JPSS Risk Reduction: Uniform Multi-Sensor Clouds, Aerosols, and Cryosphere Algorithms for Consistent Products

Algorithm Readiness Review

Dec 15, 2015

Presented By: Walter Wolf[1], Andy Heidinger[1], Mike Pavolonis[1], Jeff Key[1], Shobha Kondragunta[1], Istvan Laszlo[1], Peter Romanov[3], Andy Walther[4], Pat Heck[4], and Veena Jose[5]

[1] NOAA/NESDIS/STAR

[2] NOAA/NESDIS/OSPO

[3] CREST

[4] CIMSS

[5] IMSG

Review Agenda

• Introduction	12:00 pm – 12:15 pm	Wolf
• Risks & Actions	12:15 pm – 12:30 pm	Wolf
• Requirements	12:30 pm – 1:00 pm	Wolf
• Algorithm Readiness	1:00 pm – 3:00 pm	
» Clouds		Heidinger/ Pavolonis/ Heck/ Walther
» Aerosols		Laszlo/ Kondragunta/ Pavolonis
» Cryosphere		Key/Yinghui/Xuanji/ Romanov
• Software Architecture	3:00 pm – 4:30 pm	Jose
• Delivered Algorithm Package	4:30 pm – 4:45 pm	Wolf
• Risks Summary	4:45 pm – 4:55 pm	Wolf
• Summary and Conclusions	4:55 pm – 5:00 pm	Wolf

Outline

- Introduction
- Risks and Actions
- Requirements
- Algorithm Readiness
- Software Architecture
- Delivered Algorithm Package
- Risks Summary
- Summary and Conclusions

Introduction

Presented by

Walter Wolf

Contents

- Project Objectives
- Stakeholders
- Teams
- Project Plan
- Entry and Exit Criteria

Project Background

- NWS requests continuity of NOAA products between current and future NOAA operational satellites
- Demonstration of cost effective processing for NOAA JPSS products
- Demonstration of NOAA's goal of enterprise solutions by employing same algorithms for "POES" and "GOES"
- Supports NWS OS&T implementation strategy of multi-sensor algorithms and products

Project Background – NDE

- Disseminate JPSS/S-NPP Data Records to customers.
- Generate and disseminate tailored JPSS/S-NPP Data Records (versions of JPSS/S-NPP Data Records in previously agreed alternative formats and views).
- Generate and disseminate NOAA-unique products (augmented environmental products constructed from JPSS/S-NPP Data Records).
- Deliver NOAA-unique products, product processing elements, and associated metadata to CLASS for long-term archiving.
- Provide services to customers, including NDE product training, product enhancement, and implementation support across NOAA.
- Provide software for JPSS/S-NPP Data Record format translation and other data manipulations.

Project Objectives

- Modification of the NOAA Heritage Cloud, Cryosphere, Volcanic Ash, and Aerosol algorithms to work on VIIRS data
- This will bring scientific consistency between the current operational products, GOES-R products and VIIRS products
- Run the product system within NDE 2.0

Products Objectives
Cloud Products

- Cloud Mask
- Cloud Top Phase
- Cloud Type
- Cloud Top Height
- Cloud Top Temperature
- Cloud Top Pressure
- Cloud Optical Depth
- Cloud Particle Size Distribution
- Cloud Liquid Water
- Cloud Ice Water Path

Products Objectives
Aerosol Products

- Aerosol Detection – Smoke & Dust
- Aerosol Optical Depth
- Aerosol Particle Size
- Volcanic Ash Mass Loading
- Volcanic Ash Height

Products Objectives
Cryosphere Products

- Ice Concentration and Cover
- Ice Surface Temperature
- Ice Thickness/Age
- Snow Cover
- Fractional Snow Cover – Reflectance based & NDSI

JPSS Risk Reduction Integrated Product Team

- IPT Lead: Walter Wolf (STAR)
- IPT Backup Lead: Shuang Qiu (OSPO)
- NESDIS team:
  - » STAR: Andy Heidinger, Jeff Key, Shobha Kondragunta, Istvan Laszlo, Mike Pavolonis, Lihang Zhou
  - » OSPO: A. K. Sharma, Hanjun Ding, Zhaohui Cheng, Chris Sisko, Donna McNamera
  - » OSGS: Tom Schott, Rick Vizbulis, Geof Goodrum
  - » NOAA JPSS: Mitch Goldberg, Arron Layns, Neal Baker
  - » NIC: Sean Helfrich, Pablo Clemente
  - » Data Center: Lei Shi (NCDC)
  - » Others: Peter Romanov (CREST), William Straka III, Ray Garcia, Andi Walther, Pat Heck (CIMSS), Shanna Sampson, John Lindeman, Tianxu Yu, Aiwu Li, Alexander Ken, Hua Xie, Michael Walters, Ruiyue Chen, Valerie Mikles, Veena Jose (IMSG)
- User team
  - » Lead: Kevin Schrab (NWS), Mike Johnson(NWS), John Derber (NWS/NCEP/EMC), Jeff Ator (NWS/NCEP/NCO), Sid Boukabara (JCSDA), Carven Scott (NWS), VAACs
  - » Others: International NWP users, NWP FOs, Climate Users
- POPs involved: EPOP, ICAPOP, CAL/NAVPOP, ACPOP, SURPOP

Project Stakeholders

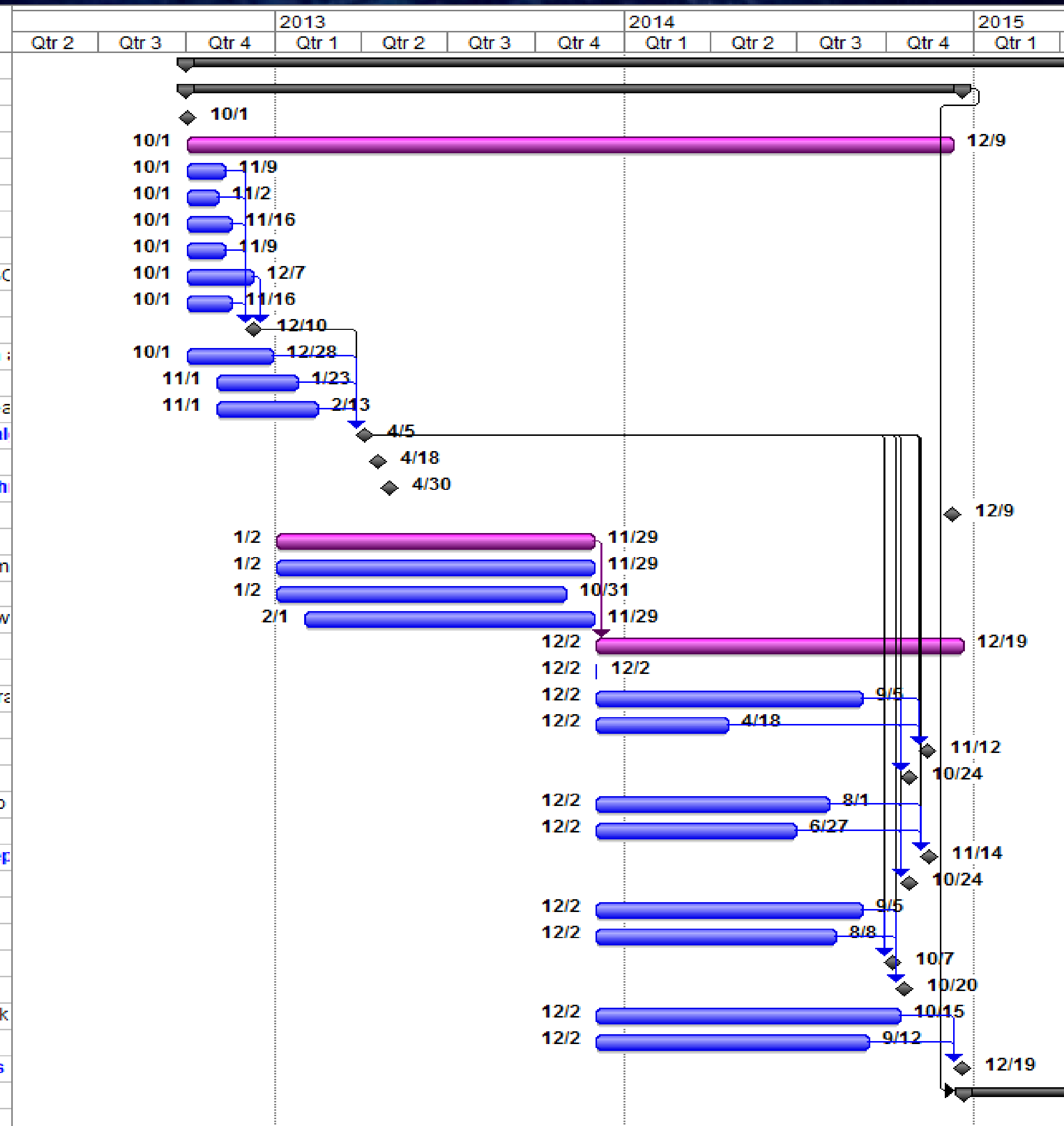
- OSPO
- STAR
- OSGS
- NOAA National Weather Service
- Department of Defense
- National Ice Center
- Global NWP

Project Plan

- Design and Development (2012 – 2014)
  - » Develop Requirements Document
  - » Product leads to identify updates to the algorithms to work with VIIRS data
  - » Identify ancillary data for the algorithms
  - » Conduct CDR
  - » Algorithm development
  - » Implement algorithms within the Framework
  - » Conduct UTRR

Project Timeline
Design and Development

ID	Task Name
1	**JPSS Risk Reduction**
2	**Development Phase**
3	IPT Lead informed to begin product development
4	**Algorithm Evaluation/Preliminary Development**
5	Initial Archive Requirements identified
6	Quality Monitoring Concept Defined
7	Long-term Maintenance Concept Defined
8	Development processing system defined
9	Evaluate the modifications required to create VIIRS products from the GC
10	Initial Information Technology (IT) Security concept defined
11	Requirements Review
12	Preliminary development Aerosol, Cloud, Cryosphere and Volcanic Ash a
13	Identify ancillary data inputs for all the algorithms
14	Preliminary development of infrastructure to implement the NetCDF4 rea
15	Critical Design Reviews for Cloud Mask, Phase, Height, and NCOMP al
16	Critical Design Review for Cryosphere Ice and Snow Cover
17	Critical Design Review for Aerosol, Volcanic Ash, and DCOMP algorith
18	Critical Design Review for Fractional Snow Cover
19	**Algorithm Development**
20	Development of Aerosol, Cloud, Cryosphere and Volcanic Ash algorithm
21	Define Aerosol, Cloud, Cryosphere and Volcanic Ash output files
22	Development of infrastructure to implement the NetCDF4 readers and w
23	**Algorithm Implementation/Testing/Demonstration**
24	Begin documentation of the framework
25	Implement Cloud Mask, Height, Phase and COMP algorithms into the fra
26	Cloud Mask, Height, Phase and COMP test cases processed
27	Test Readiness Review for Cloud Mask, Height, Phase and COMP
28	Deliver preliminary Cloud DAP to NDE
29	Implement Aerosol Detection and Aerosol Optical Depth algorithms into
30	Aerosol Detection and Aerosol Optical Depth test case processed
31	Test Readiness Review for Aerosol Detection and Aerosol Optical Dep
32	Deliver preliminary Aerosol DAP to NDE
33	Implement Cryosphere algorithms into the framework
34	Cryosphere algorithm test case processed
35	Test Readiness Review for Cryosphere(Ice only) algorithms
36	Deliver preliminary Cryosphere(Ice only) DAP to NDE
37	Implement Snow Cover and Volcanic Ash algorithms into the framework
38	Snow Cover and Volcanic Ash test case processed
39	Deliver preliminary DAP for Snow Cover and Volcanic Ash Algorithms
40	**Pre-operational Phase**
63	**Operational Phase**

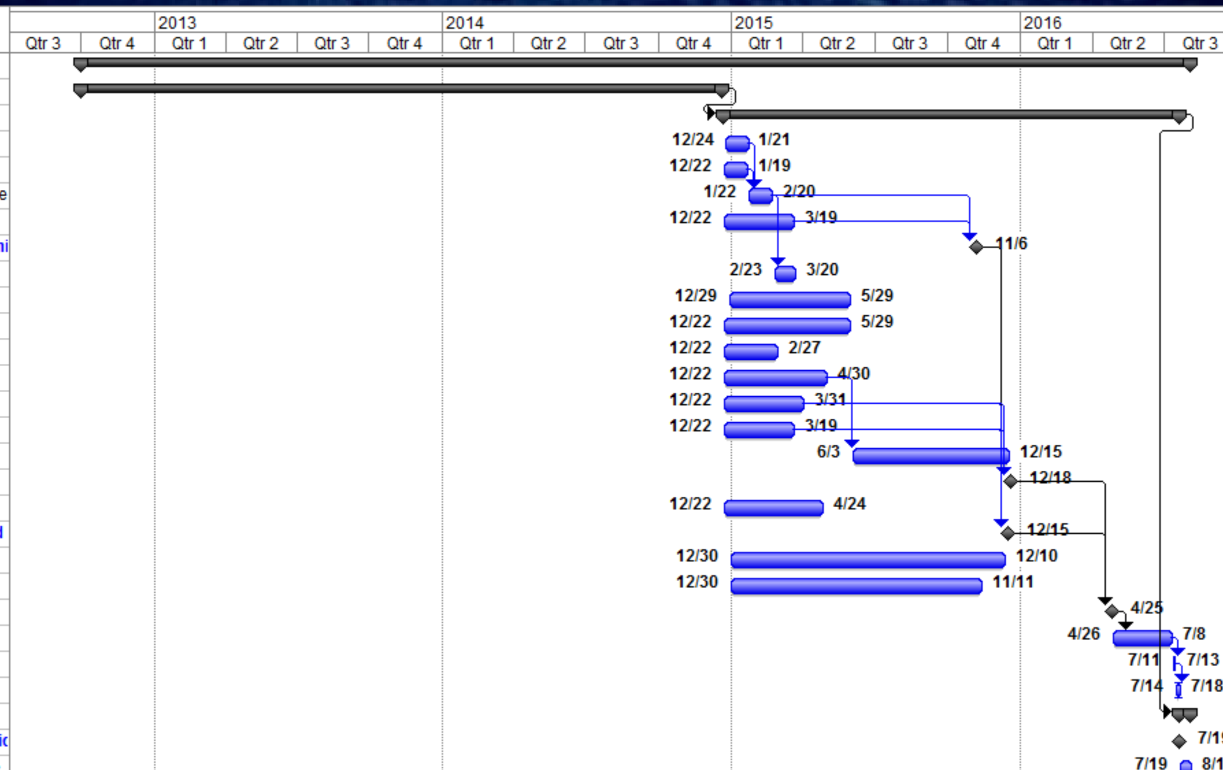


Project Plan

- Transition to Pre-Operations (2014 – 2016)
  - » Deliver initial DAP (Framework with pre-operational algorithms) to NDE
  - » Conduct Software Review
  - » Update algorithms
  - » Transition and test system within the NDE 2.0 environment
  - » Perform test data flows
  - » Conduct Algorithm Readiness Review
  - » Deliver final DAP to SADIE in Dec 2015
  - » Deliver updated DAP to NDE 2.0 in Apr 2016

Project Timeline
Transition to Pre-Operations

ID	Task Name
1	**JPSS Risk Reduction**
2	**Development Phase**
40	**Pre-operational Phase**
41	Transition Framework to the pre-operational system on the NDE hardware
42	NDE/OSPO Contractor Staff Training for the Framework
43	Pre-operational product output evaluated & tested within the NDE environme
44	Aerosol, Cloud, Cryosphere, and Volcanic Ash algorithms are upgraded
45	**Software Review for Aerosol, Cloud, Cryosphere (Ice & Snow) and Volcani**
46	Provide test products to the end users
47	Prepare Documentation
48	Developed Operational Products Implementation Plan
49	Baseline products system
50	Evaluated and Modify Operational Documentation
51	Validation and Verification of Operational Quality Assurance for Products
52	Validation and Verification of Monitoring capability for Products
53	All documentation is complete
54	**Final DAP delivered to NDE**
55	Prepare for Transition to Operations
56	**Conduct Algorithm Readiness Review for Aerosol, Cloud, Cryosphere and**
57	Operational and backup processing capabilities in place
58	Final IT Security Concept Defined
59	**Deliver updated DAP to NDE2.0**
60	Transition DAP to operations
61	Brief SPSRB Oversight Panel(s) on product status
62	Brief SPSRB capability is ready to operational
63	**Operational Phase**
64	**SPSRB manager and secretaries notified JPSS Risk Reduction NOAA Unic**
65	SPSRB Secretaries/manager update the SPSRB product metrics web page



Project Plan Schedule

- **Schedule (Milestones)**
  - » Project begins – 10/05/12
  - » Requirements Review – 12/27/12 (10/31/12)
  - » Critical Design Review – (10/31/12)
    - – Cloud Mask, Phase, Height, NCOMP – 04/05/13
    - – Cryosphere Ice and Snow Cover – 04/18/13
    - – Aerosol, Volcanic Ash, DCOMP – 04/30/13
    - – Fractional Snow Cover – 12/09/14

(cont.)

Project Plan Schedule

- **Schedule (Milestones)** *(Cont.)*
  - » Test Readiness Review – 05/06/14 (10/31/13)
    - – Ice – 10/07/14
    - – Clouds – 11/12/14
    - – Aerosols – 11/14/14
  - » Algorithm Readiness Review
    - – Clouds, Aerosols, Cryosphere – 12/15/15 (05/30/14)
  - » Software Review – 11/06/2015 (02/2014)
  - » Operational Readiness Review – 07/2016 (12/2015)

JPSS RR ARR
Review Objectives

- Review the Project Goals, Stakeholders, Schedule
- Review the Risks and Actions
- Review the Requirements
- Review the Software Architecture
- Review the JPSS RR Product Validation
- Review the Delivered Algorithm Package

JPSS RR ARR
Entry Criteria

- JPSS RR CDR Reports
  - » Updated CDR Reports for Cryosphere Snow and Volcanic Ash products
- JPSS RR UTRR Reports
  - » Updated UTRR Presentation for Clouds, Aerosols, and Cryosphere Ice products
- JPSS RR Requirements Allocation Document
- JPSS RR Review Item Disposition

JPSS RR ARR
Exit Criteria

- Algorithm Readiness Review Report
  - » The ARR Report (ARRR), a standard artifact of the SPSRB Process will be compiled after the ARR
  - » The report will contain:
    - – Review Item Disposition containing all risks, actions and comments
    - – Updated ARR presentation of all RR products

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Risks and Actions

Presented by

Walter Wolf

Pre-CDR Risks and Actions

Pre-CDR Risks and Actions

- None

CDR and UTRR Risks and Actions

Overall TRR Risks and Actions

- **TRR Risk 1: The Framework for the VPW algorithm currently uses all M bands as inputs though the algorithms only use 5 of the bands**
- **Risk Assessment: Medium**
- **Mitigation:**
  - » Update the Framework to only ingest the channels that it needs.
  - » Update the Gap Filling algorithm to only ingest the channels that it needs - Fixed to ingest only the required channels.
- **Status: Closure Pending**

Overall TRR Risks and Actions

- **TRR Risk 2:** Glint information is currently not included within the cloud mask outputs
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Cloud Mask algorithm is updated to include Glint information.
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 3:** Cloud Shadow information is currently not included within the cloud mask outputs
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Updated the Cloud height algorithm to include Cloud Shadow information
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 4**: Determine the hardware to be purchased for the Test and Operational environments – NDE 1.0 hardware vs. NDE 2.0 hardware
- **Risk Assessment:** High
- **Mitigation:**
  - » NDE has purchased and installed the NDE 2.0 hardware
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 5**: **Schedule to go operational within NDE**
- **Risk Assessment: High**
- **Mitigation:**
  - » **Work with NDE to determine when the JPSS RR processing system will be transitioned to operations – Current delivery date is December 2015 with an operational date of July 2016 (due to the PDA delay)**
- **Status: Closure Pending**

Overall TRR Risks and Actions

- **TRR Risk 6**: Product monitoring metadata variables not defined
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Worked with the Product Monitoring and algorithm team to determine the product monitoring metadata that was added for each product
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 7:** The AOD and ADP algorithms can run but not validated with the Bayesian Cloud Mask
- **Risk Assessment:** Low
- **Mitigation:**
  - » Repeat validation efforts when the required Glint Mask and Fire mask bits are available in the Bayesian Cloud Mask - AOD and ADP algorithms are validated with Bayesian Cloud mask
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 8**: PFAAST is the RTM used for Cloud product validation
- **Risk Assessment:** Low
- **Mitigation:**
  - » Cloud Mask, Height, Phase, NCOMP and DCOMP products are validated using the CRTM
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 9**: **NCOMP can run but not validated with the Bayesian Cloud Mask**
- **Risk Assessment:** Low
- **Mitigation:**
  - » NCOMP is validated using Bayesian Cloud Mask
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 10**: NIC may request a requirement change for Ice Concentration to be output in percentage (0-100%)
- **Risk Assessment:** Low
- **Mitigation:**
  - » Ice Concentration is output in percentage as per the requirement update after TRR.
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 11:** **STAR does not have an agreement to receive JPSS RR products from PDA.**
- **Risk Assessment:** **Medium**
- **Mitigation:**
  - » **JPSS RR data is on the list of data for STAR to receive from PDA**
- **Status:** **Closure Pending**

Overall TRR Risks and Actions

- **TRR Risk 14**: **Suggest identifying ancillary data and primary input data requirements separately.**
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Added sub-bullets to identify the type of ancillary data.
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 15**: **The Cloud algorithms - Height, NCOMP and DCOMP- can run but not validated with the RR Cloud Phase algorithm**
- **Risk Assessment:** Low
- **Mitigation:**
  - » The Height, NCOMP and DCOMP algorithms are validated with the RR Cloud Phase algorithm, for ARR product validation
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 16**: **Uncertainty in aerosol model selection over land by the AOT algorithm results in large uncertainty in APSP retrieval over land**
- **Risk Assessment:** High
- **Mitigation:**
  - » The requirements for APSP over land has been dropped; the JERD Vol. 2 says it is only over ocean
- **Status:** Closure Pending

Overall TRR Risks and Actions

- **TRR Risk 17:** The Planck functions used in Framework and CLAVR-x differ
- **Risk Assessment:** Low
- **Mitigation:**
  - » The difference has been Fixed with updated LUTs for VIIRS
- **Status:** Closure Pending

Cryosphere CDR Risks and Actions

- **CDR Risk 1:** Algorithm has been developed and tested with the current VIIRS operational cloud mask. Algorithm will need tuning when the NOAA unique cloud mask is used
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Start testing and evaluating the new cloud mask as soon as it is available - Algorithm has been validated using the NOAA unique cloud mask
- **Status:** Closure Pending

Cryosphere CDR Risks and Actions

- **CDR Risk 2:** Persistent cloud cover and false cloud detection in the polar regions
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Work closely with the cloud team to ensure accurate cloud classification
  - » Use alternate source of snow/ice information (GFS, IMS, Global Snow & Ice Mapping System) to flag persistent clouds – Algorithm meets requirements, but will continue to work with the cloud mask team on issues with cloud detection in the polar regions
- **Status:** Closure Pending

Cryosphere CDR Risks and Actions

- **CDR Risk 3: Lack of truth data for ice concentration and cover validation**
- **Risk Assessment: Medium**
- **Mitigation:**
  - » **Sufficient "truth" data is now available in a robust collection of Landsat data. Also some very high resolution Digital Globe imagery to validate sea ice concentration**
- **Status: Closure Pending**

Cryosphere CDR Risks and Actions

- **CDR Risk 7: In summer AMSR-E products not good to compare with**
- **Risk Assessment: Low**
- **Mitigation:**
  - » **Sufficient "truth" data is now available in a robust collection of Landsat data.**
- **Status: Closure Pending**

Cryosphere CDR Risks and Actions

- **CDR Risk 8**: Use SAR imagery to validate ice types and age
- **Risk Assessment:** Low
- **Mitigation:**
  - » Working on getting SAR imagery
  - » Algorithm does meet the requirements
  - » Will perform more validation when SAR data is acquired
- **Status:** Open

Cryosphere CDR Risks and Actions

- **CDR Risk 9**: Add NIC and NCEP requirements for the ice products
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Work with NIC and NCEP to establish user requirements. NIC is currently evaluating the JPSS L1RD requirements according to their expectations.
  - » NIC accepts the requirements as listed.
- **Status:** Closure Pending

Cryosphere CDR Risks and Actions

- **CDR Risk 10**: UTRR will be skipped for Snow Fraction
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Carried out extensive algorithm testing.
  - » Algorithm timing and accuracy information is provided in the ARR presentation
- **Status:** Closure Pending

Cryosphere CDR Risks and Actions

- **CDR Risk 11**: Work toward the implementation of an Enterprise Fractional Snow Cover Algorithm
- **Risk Assessment:** High
- **Mitigation:**
  - Evaluate the three Fractional Snow Cover Algorithms (NDSI, Reflectance based, and MODSCAG) to determine an enterprise Fractional Snow Cover algorithm.
  - Work may have to wait until GOES-R is launched.
  - Resulting enterprise algorithm may be one of the three algorithms or a combination of the three.
- **Status:** Closure Pending -- Transferred to the Cryosphere Algorithm Team

Cryosphere CDR Risks and Actions

- **CDR Risk 12**: Evaluate Fractional Snow Cover Requirement to maybe have requirement for a product under partially clear and partially cloudy conditions
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Snow fraction retrievals in the optical spectral range are hardly possible under partially cloudy/partially cloudy conditions, so there is not much sense in performing these retrievals.
- **Status:** Closure Pending

Aerosols CDR
Risks and Actions

- **CDR Risk 1**: **Smoke detection over bright surface not optimized**
- **Risk Assessment: Medium**
- **Mitigation:**
  - » **Conduct additional testing and fine tune the algorithm as needed to smoke over land - Currently, flagging the bright pixels and allowing the aerosol detection to be of low quality.**
- **Status: Closure Pending**

Aerosols CDR Risks and Actions

- **CDR Risk 2: Dust detection over bright surface not optimized**
- **Risk Assessment: Medium**
- **Mitigation:**
  - » **Conduct additional testing and fine tune the algorithm as needed to smoke over land**
  - » **Conduct additional testing and fine tune the algorithm as needed to rescue detection of thick dust or smoke over sunglint region - Currently, flagging the bright pixels and allowing the aerosol detection to be of low quality.**
- **Status: Closure Pending**

Aerosols CDR
Risks and Actions

- **CDR Risk 5**: Aerosol model selection may be inadequate for episodic events
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Identify episodic dust events using deep-blue channels, or input from dust detection, and force algorithm to use dust model - since we have implemented the first resolution, that is an initial version of internal tests for detecting heavy aerosol (dust). But this has not been thoroughly evaluated
- **Status:** Closure Pending

System CDR
Risks and Actions

- **CDR Risk 3: Will the data be CF compliant?**
- **Risk Assessment: Low**
- **Mitigation:**
  - » **Yes, the NetCDF4 files are CF compliant**
- **Status: Closure Pending**

System CDR
Risks and Actions

- **CDR Risk 7**: **Are the SDRs terrain-corrected? Identify the team is responsible for terrain-corrected SDRs.**
- **Risk Assessment:** High
- **Mitigation:**
  - » Will ensure that SDRs used are terrain-corrected. Will identify the team responsible for terrain-correction
    - » SDRs used are terrain corrected
    - » VIIRS SDR team is responsible for the terrain-corrected SDRs
- **Status:** Closure Pending

System CDR
Risks and Actions

- **CDR Review Item 8**: Latency is defined as the interval from the last observation to when the product is available to users. The definition of latency is challenging in the scope of this review. Latency is measured at a system level and includes contributors outside of STAR control.
- **Mitigation:**
  - » Latency has been redefined as processing time allocated to product generation. This plus NDE DHS and PDA system latency will not exceed required latency allocated to ESPC.
- **Status:** Closure Pending

System CDR Risks and Actions

- **CDR Review Item 9**: Source for Ground trim data
- **Mitigation:**
  - » Identify the source for ground trim data.
    - » VIIRS SDR team is the source of the ground trim data
- **Status:** Closure Pending

ARR Overall
Risks and Actions

- **ARR Risk 1**: **Address the mandatory code updates cited in OSPO Software Review, for Dec2015 DAP**
- **Risk Assessment:** Low
- **Mitigation:**
  - » All 'mandatory updates' (color coded in Orange in the checklist) for Dec 2015 DAP are addressed.
- **Status:** Closure Pending

ARR Overall Risks and Actions

- **ARR Risk 2**: Address the recommended code updates for final DAP, as cited in OSPO Software Review
- **Risk Assessment:** Low
- **Mitigation:**
  - Address remaining 'recommended updates' for final DAP in Apr 2016
- **Status:** Open

ARR Overall Risks and Actions

- **ARR Risk 3: The product monitoring metadata variables for DCOMP algorithm will undergo revision.**
- **Risk Assessment: Medium**
- **Mitigation:**
  - » **Fine tune DCOMP metadata variables**
  - » **Update OSPO product monitoring team about the changes.**
- **Status: Open**

Risk and Actions Summary

- There are currently 31 risks and 3 review items identified from the CDR
- Three remain open

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Requirements for JPSS Risk Reduction: Uniform Multi-Sensor Algorithms for Consistent Products

Presented by
Walter Wolf

JPSS Risk Reduction System Requirements

- All JPSS Risk Reduction System Project requirements are present in this section
- All JPSS Risk Reduction System Project requirements are documented in a single RAD and are part of the CDR documentation suite
- Basic requirements are shown in all yellow text on a single slide
- Requirement changes since TRR are marked in orange

JPSS Risk Reduction Requirements Information

- The JPSS Risk Reduction Products are addressing L1RD Supplement requirements
- ~~The JPSS Risk Reduction Products are addressing SPSRB requirements~~
- ~~The Products created from this project will at least meet the associated product requirements within the L1RD Supplement~~
- ~~The RAD traces the Risk Reduction products to the L1RD Supplement requirements~~

Basic Requirement 0.0

- **JPSS-PS-R 0.0:** *The JPSS Risk Reduction Product System (JPSS RRPS) development project shall adopt the standard practices of the Satellite Product and Services Review Board (SPSRB).*

  » **Driver:** *STAR Enterprise Product Lifecycle (EPL)*. The SPSRB process has been updated by incorporating aspects of the STAR EPL Process.

Basic Requirement 0.0

- **JPSS-PS-R 0.1:** *The JPSS RRPS development project practices shall be tailored from the SPSRB process.*
  - » This requirement should be met by following the SPSRB process, as long as the tailoring does not introduce an incompatibility.

Basic Requirement 1.0

- **JPSS-PS-R 1.0:** *The JPSS RRPS shall generate Global Cloud products.*

  » **<u>Driver:</u> SPSRB requirements:**
    - 1107-0011: Gridded Cloud Products for NWP Verification
    - 0909-0018: CLAVR-x and GSIP cloud product composites over Alaska

Basic Requirement 1.0

- **JPSS-PS-R 1.1:** *The Cloud products shall include Cloud Mask Product.*

    » Current operational products, with upgraded capabilities.

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.1.1:** *The Cloud Mask Product shall have JPSS 3 priority.*
- **JPSS-PS-R 1.1.2:** *The Cloud Mask Product shall have global coverage.*
- **JPSS-PS-R 1.1.3:** *The Cloud Mask Product shall have Vertical Reporting Interval of N/A.*
- **JPSS-PS-R 1.1.4:** *The Cloud Mask Product shall have Horizontal Cell Size of 0.75 km.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.1.5:** *The Cloud Mask Product shall have Mapping Uncertainty, 3 Sigma: threshold - 4 km; objective - 1 km.*

- **JPSS-PS-R 1.1.6:** *The Cloud Mask Product shall have Measurement Range of Cloudy/Not Cloudy.*

- Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.1.7:** *The Cloud Mask Product shall have Measurement Accuracy of ~~90%~~ 87% correct detection, globally.*
  - » *Ocean, Day – 92%*
  - » *Ocean, Night – 90%*
  - » *Snow-free Land, Day – 90%*
  - » *Snow-free Land, Night – 88%*
  - » *Desert, Day/Night – 85%*
  - » *Snow –covered Land, Day – 88%*
  - » *Snow –covered Land, Night – 85%*
  - » *Sea-ice, Day – 82%*
  - » *Sea-ice, Night – 72%*
  - » *Antarctica & Greenland, Day – 80%*
  - » *Antarctica & Greenland, Night – 70%*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.1.8:** *The Cloud Mask Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average)*
  - » *Objective – 4 hrs*

- **JPSS-PS-R 1.1.9:** ~~*The Cloud Mask Product False Alarm Rate shall be:*~~
  - ~~» *1. Ocean, Day, COT>1.0- 5%*~~
  - ~~» *2. Land, Day, ToC NDVI < 0.2 or ToC NDVI > 0.4,*~~
  ~~*or Desert, COT > 1.0 – 7%*~~
  - ~~» *3. Land, Ocean, Night, COT>1.0 – 8%*~~

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.1.10:** *The Cloud Mask Product shall have latency of 30 minutes after granule data is available.*

  » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

- **JPSS-PS-R 1.1.11:** *The Cloud Mask Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.1.12:** *The applicable conditions for Cloud Mask Product shall be: whenever detectable clouds are present.*

- **JPSS-PS-R 1.1.13:** *The Cloud Mask Product shall be computed and reported for the total cloud cover.*

> Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.1.14:** *The JPSS RR Cloud Mask shall use the VIIRS calibrated and navigated brightness temperature and radiances in bands M12, M13, M14, M15, M16 and reflectance in bands M5, M7, M9, M10 with solar and satellite view angles as an input data set.*
  - Primary Input
- **JPSS-PS-R 1.1.15:The** *JPSS RR Cloud Mask shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*
  - Static Ancillary input
- **JPSS-PS-R 1.1.16:** *The JPSS RR Cloud Mask shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - Static Ancillary input

Basic Requirement 1.0

- **JPSS-PS-R 1.1.17:** *The JPSS RR Cloud Mask shall use Snow Mask by the Interactive Multi-sensor Snow and Ice Mapping System as an input data set.*
  - Dynamic Ancillary Input

- **JPSS-PS-R 1.1.18:** *The JPSS RR Cloud Mask shall use calculated Desert Mask as an input data set.*
  - Ancillary Input – framework internal computation

- **JPSS-PS-R 1.1.19:** *The JPSS RR Cloud Mask shall use Coast Mask as an input data set.*
  - Static Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.1.20:** *The JPSS RR Cloud Mask shall use MODIS monthly mean IR Land Surface Emissivity for channel M7 as an input data set.*
    - Static Ancillary input

- **JPSS-PS-R 1.1.21:** *The JPSS RR Cloud Mask shall use CRTM Clear sky radiance/BT for bands M7, M14 and blackbody radiance for channel M14 and atmospheric transmittance profiles for channel M7 as an input data set.*
    - Dynamic Ancillary input – framework internal computation

- **JPSS-PS-R 1.1.22:** *The JPSS RR Cloud Mask shall use Surface, Tropopause Level and Surface Temperature from GFS model as an input data set.*
    - Dynamic Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.2:** *The Cloud products shall include Cloud Top Phase Product.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.2.1:** *The Cloud Top Phase Product shall have global coverage.*

- **JPSS-PS-R 1.2.2:** *The Cloud Top Phase Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 1.2.3:** *The Cloud Top Phase Product shall have Measurement Accuracy of 80% Correct Classification (7 phases).*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.2.4:** *The Cloud Top Phase Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average);*
  - » *Objective – 4 hrs;*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.2.5:** *The Cloud Top Phase Product shall have latency of 30 minutes after granule data is available.*

  - Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

- **JPSS-PS-R 1.2.6:** *The Cloud Top Phase Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.2.7:** *The JPSS RR Cloud Top Phase shall use the VIIRS calibrated and navigated brightness temperature in bands M14, M15, M16 as an input data set.*
  - » Primary Input data

- **JPSS-PS-R 1.2.8:** *The JPSS RR Cloud Top Phase shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 1.2.9:** *The JPSS RR Cloud Top Phase shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.2.10:** *The JPSS RR Cloud Top Phase shall use Snow Mask by the Interactive Multisensor Snow and Ice Mapping System as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 1.2.11:** *The JPSS RR Cloud Top Phase shall use calculated Coast Mask as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 1.2.12:** *The JPSS RR Cloud Top Phase shall use CRTM Clear sky radiance and transmittance for bands 14, 15, 16 TOA radiance bands 14, 15, 16 as an input data set.*
  - » Dynamic Ancillary Input – framework internal computation

Basic Requirement 1.0

- **JPSS-PS-R 1.2.13:** *The JPSS RR Cloud Top Phase shall use Temperature, Pressure, Height profiles, Surface Level, Tropopause Level, and Surface Temperature from GFS model as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 1.2.14:** *The JPSS RR Cloud Top Phase shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » RR VIIRS Derived Product Input

Basic Requirement 1.0

- **JPSS-PS-R 1.3:** *The Cloud products shall include Cloud Type Product.*

- Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.3.1:** *The Cloud Type Product shall have global coverage.*

- **JPSS-PS-R 1.3.2:** *The Cloud Type Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 1.3.3:** *The Cloud Type Product shall have Measurement Accuracy of 60%.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.3.4:** *The Cloud Type Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average)*
  - » *Objective – 4 hrs*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.3.5:** *The Cloud Type Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as processing time allocated to product generation. Current capability is 60 minutes.
- **JPSS-PS-R 1.3.6:** *The Cloud Type Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.3.7:** *The JPSS RR Cloud Type shall use the VIIRS calibrated and navigated brightness temperature in bands M14, M15, M16 as an input data set.*
  - » Primary Input data

- **JPSS-PS-R 1.3.8:** *The JPSS RR Cloud Type shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 1.3.9:** *The JPSS RR Cloud Type shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.3.10:** *The JPSS RR Cloud Type shall use Snow Mask by the Interactive Multisensor Snow and Ice Mapping System as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 1.3.11:** *The JPSS RR Cloud Type shall use Coast Mask as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 1.3.12:** *The JPSS RR Cloud Type shall use CRTM Clear sky radiance and transmittance for bands 14, 15, 16 TOA radiance bands 14, 15, 16 as an input data set.*
  - » Dynamic Ancillary Input – framework internal computation

Basic Requirement 1.0

- **JPSS-PS-R 1.3.13:** *The JPSS RR Cloud Type shall use Temperature, Pressure, Height profiles, Surface Level, Tropopause Level, and Surface Temperature from GFS model as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 1.3.14:** *The JPSS RR Cloud Type shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » RR VIIRS Derived Product as Input

Basic Requirement 1.0

- **JPSS-PS-R 1.4:** *The Cloud products shall include Cloud Top Height Product.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.4.1:** *The Cloud Top Height Product shall have priority of JPSS 3.*

- **JPSS-PS-R 1.4.2:** *The Cloud Top Height Product shall have global coverage.*

- **JPSS-PS-R 1.4.3:** *The Cloud Top Height Product shall have Vertical Reporting Interval:*
  - » ~~*Threshold - Tops of up to three cloud layers (1); applicable to single layered clouds only*~~
  - » ~~*Objective - Tops of all distinct cloud layers*~~
  - » *Threshold - Tops of highest cloud in column*
  - » *Objective - Tops of multiple clouds in column*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.4.4:** *The Cloud Top Height Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 1.4.5:** *The Cloud Top Height Product shall have Mapping Uncertainty, 3 Sigma:*
  - » *Threshold - 4 km*
  - » *Objective - 1 km.*

- **JPSS-PS-R 1.4.6:** *The Cloud Top Height Product shall have Measurement Accuracy of ~~500m for Clouds with emissivity > 0.8.~~*
  - » *Threshold: 1 km for COT ≥ 1 and 2 km for COT < 1*
  - » *Objective: 0.3 km for COT ≥ 1 and 0.3 km for COT < 1*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.4.7:** *The Cloud Top Height Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average)*
  - » *Objective – 4 hrs*

- **JPSS-PS-R 1.4.8:** *The Cloud Top Height Product Measurement Precision shall be:*
  - » *Threshold – 1. COT ≥1 – 1.0 km; 2. COT < 1 – 2.0 km;*
  - » *Objective –1. COT ≥ 1 – 0.15 km; 2. COT < 1 – 0.15 km;*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.4.9:** *The Cloud Top Height Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

- **JPSS-PS-R 1.4.10:** *The Cloud Top Height Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.4.11:** *The requirements for the Cloud Top Height Product shall apply whenever detectable clouds are present.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.4.12:** *The JPSS RR Cloud Top Height shall use the VIIRS calibrated and navigated brightness temperature and radiance in bands M14, M15, M16 with solar and satellite view angles as an input data set.*
  - » Primary Input Data
- **JPSS-PS-R 1.4.13:** *The JPSS RR Cloud Top Height shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*
  - » Static Ancillary Input
- **JPSS-PS-R 1.4.14:** *The JPSS RR Cloud Top Height shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.4.15:** *The JPSS RR Cloud Top Height shall use Snow Mask by the Interactive Multisensor Snow and Ice Mapping System as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 1.4.16:** *The JPSS RR Cloud Top Height shall use CRTM Clear sky radiance and transmittance for channels 14, 15, 16 and radiance profiles for channels 14, 15, 16 as an input data set.*
  - » Dynamic Ancillary Input – framework internal computation

Basic Requirement 1.0

- **JPSS-PS-R 1.4.17:** *The JPSS RR Cloud Top Height shall use Temperature, Pressure, Height profiles, Surface Level and Tropopause Temperature from GFS model as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 1.4.18:** *The JPSS RR Cloud Top Height shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS Derived RR Product Input

- **JPSS-PS-R 1.4.19:** *The JPSS RR Cloud Top Height shall use Cloud type produced by JPSS RR cloud type algorithm as an input data set.*
  - » VIIRS Derived RR Product Input

Basic Requirement 1.0

- ~~**JPSS-PS-R 1.5:** *The Cloud products shall include Cloud Cover/Layers Products.*~~

> ~~Current operational products, with upgraded capabilities~~

Basic Requirement 1.0

- **JPSS-PS-R 1.5.1:** ~~*The Cloud Cover/Layers Products shall have priority of JPSS 3.*~~

- ~~**JPSS-PS-R 1.5.2:**~~ ~~*The Cloud Cover/Layers Products shall have global coverage.*~~

- **JPSS-PS-R 1.5.3:** ~~*The Cloud Cover/Layers Products shall have Vertical Reporting Interval:*~~
  - ~~*Threshold -Up to three cloud layers*~~
  - ~~*Objective – 0.1 km*~~

- ~~Current operational products, with upgraded capabilities~~

Basic Requirement 1.0

- ~~**JPSS-PS-R 1.5.4:** *The Cloud Cover/Layers Products shall have Horizontal Cell Size of 0.75 km.*~~

- **JPSS-PS-R 1.5.5:** ~~*The Cloud Cover/Layers Products shall have Mapping Uncertainty, 3 Sigma:*~~
  - ~~*Threshold - 4 km*~~
  - ~~*Objective - 1 km*~~

- ~~**JPSS-PS-R 1.5.6:** *The Cloud Cover/Layers Products shall have Measurement Range (Applies only to total cloud cover; Not applicable to layers):*~~
  - ~~*Threshold - 0 to 1.0 HCS Area; Objective – 0 to 1.0*~~

➢ ~~Current operational products, with upgraded capabilities~~

Basic Requirement 1.0

- ~~**JPSS-PS-R 1.5.7:** *The Cloud Cover/Layers Products shall have Measurement Accuracy of 80% Correct Classification (Low, Mid, High).*~~

- ~~**JPSS-PS-R 1.5.8:** *The Cloud Cover/Layers Products Refresh Rate shall be:*~~
  - ~~*Threshold - At least 90% coverage of the globe every 12 hours (monthly average)*~~
  - ~~*Objective – 4 hrs*~~

➢ ~~Current operational products, with upgraded capabilities~~

Basic Requirement 1.0

- ~~**JPSS-PS-R 1.5.9:** *The Cloud Cover/Layers Products shall have latency of 30 minutes after granule data is available.*~~
  - ~~Latency is defined as processing time allocated to product generation. Current capability is 60 minutes.~~

- ~~**JPSS-PS-R 1.5.10:** *The Cloud Cover/Layers Products shall have timeliness of ≤ 3 hours.*~~

➢ ~~Current operational products, with upgraded capabilities~~

Basic Requirement 1.0

- ~~**JPSS-PS-R 1.5.11:** *The requirements for the Cloud Cover/Layers Products shall apply whenever detectable clouds are present.*~~

- ~~**JPSS-PS-R 1.5.12:** *The Cloud Cover Product shall be computed and reported at each separate, distinct layer, as well as for the total cloud cover.*~~

- ~~Current operational products, with upgraded capabilities~~

Basic Requirement 1.0

- ~~**JPSS-PS-R 1.5.13:** *The JPSS RR Cloud Cover/Layers shall use the VIIRS calibrated and navigated brightness temperature and radiance in bands M14, M15, M16 with solar and satellite view angles as an input data set.*~~
- ~~**JPSS-PS-R 1.5.14:** *The JPSS RR Cloud Cover/Layers shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*~~
- ~~**JPSS-PS-R 1.5.15:** *The JPSS RR Cloud Cover/Layers shall use Digital Surface Elevation at 1km resolution as an input data set.*~~
- ~~**JPSS-PS-R 1.5.16:** *The JPSS RR Cloud Cover/Layers shall use Snow Mask by the Interactive Multisensor Snow and Ice Mapping System as an input data set.*~~

Basic Requirement 1.0

- ~~**JPSS-PS-R 1.5.17:** *The JPSS RR Cloud Cover/Layers shall use CRTM Clear sky radiance and transmittance for channels 14, 15, 16 and radiance profiles for channels 14, 15, 16 as an input data set.*~~
- ~~**JPSS-PS-R 1.5.18:** *The JPSS RR Cloud Cover/Layers shall use Temperature, Pressure, Height profiles, Surface Level and Tropopause Temperature from GFS model as an input data set.*~~
- ~~**JPSS-PS-R 1.5.19:** *The JPSS RR Cloud Cover/Layers shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*~~
- ~~**JPSS-PS-R 1.5.20:** *The JPSS RR Cloud Cover/Layers shall use Cloud type produced by JPSS RR cloud type algorithm as an input data set.*~~

Basic Requirement 1.0

- **JPSS-PS-R 1.6:** *The Cloud products shall include Cloud Top Temperature Product.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.6.1:** *The Cloud Top Temperature Product shall have priority of JPSS 3.*
- **JPSS-PS-R 1.6.2:** *The Cloud Top Temperature Product shall have global coverage.*
- **JPSS-PS-R 1.6.3:** *The Cloud Top Temperature Product shall have Vertical Reporting Interval:*
  - ~~*Threshold – Tops of up to three cloud layers; applicable to single layered clouds only*~~
  - ~~*Objective – Tops of all distinct cloud layers*~~
  - *Threshold – Tops of highest cloud in column*
  - *Objective – Tops of multiple clouds in column*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.6.4:** *The Cloud Top Temperature Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 1.6.5:** *The Cloud Top Temperature Product shall have Mapping Uncertainty, 3 Sigma:*
  - » *Threshold - 4 km*
  - » *Objective - 1 km.*

- **JPSS-PS-R 1.6.6:** *The Cloud Top Temperature Product shall have Measurement Accuracy of ~~3 K for clouds with emissivity > 0.8.~~*
  - » *Threshold: 6 K for COT ≥ 1 and 12 K for COT < 1*
  - » *Objective: 1.5 K for COT ≥ 1 and 2 K for COT < 1*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.6.7:** *The Cloud Top Temperature Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average);*
  - » *Objective – 4 hrs;*

- **JPSS-PS-R 1.6.8:** *The Cloud Top Temperature Product Measurement Precision shall be:*
  - » ~~*Threshold – 1. Optical thickness ≥ 1 – 3K;*~~
  ~~*2. Optical Thickness < 1 – 6K;*~~
  - ~~» *Objective – N/A*~~
  - » *Threshold: 6 K for COT ≥ 1 and 12 K for COT < 1*
  - » *Objective: 1.5 K for COT ≥ 1 and 2 K for COT < 1*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.6.9:** *The Cloud Top Temperature Product shall have latency of 30 minutes after granule data is available.*
  - Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.
- **JPSS-PS-R 1.6.10:** *The Cloud Top Temperature Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.6.11:** *The requirements for the Cloud Top Temperature Product shall apply whenever detectable clouds are present.*

- Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.6.12:** *The JPSS RR Cloud Top Temperature shall use the VIIRS calibrated and navigated brightness temperature and radiance in bands M14, M15, M16 with solar and satellite view angles as an input data set.*
  - » Primary Input Data
- **JPSS-PS-R 1.6.13:** *The JPSS RR Cloud Top Temperature shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*
  - » Static Ancillary Input
- **JPSS-PS-R 1.6.14:** *The JPSS RR Cloud Top Temperature s shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.6.15:** *The JPSS RR Cloud Top Temperature shall use Snow Mask by the Interactive Multisensor Snow and Ice Mapping System as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 1.6.16:** *The JPSS RR Cloud Top Temperature shall use CRTM Clear sky radiance and transmittance for channels 14, 15, 16 and radiance profiles for channels 14, 15, 16 as an input data set.*
  - » Dynamic Ancillary Input – framework internal computation
- **JPSS-PS-R 1.6.17:** *The JPSS RR Cloud Top Temperature shall use Temperature, Pressure, Height profiles, Surface Level and Tropopause Temperature from GFS model as an input data set.*
  - » Dynamic Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.6.18:** *The JPSS RR Cloud Top Temperature shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR Product as Input

- **JPSS-PS-R 1.6.19:** *The JPSS RR Cloud Top Temperature shall use Cloud type produced by JPSS RR cloud type algorithm as an input data set.*
  - » VIIRS derived RR Product as Input

Basic Requirement 1.0

- **JPSS-PS-R 1.7:** *The Cloud products shall include Cloud Top Pressure Product.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.7.1:** *The Cloud Top Pressure Product shall have priority of JPSS 3.*

- **JPSS-PS-R 1.7.2:** *The Cloud Top Pressure Product shall have global coverage.*

- **JPSS-PS-R 1.7.3:** *The Cloud Top Pressure Product shall have Vertical Reporting Interval:*
  - » ~~*Threshold – Tops of up to three cloud layers; applicable to single layered clouds only*~~
  - » *Threshold – Tops of highest cloud in column*
  - » *Objective – Tops of multiple clouds in column*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.7.4:** *The Cloud Top Pressure Product shall have Horizontal Cell Size of 0.75 km.*
- **JPSS-PS-R 1.7.5:** *The Cloud Top Pressure Product shall have Mapping Uncertainty, 3 Sigma: threshold - 4 km ; objective - 1 km.*
- **JPSS-PS-R 1.7.6:** *The Cloud Top Pressure Product shall have Measurement Range of:*
  - » Cloudy/Not Cloudy.
- **JPSS-PS-R 1.7.7:** *The Cloud Top Pressure Product shall have Measurement Accuracy of ~~50 mb for clouds with emissivity > 0.8.~~*
  - » *Threshold: 100 hPa for COT ≥ 1 and 200 hPa for COT < 1*
  - » *Objective: 50 hPa for COT ≥ 1 and 100 hPa for COT < 1*

Basic Requirement 1.0

- **JPSS-PS-R 1.7.8:** *The Cloud Top Pressure Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average); Objective – 4 hrs*
- **JPSS-PS-R 1.7.9:** *The Cloud Top Pressure Product Measurement Precision shall be:*
  - » ~~*Threshold – COT ≥ 1:*~~
    - ~~*1. Surface to 3km – 100mb*~~
    - ~~*2. 3 to 7 – 75mb*~~
    - ~~*3. > 7km – 50mb*~~
  - » ~~*Objective –*~~
    - ~~*1. Surface to 3km – 10mb*~~
    - ~~*2. 3 to 7 – 7mb*~~
    - ~~*3. > 7km – 5mb*~~
  - » *Threshold: 100 hPa for COT ≥ 1 and 200 hPa for COT < 1*
  - » *Objective: 50 hPa for COT ≥ 1 and 100 hPa for COT < 1*

Basic Requirement 1.0

- **JPSS-PS-R 1.7.10:** *The Cloud Top Pressure Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.
- **JPSS-PS-R 1.7.11:** *The Cloud Top Pressure Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.7.12:** *The requirements for the Cloud Top Pressure Product shall apply whenever detectable clouds are present.*

- Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.7.13:** *The JPSS RR Cloud Top Pressure shall use the VIIRS calibrated and navigated brightness temperature and radiance in bands M14, M15, M16 with solar and satellite view angles as an input data set.*
  - » Primary Input data
- **JPSS-PS-R 1.7.14:** *The JPSS RR Cloud Top Pressure shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*
  - » Static Ancillary Input
- **JPSS-PS-R 1.7.15:** *The JPSS RR Cloud Top Pressure shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.7.16:** *The JPSS RR Cloud Top Pressure shall use Snow Mask by the Interactive Multisensor Snow and Ice Mapping System as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 1.7.17:** *The JPSS RR Cloud Top Pressure shall use CRTM Clear sky radiance and transmittance for channels 14, 15, 16 and radiance profiles for channels 14, 15, 16 as an input data set.*
  - » Dynamic Ancillary Input – framework internal computation
- **JPSS-PS-R 1.7.18:** *The JPSS RR Cloud Top Pressure shall use Temperature, Pressure, Height profiles, Surface Level and Tropopause Temperature from GFS model as an input data set.*
  - » Dynamic Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.7.19:** *The JPSS RR Cloud Top Pressure shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR Product as Input

- **JPSS-PS-R 1.7.20:** *The JPSS RR Cloud Top Pressure shall use Cloud type produced by JPSS RR cloud type algorithm as an input data set.*
  - » VIIRS derived RR Product as Input

Basic Requirement 1.0

- **JPSS-PS-R 1.8:** *The Cloud products shall include Cloud Optical Properties Products (Daytime and Nighttime).*

- **JPSS-PS-R 1.8.1:** *The Cloud Optical Properties products shall include Cloud Optical Thickness Product.*

- Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.1.1:** *The Cloud Optical Thickness Product shall have priority of JPSS 3.*
- **JPSS-PS-R 1.8.1.2:** *The Cloud Optical Thickness Product shall have global coverage.*
- **JPSS-PS-R 1.8.1.3:** *The Cloud Optical Thickness Product shall have Vertical Reporting Interval:*
  - ~~*Threshold – up to three cloud layers;*~~
  - ~~*Objective – 3 layers;*~~
  - *Threshold – N/A;*
  - *Objective – N/A;*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.1.4:** *The Cloud Optical Thickness Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 1.8.1.5:** *The Cloud Optical Thickness Product shall have Mapping Uncertainty, 3 Sigma:*
  - » *Threshold - 4km*
  - » *Objective - 1 km.*

- **JPSS-PS-R 1.8.1.6:** *The Cloud Optical Thickness Product shall have Measurement Range of:*
  - » *1.0 – 50 (day)*
  - » *1.0 – 5.0 (night)*

Basic Requirement 1.0

- **JPSS-PS-R 1.8.1.7:** *The Cloud Optical Thickness Product shall have Measurement Accuracy of:*
  - ~~*Liquid phase: 20% error (Day), 20% (Night);*~~
  - ~~*Ice phase: 20% Day), 30% (Night)*~~
  - *Liquid phase: 20% (Day), 30% (Night);*
  - *Ice phase: 20% (Day), 30% (Night)*

- **JPSS-PS-R 1.8.1.8:** *The Cloud Optical Thickness Refresh Rate shall be:*
  - *Threshold - At least 90% coverage of the globe every 12 hours (monthly average);*
  - *Objective – 4 hrs;*

Basic Requirement 1.0

- **JPSS-PS-R 1.8.1.9:** *The Cloud Optical Thickness Product Measurement Precision shall be:*
  - ~~*Threshold – Greater of 33 % or 1 Tau*~~
  - ~~*Objective – 2%*~~
  - *Greater of 30% error or 3.0 Tau (Day);*
  - *Greater of 30% or 0.8 Tau (Night)*
- **JPSS-PS-R 1.8.1.10:** *The Cloud Optical Thickness Product shall have latency of 30 minutes after granule data is available.*
  - Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.
- **JPSS-PS-R 1.8.1.11:** *The Cloud Optical Thickness Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.1.12:** *The requirements for the Cloud Optical Thickness Product shall apply whenever detectable clouds are present.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.2:** *The Cloud Optical Properties products shall include Cloud Effective Particle Size Product.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.2.1:** *The Cloud Effective Particle Size Product shall have priority of JPSS 3.*

- **JPSS-PS-R 1.8.2.2:** *The Cloud Effective Particle Size Product shall have global coverage.*

- **JPSS-PS-R 1.8.2.3:** *The Cloud Effective Particle Size Product shall have Vertical Reporting Interval:*
  - » ~~*Threshold – up to three cloud layers*~~
  - » ~~*Objective – 0.3 km;*~~
  - » *N/A*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.2.4:** *The Cloud Effective Particle Size Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 1.8.2.5:** *The Cloud Effective Particle Size Product shall have Mapping Uncertainty, 3 Sigma:*
  - » *Threshold - 4 km ;*
  - » *Objective - 1 km.*

- **JPSS-PS-R 1.8.2.6:** *The Cloud Effective Particle Size Product shall have Measurement Range of:*
  - ~~» *Threshold - 0 to 50 µm;*~~
  - ~~» *Objective – N/S*~~
  - » *2 – 50 um (day);*
  - » *2 – 32 um for water (night)*
  - » *2 – 50 um for ice (night)*

Basic Requirement 1.0

- **JPSS-PS-R 1.8.2.7:** *The Cloud Effective Particle Size Product shall have Measurement Accuracy of:*
  - » *greater of 4 µm or 30% for liquid phase*
  - » *10 µm for ice phase*

- **JPSS-PS-R 1.8.2.8:** *The Cloud Effective Particle Size Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average);*
  - » *Objective – 4 hrs;*

Basic Requirement 1.0

- **JPSS-PS-R 1.8.2.9:** *The Cloud Effective Particle Size Product Measurement Precision shall be:*
  - ~~*Threshold – Greater of 22% or 1 µm for water; Greater of 28% or 1µm for ice*~~
  - ~~*Objective – 2%*~~
  - *Threshold:*
    - *greater of 4 µm or 25% for liquid phase*
    - *greater of 10 µm or 25% for ice phase*
  - *Objective: 10%*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.2.10:** *The Cloud Effective Particle Size Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

- **JPSS-PS-R 1.8.2.11:** *The Cloud Effective Particle Size Product shall have timeliness of ≤ 3 hours.*

- **JPSS-PS-R 1.8.2.12:** *The requirements for the Cloud Effective Particle Size Product shall apply both day and night and whenever detectable clouds are present.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.3:** *The Cloud Optical Properties products shall include Cloud Liquid Water Product.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.3.1:** *The Cloud Liquid Water Product shall be have priority of JPSS 3.*

- **JPSS-PS-R 1.8.3.2:** *The Cloud Liquid Water Product shall have global coverage.*

- **JPSS-PS-R 1.8.3.3:** *The Cloud Liquid Water Product shall have Vertical Reporting Interval:*

  N/A

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.3.4:** *The Cloud Liquid Water Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 1.8.3.5:** *The Cloud Liquid Water Product shall have Mapping Uncertainty N/A*

- **JPSS-PS-R 1.8.3.6:** *The Cloud Liquid Water Product shall have Measurement Accuracy of:*
  - » *Greater of 25 g/m2 or 15% error (Night)*
  - » *50 g/m2 (Day)*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.3.7:** *The Cloud Liquid Water Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average)*
  - » *Objective – 4 hrs*
- **JPSS-PS-R 1.8.3.8:** *The Cloud Liquid Water Product Measurement Precision shall be:*
  - » *Greater of 25 g/m2 or 40% (Night)*
  - » *30 % (Day)*

Basic Requirement 1.0

- **JPSS-PS-R 1.8.3.9:** *The Cloud Liquid Water Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

- **JPSS-PS-R 1.8.3.10:** *The Cloud Liquid Water Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.4:** *The Cloud Optical Properties products shall include Cloud Ice Water Path Product.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.4.1:** *The Cloud Ice Water Path Product shall have global coverage.*

- **JPSS-PS-R 1.8.4.2:** *The Cloud Ice Water Path Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 1.8.4.3:** *The Cloud Ice Water Path Product shall have Measurement Accuracy of:*
  - » *Greater of 25g/m2 or 30% error.*
  - » *100 g/m2 (day)*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.4.4:** *The Cloud Ice Water Path Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every 12 hours (monthly average);*
  - » *Objective – 4 hrs;*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.4.5:** *The Cloud Ice Water Path Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.
- **JPSS-PS-R 1.8.4.6:** *The Cloud Ice Water Path Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 1.0

- **JPSS-PS-R 1.8.5:** *The JPSS RR Daytime Cloud Optical Properties shall use VIIRS calibrated and navigated brightness temperature in band 12 and reflectance in bands 5, 7, 10, and 11 with solar and satellite view angles as an input data set.*
  - » Primary Input Data

- **JPSS-PS-R 1.8.6:** *The JPSS RR Daytime Cloud Optical Properties shall use Global 1 km land/water & coast mask used for MODIS collection 5 as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 1.8.7:** *The JPSS RR Daytime Cloud Optical Properties shall use UW Baseline Fit Emissivity for band 7 as an input data set.*
  - » Static Ancillary Input

Basic Requirement 1.0

- **JPSS-PS-R 1.8.8:** *The JPSS RR Daytime Cloud Optical Properties shall use Temperature and Water Vapor profiles from GFS model as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 1.8.9:** *The JPSS RR Daytime Cloud Optical Properties shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR Product as Input

- **JPSS-PS-R 1.8.10:** *The JPSS RR Daytime Cloud Optical Properties shall use Cloud height produced by JPSS RR cloud height algorithm as an input data set.*
  - » VIIRS derived RR Product as Input

Basic Requirement 1.0

- **JPSS-PS-R 1.8.11:** *The JPSS RR Daytime Cloud Optical Properties shall use Cloud type produced by JPSS RR cloud type algorithm as an input data set.*
  - » VIIRS derived RR Product as Input

- **JPSS-PS-R 1.8.12:** *The JPSS RR Daytime Cloud Optical Properties shall be validated for Solar Zenith angle <= 70 deg and verified between 70 deg and 82 deg.*

- **JPSS-PS-R 1.8.13:** *The JPSS RR Nighttime Cloud Optical Properties shall use VIIRS calibrated and navigated brightness temperature in bands M12, M15, M16 with solar and satellite view angles as an input data set.*
  - » Primary Input Data

Basic Requirement 1.0

- **JPSS-PS-R 1.8.14:** *The JPSS RR Nighttime Cloud Optical Properties shall use Global 1 km land/water & coast mask used for MODIS collection 5 as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 1.8.15:** *The JPSS RR Nighttime Cloud Optical Properties shall use UW Baseline Fit Surface Emissivity for band 7 as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 1.8.16:** *The JPSS RR Nighttime Cloud Optical Properties shall use Clear sky radiance and transmittance for bands 12, 15, 16 TOA radiance for a black cloud bands 12, 15, 16 from CRTM model as an input data set.*
  - Dynamic Ancillary Input – framework internal computation

Basic Requirement 1.0

- **JPSS-PS-R 1.8.17:** *The JPSS RR Nighttime Cloud Optical Properties shall use Temperature, Pressure, Height profiles from GFS model as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 1.8.18:** *The JPSS RR Nighttime Cloud Optical Properties shall use Cloud mask produced by JPSS RR cloud mask algorithm and Cloud Type used by JPSS RR Cloud Type algorithm as an input data sets.*
  - » VIIRS derived RR products as input

- **JPSS-PS-R 1.8.19:** *The JPSS RR Nighttime Cloud Optical Properties shall be validated for Solar Zenith angle >= 90 deg and verified between 82 and 90 deg.*

Basic Requirement 1.0

- **JPSS-PS-R 1.9:** *The Cloud Products shall include quality information.*
  - » QC flags will be specified in the External Users Manual.

- **JPSS-PS-R 1.10:** *The JPSS RRPS shall write Cloud Products files in NetCDF4 formats.*
  - » SPSRB requirement

Basic Requirement 1.0

- **JPSS-PS-R 1.11:** *The JPSS RRPS system shall perform validation and verification of the Cloud Products.*
  - » Validation tools will be based upon the GOES-R validation tools and/or the heritage validation tools

- **JPSS-PS-R 1.11.1:** *The JPSS RRPS system shall plot datasets for verification of the Cloud Products.*

Basic Requirement 1.0

- **JPSS-PS-R 1.11.2:** *The JPSS RRPS system shall verify that Cloud Products files are generated correctly.*
  - » Will be included in the unit tests described in the UTR and the system test described in the ARR.

- **JPSS-PS-R 1.11.3:** *The JPSS RRPS system shall perform routine data range checks to flag anomalous values in the input data.*
  - » Anomalous values will be flagged. These checks will be included in the code and described in the ARR.

Basic Requirement 1.0

- **JPSS-PS-R 1.11.4:** *The JPSS RRPS system shall perform routine data range checks to flag anomalous values in the Cloud Products.*
  - » Out-of-range values will be flagged. These checks will be included in the code. UTR will address.

- **JPSS-PS-R 1.11.5:** *The JPSS RRPS system shall generate matchup datasets between Cloud Products retrievals and in situ measurements.*
  - » In situ data obtained from NCEP & ECMWF analysis, SURFRAD measurements, and CALIPSO data.

Basic Requirement 2.0

- **JPSS-PS-R 2.0:** *The JPSS RRPS shall generate Aerosol Products.*

Driver: **SPSRB requirements:**

- *1009-0016: Dust Aerosol Concentration Product*
- *0707-0014: Support satellite-based verification of the National Air Quality Forecast Capability*

Basic Requirement 2.0

- **JPSS-PS-R 2.1:** *The Aerosol Products shall include Aerosol Optical Depth.*

- **JPSS-PS-R 2.1.1**: *The Aerosol Optical Depth Product priority shall be JPSS 4.*

- **JPSS-PS-R 2.1.2:** *The Aerosol Optical Depth Product shall have global coverage.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.1.3:** *The Aerosol Optical Depth Product shall have Horizontal Cell Size of 0.75 km (nadir).*

- **JPSS-PS-R 2.1.4:** *The Aerosol Optical Depth Product shall have Vertical Reporting Interval of:*
  - » *Threshold - Total column;*
  - » *Objective - Total column*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.1.5:** *The Aerosol Optical Depth Product shall have Mapping Uncertainty, 3 Sigma, of:*
  - » *Threshold – 4 km*
  - » *Objective – 1 km*

- **JPSS-PS-R 2.1.6:** *The Aerosol Optical Depth Product shall have Measurement Range of:*
  - » ~~*Threshold – 0 to 2*~~
  - » ~~*Objective – 0 to 10*~~
  - » *Threshold – 0.05 to 5*
  - » *Objective – 0 to 10*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.1.7:** *The Aerosol Optical Depth Product shall have measurement accuracy based on Aerosol Optical Depth ranges:*
  - ~~*Over land:*~~
  - ~~*< 0.04: 0.06; 0.04 – 0.80: 0.04; > 0.80: 0.12*~~
  - ~~*Over water:*~~
  - ~~*< 0.40: 0.02; > 0.40: 0.10*~~

  Threshold:
  - *Over land:*
    - *0.06 (Tau < 0.1); 0.05 (0.1 ≤ Tau ≤ 0.8); 0.2 (Tau > 0.8)*
  - *Over water:*
    - 0.08 (Tau < 0.3); 0.15 (Tau ≥ 0.3)

  Objective : 1 %

- Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.1.8:** *The Aerosol Optical Depth Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every ~~12 hours~~ 24 hours (monthly average)*
  - » *Objective – 4 hrs*

- **JPSS-PS-R 2.1.9:** *The Aerosol Optical Depth Products shall have latency of 30 minutes after granule data is available.*

- **JPSS-PS-R 2.1.10:** *The Aerosol Optical Depth Products shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.1.11:** *The Aerosol Optical Depth Products shall have Measurement Precision of:*
  - *Threshold –*
    - » *Over Ocean - 0.15 (Tau < 0.3); 0.35 (Tau ≥ 0.3) (1,2,4);*
    - » *Over Land – 0.15 (Tau < 0.1); 0.25 (0.1 ≤ Tau ≤ 0.8); 0.45 (Tau > 0.8);*
  - *Objective –*
    - » *Over Ocean –0.01; Over Land –0.01;*
  - » *Threshold*
    - *Over land:*
    - – *0.15 (Tau < 0.1); 0.25 (0.1 ≤Tau ≤ 0.8); 0.45 (Tau > 0.8)*
    - *Over water:*
    - – *0.15 (Tau < 0.3); 0.35 (Tau ≥ 0.3);*
  - » *Objective: 0.01*
- ➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.1.12:** *Applicable Conditions for Aerosol Optical Depth shall be:*
    1. *Clear, daytime only*
    2. *Zenith angles less than or equal to 80 degrees.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.1.13:** *The JPSS RR Aerosol Optical Depth shall use the VIIRS calibrated and navigated reflectance in bands M1, M2, M3, M4, M5, M8 and M11 over land and M4, M5, M7, M8, M10, M11 over Water with solar and satellite view angles as an input data set.*
  - » Primary Input data
- **JPSS-PS-R 2.1.14:** *The JPSS RR Aerosol Optical Depth shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*
  - » Static Ancillary Input
- **JPSS-PS-R 2.1.15:** *The JPSS RR Aerosol Optical Depth shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

Basic Requirement 2.0

- **JPSS-PS-R 2.1.16:** *The JPSS RR Aerosol Optical Depth shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR product input
- **JPSS-PS-R 2.1.17:** *The JPSS RR Aerosol Optical Depth shall use Location of areas covered by snow or ice as an input data set.*
  - » Ancillary input
- **JPSS-PS-R 2.1.18:** *The JPSS RR Aerosol Optical Depth shall use Fire Mask as an input data set.*
  - » Ancillary Input
- **JPSS-PS-R 2.1.19:** *The JPSS RR Aerosol Optical Depth shall use Heavy Aerosol Mask as an input data set.*
  - » Ancillary input

Basic Requirement 2.0

- **JPSS-PS-R 2.1.20:** *The JPSS RR Aerosol Optical Depth shall use Lookup tables of atmospheric optical functions (reflectance, transmittance, and spherical albedo) calculated from 6S radiative transfer model as an input data set.*
  - » Algorithm Ancillary input
- **JPSS-PS-R 2.1.21:** *The JPSS RR Aerosol Optical Depth shall use Water surface sunglint directional-hemispherical reflectance calculated from 6S radiative transfer model as an input data set.*
  - » Algorithm Ancillary input
- **JPSS-PS-R 2.1.22:** *The JPSS RR Aerosol Optical Depth shall use Surface wind speed and direction (clockwise from local north) as an input data set.*
  - » Dynamic Ancillary input

Basic Requirement 2.0

- **JPSS-PS-R 2.1.23:** *The JPSS RR Aerosol Optical Depth shall use NCEP model predicted surface pressure and corresponding surface height as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 2.1.24:** *The JPSS RR Aerosol Optical Depth shall use NCEP total precipitable water grids that bracket the satellite data as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 2.1.25:** *The JPSS RR Aerosol Optical Depth shall use NCEP surface height grids as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 2.1.26:** *The JPSS RR Aerosol Optical Depth shall use NCEP Ozone data as an input data set.*
  - » Dynamic Ancillary Input

Basic Requirement 2.0

- **JPSS-PS-R 2.2:** *The Aerosol Products shall include Aerosol Detection.*

- **JPSS-PS-R 2.2.1:** *The Aerosol Detection Product priority shall be JPSS 3.*

- **JPSS-PS-R 2.2.2:** *The Aerosol Detection Product shall have global coverage.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.2.3:** *The Aerosol Detection Product shall have Horizontal Cell Size of 0.75 km.*

- **JPSS-PS-R 2.2.4:** *The Aerosol Detection Product shall have Vertical Reporting Interval of:*
  - » *Threshold: Total Column*
  - » *Objective: 0.2 km*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.2.5:** *The Aerosol Detection Product shall have Mapping Uncertainty, 3 Sigma, of:*
  - » *Threshold: 3 km*
  - » *Objective: 0.1 km*

- **JPSS-PS-R 2.2.6:** *The Aerosol Detection Product shall have Measurement Range of:*
  - » *Smoke: 0 to 200 microg/m3*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.2.7:** *The Aerosol Detection Product shall have measurement accuracy of:*
  - » *Dust: 80% correct detection over land and ocean*
  - » *Smoke: ~~80%~~ 70% Correct detection over land and ocean*
  - ~~» *70% correct detection over ocean*~~

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.2.8:** *The Aerosol Detection Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every ~~12 hours~~ 24 hours (monthly average);*
  - » *Objective – 4 hrs;*

- **JPSS-PS-R 2.2.9:** *The Aerosol Detection Products shall have latency of 30 minutes after granule data is available.*

- **JPSS-PS-R 2.2.10:** *The Aerosol Detection Products shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.2.11:** *The JPSS RR Aerosol Detection shall use the VIIRS calibrated and navigated reflectance in bands M1, M2, M5, M6, M7, M8, M10 and M11 with solar and satellite view angles as an input data set.*
  - » Primary input Data
- **JPSS-PS-R 2.2.12:** *The JPSS RR Aerosol Detection shall use the MODIS Collection 5 1km resolution Land/Water Mask as an input data set.*
  - » Static Ancillary Input
- **JPSS-PS-R 2.2.13:** *The JPSS RR Aerosol Detection shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input
- **JPSS-PS-R 2.2.14:** *The JPSS RR Aerosol Detection shall use Cloud mask produced by cloud mask algorithm as an input data set.*
  - » VIIRS derived RR Product as Input

Basic Requirement 2.0

- **JPSS-PS-R 2.2.15:** *The JPSS RR Aerosol Detection shall use Location of areas covered by snow or ice as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 2.2.16:** *The JPSS RR Aerosol Detection shall use Location of areas covered by sun glint as an input data set.*
  - » Dynamic Ancillary Input

- **JPSS-PS-R 2.2.17:** *The JPSS RR Aerosol Detection shall use Day/Night Mask Defined by VIIRS pixel observation time as an input data set.*
  - » Dynamic Ancillary Input

Basic Requirement 2.0

- **JPSS-PS-R 2.3:** *The Aerosol Products shall include Aerosol Particle Size Parameter Product.*

- **JPSS-PS-R 2.3.1:** *The Aerosol Particle Size Parameter Product priority shall be JPSS 4.*

- **JPSS-PS-R 2.3.2:** *The Aerosol Particle Size Parameter Product shall have global coverage.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.3.3:** *The Aerosol Particle Size Parameter Product shall have Horizontal Cell Size of 0.75 km (nadir) and 1.6 km (EOS).*

- **JPSS-PS-R 2.3.4:** ~~*The Aerosol Particle Size Parameter Product shall have Vertical Coverage of:*~~
  - ~~*Threshold - Surface to 30 km*~~
  - ~~*Objective - Surface to 50 km*~~

- **JPSS-PS-R 2.3.5:** *The Aerosol Particle Size Parameter Product shall have Vertical Cell Size of:*
  - *Threshold – Total Column;*
  - *Objective – 0.25 km;*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.3.6:** *The Aerosol Particle Size Parameter Product shall have Mapping Uncertainty, 3 Sigma, of:*
  - » *Threshold – 4 km*
  - » *Objective – 1 km*

- **JPSS-PS-R 2.3.7:** *The Aerosol Particle Size Parameter Product shall have Measurement Range of:*
  - » *Threshold Operational*
  - » *-1 to +3 alpha units*
  - » *Objective -2 to +4 alpha units*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.3.8:** *The Aerosol Particle Size Parameter Product shall have measurement accuracy of:*
  - » *Fine/Coarse Angstrom exponent: 0.3 over ocean ~~and land~~*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.3.9:** *The Aerosol Particle Size Parameter Product Refresh Rate shall be:*
  - » *Threshold - At least 90% coverage of the globe every ~~12 hours~~ 24 hours (monthly average);*
  - » *Objective – 4 hrs;*

- **JPSS-PS-R 2.3.10:** *The Aerosol Particle Size Parameter Products shall have latency of 30 minutes after granule data is available.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.3.11:** *The Aerosol Particle Size Parameter Products shall have timeliness of ≤ 3 hours.*

- **JPSS-PS-R 2.3.12:** *The Aerosol Particle Size Parameter Products shall have Measurement Precision of:*

  Operational over Ocean

  - ~~*Threshold – 0.3 alpha units*~~
  - ~~*Objective – 0.1 alpha units*~~
  - *Threshold – 0.6 alpha units*
  - *Objective – 0.1 alpha units*

- Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.3.13:** *Applicable Conditions for Aerosol Particle Size Parameter Product shall be:*
  - » *Clear, daytime only*

➢ Current operational products, with upgraded capabilities

Basic Requirement 2.0

- **JPSS-PS-R 2.3.14:** *The JPSS RR Aerosol Particle Size Parameter shall use the VIIRS calibrated and navigated reflectance in bands ~~M1, M2, M3, M4, M5, M8 and M11 over land and~~ M4, M5, M7, M8, M10, M11 over Water with solar and satellite view angles as an input data set.*
  - » Primary Input Data
- **JPSS-PS-R 2.3.15:** *The JPSS RR Aerosol Particle Size Parameter shall use the MODIS Collection 5 1km resolution Land Mask as an input data set.*
  - » Static Ancillary Input
- **JPSS-PS-R 2.3.16:** *The JPSS RR Aerosol Particle Size Parameter shall use Digital Surface Elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

Basic Requirement 2.0

- **JPSS-PS-R 2.3.17:** *The JPSS RR Aerosol Particle Size Parameter shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR Product input
- **JPSS-PS-R 2.3.18:** *The JPSS RR Aerosol Particle Size Parameter shall use Location of areas covered by snow or ice as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 2.3.19:** *The JPSS RR Aerosol Particle Size Parameter shall use Fire Mask as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 2.3.20:** *The JPSS RR Aerosol Particle Size Parameter shall use Heavy Aerosol Mask as an input data set.*
  - » Dynamic Ancillary input

Basic Requirement 2.0

- **JPSS-PS-R 2.3.21:** *The JPSS RR Aerosol Particle Size Parameter shall use Lookup tables of atmospheric optical functions (reflectance, transmittance, and spherical albedo) calculated from 6S radiative transfer model as an input data set.*
  - » Algorithm Ancillary Input
- **JPSS-PS-R 2.3.22:** *The JPSS RR Aerosol Particle Size Parameter shall use Water surface sunglint directional-hemispherical reflectance calculated from 6S radiative transfer model as an input data set.*
  - » Algorithm Ancillary Input
- **JPSS-PS-R 2.3.23:** *The JPSS RR Aerosol Particle Size Parameter shall use Surface wind speed and direction (clockwise from local north) as an input data set.*
  - » Dynamic Ancillary Input

Basic Requirement 2.0

- **JPSS-PS-R 2.3.24:** *The JPSS RR Aerosol Particle Size Parameter shall use NCEP model predicted surface pressure and corresponding surface height as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 2.3.25:** *The JPSS RR Aerosol Particle Size Parameter shall use NCEP total precipitable water grids that bracket the satellite data as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 2.3.26:** *The JPSS RR Aerosol Particle Size Parameter shall use NCEP surface height grids as an input data set.*
  - » Dynamic Ancillary Input
- **JPSS-PS-R 2.3.27:** *The JPSS RR Aerosol Particle Size Parameter shall use NCEP Ozone data as an input data set.*
  - » Dynamic Ancillary Input

Basic Requirement 2.0

- **JPSS-PS-R 2.4:** *The Aerosol Products shall include quality information.*
  - » QC flags will be specified in the External Users Manual.

- **JPSS-PS-R 2.5:** *The JPSS RRPS shall write Aerosol Products files in NetCDF4 formats.*
  - » SPSRB requirement

Basic Requirement 2.0

- **JPSS-PS-R 2.6:** *Aerosol Products shall be validated and verified.*
  - » Validation tools will be based upon the GOES-R validation tools

- **JPSS-PS-R 2.6.1:** *The JPSS RRPS system shall plot datasets for verification of the Aerosol Products.*

Basic Requirement 2.0

- **JPSS-PS-R 2.6.2:** *The JPSS RRPS system shall verify that Aerosol Products files are generated correctly.*
  - » Will be included in the unit tests described in the UTR and the system test described in the ARR.
- **JPSS-PS-R 2.6.3:** *The JPSS RRPS system shall perform routine data range checks to flag anomalous values in the input data.*
  - » Anomalous values will be flagged. These checks will be included in the codeand described in the ARR.

Basic Requirement 2.0

- **JPSS-PS-R 2.6.4:** *The JPSS RRPS system shall perform routine data range checks to flag anomalous values in the Aerosol Products.*
  - » Out-of-range values will be flagged. These checks will be included in the code. UTR will address.
- **JPSS-PS-R 2.6.5:** *The JPSS RRPS system shall generate matchup datasets between Aerosol Products retrievals and in situ measurements.*
  - » In situ data obtained from AERONET Measurements

Basic Requirement 3.0

- **JPSS-PS-R 3.0:** *The JPSS RRPS shall generate Volcanic Ash Products.*

Driver*: SPSRB requirements:*

  - *0507-05: Polar/Geostationary Volcanic Ash Detection and Height on CLAVR-X*

Basic Requirement 3.0

- **JPSS-PS-R 3.1:** *The Volcanic Ash Products shall include Volcanic Ash Detection (Mass Loading) and Height.*

- **JPSS-PS-R 3.1.1:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall have priority of JPSS 3.*

- **JPSS-PS-R 3.1.2:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall have Horizontal Cell Size of 0.75 km.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 3.0

- **JPSS-PS-R 3.1.3:** *The Volcanic Ash Detection (Mass Loading) and Height Products shall have global coverage.*

- **JPSS-PS-R 3.1.4:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

➢ Current operational products, with upgraded capabilities

Basic Requirement 3.0

- **JPSS-PS-R 3.1.5:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall have Product Refresh Rate of at least 90% coverage of the globe every 12 hours (monthly average).*

- **JPSS-PS-R 3.1.6:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall have timeliness of ≤ 3 hours.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 3.0

- **JPSS-PS-R 3.1.7:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall have Mapping Uncertainty, 3 Sigma of:*
  - » *Threshold – 3 km*
  - » *Objective – 0.1 km*

- **JPSS-PS-R 3.1.8:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall have Measurement Precision of:*
  - » *2.5 tons/km2*

➢ Current operational products, with upgraded capabilities

Basic Requirement 3.0

- **JPSS-PS-R 3.1.9:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall have Measurement Accuracy of:*
  - » *2 tons/km2, 3 km height.*

- **JPSS-PS-R 3.1.10:** *The Applicable Conditions for Volcanic Ash Detection (Mass Loading) and Height Product shall be:*
  - » *Clear, for AOD greater than 0.15~~, daytime only~~.*

➢ Current operational products, with upgraded capabilities

Basic Requirement 3.0

- **JPSS-PS-R 3.1.11:** *The JPSS RR Volcanic Ash Detection (Mass Loading) and Height shall use the VIIRS calibrated and navigated reflectance in band M5 and brightness temperature & radiances in bands 12, 14, 15 and 16 with solar & satellite view angles as an input data set.*
  - » Primary Input Data
- **JPSS-PS-R 3.1.12:** *The JPSS RR Volcanic Ash Detection (Mass Loading) and Height shall use the Global 1 km land/water & coast mask used for MODIS collection 5 as an input data set.*
  - Static Input Data
- **JPSS-PS-R 3.1.13:** *The JPSS RR Volcanic Ash Detection (Mass Loading) and Height shall use Temperature, Pressure, Height profiles, Surface Temperature Level, Tropopause Level, and Surface Temperature as an input data sets.*
  - Dynamic Input Data

Basic Requirement 3.0

- **JPSS-PS-R 3.1.14:** *The JPSS RR Volcanic Ash Detection (Mass Loading) and Height shall use Clear sky radiance and transmittance for bands 14, 15 and 16 TOA radiance for a black cloud bands 14, 15 and 16 from CRTM model as an input data sets.*
  - » Dynamic Input Data – framework internal computation

- **JPSS-PS-R 3.1.15:** *The JPSS RR Volcanic Ash Detection (Mass Loading) and Height shall use Snow mask by the Interactive Multisensor Snow and Ice Mapping System as an input data set.*
  - Dynamic Input data

Basic Requirement 3.0

- **JPSS-PS-R 3.2:** *The Volcanic Ash Detection (Mass Loading) and Height Product shall include quality information.*
  - » QC flags will be specified in the External Users Manual.

- **JPSS-PS-R 3.3:** *The JPSS RRPS shall write Volcanic Ash Detection (Mass Loading) and Height Product files in NetCDF4 formats.*
  - » SPSRB requirement.

Basic Requirement 3.0

- **JPSS-PS-R 3.4:** *The JPSS RRPS system shall perform validation and verification of the Volcanic Ash Detection (Mass Loading) and Height Product.*
  - » Validation tools will be based upon the GOES-R validation tools

- **JPSS-PS-R 3.4.1:** *The JPSS RRPS system shall plot datasets for verification of the Volcanic Ash Detection (Mass Loading) and Height Products.*

Basic Requirement 3.0

- **JPSS-PS-R 3.4.2:** *The JPSS RRPS system shall verify that Volcanic Ash Detection (Mass Loading) and Height Products files are generated correctly.*
  - » Will be included in the unit tests described in the UTR and the system test described in the ARR.

- **JPSS-PS-R 3.4.3:** *The JPSS RRPS system shall perform routine data range checks to flag anomalous values in the input data.*
  - » Anomalous values will be flagged. These checks will be included in the code And described in the ARR.

Basic Requirement 3.0

- **JPSS-PS-R 3.4.4:** *The JPSS RRPS system shall perform routine data range checks to flag anomalous values in the Volcanic Ash Detection (Mass Loading) and Height Products.*
  - » Out-of-range values will be flagged. These checks will be included in the code. UTR will address.

- **JPSS-PS-R 3.4.5:** *The JPSS RRPS system shall generate matchup datasets between Volcanic Ash Detection (Mass Loading) and Height Products retrievals and in situ measurements.*
  - » In situ data obtained from CALIPSO data.

Basic Requirement 4.0

- **JPSS-PS-R 4.0:** *The JPSS RRPS shall generate Cryosphere Products.*

  » **<u>Driver:</u> SPSRB requirements:** SPSRB 0707-0018 “Add 4 new capabilities to IMS snow cover analysis”

Basic Requirement 4.0

- **JPSS-RRPS-R 4.1:** *The Cryosphere Products shall include Snow Cover Product and a Fractional Snow Cover Product.*

- **JPSS-PS-R 4.1.1:** *The Snow Cover Product shall have priority of JPSS 3.*

- **JPSS-PS-R 4.1.2:** *The Snow Cover Product shall have Horizontal Cell Size of ~~0.375 km~~ 1.6 km EOS.*

➢ Continuity with GOES product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.3:** *The Snow Cover Product shall have global coverage.*

- **JPSS-PS-R 4.1.4:** *The Snow Cover Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

➢ Continuity with GOES product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.5:** *The Snow Cover Product shall have Product Refresh Rate of:*
  - *Threshold - at least 90% coverage of the globe every ~~12 hours~~ 24 hours (monthly average).*
  - *Objective – 3 hrs;*

- **JPSS-PS-R 4.1.6:** *The Snow Cover Product shall have timeliness of ≤ 3 hours.*

➢ Continuity with GOES product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.7:** *The Snow Cover Product shall have Mapping Uncertainty, 3 Sigma of:*
  - » *Threshold*
    - *Clear – 3km;*
    - *Cloudy – N/S*
  - » *Objective*
    - *Clear – 1 km;*
    - *Cloudy – 1km;*

- **JPSS-PS-R 4.1.8:** *The Snow Cover Product shall have Measurement Range of :*
  - » *0 or 1 BSC mask*

➢ Continuity with GOES product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.9:** *The Snow Cover Product shall have Measurement Accuracy of 90% correct classification.*

- **JPSS-PS-R 4.1.10:** *The Snow Cover Product shall have Sensing Depth of:*
  - » *Threshold – N/S*
  - » *Objective – 1.0 m*

- **JPSS-PS-R 4.1.11:** *The Applicable Conditions for Snow Cover Product shall be:*
  - » *Clear Daytime, only*

➢ Continuity with GOES product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.12:** *The JPSS RR Snow Cover shall use the VIIRS calibrated and navigated reflectance in bands I1, I2, and I3 along with solar and satellite view angles as an input data set.*
  - » Primary Input Data

- **JPSS-PS-R 4.1.13:** *The JPSS RR Snow Cover shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR product as input

- **JPSS-PS-R 4.1.14:** *The JPSS RR Snow Cover shall use Global 1 km land/water & coast mask used for MODIS collection 5 as an input data set.*
  - » Static Ancillary Input

Basic Requirement 4.0

- **JPSS-PS-R 4.1.15:** *The JPSS RR Snow Cover shall use Digital surface elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 4.1.16:** *The JPSS RR Snow Cover shall use Weekly maps of snow cover frequency of occurrence on 1/3 degree global lat/lon grid as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 4.1.17:** *The JPSS RR Snow Cover shall use Monthly mean land surface temperature as an input data set.*
  - » Static Ancillary Input

Basic Requirement 4.0

- **JPSS-RRPS-R 4.1.18:** *The Cryosphere Products shall include Fractional Snow Cover Product.*
- **JPSS-PS-R 4.1.19:** *The Fractional Snow Cover Product shall have priority of JPSS 3.*
- **JPSS-PS-R 4.1.20:** *The Fractional Snow Cover Product shall have Horizontal Cell Size of 0.375 km.*

➢ Continuity with MODIS product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.21:** *The Fractional Snow Cover Product shall have global coverage.*

- **JPSS-PS-R 4.1.22:** *The Fractional Snow Cover Product shall have latency of 30 minutes after granule data is available.*
  - Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

➢ Continuity with MODIS product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.23:** *The Fractional Snow Cover Product shall have Product Refresh Rate of:*
  - » *Threshold - at least 90% coverage of the globe every ~~12 hours~~ 24 hours (monthly average).*
  - » *Objective – 3 hrs*

- **JPSS-PS-R 4.1.24:** *The Fractional Snow Cover Product shall have timeliness of ≤ 3 hours.*

➢ Continuity with MODIS product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.25:** *The Fractional Snow Cover Product shall have Mapping Uncertainty, 3 Sigma of:*
  - » *Threshold*
    - *Clear – 3km;*
    - *Cloudy – N/S*
  - » *Objective*
    - *Clear – 1 km;*
    - *Cloudy – 1km;*

- **JPSS-PS-R 4.1.26:** *The Fractional Snow Cover Product shall have Measurement Range of :*
  - » *0 or 100% HSC area fraction*

➢ Continuity with MODIS product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.27:** *The Fractional Snow Cover Product shall have Measurement Uncertainty of 10% of FSC area.*

- **JPSS-PS-R 4.1.28:** *The Fractional Snow Cover Product shall have Sensing Depth of:*
  - » *Threshold – N/S*
  - » *Objective – 1.0 m*

- **JPSS-PS-R 4.1.29:** *The Applicable Conditions for Fractional Snow Cover Product shall be:*
  - » *Clear Daytime, only*

➢ Continuity with MODIS product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.1.30:** *The JPSS RR Fractional Snow Cover shall use the VIIRS calibrated and navigated reflectance in bands I1, I2, I3, I4 and I5 along with solar and satellite view angles as an input data set.*
  - » Primary Input Data

- **JPSS-PS-R 4.1.31:** *The JPSS RR Fractional Snow Cover shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR product as input

- **JPSS-PS-R 4.1.32:** *The JPSS RR Fractional Snow Cover shall use Binary Snow mask produced by JPSS RR Snow Cover algorithm as an input data set.*
  - » VIIRS derived RR product as input

Basic Requirement 4.0

- **JPSS-PS-R 4.1.33:** *The JPSS RR Fractional Snow Cover shall use Digital surface elevation at 1km resolution as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 4.1.34:** *The JPSS RR Fractional Snow Cover shall use Global 1 km land/water & coast mask used for MODIS collection 5 as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R ~~4.1.35:~~** ~~*The JPSS RR Fractional Snow Cover shall use Global 250 m land/water mask used for MODIS collection 6 as an input data set.*~~
  - ~~» Static Ancillary Input~~

Basic Requirement 4.0

- **JPSS-RRPS-R 4.2:** *The Cryosphere Products shall include Sea Ice Concentration Product.*

- **JPSS-PS-R 4.2.1:** *The Sea Ice Concentration Product shall have priority of JPSS 3.*

- **JPSS-PS-R 4.2.2:** *The Sea Ice Concentration Product shall have Horizontal Cell Size of 0.75 km.*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.2.3:** *The Sea Ice Concentration Product shall have global coverage.*

- **JPSS-PS-R 4.2.4:** *The Sea Ice Concentration Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.2.5:** *The Sea Ice Concentration Product shall have timeliness of ≤ 3 hours.*

- **JPSS-PS-R 4.2.6:** *The Sea Ice Concentration Product shall have Product Refresh Rate of:*
  - » *Threshold - at least 90% coverage of the globe every ~~12 hours~~ 24 hours (monthly average).*
  - » *Objective – 6 hrs*

- **JPSS-PS-R 4.2.7:** *The Sea Ice Concentration Product shall have vertical coverage of Ice Surface.*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.2.8:** *The Sea Ice Concentration Product shall have Mapping Uncertainty, 3 Sigma of:*
  - » *Threshold*
    - *Clear - 1km @ nadir*
    - *Cloudy -No capability*
  - » *Objective*
    - *Clear – 0.5 km*
    - *Cloudy - 1 km*

- **JPSS-PS-R 4.2.9:** *The Sea Ice Concentration Product shall have Measurement Range of ~~0/10 to 10/10~~ 0 – 100%.*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.2.10:** *The Sea Ice Concentration Product shall have Measurement Uncertainty of ~~10%~~ 25%.*

- **JPSS-PS-R 4.2.11:** *~~The Sea Ice Concentration Product shall have Cloud Leakage Rate of:~~*
  - » *~~Ocean, Day, COT>1.0, outside Sun Glint region – 1%;~~*
  - » *~~Day, Land, COT>1.0 – 3%;~~*
  - » *~~Land, Ocean, Night, COT>1.0 – 5%~~*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.2.12:** *The JPSS RR Sea Ice Concentration shall use VIIRS calibrated and navigated Brightness Temperature in Channel M5, M7, M10, M15 and M16 along with solar and satellite view angles as an input data set.*
  - » Primary Input Data

- **JPSS-PS-R 4.2.13:** *The JPSS RR Sea Ice Concentration shall use global 1 km land/water & coast mask used for MODIS collection 5 as an input data set.*
  - » Static Ancillary Input

- **JPSS-PS-R 4.2.13:** *The JPSS RR Sea Ice Concentration shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR product as input

Basic Requirement 4.0

- **JPSS-RRPS-R 4.3:** *The Cryosphere Products shall include Ice Age Product.*
- **JPSS-PS-R 4.3.1:** *The Ice Age Product shall have priority of JPSS 3.*
- **JPSS-PS-R 4.3.2:** *The Ice Age Product shall have Horizontal Cell Size of 0.75 km.*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.3.3:** *The Ice Age Product shall have global coverage.*

- **JPSS-PS-R 4.3.4:** *The Ice Age Product shall have latency of 30 minutes after granule data is available.*
  - » Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.3.5:** *The Ice Age Product shall have timeliness of ≤ 3 hours.*

- **JPSS-PS-R 4.3.6:** *The Ice Age Product shall have Product Refresh Rate of:*
  - » *Threshold - at least 90% coverage of the globe every ~~12 hours~~ 24 hours (monthly average).*
  - » *Objective – 6 hrs*

- **JPSS-PS-R 4.3.7:** *The Ice Age Product shall have vertical coverage of Ice Surface.*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.3.8:** *The Ice Age Product shall have Mapping Uncertainty, 3 Sigma of:*
  - » *Threshold*
    - *Clear - 1km @ nadir*
    - *Cloudy -No capability*
  - » *Objective*
    - *Clear – 0.5 km*
    - *Cloudy - 1 km*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.3.9:** *The Ice Age Product shall have Measurement Range of:*
  - » *Threshold*

    Ice free, New/Young Ice, all other ice
  - » *Objective*

    Ice Free, Nilas, Grey White, Grey, White, First Year Medium, First Year Thick, Second Year, and Multiyear; Smooth and Deformed Ice

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.3.10:** *The Ice Age Product shall have Measurement Uncertainty of :*
  - » ~~*80% correct classification (Ice free areas, First year ice, Older ice)*~~
  - » *70% correct classification*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.3.11:** *The JPSS RR Ice Age shall use VIIRS solar and satellite view angles as an input data set.*
  - » Primary Input data
- **JPSS-PS-R 4.3.12:** *The JPSS RR Ice Age shall use Global 1 km land/water & coast mask used for MODIS collection 5 as an input data set.*
  - » Static Ancillary Input
- **JPSS-PS-R 4.3.13:** *The JPSS RR Ice Age shall use NWP Derived surface air temperature, surface air pressure, surface air moisture, surface wind speed, snow cover, and snow depth as an input data set.*
  - » Dynamic Ancillary Input

Basic Requirement 4.0

- **JPSS-PS-R 4.3.14:** *The JPSS RR Ice Age shall use Ice concentration and Ice cover produced by JPSS RR ice concentration/cover algorithm as an input data set.*
  - » VIIRS derived RR product as input

- **JPSS-PS-R 4.3.15:** *The JPSS RR Ice Age shall use Ice surface skin temperature produced by JPSS RR ice surface temperature algorithm as an input data set.*
  - » VIIRS derived RR product as input

- **JPSS-PS-R 4.3.16:** *The JPSS RR Ice Age shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS derived RR product as input

Basic Requirement 4.0

- **JPSS-PS-R 4.3.17:** *The JPSS RR Ice Age shall use Parameterization File to represent the VIIRS Surface Solar Radiation as an input data set.*
  - Algorithm Ancillary Input
- **JPSS-PS-R 4.3.18:** *The JPSS RR Ice Age shall use Parameterization File to represent the VIIRS Surface Thermal Radiation as an input data set.*
  - Algorithm Ancillary Input
- **JPSS-PS-R 4.3.19:** *The JPSS RR Ice Age shall use Parameterization File to represent the VIIRS Surface Broadband Albedo as an input data set.*
  - Algorithm Ancillary Input

Basic Requirement 4.0

- **JPSS-RRPS-R 4.4:** *The Cryosphere Products shall include Ice Surface Temperature Product.*

- **JPSS-PS-R 4.4.1:** *The Ice Surface Temperature Product shall have priority of JPSS 4.*

- **JPSS-PS-R 4.4.2:** *The Ice Surface Temperature Product shall have Horizontal Cell Size of ~~0.75 km~~ 1.6 km.*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.4.3:** *The Ice Surface Temperature Product shall have global coverage.*

- **JPSS-PS-R 4.4.4:** *The Ice Surface Temperature Product shall have latency of 30 minutes after granule data is available.*
  - Latency is defined as the processing time allocated to product generation. Current capability is 60 minutes.

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.4.5:** *The Ice Surface Temperature Product shall have timeliness of ≤ 3 hours.*

- **JPSS-PS-R 4.4.6:** *The Ice Surface Temperature Product shall have Product Refresh Rate of:*
  - *Threshold - at least 90% coverage of the globe every ~~12 hours~~ 24 hours (monthly average).*
  - *Objective – 12 hrs;*

- **JPSS-PS-R 4.4.7:** *The Ice Surface Temperature Product shall have Sensing Depth of Ice Surface.*

- Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.4.8:** *The Ice Surface Temperature Product shall have Mapping Uncertainty, 3 Sigma of:*
  - » *Threshold*
    1. *Nadir - 1km*
    2. *Worst Case – 1.6 km*
  - » *Objective*
    1. *Nadir - 0.1km*
    2. *Worst Case – 0.1 km*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.4.9:** *The Ice Surface Temperature Product shall have Measurement Range of:*
  - » *Threshold*

    213 - 275 K
  - » *Objective-*

    213 - 293 K (2 m above ice)

- **JPSS-PS-R 4.4.10:** *The Ice Surface Temperature Product shall have Measurement Uncertainty of 1K.*

➢ Continuity with GOES-R product, upgraded VIIRS capability

Basic Requirement 4.0

- **JPSS-PS-R 4.4.11:** *The JPSS RR Ice Surface Temperature shall use VIIRS calibrated and navigated Brightness Temperature in Channels M15 and M16 with solar and satellite view angles as an input data set.*
  - » Primary Input data

- **JPSS-PS-R 4.4.12:** *The JPSS RR Ice Surface Temperature shall use global 1 km land/water & coast mask used for MODIS collection 5 as an input data set.*
  - » Static Ancillary Input

Basic Requirement 4.0

- **JPSS-PS-R 4.4.13:** *The JPSS RR Ice Surface Temperature shall use Cloud mask produced by JPSS RR cloud mask algorithm as an input data set.*
  - » VIIRS generated RR product as input

- **JPSS-PS-R 4.4.14:** *The JPSS RR Ice Surface Temperature shall use Ice concentration and Ice cover produced by JPSS RR ice concentration/cover algorithm as an input data set.*
  - » VIIRS generated RR product as input

Basic Requirement 4.0

- **JPSS-RRPS-R 4.5:** *The Cryosphere Products shall include quality information.*
  - » QC flags will be specified in the External Users Manual.
- **JPSS-RRPS-R 4.6:** *The JPSS RRPS shall write Cryosphere Products files in NetCDF4 formats.*
  - » SPSRB requirement.

Basic Requirement 4.0

- **JPSS-RRPS-R 4.7:** *The JPSS RRPS system shall perform validation and verification of the Cryosphere Products.*
  - » Validation tools will be based upon the GOES-R validation tools

- **JPSS-RRPS-R 4.7.1:** *The JPSS RRPS system shall plot datasets for verification of the Cryosphere Products.*

Basic Requirement 4.0

- **JPSS-RRPS-R 4.7.2:** *The JPSS RRPS system shall verify that Cryosphere Products files are generated correctly.*
  - » Will be included in the unit tests described in the UTR and the system test described in the ARR
- **JPSS-RRPS-R 4.7.3:** *The JPSS RRPS system shall perform routine data range checks to flag anomalous values in the input data.*
  - » Anomalous values will be flagged. These checks will be included in the codeand described in the ARR.

Basic Requirement 4.0

- **JPSS-PS-R .4.7.4:** *The JPSS RRPS system shall perform routine data range checks to flag anomalous values in the Cryosphere Products.*
  - » Out-of-range values will be flagged. These checks will be included in the code. UTR will address

- **JPSS-RRPS-R 4.7.5:** *The JPSS PS system shall generate matchup datasets between Cryosphere Products retrievals and in situ measurements.*
  - » In situ data obtained from NCEP & ECMWF analysis, AMSR-E products, Upward Looking Sonar data, Canadian Ice Service measurements and Buoy data.

Basic Requirement 5.0

- **JPSS-RRPS-R 5.0:** *The JPSS PS system shall have data ingestion capability.*

  - » **Driver:**
    - – This basic requirement is traced to algorithm input needs, as documented in the Algorithm Theoretical Basis Documents (ATBDs).

Basic Requirement 5.0

- **JPSS-RRPS-R 5.1:** *The JPSS PS system shall ingest NPP VIIRS L1 data.*

  » Required algorithm input. Ingest from the IDPS. Data link for development is established by NDE.

Basic Requirement 6.0

- **JPSS-RRPS-R 6.0:** *The GOES-R algorithms to generate a retrieval of Cloud Products, Aerosol Products, Volcanic Ash Products, and Cryosphere Products shall be modified.*

  » **Driver:**

  – This basic requirement is traced to user needs for Cloud, Aerosol, Volcanic Ash, and Cryosphere products.

Basic Requirement 6.0

- **JPSS-RRPS-R 6.1:** *The JPSS RRPS Algorithms shall be implemented by processing codes written in C, C++ and Fortran 90.*
  - » *Adaptation of current algorithm/framework code.*

- **JPSS-RRPS-R 6.1.1:** *The JPSS RRPS processing code shall be able to run in the STAR Development Environment (Linux with 12 dual core 3.2 GHz CPUs.*
  - » *S/W: Intel and GNU Compilers (C/C++/Fortran) and IDL for Validation*
  - » *Storage: 100 TB)*
  - » C code, C++ code, and Fortran code can run in this environment

Basic Requirement 6.0

- **JPSS-RRPS-R 6.1.2:** *The JPSS RRPS processing code shall be able to run in the NDE 2.0 Test Environment (Linux machine with 6 quad core 3.2 GHz CPUs*
  - » *S/W: Intel and GNU Compilers (C/C++/Fortran) and IDL for Validation*
  - » *Storage: 30 TB*
  - » *C code, C++ code, and Fortran code can run in this environment*

- **JPSS-RRPS-R 6.1.3:** *The JPSS RRPS processing code shall be able to run in the OSPO Operations Environment: (Linux machine with 6 quad core 3.2 GHz CPUs*
  - » *S/W: Intel and GNU Compilers (C/C++/Fortran) and IDL for Validation*
  - » *Storage: 30 TB*
  - » *C code, C++ code, and Fortran code can run in this environment*

Basic Requirement 7.0

- **JPSS-RRPS-R 7.0:** *The JPSS RRPS system shall generate metadata for each retrieved product.*

  » **Driver:**
    – *Metadata will be used by the Product Monitoring Project*

Basic Requirement 7.0

- **JPSS-RRPS-R 7.1:** *The JPSS RRPS system shall write metadata into the NetCDF4 files associated with the retrieved products.*
  - » Coordinate with the Product Monitoring Project.

- **JPSS-RRPS-R 7.1.1:** *The metadata shall include overall quality and summary level metadata.*
  - » Coordinate with the Product Monitoring Project.

Basic Requirement 7.0

- **JPSS-RRPS-R 7.1.2:** *The metadata shall include Granule metadata.*
  - » Coordinate with the Product Monitoring Project.
- **JPSS-RRPS-R 7.1.3:** *The metadata shall include product specific metadata.*
  - » Coordinate with the Product Monitoring Project.

Basic Requirement 8.0

- **JPSS-RRPS-R 8.0:** *The JPSS RRPS system shall have QC monitoring capability.*

  » **Driver:**

  – This basic requirement is traced to an OSPO need for QC monitoring.

Basic Requirement 8.0

- **JPSS-RRPS-R 8.1:** *The JPSS RRPS Product files shall include overall quality control flags and quality summary level metadata.*
  - » Needed for distribution, quality control and post-processing. JPSS PS code will generate metadata for this purpose.

- **JPSS-RRPS-R 8.2:** *The JPSS RRPS system shall be capable of monitoring input data latency and overall quality.*
  - » Need to import metadata from input file and create code for generating metadata.

Basic Requirement 8.0

- **JPSS-RRPS-R 8.3:** *The JPSS RRPS system shall be capable of monitoring product latency.*
  - Run status file will include processing time.

- ~~**JPSS-RRPS-R 8.4:** *The JPSS RRPS system shall produce real-time imagery for visual inspection of output files.*~~
  - ~~Will be done with IDL.~~

Basic Requirement 8.0

- **JPSS-RRPS-R 8.5:** *The JPSS RRPS system shall be capable of monitoring product distribution status to ensure that the data/products are successfully available for transfer to the user community.*
  - » A run status file will be produced. Work with OSPO to determine needs.
- **JPSS-RRPS-R 8.5.1:** *Each run status file shall include all runtime error messages.*
  - » Error messages will include system messages and error conditions written by the code.

Basic Requirement 8.0

- **JPSS-RRPS-R 8.5.2:** *Each run status file shall indicate whether or not the run was completed without error.*
  - » Code will write this message. This indication will be the last message in the file, so that operators can find it easily.
- **JPSS-RRPS-R 8.6:** *The JPSS PS system shall write a log file for each production run.*
  - » Used by OSPO for QC monitoring and troubleshooting.

Basic Requirement 9.0

- **JPSS-RRPS-R 9.0:** *The JPSS PS shall produce a fully functional pre-operational system in the STAR Development Environment.*

  » **Driver:**

  – This basic requirement is traced to an NDE need for a unit-tested, fully functional system delivered to its Test Environment.

Basic Requirement 9.0

- **JPSS-RRPS-R 9.1:** *The STAR Development Environment shall be capable of hosting the conversion of JPSS RRPS science code to JPSS RRPS pre-operational code.*
  - » See derived requirements 9.1.x.

- **JPSS-RRPS-R 9.1.1:** *The STAR Development Environment shall include the INTEL FORTRAN 90/95 compiler and GNU FORTRAN 90/95 compiler.*
  - » Needed for the Framework FORTRAN code. Development Environment servers have this.

Basic Requirement 9.0

- **JPSS-RRPS-R 9.1.2:** *The STAR Development Environment shall include the INTEL C compiler and the GNU C compiler.*
  - » Needed for the Framework C code. Development Environment servers have this.

- **JPSS-RRPS-R 9.1.3:** *The STAR Development Environment shall include the INTEL C++ compiler and the GNU C++ compiler.*
  - » Needed for the Framework C++ code. Development Environment servers have this.

Basic Requirement 9.0

- **JPSS-RRPS-R 9.1.4:** *The STAR Development Environment shall include Linux machine with 100TB of disk storage.*
  - » Development Environment servers have this.

- **JPSS-RRPS-R 9.2:** *The STAR Development Environment shall be capable of hosting unit tests and a system test.*
  - » Unit tests and system test required prior to delivery of pre-operational system to OSPO.

Basic Requirement 9.0

- **JPSS-RRPS-R 9.2.1:** *The STAR Development Environment shall have access to the OSPO DDS/PDA server.*
  - » For ingest of JPSS VIIRS RR products.

- **JPSS-RRPS-R 9.2.2:** *The STAR Development Environment shall have access to the GRAVITE server.*
  - » For ingest of JPSS VIIRS SDR data.

Basic Requirement 9.0

- **JPSS-RRPS-R 9.3:** *The STAR Development Environment shall host the pre-operational system.*
  - » For development and unit testing. Complete unit test of the pre-operational system is expected before delivery to NDE.

- **JPSS-RRPS-R 9.3.1:** *The pre-operational system shall include all processing code and ancillary files needed to conduct unit tests.*
  - » Complete unit test of the pre-operational system is expected before delivery to NDE. The UTRR will provide a detailed description of the source code units and ancillary files.

Basic Requirement 9.0

- **JPSS-RRPS-R 9.3.2:** *The pre-operational system shall include all input test data needed to conduct unit tests.*
  - » Complete unit test of the pre-operational system is expected before delivery to NDE. The UTRR will provide a detailed description of the unit test data.

- **JPSS-RRPS-R 9.3.3:** *The JPSS RRPS pre-operational system baseline shall be established and maintained with the Clear Case CM tool.*
  - » CM of the pre-operational system is expected throughout its development.

Basic Requirement 10.0

- **JPSS-RRPS-R 10.0:** *The JPSS RRPS integrated pre-operational system shall be transitioned from the STAR Development Environment to the NDE 2.0 Test Environment.*

  » **Driver:**

  – This basic requirement is traced to an NDE need for a system-tested, integrated pre-operational system delivered to its Test Environment.

Basic Requirement 10.0

- **JPSS-RRPS-R 10.1:** *The STAR Development Environment shall host the JPSS RRPS integrated pre-operational system.*
  - » For system testing. A complete system test of the integrated pre-operational system is expected before delivery to NDE.

- **JPSS-RRPS-R 10.1.1:** *The integrated pre-operational system shall include all processing code and ancillary files needed to conduct the system test.*
  - » Complete system test of the integrated pre-operational system is expected. The ARR will provide a description of the processing software system and ancillary files.

Basic Requirement 10.0

- **JPSS-RRPS-R 10.1.2:** *The integrated pre-operational system shall include all input data needed to conduct a system test.*
  - » Complete system test of the integrated pre-operational system is expected. The ARR will provide a description of the system test data.

- **JPSS-RRPS-R 10.1.3:** *The integrated pre-operational system shall include all output data produced by the system test.*
  - » Needed by NDE to verify the system test in its Test Environment. Comparison of outputs from system test in STAR and NDE 2.0 environments will be part of the NDE system test. Specific items will be listed in the ARR.

Basic Requirement 10.0

- **JPSS-RRPS-R 10.1.4:** *The JPSS RRPS integrated pre-operational system baseline shall be established and maintained with the Clear Case CM tool.*
  - » CM of the integrated pre-operational system is expected throughout its development.

Basic Requirement 10.0

- **JPSS-RRPS-R 10.2:** *The integrated pre-operational system shall be delivered to NDE via SADIE as a preliminary Delivered Algorithm Package (DAP).*
  - » NDE needs to reproduce the system test in its Test Environment.

- **JPSS-RRPS-R 10.2.1:** *The JPSS RRPS development team shall ensure that the NDE PAL has the information needed to acquire the preliminary JPSS RRPS DAP from SADIE.*
  - » Use of SADIE ensures this.

Basic Requirement 11.0

- **JPSS-RRPS-R 11.0:** *STAR shall deliver a JPSS RRPS document package to OSPO.*

  » **Driver:**
  - This basic requirement is traced to an OSPO need for documentation to support operations, maintenance, and distribution.

Basic Requirement 11.0

- **JPSS-RRPS-R 11.1:** *The JPSS RRPS document package shall include a README text file.*

- **JPSS-RRPS-R 11.1.1:** *The README file shall list each item in the final pre-operational system baseline, including code, test data, and documentation.*
  - » All required deliverable items must be correctly identified

Basic Requirement 11.0

- **JPSS-RRPS-R 11.2:** *The JPSS RRPS document package shall include a Review Item Disposition (RID) document.*

- **JPSS-RRPS-R 11.2.1:** *The RID shall describe the final status of all development project tasks, work products, and risks.*
  - » Supports the final Algorithm Readiness Review Report (ARRR)

Basic Requirement 11.0

- **JPSS-RRPS-R 11.3:** *The JPSS RRPS document package shall include an Algorithm Theoretical Basis Document (ATBD).*
    - » The ATBD will follow SPSRB Version 2 document standards
- **JPSS-RRPS-R 11.4:** *The JPSS RRPS document package include a Requirements Allocation Document (RAD).*
    - » The RAD will follow document standards stated in EPL v3 process asset DG-6.2

Basic Requirement 11.0

- **JPSS-RRPS-R 11.5:** *The JPSS RRPS document package shall include a System Maintenance Manual (SMM).*
  - » The SMM will follow SPSRB Version 2 document standards.

- **JPSS-RRPS-R 11.6:** *The JPSS RRPS document package shall include an External Users Manual (EUM).*
  - » The EUM will follow SPSRB Version 2 document standards.

Basic Requirement 11.0

- ~~**JPSS-RRPS-R 11.7:** *The JPSS RRPS document package shall include an Internal Users Manual (IUM).*~~
  - » ~~The IUM will follow SPSRB Version 2 document standards.~~

- **JPSS-RRPS-R 11.8:** *The JPSS RRPS document package shall include a Critical Design Document (CDD).*
  - » The CDD will follow STAR EPL document standards in DG-8.2 and DG-8.2.A.

Basic Requirement 11.0

- **JPSS-RRPS-R 11.9:** *The JPSS RRPS document package shall include a Code Test Document (CTD).*
  - » The CTD will follow STAR EPL document standards in DG-10.3 and DG-10.3.A.

- **JPSS-RRPS-R 11.10:** *The JPSS RRPS document package shall include a System Readiness Document (SRD).*
  - » The SRD will follow STAR EPL document standards in DG-11.5 and DG-11.5.A.

Basic Requirement 11.0

- **JPSS-RRPS-R 11.11:** *The JPSS RRPS document package shall include a Algorithm Readiness Review Report (ARRR).*
  - » The ARRR will follow document standards stated in EPL v3 process asset DG-11.6

- **JPSS-RRPS-R 11.11.1:** *The ARRR shall document the approved readiness of the JPSS RR PS system for transition to operations.*
  - » This is an ARR exit criteria item

Basic Requirement 12.0

- **JPSS-RRPS-R 12.0:** *The JPSS RRPS system shall undergo an OSPO Code Review Security for security compliance*

  - » **Driver:**
    - – OSPO Security

Basic Requirement 12.0

- **JPSS-RRPS-R 12.1:** *The JPSS RRPS system shall comply with OSPO data integrity check list.*
  - » OSPO data integrity check list is part of the OSPO Code Review Security check lists.

- **JPSS-RRPS-R 12.2:** *The JPSS RRPS system shall comply with OSPO development security check list.*
  - » OSPO development security check list is part of the OSPO Code Review Security check lists.

Basic Requirement 12.0

- **JPSS-RRPS-R 12.3:** *The JPSS RRPS system shall comply with OSPO code check list.*
  - » OSPO code check list is part of the OSPO Code Review Security check lists.

Basic Requirement 13.0

- **JPSS-RRPS-R 13.0:** *The IT resource needs for operations shall be specified.*

  » **Driver:**
    - OSPO IT Capacity Planning

Basic Requirement 13.0

- **JPSS-RRPS-R 13.1:** *The JPSS RRPS system shall run on Redhat Linux.*
  - Servers are available.
- **JPSS-RRPS-R 13.2:** *Operational server shall have 30 TB of disk space.*
  - Available servers have this capability.
- **JPSS-RRPS-R 13.3:** *Each operational server shall have 8 GB of RAM for each core.*
  - Available servers have this capability.

JPSS RR Requirements shown with the JPSS L1RD Supplement Requirements

Cloud Mask

JPSS RRPS Cloud Mask Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	400 m
Cloud Mask Horizontal Reporting Interval	Cloud Mask HCS	NS
Mapping Uncertainty, 3 Sigma	4 km	1 km
Cloud Mask Measurement Range	Cloudy/Not Cloudy	NS
Cloud Mask Probability of Correct Typing	1. Global - 87% 2. Ocean, Day – 92% 3. Ocean, Night – 90% 4. Snow-free Land, Day – 90% 5. Snow-free Land, Night – 88% 6. Desert, Day – 85% 7. Desert, Night – 85% 8. Snow-covered Land, Day – 88% 9. Snow-covered Land, Night – 85% 10. Sea-Ice, Day – 82% 11. Sea-Ice, Night – 72% 12. Antarctica and Greenland, Day – 80% 13. Antarctica and Greenland, Night – 70%	N/S
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Mask

Cloud Mask Applicable Conditions:

- 1. Requirements apply whenever detectable clouds are present.
- 2. Cloud Mask shall be computed and reported for the total cloud cover.

Cloud Top Phase

JPSS RRPS Cloud Phase Supplement Requirements Table		
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	400 m
Vertical Reporting Interval	N/S	N/S
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Accuracy	80% correct classification	
Measurement Precision	N/S	N/S
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Type

JPSS RRPS Cloud Type Supplement Requirements Table		
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	400 m
Vertical Reporting Interval	N/S	N/S
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Accuracy	60% correct classification	
Measurement Precision	N/S	N/S
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Top Height

JPSS RRPS Cloud Top Height Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Reporting Interval	Top of highest Cloud in column	Top of multiple cloud layers in column
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Precision	COT ≥ 1 – 1.0 km COT < 1 – 2.0 km	COT ≥ 1 – 0.15 km COT < 1 – 0.15 km
Measurement Accuracy	COT ≥ 1 – 1.0 km COT < 1 – 2.0 km	COT ≥ 1 – 0.30 km COT < 1 – 0.30 km
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Top Height (CTH)

CTH Applicable Conditions:

- 1. Requirements apply whenever detectable clouds are present.

Cloud Top Temperature

JPSS RRPS Cloud Top Temperature Supplement Requirements Table		
User & Priority	**JPSS4**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Reporting Interval	Top of highest Cloud in column	Top of multiple clouds in column
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Precision	COT ≥ 1 – 6 K COT < 1 – 12 K	COT ≥ 1 – 1.5 K COT < 1 – 2 K
Measurement Accuracy	COT ≥ 1 – 6 K COT < 1 – 12 K	COT ≥ 1 – 1.5 K COT < 1 – 2 K
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Top Temperature (CTT)

CTT Applicable Conditions:

- 1. Requirements apply whenever detectable clouds are present.

Cloud Top Pressure

JPSS RRPS Cloud Top Pressure Supplement Requirements Table		
User & Priority	**JPSS4**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Reporting Interval	Top of highest Cloud in column	Top of multiple clouds in column
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Precision	COT ≥ 1 – 100 hPa COT < 1 – 200 hPa	COT ≥1 – 50 mb COT <1 – 100 mb
Measurement Accuracy	COT ≥ 1 – 100 hPa COT < 1 – 200 hPa	COT ≥1 – 50 mb COT <1 – 100 mb
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Top Pressure (CTP)

CTP Applicable Conditions:

- 1. Requirements apply whenever detectable clouds are present.

Cloud Optical Depth

JPSS RRPS Cloud Optical Depth Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Reporting Interval	N/A	N/A
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Range	1.0 – 50.0 (Day) 1.0 – 5.0 (Night)	N/A
Measurement Precision	Greater of 30 % or 3.0 Tau (Day) Greater of 30 % or 0.8 Tau (Night)	10 %
Measurement Accuracy	Liquid phase: 20% (Day), 30% (Night); Ice phase: 20% (Day), 30% (Night)	N/A
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Optical Thickness (COD)

COD (COT) Applicable Conditions:

- 1. Requirements apply whenever detectable clouds are present.

Cloud Effective Particle Size

JPSS RRPS Cloud Effective particle Size Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Reporting Interval	N/A	N/A
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Range	2 to 50 µm(day); 2 to 32 µm for water (night); 2 to 50 µm for ice (night)	NS
Measurement Precision	Greater of 4 µm or 25% for water; Greater of 10 µm or 25% for ice	10 %
Measurement Accuracy	Greater of 4 µm or 30% for water; 10 µm for ice	
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Effective Particle Size (CEPS)

CEPS Applicable Conditions:

- 1. Requirements apply both day and night and whenever detectable clouds are present.

Cloud Liquid Water

JPSS RRPS Cloud Liquid Water Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Reporting Interval	N/A	N/A
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Range	25 – 100 g/m2	NS
Measurement Precision	30% (Day) Greater of 25 g/m2 or 40% (Night)	
Measurement Accuracy	50 g/m2 (Day) Greater of 25 g/m2 or 15% (Night)	
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Cloud Ice Water Path

JPSS RRPS Cloud Ice Water Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Reporting Interval	N/A	N/A
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Range	25 – 175 g/m2	NS
Measurement Precision	40% (Day) Greater of 25 g/m2 or 40% (Night)	
Measurement Accuracy	100 g/m2 (Day) Greater of 25 g/m2 or 30% (Night)	
Product Refresh Rate	At least 90% coverage of the globe every 12hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Aerosol Detection

JPSS RRPS Aerosol Detection Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Cell Size	Total Column	0.2 km
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Range	Dust/sand and Smoke.	Dust/Sand, Ash, sea salt
Probability of correct typing	Smoke: 70 % Dust: 80%	Smoke: 100 % Dust: 100%
Product Refresh Rate	At least 90% coverage of the globe every 24hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Aerosol Detection

Aerosol Detection Applicable Conditions:

- Clear, for AOT > 0.15, daytime only

Aerosol Optical Depth

JPSS RRPS AOD Supplement Requirements Table		
User & Priority	**JPSS4**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	0.4 km
Vertical Cell Size	Total Column	0.2 km
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Range	-0.05 to 5	0 to 10
Measurement Precision	Over Ocean: 0.15 (Tau < 0.3) 0.35 (Tau ≥ 0.3) Over land: 0.15 (Tau < 0.1); 0.25 (0.1 ≤ Tau ≤ 0.8); 0.45 (Tau > 0.8)	0.01
Measurement Accuracy	Over Ocean: 0.08 (Tau < 0.3) 0.15 (Tau ≥ 0.3) Over land: 0.06 (Tau < 0.1); 0.05 (0.1 ≤ Tau ≤ 0.8); 0.2 (Tau > 0.8)	1%
Product Refresh Rate	At least 90% coverage of the globe every 24hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Aerosol Optical Depth (AOD)

AOD Applicable Conditions:

- Clear, daytime only
- Zenith angles less than or equal to 80 degrees.

Aerosol Particle Size Parameter

JPSS RRPS APSP Supplement Requirements Table		
User & Priority	**JPSS4**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	
Vertical Cell Size	Total Column	0.25 km
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Range	-1 to +3 alpha units	-2 to +4 alpha units
Measurement Precision	Operational Over Ocean: 0.6 alpha units	Operational Over Ocean: 0.6 alpha units
Measurement Uncertainty	Operational Over Ocean: 0.3 alpha units	Operational Over Ocean: 0.1 alpha units
Product Refresh Rate	At least 90% coverage of the globe every 24hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Aerosol Particle Size Parameter (APSP)

APSP Applicable Conditions:

- 1. Clear, daytime, Ocean only

Volcanic Ash and Height

JPSS RRPS Volcanic Ash Detection and Height Supplement Requirements Table		
User & Priority	**JPSS4**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	0.8 km at Nadir	
Vertical Cell Size	Total Column	0.2 km
Mapping Uncertainty, 3 Sigma	4 km	1 km
Measurement Accuracy	2 tons/km2, 3 km height	
Measurement Precision	2.5 tons/km2	
Product Refresh Rate	At least 90% coverage of the globe every 12 hours (monthly average)	4 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Volcanic Ash

Applicable Conditions:

- 1. Clear, for AOD greater than 0.15.

Snow Cover

JPSS RRPS Snow Cover Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	1.6 km EOS	1 km
Measurement Range	0 or 1 binary mask	
Mapping Uncertainty, 3 Sigma	4 km Cloudy: Not Applicable	Clear/Cloudy: 1 km
Probability of correct classification	Clear: 90% Cloudy: Not Applicable	
Product Refresh Rate	At least 90% coverage of the globe every 24 hours (monthly average)	3 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Fractional Snow Cover

JPSS RRPS Fractional Snow Cover Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	Global coverage	
Horizontal Cell Size	1.6 km EOS	1 km
Measurement Range	0 – 100% area fraction	
Mapping Uncertainty, 3 Sigma	4 km Cloudy: Not Applicable	Clear/Cloudy: 1 km
Probability of correct detection	Clear: 20% Cloudy: Not Applicable	Clear: 10% Cloudy: Not Applicable
Product Refresh Rate	At least 90% coverage of the globe every 24 hours (monthly average)	3 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Snow Cover

Snow Cover Applicable Conditions:

- Clear Daytime, only

Sea Ice Concentration

JPSS RRPS Sea Ice Concentration Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	All ice-covered regions of the global ocean	
Vertical Coverage	Ice Surface	Ice Surface
Horizontal Cell Size	Clear: 1.0 km All weather: no capability	Clear: 0.5 km All weather: 1 km
Measurement Range	0 – 100%	
Mapping Uncertainty, 3 Sigma	Clear: 1 km at nadir Cloudy: No capability	Clear: 0.5 km Cloudy: 1 km
Measurement Accuracy	10%	
Measurement Uncertainty	25%	
Product Refresh Rate	At least 90% coverage of the globe every 24 hours (monthly average)	6 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Ice Age/Thickness

JPSS RRPS Ice Age/Thickness Supplement Requirements Table		
User & Priority	**JPSS3**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	All ice-covered regions of the global ocean	
Vertical Coverage	Ice Surface	Ice Surface
Horizontal Cell Size	Clear: 1.0 km All weather: no capability	Clear: 0.5 km All weather: 1 km
Measurement Range	Ice free, New/Young Ice, all other ice	Ice Free, Nilas, Grey White, Grey, White, First Year Medium, First Year Thick, Second Year, and Multiyear; Smooth and Deformed Ice
Mapping Uncertainty, 3 Sigma	Clear: 1 km at nadir Cloudy: No capability	Clear: 0.5 km Cloudy: 1 km
Measurement Uncertainty, Probability of correct Typing of ice classes	New/Young Ice – 70% Other Ice – 70%	New/Young Ice – 90% Other Ice – 90%
Product Refresh Rate	At least 90% coverage of the globe every 24 hours (monthly average)	6 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Ice Surface Temperature

JPSS RRPS Ice Surface Temperature Supplement Requirements Table		
User & Priority	**JPSS4**	
Attribute	**Threshold**	**Objective**
Geographic Coverage	All ice-covered regions of the global ocean	
Sensing Depth	Ice Surface	Ice Surface
Horizontal Cell Size	Nadir - 1km Worst Case –1.6 km	Nadir - 0.1km Worst Case – 0.1 km
Measurement Range	213 - 275 K	213 - 293 K (2 m above ice)
Mapping Uncertainty, 3 Sigma	Clear: 1 km at nadir Cloudy: No capability	Clear: 0.5 km Cloudy: 1 km
Measurement Uncertainty	1 K	1 K
Product Refresh Rate	At least 90% coverage of the globe every 24 hours (monthly average)	6 hrs
Latency	30 minutes after granule data is available	
Timeliness	≤ 3hours	

Sea Ice Characterization

Sea Ice Characterization Applicable Conditions:

- Clear sky conditions only.

JPSS RRPS System Requirements – Summary

- The JPSS Risk Reduction System Requirements have been established.
- The Requirements have been documented in the Requirements Allocation Document (RAD).
- The Requirements are traceable to drivers (customer needs or expectations) and other requirements.

Outline

- Introduction
- Risks and Actions
- Requirements
- Algorithm Readiness
- Software Architecture
- Delivered Algorithm Package
- Risks Summary
- Summary and Conclusions

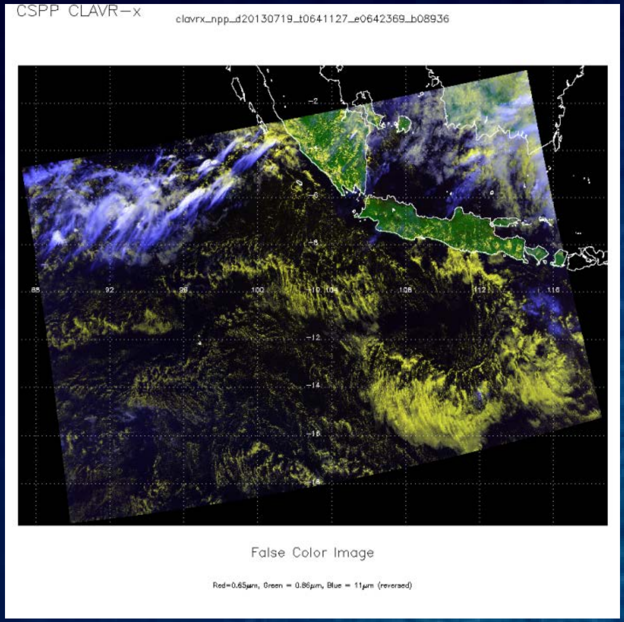
Algorithm Readiness Review (ARR)
VIIRS Clear Sky Mask

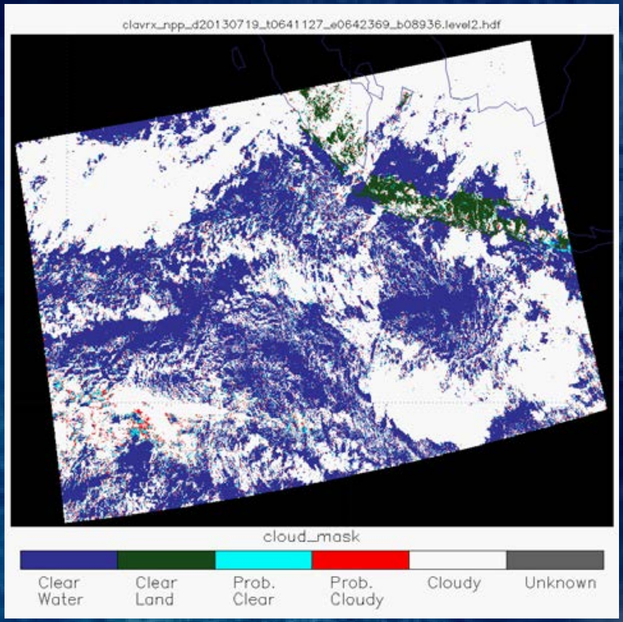
Presented by

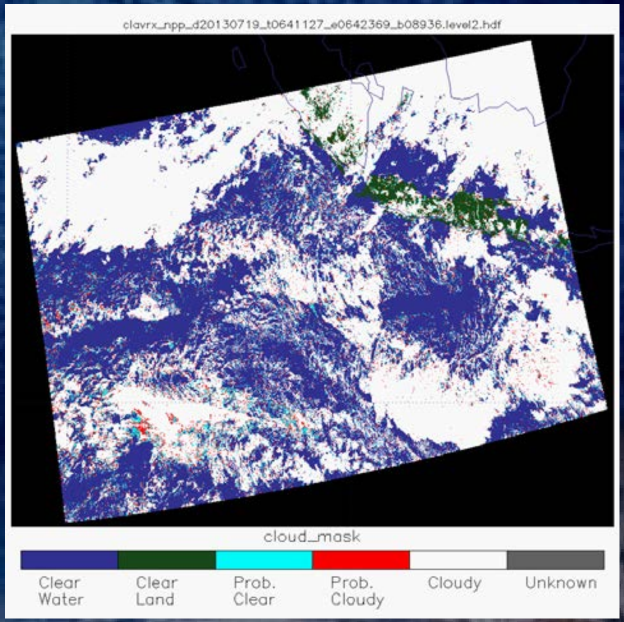
Andrew Heidinger
NOAA/NESDIS/STAR

Algorithm Output: Example 4-level Mask

Example Output of the RGB (left), CLAVR-x Cloud Mask (center), and Framework Cloud Mask (right)
July 19, 2013 from 06:38:21 to 06:42:36 UTC







RGB

Cloud Mask CLAVR-x

Cloud Mask Framework

ARR Data

- The equivalence of one day's worth of data (≈1000 granules) processed through Cloud Mask implemented in the Framework/SAPF.
- These granules are chosen to be co-located with CALIPSO, and spread over the whole 2013 year.
- CALIPSO and VIIRS validation tools run on these data to demonstrate compliance with the L1RD requirements.

CDR Requirements
Clear Sky Masks

Name	Vertical Resolution	Horizontal Resolution	Mapping Accuracy	Measurement Range	Measurement Accuracy	Temporal Coverage Qualifiers	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Clear Sky Mask	N/A	0.75 km	0.75 km	0 – 1 Binary (0 – 3 for 4-Level Mask)	13% probability of incorrect detection	Day and night	Clear conditions associated with threshold accuracy	Over specified geographic area

Performance Estimates: Calculation of Metrics

• The Probability of Incorrect Detection (POID) is 13% (threshold)

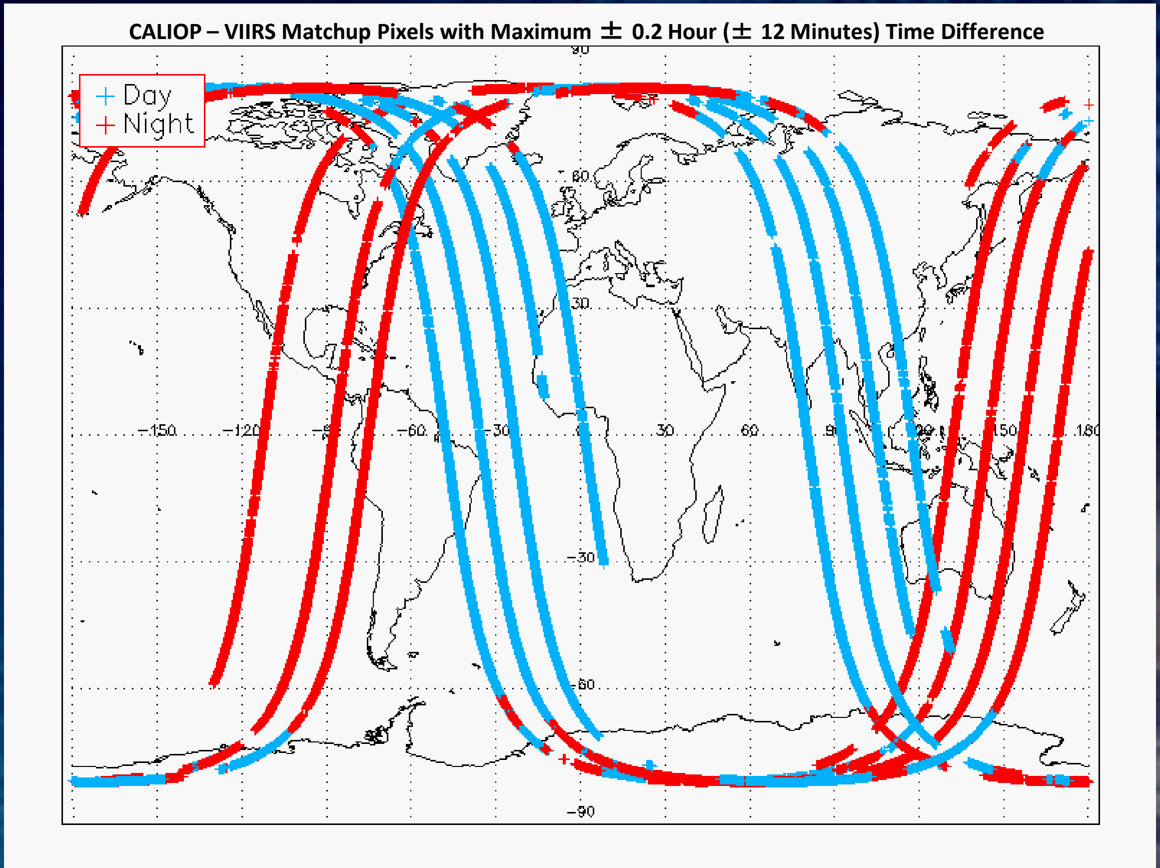
• POD = (number of correctly identified clear pixels + number of correctly identified cloudy pixels) / (number of cloudy CALIPSO pixels and number of clear CALIPSO pixels)

• Leakage or Missed Cloud = number of pixels with cloud mask = CLEAR or PROBABLY CLEAR when collocated CALIPSO views within a VIIRS pixel were cloudy.

• False Alarm = number of pixels with cloud mask = CLOUDY or PROBABLY CLOUDY when no collocated CALIPSO views within VIIRS pixel were cloudy.

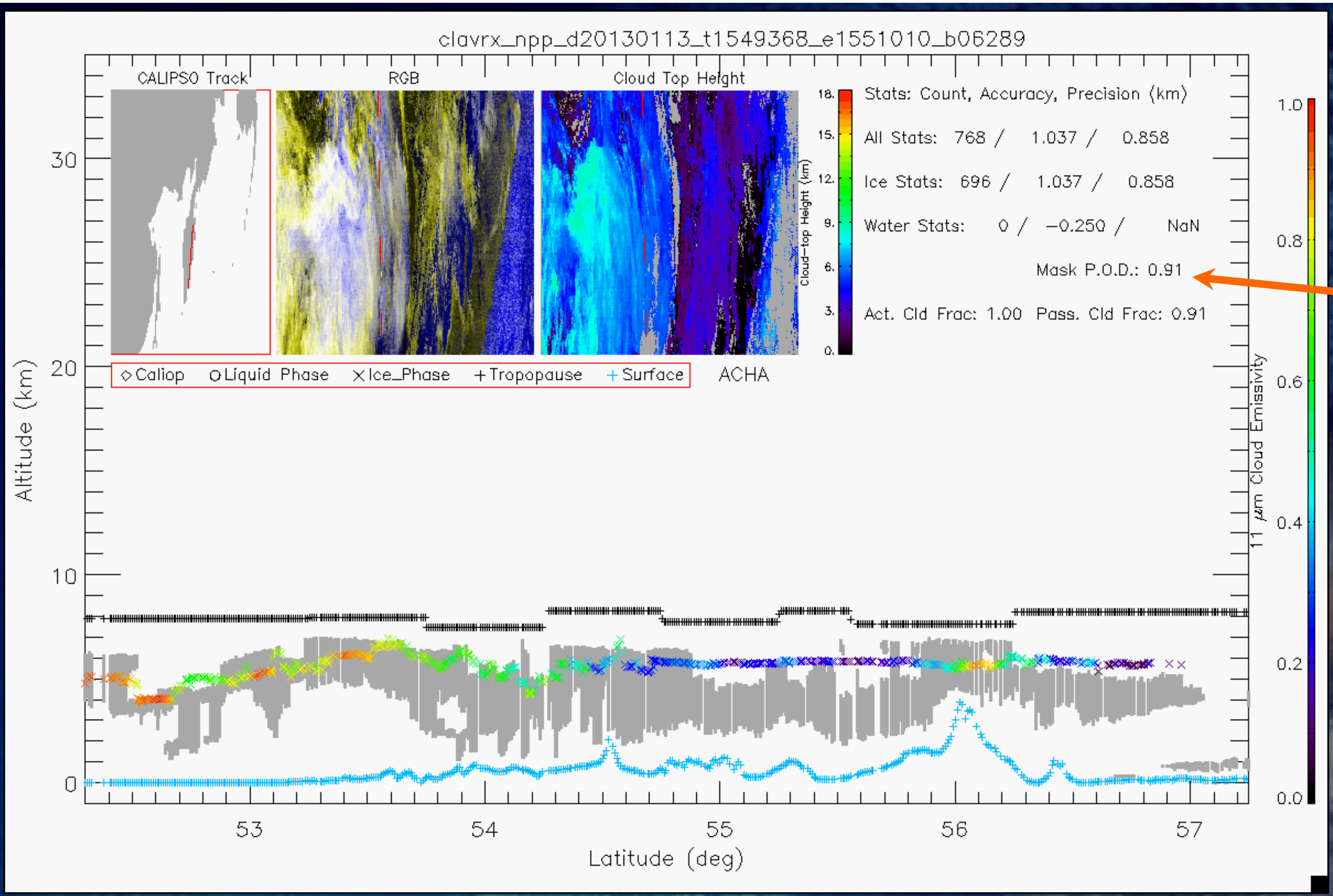
•For this computation, the 4-level mask was converted to a binary mask

CALIPSO Collocation Pixels



~1000 granules collocation from 2013
Processed by Framework

VIIRS Cloud Mask with CALIPSO/CALIOP



Cloud Mask
POD = 91%

Collocation tools are applied to VIIRS Cloud Mask for CALIPSO based Cloud Layer Products.

CALIPSO Collocation Stats

~1000 granules collocation from 2013 Processed by Frame Work

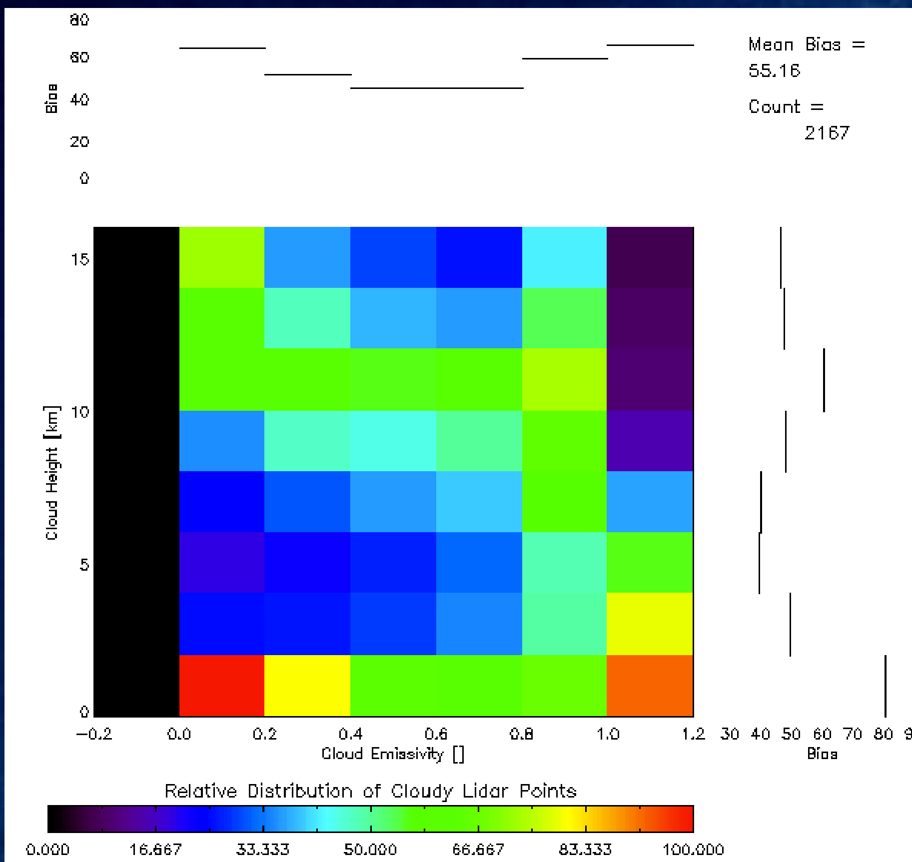
Sample Size	Cloud fraction				Probability of		
	Active	Passive	Prob. Clear	Prob. Cloudy	Detection	False Detect.	Leakage
90N – 90S (Global), Ocean / Land, Day / Night, No Snow / Snow / Ice							
453935	0.727	0.692	0.075	0.089	0.888	0.038	0.074
60N – 60S, Ocean / Land, Day / Night, No Snow / No Ice							
283271	0.698	0.651	0.034	0.046	0.933	0.010	0.057
60N – 60S, Ocean, Day, No Snow / No Ice							
122078	0.688	0.661	0.016	0.021	0.951	0.011	0.038
60N – 60S, Ocean, Night, No Snow / No Ice							
84021	0.803	0.721	0.056	0.088	0.908	0.005	0.087
60N – 60S, Land, Day, No Snow / No Ice							
33193	0.571	0.551	0.017	0.015	0.952	0.014	0.034
60N – 60S, Land, Night, No Snow / No Ice							
24534	0.568	0.492	0.072	0.054	0.906	0.009	0.085
90N – 60N (Arctic), Ocean / Land, Day / Night, No Snow / Snow / Ice							
55222	0.707	0.654	0.180	0.155	0.725	0.111	0.164
90S – 60S (Antarctic), Ocean / Land, Day / Night, No Snow / Snow / Ice							
55184	0.642	0.701	0.209	0.269	0.766	0.146	0.088

POD exceeds 87% threshold for all but Polar Regions.
Overall global POD = 88.8%.

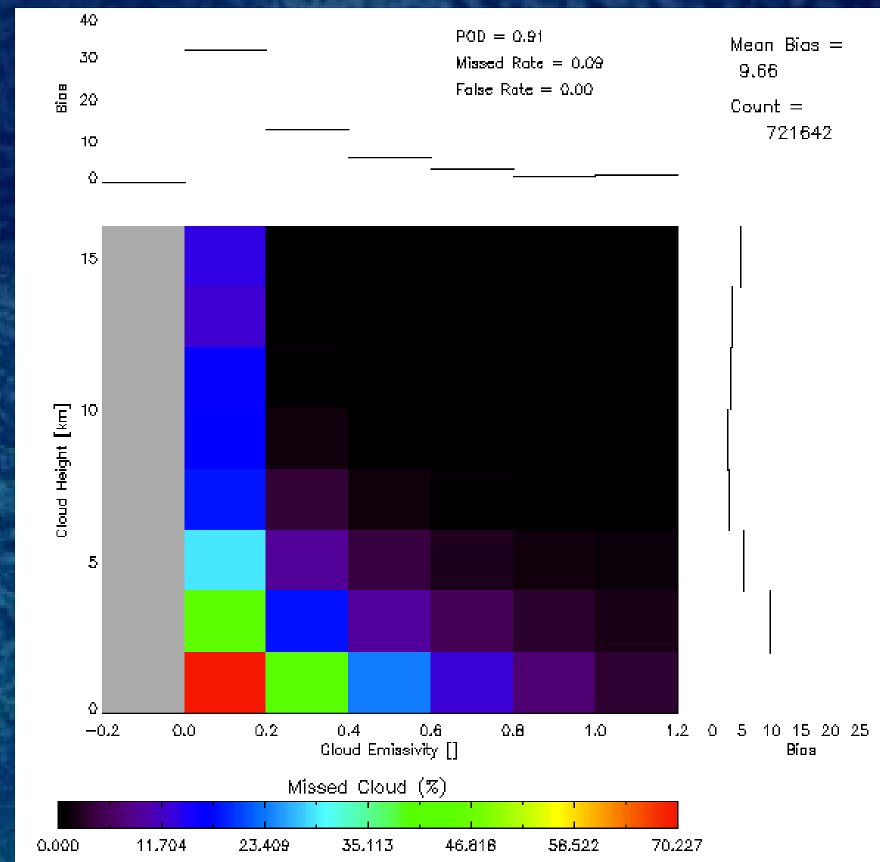
CALIPSO – VIIRS Analysis

Given the quantity of VIIRS/CALIPSO matchups.
Here are results for ~1000 granules of 2013 for all regions.

Height/Emissivity distribution of Cloudy CALIPSO values



Height/Emissivity distribution of missed pixels



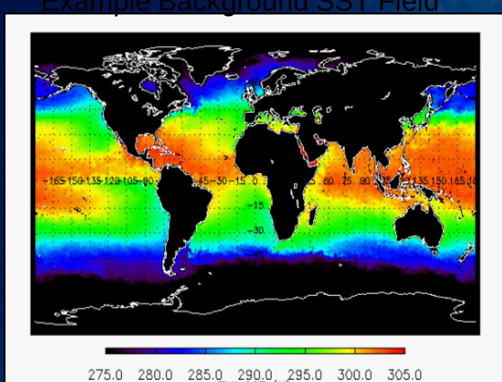
Performance Estimates: SST Bias Monitoring

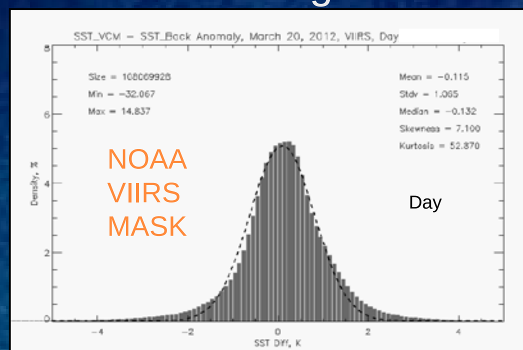
• We have worked closely with STAR SST Team on the GOES-R AWG and JPSS CAL/VAL programs.

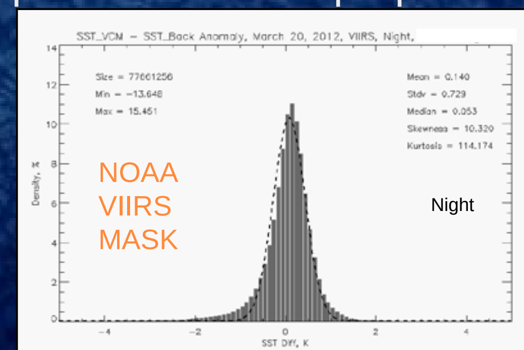
• We have developed tools to match the SQUAM (SST Quality Monitoring Analysis) results and will use these to monitor our cloud mask's performance.

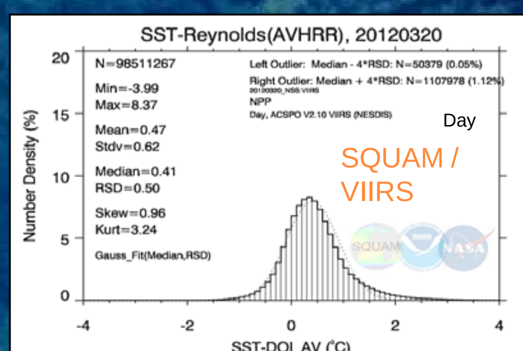
•SST Team will always do additional filtering that is not appropriate for a multi-purpose cloud mask.

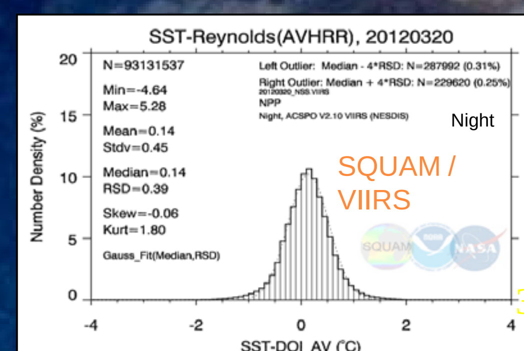
Example Background SST Field











Summary of Validation Results

- ~1000 granules of VIIRS where processed and validated against CALIOP cloud product;
- VIIRS Clear Sky Mask performance is within requirements, but improvement is possible and should be executed.

References

- Heidinger, Andrew K.; Evan, Amato T.; Foster, Michael J. and Walther, Andi. **A naive Bayesian cloud-detection scheme derived from CALIPSO and applied within PATMOS-x.** Journal of Applied Meteorology and Climatology, Volume 51, Issue 6, 2012, 1129–1144

- Schreiner, Anthony J.; Ackerman, Steven A.; Baum, Bryan A. and Heidinger, Andrew K.. **A multispectral technique for detecting low-level cloudiness near sunrise**. Journal of Atmospheric and Oceanic Technology, Volume 24, Issue 10, 2007, pp.1800-1810.

- Thomas, Sarah M.; Heidinger, Andrew K. and Pavolonis, Michael J.. **Comparison of NOAA's operational AVHRR-derived cloud amount to other satellite-derived cloud climatologies**. Journal of Climate, Volume 17, Issue 24, 2004, pp.4805-4822.

- Heidinger, Andrew K.; Frey, Richard and Pavolonis, Michael. **Relative merits of the 1.6 and 3.75 micron channels of the AVHRR/3 for cloud detection**. Canadian Journal of Remote Sensing, Volume 30, Issue 2, 2004, pp.182-194.

VIIRS Cloud Phase/Type Algorithm Readiness

Presented by

Mike Pavolonis

NOAA/NESDIS/STAR

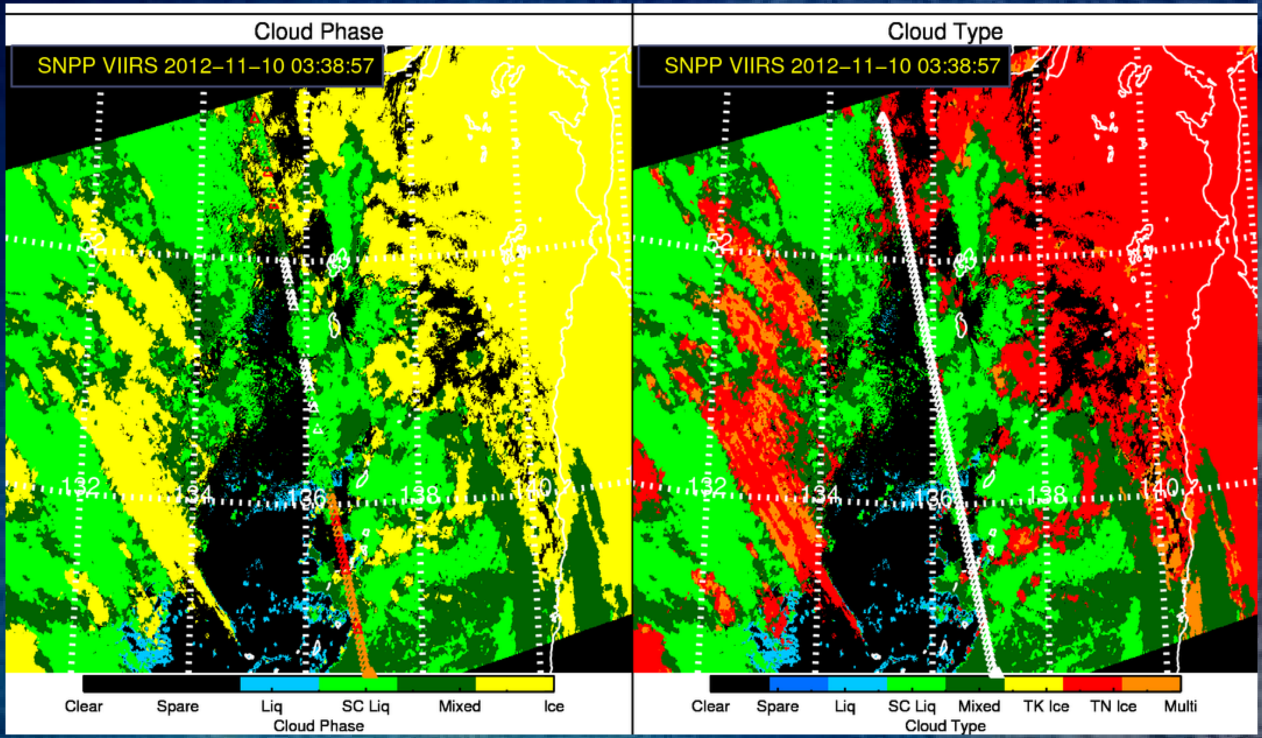
Outline

- Product Overview and Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the VIIRS cloud phase and type products.

VIIRS Cloud Phase/Type Overview

- Cloud type is derived through exploitation of multi-spectral signals in VIIRS infrared data (8.5 (M14), 11 (M15), 12 µm (M16))
  - Cloud type categories: liquid water, supercooled liquid water, mixed phase, thick ice, thin ice, multilayered ice
  - The ice related cloud type categories are combined to produce the cloud phase product
  - The product includes data quality flags and metadata



Requirements
Cloud Top Phase

Name	User & Priority	Geographic Coverage	Vertical Res.	Horiz. Res.	Msmnt. Range	Msmnt. Accuracy	Data Latency	Refresh Rate	Timeliness
Cloud Top Phase	JPSS	Global	Cloud Top	0.75 km	Liquid/solid/ super cooled/mixed (6 categories)	80% correct classification	30 minutes after granule is available	90 minutes	≤ 3 hours

Name	User & Priority	Geographic Coverage	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Cloud Top Phase	JPSS	Global	Day and night	Quantitative out to at least 65 degrees LZA and qualitative beyond	In presence of clouds with optical depth >1. Clear conditions down to cloud top associated with threshold accuracy	Over specified geographic area

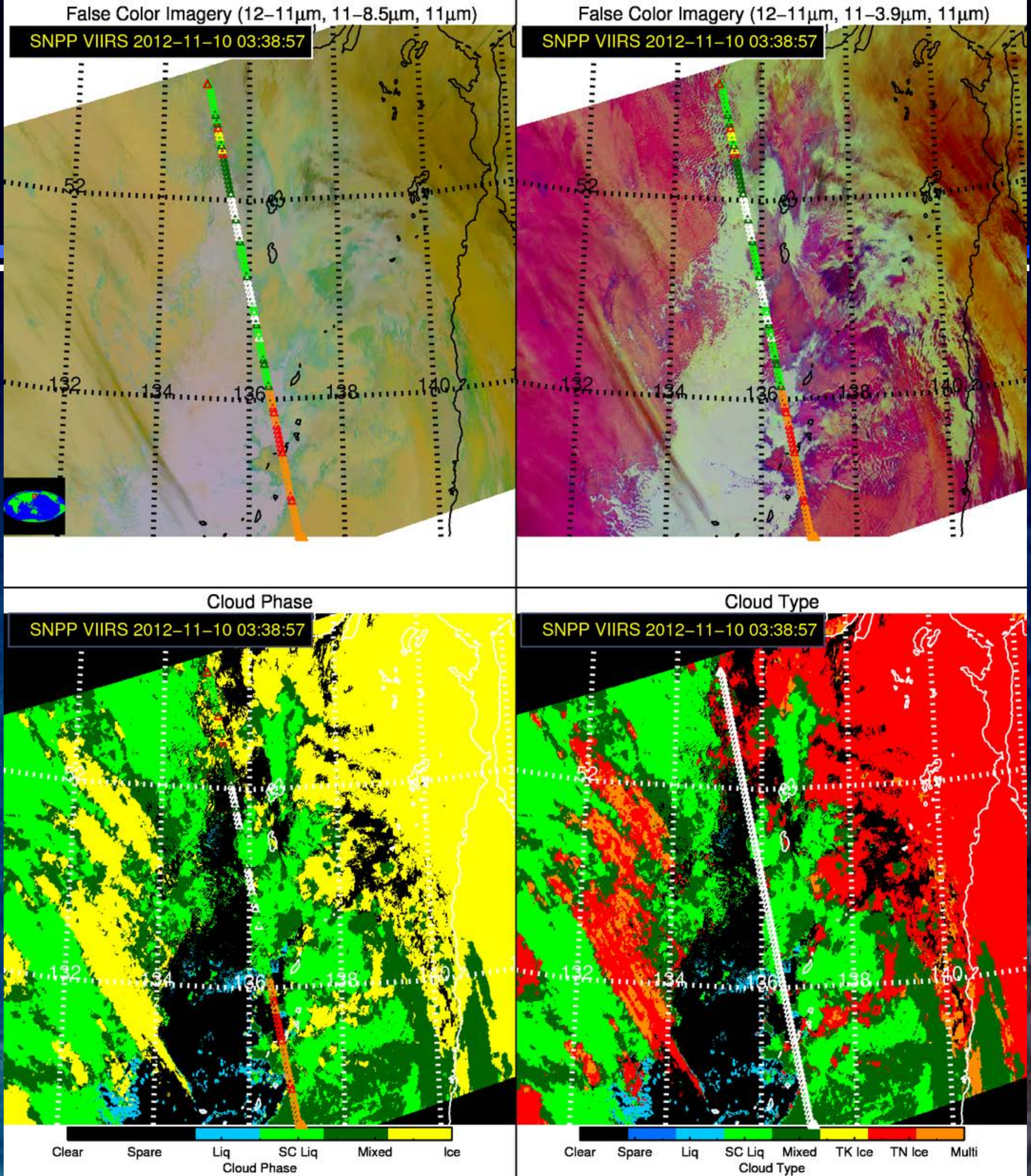
Requirements Cloud Type

Name	User & Priority	Geographic Coverage	Vertical Res.	Horiz. Res.	Msmnt. Range	Msmnt. Accuracy	Data Latency	Refresh Rate	Timeliness
Cloud Type	JPSS	Global	Cloud Top	0.75 km	7 categories	60% correct classification	30 minutes after granule is available	90 minutes	≤ 3 hours

Name	User & Priority	Geographic Coverage	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Cloud Type	JPSS	Global	Day and night	Quantitative out to at least 65 degrees LZA and qualitative beyond	In presence of clouds with optical depth >1. Clear conditions down to cloud top associated with threshold accuracy	Over specified geographic area

Algorithm Output

S-NPP VIIRS: November 10, 2012 03:39 UTC



Validation Strategy

- Derive cloud phase and type products with full global sampling
- Collocate (in space and time) VIIRS with CALIOP (lidar)
- Combine CALIOP 1 km and 5 km vertical feature masks and convert into an equivalent passive sensor relevant cloud type using cloud object based procedure
- Perform validation with and without mixed phase clouds (the ability to identify mixed phase clouds from CALIOP is very limited)
- Generate comparative statistics and deep dive analyses

JPSS-RR Cloud Phase Validation

- The JPSS-RR cloud phase algorithm was validated using a large sampling of scenes from 2013 (provided by AIT)
- The JPSS-RR cloud phase algorithm was validated in greater detail using global VIIRS data from November 10, 2012.
- Validation was performed using collocated CALIPSO data for pixels detected as cloud from both the VIIRS and CALIPSO cloud masks.
- Validation was performed for the entire dataset but was also separated into various geographical and optical depth categories

Cloud Phase Validation – AIT Framework Output from Selected Days in 2013

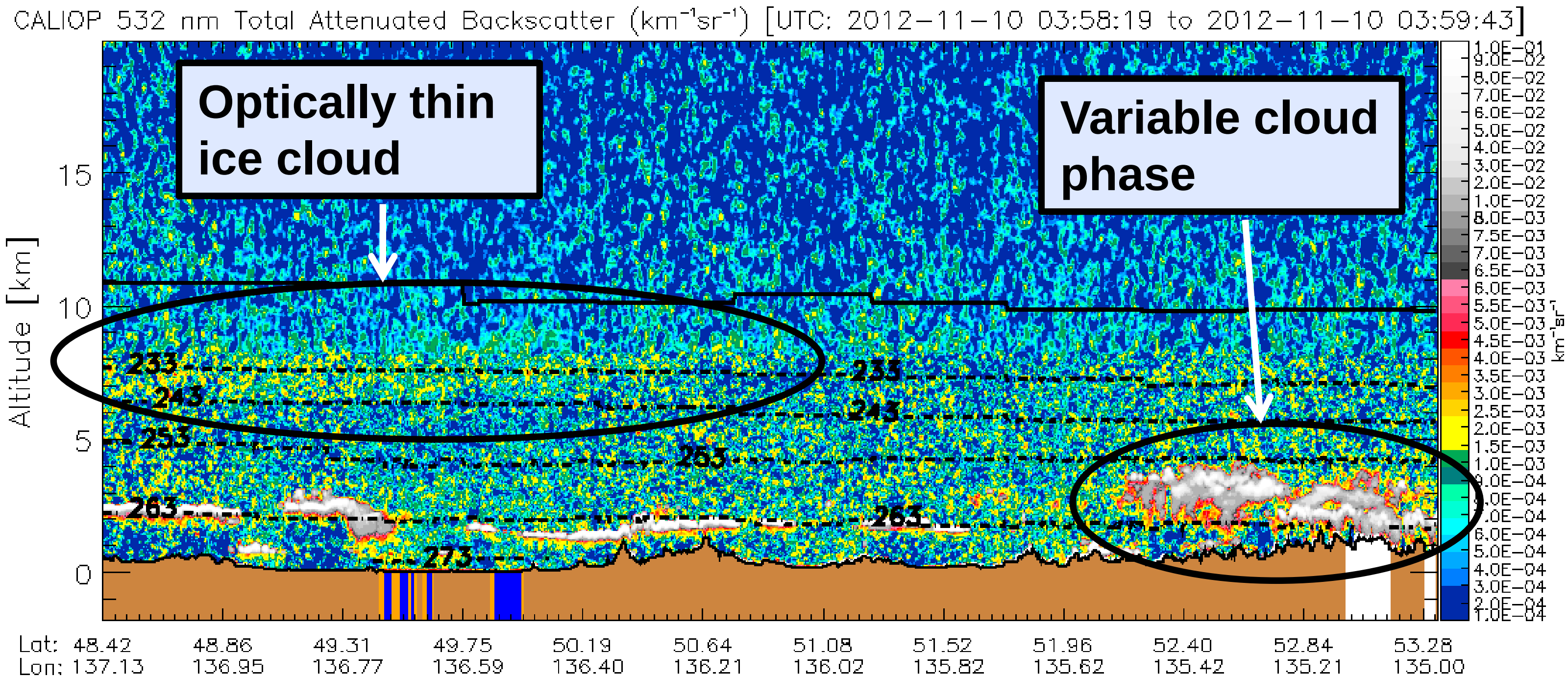
Optical Depth Filter

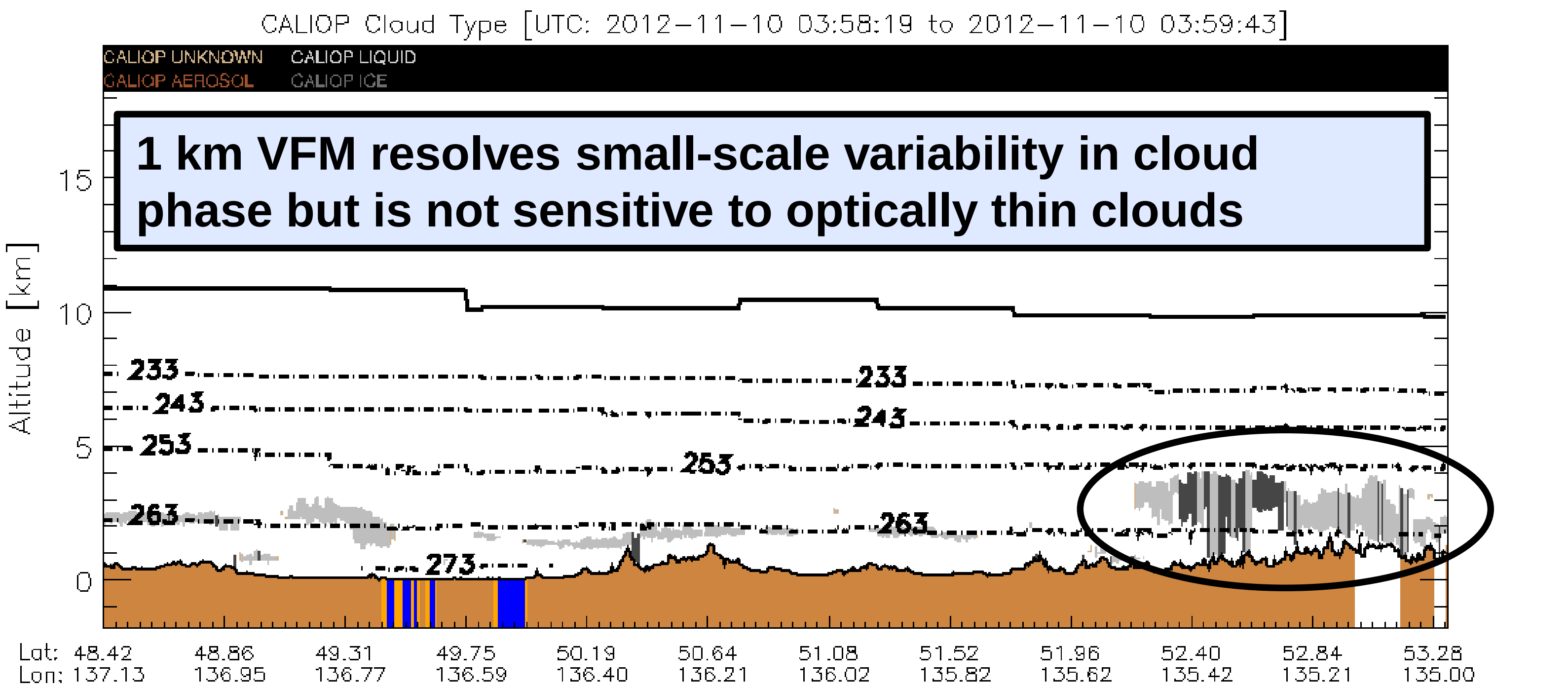
OD	>0.0	>0.1	>0.2	>0.3	>0.4	>0.5	>2.0
All data	0.826 (101144/ 122402)	0.876 (86632/ 98945)	0.882 (78632/ 89122)	0.885 (73889/ 83528)	0.885 (70792/ 79971)	0.885 (68246/ 77090)	0.849 (33375/ 39317)
Day time	0.822 (46123/ 56133)	0.875 (37517/ 42874)	0.881 (33982/ 38585)	0.880 (31653/ 35966)	0.880 (30307/ 34431)	0.880 (29267/ 33240)	0.822 (13703/ 16671)
Night time	0.830 (55021/ 66269)	0.876 (49115/ 56071)	0.884 (44650/ 50537)	0.888 (42236/ 47562)	0.889 (40485/ 45540)	0.889 (38979/ 43850)	0.869 (19672/ 22646)
Over land	0.862 (26242/ 30446)	0.897 (21655/ 24153)	0.904 (19429/ 21487)	0.907 (17766/ 19581)	0.909 (16888/ 18584)	0.910 (16193/ 17796)	0.868 (5999/ 6913)
Over water	0.815 (74902/ 91956)	0.869 (64977/ 74792)	0.875 (59203/ 67635)	0.878 (56123/ 63947)	0.878 (53904/ 61387)	0.878 (52053/ 59294)	0.845 (27376/ 32404)
Lat > 60 deg	0.860 (23218/ 26983)	0.870 (18754/ 21561)	0.873 (17127/ 19612)	0.873 (16046/ 18387)	0.873 (15407/ 17642)	0.872 (14772/ 16949)	0.782 (6264/ 8007)
Lat < 60 deg	0.817 (77926/ 95419)	0.877 (67878/ 77384)	0.885 (61505/ 69510)	0.888 (57843/ 65141)	0.889 (55385/ 62329)	0.889 (53474/ 60141)	0.866 (27111/ 31310)

Cloud Type Validation – AIT Framework Output from Selected Days in 2013

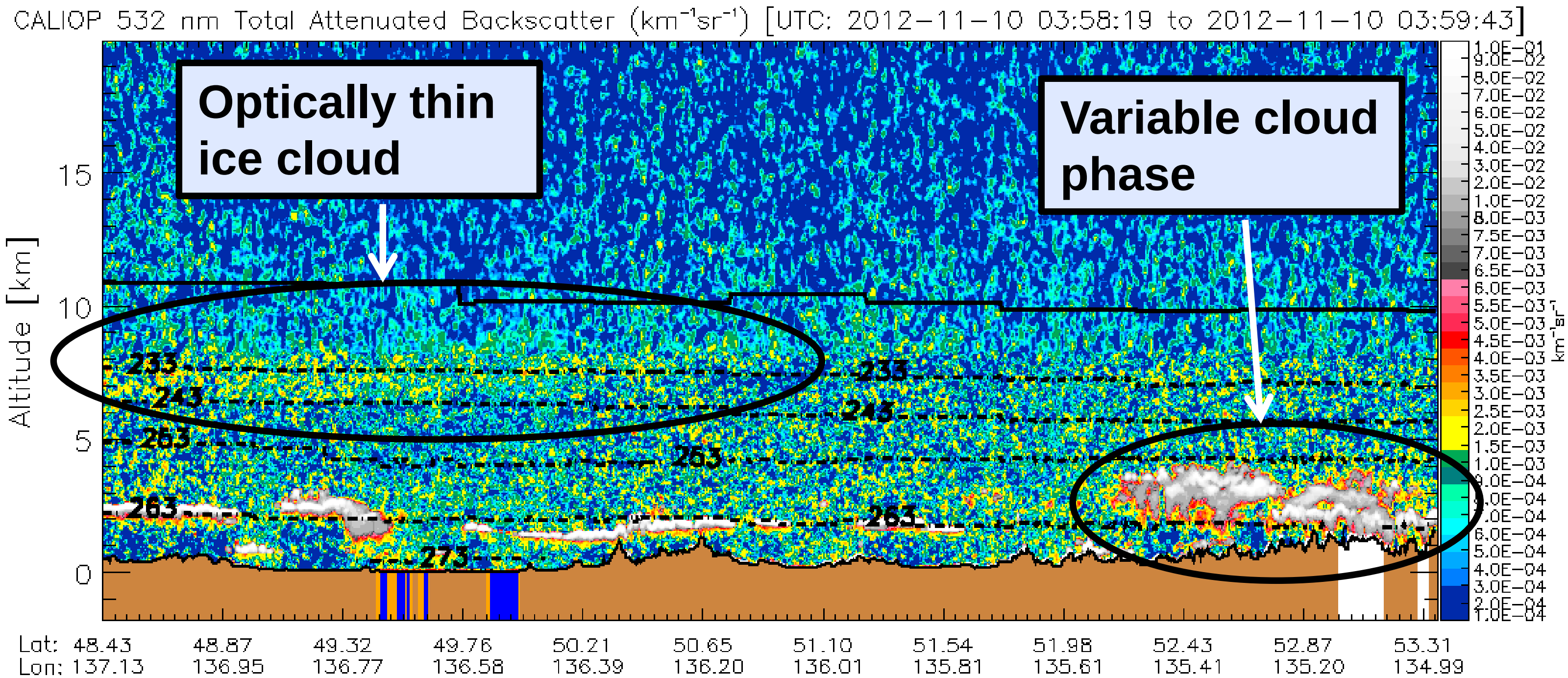
Optical Depth Filter

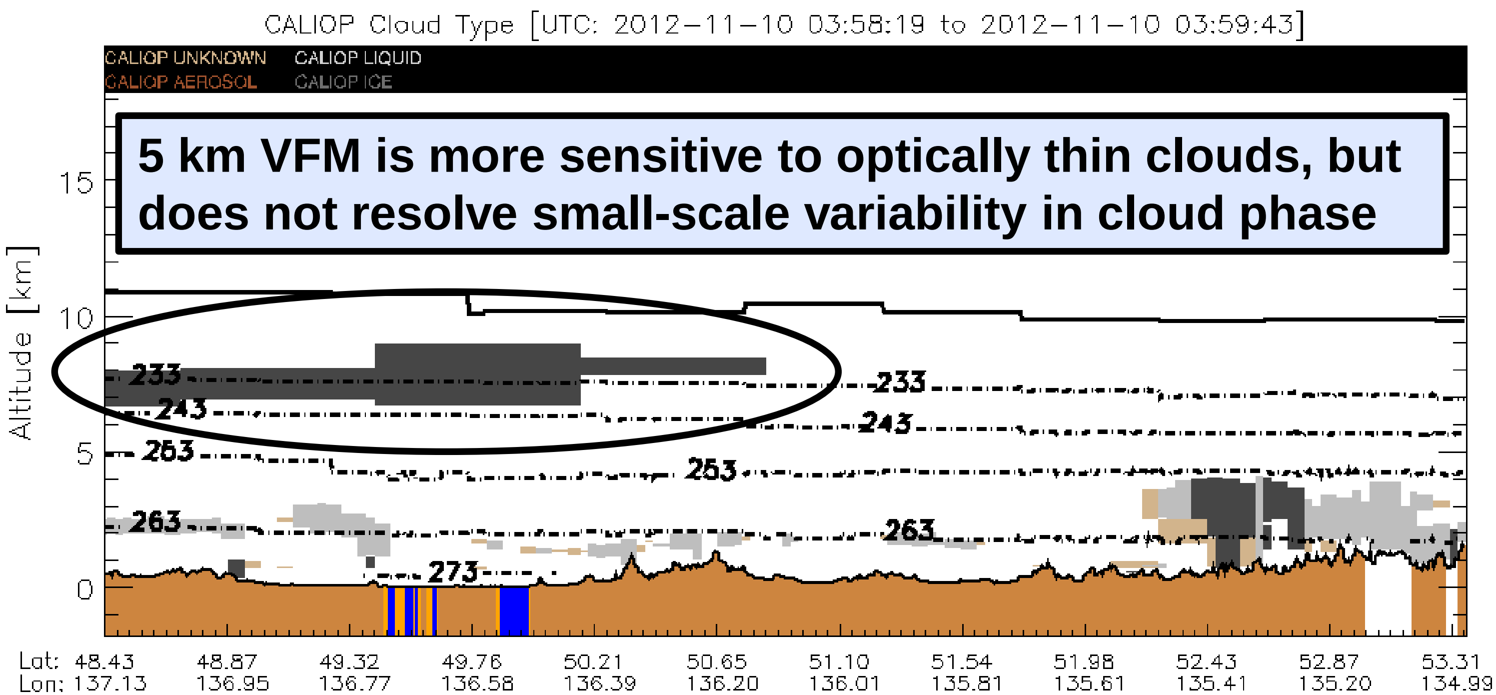
OD	> 0.0	>0.1	>0.2	>0.3	>0.4	>0.5	>2.0
All data	0.726 (82679/ 113807)	0.778 (71968/ 92555)	0.791 (65841/ 83244)	0.799 (62265/ 77943)	0.802 (59771/ 74539)	0.805 (57802/ 71847)	0.775 (28372/ 36601)
Day time	0.712 (35328/ 49614)	0.775 (29527/ 38104)	0.790 (27015/ 34180)	0.797 (25307/ 31770)	0.799 (24247/ 30357)	0.803 (23514/ 29293)	0.754 (11044/ 14642)
Night time	0.738 (47351/ 64193)	0.779 (42441/ 54451)	0.791 (38826/ 49064)	0.800 (36958/ 46173)	0.804 (35524/ 44182)	0.806 (34288/ 42554)	0.789 (17328/ 21959)
Over land	0.719 (19737/ 27445)	0.753 (16429/ 21819)	0.760 (14670/ 19315)	0.763 (13393/ 17547)	0.766 (12755/ 16656)	0.768 (12261/ 15965)	0.676 (4118/ 6095)
Over water	0.729 (62942/ 86362)	0.785 (55539/ 70736)	0.800 (51171/ 63929)	0.809 (48872/ 60396)	0.812 (47016/ 57883)	0.815 (45541/ 55882)	0.795 (24254/ 30506)
Lat > 60 deg	0.803 (15903/ 19805)	0.844 (13560/ 16063)	0.865 (12557/ 14514)	0.876 (11874/ 13556)	0.881 (11399/ 12945)	0.884 (10980/ 12426)	0.837 (4846/ 5789)
Lat < 60 deg	0.710 (66776/ 94002)	0.764 (58408/ 76492)	0.775 (53284/ 68730)	0.783 (50391/ 64387)	0.785 (48372/ 61594)	0.788 (46822/ 59421)	0.764 (23526/ 30812)





1 km CALIOP VFM





5 km CALIOP VFM

Cloud Phase Validation – November 10, 2012 With Mixed Phase

Optical Depth Filter

OD	>0.01	>0.05	>0.10	>0.50	>1.0	>2.0
All data	0.767(46191)	0.769(41576)	0.763(38866)	0.729(30593)	0.696(25574)	0.631(19139)
Water	0.752(34387)	0.751(30894)	0.742(28908)	0.707(23290)	0.679(19936)	0.626(15581)
Land	0.812(11804)	0.822(10682)	0.823(9958)	0.797(7303)	0.756(5638)	0.656(3558)
Desert	0.753(4385)	0.756(3880)	0.748(3582)	0.668(2270)	0.538(1513)	0.347(974)
Lat > 60 deg	0.702(16064)	0.693(14729)	0.684(14010)	0.625(10946)	0.560(8881)	0.467(6724)

Cloud Phase Validation – November 10, 2012 Without Mixed Phase

Optical Depth Filter

OD	>0.01	>0.05	>0.10	>0.50	>1.0	>2.0
All data	0.910(37467)	0.919(33317)	0.920(30802)	0.912(23062)	0.904(18374)	0.878(12493)
Water	0.902(27489)	0.910(24311)	0.908(22453)	0.899(17206)	0.892(14107)	0.870(10189)
Land	0.933(9978)	0.944(9006)	0.949(8349)	0.950(5856)	0.943(4267)	0.915(2304)
Desert	0.951(3398)	0.959(2984)	0.960(2720)	0.963(1510)	0.952(795)	0.919(309)
Lat > 60 deg	0.932(11271)	0.931(10144)	0.928(9522)	0.914(6699)	0.893(4791)	0.853(2904)

Cloud Type Validation – November 10, 2012 With Mixed Phase

Optical Depth Filter

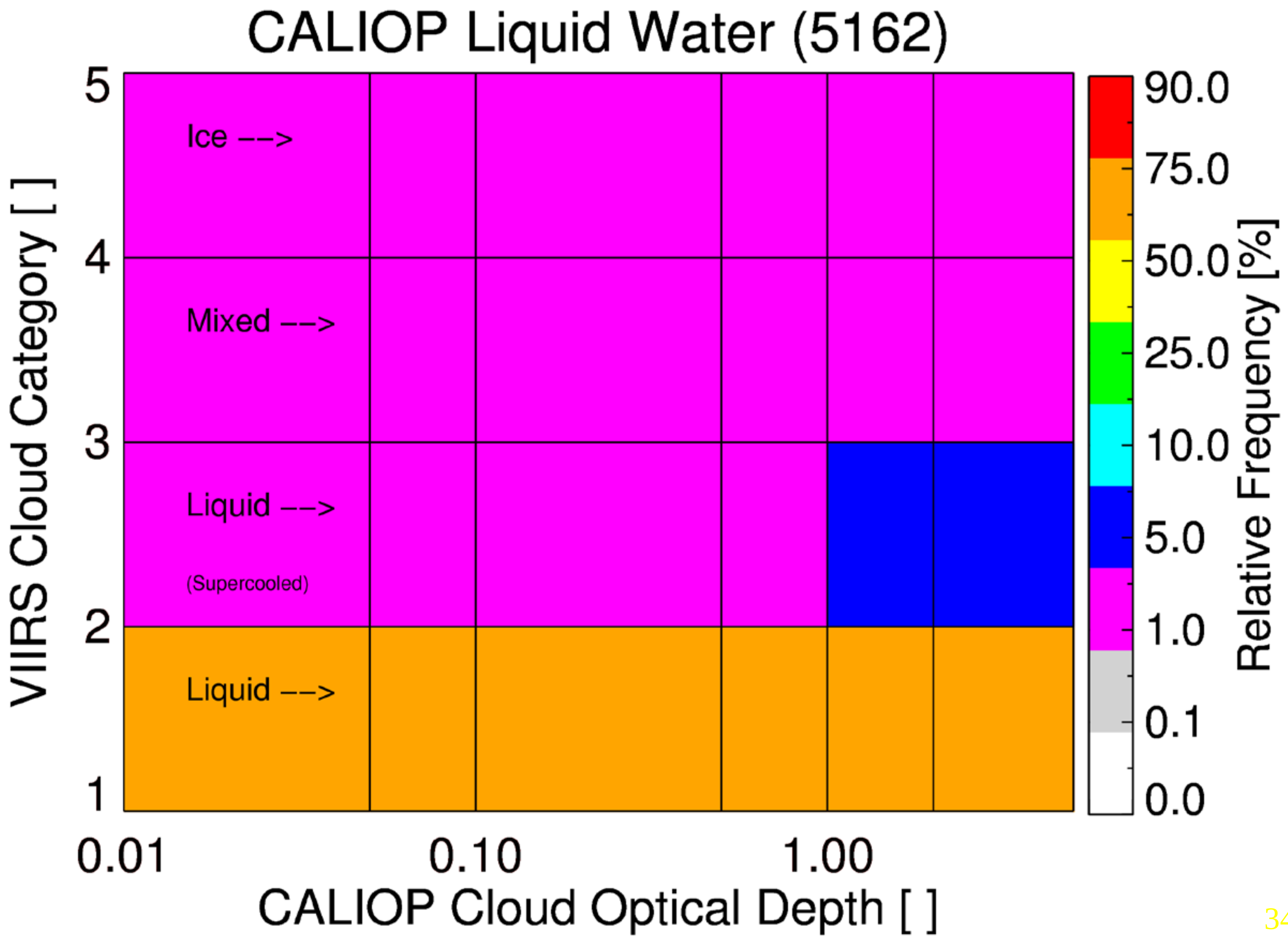
OD	>0.01	>0.05	>0.10	>0.50	>1.0	>2.0
All data	0.518(48767)	0.540(43794)	0.548(40579)	0.577(31638)	0.586(26467)	0.556(19795)
Water	0.525(36497)	0.545(32679)	0.549(30271)	0.573(24094)	0.585(20647)	0.563(16124)
Land	0.498(12270)	0.526(11115)	0.545(10308)	0.591(7544)	0.590(5820)	0.524(3671)
Desert	0.487(4561)	0.513(4055)	0.528(3730)	0.541(2370)	0.475(1572)	0.300(1006)
Lat > 60 deg	0.463(16965)	0.471(15512)	0.474(14650)	0.487(11335)	0.467(9200)	0.395(6951)

Cloud Type Validation – November 10, 2012 Without Mixed Phase

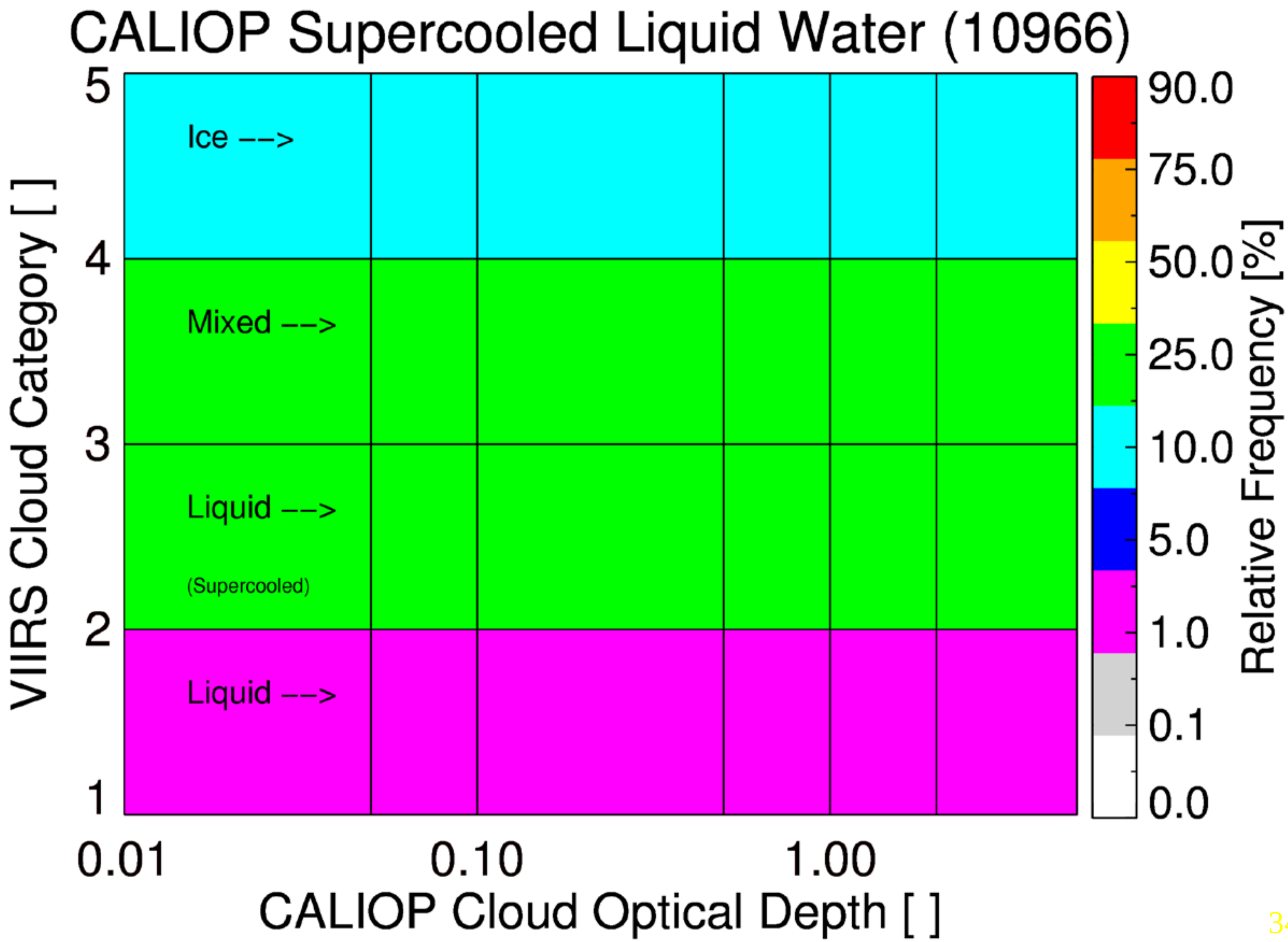
Optical Depth Filter

OD	>0.01	>0.05	>0.10	>0.50	>1.0	>2.0
All data	0.631(37483)	0.659(33620)	0.671(31237)	0.731(23718)	0.772(18991)	0.788(13026)
Water	0.647(27605)	0.676(24620)	0.684(22842)	0.739(17710)	0.783(14565)	0.802(10578)
Land	0.584(9878)	0.613(9000)	0.635(8395)	0.709(6008)	0.735(4426)	0.726(2448)
Desert	0.631(3334)	0.668(2949)	0.695(2702)	0.807(1530)	0.860(817)	0.830(329)
Lat > 60 deg	0.627(11313)	0.642(10286)	0.654(9718)	0.730(6988)	0.769(5064)	0.760(3134)

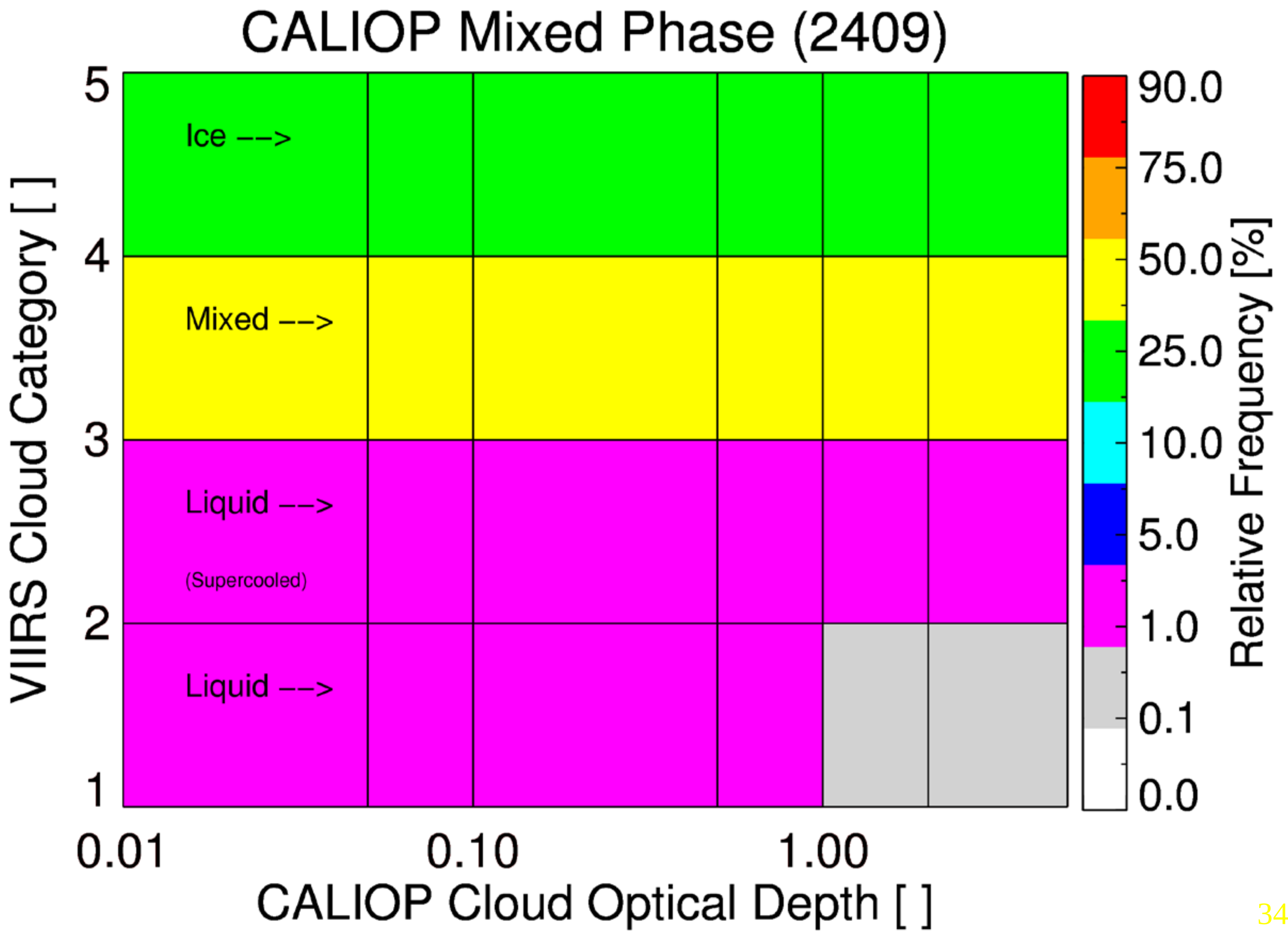
When CALIOP indicates warm liquid water, the VIIRS algorithm generally agrees (most disagreements fall into supercooled liquid water category)



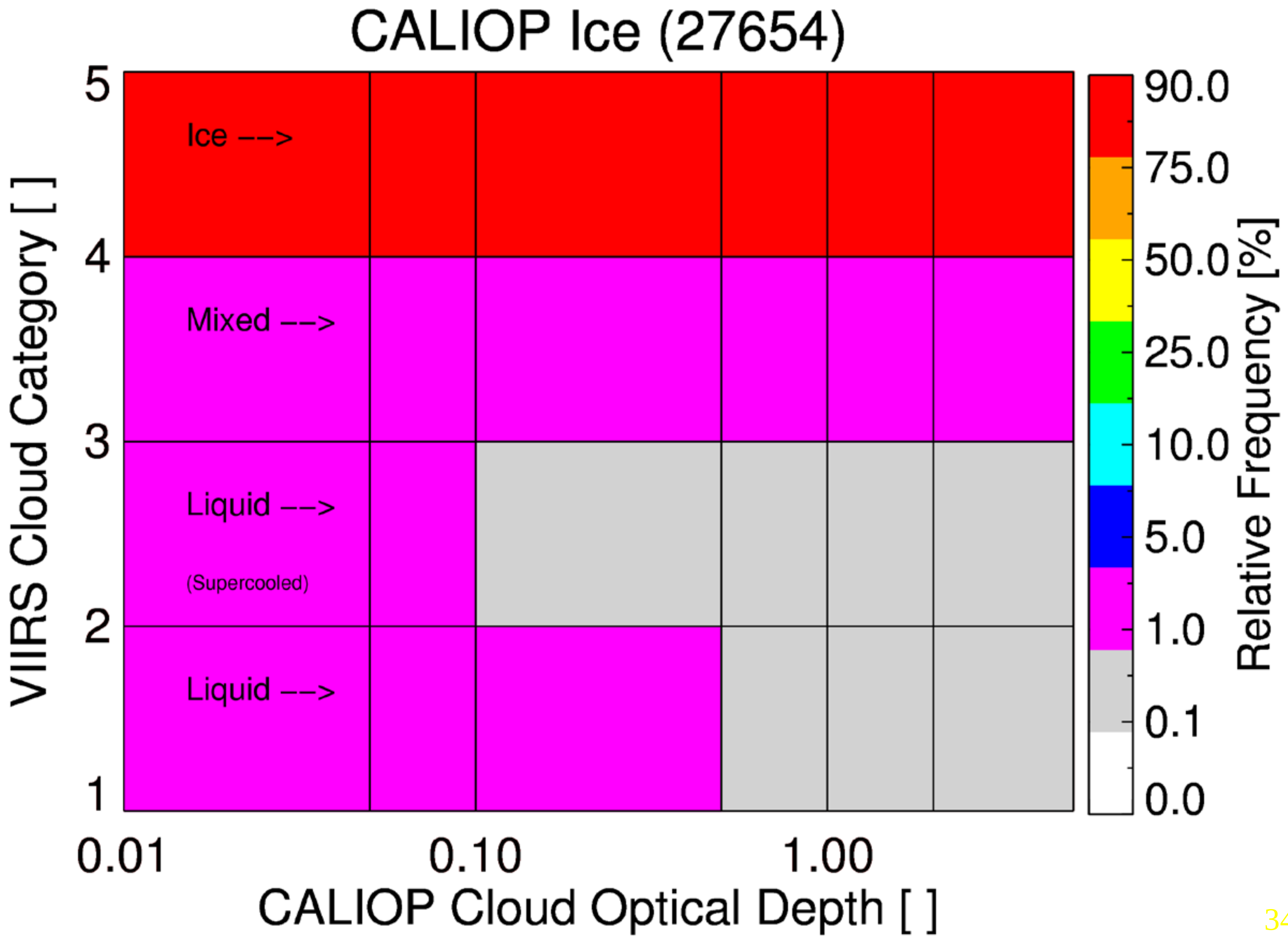
When CALIOP indicates supercooled liquid water, the VIIRS algorithm generally classifies clouds as supercoooled liquid or mixed phase



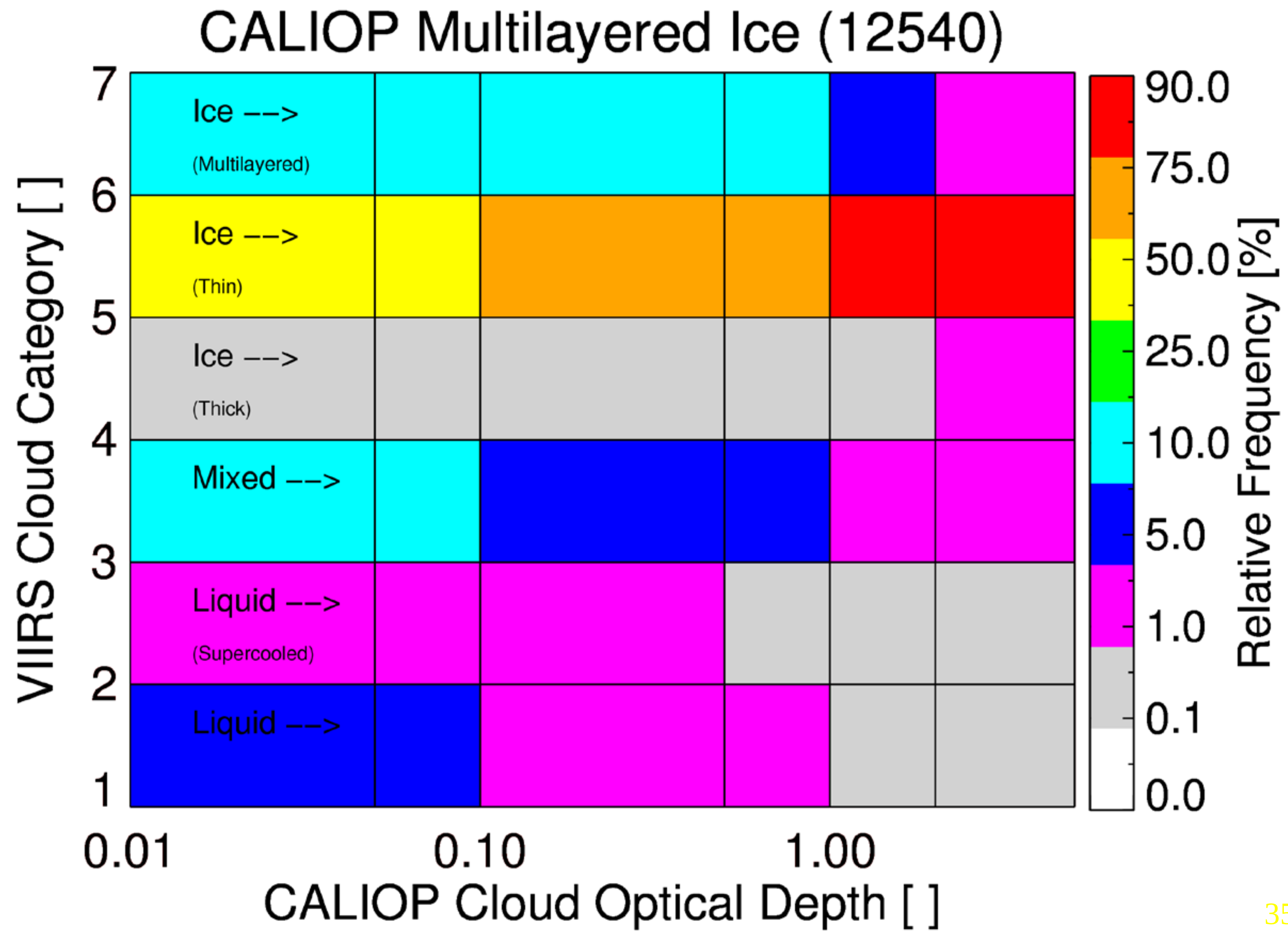
When CALIOP indicates mixed phase, the VIIRS algorithm generally agrees (most disagreements fall into ice phase category)

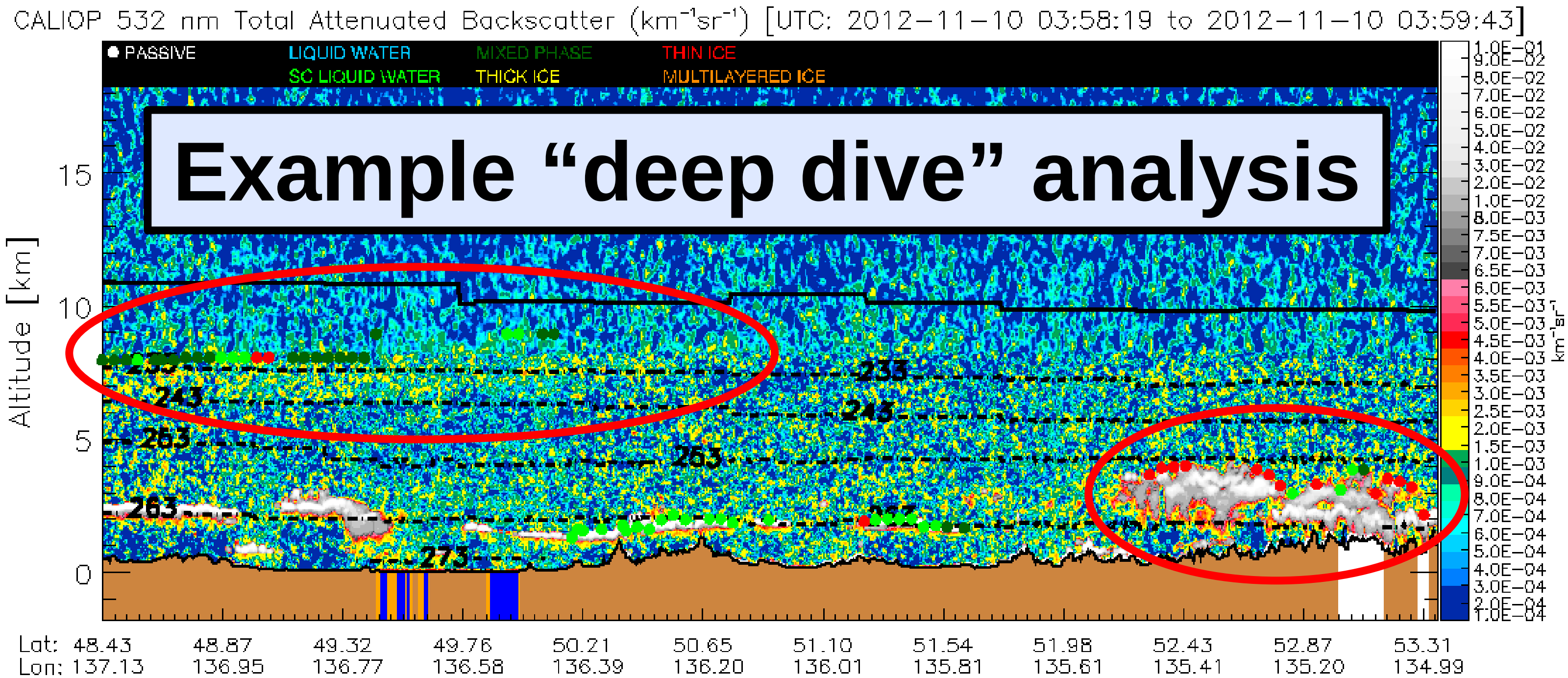


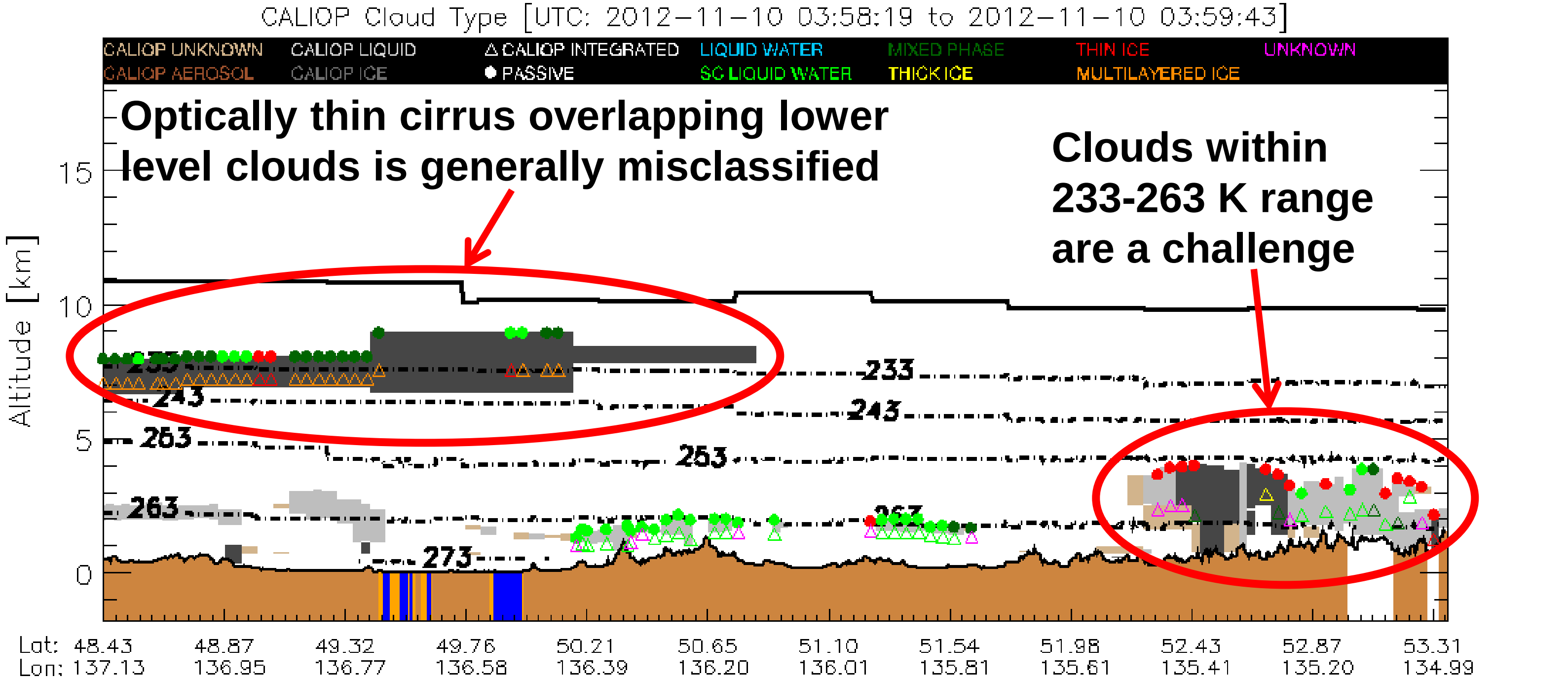
When CALIOP indicates ice phase, the VIIRS algorithm generally agrees (most disagreements fall into mixed phase category)



When CALIOP indicates multilayered ice, the VIIRS algorithm has a difficult time identifying the cloud as multilayered ice




CALIOP 532 nm Total Attenuated Backscatter (km⁻¹sr⁻¹) [UTC: 2012-11-10 03:58:19 to 2012-11-10 03:59:43]
PASSIVE
LIQUID WATER
SC LIQUID WATER
MIXED PHASE
THICK ICE
THIN ICE
MULTILAYERED ICE
Example "deep dive" analysis
Altitude [km]
233
243
263
273
Lat: 48.43 48.87 49.32 49.76 50.21 50.65 51.10 51.54 51.98 52.43 52.87 53.31
Lon: 137.13 136.95 136.77 136.58 136.39 136.20 136.01 135.81 135.61 135.41 135.20 134.99


CALIOP Cloud Type [UTC: 2012-11-10 03:58:19 to 2012-11-10 03:59:43]
CALIOP UNKNOWN
CALIOP AEROSOL
CALIOP LIQUID
CALIOP ICE
Δ CALIOP INTEGRATED
PASSIVE
LIQUID WATER
SC LIQUID WATER
MIXED PHASE
THICK ICE
THIN ICE
MULTILAYERED ICE
UNKNOWN
Optically thin cirrus overlapping lower level clouds is generally misclassified
Clouds within 233-263 K range are a challenge
Altitude [km]
233
243
263
273
Lat: 48.43 48.87 49.32 49.76 50.21 50.65 51.10 51.54 51.98 52.43 52.87 53.31
Lon: 137.13 136.95 136.77 136.58 136.39 136.20 136.01 135.81 135.61 135.41 135.20 134.99

Summary of Validation Results for VIIRS Cloud Phase and Type Products

- The NPP/VIIRS cloud phase and type products have been validated against cloud phase/type products derived from spaceborne lidar measurements
- Taking into account the uncertainty in the lidar derived products, the VIIRS cloud phase/type products fall within the accuracy specifications without invoking the cloud optical depth qualifier
- As shown by the GOES-R AWG, infrared absorption channels are important for identifying multilayered cloud systems and optically thin cirrus clouds. For JPSS, this can only be achieved by combining VIIRS and CrIS measurements.

Andrew Heidinger (presenting) , Ruiyue Chen, Yue Li, Jay Hoffman and William Straka

AWG CLOUD HEIGHT ALGORITHM (ACHA) VALIDATION – ALGORITHM READINESS REVIEW (ARR)

ARR Data

- We processed the equivalence of one day's worth of data (≈1000 granules) in 2013 through ACHA implemented in the Framework/SAPF.
- These granules are chosen to be co-located with CALIPSO and spread over all seasons.
- We run our CALIPSO and VIIRS validation tools on these data to demonstrate compliance with the L1RD requirements.
- Collocated MODIS Collection 6 data are used as an additional source of verification.
- The same analysis is done with CLAVR-x.

ACHA Products

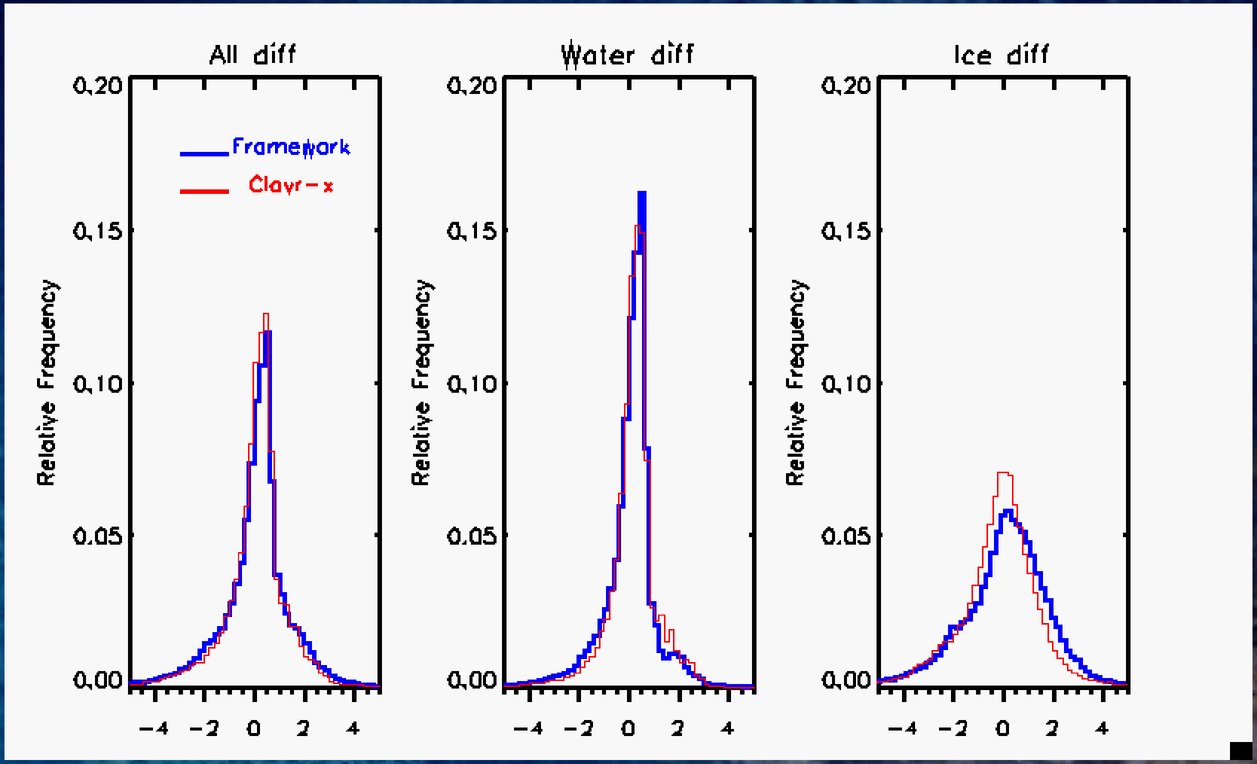
- CTT = Cloud-top Temperature
- CTH = Cloud-top Height
- CTP = Cloud-top Pressure

Attribute Analyzed	L1RD Threshold (accuracy = precision)
CTT	3K when $\tau \geq 1$, 6K when $\tau < 1$
CTH	1km when $\tau \geq 1$, 2km when $\tau < 1$
CTP	$\tau \geq 1$: 100mb for [0,3km], 75mb for [3,7km], 50mb for > 7km

CTH ACHA/CLIPSO Comparisons, Phase-matched

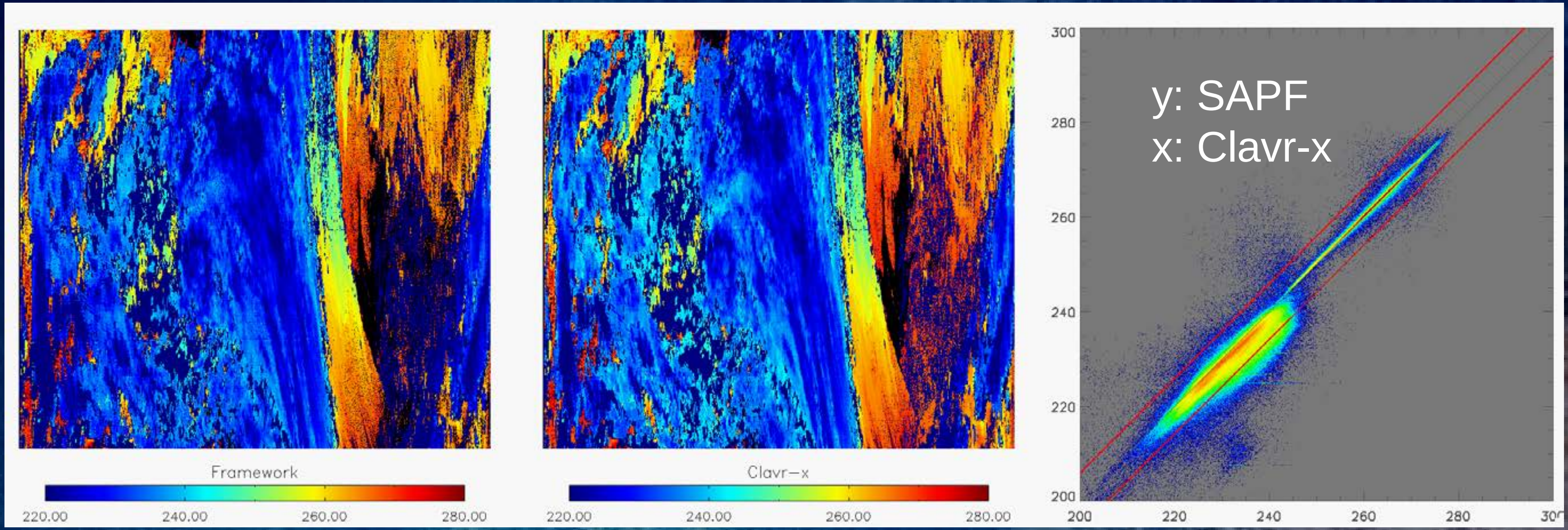
Differences can be attributed to:.

- Radiative transfer models
- NWP data
- Controlling flags such as NWP smoothing

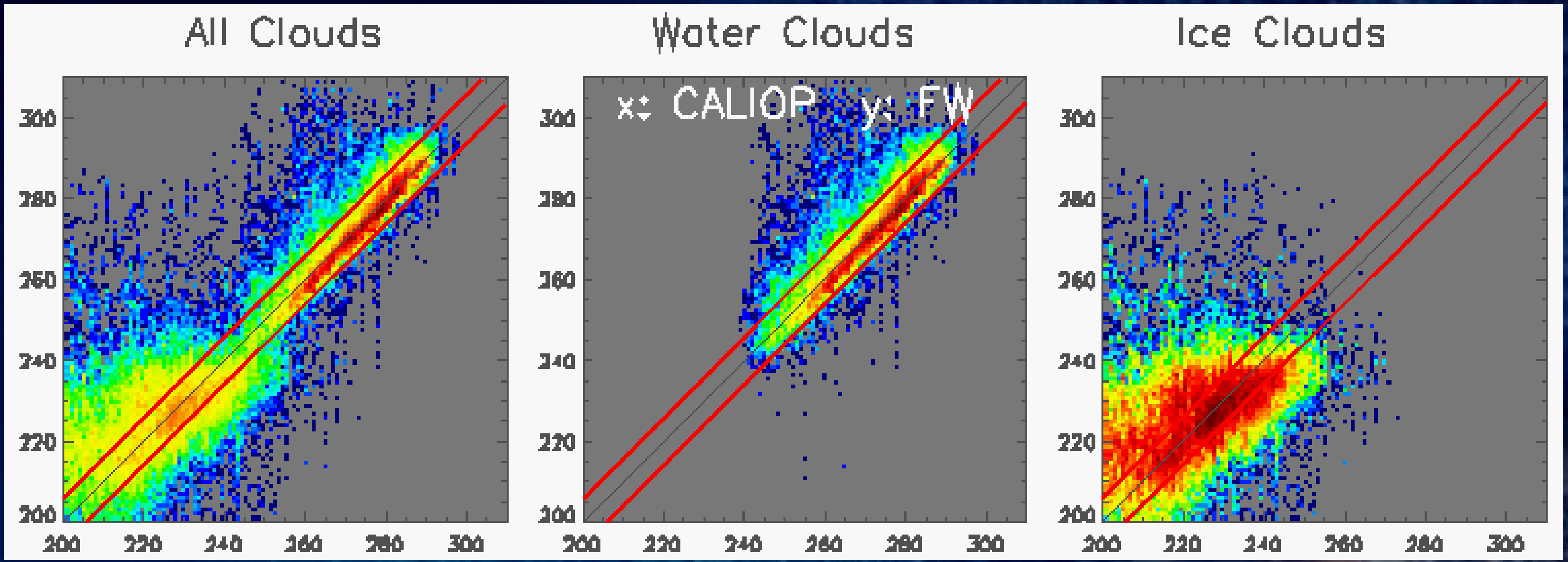


Example Granule, Phase-matched

- This granule shows comparison of phase-matched CTT dated 01/13/2013 at 1531 UTC.
- Both the spatial distribution and scatter plot indicate good agreement between the two datasets.

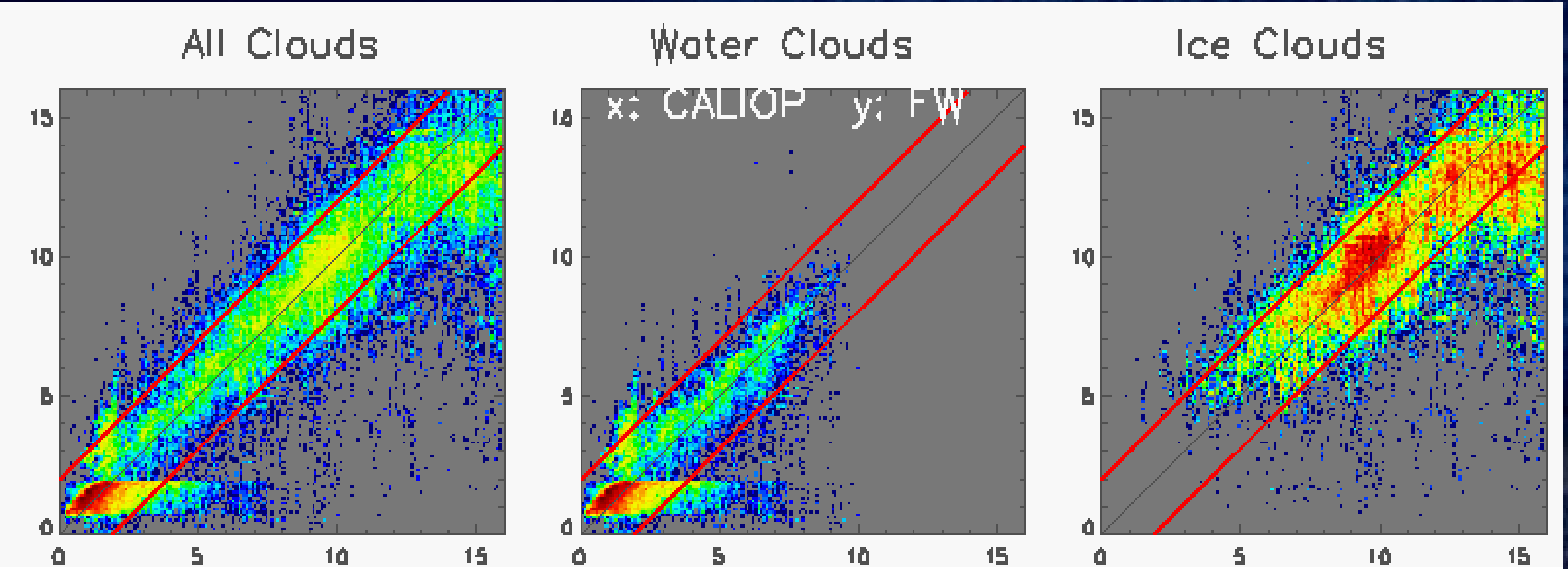


CTT - SAPF vs. Calipso



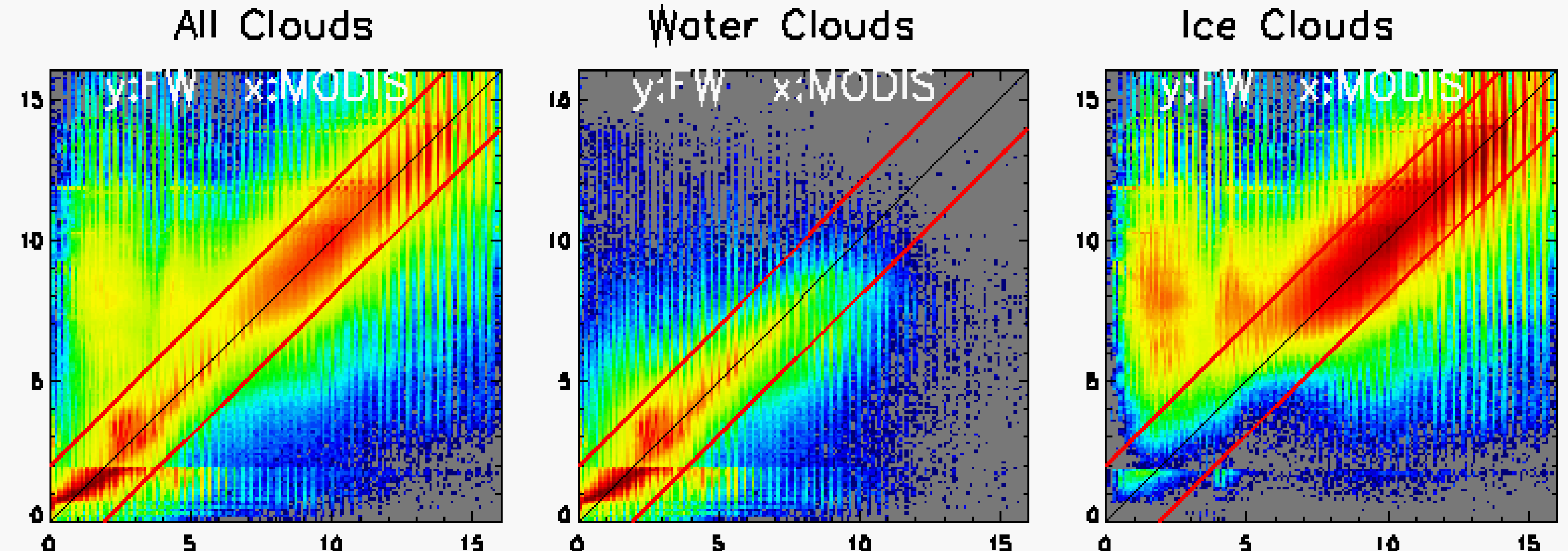
CTT Statistics (Framework vs CALIPSO)					
Type	Bias(K)	StanDev(K)	Counts	Within Specs - Accuracy	Within Specs - Precision
All clouds	1.33	9.43	166853	50.3%	40.0%
Water	0.04	5.17	88410	69.0%	68.6%
Ice	2.78	12.45	78443	29.3%	25.3%

CTH - SAPF vs. Calipso



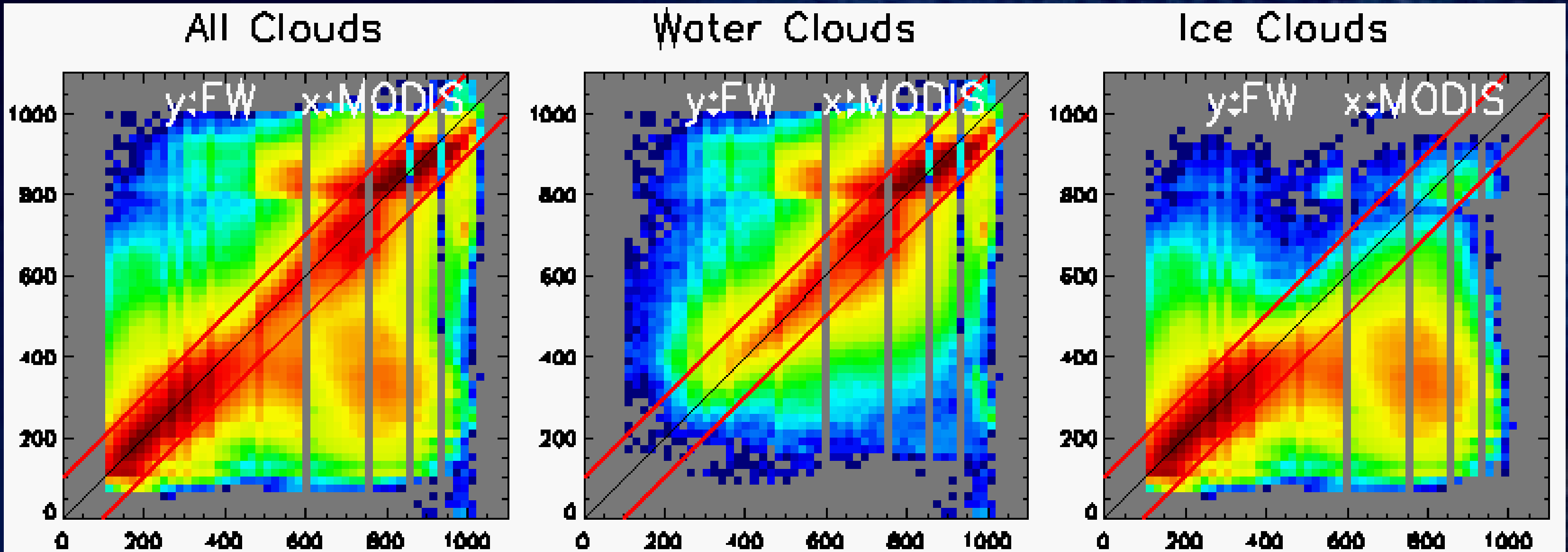
CTH Statistics (Framework vs CALIPSO)					
Type	Bias(km)	StanDev(km)	Counts	Within Specs - Accuracy	Within Specs - Precision
All clouds	-0.29	1.57	176867	68.9%	68.8%
Water	-0.04	1.10	88454	79.3%	79.5%
Ice	-0.55	1.90	88413	58.5%	55.6%

CTH - SAPF vs. MODIS



CTH Statistics (Framework vs MODIS)					
Type	Bias(km)	StanDev(km)	Counts	Within Specs - Accuracy	Within Specs - Precision
All clouds	0.21	1.65	5.9e+7	74.5%	73.0%
Water	-0.09	0.80	2.7e+7	88.8%	88.8%
Ice	0.47	2.09	3.2e+7	62.3%	56.9%

CTP - SAPF vs. MODIS



CTP Statistics (Framework vs MODIS)					
Type	Bias(hPa)	StanDev(hPa)	Counts	Within Specs - Accuracy	Within Specs - Precision
All clouds	-11.0	95.7	5.8e+7	80.9%	80.1%
Water	8.8	68.8	2.7e+7	89.6%	89.4%
Ice	-28.6	111.6	3.1e+7	73.2%	63.7%

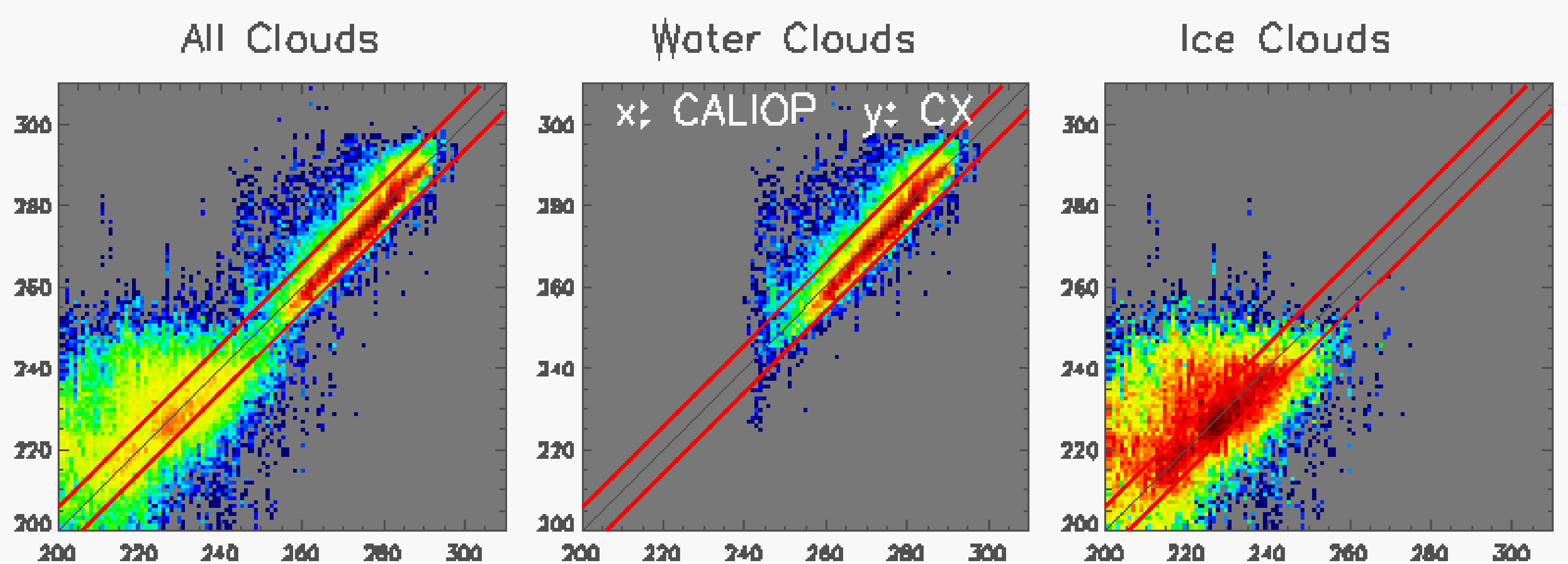
CTH Statistics based on different latitude regions

- The best performance is for water clouds over tropics.
- There are less pixels available for comparison over the polar regions; however, ACHA performance is nearly as good as in non-polar regions.

CTH Statistics (Framework vs Calipso)						
Region	Type	Bias(km)	StanDev (km)	Counts	Within Specs - Accuracy	Within Specs - Precision
Tropical	Water	-0.27	1.20	29655	83.1%	84.6%
	Ice	-1.06	2.19	40809	53.6%	51.3%
MidLat	Water	-0.07	1.03	58799	77.4%	77.2%
	Ice	-0.11	1.47	47604	62.8%	62.1%
Polar	Water	-0.01	1.09	11749	73.5%	73.4%
	Ice	0.46	1.75	14381	58.2%	59.8%

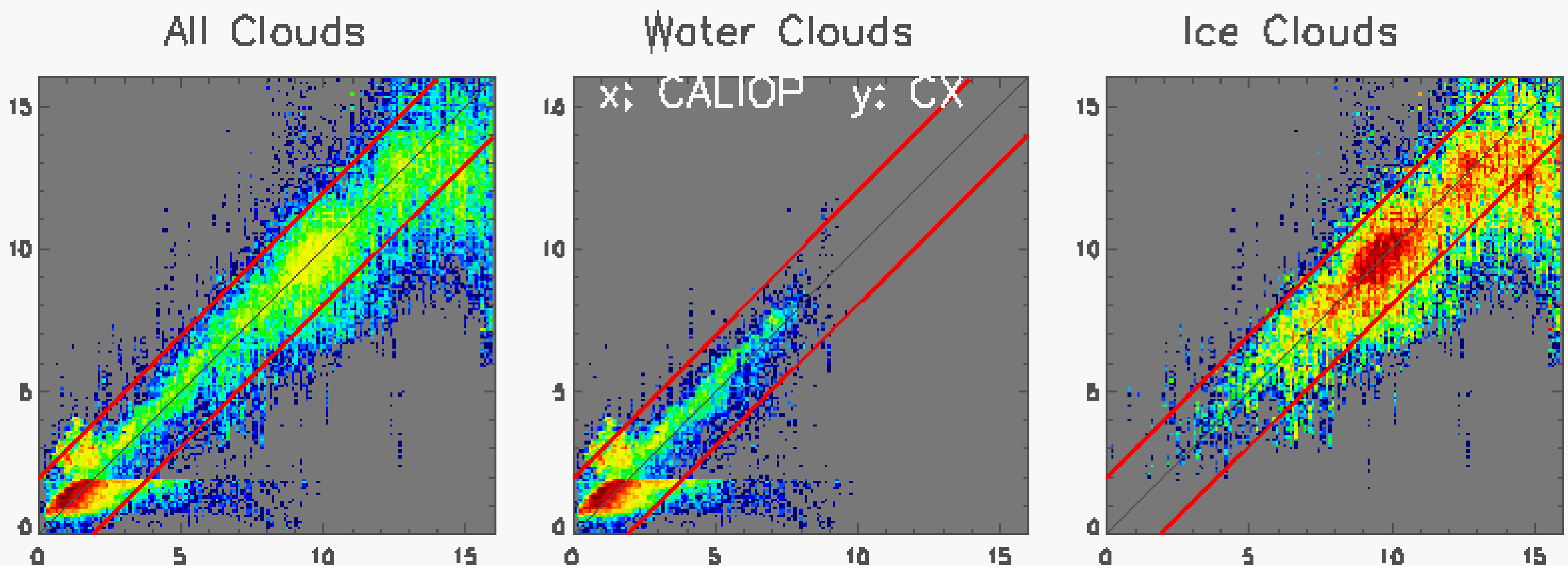
Additional Verification of CTH using Clavr-x data

CTT – Clavr-x vs. Calipso



CTT Statistics (Clavr-x vs CALIPSO)					
Type	Bias(K)	StanDev(K)	Counts	Within Specs - Accuracy	Within Specs - Precision
All clouds	1.65	9.08	153602	51.2%	36.3%
Water	-0.51	4.08	80713	70.4%	74.5%
Ice	4.03	12.02	72889	29.8%	24.2%

CTH – Clavr-x vs. Calipso



CTH Statistics (Clavr-x vs CALIPSO)					
Type	Bias(km)	StanDev(km)	Counts	Within Specs - Accuracy	Within Specs - Precision
All clouds	-0.33	1.52	162493	68.1%	68.3%
Water	0.08	1.04	80714	78.8%	78.6%
Ice	-0.74	1.79	81779	57.5%	55.8%

Summary

- Cloud top parameters generated from thousand granules in ACHA/Framework are evaluated by comparing to two independent sources – Calipso and MODIS Collection 6
- Clavr-x output from the same granules are also evaluated for comparison purpose
- It is believed ACHA is implemented correctly in Framework and the performance meets expectation
- Differences still exist between Framework and Clavr-x but this does not affect performances

Daytime Cloud Optical and Microphysical Products

Presented by Andi Walther CIMSS

DCOMP

- DCOMP is the Daytime Cloud Optical and Microphysical Properties algorithm of the NOAA-AWG retrieval scheme PATMOS-x.
- DCOMP was developed for GOES-AWG and works presently on VIIRS, MODIS, GOES, SEVIRI, MSAT, GOES-ABI and others.
- DCOMP is a FORTRAN 90/95 package which works with the identical code for all sensors and software environments (e.g. CLAVR-x, GEOCAT, FRAMEWORK).
- DCOMP was evaluated and validated in several inter-comparison cloud workshops with products of 8 other state-of-the-art algorithms.
- DCOMP in FRAMEWORK has been slightly adjusted to compiler requirements (gfortran 9.4)

Daytime Cloud Optical Microphysical Properties Overview

- Products : **Cloud Optical Thickness (COD) and Cloud Particle Size (CPS)**
- Derived products from COD and REF: **Liquid water path (LWP) and Ice Water Path (IWP)**
- VIIRS SAPF mode is DCOMP-2. Use of channel combination at 0.6 and 2.2 micron (M5/M11)
- RTM-independent.
- DCOMP input:
  - Reflectance
  - Radiance
  - Cloud detection
  - Cloud top temperature, Cloud height
  - Cloud Phase
  - Static Aux data (white sky surface albedo, GFS temperature and humidity profiles, snow mask)

Requirements

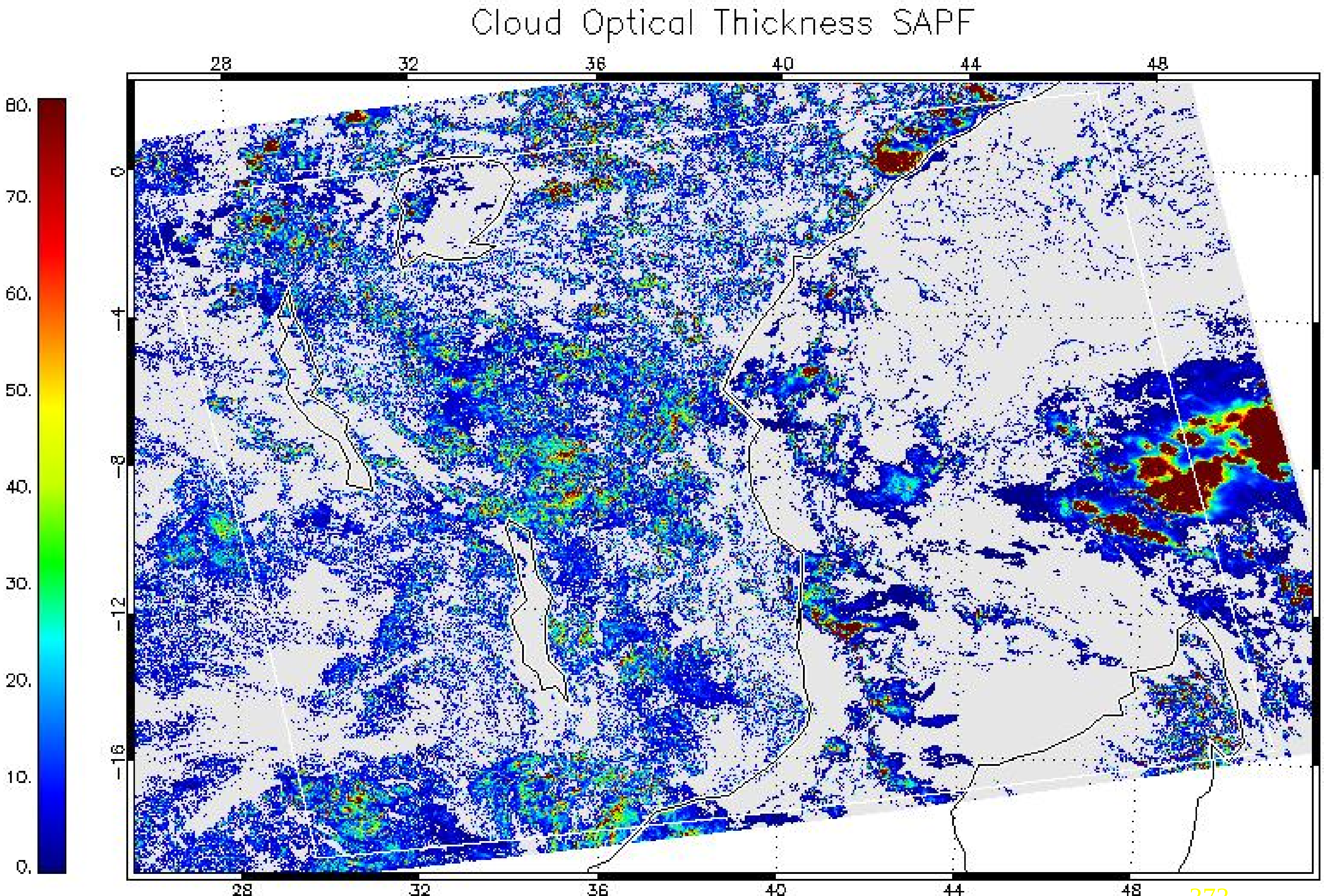
	Requirements			
Product	Range	Accuracy	Precision	
COD	0.5-50	2 or 20% (liquid) 3 or 30% (ice)	2 or 20% (liquid) 3 or 30% (ice)	> 65 degree solar zenith
CPS	0-50 µm	4µm /10µm (liquid/ice)	4µm /10µm	> 65 degree solar zenith
LWP		50g/m2	30%	> 65 degree solar zenith
IWP		100g/m2	40%	> 65 degree solar zenith

DCOMP : ARR Validation Strategies

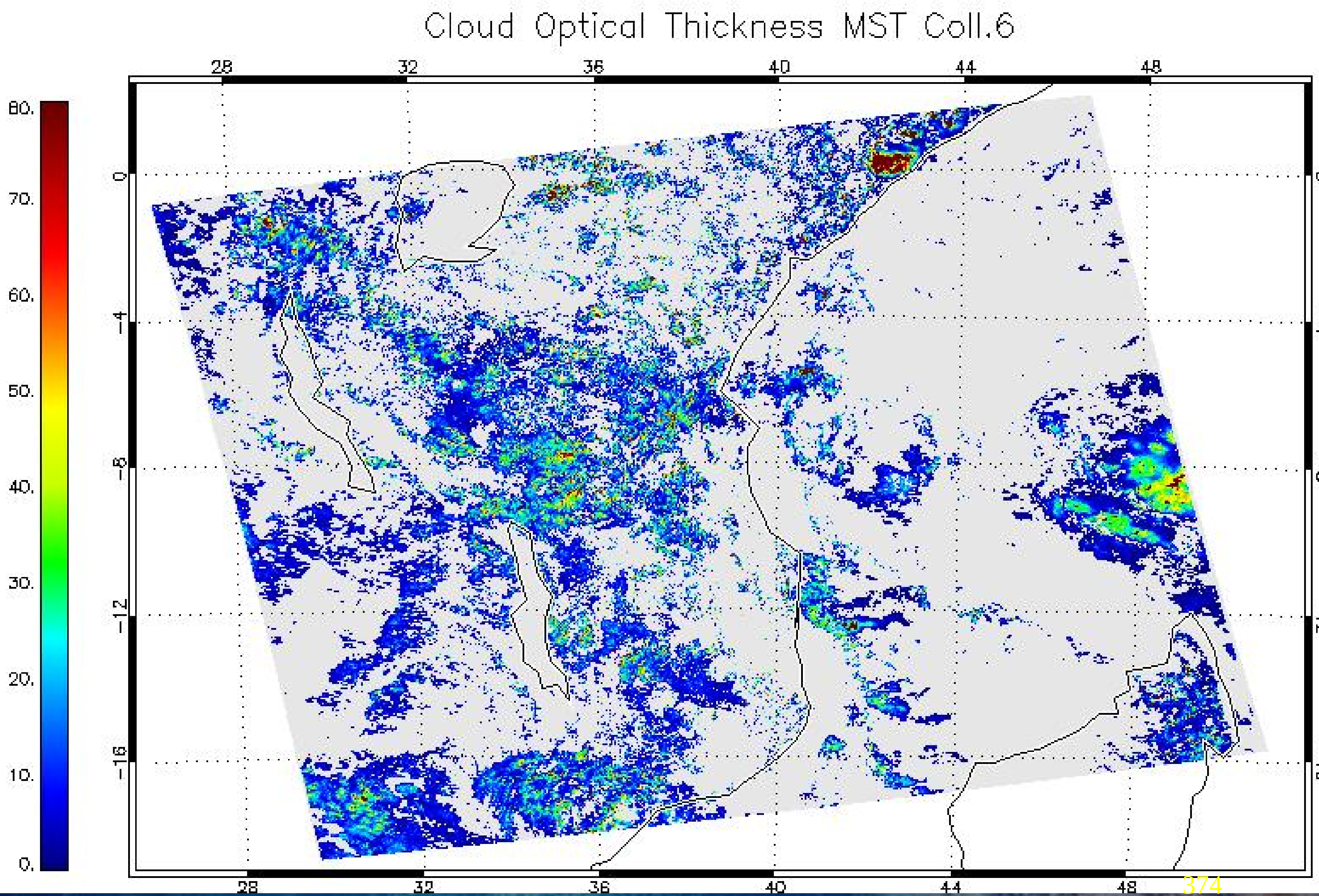
- **Cloud Optical parameters are difficult to validate!** Optical properties are radiative parameters. Thus, it is not possible to validate COD directly from in-situ observations without making assumptions about scattering properties of cloud particles. ➔ **Validation sources are rare!**
- Retrieval uncertainties of other parameters (e.g. Cloud mask, phase height, snow mask) will heavily affect uncertainty in DCOMP retrievals. As an example, in the event of false classification of cloud phase, COD can be wrong by 50% [Wolters et al. 2008].
- **ARR validation strategy:**
  - ***Visual inspection*** of mapped images animations and histograms to detect obvious artifacts
  - ***MODIS*** Science team provides COD and CPS in ***collection 6***. We directly compare approx.1000 granules from SAPF Framework.
  - To overcome colocation errors we additionally compare DCOMP results run in CLAVR-x on MODIS level1b data to compare directly to MYD06 c6 products.
  - Only for liquid clouds, the use of ***passive microwave retrievals*** constrain the possible solutions for COD and CPS. Validation of LWP is therefore an indirect validation of COD and CPS.

Validation with co-located MODIS-AQUA products

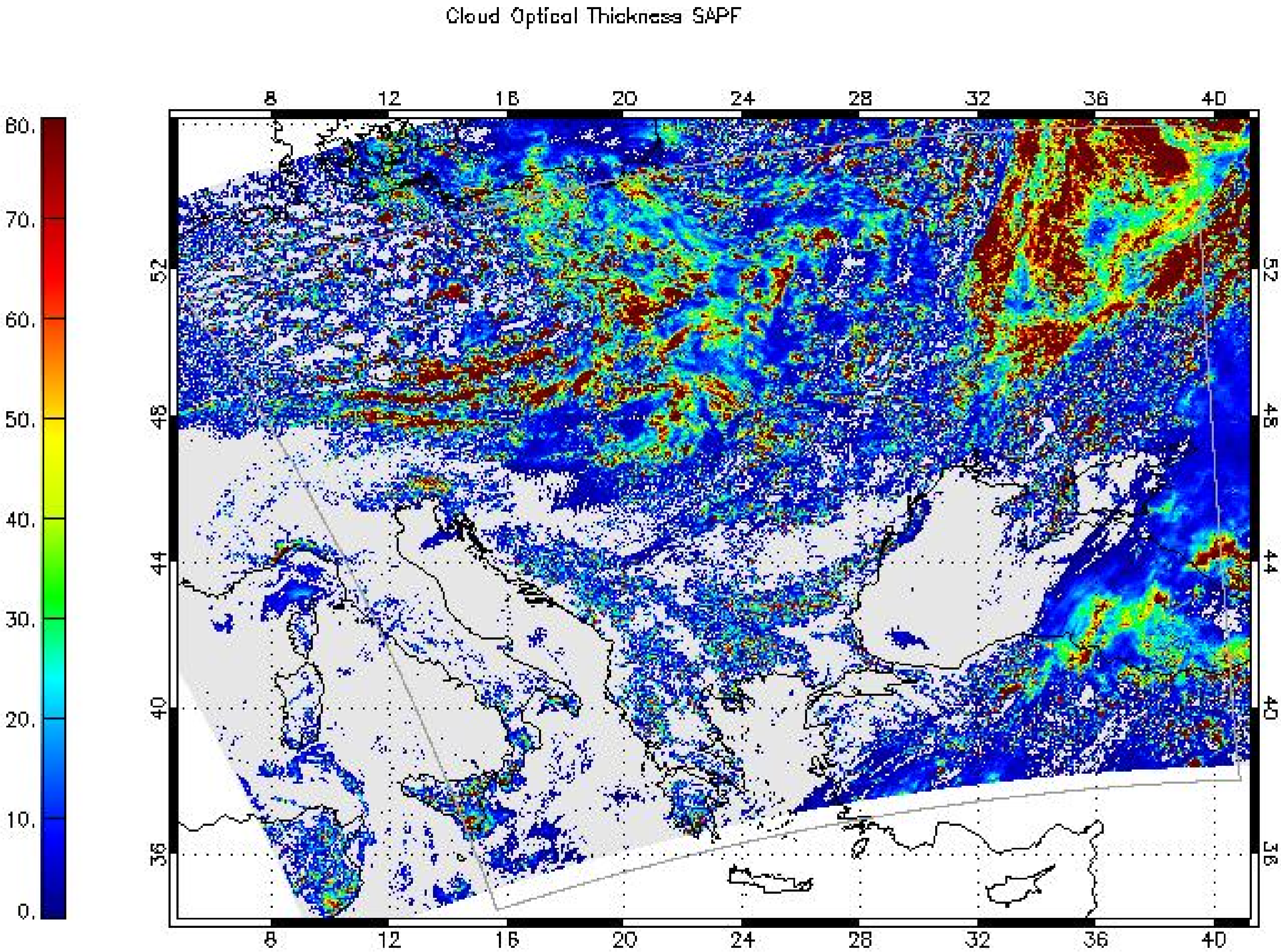
- MODIS Science team collection 6 products on AQUA for COD and CPS.
- Data used 10 days of all seasons. Daytime scenes for about 200 scenes.
- **Problems/Challenges:**
  - MODIS and VIIRS have **different spatial resolution**.
  - Spatial and temporal **co-location** differences (windows are 2km and 120sec)
  - MODIS approach is similar to DCOMP approach. The MODIS products are therefor **not** an **independent** validation source.
  - **Basic assumptions** may be different (cloud phase, cloud height, surface conditions). These assumptions are beyond control of DCOMP and have to be tested/validated outside this ARR
  - **Calibration differences** between MODIS-AQUA and NPP suspected (personal communication with S. Platnick)
  - Thus, **perfect match cannot be expected**
- Solutions:
  - The 1:1 comparisons shouldn't seen as validation/performance truth.
  - COD-CTP joint histograms
  - Compare only results with same phase

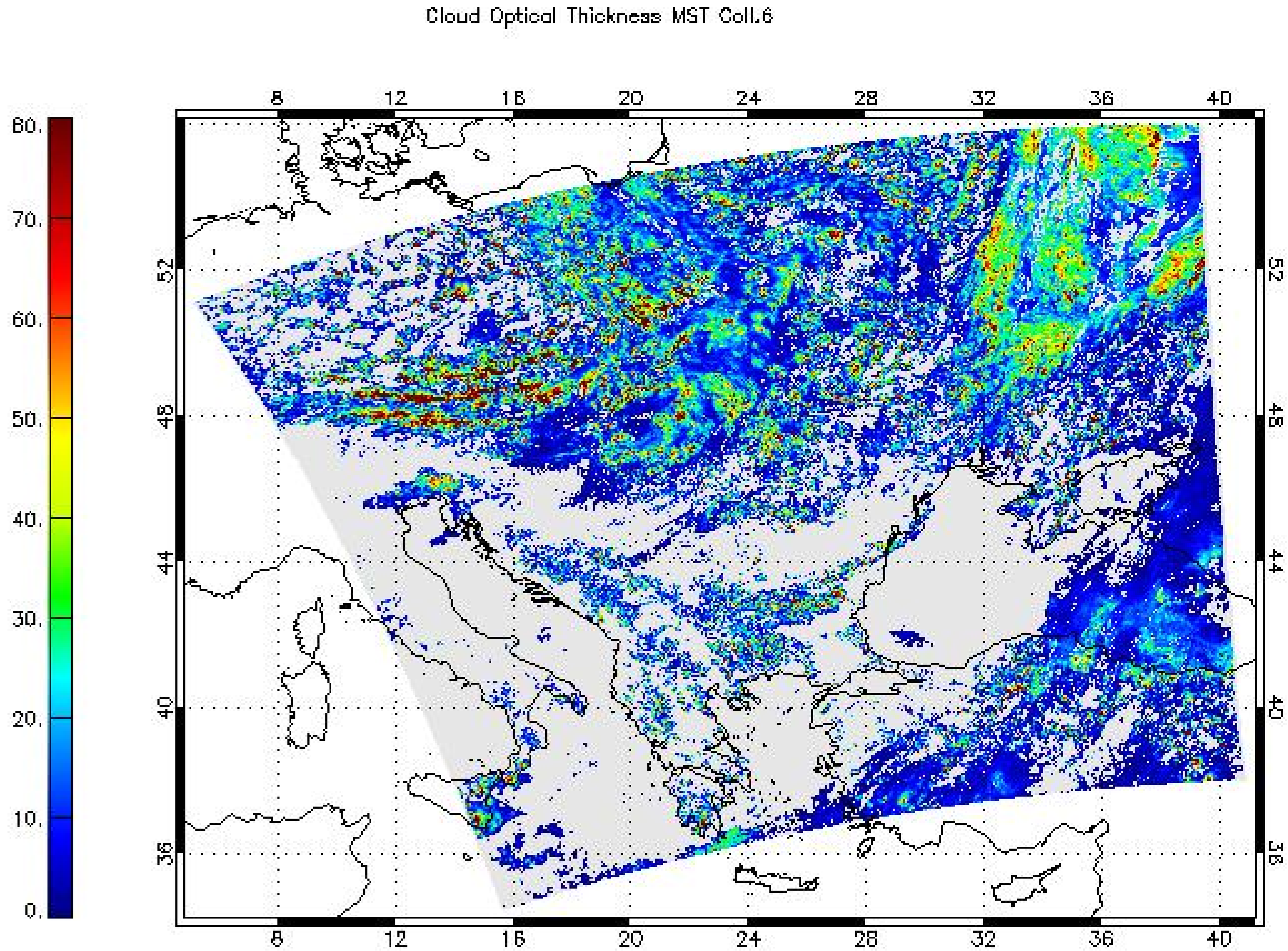


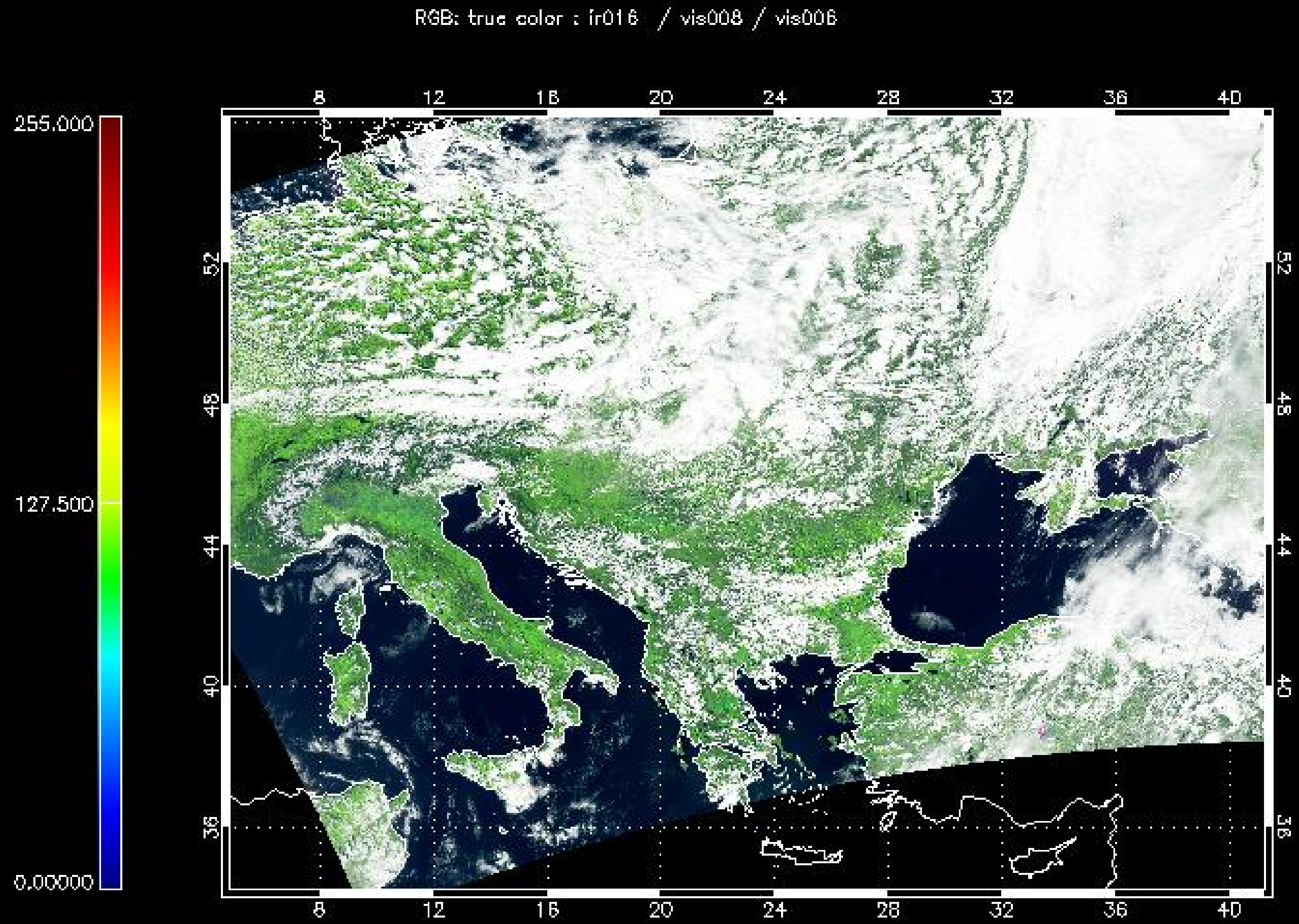
Cloud Optical Thickness SAPF
80.
70.
60.
50.
40.
30.
20.
10.
0.
28
32
36
40
44
48
0
−4
−8
−12
−16



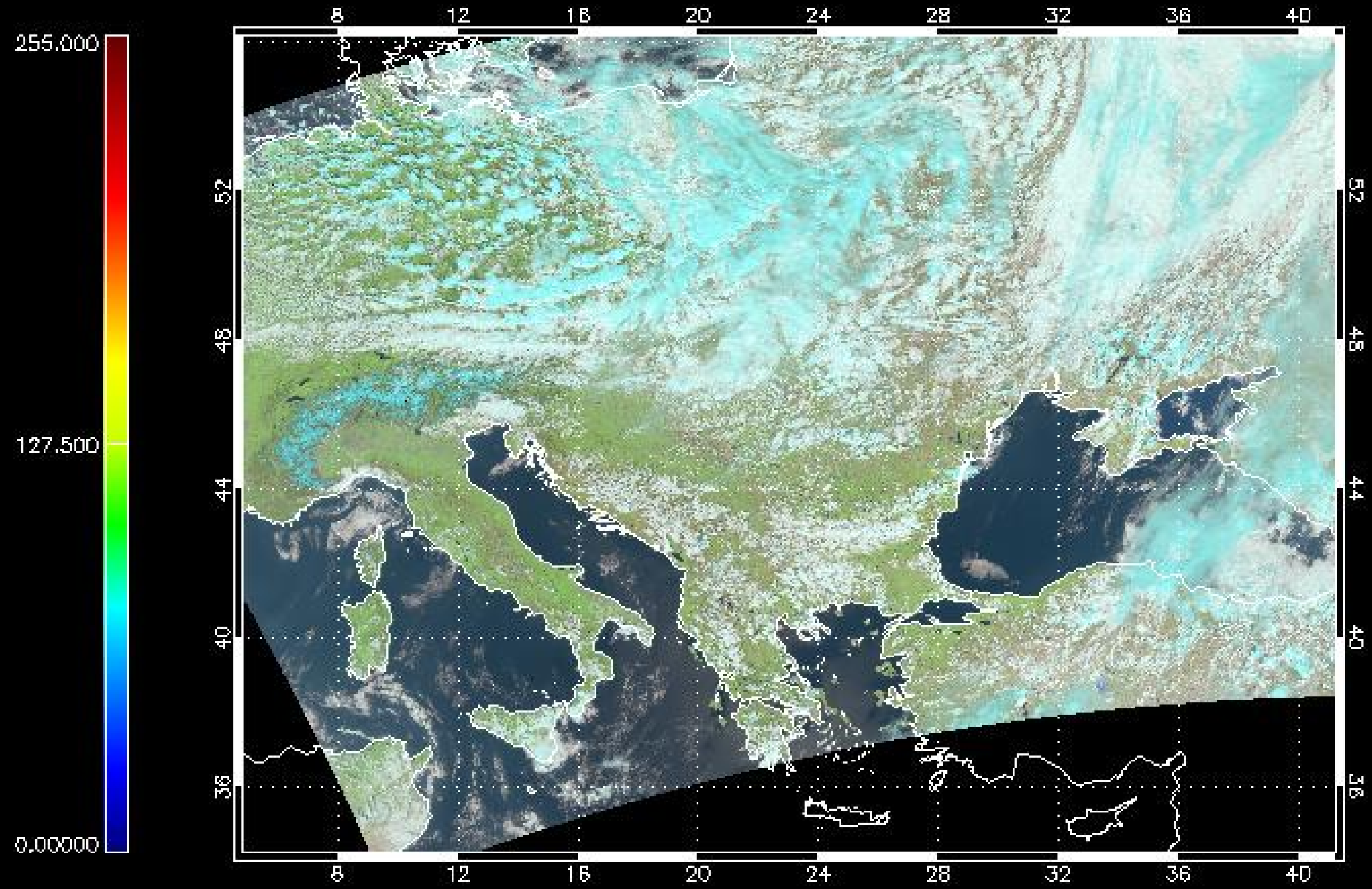
Cloud Optical Thickness MST Coll.6
80.
70.
60.
50.
40.
30.
20.
10.
0.
28
32
36
40
44
48
0
-4
-8
-12
-16

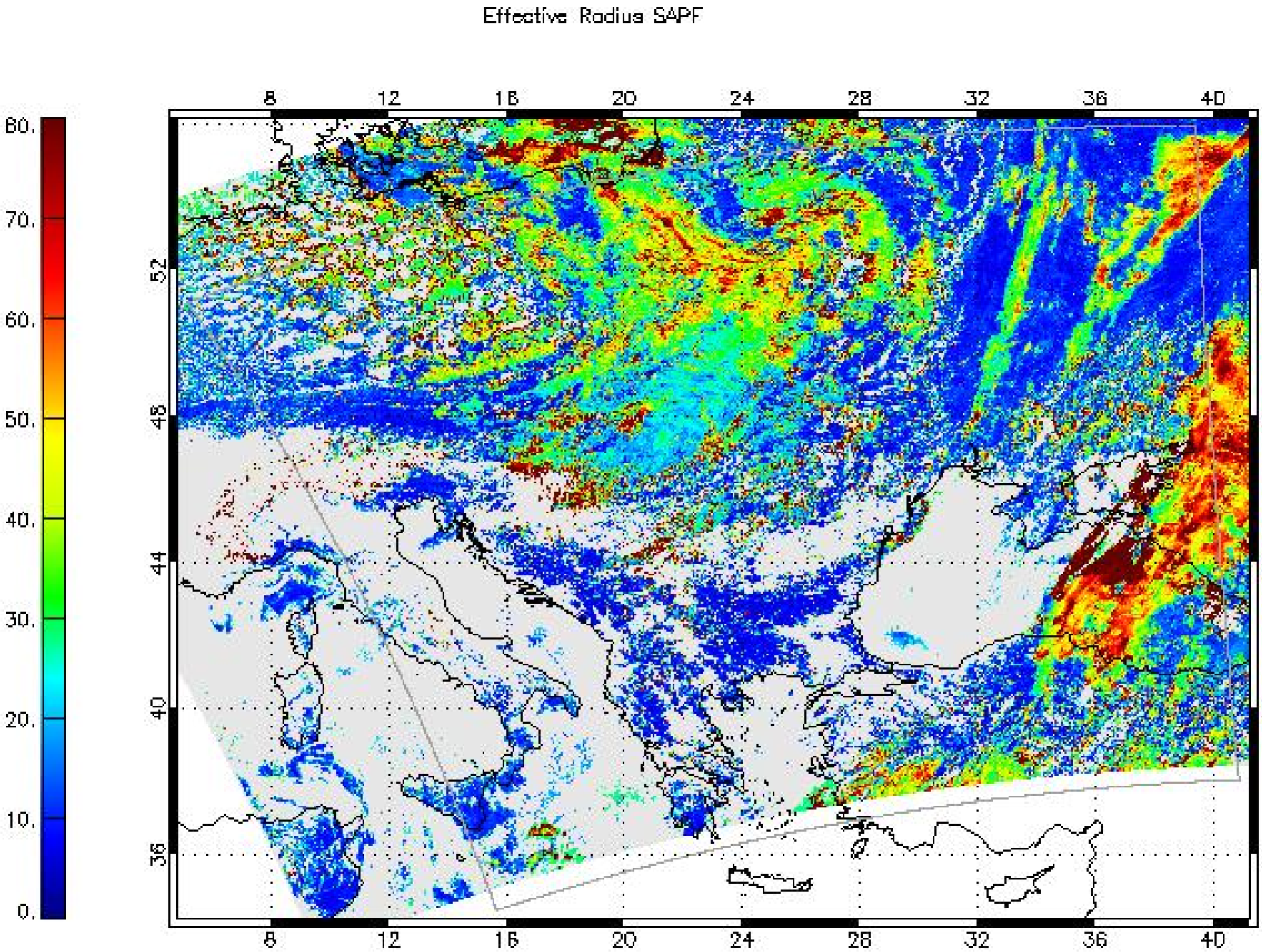

Cloud Optical Thickness SAPF
80.
70.
60.
50.
40.
30.
20.
10.
0.
8
12
16
20
24
28
32
36
40
52
48
44
40
36

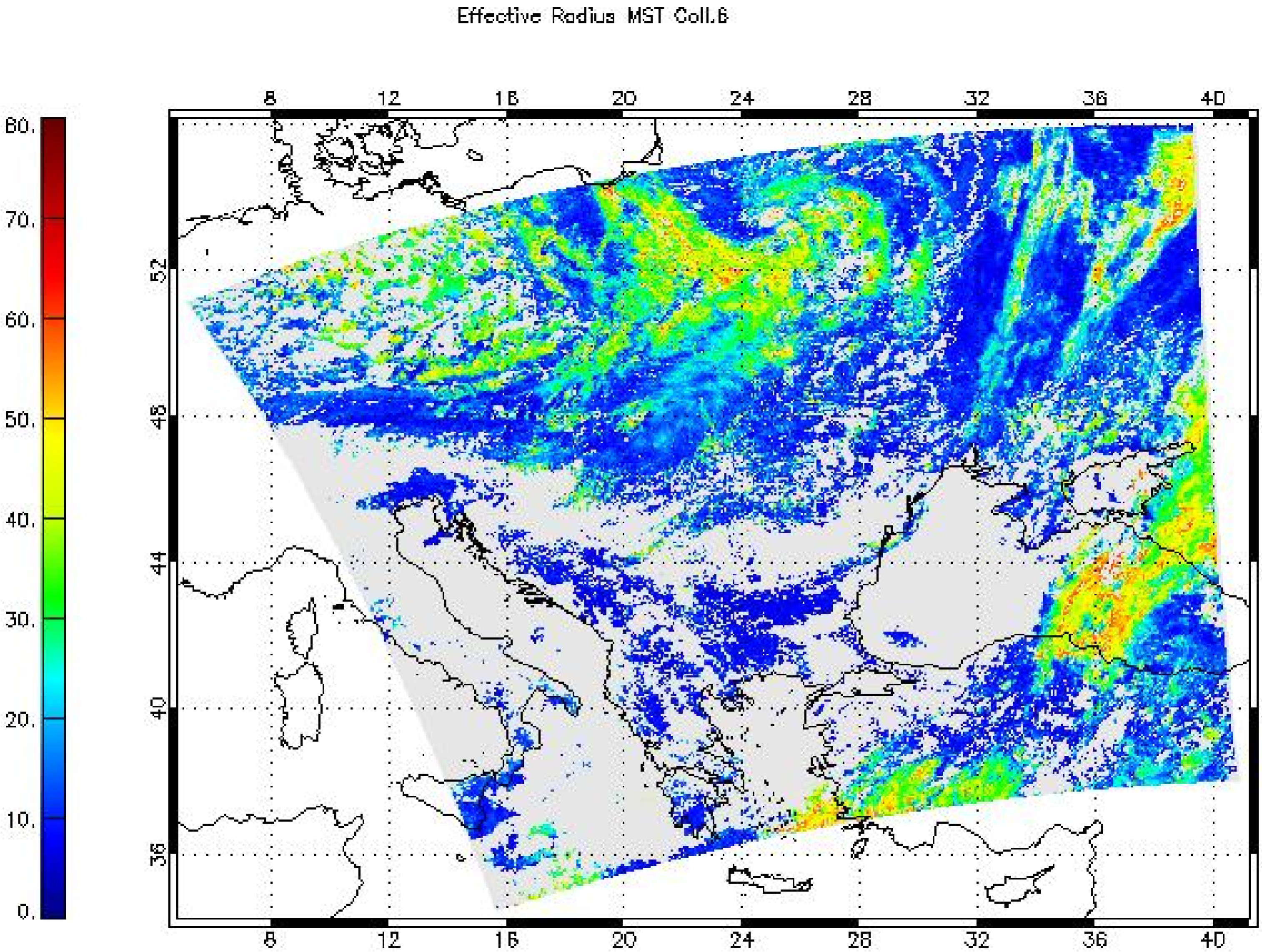

Cloud Optical Thickness MST Coll.6
80.
70.
60.
50.
40.
30.
20.
10.
0.
8
12
16
20
24
28
32
36
40
52
48
44
40
36


RGB: true color : ir016 / vis008 / vis006
255.000
127.500
0.00000
8
12
16
20
24
28
32
36
40
52
48
44
40
36

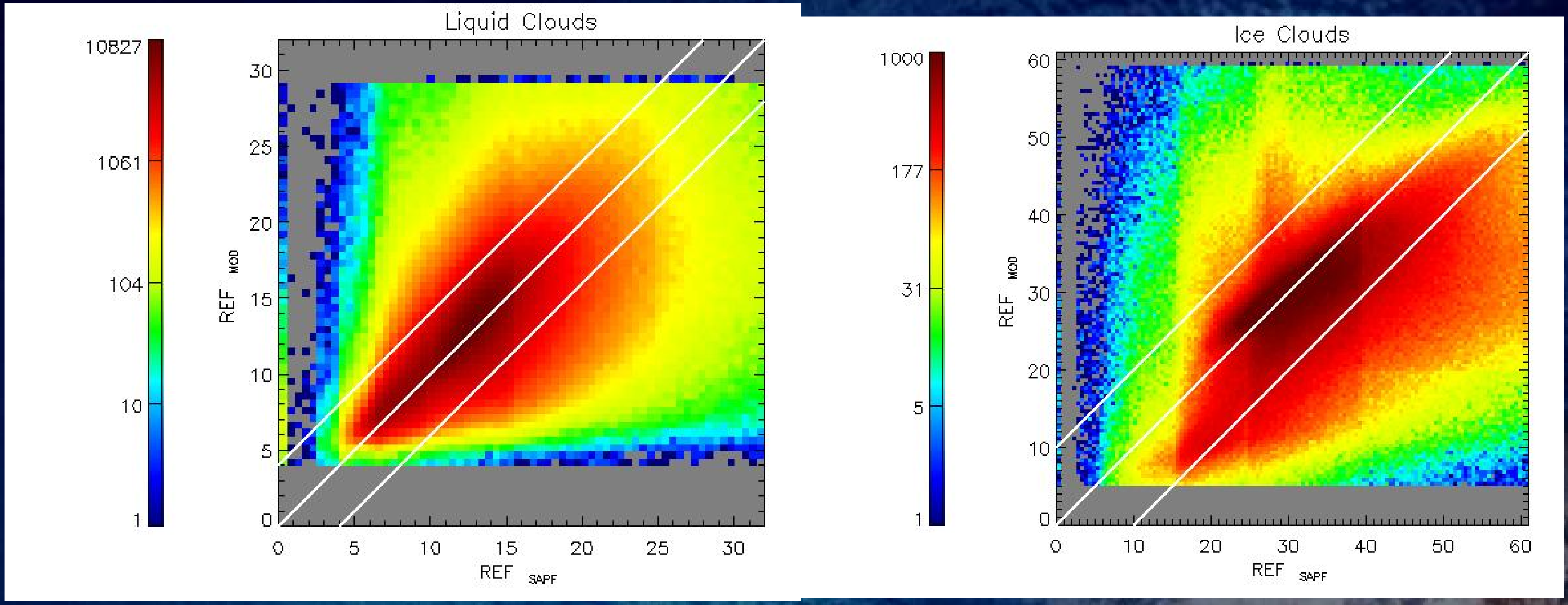
RGB: true color enhanced




Effective Radius SAPF
80.
70.
60.
50.
40.
30.
20.
10.
0.
8
12
16
20
24
28
32
36
40
52
48
44
40
36


Effective Radius MST Coll.6
80.
70.
60.
50.
40.
30.
20.
10.
0.
8
12
16
20
24
28
32
36
40
52
48
44
40
36

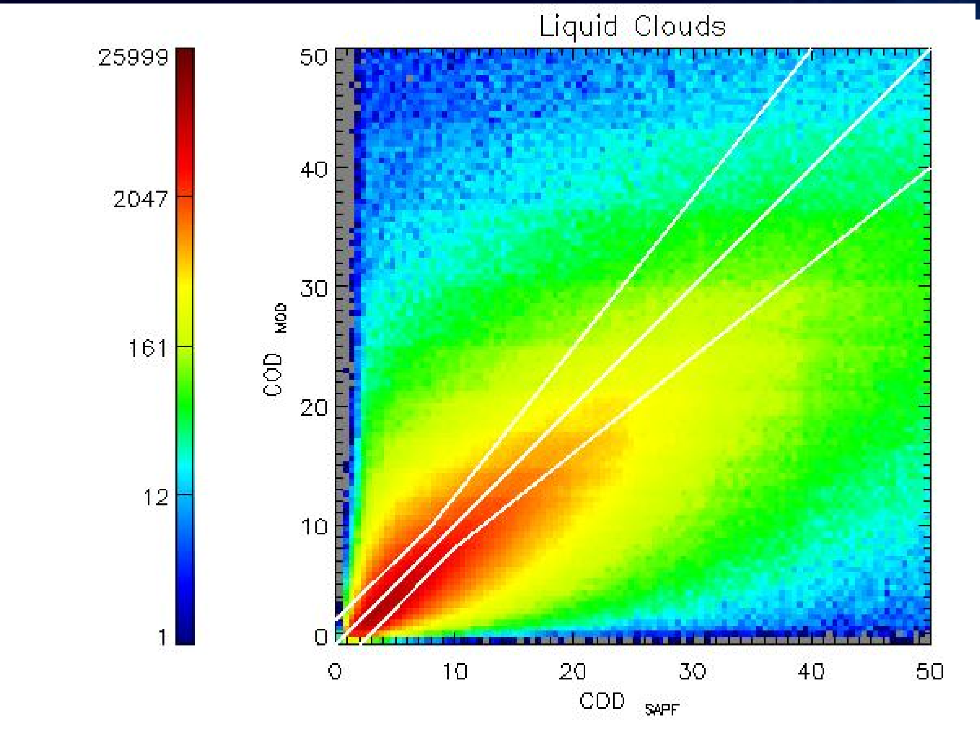
Validation results REF vs. MODIS c6

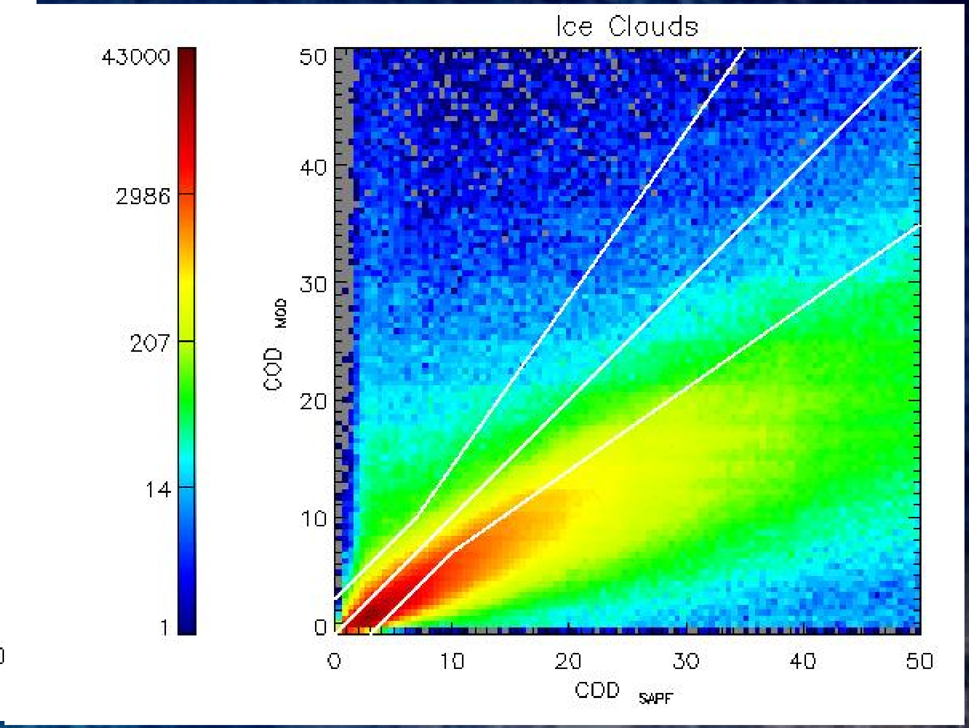


Accuracy: 0.29µm , 5.8%
Precision: 4.7µm
Correlation: 0.55

Accuracy: 5.91µm , 10.2%
Precision: 11.5µm
Correlation: 0.42

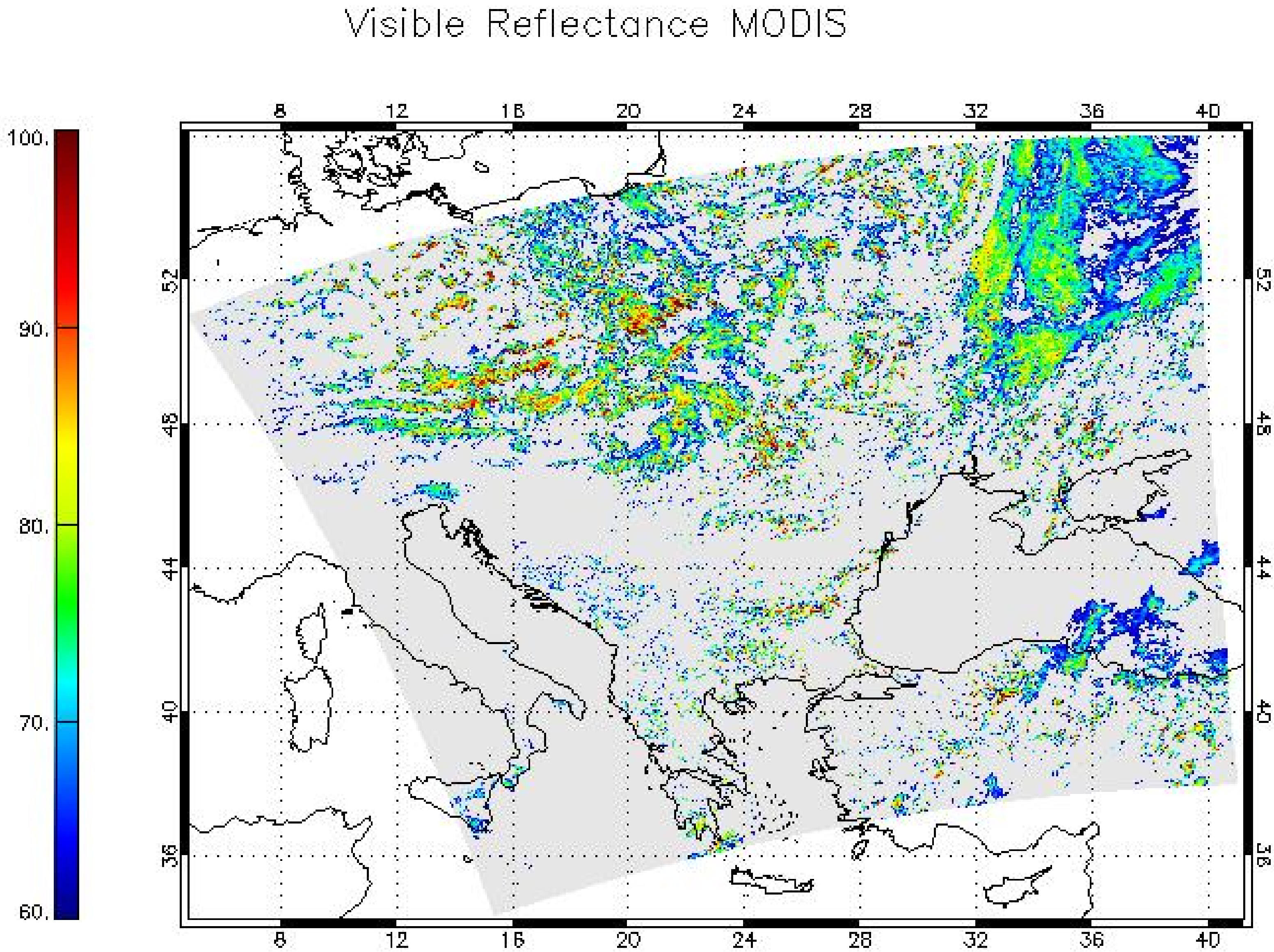
Validation results COD vs. MODIS c6



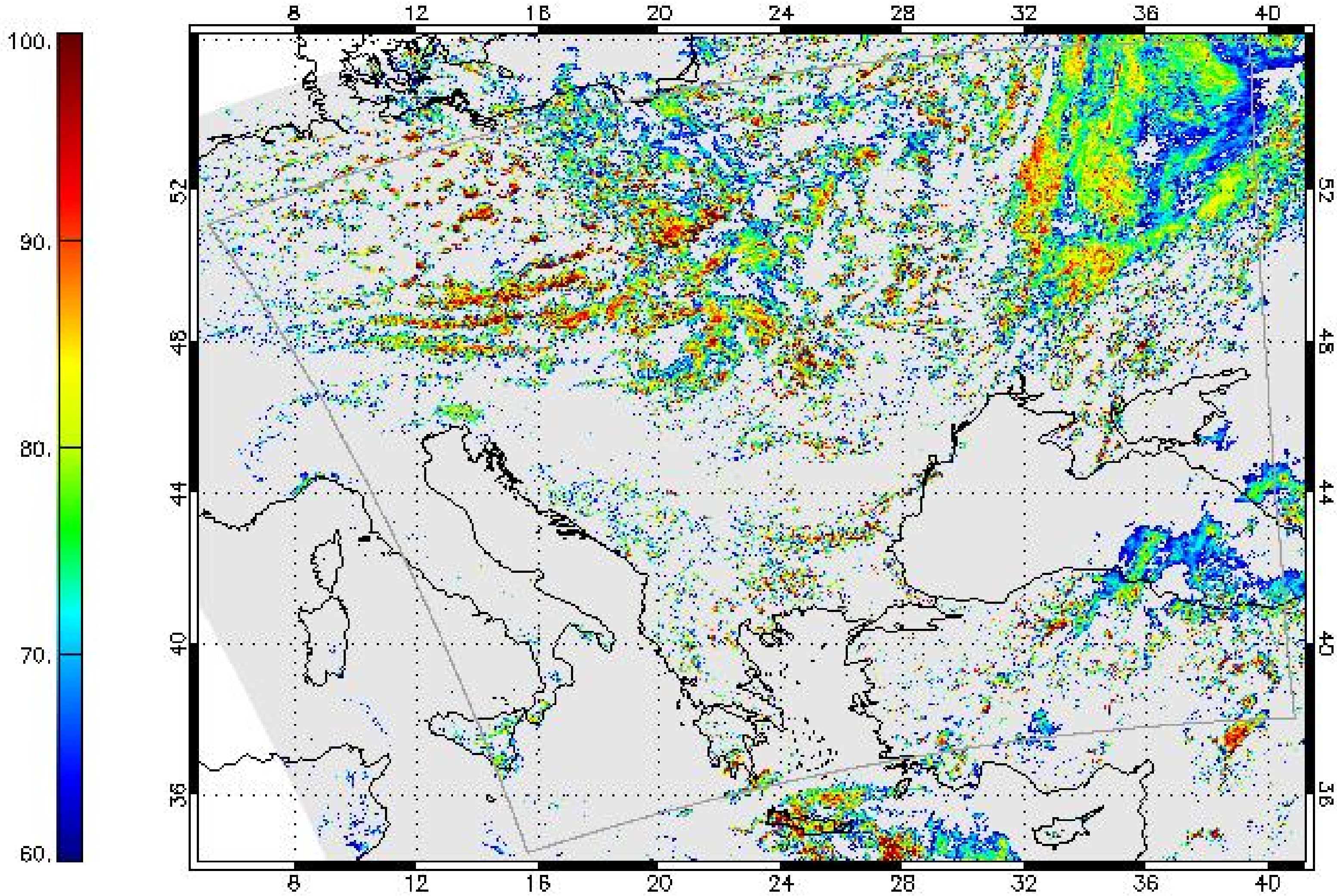


Accuracy: 2.67 , 3.2%
Precision: 8
Correlation: 0.71

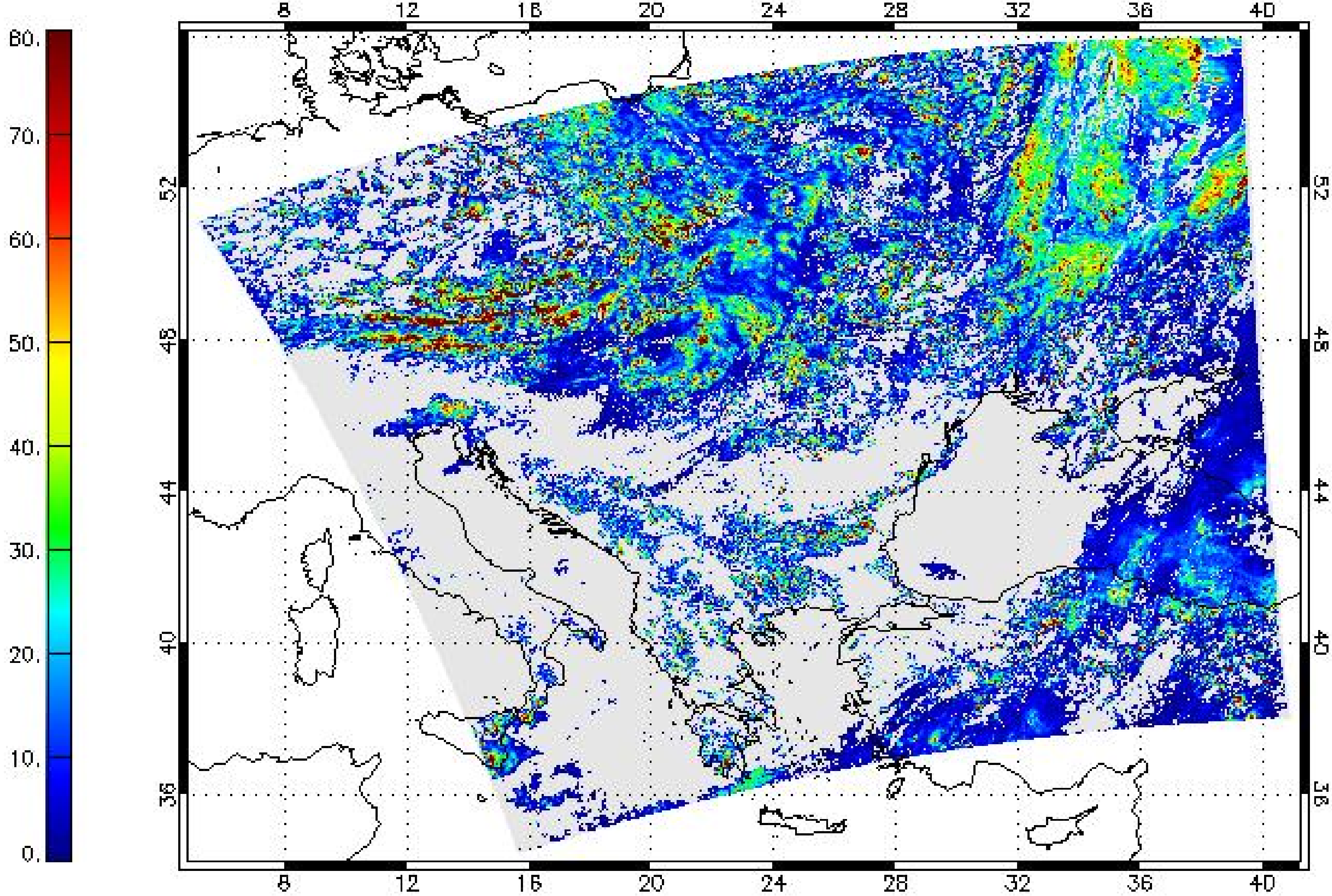
Accuracy: 5.66 , 35 %
Precision: 7.6
Correlation: 0.77

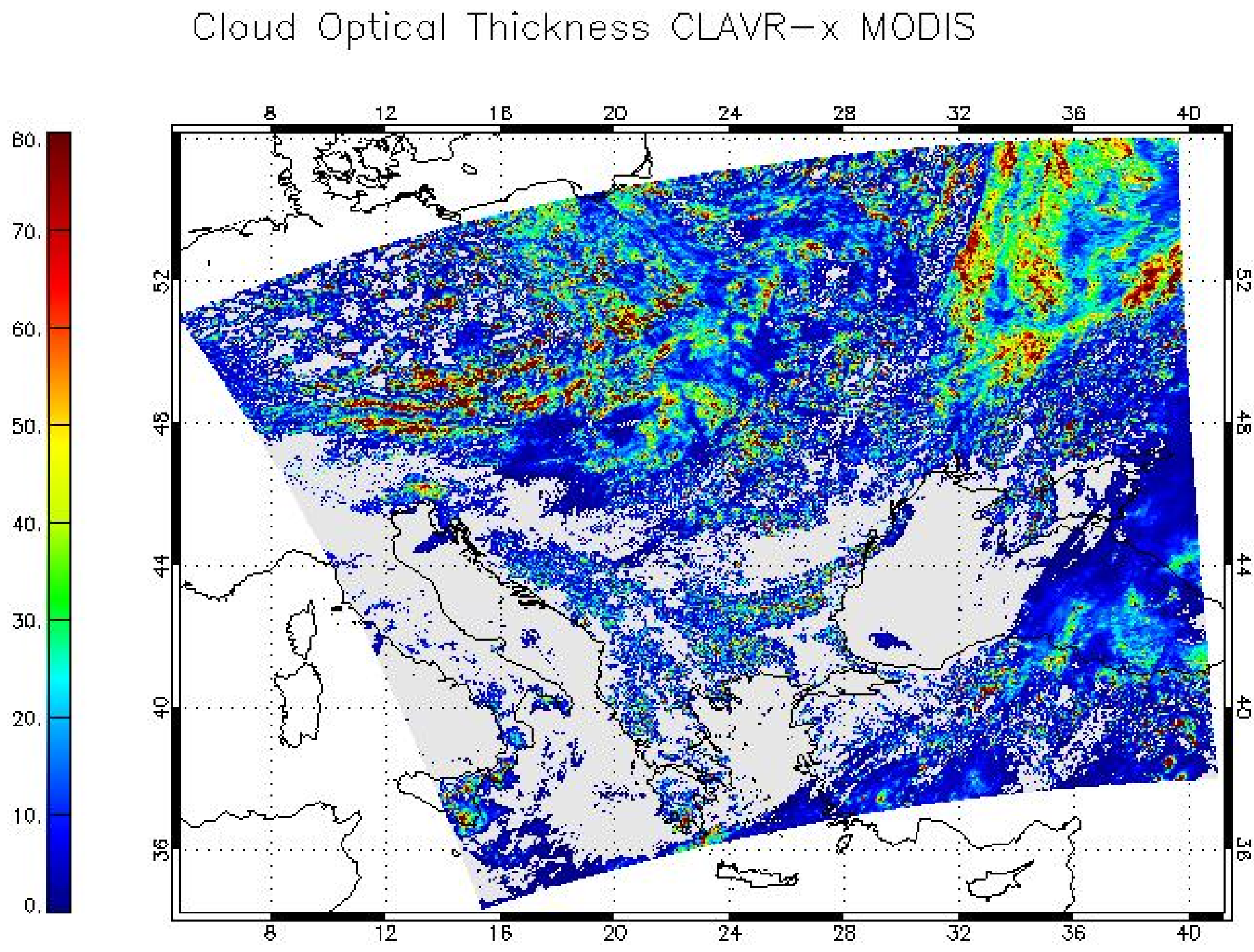

Visible Reflectance MODIS
100.
90.
80.
70.
60.
8
12
16
20
24
28
32
36
40
52
48
44
40
36

Visible Reflectance VIIRS

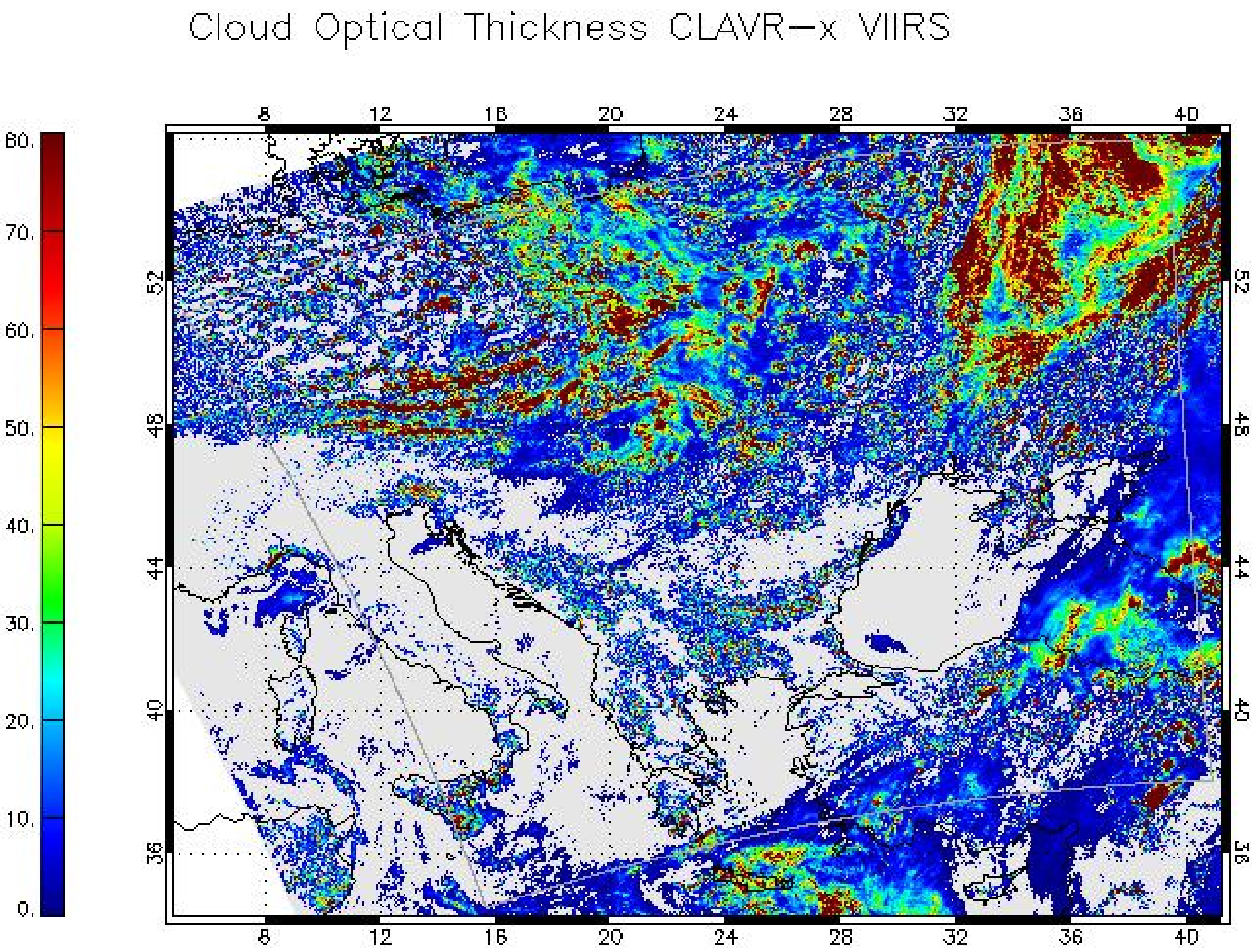


Cloud Optical Thickness MST Coll.6 MODIS



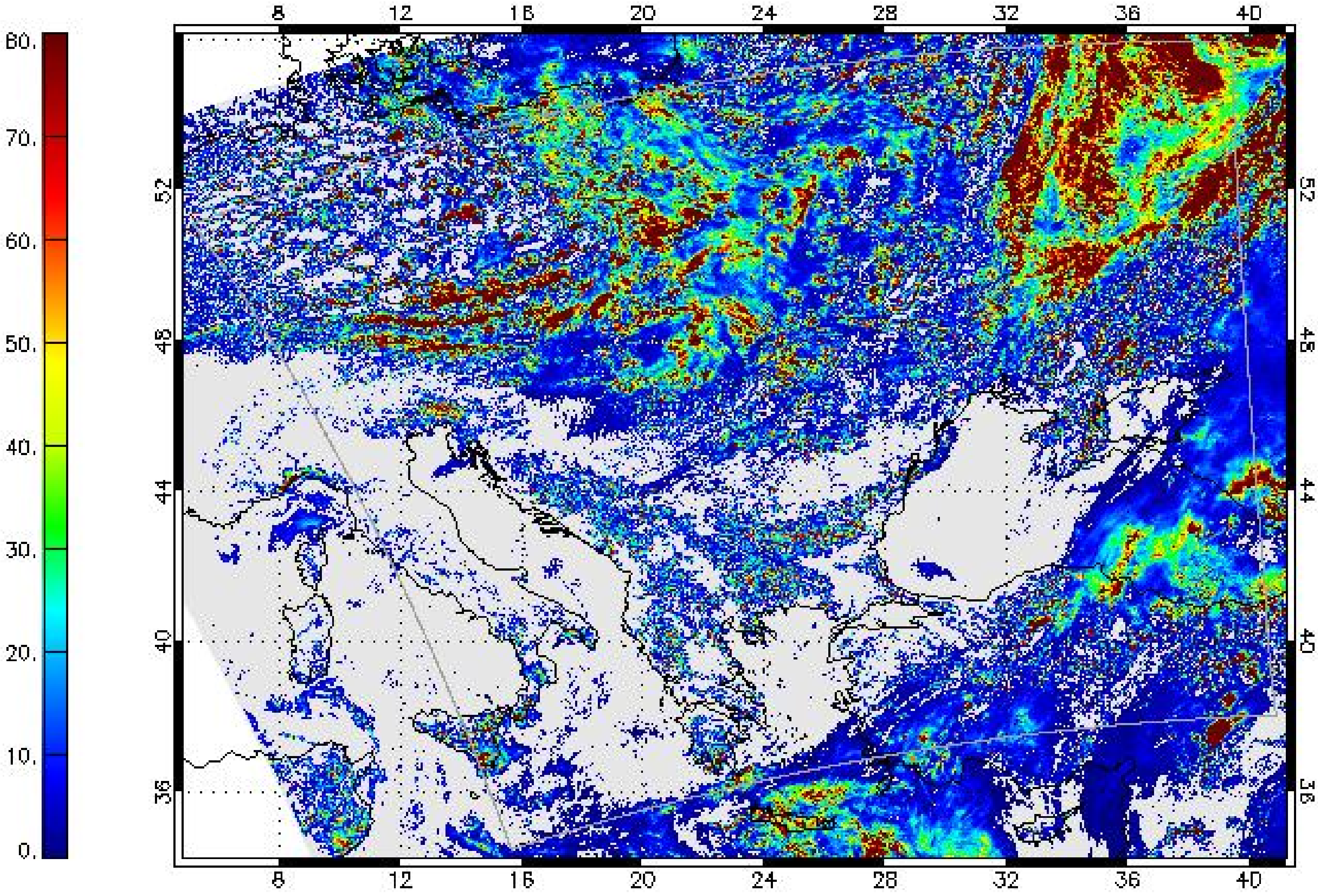


Cloud Optical Thickness CLAVR-x MODIS
80.
70.
60.
50.
40.
30.
20.
10.
0.
8
12
16
20
24
28
32
36
40
52
48
44
40
36



Cloud Optical Thickness CLAVR-x VIIRS
80.
70.
60.
50.
40.
30.
20.
10.
0.
8
12
16
20
24
28
32
36
40
52
48
44
40
36

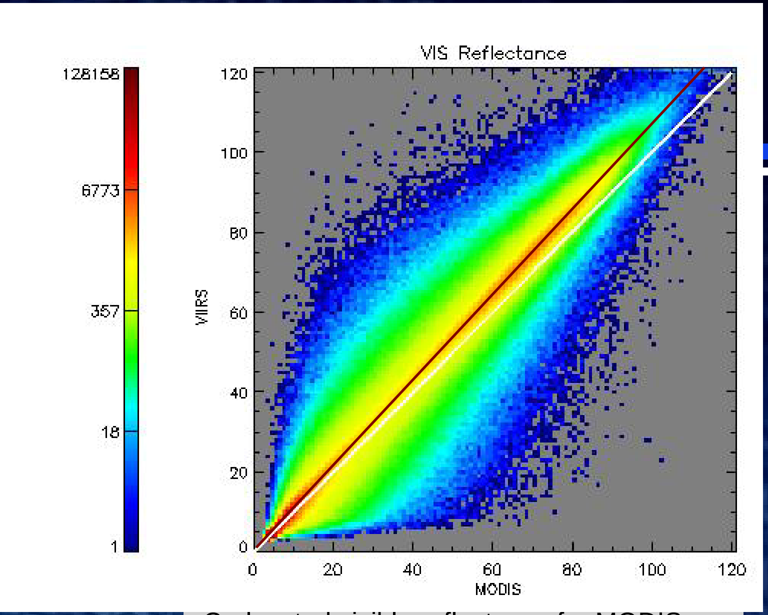
Cloud Optical Thickness SAPF VIIRS



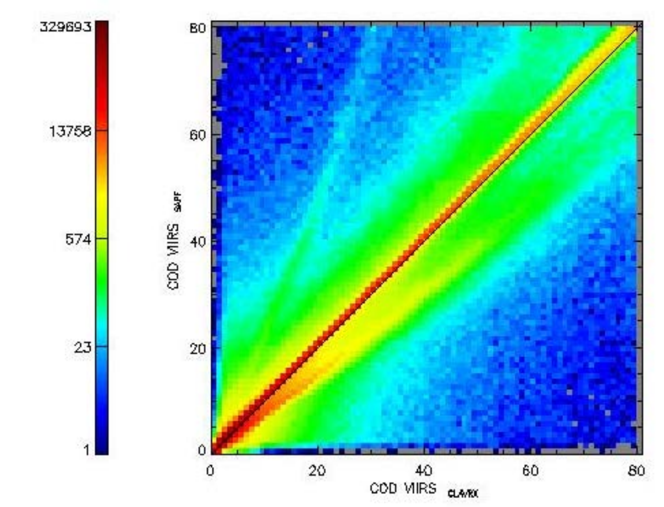
Discussion

- Reflectance of 0.64 micron channels on MODIS and VIIRS seems to be inconsistent. (Geometry for both sensors are very similar for this case)
- Small changes in Reflectance for thick clouds ➔ high impact on COD

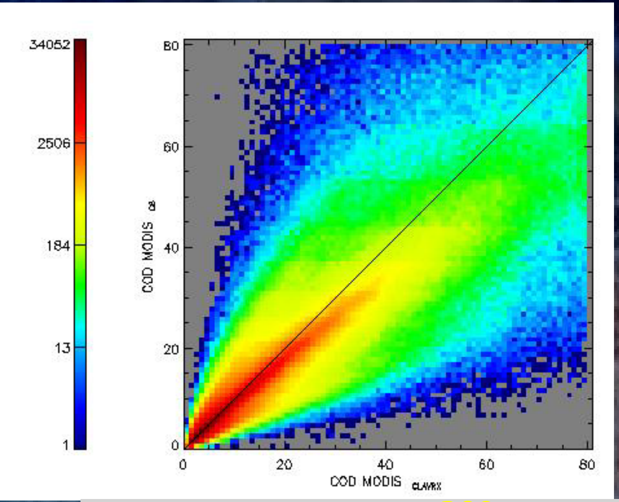
- Since DCOMP runs as exact same code on both sensors we checked direct pixel-based results on VIIRS for CLAVR-x vs. SAPF and on MODIS for CLAVR-x and MST coll.6 and found very good agreement.



Co-located visible reflectance for MODIS-AQUA and VIIRS

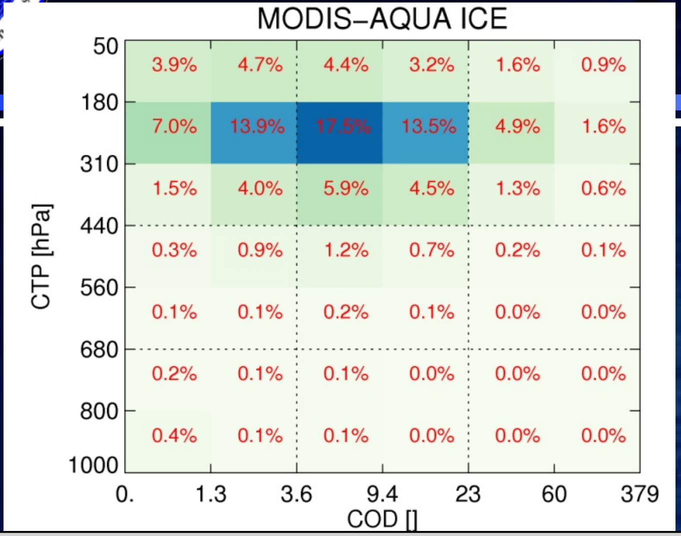


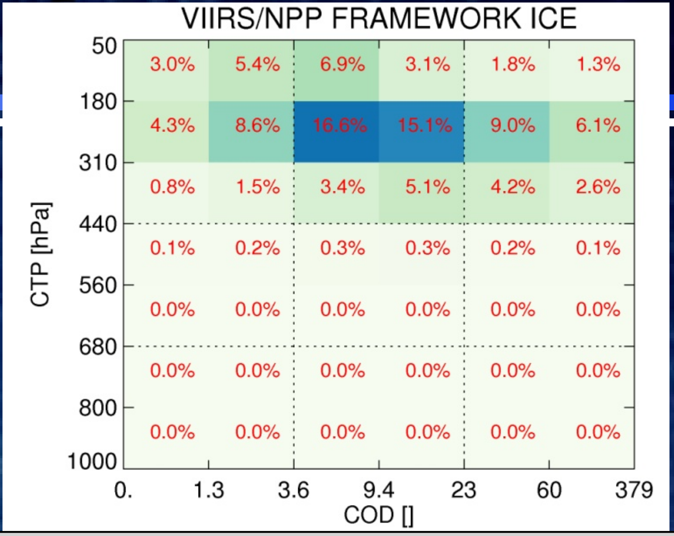
COD on VIIRS- CLAVR-x vs. SAPF (The TRR experiment)



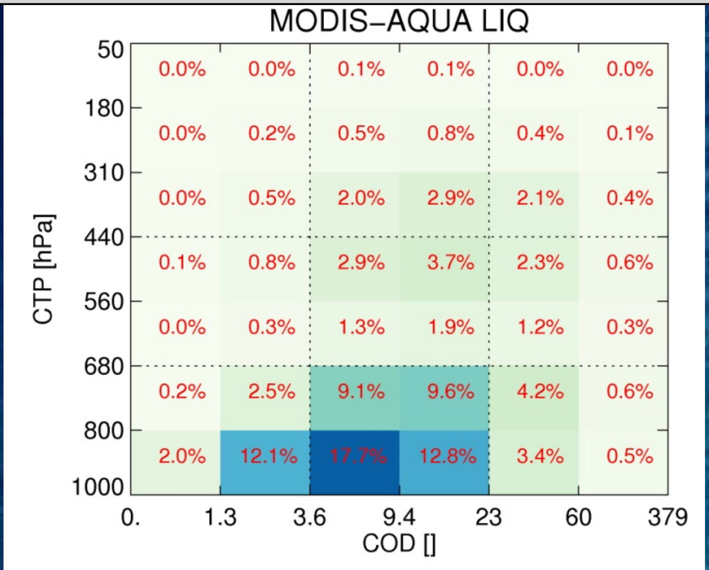
COD on MODIS-AQUA: CLAVR-x vs. MAST coll.6

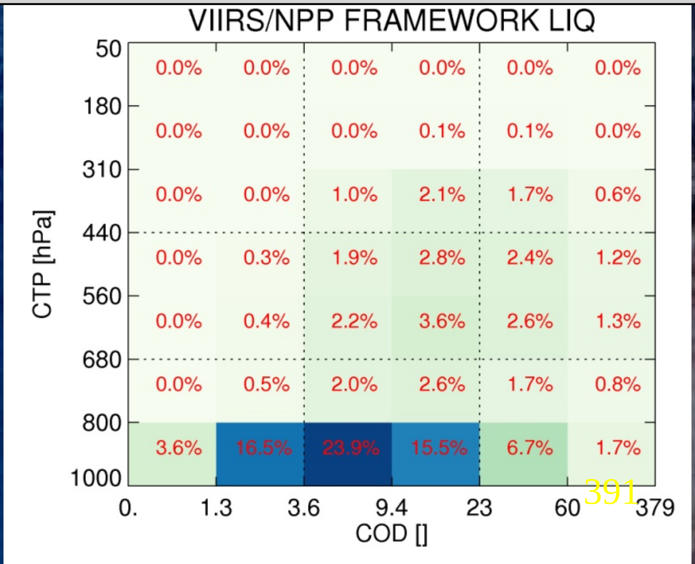
Validation results COD – MODIS: phase separated



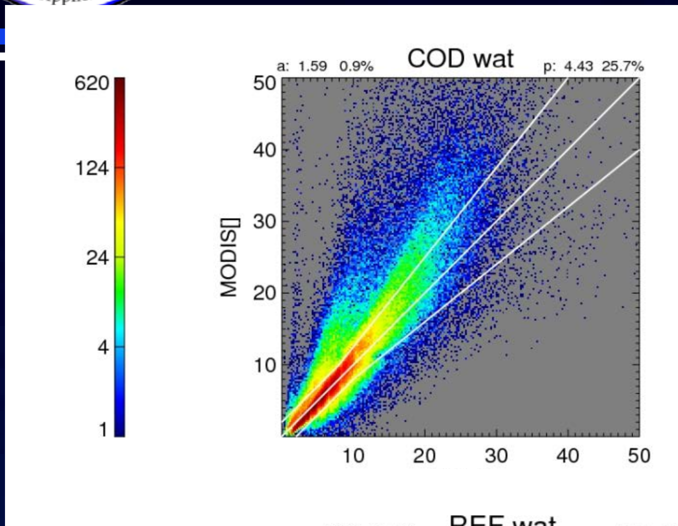


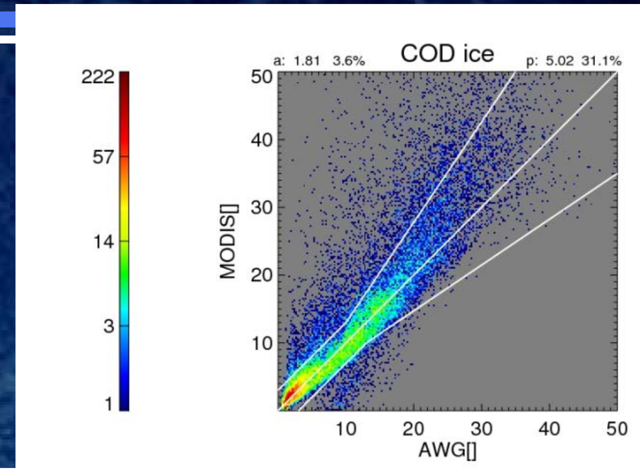
Conclusion:
DCOMP/SAPF on VIIRS is consistent with MODIS coll.6 for climatological purposes

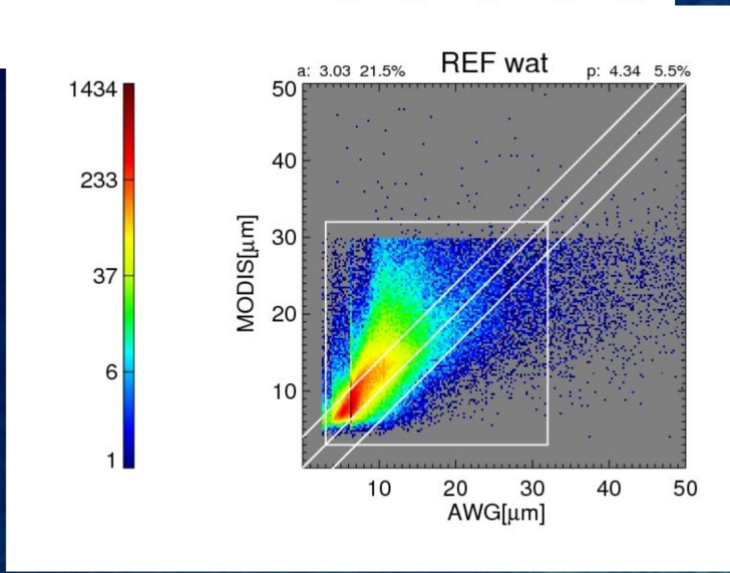


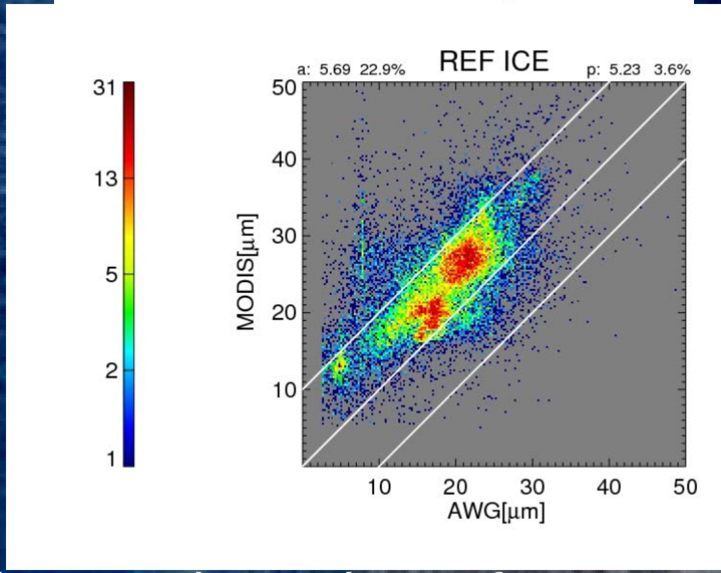


DCOMP/MODIS on CLAVRx vs. MODIS coll.6









Comparison of DCOMP to MODIS (MYD06) products for 10 full days. White lines depict requirement limits.

DCOMP on CLAVR-x: Liquid water path validation

Microwave satellite based sensors offer a further validation source
Validation is limited due to coarse spatial resolution and to only liquid phase sensitivity
We apply several filter criteria:

- 90% of DCOMP pixels must be covered by liquid clouds
- MW is insensitive to thin clouds. We exclude clouds thinner than COD = 5.
- We exclude all MW pixels with rain flag.

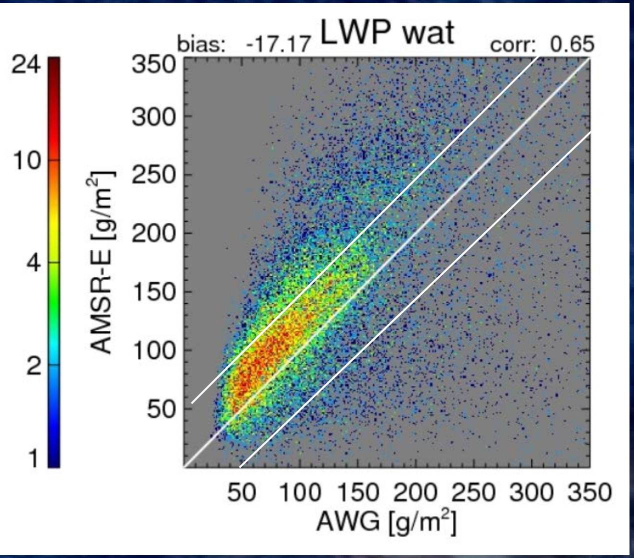


Image shows that 90 percent of pixels are within the 50 g/m2 spec.

DCOMP on CLAVR-x: Validation Summary

Product	Validation Source	Accuracy	Specs	Precision	Specs
COD Water	MODIS	1.59/0.9%	2. or 20%	4.43/25.7%	2. or 20%
COD Ice	MODIS	1.81/3.6%	3. or 30%	5.02/31.1%	3. or 30%
CPS Water	MODIS	3.03µm	4µm	4.3µm	4µm
CPS Ice	MODIS	5.69µm	10µm	5.23µm	10µm
LWP	MODIS	10g/m2	50 g/m2	17 g/m2	50 g/m2
LWP	AMSR-E	17 g/m2	50 g/m2	47 g/m2	50 g/m2
IWP	MODIS	44 g/m2	100 g/m2	65 g/m2	100 g/m2

Validation summary for DCOMP in comparison to MODIS science team results.

Accuracy is met for all validation studies.

Precision is met for Water content and for Effective Radius (CPS- Cloud Particle Size). (Reasons may be spatial and temporal matching, different calibration and wrong assumptions of cloud height for atmospheric correction)

Conclusions

- **Visual inspection** of mapped images doesn't show any obvious errors, such as a-priori peaks or artificial erroneous pattern.
- SAPF DCOMP products were validated against MODIS collection 6 and microwave data
- **COD:** Liquid clouds meet the specs for validation with MODIS. Ice clouds have a significant bias for thicker clouds and don't meet the spec there.
- **CPS:** DCOMP meets the accuracy specs for both phases. Precision is slightly outside the spec threshold.
- However, The MODIS coll.6 cannot be seen as "truth" because:
  - » Collocation uncertainty (up to 3 km and 120 seconds) may have a significant impact to precision and accuracy
  - » Different spatial resolution of both sensors (a 1-km COD is something different than a 4-km COD)
  - » We could show that reflectance values in 0.64µm channels differ up to 8 percent. There might be similar difference in 2.2µm channels (It is harder to show, because SRF are not that close to identical). This has a huge impact especially to thick cloud retrievals.
- Direct comparisons of DCOMP on MODIS L1b data (vs. MYD06) and VIIRS (vs. SAPF) show good agreement.

VIIRS Nighttime Cloud and Optical Properties Algorithm Readiness

Presented by

Patrick Heck

UW-Madison CIMSS

Outline

- Product Overview and Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the VIIRS NCOMP Product.

VIIRS NCOMP Product Overview & Requirements

- VIIRS Nighttime Cloud Optical and Microphysical Properties will be derived by matching observed VIIRS thermal channels (Band M12, M15 and M16 – 3.7µm, 10.8µm and 12µm) to modeled radiances and minimizing errors using an iterative technique.

  » Cloud Optical Depth, Cloud Particle Size, Liquid Water Path and Ice Water Path are derived for nighttime and twilight cloudy pixels. Only nighttime pixels (Solar Zenith Angle ≥ 90º) are required to meet validation specs.

  » NCOMP products are generated for Viewing Zenith Angle < 72º

  » The product will include location, time, data quality and processing flags, and other metadata

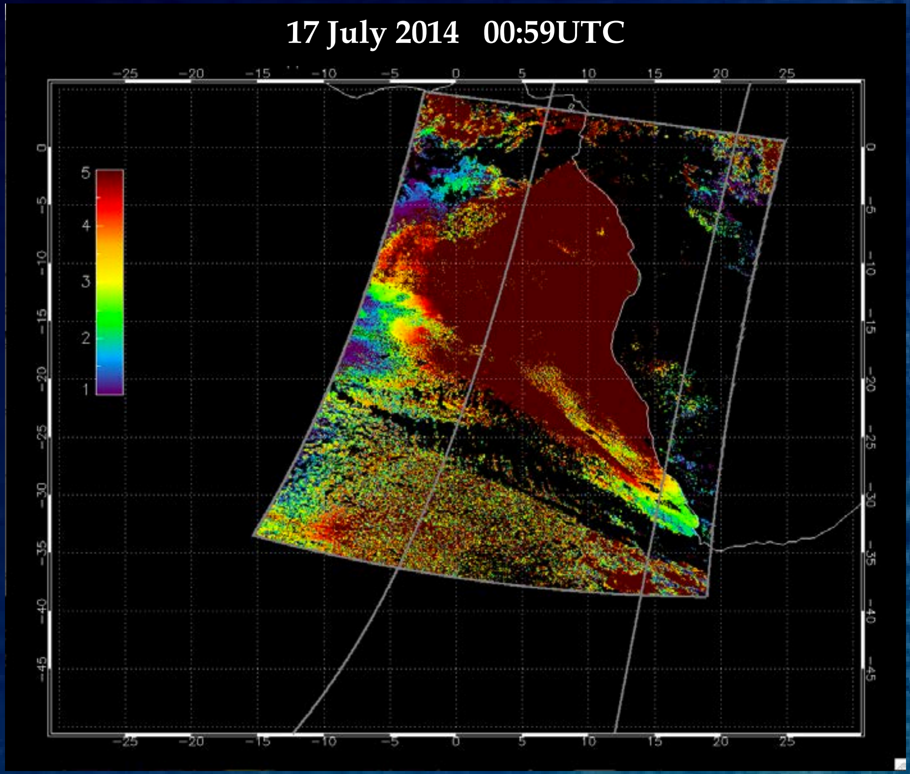
VIIRS NCOMP Product Overview & Requirements (2)

VIIRS NCOMP products and requirements

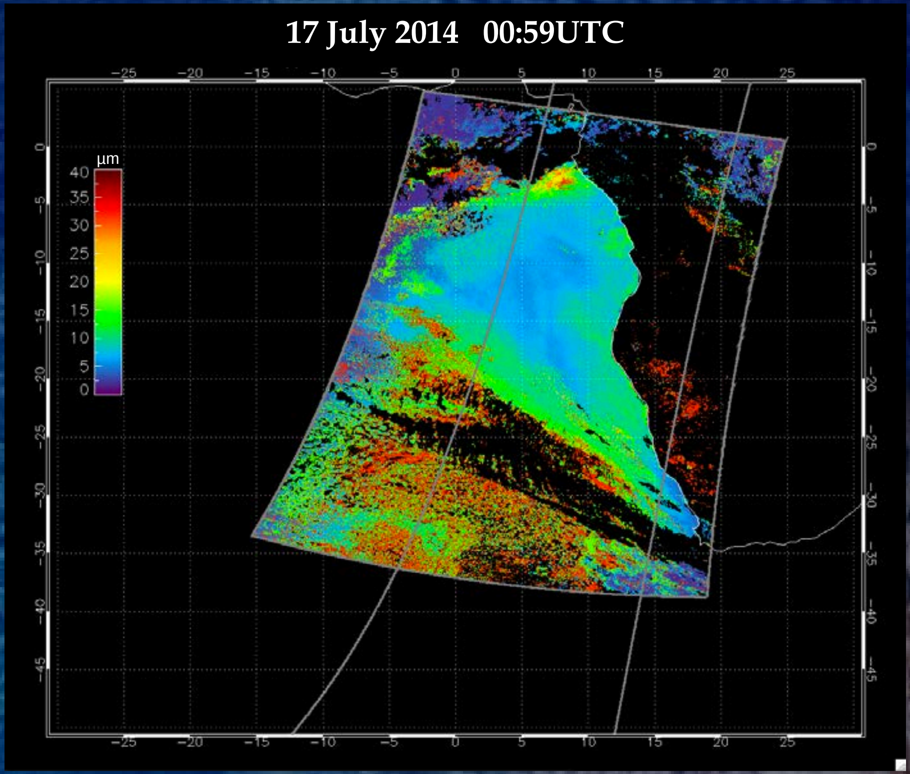
Product	Range	Accuracy	Precision
COD	1.0 - 5.0	30%	Max of 0.8 or 30%
CPS	2 – 32 µm (liquid) 2 – 50 µm (ice)	Max of 4 µm or 30% (liquid) 10 µm (ice)	Max of 4 µm or 25% (liquid) 10 µm or 25% (ice)
LWP	25 – 100 g/m2	Greater of 25 g/m2 or 15%	Greater of 25 g/m2 or 40%
IWP	25 – 175 g/m2	Greater of 25 g/m2 or 30%	Greater of 25 g/m2 or 40%

Algorithm Output

Cloud Optical Depth

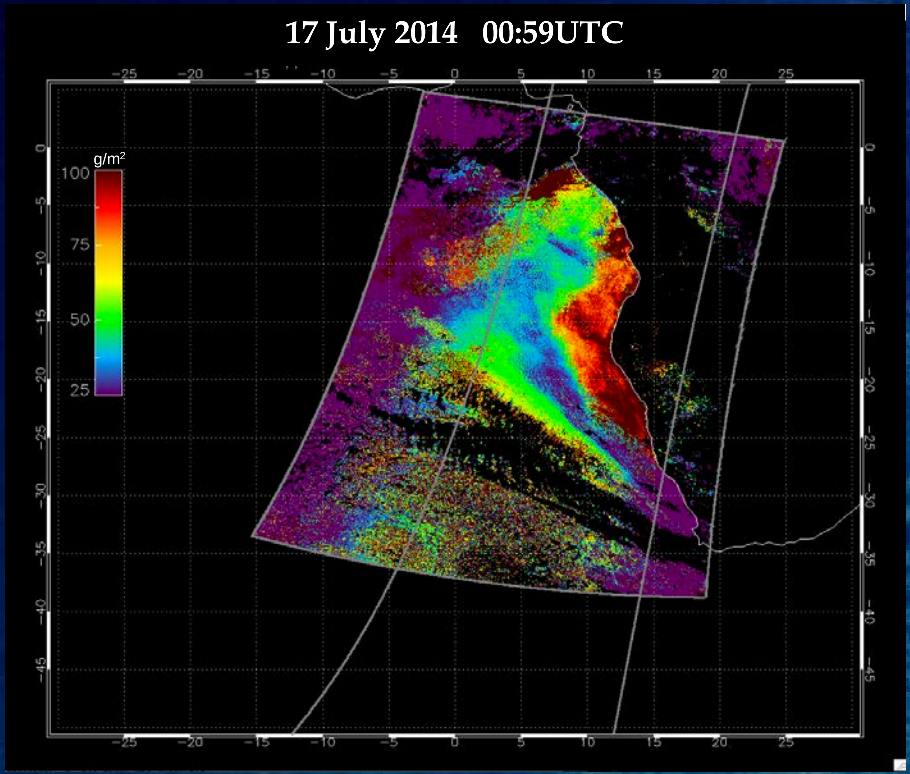


Cloud Particle Size

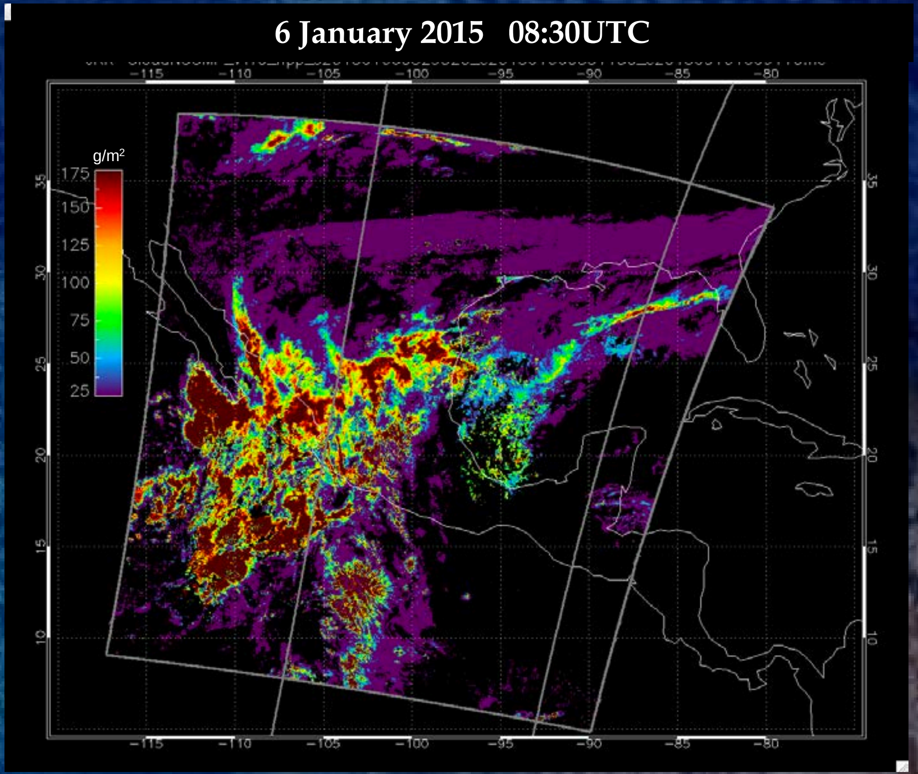


Algorithm Output (2)

Cloud Liquid Water Path



Cloud Ice Water Path



Validation Strategy

- Typical truth datasets are not available, so use independent sources that are most directly comparable, i.e., derived water path for water clouds (LWP) and optical depth for ice clouds (COD).
- LWP
  - » Microwave instruments provide the most direct comparison opportunity
  - » AMSR-2 is the current validation source and follow-ons are expected.
  - » AMSR-2 can be compared at nadir-only or for gridded data off nadir to expand the colocation opportunities.
- COD
  - » Lidar retrievals from CALIOP are used.
  - » Thin ice clouds provide good validation opportunities for both NCOMP and CALIOP, although CALIOP's strength is very thin clouds whereas very optically thin clouds (COD < 1.0) are outside of NCOMP's retrieval range.
- Accuracy and Precision results are generated for LWP and COD.

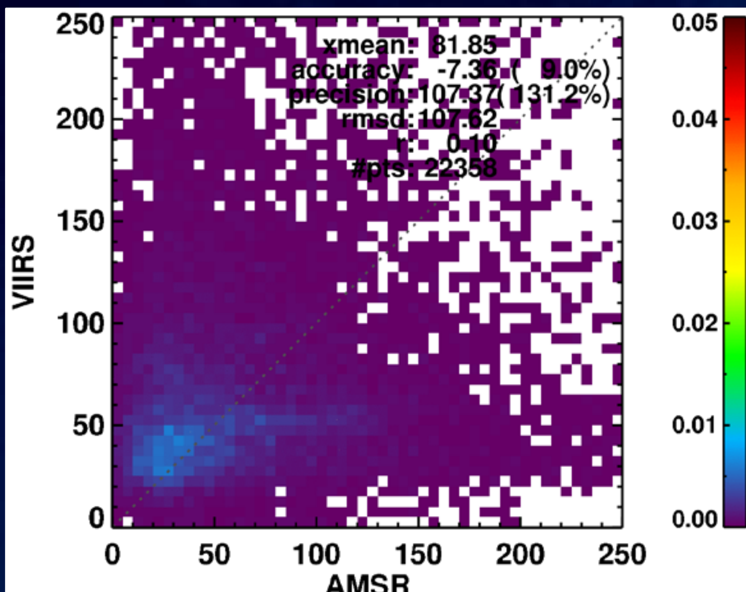
Validation Strategy (2)

- NCOMP products are compared to the analogous CERES VIIRS products from NASA Langley to check consistency.
  - » NCOMP COD, LWP and IWP comparisons to CERES VIIRS products provide reasonable consistency check opportunities.
  - » NCOMP CPS comparisons to CERES VIIRS are not useful because CERES VIIRS algorithm uses different ice particle sizes and a different thresholding technique in incorporated into CERES VIIRS for water particle sizes.

LWP Comparisons to AMSR-2

Nadir only

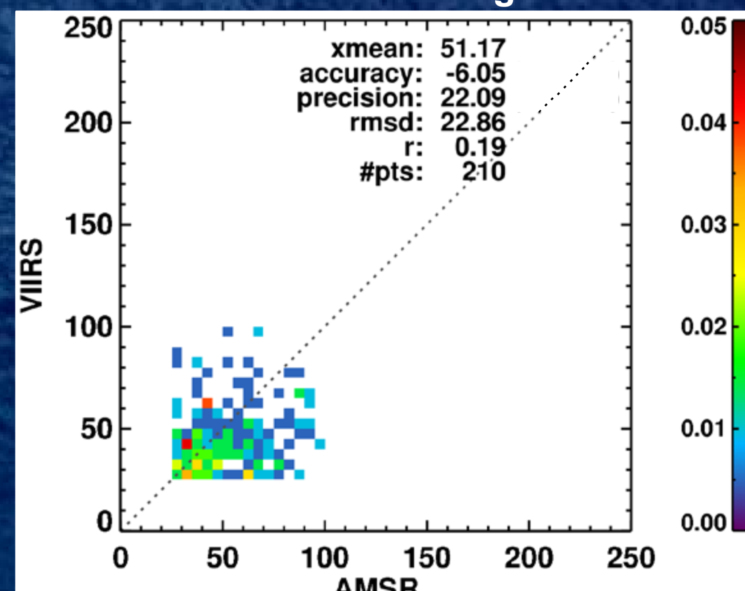
Exceeding NCOMP Range
0 < LWP ≤ 250 g/m²



Accuracy: -7.4 (9.0%)
Precision: 107.6 (31.2%)
N = 22358

900+ granules selected for seasonal and geographic variation

NCOMP Range
25 ≤ LWP ≤ 100 g/m²



NCOMP Range version meets accuracy and precision specs, but very small sample

Specifications:

Measurement Accuracy	Greater of 25 g/m² or 15%
Measurement Precision	Greater of 25 g/m² or 40%

LWP Comparisons to AMSR-2 (2)

Expansion to full swath - gridded

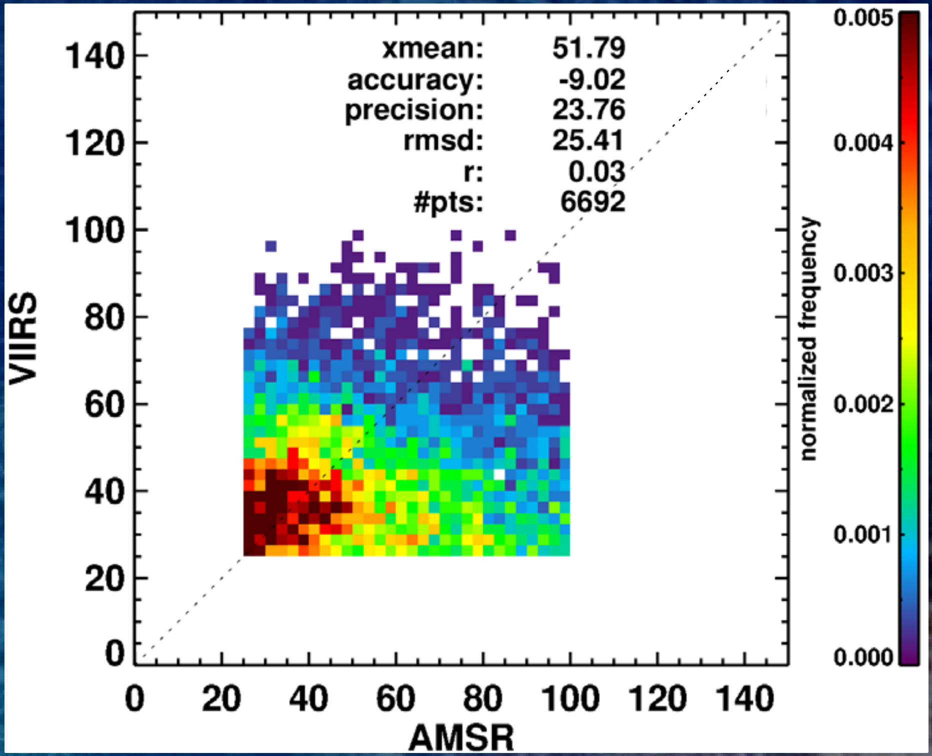
900+ granules selected for seasonal and geographic variation

0.5º x 0.5º latitude longitude grid

Limited to 1 ≤ COD ≤ 5
CF > 0.8

Higher number of samples - meets accuracy and precision specs

NCOMP Range
25 ≤ LWP ≤ 100 g/m^2



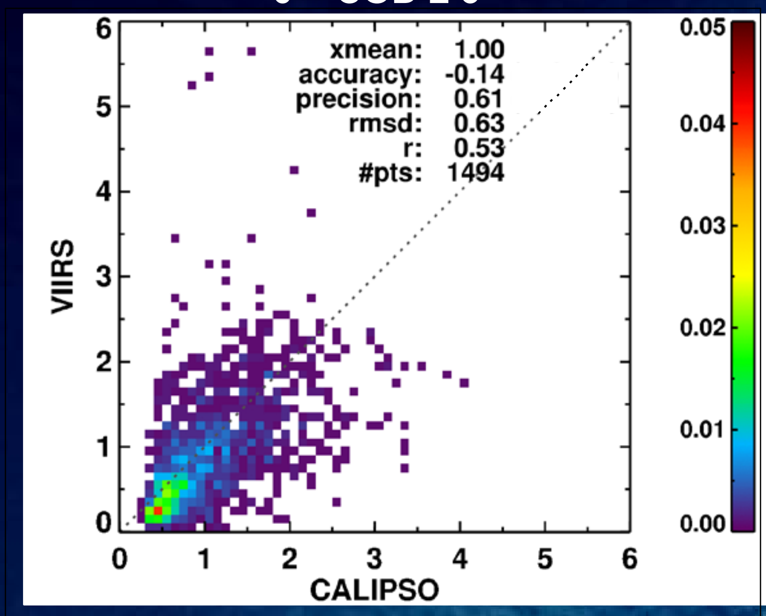
Specifications:

Measurement Accuracy	Greater of 25 g/m^2 or 15%
Measurement Precision	Greater of 25 g/m^2 or 40%

COD Comparisons to CALIOP

Nadir only

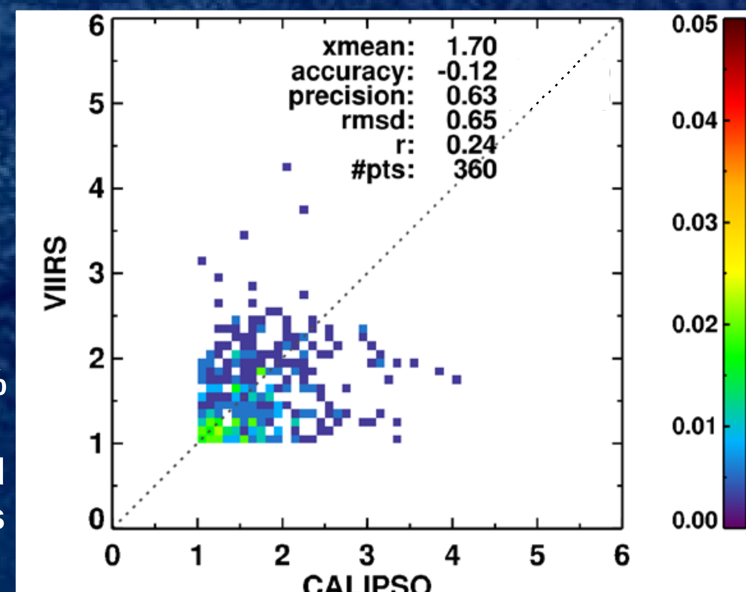
Exceeding NCOMP Range
0 < COD ≤ 6



900+ granules selected for seasonal and geographic variation

Accuracy: 13.7%

NCOMP Range
1 ≤ COD ≤ 5



Accuracy: 7.3%

Meets accuracy and precision specs

Specifications:

Measurement Accuracy	30%
Measurement Precision	Greater of 8.0 or 30%

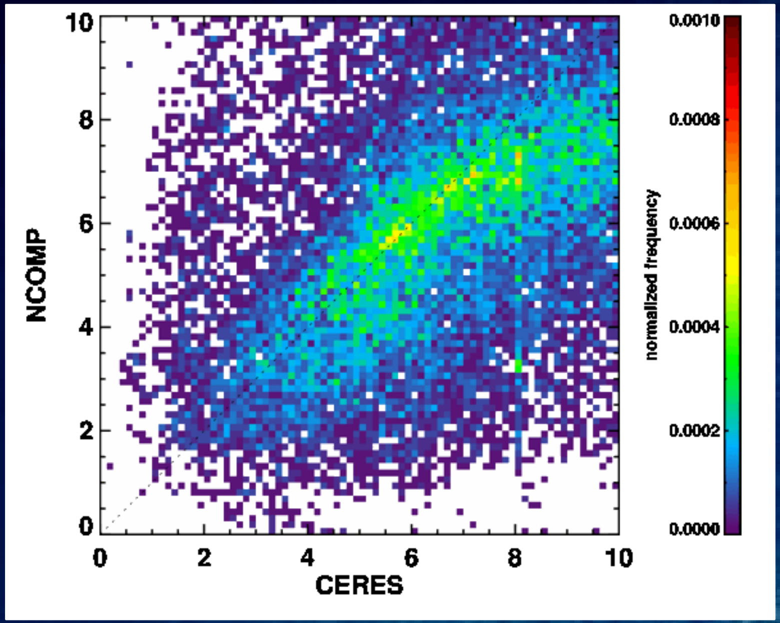
COD and LWP Validation Summary Table

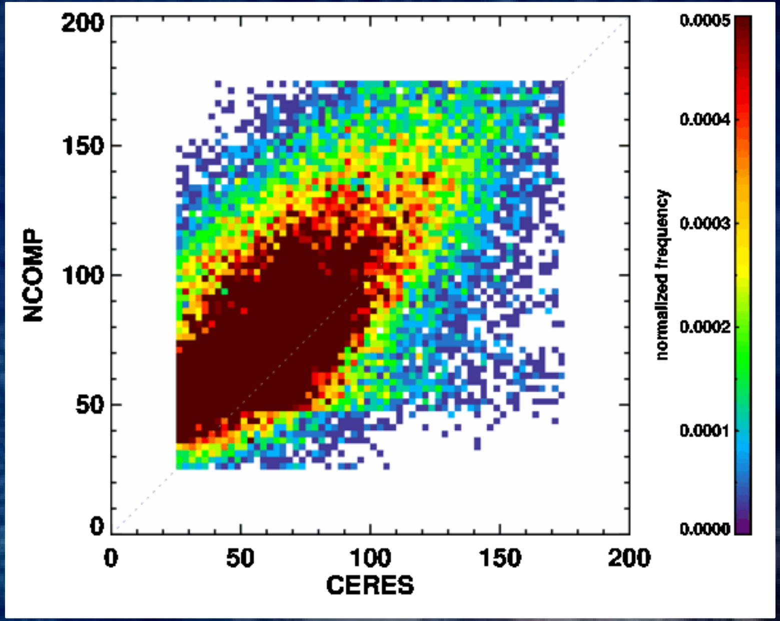
Product	Range	Validation Source	Accuracy	Precision	Samples
COD (Ice)	0 ≤ COD ≤ 6	CALIOP (Nadir)	-0.14 (13.7%)	0.61	1494
COD (Ice)	1 ≤ COD ≤ 5	CALIOP (Nadir)	-0.12 (7.3%) (30%)	0.63 (Max of 0.8 or 30%)	360
LWP	0 < LWP ≤ 250	AMSR-2 (Nadir)	-7.4 (9.0%)	107.6 (31.6%)	22358
LWP	25 ≤ LWP ≤ 100 1 ≤ COD ≤ 5	AMSR-2 (Nadir)	-6.05 (Max of 25g/m^2 or 15%)	22.09 (Max of 25g/m^2 or 40%)	210
LWP	25 ≤ LWP ≤ 100 1 ≤ COD ≤ 5	AMSR-2 (Full Swath-Gridded)	-9.02	23.76	6692

Red are NCOMP product requirements
Black-only rows are supplementary validations

Comparisons to CERES VIIRS
Gridded

COD Water Clouds | **439 granules** | **IWP (g/m^2)**





- NCOMP COD is similar to CERES
- Algorithms are conceptually related, but not the same. Also differing spatial resolutions.
- Framework and inputs also vary, including Cloud Temperature and Phase, profiles, etc., hence exact agreement is not expected.

- NCOMP IWP is similar, but there is a bias and larger variance.
- CERES IWP calculations are different than those in NCOMP.
- Same caveats as COD comparison, hence only general agreement expected.

Summary of Validation Results for VIIRS NCOMP Product

- NPP/VIIRS LWP and COD products have been validated against Microwave and Lidar retrievals, respectively.
- The accuracy and precision of the NPP/VIIRS LWP and COD falls within specifications.
- Despite a lack of truth datasets, water cloud CPS can be assumed to be reasonable since LWP and COD meet specifications.
- The accuracy and precision of ice cloud CPS and IWP have yet to be evaluated due to lack of reliable validation sources, but IWP comparisons to CERES VIIRS products imply NCOMP IWP is reasonable.
- Comparisons with CERES VIIRS products, while not independent, provide assurance that products are acceptable.

VIIRS Aerosol Optical Depth and Aerosol Particle Size Algorithm Readiness

Presented by

Istvan Laszlo

NOAA/NESDIS/STAR

Outline

- Product Overview
- Product Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the VIIRS aerosol optical depth product.

VIIRS Aerosol Optical Depth Product Overview

- Products:
  - Aerosol Optical Depth, AOD (at 550nm and at VIIRS M1-11 bands),
  - Aerosol Particle Size, APS (Ångström Exponent) over water,
  - quality flags.
- VIIRS AOD is derived over global cloud-free area during daytime.
- Separate algorithms used over land and water
- AOD retrieval over land
  - Use M1, M2, M3, M5 and M11 bands
  - Over dark surface
  - Experimental retrieval over bright surface (desert) and Angstrom Exponent
- AOD retrieval over water
  - Use M4, M5, M6, M7, M8, M10 and M11 bands
  - Over glint-free surface
- APS is calculated from AOD values at 550nm vs. 865nm and 865nm vs. 1610nm

Product Requirements VIIRS Aerosol Optical Depth

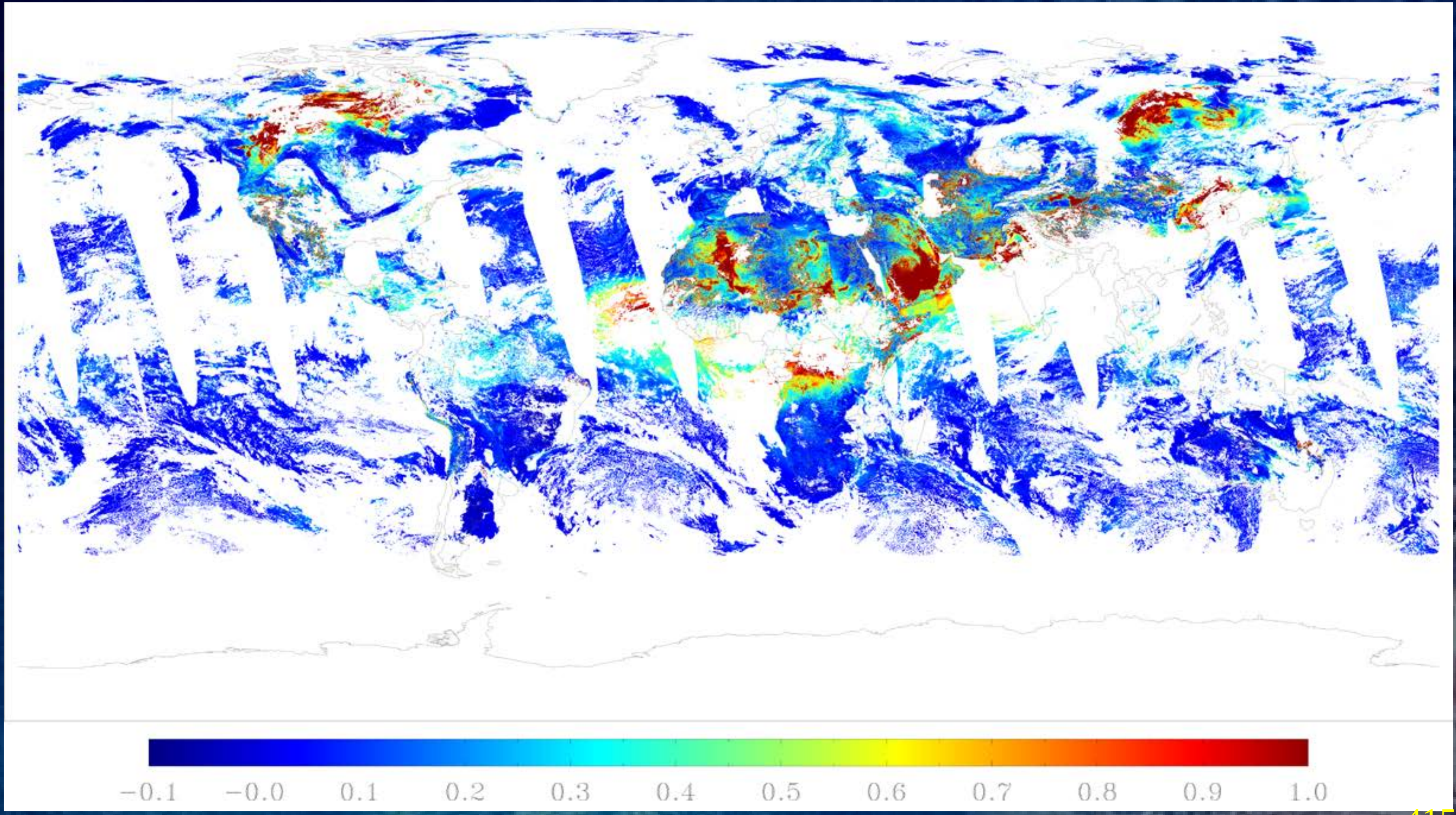
Product Name	Aerosol Optical Depth	
	Over land:	Over water:
Measurement Accuracy	AOD < 0.1: 0.06 0.1 ≤ AOD ≤ 0.8: 0.05 AOD > 0.8: 0.20	AOD < 0.3: 0.08 AOD ≥ 0.3: 0.15
Measurement Precision	AOD < 0.1: 0.15 0.1 ≤ AOD ≤ 0.8: 0.25 AOD > 0.8: 0.45	AOD < 0.3: 0.15 AOD ≥ 0.3: 0.35
Measurement Range	-0.05 to +5.0	
Latency	30 minutes after granule data is available	
Refresh	90 minutes	
Timeliness	≤ 3 hours	
Coverage	Global	
Horizontal Resolution	0.75 km (nadir)	
Vertical coverage	Total column	

Product Requirements Aerosol Particle Size

Product Name	Aerosol Particle Size (over water)
Measurement Accuracy	0.3
Measurement Precision	0.6
Measurement Range	-1 to +3
Latency	30 minutes after granule data is available
Refresh	90 minutes
Timeliness	≤ 3 hours
Coverage	Ocean
Horizontal Resolution	0.75 km (nadir)
Vertical coverage	Total column

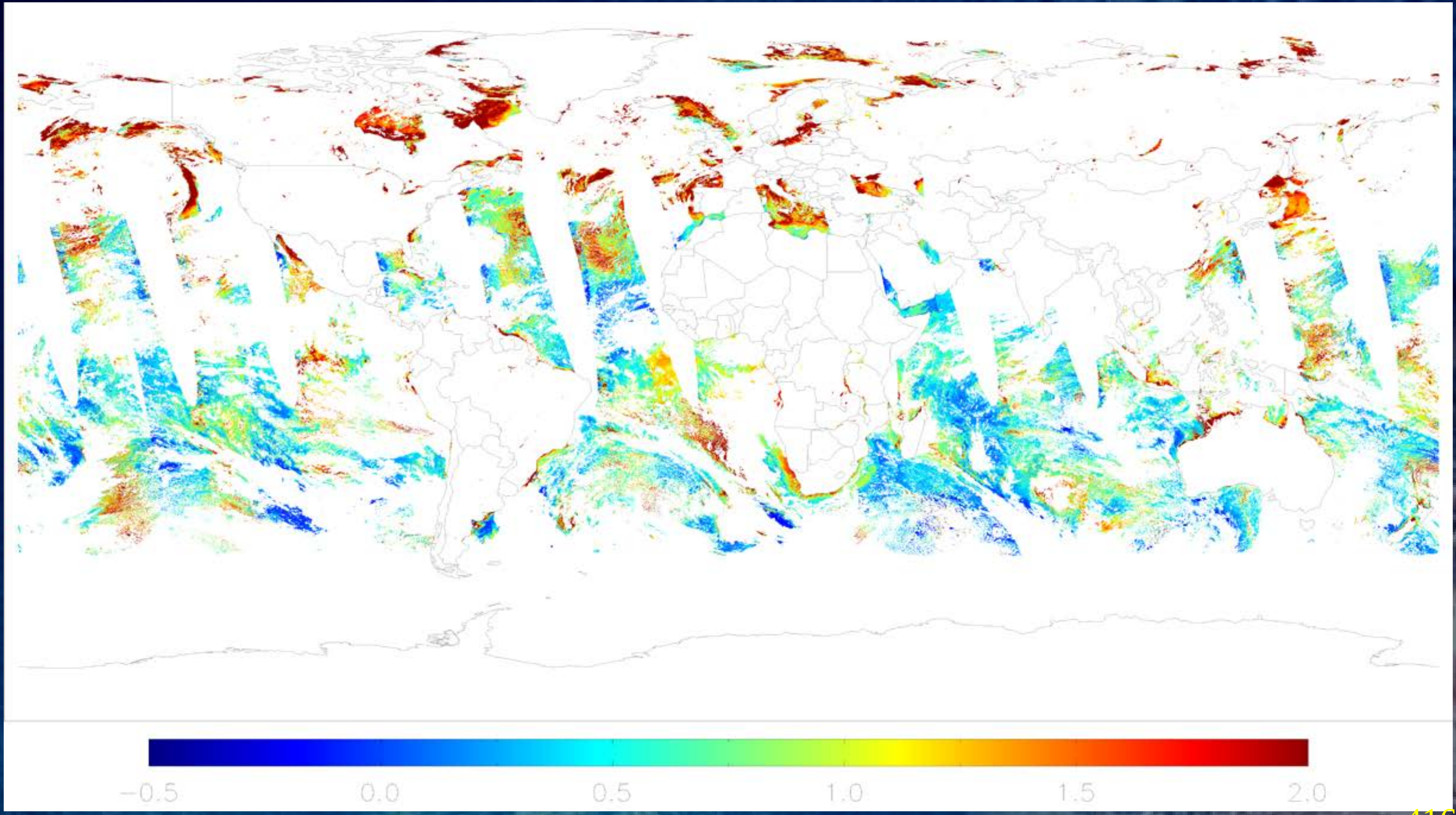
Algorithm Output - AOD

Aerosol Optical Depth at 550nm (07/15/2014)



Algorithm Output - APS

Aerosol Particle Size (07/15/2014) – Ångström Exponent (550 vs. 865nm)

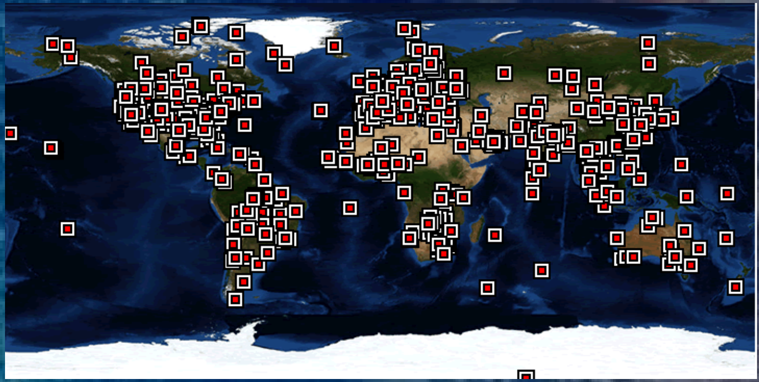


Validation Strategy

- Retrieve aerosol optical depth with global NPP/VIIRS measurements during daytime.
- Retrieve aerosols with full product precedence in place
  - » Official NPP cloud mask product is used
  - » Official NPP snow/ice product is used
- Time period: 2.5 months
  - » 2014: 04/10-04/25; 07/10-07/25; 10/10-10/25
  - » 2015: 01/01-01/31
- Collocate (in space and time) retrieved aerosol optical depth with reference ("truth") ground AERONET Level 1.5 measurements
- Generate comparative statistics (Retrieval – Reference aerosol optical depth and Ångström Exponent)
  - » Accuracy
  - » Precision

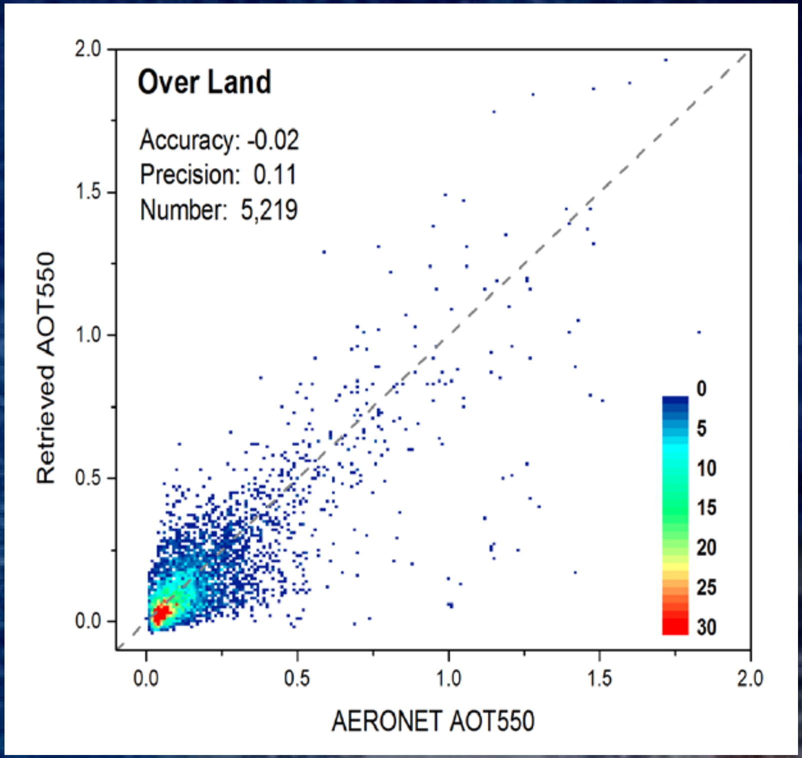
AOD and APS Test Plan - Offline Validation: Truth Data

- AERONET: ground-based measurements over 100 stations worldwide for more than 10 years; quality assured aerosol optical properties (*Holben et al*., 1998).
- Collocated AERONET and retrieved AOD dataset
  - Spatial average: high quality retrievals within a circle of 27.5-km radius centered on AERONET stations.
  - Temporal average: AERONET measurements within one-hour window centered on the NPP overpass time, at least three measurements are available.



AOD Validation Results (Land)

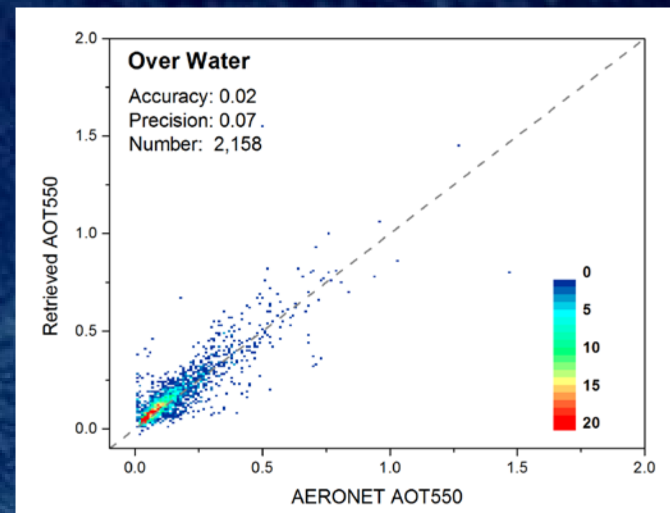
AOD	Retrieval	Specification
AOD550 < 0.1		
Accuracy	0.00	0.06
Precision	0.06	0.15
Sample#	2,818	
0.1 ≤ AOD550 ≤ 0.8		
Accuracy	-0.04	0.05
Precision	0.12	0.25
Sample#	2,309	
AOD550 > 0.8		
Accuracy	-0.23	0.20
Precision	0.43	0.45
Sample#	92	

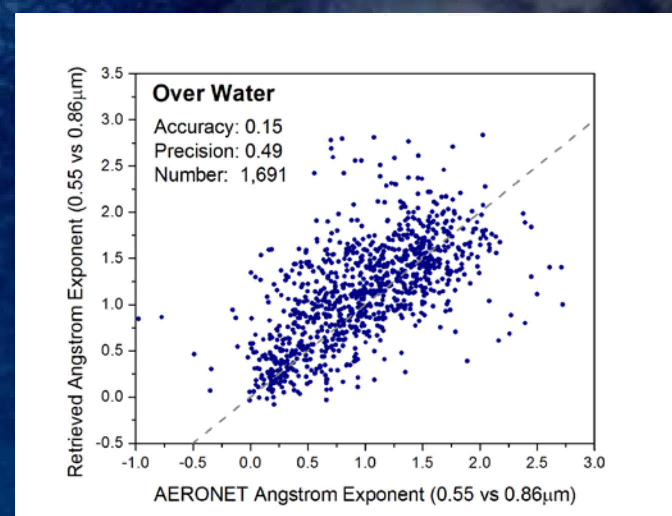


Retrievals meet requirements except at high AOD range where sample size is small

AOD & APS Validation Results (Ocean)

AOD	Retrieval	Specification
AOD550 < 0.3		
Accuracy	0.02	0.08
Precision	0.05	0.15
Sample#	1,954	
AOD550 ≥ 0.3		
Accuracy	0.00	0.15
Precision	0.16	0.35
Sample#	204	
APS (Ångström Exponent)		
Accuracy	0.15	0.30
Precision	0.49	0.60
Sample#	1,691	





Summary of Validation Results for VIIRS Aerosol Optical Depth Product

- NPP/VIIRS aerosol optical depth product has been validated against AERONET ground observations.
- The accuracy and precision of the VIIRS aerosol optical depth meet the accuracy and precision specifications (except at high values over land)

VIIRS Aerosol Detection Algorithm Readiness

Presented by

Shobha Kondragunta

NOAA/NESDIS/STAR

Outline

- Product Overview
- Product Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the VIIRS Aerosol detection product.

VIIRS Aerosol Detection Product Overview

- Products:
  - Smoke /dust flag, volcanic ash flag (from VCM product)
  - Quality flags
- VIIRS smoke/dust detection is derived over the globe for cloud-free and snow/ice free (glint-free over water) areas during daytime.
- Dust detection
  - Uses multiple visible and IR bands
  - Based on threshold test using Absorbing Aerosol Index (AAI) and Dust Smoke Discrimination Index (DSDI)

$$AAI = -100*[\log_{10}(R_{M1}/R_{M2})-\log10(R'_{M1}/R'_{M2})]$$
$$DSDI = -10*[\log_{10}(R_{M1}/R_{M11})]$$

R is the observed TOA reflectance
R' is the Reflectance from Rayleigh scattering

  - Also uses various spectral difference threshold tests
- Smoke Detection
  - Use M1, M2, M5, M7, M10 and M11 bands
  - Based on threshold tests on AAI and DSDI
  - Based on spectral contrast and variability test in visible .

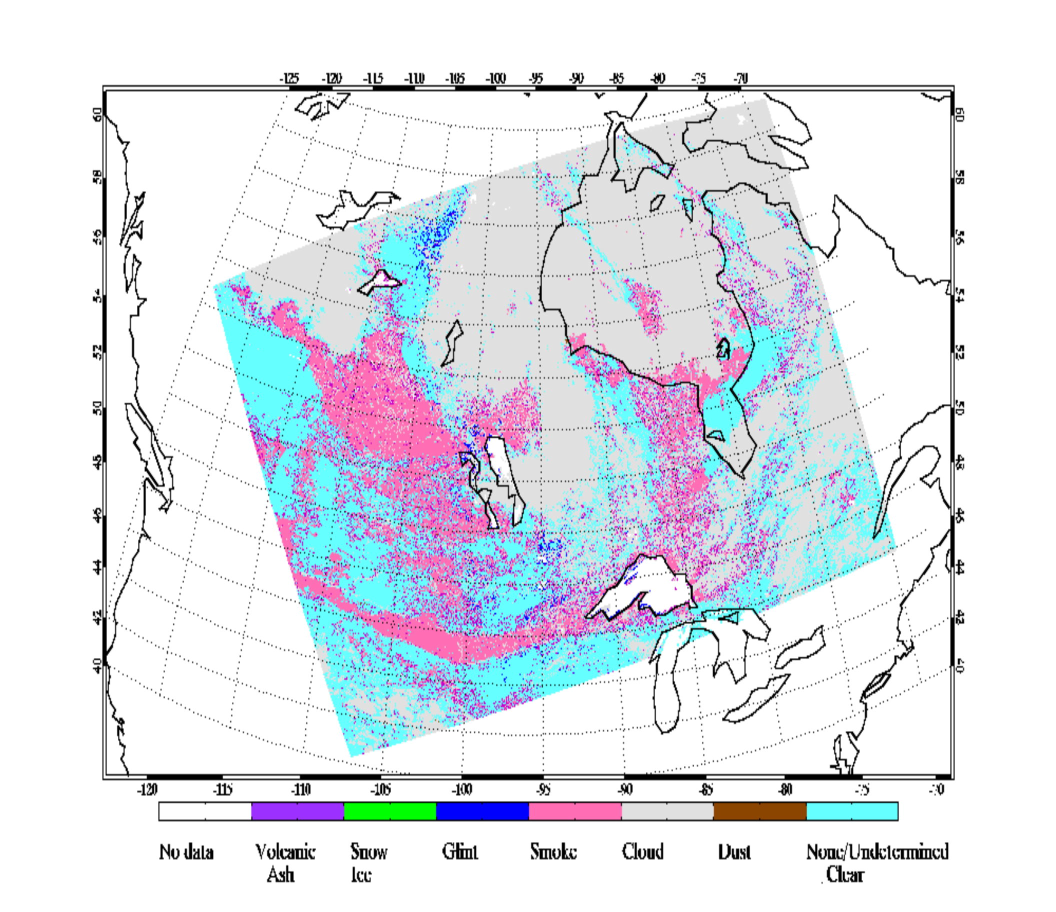
Product Requirements VIIRS Aerosol Detection

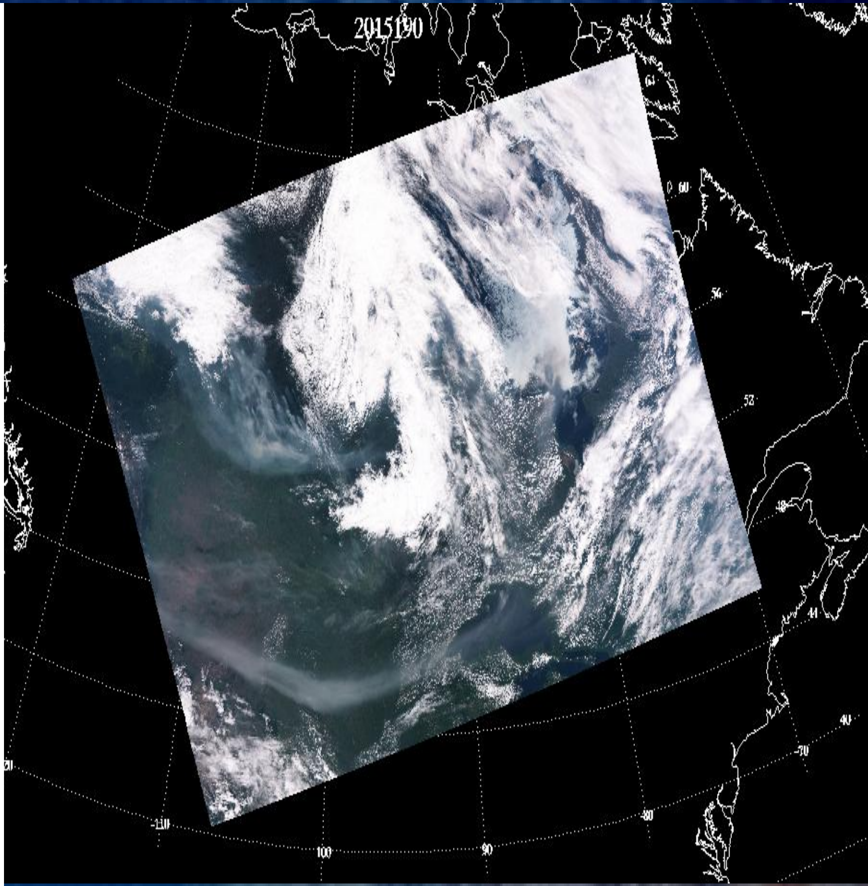
Product Name	Aerosol Detection	
	Dust	smoke
Measurement Accuracy	80% over land 80% over water	70% over land 70% over water
Measurement Range	N/A	
Latency	30 minutes after granule data is available	
Refresh	90 minutes	
Timeliness	≤ 3 hours	
Coverage	Global	
Horizontal Resolution	0.75 km (nadir)	
Vertical coverage	Total column	

Algorithm Output – example

Smoke outbreak over U.S. (07/09/2015)

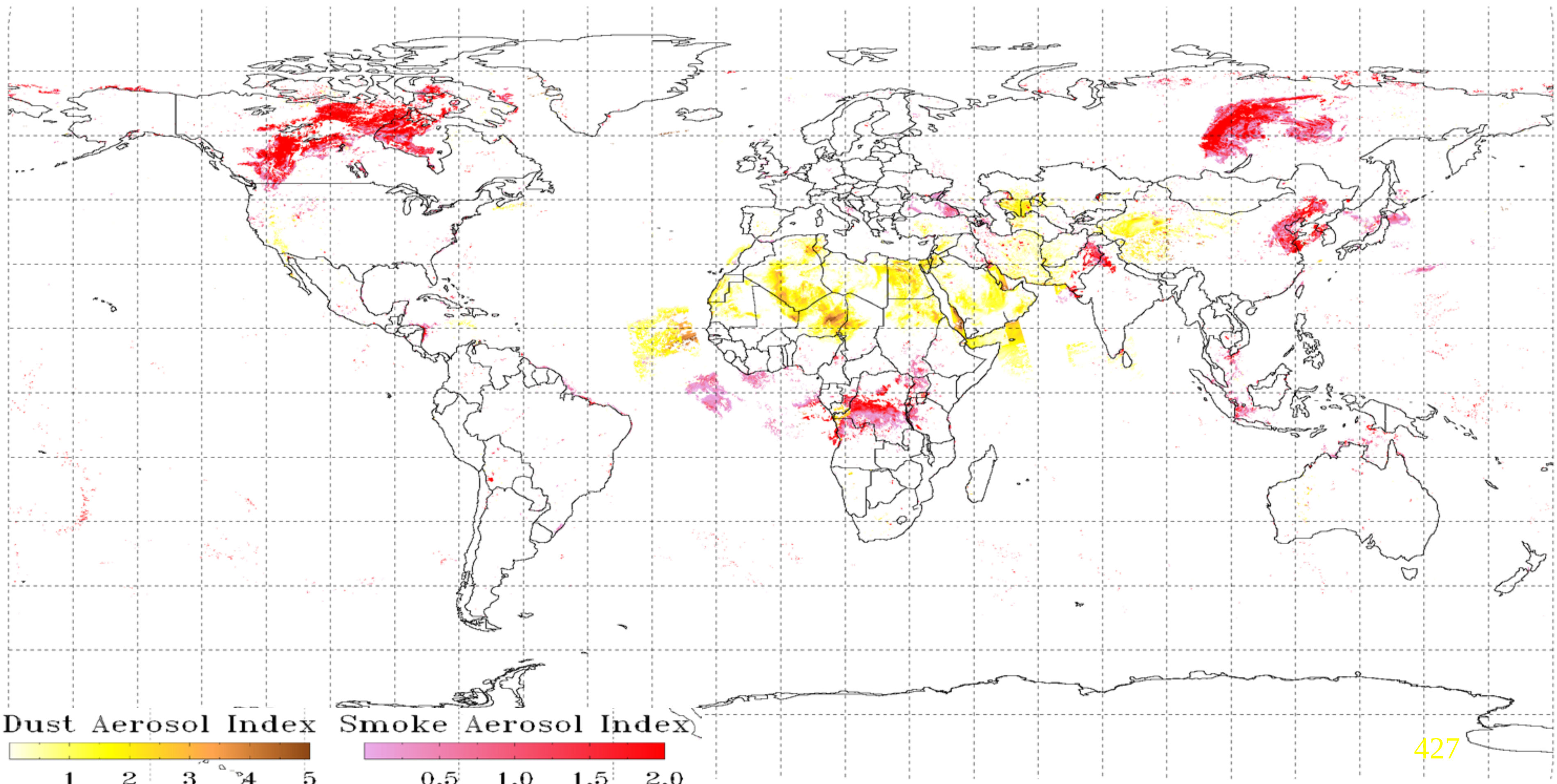
RGB image





Algorithm Output – Smoke/Dust global

Smoke/dust Detection (07/15/2014)



Validation Strategy

- Aerosol Detection algorithm run on VIIRS with global NPP/VIIRS measurements during daytime.
  - » with full product precedence in place
    - – Official NPP cloud mask product is used
    - – Official NPP snow/ice product is used
  - » Time period: 2.5 months
    - – 2014: 04/10-04/25; 07/10-07/25; 10/10-10/25
    - – 2015: 01/01-01/31
- VIIRS smoke and dust detection matchups with CALIPSO VFM and AERONET (Level 1.5)
- Derive performance metrics
  - » Accuracy
  - » Probability of Correct Detection (POCD)
  - » Probability of False Detection (POFD)

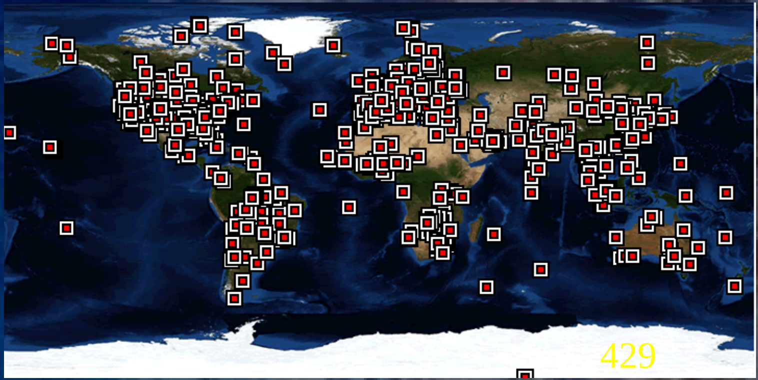
TRUTH DATA

VIIRS	Yes	No
Yes	A	B
No	C	D

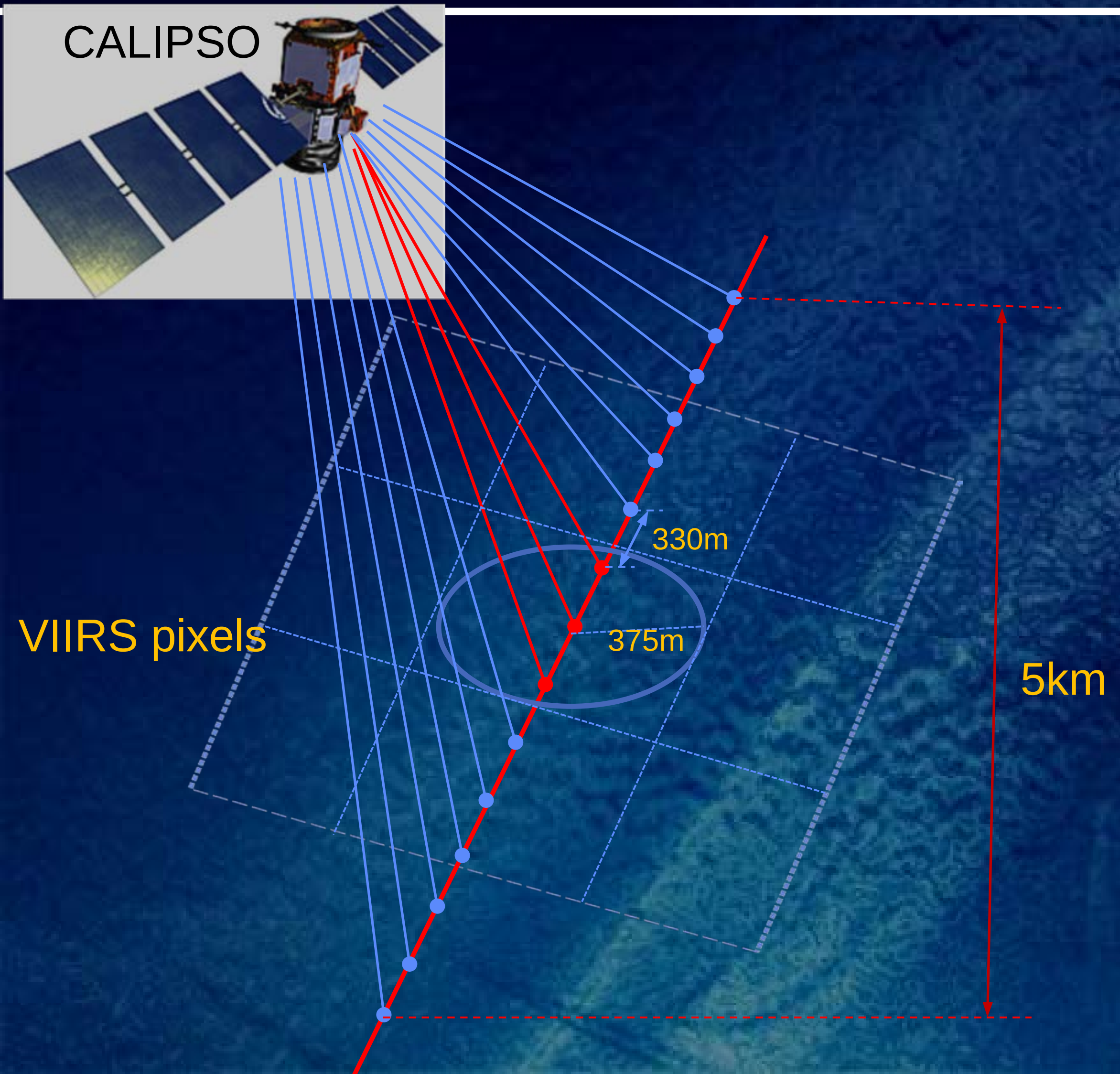
POCD = A/(A+C)
POFD = B/(A+B)
Accuracy* = (A+D)/(A+B+C+D)

Aerosol Detection Test Plan - Offline Validation: Truth Data (1)

- AERONET: ground-based measurements over 100 stations worldwide for more than 10 years; quality assured aerosol optical properties (*Holben et al*., 1998).
- Collocated AERONET and smoke/dust detection results
  - Dominant type from high quality retrievals of a 50 by 50 box centered on AERONET stations.
  - Temporal average: AERONET measurements within half hour window centered on the NPP overpass time, at least three measurements are available.
- Classification of Aerosol Type over AERONET:
  - » Smoke:
    AOD>0.3 and AE>1.1
  - » Dust:
    AOD>0.3 and AE<0.6



Aerosol Detection Test Plan - Offline Validation: Truth Data (2)



1. time difference: ±2 minutes
2. Spatially , VIIRS pixels within ± 375m of the middle CALIPSO profile was matched.
3. CALIPSO VFM dominated aerosol type is determined through the calculation of dust (or smoke) fraction (i.e., no of dust (or smoke) layer divided by the no. of aerosol layer from surface to 12km.
4. CALIPSO VFM are grouped as :
   a. dust (including polluted dust)
   b. smoke
   c. cloudy
   d. clear
   f. others
5. VIIRS SM types are grouped in 5 by 5 box as :
   a. dust
   b. smoke
   c. not produced (cloudy)
   d. clear (or none)
6. Quality Control
   medium to high quality used

VIIRS ADP vs. CALIPSO

Land

Type	True positive	False positive	True negative	False Negative	Accuracy (%)	POCD (%)	POFD (%)
Dust	2202	69	2397	375	91.1	85.3	3.1
Smoke	117	98	4214	1	95.4	99.2	45.5

Water

Type	True positive	False positive	True negative	False negative	Accuracy (%)	POCD (%)	POFD (%)
Dust	297	11	139	10	95.4	96.4	3.3
Smoke	107	85	2309	3	92.7	97.2	44.2

VIIRS ADP vs. AERONET

Type	True positive	False positive	True negative	False negative	Accuracy	POCD	POFD
Dust	124	22	2140	30	97.7	80.5	15.1
Smoke	19	5	1101	11	98.6	63.3	20.8

Summary of Validation Results for Aerosol Detection Product

- VIIRS Aerosol detection product has been validated against both AERONET observations and CALIPSO VFM product for the time period of 2.5 month run.

- VIIRS Aerosol Detection product meet the accuracy specifications with a relative higher POFD for smoke.

VIIRS Volcanic Ash Algorithm Readiness

Presented by

Michael Pavolonis

NOAA/NESDIS/STAR

Outline

- Product Overview and Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the VIIRS volcanic ash products.

VIIRS Volcanic Ash Overview & Requirements

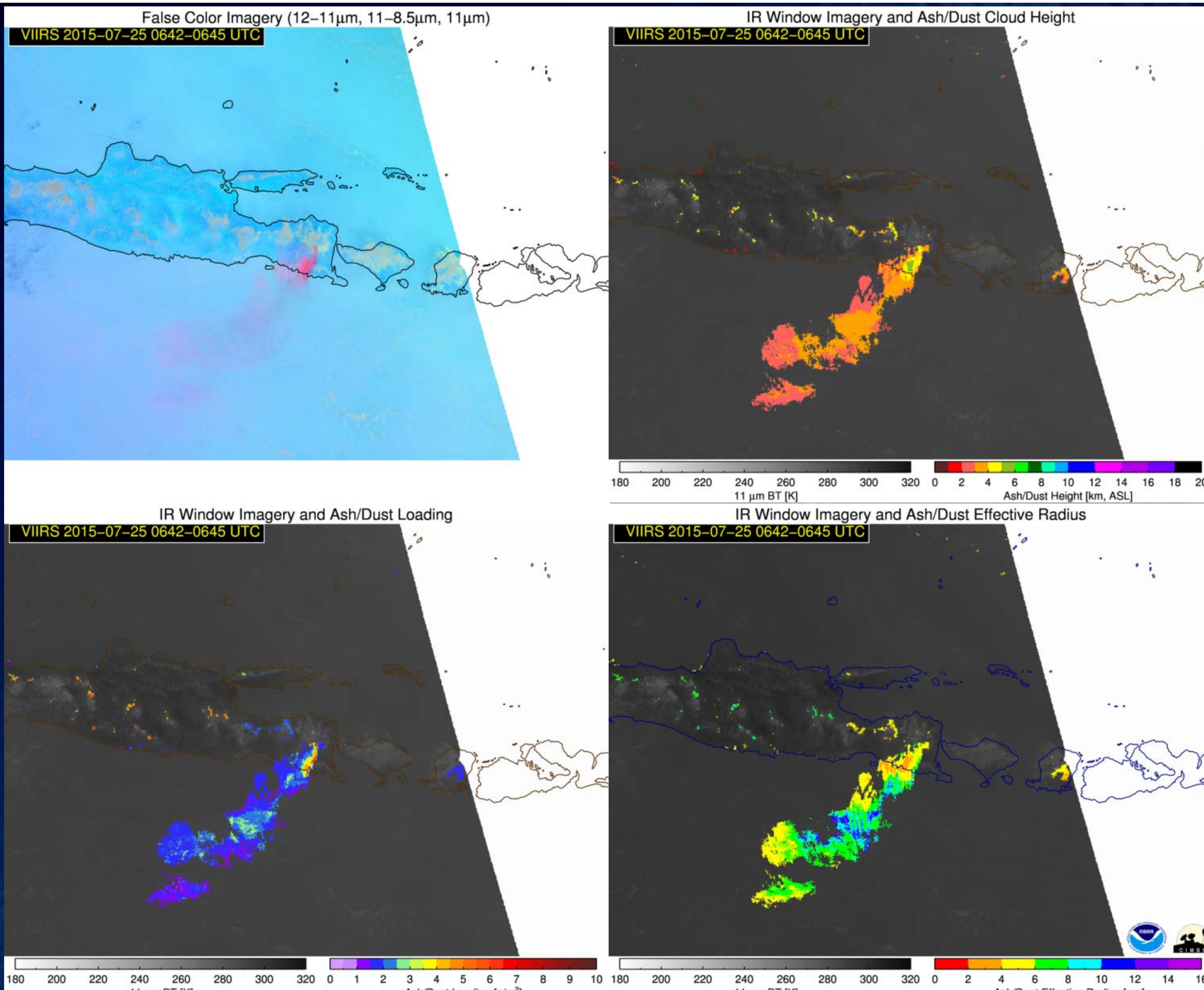
- VIIRS Volcanic Ash algorithm consists of two parts—ash detection and an ash cloud property retrieval. The ash detection algorithm uses VIIRS bands M14, M15, and M16 (8.5, 11, and 12 µm) and the ash retrieval algorithm uses VIIRS bands M15 and M16 (11 and 12 µm)
  - » The VIIRS Volcanic ash detection algorithm classifies pixels as: high confidence ash, moderate confidence ash, low confidence ash, very low confidence ash, and no ash.
  - » The VIIRS volcanic ash retrievals are performed for all pixels with ash detection confidence of "very low" and higher confidence. The bulk of volcanic ash pixels fall into the high and moderate confidence categories, but the low and very low categories are retained as needed for more complete detection of ash clouds (some ash clouds pixels will be spectrally ambiguous).
  - » The required output products are ash cloud top height (km) and ash mass loading (ton/km^2). The ash detection results and ash effective radius (µm) are available within data quality flags. Additional data quality flags and metadata are also generated.

VIIRS Volcanic Ash Overview & Requirements

Name	Sensor	Coverage	Vertical Res.	Horiz. Res.	Measuremnt Range	Measuremnt Accuracy	Measuremnt Precision	Refresh Rate	Data Latency
Volcanic Ash Detection and Height	VIIRS	Global	3 km (top height)	750 m	0-50 tom/km^2	2 tons/km^2	2.5 tons/km^2	90 min	30 min

Name	Sensor	Coverage	Temporal Coverage	Cloud Cover Cond. Qualifiers	Product Statistics Qualifiers
Volcanic Ash Detection and Height	VIIRS	Global	Day and night	Clear conditions down to feature of interest associated with threshold accuracy	Over volcanic ash scenes

Algorithm Output

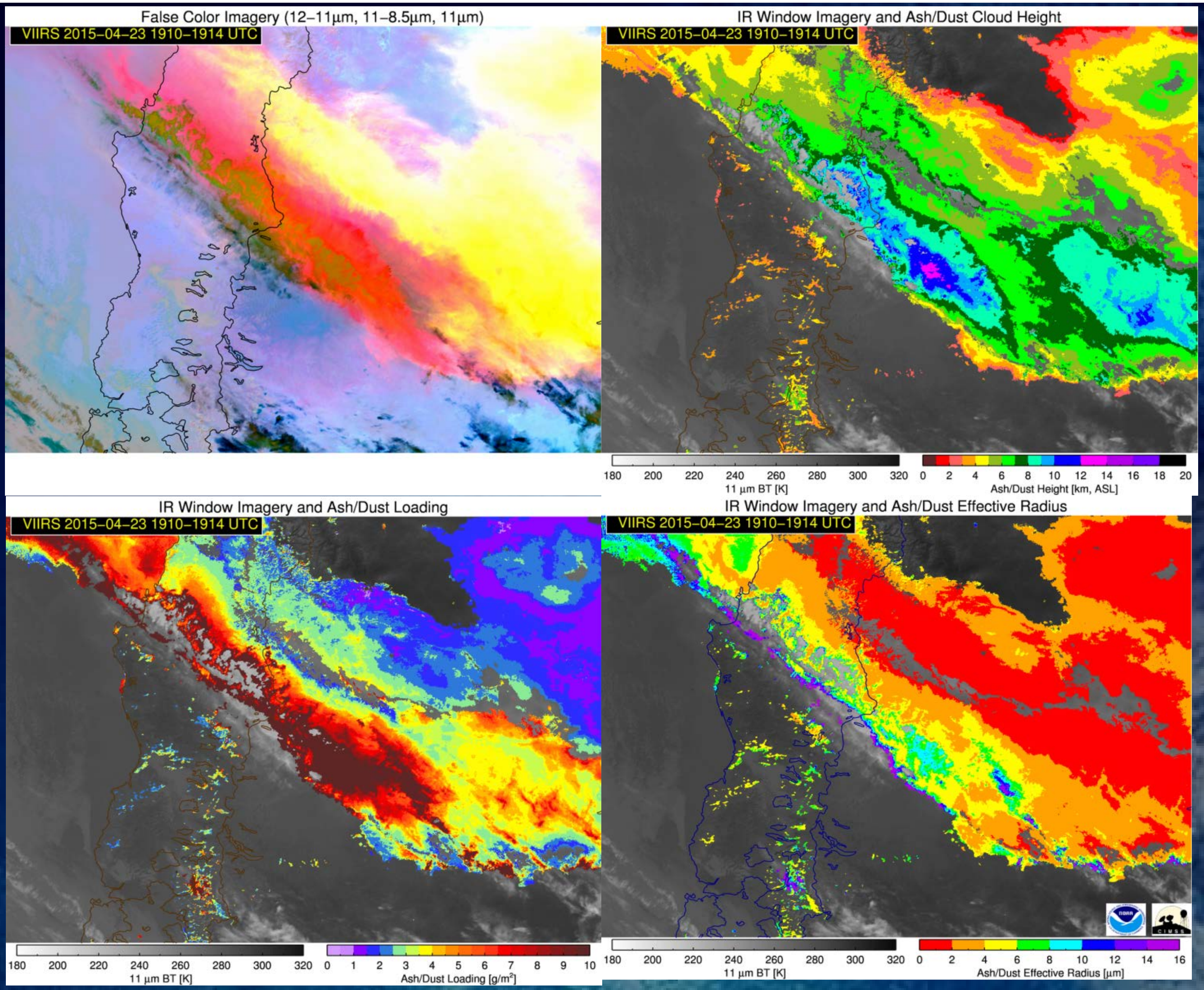


Raung Volcano (Indonesia)

~0643 UTC
25 July 2015

Pink colors in RGB image indicate areas of volcanic ash

Algorithm Output



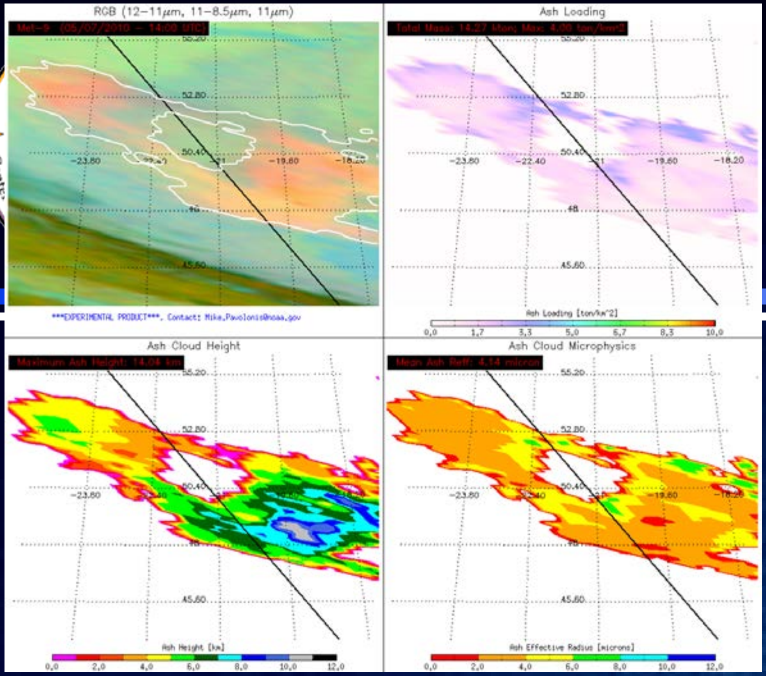
Calbuco Volcano (Chile)

~1910 UTC
23 April 2015

Pink colors in RGB image indicate areas of volcanic ash; yellow colors indicate areas of volcanic ash and sulfur dioxide

Validation Strategy

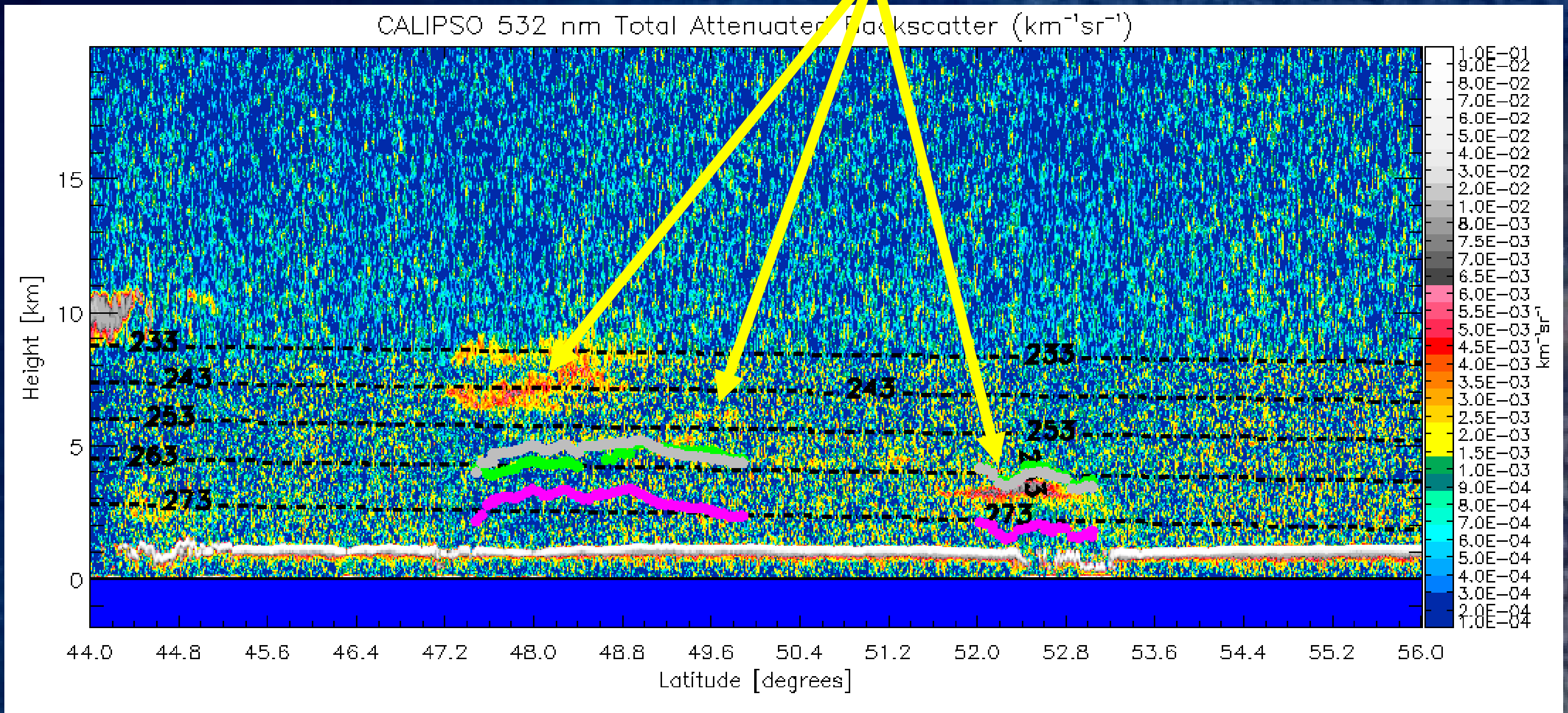
- CALIOP (space-borne lidar) provides accurate information of the vertical structure of clouds (60 m vertical resolution)
  - CALIOP ash cloud boundaries can be also used to compute mass loading (using the same microphysical assumptions as the VIIRS ash retrieval)
- Since volcanic ash is rare (relative to many other cloud types), there is a limited number of CALIOP observations of volcanic ash
  - » This is especially true for VIIRS/CALIOP matchups since VIIRS and CALIOP seldom overlap
- Thus, CALIOP co-locations with MODIS are leveraged (the VIIRS algorithm is simply applied to MODIS)
- In addition, dust clouds exhibit very similar spectral signatures as volcanic ash and are far more common. Dust pixels have been leveraged to increase the sample size of validation dataset



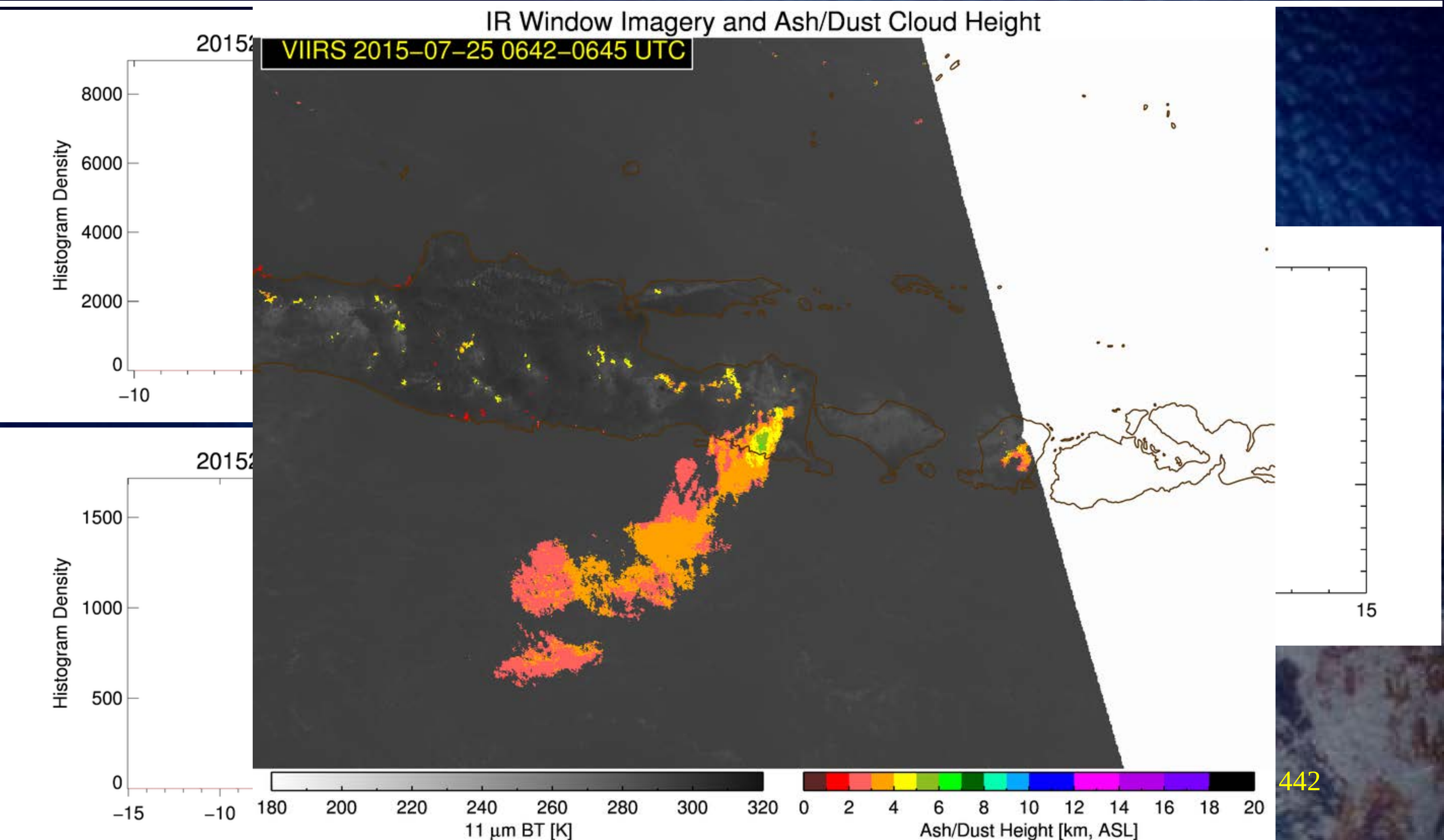
May 7, 2010 (14:00 UTC)

- Single channel IR window
- 11/13.3 μm retrieval
- 11/12 μm retrieval

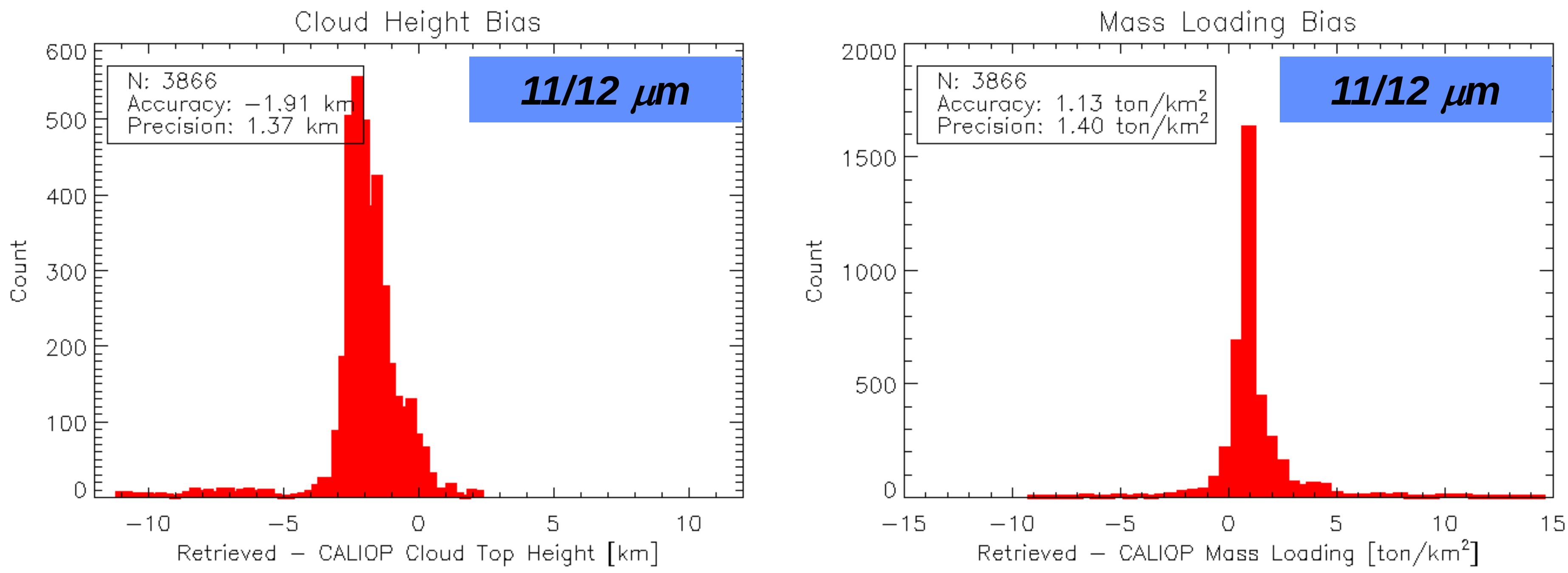
Ash clouds



Validation Strategy Using MODIS with VIIRS Channels



Validation Strategy Using MODIS with VIIRS Channels



The VIIRS algorithm applied to MODIS is *well within specifications* for both ash cloud height and ash mass loading.

Validation Strategy
Null Case Validation

- We can confidently identify VIIRS scenes absent of volcanic ash, known as the null case.
  - » The truth mass loading in these scenes is 0.00 tons/km^2. The results below indicate the VIIRS volcanic ash algorithm is well within specifications for the null cases analyzed (using moderate and high confidence ash pixels).

Day	Time Range	Accuracy (tons/km^2)	Precision (tons/km^2)	Total Pixels
2015265	04:56 – 05:11 UTC	0.009	0.179	2.458×10^7
2015265	07:16 – 07:30 UTC	0.045	0.381	2.458×10^7
2015053	04:34 – 04:47 UTC	0.006	0.144	2.212×10^7
2015053	0830 – 08:46 UTC	0.081	0.731	2.458×10^7
Mean/Total	**-**	**0.036**	**0.364**	**9.586×10^7**

Summary of Validation Results for VIIRS Volcanic Ash Algorithm

- The VIIRS volcanic ash algorithm produces consistent results when applied to VIIRS and MODIS
- VIIRS/CALIOP co-locations with volcanic ash present are exceptionally rare
- The VIIRS algorithm applied to MODIS is well within specifications when compared to CALIOP
- We will validate any future matchups of VIIRS and CALIOP observations of volcanic ash, but these opportunities will be quite limited
- The VIIRS ash cloud heights are biased by about 1.91 km and the mass loading is biased high by 1.13 ton/km^2. This is an expected result.

VIIRS Ice Product Algorithm Readiness:

1. Ice Concentration and Cover
2. Ice Surface Temperature
3. Ice Thickness and Age

Outline

- Product Overview and Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the VIIRS sea ice products.

VIIRS Ice Concentration Algorithm Readiness

Presented by

Yinghui Liu[1] or Jeff Key[2]

[1]Cooperative Institute for Meteorological Satellite Studies (CIMSS)
[2]NOAA/NESDIS/STAR

VIIRS Ice Concentration Overview

- The JPSS VIIRS Ice Concentration and Ice Mask Product will be produced for each VIIRS image and will provide ice mask, and ice concentration over all water surfaces of the globe.
- Procedures of ice concentration and cover algorithm

1. Use threshold tests to detect possible ice cover: Daytime and Nighttime
2. Use a tie-point algorithm to derive reflectance (temperature) for pure ice pixel, and then calculate ice concentration
   - Reflectance (temperature) of pure ice and pure water are tied to points in a frequency histogram, and the ice fraction in a pixel (ice concentration) is determined by linearly interpolating between these tie points
3. Ice pixels with retrieved ice concentration larger than 15% are identified as ice. Ice pixels with retrieved ice concentration smaller than 15% are not identified as ice.

VIIRS Ice Concentration Requirements

Ice concentration:

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Res.	Horiz. Res.	Mapping Accuracy	Msmnt. Range	Msmnt. Accuracy	Product Refresh Rate/Coverage Time	Vendor Allocated Ground Latency	Product Measurement Precision	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Ice Concentration	JPSS VIIRS	All ice-covered regions of the global ocean	Ice Surface	1 km	1 km	Ice concentration – 0/10 to 10/10	Ice concentration – 10%	At least 90% coverage of the globe every 24 hours	3236 sec	30%	All conditions	Quantitative under all conditions	Clear conditions associated with threshold accuracy	Over specified geographic area

Ice cover:

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Res.	Horiz. Res.	Mapping Accuracy	Msmnt. Range	Msmnt. Accuracy	Product Refresh Rate/Coverage Time	Vendor Allocated Ground Latency	Product Measurement Precision	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Ice: Cover (mask)	JPSS VIIRS	FD	N/A	1 km	1 km	From the 100% ice concentration at the land edge to the less then 15% ice concentration that is the ice extent	1 km	180 min	90% coverage of the globe every 24 hours	80% probability of correct typing	All condition	All condition	Clear conditions associated with threshold accuracy	Over specified geographic area

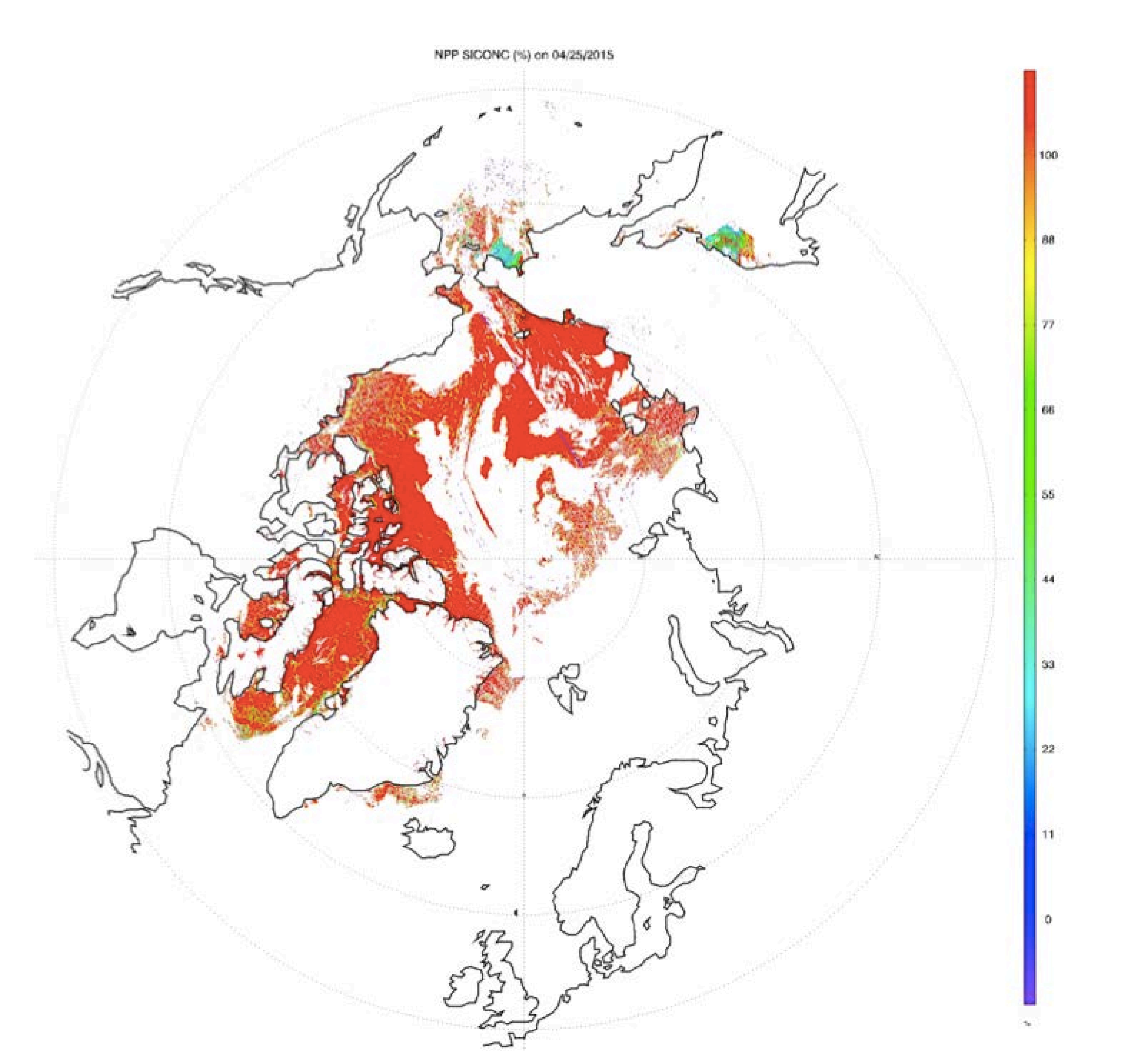
Algorithm Output

- Output :
  - Ice concentration and cover can be presented in a variety of methods
  - Ice surface skin temperature derived by this algorithm

Name	Type	Description	Dimension
Ice cover	output	Output contains ice extent map for each pixel with water surface type	Scan grid (xsize, ysize)
Ice concentration	output	Output contains ice concentration for each pixel identified as ice	Scan grid (xsize, ysize)
QC flags for Ice Concentration/cover	output	Quality Control Flags for every pixel	Scan grid (xsize, ysize)
Ice surface skin temperature	output	Output contains ice surface skin temperature for each pixel identified as ice	Scan grid (xsize, ysize)
QC flags for ice surface skin temperature	output	Quality Control Flags for every pixel	Scan grid (xsize, ysize)

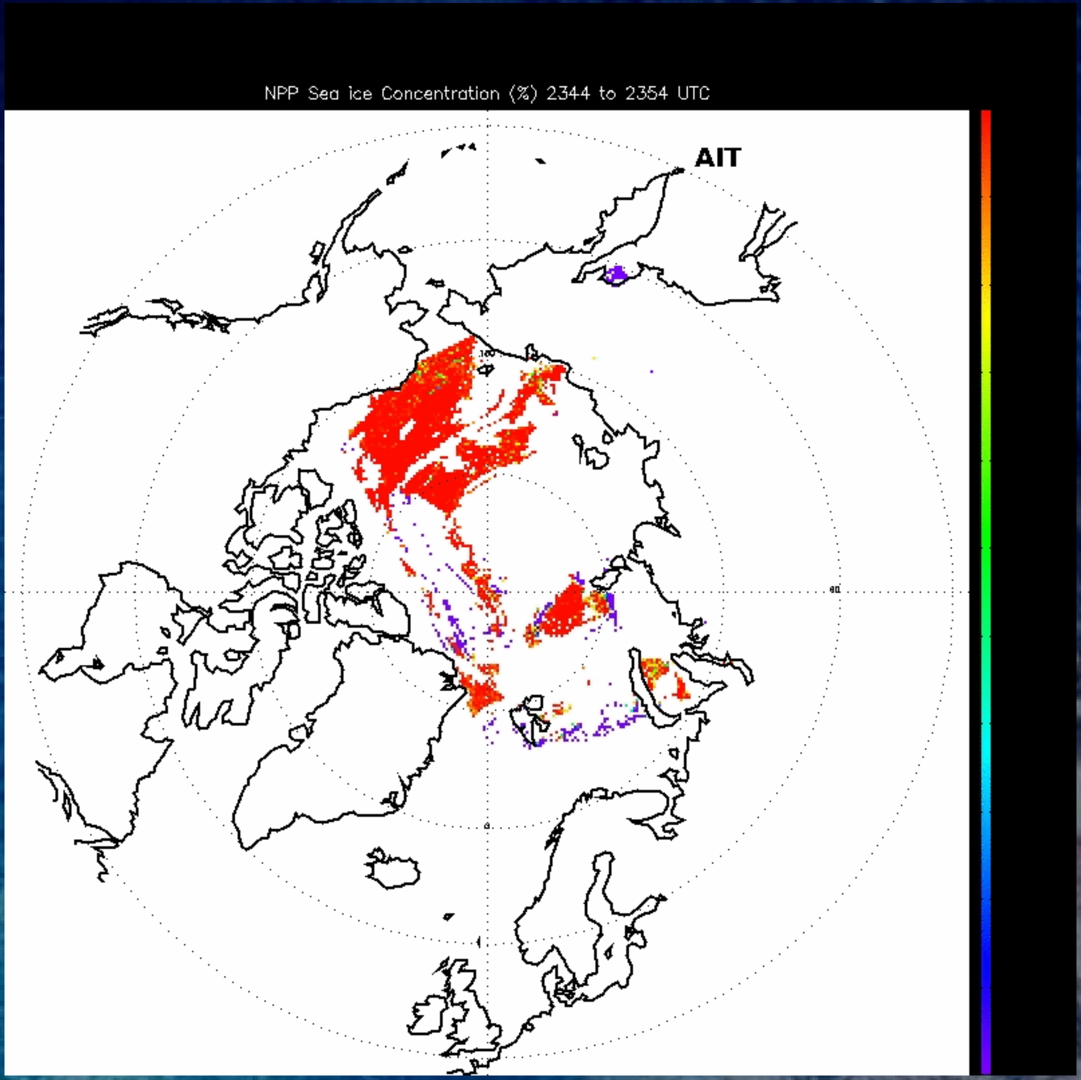
Algorithm Output

Example of VIIRS ice concentration over the Arctic on 25 April 2015.



Algorithm Output: CIMSS vs. AIT

Ice concentration from CIMSS and from the Framework. (animation)

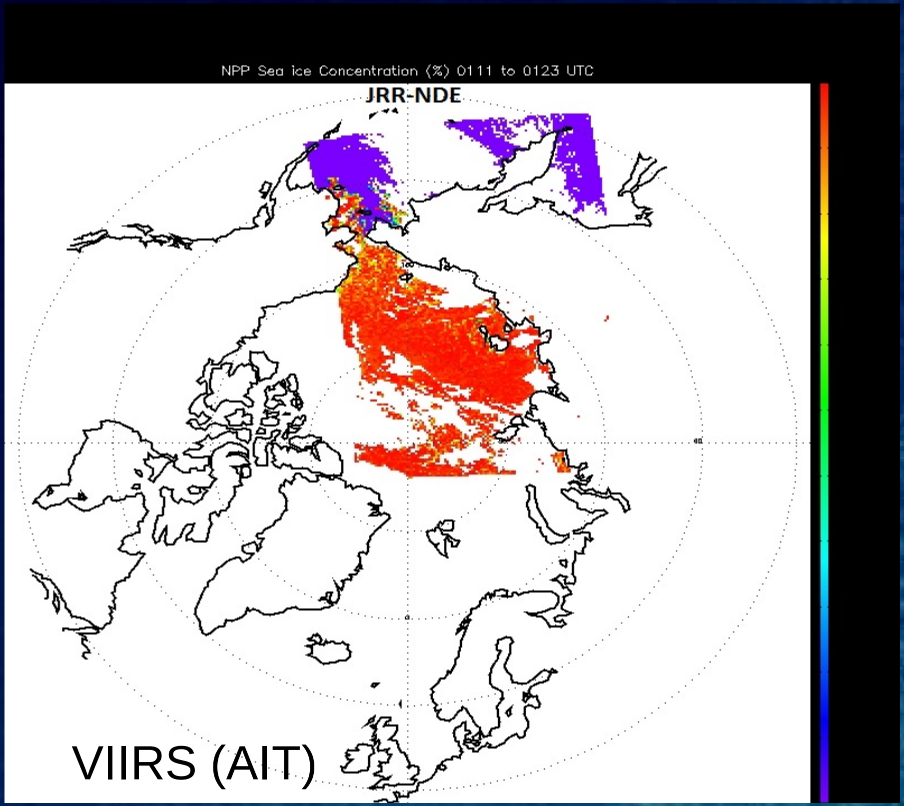


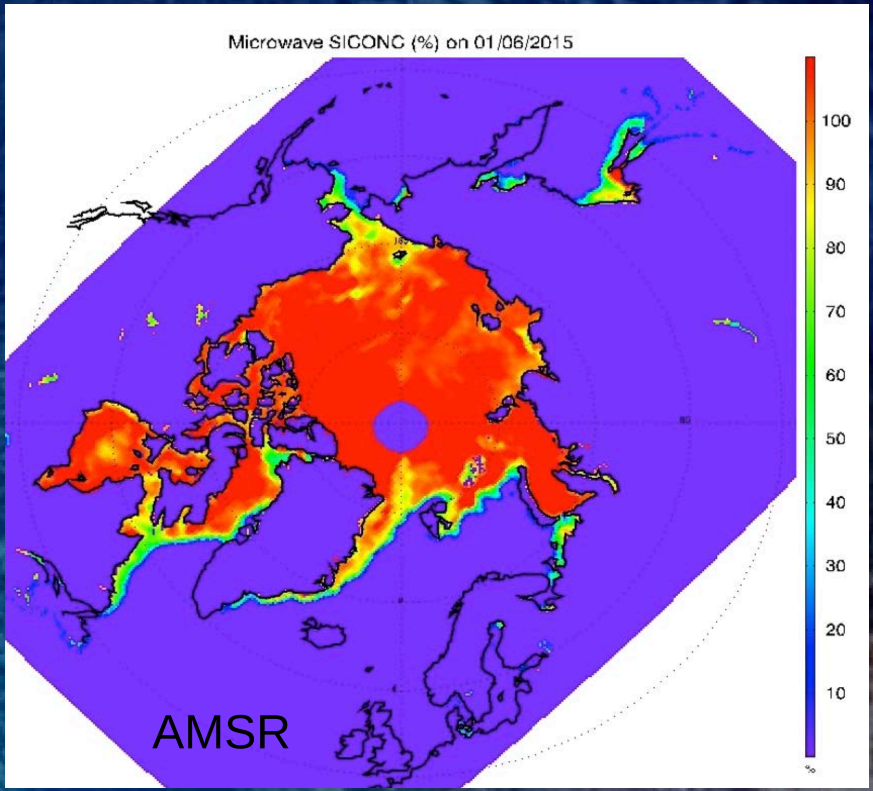
Validation Strategy

- **Truth Measurements and other products**
  - » **Truth**
    - – AMSR-E/Aqua Daily L3 12.5 km Sea Ice Concentration (pixel averaging of ABI ice fraction is needed because AMSR-E is lower resolution)
    - – Ice chart from National Ice Center and Canadian Ice Service with 0.25 degree resolution (pixel averaging of ABI ice fraction is needed because AMSR-E is lower resolution)
  - » Verification (qualitative)
    - – MODIS true color imagery

Validation Results: Arctic Winter Case Study

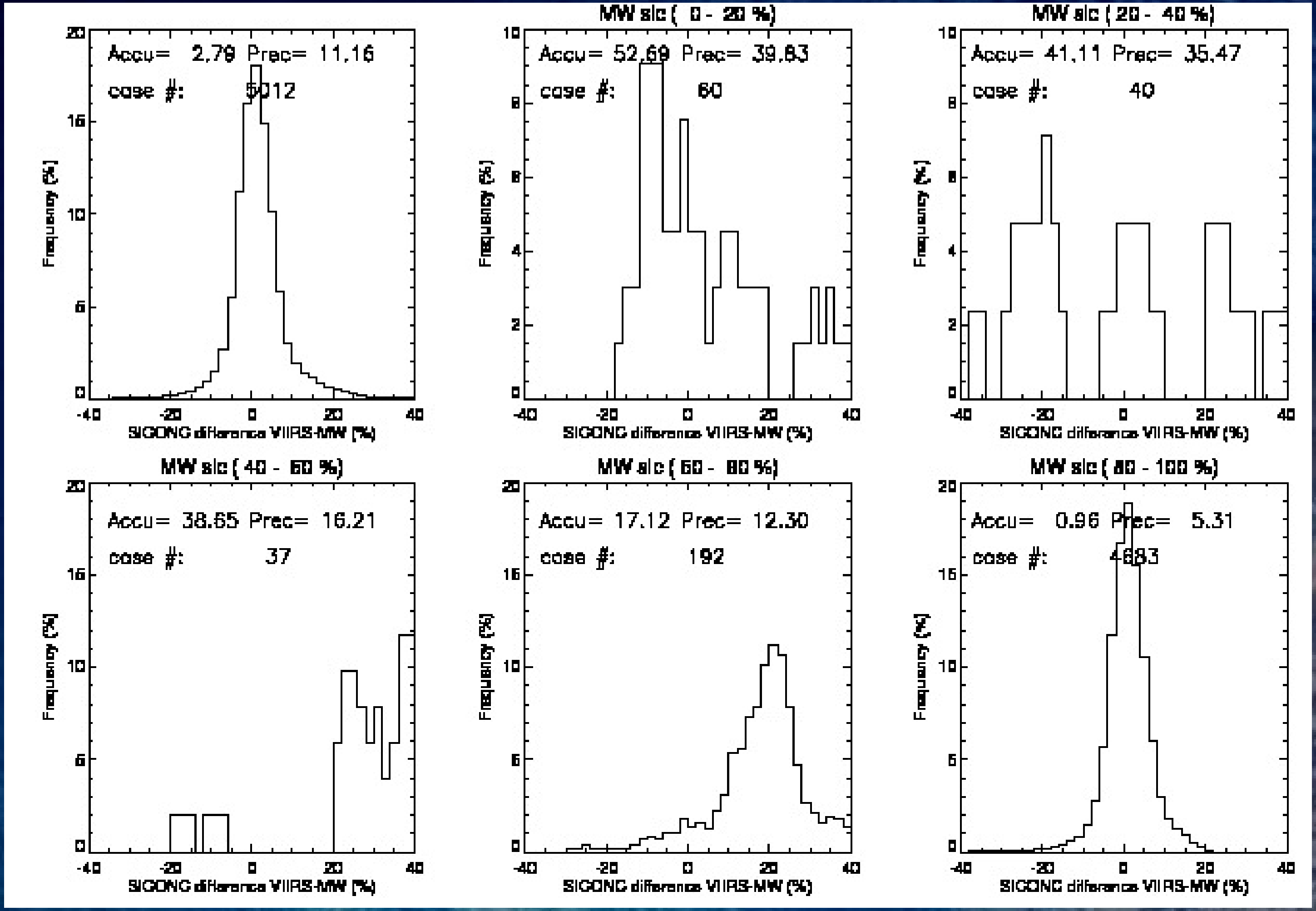
01/06/2015 - Arctic





Validation Results: Arctic Winter Case Study

01/06/2015 - Arctic



Validation Results: Arctic Winter Case Study

Statistical results of the comparison in sea ice concentration between VIIRS (AIT) and AMSR.

	Arctic			Antarctic		
	Accu	Prec	Cases	Accu	Prec	Cases
04/14	0.51	14.45	7749	9.63	16.35	14774
07/14	7.52	40.79	258	5.94	10.79	12090
10/14	8.80	19.60	12580	12.17	15.69	4302
01/15	1.46	9.00	42581	18.51	32.95	700

Summary of Validation Results for VIIRS Ice Concentration

- CIMSS and the AIT Framework are nearly identical, with differences attributed to the different use of the cloud shadow flag.
- The NPP/VIIRS Ice Concentration product (AIT) has been validated against lower-resolution passive microwave ice concentration.
- The VIIRS ice concentration (AIT) product meets the accuracy and precision specifications.

VIIRS Ice Surface Temperature Algorithm Readiness

Presented by

Yinghui Liu[1], Rich Dworak[1], or Jeff Key[2]

[1]Cooperative Institute for Meteorological Satellite Studies (CIMSS)
[2]NOAA/NESDIS/STAR

VIIRS Ice Surface Temperature Overview

- The JPSS VIIRS Ice Surface Temperature Product will be produced for each VIIRS image and will provide values over all water surfaces of the globe.
- Procedures of ice surface temperature algorithm
  1. Select pixels for IST retrieval: clear sky, ice pixels only. Daytime and nighttime.
  2. Use a regression algorithm similar to the conventional split-window (infrared) sea surface temperature algorithms. IST is a simple calculation based on two channels with regression coefficients that are a function of temperature.

VIIRS Ice Surface Temperature Requirements

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Res.	Horiz. Res.	Mapping Accuracy	Msmnt. Range	Msmnt. Accuracy	Product Refresh Rate/Coverage Time	Vendor Allocated Ground Latency	Product Measurement Precision	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Ice Surface Temperature	JPSS VIIRS	All ice-covered regions of the global ocean	Ice Surface	1.6 km	1.6 km	213 – 275 K	1 K	At least 90% coverage of the globe every 24 hours	3236 sec	1 K	All conditions	Quantitative under all conditions	Clear conditions associated with threshold accuracy	Over specified geographic area

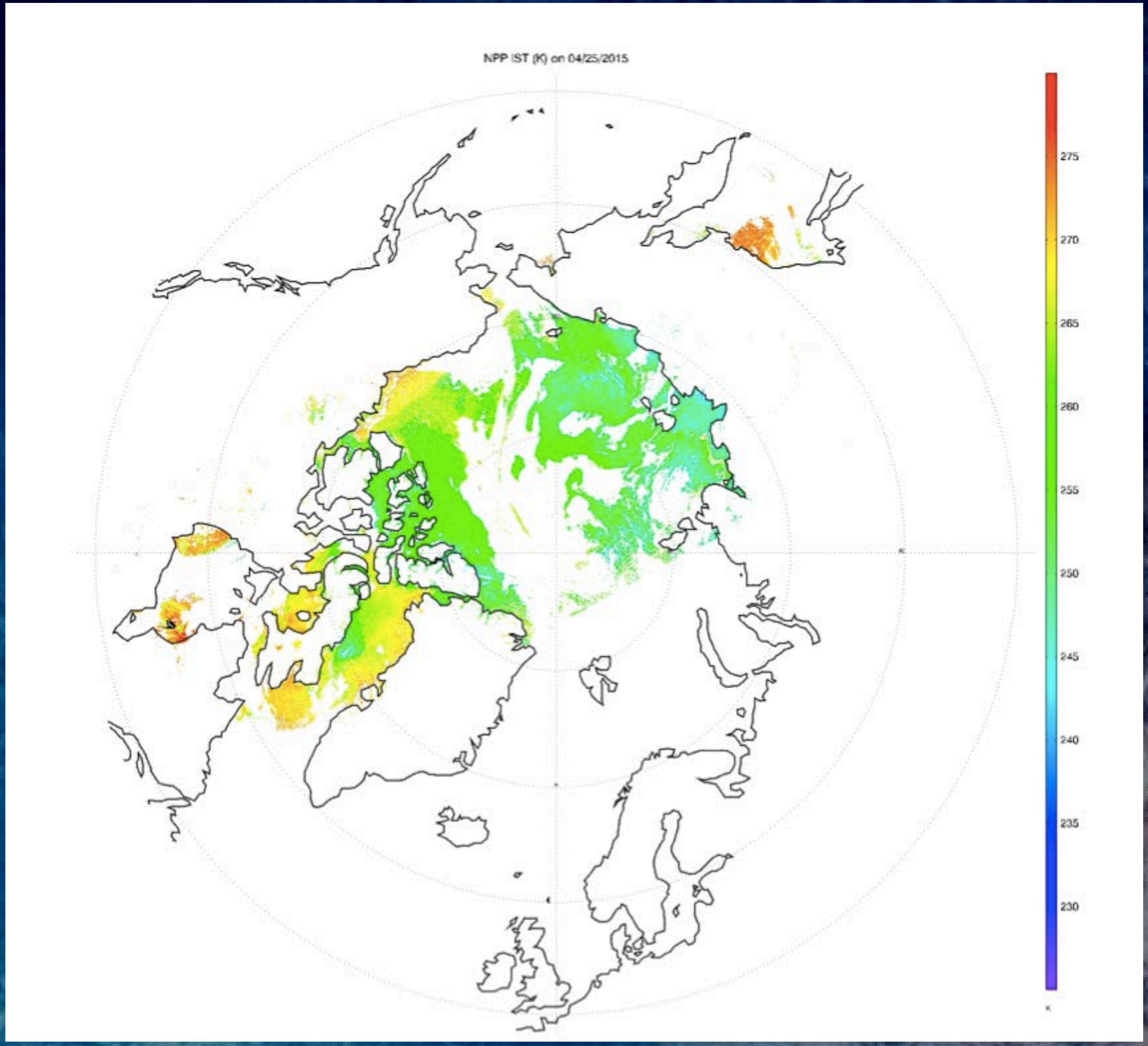
Algorithm Output

- Output Data:
  - Ice surface skin temperature derived by this algorithm

Name	Type	Description	Dimension
Ice surface skin temperature	output	Output contains ice surface skin temperature for each pixel identified as ice	Scan grid (xsize, ysize)
QC flags for ice surface skin temperature	output	Quality Control Flags for every pixel	Scan grid (xsize, ysize)

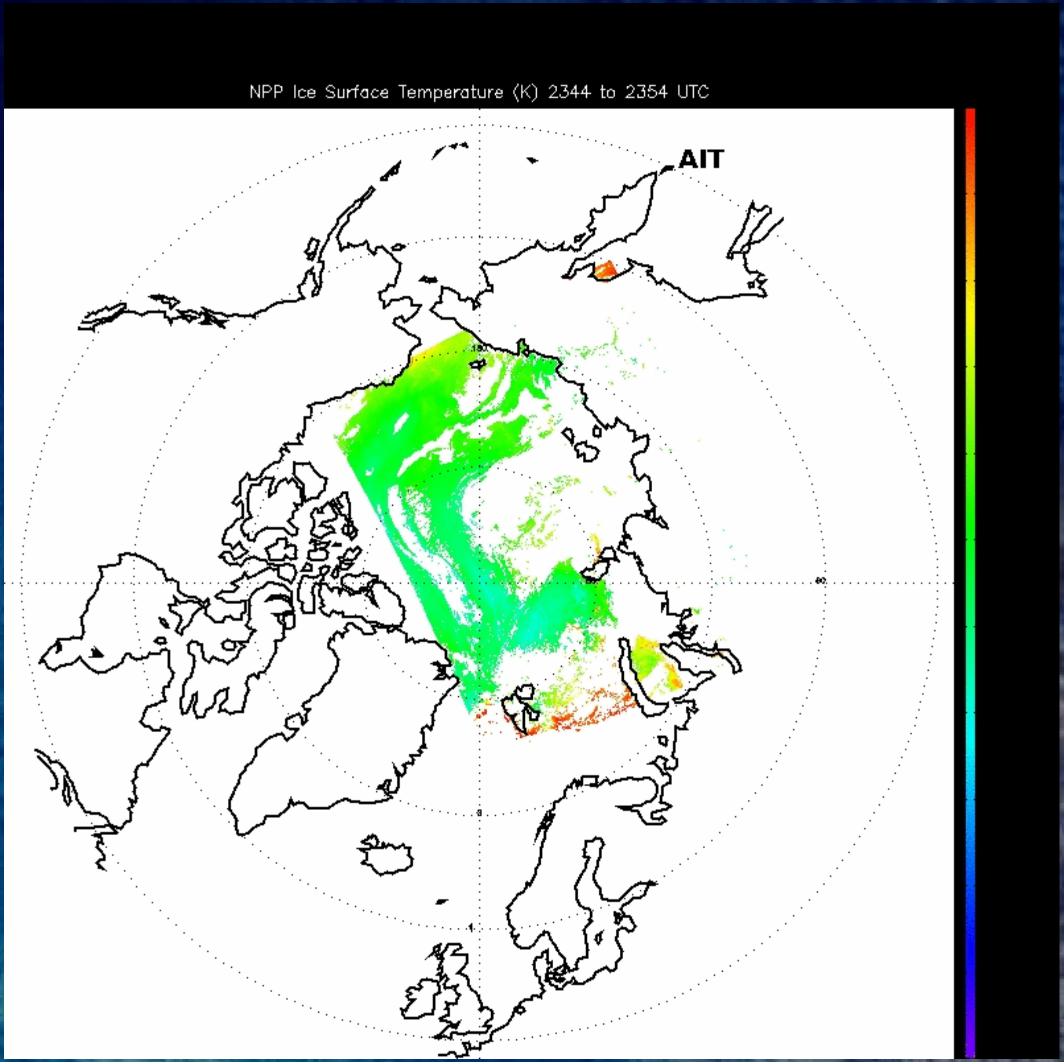
Algorithm Output

Example of VIIRS ice surface temperature over the Arctic on 25 April 2015.



Algorithm Output: CIMSS vs. AIT

IST from CIMSS and from the Framework. (animation)

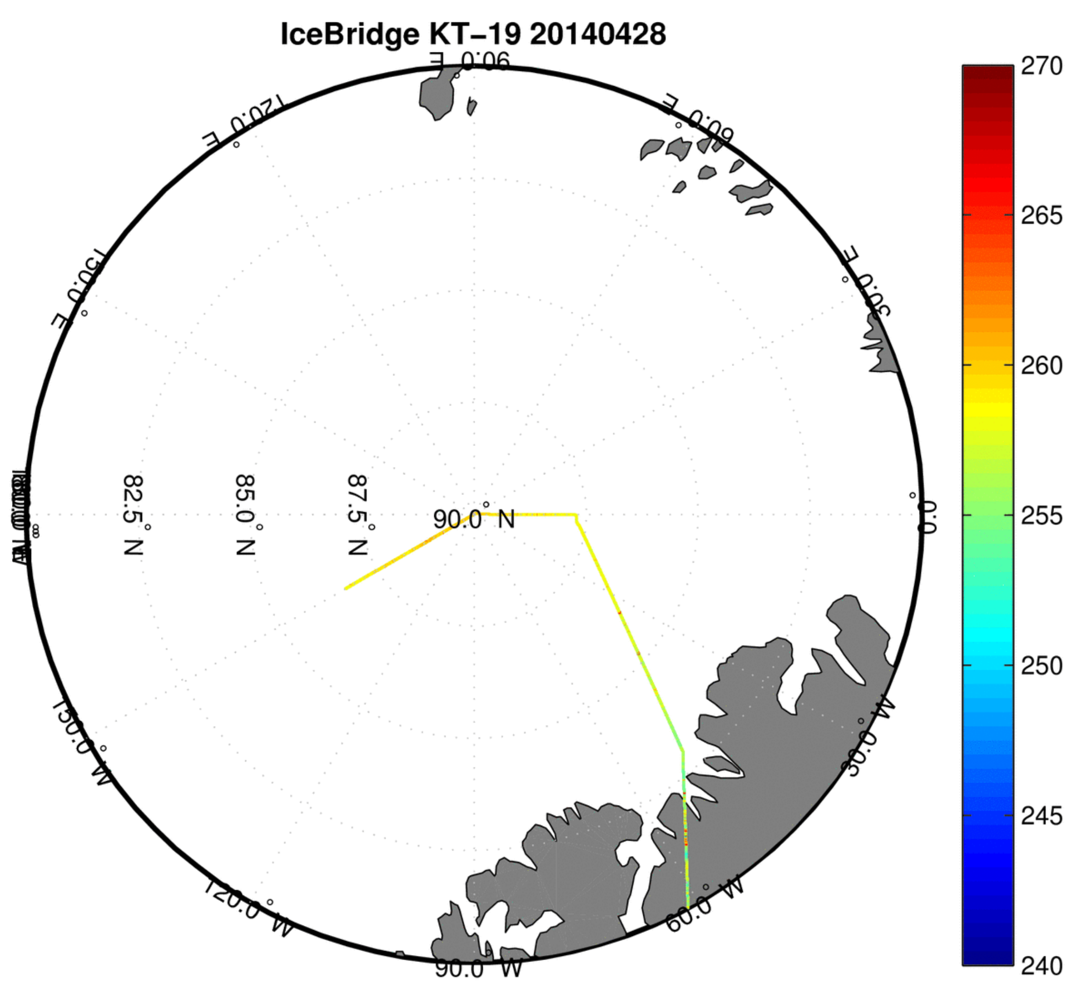


Validation Strategy

- **Truth Measurements and other products**
  - » In situ observations of ice surface temperature from field campaign, Ice Bridge KT-19 Sensor @ 15 m resolution averaged into 750 m collocated VIIRS pixel
  - » Co-located ice surface temperature retrievals from MODIS

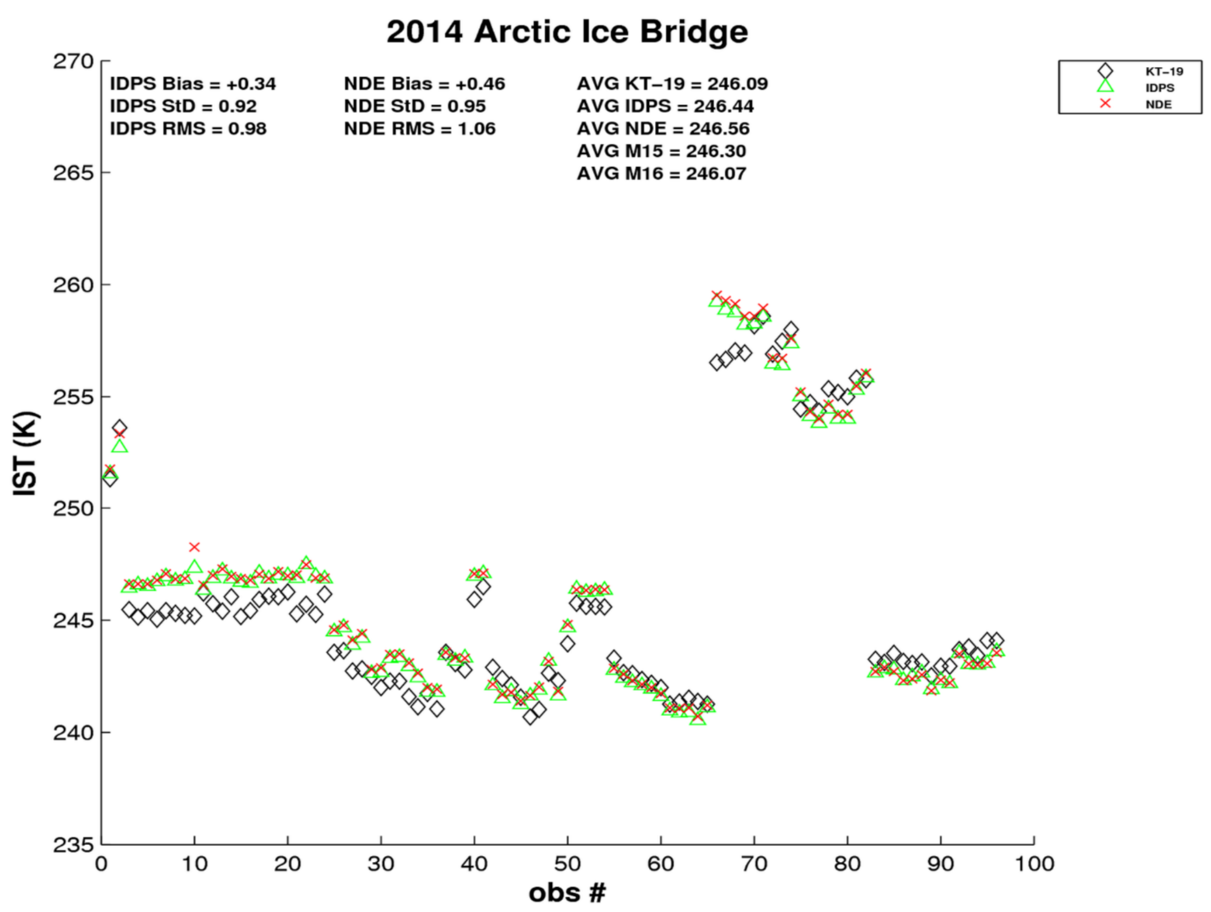
Validation Results

Sea Ice Surface Temperature versus IceBridge KT-19 (animation)



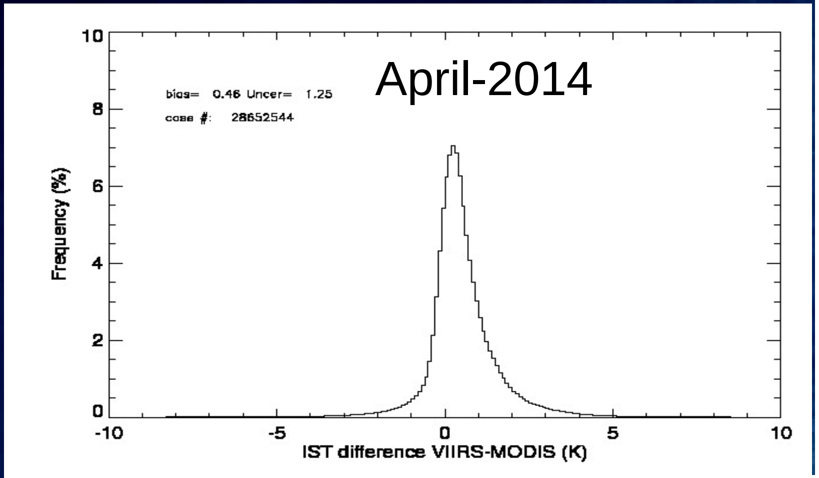
Validation Results

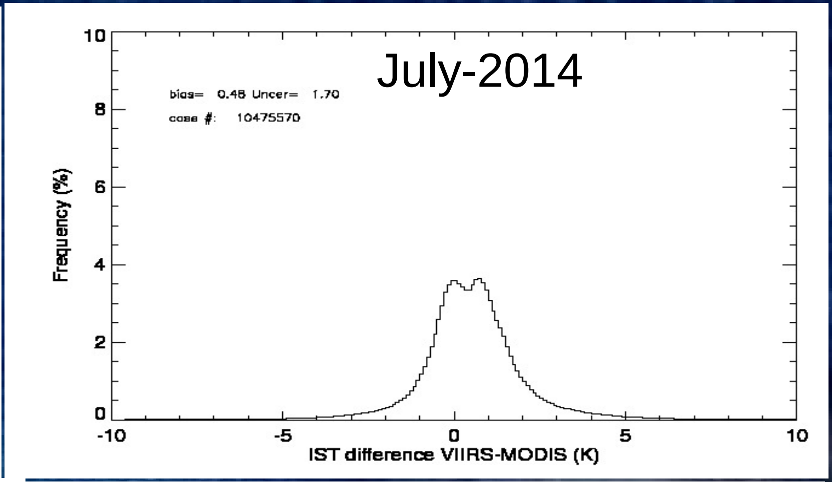
Ice Surface Temperature versus IceBridge KT-19

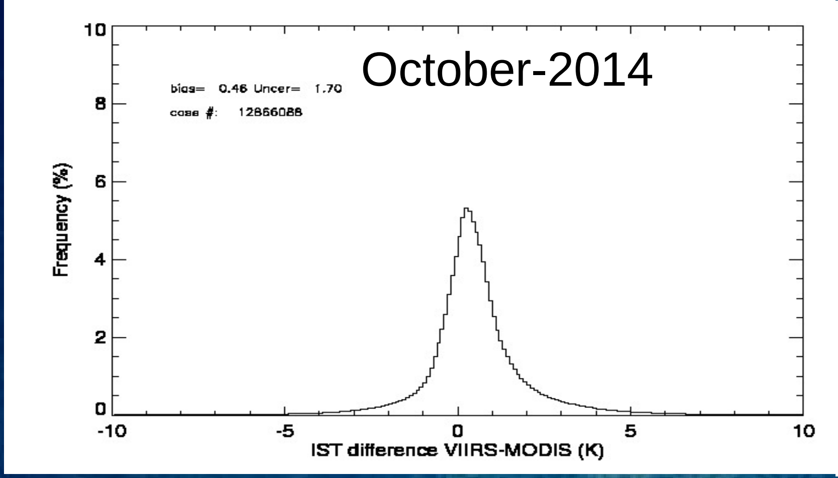


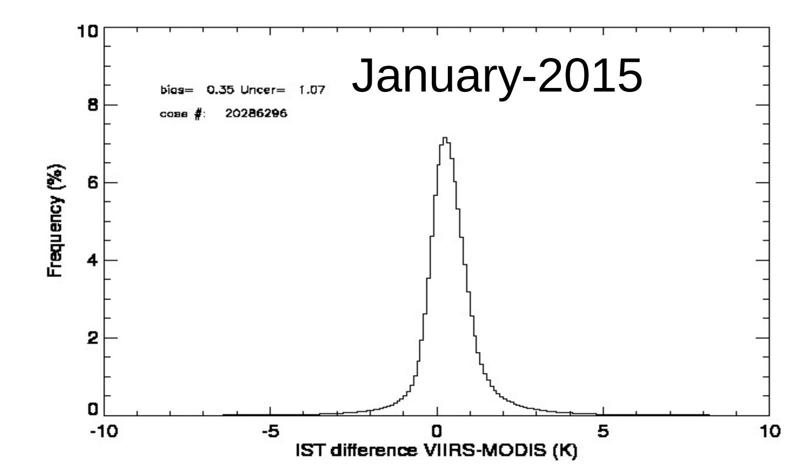
Validation Results

Ice Surface Temperature versus MODIS, Arctic + Antarctic









Validation Results

Statistical results of the comparison in sea ice concentration between VIIRS (AIT) and MODIS.

	Arctic			Antarctic		
	Bias	Uncer	Cases	Bias	Uncer	Cases
04/14	0.38	0.95	18679744	0.80	1.68	9972799
07/14	1.18	1.72	2914658	0.20	1.69	7560912
10/14	0.70	1.68	7847217	0.10	1.78	5018871
01/15	0.31	1.01	18403556	0.74	1.57	1882740

Cases where only near simultaneous overpasses occur between S-NPP and MODIS.

Summary of Validation Results for VIIRS Ice Surface Temperature

- There were no significant differences between the results generated by the Framework and our locally-generated results.
- NPP/VIIRS ice surface temperature product has been validated against a similar product from MODIS and aircraft measurements from the NASA IceBridge campaign.
- The VIIRS ice surface temperature product meets the accuracy and precision specifications, though a warm bias is observed compared to MODIS and IceBridge.

VIIRS Ice Thickness and Age Algorithm Readiness

Presented by

Xuanji Wang[1] or Jeff Key[2]

[1]Cooperative Institute for Meteorological Satellite Studies (CIMSS)
[2]NOAA/NESDIS/STAR

VIIRS Ice Thickness/Age Overview

- The VIIRS sea ice thickness and age product provides a continuous range of ice thickness values as well as ice age classes.

- One-dimensional Thermodynamic Ice Model (OTIM) algorithm design:
  - Solid physical foundation with all components of surface energy budget considered,
  - Capable of retrieving daytime and nighttime sea and lake ice thickness under both clear and cloudy sky conditions,
  - Very computationally efficient,
  - Flexible, fast and easy to maintain and improve later with more and accurate satellite retrieved products like radiative fluxes, snow cover and snow depth over ice,
  - Independent of historical records for ice thickness and age estimation.

VIIRS Ice Thickness/Age (Characterization) Requirements

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Res.	Horiz. Res.	Mapping Accuracy	Msmnt. Range	Msmnt. Accuracy	Product Refresh Rate/Coverage Time	Vendor Allocated Ground Latency	Product Measurement Precision	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Sea & Lake Ice: Thickness /Age	JPSS	All ice-covered regions of the global ocean	Ice Surface	1 km	1 km	Ice thickness , ice free, New/Young ice, all other ice	70% probability of detection	At least 90% coverage of the globe every 24 hours (monthly average)	80 min	15%	Day and night		Clear conditions associated with threshold accuracy	Over specified geographic area

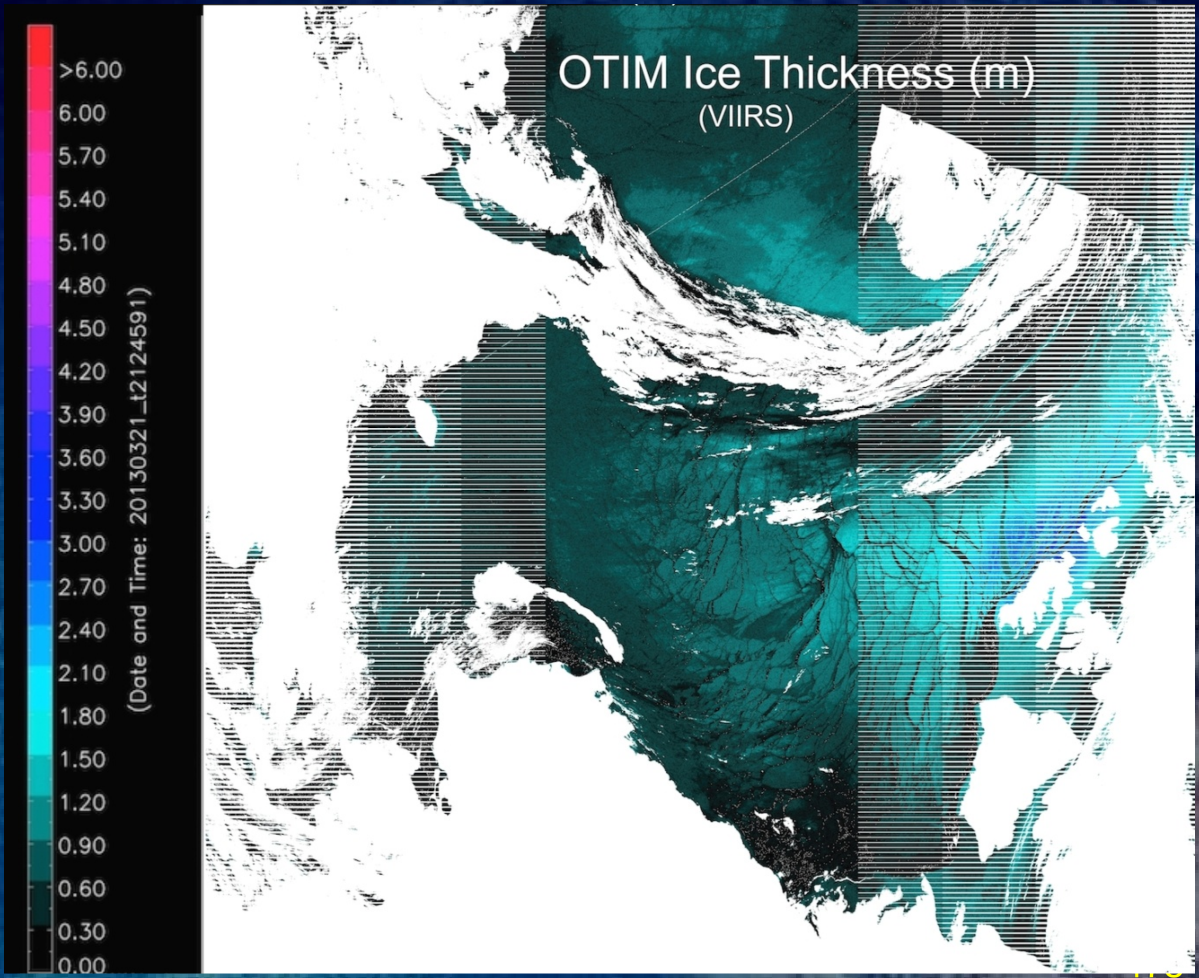
Algorithm Output

OTIM output:

Name	Type	Description	Dimension
Ice Thickness	**Output**	**Ice thickness is defined as the total vertical length of the ice under and above water surface. The reliable ice thickness retrieved from this algorithm ranges between *0 ~ 5.0 m*.**	2-D
Ice age	**Output**		2-D
1: New	**Output**	**New ice *0~10 cm* thick. Recently formed ice which includes frazil ice, grease ice, slush, shuga, and nilas. These types of ice include ice crystals which are only weakly frozen together (if at all) and have a definite form only while they are afloat, and a thin elastic crust of ice that is easily bending on waves and swell and under pressure growing in a pattern of interlocking "fingers" (finger rafting).**	2-D
2: Grey	**Output**	**Young ice *10-15 cm* thick. Less elastic than nilas and breaks on swell. Usually rafts under pressure.**	2-D
3: Grey-white	**Output**	**Young ice *15-30 cm* thick. Under pressure it is more likely to ridge than to raft.**	2-D
4: First-year Thin	**Output**	**First-year ice of not more than one winter's growth, *30-70 cm* thick.**	2-D
5: First-year Medium	**Output**	**First-year, ice *70-120 cm* thick.**	2-D
6: First-year Thick	**Output**	**First-year ice *120-170 cm* thick.**	2-D
7: Old Ice	**Output**	**Sea ice which has survived at least one summer's melt. Topographic features generally are smoother than first-year ice, and *more than 170 cm* thick. May be subdivided into second-year ice and multi-year ice.** **Second-year Ice: Old ice which has survived only one summer's melt.** **Multi-year Ice: Old ice which has survived at least two summer's melt.**	2-D

Algorithm Output

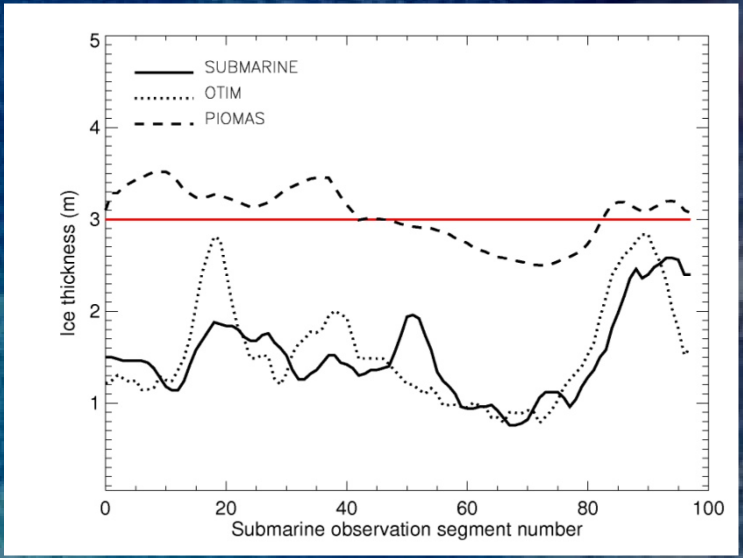
Example of VIIRS ice thickness over the Arctic on 21 March 2013.



Validation Strategy

- **Truth Measurements and other products**
  - » In situ observations of ice surface temperature from the IceBridge aircraft campaign
  - » Previous validation has been done with upward-looking sonar from nuclear submarines, in situ thickness measurements, CryoSat-2, and an ice-ocean model.

Validation with submarine sonar and modeled ice thicknesses.



Validation Results

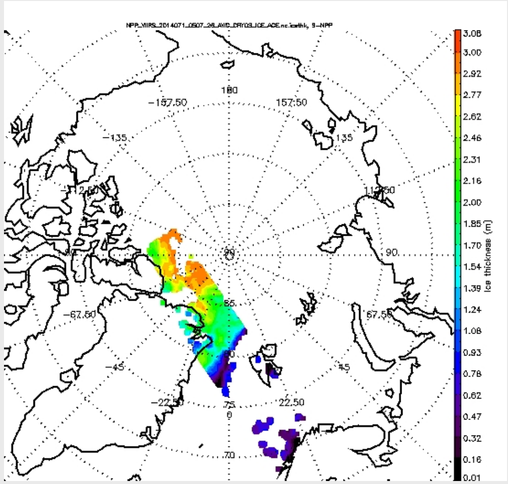
Statistical results of the comparison in sea ice thickness between S-NPP and IceBridge for matched locations (S-NPP pixels) .

Case no	Date	S-NPP		IceBridge		S-NPP minus IceBridge			
		mean	STD	mean	STD	mean	STD	percent (%)	matched pixels
1	2014.03.12	1.18	0.52	1.45	0.69	-0.27	0.55	-5.34	495
2	2014.03.13	2.48	0.55	2.24	0.52	0.24	0.55	16.49	438
3	2014.03.24	1.88	0.78	2.33	0.48	-0.45	0.78	-6.31	803
4	2014.03.31	2.28	0.21	2.56	0.35	-0.28	0.43	-8.97	37
5	2015.03.24	2.06	0.59	2.45	0.43	-0.39	0.75	-11.63	1050
6	2015.03.29	1.72	0.43	1.88	0.54	-0.16	0.74	-1.69	5153
Average		1.93	0.50	2.15	0.50	-0.22	0.63	-2.91	7976 (total)

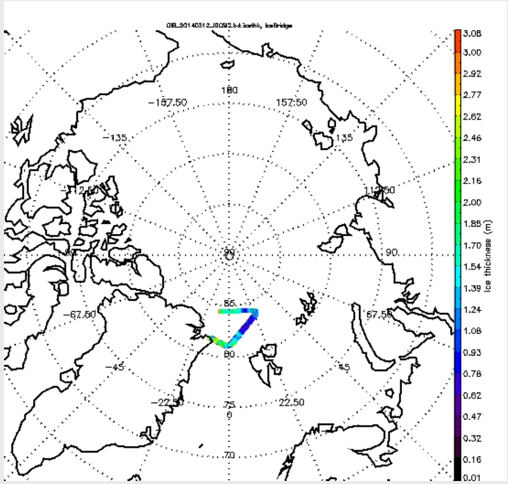
From 24 cases of S-NPP granule data when IceBridge has measurements, 6 cases out of the total 24 cases from S-NPP have good overlapped locations with IceBridge where they both have ice thickness values for comparison.

2014.03.12

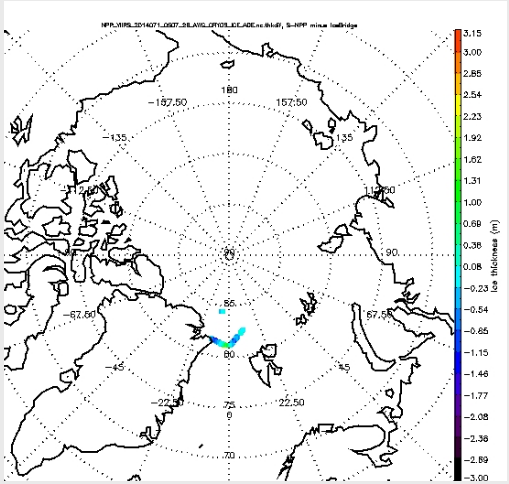
S-NPP Framework

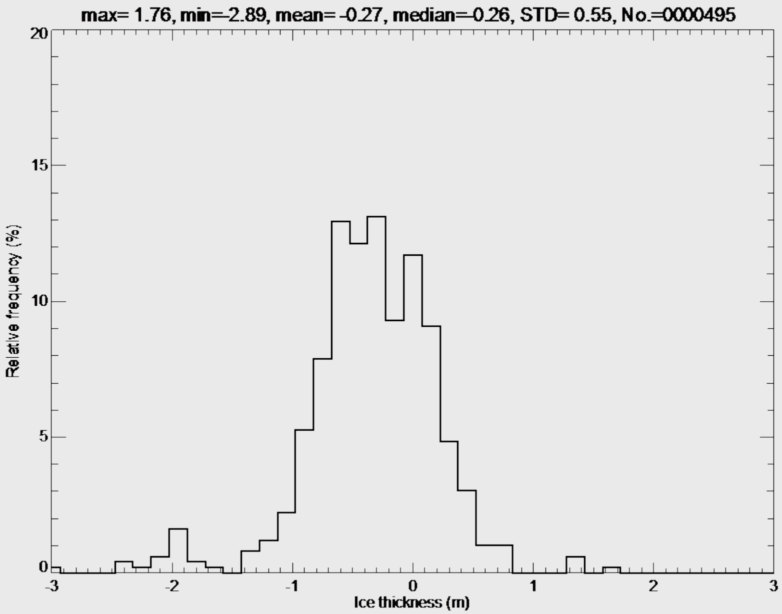


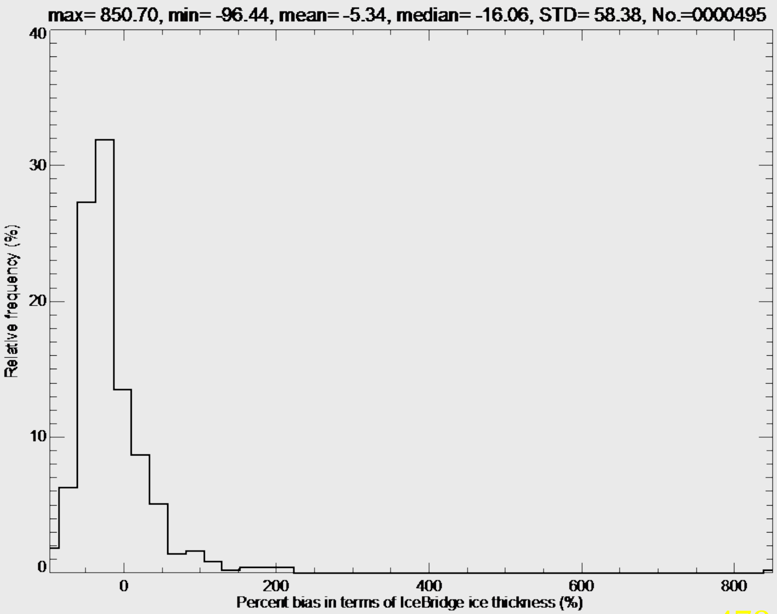
IceBridge



S-NPP minus IceBridge

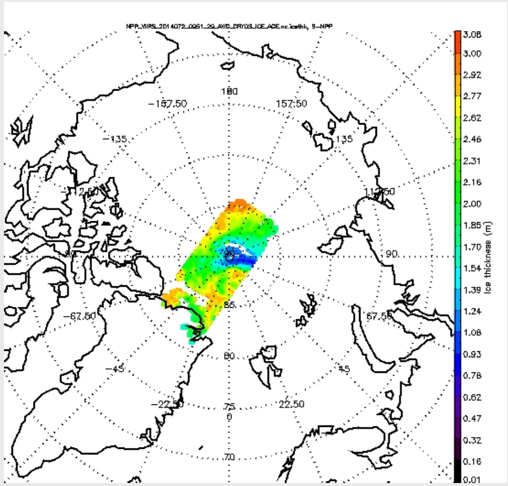


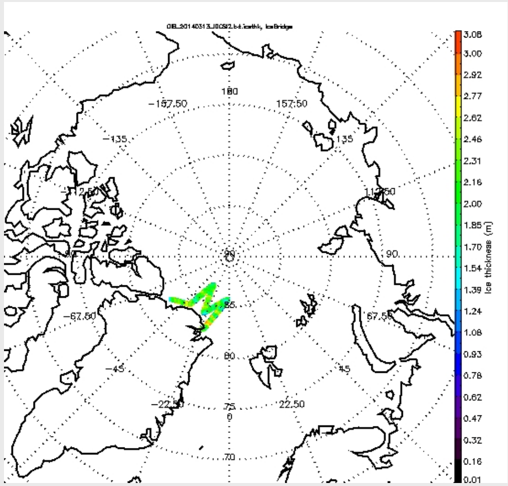


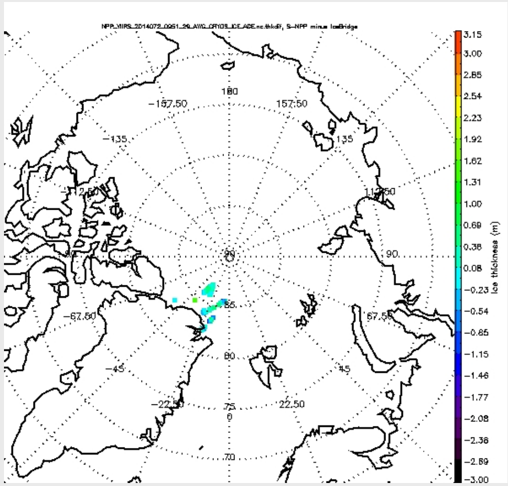


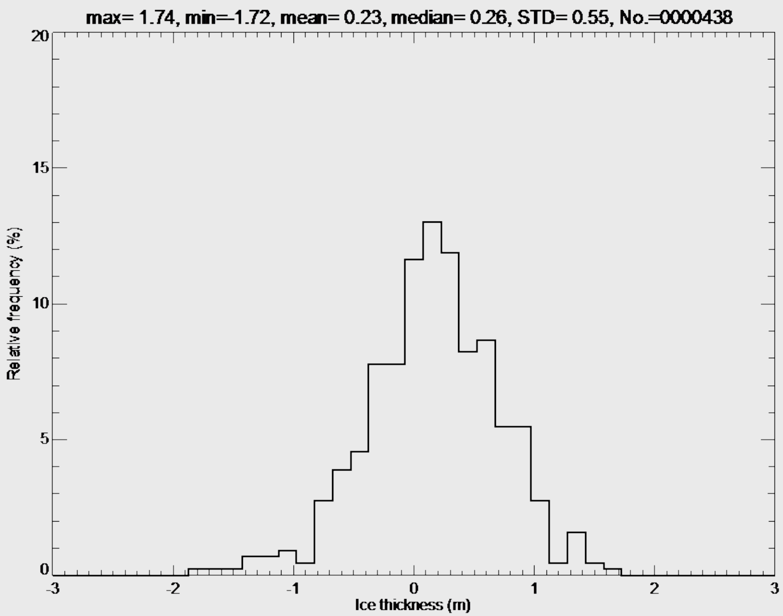
2014.03.13

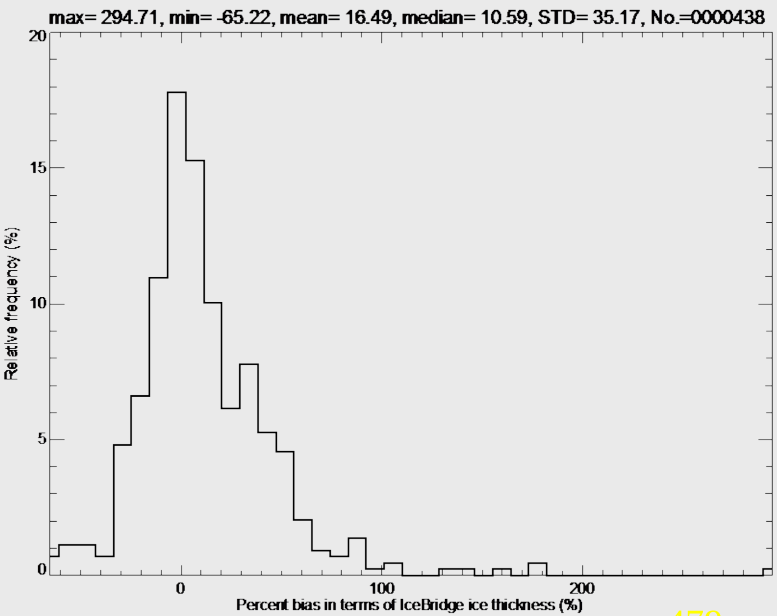
S-NPP Framework | IceBridge | S-NPP minus IceBridge





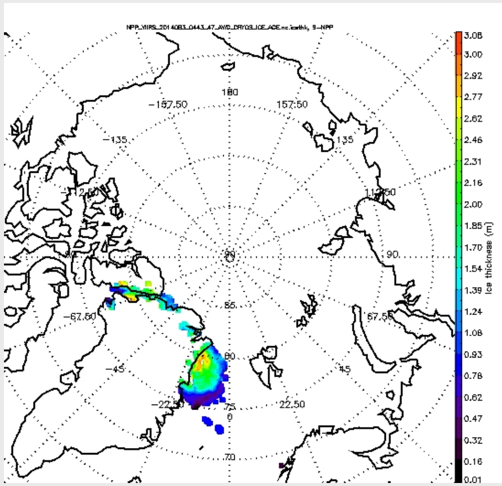


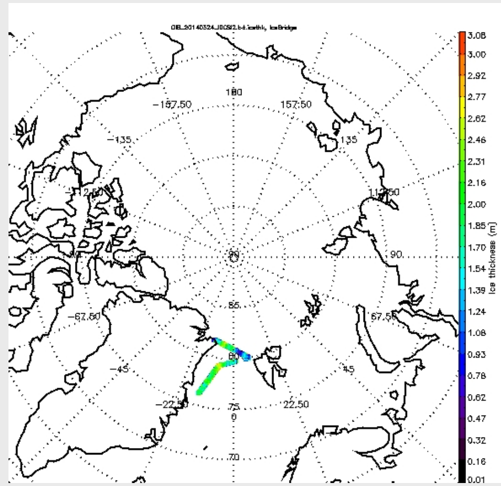


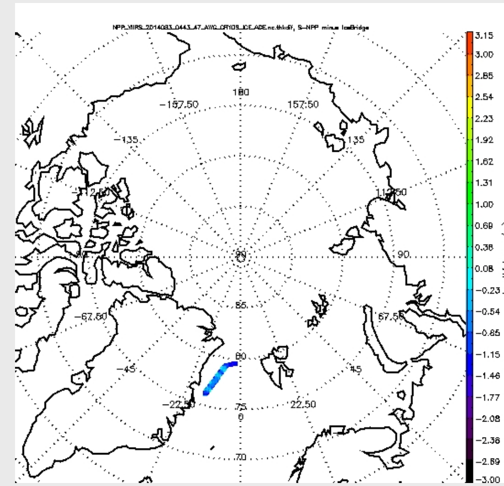


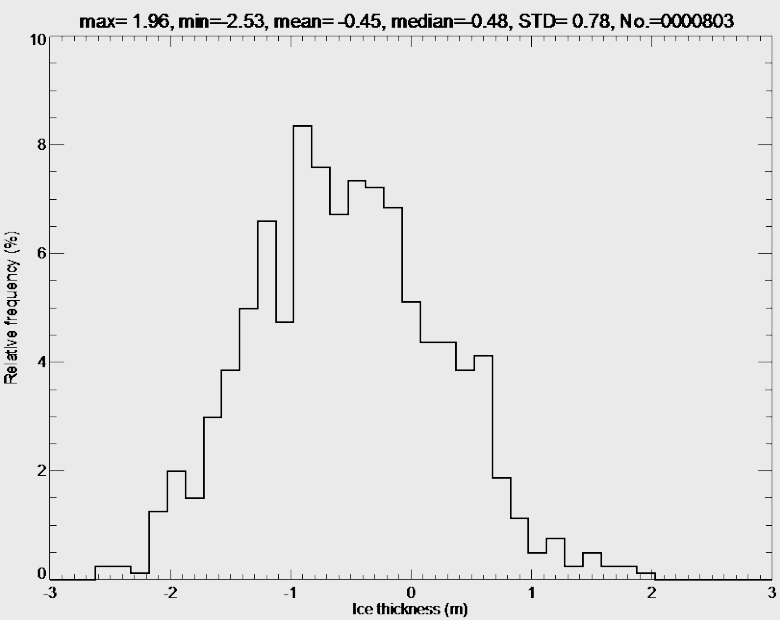
2014.03.24

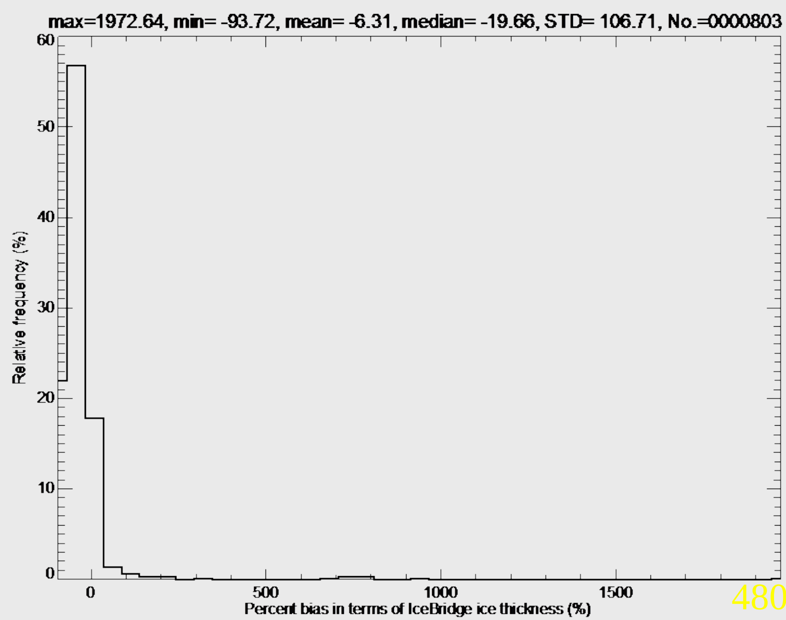
S-NPP Framework | IceBridge | S-NPP minus IceBridge











Summary of Validation Results for VIIRS Ice Thickness and Age

- There were no significant differences between the results generated by the Framework and our locally-generated results.
- NPP/VIIRS ice thickness/age product has been validated against aircraft measurements from the NASA IceBridge campaign. (The IceBridge data in about 7 m resolution were grouped up in S-NPP 750 m resolution box, and then averaged to match S-NPP 750 m pixel size sea ice thickness for comparison.)
- The VIIRS ice thickness/age product meets the accuracy and precision specifications as expected.

VIIRS Binary Snow Cover Algorithm Readiness

Presented by

Peter Romanov

NOAA-CREST/CUNY and NOAA/NESDIS/STAR

Outline

- Product Overview and Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the VIIRS binary snow cover product.

VIIRS Binary Snow Cover Product Overview & Requirements

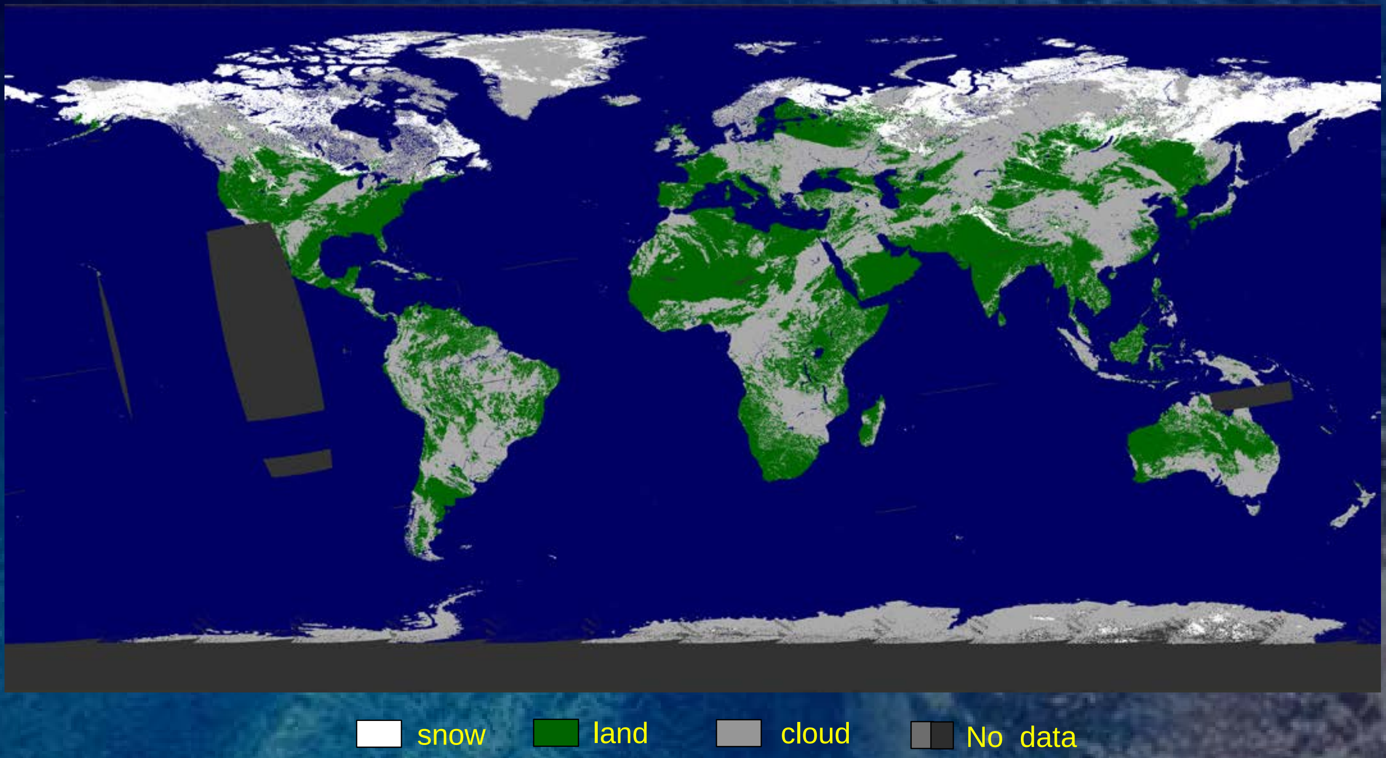
- VIIRS Binary Snow Cover will be derived from daytime VIIRS observations in the visible, near IR, shortwave IR and longwave IR spectral bands at the imagery resolution of 375m
  - » Snow cover is identified over cloud-clear land surface only.
  - » The coverage of the product is global.
  - » The product will include data quality flags, and metadata

System Capability	Objective
Vertical Coverage	N/A
Horizontal Resolution	1 km
Mapping Uncertainty	3 km
Measurement Range	Binary (0,1)
Measurement Uncertainty	90% probability of correct snow/no-snow classification
Measurement Accuracy	
Latency	
Refresh	90% coverage of the globe every 24 hours

Algorithm Output

VIIRS binary snow map

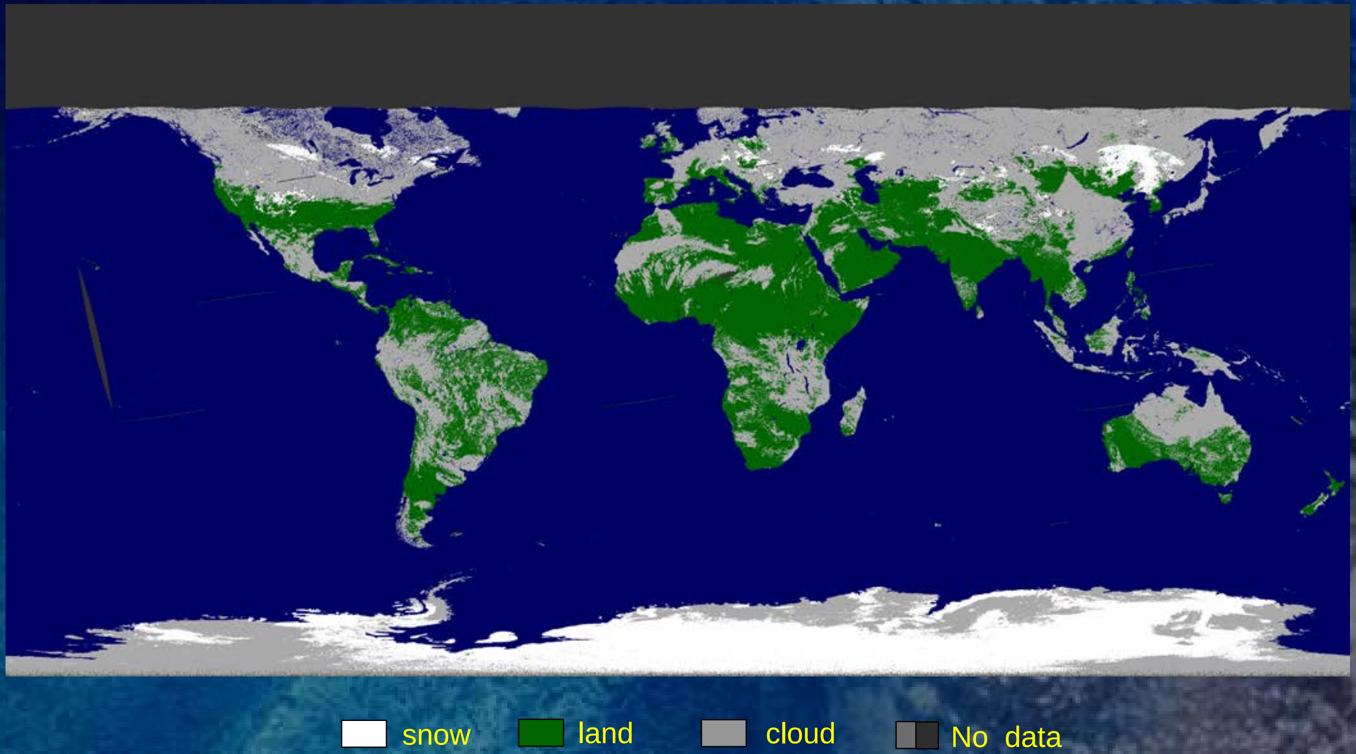
S-NPP/VIIRS Binary Snow Map derived from VIIRS observations on April 10, 2014 (day 2014100)



Algorithm Output

VIIRS binary snow map

S-NPP/VIIRS Binary Snow Map derived from VIIRS observations on January 06, 2015 (day 2015006)



Validation Strategy

Approach

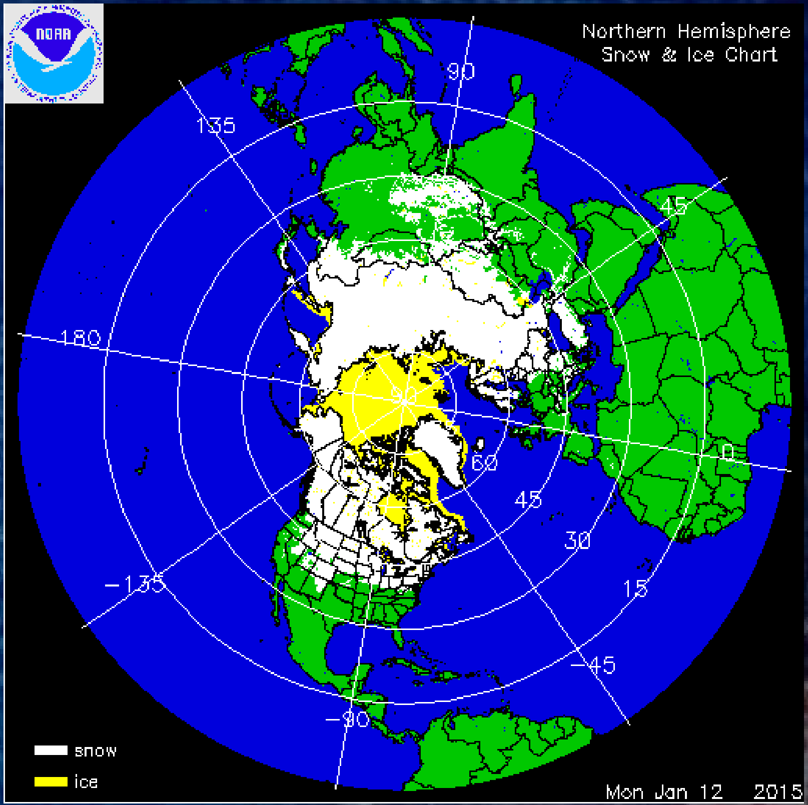
Compare the derived daily binary snow cover maps with NOAA Interactive snow/ice maps and with collocated in situ snow observations

Technique

- Generate daily global binary snow map
- Employ NDE cloud mask and land/water mask
- Collocate IMS or in situ data with VIIRS clear sky snow retrievals.
- Generate overlays (for visual analysis and assessment)
- Generate comparative statistics (for quantitative evaluation)
  - » Generate full hits/misses statistics
  - » Estimate probability of correct typing

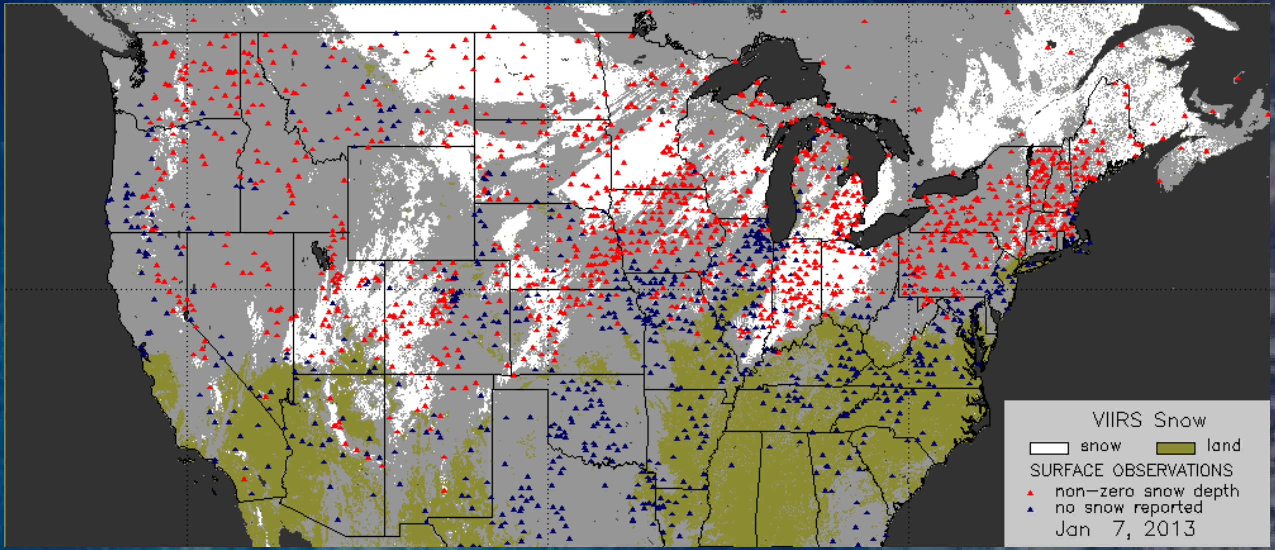
Validation Data Sources: IMS

- IMS: NOAA Interactive Multisensor Snow and Ice Mapping System
- One of the most accurate and detailed characterization of the snow and ice extent in the Northern Hemisphere
- Maps are generated interactively
- Daily at 4 km (1 km since 2015)
- Product is used by NCEP in all operational NWP models



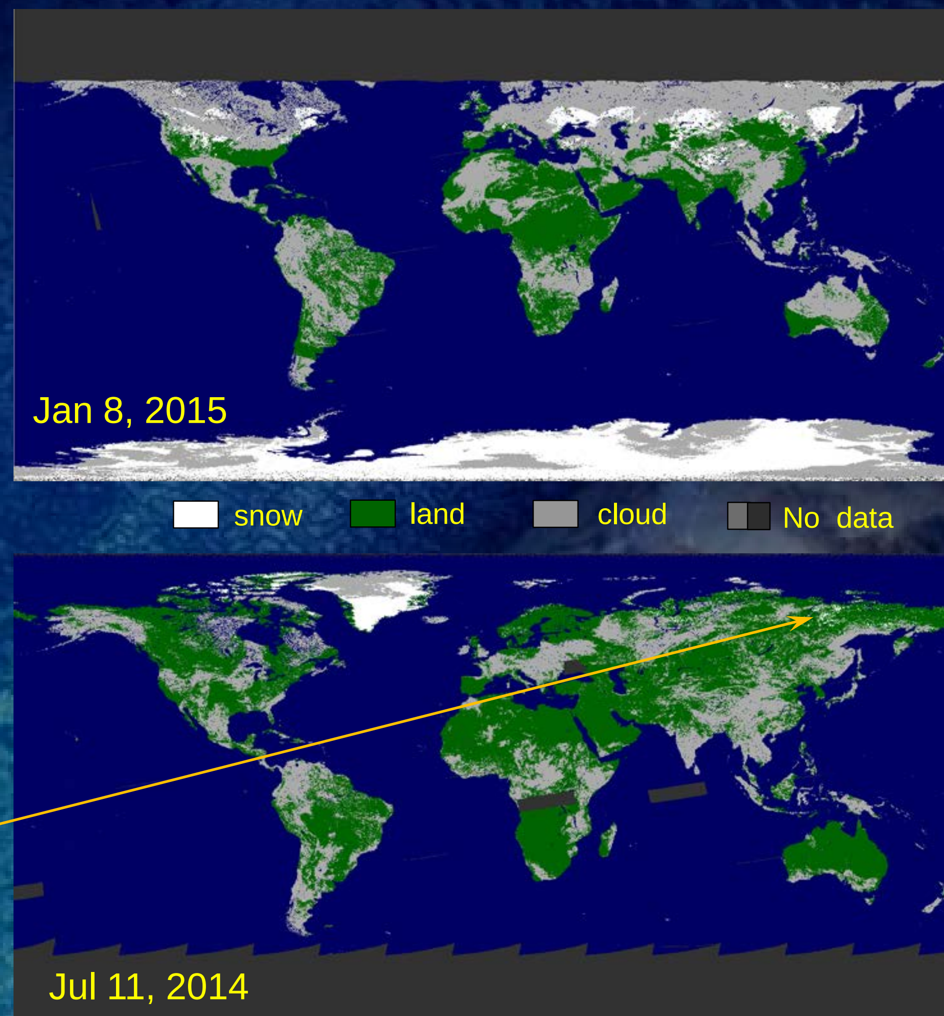
Validation Data Sources: In Situ Snow Reports

- Reports from WMO (first order) stations
- US Cooperative stations
- Total: Several thousand snow reports daily
- Other networks to consider:
  - SNOWTEL
  - CoCoRaHS



VIIRS Snow Map: Qualitative Assessment

- NH Winter: Adequate characterization of snow cover extent
- Too conservative cloud mask at low solar elevation angles (below 15-20 deg)
- NH summer: Some false snow identifications over boreal forests in Eurasia



“False snow” identifications

Comparison with IMS (1/4)

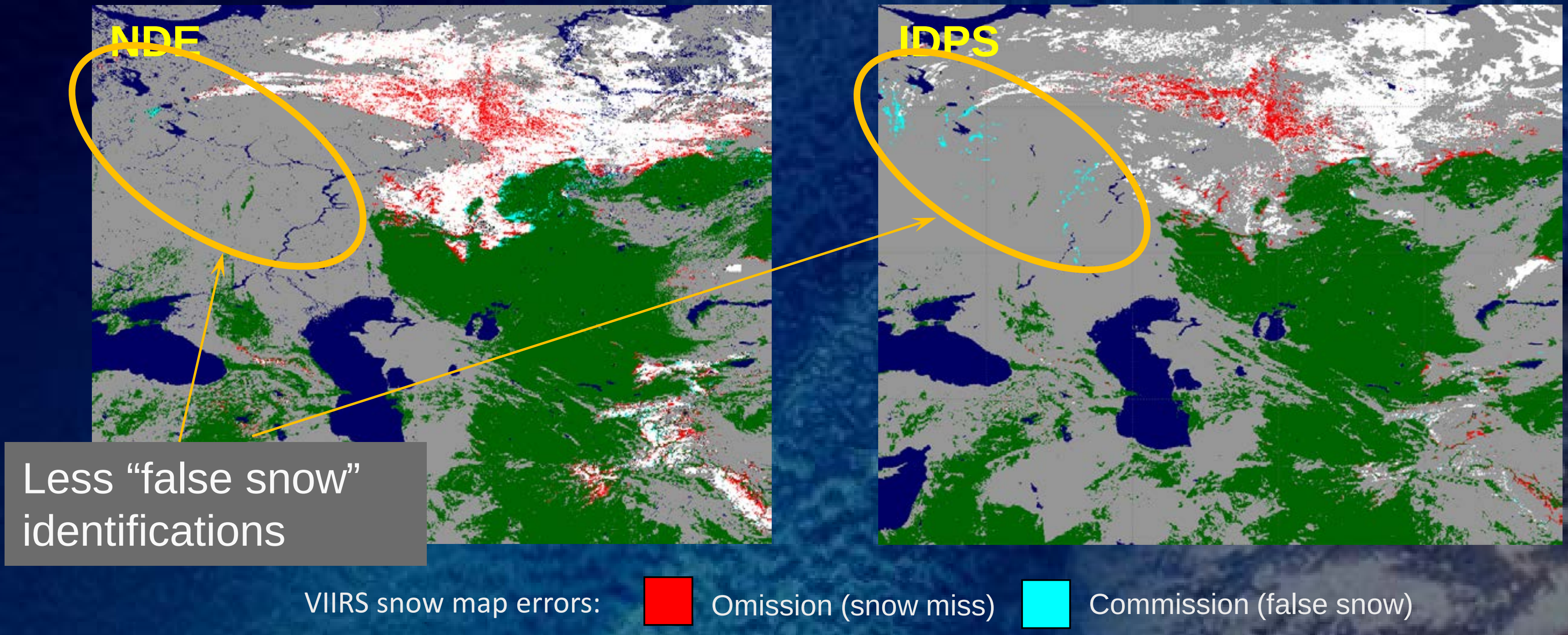
- Overlaid images help to visually evaluate disagreement between daily products
- Need to remember that IMS analysts are inclined to overestimate rather than underestimate the snow extent

Both snow | Both land | Cloud | No data

VIIRS snow map errors: Omission (snow miss) | Commission (false snow)

Comparison with IMS (2/4)

- NDE and IDPS vs. IMS (Apr 14, 2014, Day 2014104)



- NDE vs. IDPS: less snow misses (red) and snow false identifications (light blue)
- NDE vs. IDPS: less clouds over mountains and along the snow cover boundary
- VIIRS snow misses are mostly due to shallow snow pack or dense forest cover

Comparison with IMS (3/4)

Year	Day	Agree, %	Disagr, %	Snow Miss, %	False Snow, %	Cloudy , %
2014	100	96.8	3.2	2.7	0.5	51.9
2014	101	96.9	3.1	2.8	0.3	49.6
2014	102	97.4	2.6	2.2	0.4	49.7
2014	103	96.9	3.1	2.6	0.5	50.4
2014	104	97.1	2.9	2.5	0.3	47.5
2014	105	99.2	0.8	0.7	0.1	15.8
2014	191	97.8	2.2	0.9	1.3	60.4
2014	192	97.7	2.3	1	1.3	61.9
2014	193	97.9	2.1	1	1.1	64.1
2014	194	97.7	2.3	0.8	1.5	62.1
2014	195	97.8	2.2	0.8	1.5	61.4
2014	196	97.4	2.6	0.8	1.8	63.4
2014	283	97	3	1.9	1.1	51.8
2014	284	97.3	2.7	1.9	0.8	52.5
2014	285	97.1	2.9	2.2	0.7	51.5
2014	286	97.3	2.7	2	0.8	52.7
2014	287	97.9	2.1	1.7	0.4	50.2
2015	1	96.9	3.1	2.5	0.6	35.5
2015	2	96.5	3.5	2.9	0.6	32.9
2015	3	96.9	3.1	2.6	0.5	32.9
2015	4	97	3	2	1	32.2
2015	5	97.4	2.6	1.9	0.7	33.7
………	……..	…………..	………..	……….	…………	………..
2015	25	96.2	3.8	3.4	0.4	40.4
2015	26	96.1	3.9	3.5	0.4	40
2015	27	97.1	2.9	2.7	0.2	40.8
2015	28	97.3	2.7	2.2	0.5	40.4
2015	29	96.8	3.2	2.7	0.4	39.1
2015	30	97.1	2.9	2.5	0.3	40.6
2015	31	97.2	2.8	2.3	0.5	44.3

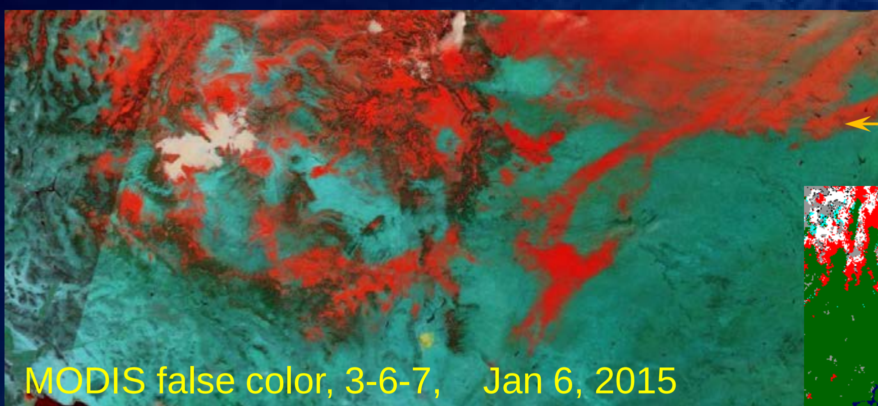
- Quantitative comparison performed over NH, for 60 days in January 2015 (30 days), April 2014 (10 days), Jul 3.5y 2014 (10 Days), October 2014 (10days)
- VIIRS gridded (1 km) snow map used
- Accuracy estimates made daily

	Mean	*Range*
Agreement	96.8%	96.1 ÷ 99.2
Snow misses	2.6%	0.7 ÷ 3.5
“False” snow	0.6%	0.1 ÷ 1.8
Cloud fraction	42.6%	32.2 ÷ 63.4

Comparison with IMS (4/4)

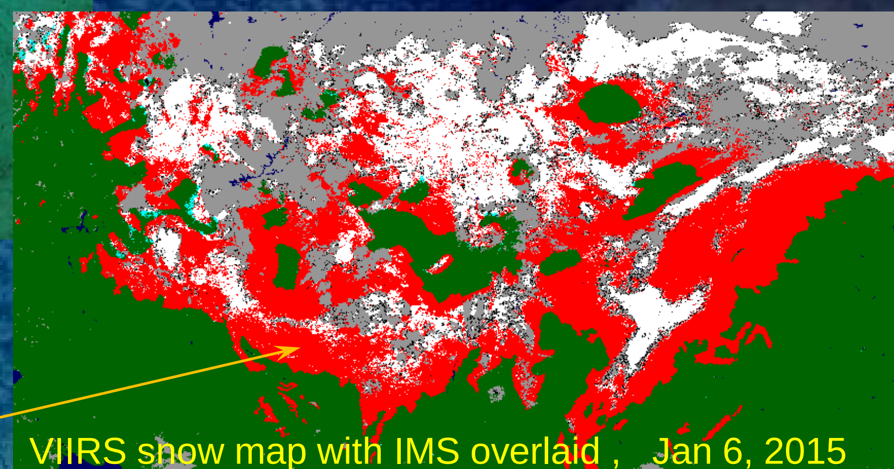
Other possible reasons for disagreement between VIIRs and IMS besides the finite accuracy of VIIRS snow retrievals:

- Time difference (VIIRS: ~1330 local time, IMS: ~1300 ÷ 1700 EST)
- Frequent overestimates of snow extent by IMS analysts (see example below)



MODIS false color, 3-6-7,   Jan 6, 2015

Red: Snow seen in MODIS imagery



VIIRS snow map with IMS overlaid ,   Jan 6, 2015

snow   land   cloud   No data
omission (snow miss)   commission (false snow)

Red: Areas identified as snow-free by VIIRS but mapped as “snow” by IMS analysts

Comparison with In Situ Data

Year	Day	Match-ups	Agree %	Snow Miss, %	False Snow, %
2015	1	564	92.6	5.3	2.1
2015	2	460	90	6.7	3.3
2015	3	187	88.2	4.3	7.5
2015	4	335	92.8	4.8	2.4
2015	5	686	96.5	1	2.5
2015	6	567	94	1.9	4.1
2015	7	1051	91.8	4.9	3.3
2015	8	789	88.3	4.7	7
2015	9	920	93.7	2.6	3.7
2015	10	759	92.8	3.8	3.4
2015	11	221	93.7	4.1	2.3
2015	12	726	95.5	2.8	1.8
2015	13	1038	94.3	3.2	2.5
2015	14	609	90.8	3.6	5.6
2015	15	1280	92	3.8	4.1
2015	16	1047	91.7	3.4	4.9
2015	17	885	92.1	3.2	4.7
2015	18	850	90.1	3.6	6.2
2015	19	929	92.4	2	5.6
2015	20	831	92.8	2.3	4.9
2015	21	633	93.8	3.2	3
2015	22	738	91.2	3.8	5
2015	23	785	88	4.7	7.3
2015	24	673	92.6	1.2	6.2
2015	25	697	91.8	1.4	6.7
2015	26	939	90.3	2.7	7
2015	27	897	95.4	1.4	3.1
2015	28	1011	95.5	1.7	2.8
2015	29	502	97.4	1	1.6
2015	30	697	94	4.4	1.6

- Quantitative comparison performed over North America for 31 days in January 2015
- VIIRS gridded(1 km) snow map used
- Accuracy estimates made daily
- From 221 to 1280 daily match-ups with station data
- Part of the disagreement (about 1%) may be due to errors in in situ snow reports

	Mean	*Range*
Agree	92.5%	88.0 ÷ 97.4
Snow misses	3.2%	1.0 ÷ 6.7
"False" snow	4.3%	1.6 ÷ 7.5
Match-ups	735	221 ÷ 1280

Summary of Validation Results for VIIRS Binary Snow Cover Product

- S-NPP/VIIRS binary snow product generated with the new NDE algorithm has been validated
- The estimated probability of correct typing in the VIIRS binary snow product
  - 96.8% when compared to IMS
  - 92.5% when compared to in situ data
- The accuracy of the product is above the accuracy specification of 90% probability of correct typing

VIIRS Binary Snow Cover Product: Remaining Issues

- False snow identifications over boreal forests in summer
  - » Possibly related to smoke due to forest fires
  - » May require adjustment of the snow identification algorithm

- Too conservative cloud masking at high solar zenith angles, above 70-75 deg
  - » Reduces the effective area coverage of the Snow Map Product
  - » Affects the product mostly during winter months

VIIRS Snow Fraction Algorithm Readiness

Presented by

Peter Romanov

NOAA-CREST/CUNY and NOAA/NESDIS/STAR

Outline

- Product Overview and Requirements
- Product Examples
- Validation Strategy
- Validation Results

Goal: Demonstrate science quality of the VIIRS snow fraction product.

VIIRS Snow Fraction Product Overview

- Snow Fraction is assumed to be “viewable” snow fraction. It only includes snow “seen” by the satellite sensor , i.e., snow that is not masked by vegetation canopy or topography.

- VIIRS Snow Fraction will be derived from daytime VIIRS observations in the visible, spectral band at the imagery resolution of 375m
  - » Derived over cloud-clear land surface only
  - » Estimated for pixels identified as “snow covered” by the VIIRS binary snow mask
  - » Global coverage
  - » The product will include data quality flags, and metadata

VIIRS Snow Fraction Product Overview (Cont'd)

Two algorithms and two snow fraction products

- NDSI-based algorithm
  - » MODIS heritage
  - » Widely utilized by MODIS data users

- Reflectance-based algorithm
  - » GOES, AVHRR heritage (single-band version)
  - » Applied to MODIS regionally (multiband version) (Painter, 2009)
  - » Approved for and implemented with GOES-R ABI (multi-band version)

The two approaches are different and may result in different estimates of the snow fraction. Implementing both approaches with VIIRS answers the interests of both MODIS and GOES/GOES-R user communities.

NDSI-Based Snow Fraction

The Salomonson-Appel (2004) algorithm linearly relates snow fraction to the observed NDSI*

$$SF_{NDSI} = a + b*NDSI$$

Parameters a =-0.01 and b=1.45 of the linear function have been established empirically through comparison of MODIS data with Landsat.

NASA MODIS team (D.Hall, G.Riggs) has found that the optimal values of a and b for VIIRS are the same as for MODIS (a = - 0.01; b = 1.45)

*$NDSI = (R_{0.6} - R_{1.6})/(R_{0.6} + R_{1.6})$: Normalized Difference Snow Index

Reflectance-Based Snow Fraction

Single-band dual-end member algorithm (Romanov et al, 2003) linearly relates snow fraction to normalized visible reflectance

$$SF_R = (R_1 - R_{1land})/(R_{1snow} - R_{1land}),$$

where R_1 is VIIRS-observed reflectance in band I1,

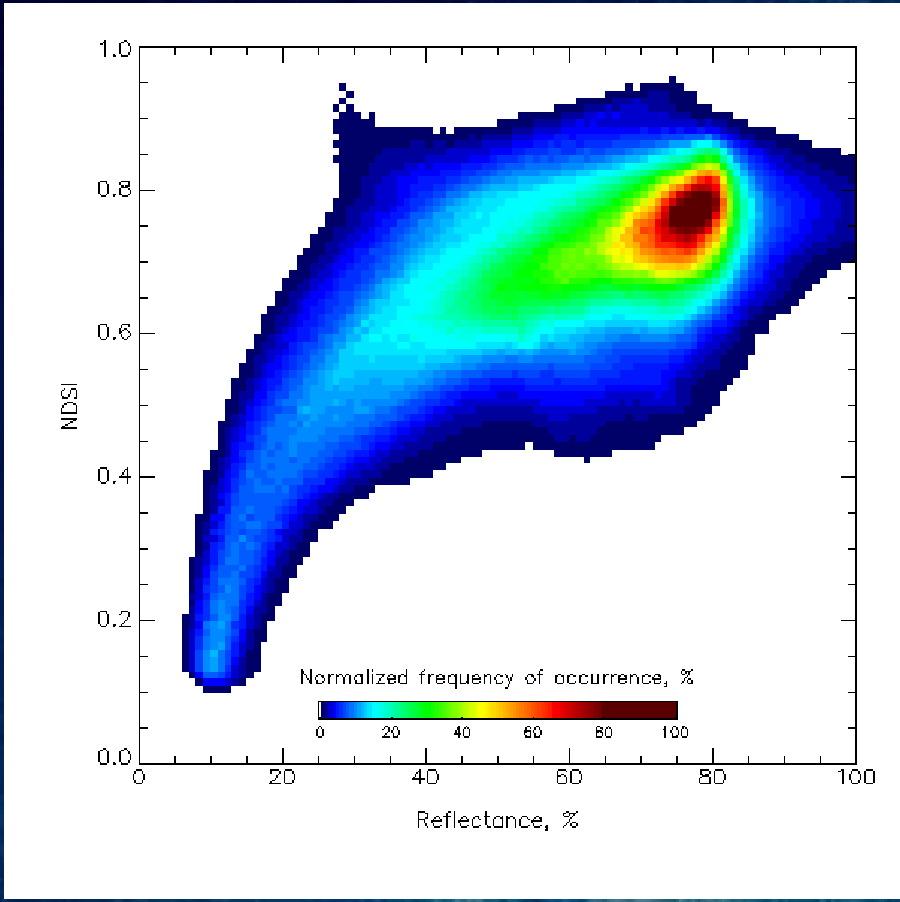
R_{1land} is reflectance of snow-free land in VIIRS band I1

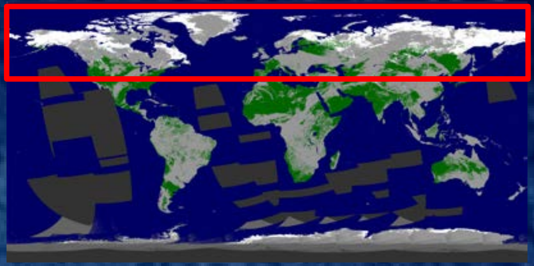
R_{1snow} is reflectance of snow in VIIRS band 1

Both endmemebrs R_{1land} and R_{1snow} vary with the observation geometry but are assumed independent of location and time of the year

Reflectance vs NDSI

Scatter plot of VIIRS visible (band 1) reflectance and NDSI for snow-covered pixels





VIIRS snow map , April 9, 2014

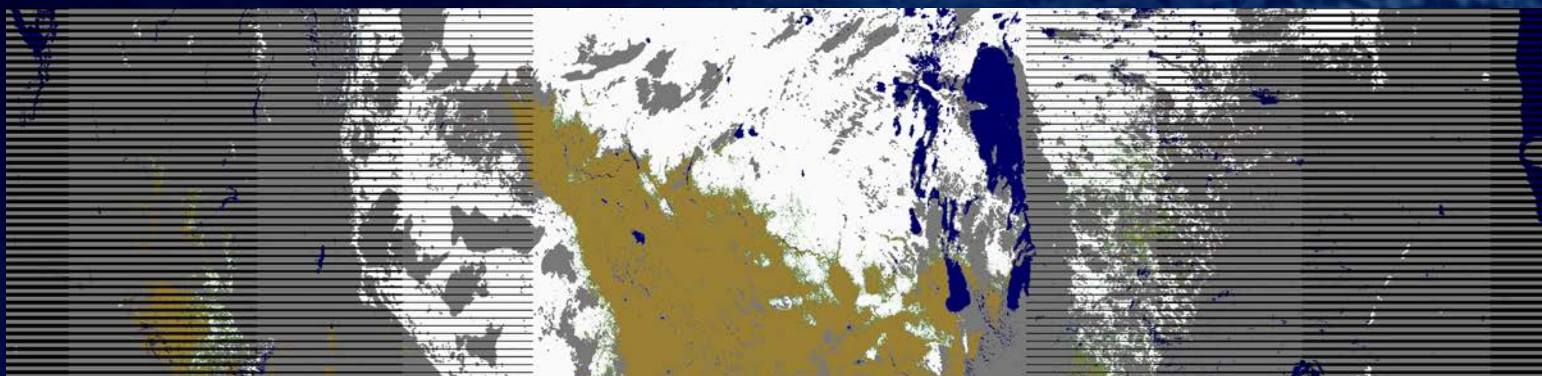
The difference between NDSI and Reflectance causes difference in the snow fraction estimated from these parameters

VIIRS Snow Fraction Product Requirements

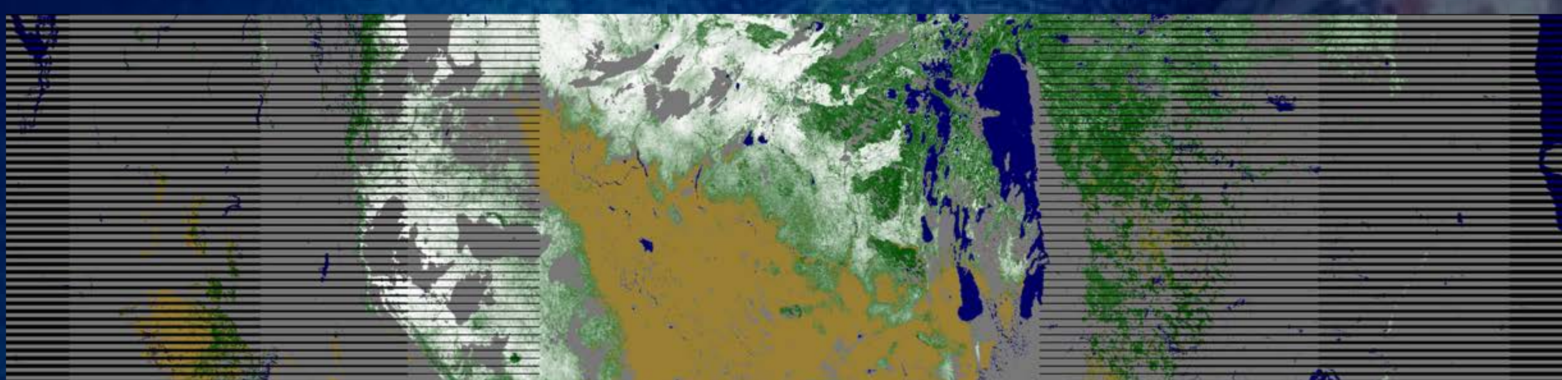
System Capability	Objective
Vertical Coverage	N/A
Horizontal Resolution	1 km
Mapping Uncertainty	3 km
Measurement Range	Snow fraction (0,100)
Measurement Uncertainty	10% ?
Measurement Accuracy	10%
Latency	
Refresh	90% coverage of the globe every 24 hours

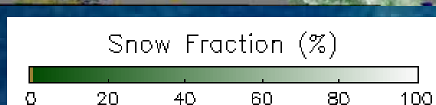
NDE vs IDPS Snow Fraction

VIIRS IDPS snow fraction: derived through 2x2 pixel aggregation of the binary map



VIIRS NDE reflectance-based snow fraction: sub-pixel snow fraction retrieval





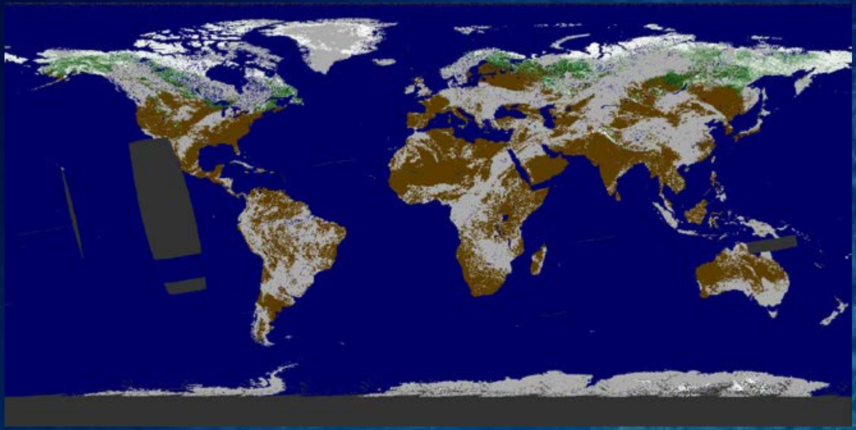
land cloud No data

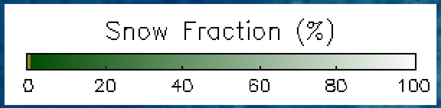
Global Snow Fraction

VIIRS snow fraction maps

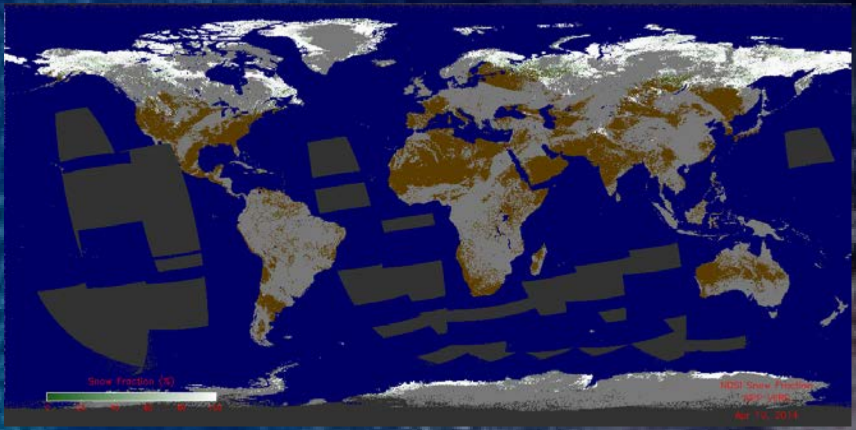
S-NPP/VIIRS Snow Fraction Maps derived from VIIRS observations on April 10, 2014 (day 2014100)

Reflectance-based





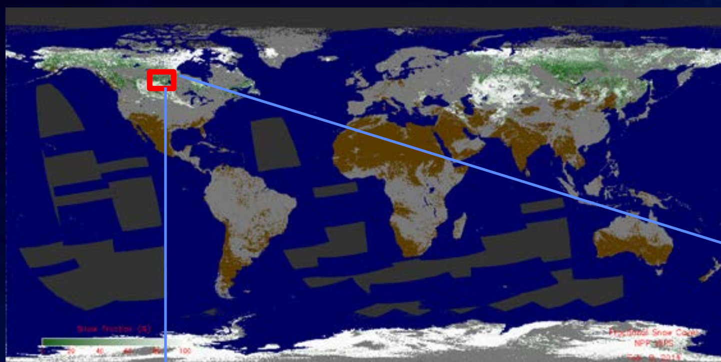
NDSI-based



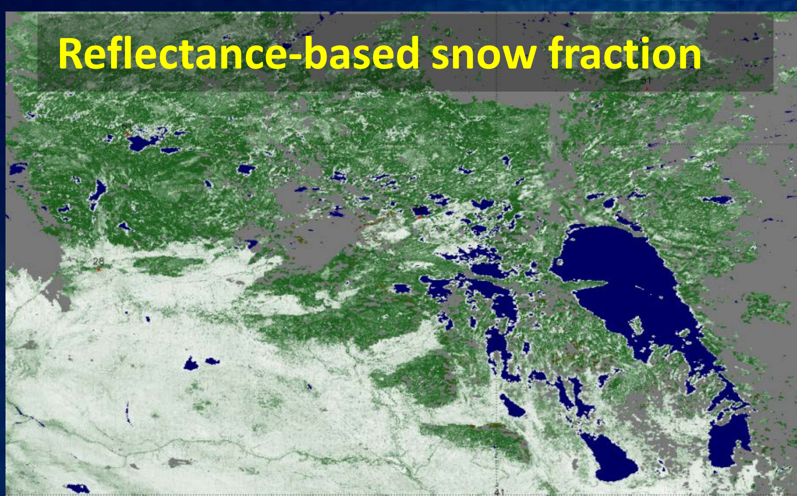
land cloud No data

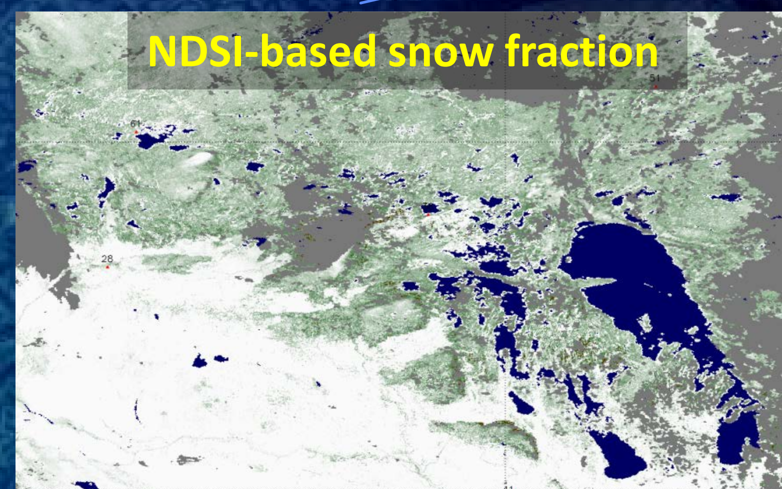
Regional Snow Fraction

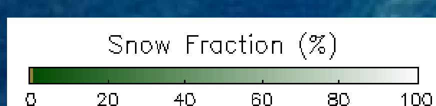
S-NPP/VIIRS Snow Fraction Maps from VIIRS
February 9, 2014



Some similarity in the snow fraction patterns in the two products on the regional scale. NDSI-based snow fraction is larger in the forest







land cloud No data

Snow Fraction Product Verification

Snow fraction is not observed in situ. Proper quantitative validation of the product accuracy is virtually impossible.

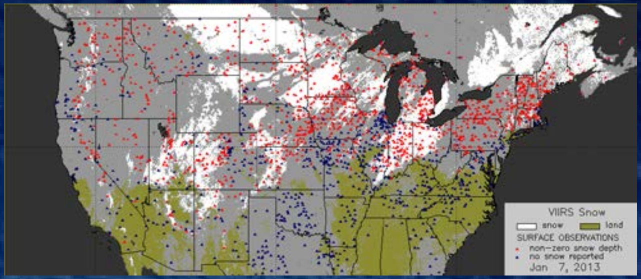
General approach to the product verification

- Consistency testing
  - Self-consistency:
    - Lack of abnormal spatial patterns
    - Day-to-day repeatability of spatial patterns
  - Consistency with the forest cover distribution
  - Consistency with in situ snow depth data over open flat areas.
- Comparison with higher spatial resolution data

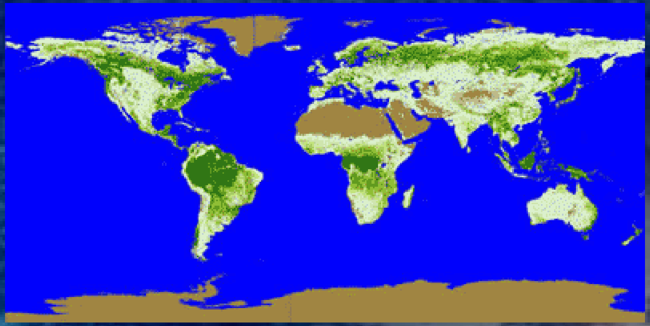
Verification was conducted using the results of the 10-weeks algorithm run with VIIRS data performed by AIT.

Validation Data Sources

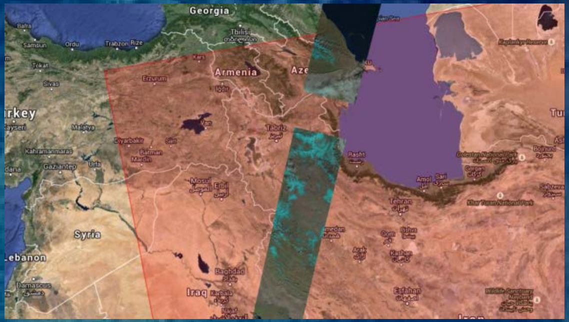
- Surface snow depth observations:
  Station data over Great Plains and Canadian Prairies



- Forest cover fraction dataset (GLCF, Univ of Maryland)



- Landsat Imagery



VIIRS Snow Fraction: Consistency with Forest Cover Distribution

- To verify consistency we calculated daily correlation of the derived "viewable" snow fraction and the forest fraction in the Northern Hemisphere.

- Derived "viewable" snow fraction decreases with increasing forest fraction (correlation is strongly negative) and thus is consistent with forest cover data.

- Reflectance-based snow fraction demonstrates a better agreement to forest fraction than the NDSI-based snow fraction

vs

Snow Fraction vs Forest Fraction Statistics

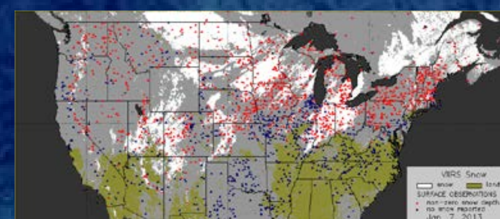
Date	Mean forest fraction	Reflectance-based		NDSI-based	
		Mean SnFrac	Correl	Mean SnFrac	Correl
01/01/15	0.22	0.48	-0.57	0.79	-0.39
01/02/15	0.26	0.44	-0.60	0.75	-0.42
01/14/15	0.26	0.46	-0.58	0.79	-0.37
01/14/15	0.26	0.46	-0.58	0.79	-0.37
01/16/15	0.26	0.47	-0.59	0.77	-0.39
01/17/15	0.22	0.49	-0.59	0.79	-0.48
01/18/15	0.23	0.45	-0.57	0.76	-0.44
01/19/15	0.24	0.48	-0.61	0.78	-0.42
01/30/15	0.24	0.53	-0.65	0.81	-0.52
01/31/15	0.29	0.49	-0.68	0.80	-0.54
Mean	0.24	0.47	**-0.60**	0.78	**-0.44**

- NDSI algorithm generates larger snow fraction values as compared to the reflectance algorithm

VIIRS Snow Fraction: Consistency with Observed Snow Depth

- Daily correlation between the snow fraction and in situ snow depth calculated over flat non-forested areas (Great Plains)
- Derived snow fraction increases with increasing snow depth (correlation is positive) and thus is consistent with in situ snow depth data
- Two products exhibit approximately the same level of consistency (correlation) with snow depth

VIIRS Snow Fraction



In Situ Snow Depth

Snow Fraction vs Snow Depth Statistics

Date	Snow Depth Range, cm	Number of match-ups	Reflectance-based		NDSI-based	
			Mean SnFrac	Correlation	Mean SnFrac	Correlation
01/01/15	2 - 43	106	0.66	0.68	0.92	0.44
01/04/15	2 - 25	58	0.53	0.54	0.74	0.55
01/07/15	2 - 27	302	0.60	0.70	0.84	0.68
01/09/15	2 - 30	184	0.60	0.53	0.79	0.59
01/14/15	2 - 27	66	0.57	0.31	0.83	0.29
01/17/15	2 - 25	47	0.43	0.52	0.79	0.49
01/18/15	2 - 15	42	0.25	0.40	0.57	0.47
Mean			0.52	**0.52**	0.78	**0.50**

VIIRS Snow Fraction: Self-Consistency

- Compare snow fraction derived on two consecutive days. Calculate correlation and mean absolute difference.
- Spatial patterns and the mean snow fraction are reproduced well indicating consistency of retrievals

VIIRS Snow Fraction, Day N

vs

VIIRS Snow Fraction, Day N+1

Snow Fraction : Day N vs Day N+1 Correlation

Date 1	Date 2	Reflectance-based			NDSI-based		
		SnFrac1	SnFrac2	Correl	SnFrac1	SnFarc2	Correl
01/03/15	01/04/15	0.46	0.46	0.89	0.78	0.76	0.83
01/10/15	01/11/15	0.50	0.50	0.88	0.78	0.79	0.84
01/16/15	01/17/15	0.55	0.52	0.83	0.83	0.82	0.81
01/17/15	01/18/15	0.55	0.52	0.85	0.83	0.82	0.84
01/18/15	01/19/15	0.51	0.50	0.86	0.80	0.79	0.84
01/22/15	01/23/15	0.57	0.57	0.89	0.83	0.83	0.82
01/25/15	01/26/15	0.63	0.63	0.91	0.86	0.88	0.84
01/30/15	01/31/15	0.57	0.56	0.91	0.83	0.83	0.86
Mean				**0.88**			**0.83**

VIIRS Snow Fraction: Verification with Landsat Data

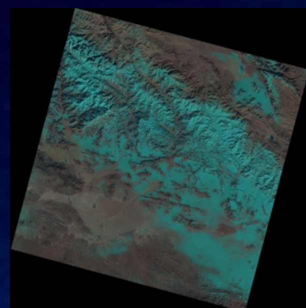
Approach

(1) Generate binary snow mask for a Landsat scene at 30 m resolution

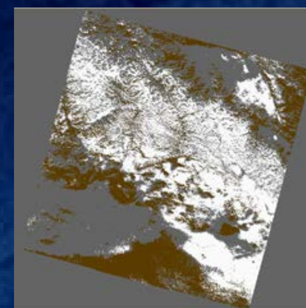
(2) Aggregate Landsat binary snow identifications to estimate snow fraction at VIIRS spatial resolution

(3) Compare with VIIRS sub-pixel snow fraction estimate

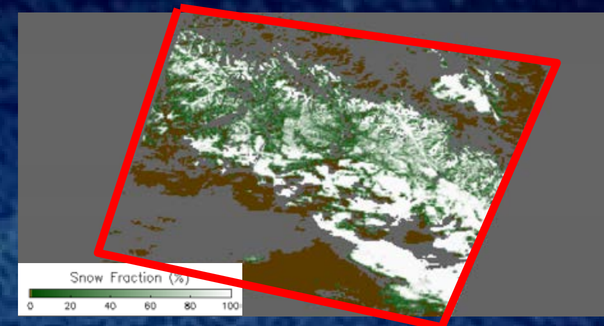
VIIRS-Landsat Matching: Example



Landsat RGB

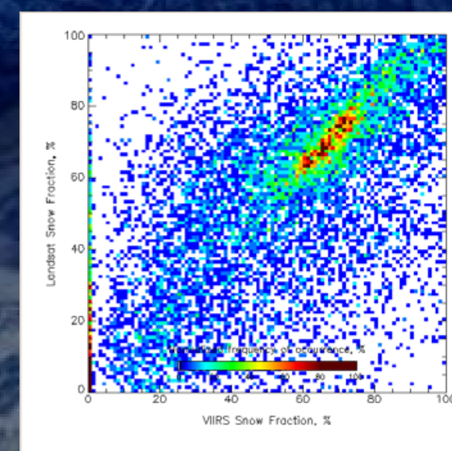


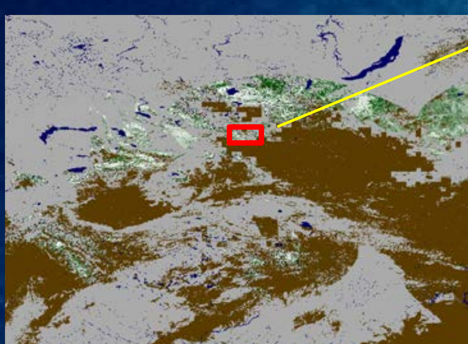
Landsat Binary Snow

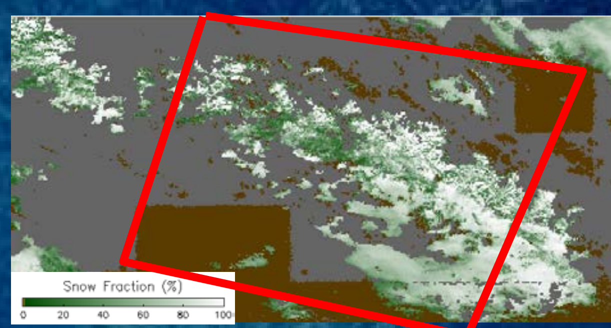


Landsat Aggregated Snow Fraction

Matched







VIIRS Snow Fraction matched with Landsat

VIIRS-Landsat Match-up Statistics

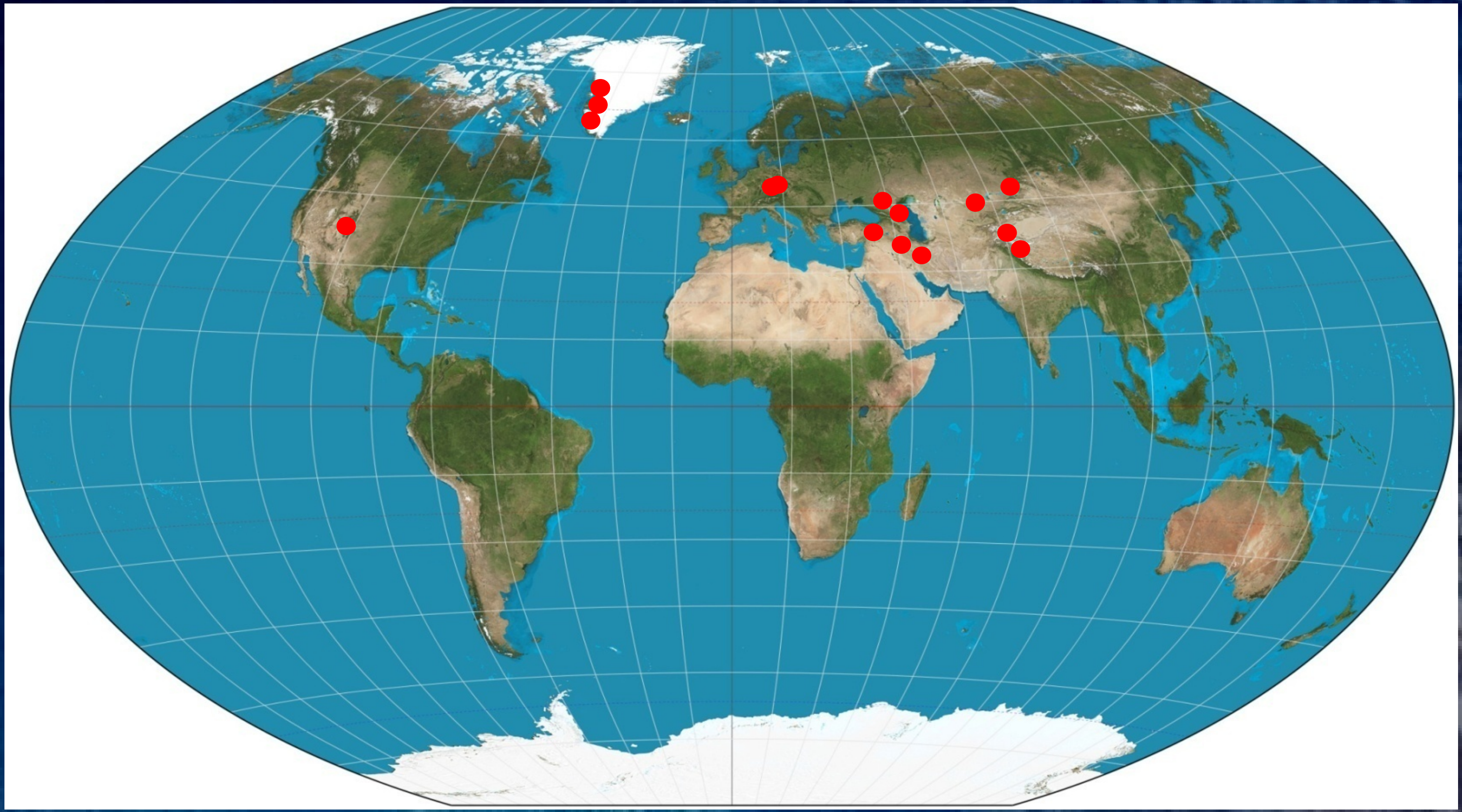
Correlation: 0.85

Bias: -0.076

RMSE: 0.162

Algorithm Verification with Landsat Data

Location of VIIRS and Landsat Comaprison (Apr 2014-Jan 2015)



Reflectance-based Snow Fraction Algorithm Verification

VIIRS reflectance-based snow fraction vs Landsat

Date	Place	Path	Row	1 km			5 km		
				Corr	Bias	RMSE	Corr	Bias	RMSE
01/01/15	Mongolia	140	28	0.78	-0.054	0.247	0.91	-0.076	0.162
01/13/15	Germany	192	26	0.78	-0.004	0.04	0.93	-0.006	0.021
01/13/15	Austria	192	27	0.67	0.064	0.208	0.87	0.077	0.144
01/14/15	Iran	167	35	0.88	-0.031	0.122	0.94	-0.039	0.096
01/14/15	Iran	167	36	0.82	-0.018	0.085	0.91	-0.027	0.072
01/15/15	Caucasus	174	28	0.95	-0.035	0.150	0.98	-0.037	0.082
01/15/15	Caucasus	174	29	0.93	-0.025	0.174	0.98	-0.026	0.079
01/15/15	Turkey	174	32	0.76	-0.025	0.263	0.94	-0.037	0.089
01/16/15	Kazakhstan	165	27	0.92	-0.025	0.197	0.95	-0.019	0.163
01/22/15	Rocky Mnts	38	30	0.80	-0.095	0.210	0.89	-0.105	0.134
04/10/14	Himalaya	150	36	0.95	0.001	0.099	0.93	0.002	0.106
04/10/14	Himalaya	150	35	0.89	-0.013	0.193	0.87	0.001	0.112
07/14/14	Greenland	6	13	0.93	-0.040	0.181	0.84	-0.046	0.156
07/14/14	Greenland	6	14	0.86	-0.070	0.154	0.95	-0.07	0.128
07/14/14	Greenland	6	15	0.93	-0.045	0.150	0.95	-0.051	0.114
Mean				0.84	-0.036	**0.174**	0.89	-0.054	**0.127**

Statistics was calculated for observations aggregated within 1 km and 5 km grid boxes.

Each Landsat-VIIRS matched scene includes from about 400 to several thousand matched snow fraction estimates.

The RMSE between VIIRS and Landsat snow fraction estimates is 17.4% for 1 km grid cells and 12.7 % for 5 km aggregation

Reflectance-based Snow Fraction Algorithm Verification

VIIRS reflectance-based and NDSI snow fraction

Date	Place	Reflectance-based, 5km			NDSI-based, 5 km		
		Corr	Bias	RMSE	Corr	Bias	RMSE
01/01/15	Mongolia	0.91	-0.076	0.162	0.86	0.115	0.245
01/13/15	Germany	0.93	-0.006	0.021	0.91	0.022	0.080
01/13/15	Austria	0.87	0.077	0.144	0.84	0.236	0.362
01/14/15	Iran(1)	0.94	-0.039	0.096	0.94	0.001	0.092
01/14/15	Iran (2)	0.91	-0.027	0.072	0.90	-0.007	0.066
01/15/15	Caucasus (1)	0.98	-0.037	0.082	0.94	0.096	0.176
01/15/15	Caucasus (2)	0.98	-0.026	0.079	0.88	0.210	0.281
01/15/15	Turkey	0.94	-0.037	0.089	0.82	0.307	0.367
01/16/15	Kazakhstan	0.95	-0.019	0.163	0.83	0.188	0.310
01/22/15	Rocky Mnts	0.89	-0.105	0.134	0.71	0.279	0.329
Mean		0.93	-0.003	**0.104**	0.86	0.145	**0.223**

Comparison of NDSI and Reflectance based snow fraction was limited to 5 scenes

Correlation of both types of snow fraction to Landsat is high (0.82-0.98)

Smaller bias and RMSE of the reflectance-based snow fraction

Considerable positive bias (~0.09) of the heritage NDSI algorithm

VIIRS-Landsat Comparison: Limited Validity

Comparison of VIIRS and Landsat snow fraction can not be viewed as a legitimate validation of VIIRS snow fraction retrievals for the following reasons:

- The same algorithm and same spectral bands are used to identify snow in Landsat and VIIRS imagery, therefore products are not independent
- Landsat snow retrievals and Landsat cloud mask have not been validated and their accuracy is largely unknown.
- Landsat scene is assumed to have no partially snow covered pixels. This condition is unrealistic and can never be satisfied unless the whole VIIRS footprint is completely snow-covered or snow-free.
- Aggregation of binary snow retrievals at finer spatial resolution is not a proper way to estimate the "viewable" snow fraction. This was the primary reason for replacing the current VIIRS IDPS snow fraction algorithm with subpixel snow fraction estimates.

Summary of Validation/Verification Results for VIIRS Snow Fraction

- S-NPP/VIIRS snow fraction products generated with the new NDE algorithm have been evaluated and their quality has been assessed.
- The VIIRS Snow Fraction product realistically reproduces the fractional snow cover is consistent with related environmental datasets.
- VIIRS reflectance-based snow fraction demonstrates better consistency with the forest cover as compared to the NDSI-based snow fraction.
- VIIRS snow fraction (both reflectance-based and NDSI-based) agrees to within 10-25% to the snow fraction derived through aggregation of Landsat binary snow cover estimates.
- MODIS heritage NDSI-based algorithm applied for VIIRS results in overestimated snow fraction values

VIIRS Snow Fraction Products: Remaining Issues

Reflectance-based snow fraction

- Snow and snow-free land BRDF model may need adjustment
- The algorithm may be improved by accounting for shadowed portions of the scene. Disregard of shadows may cause some underestimate of the snow fraction in forests.

NDSI-based snow fraction

- Introduce geometry-corrected NDSI for land and snow endmembers
- Correspondence between VIIRS and MODIS NDSI should be evaluated.
- The MODIS NDSI algorithm applied to VIIRS results in overestimated snow fraction. Adjustment may be needed to algorithm coefficients.

VIIRS Snow Fraction Products: Remaining Issues

Both algorithms

- The true fractional snow cover (characterizing the portion of land surface covered with snow) is needed besides the “viewable” snow fraction. To estimate the “true” snow fraction, the masking effect of forests has to be accounted for in the “viewable” snow fraction.

Outline

- Introduction
- Risks and Actions
- Requirements
- Algorithm Readiness
- Software Architecture
- Delivered Algorithm Package
- Risks Summary
- Summary and Conclusions

JPSS RR Product System (JPSS RR PS) Software Architecture and Detailed Design

Andy Heidinger, Denis Botambekov, Mike Pavolonis, Corey Calvert, Pat Heck, Andy Walther, Shobha Kondrangunta, Pubu Ciren, Istvan Laszlo, Hongqing Liu , Jeff Key, Xuanji Wang, Yinghui Liu, Richard Dworak, Peter Romanov
Hua Xie, Shanna Sampson, Aiwu Li, Tianxu Yu, Ruiyue Chen, Tom King, Mike Walters, Alexander Ken, John Lindeman, Walter Wolf, William Straka III, Peter Kheen, Meizhu Fan, Veena Jose

JPSS RR PS
Software Architecture

Outline

- JPSS RR PS System Overview
- JPSS RR PS Detailed Design
- JPSS RR PS Algorithm Software
- AIT Framework
- Transition to Operations

JPSS RR PS Processing Architecture

- Hardware Environment
  - » STAR Science Development
  - » System Development and Unit Testing
  - » Test and Production
- Software Description
  - » External-Level Flow
  - » System Level Flow
  - » Unit Level Flow
  - » Sub-Unit Flow
- Data Files
  - » Input Files
  - » Static/Ancillary Files
  - » Output Files
  - » Log Files
  - » Resource Files
  - » File Formats

JPSS RR PS Development Hardware

- The JPSS RR science development occurs in the STAR Collaborative Environment.
- Science development hardware:
  - » Dell Intel
  - » OS Version: Red Hat Enterprise Linux 6.7
  - » Fortran Compiler: Intel 13.0.1, GNU 4.4.7
  - » C/C++ Compiler: Intel 13.0.1, GNU 4.4.7
- STAR machines
  - » rhw1044 – Algorithm Integration
  - » rhw1045 – Testing
  - » orbit242l – SDR reformatting
  - » orbit241l – Validation

JPSS RR PS Development Environment

- JPSS RR Processing System development occurs on rhw1044 located in the STAR Collaborative Environment.
- The current rhw1044 configuration is:
  - » Dell Intel
  - » OS Version: Red Hat Enterprise Linux 6.7
  - » Disk space: 2 TB
  - » Number of Processors: 16
  - » Total Memory: 32 GB
  - » Processor Clockspeed: 3.20 GHz
  - » Fortran Compiler: Intel 13.0.1, GNU 4.4.7
  - » C/C++ Compiler: Intel 13.0.1, GNU 4.4.7
- Upgrades: No plans for upgrades at this time.

JPSS RR PS Test Hardware at STAR

- JPSS RR Product System testing occurs on rhw1045 located in the STAR Collaborative Environment.
- The current rhw1045 configuration is:
  - » Dell Intel
  - » OS Version: Red Hat Enterprise Linux 6.7
  - » Disk space: 2 TB
  - » Number of Processors: 16
  - » Total Memory: 32 GB
  - » Processor Clockspeed: 3.20 GHz
  - » (No compiler)
- Upgrades: No plans for upgrades at this time.

JPSS RR PS NDE Hardware

- The JPSS RR Product System official test machine is located within the NDE2.0 environment

- The JPSS RR Product System operational machine is located within the NDE environment.

JPSS RR PS
Software Package Summary

- The JPSS RR PS is an integrated system built on top of the GOES-R AIT framework.
- The system is written in C/C++, FORTRAN, PERL
- Two third-party software applications are used.

Description	File and Language	Number of Files	Number of Lines
System/Sub-system processing control scripts	Perl scripts	20	5727
AIT Framework (Including SDR reader, CRTM, Clouds, Aerosols, Cryosphere algorithms, etc.)	C/C++, FORTRAN 90, Makefiles, XML, etc.	1549	463315
SDR Gap-filling*	Python scripts (python 2.7.3)	2	332
JPSS HDF5 to netCDF4 Convertor*	C, Makefiles	8	1814

* third-party software

JPSS RR PS
Software Package Summary (cont.)

- Third-party software applications*:
  - » SDR Gap-filling utility tool
    - – Python package for mending bowtie removed pixels in a VIIRS SDR image.
    - – *ftp://ftp.ssec.wisc.edu/pub/shellb3/ShellB3-Linux-x86_64-20120621-r713-core.tar.gz*
  - » JPSS HDF5 to NetCDF4 conversion utility ***(h5augjpss**, v1.1.0)*
    - – Command line tool that modifies JPSS HDF5 files by adding associated data or metadata or by hiding HDF5 elements in order to make the file accessible to NetCDF4 based applications and tools.
    - – *http://www.hdfgroup.org/projects/jpss/h5augjpss_index.html*

* Source code of the 3rd-party tools will be included in the JPSS RR PS DAP

JPSS RR PS
Software Package Summary (cont.)

- **Libraries and Utilities**:
  - » **NetCDF4 Library version 4.1.3 (available from Unidata website)**
    - – Compiled as 64 bit
    - – Libraries supplied by NDE
  - » **HDF5 Library version 1.8.10 (available from HDF Group website)**
    - – Compiled as 64 bit
    - – Requires szip 2.1 and zlib zlib-1.2.5
    - – Libraries supplied by NDE
  - » **CRTM Library version 2.0.2 (available from Joint Center for Satellite Data Assimilation (JCSDA)**
    - – Fortran 90 code
    - – Compiled as 64 bit
    - – Source code supplied within the JPSS RR PS DAP
  - » **wgrib2 version 0.1.8.2 (available from NCEP CPC website)**
    - – C and Fortran 90 code
    - – Compiled as 64 bit
    - – Utility tool supplied by NDE
  - » **Libxml2 devel version 2.7.6 (available from website xmlsoft.org or gnome.org)**
    - – C code
    - – Compiled as 64 bit
    - – Utility tool supplied by NDE

JPSS RR PS
Data Storage Information

- The storage usage for all JPSS RR PS primary and ancillary input data, intermediate data, and output data for one day.

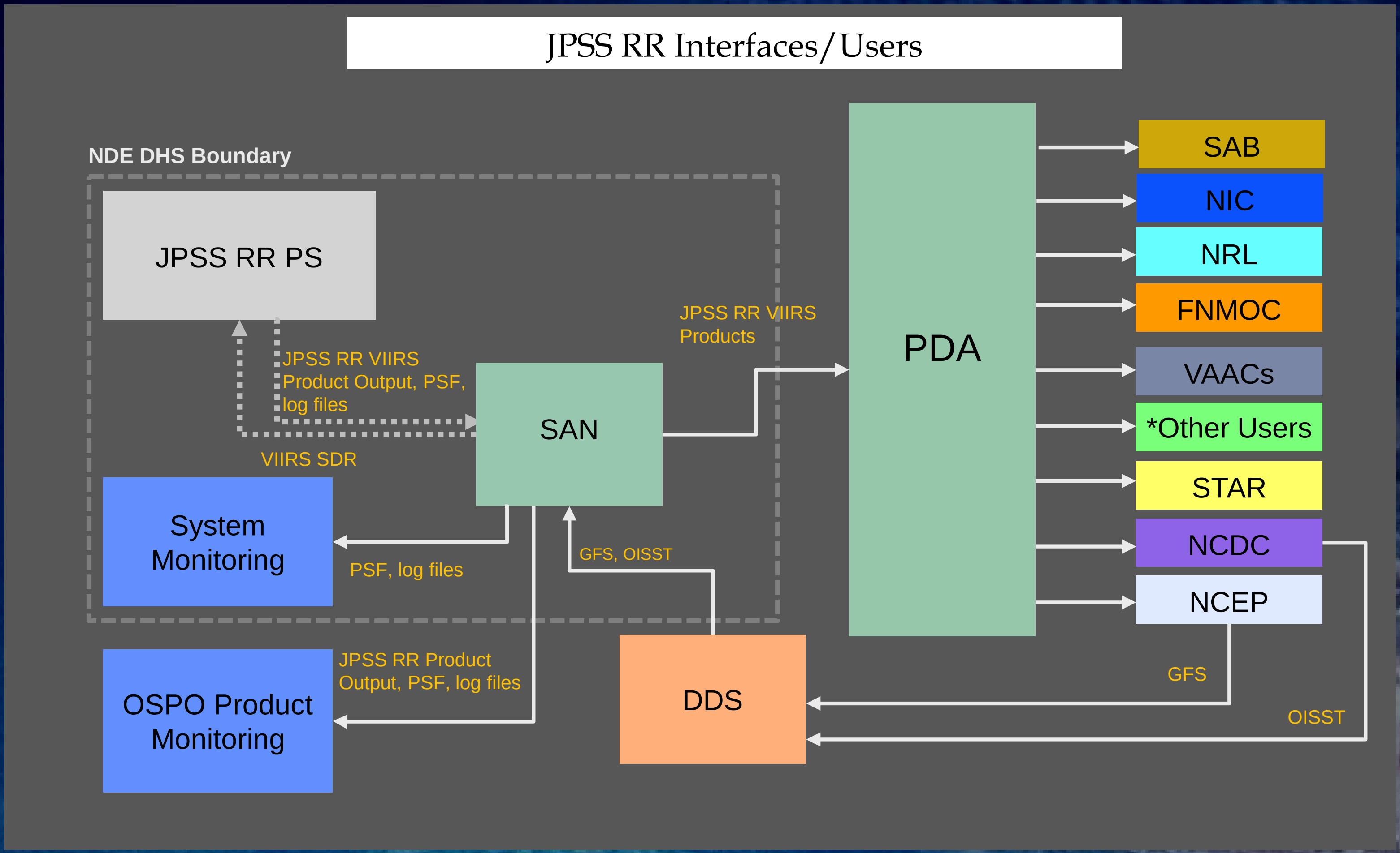
Storage Item	Size (1 day data storage)
Data Products Files	~1.72 TB
Incoming SDR Data and IP	~825 GB
Gap-filled/converted SDR	~645 GB
Static Ancillary	~17 GB
GFS Forecasts	~1.1GB
OISST Daily	~8 MB
System Code (executables, include third party of H5augjpss and gap-filling)	~23 MB
System scripts	~208 KB
System Resource Files	96 KB
CRTM version 2.0.2 package	~101 MB
Total	**~2.7 TB**

* The information in the table is based on the assumption of ~1000 granules per day.

JPSS RR PS External-Level Interface

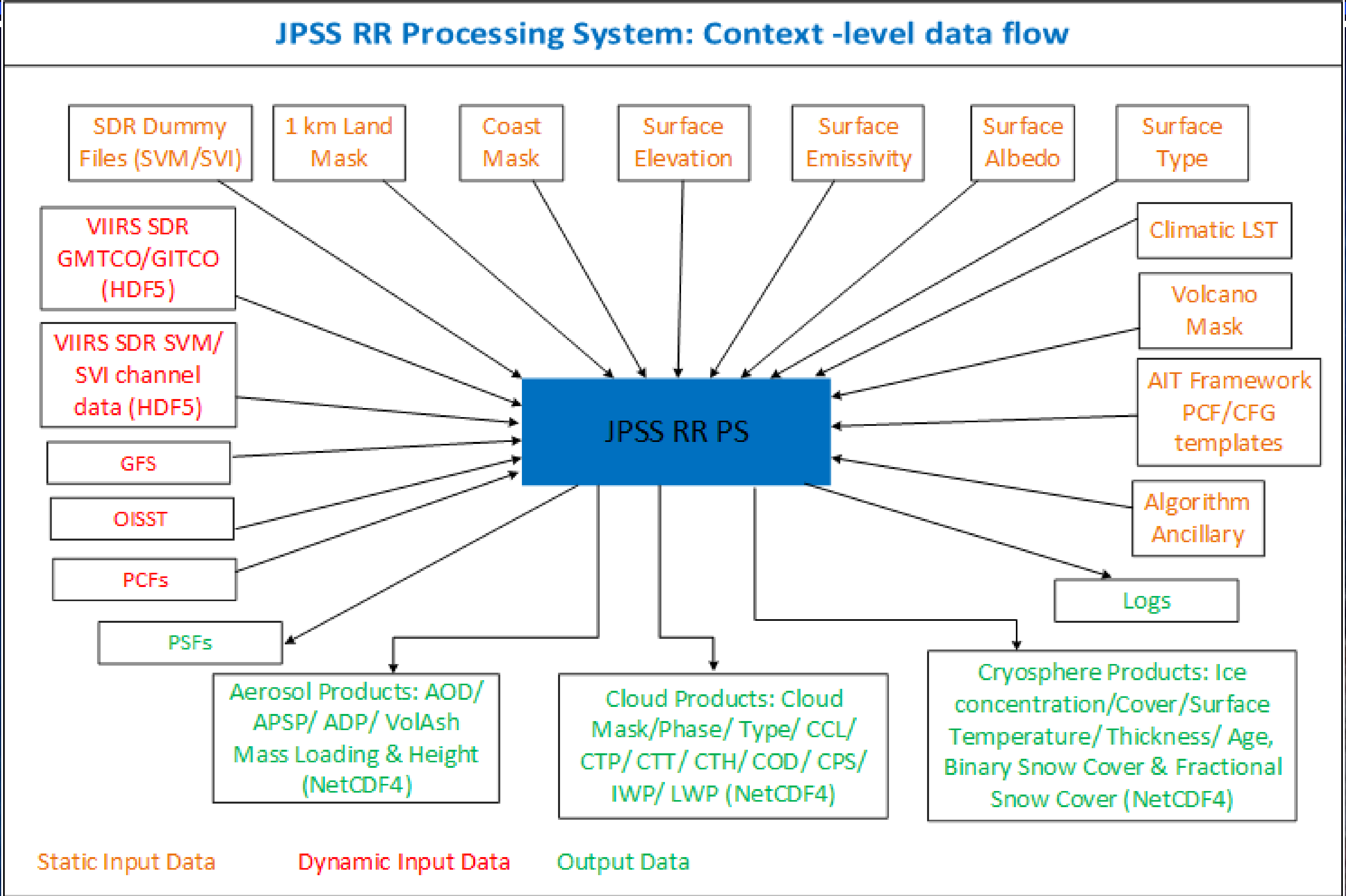
- All JPSS RR Product System external interfaces are shown on the following 4 slides
  - » 1 slide showing production and user interface flow chart
  - » 1 slide illustrating the external level data flow
  - » 2 slides on external-level interfaces in NDE DHS environment

JPSS RR PS Interfaces/Users



*Other Users: Climate users, International NWP Users, NWP FOs

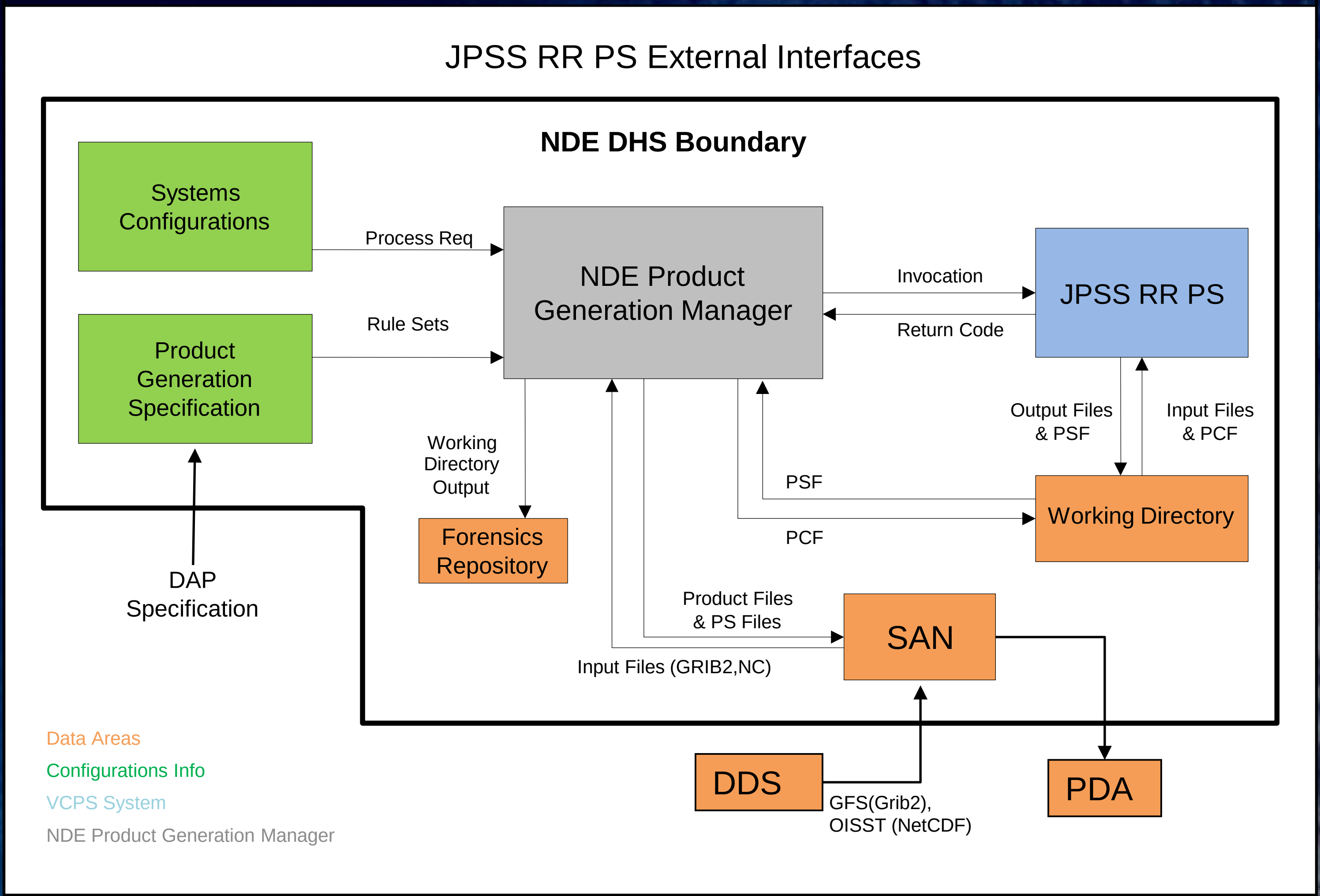
JPSS RR PS
Context Level Data Flow



JPSS RR PS
External Interfaces

- The JPSS RR Processing System will be run via execution of top level driver script that will be invoked, monitored, and managed by the NDE Data Handling System(DHS)
- The driver script is designed to run in a single working directory. All unit output will be produced in the same working directory
- The processing run will receive a Process Control File (PCF) from the NDE Product Generation Manager (PGM) containing all input file locations, parameters and other information needed by the Processing System
- The processing run will produce a PSF containing information about product files

JPSS RR PS External Interfaces



JPSS RR PS Software Architecture

Outline

- JPSS RR PS System Overview
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- JPSS RR PS Algorithm Software
- AIT Framework
- Transition to Operations

JPSS RR PS
System Level

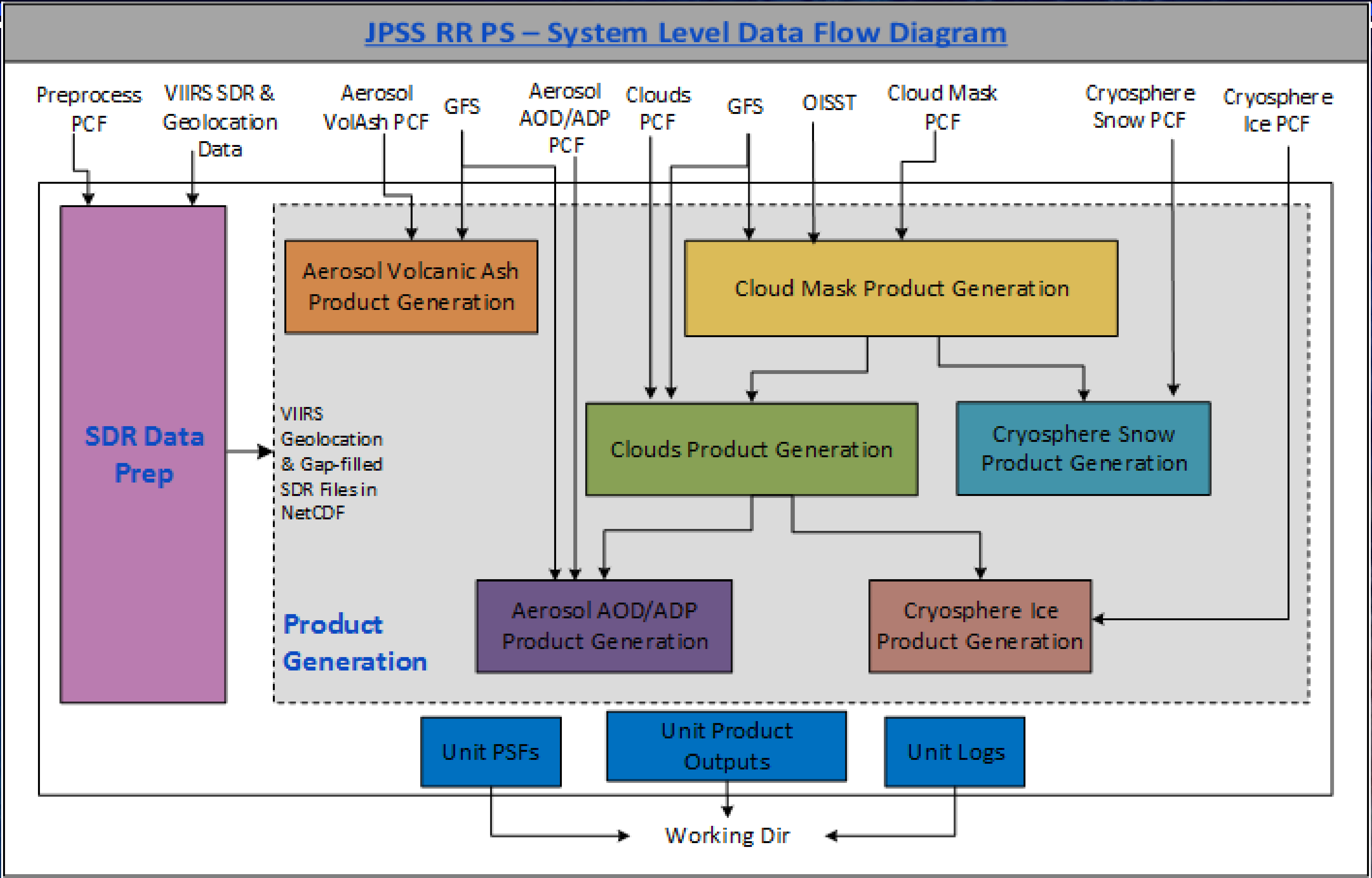
- The JPSS RR Product System consists of seven sub-systems (units) – one pre-processing unit and six stand-alone production units:
  - SDR Data Preparation Unit → *Pre-process*
  - Cloud Mask Product Generation Unit
  - Clouds Product Generation Unit
  - Cryosphere Ice product Generation Unit
  - Cryosphere Snow product Generation Unit
  - Aerosol AOD and ADP Product Generation Unit
  - Aerosol Volcanic Ash Product Generation Unit

Production

JPSS RR PS System Level

- SDR Data Preprocessing is carried out once, for use by all product generation units or sub-systems.
- Cloud Mask Product Generation and Volcanic Ash Product Generation have no product precedence.
- Cloud Mask Product Generation is a pre-requisite for Clouds, Aerosol AOD/ADP, and Cryosphere Snow product generation units
- Whereas, Clouds Product Generation is a pre-requisite for Aerosol AOD/ADP, and Cryosphere Ice product generation units

JPSS RR PS
System Level Diagram



System Level Data Overview

System PCFs

File	Data Type	Size of single file	Source	Format
JRR_PREPROCESS_SDR.pl.PCF	Dynamic Primary Input	2.7 KB	NDE	ASCII
JRR_PRODUCT_AEROSOL_AODADP.pl.PCF	Dynamic Primary Input	5.1K	NDE	ASCII
JRR_PRODUCT_AEROSOL_VOLASH.pl.PCF	Dynamic Primary Input	6.5K	NDE	ASCII
JRR_PRODUCT_CLOUD_CLOUDS.pl.PCF	Dynamic Primary Input	20K	NDE	ASCII
JRR_PRODUCT_CLOUD_MASK.pl.PCF	Dynamic Primary Input	19K	NDE	ASCII
JRR_PRODUCT_CRYOSPHERE_ICE.pl.PCF	Dynamic Primary Input	4.0K	NDE	ASCII
JRR_PRODUCT_CRYOSPHERE_SNOW.pl.PCF	Dynamic Primary Input	17K	NDE	ASCII

System Level Data Overview

Satellite data

Data File/ Resolution	No of files/ day	Data Type	Apprx. size / day	Source	Format
VIIRS Geo-location File for M-Bands	~1000	Primary Dynamic Input	56 GB	IDPS	HDF5
VIIRS SDR M-Band Files	~16000	Primary Dynamic Input	172 GB	IDPS	HDF5
VIIRS Geo-location File for I-Bands	~1000	Primary Dynamic Input	219 GB	IDPS	HDF5
VIIRS SDR I-Band Files	~5000	Primary Dynamic Input	201 GB	IDPS	HDF5
VIIRS Geo-location File for M-Bands	~1000	Inter. Input/Output	56 GB	JPSS RR PS	NetCDF4
Gap-filled VIIRS SDR M-Band Files	~16000	Inter. Input/Output	172 GB	JPSS RR PS	NetCDF4
VIIRS Geo-location File for I-Bands	~1000	Inter. Input/Output	219 GB	JPSS RR PS	NetCDF4
Gap-filled VIIRS SDR I-Band Files	~5000	Inter. Input/Output	201 GB	JPSS RR PS	NetCDF4

System Level Data Overview

Dynamic Ancillary Input

Data	No of files/ day	Data Type	Apprx. size / day	Source	Format
*Half deg. NWP GFS	16	Primary Dynamic Input	1.1 GB	NCEP	GRIB2
Quarter deg. OISST Daily	1	Primary Dynamic Input	8 MB	NCDC	NetCDF4
CRTM	N/A	Dynamic Input (framework internal computation)	Not saved to disk	JPSS RR PS	NetCDF4
+SNOW_MASK_NWP	N/A	Dynamic Input (framework internal computation)	Not saved to disk	JPSS RR PS	NetCDF4
3.9 um Pseudo Emissivity	N/A	Dynamic Input (framework internal computation)	Not saved to disk	JPSS RR PS	NetCDF4

*Might require up to 8-10 GFS files (trace back); although, system makes use of only 2 files for each processing run

+Snow Mask NWP will be replaced with IMS Snow Mask, as it gets implemented in framework

System Level Data Overview

Static Ancillary Input

Data/Description	No of files	Data Type	Size of single file	Source	Format
LAND_MASK_MODIS_250M	318	Static Input	108 KM – 1.7 MB	DAP/ NDE	NetCDF4
LAND_MASK_NASA_1KM	1	Static Input	890 MB	DAP/ NDE	NetCDF4
COAST_MASK_NASA_1KM	1	Static Input	890 MB	DAP/ NDE	NetCDF4
SFC_ELEV_GLOBE_1KM	1	Static Input	1.8 GB	DAP/ NDE	NetCDF4
SFC_TYPE_AVHRR_1KM	1	Static Input	890 MB	DAP/ NDE	NetCDF4
SFC_EMISS_SEEBOR	12	Static Input	693 MB	DAP/ NDE	NetCDF4
SFC_ALBEDO	69	Static Input	28 MB	DAP/ NDE	NetCDF4
VOLCANO_SMITH_1KM	1	Static Input	890 MB	DAP/ NDE	NetCDF4
CLIMATIC_LST_ISCCP	12	Static Input	47 KB	DAP/ NDE	NetCDF4
DESERT_MASK_CALCLTED (framework internal computation)	N/A	Static Input	Not saved to disk	JPSS RR PS	NetCDF4

System Level Data Overview

Static Algorithm Ancillary Input

Data/Description	No of files	Input Data Type	Size of single file	Source	Format
npp_viirs_ancil.nc VIIRS SDR Ancil Files for I/M bands	2	Static Algorithm Ancillary	2.2 - 2.6 KB	DAP/ NDE	NetCDF4
VIIRS SDR Dummy files (SVI01/04, SVM01/12/13)	5	Static Algorithm Ancillary	9.3 - 50 MB	DAP/NDE	NetCDF4
NCOMP coeff file for VIIRS	1	Static Algorithm Ancillary	47KB	DAP/ NDE	NetCDF4
DCOMP channel ref/ems Coeff files for ice/water phases	10	Static Algorithm Ancillary	91-99MB	DAP/ NDE	NetCDF4
Volcanic Ash IR retreival coeff. file	1	Static Algorithm Ancillary	35 KB	DAP/ NDE	NetCDF4
CloudCoeff.bin CRTM coeff file	1	Static Algorithm Ancillary	1.6MB	DAP/ NDE	Binary
AerosolCoeff.bin CRTM coeff file	1	Static Algorithm Ancillary	5.5MB	DAP/ NDE	Binary
EmisCoeff.bin CRTM coeff file	1	Static Algorithm Ancillary	1.9MB	DAP/ NDE	Binary
viirs-m_npp.SpcCoeff.bin CRTM coeff file	1	Static Algorithm Ancillary	472B	DAP/ NDE	Binary
viirs-m_npp.TauCoeff.bin CRTM coeff file	1	Static Algorithm Ancillary	104KB	DAP/ NDE	Binary

System Level Data Overview

Static Algorithm Ancillary Input

Data/Description	No of files	Input Data Type	Size of single file	Source	Format
VIIRS_Aerosol_LUT.nc Aerosol LUT File	1	Static Algorithm Ancillary	39 MB	DAP/ NDE	NetCDF4
VIIRS_BrightSfc_Refl_Coeff.nc Aerosol coeff. File	1	Static Algorithm Ancillary	47 MB	DAP/ NDE	NetCDF4
VIIRS_Coeff_File.nc Aerosol coeff. File	1	Static Algorithm Ancillary	6.8 KB	DAP/ NDE	NetCDF4
VIIRS_Aerosol_Sunglint_Lut.nc Aerosol LUT File	1	Static Algorithm Ancillary	179 MB	DAP/ NDE	NetCDF4
AITA_Coefficients_ResiFlux.nc Ice Age Coeff. file	1	Static Algorithm Ancillary	1.4 KB	DAP/ NDE	NetCDF4
AITA_INPUT_Coefficients_ResiFlux.nc Ice Age Coeff. file	1	Static Algorithm Ancillary	1.4 KB	DAP/ NDE	NetCDF4
IceSrfTempCoeff_NPP_VIIRS.nc Ice Conc. Coeff. file	1	Static Algorithm Ancillary	1.2 KB	DAP/ NDE	NetCDF4
viirs_default_nb_cloud_mask_lut.nc Bayesian Cloud Mask coeff. File	1	Static Algorithm Ancillary	94 KB	DAP/ NDE	NetCDF4
snow_occurrence_latlon_week_??.nc Climatic snow files for Snow Cover	52	Static Algorithm Ancillary	576 KB	DAP/ NDE	NetCDF4

System Level Data Overview

Output Product Files

Data	No of files/ day	Data Type/ Resolution	Apprx. size / day	Source	Format
JPSS RR VIIRS Cloud Mask	~1000	Product Output (750 m)	140 GB	JPSS RR PS	NetCDF4
JPSS RR VIIRS Cloud Phase: Phase & Type	~1000	Product Output (750 m)	40 GB	JPSS RR PS	GRIB2
JPSS RR VIIRS Cloud Height: Cloud-top Height/ Pressure/ Temperature	~1000	Product Output (750 m)	155 GB	JPSS RR PS	NetCDF4
JPSS RR VIIRS Daytime Cloud Optical Properties: CPS, COD, LWP, IWP	~1000	Product Output (750 m)	113 GB	JPSS RR PS	NetCDF4
JPSS RR VIIRS Nighttime Cloud Optical Properties: CPS, COD, LWP, IWP	~1000	Product Output (750 m)	113 GB	JPSS RR PS	NetCDF4
JPSS RR VIIRS Aerosol Detection: Smoke & Dust	~1000	Product Output (750 m)	61 GB	JPSS RR PS	NetCDF4
JPSS RR VIIRS Aerosol Optical Depth: AOD & Aerosol Particle Size Parameter	~1000	Product Output (750 m)	303 GB	JPSS RR PS	NetCDF4
JPSS RR VIIRS Aerosol Volcanic Ash: Mass Loading and Height	~1000	Product Output (750 m)	110 GB	JPSS RR PS	NetCDF4

System Level Data Overview

Output Product Files

Data/Resolution	No of files/ day	Data Type /Resolution	Apprx. size / day	Source	Format
JPSS RR VIIRS Cryosphere Ice Conc. and Ice Surface Temperature	~1000	Product Output (750 m)	51GB	JPSS RR PS	NetCDF4
JPSS RR VIIRS Cryosphere Ice Thickness and Age	~1000	Product Output (750 m)	47 GB	JPSS RR PS	NetCDF4
JPSS RR VIIRS Cryosphere Snow Cover: Binary Snow Mask, NDSI Snow Fraction and Reflectance based Snow Fraction	~1000	Product Output (375 m)	61 GB	JPSS RR PS	NetCDF4

System Level Data Overview

System PSFs

File	Data Type	Size of single file	Source	Format
JRR_PREPROCESS_SDR.pl.PSF	Output	4.1 KB	NDE	ASCII
JRR_PRODUCT_AEROSOL_AODADP.pl.PSF	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_AEROSOL_VOLASH.pl.PSF	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_CLOUD_CLOUDS.pl.PSF	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_CLOUD_MASK.pl.PSF	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_CRYOSPHERE_ICE.pl.PSF	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_CRYOSPHERE_SNOW.pl.PSF	Output	< 1 KB	NDE	ASCII

System Level Data Overview

System Log files

File	Data Type	Size of single file	Source	Format
JRR_PREPROCESS_SDR.pl.log	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_AEROSOL_AODADP.pl.log	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_AEROSOL_VOLASH.pl.log	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_CLOUD_CLOUDS.pl.log	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_CLOUD_MASK.pl.log	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_CRYOSPHERE_ICE.pl.log	Output	< 1 KB	NDE	ASCII
JRR_PRODUCT_CRYOSPHERE_SNOW.pl.log	Output	< 1 KB	NDE	ASCII

JPSS RR PS System Level Interfaces

- The system level is where NDE invokes the Processing System
- Each processing unit (sub-system) has a Perl wrapper script that drives the processing algorithms
- The system PCF generated by NDE PGM contains all the input file locations and parameters needed by each processing unit.
- Each Processing System, in turn, produces a PSF file containing information about the system product file status

System Level
System Driver Script

- The system driver script is the top level script called by NDE PGM to invoke the production unit processing.
  - » There are no hard coded paths in the scripts. All needed information regarding locations of files will come through the system PCF
  - » All Perl library function calls and system calls have their return values checked and errors trapped so the exits are graceful and informative.
  - » All standard out and standard error is directed to a single log file that can be read by NDE for obtaining any error or warning messages.
  - » The driver script translate the low-level program errors into a high-level numerical value expected by the PGM (0 = success, 1=failure).
  - » The driver script set up the local environments (i.e. create unit PCFs, symbolic links, etc.) upfront before proceeding to low-level processing.

System Level Script Execution Tree (1/4)

Priority #1	JRR_PREPROCESS_SDR.pl (pre-process driver script)
	➢ jrr_preprocess_gapfill.pl (do gap filling if required) • *mender.py o *viirsmend.py ➢ jrr_preprocess_cvth52nc.pl (convert data from HDF5 to NetCDF4) • *h5augjpss

* third-party software

System Level Script Execution Tree (2/4)

Priority #2	JRR_PRODUCT_CLOUD_MASK.pl (product driver script)
	➢ jrr_product_sdr4frmwk.pl (rename the geo-location/SDR files for Framework use) • get_sdr_scan_time.exe ➢ jrr_product_env4frmwk.pl (set up environment for the Framework run) ➢ jrr_product_cld_mask.pl (Framework Cfg-Pcf Generator & Cloud Mask Product Retrieval) • pcf_framework.exe o run_wgrib.pl
Priority #2	JRR_PRODUCT_AEROSOL_VOLASH.pl(product driver script)
	➢ jrr_product_sdr4frmwk.pl (rename the geo-location/SDR files for Framework use) • get_sdr_scan_time.exe ➢ jrr_product_env4frmwk.pl (set up environment for the Framework run) ➢ jrr_product_aer_volash.pl (Framework Cfg-Pcf Generator & Volcanic Ash Product Retrieval) • pcf_framework.exe o run_wgrib.pl

System Level Script Execution Tree (3/4)

Priority #3	JRR_PRODUCT_CLOUD_CLOUDS.pl (product driver script)
	➢ jrr_product_sdr4frmwk.pl (rename the geo-location/SDR files for Framework use) • get_sdr_scan_time.exe ➢ jrr_product_env4frmwk.pl (set up environment for the Framework run) ➢ jrr_product_cld_clouds.pl (Framework Cfg-Pcf Generation & Cloud Phase/ Height/ Micro-Properties Product Retrieval) • pcf_framework.exe o run_wgrib.pl
Priority #3	JRR_PRODUCT_CRYOSPHERE_SNOW.pl (product driver script)
	➢ jrr_product_sdr4frmwk.pl (rename the geo-location/SDR files for Framework use) • get_sdr_scan_time.exe ➢ jrr_product_env4frmwk.pl (set up environment for the Framework run) ➢ jrr_product_cryos_snow.pl (Framework Cfg-Pcf Generation & Cryosphere Snow Cover / Fractional Snow Cover Product Retrieval) • pcf_framework.exe o run_wgrib.pl

System Level Script Execution Tree (4/4)

Priority #4	JRR_PRODUCT_AEROSOL_AODADP.pl (product driver script)
	➢ jrr_product_sdr4frmwk.pl (rename the geo-location/SDR files for Framework use) • get_sdr_scan_time.exe ➢ jrr_product_env4frmwk.pl (set up environment for the Framework run) ➢ jrr_product_aer_aodadp.pl (Framework Cfg-Pcf Generation & AOD/ ADP Product Retrieval) • pcf_framework.exe o run_wgrib.pl
Priority #4	JRR_PRODUCT_CRYOSPHERE_ICE.pl (product driver script)
	➢ jrr_product_sdr4frmwk.pl (rename the geo-location/SDR files for Framework use) • get_sdr_scan_time.exe ➢ jrr_product_env4frmwk.pl (set up environment for the Framework run) ➢ jrr_product_cryos_ice.pl (Framework Cfg-Pcf Generation & Cryosphere Ice Age/ Ice Concentration/ Ice Thickness Product Retrieval) • pcf_framework.exe o run_wgrib.pl

System Level Process Control File(PCF)

- A system PCF is generated by NDE PGM for each processing unit viz.
  - » JRR_PREPROCESS_SDR.pl.PCF
  - » JRR_PRODUCT_CLOUD_MASK.pl.PCF
  - » JRR_PRODUCT_CLOUD_CLOUDS.pl.PCF
  - » JRR_PRODUCT_AEROSOL_AODADP.pl.PCF
  - » JRR_PRODUCT_AEROSOL_ VOLASH.pl.PCF
  - » JRR_PRODUCT_ CRYOSPHERE_SNOW.pl.PCF
  - » JRR_PRODUCT_ CRYOSPHERE_ICE.pl.PCF
- Contains:
  - » Environmental variables required by the unit
  - » Contains input VIIRS Granule filenames.
  - » Dynamic ancillary & primary input data filenames; name and location for static input data for the current process
  - » Ancillary data files and location for framework product generation
  - » Path to the executables and scripts

System Level Product Status File(PSF)

- A system PSF is produced from each processing unit run
  - » The System PSFs contains the successfully generated output/ product filenames and location, for that unit.
  - » The PSFs can be used for PS production monitoring purpose.
- Namely:
  - » JRR_PREPROCESS_SDR.pl.PSF
  - » JRR_PRODUCT_CLOUD_MASK.pl.PSF
  - » JRR_PRODUCT_CLOUD_CLOUDS.pl.PSF
  - » JRR_PRODUCT_AEROSOL_AODADP.pl.PSF
  - » JRR_PRODUCT_AEROSOL_ VOLASH.pl.PSF
  - » JRR_PRODUCT_ CRYOSPHERE_SNOW.pl.PSF
  - » JRR_PRODUCT_ CRYOSPHERE_ICE.pl.PSF

System Level Product Log File

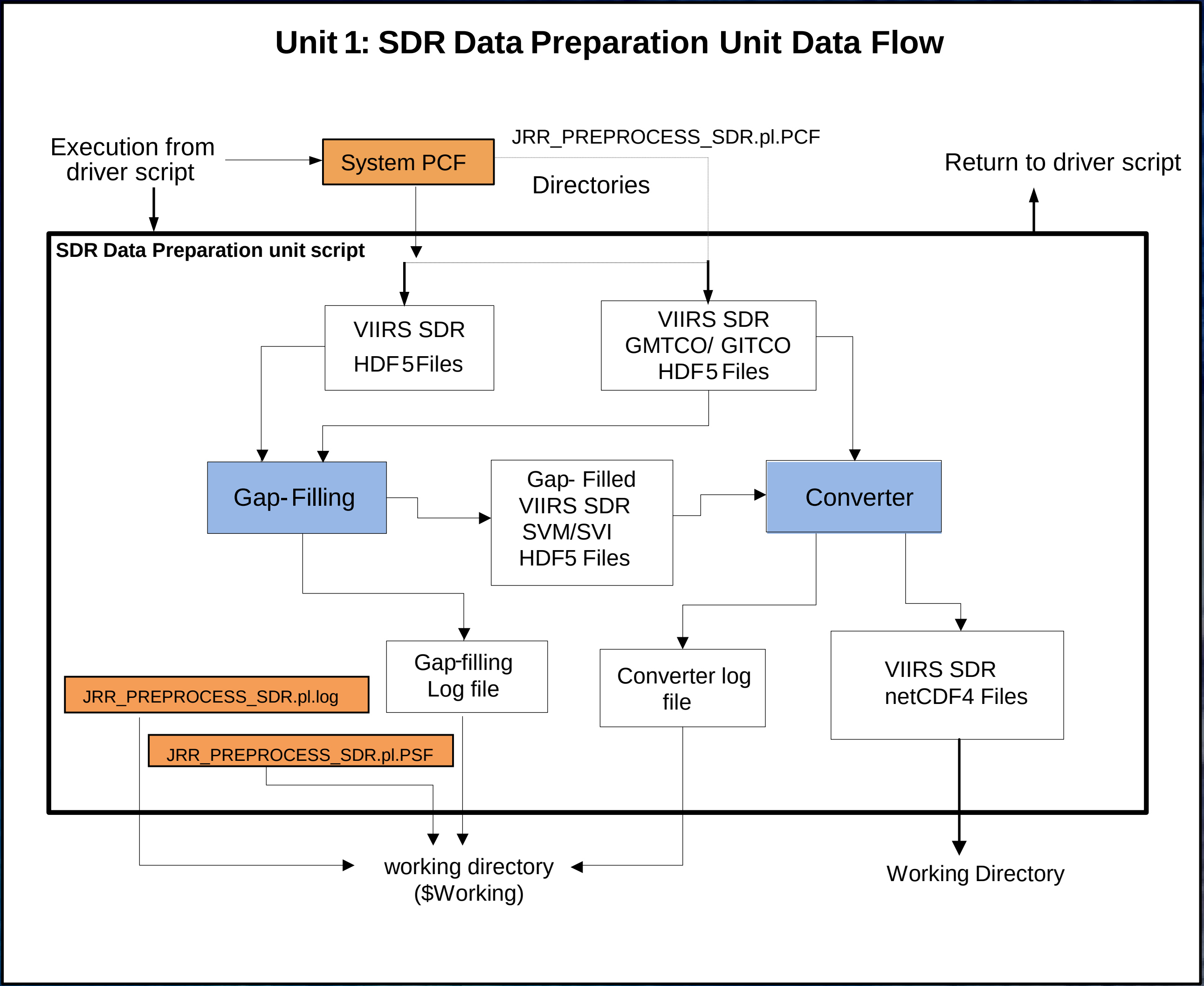
- A system level log file is produced from each processing unit run
  - » The System Log files contains the run status information for unit processing system.
  - » Any errors encountered during processing are notified through log file.
- Namely:
  - » JRR_PREPROCESS_SDR.pl.log
  - » JRR_PRODUCT_CLOUD_MASK.pl.log
  - » JRR_PRODUCT_CLOUD_CLOUDS.pl.log
  - » JRR_PRODUCT_AEROSOL_AODADP.pl.log
  - » JRR_PRODUCT_AEROSOL_VOLASH.pl.log
  - » JRR_PRODUCT_ CRYOSPHERE_SNOW.pl.log
  - » JRR_PRODUCT_ CRYOSPHERE_ICE.pl.log

JPSS RR PS
Unit Level

Unit 1. SDR Data Preparation

- 1.1. SDR Gap-filling
- 1.2. HDF5 to NetCDF4 Conversion

Unit Level Interfaces
1. SDR Data Preparation



SDR Data Preparation System PCF

System PCF

- A System PCF (Unit level) is passed by the System driver script to the sub-units for preparation of SDR data
- The system PCF contains the input SDR data and other information required by the Gap-Filling and SDR Converter sub-units
- A section of the system PCF (JRR_PREPROCESS_SDR.pl.PCF) is shown below:

```
PERL_LOC=/usr/bin/perl
OPS_SCRIPT=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/scripts
OPS_BIN=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/bin

gitco=GITCO_npp_d20150402_t1054237_e1055479_b17764_c20150402172259067059_noaa_ops.h5
gmtco=GMTCO_npp_d20150402_t1054237_e1055479_b17764_c20150402171617371175_noaa_ops.h5
svi01=SVI01_npp_d20150402_t1054237_e1055479_b17764_c20150402172912367353_noaa_ops.h5
svi02=SVI02_npp_d20150402_t1054237_e1055479_b17764_c20150402172855756881_noaa_ops.h5
svi03=SVI03_npp_d20150402_t1054237_e1055479_b17764_c20150402174048712352_noaa_ops.h5
svi04=SVI04_npp_d20150402_t1054237_e1055479_b17764_c20150402172950556360_noaa_ops.h5
```

SDR Data Preparation
1.1 SDR Gap Filling

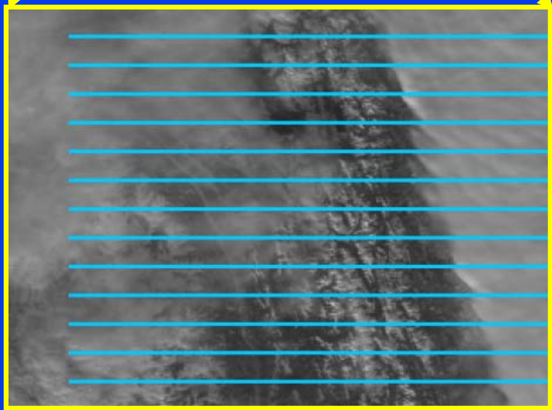
Sub-unit level interfaces

- A sub-unit level driver script is invoked by the system level script to start the sub-unit processing.
- Information in the system PCF is used to set up the sub-unit configuration, creating symbolic links for system files, etc.
- Gap-Filling python run scripts are called to fill the gaps on the VIIRS SDR files listed in the system PCF
- A log file is saved for the sub-unit process

SDR Data Preparation
1.1 SDR Gap Filling

Gaps on SDR granule

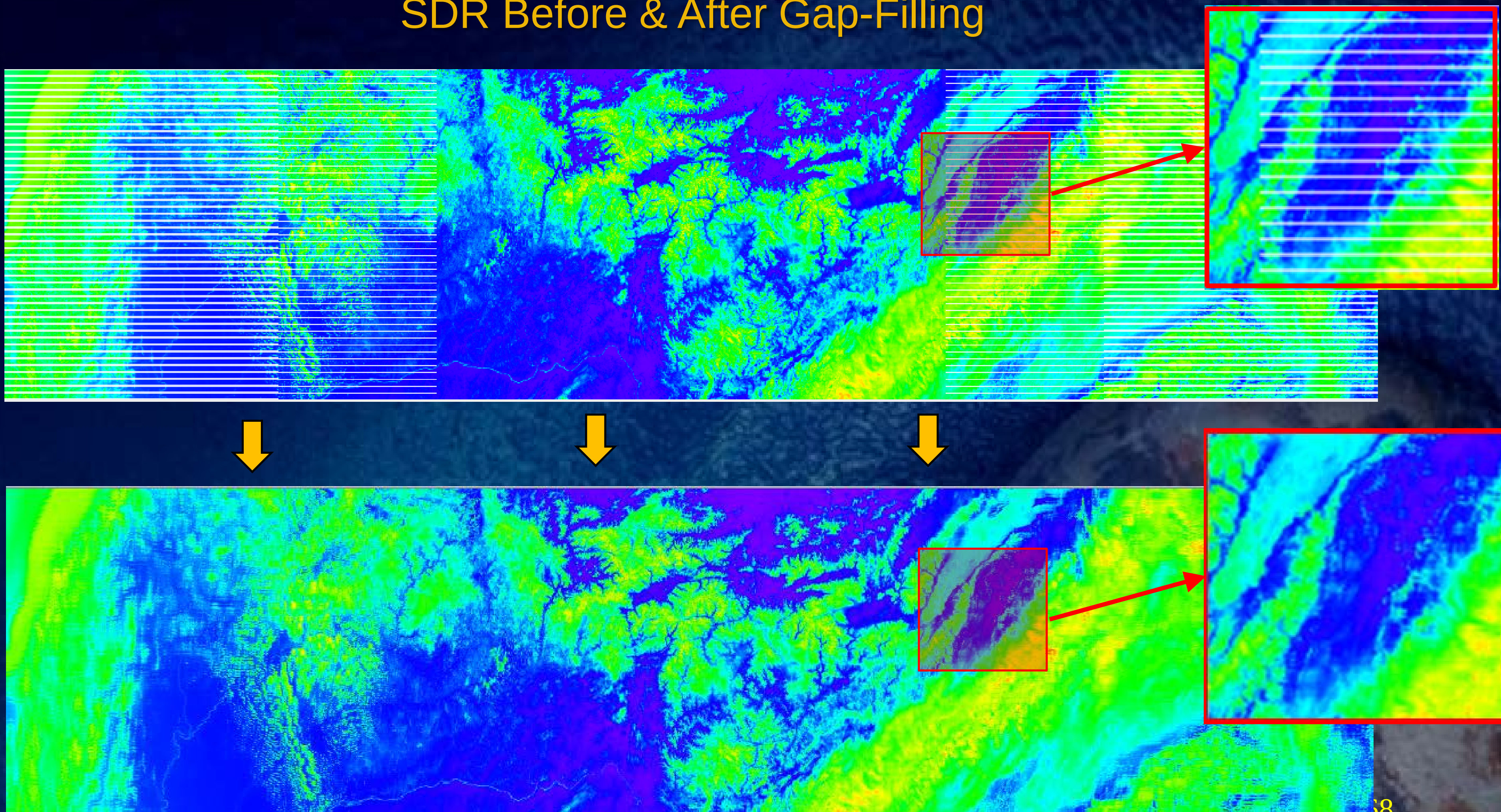
SVM01_npp_d20130117_t2059265_e2100506_b06349_c20130118032130407525_noaa_ops.h5



Gaps on the edges of a SDR granule, shows dropped portions of scan to reduce bow-tie effect

SDR Data Preparation
1.1 SDR Gap Filling

SDR Before & After Gap-Filling



SDR Data Preparation
1.1 SDR Gap Filling

Sub-unit Input/Output Data

File	Input /Output	Data description	Format
VIIRS SDR M-band files	Input	Total of 16 moderate resolution SDR files for each VIIRS granule. *SVM??_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.h5*	HDF5
VIIRS geolocation (M-band)	Input	Terrain corrected geolocation data file for each Moderate resolution VIIRS granule. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.h5*	HDF5
VIIRS SDR I-band files	Input	Total of 5 high resolution Imagery bands for each VIIRS granule. *SVI??_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.h5*	HDF5
VIIRS geolocation (I-band)	Input	Terrain corrected geolocation data file for high resolution Imagery channels. *GITCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.h5*	HDF5
Unit PCF	Input	Contains the directory setup of input data, scripts, etc.	ASCII
Gap-filled VIIRS SDR M-band files	Output	Gap-filled 16 moderate resolution SDR files for each VIIRS granule. *SVM??_npp_d????????_t???????_e???????_b?????_c??????????????_noaa_ops.h5*	HDF5
Gap-filled VIIRS SDR I-band files	Output	Gap-filled 5 high resolution Imagery bands for each VIIRS granule. *SVI??_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.h5*	HDF5
Sub-unit Log file	Output	Contains log for the gap-filling sub-unit	ASCII

SDR Data Preparation
1.2 HDF5 to NetCDF4 Convertor

Sub-unit level interfaces

- Information in the system PCF is used to set up the sub-unit configuration, creating symbolic links for system files, etc.
- The JPSS HDF5 converter is invoked to convert the gap-filled SDR HDF5 files, (SVM01-16 & SVI01-05) along with geolocation (GMTCO/GITCO), into NetCDF4 format
- A log file is saved for each script invoked during the process
- A Preprocessor PSF file containing the filenames of all converted VIIRS SDR/Geolocation files, is generated

SDR Data Preparation
1.2 HDF5 to NetCDF4 Convertor

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
Gap-filled VIIRS SDR M-band files	Input	Gap-filled 16 moderate resolution SDR files for each VIIRS granule. *SVM??_npp_d????????_t???????_e???????_b?????_c??????????????_noaa_ops.h5*	HDF5
VIIRS geolocation (M-band)	Input	Terrain corrected geolocation data file for each Moderate resolution VIIRS granule. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.h5*	HDF5
Gap-filled VIIRS SDR I-band files	Input	Gap-filled 5 high resolution Imagery bands for each VIIRS granule. *SVI??_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.h5*	HDF5
VIIRS geolocation (I-band)	Input	Terrain corrected geolocation data file for high resolution Imagery channels. *GITCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.h5*	HDF5
Unit PCF	Input	Contains the directory setup of input data, scripts, etc.	ASCII
Gap-filled VIIRS SDR M-band files in NetCDF	Output	NetCDF converted & Gap-filled 16 moderate resolution SDR files for each VIIRS granule. *SVM??_npp_d????????_t???????_e???????_b?????_c??????????????_noaa_ops.nc*	NetCDF4
VIIRS geolocation (M-band) in NetCDF	Output	NetCDF converted geolocation data (terrain-corrected) file for each Moderate resolution VIIRS granule. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
Gap-filled VIIRS SDR I-band files in NetCDF	Output	NetCDF converted & Gap-filled 5 high resolution Imagery bands for each VIIRS granule. *SVI??_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
VIIRS geolocation (I-band) in NetCDF	Output	NetCDF converted geolocation data (terrain-corrected) file for high resolution Imagery channels. *GITCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
Sub-unit Log file	Output	Contains log for the gap filling sub unit	ASCII

SDR Data Preparation Unit PSF and Log

- A preprocessor PSF containing the filenames of all converted VIIRS SDR files, is generated
  - » A section of JRR_PREPROCESS_SDR.pl.PSF is given below:

```
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764/GMTCO_npp_d20150402_t1054237_e1055479_b17764_c20150402171617371175_noaa_ops.nc
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764/SVM01_npp_d20150402_t1054237_e1055479_b17764_c20150402172853771802_noaa_ops.nc
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764/SVM02_npp_d20150402_t1054237_e1055479_b17764_c20150402172837504244_noaa_ops.nc
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764/SVM03_npp_d20150402_t1054237_e1055479_b17764_c20150402172859491592_noaa_ops.nc
```

- A log file is saved for each script invoked during the process
  - » A section of JRR_PREPROCESS_SDR.pl.log is given below:

```
JRR_PREPROCESS_SDR.pl is now starting at: 20150716-10:20:35
   switch_gapfill: ON
   Running jrr_preprocess_gapfill.pl
     - log:  jrr_preprocess_gapfill.pl.log
       - sublog:  mender.log
real     0m1.452s
user     0m0.476s
sys      0m0.813s
```

SDR Data Preparation
Unit level Input/Output Data

File	Input/ Output	No. of Files	Source	Format
VIIRS SDR M-band files	Input	16	IDPS	HDF5
VIIRS geolocation (M-band)	Input	1	IDPS	HDF5
VIIRS SDR I-band files	Input	5	IDPS	HDF5
VIIRS geolocation (I-band)	Input	1	IDPS	HDF5
Unit PCF	Input	1	NDE	ASCII
Gap-filled VIIRS SDR M-band files in NetCDF	Output	16	JPSS RR PS	NetCDF4
VIIRS geolocation (M-band) in NetCDF	Output	1	JPSS RR PS	NetCDF4
Gap-filled VIIRS SDR I-band files in NetCDF	Output	5	JPSS RR PS	NetCDF4
VIIRS geolocation (I-band) in NetCDF	Output	1	JPSS RR PS	NetCDF4
Unit PSF	Output	1	JPSS RR PS	ASCII
Unit Log file	Output	1	JPSS RR PS	ASCII

JPSS RR PS
Unit Level

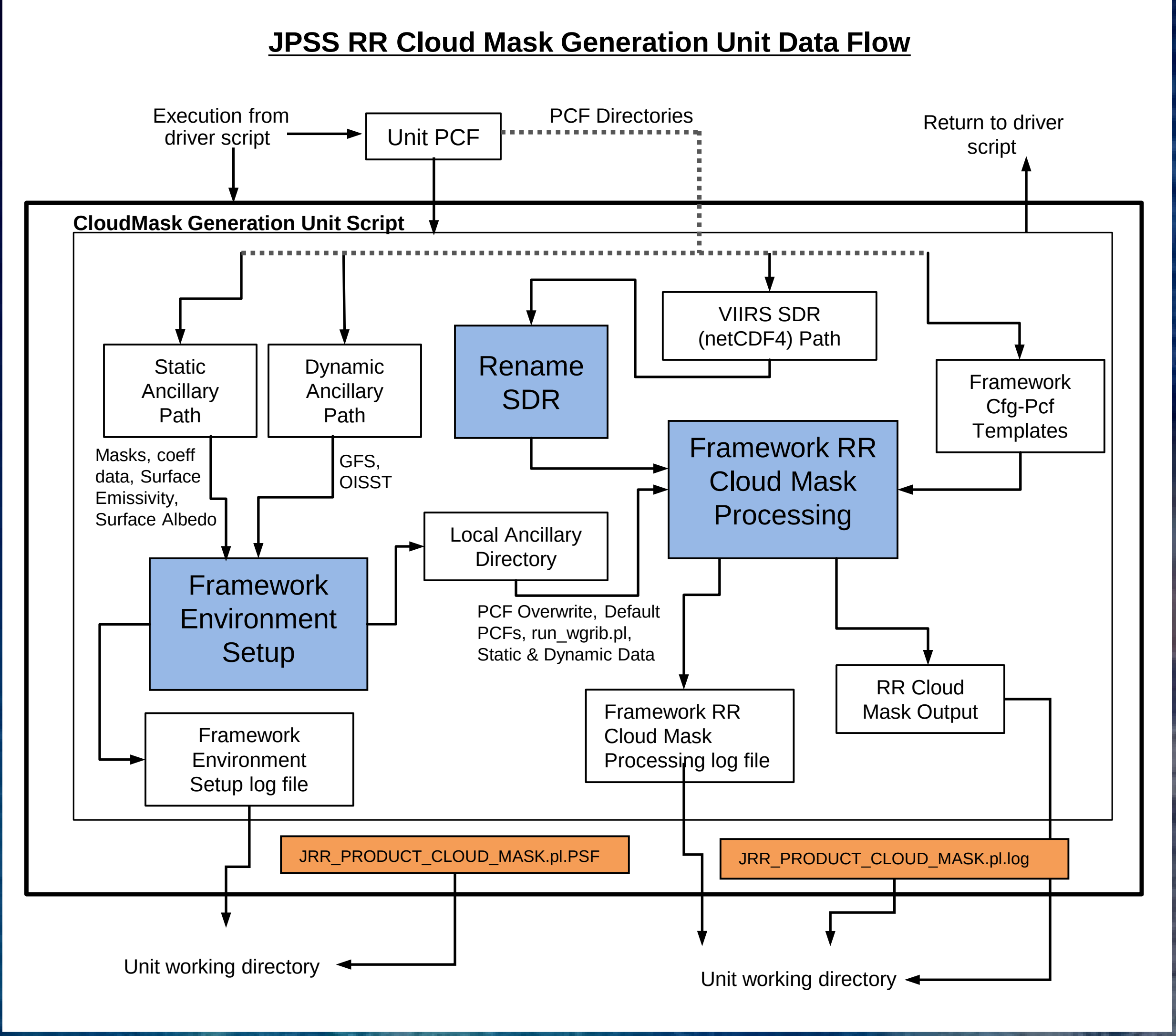
Unit 2. Cloud Mask Product Generation

2.1. Rename SDR for Framework

2.2. Framework Environment Setup

2.3. Framework Product Processing

Unit Level Interfaces
2. Cloud Mask Product Generation



2. Cloud Mask Product Generation

System PCF

- A System PCF(Unit level) is passed by the System driver script to the sub-units for CloudMask Generation
- The system PCF contains information on input SDR data in NetCDF format, static and dynamic ancillary data, location of scripts etc. required by the sub-units
- A section of the system PCF is given below:

```
OPS_BIN=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/bin
PCF_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_SDR_Template.pcf
CFG_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_CLOUD_MASK_Template.cfg
DIR_DEFAULT_PCF=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/Default_PCF
DIR_PCF_OVERWRITES=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/PCF_Overwrites
DIR_CUSTOMPRODUCTLISTS=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JR
RPS-OPS/CustomProductLists
```

Cloud Mask Product Generation
2.1 Rename SDR for Framework

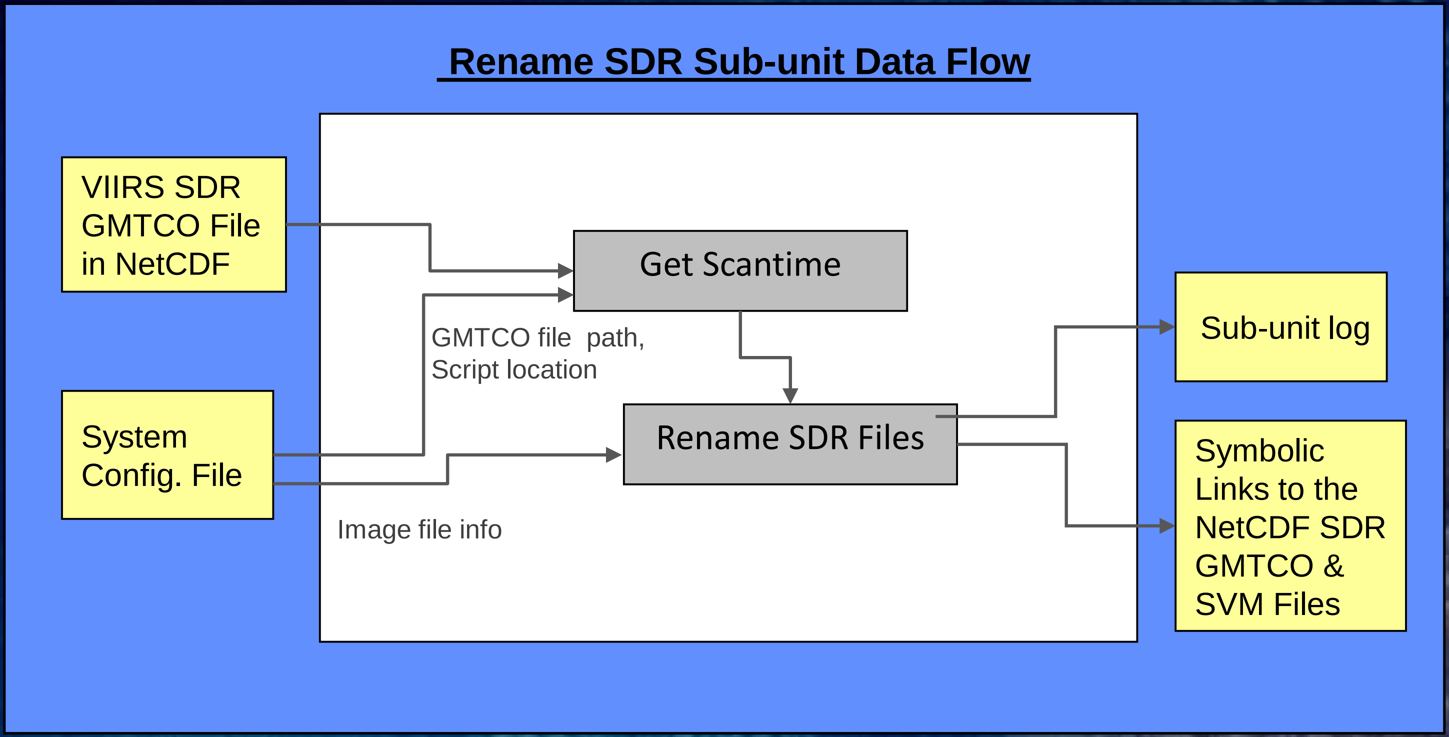
Sub-unit level interfaces

- Information in the system PCF is used to set up the sub-unit configuration
- The granule scantime obtained from the Geolocation file, by execution of *get_sdr_scan_time.exe,* is used to coin filenames comprehensible to framework
- Symbolic links are established with respective input NetCDF4 SDR files
- A sub-unit log file is saved for the process
- The general convention for renaming is as below:

Input Files:
G?TCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc
SV???_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc

Symbolic Link names, for framework:
G?TCO_npp_{scantime}_d????????_t???????.nc
SV???_npp_{scantime}_d????????_t???????.nc
where, scantime format is YYYYMMDD_hhmmss

Cloud Mask Product Generation
2.1 Rename SDR for Framework



Cloud Mask Product Generation
2.1 Rename SDR for Framework

Sub-unit Input/Output Data

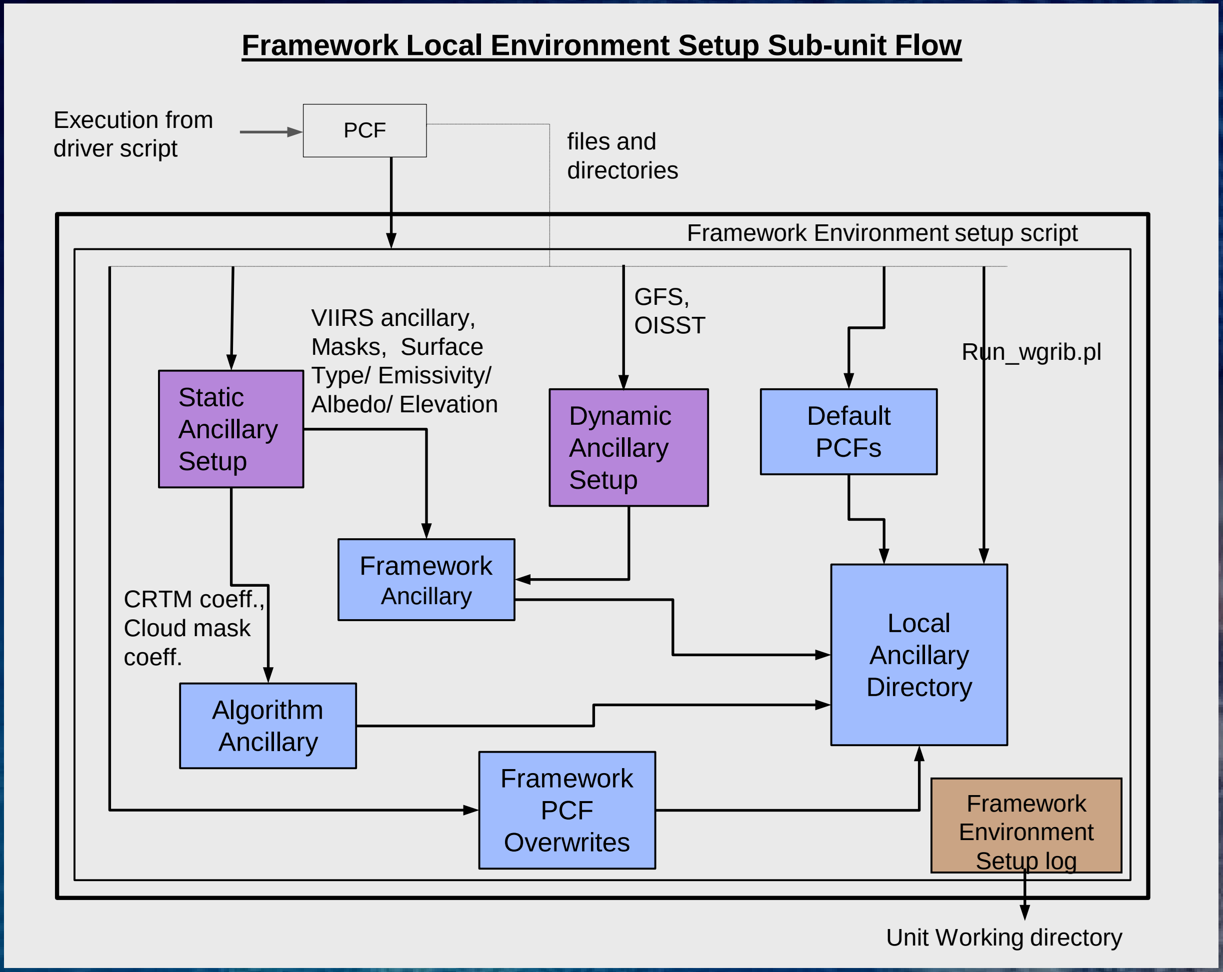
File	Input/ Output	Data description	Format
VIIRS granule geolocation file	Input	VIIRS granule terrain corrected geolocation data. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
System PCF	Input	Contains directories and setup of input data, scripts, etc. JRR_PRODUCT_CLOUD_MASK.pl.PCF	ASCII
Log file	Output	Contains log for the sub-unit	ASCII

Cloud Mask Product Generation
2.2 Framework Environment Setup

Sub-unit level interfaces

- The Framework Environment Setup script make use of the system PCF to set up the local environment
- Creates directories for algorithm_ancillary, framework_ancillary and their subdirectories
- Establish symbolic links to AIT Framework Default_PCF, PCF_Overwrites, and ancillary data
- A sub-unit log file is saved for the process

Cloud Mask Product Generation
2.2 Framework Environment Setup

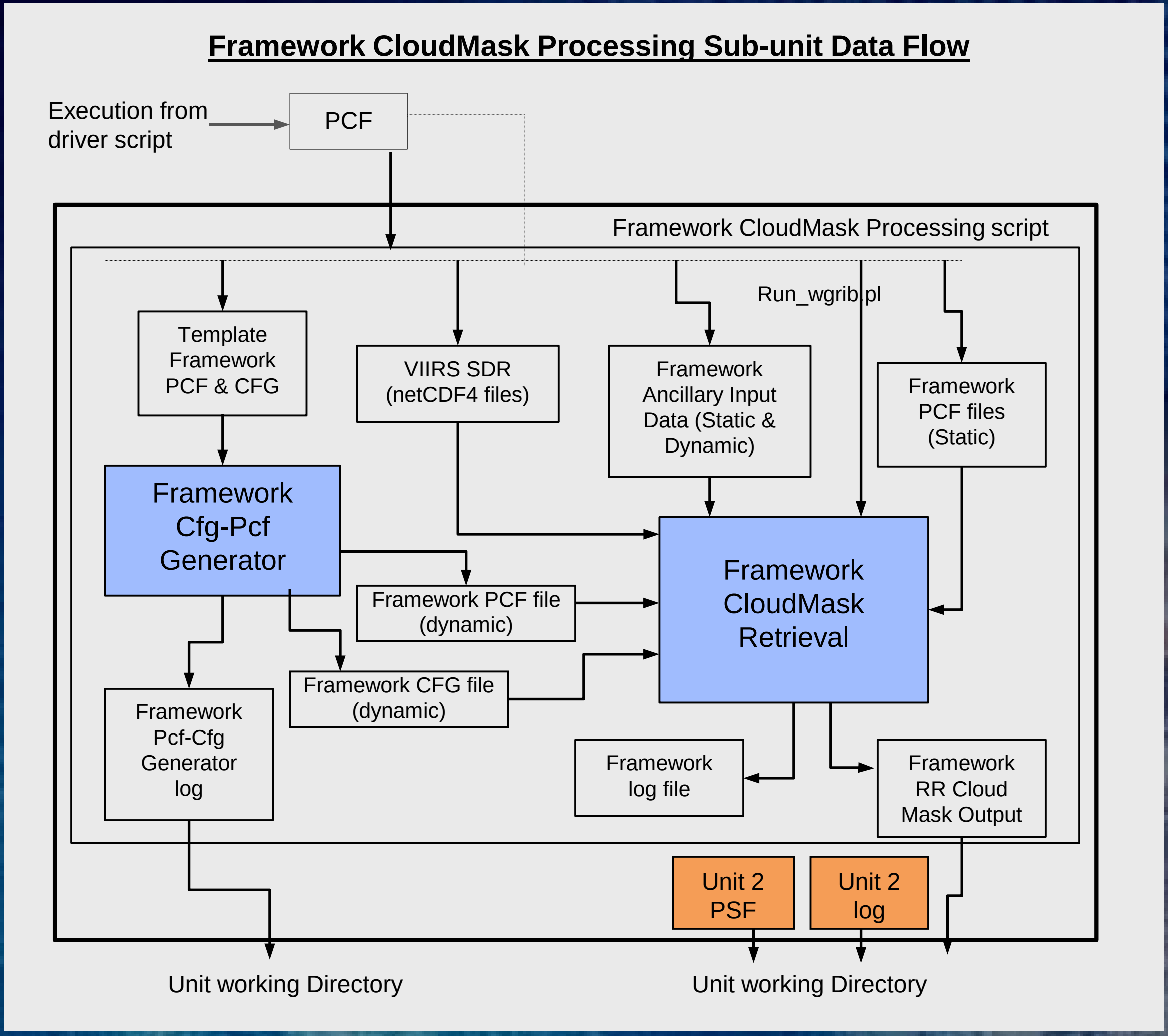


Cloud Mask Product Generation
2.2 Framework Environment Setup

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
System PCF	Input	JRR_PRODUCT_CLOUD_MASK.pl.PCF Contains the setup of working directory, directory settings, filename & path for static ancillary, filenames of dynamic ancillary, location and name of each gap-filled and converted input SDR files for the granule, etc.	ASCII
Log file	Output	The sub-unit processing log	ASCII

Cloud Mask Product Generation
2.3 Framework CloudMask Processing



Cloud Mask Product Generation
2.3 Framework CloudMask Processing

Sub-unit Level Interfaces

- The Framework PCFs and CFG are generated from the template files before the CloudMask product retrieval is triggered
- The Framework executable is invoked to process the RR Cloud Mask retrieval systems
- The CloudMask Product Output is renamed with the granule starttime, endtime and createtime to meet NDE requirement
- A sub-unit log file is saved for the process

Cloud Mask Product Generation
2.3 Framework CloudMask Processing

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
Gap-filled VIIRS SDR M/I-band files	Input	NetCDF converted & Gap-filled VIIRS M/I band SDR files for each granule. *SVM{bb}_npp_YYYYMMDD_hhmmss_d????????_t???????.nc, bb={03, 05, 07, 09, 10, 11, 12, 14, 15, 16}* *SVI{bb}_npp_YYYYMMDD_hhmmss_d????????_t???????.nc, bb={01, 04, 05}*	NetCDF4
VIIRS geolocation (M/I-band)	Input	NetCDF converted VIIRS geolocation data (terrain-corrected) file for each M/I res. granule. *GMTCO_npp_YYYYMMDD_hhmmss_d????????_t???????.nc* *GITCO_npp_YYYYMMDD_hhmmss_d????????_t???????.nc*	NetCDF4
System PCF	Input	JRR_PRODUCT_CLOUD_MASK.pl.PCF Contains the setup of working directory, directory settings, location and name of granule SDR files, primary /ancillary inputs, etc. for Cloud Mask processing .	ASCII
Framework PCF/CFG templates	Input	Template files used to generate overwritten PCFs and CFGs for framework CloudMask generation	ASCII
Static Framework ancillary data	Input	Static data for framework product run, including land & coast mask, Surface Emissivity, Surface Albedo, Surface Elevation, satellite instrument ancillary data, SDR dummy files etc.	NetCDF4
Static Algorithm ancillary data	Input	Static coefficient file for CloudMask, CRTM coefficients files	NetCDF4/ Binary
Daily OISST	Input	Contains Reynolds OISST daily analysis at 0.25 degree resolution	NetCDF4
GFS data	Input	NCEP GFS model data in grib2 format at 0.5 degree resolution	GRIB2
RR Cloud Mask product output	Output	JPSS RR VIIRS Cloud Mask product output with related flags, metadata, etc. JRR-CloudMask_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
Log file	Output	The sub-unit processing log file	ASCII

Cloud Mask Product Generation Unit PSF and Log

- A Unit level PSF containing the filename and location of the successfully generated framework output product file from CloudMask retrieval processing, is created.
  - » A section of JRR_PRODUCT_CLOUD_MASK.pl.PSF is given below:

```
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e1055479_b17764//JRR-CloudMask_v1r0_npp_s201504021054237_e201504021055479_c201507171644170.nc

#END-of-PSF
```

- A unit log file is saved for each script invoked during the process
  - » A section of JRR_PRODUCT_CLOUD_MASK.pl.log is given below:

```
JRR_PRODUCT_CLOUD_MASK.pl is now starting at: 20150717-12:42:39

   Running jrr_product_sdr4frmwk.pl
     - log:  jrr_product_sdr4frmwk.pl.log

real    0m1.912s
user    0m0.235s
sys     0m0.421s
   running jrr_product_sdr4frmwk.pl: OK
```

Cloud Mask Product Generation Unit Input/Output Data

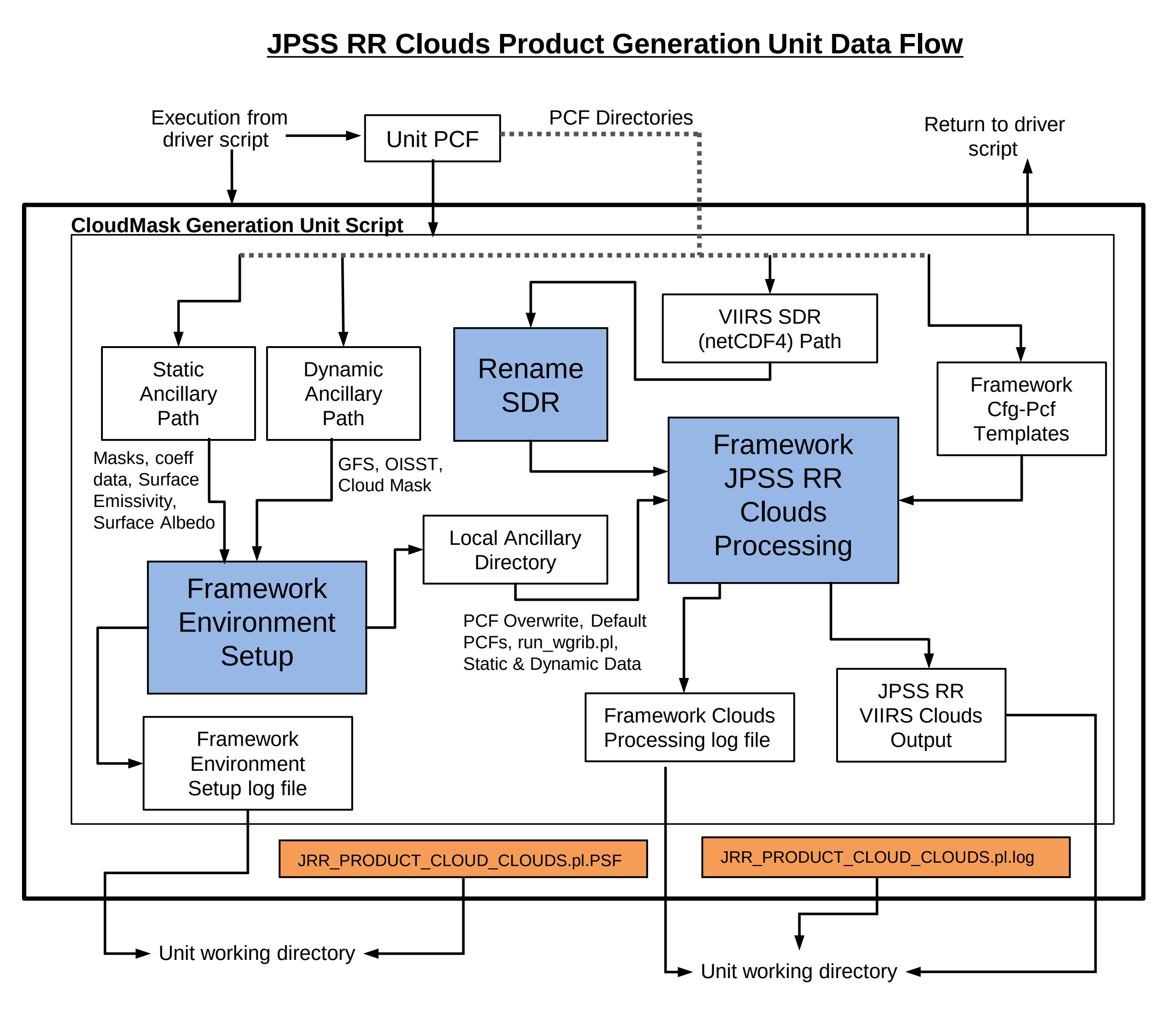
File	Input/ Output	No. of Files	Source	Format
Gap-filled VIIRS SDR M band files for channels *03, 05, 07, 09, 10, 11, 12, 14, 15, 16*	Input	10	JPSS RR PS	NetCDF4
Gap-filled VIIRS SDR I band files for channels *01, 04, 05*	Input	3	JPSS RR PS	NetCDF4
VIIRS geolocation files (M & I bands)	Input	2	JPSS RR PS	NetCDF4
Daily OISST	Input	1	PDA	NetCDF4
GFS	Input	2	PDA	GRIB2
Static Framework ancillary data	Input	-	DAP	NetCDF4
Static Algorithm ancillary data	Input	-	DAP	NetCDF4/Binary
Unit PCF	Input	1	NDE	ASCII
RR Cloud Mask product	Output	1	JPSS RR PS	NetCDF4
Unit PSF	Output	1	JPSS RR PS	ASCII
Unit Log file	Output	1	JPSS RR PS	ASCII

JPSS RR PS Unit Level

Unit 3. Clouds Product Generation

- 3.1. Rename SDR for Framework
- 3.2. Framework Environment Setup
- 3.3. Framework Clouds Product Processing

Unit Level Interfaces
3. Clouds Product Generation



3. Clouds Product Generation

System PCF

- A System PCF(Unit level) is passed by the System driver script to the sub-units for Clouds Product Generation
- The system PCF contains information on input SDR data in NetCDF format, RR VIIRS Cloud Mask data, static and dynamic ancillary data, location of scripts etc. required by the sub-units
- A section of the system PCF is given below:

```
SCRIPT_FOR_GFS=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/scripts/run_wgrib.pl
PERL_LOC=/usr/bin/perl
OPS_SCRIPT=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/scripts
OPS_BIN=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/bin
PCF_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_SDR_Template.pcf
CFG_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_CLOUD_CLOUDS_Template.cfg
DIR_DEFAULT_PCF=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/Default_PCF
DIR_PCF_OVERWRITES=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/PCF_Overwrites
```

Clouds Product Generation
3.1 Rename SDR for Framework

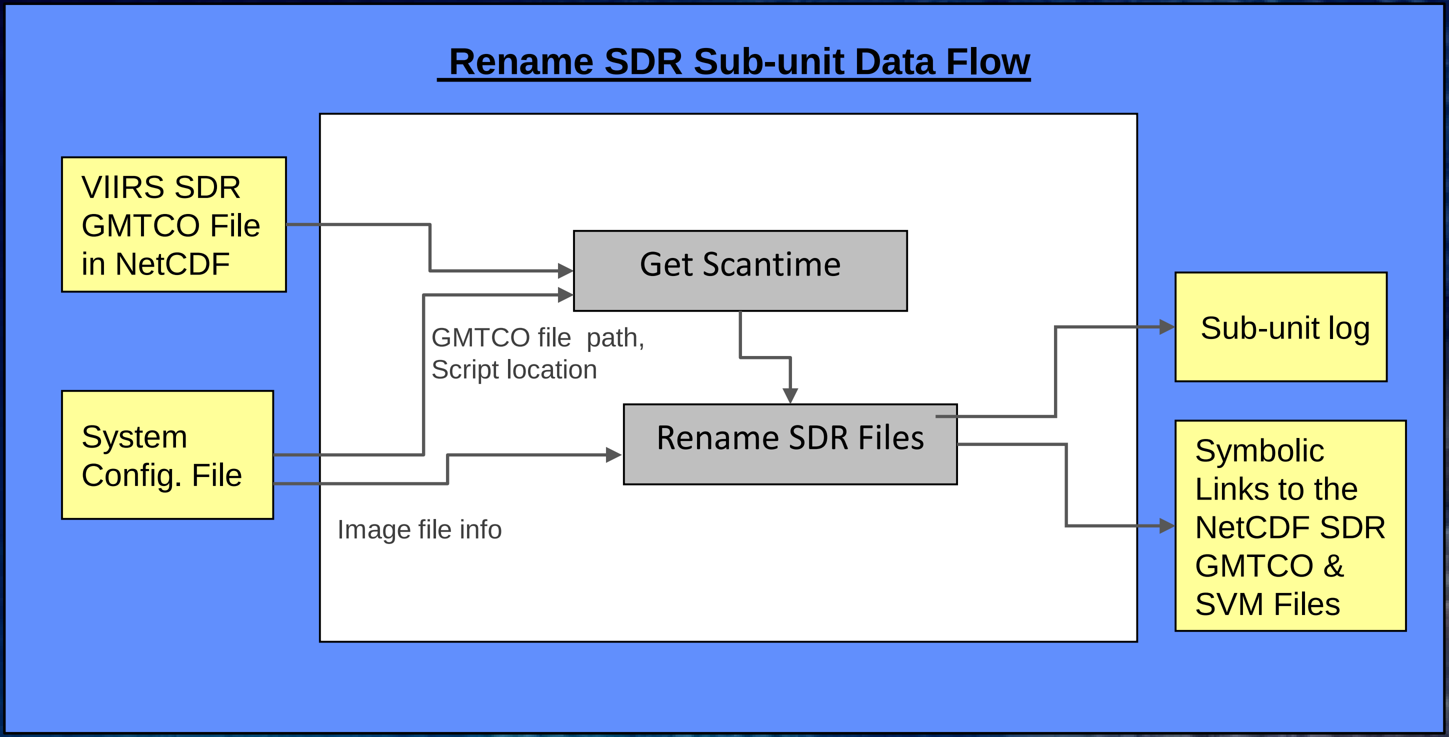
Sub-unit level interfaces

- Information in the system PCF is used to set up the sub-unit configuration
- The granule scantime obtained from the Geolocation file, by execution of *get_sdr_scan_time.exe,* is used to coin filenames comprehensible to framework
- Symbolic links are established with respective input NetCDF4 SDR files
- A sub-unit log file is saved for the process
- The general convention for renaming is as below:

Input Files:
G?TCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc
SV???_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc

Symbolic Link names, for framework:
G?TCO_npp_{scantime}_d????????_t???????.nc
SV???_npp_{scantime}_d????????_t???????.nc
where, scantime format is YYYYMMDD_hhmmss

Clouds Product Generation
3.1 Rename SDR for Framework



Clouds Product Generation
3.1 Rename SDR for Framework

Sub-unit Input/Output Data

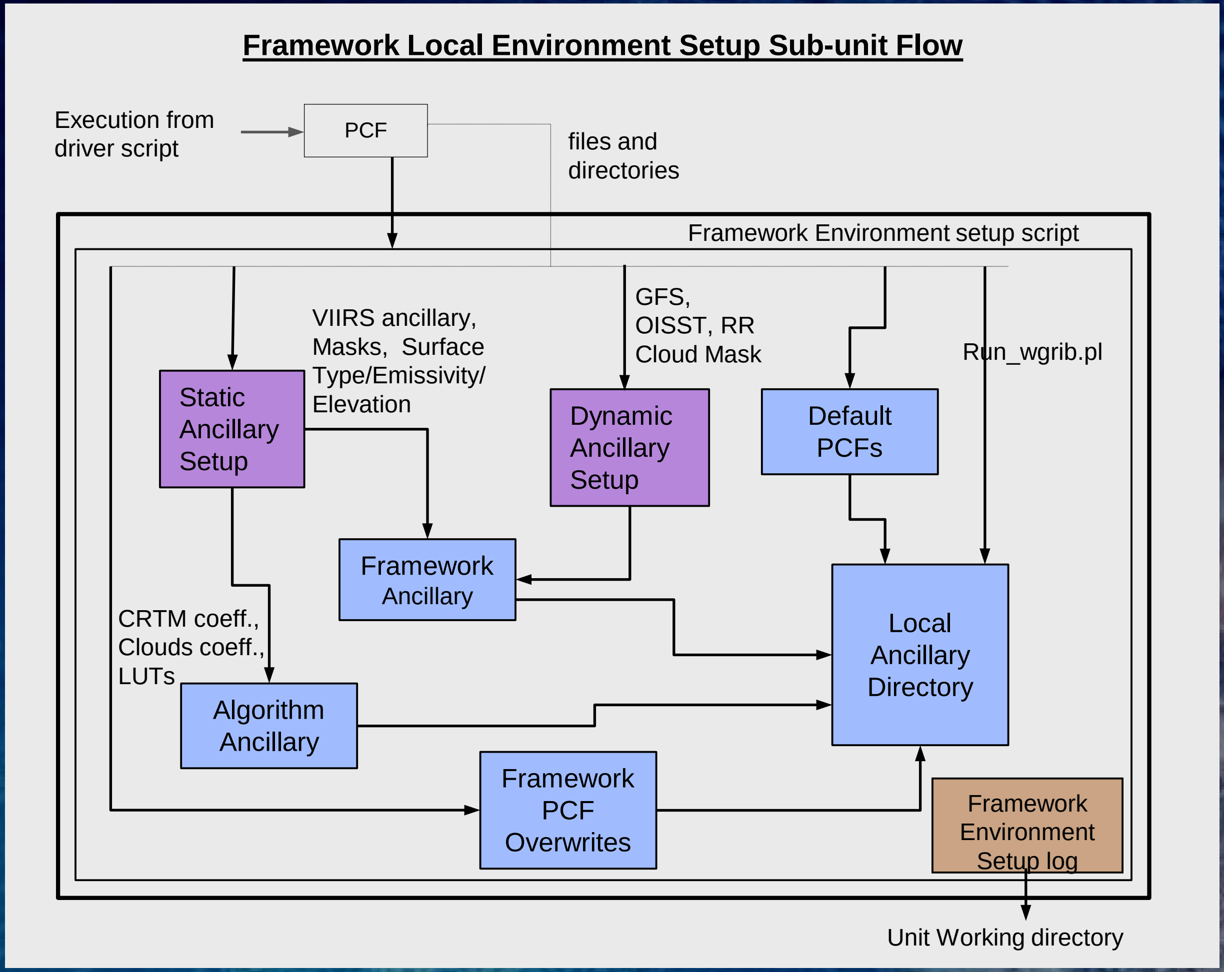
File	Input/ Output	Data description	Format
VIIRS granule geolocation file	Input	VIIRS granule terrain corrected geolocation data. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
System PCF	Input	Contains directories and setup of input data, scripts, etc. JRR_PRODUCT_CLOUD_CLOUDS.pl.PCF	ASCII
Log file	Output	Contains log for the sub-unit	ASCII

Clouds Product Generation
3.2 Framework Environment Setup

Sub-unit level interfaces

- The Framework Environment Setup script make use of the system PCF to set up the local environment
- Creates directories for algorithm_ancillary, framework_ancillary and their subdirectories
- Establish symbolic links to AIT Framework Default_PCF, PCF_Overwrites, and ancillary data
- A sub-unit log file is saved for the process

Clouds Product Generation
3.2 Framework Environment Setup

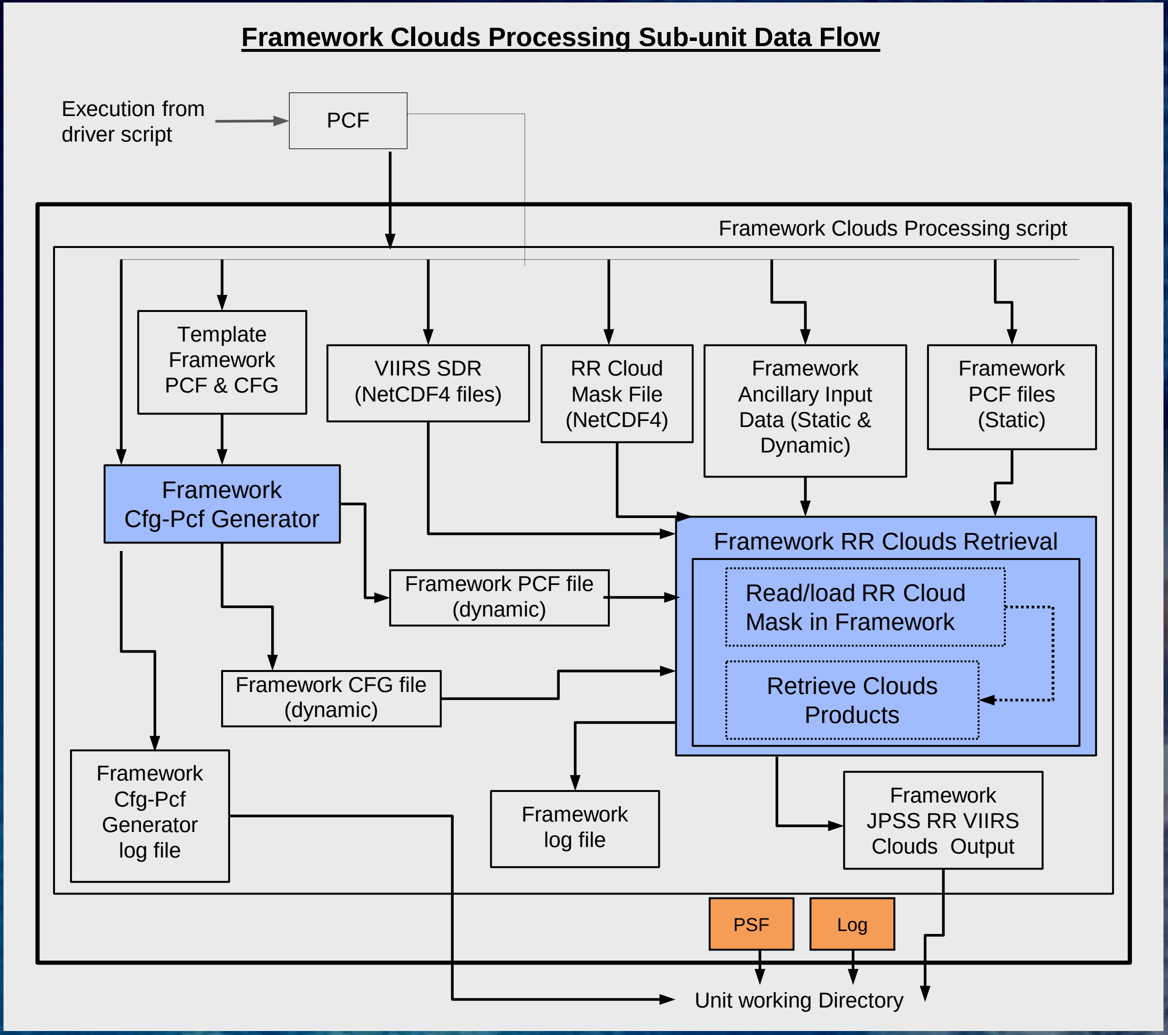


Clouds Product Generation
3.2 Framework Environment Setup

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
System PCF	Input	JRR_PRODUCT_CLOUD_CLOUDS.pl.PCF Contains the setup of working directory, directory settings, filename & path for static ancillary, filenames of dynamic ancillary, location and name of each gap-filled and converted input SDR files for the granule, etc.	ASCII
Log file	Output	The sub-unit processing log	ASCII

Clouds Product Generation
3.3 Framework Clouds Processing



Clouds Product Generation
3.3 Framework Clouds Processing

Sub-unit Level Interfaces

- The Framework PCFs and CFG are generated from the template files before the Clouds product retrieval is triggered
- The Framework executable is invoked to process the JPSS RR VIIRS Clouds retrieval systems
- The Clouds Product Output files are renamed with the granule starttime, endtime and createtime to meet NDE requirement
- A sub-unit log file is saved for the process

Clouds Product Generation
3.3 Framework Clouds Processing

Sub-unit Input Data

File	Input/ Output	Data description	Format
Gap-filled VIIRS SDR M-band files	Input	NetCDF converted & Gap-filled VIIRS M band SDR files for each granule. *SVM{bb}_npp_YYYYMMDD_hhmmss_d????????_t???????.nc, bb={05, 11, 12, 14, 15, 16}*	NetCDF4
VIIRS geolocation (M-band)	Input	NetCDF converted VIIRS geolocation data (terrain-corrected) file for each granule. *GMTCO_npp_YYYYMMDD_hhmmss_d????????_t???????.nc*	NetCDF4
System PCF	Input	JRR_PRODUCT_CLOUD_CLOUDS.pl.PCF Contains the setup of working directory, directory settings, location and name of granule SDR files, primary /ancillary inputs including RR Cloud Mask product , etc. required for Clouds processing .	ASCII
Framework PCF/CFG templates	Input	Template files used to generate overwritten PCFs and CFGs for framework Clouds generation	ASCII
Static Framework ancillary data	Input	Static data for framework product run, including land & coast mask, Surface Emissivity, Surface Elevation, Surface Albedo, satellite instrument ancillary data, SDR dummy files, etc.	NetCDF4
Static Algorithm ancillary data	Input	Static coefficient file for DCOMP, NCOMP, CRTM coefficients, etc.	NetCDF4/ Binary
Daily OISST	Input	Contains Reynolds OISST daily analysis at 0.25 degree resolution	NetCDF4
GFS data	Input	NCEP GFS model data in grib2 format at 0.5 degree resolution	GRIB2
RR Cloud Mask	Input	JPSS RR VIIRS Cloud Mask product file	NetCDF4

Clouds Product Generation
3.3 Framework Clouds Processing

Sub-unit Output Data

File	Input/ Output	Data description	Format
RR Cloud Phase output file	Output	JPSS RR VIIRS Cloud Phase and Cloud Type product output file. JRR-CloudPhase_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
RR Cloud Height output file	Output	Contains JPSS RR VIIRS Cloud -top Height/Pressure/Temperature products and related quality flags and metadata JRR-CloudHeight_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
RR Daytime Cloud Optical Properties	Output	Contains JPSS RR Daytime Cloud Liquid/Ice Water Path, Cloud Particle Size and Cloud Optical Depth products and related quality information JRR-CloudDCOMP_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
RR Nighttime Cloud Optical Properties	Output	Contains JPSS RR Nighttime Cloud Liquid/Ice Water Path, Cloud Particle Size and Cloud Optical Depth products and related quality information JRR-CloudNCOMP_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
Log file	Output	The sub-unit processing log file	ASCII

Clouds Product Generation Unit PSF and Log

- A Unit level PSF containing the filename and location of the successfully generated framework output product file from CloudMask retrieval processing, is created.
  - » A section of JRR_PRODUCT_CLOUD_CLOUDS.pl.PSF is given below:

```
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764//JRR-CloudPhase_v1r0_npp_s201504021054237_e201504021055479_c201507171652000.nc
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764//JRR-
CloudHeight_v1r0_npp_s201504021054237_e201504021055479_c201507171652020.nc
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764//JRR-CloudDCOMP_v1r0_npp_s201504021054237_e201504021055479_c201507171652070.nc
```

- A unit log file is saved for each script invoked during the process
  - » A section of JRR_PRODUCT_CLOUD_CLOUDS.pl.log is given below:

```
JRR_PRODUCT_CLOUD_CLOUDS.pl is now starting at: 20150717-16:50:54

   Running jrr_product_sdr4frmwk.pl
     - log:  jrr_product_sdr4frmwk.pl.log

real    0m0.849s
user    0m0.235s
sys     0m0.205s
   running jrr_product_sdr4frmwk.pl: OK
```

Clouds Product Generation Unit Input/Output Data

File	Input/ Output	No. of Files	Source	Format
Gap-filled VIIRS SDR M band files for channels 05, 11, 12, 14, 15, 16	Input	6	JPSS RR PS	NetCDF4
VIIRS M band geolocation file	Input	1	JPSS RR PS	NetCDF4
Daily OISST	Input	1	PDA	NetCDF4
GFS	Input	2	PDA	GRIB2
RR Cloud Mask product	Input	1	NDE	NetCDF4
Static Framework ancillary data	Input	-	DAP	NetCDF4
Static Algorithm ancillary data	Input	-	DAP	NetCDF4/Binary
Unit PCF	Input	1	NDE	ASCII
RR Cloud Phase output file (Cloud Phase/Type)	Output	1	JPSS RR PS	NetCDF4
RR Cloud Height output file (Cloud-top Height/Pressure/Temperature, CCL)	Output	1	JPSS RR PS	NetCDF4
RR Daytime Cloud Optical Properties (LWP, IWP, COD, CPS)	Output	1	JPSS RR PS	NetCDF4
RR Nighttime Cloud Optical Properties (LWP, IWP, COD, CPS)	Output	1	JPSS RR PS	NetCDF4
Unit PSF	Output	1	JPSS RR PS	ASCII
Unit Log file	Output	1	JPSS RR PS	ASCII

JPSS RR PS Unit Level

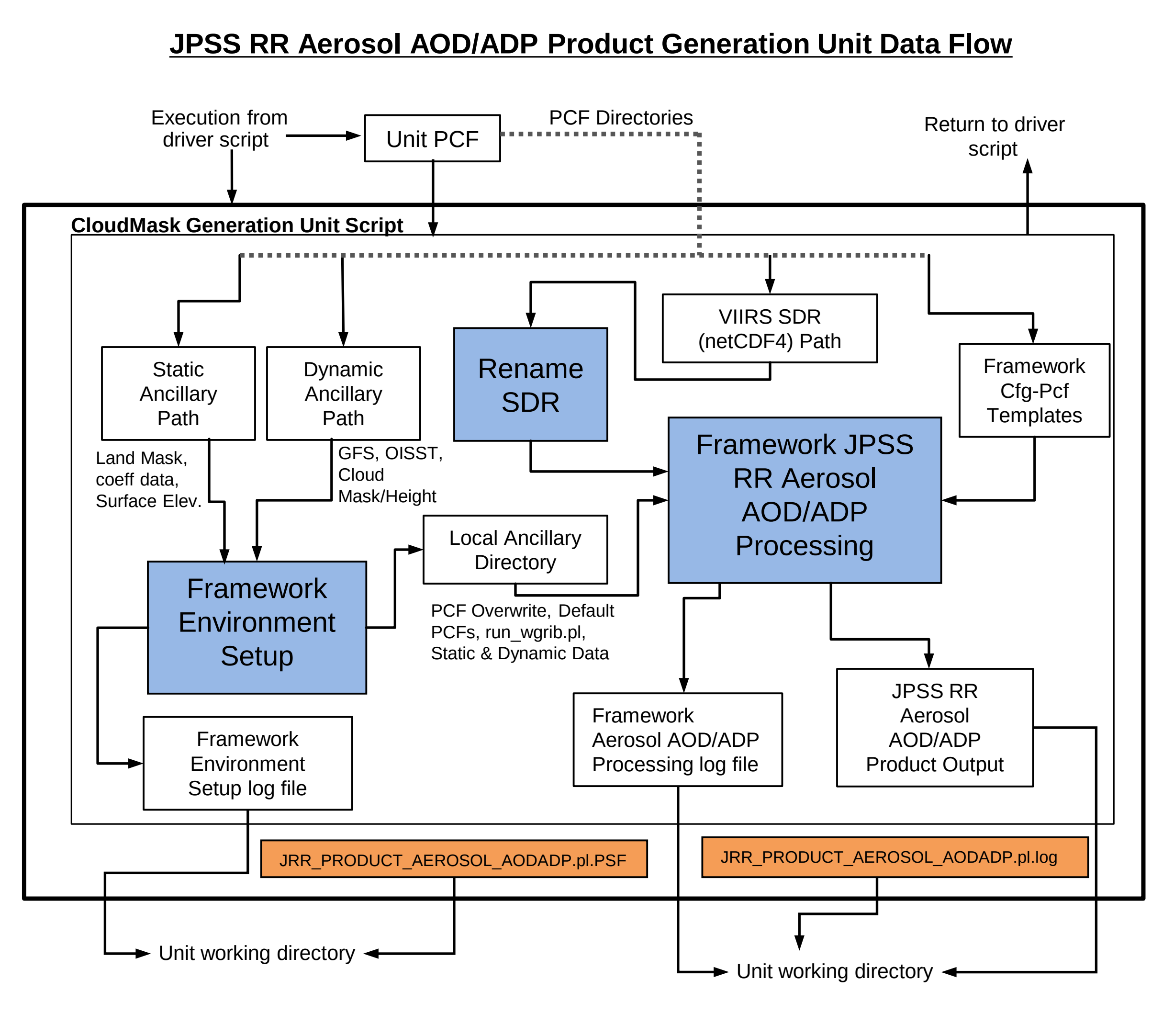
Unit 4. Aerosol AOD/ADP Product Generation

4.1. Rename SDR for Framework

4.2. Framework Environment Setup

4.3. Framework Aerosol AOD/ADP Product Processing

Unit Level Interfaces
4. Aerosol AOD/ADP Product Generation



4. Aerosol AOD/ADP Product Generation

System PCF

- A System PCF(Unit level) is passed by the System driver script to the sub-units for Clouds Product Generation
- The system PCF contains information on input SDR data in NetCDF format, RR VIIRS Cloud Mask & Cloud Height data, static and dynamic ancillary data, location of scripts etc. required by the sub-units
- A section of the system PCF is given below:

```
SCRIPT_FOR_GFS=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/scripts/run_wgrib.pl
PERL_LOC=/usr/bin/perl
OPS_SCRIPT=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/scripts
OPS_BIN=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/bin
PCF_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_SDR_Template.pcf
CFG_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_AEROSOL_AODADP_Template.cfg
DIR_DEFAULT_PCF=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/Default_PCF
DIR_PCF_OVERWRITES=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/PCF_Overwrites
```

Aerosol AOD/ADP Product Generation
4.1 Rename SDR for Framework

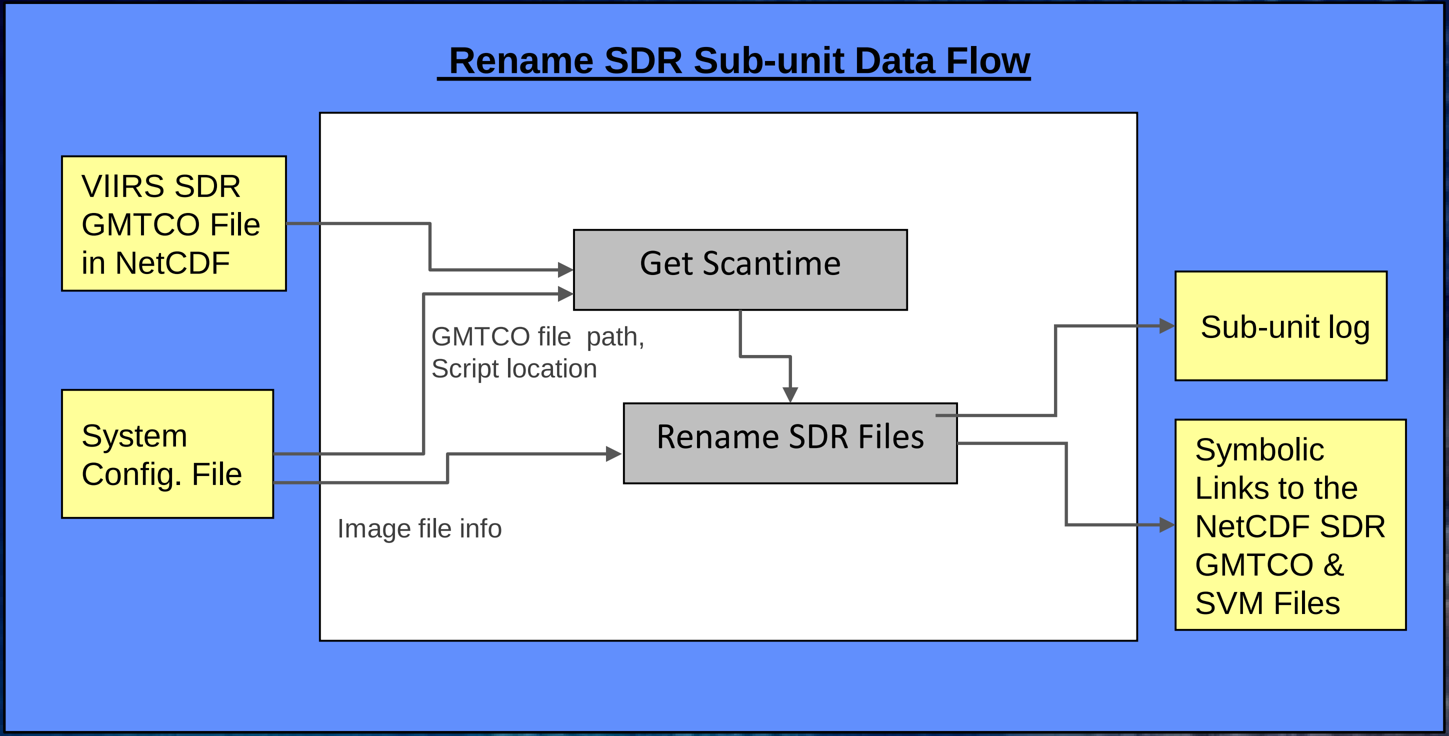
Sub-unit level interfaces

- Information in the system PCF is used to set up the sub-unit configuration
- The granule scantime obtained from the Geolocation file, by execution of *get_sdr_scan_time.exe,* is used to coin filenames comprehensible to framework
- Symbolic links are established with respective input NetCDF4 SDR files
- A sub-unit log file is saved for the process
- The general convention for renaming is as below:

Input Files:
G?TCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc
SV???_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc

Symbolic Link names, for framework:
G?TCO_npp_{scantime}_d????????_t???????.nc
SV???_npp_{scantime}_d????????_t???????.nc
where, scantime format is YYYYMMDD_hhmmss

Aerosol AOD/ADP Product Generation
4.1 Rename SDR for Framework



Aerosol AOD/ADP Product Generation
4.1 Rename SDR for Framework

Sub-unit Input/Output Data

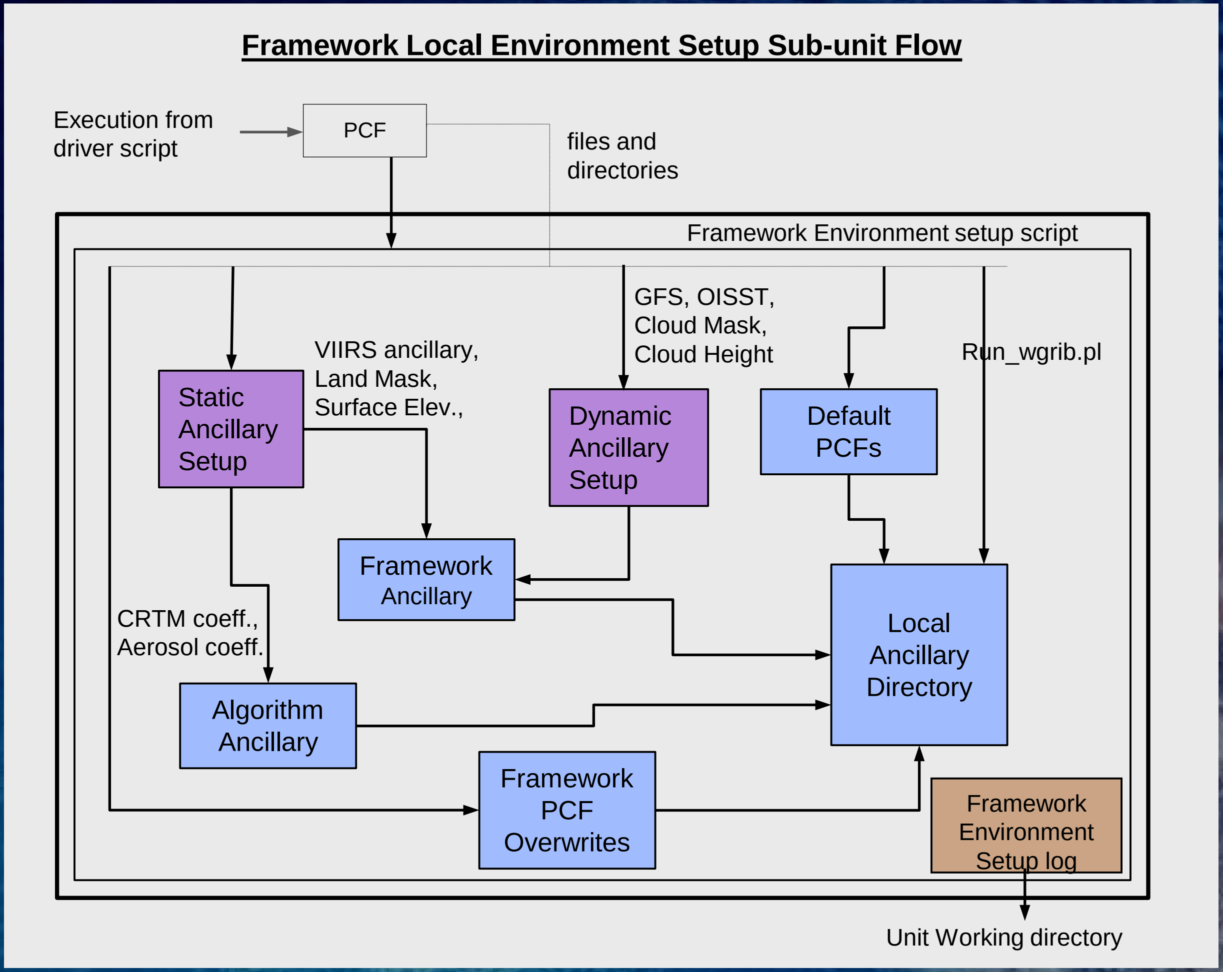
File	Input/ Output	Data description	Format
VIIRS granule geolocation file	Input	VIIRS granule terrain corrected geolocation data. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
System PCF	Input	Contains directories and setup of input data, scripts, etc. JRR_PRODUCT_AEROSOL_AODADP.pl.PCF	ASCII
Log file	Output	Contains log for the sub-unit	ASCII

Aerosol AOD/ADP Product Generation
4.2 Framework Environment Setup

Sub-unit level interfaces

- The Framework Environment Setup script make use of the system PCF to set up the local environment
- Creates directories for algorithm_ancillary, framework_ancillary and their subdirectories
- Establish symbolic links to AIT Framework Default_PCF, PCF_Overwrites, and ancillary data
- A sub-unit log file is saved for the process

Aerosol AOD/ADP Product Generation
4.2 Framework Environment Setup

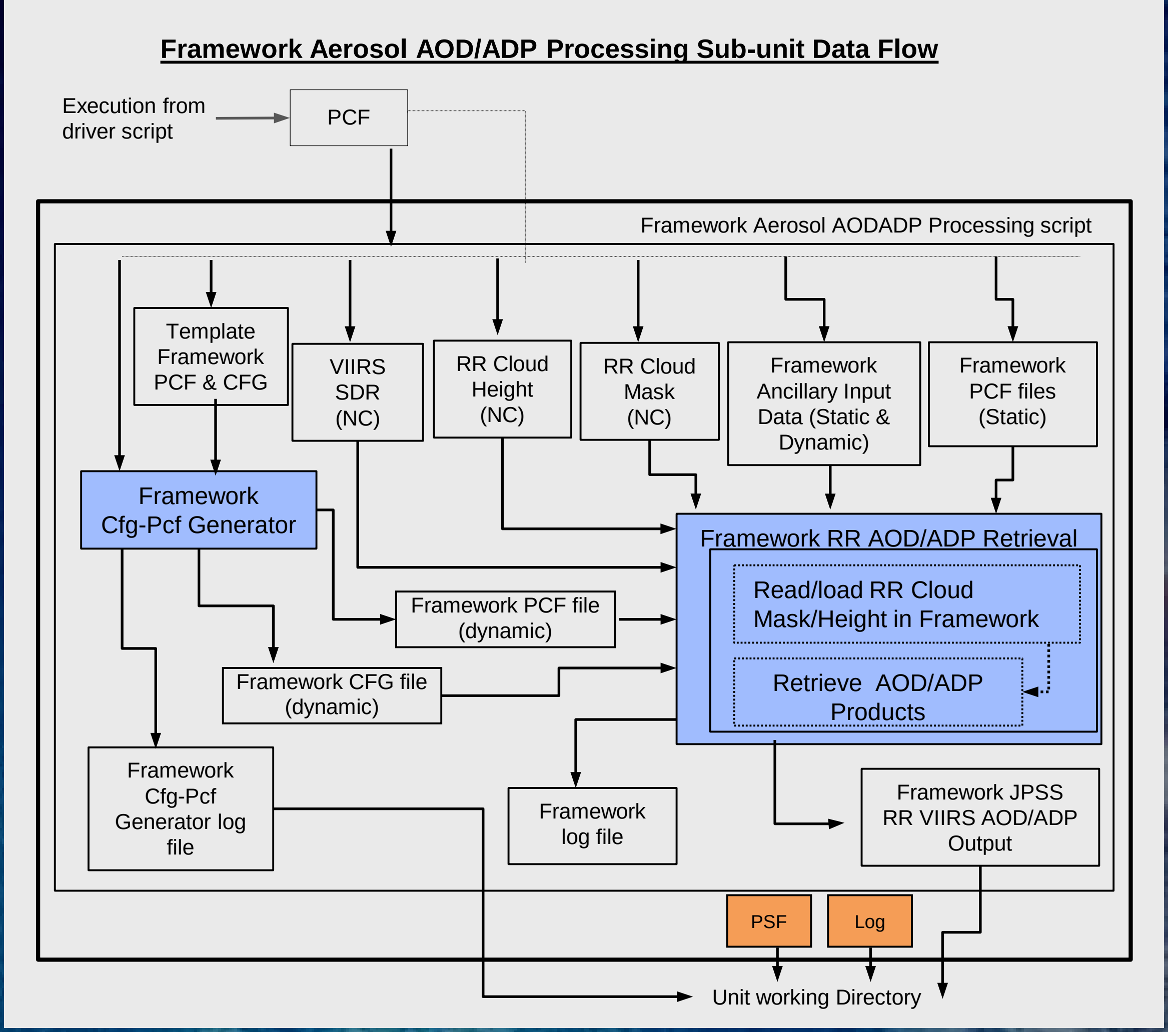


Aerosol AOD/ADP Product Generation
4.2 Framework Environment Setup

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
System PCF	Input	JRR_PRODUCT_AEROSOL_AODADP.pl.PCF Contains the setup of working directory, directory settings, filename & path for static ancillary, filenames of dynamic ancillary, location and name of each gap-filled and converted input SDR files for the granule, etc.	ASCII
Log file	Output	The sub-unit processing log	ASCII

Aerosol AOD/ADP Product Generation
4.3 Framework AOD/ADP Processing



Aerosol AOD/ADP Product Generation
4.3 Framework AOD/ADP Processing

Sub-unit Level Interfaces

- The Framework PCFs and CFG are generated from the template files before AOD/ADP product retrieval is triggered
- The Framework executable is invoked to process the JPSS RR VIIRS AOD/ADP retrieval systems
- Framework reads the L1b, ancillary data, and the RR the Cloud Mask & Cloud Height product data before processing the RR AOD/ADP algorithms
- The AOD/ADP Product Output is renamed with the granule starttime, endtime and createtime to meet NDE requirement
- A sub-unit log file is saved for the process

Aerosol AOD/ADP Product Generation
4.3 Framework AOD/ADP Processing

File	Input/ Output	Data description	Format
Gap-filled VIIRS SDR M-band files	Input	NetCDF converted & Gap-filled VIIRS M/I band SDR files for each granule. *SVM{bb}_npp_YYYYMMDD_hhmmss_d????????_t???????.nc, bb={01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 15, 16}*	NetCDF4
VIIRS geolocation (M-band)	Input	NetCDF converted VIIRS geolocation data (terrain-corrected) file for each granule. *GMTCO_npp_YYYYMMDD_hhmmss_d????????_t???????.nc*	NetCDF4
System PCF	Input	JRR_PRODUCT_AEROSOL_AODADP.pl.PCF Contains the setup of working directory, directory settings, location and name of granule SDR files, primary /ancillary inputs including RR Cloud Mask and Cloud Height product files, etc.	ASCII
Framework PCF/CFG templates	Input	Template files used to generate overwritten PCFs and CFGs for framework Aerosol AOD and ADP generation	ASCII
Static Framework ancillary data	Input	Static data for framework product run, including land & coast mask, Surface Emissivity, Surface Elevation, satellite instrument ancillary data, etc.	NetCDF4
Static Algorithm ancillary data	Input	Static coefficient files for AOD, SDR dummy files, etc.	NetCDF4
Daily OISST	Input	Contains Reynolds OISST daily analysis at 0.25 degree resolution	NetCDF4
GFS data	Input	NCEP GFS model data in grib2 format at 0.5 degree resolution	GRIB2
RR Cloud Mask	Input	JPSS RR VIIRS Cloud Mask product file	NetCDF4
RR Cloud Height	Input	JPSS RR VIIRS Cloud Height product file	NetCDF4
JPSS RR VIIRS AOD Product Output	Output	JPSS RR VIIRS Aerosol Product output containing Aerosol Optical Depth and Aerosol Particle Size Parameter JRR-AOD_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
JPSS RR VIIRS ADP Product Output	Output	JPSS RR VIIRS Aerosol product output containing Aerosol Detection (Smoke & Dust) product File JRR-ADP_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
Log file	Output	The sub-unit processing log file	ASCII

Aerosol AOD/ADP Product Generation Unit PSF and Log

- A Unit level PSF containing the filename and location of the successfully generated framework output product file from CloudMask retrieval processing, is created.
  - » A section of JRR_PRODUCT_AEROSOL_AODADP.pl.PSF is given below:

```
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764//JRR-AOD_v1r0_npp_s201504021054237_e201504021055479_c201507171724120.nc
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e105
5479_b17764//JRR-ADP_v1r0_npp_s201504021054237_e201504021055479_c201507171724150.nc

#END-of-PSF
```

- A unit log file is saved for each script invoked during the process
  - » A section of JRR_PRODUCT_AEROSOL_AODADP.pl.log is given

```
JRR_PRODUCT_AEROSOL_AODADP.pl is now starting at: 20150717-17:22:58

   Running jrr_product_sdr4frmwk.pl
     - log:  jrr_product_sdr4frmwk.pl.log

real    0m0.754s
user    0m0.253s
sys     0m0.456s
   running jrr_product_sdr4frmwk.pl: OK
```

Aerosol AOD/ADP Product Generation Unit Input/Output Data

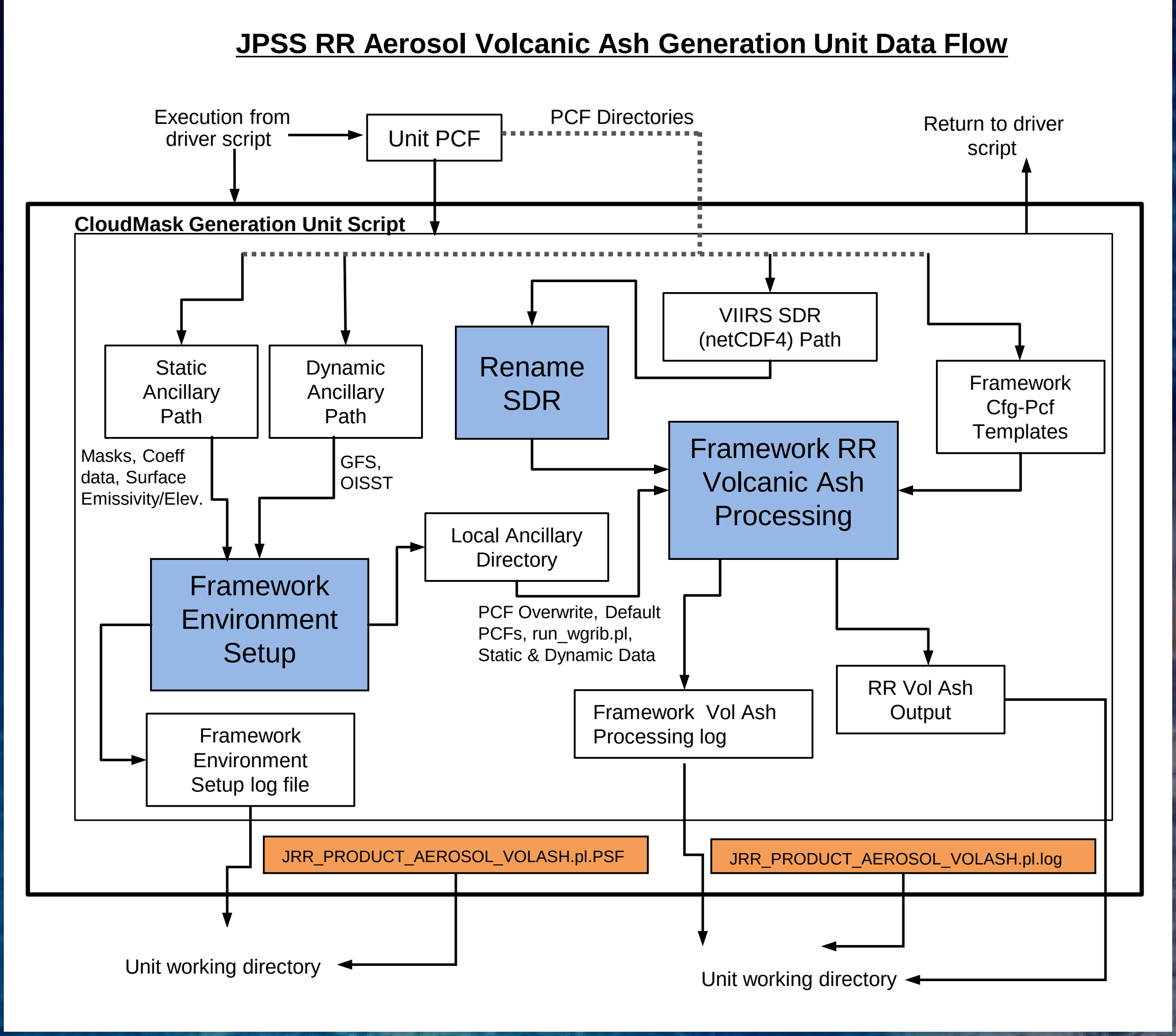
File	Input/ Output	No. of Files	Source	Format
Gap-filled VIIRS SDR M band files for channels *01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 13, 15, 16*	Input	15	JPSS RR PS	NetCDF4
VIIRS M band geolocation file	Input	1	JPSS RR PS	NetCDF4
Daily OISST	Input	1	PDA	NetCDF4
GFS	Input	2	PDA	GRIB2
RR Cloud Mask product	Input	1	NDE	NetCDF4
RR Cloud Height product output	Input	1	NDE	NetCDF4
Static Framework ancillary data	Input	-	DAP	NetCDF4
Static Algorithm ancillary data	Input	-	DAP	NetCDF4/Binary
Unit PCF	Input	1	NDE	ASCII
RR AOD product output file (AOD/APS)	Output	1	JPSS RR PS	NetCDF4
RR ADP product output (Aerosol detection: Smoke/Dust)	Output	1	JPSS RR PS	NetCDF4
Unit PSF	Output	1	JPSS RR PS	ASCII
Unit Log file	Output	1	JPSS RR PS	ASCII

JPSS RR PS Unit Level

Unit 5. Aerosol Volcanic Ash Product Generation

- 5.1. Rename SDR for Framework
- 5.2. Framework Environment Setup
- 5.3. Framework Product Processing

Unit Level Interfaces
5. Volcanic Ash Product Generation



5. Volcanic Ash Product Generation

System PCF

- A System PCF(Unit level) is passed by the System driver script to the sub-units for Volcanic Ash Generation
- The system PCF contains information on input SDR data in NetCDF format, static and dynamic ancillary data, location of scripts etc. required by the sub-units
- A section of the system PCF is given below:

```
OPS_BIN=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/bin
PCF_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_SDR_Template.pcf
CFG_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_AEROSOL_VOLASH_Template.cfg
DIR_DEFAULT_PCF=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/Default_PCF
DIR_PCF_OVERWRITES=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/PCF_Overwrites
DIR_CUSTOMPRODUCTLISTS=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JR
RPS-OPS/CustomProductLists
```

Volcanic Ash Product Generation
5.1 Rename SDR for Framework

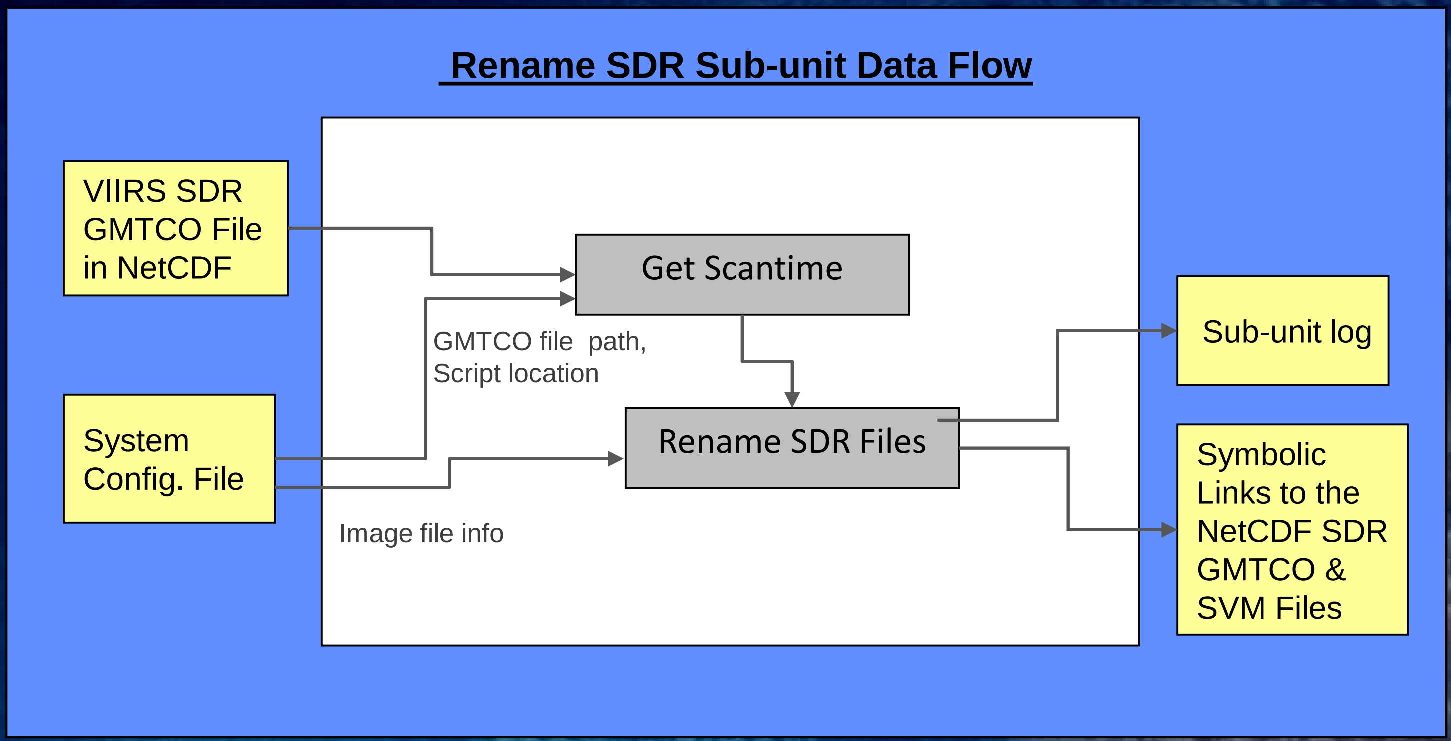
Sub-unit level interfaces

- Information in the system PCF is used to set up the sub-unit configuration
- The granule scantime obtained from the Geolocation file, by execution of *get_sdr_scan_time.exe,* is used to coin filenames comprehensible to framework
- Symbolic links are established with respective input NetCDF4 SDR files
- A sub-unit log file is saved for the process
- The general convention for renaming is as below:

Input Files:
G?TCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc
SV???_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc

Symbolic Link names, for framework:
G?TCO_npp_{scantime}_d????????_t???????.nc
SV???_npp_{scantime}_d????????_t???????.nc
where, scantime format is YYYYMMDD_hhmmss

Volcanic Ash Product Generation
5.1 Rename SDR for Framework



Volcanic Ash Product Generation
5.1 Rename SDR for Framework

Sub-unit Input/Output Data

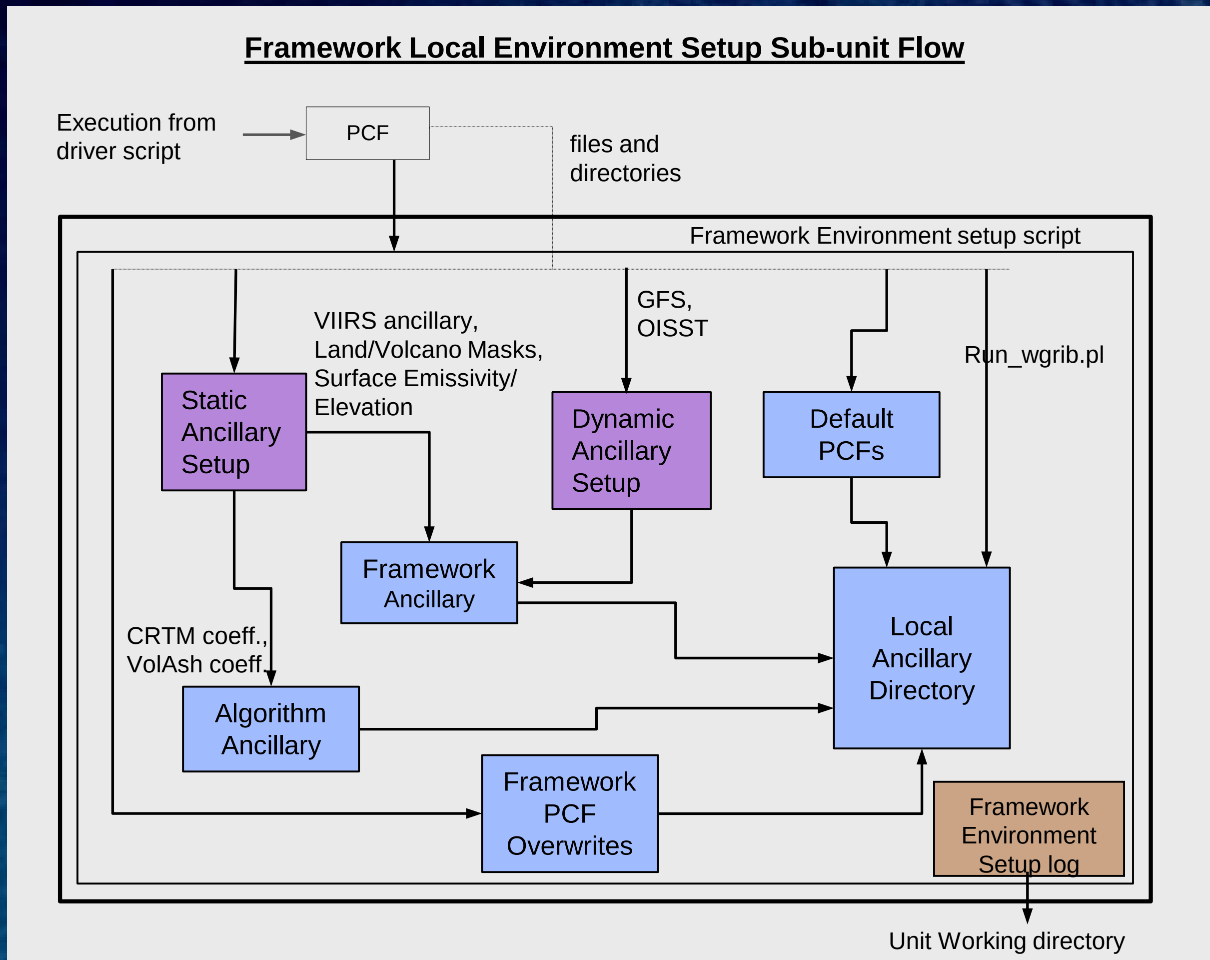
File	Input/ Output	Data description	Format
VIIRS granule geolocation file	Input	VIIRS granule terrain corrected geolocation data. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
System PCF	Input	Contains directories and setup of input data, scripts, etc. JRR_PRODUCT_AEROSOL_VOLASH.pl.PCF	ASCII
Log file	Output	Contains log for the sub-unit	ASCII

Volcanic Ash Product Generation
5.2 Framework Environment Setup

Sub-unit level interfaces

- The Framework Environment Setup script make use of the system PCF to set up the local environment
- Creates directories for algorithm_ancillary, framework_ancillary and their subdirectories
- Establish symbolic links to AIT Framework Default_PCF, PCF_Overwrites, and ancillary data
- A sub-unit log file is saved for the process

Volcanic Ash Product Generation
5.2 Framework Environment Setup

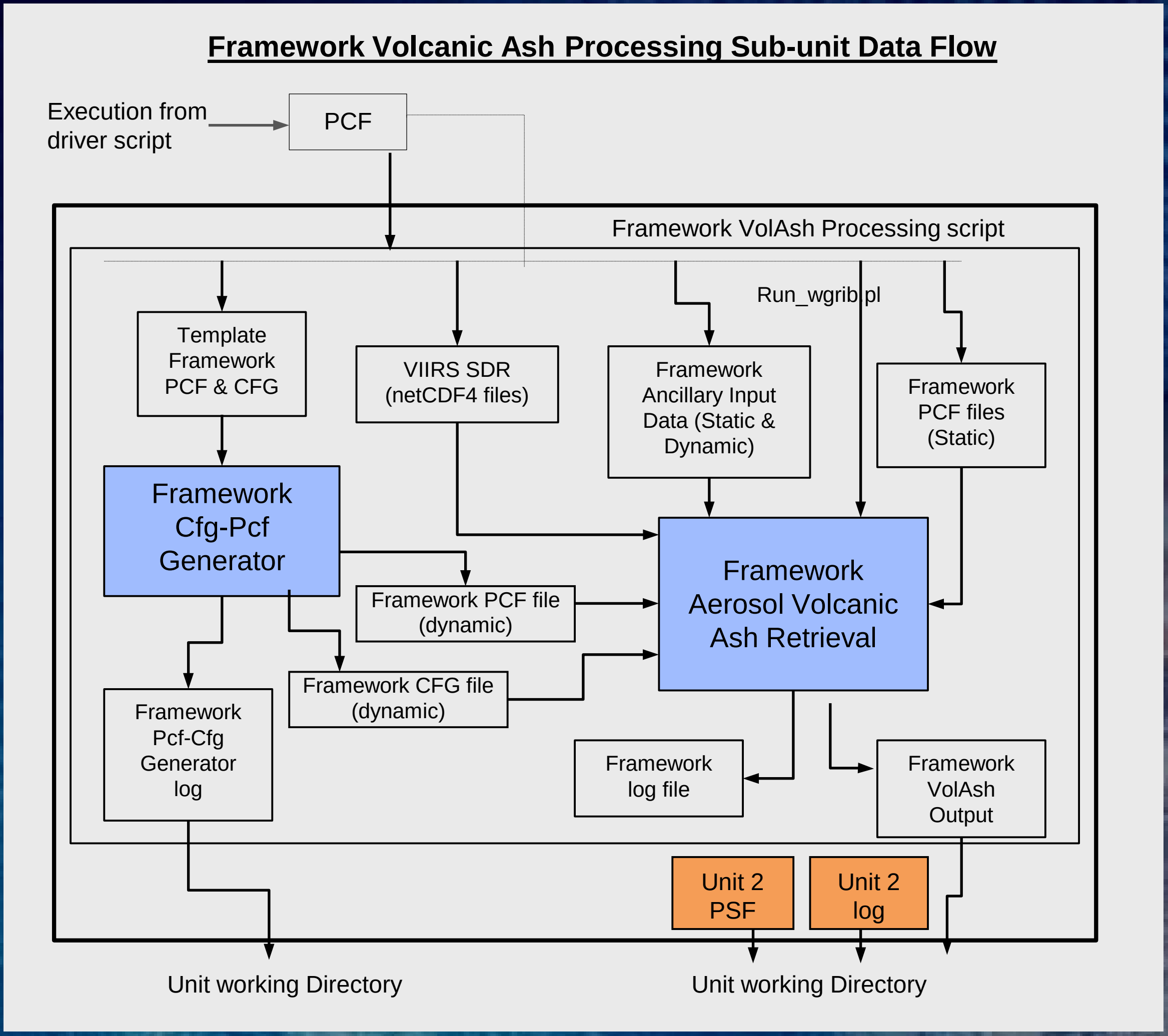


Volcanic Ash Product Generation
5.2 Framework Environment Setup

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
System PCF	Input	JRR_PRODUCT_AEROSOL_VOLASH.pl.PCF Contains the setup of working directory, directory settings, filename & path for static ancillary, filenames of dynamic ancillary, location and name of each gap-filled and converted input SDR files for the granule, etc.	ASCII
Log file	Output	The sub-unit processing log	ASCII

Volcanic Ash Product Generation
5.3 Framework VolAsh Processing



Volcanic Ash Product Generation
5.3 Framework VolAsh Processing

Sub-unit Level Interfaces

- The Framework PCFs and CFG are generated from the template files before Volcanic Ash product retrieval is triggered
- The Framework executable is invoked to process the Volcanic Ash retrieval systems
- The Volcanic Ash Product Output is renamed with the granule starttime, endtime and createtime to meet NDE requirement
- A sub-unit log file is saved for the process

Volcanic Ash Product Generation
5.3 Framework VolAsh Processing

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
Gap-filled VIIRS SDR M-band files	Input	NetCDF converted & Gap-filled VIIRS M/I band SDR files for each granule. *SVM{bb}_npp_YYYYMMDD_hhmmss_d????????_t???????.nc, bb={14, 15, 16}*	NetCDF4
VIIRS geolocation (M-band)	Input	NetCDF converted VIIRS geolocation data (terrain-corrected) file for each M res. granule. *GMTCO_npp_YYYYMMDD_hhmmss_d????????_t???????.nc*	NetCDF4
System PCF	Input	JRR_PRODUCT_AEROSOL_VOLASH.pl.PCF Contains the setup of working directory, directory settings, location and name of granule SDR files, primary /ancillary inputs, etc. for VolAsh processing .	ASCII
Framework PCF/CFG templates	Input	Template files used to generate overwritten PCFs and CFGs for framework VolAsh generation	ASCII
Static Framework ancillary data	Input	Static data for framework product run, including Land Mask, Volcano Mask, Surface Emissivity, Surface Elevation, satellite instrument ancillary data, etc.	NetCDF4
Static Algorithm ancillary data	Input	Static coefficient file for VolAsh, CRTM coefficients, SDR dummy files	NetCDF4/ Binary
Daily OISST	Input	Contains Reynolds OISST daily analysis at 0.25 degree resolution	NetCDF4
GFS data	Input	NCEP GFS model data in grib2 format at 0.5 degree resolution	GRIB2
RR Volcanic Ash product file	Output	JPSS RR VIIRS Volcanic Ash detection –Mass Loading and Height product output with related flags, metadata, etc. JRR-VolcanicAsh_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
Log file	Output	The sub-unit processing log file	ASCII

Volcanic Ash Product Generation Unit PSF and Log

- A Unit level PSF containing the filename and location of the successfully generated framework output product file from Volcanic Ash retrieval processing, is created.
  - » A section of JRR_PRODUCT_AEROSOL_VOLASH.pl.PSF is given below:

```
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150402_t1054237_e1055479_b17764//JRR-VolcanicAsh_v1r0_npp_s201504021054237_e201504021055479_c201507171707180.nc

#END-of-PSF
```

- A unit log file is saved for each script invoked during the process
  - » A section of JRR_PRODUCT_AEROSOL_VOLASH.pl.log is given

```
JRR_PRODUCT_AEROSOL_VOLASH.pl is now starting at: 20150717-17:06:08

   Running jrr_product_sdr4frmwk.pl
     - log:  jrr_product_sdr4frmwk.pl.log

real    0m1.394s
user    0m0.245s
sys     0m0.462s
   running jrr_product_sdr4frmwk.pl: OK
```

Volcanic Ash Product Generation Unit Input/Output Data

File	Input/ Output	No. of Files	Source	Format
Gap-filled VIIRS SDR M band files for channels *14, 15, 16*	Input	3	JPSS RR PS	NetCDF4
VIIRS M band geolocation file	Input	1	JPSS RR PS	NetCDF4
Daily OISST	Input	1	PDA	NetCDF4
GFS	Input	2	PDA	GRIB2
Static Framework ancillary data	Input	-	DAP	NetCDF4
Static Algorithm ancillary data	Input	-	DAP	NetCDF4/Binary
Unit PCF	Input	1	NDE	ASCII
RR Volcanic Ash product output file (Mass Loading/Height)	Output	1	JPSS RR PS	NetCDF4
Unit PSF	Output	1	JPSS RR PS	ASCII
Unit Log file	Output	1	JPSS RR PS	ASCII

JPSS RR PS
Unit Level

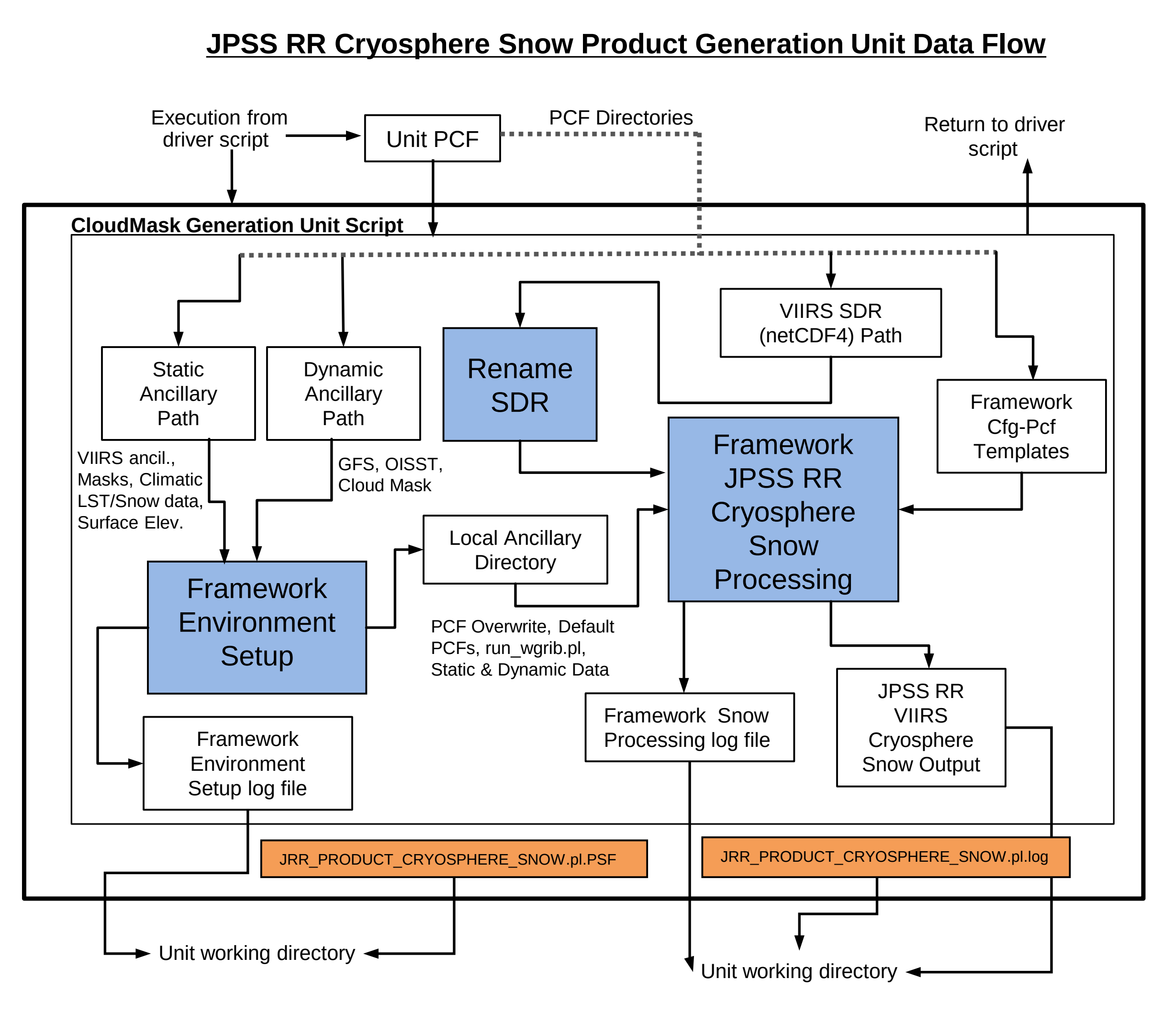
Unit 6. Cryosphere Snow Product Generation

6.1. Rename SDR for Framework

6.2. Framework Environment Setup

6.3. Framework Snow Product Processing

Unit Level Interfaces
6. Cryosphere Snow Product Generation



6. Cryosphere Snow Product Generation

System PCF

- A System PCF(Unit level) is passed by the System driver script to the sub-units for Clouds Product Generation
- The system PCF contains information on input SDR data in NetCDF format, RR VIIRS Cloud Mask data, static and dynamic ancillary data, location of scripts etc. required by the sub-units
- A section of the system PCF is given below:

```
PERL_LOC=/usr/bin/perl
OPS_SCRIPT=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/scripts
OPS_BIN=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/bin
PCF_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_SDR_Template.pcf
CFG_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_CRYOSPHERE_SNOW_Template.cfg
DIR_DEFAULT_PCF=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/Default_PCF
DIR_PCF_OVERWRITES=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/PCF_Overwrites
DIR_CUSTOMPRODUCTLISTS=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/CustomProductLists
```

Cryosphere Snow Product Generation
6.1 Rename SDR for Framework

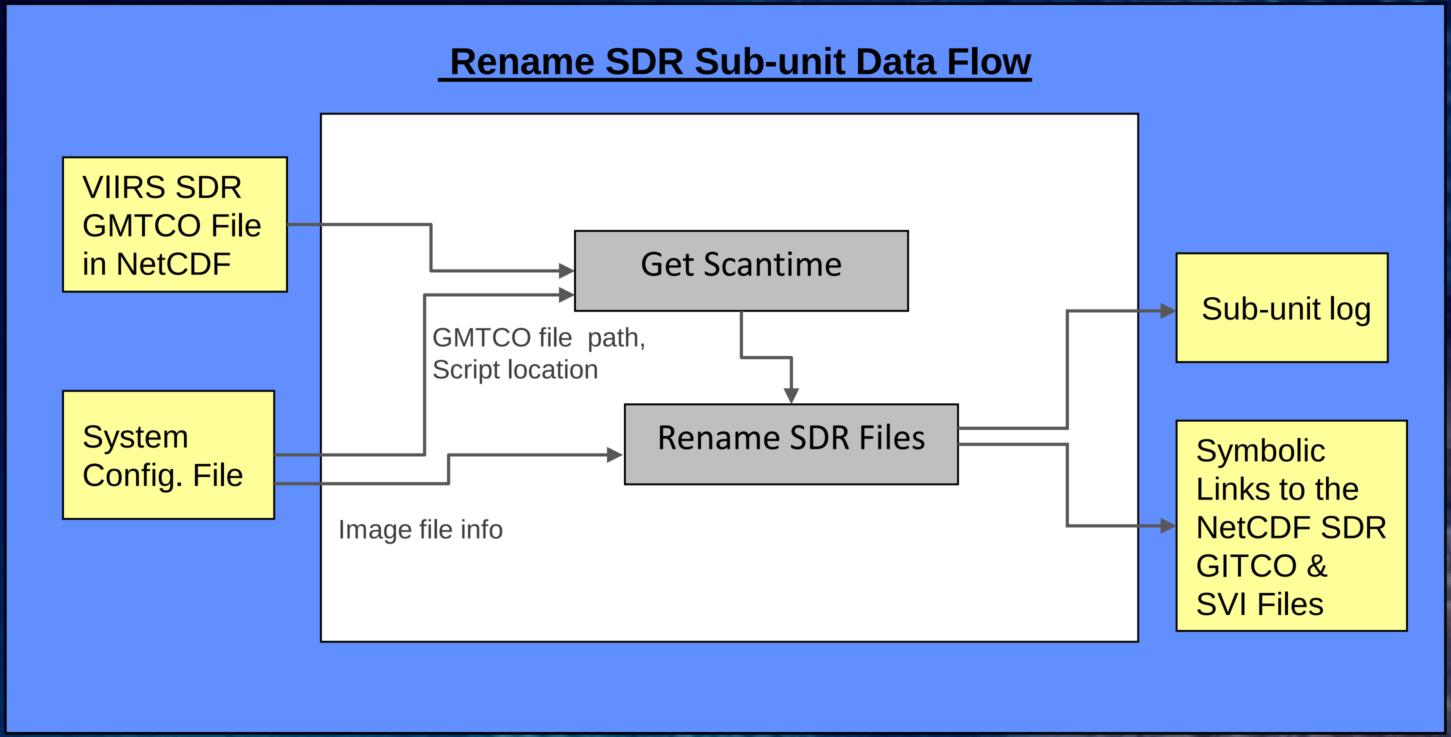
Sub-unit level interfaces

- Information in the system PCF is used to set up the sub-unit configuration
- The granule scantime obtained from the Geolocation file, by execution of *get_sdr_scan_time.exe,* is used to coin filenames comprehensible to framework
- Symbolic links are established with respective input NetCDF4 SDR files
- A sub-unit log file is saved for the process
- The general convention for renaming is as below:

Input Files:
G?TCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc
SV???_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc

Symbolic Link names, for framework:
G?TCO_npp_{scantime}_d????????_t???????.nc
SV???_npp_{scantime}_d????????_t???????.nc
where, scantime format is YYYYMMDD_hhmmss

Cryosphere Snow Product Generation 6.1 Rename SDR for Framework



Cryosphere Snow Product Generation
6.1 Rename SDR for Framework

Sub-unit Input/Output Data

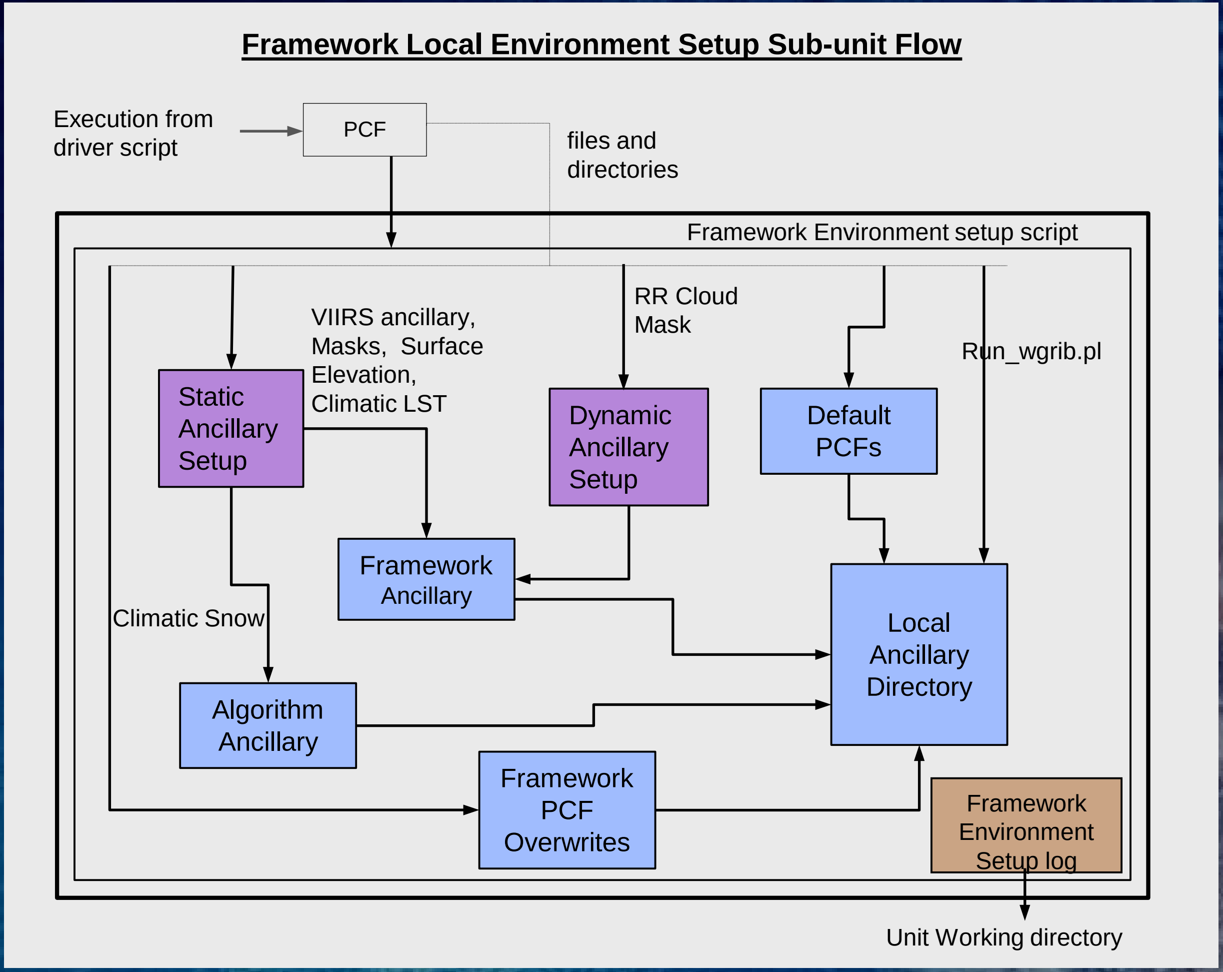
File	Input/ Output	Data description	Format
VIIRS granule geolocation file	Input	VIIRS granule terrain corrected geolocation data. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
System PCF	Input	Contains directories and setup of input data, scripts, etc. JRR_PRODUCT_CRYOSPHERE_SNOW.pl.PCF	ASCII
Log file	Output	Contains log for the sub-unit	ASCII

Cryosphere Snow Product Generation 6.2 Framework Environment Setup

Sub-unit level interfaces

- The Framework Environment Setup script make use of the system PCF to set up the local environment
- Creates directories for algorithm_ancillary, framework_ancillary and their subdirectories
- Establish symbolic links to AIT Framework Default_PCF, PCF_Overwrites, and ancillary data
- A sub-unit log file is saved for the process

Cryosphere Snow Product Generation 6.2 Framework Environment Setup

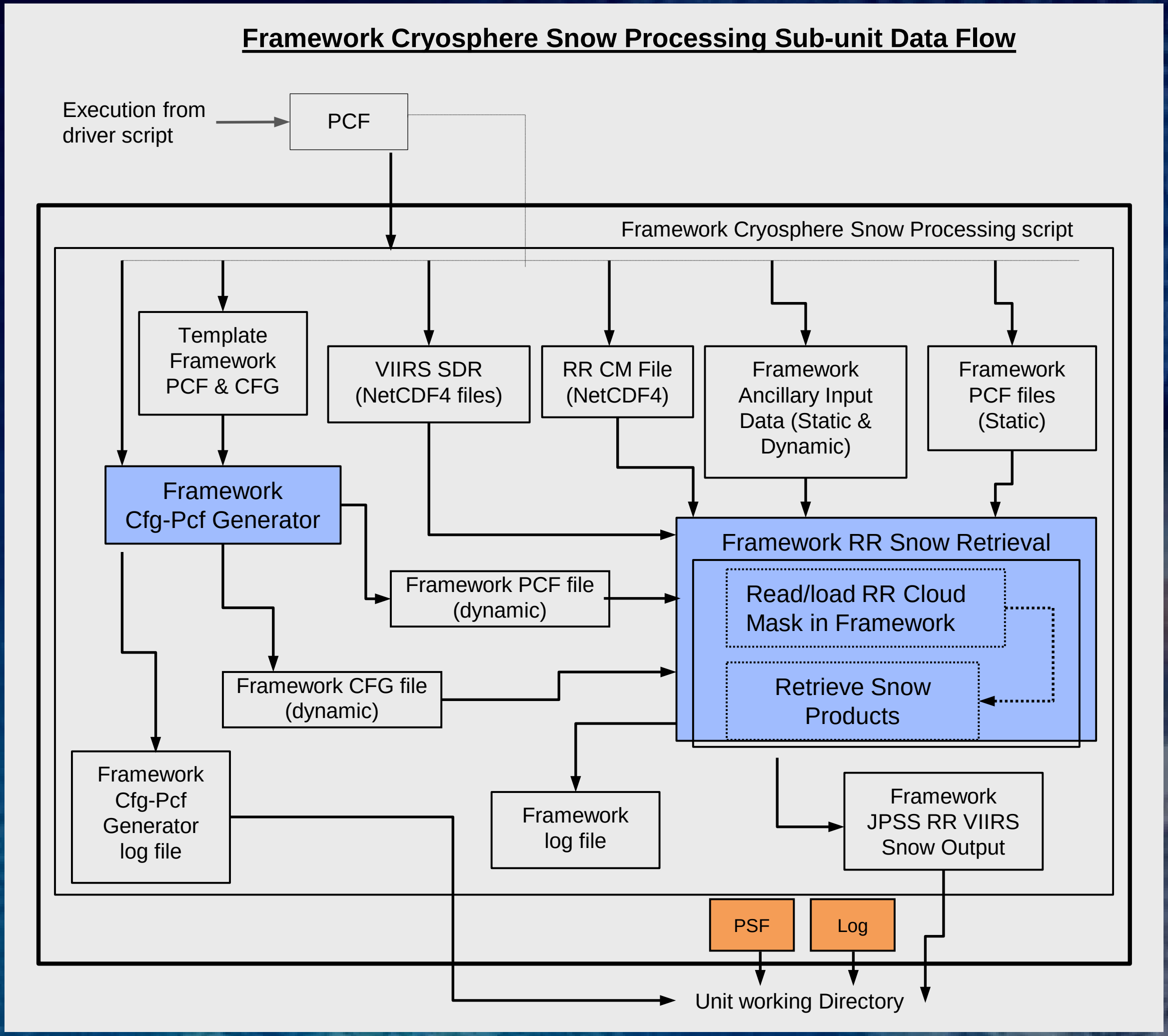


Cryosphere Snow Product Generation 6.2 Framework Environment Setup

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
System PCF	Input	JRR_PRODUCT_CRYOSPHERE_SNOW.pl.PCF Contains the setup of working directory, directory settings, filename & path for static ancillary, filenames of dynamic ancillary, location and name of each gap-filled and converted input SDR files for the granule, etc.	ASCII
Log file	Output	The sub-unit processing log	ASCII

Cryosphere Snow Product Generation 6.3 Framework Snow Processing



Cryosphere Snow Product Generation 6.3 Framework Snow Processing

Sub-unit Level Interfaces

- The Framework PCFs and CFG are generated from the template files before the Snow product retrieval is triggered
- The Framework executable is invoked to process the JPSS RR VIIRS Snow retrieval systems
- Framework reads the L1b, ancillary data, and the RR the Cloud Mask product data before processing the RR Snow algorithms
- The Snow Product Output files for both Binary and Fractional Snow Cover are renamed with the granule starttime, endtime and createtime to meet NDE requirement
- A sub-unit log file is saved for the process

Cryosphere Snow Product Generation 6.3 Framework Clouds Processing

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
Gap-filled VIIRS SDR I-band files	Input	NetCDF converted & Gap-filled VIIRS I band SDR files for each granule. *SVI{bb}_npp_YYYYMMDD_hhmmss_d????????_t???????.nc, bb={01, 02, 03, 04, 05}*	NetCDF4
VIIRS geolocation (M/I-band)	Input	NetCDF converted VIIRS geolocation data (terrain-corrected) file for each granule. *GMTCO_npp_YYYYMMDD_hhmmss_d????????_t???????.nc* *GITCO_npp_YYYYMMDD_hhmmss_d????????_t???????.nc*	NetCDF4
System PCF	Input	JRR_PRODUCT_CRYOSPHERE_SNOW.pl.PCF Contains the setup of working directory, directory settings, location and name of granule SDR files, primary /ancillary inputs including RR Cloud Mask product , etc. required for Snow processing .	ASCII
Framework PCF/CFG templates	Input	Template files used to generate overwritten PCFs and CFGs for framework Snow generation	ASCII
Static Framework ancillary data	Input	Static data for framework product run, including 1km and 250m Land Mask, Surface Elevation, Satellite Instrument Ancillary data, SDR dummy files, Climatic LST etc.	NetCDF4
Static Algorithm ancillary data	Input	Static files for Climatic Snow	NetCDF4
RR Cloud Mask	Input	JPSS RR VIIRS Cloud Mask product file	NetCDF4
RR Binary Snow Cover output file	Output	JPSS RR VIIRS Binary Snow Mask product , NDSI Fractional Snow Cover product, & Reflectance-based Fractional Snow Cover product with associated quality flag and metadata. JRR-SnowCover_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
Log file	Output	The sub-unit processing log file	ASCII

Cryosphere Snow Product Generation Unit PSF and Log

- A Unit level PSF containing the filename and location of the successfully generated framework output product file from Snow retrieval processing, is created.
  - » A section of JRR_PRODUCT_CRYOSPHERE_SNOW.pl.PSF is given:

```
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150511_t1225439_e1227081_b18318//JRR-SnowCover_v1r0_npp_s201505111225439_e201505111227081_c201508261935540.nc

#END-of-PSF
```

- A unit log file is saved for each script invoked during the process
  - » A section of JRR_PRODUCT_CRYOSPHERE_SNOW.pl.log is given:

```
JRR_PRODUCT_CRYOSPHERE_SNOW.pl is now starting at: 20150826-19:34:51

   Running jrr_product_sdr4frmwk.pl
     - log:  jrr_product_sdr4frmwk.pl.log

real    0m0.532s
user    0m0.243s
sys     0m0.124s
   running jrr_product_sdr4frmwk.pl: OK
```

Cryosphere Snow Product Generation Unit Input/Output Data

File	Input/ Output	No. of Files	Source	Format
Gap-filled VIIRS SDR I band files for channels *01, 02, 03, 04, 05*	Input	5	JPSS RR PS	NetCDF4
VIIRS I band geolocation file	Input	1	JPSS RR PS	NetCDF4
VIIRS M band geolocation file	Input	1	JPSS RR PS	NetCDF4
RR Cloud Mask product	Input	1	NDE	NetCDF4
Static Framework ancillary data	Input	-	DAP	NetCDF4
Static Algorithm ancillary data	Input	-	DAP	NetCDF4/Binary
Unit PCF	Input	1	NDE	ASCII
RR Binary Snow Cover output file containing products Binary Snow Mask, NDSI Snow Fraction, and Reflectance based Snow fraction, at 375 m resolution	Output	1	JPSS RR PS	NetCDF4
Unit PSF	Output	1	JPSS RR PS	ASCII
Unit Log file	Output	1	JPSS RR PS	ASCII

JPSS RR PS
Unit Level

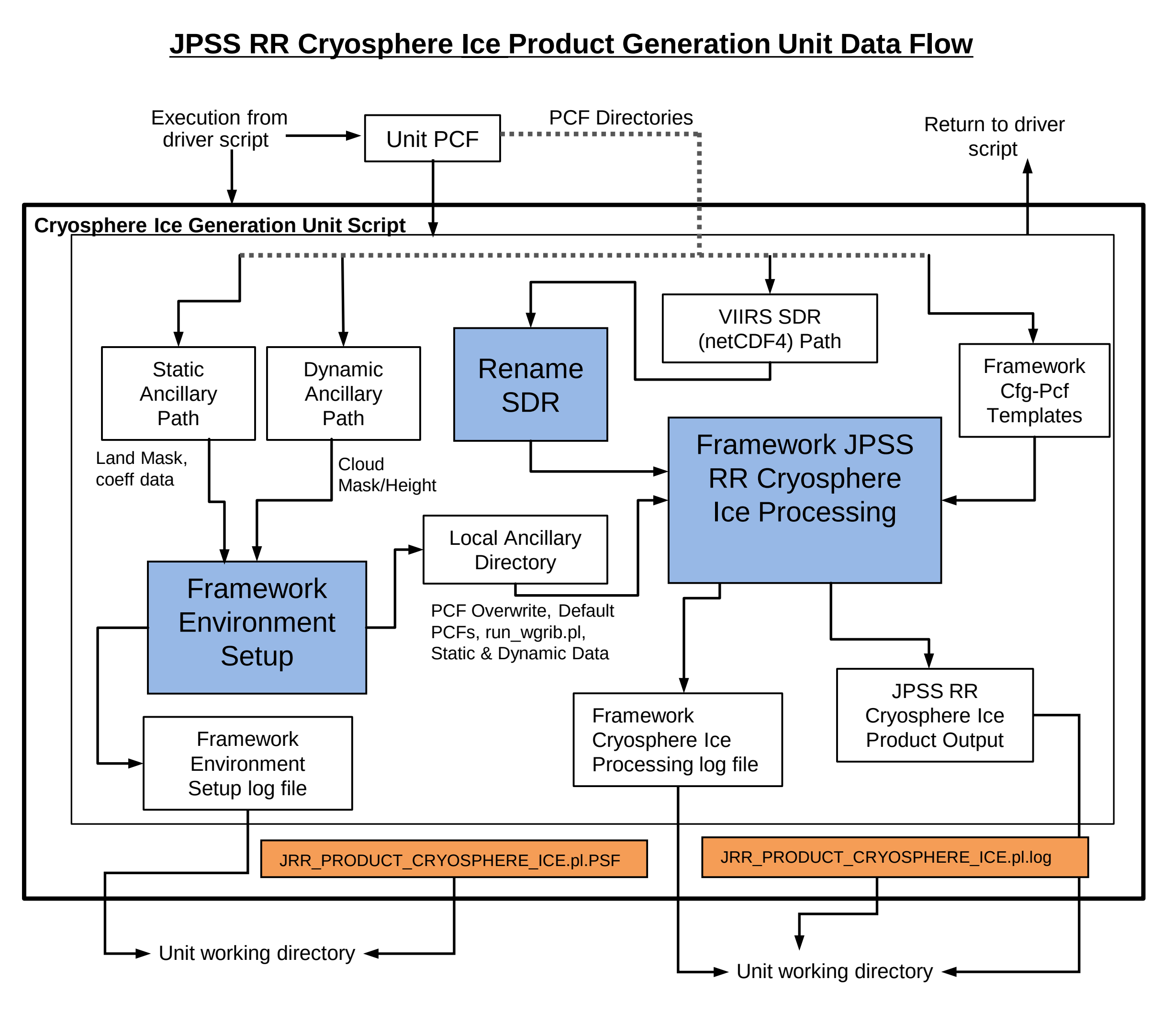
Unit 7. Cryosphere Ice Product Generation

7.1. Rename SDR for Framework

7.2. Framework Environment Setup

7.3. Framework Cryosphere Ice Product Processing

Unit Level Interfaces
7. Cryosphere Ice Product Generation



7. Cryosphere Ice Product Generation

System PCF

- A System PCF(Unit level) is passed by the System driver script to the sub-units for Cryosphere Ice Product Generation
- The system PCF contains information on input SDR data in NetCDF format, RR VIIRS Cloud Mask & Cloud Height data, static and dynamic ancillary data, location of scripts etc. required by the sub-units
- A section of the system PCF is given below:

```
PERL_LOC=/usr/bin/perl
OPS_SCRIPT=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/scripts
OPS_BIN=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/bin
PCF_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_SDR_Template.pcf
CFG_TEMPLATE=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/templates/NPP_VIIRS_CRYOSPHERE_ICE_Template.cfg
DIR_DEFAULT_PCF=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-OPS/Default_PCF
DIR_PCF_OVERWRITES=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/PCF_Overwrites
DIR_CUSTOMPRODUCTLISTS=/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/JRRPS-
OPS/CustomProductLists
```

Cryosphere Ice Product Generation
7.1 Rename SDR for Framework

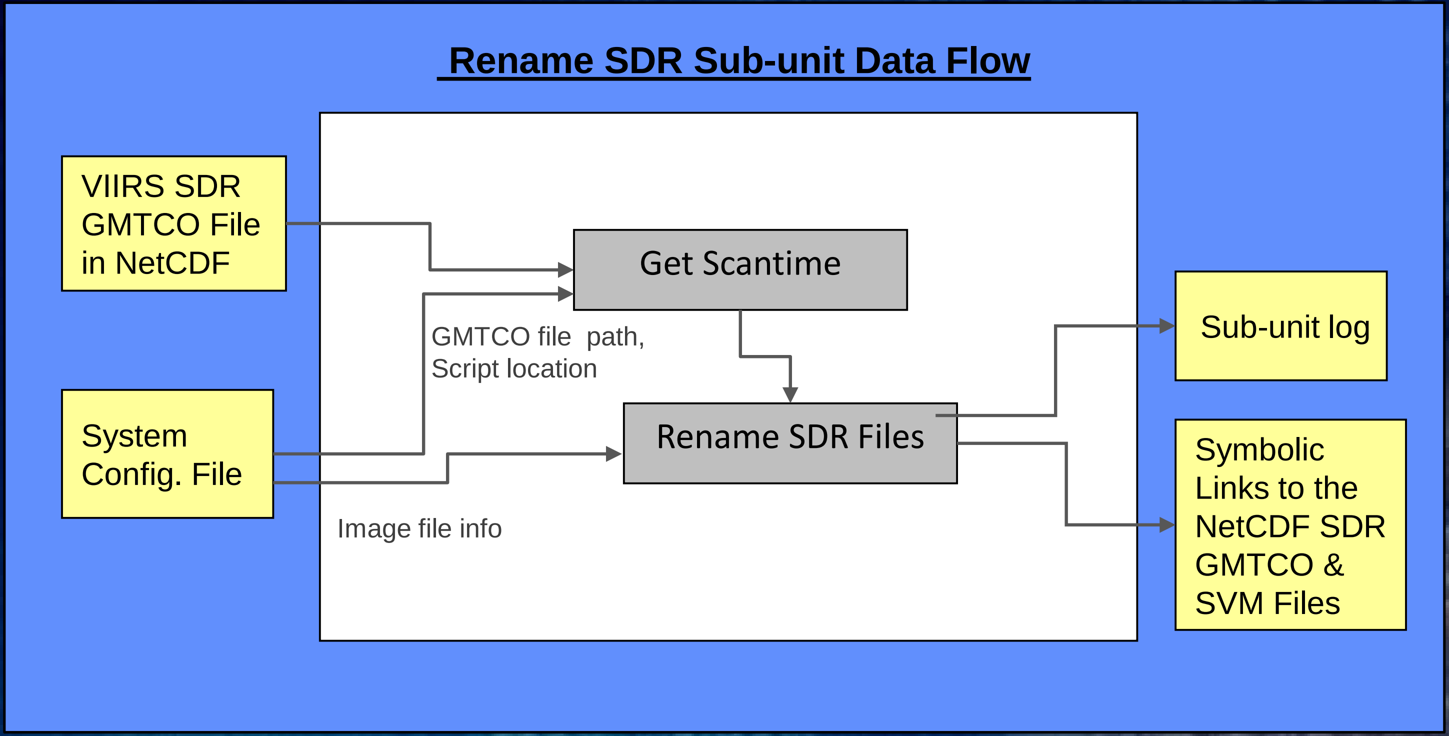
Sub-unit level interfaces

- Information in the system PCF is used to set up the sub-unit configuration
- The granule scantime obtained from the Geolocation file, by execution of *get_sdr_scan_time.exe,* is used to coin filenames comprehensible to framework
- Symbolic links are established with respective input NetCDF4 SDR files
- A sub-unit log file is saved for the process
- The general convention for renaming is as below:

Input Files:
G?TCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc
SV???_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc

Symbolic Link names, for framework:
G?TCO_npp_{scantime}_d????????_t???????.nc
SV???_npp_{scantime}_d????????_t???????.nc
where, scantime format is YYYYMMDD_hhmmss

Cryosphere Ice Product Generation
7.1 Rename SDR for Framework



Cryosphere Ice Product Generation
7.1 Rename SDR for Framework

Sub-unit Input/Output Data

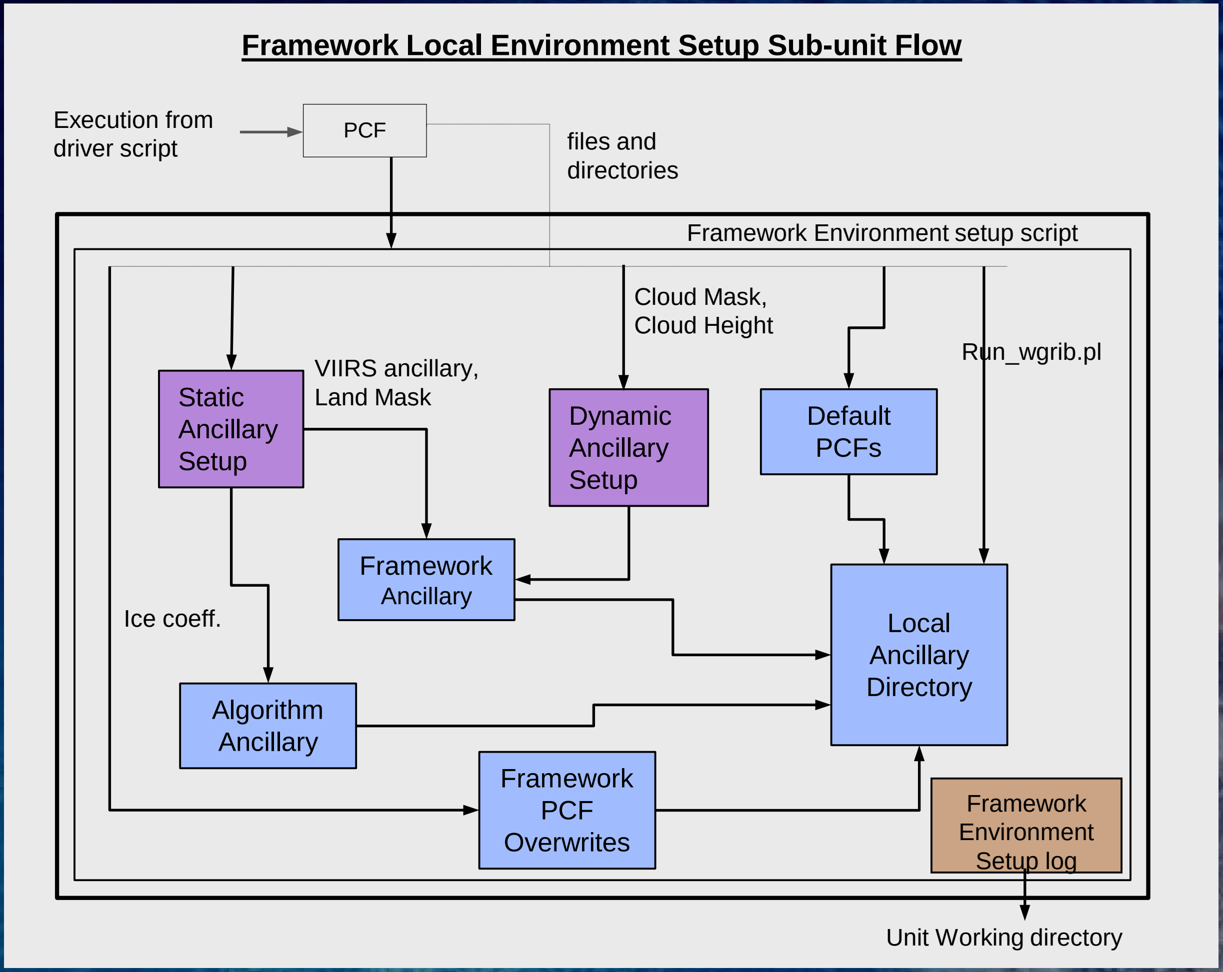
File	Input/ Output	Data description	Format
VIIRS granule geolocation file	Input	VIIRS granule terrain corrected geolocation data. *GMTCO_npp_d????????_t???????_e???????_b?????_c????????????????????_noaa_ops.nc*	NetCDF4
System PCF	Input	Contains directories and setup of input data, scripts, etc. JRR_PRODUCT_CRYOSPHERE_ICE.pl.PCF	ASCII
Log file	Output	Contains log for the sub-unit	ASCII

Cryosphere Ice Product Generation
7.2 Framework Environment Setup

Sub-unit level interfaces

- The Framework Environment Setup script make use of the system PCF to set up the local environment
- Creates directories for algorithm_ancillary, framework_ancillary and their subdirectories
- Establish symbolic links to AIT Framework Default_PCF, PCF_Overwrites, and ancillary data
- A sub-unit log file is saved for the process

Cryosphere Ice Product Generation
7.2 Framework Environment Setup

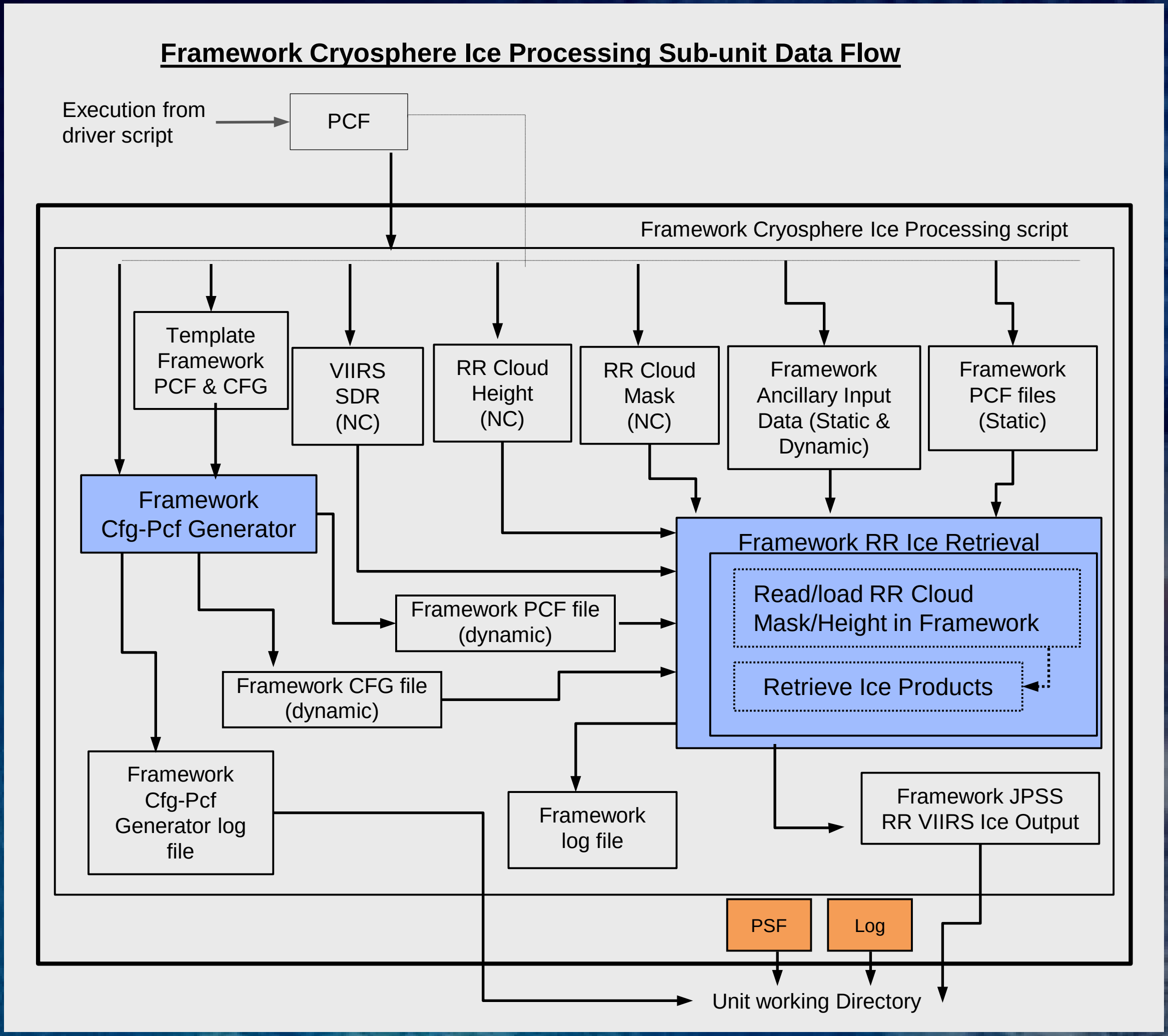


Cryosphere Ice Product Generation
7.2 Framework Environment Setup

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
System PCF	Input	JRR_PRODUCT_CRYOSPHERE_ICE.pl.PCF Contains the setup of working directory, directory settings, filename & path for static ancillary, filenames of dynamic ancillary, location and name of each gap-filled and converted input SDR files for the granule, etc.	ASCII
Log file	Output	The sub-unit processing log	ASCII

Cryosphere Ice Product Generation
7.3 Framework Ice Processing



Cryosphere Ice Product Generation
7.3 Framework Ice Processing

Sub-unit Level Interfaces

- The Framework PCFs and CFG are generated from the template files before the Cryosphere Ice product retrieval is triggered
- The Framework executable is invoked to process the JPSS RR VIIRS Ice retrieval systems
- Framework reads the L1b, ancillary data, and the RR the Cloud Mask & Cloud Height product data before processing the RR Ice algorithms
- The Ice Product Output files are renamed with the granule starttime, endtime and createtime to meet NDE requirement
- A sub-unit log file is saved for the process

Cryosphere Ice Product Generation
7.3 Framework Ice Processing

Sub-unit Input/Output Data

File	Input/ Output	Data description	Format
Gap-filled VIIRS SDR M-band files	Input	NetCDF converted & Gap-filled VIIRS M/I band SDR files for each granule. *SVM{bb}_npp_YYYYMMDD_hhmmss_d????????_t???????.nc, bb={03, 04, 05, 07, 10, 15, 16}*	NetCDF4
VIIRS geolocation (M-band)	Input	NetCDF converted VIIRS geolocation data (terrain-corrected) file for each granule. *GMTCO_npp_YYYYMMDD_hhmmss_d????????_t???????.nc*	NetCDF4
System PCF	Input	JRR_PRODUCT_CRYOSPHERE_ICE.pl.PCF Contains the setup of working directory, directory settings, location and name of granule SDR files, primary /ancillary inputs including RR Cloud Mask and Cloud Height product files, etc.	ASCII
Framework PCF/CFG templates	Input	Template files used to generate overwritten PCFs and CFGs for framework Cryosphere Ice generation	ASCII
Static Framework ancillary data	Input	Static data for framework product run such as Land mask	NetCDF4
Static Algorithm ancillary data	Input	Static coefficient files for Ice, SDR dummy files, etc.	NetCDF4
RR Cloud Mask	Input	JPSS RR VIIRS Cloud Mask product file	NetCDF4
RR Cloud Height	Input	JPSS RR VIIRS Cloud Height product file	NetCDF4
JPSS RR VIIRS Cryosphere Ice Concentration Product File	Output	Contains Cryosphere Ice Concentration a& Ice Surface Temperature product output with related meta data and quality flags JRR-IceConcentration_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
JPSS RR VIIRS Ice Age Product File	Output	Contains Cryosphere Ice Age & Ice Thickness product outputs with related meta data and quality flags JRR-IceAge_v1r0_npp_s???????????????_e???????????????_c???????????????.nc	NetCDF4
Log file	Output	The sub-unit processing log file	ASCII

Cryosphere Ice Product Generation Unit PSF and Log

- A Unit level PSF containing the filename and location of the successfully generated framework output product file from CloudMask retrieval processing, is created.
  - » A section of JRR_PRODUCT_CRYOSPHERE_ICE.pl.PSF is given below:

```
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150511_t2240157_e2241381_b18324//JRR-IceConcentration_v1r0_npp_s201505112240157_e201505112241381_c201507171818100.nc
/data/data092/hxie/dlv/npp_dap/nde_apr2015/JRR_DAP_apr2015/working_d20150511_t2240157_e2241381_b18324//JRR-IceAge_v1r0_npp_s201505112240157_e201505112241381_c201507171818110.nc
```

- A unit log file is saved for each script invoked during the process
  - » A section of JRR_PRODUCT_CRYOSPHERE_ICE.pl.log is given

```
JRR_PRODUCT_CRYOSPHERE_ICE.pl is now starting at: 20150717-18:17:59

   Running jrr_product_sdr4frmwk.pl
     - log:  jrr_product_sdr4frmwk.pl.log

real    0m0.652s
user    0m0.232s
sys     0m0.119s
   running jrr_product_sdr4frmwk.pl: OK
```

Cryosphere Ice Product Generation Unit Input/Output Data

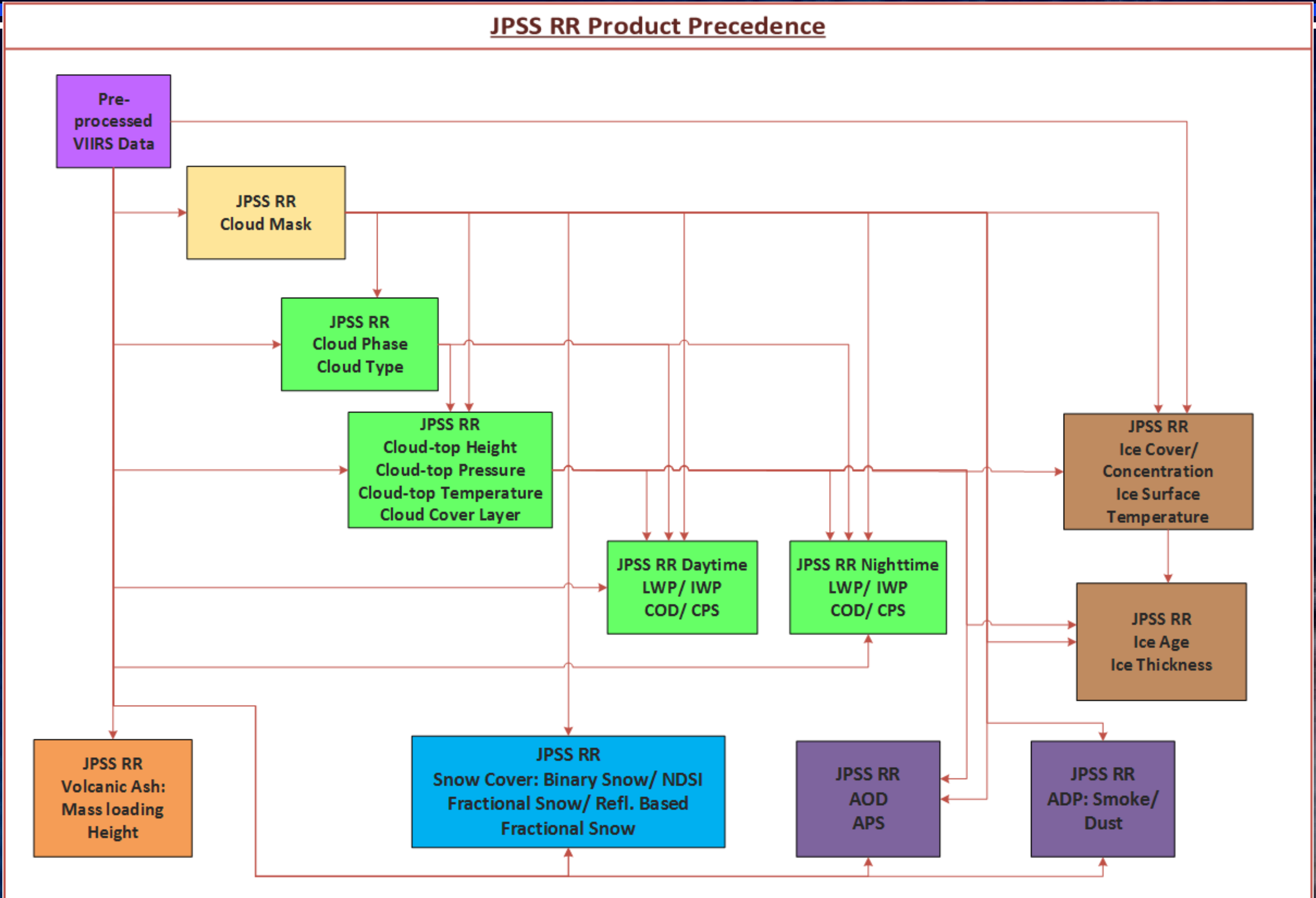
File	Input/ Output	No. of Files	Source	Format
Gap-filled VIIRS SDR M band files for channels *03, 04, 05, 07, 10, 15, 16*	Input	7	JPSS RR PS	NetCDF4
VIIRS M band geolocation file	Input	1	JPSS RR PS	NetCDF4
RR Cloud Mask product	Input	1	NDE	NetCDF4
RR Cloud Height product file	Input	1	NDE	NetCDF4
Static Framework ancillary data	Input	-	DAP	NetCDF4
Static Algorithm ancillary data	Input	-	DAP	NetCDF4
Unit PCF	Input	1	NDE	ASCII
JPSS RR VIIRS Cryosphere Ice Concentration /Cover Product File	Output	1	JPSS RR PS	NetCDF4
JPSS RR VIIRS Ice Age/Thickness Product File	Output	1	JPSS RR PS	NetCDF4
Unit PSF	Output	1	JPSS RR PS	ASCII
Unit Log file	Output	1	JPSS RR PS	ASCII

JPSS RR PS
Software Architecture

Outline

- JPSS RR PS System Overview
- JPSS RR PS Detailed Design
- JPSS RR PS Algorithm Software
- AIT Framework
- Transition to Operations

JPSS RR PS
Algorithm Product Precedence



Sub-system, Algorithm & Product Categorization

- Cloud Mask Product Generation Unit
  - » Cloud Mask Algorithm – Cloud Mask Product
- Clouds Product Generation Unit
  - » Cloud Phase Algorithm – Cloud Phase/Type Products
  - » Cloud Height Algorithm – Cloud-top Height/Temperature/Pressure Products
  - » DCOMP Algorithm – Daytime LWP, IWP, COD, and CPS Products
  - » NCOMP Algorithm – Nighttime LWP, IWP, COD, and CPS Products
- Aerosol AOD/ADP Product Generation Unit
  - » AOD Algorithm – AOD, APSP Products
  - » ADP Algorithm – Smoke/Dust Aerosol Detection Products
- Aerosol VolAsh Product Generation Unit
  - » Volcanic Ash Algorithm – Volcanic Ash Mass Loading and Height Products
- Cryosphere Ice Product Generation Unit
  - » Ice Concentration Algorithm – Ice Concentration/Cover, IST Products
  - » Ice Age Algorithm – Ice Age/Thickness Products
- Cryosphere Snow Product Generation Unit
  - » Snow Cover Algorithm – Binary/Fractional Snow Cover Product s

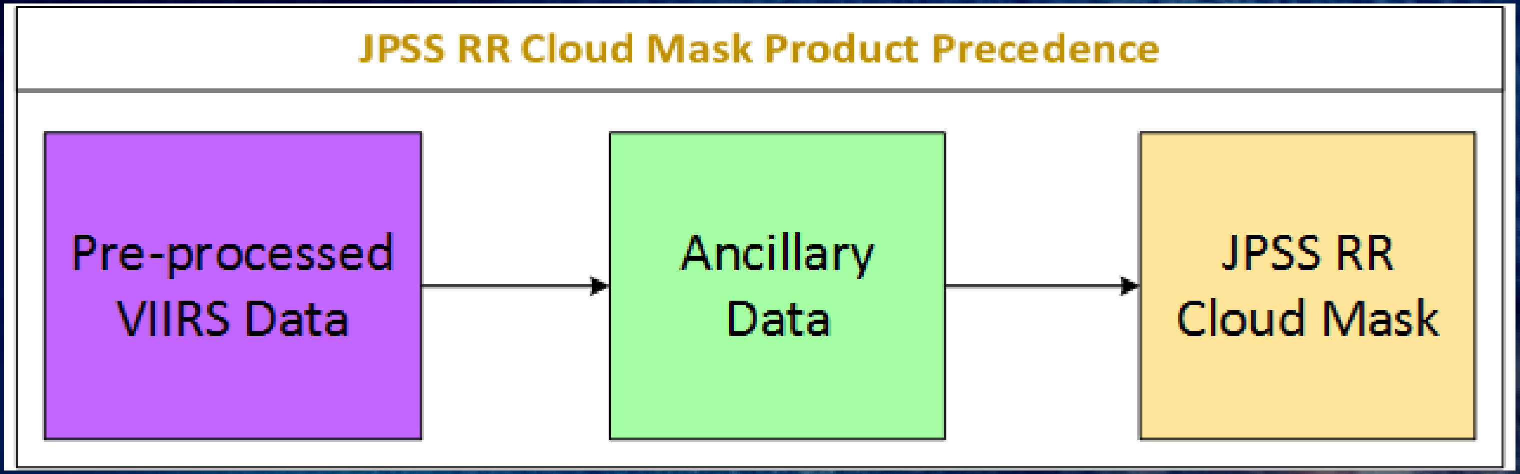
JPSS RR PS
Algorithm Software

- Cloud Mask Product Generation Unit
  - » Cloud Mask Algorithm
    - – Cloud Mask Product

Cloud Mask Algorithm Software Description

- Design Languages – Fortran 90
- SLOC
  - » Executable code – 3356
  - » With Comments – 4042

Cloud Mask Algorithm Product Precedence



Cloud Mask Algorithm Output

- Algorithm employs VIIRS Mbands M03, M05, M07, M09, M10, M11, M12, M14, M15, M16 and Ibands I01, I04, I05
- Cloud Mask is derived whenever detectable clouds are present.

Name	Type	Description	Dimension
cloud_mask	Product	Cloud Mask product: 4 level cloud mask 0-cloudy; 1-prob. cloudy; 2-prob. clear; 3-clear	grid (xsize, xsize)
cloud_probability	Output	Cloud probability floating point value 0 -1	grid (xsize, ysize)
clear_sky_mask	Product	Binary clear sky mask product: 2 level clear sky mask 0- clear; 1-cloudy	grid (xsize, ysize)
cloud_mask_packed	Output	Packed cloud mask product: 8 byte array containing the individual test & flag output bits.	grid (xsize, ysize, PkedCnst)
Smoke_Mask	Output	Smoke contamination mask	grid (xsize, xsize)
Fire_Mask	Output	Cloud probability floating point value 0 -1	grid (xsize, ysize)
Dust_Mask	Output	Binary clear sky mask product: 2 level clear sky mask 0- clear; 1-cloudy	grid (xsize, ysize)
CloudMaskQualFlag	Output	Cloud mask Quality control flags	grid (xsize, ysize)

Cloud Mask Algorithm Output Product Details

4-level cloud mask output values

Value	Description
Clear	Pixels that passed no test for cloud and failed a test for spatial heterogeneity
Probably Clear	Pixels that passed no test for cloud but passed tests for spatial heterogeneity
Probably Cloudy	Pixels that passed a test for cloud and passed a test for cloud edges
Cloudy	Pixels that passed a test for cloud and failed a test for cloud edges

Binary cloud mask output values

Value	Description
Clear	Pixel is clear
Cloudy	Pixel is cloudy

4-level cloud mask test output values

Value	Description
Clear	Test was failed strongly
Probably Clear	Test was failed weakly
Probably Cloudy	Test was passed weakly
Cloudy	Test was passed strongly.

Cloud Mask Algorithm Output Product Quality Flags

Individual test and flag output bits

Ancillary Data Flags		
Byte	Bit	Description
1	1	Cloud mask attempted flag
1	2	daytime visible tests attempted
1	3	Daytime spatial uniformity tests attempted
1	4	4 um daytime tests attempted
1	5	4 um nighttime tests attempted
1	6	Solar contamination
1	7	Coast / no coast
1	8	Mountain/ No Mountain Flag
2	1	Forward scattering
2	2	Cold scene 4 um
2	3	Cold scene btd
2	4	Glint flag
2	5	Smoke contaminated flag (not currently filled)
2	6	Dust contaminated flag (not currently filled)
2	7	Shadow contaminated flag (not currently filled)
2	8	Fire contaminated flag (not currently filled)
3	1-3	Surface type used for thresholds
3	4	Blank

Cloud Tests		
Byte	Bit	Description
3	5-6	TGCT – Thermal Gross Contrast Test
3	7-8	RTCT – Relative Thermal Contrast Test
4	1-2	TUT – Thermal (11 um BT) Uniformity Test
4	3-4	ETROP – Emissivity at Tropopause Test
4	5-6	FMFT – (11um - 12um) Test
4	7-8	(11um - 6.7um) Test
5	1-2	(11um - 6.7um) Covariance Test
5	3-4	(11um - 8.5um) Covariance Test
5	5-6	EMISS4 – 4um emissivity test
5	7-8	EMISS4 Day – 4um emissivity test
6	1-2	EMISS4 Night – 4um emissivity test
6	3-4	(11um – 4um) night test
6	5-6	RGCT – reflectance Gross Contrast Test
6	7-8	RUT – Reflectance (0.63 um) uniformity Test
7	1-2	RVCT – Relative Visible Contrast Test
7	3-4	RRCT – Reflectance Ratio Test
7	5-6	Near-IR Cirrus Test (CIRREF)
7	7-8	Near IR Snow Test (NIRREF)

Cloud Mask Algorithm Output Product Quality Flags

Individual test and flag output bits

Ancillary Data Flags

Byte	Bit	Description
0	0	Cloud Mask Attempted Flag
	1	Daytime Visible Tests Attempted
	2	Daytime Spatial Uniformity Tests Attempted
	3	4 mm Daytime Tests Attempted
	4	4 mm Nighttime Tests Attempted
	5	Solar Contamination Flag
	6	Coast / No Coast Flag
	7	Mountain / No Mountain Flag
1	0	Smoke Contamination Flag
	1	Dust Contamination Flag
	2	Shadow Contamination Flag
	3	Fire Contamination Flag
	4-6	Surface Type Used for Thresholds (Deep Ocean, Shallow Water, Land, Snow, Arctic, Antarctic + Greenland, Desert
	7	Spare
2	0-1	BT11 – 11 µm Thermal Test
	2-3	RTCT – Relative Thermal Contrast Test
	4-5	BT11STD – 11mm Thermal Uniformity Test
	6-7	ETROP – Emissivity at Tropopause Test

Cloud Tests

Byte	Bit	Description
3	0-1	BTD11_12 – 11 and 12 mm Split-Window Test
	2-3	BTD11_6.7 – 11 and 6.7 mm Thermal Contrast Test
	4-5	BTD11_6.7 – 11 and 6.7 mm Thermal Covariance Test
	6-7	BTD11_8.5 – 11 and 8.5 mm Thermal Contrast Test
4	0-1	EMISS4 – 4 mm Emissivity Test
	2-3	EMISS4 _Day – Daytime 4 mm Emissivity Test
	4-5	EMISS4 _Night – Nighttime 4 mm Emissivity Test
	6-7	BTD4_11 - Night 4 and 11 mm Thermal Contrast Test
5	0-1	Ref0.63 – 0.63 mm Reflectance Test
	2-3	Ref0.63STD – 0.63 mm Reflectance Uniformity Test
	4-5	RVCT – Relative Visible Contrast Test
	6-7	Ref_Ratio – Reflectance Ratio Test
6	0-1	NDSI – NDSI Test
	2-3	Ref1.38 – 1.38 mm Reflectance Test
	4-7	SPARE

Cloud Mask Algorithm Product Quality Control Flags

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

Cloud Mask Algorithm Product Monitoring Metadata

Cloud Mask Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
TerminatorPixPercent	Percent of terminator pixels - Number_of_pixels_with_solar_zenith_angle_between_87_and_93_degrees/ Total_number_of_attempted_retrievals
Cloudy	Percent of Pixels that passed a test for cloud and failed a test for cloud edge
ProbCloudy	Percent of Pixels that passed a test for cloud and passed a test for cloud edge
ProbClear	Percent of Pixels that passed no test for cloud but passed tests for spatial heterogenity
Clear	Percent of Pixels that passed no test for cloud and failed a test for spatial heterogenity
MinClrSkyOBS_RTM	Minimum observation - RTM calculation Brightness Temperature for clear-sky Good pixels for IR channels
MaxClrSkyOBS_RTM	Maximum observation - RTM calculation Brightness Temperature for clear-sky Good pixels for IR channels
MeanClrSkyOBS_RTM	Mean observation - RTM calculation Brightness Temperature for clear-sky Good pixels for IR channels
StdDevClrSkyOBS_RTM	Standard deviation of observation - RTM calculation Brightness Temperature for clear-sky Good pixels for IR channels
MinAllSkyOBS_RTM	Minimum observation - RTM calculation Brightness Temperature for all-sky Good pixels for IR channels
MaxAllSkyOBS_RTM	Maximum observation - RTM calculation Brightness Temperature for all-sky Good pixels for IR channels
MeanAllSkyOBS_RTM	Mean observation - RTM calculation Brightness Temperature for all-sky Good pixels for IR channels
StdDevAllSkyOBS_RTM	Standard deviation of observation - RTM calculation Brightness Temperature for all-sky Good pixels for IR channels

Cloud Mask Algorithm
Test Environment & Timing Info.

- The algorithm was tested on a Linux machine (3.2 GHz 12 dual core CPUs with 32 GB memory/CPU, 2TB disk space).
  - » Intel compiler was used
  - » Algorithm was compiled as 64 bit
- It takes ~130 seconds to generate RR Cloud Mask product output on a single granule (using combination of M & I bands) at 750 m resolution, with a segment size of 120 in framework

Cloud Mask Algorithm Timing Information

Unit	Time (seconds)
VIIRS_SDR_MULTIRES	49.99
LAND_MASK_NASA_1KM	0.17
OISST_DAILY_QTRDEG	1.91
NWP_GFS	22.17
SFC_ELEV_GLOBE_1KM	0.53
SFC_EMISS_SEEBOR	0.4
CRTM	33.42
COAST_MASK_NASA_1KM	0.1
SFC_TYPE_AVHRR_1KM	0.13
DESERT_MASK_CALCLTED	0.04
SNOW_MASK_NWP	0.12
GOESR_ABI_CHN7_EMISS	0.15
SFC_ALBEDO	0.41
NPP_BAYES_CLOUD_MASK	16.89
Total	**126.43**

Cloud Mask Algorithm Validation Datasets

- Apr 10-25, 2014
- Jul 10-25, 2014
- Oct 10-25, 2014
- Jan 01-31, 2015

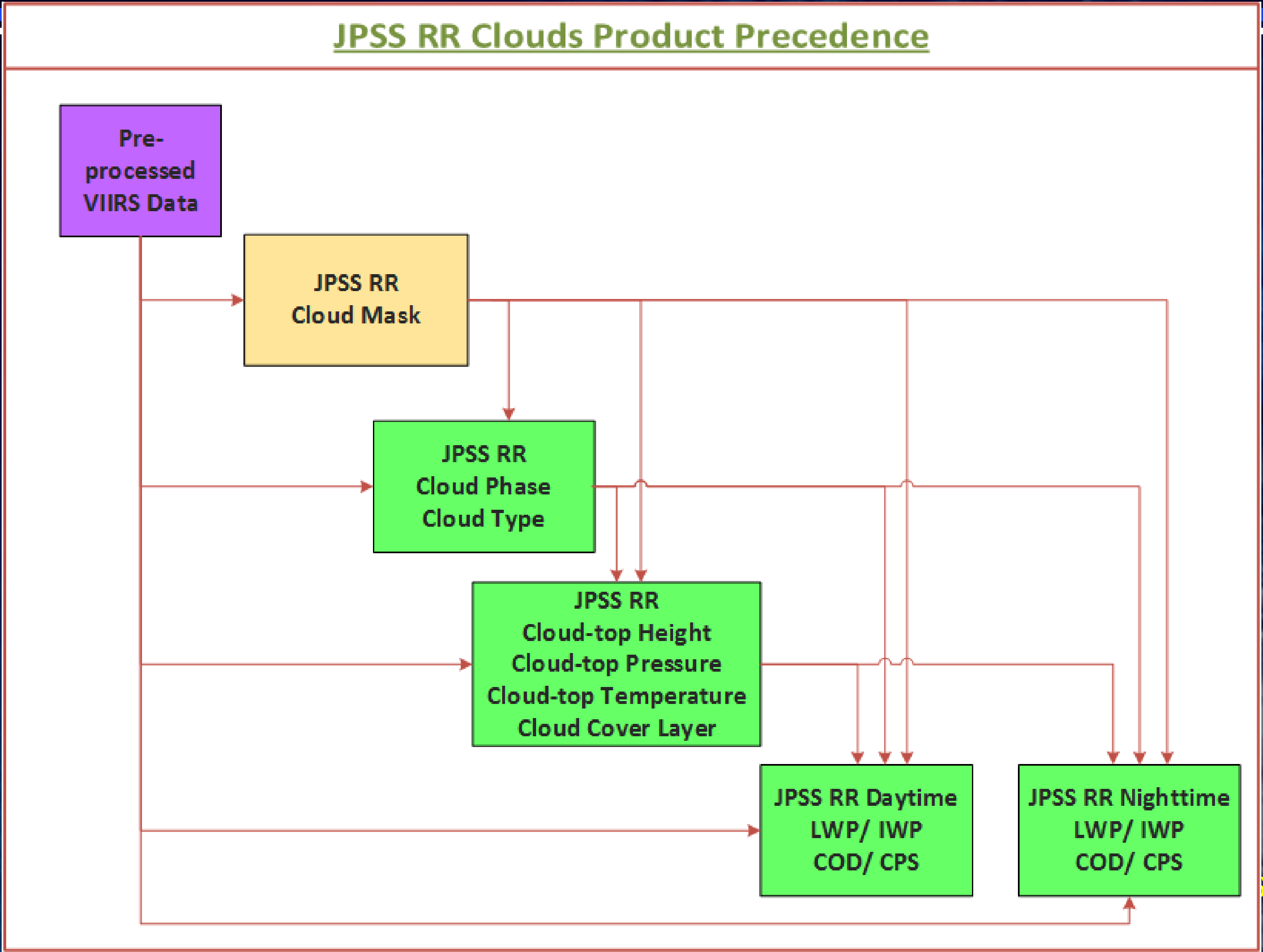
JPSS RR PS Algorithm Software

- Clouds Product Generation Unit
  - » Cloud Phase Algorithm
    - – Cloud Phase Product
    - – Cloud Type Product
  - » Cloud Height Algorithm
    - – Cloud-top Height
    - – Cloud-top Temperature
    - – Cloud-top Pressure
  - » DCOMP Algorithm
    - – Daytime LWP/ IWP/ COD/ CPS Products
  - » NCOMP Algorithm
    - – Nighttime LWP/ IWP/ COD/ CPS Products

Clouds Algorithm Software Description

- Design Language – Fortran 90
- SLOC
  - » Executable code
    - – Cloud Phase – 3464
    - – Cloud Height – 5077
    - – DCOMP – 4734
    - – NCOMP – 4685
  - » With Comments
    - – Cloud Phase – 4645
    - – Cloud Height – 6072
    - – DCOMP – 5848
    - – NCOMP – 5394

Clouds Algorithm Product Precedence



Cloud Phase Algorithm Output

- Cloud Phase Algorithm use VIIRS Mbands M14, M15, and M16
- Products: Cloud Phase, Cloud Type

Name	Type	Description	Dimension
CloudPhase	Product	Cloud Phase Category Output	grid (xsize, xsize)
CloudType	Product	Cloud Type Category Output	grid (xsize, ysize)
CloudTypePacked	Output	Cloud Type Diagnostic Flag	grid (xsize, ysize)
CloudPhaseFlag	Output	Overall Cloud Phase and Type Quality Flag	grid (xsize, ysize, 1)

Cloud Phase Algorithm Product Details

Cloud Phase Category	Description	Value
Clear	Clear cloud mask output	0
Liquid Water	Cloud top temperature > 273 K	1
Supercooled Water	Cloud top temperature < 273 K	2
Mixed Phase	Mainly a water signal, but may contain some ice	3
Ice	All ice phased clouds (cloud top)	4

Cloud Type Category	Description	Value
Clear	Clear cloud mask output	0
Spare	Spare category	1
Liquid Water	Liquid water with cloud top temperature > 273 K	2
Supercooled Water	Liquid water with cloud top temperature < 273 K	3
Mixed Phase	Mainly a water signal, but may contain some ice	4
Thick Ice	Ice cloud that is opaque in the infrared	5
Thin Ice	An approximate optical depth threshold is used to distinguish between thin and thick ice clouds	6
Multilayered Ice	Mainly ice cloud overlapping a lower, distinct, cloud layer	7

Cloud Phase Algorithm Quality Flags

Bit(s)	QF Description	Bit Interpretation
1	**Overall cloud phase/type product quality flag -** the overall quality will be set to "low quality" if any of the more specific quality flags listed below are set to "low quality"	0 = high quality 1 = low quality
2	**L1b quality flag** – this will be set to "low quality" if any of the spectral data used in the algorithm is of low quality, based on L1b calibration flags	0 = high quality spectral data 1 = low quality spectral data
3	**Beta quality flag** – this will be set to "low quality" if β_{stropo}(12/11μm), $\beta_{sopaque}$(12/11μm), β_{stropo}(8.5/11μm), **or** $\beta_{sopaque}$(8.5/11μm) fall outside of the 0.1 – 10.0 range	0 = high quality beta calculation 1 = low quality beta calculation
4	**Ice cloud quality flag** – this will be set to "low quality" if the cloud phase was determined to be ice and the ε_{stropo}(11μm) < 0.05	0 = ice cloud determination based on strong radiative signal 1 = ice cloud determination based on weak radiative signal (low quality)
5	**Surface emissivity quality flag** – this will be set to "low quality" if the result of the Low Surface Emissivity (LSE) Test is TRUE and the result of the Overall Opaque Cloud (OOC) Test is FALSE	0 = surface emissivity does NOT significantly impact product quality 1 = surface emissivity significantly impacts product quality (low quality)
6	**Satellite zenith angle quality flag** – this will be set to "low quality" if the cosine of the satellite zenith angle is less than 0.15 (~82 degrees)	0 = satellite zenith angle does NOT significantly impact product quality 1 = satellite zenith angle significantly impacts product quality (low quality)

Cloud Phase Algorithm Product Monitoring Metadata

Cloud Phase Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
TerminatorPixPercent	Percent of terminator pixels - Number_of_pixels_with_solar_zenith_angle_between_87_and_93_degrees/ Total_number_of_attempted_retrievals
LiquidWaterPct	Percent of pixels with Warm Liquid Water category (excluding Clear)
SuperCooledLiquidWaterPct	Percent of pixels with SuperCooled Liquid Water category (excluding Clear)
MixedPhasePct	Percent of pixels with Mixed Phase category (excluding Clear)
IcePct	Percent of pixels with All ice topped clouds (excluding Clear):
NumberofLowQuality	Overall Cloud Phase/Type quality flags: Low Quality Cloud Phase/Type retrievals
NumberofHighQuality	Overall Cloud Phase/Type quality flags: High Quality Cloud Phase/Type retrievals

Cloud Height Algorithm Output

- Cloud Height Algorithm use VIIRS Mbands M14, M15, and M16

Name	Type	Description	Dimension
CldTopTemp	Product	Cloud top temperature in Kelvin	grid (xsize, ysize)
CldTopPres	Product	Cloud top pressure in hPa	grid (xsize, ysize)
CldTopHght	Product	Cloud top height in meters	grid (xsize, ysize)
CloudLayer	output	Classifies low cloud, mid cloud and high cloud	grid (xsize, ysize)
InverFlag	output	Inversion Flag	grid (xsize, ysize)
Shadow_Mask	output	Cloud shadow mask	grid (xsize, ysize)
CldHgtFlag	output	Cloud Height Processing Flag	grid (xsize, ysize, 3)
CldPackedFlag	output	Cloud Height Diagnostic Flag	grid (xsize, ysize, 1)
CloudHgtQF	output	Cloud Height Quality Flag	grid (xsize, ysize)
TcError	output	Cloud top temperature uncertainty	grid (xsize, ysize)
PcError	output	Cloud top pressure uncertainty product	grid (xsize,ysize)
ZcError	output	Cloud top height uncertainty product	grid (xsize,ysize)
Cost	output	Final cost function value from optimal estimation	grid (xsize, ysize)

Cloud Height Algorithm Product Quality Flags

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

Cloud Height Algorithm Product Monitoring Metadata

Cloud Height Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
TerminatorPixPercent	Percent of terminator pixels - Number_of_pixels_with_solar_zenith_angle_between_87_and_93_deg/ Total_number_of_attempted_retrievals
ValidRetrPct	Valid, good quality converge retrieval
InvalidRetrSpaceViewPct	Percentage of invalid pixel due to space view
InvalidRetrSatZenPct	Percent of invalid pixel due to being outside of sensor zenith range
InvalidRetrBadDataPct	Percent of invalid earth pixel due to bad or missing 11 um BT or bad/missing clear sky 11 um BT
InvalidRetrCldMaskPct	Percentage of invalid pixels due to cloud mask being clear or probably clear
InvalidRetrMissCldTypePct	Percentage of invalid pixels due to missing cloud type
InvalidRetrFailedPct	Percentage of failed retrieval
MinCldTopTemp	Minimum Cloud Top Temperature for QA = 0 and 180 ≤ T ≤ 340 pixels (K)
MaxCldTopTemp	Maximum Cloud Top Temperature for QA = 0 and 180 ≤ T ≤ 340 pixels (K)
MeanCldTopTemp	Mean Cloud Top Temperature for QA = 0 and 180 ≤ T ≤ 340 pixels (K)
StdDevCldTopTemp	Standard Deviation of Cloud Top Temperature for QA = 0 and 180 ≤ T ≤ 340 pixels (K)
MinCldTopPres	Minimum Cloud Top Pressure for QA = 0 and 0 ≤ P ≤ 1100 pixels (hPa)
MaxCldTopPres	Maximum Cloud Top Pressure for QA = 0 and 0 ≤ P ≤ 1100 pixels (hPa)
MeanCldTopPres	Mean Cloud Top Pressure for QA = 0 and 0 ≤ P ≤ 1100 pixels (hPa)
StdDevCldTopPres	Standard deviation of Cloud Top Pressure for QA = 0 and 0 ≤ P ≤ 1100 pixels (hPa)
MinCldTopHeight	Minimum Cloud Top Height (H) for QA = 0 and -300 ≤ H ≤ 20000 pixels (m)
MaxCldTopHeight	Maximum Cloud Top Height (H) for QA = 0 and -300 ≤ H ≤ 20000 pixels (m)
MeanCldTopHeight	Mean Cloud Top Height (H) for QA = 0 and -300 ≤ H ≤ 20000 pixels (m)
StdDevCldTopHeight	Standard Deviation of Cloud Top Height (H) for QA = 0 and -300 ≤ H ≤ 20000 pixels (m)

DCOMP Algorithm Output Product

- DCOMP Algorithm use VIIRS Mbands M05, M07, M10, M11, and M12
- Daytime COMP Products:

Name	Type	Description	Dimension
Cloud Optical Thickness value	product	Retrieved cloud visible optical depth (dimensionless) for each cloudy pixel	grid (xsize, ysize)
Cloud Particle Size value	product	Retrieved cloud effective particle size (microns) value for each cloudy pixel	grid (xsize, ysize)
Cloud Liquid Water Path value	product	For Water Clouds. Retrieved LWP value for each water pixel (g/m^2)	grid (xsize, ysize)
Cloud Ice Water Path value	product	For Ice Clouds. Retrieved IWP value for each ice pixel (g/m^2)	grid (xsize, ysize)
Quality_Flag	output	quality flag	grid (xsize, ysize)

DCOMP Algorithm Output Product Quality Flags

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

NCOMP Algorithm Output Product

- NCOMP Algorithm use VIIRS Mbands M12, M14, M15, and M16
- Nighttime COMP Products:

Name	Type	Description	Dimension
Cloud Optical Thickness value	product	Retrieved cloud visible optical depth (dimensionless) for each cloudy pixel	grid (xsize, ysize)
Cloud Particle Size value	product	Retrieved cloud effective particle size (microns) value for each cloudy pixel	grid (xsize, ysize)
Cloud Liquid Water Path value	product	For Water Clouds. Retrieved LWP value for each water pixel (g/m^2)	grid (xsize, ysize)
Cloud Ice Water Path value	product	For Ice Clouds. Retrieved IWP value for each ice pixel (g/m^2)	grid (xsize, ysize)
Quality_Flag	output	quality flag	grid (xsize, ysize)
Processing_Flag	output	processing flag	grid (xsize, ysize, 14)

NCOMP Algorithm Output Product Quality Flags

NCOMP Control Codes		
Bit	**Quality Flag Name**	**Cause and effect**
Angle restriction flags		
1	QC_CYCLE_VZA	Viewing Zenith Angle >= 72.0
2	QC_CYCLE	Solar Zenith Angle < 82.0
Ancillary Data Flags		
3	QC_CYCLE_NOCLOUD	Cloud Type indicates it is not a cloud
4	QC_CYCLE_CLOUDTYPE	Cloud Type has an unknown value
5	QC_CYCLE_TCLOUD	Cloud Temperature is < 0.0
No Retrieval Flags		
6	QC_MINERR_WATER_0	No retrieval: Minimum error model for water = 0
7	QC_MINERR_ICE_0	No retrieval: Minimum error model for ice = 0
Valid Retrieval Flags		
8	QC__TWILIGHT_	82.0 <= Solar Zenith Angle < 90.0
9	QC_CTWATER_NCOMPICE	Cloud Type = water, NCOMP preferred phase = ice
10	QC_CTICE_NCOMPWATER	Cloud Type = ice, NCOMP preferred phase = water
11	QC_CTMIX_NCOMPWATER	Cloud Type = mixed, NCOMP preferred phase = water
12	QC_CTMIX_NCOMPICE	Cloud Type = mixed, NCOMP preferred phase = ice
13	QC__NCOMPWATER	Cloud Type = supercooled, NCOMP preferred phase = water
14	QC__NCOMPICE	Cloud Type = supercooled, NCOMP preferred phase = ice

Clouds Algorithm
Test Environment/ Timing Info.

- The algorithm was tested on a Linux machine (3.2 GHz 12 dual core CPUs with 32 GB memory/CPU, 2TB disk space).
  - » Intel compiler was used
  - » Algorithm was compiled as 64 bit
- It takes ~100 s (daytime) and ~260 s (nighttime), to generate all RR Clouds Algorithm product outputs on a single granule at 750 m resolution, with a segment size of 120 in framework

NCOMP/*DCOMP Algorithms Product Monitoring Metadata

COMP Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
TerminatorPixPercent	Percent of terminator pixels - Number_of_pixels_with_solar_zenith_angle_between_87_and_93_deg/ Total_number_of_attempted_retrievals
ValidRetrPct	Valid, good quality converge retrieval in percentage
ValidDegradedSnowPct	Not valid, quality may be degraded due to snow or sea ice surface in percentage
ValidDegradedTwilightPct	Not valid, degraded quality due to twilight conditions (solar zenith between 65 and 82 degree) in %
InvalidCloudFreePct	Invalid due to cloud-free condition in %
InvlidOutsideRangePct	Invalid pixel due to being outside of observation range in %
InvalidMissPct	Invalid pixel due to missing input data in %
InvalidFaliedPct	Invalid pixel, DCOMP/NCOMP attempted but failed retrieval in %
NitCat00Pct	Percent of Nighttime retrievals with Space Mask
NitCat01Pct	Percent of Nighttime retrievals with Viewing Zenith Angle > 65.0
NitCat02Pct	Percent of Nighttime retrievals with Solar Zenith Angle < 82.0
NitCat03Pct	Percent of Nighttime retrievals with Cloud Type indicates it is not a cloud
NitCat04Pct	Percent of Nighttime retrievals with Cloud Type has an unknown value
NitCat05Pct	Percent of Nighttime retrievals with Cloud Temperature is < 0.0
NitCat06Pct	Percent of Nighttime retrievals with No retrieval: Minimum error model for water = 0
NitCat07Pct	Percent of Nighttime retrievals with No retrieval: Minimum error model for ice = 0
MinOpticalDepth	Minimum COD for 0 ≤ COD≤ 100 daytime/nighttime pixels . Valid range: [0.0, 100.0]
MaxOpticalDepth	Maximum COD for 0 ≤ COD≤ 100 daytime/nighttime pixels. Valid range: [0.0, 100.0]
MeanOpticalDepth	Mean COD for 0 ≤ COD≤ 100 daytime/nighttime pixels. Valid range: [0.0, 100.0]
StdDevOpticalDepth	Standard Deviation of COD for 0 ≤ COD≤ 100 daytime/nighttime pixels. Valid range: [0.0, 100.0]
MinParticleSize	Minimum CPS for 0 ≤ CPS ≤ 100 daytime/nighttime pixels ; unit: μm; valid range: [0.0, 100.0]
MaxParticleSize	Maximum CPS for 0 ≤ CPS ≤ 100 daytime/nighttime pixels ; unit: μm; valid range: [0.0, 100.0]
MeanParticleSize	Mean CPS for 0 ≤ CPS ≤ 100 daytime/nighttime pixels ; unit: μm; valid range: [0.0, 100.0]
StdDevParticleSize	Standard Deviation of CPS for 0 ≤ CPS ≤ 100 daytime/nighttime pixels ; unit: μm; valid range: [0.0, 100.0]

NCOMP/*DCOMP Algorithms Product Monitoring Metadata

COMP Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
TerminatorPixPercent	Percent of terminator pixels - Number_of_pixels_with_solar_zenith_angle_between_87_and_93_deg/ Total_number_of_attempted_retrievals
ValidRetrPct	Valid, good quality converge retrieval in percentage
ValidDegradedSnowPct	Not valid, quality may be degraded due to snow or sea ice surface in percentage
ValidDegradedTwilightPct	Not valid, degraded quality due to twilight conditions (solar zenith between 65 and 82 degree) in %
InvalidCloudFreePct	Invalid due to cloud-free condition in %
InvlidOutsideRangePct	Invalid pixel due to being outside of observation range in %
InvalidMissPct	Invalid pixel due to missing input data in %
InvalidFaliedPct	Invalid pixel, DCOMP/NCOMP attempted but failed retrieval in %
NitCat00Pct	Percent of retrievals with Space Mask
NitCat01Pct	Percent of retrievals with Viewing Zenith Angle > 65.0
NitCat02Pct	Percent of retrievals with Solar Zenith Angle < 82.0
NitCat03Pct	Percent of retrievals with Cloud Type indicates it is not a cloud
NitCat04Pct	Percent of retrievals with Cloud Type has an unknown value
NitCat05Pct	Percent of retrievals with Cloud Temperature is < 0.0
NitCat06Pct	Percent of retrievals with No retrieval: Minimum error model for water = 0
NitCat07Pct	Percent of retrievals with No retrieval: Minimum error model for ice = 0
MinOpticalDepth	Minimum COD for 0 ≤ COD≤ 100 daytime/nighttime pixels . Valid range: [0.0, 100.0]
MaxOpticalDepth	Maximum COD for 0 ≤ COD≤ 100 daytime/nighttime pixels. Valid range: [0.0, 100.0]
MeanOpticalDepth	Mean COD for 0 ≤ COD≤ 100 daytime/nighttime pixels. Valid range: [0.0, 100.0]
StdDevOpticalDepth	Standard Deviation of COD for 0 ≤ COD≤ 100 daytime/nighttime pixels. Valid range: [0.0, 100.0]
MinParticleSize	Minimum CPS for 0 ≤ CPS ≤ 100 daytime/nighttime pixels ; unit: μm; valid range: [0.0, 100.0]
MaxParticleSize	Maximum CPS for 0 ≤ CPS ≤ 100 daytime/nighttime pixels ; unit: μm; valid range: [0.0, 100.0]
MeanParticleSize	Mean CPS for 0 ≤ CPS ≤ 100 daytime/nighttime pixels ; unit: μm; valid range: [0.0, 100.0]
StdDevParticleSize	Standard Deviation of CPS for 0 ≤ CPS ≤ 100 daytime/nighttime pixels ; unit: μm; valid range: [0.0, 100.0]

Clouds Algorithm Timing Information

Unit	Time (s)
VIIRS_SDR_MULTIRES	8.72
LAND_MASK_NASA_1KM	0.09
OISST_DAILY_QTRDEG	1.16
NWP_GFS	21.37
SFC_ELEV_GLOBE_1KM	0.34
SFC_EMISS_SEEBOR	0.3
CRTM	31.57
COAST_MASK_NASA_1KM	0.09
SFC_TYPE_AVHRR_1KM	0.08
DESERT_MASK_CALCLTED	0
SNOW_MASK_NWP	0.11
GOESR_ABI_CHN7_EMISS	0.12
SFC_ALBEDO	0.21
NPP_BAYES_CLOUD_MASK	1.47
NPP_VIIRS_CLD_PHASE	6.63
NPP_VIIRS_CLD_HEIGHT	14.76
AWG_CLOUD_MICRO_DAY	11.31
Total	**98.33**

Unit	Time (s)
VIIRS_SDR_MULTIRES	9.54
LAND_MASK_NASA_1KM	0.15
OISST_DAILY_QTRDEG	1.36
NWP_GFS	19.31
SFC_ELEV_GLOBE_1KM	0.46
SFC_EMISS_SEEBOR	0.33
CRTM	22.14
COAST_MASK_NASA_1KM	0.14
SFC_TYPE_AVHRR_1KM	0.16
DESERT_MASK_CALCLTED	0
SNOW_MASK_NWP	0.15
GOESR_ABI_CHN7_EMISS	0.17
SFC_ALBEDO	0.34
NPP_BAYES_CLOUD_MASK	2.22
NPP_VIIRS_CLD_PHASE	10.9
NPP_VIIRS_CLD_HEIGHT	35.85
NPP_VIIRS_CLD_NCOMP	153.03
Total	**256.25**

Clouds Algorithm Validation Datasets

- Apr 10-25, 2014
- Jul 10-25, 2014
- Oct 10-25, 2014
- Jan 01-31, 2015

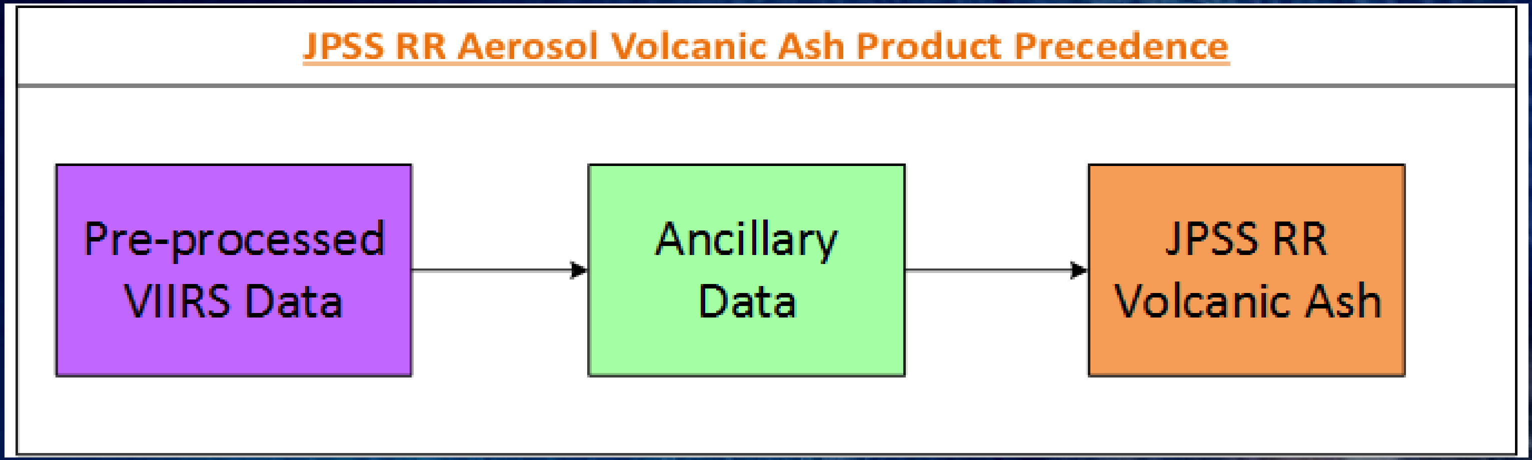
JPSS RR PS Algorithm Software

- Aerosol VolAsh Product Generation Unit
  - » Volcanic Ash Algorithm
    - – Volcanic Ash Mass Loading Product
    - – Volcanic Ash Height Product

Volcanic Ash Algorithm Software Description

- Design Languages – Fortran 90
- SLOC
  - » Executable code – 6404
  - » With Comments – 8664

Volcanic Ash Algorithm Product Precedence



Volcanic Ash Algorithm Output

- Algorithm employs VIIRS Mbands M14, M15, and M16
- Clear; for AOT greater than 0.15
- Products: Volcanic Ash Mass Detection and Height

Name	Type	Description	Dimension
AshTopHeight	product	Ash top height (m)	grid (xsize, ysize)
AshMassLoading	product	Ash mass loading (ton/km2 or g/m2)	grid (xsize, ysize)
AshConfidence	output	Ash Confidence for Single layered Ash	grid (xsize, ysize)
AshConfidenceMulti	output	Ash Confidence for Multi layered Ash	grid (xsize, ysize)
AshDetectionQPI	output	Ash Detection Product Quality Information	grid (xsize, ysize, 6)
AshDetectionQF	output	Ash Detection Quality Flag	grid (xsize, ysize, 2)
AshTopTemp	output	Ash Top Temperature (K)	grid (xsize, ysize)
AshTopPress	output	Ash Top Pressure (hPa)	grid (xsize, ysize)
AshTopHeight	output	Ash Top Height (m)	grid (xsize, ysize)

Volcanic Ash Algorithm Output (cont.)

Name	Type	Description	Dimension
AshEmiss	output	Ash Emissivity at 11um	grid (xsize, ysize)
AshEffRad	output	Ash Effective Particle Size (microns)	grid (xsize, ysize)
AshOD_VIS	output	Ash visible optical depth	grid (xsize, ysize)
AshOD_IR	output	Ash infrared optical depth	grid (xsize, ysize)
AshBeta	output	Beta value for 11 and 12 microns	grid (xsize, ysize)
AshTempErr	output	Estimated error in ash temperature (K)	grid (xsize, ysize)
AshPressErr	output	Estimated error in ash pressure (hPa)	grid (xsize, ysize)
AshHgtErr	output	Estimated error in Ash Height (m)	grid (xsize, ysize)
Ash_QF	output	Ash Retrieval Quality Flag	grid (xsize, ysize, 2)
Ash_PQI	output	Ash Retrieval Product Quality Information	grid (xsize, ysize, 1)

Volcanic Ash Algorithm Output Product Quality Flags

Volcanic Ash Retrieval Quality Control Codes			
Byte	**Bit**	**Name**	**Values**
1	1-2	Retrieval Status	0 - Successful 1 - Failed 2 - Not Attempted
1	3-4	T_{cld} QF	0 – High Quality 1 – Medium Quality 2 – Low Quality
1	5-6	ε_{cld} QF	0 – High Quality 1 – Medium Quality 2 – Low Quality
1	7-8	$\beta(12/11\mu m)$ QF	0 – High Quality 1 – Medium Quality 2 – Low Quality
2	1-4	Ash Particle Size	0 – < 2 µm 1 – ≥2 – < 3 µm 2 – ≥3 – < 4 µm 3 – ≥4 – < 5 µm 4 – ≥5 – < 6 µm 5 – ≥6 – < 7 µm 6 – ≥7 – < 8 µm 7 – ≥8 – < 9 µm 8 – ≥9 – < 10 µm 9 – ≥ 10 µm 10 - invalid

Volcanic Ash Algorithm Product Monitoring Metadata

Volcanic Ash Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
TotMassVolAsh	Total Ash Mass Loading for Overall High Quality pixels (unit: tons/km2)
MassLoadingMax	Maximum Ash Mass Loading for Overall High Quality pixels (unit: tons/km2)
MassLoadingMin	Minimum Ash Mass Loading for Overall High Quality pixels (unit: tons/km2)
MassLoadingMean	Mean Ash Mass Loading for Overall High Quality pixels (unit: tons/km2)
MassLoadingStdDev	Standard Deviation of Ash Mass Loading for Overall High Quality pixels (unit: tons/km2)
AshCldHgtMax	Maximum Ash Cloud Height for Overall High Quality pixels (unit: Meter)
AshCldHgtMin	Minimum Ash Cloud Height for Overall High Quality pixels (unit: Meter)
AshCldHgtMean	Mean Ash Cloud Height for Overall High Quality pixels (unit: Meter)
AshCldHgtStdDev	Standard Deviation of Ash Cloud Height for Overall High Quality pixels (unit: Meter)
DetQF_OverallPerc	Percent of retrievals with ash detection QA bits set to High Quality
RetQF_OverallPerc	Percent of retrievals with ash retrieval QA bits set to Successful/High Quality

Volcanic Ash Algorithm
Test Environment & Timing Info.

- The algorithm was tested on a Linux machine (3.2 GHz 12 dual core CPUs with 32 GB memory/CPU, 2TB disk space).
  - » Intel compiler was used
  - » Algorithm was compiled as 64 bit
- It takes ~92 seconds to generate RR Volcanic Ash product output on a single granule at 750 m resolution, with a segment size of 120 in framework

Volcanic Ash Algorithm Timing Information

Unit	Time (seconds)
VIIRS_SDR_MULTIRES	11.06
LAND_MASK_NASA_1KM	0.12
OISST_DAILY_QTRDEG	1.47
NWP_GFS	21.43
SFC_ELEV_GLOBE_1KM	0.58
SFC_EMISS_SEEBOR	0.45
CRTM	33.18
COAST_MASK_NASA_1KM	0.11
SNOW_MASK_NWP	0.11
SFC_TYPE_AVHRR_1KM	0.15
VOLCANO_SMITH_1KM	0.15
NPP_VOLCANIC_ASH	22.83
Total	**91.64**

Volcanic Ash Algorithm Validation Datasets (1/2)

- A total of 81 special cases for Volcanic Ash validation.
- The VIIRS granule time tags are given as below:

2013270_0137_08_d20130927_t0136337_e0137579_b09927	2015113_0510_13_d20150423_t0509380_e0511022_b18058
2013270_0959_17_d20130927_t0958421_e1000063_b09932	2015113_0511_38_d20150423_t0511034_e0512276_b18058
2013270_1000_42_d20130927_t1000075_e1001317_b09932	2015113_0513_03_d20150423_t0512288_e0513530_b18058
2013270_2015_14_d20130927_t2014393_e2016034_b09938	2015113_0514_29_d20150423_t0513542_e0515184_b18058
2014271_0224_36_d20140928_t0224016_e0225258_b15120	2015113_0645_31_d20150423_t0644566_e0646208_b18059
2014271_0226_02_d20140928_t0225270_e0226512_b15120	2015113_0646_57_d20150423_t0646220_e0647462_b18059
2014271_0227_27_d20140928_t0226524_e0228166_b15120	2015113_0648_22_d20150423_t0647474_e0649116_b18059
2014271_0228_52_d20140928_t0228178_e0229420_b15120	2015113_0649_47_d20150423_t0649128_e0650370_b18059
2014271_0233_09_d20140928_t0232340_e0233582_b15120	2015113_0651_13_d20150423_t0650382_e0652024_b18059
2014327_0139_11_d20141123_t0138365_e0140007_b15914	2015113_0652_38_d20150423_t0652036_e0653278_b18059
2014329_0240_55_d20141125_t0240200_e0241442_b15943	2015113_0654_04_d20150423_t0653290_e0654532_b18059
2015047_0323_28_d20150216_t0322539_e0324181_b17121	2015113_0655_29_d20150423_t0654544_e0656186_b18059
2015056_0748_27_d20150225_t0747526_e0749168_b17251	2015113_1729_55_d20150423_t1729201_e1730443_b18065
2015056_1858_26_d20150225_t1857516_e1859158_b17258	2015113_1731_20_d20150423_t1730455_e1732097_b18065
2015056_1859_52_d20150225_t1859170_e1900412_b17258	2015113_1732_45_d20150423_t1732109_e1733351_b18065
2015075_1506_57_d20150316_t1506220_e1507462_b17525	2015113_1734_11_d20150423_t1733363_e1735005_b18065
2015113_0504_33_d20150423_t0503582_e0505224_b18058	2015113_1735_36_d20150423_t1735017_e1736259_b18065
2015113_0505_58_d20150423_t0505236_e0506478_b18058	2015113_1737_02_d20150423_t1736271_e1737513_b18065
2015113_0507_24_d20150423_t0506490_e0508114_b18058	2015113_1738_27_d20150423_t1737525_e1739167_b18065
2015113_0508_47_d20150423_t0508126_e0509368_b18058	2015113_1739_52_d20150423_t1739179_e1740421_b18065

Volcanic Ash Algorithm Validation Datasets (2/2)

- The VIIRS granule time tags are given as below:

2015113_1909_29_d20150423_t1908549_e1910191_b18066
2015113_1910_55_d20150423_t1910203_e1911445_b18066
2015113_1912_20_d20150423_t1911457_e1913099_b18066
2015113_1913_46_d20150423_t1913111_e1914353_b18066
2015113_1915_11_d20150423_t1914365_e1916007_b18066
2015113_1916_36_d20150423_t1916019_e1917261_b18066
2015113_1918_02_d20150423_t1917273_e1918515_b18066
2015113_1919_27_d20150423_t1918527_e1920169_b18066
2015114_0444_12_d20150424_t0443371_e0445013_b18072
2015114_0445_37_d20150424_t0445025_e0446267_b18072
2015114_0447_02_d20150424_t0446279_e0447521_b18072
2015114_0448_28_d20150424_t0447533_e0449175_b18072
2015114_0449_53_d20150424_t0449187_e0450429_b18072
2015114_0451_19_d20150424_t0450441_e0452083_b18072
2015114_0452_44_d20150424_t0452095_e0453337_b18072
2015114_0454_09_d20150424_t0453349_e0454591_b18072
2015114_0455_35_d20150424_t0455003_e0456245_b18072
2015114_0625_12_d20150424_t0624373_e0626015_b18073
2015114_0626_37_d20150424_t0626027_e0627269_b18073
2015114_0628_03_d20150424_t0627281_e0628523_b18073
2015114_0629_28_d20150424_t0628535_e0630159_b18073
2015114_0630_52_d20150424_t0630171_e0631413_b18073
2015114_0632_17_d20150424_t0631425_e0633067_b18073
2015114_0633_42_d20150424_t0633079_e0634321_b18073
2015114_0635_08_d20150424_t0634334_e0635575_b18073
2015114_1709_35_d20150424_t1709008_e1710250_b18079
2015114_1711_01_d20150424_t1710262_e1711504_b18079
2015114_1712_26_d20150424_t1711516_e1713158_b18079
2015114_1713_52_d20150424_t1713170_e1714412_b18079
2015114_1715_17_d20150424_t1714424_e1716048_b18079
2015114_1716_41_d20150424_t1716060_e1717302_b18079
2015114_1718_06_d20150424_t1717315_e1718556_b18079
2015114_1719_31_d20150424_t1718569_e1720210_b18079
2015114_1850_34_d20150424_t1849592_e1851234_b18080
2015114_1851_59_d20150424_t1851246_e1852488_b18080
2015114_1853_25_d20150424_t1852500_e1854142_b18080
2015114_1854_50_d20150424_t1854154_e1855396_b18080
2015114_1856_15_d20150424_t1855408_e1857050_b18080
2015114_1857_41_d20150424_t1857062_e1858304_b18080
2015114_1859_06_d20150424_t1858316_e1859558_b18080
2015114_1900_32_d20150424_t1859570_e1901212_b18080

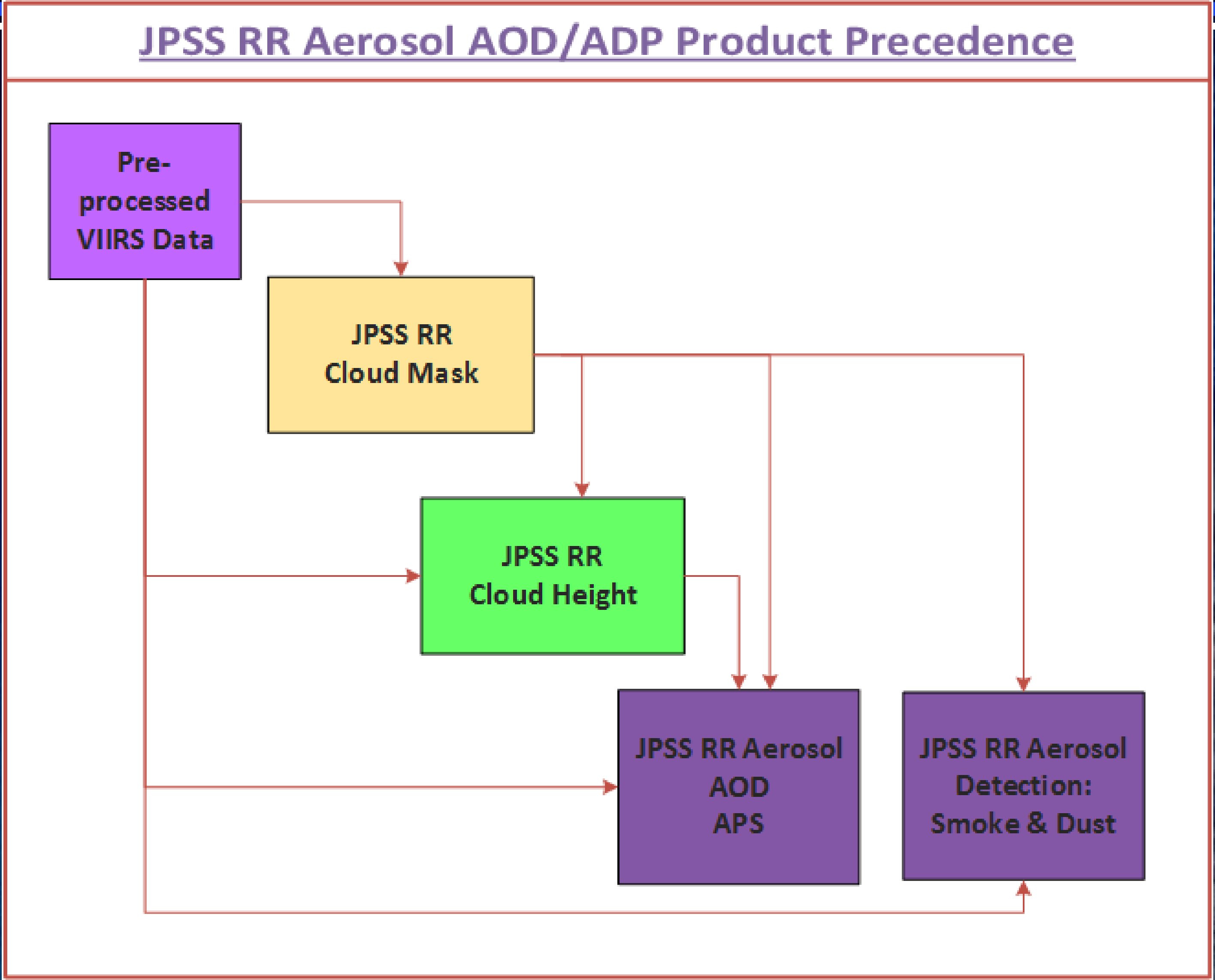
JPSS RR PS Algorithm Software

- Aerosol AOD/ADP Product Generation Unit
  - » AOD Algorithm
    - – Aerosol Optical Depth Product
    - – Aerosol particle Size Product
  - » ADP Algorithm
    - – Aerosol Smoke Detection
    - – Aerosol Dust detection

AOD/ADP Algorithm Software Description

- Design Language – C/C++
- SLOC
  - » Executable code
    - – AOD – 4719
    - – ADP – 2602
  - » With Comments
    - – AOD – 10078
    - – ADP – 5678

AOD/ADP Algorithm Product Precedence



AOD Algorithm Output

- Algorithm employs VIIRS Mbands M01 - M11, M15, and M16
- Clear, daytime only
- Products: AOD and APS

Name	Type	Description	Dimension
AOD at 550nm	product	Retrieved aerosol optical depth at 550 nm	granule (xsize, ysize)
AOD in VIIRS channels	product	Retrieved aerosol optical depth in VIIRS bands M1-M11	granule (xsize, ysize)
Aerosol type ID	output	Aerosol model selected from prescribed models during the retrieval; one for land and two (fine-mode and coarse mode) for ocean	granule (xsize, ysize)
Fine-mode weight (ocean only)	output	Fraction of fine-mode particle AOD to total AOD retrieved at 550nm over ocean	granule (xsize, ysize)
Aerosol Particle size	product	Ångström Exponents (proxy for particle size) calculated from AOD at two pairs of wavelengths (0.48,0.86 µm and 0.86, 2.25 µm)	granule (xsize, ysize)
Suspended Matter	output	Suspended Matter for both ocean and land	granule (xsize, ysize)

AOD Algorithm Output (cont.)

Name	Type	Description	Dimension
CoarseMdlIdx	output	Retrieved coarse aerosol model index over ocean (best solution)	granule (xsize, ysize)
FineMdlIdx	output	Retrieved fine aerosol model index over ocean (best solution)	granule (xsize, ysize)
SfcRefl	output	land surface reflectance at 0.47, 0.64 and 2.26 micron	granule (xsize, ysize, 11)
AerMdl	output	Aerosol model: 0-oceanic, 1-dust, 2-generic, 3-urban, 4-heavy smoke	granule (xsize, ysize)
QCPath	output	Flags indicating critical path	granule (xsize, ysize)
QCAOD	output	Flags indicating AOD quality	granule (xsize, ysize)
QCFlag	output	Flags indicating retrieval quality	granule (xsize, ysize)
QC flags	output	Input Quality control flags for each pixel indicating: input reflectance data quality, input ancillary data quality, input geometry quality	granule (xsize, ysize)

AOD Algorithm
Output Product Quality Flags

Aerosol Optical Depth Quality Control Codes			
Byte	**Bits**	**Quality Flag Name**	**Meaning**
1: Input Geometry Quality Flag	0	QC_INPUT_LON	0: valid longitude (-180 - 180°) 1: out-of-range longitude
	1	QC_INPUT_LAT	0: valid latitude (-90 - 90°) 1: out-of-range latitude
	2	QC_INPUT_ELEV	0: valid elevation (-2 – 10 km) 1: out-of-range elevation
	3	QC_INPUT_SOLZEN	0: valid solar zenith (0 - 90°) 1: out-of-range solar zenith
	4	QC_INPUT_SATZEN	0: valid satellite zenith (0 - 90°) 1: out-of-range satellite zenith
	5	QC_INPUT_SOLAZI	0: valid solar azimuth (0 - 180°) 1: out-of-range solar azimuth
	6	QC_INPUT_SATAZI	0: valid satellite azimuth (0 - 180°) 1: out-of-range satellite azimuth
2: Input Ancillary Data Flag	0 1	QC_INPUT_TPW	00: constant TPW data (2.0 cm) 01: valid TPW data from ABI retrieval (0-20 cm) 10: valid TPW data from model (0-20 cm)
	2 3	QC_INPUT_OZONE	00: constant ozone data (0.35 atm-cm) 01: valid ozone data from ABI retrieval (0.0 – 0.7 atm-cm) 10: valid ozone data from model (0.0 – 0.7 atm-cm)
	4	QC_INPUT__PRES	0: valid model surface pressure (500 – 1500 mb) 1: constant surface pressure (1013 mb)
	5	QC_INPUT_HGT	0: valid model surface height (-2 – 10 km) 1: constant surface height (0 km)
	6	QC_INPUT_WSP	0: valid model surface wind speed (0 – 100 m/s) 1: constant surface wind speed (6 m/s)
	7	QC_INPUT_WDR	0: model surface wind direction (0° - 360°) 1: fixed surface wind direction (90°)
3: Input Reflectance Data Flag	0	QC_INPUT_REFL_CH1	0: valid ABI reflectance in band 1 (0 – 1) 1: out-of-range ABI reflectance in band 1
	1	QC_INPUT_REFL_CH2	0: valid ABI reflectance in band 2 (0 – 1) 1: out-of-range ABI reflectance in band 2
	2	QC_INPUT_REFL_CH3	0: valid ABI reflectance in band 3 (0 – 1) 1: out-of-range ABI reflectance in band 3
	3	QC_INPUT_REFL_CH5	0: valid ABI reflectance in band 5 (0 – 1) 1: out-of-range ABI reflectance in band 5
	4	QC_INPUT_REFL_CH6	0: valid ABI reflectance in band 6 (0 – 1) 1: out-of-range ABI reflectance in band 6

AOD Algorithm
Output Product Quality Flags (cont.)

Aerosol Optical Depth Quality Control Codes			
Byte	**Bits**	**Quality Flag Name**	**Meaning**
4: Critical Path Flag	0	QC_CLOUD_MASK	0: clear sky 1: cloudy sky
	1	QC_RET_SCENE	0: over-land algorithm is used 1: over-water algorithm is used
	2	QC_LAND_TYPE	0: vegetation 1: soil
	3	QC_LAND_BRISFC	0: dark surface 1: bright surface
	4	QC_LAND_SNOW	0: no snow contamination 1: with snow contamination
	5	QC__WATER_GLINT	0: no sunglint contamination 1: with sunglint contamination
5: AOD Product Quality Flag	0	QC_RET	0: AOD is retrieved 1: AOD is not retrieved
	1	QC_RET_EXTRP	0: interpolation within LUT AOD range 1: extrapolation of AOD used
	2	QC_OUT_SPEC	0: within F&PS specification range 1: out of F&PS specification range
	3	QC_LOWSUN	0: solar zenith angle not larger than 80° 1: solar zenith angle larger than 80°
	4	QC_LOWSAT	0: local zenith angle not larger than 60º 1: local zenith angle larger than 60º

AOD Algorithm Product Monitoring Metadata

AOD Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
MeanAOT	Mean AOT at 550 nm
HighQualityPct	Percent of high quality retrievals
RetrievalPct	Percent of AOD retrievals

ADP Algorithm Output

- Algorithm employs VIIRS Mbands M01 - M13, M15, and M16
- Clear, daytime only
- Products: Aerosol Detection- Smoke & Dust

Name	Type	Description	Dimension
Smoke Flag	output	Detected smoke binary flag (1/0 - yes/no)	granule (xsize, ysize)
Dust Flag	output	Detected dust binary flag (1/0 – yes/no)	granule (xsize, ysize)
Aerosol	output	Detected Aerosol binary flag(1/0 – yes/no)	granule (xsize, ysize)
DAII	output	Dust Aerosol Index	granule (xsize, ysize)
NDAI	output	Non-Dust Aerosol Index	granule (xsize, ysize)
ADP QC Flags	output	Retrieval and diagonostic Quality Flags	granule (xsize, ysize)

ADP Algorithm
Output Product Quality Flags

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

ADP Algorithm Product Monitoring Metadata

ADP Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
NumOfGoodDustRetrieval	Number of good dust retrievals
NumOfGoodSmokeRetrieval	Number of good smoke retrievals
TotalPixel	Total number of attempted retrievals
SmokePct	Percent of retrievals with Good (determined) smoke retrievals
NoSmokePct	Percent of retrievals with Bad (not determined) smoke retrieval
DustPct	Percent of retrievals with Good (determined) dust retrievals
NoDustPct	Percent of retrievals with Bad (not determined) dust retrieval
SmokeConfidLowPct	Percent of retrievals with Low Confidence Smoke Detection
SmokeConfidMediumPct	Percent of retrievals with Medium Confidence Smoke Detection
SmokeConfidHighPct	Percent of retrievals with High Confidence Smoke Detection
DustConfidLowPct	Percent of retrievals with Low Confidence Dust Detection
DustConfidMediumPct	Percent of retrievals with Medium Confidence Dust Detection
DustConfidHighPct	Percent of retrievals with High Confidence Dust Detection

AOD/ADP Algorithm
Test Environment & Timing Info.

- The algorithm was tested on a Linux machine (3.2 GHz 12 dual core CPUs with 32 GB memory/CPU, 2TB disk space).
  - » Intel compiler was used
  - » Algorithm was compiled as 64 bit
- It takes ~162 seconds to generate RR AOD/ADP product outputs on a single granule at 750 m resolution, with a segment size of 120 in framework

AOD/ADP Algorithm Timing Information

Unit	Time (seconds)
VIIRS_SDR_MULTIRES	9.67
LAND_MASK_NASA_1KM	0.09
NWP_GFS	18.53
SFC_ELEV_GLOBE_1KM	0.34
SFC_TYPE_AVHRR_1KM	0.08
DESERT_MASK_CALCLTED	0.01
OISST_DAILY_QTRDEG	1.06
SNOW_MASK_NWP	0.11
NPP_BAYES_CLOUD_MASK	1.58
NPP_VIIRS_CLD_HEIGHT	4.56
AWG_AER_AOD	121.19
NPP_VIIRS_AERADP	4.48
Total	**161.7**

AOD/ADP Algorithm Validation Datasets

- Apr 10-25, 2014
- Jul 10-25, 2014
- Oct 10-25, 2014
- Jan 01-31, 2015

JPSS RR PS Algorithm Software

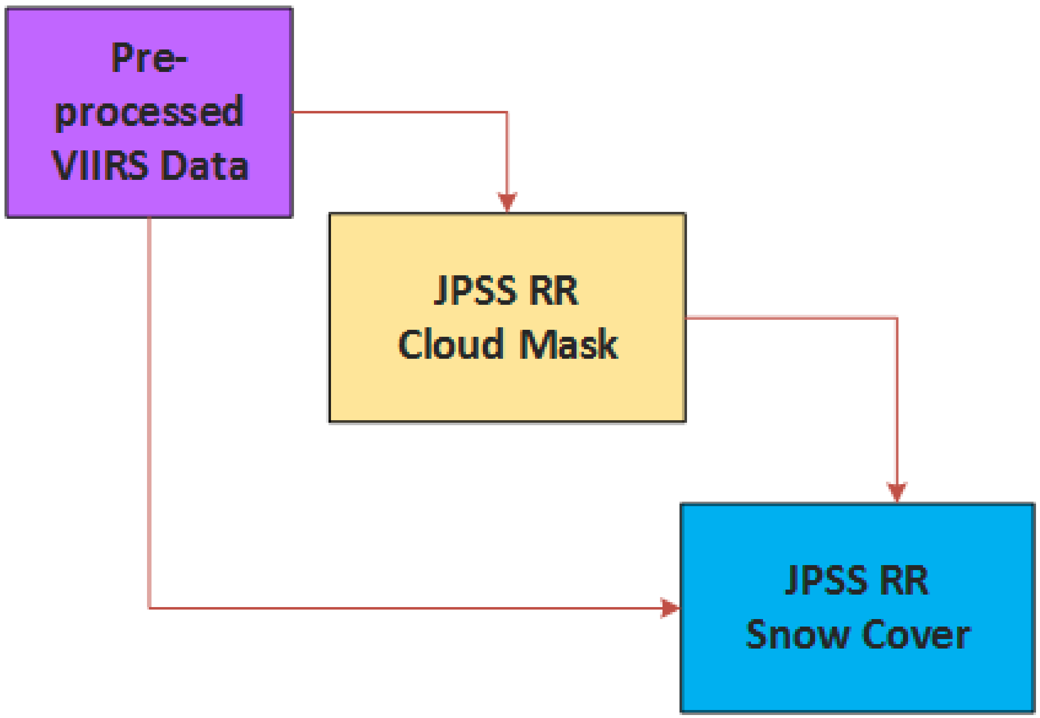
- Cryosphere Snow Product Generation Unit
  - » Snow Cover Algorithm
    - – Binary Snow Mask Product
    - – Reflectance based Snow Fraction (RR Product)
    - – NDSI Snow Fraction Product (Primary Product)

Snow Algorithm Software Description

- Design Language – Fortran90
- SLOC
  - » Executable code
    - – Snow Cover – 2048
  - » With Comments
    - – Snow Cover – 2429

Snow Algorithms Product Precedence

JPSS RR Cryosphere Snow Product Precedence



Snow Cover Algorithm Output

- Algorithm uses VIIRS bands (Iband) I01, I02, I03, I04, I05
- Clear, daytime only
- Products: Snow Mask, Reflectance based Snow Fraction, and NDSI Snow Fraction

Name	Type	Description	Dimension
Snow Mask	Product	Pixel level output: Binary Snow Mask product	granule (xsize, ysize)
Reflectance based Snow Fraction	RR Product	Pixel level output: Snow Fraction RR product	granule (xsize, ysize)
NDSI Snow Fraction	Primary Product	Pixel level output: Snow Fraction operational product	granule (xsize, ysize)
Quality Flags for Snow Mask/ Reflectance based Snow Fraction	Output	Pixel level output: quality flag for Snow Cover/Fraction retrieval	granule (xsize, ysize)
Quality Flags for NDSI Snow Fraction	Output	Pixel level output: quality flag for NDSI Snow fraction	granule (xsize, ysize)

Snow Cover Algorithm Output Product Quality Flags

Snow Cover (Binary/ Fractional) Retrieval Quality Control Codes	
Flag Description	**Flag Value**
Good Retrieval	0
water pixel flag	105
cloudy pixel flag	110
rejected snow pixel (snow climatology) flag	111
rejected snow pixel (temperature climatology)	112
rejected snow pixel (spatial consistency) flag	113
rejected snow pixel (temperature uniformity) flag	114
rejected snow pixel spare	115
unclassified pixel flag value	120
dark (insufficient daylight) pixel flag	121
undetermined pixel flag	122
VIIRS bad pixel data flag	124
No VIIRS coverage pixel flag value (fill value)	125

Snow Cover Algorithm Product Monitoring Metadata

Snow Cover Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
NumTotalPix	Total number of pixels on which retrieval attempted
NumClearPix	Number of pixels which are cloud free
NumConfSnowPix	Number of confidently snow pixels
NumRejSnowPix	Number of rejected snow pixels based on various tests (snow climatology, temperature climatology, spatial consistency, and temperature uniformity)

Snow Algorithm
Test Environment & Timing Info.

- The algorithm was tested on a Linux machine (3.2 GHz 12 dual core CPUs with 32 GB memory/CPU, 2TB disk space).
  - » Intel compiler was used
  - » Algorithm was compiled as 64 bit
- It takes ~75 seconds to generate RR Snow product outputs on a single granule at 375 m resolution, with a segment size of 120, in framework

Snow Algorithm Timing Information

Unit	Time (seconds)
VIIRS_SDR_MULTIRES	36.5
LAND_MASK_NASA_1KM	0.3
NWP_GFS	17.08
SFC_ELEV_GLOBE_1KM	2.26
CLIMATIC_LST_ISCCP	0.04
NPP_BAYES_CLOUD_MASK	1.62
NPP_VIIRS_SNOW_COVER	18.02
Total	**75.82**

Snow Algorithm Validation Datasets

- Apr 10-25, 2014
- Jul 10-25, 2014
- Oct 10-25, 2014
- Jan 01-31, 2015

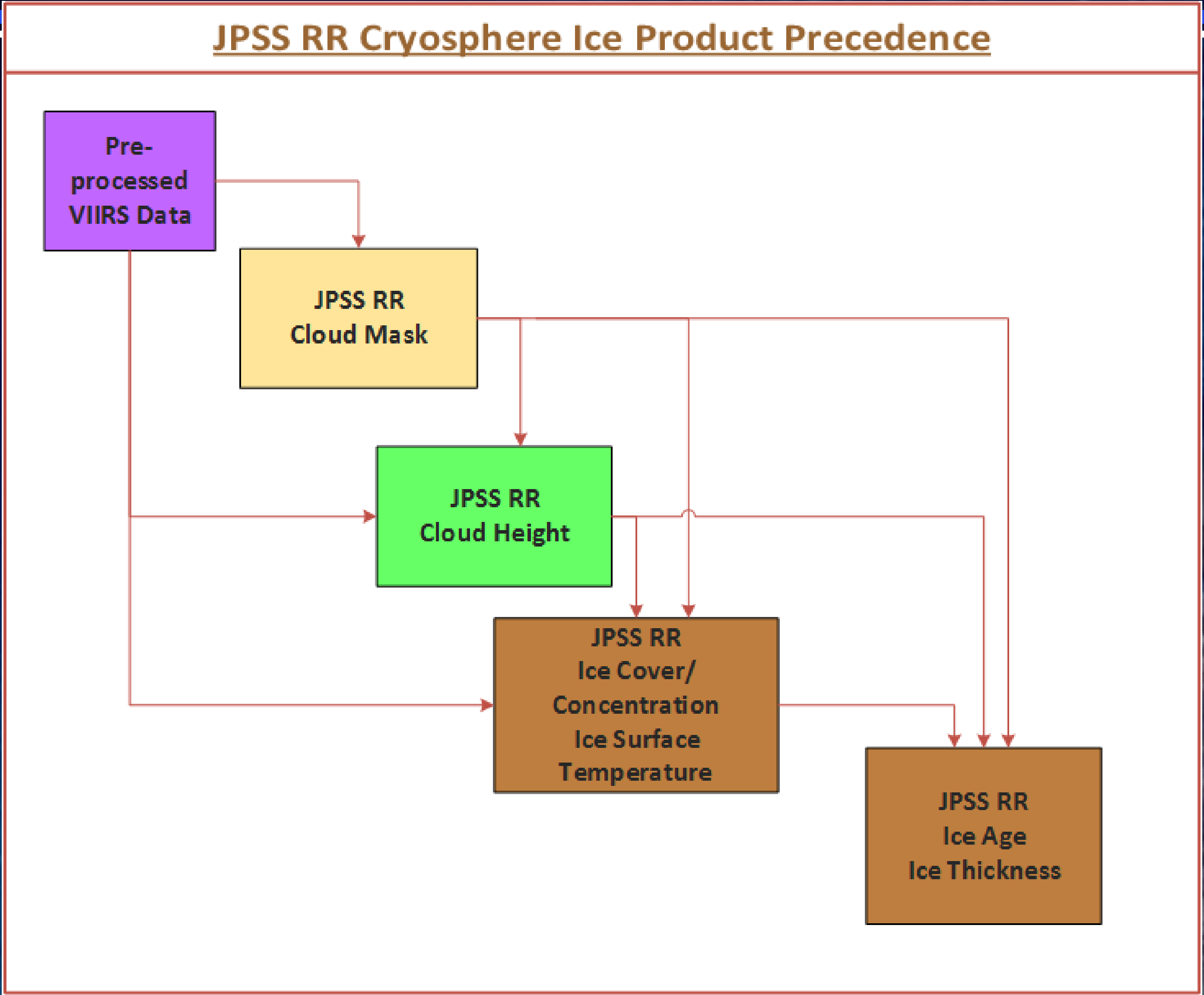
JPSS RR PS Algorithm Software

- Cryosphere Ice Product Generation Unit
  - » Ice Concentration Algorithm
    - – Ice Concentration/Cover Product
    - – Ice Surface Temperature Product
  - » Ice Age Algorithm
    - – Ice Age Product
    - – Ice Thickness

Ice Algorithm Software Description

- Design Language – Fortran90
- SLOC
  - » Executable code
    - – Ice Concentration – 2585
    - – Ice Age – 3379
  - » With Comments
    - – Ice Concentration – 3099
    - – Ice Age – 3727

Ice Algorithms Product Precedence



Ice Concentration Algorithm Output

- Algorithm uses VIIRS Mbands 03, 04, 05, 07, 10, 15, 16
- Products: Ice Concentration/Cover and IST

Name	Type	Description	Dimension
Ice cover	output	Output contains ice extent map for each pixel with water surface type	Scan grid (xsize, ysize)
Ice concentration	product	Output contains ice concentration for each pixel identified as ice	Scan grid (xsize, ysize)
Ice surface skin temperature	product	Output contains ice surface skin temperature for each pixel identified as ice	Scan grid (xsize, ysize)
QC flags	output	Quality Control Flags for every pixel	Scan grid (xsize, ysize)

Ice Concentration Algorithm Output Product Quality Flags

Ice Concentration Retrieval Quality Flags		
Bit 0	**Bit 1**	**Definition**
0	0	Valid retreival; Normal or optimal
0	1	Retreival; Uncertrain or sub-optimal
1	0	Non-retrievable
1	1	Bad data

Ice Concentration Algorithm Product Monitoring Metadata

Ice Concentration Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
TotWaterPixs	Total number of pixels with water surface
TotIceRetrvls	Total number of valid ice cover and concentration retrievals (normal + uncertain)
IceRetrPct	Total percentage of valid ice cover and concentration retrievals of all pixels with water surface
TotIceTermnt	Total pixels numbers of terminator pixels (Non-retrievable and Bad data)
IceTermntPct	percentage of terminator pixels (Non-retrievable and Bad data)
TotDaytimePixs	Pixel number of daytime ice cover and concentration valid retrievals
TotNighttimePixs	Pixel number of nighttime ice cover and concentration valid retrievals
MeanIceConc	Mean of valid ice concentration retrievals
MaxIceConc	Maximum of valid ice concentration retrievals
MinIceConc	Minimum of valid ice concentration retrievals
STDIceConc	Standard deviation of valid ice concentration retrievals
Tot_QACat01	Number of QA flags with Normal or Optimal values
Tot_QACat02	Number of QA flags with Uncertain or Suboptimal values
Tot_QACat03	Number of QA flags with Non-retrievable values
Tot_QACat04	Number of QA flags with Bad data values

Ice Age Algorithm Output

- No VIIRS data
- Products: Ice Age/Thickness

Name	Type	Description	Dimension
Ice Thickness	Product	Automated sea and lake ice thickness	granule (xsize, ysize)
Ice age	Product	Automated sea and lake ice age	granule (xsize, ysize)
QC	Output	granule level output: ice retrieval quality	granule (xsize, ysize)
Product Quality	Output	Product qualiity information	granule (xsize, ysize)

Ice Age Algorithm Output Product Quality Flags

Ice Age Retrieval Quality Flags		
Bit 0	**Bit 1**	**Definition**
0	0	Valid retrieval; Normal or optimal
0	1	Retrieval; Uncertain or sub-optimal
1	0	Bad data
1	1	Non-retrievable

Ice Age Algorithm Product Monitoring Metadata

Ice Age Algorithm Product Monitoring Metadata	
Variable Name	**Definition**
Tot_QACat01	Number of QA flag values with Good or Optimal retrievals
Tot_QACat02	Number of QA flag values with Uncertain or Suboptimal retrievals
Tot_QACat03	Number of QA flag values with Bad or missing retrievals
Tot_QACat04	Number of QA flag values with Non-retrievable retrievals
TotWaterPixs	Number of pixels with water surface
TotRetrPixs	Number of valid ice thickness and age retrievals (good + uncertain)
TermntPixPct	Percentage of terminator pixels (Non-retrievable and Bad)
TotDaytimePixs	Number of valid daytime ice thickness and age valid retrievals
TotNighttimePixs	Number of valid nighttime ice thickness and age valid retrievals
MeanIceThk	Mean valid ice thickness retrievals
MaxIceThk	Maximum of valid ice thickness retrievals
MinIceThk	Minimum of valid ice thickness retrievals
STDIceThk	Standard Deviation of valid ice thickness retrievals

Ice Algorithm
Test Environment & Timing Info.

- The algorithm was tested on a Linux machine (3.2 GHz 12 dual core CPUs with 32 GB memory/CPU, 2TB disk space).
  - » Intel compiler was used
  - » Algorithm was compiled as 64 bit
- It takes ~30 seconds to generate RR Ice products on a single granule at 750 m resolution, with a segment size of 120 in framework

Ice Algorithm Timing Information

Unit	Time (seconds)
VIIRS_SDR_MULTIRES	10.03
LAND_MASK_NASA_1KM	0.19
NPP_BAYES_CLOUD_MASK	1.62
NPP_VIIRS_CLD_HEIGHT	4.67
AWG_ICE_CONC	11.83
AWG_CRYOS_ICE_AGE	0.73
Total	**29.07**

Ice Algorithm Validation Datasets

- Apr 10-25, 2014
- Jul 10-25, 2014
- Oct 10-25, 2014
- Jan 01-31, 2015

JPSS RR PS NDE Required Metadata

- All JPSS RR product output files contain information on NDE required metadata
  - » Collection Level Metadata
    - – static with respect to each NUP*.
  - » Granule Level Metadata
    - – granule dependent and thus are dynamic with respect to the observation
  - » Swath Geographic Metadata
    - – satellite's native geolocated observation

*NOAA Unique Product

JPSS RR PS
NDE Required Metadata

- Collection level Metadata

Attribute Name	Data Type	Value/Description
Conventions	string	“CF-1.5”
Metadata_Conventions	string	“CF-1.5, Unidata Dataset Discovery v1.0”
standard_name_vocabulary	string	“CF Standard Name Table (version 17, 24 March 2011)”
project	string	“S-NPP Data Exploitation”
institution	string	“DOC/NOAA/NESDIS/NDE->S-NPP Data Exploitation, NESDIS, NOAA, U.S. Department of Commerce”
naming_authority	string	“gov.noaa.nesdis.nde”
satellite_name	string	“NPP”
instrument_name	string	“VIIRS”
title	string	Set to the NUP product short name
summary	string	Brief description of the product
history	string	Provides the algorithm name and version used to producte the NUP
processing_level	string	“NOAA Level 2”
references	string	Published or web-based references describing the data or methods used to produce the product

JPSS RR PS NDE Required Metadata

- Granule Level Metadata

Attribute Name	Data Type	Description
id	string	Each product team can implement a unique identifier, approved by NEDSIS data center representative.
Metadata_Link	string	This attribute lists the unique NUP product file name
start_orbit_number	int	This attribute is a sequential whole number set by the S-NPP/JPSS Ground System in the xDR metadata. Orbits are incremented on the northward equatorial node
end_orbit_number	int	This attribute is a sequential whole number set by the S-NPP/JPSS Ground System in the xDR metadata. Orbits are incremented on the northward equatorial node
day_night_data_flag	string	This attribute should be set to “day”, “night”, or “both” depending on sunlight conditions for observation
ascend_descend_data_flag	int	This attribute indicates whether the satellite is moving northward or southward. The center time of an observation is used. This attribute should be set to 0 (ascending or northward) or 1 (descending or southward)
time_coverage_start	string	This attribute is set to the UTC start time of an observation as “YYYY-MM-DDThh:mm:ssZ”, where YYYY is the four digit year, MM is the two digit month, DD is the two digit day, hh is the UTC hour, mm is the UTC minute, and ss is the UTC second
time_coverage_end	string	This attribute is set to the UTC end time of an observation as “YYYY-MM-DDThh:mm:ssZ”, where YYYY is the four digit year, MM is the two digit month, DD is the two digit day, hh is the UTC hour, mm is the UTC minute, and ss is the UTC second
date_created	string	This attribute is set to the UTC time the NUP file was created by NDE as “YYYY-MM-DDThh:mm:ssZ”, where YYYY is the four digit year, MM is the two digit month, DD is the two digit day, hh is the UTC hour, mm is the UTC minute, and ss is the UTC second

JPSS RR PS NDE Required Metadata

- Swath Geographic Metadata

Attribute Name	Data Type	Description
cdm_data_type	string	This attribute describes the geographic category the NUP data represents. This should be “swath” for native 2-D satellite swath data
geospatial_first_scanline_first_fov_lat	float	These attributes describes the four point geolocated latitude and longitude (polygon) that describes the geographic context for the NUP observation. Latitudes values include -90 (south) to 90 (north) degrees and Longitude values include -180 (west) to 180 (east).
geospatial_first_scanline_last_fov_lat	float	
geospatial_last_scanline_first_fov_lat	float	
geospatial_last_scanline_last_fov_lat	float	
geospatial_first_scanline_first_fov_lon	float	
geospatial_first_scanline_last_fov_lon	float	
geospatial_last_scanline_first_fov_lon	float	
geospatial_last_scanline_last_fov_lon	float	
geospatial_lat_units	string	This attribute should be “degrees_north”
geospatial_lon_units	string	This attribute should be “degrees_east”
geospatial_bounds	string	This attribute describes a closed polygon of N (N>3) latitude and longitude vertices. The last latitude/longitude pair must be identical to the first pair. Latitudes values include -90 (south) to 90 (north) degrees and Longitude values include -180 (west) to 180 (east). This should be “POLYGON((lon1 lat1, lon2 lat2,…,lonN latN, lon1 lat1))

JPSS RR PS
Software Architecture

Outline

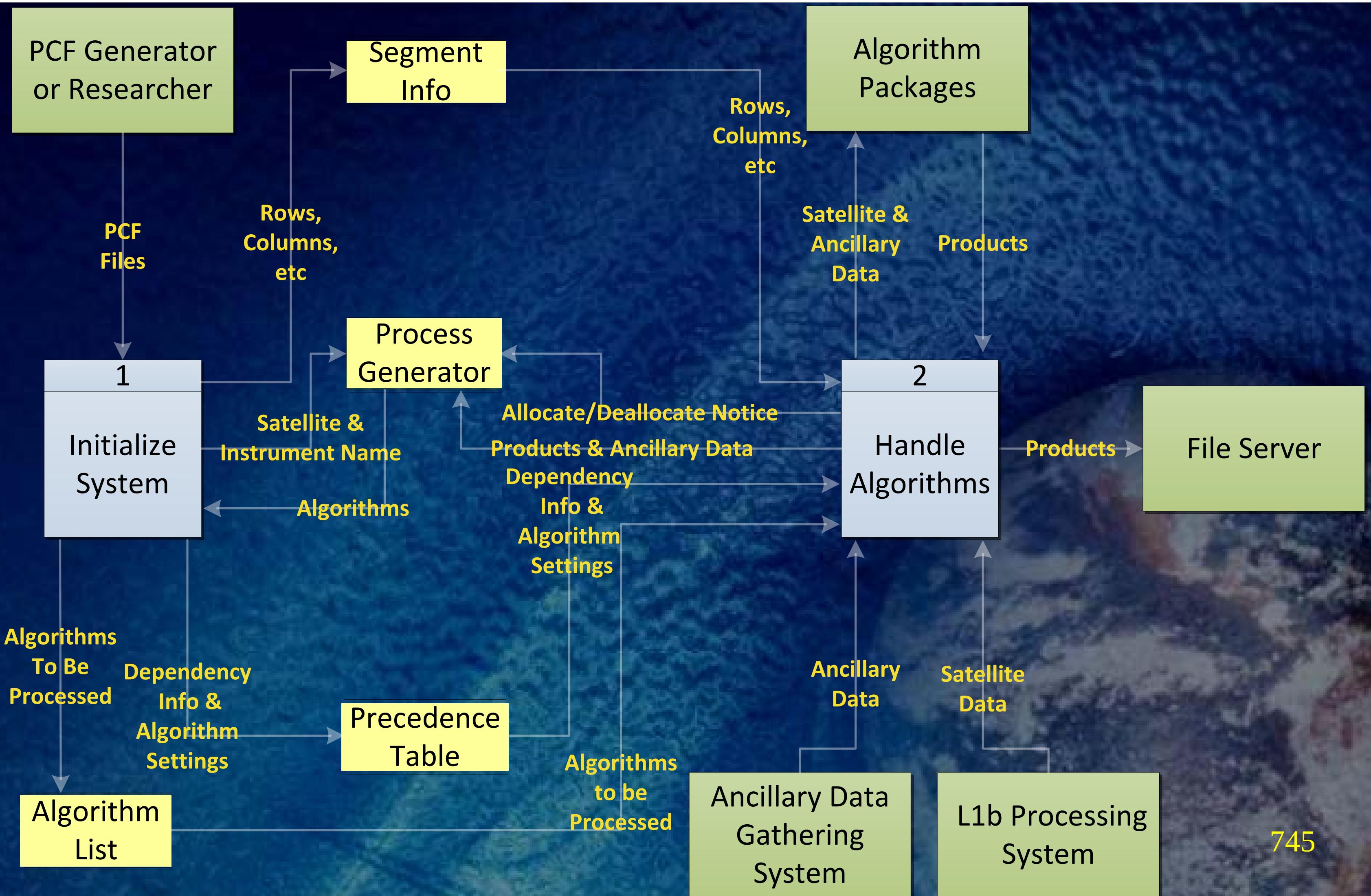
- JPSS RR PS System Overview
- JPSS RR PS Detailed Design
- JPSS RR PS Algorithm Software
- AIT Framework
- Transition to Operations

JPSS RR PS

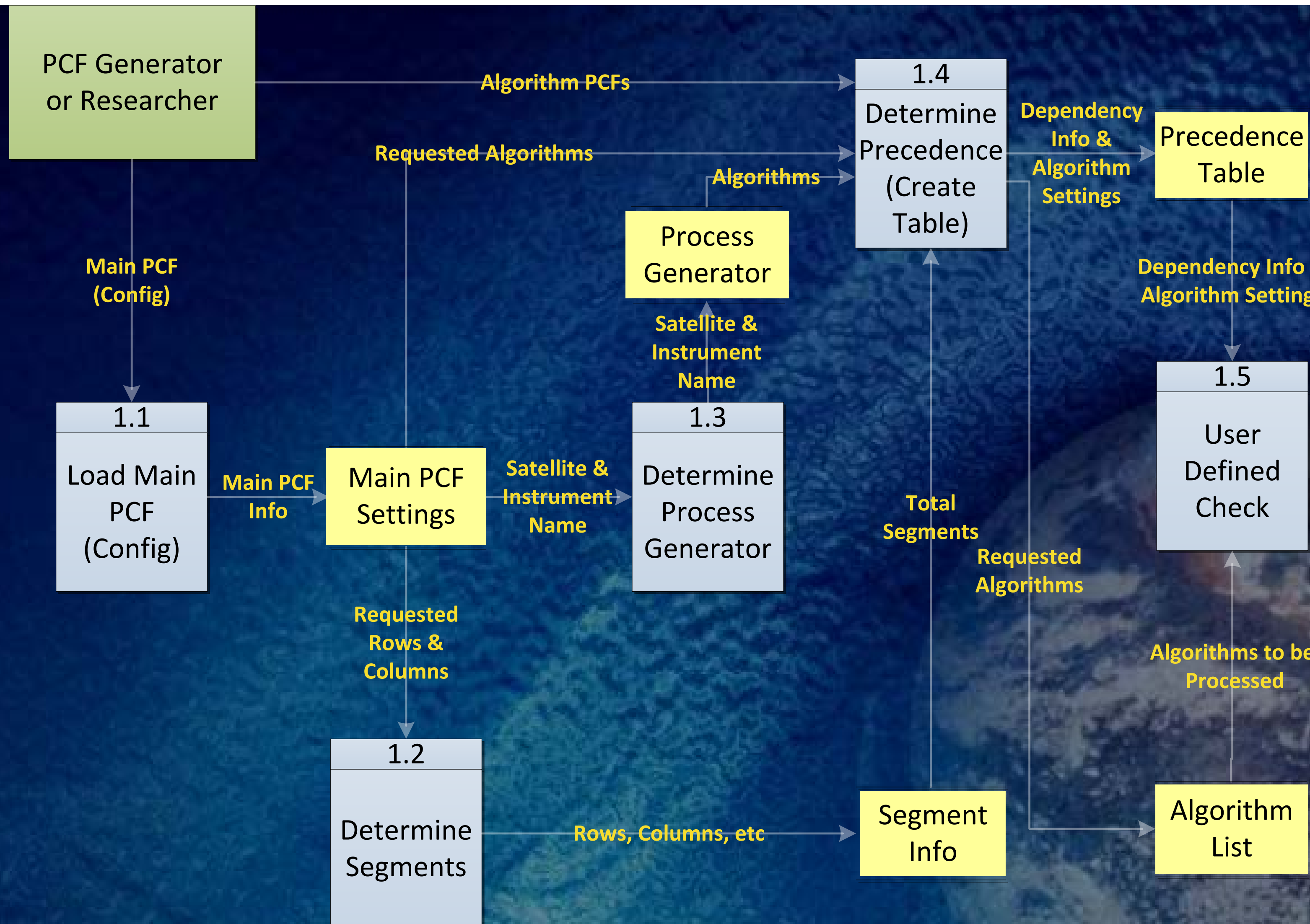
- AIT Framework provides an integrated processing environment for Cloud, Aerosol, and Cryosphere product retrieval processing.

- The following nine slides show the AIT framework unit detailed design, diagram, and data flow.

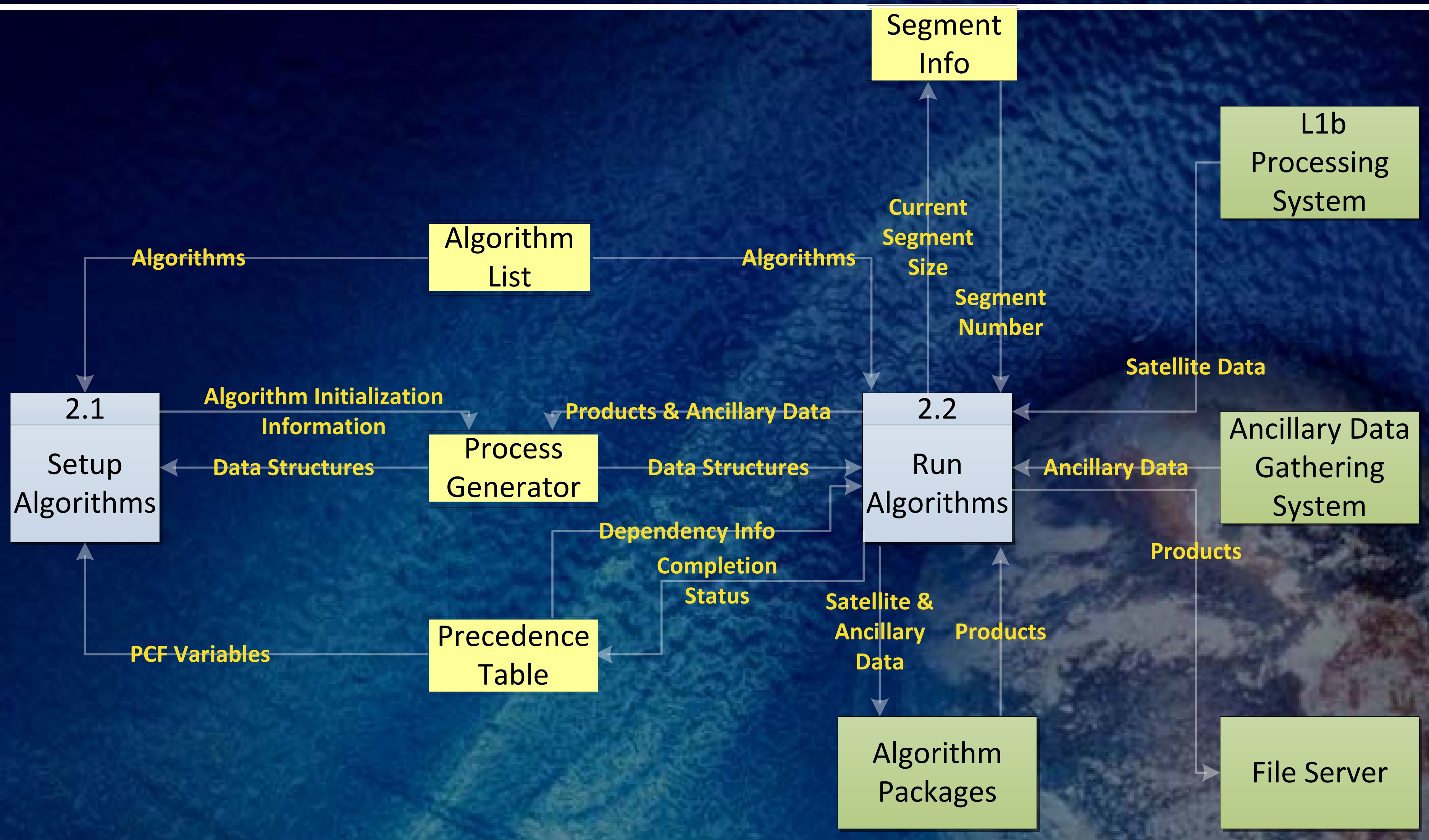
Framework System Level



Framework Unit Level 1
Initialize System



Framework Unit Level 2
Handle Algorithms



Inputs

- **Production Control Files (PCF)**
- **Data**
  - » Radiance data
  - » Common ancillary data
  - » Specific algorithm data

PCF Files

- Production Control Files (PCF) contain the information required to run an algorithm
  - » Algorithm dependencies to determine product precedence
  - » Algorithm specific variables such as flags and thresholds
  - » Framework loads the contents of the PCF file when the algorithm has been flagged to run in the configuration file or if it is needed by something that has been flagged to run in the configuration file.

Table of DynamicAncillary Data

Ancillary Data	Description	Filename	Size
CRTM	Community Radiative Transfer Model	N/A	N/A
NWP_GFS	NCEP GFS model data in grib2 format – 0.5x0.5 degree (720x361), 26 levels	gfs.tHHz.pgrbfhh	55 – 56MB
OISST_DAILY_QTRDEG	NCEP EMC Reynolds OISST daily analysis, 0.25 degree resolution	avhrr-only-v2.YYYYMMDD.nc	8MB
SNOW_MASK_NWP	Snow/Ice mask, calculated from snow surface variable in the GFS Grib2 file	N/A	N/A

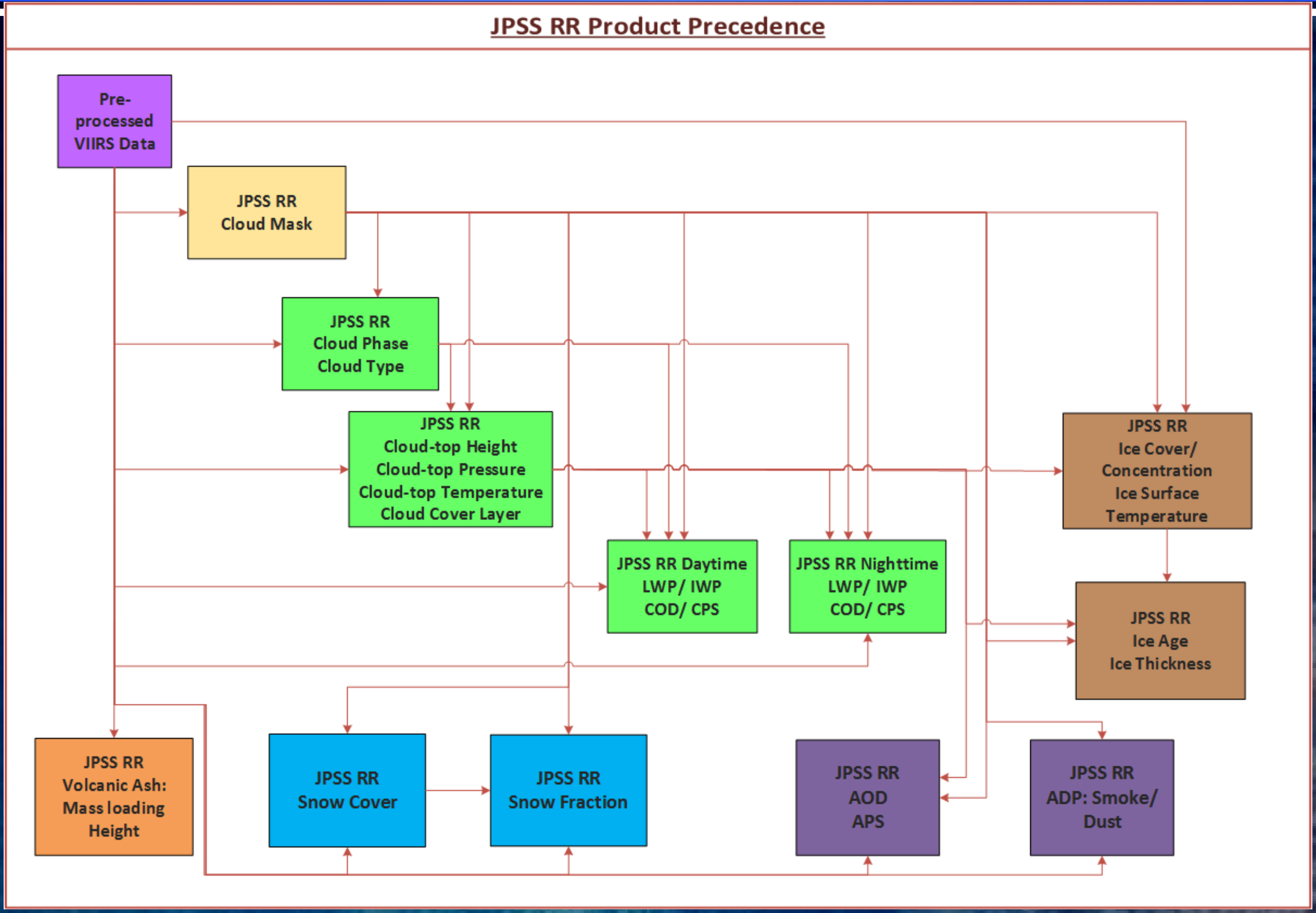
Table of Static Ancillary Data

Ancillary Data	Description	Filename	Size
COAST_MASK_NASA_1KM	Global 1km land/water used for MODIS collection 5	coast_mask_1km.nc	890 MB
DESERT_MASK_CALCLTED	Desert mask calculated using LAND_MASK_NASA_1KM and SFC_TYPE_AVHRR_1KM	N/A	N/A
LAND_MASK_NASA_1KM	Global 1km land/water used for MODIS collection 5	lw_geo_2001001_v03m.nc	890 MB
LAND_MASK_NASA_250M	Global 250 m land/water used for MODIS collection 6	MOD44W.A2000055.h??v??. .005.nc	TBD
SFC_ELEV_GLOBE_1KM	Digital surface elevation at 1km resolution	GLOBE_1km_digelev.nc	1843 MB
SFC_TYPE_AVHRR_1KM	Surface type mask based on AVHRR at 1km resolution	gl-latlong-1km-landcover.nc	890 MB
SFC_EMISS_SEEBOR	Surface emissivity at 5km resolution, climatology monthly	global_emiss_intABI_2005DDD.nc	693 MB x 12
GOESR_ABI_CHN7_EMISS	Channel 3.9 um pseudo emissivity	N/A	N/A
SFC_ALBEDO	White Sky Surface albedo- 4 year composites for 0.659um, 1.64um and 2.13um	AlbMap.WS.c004.v2.0.YYYY.DDD. 0.659_x4.nc AlbMap.WS.c004.v2.0.YYYY.DDD. 1.64_x4.nc	28MB x 23 x3
CLIMATIC_LST_ISCCP	Monthly-averaged mean surface temperatures over the globe at 2.5 degree resolution	climatic_lst_month_MM.nc	47MBx12

CRTM Inputs

Filename	Description	Size
CloudCoeff.bin	Cloud coefficient data for CRTM	1.6MB
AerosolCoeff.bin	Aerosol coefficient data for CRTM	5.5MB
EmisCoeff.bin	Emissivity coefficient data for CRTM	1.9MB
viirs_npp.SpcCoeff.bin	Space coefficient data of NPP VIIRS-M for CRTM	472B
viirs_npp.TauCoeff.bin	Tau coefficient data of NPP VIIRS-M for CRTM	104KB

Framework
Product Precedence



All VIIRS products listed within product precedence are products created within the NDE JPSS Risk Reduction project

JPSS RR PS
Software Architecture

Outline

- JPSS RR PS System Overview
- JPSS RR PS Detailed Design
- JPSS RR PS Algorithm Software
- AIT Framework
- Transition to Operations

JPSS RR PS
Error Handling

- All return values and exit status from executables, script functions, unit driver scripts, and system calls from scripts are checked
- All errors or noteworthy conditions are trapped. Three common error codes are used in AIT framework product processing to categorize the severity levels:
  - » 0 = NOTICE
  - » 1 = WARNING
  - » 2 = FATAL

  Messages are labeled and produced based on the error codes and are directed to log files.

JPSS RR PS
Product Processing Monitoring

- The SDR processing status file contains information about the VIIRS SDR data preparation. It can be used for tracking the Preprocessor unit on generation of gap-filled SDR data files.

- The unit PSFs provide information about the successfully generated product files from each unit run. The files can be made available to NDE monitoring system for tracking the processing steps and checking the availability of the product files.

- The product files contain algorithm specified metadata. Depending on the requirements, detailed product attributes, such as categorized QA flags and product statistic reports, are provided in the output files. The metadata can be extracted and used as input to the product quality monitoring tool at NDE.

JPSS RR PS
System Design Assumptions

- The JPSS RR PS design assumes the NDE PGM will run JPSS RR PS Units in a single working directory that is unique to that run.
- The system PCF will be made available to the system driver script locally in the working directory at run time.
- The NDE DHS must be able to run multiple instances of these units to process concurrently available input data.
- The JPSS RR PS relies on NDE on the data availability of the input data sets, as well as the dynamic ancillary data, such as GFS data, OISST, etc.
- The NDE DHS will perform all file management for JPSS RR PS outside of the working directories where the JPSS RR PS Units run.

JPSS RR PS
Transition to NDE

- JPSS RR PS has been fully tested in STAR development environment. The product processing time meets the latency requirements (<30 min). It is ready to run in NDE operational environment.
- All JPSS RR final products will be generated by JPSS RR PS in NDE DHS and will be distributed to NDE DDS
- Detailed information about the unit and subunit level data flow are documented in the JPSS RR PS System Maintenance Manual (SMM) in the DAP delivery
- The final JPSS RR PS package will be:
  - » Delivered to NDE2.0
  - » Integrated into the NDE DHS by the NDE team
  - » NDE will run JPSS RR PS in production mode at NSOF

Summary

- The software architecture design and interfaces of each component in JPSS RR PS have been presented.
- The system data flow of each processing unit has been presented.
- The error handling and product generation information that can be used for JPSS RR product processing monitoring have been presented.

Outline

- Introduction
- Risks and Actions
- Requirements
- Algorithm Readiness
- Software Architecture
- Delivered Algorithm Package
- Risks Summary
- Summary and Conclusions

Delivered Algorithm Package

Presented by

Walter Wolf

JPSS RR PS DAP

- The JPSS RR PS DAP will be contained in a single tar file that has been compressed using gzip. It has the following name: JRR_DAP_201512.tar.gz
- It will be delivered to SADIE on 18 Dec 2015
- Note that the DAP file name complies with the DAP naming convention identified on page 7 of the DAP Standards.
- When ungzip'd and untar'd, there are 4 main subdirectories and a README file produced in the current working directory:
  - » *SOURCE/* - All Fortran 77/90, C/C++ code
  - » *JPSS RPS_OPS/* - All scripts and static system files
  - » *DATA/* - All sample/test data
  - » *DOC/* - All SPSRB and NDE documentation
  - » REL-2.0.2.JCSDA_CRTM_gm.tar - CRTM 2.0.2 package
  - » README - the README file for JPSS RR PS

DAP Checklist

Required DAP Item	Location in DAP
Science algorithm & HDF to NetCDF conversion source code, including make files and build scripts.	./SOURCE/AIT_framework/ ./SOURCE/extrcat_scan_time/ ./SOURCE/h5augjpss-1.0.0/
Test plans, test description, test procedures, and detailed performance testing results	./DOC/
Test input data, ancillary data(static and dynamic), and expected output data.	./DATA/static_input/ ./DATA/supplement_d20150511_t0919230_e0920472_b18316/ ./DATA/supplement_d20150511_t1225439_e1227081_b18318/ ./DATA/supplement_d20150511_t2240157_e2241381_b18324/ ./DATA/working_d20150402_t1054237_e1055479_b17764/ ./DATA/working_d20150511_t0919230_e0920472_b18316/ ./DATA/working_d20150511_t1225439_e1227081_b18318/ ./DATA/working_d20150511_t2240157_e2241381_b18324/ ./DATA/working_output_d20150402_t1054237_e1055479_b17764/ ./DATA/working_output_d20150511_t0919230_e0920472_b18316/ ./DATA/working_output_d20150511_t1225439_e1227081_b18318/ ./DATA/working_output_d20150511_t2240157_e2241381_b18324/
Processing Scripts	./JRRPS-OPS/scripts/
Template files for framework algorithm PCFs and processing configuration files.	./JRR-OPS/PCF_Overwrites/ ./JRR-OPS/templates/
Executables for running Framework, NetCDF conversion , and SDR scan time extraction.	JRRPS-OPS/bin/
Framework Production Control Files associated with the science algorithms.	JRRPS-OPS/Default_PCF/
List of algorithms specific to NPP VIIRS (a subset of framework Master List, which includes algorithms for other satellite/instrument pair as well).	JRRPS-OPS/CustomProductLists/

DAP Checklist

Required DAP Item	Location in Delivered DAP
Production rule-set definitions.	./DOC/JRRPS_Production_Rules.docx
Production Control File and Product Status File content and descriptions	./DOC/JRRPS_PCF-PSF.docx
Quality monitoring information (quality flags, quality flag values).	Section 6 of ./DOC/JRRPS_SMM_1.0.docx
Product file specifications – layout, content, and size.	Section 7 of ./DOC/JRRPS_SMM_1.0.docx Section 1 of ./DOC/JRRPS_EUM_1.0.docx
Data flow diagrams.	Section 7 of ./DOC/JRRPS_SMM_1.0.docx
List of exit codes and their associated messages.	Section 6 of ./DOC/JRRPS_SMM_1.0.docx
List of expected compiler warnings	Section 4 of ./DOC/JRRPS_SMM_1.0.docx
Estimates of resources required for execution.	Section 2 of ./DOC/JRRPS_SMM_1.0.docx
Algorithm Theoretical Basis Documents (ATBDs) or reference to where the ATBDs can be obtained.	./DOC/Algorithm_Theoretical_Basis_Document_???.docx
Delivery Memo.	./DOC/Delivery_Memo (To be sent via email at time of delivery to NDE)
README text file.	./README

JPSS RR PS Source Code

JPSS RR PS Code Area	Language	Number of Files	Number of Lines
AIT Framework (including JPSS RR algorithm code)	Fortran 90	496	235368
AIT Framework(including JPSS RR algorithm code)	C/C++	879	235908
VIIRS SDR gap-filling*	Python	2	332
VIIRS SDR data conversion* (H5 to NetCDF4)	C	7	1804
Unit scripts and utilities	Perl	20	5767
Makefiles, compile scripts*	Make	190	7961

*third-party software source code.

JPSS RR PS Documentation

- The JPSS RR PS DAP will contains the following documents:
  - » Delivery Memo (also included in email notification)
  - » README
  - » JPSSRRPS_SMM_1.0.docx
  - » JPSSRRPS_EUM_1.0.docx
  - » Algorithm_Theoretical_Basis_Document_???.docx
  - » JPSSRRPS_Production_Rules.docx
- The SMM, EUM, and ATBD contain unfinished sections that need to be completed by Integration Programmers (NDE) and the PAL (OSPO).
  - » The document objects for sections have been highlighted in yellow

JPSS RR Algorithm Readiness Summary

- The JPSS RR PS software has been tested; the results have been presented.
- The DAP contents have been verified.
- DAP has been delivered to NDE.
- JPSS RR PS developers will work with NDE to address any issues that arise during integration and NDE system testing.

Outline

- Introduction
- Risks and Actions
- Requirements
- Algorithm Readiness
- Software Architecture
- Delivered Algorithm Package
- Risks Summary
- Summary and Conclusions

Risks Summary

Presented by

Walter Wolf

Cryosphere CDR Risks and Actions

- **CDR Risk 8**: Use SAR imagery to validate ice types and age
- **Risk Assessment:** Low
- **Mitigation:**
  - » Working on getting SAR imagery
  - » Algorithm does meet the requirements
  - » Will perform more validation when SAR data is acquired
- **Status:** Open

ARR Overall Risks and Actions

- **ARR Risk 2**: Address the recommended code updates for final DAP, as cited in OSPO Software Review
- **Risk Assessment:** Low
- **Mitigation:**
  - » Address remaining 'recommended updates' for final DAP in Apr 2016
- **Status:** Open

ARR Overall Risks and Actions

- **ARR Risk 3**: **The product monitoring metadata variables for DCOMP algorithm will undergo revision.**
- **Risk Assessment:** Medium
- **Mitigation:**
  - » Fine tune DCOMP metadata variables
  - » Update OSPO product monitoring team about the changes.
- **Status:** Open

Risk and Actions Summary

- There is currently three risks identified
- They remains open until final DAP

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Summary and Conclusions

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Review Objectives Have Been Addressed

- Risks and Actions have been reviewed
- Requirements have been reviewed
- Algorithm Readiness has been reviewed
- Software Architecture has been reviewed
- Open Risks and Actions have been reviewed

Current Status

- Development on the JPSS RR Processing System has been completed
- The JPSS RR documents have been completed
- The Final JPSS RR Processing System DAP will be delivered to NDE via SADIE on December 18th

Next Steps

- Updated DAP delivery to NDE2.0 in April 2016
- Operational Readiness Review

Open Discussion

- The review is now open for free discussion