) for 3.7, 10.8, and 12.0  $\mu\text{m}$  channels; VIIRS Cloud Mask (VCM); Aerosol Optical Thickness (AOT); Ice Concentration; and National Centers for Environmental Prediction (NCEP) Skin Temperature. Outputs are the skin SST, first guess, or reference, SST, bulk-skin offset, plus some Quality Flags (QF)s.



**Figure 1. Basic Processing Flow for the VIIRS SST EDR**

### 2.1 Sea Surface Temperature Description

#### 2.1.1 Interfaces

To begin data processing, the Infrastructure (INF) Subsystem Software Item (SI) initiates the SST algorithm. The INF SI provides tasking information to the algorithm indicating which granule to process. The Data Management System (DMS) SI provides data storage and retrieval capability. A library of C++ classes is used to implement the SI interfaces. More information regarding these topics is found in document UG60917-IDP-026 with reference in particular to sections regarding PRO Common (CMN) processing and the IPO Model.

##### 2.1.1.1 Inputs

Table 3 describes the VIIRS SST inputs for the SDR products, Table 4 describes the VIIRS SST inputs for the IPs, Table 5 describes the VIIRS SST inputs for the LUTs, and Table 6 details the VCM Bits descriptions. Refer to the CDFCB-X, 474-00001, for a detailed description of the inputs.

**Table 3. VIIRS SST Inputs – SDR Products**

| Input  | Type  | Description/Source   | Units/Valid Range  |
|--------|---|--|--|
| Btemp  | Real * 32 x<br>M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS   | Brightness Temperature of Band<br>M12/<br>VIIRS 750 m resolution SDR | Kelvin /<br>203 K < BT <sub>M12</sub> < 368 K<br>NA_FLOAT32_FILL = -999.9<br>MISS_FLOAT32_FILL = -999.8<br>ERR_FLOAT32_FILL = -999.5 |
| Btemp  | Real * 32 x<br>M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS   | Brightness Temperature of Band<br>M15/<br>VIIRS 750 m resolution SDR | Kelvin /<br>190 K < BT <sub>M15</sub> < 343 K<br>NA_FLOAT32_FILL = -999.9<br>MISS_FLOAT32_FILL = -999.8<br>ERR_FLOAT32_FILL = -999.5 |
| Btemp  | Real * 32 x<br>[M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS] | Brightness Temperature of Band<br>M16/<br>VIIRS 750 m resolution SDR | Kelvin /<br>190 K < BT <sub>M16</sub> < 340 K<br>NA_FLOAT32_FILL = -999.9<br>MISS_FLOAT32_FILL = -999.8<br>ERR_FLOAT32_FILL = -999.5 |
| satzen | Real * 32 x<br>M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS   | Sensor Zenith Angle/<br>VIIRS 750 m resolution SDR                   | Radians/<br>0 to 1.25  |
| lat    | Real * 32 x<br>M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS   | Latitude/<br>VIIRS 750 m resolution geo-<br>location                 | Degrees/<br>-90 to 90  |

**Table 4. SST Inputs - IPs and Ancillary Data**

| Input              | Type  | Description/Source                           | Units/Valid Range   |
|--------------------|---|--|---|
| AOT                | Real * 32 x<br>[M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS] | Slant path AOT at 550 nm                     | Unitless / 0 ≤ 2<br>NA_FLOAT32_FILL = -999.9<br>MISS_FLOAT32_FILL = -999.8<br>ERR_FLOAT32_FILL = -999.5 |
| Ice Fraction       | Real * 32 x<br>I_VIIRS_SDR_ROWS x<br>I_VIIRS_SDR_COLS   | Ice Fraction /<br>VIIRS Ice Concentration IP | Unitless / 0.0 to 1.0   |
| Ice Conc<br>Weight | Real * 32 x<br>I_VIIRS_SDR_ROWS x<br>I_VIIRS_SDR_COLS   | Ice Fraction/<br>VIIRS Ice Concentration IP  | Unitless / 0.0 to 1.0   |
| VCM                | Char * 8 x<br>M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS    | See<br>Table 6                               | See Table 6   |
| Skin Temp          | Real * 32 x<br>M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS   | NCEP Skin Temperature                        | Kelvin  |

**Table 5. SST Inputs - LUTs**

| Input                      | Type   | Description/Source  | Units/Valid Range   |
|----------------------------|--|---|---|
| SST Coeffs LUT             | Real * 32 x<br>[MAXCOEFFS][DYNGT][ALG]                   | LUT of regression coefficients for<br>calculation of skin SST | Unitless  |
| Configurable<br>Parameters | See Table 11 for List of<br>Tunable Algorithm Parameters | Ingest (ING)  | See Table 11 for List of<br>Tunable Algorithm<br>Parameters |
| SST EDR DQTT               | IngMsdThresholds_DQTT                                    | Data quality threshold table<br>provided by the ING subsystem | Defined in CDFCB-X, 474-<br>00001                           |

**Table 6. VCM Bits Description (Relevant bits [passed into SST QF bytes] are shaded yellow)**

| BYTE | Bit | Flag Description Key | Result |
|------|-----|----------------------|--------|
|------|-----|----------------------|--------|

| BYTE | Bit | Flag Description Key  | Result  |
|------|-----|---|---|
| 0    | 0-1 | Cloud Mask Quality  | 00=Poor, 01=Low, 10=Medium, 11=High   |
|      | 2-3 | Cloud Detection Result & Confidence Indicator                       | 11=Confident Cloudy<br>10=Probably Cloudy<br>00=Confident Clear<br>01=Probably Clear  |
|      | 4   | Day / Night   | 0 = Night 1 = Day   |
|      | 5   | Snow / Ice Surface  | 1 = Snow/Ice<br>0 = No Snow/Ice   |
|      | 6-7 | Sun Glint   | 00 = None<br>01 = Geometry Based<br>10 = Wind Speed Based<br>11 = Geometry & Wind   |
|      | 1   | 0-2   | Land / Water Background   |
| 3    |     | Shadow Detected   | 1 = Yes 0 = No  |
| 4    |     | Non Cloud Obstruction (Heavy Aerosol)                               | 1 = Yes 0 = No  |
| 5    |     | Fire Detected   | 1 = Yes 0 = No  |
| 6    |     | Cirrus Detection (Solar) (RM9)                                      | 1 = Cloud<br>0 = No Cloud   |
| 7    |     | Cirrus Detection (IR) (BTM15-BTM16)                                 | 1 = Cloud<br>0 = No Cloud   |
| 2    |     | 0   | IR Threshold Cloud Test (BTM15)   |
|      | 1   | High Cloud (BTM12 - BTM16) Test                                     | 1 = Cloud<br>0 = No Cloud   |
|      | 2   | IR Temperature Difference Test (BTM14 - BTM15 & BTM15 - BTM16)      | 1 = Cloud<br>0 = No Cloud   |
|      | 3   | Temperature Difference Test (BTM15 - BTM12)                         | 1 = Cloud<br>0 = No Cloud   |
|      | 4   | Temperature Difference Test (BTM12 - BTM13)                         | 1 = Cloud<br>0 = No Cloud   |
|      | 5   | Visible Reflectance Test (RM5)                                      | 1 = Cloud<br>0 = No Cloud   |
|      | 6   | Visible Reflectance Test (RM7), also Visible Reflectance Test (RM1) | 1 = Cloud<br>0 = No Cloud   |
|      | 7   | Visible Ratio Test (RM7/RM5)  | 1 = Cloud<br>0 = No Cloud   |
| 3    | 0-1 | Adjacent Pixel Cloud Confident Value                                | 11 = Confident Cloudy<br>10 = Probably Cloudy<br>00 = Confident Clear<br>01 = Probably Clear  |
|      | 2   | Conifer Boreal Forest   | 1 = Yes 0 = No  |
|      | 3   | Spatial Uniformity  | 1 = Yes 0 = No  |
|      | 4   | Dust candidate  | 1 = Yes 0 = No  |
|      | 5   | Smoke candidate   | 1 = Yes 0 = No  |
|      | 6   | Dust/Volcanic Ash   | 1 = Yes 0 = No  |
|      | 7   | SPARE   |   |
| 4    | 0-7 | SPARE   |   |
| 5    | 0-2 | Cloud Phase   | 000 = Not Executed<br>001 = Clear<br>010 = Partly Cloudy<br>011 = Water Cloud<br>100 = Supercooled Water/Mixed<br>101 = Opaque Ice Cloud<br>110 = Cirrus Cloud<br>111 = Cloud Overlap |
|      | 3   | Thin Cirrus Flag  | 1 = Yes 0 = No  |
|      | 4   | Ephemeral Water Flag  | 1 = Yes 0 = No  |
|      | 5-7 | SPARE   |   |

**2.1.1.2 Outputs**

Refer to the CDFCB-X, 474-00001, for a detailed description of the outputs.

The SST EDR produces seven data fields (skin SST, reference SST, bulk-skin offset, and four quality flag fields) summarized in Table 7 for the scaled EDR product and Table 8 for the unscaled EDR product. Table 9 describes the quality flags.

**Table 7. Contents of the SST Scaled Output (EDR)**

| Output                | Data Type/size  | Description   | Units  |
|-----------------------|---|---|--|
| Skin SST              | UInt16 *<br>[M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS]    | Skin Sea Surface Temperature  | Kelvin / 265 to 320<br>NA_UINT16_FILL = 65535<br>MISS_UINT16_FILL = 65534<br>ERR_UINT16_FILL = 65531 |
| Reference SST         | UInt16 *<br>[M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS]    | Reference Sea Surface Temperature. This comes directly from the input NCEP Skin Temperature.  | Kelvin   |
| Bulk-Skin Offset      | Float32   | Offset for computing bulk SST (i.e., skin SST + this offset = bulk SST)   | Kelvin   |
| SST EDR Quality Flags | UInt8 * 4 *<br>[M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS] | Sea Surface Temperature Quality Flags. See Table 9 for detailed description.  | Unitless   |
| Skin Scale            | Float32   | The scale value for the Sea Surface Temperature. This can be found by subtracting the min acceptable skin SST temperature from the max and dividing this result by 65527. | Unitless   |
| Skin Offset           | Float32   | The offset value is the minimum acceptable temperature of the skin SST.   | Kelvin   |
| Reference Scale       | Float32   | The scale value for the reference SST. This is the same as Skin Scale, above..  | Unitless   |
| Reference Offset      | Float32   | The offset value of the reference SST. This is the same as Skin Offset, above..   | Kelvin   |

**Table 8. Contents of the SST Unscaled Output (EDR)**

| Output                | Data Type/size  | Description   | Units  |
|-----------------------|---|---|--|
| Skin SST              | Real * 32*<br>[M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS]  | Skin Sea Surface Temperature  | Kelvin / 271.0 to 313.0<br>NA_FLOAT32_FILL = -999.9<br>MISS_FLOAT32_FILL = -999.8<br>ERR_FLOAT32_FILL = -999.5 |
| Reference SST         | Real * 32*<br>[M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS]  | Reference Sea Surface Temperature   | Kelvin   |
| Bulk-Skin Offset      | Float32   | Offset for computing bulk SST (i.e., skin SST + this offset = bulk SST)     | Kelvin   |
| SST EDR Quality Flags | UInt8 * 4 *<br>[M_VIIRS_SDR_ROWS x<br>M_VIIRS_SDR_COLS] | Sea Surface Temperature Quality Flags; see Table 9 for detailed description | Unitless   |

**Table 9. VIIRS SST EDR/FEDR Quality Flags**

| Byte | VIIRS SST Flag   | Result  | Bits |
|------|------------------|---|------|
| 0    | Skin SST Quality | 11 = High Quality<br>10 = Degraded<br>01 = Excluded<br>00 = Not retrieved | 2    |

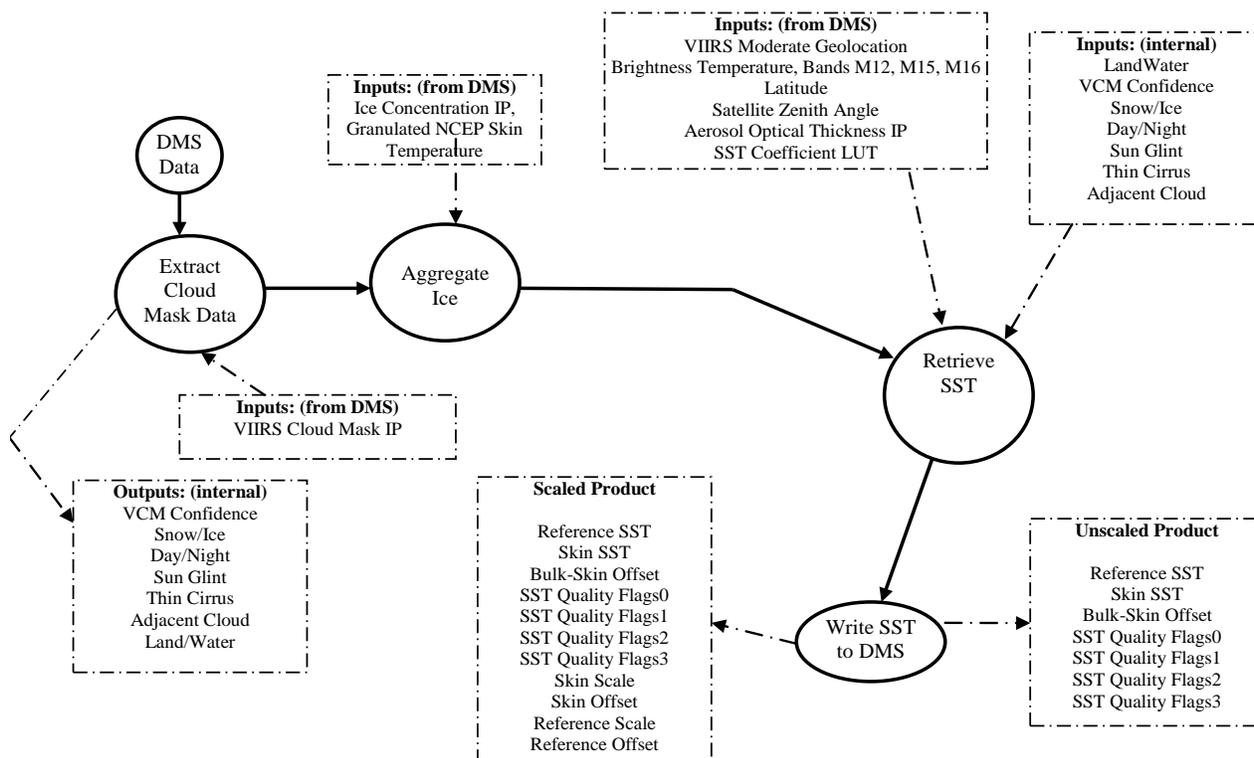
| Byte | VIIRS SST Flag                       | Result   | Bits |
|------|--------------------------------------|--|------|
|      | Spare Bit                            |  | 1    |
|      | Spare Bit                            |  | 1    |
|      | Spare Bit                            |  | 1    |
|      | Spare Bits                           |  | 1    |
|      | Algorithm                            | 1 = Triple Window<br>0 = Non-linear Split Window   | 1    |
|      | Day / Night                          | 1 = Day<br>0 = Night   | 1    |
| 1    | Bad LWIR Pixel                       | 1 = Bad SDR<br>0 = Good SDR  | 1    |
|      | Bad SWIR Pixel                       | 1 = Bad SDR<br>0 = Good SDR  | 1    |
|      | Cloud Confidence                     | 11 = Confident Cloudy<br>10 = Probably Cloudy<br>01 = Probably Clear<br>00 = Confident Clear | 2    |
|      | Adjacent Pixel Cloud Confident Value | 11 = Confident Cloudy<br>10 = Probably Cloudy<br>01 = Probably Clear<br>00 = Confident Clear | 2    |
|      | Thin Cirrus                          | 1 = Thin Cirrus<br>0 = No Thin Cirrus  | 1    |
|      | Sea Ice                              | 1 = Sea Ice<br>0 = No Sea Ice  | 1    |
| 2    | Sun Glint                            | 1 = Sun glint<br>0 = No sun glint  | 1    |
|      | Exclusion, AOT >= 1                  | 1 = Yes<br>0 = No  | 1    |
|      | Degraded, AOT >= 0.6                 | 1 = Yes<br>0 = No  | 1    |
|      | Exclusion, Not Ocean                 | 1 = Not ocean<br>0 = Ocean   | 1    |
|      | Degraded, HCS limit                  | 1 = Past HCS limit<br>0 = Within HCS limit   | 1    |
|      | Degraded, Sensor Zenith Angle > 40   | 1 = Yes<br>0 = No  | 1    |
|      | Skin SST Outside Range               | 1 = Out of range<br>0 = In range   | 1    |
|      | Spare Bit                            |  | 1    |
| 3    | Skin SST Degraded, T > 305 K         | 1 = Degraded<br>0 = Not degraded   | 1    |
|      | Spare Bit                            |  | 1    |

### 2.1.2 Algorithm Processing

This is the derived algorithm for the VIIRS SST algorithm and is a subclass of the ProCmnAlgorithm class. The class creates a list of input data items that are read from DMS and passes all of the required data into the SST algorithm itself. When the SST algorithm has finished processing that data, the output items are written to DMS. The SST algorithm produces

both a scaled (VIIRS-SST-EDR) and unscaled (VIIRS-SST-FEDR) product. Figure 2 depicts overall data flow of this operational code. The code determines a skin SST for each pixel flagged as clear, probably clear, or probably cloudy by the VCM Intermediate Product (IP) that is non-ice ocean. If the pixel is flagged as probably clear or probably cloudy, the quality is flagged as excluded.

The baseline daytime retrieval algorithm used is the 2-band (M15, M16) non-linear split window algorithm. The baseline nighttime retrieval algorithm used is the 3-band (M12, M15, M16) triple window algorithm. If band M12 is not functioning at night, the non-linear split window algorithm is used.



**Figure 2. Level 1 Data Flow Diagram of Overall SST Methodology**

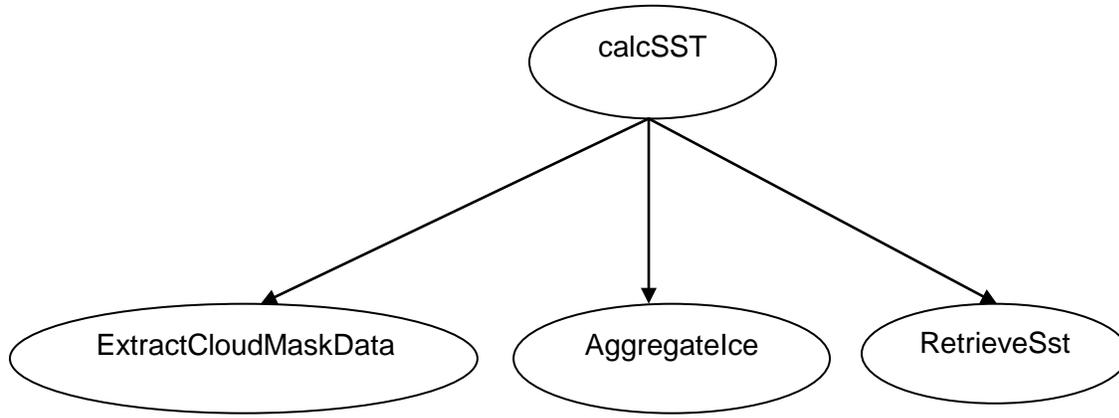
The VIIRS SST algorithm can run without the following inputs:

- VIIRS-M12-FSDR
- VIIRS-I-Conc-IP

The VIIRS SST algorithm has the capability to set the triple-window regression form if sensor data for VIIRS M12 channel is bad. If channels M15 or M16 are missing, the algorithm fills that pixel with a `FLOAT32_FILL_VALUE`. Snow/ice cover can be determined from the VCM snow/ice surface flag. Additionally at high latitudes, the Ice Concentration IP can be used to identify the presence of ice.

**2.1.2.1 Main Module - calcSST**

All subroutines are called from this procedure—i.e., it controls the flow of the algorithm. The following diagram, Figure 3, shows the calling sequence.



**Figure 3. calcSST Calling Sequence Diagram**

#### **2.1.2.2 Submodule - ExtractCloudMaskData**

This module is used to extract information (quality flags) from the VIIRS Cloud Mask. In addition to cloud cover assessment, the VCM IP provides information on surface type, day/night, and sun glint. The following Cloud Mask flags are extracted from VIIRS Cloud Mask IP:

- LandWater Flag
- Confidence Flag
- Snow/Ice Flag
- Day/Night Flag
- ThinCirrus Flag
- Glint Flag
- Adjacent Cloud Flag

#### **2.1.2.3 Submodule - AggregateIce**

This subroutine aggregates imagery resolution ice concentration data to moderate resolution and determines if ice is present based on a configurable threshold.

#### **2.1.2.4 Submodule - RetrieveSST**

This process loops through the pixels, performs a series of quality and processing logic tests and computes SST using either the non-linear split window (day) or triple window regression formulas (night). Figure 4 below outlines the processing logic.

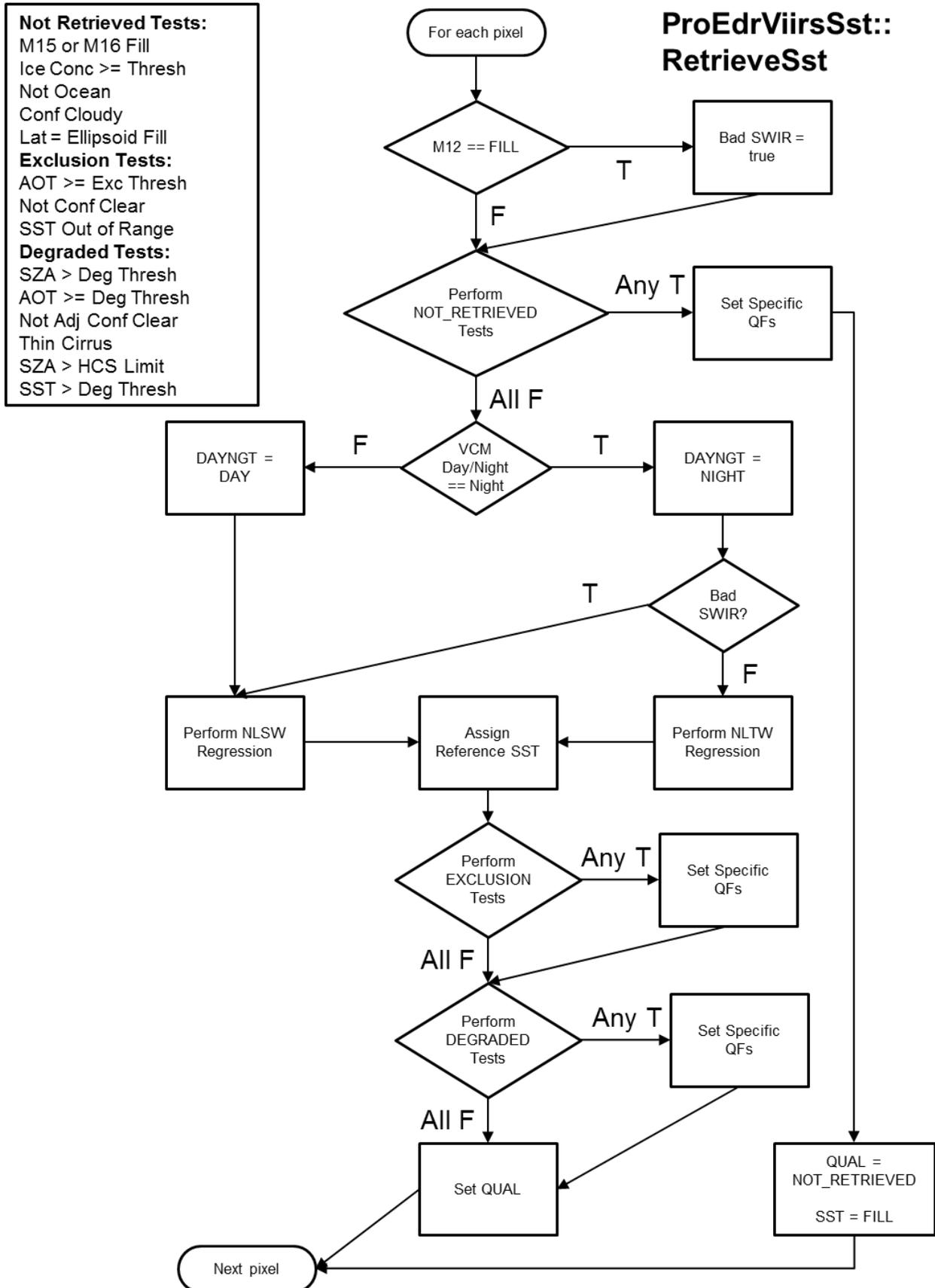


Figure 4. Data Flow Diagram for Retrieve SST

The non-linear split window algorithm is as follows:

$$SST = a_0 + (a_1 + a_2(\sec(z) - 1))T_{11} + (a_3 + a_4(RSST - 273.15) + a_5(\sec(z) - 1))(T_{11} - T_{12}) + a_6(\sec(z) - 1)$$

Where: SST is sea surface temperature in Kelvin

$a_0$ ,  $a_1$ ,  $a_2$ ,  $a_3$ ,  $a_4$ ,  $a_5$ , and  $a_6$  are regression coefficients  
 $T_{11}$  is the M15 brightness temperature in Kelvin  
 $T_{12}$  is the M16 brightness temperature in Kelvin  
 RSST is the NCEP skin temperature in Kelvin (spatially and temporally interpolated)  
 z is the satellite zenith angle in radians

The triple window algorithm equation is as follows:

$$SST = a_0 + (a_1 + a_2(\sec(z) - 1))T_{3.7} + (a_3 + a_4(\sec(z) - 1))(T_{11} - T_{12}) + a_5(\sec(z) - 1)$$

Where: SST is sea surface temperature in Kelvin

$a_0$ ,  $a_1$ ,  $a_2$ ,  $a_3$ ,  $a_4$ , and  $a_5$  are regression coefficients  
 $T_{3.7}$  is the M12 brightness temperature in Kelvin  
 $T_{11}$  is the M15 brightness temperature in Kelvin  
 $T_{12}$  is the M16 brightness temperature in Kelvin  
 z is the satellite zenith angle in radians

If band M12 is not available, the non-linear split window algorithm is used as a fallback for nighttime processing. Coefficients are retrieved from VIIRS SST Regression Coefficients LUT based on the processing logic stratification. Separate processing coefficients exist for each algorithm and night and day stratifications (NLSW only).

The reference SST is simply a copy of the input NCEP skin temperature.

#### 2.1.2.5 SST QF Logic

SST Flags consist of four 8-bit words as shown in Table 9.

The overall quality of the SST pixel is represented by the Skin quality bit field.

The setting of pixel-level Skin SST Quality (QF1 offset 0) is determined by:

The quality flag setting of Not Retrieved is triggered by any of the following:

- Cloud confidence = confidently cloudy
- Not ocean
- SDR M15 or M16 missing
- Ice

The quality flag setting of Excluded is triggered by any of the following:

- Cloud confidence = probably cloudy
- Cloud confidence = probably clear

- AOT >= 1.0
- 271 degrees K > Skin SST > 313 degrees K

The quality flag setting of Degraded is triggered by any of the following:

- Skin SST > 305 degrees K
- AOT >= 0.6
- Satellite Zenith Angle > 40
- HCS flag
- Thin Cirrus present
- Adjacent Cloud present

The quality flag setting of High Quality occurs when all of the above criteria are not triggered:

Confidently Clear, and none of the other degradation, exclusion, or not-retrieved conditions.

### 2.1.3 Graceful Degradation

#### 2.1.3.1 Graceful Degradation Inputs

There are two cases where input graceful degradation is indicated in the SST:

1. A primary input denoted in the algorithm configuration guide cannot be successfully retrieved but an alternate input can be retrieved.
2. An input that is retrieved for an algorithm has the N\_Graceful\_Degradation metadata field set (propagation).

Table 10 details the instances of these cases. Note that the shaded cells indicate that the graceful degradation was done upstream at product production.

**Table 10. Graceful Degradation**

| Input Data Description    | Satellite   | Baseline Data Source            | Primary Backup Data Source | Secondary Backup Data Source   | Tertiary Backup Data Source | Graceful Degradation Done Upstream |
|---------------------------|-------------|---------------------------------|----------------------------|--------------------------------|-----------------------------|------------------------------------|
| Aerosol Optical Thickness | NPP, J1, J2 | VIIRS_GD_15.4.1<br>VIIRS AOT IP | VIIRS_GD_25.4.1<br>NAAPS   | VIIRS_GD_15.4.1<br>Climatology | N/A                         | Yes, backup only.                  |
| Skin Temperature          | NPP, J1, J2 | NCEP Skin Temperature           | NAVGEM                     | VIIRS<br>Climatology           | N/A                         | Yes, backup only.                  |

#### 2.1.3.2 Graceful Degradation Processing

None.

#### 2.1.3.3 Graceful Degradation Outputs

None.

### 2.1.4 Exception Handling

To prevent unneeded calculations from occurring, a check was added to verify that the granule contains ocean pixels. In the event that the entire granule is made up of land pixels, the algorithm fills the output buffer with a fill value and returns PRO\_SUCCESS. For granules that contain ocean pixels, pixels identified by VCM as confident cloudy are not processed and are also filled with a fill value. Sea ice pixels are also identified and not processed if present.

Each brightness temperature band, specifically bands M15 and M16, is checked for a fill value. If a fill value is present, this value is copied into the same pixel location in the output product. Also, each pixel’s latitude is checked for the specific fill value that indicates the pixel does not intersect the earth’s surface (e.g., due to a calibration maneuver). If such a fill value is present, it is copied into the same pixel location in the output product.

**2.1.5 Data Quality Monitoring**

Each algorithm uses specific criteria contained in a Data Quality Threshold Table (DQTT) to determine when a Data Quality Notification (DQN) is produced. The DQTT contains the threshold used to trigger the DQN as well as the text contained in the DQN. If a threshold is met, the algorithm stores a DQN in DMS indicating the test(s) that failed and the value of the DQN attribute. For more algorithm specific detail refer to the CDFCB-X, 474-00001, Volume VI, Appendix C.

**2.1.6 Computational Precision Requirements**

The NPP VIIRS SST EDR requires accuracy and precision on the order of tenths of Kelvins. Input data used meets this degree of precision requirement. Regression equations are executed using a combination of 32-bit floating-point precision values.

**2.1.6.1 Numerical Computation Considerations**

In order to retrieve SST within an operational timeframe, statistical algorithms meeting quality requirements have been developed that are much quicker than physical modeling methods. Pre-generated LUTs are used to speed processing yet retain flexibility. Therefore, SST runtime considerations should not pose any serious problems meeting timeliness requirements.

**2.1.7 Algorithm Support Considerations**

Flexibility built into the architecture allows easy implementation of future P<sup>3</sup>I developments.

Any thresholds, also referred to as “settable parameters” used in the SST algorithm that can be changed on a frequent basis, are contained within an algorithm specific configuration file.

INF and DMS must be running before the SST algorithm is executed.

**2.1.7.1 Program Parameters for Continuous Monitoring**

Table 11 shows a list of configurable parameters.

**Table 11. VIIRS SST EDR Tunable Parameters**

| Algorithm Parameter Name | Description                               | Assigned Value |
|--------------------------|---|----------------|
| aotDegThresh             | AOT degraded threshold                    | 0.6            |
| aotExclThresh            | AOT exclusion threshold                   | 1.0            |
| szaUnfThresh             | Sensor zenith angle unfavorable threshold | 0.6981 Radians |

| Algorithm Parameter Name | Description                             | Assigned Value |
|--------------------------|---|----------------|
| szaExclThresh            | Sensor zenith angle exclusion threshold | 0.9250 Radians |
| sstLowThresh             | SST low threshold                       | 271.0          |
| sstHighThresh            | SST high threshold                      | 313.0          |
| sstDegThresh             | SST degraded threshold                  | 305.0          |
| iceConcThresh            | Ice Concentration threshold             | 0.1            |

**2.1.8 Assumptions and Limitations**

**2.1.8.1 Assumptions**

No assumptions are identified at this time.

**2.1.8.2 Limitations**

The architecture is implemented to retrieve skin SST only. Calculation of bulk SST can be done from the skin SST via the provided fixed offset. Full implementation of a skin to bulk model would require further development of a skin to bulk algorithm.

### 3.0 GLOSSARY/ACRONYM LIST

#### 3.1 Glossary

Table 12 contains terms most applicable for this OAD.

**Table 12. Glossary**

| Term   | Description   |
|--|---|
| Algorithm                                    | A formula or set of steps for solving a particular problem. Algorithms can be expressed in any language, from natural languages like English to mathematical expressions to programming languages like FORTRAN. On NPOESS, an algorithm consists of: <ol style="list-style-type: none"> <li>1. A theoretical description (i.e., science/mathematical basis)</li> <li>2. A computer implementation description (i.e., method of solution)</li> <li>3. A computer implementation (i.e., code)</li> </ol>  |
| Algorithm Configuration Control Board (ACCB) | Interdisciplinary team of scientific and engineering personnel responsible for the approval and disposition of algorithm acceptance, verification, development and testing transitions. Chaired by the Algorithm Implementation Process Lead, members include representatives from IWPTB, Systems Engineering & Integration IPT, System Test IPT, and IDPS IPT.   |
| Algorithm Verification                       | Science-grade software delivered by an algorithm provider is verified for compliance with data quality and timeliness requirements by Algorithm Team science personnel. This activity is nominally performed at the IWPTB facility. Delivered code is executed on compatible IWPTB computing platforms. Minor hosting modifications may be made to allow code execution. Optionally, verification may be performed at the Algorithm Provider's facility if warranted due to technical, schedule or cost considerations.   |
| cm   | Centimeter - unit of measurement for length.  |
| EDR Algorithm                                | Scientific description and corresponding software and test data necessary to produce one or more environmental data records. The scientific computational basis for the production of each data record is described in an ATBD. At a minimum, implemented software is science-grade and includes test data demonstrating data quality compliance.   |
| Environmental Data Record (EDR)              | <p><i>[IORD Definition]</i></p> <p>Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to geophysical parameters (including ancillary parameters, e.g., cloud clear radiation, etc.).</p> <p><i>[Supplementary Definition]</i></p> <p>An Environmental Data Record (EDR) represents the state of the environment, and the related information needed to access and understand the record. Specifically, it is a set of related data items that describe one or more related estimated environmental parameters over a limited time-space range. The parameters are located by time and Earth coordinates. EDRs may have been resampled if they are created from multiple data sources with different sampling patterns. An EDR is created from one or more NPOESS SDRs or EDRs, plus ancillary environmental data provided by others. EDR metadata contains references to its processing history, spatial and temporal coverage, and quality.</p> |
| K  | Kelvin - unit of measurement for temperature.   |
| M/s  | Meters per second - unit of measurement for velocity.   |
| Model Validation                             | The process of determining the degree to which a model is an accurate representation of the real-world from the perspective of the intended uses of the model. [Ref.: DoDD 5000.59-DoD Modeling and Simulation Management]  |
| Model Verification                           | The process of determining that a model implementation accurately represents the developer's conceptual description and specifications. [Ref.: DoDD 5000.59-DoD Modeling and Simulation Management]   |
| Operational Code                             | Verified science-grade software, delivered by an algorithm provider and verified by IWPTB, is developed into operational-grade code by the IDPS IPT.  |
| Operational-Grade Software                   | Code that produces data records compliant with the System Specification requirements for data quality and IDPS timeliness and operational infrastructure. The software is modular relative to the IDPS infrastructure and compliant with IDPS application programming interfaces (APIs) as specified for TDR/SDR or EDR code.   |

| Term                       | Description  |
|----------------------------|--|
| Raw Data Record (RDR)      | <p><i>[IORD Definition]</i></p> <p>Full resolution digital sensor data, time referenced, with absolute radiometric and geometric calibration coefficients appended, but not applied, to the data. Aggregates (sums or weighted averages) of detector samples are considered to be full resolution data if the aggregation is normally performed to meet resolution and other requirements. Sensor data shall be unprocessed with the following exceptions: time delay and integration (TDI), detector array non-uniformity correction (i.e., offset and responsivity equalization), and data compression are allowed. Lossy data compression is allowed only if the total measurement error is dominated by error sources other than the data compression algorithm. All calibration data will be retained and communicated to the ground without lossy compression.</p> <p><i>[Supplementary Definition]</i></p> <p>A Raw Data Record (RDR) is a logical grouping of raw data output by a sensor, and related information needed to process the record into an SDR or TDR. Specifically, it is a set of unmodified raw data (mission and housekeeping) produced by a sensor suite, one sensor, or a reasonable subset of a sensor (e.g., channel or channel group), over a specified, limited time range. Along with the sensor data, the RDR includes auxiliary data from other portions of NPOESS (space or ground) needed to recreate the sensor measurement, to correct the measurement for known distortions, and to locate the measurement in time and space, through subsequent processing. Metadata is associated with the sensor and auxiliary data to permit its effective use.</p> |
| Retrieval Algorithm        | A science-based algorithm used to 'retrieve' a set of environmental/geophysical parameters (EDR) from calibrated and geolocated sensor data (SDR). Synonym for EDR processing.   |
| Science Algorithm          | The theoretical description and a corresponding software implementation needed to produce an NPP/NPOESS data product (TDR, SDR or EDR). The former is described in an ATBD. The latter is typically developed for a research setting and characterized as "science-grade".   |
| Science Algorithm Provider | Organization responsible for development and/or delivery of TDR/SDR or EDR algorithms associated with a given sensor.  |
| Science-Grade Software     | Code that produces data records in accordance with the science algorithm data quality requirements. This code, typically, has no software requirements for implementation language, targeted operating system, modularity, input and output data format or any other design discipline or assumed infrastructure.  |
| SDR/TDR Algorithm          | Scientific description and corresponding software and test data necessary to produce a Temperature Data Record and/or Sensor Data Record given a sensor's Raw Data Record. The scientific computational basis for the production of each data record is described in an Algorithm Theoretical Basis Document (ATBD). At a minimum, implemented software is science-grade and includes test data demonstrating data quality compliance.   |
| Sensor Data Record (SDR)   | <p><i>[IORD Definition]</i></p> <p>Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to calibrated brightness temperatures with associated ephemeris data. Temperature Data Records (TDRs) are geolocated, antenna temperatures with all relevant calibration data counts and ephemeris data to revert from T-sub-a into counts. The existence of the SDRs provides reversible data tracking back from the EDRs to the Raw data.</p> <p><i>[Supplementary Definition]</i></p> <p>A Sensor Data Record (SDR) is the recreated input to a sensor, and the related information needed to access and understand the record. Specifically, it is a set of incident flux estimates made by a sensor, over a limited time interval, with annotations that permit its effective use. The environmental flux estimates at the sensor aperture are corrected for sensor effects. The estimates are reported in physically meaningful units, usually in terms of an angular or spatial and temporal distribution at the sensor location, as a function of spectrum, polarization, or delay, and always at full resolution. When meaningful, the flux is also associated with the point on the Earth geoid from which it apparently originated. Also, when meaningful, the sensor flux is converted to an equivalent top-of-atmosphere (TOA) brightness. The associated metadata includes a record of the processing and sources from which the SDR was created, and other information needed to understand the data.</p>  |
| Tau                        | Unit of measurement for Optical Thickness.   |

| Term                          | Description  |
|-------------------------------|--|
| Temperature Data Record (TDR) | <p><i>[IORD Definition]</i><br/>                     Temperature Data Records (TDRs) are geolocated, antenna temperatures with all relevant calibration data counts and ephemeris data to revert from T-sub-a into counts.</p> <p><i>[Supplementary Definition]</i><br/>                     A Temperature Data Record (TDR) is the brightness temperature value measured by a microwave sensor, and the related information needed to access and understand the record. Specifically, it is a set of the corrected radiometric measurements made by an imaging microwave sensor, over a limited time range, with annotation that permits its effective use. A TDR is a partially-processed variant of an SDR. Instead of reporting the estimated microwave flux from a specified direction, it reports the observed antenna brightness temperature in that direction.</p> |
| ViirsAncSkinTemp Type         | Granulated NCEP Skin Temperature. Data is store in an array of 32 bit floating point numbers. Data is spatially interpolated by the granulation process and is temporally interpolated by a process earlier in the chain.  |
| ViirsAotlPType                | VIIRS Aerosol Optical Thickness Intermediate Product. Data is stored in an array of 32 bit floating point numbers.   |
| ViirsCloudMask IPType         | A 48-bit word (6 bytes) for each moderate resolution pixel that includes information about whether the view of the surface is obstructed by clouds and specifies the processing path the algorithm took. Cloud phase data is also included as well as spatial uniformity, aerosol, shadow, and fire detection data.  |
| ViirsIceConcIP Type           | VIIRS Ice Concentration Intermediate Product. Data is stored in an array of 32 bit floating point numbers.   |
| ViirsModBtType                | VIIRS Moderate Resolution Channel Brightness Temperature. Data is stored in an array of 32 bit floating point numbers.   |
| ViirsSnowIce CoverIPType      | VIIRS Snow Ice Cover Intermediate Product. Data is stored in an array of 32 bit floating point numbers.  |
| ViirsSstCoeffsLut Type        | VIIRS SST Coefficient Look Up Table.   |

### 3.2 Acronyms

Table 13 contains terms most applicable for this OAD.

**Table 13. Acronyms**

| Term     | Expansion   |
|----------|---|
| AM&S     | Algorithms, Models & Simulations                          |
| API      | Application Programming Interfaces                        |
| ARP      | Application Related Product                               |
| CDFCB-X  | Common Data Format Control Book - External                |
| DMS      | Data Management Subsystem                                 |
| DPIS ICD | Data Processor Inter-subsystem Interface Control Document |
| DQTT     | Data Quality Test Table                                   |
| FEDR     | Full EDR  |
| INF      | Infrastructure  |
| ING      | Ingest  |
| IP       | Intermediate Product                                      |
| LUT      | Look-Up Table   |
| MDFCB    | Mission Data Format Control Book                          |
| NAAPS    | Navy Aerosol Analysis and Prediction System               |
| NLSW     | Non-linear Split Window                                   |
| NAVGEN   | Navy Global Environmental Model                           |
| QF       | Quality Flag  |
| SDR      | Sensor Data Record  |
| SI       | International System of Units                             |
| SST      | Sea Surface Temperature                                   |
| TBD      | To Be Determined  |
| TBR      | To Be Resolved  |
| TBS      | To Be Supplied  |
| TOA      | Top of the Atmosphere                                     |
| VCM      | VIIRS Cloud Mask  |

**4.0 OPEN ISSUES**

**Table 14. TBXs**

| TBX ID | Title/Description | Resolution date |
|--------|-------------------|-----------------|
| None   |                   |                 |
|        |                   |                 |
|        |                   |                 |
|        |                   |                 |