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Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for VIIRS Sea Ice Quality (SIQ) Intermediate Product (IP) and Surface Temperature (ST) IP Software

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Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for VIIRS Sea Ice Quality (SIQ) Intermediate Product (IP) and Surface Temperature (ST) IP 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 (Reference the CCR & CCB/ERB Approve Date)
Original	06/03/2011	This version incorporates **474-CCR-11-0110** which converts D42821, Operational Algorithm Description Document for VIIRS Sea Ice Quality (SIQ) Intermediate Product (IP) and Surface Temperature (ST) IP, Rev B dated 03/17/2010 to a JPSS document, Rev -. This was approved by the JPSS Ground Algorithm ERB on June 3, 2011.
Revision A	01/18/2012	**474-CCR-11-0281:** This version baselines 474-00095, Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for VIIRS Sea Ice Quality (SIQ) Intermediate Product (IP) and Surface Temperature (ST) IP 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	**474-CCR-13-0948:** This version authorizes 474-00095, JPSS OAD Document for VIIRS SIQ IP ST IP Software, for the Mx 7.0 IDPS release. Includes Raytheon PCR032720; 474-CCR-13-0916/ECR-ALG-0037: Update applicable OAD filenames/template/Rev/etc. for Mx7 Release.

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS)

OPERATIONAL ALGORITHM DESCRIPTION DOCUMENT FOR VIIRS SEA ICE QUALITY (SIQ) INTERMEDIATE PRODUCT (IP) AND SURFACE TEMPERATURE (ST) IP

SDRL No. S141
SYSTEM SPECIFICATION SS22-0096

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

IAW DFAR 252.227-7036, Raytheon hereby declares that, to the best of its knowledge and belief, the technical data delivered under Subcontract No. 7600002744 is complete, accurate, and complies with all requirements of the Subcontract.

TITLE: NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS) OPERATIONAL ALGORITHM DESCRIPTION DOCUMENT FOR VIIRS SEA ICE QUALITY (SIQ) INTERMEDIATE PRODUCT (IP) AND SURFACE TEMPERATURE (ST) IP

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Engineering & Manufacturing Development (EMD) Phase
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Operational Algorithm Description Document for VIIRS Sea Ice Quality (SIQ) Intermediate Product IP and Surface Temperature (ST) IP

Document Number: D42821
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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.

Northrop Grumman Space & Mission Systems Corp. **Space Technology** One Space Park Redondo Beach, CA 90278	NORTHROP GRUMMAN Raytheon
Revision/Change Record	**Document Number D42821**

Revision	Document Date	Revision/Change Description	Pages Affected
---	5-6-05	Initial PCIM Release - Reference ECR A049.	All
A1	2-7-06	05Dec05 – Reflects Raytheon-Omaha's Science To Operational Code Conversion combining NGST's ST IP OAD (30Jul04) and their Sea Ice Characterization EDR OAD (06May05) into a single Sea Ice Quality IP OAD 25Jan06 – Made edits to adjudicate comments from 10Jan06 Code Completion Peer Review (CCPR) plus prepare this document for official delivery to NGST by 09Feb06 (i.e., within 30 days after CCPR date). 07Feb06 – Inserted NPOESS-Omaha's CAM and QA electronic signatures, sync'd 07Feb06 date in upper right header, signature page, and Revision/Change Record page. Made minor QA edits and finalized document for official delivery to NGST.	All
A2	10-18-06	Updates for code peer review.	All
A3	6-15-07	Logo, cleanup updates. Delivered to NGST.	All
A4	9-6-07	Updated with comments in TM #: NP-EMD.2006.510.0059. Note comments in TM were modified by scientist based on the merging of STIP and Ice Qual.	All
A5	10-3-07	Updated with comments from review notes from Robert Mahoney. Merged tables, corrected values. Implemented TM #s: NP-EMD.2005.510.0115, NP-EMD.2006.510.0028, NP-EMD.2006.510.0062, NP-EMD.2006.510.0063, NP-EMD.2006.510.0065, NP-EMD.2006.510.0066, NP-EMD.2006.510.0074, & NP-EMD.2006.510.0083.	All
A6	10-17-07	Delivered to NGST.	All
A7	2-18-07	Remove VCM Bits Description table. Renumber remaining tables and references.	All
A8	3-5-08	Changed SolZenAng values to sunzen to agree with true input values (SPCR # 17013).	All
A9	3-7-08	Implemented changes specified in TM #NP-EMD-2007.510.0046.	All
A10	6-6-08	Reformatted in order to conform to template D41851. Updated graceful degradation section.	All
A11	10-20-08	Incorporated OAD updates from TM NP-EMD.2008.510.0018 and TIM comments. Prepared for delivery to NGST.	All
A	12-17-08	Addressed TIM/ACCB comments. ECR A-183 Rev. A.	All
B1	12-01-09	Updated subcontract number	Title pgs
B2	1-19-10	Updated based on TM NP-EMD-2009.510.0068	All
B3	2-24-10	Updated for TIM	All
B	3-17-10	Incorporated TIM comments and prepared for ARB/ACCB.	All

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C1	9-30-10	PCR024712 Removed fwRange field from LUT	Table 5
C2	10-21-10	Corrections to Table 5 and Table 15 to remove entry for “fwRange” Added clarification statement about “fwRange” not implemented in the operational algorithm Corrections Table 7 ice quality flags entry (removed IQ_N_BANDS) for consistency with IDFCB Vol III definition. Corrected name of Table 5 to Sea Ice Quality PC LUT and references to Table 5 appearing throughout the document. Added clarification statement for quality weights for fire and sun glint. Added clarification statements for quality weights for low light condition Formatting error corrections	p. 8;9; 21 p. 9 p. 9 p. 16 p. 19 All
C3	10-21-10	Updated due to document convergence to include tech memos 2010.510.0077.Rev-A, 2010.510.0011, 2010.510.0012 & 2010.510.0014,	All
C4	06-29-11	Updated due to ISTN_VIIRS_NGST_4.17.2	All
C5	09-19-11	Updated for PCR027383.	11
C6	09-27-11	Updated OAD for PCR027831.	p. 4;11

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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.

1.2 Scope

The scope of this document is limited to the description of the core operational algorithms required to create the VIIRS Sea Ice Quality IP and VIIRS ST IP software. The theoretical basis for these algorithms is described in Section 3.3 of the VIIRS Sea Ice Characterization Algorithm Theoretical Basis Document (ATBD), 474-00047, and Section 3.3 of the VIIRS Ice Surface Temperature Algorithm Theoretical Basis Document (ATBD), 474-00052.

1.3 References

1.3.1 Document References

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

Table 1. Document References

Document Title	Document Number/Revision	Revision Date
VIIRS Ice Quality Unit Level Detailed Design Document	Y0011649 Ver. 5 Rev. 5	15 Mar 2005
VIIRS Surface Temperature Module-Level Interface Control Document	Y3281 Ver. 5 Rev. 4	Dec 2003
VIIRS Surface Temperature Module Level Software Architecture	Y2473 Ver. 5 Rev. 12	30 Jul 2004
VIIRS Surface Temperature Module Level Data Dictionary	Y0011652 Ver. 5 Rev. 3	Dec 2003
VIIRS Ice Surface Temperature Appendix A: Surface Temperature IP Unit Level Detailed Design	Y0010880 Ver. 5 Rev. 9	30 Jul 2004

Document Title	Document Number/Revision	Revision Date
VIIRS Radiometric Calibration Component Detailed Design Document	Y2490 Ver. 5 Rev. 4	30 Sep 2004
VIIRS Aerosol Optical Thickness Unit Detailed Design	Y2496 Ver. 5 Rev. 6	31 Aug 2004
VIIRS Sea Ice Characterization Algorithm Theoretical Basis Document	474-00047	Latest
Operational Algorithm Description Document for VIIRS Ice Surface Temperature (IST) Environmental Data Records (EDR) Software	474-00072	Latest
JPSS Environmental Data Record (EDR) Production Report (PR) for NPP	474-00012	Latest
JPSS Environmental Data Record (EDR) Interdependency Report (IR) for NPP	474-00007	Latest
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 CDFCB-X Vol I 474-00001-02-B0122 CDFCB-X Vol II 474-00001-03-B0122 CDFCB-X Vol III 474-00001-04-01-B0122 CDFCB-X Vol IV Part 1 474-00001-04-02-B0122 CDFCB-X Vol IV Part 2 474-00001-04-03-B0122 CDFCB-X Vol IV Part 3 474-00001-04-04-B0122 CDFCB-X Vol IV Part 4 474-00001-05-B0122 CDFCB-X Vol V 474-00001-06-B0122 CDFCB-X Vol VI 474-00001-08-B0122 CDFCB-X Vol VIII	Latest
JPSS Common Data Format Control Book - External - Block 1.2.3 (All Volumes)	474-00001-01-B0123 CDFCB-X Vol I 474-00001-02-B0123 CDFCB-X Vol II 474-00001-03-B0123 CDFCB-X Vol III 474-00001-04-01-B0123 CDFCB-X Vol IV Part 1 474-00001-04-02-B0123 CDFCB-X Vol IV Part 2 474-00001-04-03-B0123 CDFCB-X Vol IV Part 3 474-00001-04-04-B0123 CDFCB-X Vol IV Part 4 474-00001-05-B0123 CDFCB-X Vol V 474-00001-06-B0123 CDFCB-X Vol VI 474-00001-08-B0123 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
JPSS Data Format Control Book - Internal Volume III – Retained Intermediate Product Formats (IDFCB) – Block 1.2.3	474-00020-03-B0123 IDFCB Vol III	Latest
VIIRS Ice Surface Temperature Algorithm Theoretical Basis Document (ATBD)	474-00052	Latest
IDPS Processing SI Common IO Design	DD60822-IDP-011 Rev. A	21 Jun 2007

Document Title	Document Number/Revision	Revision Date
JPSS Program Lexicon	474-00175	Latest
NGST/SE technical memo – NPP_VIIRS_STIP_CodeQFUpdate_SPCR_ALG987	NP-EMD.2006.510.0059	27 Feb 2006
NGST/SE technical memo – MS_EngMemo_STIP_codefix_SPCR982_971	NP-EMD.2006.510.0004	03 Mar 2006
NGST/SE technical memo – NPP_VIIRS_STIP_QFUpdate_SCPR_ALG1010	NP-EMD.2006.510.0018	17 Mar 2006
NGST/SE technical memo – NPP_VIIRS_IceQual_VCM_ThinCirrus_Flag	NP-EMD.2006.510.0080	14 Nov 2006
NGST/SE technical memo – NPP_VIIRS_IST_LST_STIP_BugsFix_20061031	NP-EMD.2006.510.0081	01 Nov 2006
NGST/SE technical memo – NPP_VIIRS_SeaIce_Night_granule_AOT_RevA	NP-EMD-2006.510.0095 Rev. A	26 Jan 2007
NGST/SE technical memo – NPP_VIIRS_SeaIce_3.4.4_delta_delivery_OAD_updates	NP-EMD.2007.510.0046	08 Aug 2007
NGST/SE technical memo – NPP_VIIRS_SeaIce_v3.4.5_delta_delivery_OAD_updates	NP-EMD.2008.510.0018	15 Apr 2008
NGAS/SE technical memo – NPP_VIIRS_SeaIceQualSTIP_v4.17_OAD_updates	NP-EMD.2009.510.0068	20 Nov 2009
NGST/SE technical memo – SeaIceQualStip_OAD_Corrections	NP-EMD.2010.510.0077.Rev-A	21 Sep 2010
NGST/SE technical memos: LUT_OAD_Drop History_Corrections LUT_Format_Corrections PC_Format_Corrections	 NPOESS GJM-2010.510.0011 NPOESS GJM-2010.510.0012 NPOESS GJM-2010.510.0014	 21 Sep 2010 21 Sep 2010 22 Sep 2010

1.3.2 Source Code References

The science and operational code and associated documentation relevant to the algorithms described in this OAD are listed in Table 2. Indented rows are included as a reference to other Sea Ice Characterization algorithms.

Table 2. Source Code References

Reference Title	Reference Tag/Revision	Revision Date
VIIRS SeaIceCharacterization science-grade software (original reference source) (ECR-A049)	ISTN_VIIRS_NGST_3.4 (OAD Rev. ---)	05 May 2005
VIIRS SeaIceCharacterization (SIQ-STIP) operational software	B1.4 (OAD Rev. A1)	07 Feb 2006
VIIRS SeaIceCharacterization science-grade software (ECR-A066)(Sea Ice Age) Includes Tech Memo: NP-EMD.2005.510.0115	ISTN_VIIRS_NGST_3.4.1	29 Sep 2005
VIIRS SeaIceCharacterization science-grade software (ECR-A073)(Sea Ice Quality) Includes OAD update Tech Memo: NP-EMD.2005.510.0137	ISTN_VIIRS_NGST_3.4.2	14 Nov 2005
VIIRS SeaIceCharacterization (SIQ-STIP) operational software	B1.5 (OAD Rev. A2)	18 Oct 2006
VIIRS SeaIceCharacterization science-grade software (ECR-A073 & A108)(Sea Ice Age)	ISTN_VIIRS_NGST_3.4.3 Data	18 Dec 2006
VIIRS SeaIceCharacterization science-grade software (ECR-A127A)(Sea Ice Age) Includes Tech Memo: NP-EMD.2007.510.0046	ISTN_VIIRS_NGST_3.4.4 Data	11 Sep 2007
Implemented TM 2006.510.0080 (ECR A-108) (PCR14258)	B1.5 (OAD Not referenced)	17 Sep 2007
Implemented TM 2007.510.0046 (PCR14258) (ECR A-127)	B1.5 (OAD Rev A9)	07 Mar 2008
VIIRS SeaIceCharacterization science-grade software (Sea Ice Characterization) Includes OAD update Tech Memo: NP-EMD.2008.510.0018	ISTN_VIIRS_NGST_3.4.5 (OAD updated by TM)	14 May 2008
VIIRS SeaIceCharacterization (SIQ-STIP) operational software implemented TMs 2006.510.0095.Rev-A (PCR 14275) and 2008.510.0018	B1.5x1 (OAD Rev. A11)	20 Oct 2008
ACCB (no code changes)	OAD Rev A	17 Dec 2008
VIIRS SeaIceCharacterization science-grade software (Sea Ice Characterization) Includes OAD update Tech Memos: NP-EMD.20098.510.0049 & NP-EMD.20098.510.0068 (PCR 21984)	ISTN_VIIRS_NGST_4.17 (OAD updated by TM)	16 Dec 2009
VIIRS SeaIceCharacterization (SIQ-STIP) operational software (PCRs 21984-SIQ & 21983-SIC)	Sensor Characterization (Build SC-6) (OAD Rev B2)	19 Jan 2010
ACCB	OAD Rev B	31 Mar 2010
PCR024712	Mxl1.5.4 (OAD Rev C1)	30 Sep 2010
Convergence Updates (No code updates) includes Tm 2010.510.0077.Rev-A	(OAD Rev C2 & C3)	21 Oct 2010
VIIRS SeaIceCharacterization science-grade software	ISTN_VIIRS_NGST_ 4.17.2	25 Jan 2011
VIIRS SeaIceCharacterization (SIQ-STIP) operational software (PCRs025896 & 026162)	ECR-A0003 Maintenance Build 1.5.05.00.01 (OAD Rev. C4)	07 Mar 2011 & 29 Jun 2011 (OAD)
PCR027383	(OAD Rev C5)	19 Sep 2011
PCR027831 (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

2.1 Sea Ice Characterization Description

The Sea Ice Characterization EDR retrieval algorithm and the theoretical basis are described in detail in the VIIRS Sea Ice Characterization ATBD (474-00047). That document also gives the theoretical basis for the Ice Quality algorithm in Section 3.3.2.

The Sea Ice Characterization Ice Quality algorithm is the first executable in the Sea Ice Characterization chain. The Ice Quality algorithm produces the Ice Quality Flags IP and the Ice Weights IP. They utilize the VIIRS 375m Sensor Data Record (SDR), IP files from other VIIRS algorithms, and Look-Up-Tables (LUTs). Figure 1 shows the input and output data flow associated with the Ice Quality algorithm. The flowchart box for Ice Quality IP shown in orange is highlighted to indicate that the IP, formerly known as the Ice Mask IP, is now named the Ice Quality Flags IP. The flow chart box for Ice Location IP is shown in red to indicate that this IP is not produced by the operational code.

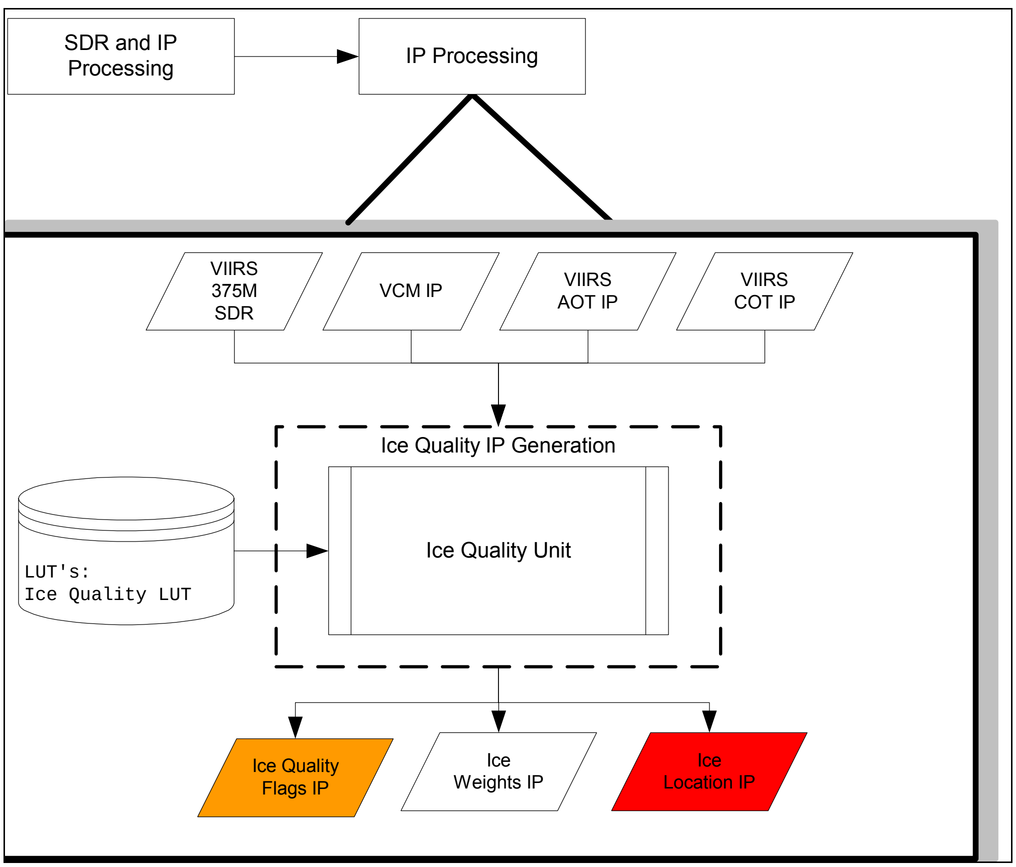

Figure 1. Ice Quality Unit IP Processing Chain

2.1.1 Interfaces

Table 3 shows the global constant attributes of the ice quality IP unit.

Table 3. Ice Quality Global Attributes

Input	Type	Description/Source	Units/Valid Range
VIIRS_RDR_SCANS	Int32	Number of RDR scans	Unitless/ VIIRS_RDR_SCANS > 0 ***(Currently set to 48)***
M_DETECTORS	Int32	Number of Moderate detectors	Unitless/ M_DETECTORS > 0 ***(Currently set to 16)***
I_DETECTORS	Int32	Number of Image detectors	Unitless/ I_DETECTORS > 0 ***(Currently set to 32)***
M_VIIRS_SDR_ROWS	Int32	Number of moderate Viirs rows	Unitless/ VIIRS_RDR_SCANS * M_DETECTORS
M_VIIRS_SDR_COLS	Int32	Number of moderate Viirs columns	Unitless/ M_VIIRS_SDR_COLS > 0 ***(Currently set to 3200)***
I_VIIRS_SDR_ROWS	Int32	Number of image Viirs rows	Unitless/ VIIRS_RDR_SCANS * I_DETECTORS
I_VIIRS_SDR_COLS	Int32	Number of image Viirs columns	Unitless/ I_VIIRS_SDR_COLS > 0 ***(Currently set to 6400)***
VIIRS_MODERATE_PIXEL_COUNT	Int32	Number of moderate columns X rows	Unitless/ M_VIIRS_SDR_ROWS * M_VIIRS_SDR_COLS
IQ_N_BANDS	Int32	Number of bands	Unitless/ IQ_N_BANDS > 0 ***(Currently set to 3 => I1,I2, I5)***
IQ_N_CLD_TYPES	Int32	Number of Cloud Types	Unitless/ IQ_N_CLD_TYPES > 0 ***(Currently set to 7)***
IQ_N_THRESH	int32	Cloud Optical Thickness Quality Threshold Values; Boundary values correspond to RED (1) or YELLOW (2) quality thresholds	Unitless/ IQ_N_THRESH > 0 ***(Currently set to 2)***
IQ_N_AOT_BINS	Int32	Number of AOT bins, which correspond to the number of AOT values used for thresholding (aotBin, see Table 5)	Unitless/ IQ_N_AOT_BINS > 0 ***(Currently set to 4)***
IQ_N_WGTS	Int32	Number of ice quality band weights	Unitless/ IQ_N_WGTS > 0 ***(Currently set to 3)***

2.1.1.1 Inputs

The Ice Quality inputs are shown in Table 4. Refer to the CDFCB-X, 474-00001, for a detailed description of the inputs.

Table 4. Ice Quality Inputs

Input	Data Type/Size	Description/Source	Units/Valid Range
Latitude	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Latitude @ Imagery Resolution, from IMG Geolocation SDR	Radians/ -PI/2 ≤ Latitude ≤ PI/2 *FILL_VALUE = -999.9*
Longitude	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Longitude @ Imagery Resolution, from IMG Geolocation SDR	Radians/ -PI ≤ Longitude ≤ PI *FILL_VALUE = -999.9*
sunzen	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Solar Zenith Angle @ Imagery Resolution, from IMG Geolocation SDR	Radians/ -PI/2 ≤ sunzen ≤ PI/2 *FILL_VALUE = -999.9*

Input	Data Type/Size	Description/Source	Units/Valid Range
sunazi	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Solar Azimuth Angle @ Imagery Resolution, from IMG Geolocation SDR	Radians/ -PI ≤ sunazi ≤ PI *FILL_VALUE = -999.9*
Reflectance_Img	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	I1 and I2 Reflectances / VIIRS 375 m resolution SDR	Unitless/ >= 0 Fill_VALUE= 65535 (Integer Scaled)
BT_I5	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Brightness Temperature of Band I5 / VIIRS 375 m resolution SDR	Kelvin / 190 K < BT_{I5} < 340 K Fill_VALUE= 65535 (Integer Scaled)
COT	float*32 x M_VIIRS_SDR_ROWS x M_VIIRS_SDR_COLS	Cloud Optical Thickness @ 750m resolution	Unitless/ COT ≥ 0.0 *FILL_VALUE = -999.9*
AOT	float*32 x M_VIIRS_SDR_ROWS x M_VIIRS_SDR_COLS	Aerosol Optical Thickness (550nm) @ 750m	Unitless/ AOT >= 0.0 *FILL_VALUE = -999.9*
VCM	VIIRS_MODERATE_PIXEL_COUNT	Cloud Mask Flags	VCMLANDWATER, VCMQUAL, VCMCONF, VCMADJCONF, VCMCIRSOL, VCMCIRIR, VCMTHINCIR, VCMSHADOW, VCMOBSTRUCT, VCMPHASE, VCMFIRE, VCMGLINT
Sea Ice Quality PC	See Table 5	See Table 5	See Table 5

Table 5 contains the Sea Ice Quality algorithm PC description. The cot_switch entry has been removed from this table since the value was moved to the algorithms configuration guide during Sci2Ops. This switch controls whether the Sea Ice Quality algorithm runs in either of two modes for determining cloud confidence and de-weighting retrieval quality for cloud contaminated pixels such that for VCM IP cloud confidence mode, then cot_switch = 0 and COP IP cloud confidence mode, then cot_switch = 1. This switch is unitless, with values of either 1 or 0. The default value for cot_switch is 0. Depending on the cot_switch selection the appropriate set of Sea Ice Quality PC table values for the respective mode are read from the table. The table definitions for the cot_switch modes at prelaunch are identical but are allowed to change as determined during cal/val. Note that Table 5 no longer contains an entry for the parameter "fwRange" defined in previous versions of this OAD since it is not used by the algorithm and therefore not implemented in the operational algorithm.

Table 5. Sea Ice Quality PC Description

Input	Data Type/Size	Description/Source	Units/Valid Range
bandWgts	float*32 x IQ_N_BANDS	Initial Ice Quality Band Weights	Unitless/ bandWgts ≥ 0.0 bandWgts = `[0.3, 0.6, 0.1]`

Input	Data Type/Size	Description/Source	Units/Valid Range
cloudWgts	float*32 x IQ_N_CLD_TYPES x IQ_N_BANDS	Cloud weights corresponding to the three imagery bands (I1, I2, I5) and the seven cloud properties - four phases = Default (1), Water (2), Ice (3), Mixed (4), and 3 types = cirrus (5), shadow (6), adjacency (7); the parenthetical values correspond to the rows of the matrix shown in the "Units/Range" cell, the column represent the bands I1, I2, and I5	Unitless/ cloudWgts ≥ 0.0 cloudWgts = **(I1) (I2) (I5)** [0.5, 0.5, 0.5;**(1)** 0.5, 0.5, 0.5;**(2)** 0.5, 0.5, 0.5;**(3)** 0.5, 0.5, 0.5;**(4)** 0.6, 0.6, 0.6;**(5)** 0.3, 0.3, 1.0;**(6)** 0.8, 0.8, 0.8]**(7)**
cotThresh	float*32 x 4 x IQ_N_THRESH x IQ_N_BANDS	Cloud Optical Thickness Thresholds used when *cotThresh* == 1 (used COT to determine ***cloud confidence*** in the Ice Quality Flags IP output. The "4" in the "Data Type/Size" cell corresponds to the four phases (Default(1), Water(2), Ice(3), Mixed(4)). "IQ_N_THRESH" corresponds to the rows of each set of matrices which are a function of cloud phase; the "(1)'s" represent the YELLOW/RED cot thresholds and the "(2)'s" represent the GREEN/YELLOW COT thresholds.	Unitless/ cotThresh ≥ 0.0 cotThresh = **(Default,Water,Ice,Mixed)** **(I1) (I2) (I5)** [0.5, 0.5, 0.5;**(1)** 0.2, 0.2, 0.2]**(2)** (Phases follow the order shown above)
minNLat	float*32	Sea Ice Latitude Range – Minimum Northern Latitude	radians/ -PI/2 ≤ minNLat ≤ PI/2 ***(Currently set to 0.62831 (36°))***
maxSLat	float*32	Sea Ice Latitude Range – Maximum Southern Latitude	radians/ -PI/2 ≤ maxSLat ≤ PI/2 ***(Currently set to –0.87266 (-50°))***
aotBin	float*32 x IQ_N_AOT_BINS	AOT bin boundary values	Unitless/ aotBin ≥ 0.0 aotBin = [0.0,0.15,0.5,1.0]
qAotSunZen	float*32 x IQ_N_BANDS (I1,I2) x IQ_N_AOT_BINS x 2	Solar Zenith Angle values that correspond to the Solar Zenith Angle quality regimes (G/Y = "Green/Yellow", Y/R = "Yellow/Red", this corresponds to the "2" in the "Data Types/Size" column) and to the "aotBin" values (**(1) -> 0.0,(2) -> 0.15,(3) -> 0.5,(4) -> 1.0**)	Radians/ -PI/2 ≤ qAotSunZen ≤ PI (**I1,I2**) **(G/Y) (Y/R)** [1.308997(75°),1.48353(85°)**(1)** 1.22173(70°),1.48353(85°)**(2)** 1.13446(65°),1.39626(80°);**(3)** 1.04719(60°),1.308997(75°)]**(4)** (Bands follow the order shown above)
qualWgts	float*32 x IQ_N_WGTS x IQ_N_BANDS	Overall Ice Quality Band Weights for each band (**I1, I2, I5**) and for each set of weights for each band; the **(1)="RED"**, **(2)="YELLOW"** and **(3)="GREEN"** quality regions. Used in IQ_write_ice_mask()	Unitless/ qualWgts ≥ 0.0 qualWgts = **(I1) (I2) (I5)** [0.060,0.12,0.195;**(1)** 0.12 ,0.24,0.39 ;**(2)** 0.02 ,0.04,0.065]**(3)**

2.1.1.2 Outputs

The Sea Ice Quality algorithm produces two output IP products: Ice Weights and Ice Quality Flags IP.

2.1.1.2.1 Ice Weights IP

The Ice Weight IP contains a single field (see Table 6) for ice weights of each imagery band.

Table 6. Ice Weights IP Outputs

Output	Data Type/Size	Description	Units/Valid Range
Ice Weights	float*32 x IQ_N_BANDS x I_VIIRS_SDR_ROWS x I_VIIRS_SDR_COLS	Output Ice Weights for each Imagery Band (I1, I2, I5) for the ***Ice Weights IP***	Unitless/ 0.0 ≤ Ice Weights ≤ 1.0

2.1.1.2.2 Ice Quality Flags IP

The Ice Quality Flags IP contains three fields (see Table 7): an ice quality flags array and two granule level attributes: granuleNotInSeaIceRange and granuleNotInFWIceRange. The pixel level qualityflags are contained in three bytes.

Table 7. Ice Quality Flags IP Outputs

Output	Data Type/Size	Description	Units/Valid Range
Ice Quality Flags	int8 x 3 x I_VIIRS_SDR_ROWS x I_VIIRS_SDR_COLS	Output Ice Quality Flags for the ***Ice Quality Flags IP*** (See Table 8 for description)	See Table 8
granuleNotInSeaIce Range	int	Flags whether the granule is entirely outside the sea ice range	Units: none (1=YES, 0 = NO)
granuleNotInFWIceR ange	int	Flags whether the granule is entirely outside the fresh water ice range	Units: none (1=YES, 0 = NO)

Table 8. Ice Quality Flags IP: Description of Output Quality Flags

Byte	Bit	Flag Description Key	Result
0	0	Sea Ice Range	0 = Within Range, Default 1 = Out of Range Range as determined by min_nlat and max_slat as defined in Table 3
	1	Fresh Water Ice Range	0 = Within Range, Default 1 = Out of Range
	2	Coastline	0 = No coastline (Default) 1 = Coastline
	3-4	Cloud Confidence Indicator	Bit 4 | Bit 3 0 | 0 | Confident Clear, (Default) 0 | 1 | Probably Clear 1 | 0 | Probably Cloudy, Adjacency 1 | 1 | Confident Cloudy
	5-6	Cirrus Confidence Indicator	Bit 6 | Bit 5 0 | 0 | Confident Clear, (Default) 0 | 1 | Solar 1 | 0 | IR 1 | 1 | Solar & IR
	7	Cloud Shadow	0 = No (Default) 1 = Yes
1	0-1	Cloud Phase	Bit 1 | Bit 0 0 | 0 | Spare 0 | 1 | Water 1 | 0 | Ice 1 | 1 | Mixed
	2	Fire Detected	0 = No (Default) 1 = Yes
	3	Sun Glint	0 = No (Default) (Test not implemented) 1 = Yes
	4-6	Band Quality	Bit 6(I5) | Bit 5(I2) | Bit 4(I1) 0 | 0 | 0 | I1 = Good, I2 = Good, I5 = Good 0 | 0 | 1 | I1 = BAD, I2 = Good, I5 = Good 0 | 1 | 0 | I1 = Good, I2 = BAD, I5 = Good 1 | 0 | 0 | I1 = Good, I2 = Good, I5 = BAD 0 | 1 | 1 | I1 = BAD, I2 = BAD, I5 = Good 1 | 1 | 0 | I1 = Good, I2 = BAD, I5 = BAD 1 | 1 | 1 | AD, I5 = BAD
	7	Ocean/No Ocean	0 = Ocean 1 = No Ocean

Byte	Bit	Flag Description Key	Result		
2	0-1	Overall Quality (Reflectance Band I1)	Bit 1	Bit 0	
			0	0	High
			0	1	Medium
			1	0	Low
			1	1	Poor
	2-3	Overall Quality (Reflectance Band I2)	Bit 1	Bit 0	
			0	0	High
			0	1	Medium
			1	0	Low
			1	1	Poor
	4-5	Overall Quality (Brightness Temperature Band I5)	Bit 1	Bit 0	
			0	0	High
			0	1	Medium
			1	0	Low
			1	1	Poor
	6	Non Cloud Obstruction/Heavy Aerosol	0 = No 1 = Yes		
	7	Thin Cirrus (from VCM)	0 = No 1 = Yes		

2.1.2 Algorithm Processing

2.1.2.1 Main Module - ProEdrViirsIceQual.cpp

The ProEdrViirsIceQual.cpp code produces outputs listed in Table 7. The output IPs are determined using a series of tests, which determine the quality of each pixel. Each pixel's "quality" depends upon the quality of the VIIRS Cloud Mask (VCM), Cloud Optical Thickness (COT), and Aerosol Optical Thickness (AOT) IPs. Based on these inputs, weighting factors from the Sea Ice Quality PC (Table 5) are applied to each pixel. The use of these input parameters for testing pixel quality takes place in the following functions: calcIqStip() (Section 2.1.2.5), and calcBandWeights() (Section 2.1.2.6). The I1 and I2 Reflectance qualities and the I5 Brightness Temperature qualities are used in calcIqStip() to compute the quality of each band. This algorithm only processes if the granule is within the specified range of latitude.

2.1.2.2 setupDataItems (ProEdrViirsIceQual.cpp)

The setupDataItems method works in conjunction with auto-generated source code class "AutoGeneratedProEdrViirsIceQual" to set-up the input & output data item class objects (DMS data structures) that are required by the algorithm for processing, for both Ice Quality IP and Surface the Temperature IP (see Section 2.2).

2.1.2.3 doProcessing (ProEdrViirsIceQual.cpp)

The doProcessing method performs further initialization of data assigns pointers, allocates temporary memory for and extracts VIIRS Cloud Mask data, and then calls functions "determineIceRange" and "calcIqStip" to process the data buffers retrieved from DMS. These pointers are then used by the algorithm to read and update the DMS data buffers. After processing has completed, temporary memory is deleted.

2.1.2.4 determineIceRange (ProEdrViirsIceQual.cpp)

The determineIceRange method is used to determine if the granule is "out of range" for sea ice or fresh water ice.

2.1.2.5 calcIqStip (ProEdrViirsIceQual.cpp)

The calcIqStip method is the main method of ProEdrViirsIceQuality algorithm. This method calculates the ice quality flags, ice weights, and calls calcSurfTemp (see Section 2.2.2.1) for each pixel. It uses the VCM IP to produce Ice Quality Flags, which contains the quality flags (bits) for each pixel. The Ice Quality Flags bit structure is detailed in Table 8. See Figure 2 for the logic flow in the creating of the Ice Quality Flags.

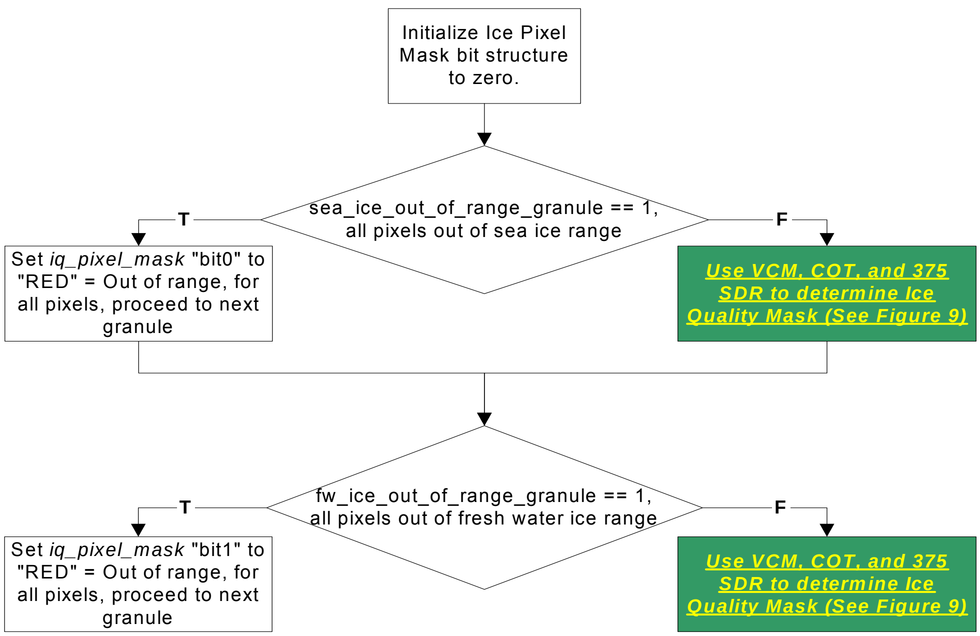

Figure 2. Logic Flow to Create the Ice Quality Flags

In Figure 2 all tests done using COT or the VCM are done at the moderate resolution pixel level. Table 6 details the results of these tests. A test with the LUT field "qualWgts" against the weighting factors computed in calcBandWeights() is performed in order to determine the overall qualities for bands I1, I2, and I5; these are described in Table 8.

The VCM has recently been updated to handle more cloud phases. However, because the number of phases has increased, the number of bits necessarily must increase. In order to minimize the number of changes to the VCM output bit structure, the cloud phase has moved from byte 4 (on a 0-5 scale) to byte 5. Table 9 details the mapping of the new VCM to the current cloud phases handled by the Sea Ice algorithm.

Note that the new VCM no longer produces a cloud phase for “PROBABLY CLEAR” pixels and instead uses a “PARTLY CLOUDY” label. Ice Quality Unit, using the new VCM, classifies formerly “PROBABLY CLEAR” pixels as “CONFIDENTLY CLEAR.”

Table 9. Mapping of New VCM to Ice Quality Flags

VCM Cloud Phase	Mapped Cloud Phase in Ice Quality Flags	2-Bit Assignment
Not Executed	Not Executed	00
Clear	Not Executed	00
Partly Cloudy	Not Executed	00
Water	Water	01
Mixed	Mixed	11
Opaque Ice	Ice	10
Cirrus	Ice	10
Overlap	Mixed	11

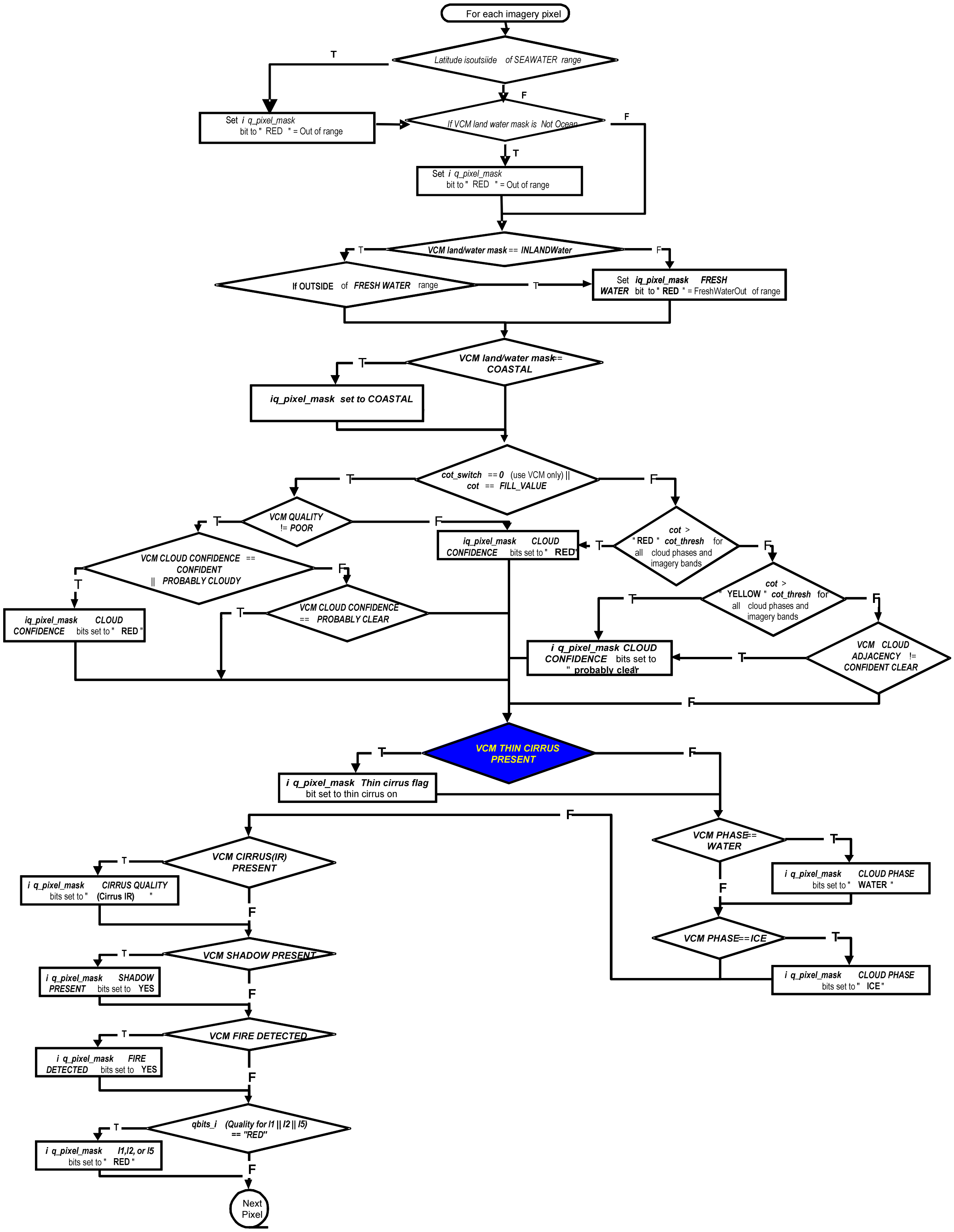

Figure 3. Detailed Logic Flow to Create the Ice Quality Flags

2.1.2.6 calcBandWeights (ProEdrViirsIceQual.cpp)

Band weighting factors, which are a function of the "quality" of the IPs, are determined using threshold and weight values in the Ice Quality LUT. The algorithm determines weights in applyToWeights() due to cloud effects or cloud optical thickness values if COT is available. If the COT IP is not available the algorithm uses the VCM cloud properties to define the weighting factors for each of the ice pixels.

This function does, however, perform an initial weighting on the reflectance and brightness temperature bands based on various VCM tests results determined earlier in the calcIqStip() function. Figure 4 details the logic flow of calcBandWeights().

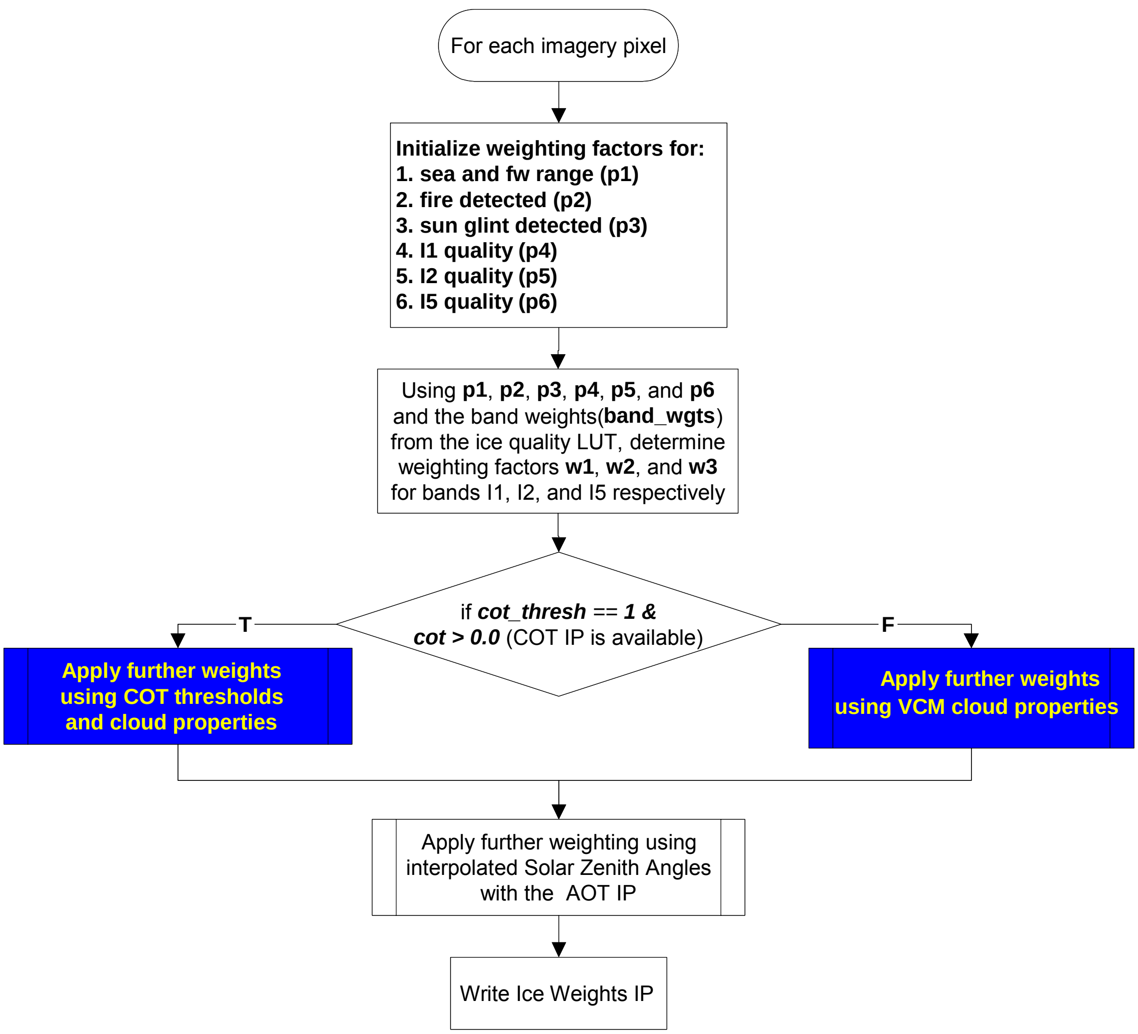

Figure 4. Logic Flow of calcBandWeights

The computation of all weighting factors (due to clouds and AOT) are detailed in Table 6. These band weights include weights computed by calcBand_weights(), applyToWeights(), and applyAotSunZen(). Note that parameters in red (Table 10) denote individual weighting factors that differ depending on availability of the COT IP and/or VCM IP.

Table 10. Factors Determining the Ice Weights IP

Band Weight Parameters	Final Band Weight Computation
Parameters for I1 (s = along-scan, t = along-track): ***p1(t,s)*** *= sea or fresh water present (0 = No, 1 = yes)* ***p2(t,s)*** *= fire detected (1 = Yes, 1 = No)* ***p3(t,s)*** *= sun glint detected (1 = Yes, 1 = No)* ***p4(t,s)*** *= I1 quality (0 = Poor, 1 = Good)* ***w_0(I1)*** *= I1 weighting factor from the Ice Quality PC = bandWgts(1) in Table 18* *Note: For other parameter definitions see Table 11, Table 12 and Table 13.*	*IF COT is not available* *IF Cloud Confidence == Probably Clear* ***w(I1,t,s)*** = ***w_0(I1)*** x ***p1*** x ***p2*** x ***p3*** x ***p4*** x ***cw1*** x ***cw3*** x ***a_sza*** x ***s0 (if shadow detected)*** *ELSE IF Cloud Confidence == Probably Cloudy* ***w(I1,t,s)*** = ***w_0(I1)*** x ***p1*** x ***p2*** x ***p3*** x ***p4*** x ***cw2*** x ***cw3*** x ***a_sza*** x ***s0 (if shadow detected)*** *END IF* *ELSE* ***w(I1,t,s)*** = ***w_0(I1)*** x ***p1*** x ***p2*** x ***p3*** x ***p4*** x ***w_x*** x ***a_sza*** x ***s0 (if shadow detected)*** *END*
Parameters for I2: ***p1(t,s)*** *= sea or fresh water present (0 = No, 1 = yes)* ***p2(t,s)*** *= fire detected (1 = Yes, 1 = No)* ***p3(t,s)*** *= sun glint detected (1 = Yes, 1 = No)* ***p5(t,s)*** *= I2 quality (0 = Poor, 1 = Good)* ***w_0(I2)*** *= I2 weighting factor from the Ice Quality PC= bandWgts(2) in Table 18* *Note: For other parameter definitions see Table 11, Table 12 and Table 13.*	*IF COT is not available* *IF Cloud Confidence == Probably Clear* ***w(I2,t,s)*** = ***w_0(I2)*** x ***p1*** x ***p2*** x ***p3*** x ***p5*** x ***cw1*** x ***cw3*** x ***a_sza*** x ***s0 (if shadow detected)*** *ELSE IF Cloud Confidence == Probably Cloudy* ***w(I2,t,s)*** = ***w_0(I2)*** x ***p1*** x ***p2*** x ***p3*** x ***p5*** x ***cw2*** x ***cw3*** x ***a_sza*** x ***s0 (if shadow detected)*** *END IF* *ELSE* ***w(I2,t,s)*** = ***w_0(I2)*** x ***p1*** x ***p2*** x ***p3*** x ***p5*** x ***w_x*** x ***a_sza*** x ***s0 (if shadow detected)*** *END*
Parameters for I5: ***p1(t,s)*** *= sea or fresh water present (0 = No, 1 = yes)* ***p2(t,s)*** *= fire detected (1 = Yes, 1 = No)* ***p6(t,s)*** *= I5 quality (0 = Poor, 1 = Good)* ***w_0(I5)*** *= I5 weighting factor from the Ice Quality PC= bandWgts(3) in Table 18* *Note: For other parameter definitions see Table 11, Table 12 and Table 13.*	*IF COT is not available* *IF Cloud Confidence == Probably Clear* ***w(I5,t,s)*** = ***w_0(I5)*** x ***p1*** x ***p2*** x ***p6*** x ***cw1*** x ***cw3*** *ELSE IF Cloud Confidence == Probably Cloudy* ***w(I5,t,s)*** = ***w_0(I5)*** x ***p1*** x ***p2*** x ***p6*** x ***cw2*** x ***cw3*** *END IF* *ELSE* ***w(I5,t,s)*** = ***w_0(I5)*** x ***p1*** x ***p2*** x ***p6*** x ***w_x*** *END*

Note that weighting of band I5 does not depend on the presence of sun glint. This is because I5 is a LWIR band, which is not affected by sun glint. The weights for band I1 and I2 are not set to 0 for fire and sun glint to allow retrievals to be produced for these conditions. Quality flags are set for these conditions.

2.1.2.7 applyToWeights (ProEdrViirsIceQual.cpp)

This function uses either COT data or VCM cloud properties to do thresholding and weighting on each of the ice pixels. The logic for using VCM cloud properties is detailed in Figure 5. Cloud weight LUT values corresponding to shadows only affect bands I1 and I2. This again is due to I5's bandwidth. All the other weight factors, calculated in this function, are computed for all three imagery bands. The cloud weighting parameters are listed in Table 6.

Figure 6 details the logic to compute additional weighting factors due to clouds. The weighting parameters are listed in Table 11. Since the COT IP is reported at 750-meters resolution and the Ice Quality is computed at the 375-meters, the COT values at each moderate resolution pixel must be replicated over the four imagery pixels.

Table 11. Weighting Parameters Computed in applyToWeights for VCM Cloud Properties

(See Table 5 for a description of "cloudWgts")

Band Weight Parameter	Definition/Computation
cw1(c,b) *where* *c(t,s) = 1-4 (cloud phase)* *b = band (I1, I2, I5)* *t = along-track,* *s = along-scan*	This is the cloud-weighting factor, from "cloud_wgts", which corresponds to a particular cloud phase and for each imagery band.
cw2(c,b) *where* *c(t,x) = 7 (cloud adjacency property)* *b = band (I1, I2, I5)* *t = along-track,* *s = along-scan*	This is the cloud-weighting factor, from "cloud_wgts", which corresponds to the cloud adjacency property and for each imagery band.
cw3(c,b) *where* *c(t,s) = 5 (cirrus cloud property)* *b = band (I1, I2, I5)* *t = along-track,* *s = along-scan*	This is the cloud-weighting factor, from "cloud_wgts", which corresponds to the cirrus cloud property and for each imagery band.
s0(t,s,c,b) *where* *t = along-track,* *s = along-scan* *c = 6 (shadow detected property)* *b = band (I1, I2)*	This is the cloud-weighting factor, from "cloud_wgts", which corresponds to the shadow detected property and for each imagery band.

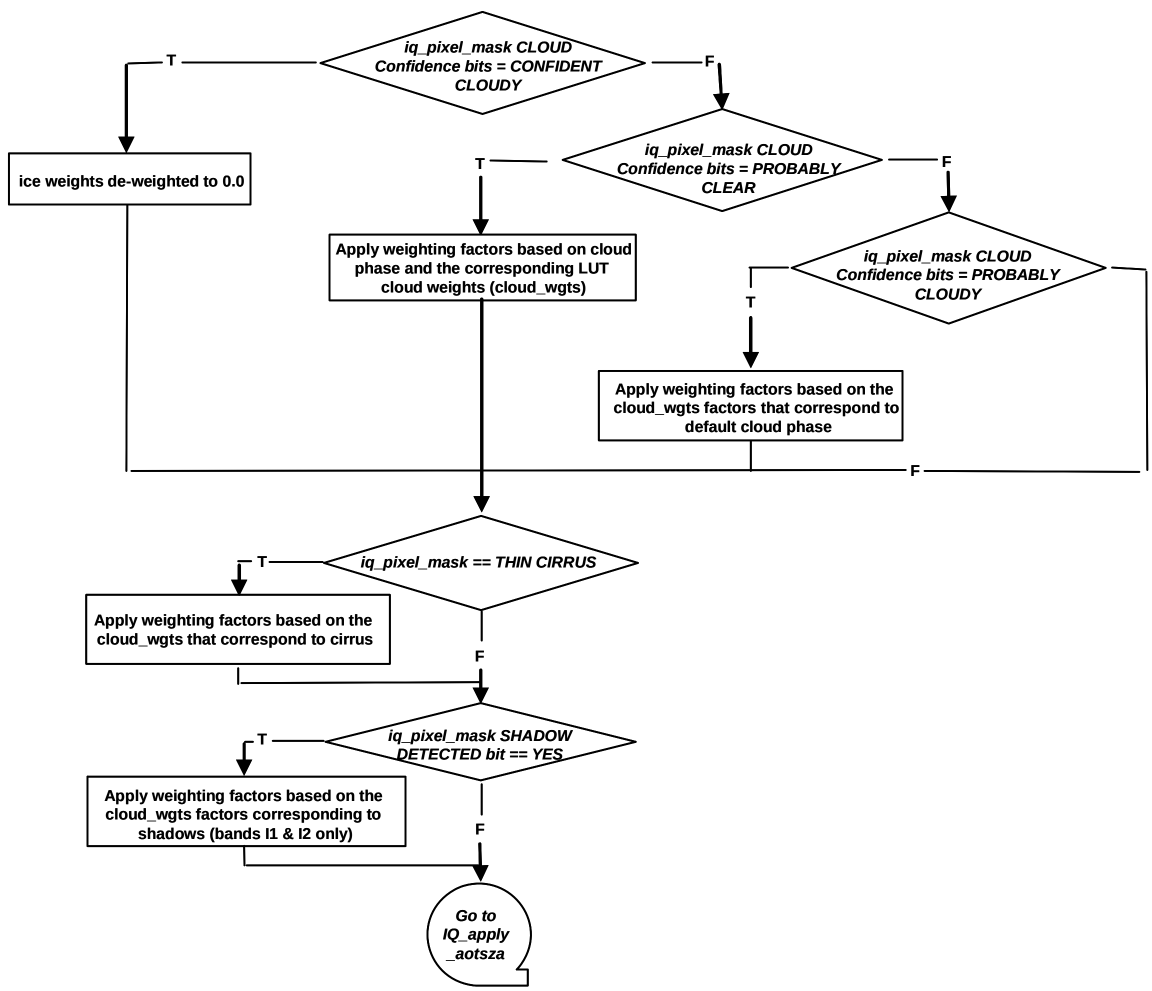

Figure 5. Logic Flow of Using VCM Cloud Properties in applyToWeights

Table 12. Weighting Parameters Computed in applyToWeights for COT

(See Table 5 for a description of “cloudWgts” and “cotThresh”.)

Band Weight Parameter	Definition/Computation
w_x(c,ct,b) *where* *c(t,s) = 1-4 (cloud phase)* *ct = cloud optical thickness* *b = band (I1, I2, I5)* *t = along-track,* *s = along-scan*	***w_x =[cot_thresh(c,1,b) – cot(t,s)]/*** ***[cot_thresh(c,1,b)-cot_thresh(c,2,b)]*** *where* *“cot_thresh” are the cloud optical thickness weighting factors extracted from the Ice Quality LUT.*
s0(t,s,c,b) *where* *t = along-track,* *s = along-scan* *c = 6 (shadow detected property)* *b = band (I1, I2)*	This is the cloud-weighting factor, from “cloud_wgts”, which corresponds to the shadow detected property and for each imagery band.

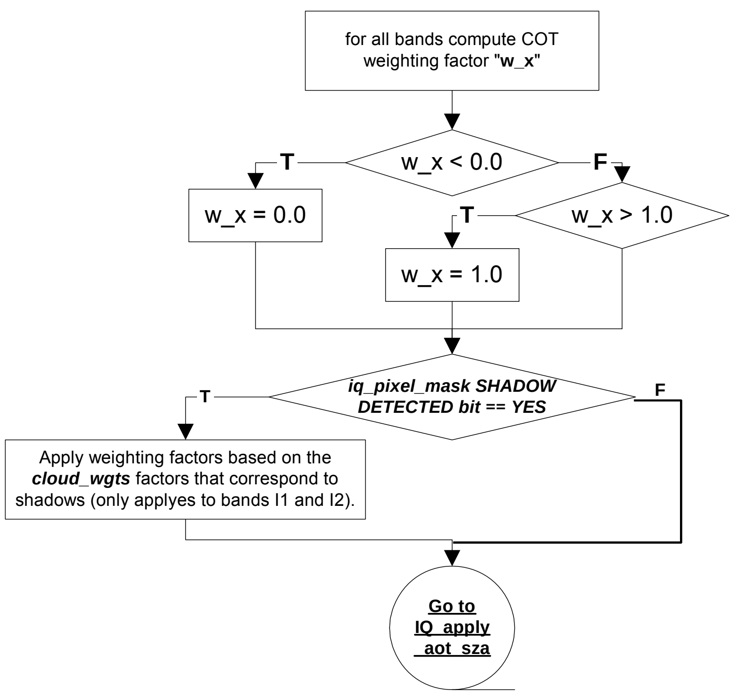

Figure 6. Logic Flow of Using COT Data in applyToWeights

2.1.2.8 applyAotSunZen (ProEdrViirsIceQual.cpp)

After applying weights due to cloud effects, this function computes weighting factors by interpolating solar zenith angle intersections for each reflectance band, given the AOT for a pixel. If any AOT (input from the AOT IP) is outside the boundaries of the AOT values defined in “aotBin”, the band weight is set to 0.0. This also occurs if the input LUT parameter of “aotBin” is out of order. See Table 5 for Ice Quality LUT description. After determining that the current AOT value for the pixel falls within the boundaries of “aotBin”, the code must determine which intermediate values of “aotBin” the AOT falls between. The two “aotBin” values serve as interpolation points. The following equation interpolates the solar zenith angles for each band reflectance band, given the AOT for the current pixel:

$$\theta_k(t,s,b) = \theta'_{i,k}(b)\left(\frac{\tau'_{i+1} - \tau(t,s)}{\tau'_{i+1} - \tau'_i}\right) + \theta'_{i+1,k}(b)\left(\frac{\tau(t,s) - \tau'_i}{\tau'_{i+1} - \tau'_i}\right),$$

where the $\theta'_{i,k}$, τ, and τ'_i represent the solar zenith angle values from the LUT parameter "**qAotSunZen**", AOT of the pixel, and the AOT intermediate boundary values (**aotBin**) respectively. The index *"i"* represents the column index in "aotBin" and "row" index in "**qAotSunZen**" as described in Table 1; *i = 1…4*. The index *"k"* corresponds to the "quality" of the interpolation, which refers to the "column" index in "**qAotSunZen**"; *k = 1 (Green/Yellow quality)* or *2 (Yellow/Red quality)*. The index "b" refers to the band bin index b=1 (VIIRS I1 band) or 2 (VIIRS I2 band). The weighting factor depends on the difference between θ_2 and θ_1 (where the indices correspond to ***k***). Figure 7 gives the logic flow of this function; see Table 13 for weighting calculation. As with the COT IP, the AOT IP values at each moderate resolution pixel must be replicated over the four imagery pixels.

Thermal band quality weights are not modified by AOT or solar zenith angle. The band specific quality weights are used to determine the "relative" retrieval quality of retrievals for each band (used to determine whether a VIIRS I1 band based retrieval is of better quality than a VIIRS I2 or Thermal band based retrieval.) Low light associated degradation of retrieval quality for reflectance based retrievals is inherently captured by relative quality weights, the setting of the Ice Quality Flags IP "relative" overall quality flags for each band and the algorithm branch flags in the downstream Sea Ice Age algorithm. The relative quality however are cumulative flags in the sense that other conditions such as cloud shadows can also lower the quality of reflectance bands relative to the thermal band. The quality weights are passed to the Sea Ice Concentration and the Sea Ice Age algorithms and are used internally to determine whether the overall retrieval is based on a reflective or thermal band. No explicit quality flag is implemented to indicate low light condition.

Table 13. Weighting Parameter Computation in applyAotSunZen

Band Weight Parameter	Definition/Computation
a_sza(τ, $\theta_{t,s}$ ***,b)*** *where* τ***(t,s)*** *= Aerosol Optical Thickness* *b = band (I1, I2), no I5 since only reflective bands are necessary* $\theta_{t,s}$ = Solar Zenith Angle of the pixel *t = along-track,* *s = along-scan*	*Weighting factor due to AOT where,* ***a_sza*** = $\frac{\theta_2 - \theta_{t,s}}{\theta_2 - \theta_1}$, ***a_sza*** = *0*, if $\theta_{t,s} \geq \theta_2$

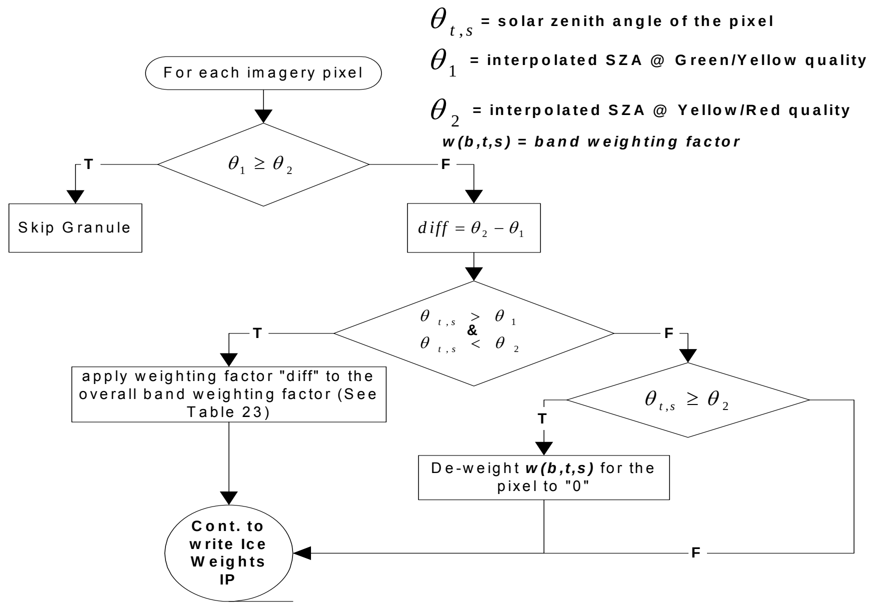

Figure 7. Logic Flow of applyAotSunZen

2.1.2.9 Current Issues

None.

2.1.3 Graceful Degradation

2.1.3.1 Graceful Degradation Inputs

There are two cases where input graceful degradation is indicated in the Sea Ice Quality EDR.

1. The primary input denoted in the algorithm configuration guide cannot be successfully retrieved but alternate input can be retrieved.
2. Graceful degradation is indicated if an input retrieved for the algorithm has its N_Graceful_Degradation metadata field set to YES (propagation).

Table 14 details the instances of this case for SIQ. Note that the shaded cells indicate that the graceful degradation was done upstream at product production.

Table 14. SIQ 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,PM1, TR1	VIIRS_GD_15.4.1 VIIRS AOT IP	VIIRS_GD_25.4.1 NAAPS	VIIRS_GD_15.4.1 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

When processing a Night scene, the AOT cannot be applied to the I1 and I2 weights. The Ice Weights for I1 and I2 are set to 0.0.

If an error occurs applying the AOT to the I1 and I2 weights, the Ice Weights for I1 and I2 are set to 0.0.

If the geolocation data is invalid, the Ice Quality Flags is set to RED for I1, I2, and I5. The Ice Weights are set to 0.0 for I1, I2, and I5.

2.1.5 Data Quality Monitoring

The only data quality monitoring is by way of the Ice Quality IP quality flags listed in Table 8.

2.1.6 Computational Precision Requirements

Single precision 32-bit floating point computations are required for the Ice Quality IP.

2.1.7 Algorithm Support Considerations

Table 15 contains the tunable algorithm parameters that may need adjustment throughout the SNPP and NPOESS program. Note that Table 15 no longer contains an entry for the parameter “fwRange” defined in previous versions of this OAD since it is not used by the algorithm and therefore not implemented in the operational algorithm.

Table 15. List of Tunable Algorithm Parameters

Input	Data Type/Size	Description/Source	Units/Valid Range
bandWgts	float*32 x IQ_N_BANDS	Initial Ice Quality Band Weights	Unitless/ bandWgts ≥ 0.0 bandWgts = `[0.3, 0.6, 0.1]`
cloudWgts	float*32 x IQ_N_CLD_TYPES x IQ_N_BANDS	Cloud weights corresponding to the three imagery bands (I1, I2, I5) and the seven cloud properties - four phases = Default (1), Water (2), Ice (3), Mixed (4), and 3 types = cirrus (5), shadow (6), adjacency (7); the parenthetical values correspond to the rows of the matrix shown in the “Units/Range” cell, the column represent the bands I1, I2, and I5	Unitless/ cloudWgts ≥ 0.0 cloudWgts = **(I1) (I2) (I5)** `[0.5, 0.5, 0.5;`**(1)** `0.5, 0.5, 0.5;`**(2)** `0.5, 0.5, 0.5;`**(3)** `0.5, 0.5, 0.5;`**(4)** `0.6, 0.6, 0.6;`**(5)** `0.3, 0.3, 1.0;`**(6)** `0.8, 0.8, 0.8]`**(7)**

Input	Data Type/Size	Description/Source	Units/Valid Range
cotThresh	float*32 x 4 x IQ_N_THRESH x IQ_N_BANDS	Cloud Optical Thickness Thresholds used when *cotThresh* == 1 (used COT to determine ***cloud confidence*** in the Ice Quality Flags IP output. The "4" in the "Data Type/Size" cell corresponds to the four phases (Default(1), Water(2), Ice(3), Mixed(4)). "IQ_N_THRESH" corresponds to the rows of each set of matrices which are a function of cloud phase; the "(1)'s" represent the YELLOW/RED cot thresholds and the "(2)'s" represent the GREEN/YELLOW COT thresholds.	Unitless/ cotThresh ≥ 0.0 cotThresh = **(Default,Water,Ice,Mixed)** **(I1) (I2) (I5)** [0.5, 0.5, 0.5;**(1)** 0.2, 0.2, 0.2]**(2)** (Phases follow the order shown above)
minNLat	float*32	Sea Ice Latitude Range – Minimum Northern Latitude	radians/ -PI/2 ≤ minNLat ≤ PI/2 ***(Currently set to 0.62831 (36°))***
maxSLat	float*32	Sea Ice Latitude Range – Maximum Southern Latitude	radians/ -PI/2 ≤ maxSLat ≤ PI/2 ***(Currently set to –0.87266 (-50°))***
aotBin	float*32 x IQ_N_AOT_BINS	AOT bin boundary values	Unitless/ aotBin ≥ 0.0 aotBin = [0.0,0.15,0.5,1.0]
qAotSunZen	float*32 x IQ_N_BANDS (I1,I2) x IQ_N_AOT_BINS x 2	Solar Zenith Angle values that correspond to the Solar Zenith Angle quality regimes (G/Y = "Green/Yellow", Y/R = "Yellow/Red", this corresponds to the "2" in the "Data Types/Size" column) and to the "aotBin" values (**(1) -> 0.0,(2) -> 0.15,(3) -> 0.5,(4) -> 1.0**)	Radians/ -PI/2 ≤ qAotSunZen ≤ PI (**I1,I2**) **(G/Y) (Y/R)** [1.308997(75°),1.48353(85°)**(1)** 1.22173(70°),1.48353(85°)**(2)** 1.13446(65°),1.39626(80°);**(3)** 1.04719(60°),1.308997(75°)]**(4)** (Bands follow the order shown above)
qualWgts	float*32 x IQ_N_WGTS x IQ_N_BANDS	Overall Ice Quality Band Weights for each band (**I1, I2, I5**) and for each set of weights for each band; the **(1)="RED"**, **(2)="YELLOW"** and **(3)="GREEN"** quality regions. Used in IQ_write_ice_mask()	Unitless/ qualWgts ≥ 0.0 qualWgts = **(I1) (I2) (I5)** [0.060,0.12,0.195;**(1)** 0.12 ,0.24,0.39 ;**(2)** 0.02 ,0.04,0.065]**(3)**

The tunable parameters described and defined in table 15 consist of two categories: 1) relative empirical and 2) physical. Empirical parameters define the relative quality weights were 0 is bad quality and 1 represents good quality The recommended values listed in table 16 are empirically based on testing with MODIS proxy scenes. Physical parameters are those such as angle and latitude, longitude thresholds and AOT quality weight bin values. These thresholds are determined based on inspection of the MODIS proxy scenes tested. Optimal values are to be determined during calibration/validation.

2.1.8 Assumptions and Limitations

2.1.8.1 Assumptions

None identified.

2.1.8.2 Limitations

None identified.

2.2 Surface Temperature Description

The ST IP retrieval algorithm and its theoretical basis are described in detail within the VIIRS IST Algorithm Theoretical Basis Document, 474-00052. The operational implementation of the IST EDR algorithm is described in the Operational Algorithm Description Document for the VIIRS Ice Surface Temperature (IST) EDR, 474-00072.

The purpose of the ST IP module is to retrieve the Surface Temperature for each cloud-free ocean pixel at VIIRS imagery-resolution. Brightness Temperature data from the VIIRS SDR, VIIRS Aerosol Optical Thickness (AOT) IP, VIIRS Ice Quality Flags IP and Ice Weight IP are used to decide whether the pixel is processed and, whether to use a 2-band split window baseline algorithm or a single-band split window fallback algorithm. The ST IP is retrieved using a regression equation with separate coefficients for day and for night retrievals. ST and ST quality information are written to the VIIRS ST IP. Figure 8 below shows the ST IP Processing Chain.

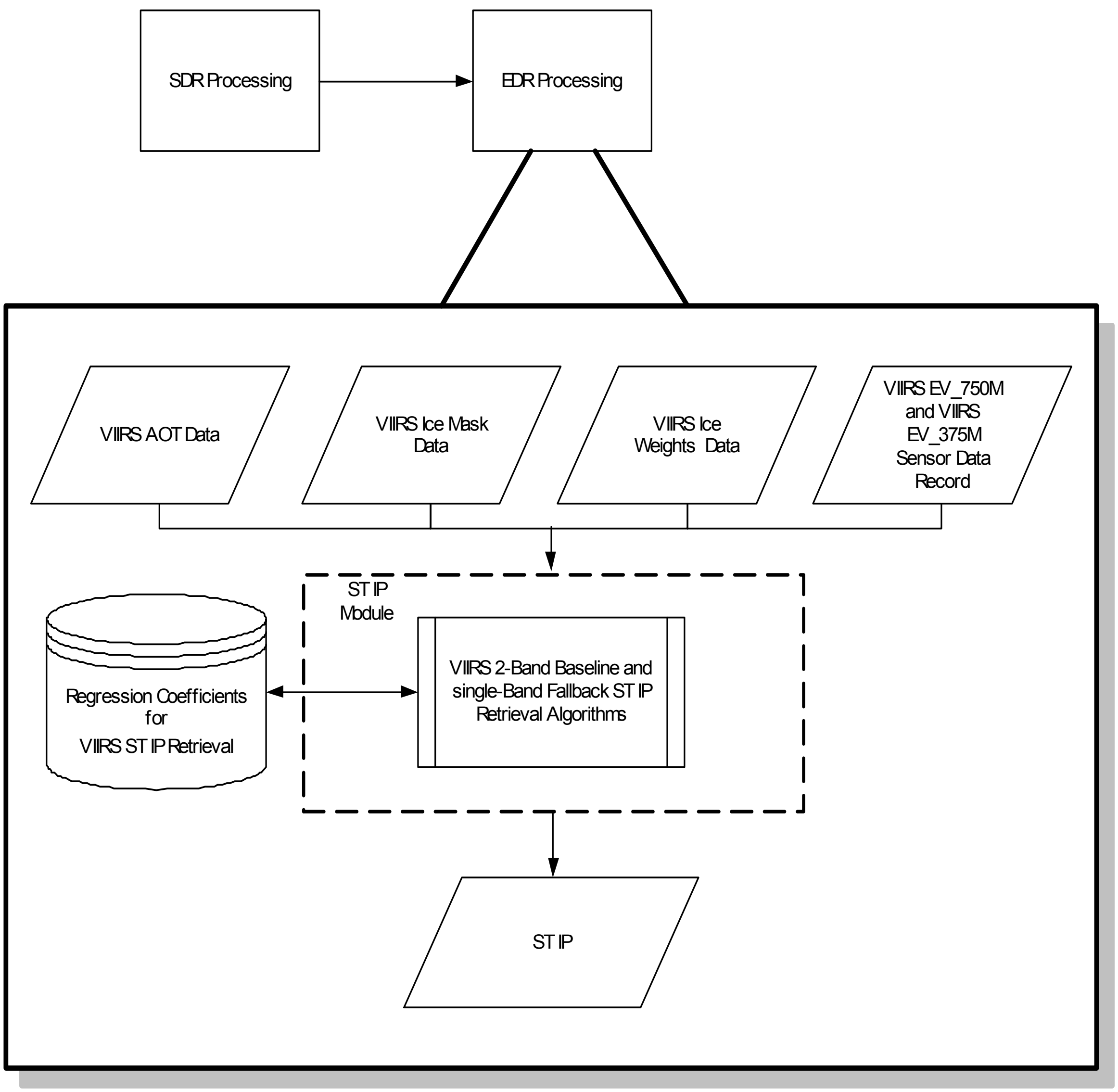

Figure 8. Surface Temperature IP Processing Chain

2.2.1 Interfaces

Table 16 shows the global constant attributes of the Surface Temperature IP unit.

Table 16. Surface Temperature Global Attributes

Input	Type	Description/Source	Units/Valid Range
VIIRS_RDR_SCANS	Int32	Number of RDR scans	Unitless/ VIIRS_RDR_SCANS > 0 ***(Currently set to 48)***
M_DETECTORS	Int32	Number of Moderate detectors	Unitless/ M_DETECTORS > 0 ***(Currently set to 16)***
I_DETECTORS	Int32	Number of Image detectors	Unitless/ I_DETECTORS > 0 ***(Currently set to 32)***
M_VIIRS_SDR_ROWS	Int32	Number of moderate VIIRS rows	Unitless/ VIIRS_RDR_SCANS * M_DETECTORS
M_VIIRS_SDR_COLS	Int32	Number of moderate VIIRS columns	Unitless/ M_VIIRS_SDR_COLS > 0 ***(Currently set to 3200)***
I_VIIRS_SDR_ROWS	Int32	Number of image VIIRS rows	Unitless/ VIIRS_RDR_SCANS * I_DETECTORS
I_VIIRS_SDR_COLS	Int32	Number of image VIIRS columns	Unitless/ I_VIIRS_SDR_COLS > 0 ***(Currently set to 6400)***
VIIRS_MODERATE_PIXEL_COUNT	Int32	Number of moderate columns X rows	Unitless/ M_VIIRS_SDR_ROWS * M_VIIRS_SDR_COLS
STIP_LUT_MAX_TERMS	Int32	Max dimension of the term field used in ST IP LUT	Unitless / STIP_LUT_MAX_TERMS > 0 ***(Currently set to 4)***
STIP_LUT_MAX_DN	Int32	Max dimension of LUT day/night dimension	Unitless / STIP_LUT_MAX_DN > 0 ***(Currently set to 2)***
STIP_LUT_MAX_ALG	Int32	Max dimension of LUT algorithm field, refers to ST IP algorithm approaches	Unitless / STIP_LUT_MAX_ALG > 0 ***(Currently set to 2)***
STIP_LUT_2BAND_COEFFS	Int32	Indices representing coefficients $a_0 \ldots a_3$	Unitless / STIP_LUT_2BAND_COEFFS > 0 ***(Currently set to 4)***
STIP_LUT_1BAND_COEFFS	Int32	Indices representing coefficients a_0, a_1	Unitless / STIP_LUT_1BAND_COEFFS > 0 ***(Currently set to 2)***
STIP_LUT_DAY_INDEX	Int32	Key to LUT day dimension	Unitless / STIP_LUT_DAY_INDEX => 0 ***(Currently set to 1)***
STIP_LUT_NIGHT_INDEX	Int32	Key to LUT night dimension	Unitless / STIP_LUT_NIGHT_INDEX => 0 ***(Currently set to 0)***

2.2.1.1 Inputs

Table 17 lists the inputs to the Surface Temperature algorithm.

Table 17. Surface Temperature Inputs

Input	Data Type/Size	Description/Source	Units/Valid Range
Latitude	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Latitude @ Imagery Resolution, from IMG Geolocation SDR	Radians/ $-PI/2 \leq$ Latitude $\leq PI/2$ *FILL_VALUE = -999.9*

Input	Data Type/Size	Description/Source	Units/Valid Range
Longitude	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Longitude @ Imagery Resolution, from IMG Geolocation SDR	Radians/ -PI ≤ Longitude ≤ PI *FILL_VALUE = -999.9*
satzen	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Sensor Zenith Angle @ Imagery Resolution, from IMG Geolocation SDR	Radians/ -PI/2 ≤ satzen ≤ PI/2 *FILL_VALUE = -999.9*
satazi	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Sensor Azimuth Angle @ Imagery Resolution, from IMG Geolocation SDR	Radians/ -PI ≤ satazi ≤ PI *FILL_VALUE = -999.9*
BT_M15	float*32 x M_VIIRS_SDR_ROWS X M_VIIRS_SDR_COLS	Brightness Temperature of Band M15 / VIIRS 750 m resolution SDR	Kelvin / 190 K < BT_{M15} < 343 K Fill_VALUE= 65535 (Integer Scaled)
BT_M16	float*32 x M_VIIRS_SDR_ROWS X M_VIIRS_SDR_COLS	Brightness Temperature of Band M16 / VIIRS 750 m resolution SDR	Kelvin / 190 K < BT_{M16} < 340 K Fill_VALUE= 65535 (Integer Scaled)
BT_I5	float*32 x I_VIIRS_SDR_ROWS X I_VIIRS_SDR_COLS	Brightness Temperature of Band I5 / VIIRS 375 m resolution SDR	Kelvin / 190 K < BT_{I5} < 340 K Fill_VALUE= 65535 (Integer Scaled)
AOT	float*32 x M_VIIRS_SDR_ROWS x M_VIIRS_SDR_COLS	Aerosol Optical Thickness (550nm) @ 750m	Unitless/ AOT >= 0.0 *FILL_VALUE = -999.9*
VCM	VIIRS_MODERATE_PIXEL_COUNT	Cloud Mask Flags	VCMLANDWATER, VCMQUAL, VCMCONF, VCMADJCONF, VCMCIRSOL, VCMCIRIR, VCMTHINCIR, VCMSHADOW, VCMOBSTRUCT, VCMPHASE, VCMFIRE, VCMGLINT
STIP LUT	See Table 18	See Table 18	See Table 18

Table 18 contains the Surface Temperature algorithm LUT description.

Table 18. Surface Temperature LUT Description

Input	Type	Description/Source	Units/Valid Range
StipCoeffs[term][day/night][algorithm][regime]	float*32 x nterms x ndaynight x nalgorithms x nregimes	LUT Coefficients / ST IP LUT data file	See Algorithm section below

2.2.1.2 Outputs

2.2.1.2.1 Surface Temperature (ST) IP Unit

The ST IP contains two output fields (see Table 19): an ST value in Kelvin and ST IP Quality Flag (QF) for each moderate resolution pixel. Refer to the CDFCB-X, 474-00001, for a detailed description of the outputs. One input (VIIRS Surface Temperature IP) is described in the IDFCB, 474-00020-03-B0123 IDFCB Vol III, Note that ST IP is a required input for the VIIRS Ice Concentration algorithm.

Table 19. Surface Temperature IP Outputs

Output	Data Type/Size	Description	Units/Range
Surface Temperature	float*32 x I_VIIRS_SDR_ROWS x I_VIIRS_SDR_COLS	Surface temperature	Units: degrees Kelvin Range: T > 0 Fill: -999.9
STIP Quality Flags	Int*8 x I_VIIRS_SDR_ROWS x I_VIIRS_SDR_COLS	ST IP Quality Flags	Units: none See Table 20

Table 20. Surface Temperature IP QF Output Bits and Descriptions

Byte	Bit	Flag Description Key	Result
0	0-1	ST IP Quality	Bit 1 Bit 0 0 0 = High 0 1 = Medium 1 0 = Low 1 1 = No Retrieval
	2	AOT Condition (VIIRS 550 nm band)	0 = Within range, (0 <= AOT <= 1.0) 1 = Outside range
	3	Day/Night	0 = Night, (85^o < Solar Zenith Angle) 1 = Day, (0^o <= Solar Zenith Angle <= 85^o)
	4	Fire Detection	0 = No 1 = Yes
	5	Shadow Detected	0 = No 1 = Yes
	6	Cloud Indicator	0 = Not Confidently Cloudy 1 = Confidently Cloudy
	7	Cirrus Indicator	0 = Not Cloudy 1 = Cloudy (Solar & IR)

2.2.2 Algorithm Processing

2.2.2.1 Main Module - calcSurfTemp() (ST IP)

The objective of the ST IP algorithm is to calculate the ocean and sea-ice surface temperature at each pixel indicated by the VIIRS Ice Quality Flags IP at VIIRS imagery resolution (375 m) when all the necessary inputs are available. Two similar regression algorithms are used to perform this retrieval:

1) A baseline 2-band split window algorithm which uses the brightness temperature from a pair of VIIRS wavebands in the Long-Wavelength Infrared (LWIR) atmospheric window (Bands M15 and M16) at moderate resolution and Band I5 at imagery resolution, and
2) A fallback single-band algorithm where only the LWIR band I5 at imagery resolution is used.

Quality assessment flags for each pixel are stored in the ST IP Flag output.

This module is called by calcIqStip (see Section 2.1.2.5). Sections 2.2.2.2 through 2.2.2.4 provide a detailed description of this module.

2.2.2.2 ST IP Logic

The ST IP's retrieval logic flow diagram is provided in Figure 9. The core logic occurs in two functions, setStipQualFlags()and calculateSt(). In the current implementation, ST IP QFs additionally serve as decision flags. Their values are used in the decision of whether ST IP can be retrieved and, if so, which algorithm to use.

ST IP is not retrieved if any of the following conditions occur:

- The pixel is confidently cloudy, or
- Band I5 Brightness Temperature is outside the SDR defined range, or
- The pixel is "Not to process".

These pixels are filled (-999.9) and marked with an ST IP quality flag of "No Retrieval".

For the pixels that are processed, ST IP is retrieved by either the baseline 2-band split-window algorithm or the single-band fallback algorithm. In general, the 2-band split-window algorithm is used under optimal conditions: "to process" pixel indicated by the Sea Ice Range flag, no fire, and "in-range" brightness temperatures for the M15 and M16 and I5 bands. Otherwise, the single-band fallback algorithm is used. The logic to determine which algorithm is used is provided in the ST IP QF Logic table, Table 21.

The equations for the 2-band split-window and single-band algorithms are specified in Table 22. The implementation is presented in calculateSt(). Daytime and nighttime retrievals are identical except with different sets of regression coefficients in the LUT.

For an off-nominal condition where a negative ST IP is retrieved, the ST IP field is filled with -999.9 and the ST IP quality bit field is set to "No Retrieval".

The AOT values from the VIIRS band 550 nm are used. Final data type of AOT and its availability are subject to change and should be verified once becoming available.

2.2.2.3 ST IP QF Logic

ST IP Flags consist of one 8-bit word shown in Table 20. The logic to set these quality flags is performed in function setStipQualFlags()and provided in Table 21. The first byte of the ST IP quality flags is written as output for use by the Sea Ice Concentration algorithm.

Overall quality of the ST IP pixel is represented by the quality bit field. Pixel quality is flagged as "No Retrieval" when the following applies:

- (BT_I5 is outside range) or (Pixel is "not to process" indicated by the VIIRS Ice Quality Flags IP) or (Cloud Confidence is "Confidently Cloudy")
- ST <= 0 (Determined after an attempt is made to retrieve ST IP).

2.2.2.4 ST IP LUT Coefficient Selection

A unique set of regression coefficients is derived offline for ST IP. Each ST IP equation (Table 22) uses a different set of coefficients for a given day/night condition. Access to the coefficients is achieved by setting index values based on the given pixel viewing conditions and indicating which algorithm approach to use. Once these indices are specified, coefficients are retrieved for the desired ST IP algorithm by selecting a specific “term” index. For example, currently the “regime” index should be set to “0” and has only one value. It is a placeholder for possible future improvement by further stratification of atmospheric conditions. For the 2-band split window algorithm, there are four coefficients. For the fallback single-band algorithm, there are two coefficients. For the latter, an additional zero-valued coefficient is present as “filler” in the LUT file.

Example:

> LUTCoeffs[n][1][0], where n is indexed from 0 to 3, corresponds to the coefficients a_0 to a_3 of the 2-band split window algorithm under daytime viewing conditions.

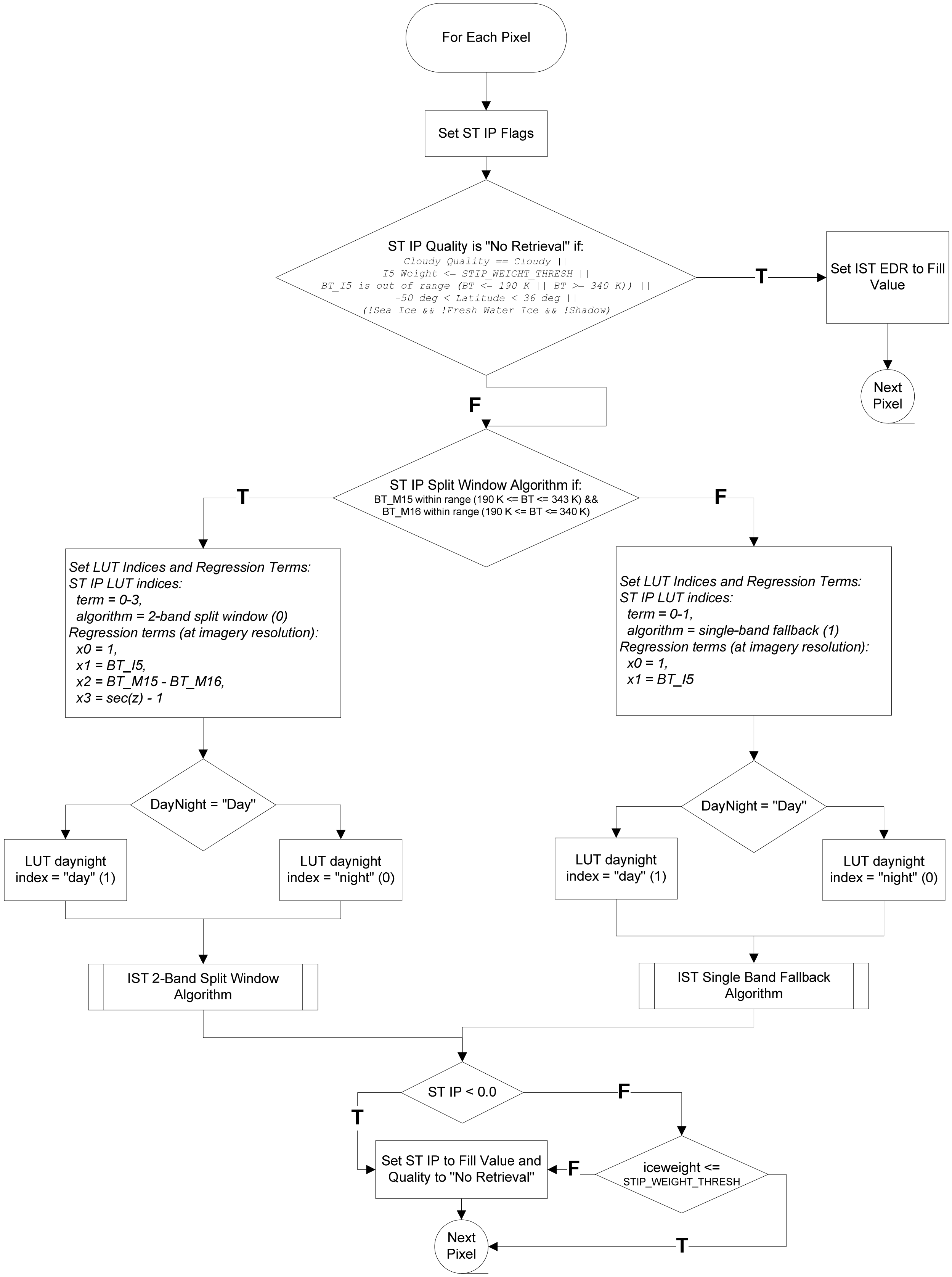

Figure 9. Surface Temperature IP Retrieval Logic Flow

Table 21. Surface Temperature IP QF Logic

ST IP Flag	Input Source	Flag Setting
Sea Ice Flag	VIIRS Ice Quality Flags IP/Sea Ice Range Flag	ST IP Sea Ice Flag = VIIRS Ice Quality Flags IP Sea Ice Range Flag
Fresh Water Ice Flag	VIIRS Ice Quality Flags IP/Fresh Water Ice Range Flag	ST IP Fresh Water Ice Flag = VIIRS Ice Quality Flags IP Fresh Water Ice Range Flag
Band M15 Brightness Temperature Range	VIIRS Earth View 750-meter SDR	if (190 K < BT_{M15} < 343 K) set to "within range" otherwise set to "out of range" end if
Band M16 Brightness Temperature Range	VIIRS Earth View 750-meter SDR	if (190 K < BT_{M16} < 340 K) set to "within range" otherwise set to "out of range" end if
Band I5 Brightness Temperature Range	VIIRS Earth View 375-meter SDR	if (190 K < BT_{I5} < 340 K) set to "within range" otherwise set to "out of range" end if
Band I5 Quality	VIIRS Ice Quality Flags IP/I5 Quality Flag	I5 Quality Flag = VIIRS Ice Quality Flags IP I5 Quality
Band I5 Overall Quality	VIIRS Ice Quality Flags IP/I5 Overall QF	I5 Overall Quality Flag = VIIRS Ice Quality Flags IP I5 Overall Quality Flag
AOT Condition	VIIRS AOT IP	if (0 <= AOT <= 1.0) set to "within range" otherwise set to "out of range" end if
Day/Night	VIIRS Earth View 375-meter SDR	if (0^o <= Solar Zenith Angle <= 85^o) set to "Day" otherwise set to "Night" end if
Cloud Shadow	VIIRS Ice Quality Flags IP/Cloud Shadow Flag	ST IP Cloud Shadow Flag = VIIRS Ice Quality Flags IP Cloud Shadow Flag
Fire Detection	VIIRS Ice Quality Flags IP/Fire Detection Flag	ST IP Fire Flag = VIIRS Ice Quality Flags IP Fire Flag
Cloud Confidence Indicator	VIIRS Ice Quality Flags IP/Cloud Confidence Indicator	ST IP Cloud Confidence Flag = VIIRS Ice Quality Flags IP Cloud Confidence Flag
Cirrus Confidence Indicator	VIIRS Ice Quality Flags IP/Cirrus Confidence Indicator	ST IP Cirrus Quality Flag = VIIRS Ice Quality Flags IP Cirrus Confidence Flag
Algorithm	Logical combination of ST IP Flags	if (BT_{M15} is "within range") and (BT_{M16} is "within range") and (BT_{I5} is "within range") set to "2-Band" otherwise set to "1-Band" end if
ST IP Retrieval Quality	Logical combination of ST IP Flags	See Logic Table

Table 22. Surface Temperature IP Core Equations

VIIRS ST IP Baseline Split Window Algorithm

Daytime:

$$ST = a_0 + a_1 t_{I5} + a_2 (T_{M15} - T_{M16}) + a_3 (\sec\theta - 1)$$

Nighttime:

$$ST = b_0 + b_1 t_{I5} + b_2 (T_{M15} - T_{M16}) + b_3 (\sec\theta - 1)$$

VIIRS ST IP fallback single-band algorithm

Daytime:

$$ST = a_0 + a_1 t_{I5}$$

Nighttime:

$$ST = b_0 + b_1 t_{I5}$$

where

- *ST* is the retrieved ice surface temperature at imagery resolution,
- a_n and b_n are coefficients in the ST IP LUT and are dependent on day/night conditions,
- θ is the sensor zenith angle,
- T_λ is the brightness temperature at λ = VIIRS Bands M15, M16,
- t_{I5} is the brightness temperature at 11.5 µm = VIIRS Band I5.

The equations above correspond to the IST ATBD (474-00052) Appendix A, Section A.3.3.2 and A.3.3.3, Equations (A-13) and (A-14) with minor modifications.

2.2.3 Graceful Degradation

2.2.3.1 Graceful Degradation Inputs

See Section 2.1.3.1.

2.2.3.2 Graceful Degradation Processing

None.

2.2.3.3 Graceful Degradation Outputs

None.

2.2.4 Exception Handling

When ST IP cannot be retrieved due to conditions such as invalid SDR data, cloudy pixel, non-processing pixel, ST IP pixel values are set to a FILL_VALUE of -999.9. The ST IP QFs are unaffected by this condition and should still be set as they provide information on why the ST IP was not retrieved successfully.

2.2.5 Data Quality Monitoring

The only data quality monitoring is by way of the Surface Temperature IP quality flags listed in Table 20.

2.2.6 Computational Precision Requirements

Single precision 32-bit floating point computations are required for the Surface Temperature IP.

2.2.7 Algorithm Support Considerations

Table 23 contains the algorithm parameter coefficients that may need updating throughout the SNPP and NPOESS program. Table 23 contains the Surface Temperature algorithm LUT description.

Table 23. Surface Temperature LUT Description

Input	Type	Description/Source	Units/Valid Range
StipCoeffs[term] [day/night] [algorithm][regime]	float*32 x nterms x ndaynight x nalgorithms x nregimes	LUT Coefficients / ST IP LUT data file	See Algorithm section above

2.2.8 Assumptions and Limitations

2.2.8.1 Assumptions

The ST IP retrieval algorithm assumes VIIRS 375 M SDR, VIIRS 750 M SDR, VIIRS Ice Quality Flags IP, VIIRS Ice Weights IP, and VIIRS AOT IP are available before processing.

2.2.8.2 Limitations

The ST IP is retrieved under clear conditions with known ice type classification and valid brightness temperature from at least the VIIRS I5 band, and with 0.0 <= AOT < 1.

3.0 GLOSSARY/ACRONYM LIST

3.1 Glossary

Table 24 contains terms most applicable for this OAD.

Table 24. 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: 1. A theoretical description (i.e., science/mathematical basis) 2. A computer implementation description (i.e., method of solution) 3. A computer implementation (i.e., code)
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.
Ancillary Data	Any data which is not produced by the NPOESS System, but which is acquired from external providers and used by the NPOESS system in the production of NPOESS data products.
Auxiliary Data	Auxiliary Data is defined as data, other than data included in the sensor application packets, which is produced internally by the NPOESS system, and used to produce the NPOESS deliverable data products.
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)	*[IORD Definition]* 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.). *[Supplementary Definition]* 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.
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.

Term	Description
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.
Raw Data Record (RDR)	*[IORD Definition]* Full resolution digital sensor data, time referenced and earth located, 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. *[Supplementary Definition]* 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.
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)	*[IORD Definition]* Data record produced when an algorithm is used to convert Raw Data Records (RDRs) to calibrated brightness temperatures with associated ephemeris data. The existence of the SDRs provides reversible data tracking back from the EDRs to the Raw data. *[Supplementary Definition]* 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.

Term	Description
Temperature Data Record (TDR)	*[IORD Definition]* 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. *[Supplementary Definition]* 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.

3.2 Acronyms

Table 25 contains terms most applicable for this OAD.

Table 25. Acronyms

Term	Expansion
ACO	Atmospheric Correction over Ocean
AM&S	Algorithms, Models & Simulations
API	Application Programming Interfaces
ARP	Application Related Product
CDFCB-X	Common Data Format Control Book - External
CDR	Climate Data Records
CI	Configured Item
COT	Cloud Optical Thickness
DMS	Data Management Subsystem
DPIS ICD	Data Processor Inter-subsystem Interface Control Document
DQN	Data Quality Notification
IET	IDPS Epoch Time
IIS	Intelligence and Information Systems
INF	Infrastructure
ING	Ingest
IP	Intermediate Product
LUT	Look-Up Table
MDFCB	Mission Data Format Control Book
PRO	Processing
PW	Precipitable Water
QF	Quality Flag
RTM	Radiative Transfer Model
SDR	Sensor Data Records
SI	Software Item or International System of Units
SST	Sea Surface Temperature
ST	Surface Temperature
SWS	Surface Wind Speed
TBD	To Be Determined
TBR	To Be Resolved
TOA	Top of the Atmosphere
VCM	VIIRS Cloud Mask

4.0 OPEN ISSUES

Table 26. TBXs

TBX ID	Title/Description	Resolution date
None		