S-NPP VIIRS Vegetation Health Products (VIIRS VHP)

Algorithm Readiness Review

June 17, 2015

Prepared by

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- Pre-ARR Risks and Actions
- Requirements
- Software Architecture
- Algorithm Readiness
- Delivered Algorithm Package
- Risk and Action Summary
- Summary and Conclusion
- Appendix: VHP Unit Tests

INTRODUCTION

Priyanka Roy

Project Objectives

- **Meet user request** # : 1105-0004 (NWS/NCEP/CPC) and 1105-0009 (USDA/FAS & WAOB)
  - Develop S-NPP/VIIRS 4 km resolution Vegetation health (VH) products.
    - Will be used globally by the NOAA/NWS/NCEP's Climate Prediction Center, USDA's World Agricultural Outlook Board, NWS/OAR's NIDIS, USDM, International Organizations (WMO, FAO) & others.
  - The current operational POES/AVHRR 4 km VH product will be replaced by the VIIRS/VHP-4.
- Meet the specified product requirements by (a) developing & implementing a multi-channel VH retrieval algorithm (Kogan 2001)1 , (b) developing products & (c) providing this product operationally to users.

[1]**Kogan. F.N., 2001**: Operational Space Technology for Global Vegetation Assessment. *Bull. Amer. Meteor. Soc*. **82**, 9, 1949-1964.

Integrated Product Team

- IPT Lead: Felix Kogan(STAR)
- IPT Backup Lead: Hanjun Ding(OSPO)
- NESDIS team:
  - STAR: Felix Kogan, Wei Guo (IMSG), Min Li (IMSG)
  - NDE: Geof Goodrum, Dylan Powell
  - OSPO: Hanjun Ding, Jing Han
  - OSGS: Tom Schott
  - NCEI
- User team
  - NWS/NCEP CPC: Contact (Matthew Rosencrans)
  - USDA WAOB: Contact (Eric Luebehusen)
- Product Oversight Panel: Land Surface POP (LSPOP)

Project Stakeholders

- NESDIS
  - STAR
  - OSPO
  - OSGS
  - NCEI
  - NDE
- NWS/NCEP CPC
- NWS/OAR NIDIS
- USDA WAOB
- USDM

Project Plan (1)

- Year 1 – Design and Development (2013 – 2014)
  - Verify Requirements
  - Design the VIIRS VH system
  - VIIRS SDR data retrieval
  - Calculate NDVI & BT
  - Develop daily composite map
  - Develop weekly composite map
  - Conduct PDR
  - Produce NDVI & BT time series and noise removal
  - Develop adjustment for VIIRS NDVI and BT
  - Develop climatology records
  - Develop VH products
  - Conduct CDR

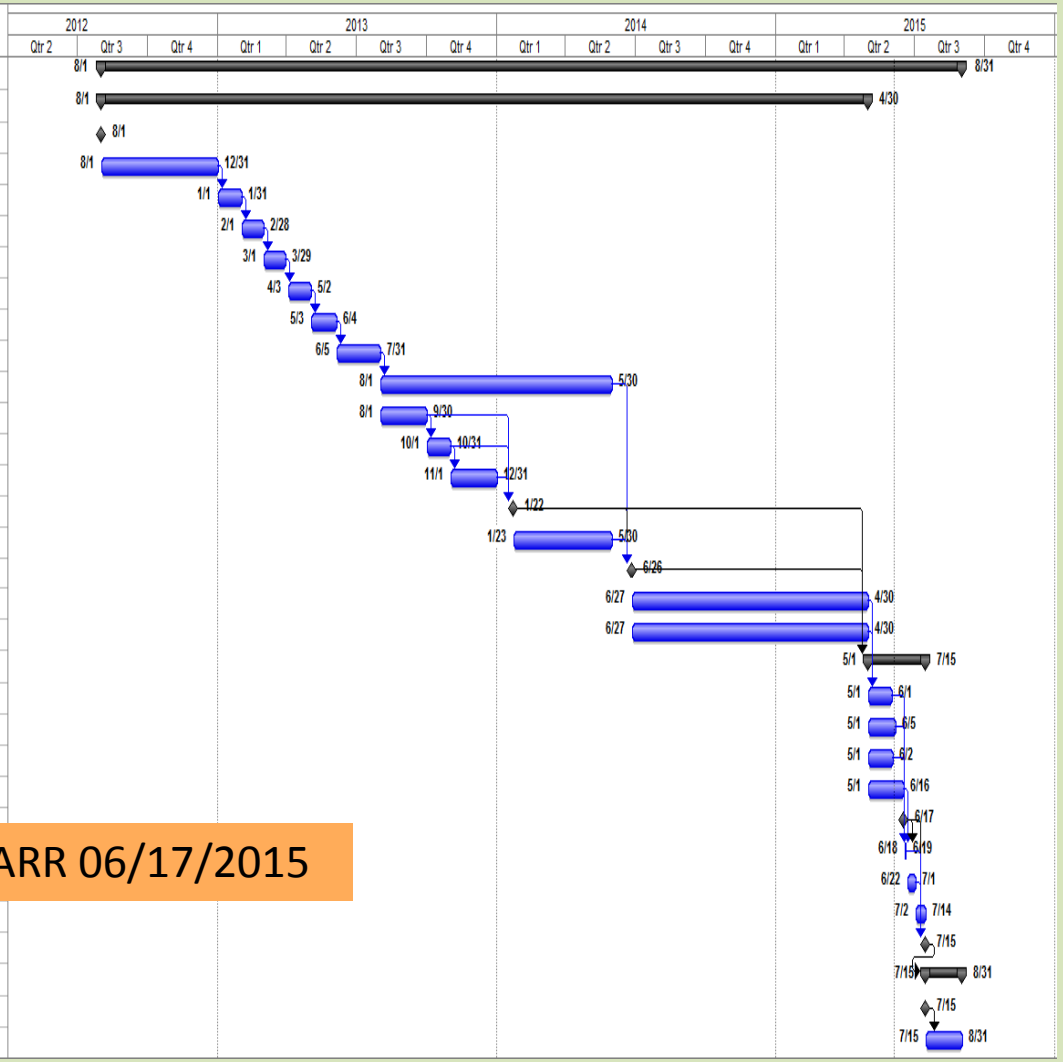
Project Plan (2)

- Year 2 –Transition to Pre-Operations (2014 – 2015)
  - Validation
  - Algorithm adjustment
  - Implement VIIRS VH system
  - Conduct Algorithm Readiness Review for products
  - Transition and test system within the NDE environment
  - Conduct Code Review for products

Project Timeline contd.

Office Of Satellite and Product Operations

ID	Task Name
1	**VIIRS-Veg. Health Project**
2	**Development Phase**
3	VIIRS becomes operational providing data; Start of VIIRS & MODIS data collection
4	Development of VIIRS daily composite maps and files; Calculation of NDVI & BT
5	Development of procedur for spatial data sampling, data geolocation & filing gaps
6	Adjusting VIIRS NDVI and BT to the AVHRR parameters
7	High frequency noise removal from the adjusted NDVI & BT
8	Testing the adjusted NDVI and BT with standard VH climatology
9	Calculation of VIIRS-VH indices (VCI, TCI, VHI) & time series
10	Testing the VH indices against in situ data
11	Beginning of operational product development
12	Initial Archive Requirement identified
13	Quality Monitoring Concept Defined
14	Long term maintenance concept defined
15	Priliminary Design Review
16	Development processing system defined
17	Critical Design Review
18	Code is prepared
19	Final Archive requirements identified
20	**Pre-Operational Phase**
21	Initial DAP to NDE
22	Software Code Review
23	Provide test data to users
24	Pre-operational product output evaluated and tested
25	Algorithm Readiness Review
26	Final DAP to NDE
27	Code transitions to operations; all documentation is complete
28	Brief SPSRB Oversight Panel on product status
29	Brief SPSRB capability is ready to go operational
30	**Operational Phase Begins**
31	SPSRB declares product operational
32	End users start using VH system operationally



ARR 06/17/2015

Project Milestones

- Preliminary Design Review – 01/22/2014 (Jan14)
- Critical Design Review – 06/26/2014 (Jun 14)
- Software Code Review – 06/05/2015 (March 2015)
- Algorithm Readiness Review – 06/17/2015 (March 2015)
- Operational Readiness Review – 06/24/2015
- Decision Briefing to SPSRB – 07/15/2015

ARR Entry Criteria

- Requirements Document
- Veg. Health CDR Report
- Review of Project:
  - Requirements
  - Algorithm Readiness
  - Software Architecture
  - Risks and Actions

ARR Exit Criteria

- Veg. Health ARR Report
  - The report will contain:
    - Actions
    - Comments
    - ARR presentation
- Updated Veg. Health RID
- Updated Veg. Health RAD

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PRE-ARR RISKS AND ACTIONS

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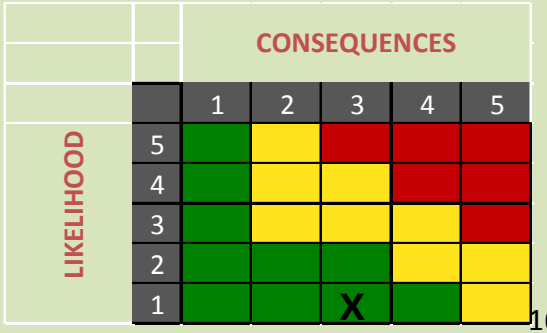
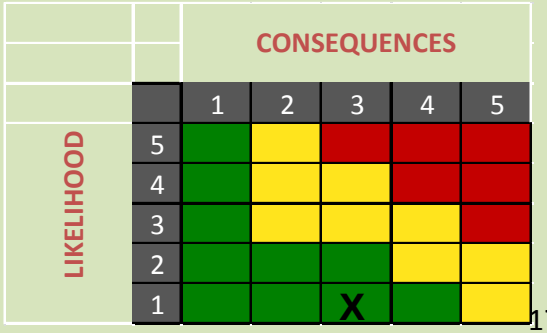
PDR Risks and Actions

- **Risk 2:** The climatology data set need to be updated by using most recent dataset.
- **Risk Assessment:** Low
- **Impact:** If climatology data is not updated then will impact quality of the VIIRS VH product
- **Likelihood:** Low
- **Mitigation:**
  - Update climatology by using from longer series of data set
- **Status:** Closed



PDR Risks and Actions

- **Risk 3:** Adjustment of VIIRS NDVI/BT to AVHRR equivalent, may require update.
- **Risk Assessment:** Low
- **Impact:** If proper adjustments are not made then the product will not meet requirements
- **Likelihood:** Low
- **Mitigation:**
  - Continue investigation of stability VIIRS NDVI/BT – AVHRR NDVI/BT relationship;
  - Update the adjustment parameters
- **Status:** Closed



CDR Risks and Actions

- None

Summary

- Summary of Risks and Actions after CDR
  - 2 PDR risks recommended to be closed.
  - No new CDR risk.

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REQUIREMENTS

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- All Veg Health Product System project requirements are documented in a single RAD provided with the review materials

- Basic requirements are shown in all purple text on a single slide.

- New requirements since the CDR are listed in red. We will discuss only these in this presentation.

Basic Requirement # 0

VIIRS-VH-R 0.0: The Vegetation Health Products (VHP) development project shall adopt the standard practices of the Satellite Product and Services Review Board (SPSRB), except for specific tailored practices to be itemized in derived requirements (0.x).

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

Basic Requirement # 0

VIIRS-VH-R 0.1: ***The VHP 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.

- **VIIRS-VH -R 0.1.1:** *There shall be a combined Project Requirements Review (PRR) and Preliminary Design Review (PDR).*
  - This derived requirement has been adopted to mitigate schedule risk by eliminating the overhead of preparing a PRR and PDR slide packages and reports. The Technical risk is assessed as Low because the PDR will be tailored to accomplish the standard objectives of a PRR. Risks will be tracked.

Basic Requirement # 0

VIIRS-VH -R 0.1.2: *There shall be a Preliminary Design Review Report (PDRR)*

- The PDRR is one of the exit criteria for PDR.

VIIRS-VH -R 0.1.3: *There shall be a VIIRS Veg. Health Critical Design Review (CDR).*

- This derived requirement has been adopted from the SPSRB Review process. Risks will be tracked.

VIIRS-VH -R 0.1.4: *There shall be a VIIRS Veg. Health Critical Design Review Report (CDRR)*

- The CDRR is one of the exit criteria for CDR.

Basic Requirement # 0

VIIRS-VH -R 0.1.5: *There shall be a VIIRS Veg. Health Software Review (SR).*

- This derived requirement has been adopted from the SPSRB Review process. Risks will be tracked.

VIIRS-VH -R 0.1.6: *There shall be a VIIRS Veg. Health Algorithm Readiness Review (ARR).*

- This derived requirement has been adopted from the SPSRB Review process.

VIIRS-VH -R 0.1.7: *There shall be a VIIRS Veg. Health Algorithm Readiness Review Report (ARRR)*

- The ARRR is one of the exit criteria for ARR.

Basic Requirement # 0

VIIRS-VH -R 0.1.8: *There shall be a VIIRS Veg. Health Operational Readiness Review (ORR).*

- This derived requirement has been adopted from the SPSRB Review process.

VIIRS-VH -R 0.1.9: *There shall be a VIIRS Veg. Health Operational Readiness Review Report (ORRR)*

- The ORRR is one of the exit criteria for ORR.

Basic Requirement # 0

VIIRS-VH -R 0.2: *The Requirements Allocation Document (RAD) shall be created and maintained by the VIIRS Veg. Health development team.*

- This derived requirement has been adopted from the SPSRB Review process. The RAD will follow document standards stated in EPL v3 process asset DG-6.2

VIIRS-VH -R 0.3: *The Review Item Disposition (RID) spreadsheet shall be created and maintained by the VIIRS Veg. Health development team.*

- This derived requirement has been adopted from the SPSRB Review process.

VIIRS-VH -R 0.4: *Configuration Management shall be implemented for software and documentation.*

- OSPO will CM the code and associated documents

Basic Requirement # 1

VIIRS-VH-R 1.0: ***The VHP system shall generate a gridded weekly Vegetation Health Product.***

- **Driver: SPSRB requirements:** SPSRB User Requests 1105-0004 (NWS/NCEP/CPC) and 1105-0009 (USDA/FAS & WAOB) - Develop Global Vegetation Health products from the NPP VIIRS instrument . VIIRS VH observations of the Earth will replace the AVHRR-based observations and will be used in NWS/CPC operational practice for Drought monitoring in the USA and globally, analysis of climate impacts on food security in Africa. They also will be used by the USDA analysts for modeling global crop production and decision makers for projecting the global commodity market

Basic Requirement # 1

VIIRS-VH-R 1.1: ***The VHP Product grids shall have 0.036 degree horizontal resolution (4 km at equator).***

- User Request specification

VIIRS-VH-R 1.2: ***The VHP Product grids shall be in Lat/Lon projection.***

- User Request specification

VIIRS-VH-R 1.3: ***The VHP Product shall be produced once per week, updated weekly.***

- User Request specification

Basic Requirement # 1

VIIRS-VH-R 1.4: ***The VHP Product shall have a latency of 4 hours after the end of each 7-day period.***

- Latency is defined as the interval from the last observation to when the product is available to users.

VIIRS-VH-R 1.5: ***The VHP Products shall include a Vegetation Condition Index (VCI).***

- User Request specifications

VIIRS-VH-R 1.5.1: ***The VCI shall have a measurement range from 0 – 100%.***

- User Request specification

VIIRS-VH-R 1.5.2: ***The VCI shall have a measurement accuracy < 4 %.***

- User Request specification

Basic Requirement # 1

VIIRS-VH-R 1.6: ***The VHP Product shall include a Temperature Condition Index (TCI).***

- User Request specification

VIIRS-VH-R 1.6.1: ***The TCI shall have a measurement range from 0 – 100 %.***

- User Request specification

VIIRS-VH-R 1.6.2: ***The TCI shall have a measurement accuracy < 4 %.***

- User Request specification

Basic Requirement # 1

VIIRS-VH-R 1.7: ***The VHP Product shall include a Vegetation Health Index (VHI).***

- User Request specification

VIIRS-VH-R 1.7.1: ***The VHI shall have a measurement range from 0 – 100 %.***

- User Request specification

VIIRS-VH-R 1.7.2: ***The VHI shall have a measurement accuracy < 4 %.***

- User Request specification

Basic Requirement # 1

VIIRS-VH-R 1.8: ***The VHP Product shall include quality information.***

VIIRS-VH-R 1.9: ***The VHP Product shall consist of one output file***

VIIRS-VH-R 1.9.1: ***The VHP product shall be written as a Geo-Tiff file with 0.036 degree (4 km at equator) resolution.***

- User's request

VIIRS-VH-R 1.9.2: ***The VHP Product shall be written as a digital file in NetCDF4 format, with 0.036 degree (4 km at equator) resolution.***

Basic Requirement # 1

VIIRS-VH-R 1.10: ***Validation and verification of the VHP Product shall be performed.***

- Validation will be performed by comparison with ground truth data and statistically. This will be done as part of the system test.

VIIRS-VH-R 1.10.1: ***The VHP developers shall verify that VHP product NetCDF4 files are generated correctly.***

- This will be included in the unit tests.

VIIRS-VH-R 1.10.2: ***The VHP developers shall perform routine data range checks to flag anomalous values.***

- These checks will be included in the code.

~~**VIIRS-VH-R 1.10.3:** ***The VHP developers shall generate imagery for manual inspection of product quality.***~~

Basic Requirement # 2

VIIRS-VH-R 2.0: ***The VHP system shall have data ingest capability.***

- Algorithm data input requirements

Basic Requirement # 2

VIIRS-VH-R 2.1: ***The VHP system shall ingest daily orbital data of VIIRS L1b radiances in the visible (band I1), near infrared (band I2) and thermal (band I5) channels.***

- Required algorithm input will be ingested from the IDPS and data link shall be established by NDE.

~~**VIIRS-VH-R 2.1.1: The VIIRS L1B data shall be ingested from SCDR server.**~~

- ~~SCDR server already provides this data.~~

~~**VIIRS-VH R 2.1.2: The VIIRS data shall be Level 1b swath data in HDF5 format.**~~

- ~~SCDR server already provides this data.~~

Basic Requirement # 2

VIIRS-VH-R 2.2: ***The VHP system shall ingest ancillary data.***

- Needed by the VHP algorithm

VIIRS-VH-R 2.2.1: ***Ancillary data shall include 30 arc second resolution Land Sea Mask converted to HDF format.***

- Required static algorithm input shall be delivered to NDE.

VIIRS-VH-R 2.2.2: ***Ancillary data shall include Land Cover Type from IGBP converted to HDF format.***

- Required static algorithm input shall be delivered to NDE.

Basic Requirement # 3

VIIRS-VH-R 3.0: ***The VHP system shall implement the VHP algorithm to generate a retrieval of Vegetation Condition Index (VCI), Temperature Condition Index (TCI), and Vegetation Health Index (VHI).***

- Driver: SPSRB User Requests 1105-0004 (NWS/NCEP/CPC) and 1105-0009 (USDA/FAS & WAOB)

Basic Requirement # 3

VIIRS-VH-R 3.1: ***The VHP algorithm shall perform the processing functions described in the VHP ATBD.***

VIIRS-VH-R 3.1.1: ***The VHP algorithm shall create daily maps for each band.***

- This will be done by the daily map creator unit by projecting VIIRS observations from each channel into geographic grid.

VIIRS-VH-R 3.1.2: ***The VHP algorithm shall create a weekly composite of VIIRS channels 1, 2, and 5.***

- This will be done by weekly map composer unit by selecting the pixels with maximum NDVI value from 7 VIIRS daily maps.

VIIRS-VH-R 3.1.3: ***The VHP Algorithm shall calculate a raw NDVI for the calibrated weekly composite.***

- COR unit does it.

VIIRS-VH-R 3.1.4: ***The VHP Algorithm shall adjust the raw NDVI using statistical technique.***

- See the VHP ATBD for a description of the technique.

Basic Requirement # 3

VIIRS-VH-R 3.1.5: ***The VHP Algorithm shall apply a digital smoothing filter on NDVI and BT.***

- Reduces noise from cloud contamination.

VIIRS-VH-R 3.1.6: ***The VHP Algorithm shall calculate/update NDVI and BT climatology from the multi-year smoothed NDVI and BT time series.***

- Climatology variables include maximum, minimum, mean and standard deviation for NDVI and Brightness temperature respectively on a pixel by pixel basis.

VIIRS-VH-R 3.1.7: ***The VHP Algorithm shall calculate Vegetation Condition Index (VCI).***

- VCI is calculated by comparing the smoothed NDVI against the climatology (maximum and minimum) of NDVI for the corresponding week.

VIIRS-VH-R 3.1.8: ***The VHP Algorithm shall calculate Temperature Condition Index (TCI).***

- TCI is calculated by comparing the smoothed BT against the climatology (maximum and minimum) of BT for the corresponding week.

VIIRS-VH-R 3.1.9: ***The VHP Algorithm shall calculate Vegetation Health Index (VHI).***

- VHI is a weighted combination of VCI and TCI (equally weighted, so it is the average of the two).

Basic Requirement # 3

VIIRS-VH-R 3.2: ***The VHP algorithm shall be implemented by processing code written in C++.***

VIIRS-VH-R 3.3: ***The VHP processing code shall be able to run in the STAR Development Environment (Linux, Red Hat).***

- C++ code can run in this environment

VIIRS-VH-R 3.4: ***The VHP processing code shall be able to run in the NDE Operational Environment (Linux).***

- C++ code can run in this environment

Basic Requirement # 4

VIIRS-VH-R 4.0: ***The VHP system shall generate a metadata for the retrieved product.***

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

Basic Requirement # 4

VIIRS-VH -R 4.1: ***The VIIRS VHP system shall write a metadata text files associated with the retrieved product.***

- Coordinate with the Product Monitoring Project.

VIIRS-VH-R 4.1.1: ***The metadata shall include overall quality and summary level metadata.***

- Coordinate with the Product Monitoring Project.

VIIRS-VH-R 4.1.2: ***The metadata shall include Granule metadata.***

- Coordinate with the Product Monitoring Project.

Basic Requirement # 5

VIIRS-VH-R 5.0: ***The VHP system shall have QC monitoring capability.***

Driver: NDE Needs, QC Monitoring Needs

Basic Requirement # 5

VIIRS-VH-R 5.1: ***The VHP system output shall include overall quality control flags and quality summary level metadata.***

- Needed for distribution, archive, quality control and post-processing in the products files. VHP code will generate metadata for this purpose.

- **VIIRS-VH-R 5.2:** ***The VHP developers shall generate imagery (PNG) for manual inspection of product quality.***

Basic Requirement # 5

VIIRS-VH-R 5.3: ***The VHP 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 NDE to determine needs

VIIRS-VH -R 5.3.1: ***Each run status file shall include all runtime error messages.***

– Error messages will include system messages and error conditions written by the code.

VIIRS-VH -R 5.3.2: ***Each run status file shall indicate whether or not the run was completed without error.***

Basic Requirement # 5

VIIRS-VH -R 5.4: ***The*** **VIIRS-VH** ***system shall write a log file for each production run.***

- Used by OSPO for QC monitoring and troubleshooting.

Basic Requirement # 6

VIIRS-VH-R 6.0: ***The VHP developers shall produce a fully functional pre-operational system in the STAR Development Environment.***

Driver: NDE need for a fully functional system ready for system testing in its Test Environment.

Basic Requirement # 6

VIIRS-VH-R 6.1: ***The Development Environment shall be capable of hosting the conversion of VHP science code to VHP pre-operational code.***

VIIRS-VH-R 6.1.1: ***The Development Environment shall include a C++ compiler.***

- Needed for development of pre-operational code in C++. STAR Linux server has this.

VIIRS-VH-R 6.2: ***The 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 NDE

VIIRS-VH-R 6.2.1: ***The Development Environment shall have 2 GB of memory.***

- STAR Linux server has this.

VIIRS-VH-R 6.2.2: ***The Development Environment shall have 2 TB of data storage.***

- STAR Linux server has this.

VIIRS-VH-R 6.2.3: ***The Development Environment shall have access to VIIRS data.***

- Needed for development, unit testing, and system testing..

Basic Requirement # 6

VIIRS-VH-R 6.2.4: ***The Development Environment shall have access to ancillary data.***

VIIRS-VH-R 6.3: ***The Development Environment shall host the VHP pre-operational system.***

- For unit testing.

VIIRS-VH-R 6.3.1: ***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.

VIIRS-VH-R 6.3.2: ***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.

Basic Requirement # 6

VIIRS-VH-R 6.4: ***The Development Environment shall host the VHP integrated pre-operational system.***

- For system testing.

VIIRS-VH-R 6.4.1: ***The integrated pre-operational system shall include all processing code and ancillary files needed to conduct a system test.***

- Complete system test of the integrated pre-operational system is expected.

VIIRS-VH-R 6.4.2: ***The integrated pre-operational system shall include all input test data needed to conduct a system test.***

- Complete system test of the integrated pre-operational system is expected.

Basic Requirement # 7

VIIRS-VH-R 7.0: ***The VHP integrated pre-operational system shall be transitioned in the form of a Delivered Algorithm Package (DAP) generated following the standards set in the Standards for Algorithm Deliveryand Integration using Delivered Algorithm Package (DAP) v1.4 , from the STAR Development Environment to NDE's Operational Environment***

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

Basic Requirement # 7

VIIRS-VH-R 7.1: ***The integrated pre-operational system shall include all processing code and ancillary files needed to reproduce the system test.***

- For system testing. A complete system test of the integrated pre-operational system is expected before delivery to NDE.

VIIRS-VH-R 7.2: ***The integrated pre-operational system shall include all input test data needed to reproduce the system test.***

- For system testing. A complete system test of the integrated pre-operational system is expected before delivery to NDE.

VIIRS-VH-R 7.3: ***The integrated pre-operational system shall include all output data produced by the system test.***

- For system testing. A complete system test of the integrated pre-operational system is expected before delivery to NDE.

Basic Requirement # 7

VIIRS-VH-R 7.4: ***The VHP development team shall deliver the integrated pre-operational system to NDE as a Delivered Algorithm Package (DAP) following standards set in the Standards for Algorithm Deliveryand Integration using Delivered Algorithm Package (DAP) v1.4 document to NDE's Science Algorithm Development and Integration Environment (SADIE).***

VIIRS-VH-R 7.4.1: ***VHP shall be transitioned from SADIE to NDE TEST Environment by NDE personnel.***

Basic Requirement # 8

VIIRS-VH-R 8.0: ***The VHP shall deliver a document package to NDE.***

Driver: NDE need for documentation to support operations, maintenance, and distribution.

Basic Requirement # 8

VIIRS-VH-R 8.1: ***The VHP document package shall include a README text file.***

VIIRS-VH-R 8.1.1: ***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

VIIRS-VH-R 8.2: ***The VHP document package shall include a Review Item Disposition (RID) spreadsheet.***

VIIRS-VH-R 8.2.1: ***The RID shall describe the final status of all development project tasks, work products, and risks.***

Basic Requirement # 8

VIIRS-VH-R 8.3: ***The VHP document package shall include an Algorithm Theoretical Basis Document (ATBD).***

- The ATBD will follow SPSRB Version 2 document standards

VIIRS-VH-R 8.4: ***The VHP document package shall include a Requirements Allocation Document (RAD).***

– The RAD will follow document standards stated in EPL v3 process asset DG-6.2

VIIRS-VH-R 8.5: ***The VHP document package shall include a System Maintenance Manual (SMM).***

- The SMM will follow SPSRB Version 2 document standards.

VIIRS-VH-R 8.6: ***The VHP document package shall include an External Users Manual (EUM).***

- The EUM will follow SPSRB Version 2 document standards

Basic Requirement # 9

VIIRS-VH-R 9.0: ***The VHP system shall comply with OSPO Code Review Security check lists.***

Driver: OSPO security needs.

Basic Requirement # 9

VIIRS-VH-R 9.1:*The VHP system shall comply with OSPO data integrity check list.*

- OSPO data integrity check list is part of the OSPO Code Review Security check lists

VIIRS-VH-R 9.2: *The VHP system shall comply with OSPO development security check list.*

- OSPO development security check list is part of the OSPO Code Review Security check lists

VIIRS-VH-R 9.3: *The VHP system shall comply with OSPO code check list.*

- OSPO code check list is part of the OSPO Code Review Security check lists

Basic Requirement # 10

VIIRS-VH-R 10.0:*The VHP developers shall specify IT resource needs for operations.*

Driver: NDE need for IT capacity planning

Basic Requirement # 10

VIIRS-VH-R 10.1: ***The VHP system shall be able to process data using 2 TB of data storage.***

- Data storage capacity requirement is based on experience with the VHP R&D code. A minimum of 63 GB is needed. 87 GB of margin is requested. System testing in the STAR Test environment and NDE Test environment will verify this.

VIIRS-VH-R 10.2: ***The VHP system shall be able to operate on a Linux operational server.***

  - System testing in the NDE Test environment will verify this.

Requirements – Summary

- The VIIRS Veg Health Requirements have been established.
- The VH Requirements have been documented in the Requirements Allocation Document (RAD).
- The VH Requirements are traceable to drivers (customer needs or expectations) and other requirements.

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SOFTWARE ARCHITECTURE

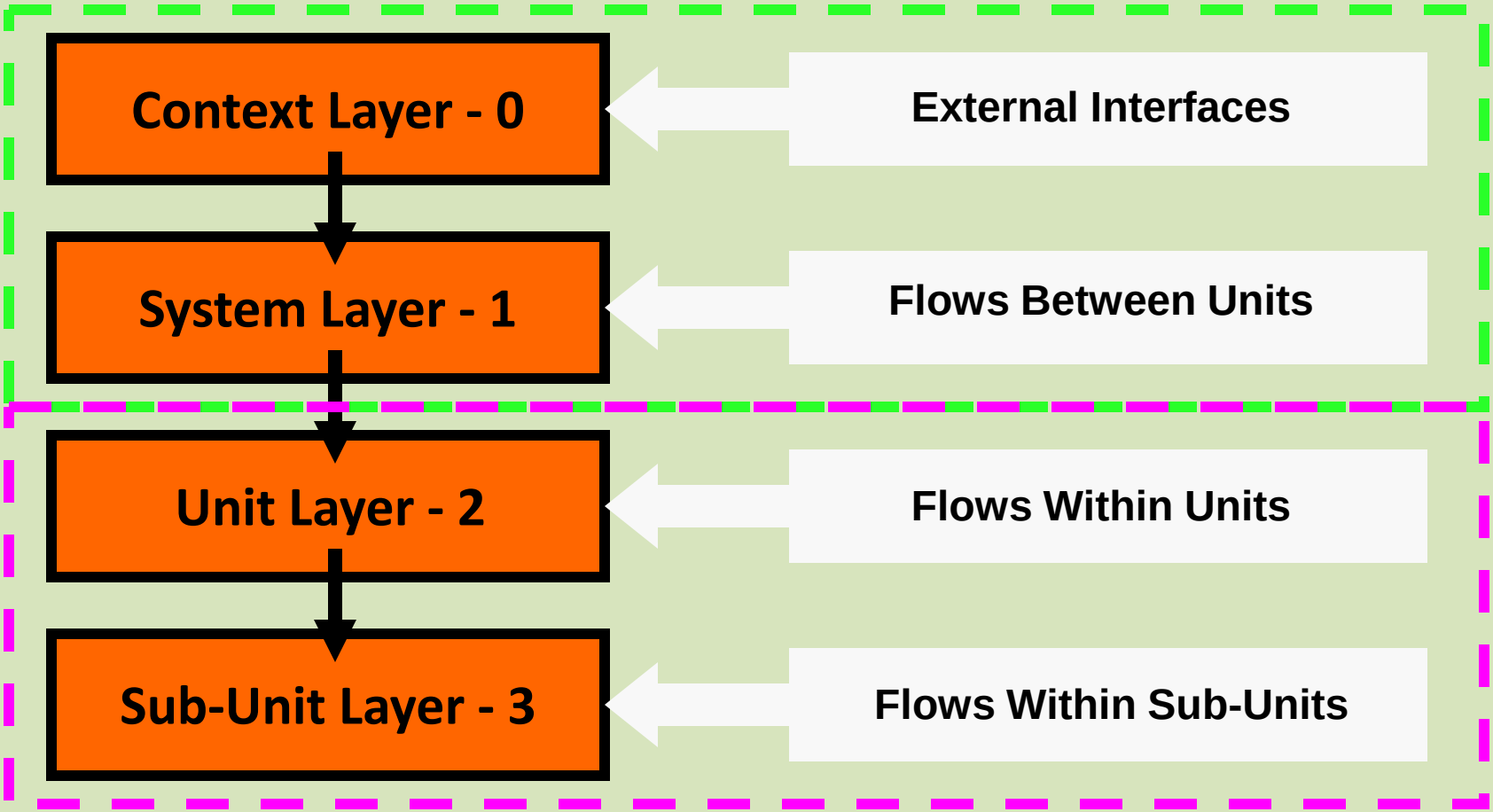
Wei Guo

Software Architecture

- Software Description
  - External Interfaces
  - System Level
  - Unit Level
- Data Files
  - Input Files
  - Static/Ancillary Files
  - Output Files
  - Run Files
- Hardware
  - Development and Unit testing
  - Test Product Distribution
  - Production

SOFTWARE DESCRIPTION

Software Architecture

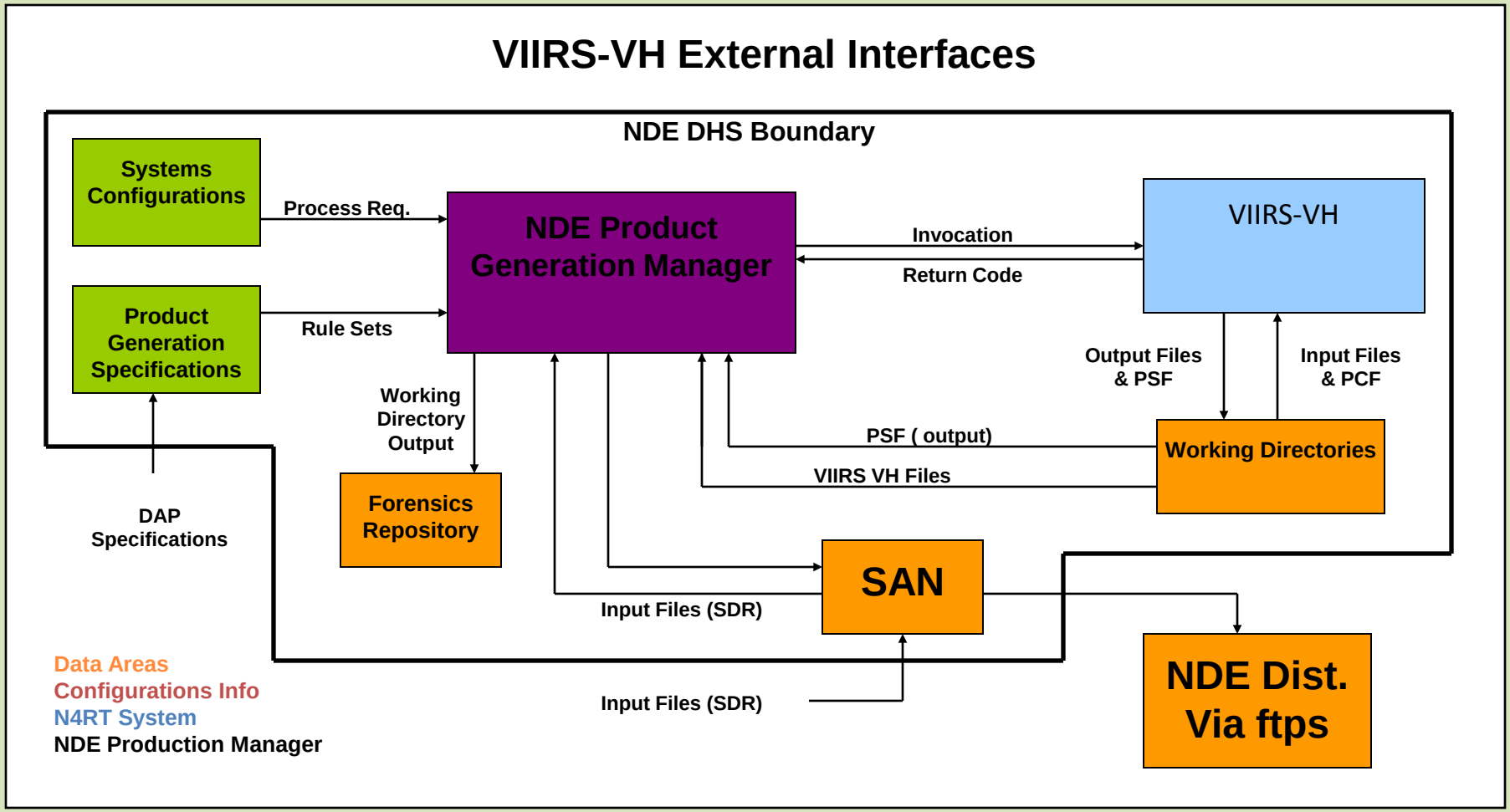


Detailed Design Adds 2 Layers

The Context-Layer

- The Context-Layer describes the flows between the system and its external interfaces
- An external input is defined as a data source needed by the system that is produced or made available by a process external to the system
- An external output is defined as a data sink that is produced by the system for an external user

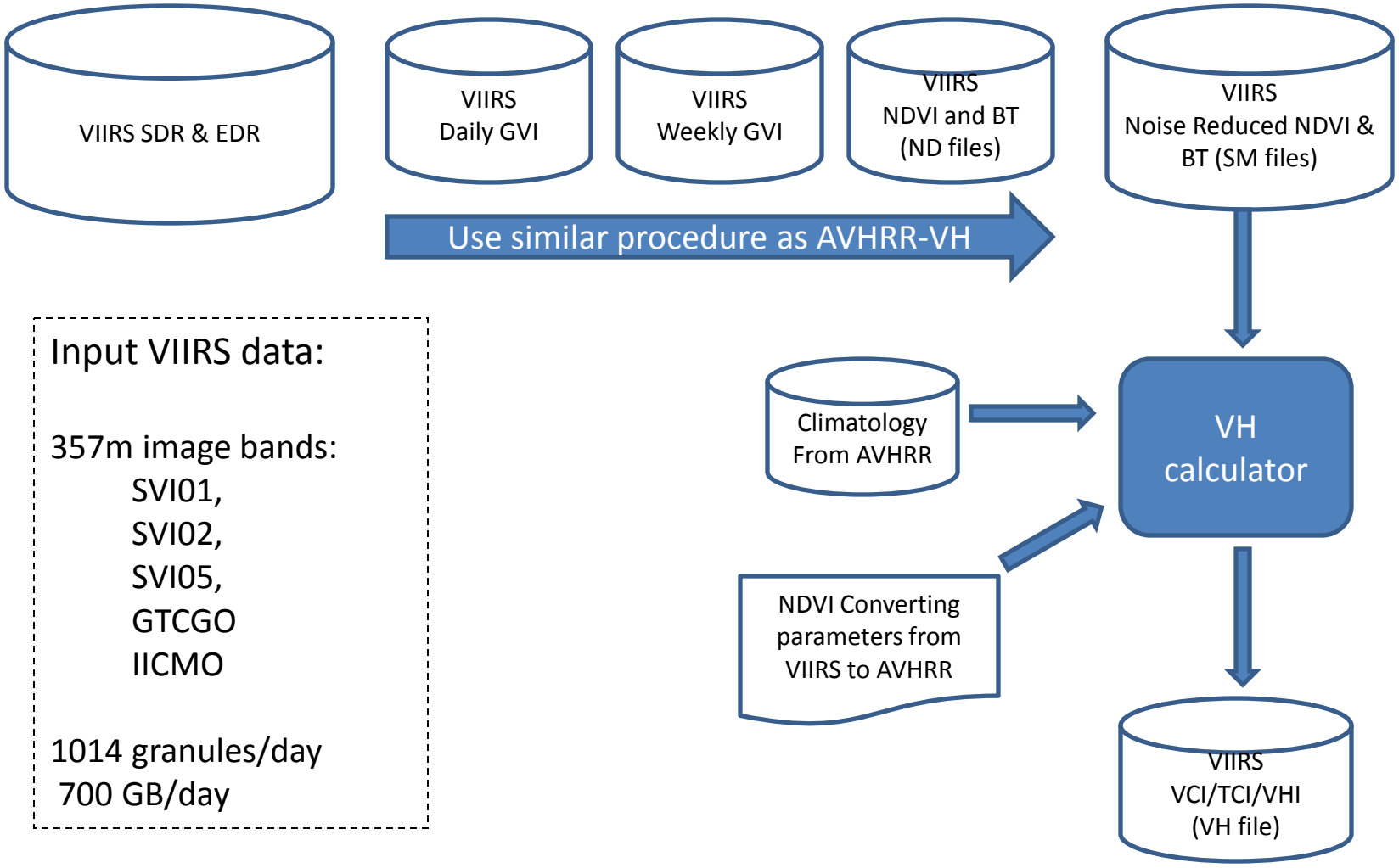
VIIRS-VH External Interfaces to NDE



System Layer

- The System-Layer data flow expands upon the Context-Layer data flow, showing the first layer of decomposition.
  - In addition to the System-Layer inputs and outputs, the major processing units are shown along with their inputs and outputs.
  - Each unit is designed as a stand-alone program for ease of testing and integration into a System-Layer scheduler.

VIIRS-VH system
System Level Data Flow



Input VIIRS data:

357m image bands:
- SVI01,
- SVI02,
- SVI05,
- GTCGO
- IICMO

1014 granules/day
700 GB/day

System-Layer Components – Processing Units (1)

- **GVI Daily Map Creator (DMC)**
  - Creates daily maps of from VIIRS SDR and EDR files.
  - If only a portion of input granules were provided, it creates a "partial daily map"
- **GVI Daily Map Merger (DMM)**
  - Merges partial daily maps together. (it is an optional unit)
- **GVI Weekly Map composer (WMC)**
  - Makes weekly maximum value composite (MVC) from Daily Maps.
- **Calibration unit (CAL)**
  - Reads GVI weekly composite map and calibration parameters
  - Generates calibrated (raw) NDVI and BT (ND) files by applying optimized (or most recent updated) post-launch calibration parameters to reflectances

System-Layer Components – Processing Units (2)

- **Corrections unit (COR)**
  - Reads weekly NDVI and BT4 (ND files) of 15 weeks
  - Performs time series smoothing to remove high frequency noise and generate smoothed NDVI and BT (SM) files. The last 7 weeks' SM files are updated.
- **Vegetation Health Calculator (VHC)**
  - Reads latest SM file of smoothed NDVI and smoothed BT
  - Reads climatology data (CLIMAT file)
  - Generates vegetation health (VH) files.
- **Metadata Write unit (MTW)**
  - Reads VH product and intermediate products in NetCDF format
  - Generates metadata files in XML format.

System-Layer Commands

- 1 executable for all units (except the unit using IDL)

```
–  VHsuite.exe  -S configure_file  DailyMap         npp year1 jday1 year2 jday2
–  VHsuite.exe  -S configure_file  MergeDailyMaps   npp year1 jday1 year2 jday2

–  VHsuite.exe  -S configure_file  CompositeMap     npp  year1 week1 year2 week2
–  VHsuite.exe  -S configure_file  ND               npp  year1 week1 year2 week2
–  VHsuite.exe  -S configure_file  SM               npp  year1 week1 year2 week2
–  VHsuite.exe  -S configure_file  VH               npp  year1 week1 year2 week2

–  VHsuite.exe  -S configure_file WeeklyTasks npp  year1 week1 year2 week2
```

System Level Scripts

- The VIIRS-VH driver scripts will have Perl scripts that act as wrappers for the compiled VIIRS-VH code.
  - There will be no hard coded paths in the script. All needed information regarding locations of files will come through the PCF.
  - All system calls have their return values checked so the exits are graceful and informative.
  - All standard out and standard error will be directed to a single log file.
  - The driver script will translate the low-level program errors into the high-level numerical error codes expected by the PGM.
  - The Perl script will generate an internal control file for the main VIIRS-VH program.

VIIRS-VH Software: Script

- It will be run via the execution of a single driver script that will be invoked, monitored, and managed by the NDE DHS Product Generation Manager.
- Execution of the script will be driven by data (process product when data is available)
- NDE will run the script in a working directory. All input/output paths are defined in Product control file (PCF). ~~A static working space will be used to update intermediate product SMN and VH files)~~
- The driver script will run VIIRS-VH, handle program output and errors, direct required NDE error codes to the DHS, generate an output log, and generate a PSF.
- If there are errors, NDE will save the contents of the run in a forensics repository.
- NDE will manage and direct error status to the operators from the DHS system.

System Level Perl Scripts

2 Perl scripts was created for:

1. Creating partial daily map: Input will be granule data files listed in PCF, may run multiple times per day.

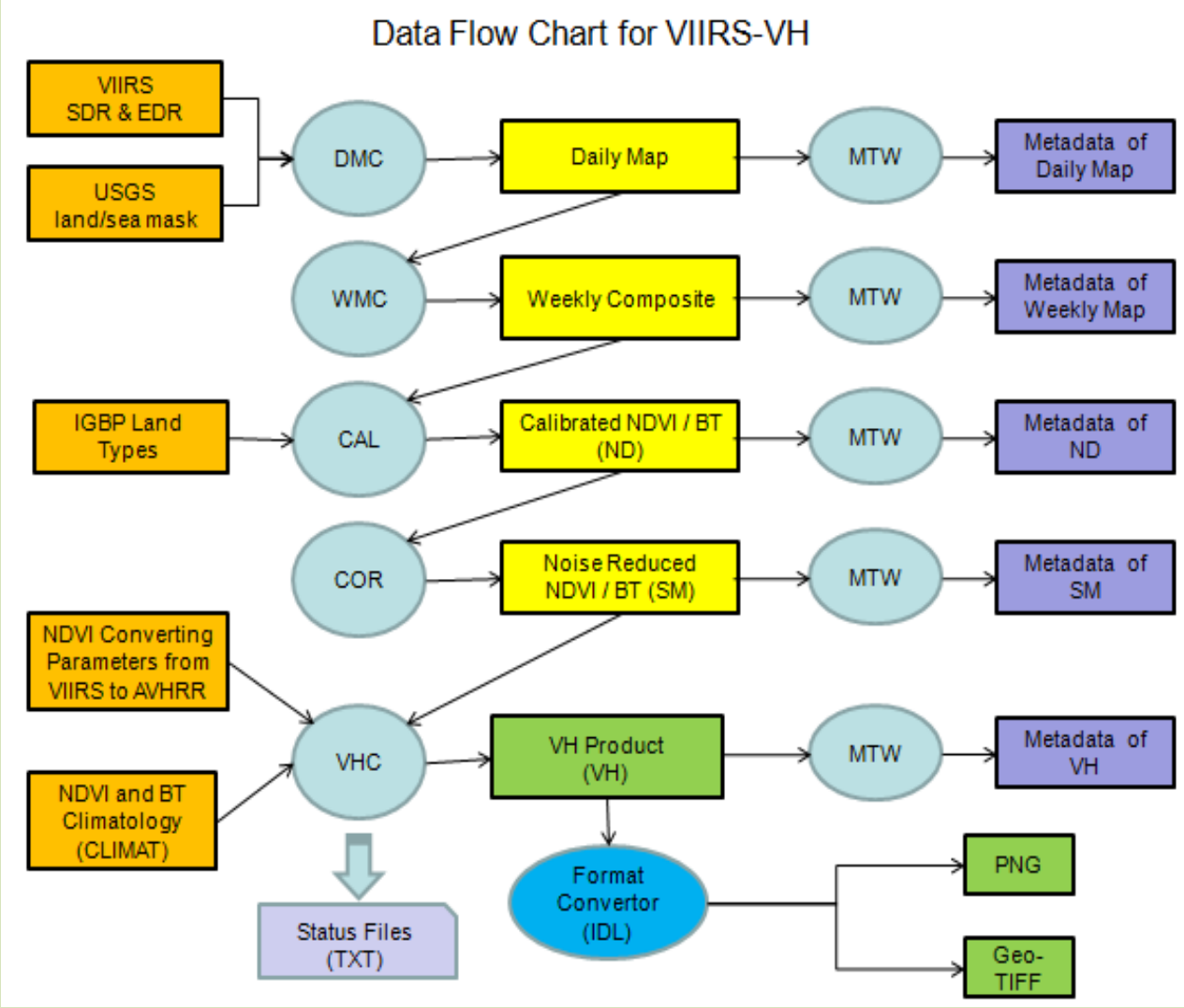
2. Run weekly procedure: Input will be partial daily maps listed in PCF, run once per week. Will run the following units in sequence:
   - Merge daily maps
   - Weekly composite
   - Calibration unit (create ND file)
   - Correction unit (create SM file)
   - VH calculation unit (create VH)
   - Make sampled files and create meta data files

VIIRS-VH Software: Unit Level

- The lowest-level VIIRS-VH functions (in C++):
  - Perform the actual reading and writing of the specific file types (HDF, HDF5,and netCDF4).

- General VIIRS-VH compiled with code characteristics:
  - The status of all functions are checked to allow for graceful and informative exits.
  - No paths are hard coded in the compiled code.
  - All code will be compiled as 64 bit to utilize the IBM architecture.

VIIRS-VH Unit Level Data Flow



System-Layer Components – Unit Data Flows (1)

- Daily Map
  - Data Flow
    - From DMC Unit to WMC Unit
    - From DMC Unit to MTW Unit
  - Description:
    - Daily maps of reflectance, BT or other variables in EDR, geometry angles, observation time and “packed_cloud_mask”.
    - For each VIIRS-VH grid cell, the AVHRR data for the observation closest to the center of the cell is selected to produce a gridded daily map of digital counts
- Weekly Composite
  - Data Flow:
    - From WMC Unit to CAL Unit
    - From WMC Unit to MTW Unit
  - Description:
    - For each VIIRS-VH grid cell, the daily map with the maximum NDVI is selected to produce a gridded weekly map.
    - Weekly composite includes all variables in daily maps. It also includes the maps of “days with valid data” and the selected date.

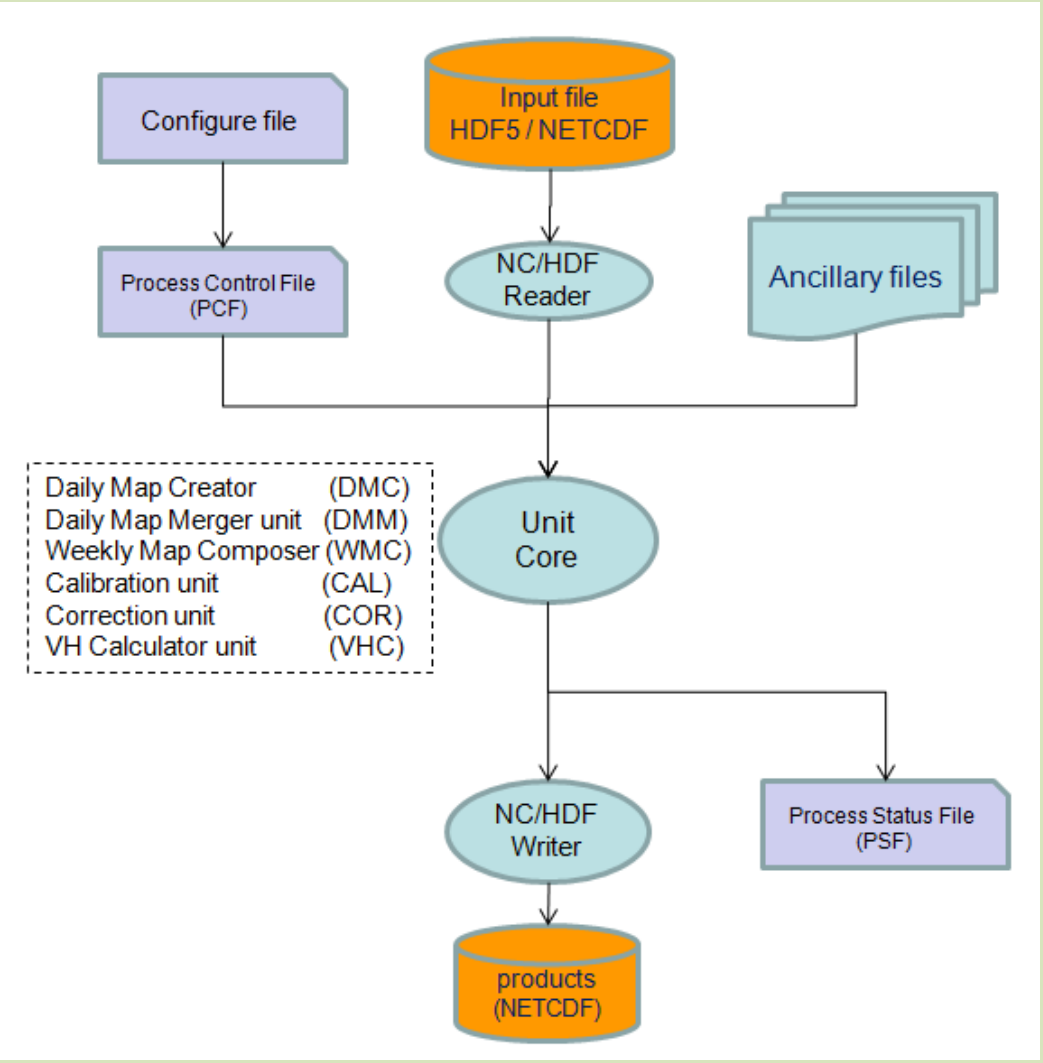
System-Layer Components – Unit Data Flows (2)

- Calibrated NDVI / BT (ND)
  - Data Flow:
    - From CAL Unit to COR Unit
    - From CAL Unit to MTW Unit
  - Description: NDVI and BT with post-launch calibration applied
- Smoothed NDVI / BT
  - Data Flow:
    - From COR Unit to VHC Unit
    - From COR Unit to MTW Unit
  - Description: NDVI and BT with high frequency noise removed
- VH Product
  - Data Flow:
    - From VHC Unit to FMC Unit
    - From VHC Unit to MTW Unit
  - Description: VH product file in netCDF format

Unit Layer

- The Unit Layer Data Flow decomposes the system level software architecture to the next (unit) level.
- In this layer, the data flows within units are described.

Unit Layer – Shared code structure for major VH units



- Configure file: parameters / paths for VH
- PCF: input file names (NDE required)
- PSF: output file names (NDE required)

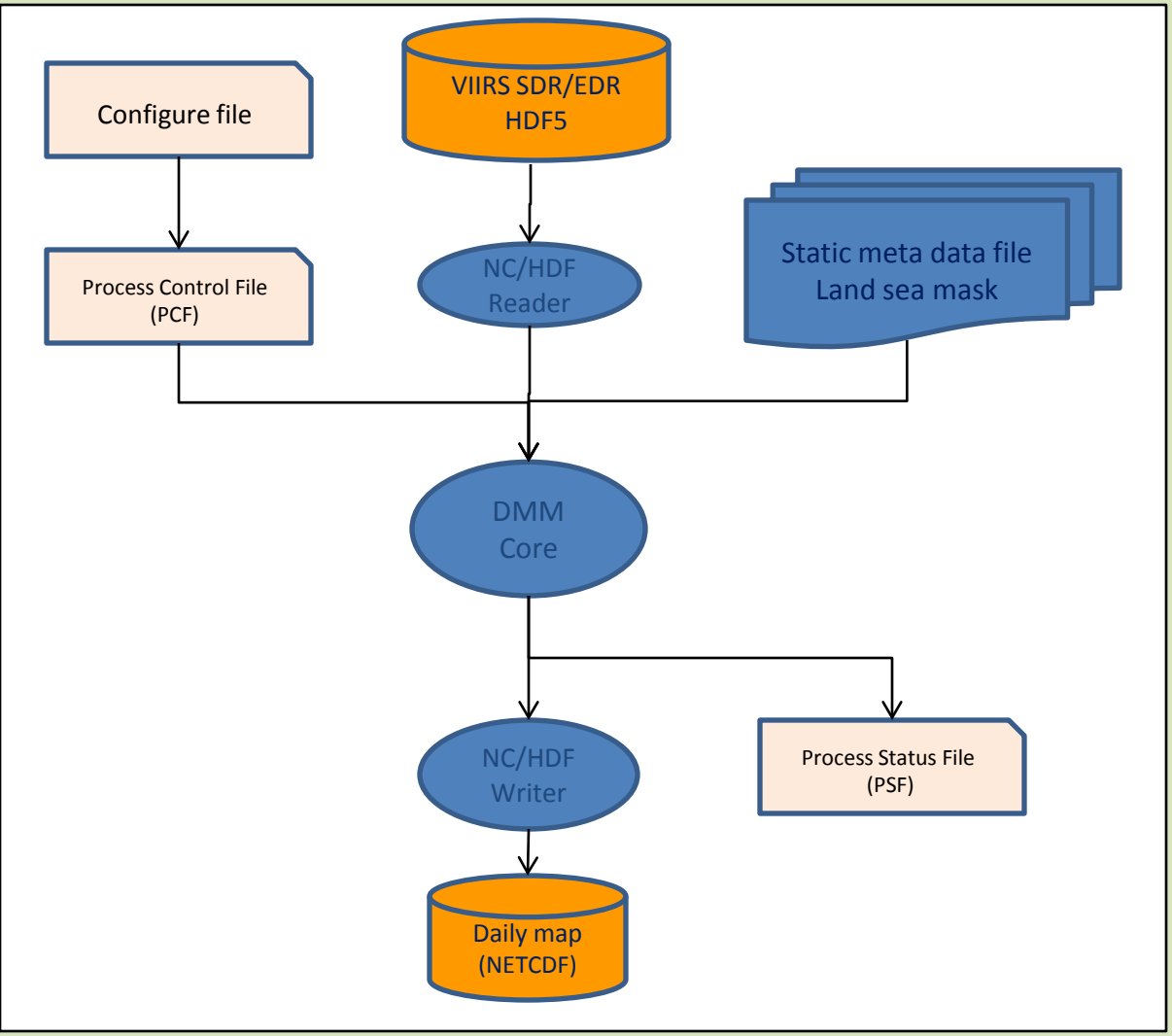
- Input files:
  HDF5 (VIIRS SDR, EDR)
  NETCDF (VH products)

- Ancillary files:
  HDF, NETCDF or ASCII format

Carry out in order:

- Parse the command line and get task name and optional parameters.
- Read VH configure file to get directory names and other parameters
- Read Process Control File (PCF) to obtain the input file names
- Switch to corresponding unit, and process this unit
- Output the product NETCDF file
- Write the output file to process status file

Unit Layer- DMC Unit

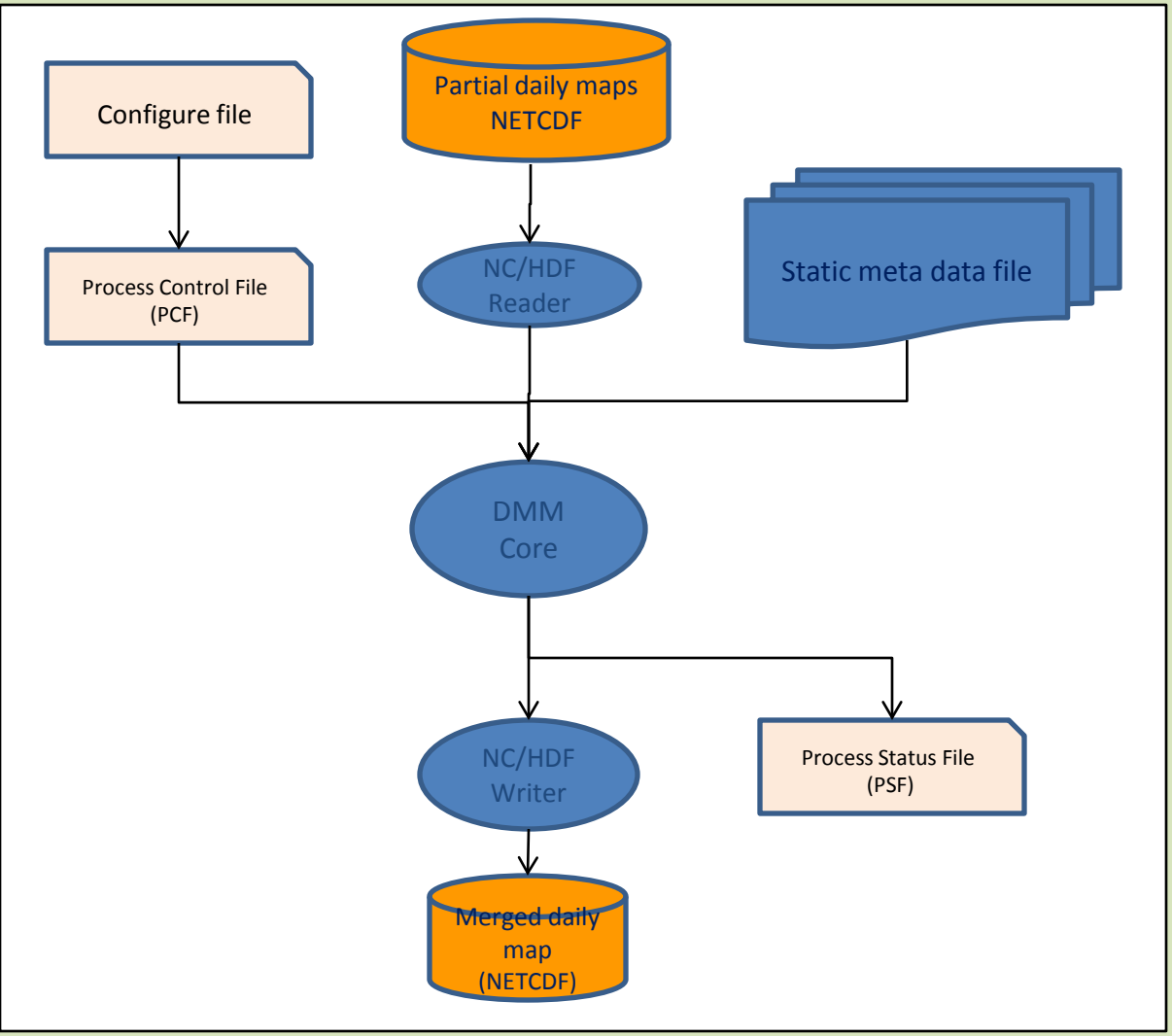


Create (partial) daily maps

Packed_cloud_mask is set and Serve as QA flags:

General Quality bit
Land /coastal bit from landse a mask file
Cloud bits (6-7) from IICMO
Sun glint was calculated from the geometry angles

Unit Layer-DMM Unit

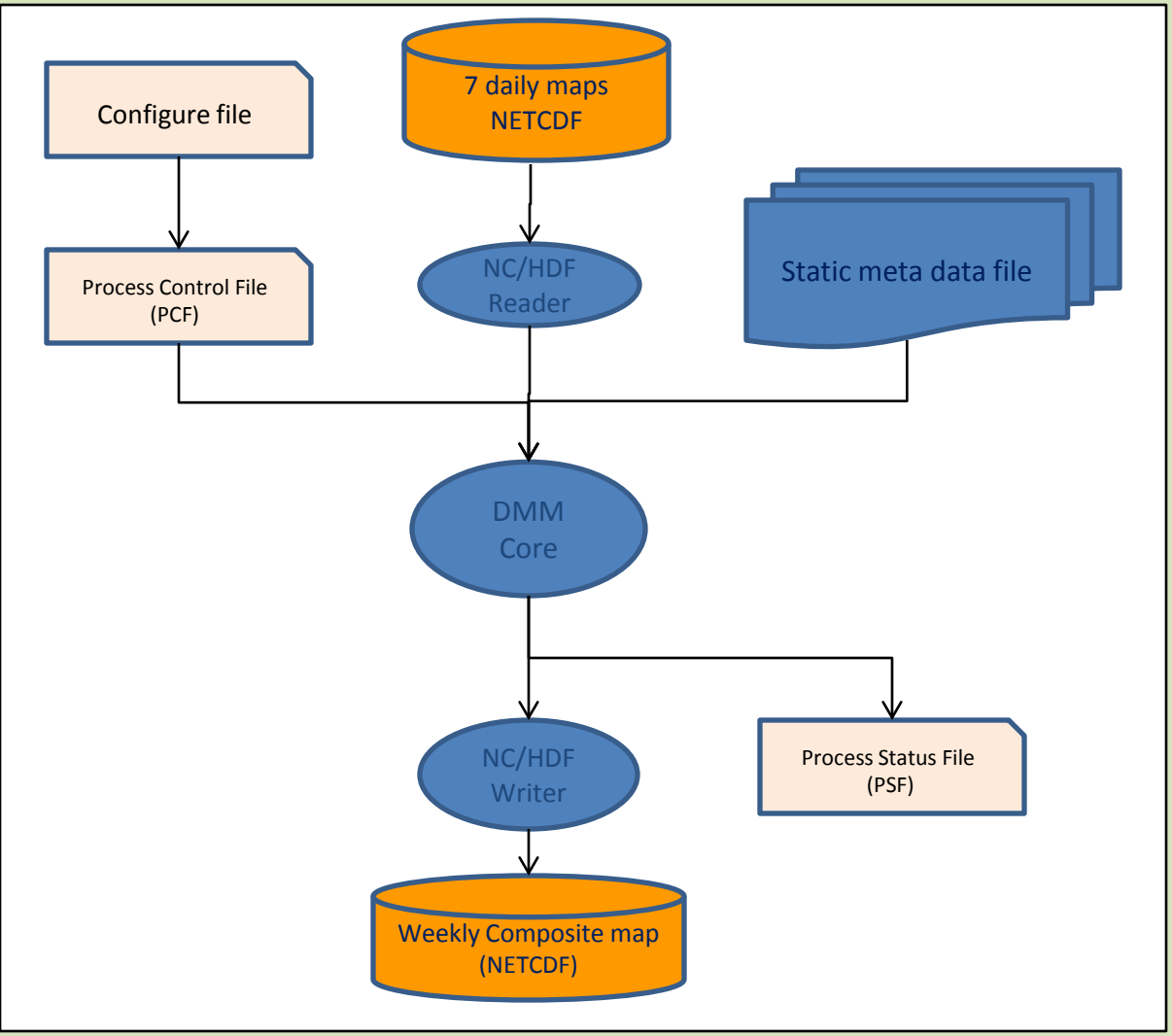


Merge partial daily maps

It is optional unit, only used when daily maps are processed in multiple runs.

Packed_cloud_mask was transfer from Daily Map

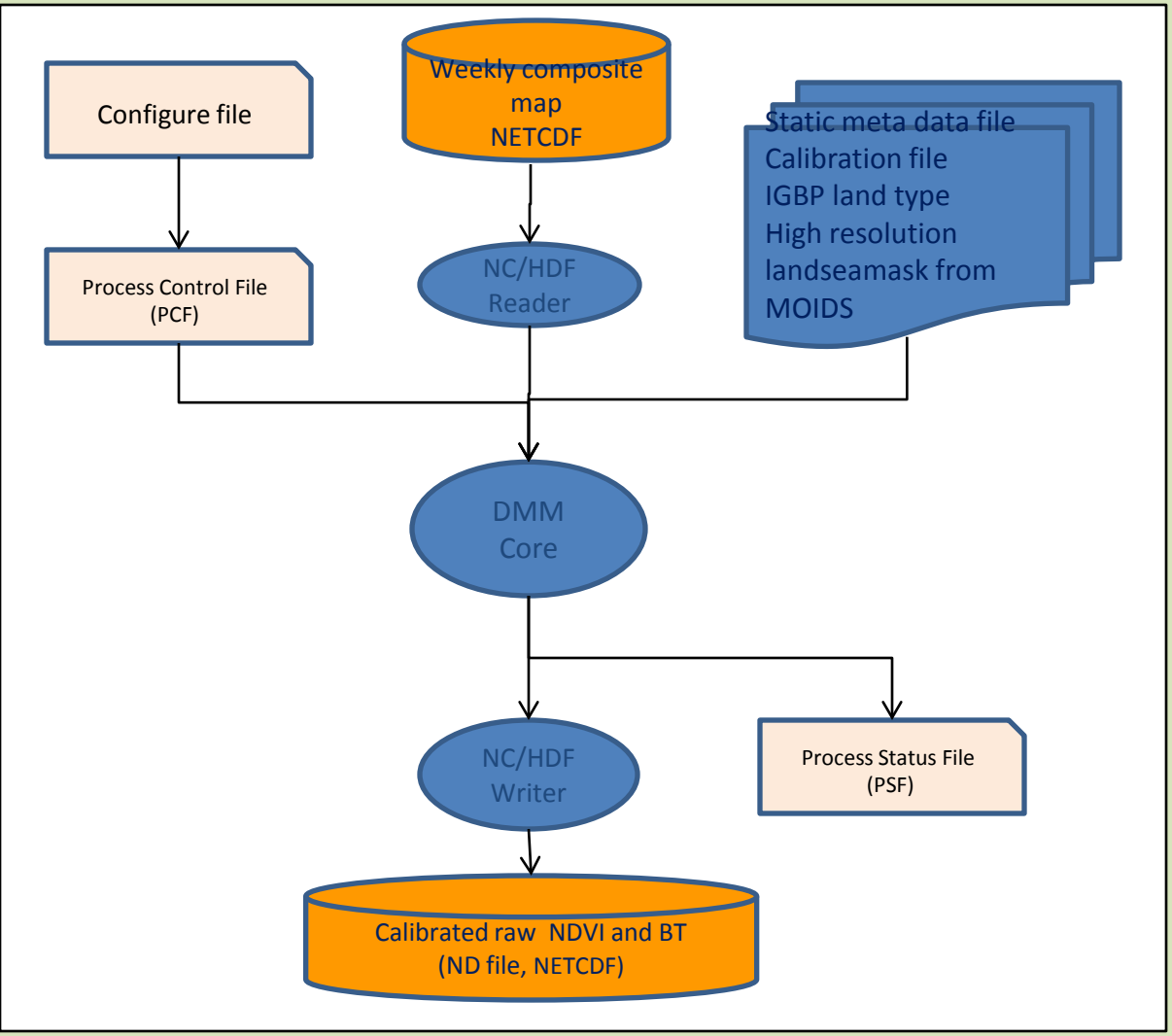
Unit Layer-WMC Unit



Make weekly composite by max NDVI composite

Packed_cloud_mask was transfer from Daily Map

Unit Layer-CAL Unit



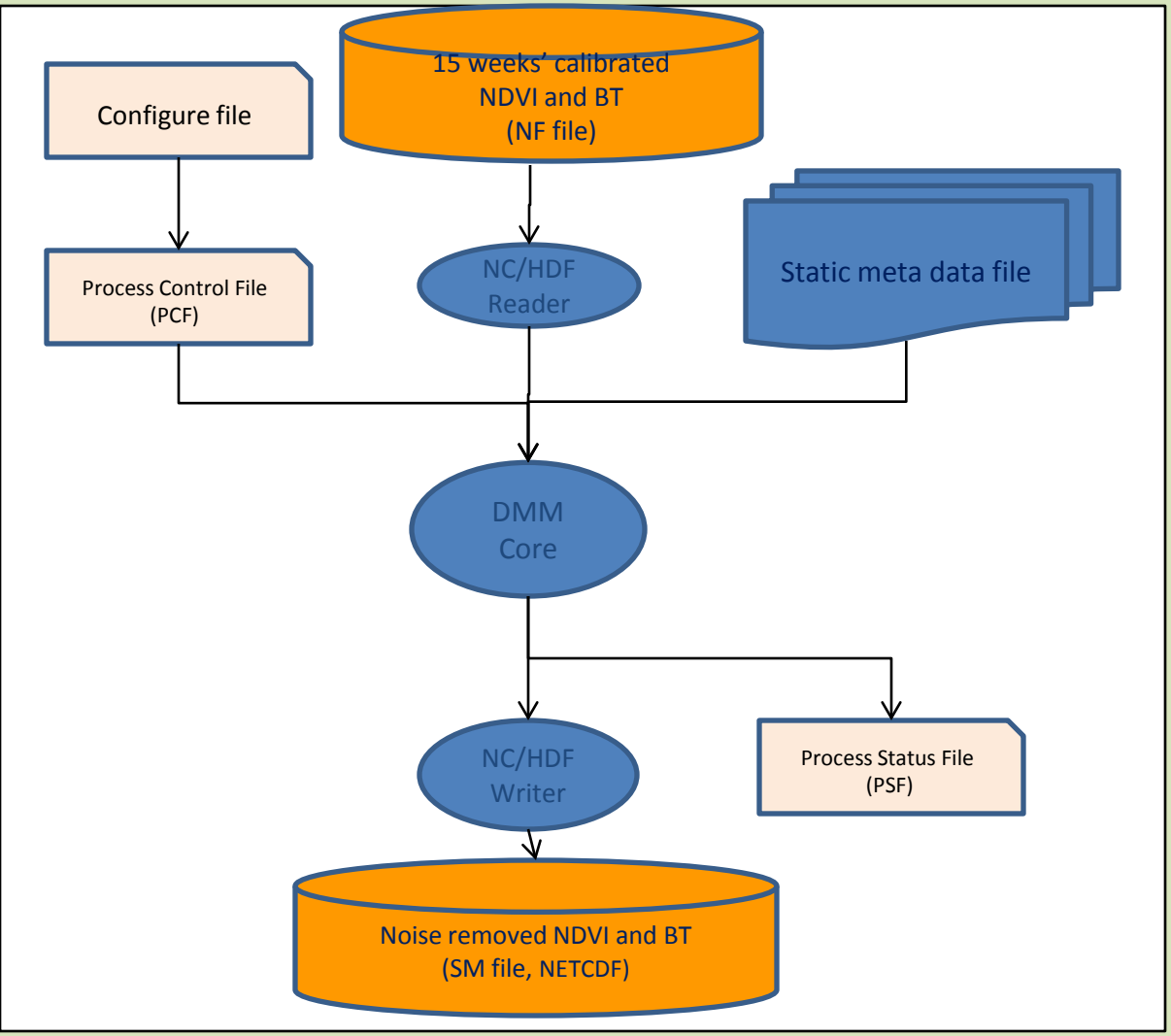
Calculate NDVI and BT by applying latest launch calibration.

IGBP land type was used to set desert bit in QA

High resolution land sea mask from MOIDS was used to set land and coastal bit in QA

BT <0° C , set too-cold bit in QA

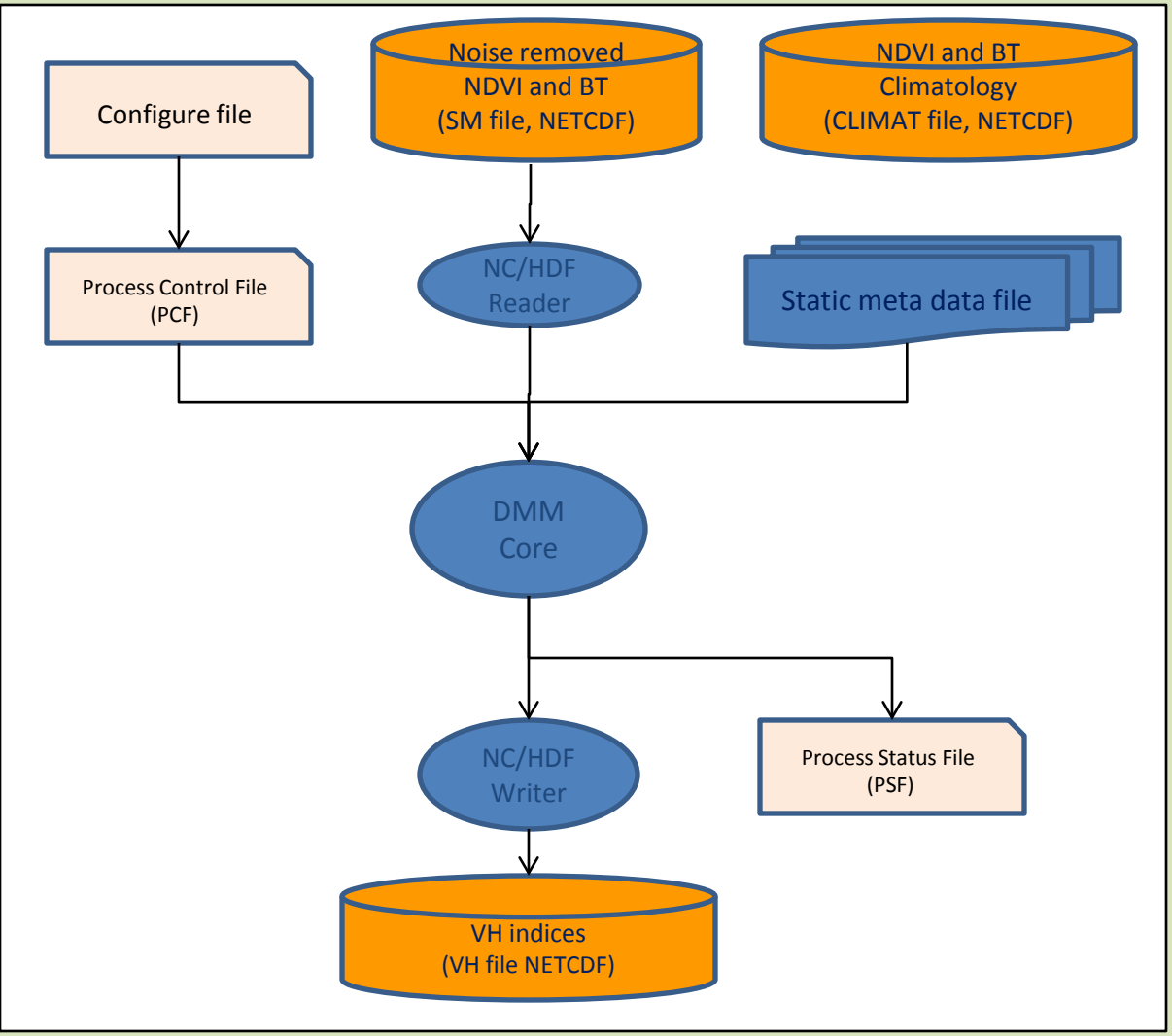
Unit Layer-COR Unit



Remove noise by time series smoothing

QA was transferred from ND file

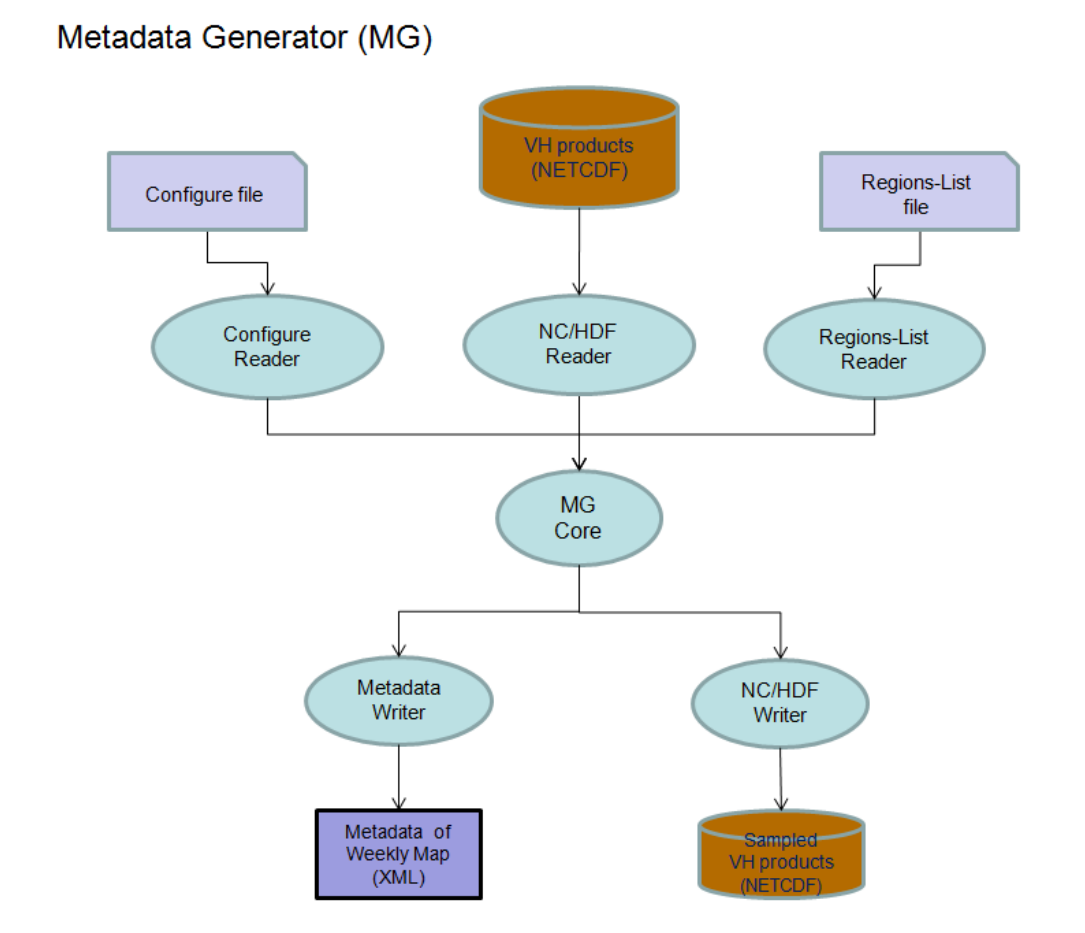
Unit Layer-VHC Unit



Calculate VHI from noise removed NDVI and BT and climatology.

QA was transferred from SM file

Unit Layer-Metadata Generator (MG) Unit



- Read a VH product file
- Create sampled dataset
- Calculate statistic information for each selected region and Save statistic information in XML file

DATA FILE DESCRIPTION

VIIRS-VH External Inputs

Item	Type	Source	Description
VIIRS SDR	Input	DDS	VIIRS SDR granule data, including reflectance of image band 1 and 2, brightness temperature of image band 5.
USGS land/sea mask	Input	USGS	Static file contains 30 arc second resolution land sea mask from USGS, It was converted to HDF format.
IGBP land types	Input	STAR	Land cover types from IGBP program, It was sampled to the grid of VH product to HDF format.
Calibration data	Input	STAR	Calibration parameters for VIS and NIR bands from NOAA/NESDIS/STAR,
NDVI and BT Climatology from AVHRR and MODIS	Input	STAR	Multiple year climatology of NDVI and BT, created from AVHRR and MODIS
Process Control File	Input	NDE	Provide input file names

VIIRS-VH External Output

Item	Type	Source	Description
VH Product	Output	VIIRS-VH	Global Gridded Vegetation Health data in NetCDf format, using Lat/Lon projection with 0.036 degree (about 4km at equator) resolution. Files are in NetCDF format.
VH metadata	Output	VIIRS-VH	Metadata in XML format,
VH in Geo-TIFF	Output	VIIRS-VH	VH data in Geo-TIFF format, it is in Lat/Lon projection, with resolution of 0.144 degree. It is possible to provide it in higher resolution (example: 0.036 degree)
VH images	Output	VIIRS-VH	VH data presented in PNG format, with resolution of 0.036 degree.
Process Status file	Output	VIIRS-VH	Output file names need to archive or distribute

HARDWARE AND SOFTWARE LIBRARIES

Hardware: Development Environment

Development Hardware - Unit tests will be conducted on the Linux development machine at STAR .

- Linux
- 2 TB disk space
- dual CPU
- 2 GB memory/CPU
- C/C++ compiler

VIIRS-VH: Test Product Distribution

- STAR Data Server - Test products will be available on a distribution server at STAR (ftp.star.nesdis.noaa.gov).
  - Linux
  - 3.2 TB disk space
  - Access via anonymous ftp

VIIRS-VH Software: Libraries

- HDF4 version 4.2 (or latest)
  - available at http://www.hdfgroup.org
- HDF5 version 1.8.7 (or latest)
  - available at http://www.hdfgroup.org
- netCDF4 version 4.2 (or latest)
  - Available at https://www.unidata.ucar.edu/downloads/netcdf/index.jsp

Summary

- The software architecture design and interfaces of each component in VH system 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 VH system product processing monitoring have been presented.

Outline

- Introduction
- Pre-ARR Risks and Actions
- Requirements
- Software Architecture
- **Algorithm Readiness**
- Delivered Algorithm Package
- Risk and Action Summary
- Summary and Conclusion
- Appendix: VHP Unit Tests

ALGORITHM READINESS

Felix Kogan

Outline

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

Goal: Demonstrate science quality of the VIIRS Veg Health product.

Product Overview and Requirements

- Three VIIRS/VH indices on 4 km global Lat/Lon geographic projection grid in NetCDF format:
  - Vegetation Condition Index (VCI): Produced from NDVI characterizes such indicators as greenness and vigor.
  - Temperature Condition Index (TCI): Produced from infrared radiance characterizes thermal conditions of land cover.
  - Vegetation Health Index (VHI): This is a weighted combination of VCI and TCI and characterizes the integrated effects of greenness, moisture and temperature on vegetation health.

Product Overview and Requirements

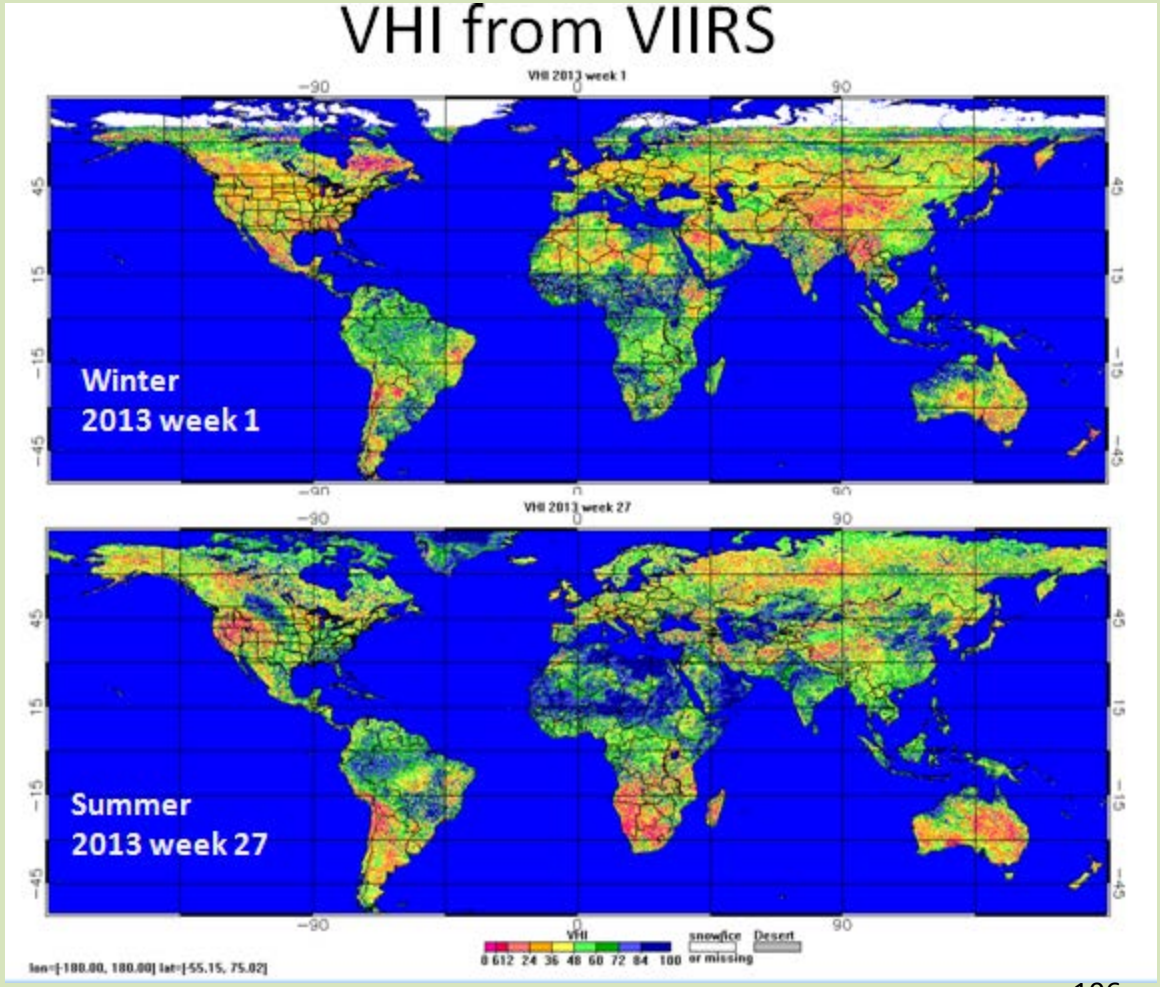
- Vegetation indices data in Geo-TIFF
- Intermediate files (NetCDF):
  - VIIRS daily map
  - VIIRS weekly composite
  - Calibrated raw NDVI and BT (ND files)
  - No noise (smoothed) NDVI and BT (SM files)
  - These files are not required to be delivered to end user, nor are required to be archived by OSPO.
- Metadata (NetCDF):
  - Major metadata will be saved as file attributes
  - They are also saved in META data file in XML format together with additional statistic information which are useful to monitor the VHP product data quality and processing status.
  - It will be used by OSPO only and do not need to be archived.

Product Overview and Requirements

EDR Attributes	JPSS L1RD	Veg. Health Product System
Horizontal Cell Size	Threshold – 0.036° (4km) Objective – 0.018°, 0.009° (2,1 km)	Threshold – 0.036° (4km) Objective – 0.018°, 0.009° (2,1 km)
Vertical Reporting Interval	NS	NS
Mapping Uncertainty, 3 sigma	Threshold – <0.036° (4km) Objective – <0.018°, <0.009° , <0.0045°	Threshold – <0.036° (4km) Objective – <0.018°, <0.009° , <0.0045°
Measurement Precision	Threshold – 4.0% (For the range 0-100%) Objective – NS	Threshold – 4.0% (For the range 0-100%) Objective – NS
Measurement Accuracy	Threshold – 1.0% Objective – NS	Threshold – 1.0% Objective – NS
Refresh	Threshold – Every 7 day period Objective – Every 5 day period	Threshold – Every 7 day period Objective – Every 5 day period

Product Examples

- The Figure shows examples of composite maps presenting typical summer and winter Vegetation Health maps produced by this algorithm for week 27 and week 1,2013).
- The retrieved Vegetation Health values generally exhibit a good dynamic range from 0-100 indicating that this algorithm is capable of retrieving the required range of Vegetation Health values given different vegetation type and brightness temperature inputs from satellite sensors.
- The spatial patterns shown in the maps are also consistent with global dry/wet patterns of climate regimes.

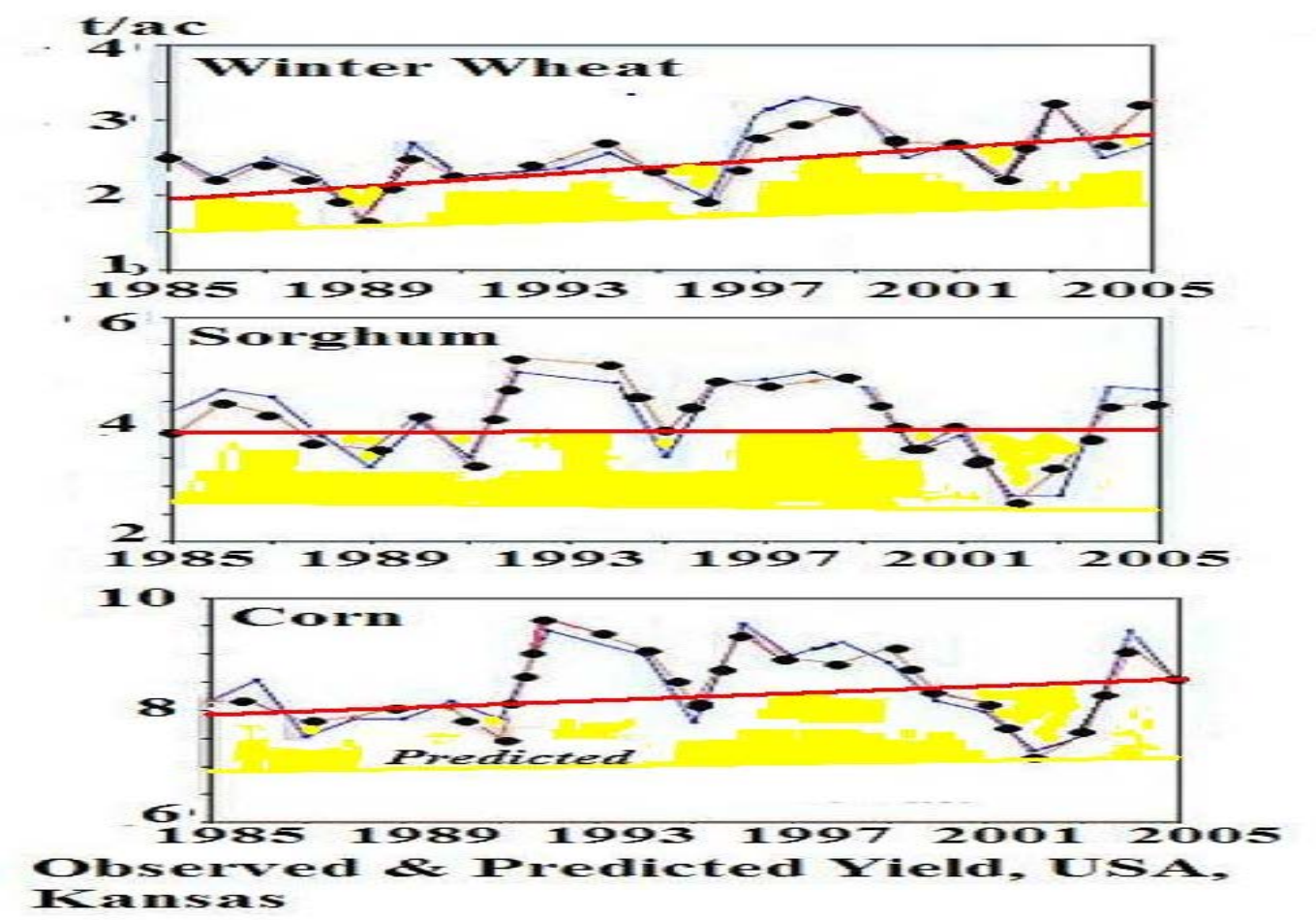


Validation Strategy

- The NOAA-19/AVHRR-VHP dataset will be used for testing and validation
- The samples of AQUA/MODIS dataset will be used for testing and validation
- VIIRS-VH indices data and daily/weekly maps has been produced from May 2012.
- VIIRS-VH products were compared with AVHRR-VHP dataset which is research prototype of VIIRS-VH system.

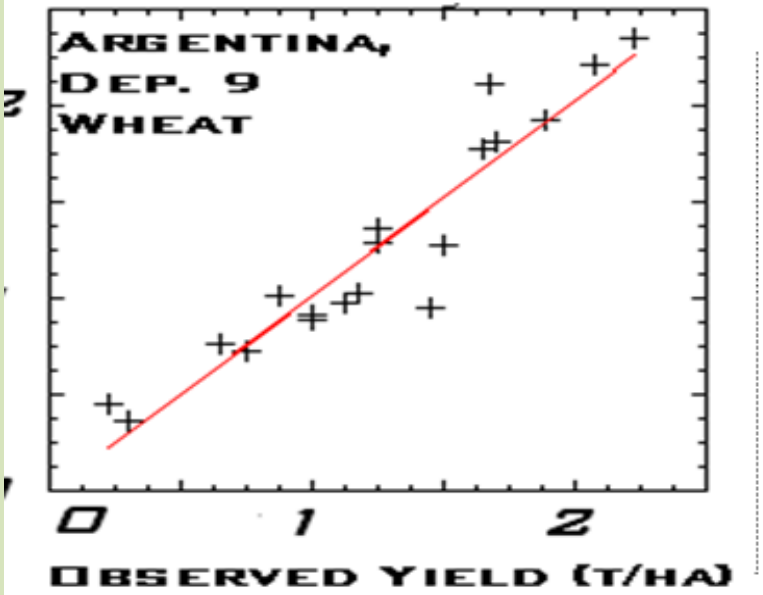
VALIDATION RESULTS

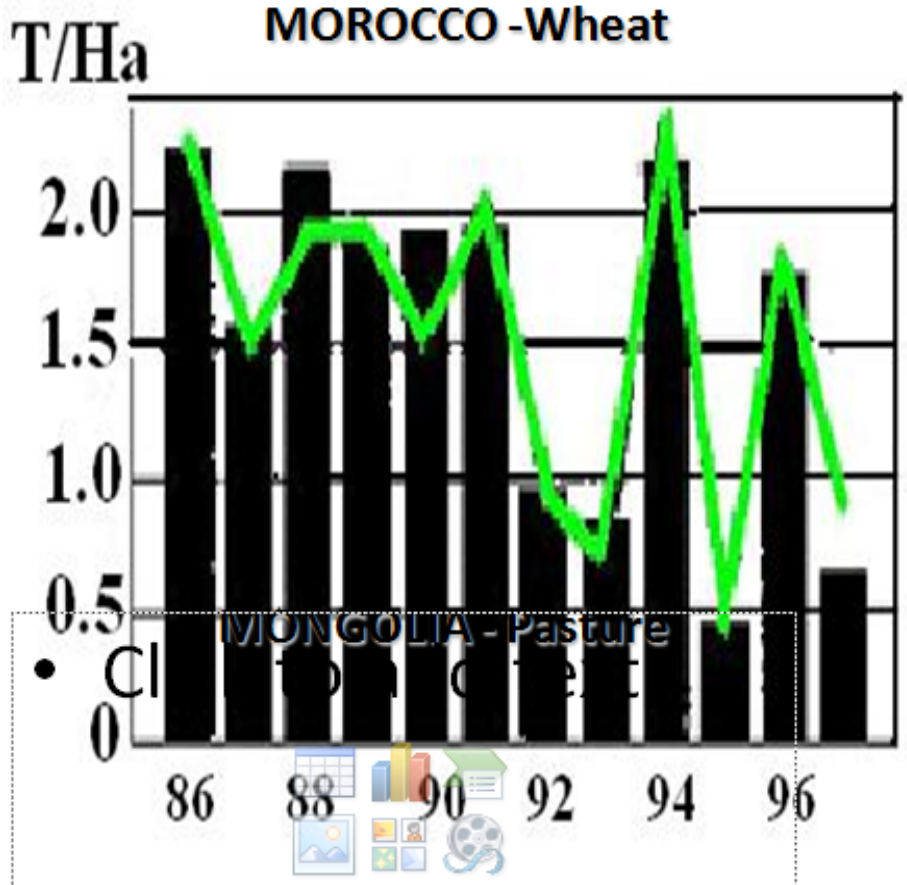
AVHRR/VH-Crop Yield Correlation: USA, Kansas



Observed & Predicted Yield, USA, Kansas

AVHRR/VH-Crop Yield Correlation



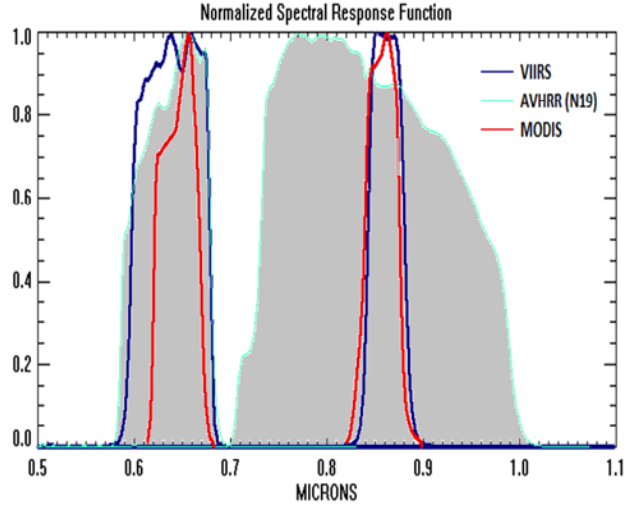


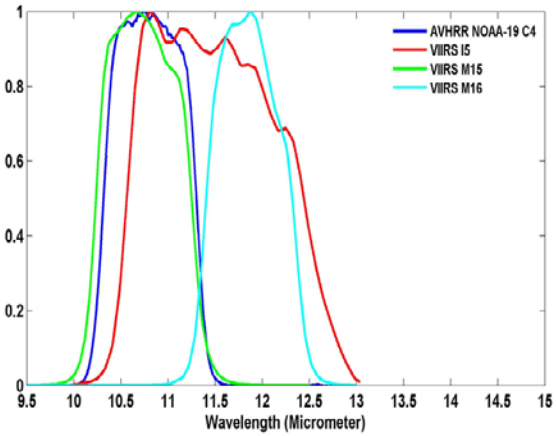
- Cl

MONGOLIA - Pasture

15

Similarity & Differences

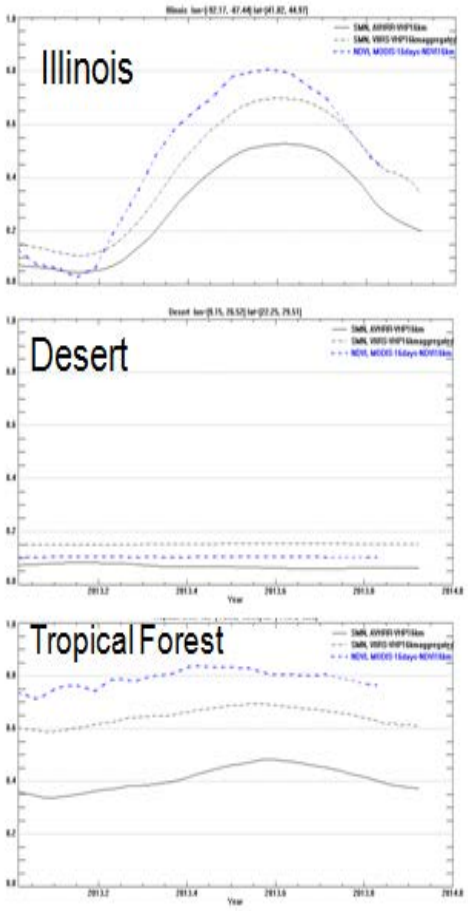


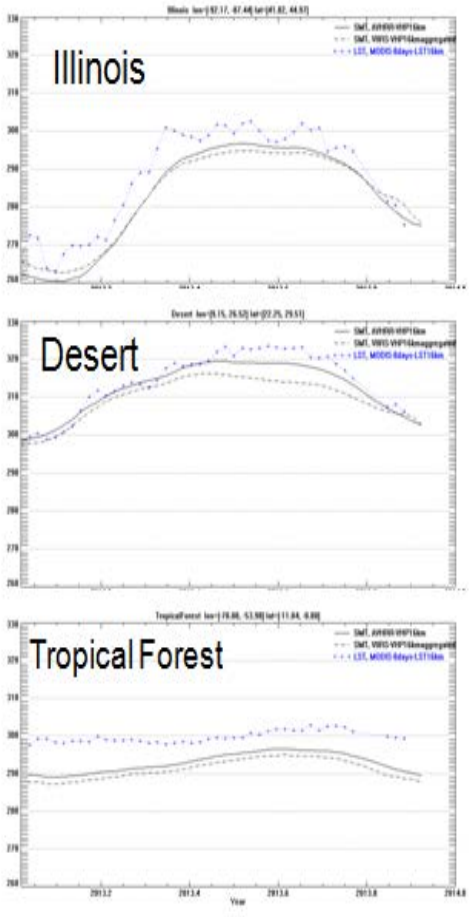


- VIIRS M15 is very close to AVHRR channel 4.
- VIIRS I5 is very broad, needs correction with band around 12 micrometers (M16) if use VIIRS I5 to correlate with AVHRR Channel 4 .

NDVI

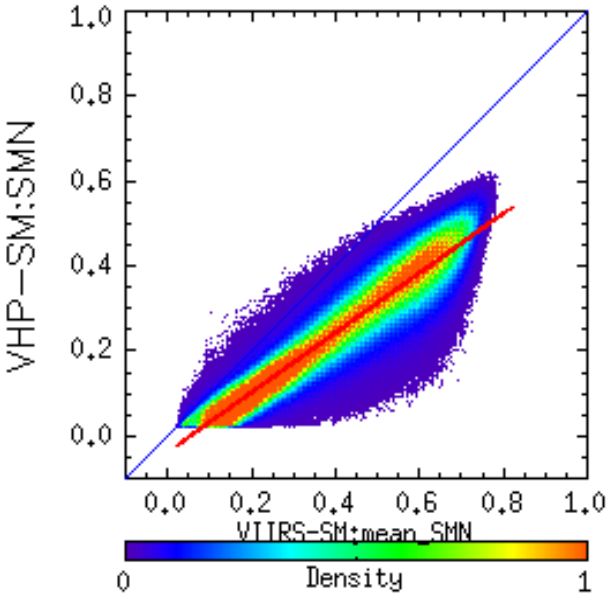
BT





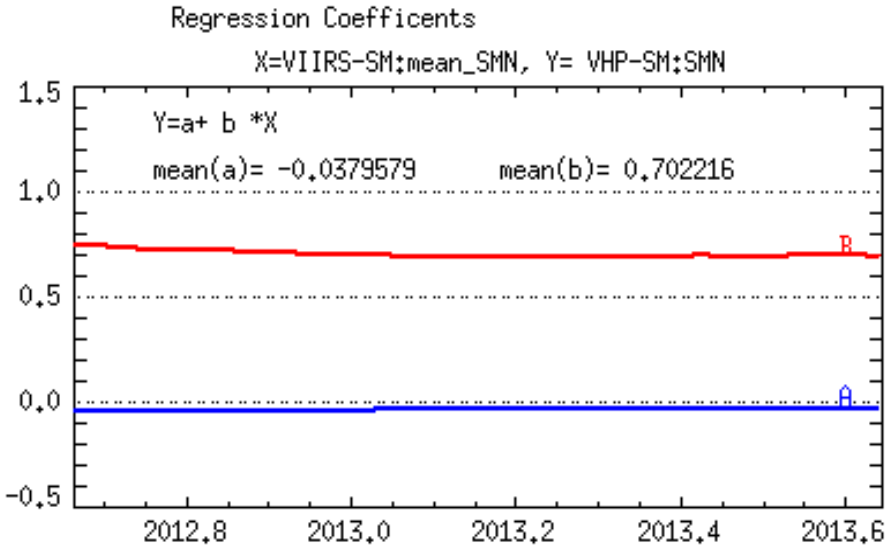
AVHRR
VIIRS
MODIS

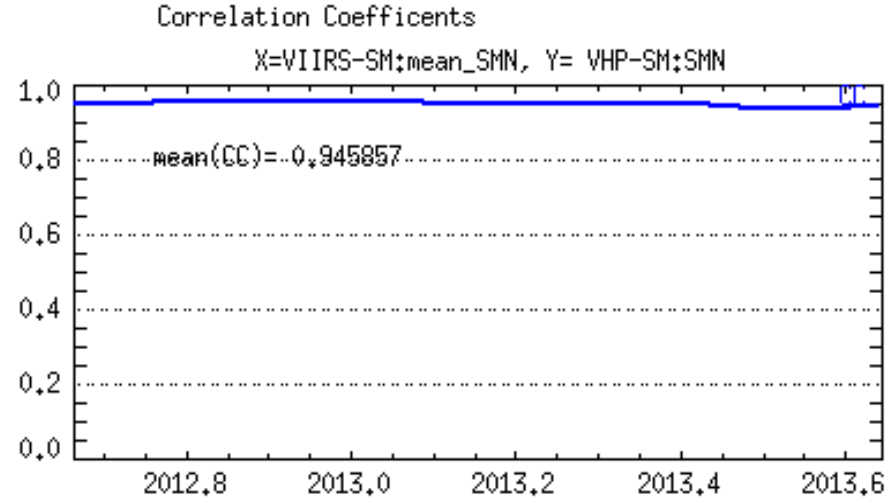
NDVI: VIIRS vs AVHRR



Y= a +b * X
a= -0.0378634
b= 0.702535

Nsamples=4604572
CC = 0.9440
RMSE =0.0458302

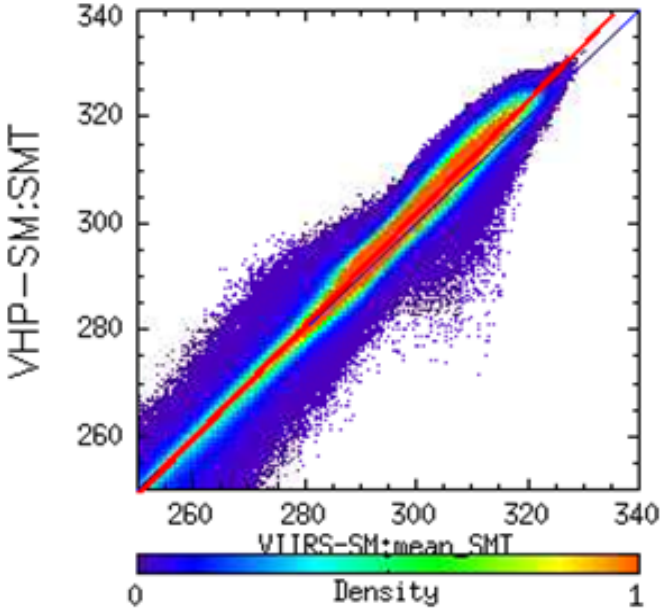




lon=[-180.00, 180.00] lat=[-40.00, 40.00]

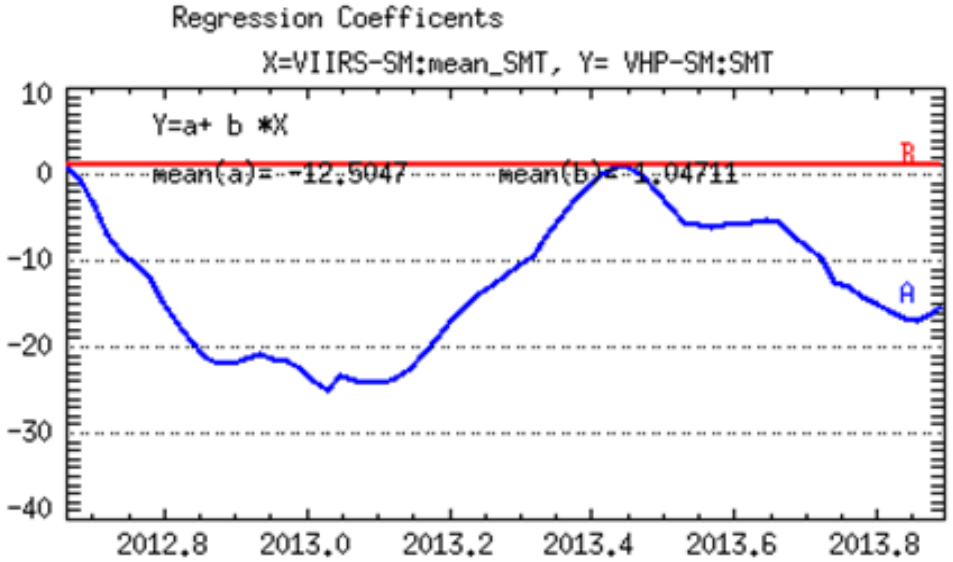
Data used: 2012 week 35 to 2013 week 34

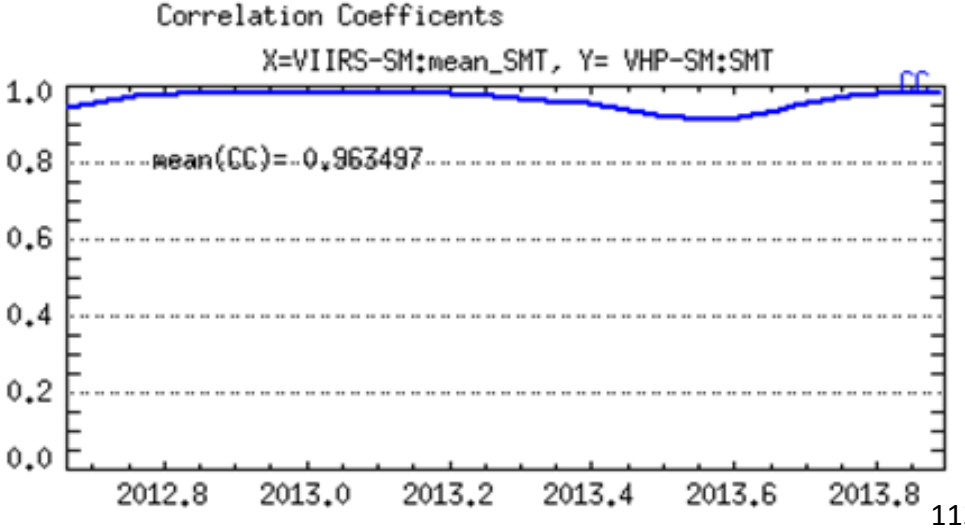
BT: VIIRS vs AVHRR



Y= a +b * X
a= -15.3288
b= 1.05696

Nsamples=8638092
CC = 0.9610
RMSE =3.51405

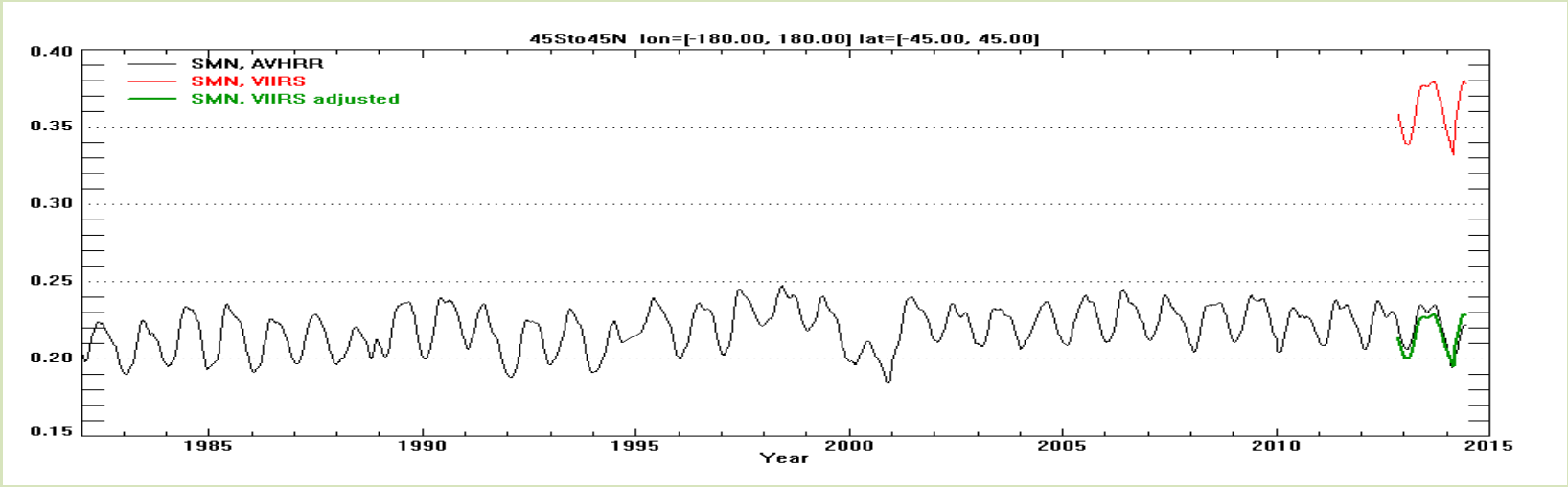


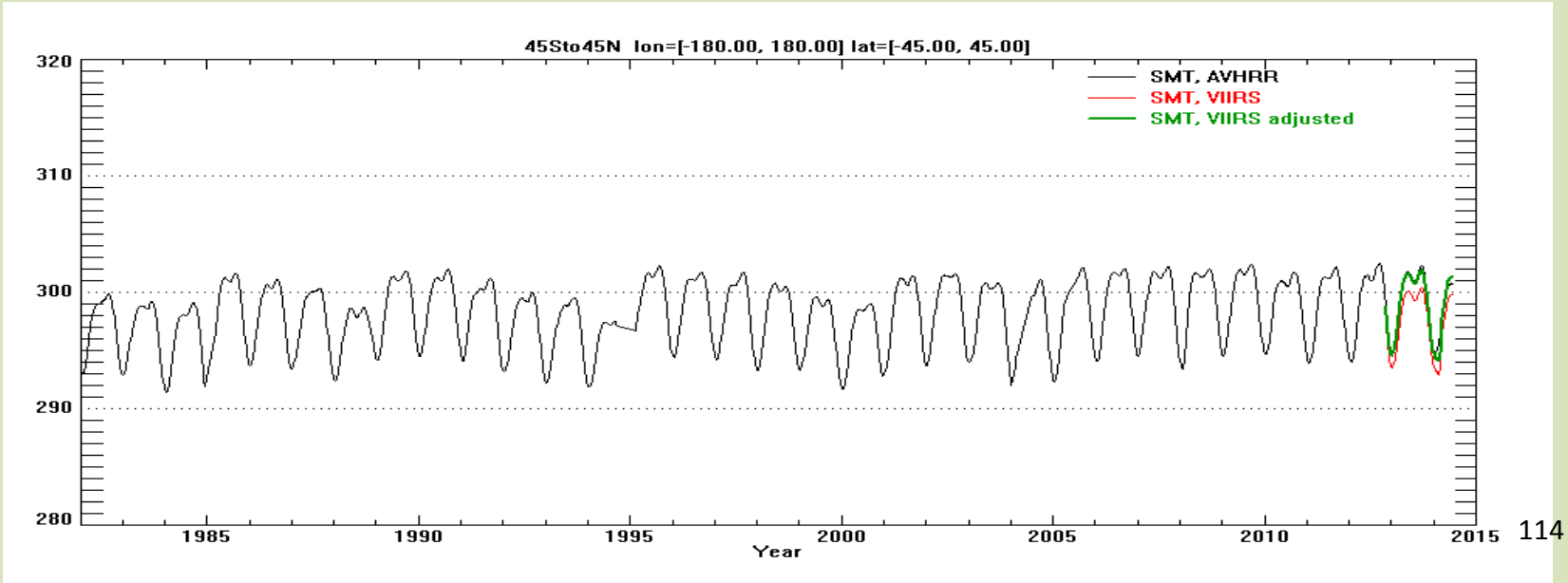


lon=[-180.00, 180.00] lat=[-40.00, 60.00]

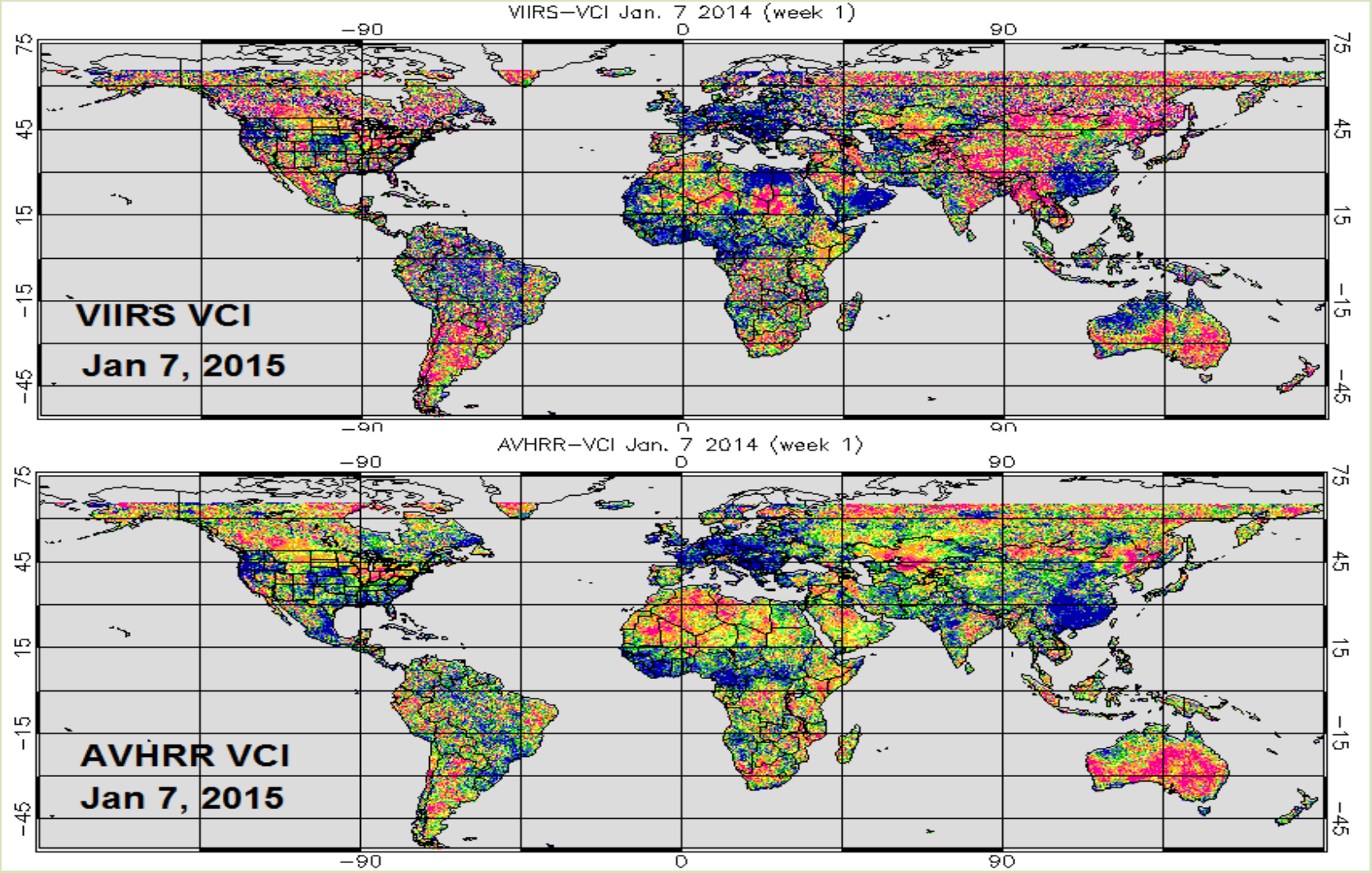
Data used: 2012 week 35 to 2013 week 47

Towards NDVI & BT Climatology

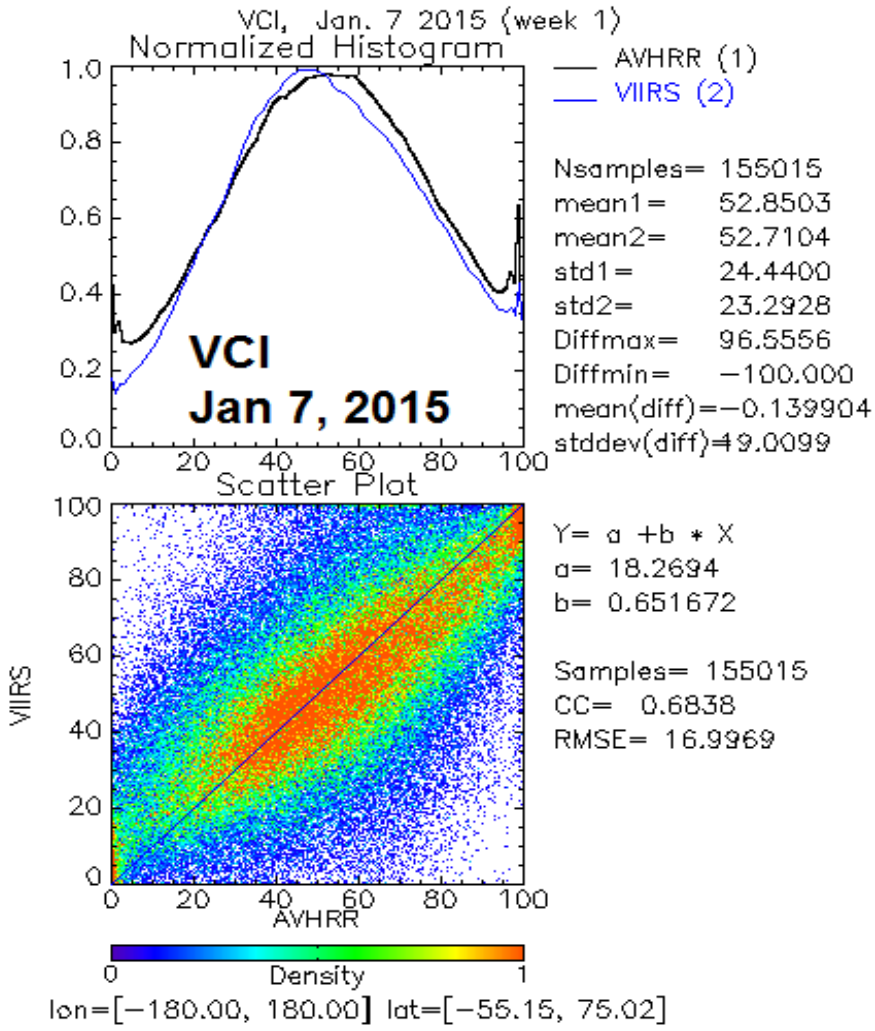


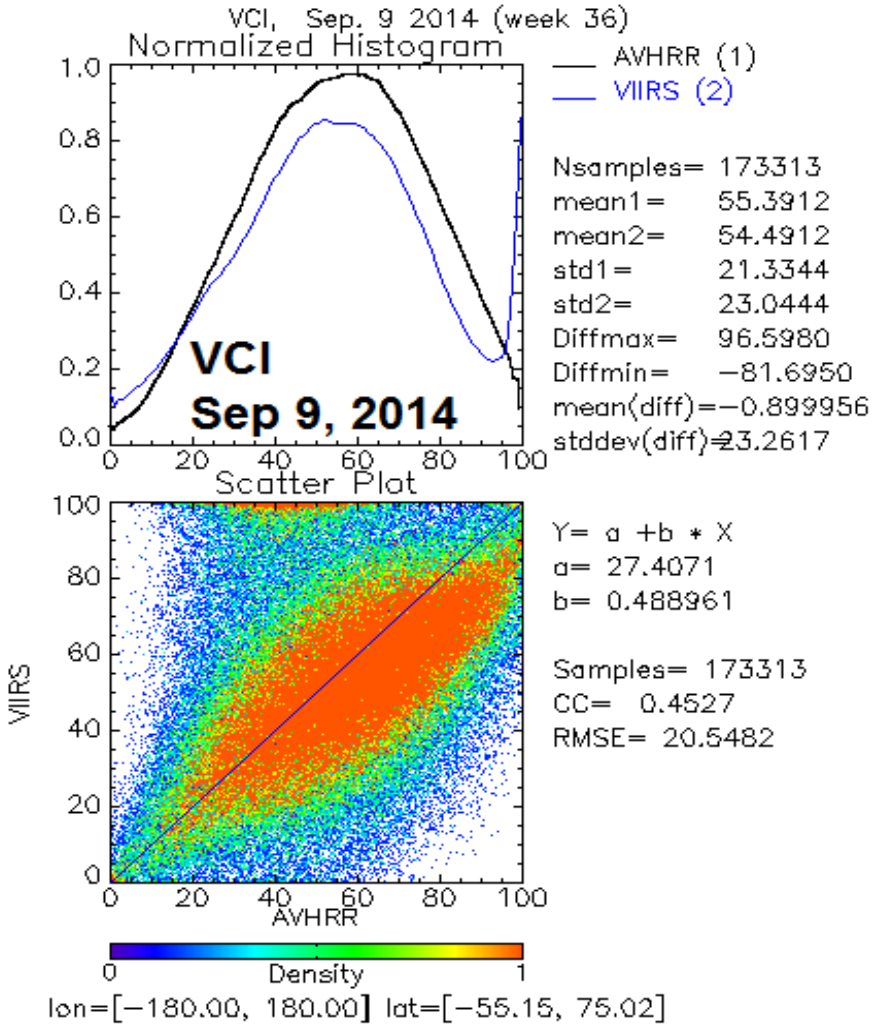


VCI/VIIRS vs. VCI/AVHRR

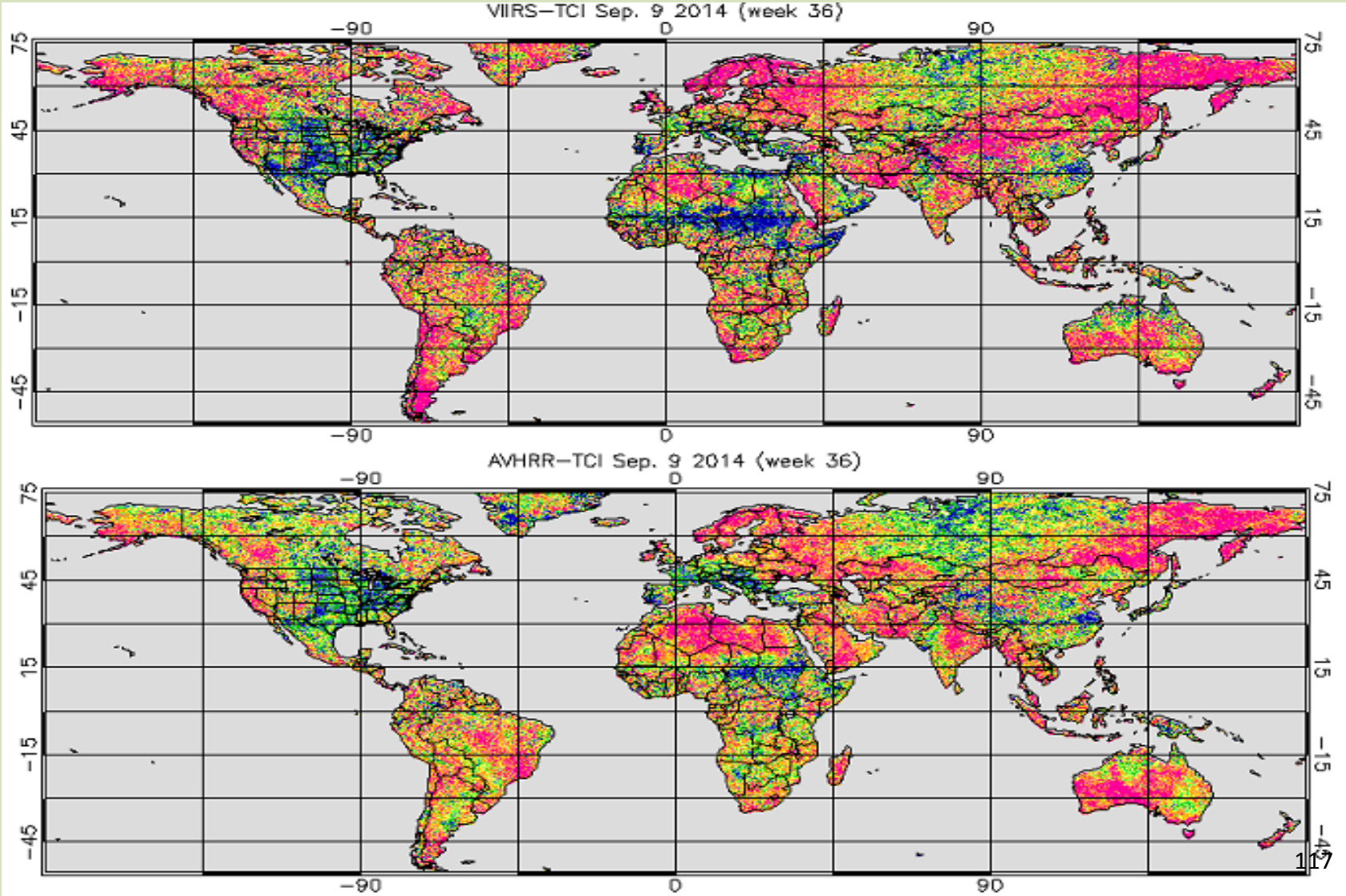


Correlation of VCI VIIRS & AVHRR Jan 7, 2015 & Sep 9, 2014

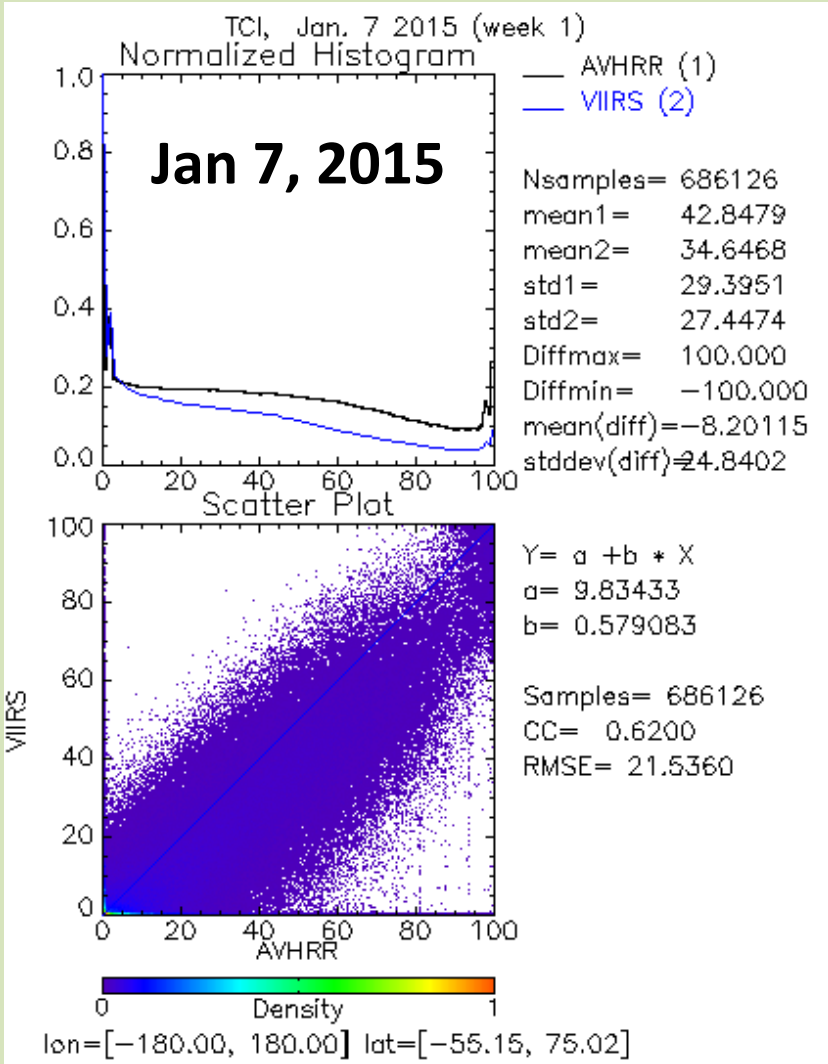


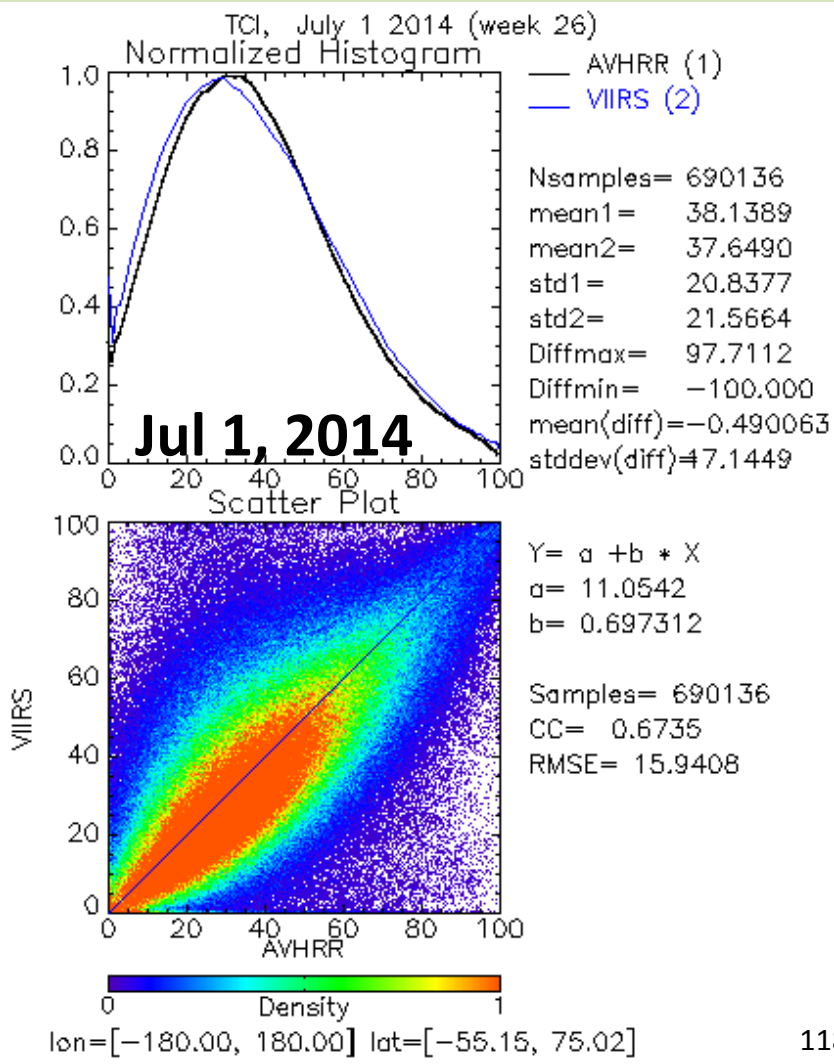


TCI VIIRS vs AVHRR Sep 9, 2014

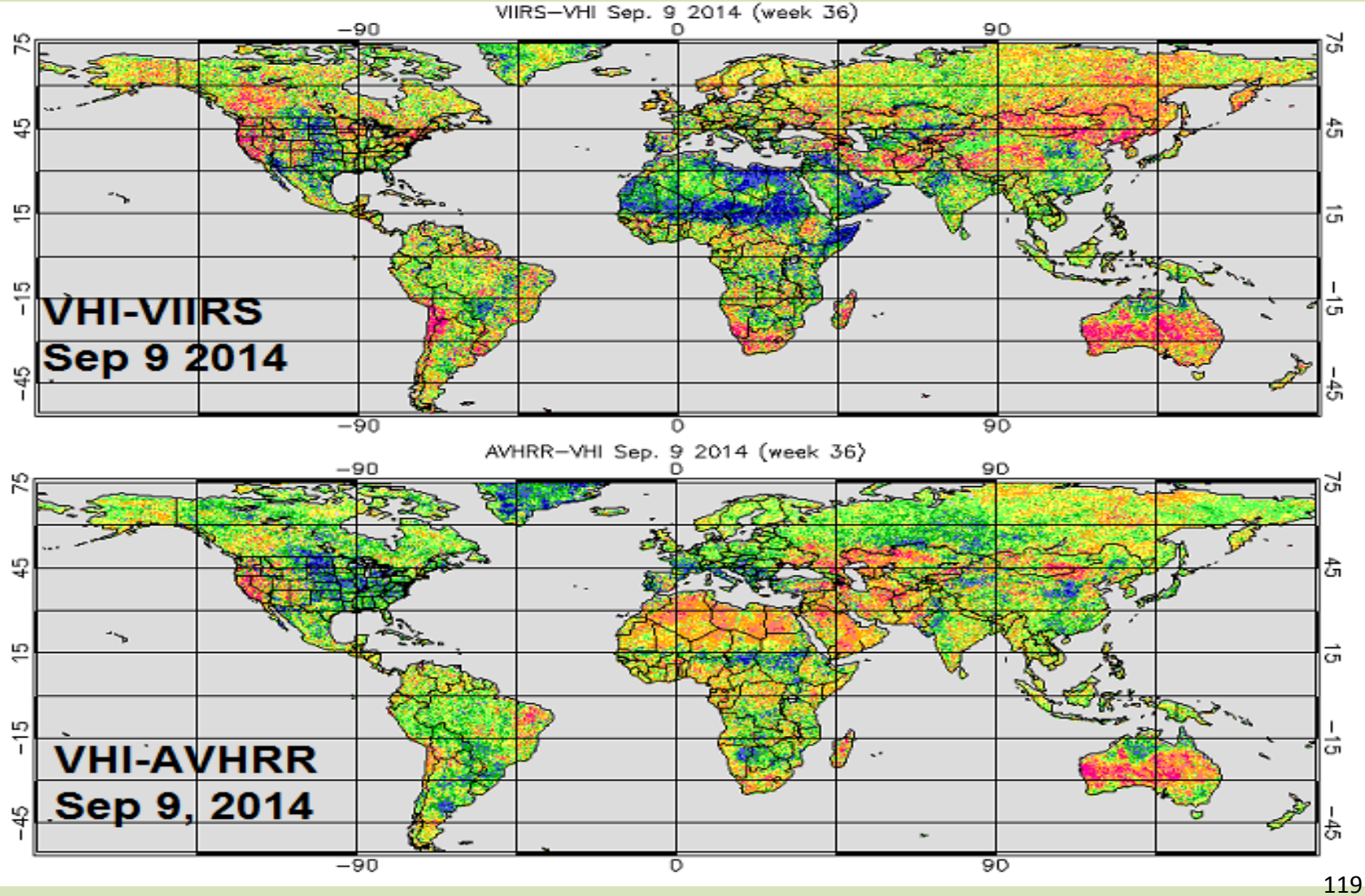


Correlation of TCI VIIRS & AVHRR Jan 7, 2015 & Jul 1, 2014

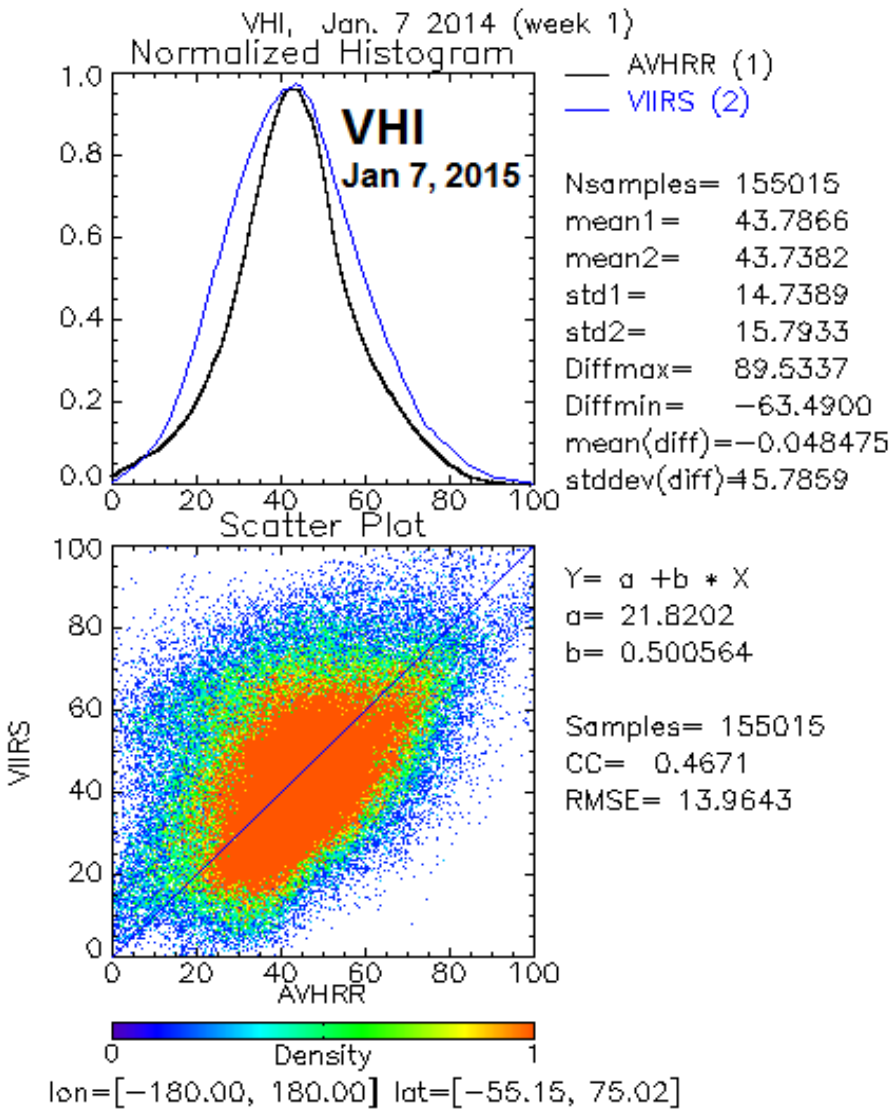


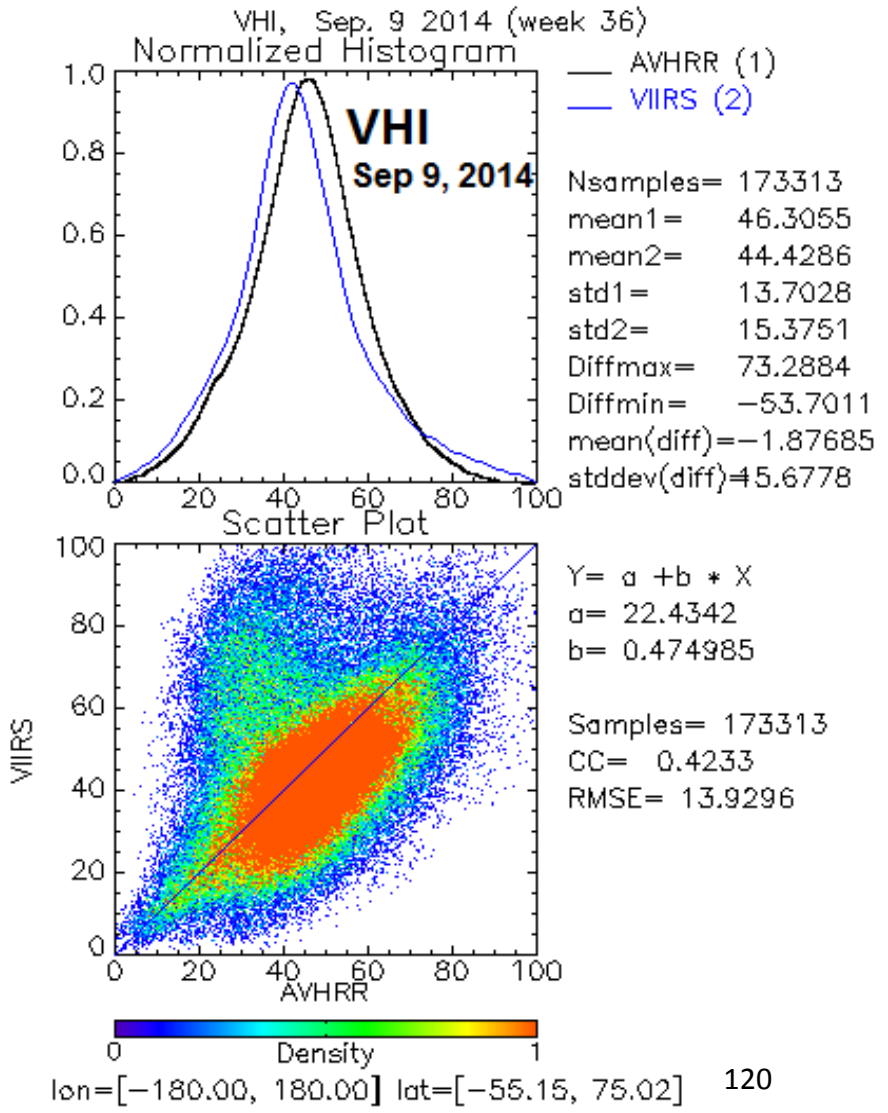


VALIDATION:
VHI VIIRS vs AVHRR
Sep 9, 2014



Correlation of VHI VIIRS & AVHRR Jan 7, 2015 & Sep 9, 2014





SUMMARY

- VH algorithm requires NDVI & BT:

  (a) Real time (from VIIRS)

  (b) Climatology (from AVHRR)

- VIIRS/VH indices (VHI, VCI & TCI) are validated against AVHRR/VH because AVHRR's VH are validated against in situ data

SUMMARY contd.

- VIIRS/ NDVI & BT are different than AVHRR
- VIIRS/NDVI & BT are adjusted to AVHRR (in order to use climatology)
- The adjustments are stable over time and correlation is strong
- New climatology will improve the results

Outline

- Introduction
- Pre-AR Risks and Actions
- Requirements
- Software Architecture
- Algorithm Readiness
- **Delivered Algorithm Package**
- Risk and Action Summary
- Summary and Conclusion
- Appendix: VHP Unit Tests

DELIVERED ALGORITHM PACKAGE

Priyanka Roy

Outline

- Introduction
- CDR Risks and Actions
- Requirements
- Software Architecture
- Algorithm Readiness
- Delivered Algorithm Package
- **Risk and Action Summary**
- Summary and Conclusion
- Appendix: VHP Unit Tests

RISK AND ACTION SUMMARY

Priyanka Roy

Review Items Summary

- **2 PDR risks have been addressed at ARR, 0 of which is still open**
- **0 risks and actions were reported from the CDR.**
- **0 risks and actions were reported from the ARR**

Outline

- Introduction
- Pre-ARR Risks and Actions
- Requirements
- Software Architecture
- Algorithm Readiness
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- Risk and Action Summary
- **Summary and Conclusion**
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SUMMARY AND CONCLUSION

Priyanka Roy

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 VH system has been completed
- The VH documents have been completed and delivered
- The final VH system will be delivered to NDE

Next Steps

- VIIRS Veg Health ORR
- SPSRB Presentation

Open Discussion

- **The review is now open for free discussion**

APPENDIX: VHP UNIT TESTS

Wei Guo

VIIRS –VH Daily Procedure

STAR	NDE
•Driven by cron job, •Determine working day by computer time •Find paths from configure file •Get other parameters from configure file	•Driven by data (PCF), •Determine working dayby PCF •Get paths from PCF •Get other parameters from configure file
•Find SDR file list by Searching SCDR •Create SDR file list	•Find input SDR file names from PCF •Create SDR file list
•Create file name of Daily Map is in VHP style	•Create file name of Daily Map is in NDE style
•Make Daily Map •Produce Sampled files	•Make partial daily maps •Write filename of daily files to PSF

VIIRS VH weekly Procedure

Office Of Satellite and Product Operations

STAR

Driven by cron job,
Determine working week by computer time
Get paths from configure file
Get other parameters from configure file
Search specific folder, find daily maps and 15 ND files

Make composite
Create ND file
Create SM file (8 weeks)
Create VH file (8 weeks)
Create sample files and metadata for Composite, ND,SM and VH files

NDE

Driven by data (PCF),
Determine working week by PCF
Get paths from PCF
Get other parameters from configure file

Find input daily maps and ND files from PCF
Move daily map to sub –folder (“data/dailyP”)
Move and rename ND file to sub-folder (“data/VH”)
Merge daily maps

Make composite
Create ND file (working week only)
Create SM files (initial and final week only)
Create VH file (initial and final week only)
Create sample files and metadata for Composite, ND,SM and VH files

Rename files need to follow NDE format and move to “data/archive”
Write filename of 5 files to PSF

Units Test Strategy

- Unit tests were conducted in the STAR Development Environment.
- Use the similar procedure for NDE

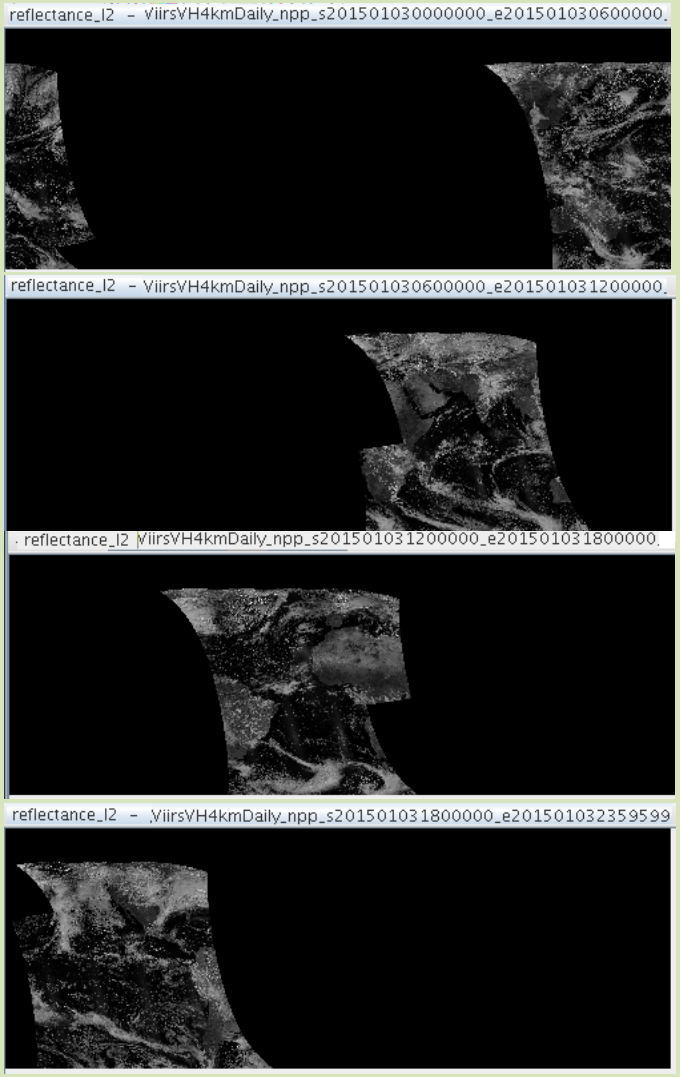
Create Partial Daily Map

- Copy SDR data of 6 hours to working directory:
  - /data/data044/DATA/DAP1/daily2015001/case0
- Create PCF file in working directory;
  - ViirsVH_daily.pcf
- Run script:
  - script/viirsVH_run_daily.pl /data/data044/DATA/DAP1/daily2015001/case0

Partial Daily maps 2015003

Partial daily maps were created by using 6 hours data.

- 00:00 – 06:00
- 06:00 – 12:00
- 12:00 – 18:00
- 18:00 – 24:00



Partial Daily maps

20150127.185527.00977758 EVENT="Making Daily Map for 2015 day=1 "	STATUS= OK, completed normally (use 8.275 minutes)
20150127.021806.00313222 EVENT="Making Daily Map for 2015 day=1 "	STATUS= OK, completed normally (use 6.708 minutes)
20150127.022645.00480038 EVENT="Making Daily Map for 2015 day=1 "	STATUS= OK, completed normally (use 8.630 minutes)
20150127.023319.00742827 EVENT="Making Daily Map for 2015 day=1 "	STATUS= OK, completed normally (use 6.558 minutes)
20150127.024232.00390654 EVENT="Making Daily Map for 2015 day=2 "	STATUS= OK, completed normally (use 8.631 minutes)
20150127.024900.00959448 EVENT="Making Daily Map for 2015 day=2 "	STATUS= OK, completed normally (use 6.459 minutes)
20150127.025651.00627720 EVENT="Making Daily Map for 2015 day=2 "	STATUS= OK, completed normally (use 7.824 minutes)
20150127.030252.00566494 EVENT="Making Daily Map for 2015 day=2 "	STATUS= OK, completed normally (use 6.003 minutes)
20150128.013422.00039878 EVENT="Making Daily Map for 2015 day=3 "	STATUS= OK, completed normally (use 10.702 minutes)
20150127.031833.00203983 EVENT="Making Daily Map for 2015 day=3 "	STATUS= OK, completed normally (use 6.918 minutes)
20150127.032622.00210320 EVENT="Making Daily Map for 2015 day=3 "	STATUS= OK, completed normally (use 7.793 minutes)
20150127.033355.00384976 EVENT="Making Daily Map for 2015 day=3 "	STATUS= OK, completed normally (use 7.531 minutes)
20150127.034133.00820365 EVENT="Making Daily Map for 2015 day=4 "	STATUS= OK, completed normally (use 7.073 minutes)
20150127.034935.00595380 EVENT="Making Daily Map for 2015 day=4 "	STATUS= OK, completed normally (use 8.014 minutes)
20150127.035611.00844175 EVENT="Making Daily Map for 2015 day=4 "	STATUS= OK, completed normally (use 6.582 minutes)
20150127.040411.00792255 EVENT="Making Daily Map for 2015 day=4 "	STATUS= OK, completed normally (use 7.976 minutes)
20150127.020911.00899524 EVENT="Making Daily Map for 2015 day=5 "	STATUS= OK, completed normally (use 5.644 minutes)
20150127.021802.00761261 EVENT="Making Daily Map for 2015 day=5 "	STATUS= OK, completed normally (use 8.834 minutes)
20150127.022531.00881962 EVENT="Making Daily Map for 2015 day=5 "	STATUS= OK, completed normally (use 7.460 minutes)
20150127.023342.00996233 EVENT="Making Daily Map for 2015 day=5 "	STATUS= OK, completed normally (use 8.167 minutes)
20150127.024214.00274805 EVENT="Making Daily Map for 2015 day=6 "	STATUS= OK, completed normally (use 7.883 minutes)
20150127.025005.00746038 EVENT="Making Daily Map for 2015 day=6 "	STATUS= OK, completed normally (use 7.845 minutes)
20150127.025831.00856824 EVENT="Making Daily Map for 2015 day=6 "	STATUS= OK, completed normally (use 8.416 minutes)
20150127.030520.00380874 EVENT="Making Daily Map for 2015 day=6 "	STATUS= OK, completed normally (use 6.784 minutes)
20150127.031402.00149159 EVENT="Making Daily Map for 2015 day=7 "	STATUS= OK, completed normally (use 8.070 minutes)
20150127.032024.00005944 EVENT="Making Daily Map for 2015 day=7 "	STATUS= OK, completed normally (use 6.349 minutes)
20150127.032842.00322081 EVENT="Making Daily Map for 2015 day=7 "	STATUS= OK, completed normally (use 8.288 minutes)
20150127.033501.00119986 EVENT="Making Daily Map for 2015 day=7 "	STATUS= OK, completed normally (use 6.294 minutes)

Each 6 hours' partial daily map requires **7.56** minutes to process.

Run Weekly Procedure

- Create a working directory
  - week2005001
- Copy 28 partial daily maps to the working directory
  - ViirsVH4kmDaily_npp_s201501010000000_e201501010600000_c201501270203492.nc
- Copy 14 ND files to the working directory
- Create PCF file in the working directory
  - ViirsVH_weekly.pcf

28 Partial Daily maps 2015 day 1-7

79M Jan 27 10:23 ViirsVH4kmDaily_npp_s201501010000000_e201501010600000_c201501270203492.nc
72M Jan 27 10:23 ViirsVH4kmDaily_npp_s201501010600000_e201501011200000_c201501270211238.nc
84M Jan 27 10:23 ViirsVH4kmDaily_npp_s201501011200000_e201501011800000_c201501270218076.nc
68M Jan 27 10:23 ViirsVH4kmDaily_npp_s201501011800000_e201501012359599_c201501270226462.nc
85M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501020000000_e201501020600000_c201501270233545.nc
66M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501020600000_e201501021200000_c201501270242334.nc
85M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501021200000_e201501021800000_c201501270249021.nc
71M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501021800000_e201501022359599_c201501270256523.nc
83M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501030000000_e201501030600000_c201501270303224.nc
75M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501030600000_e201501031200000_c201501270311380.nc
76M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501031200000_e201501031800000_c201501270318346.nc
81M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501031800000_e201501032359599_c201501270326235.nc
72M Jan 27 10:24 ViirsVH4kmDaily_npp_s201501040000000_e201501040600000_c201501270334294.nc
85M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501040600000_e201501041200000_c201501270341347.nc
67M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501041200000_e201501041800000_c201501270349369.nc
85M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501041800000_e201501042359599_c201501270356132.nc
67M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501050000000_e201501050600000_c201501270203332.nc
85M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501050600000_e201501051200000_c201501270209127.nc
70M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501051200000_e201501051800000_c201501270218042.nc
82M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501051800000_e201501052359599_c201501270225329.nc
77M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501060000000_e201501060600000_c201501270234213.nc
75M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501060600000_e201501061200000_c201501270242150.nc
82M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501061200000_e201501061800000_c201501270250068.nc
71M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501061800000_e201501062359599_c201501270258333.nc
86M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501070000000_e201501070600000_c201501270305579.nc
66M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501070600000_e201501071200000_c201501270314030.nc
85M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501071200000_e201501071800000_c201501270320250.nc
67M Jan 27 10:25 ViirsVH4kmDaily_npp_s201501071800000_e201501072359599_c201501270328434.nc

14 ND files

VIIRSVH4kmND_npp_s201409240000000_e201409302359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201410010000000_e201410072359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201410080000000_e201410142359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201410150000000_e201410212359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201410220000000_e201410282359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201410290000000_e201411042359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201411050000000_e201411112359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201411120000000_e201411182359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201411190000000_e201411252359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201411260000000_e201412022359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201412030000000_e201412092359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201412100000000_e201412162359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201412170000000_e201412232359599_c201501250000000.nc
VIIRSVH4kmND_npp_s201412240000000_e201412302359599_c201501250000000.nc

ViirsVH_weekly.pcf

working_directory=/data/data044/DATA/DAP1/week2015001
nde_mode=NDE_OP1
job_coverage_start=201501010000000
job_coverage_end=201501072359599
satelliteID=npp
DIR_BIN=/data/data044/DATA/DAP1/VHP/bin
File_Configure=/data/data044/DATA/DAP1/VHP/control/VHconfig.viirs_weekly_4km
DIR_CLIMAT=/data/data044/DATA/DAP1/VHP/ancillary/AVHRR_VHP_4km_climate
File_Metadata_Regions=/data/data044/DATA/DAP1/VHP/ancillary/regions_for_metadata.txt
File_Static_Metadata=/data/data044/DATA/DAP1/VHP/ancillary/vgvi_static_metadata.txt
File_IGBPLandTypes=/data/data044/DATA/DAP1/VHP/ancillary/gigbp2_landtype_11.hdf
DailyMap=ViirsVH4kmDaily_npp_s201501010000000_e201501010600000_c201501270203492.nc
DailyMap=ViirsVH4kmDaily_npp_s201501010600000_e201501011200000_c201501270211238.nc
DailyMap=ViirsVH4kmDaily_npp_s201501011200000_e201501011800000_c201501270218076.nc
(Partial Dilay Maps for other 6 days)
ND_FILE=ViirsVH4kmND_npp_s201409240000000_e201409302359599_c201501250000000.nc
ND_FILE=ViirsVH4kmND_npp_s201410010000000_e201410072359599_c201501250000000.nc
(ND files for other 12 weeks)

Intermediate Products 2005 week 1

Week2015001/data/daily:

ViirsVH4kmDaily_npp_s201501010000000_e201501012359599_c201501272000527.nc
ViirsVH4kmDaily_npp_s201501020000000_e201501022359599_c201501272001288.nc
ViirsVH4kmDaily_npp_s201501030000000_e201501032359599_c201501272002042.nc
ViirsVH4kmDaily_npp_s201501040000000_e201501042359599_c201501272002409.nc
ViirsVH4kmDaily_npp_s201501050000000_e201501052359599_c201501272003177.nc
ViirsVH4kmDaily_npp_s201501060000000_e201501062359599_c201501272003532.nc
ViirsVH4kmDaily_npp_s201501070000000_e201501072359599_c201501272004290.nc

Intermediate Products 2005 week 1

Week2015001/data/weekly:

ViirsVH.G04.C07.npp.P2015001.S001.E007.nc

Intermediate Products 2005 week 1

Week2015001/data/VH:

Existing files:

ViirsVH.G04.C07.npp.P2014039.ND.nc
ViirsVH.G04.C07.npp.P2014040.ND.nc
ViirsVH.G04.C07.npp.P2014041.ND.nc
ViirsVH.G04.C07.npp.P2014042.ND.nc
ViirsVH.G04.C07.npp.P2014043.ND.nc
ViirsVH.G04.C07.npp.P2014044.ND.nc
ViirsVH.G04.C07.npp.P2014045.ND.nc
ViirsVH.G04.C07.npp.P2014046.ND.nc
ViirsVH.G04.C07.npp.P2014047.ND.nc
ViirsVH.G04.C07.npp.P2014048.ND.nc
ViirsVH.G04.C07.npp.P2014049.ND.nc
ViirsVH.G04.C07.npp.P2014050.ND.nc
ViirsVH.G04.C07.npp.P2014051.ND.nc
ViirsVH.G04.C07.npp.P2014052.ND.nc

New files:

ViirsVH.G04.C07.npp.P2014046.SM.nc
ViirsVH.G04.C07.npp.P2014046.VH.nc
ViirsVH.G04.C07.npp.P2015001.ND.nc
ViirsVH.G04.C07.npp.P2015001.SM.nc
ViirsVH.G04.C07.npp.P2015001.VH.nc

Intermediate Products 2005 week 1

Week2015001/data/archive:

GVH4kmFinalSM_npp_s201411120000000_e201411182359599_c201501272008006.nc

GVH4kmFinalVH_npp_s201411120000000_e201411182359599_c201501272008025.nc

GVH4kmInitialSM_npp_s201501010000000_e201501072359599_c201501272008052.nc

GVH4kmInitialVH_npp_s201501010000000_e201501072359599_c201501272008076.nc

GVH4kmND_npp_s201501010000000_e201501072359599_c201501272008002.nc

Intermediate Products 2005 week 1

Week2015001/data/meta

Meta data

GVH4kmFinalSM_npp_s201411120000000_e201411182359599_c201501272008006.META.xml
GVH4kmFinalVH_npp_s201411120000000_e201411182359599_c201501272008025.META.xml
GVH4kmInitialSM_npp_s201501010000000_e201501072359599_c201501272008052.META.xml
GVH4kmInitialVH_npp_s201501010000000_e201501072359599_c201501272008076.META.xml
ViirsVH4kmDaily_npp_s20150101.META.xml
ViirsVH4kmDaily_npp_s20150102.META.xml
ViirsVH4kmDaily_npp_s20150103.META.xml
ViirsVH4kmDaily_npp_s20150104.META.xml
ViirsVH4kmDaily_npp_s20150105.META.xml
ViirsVH4kmDaily_npp_s20150106.META.xml
ViirsVH4kmDaily_npp_s20150107.META.xml

Intermediate Products 2005 week 1

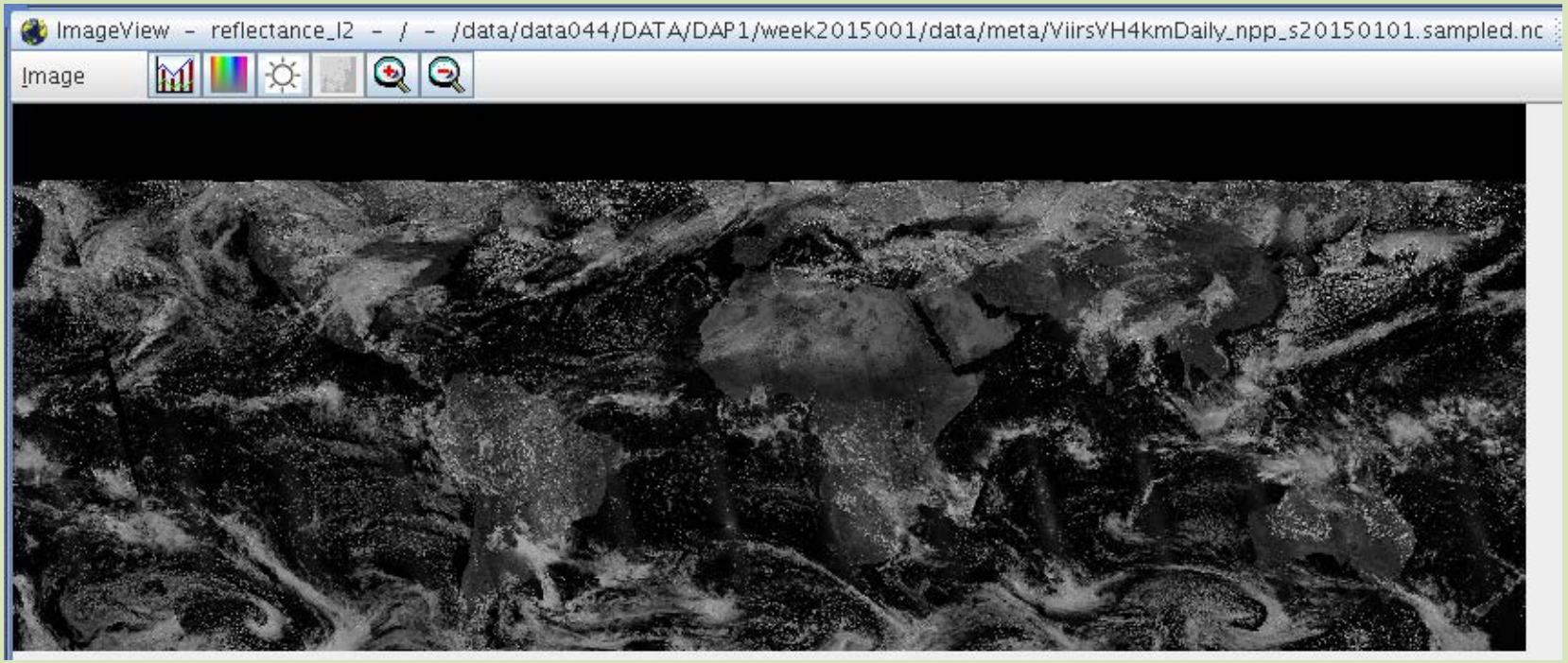
Week2015001/data/meta

Sampled products

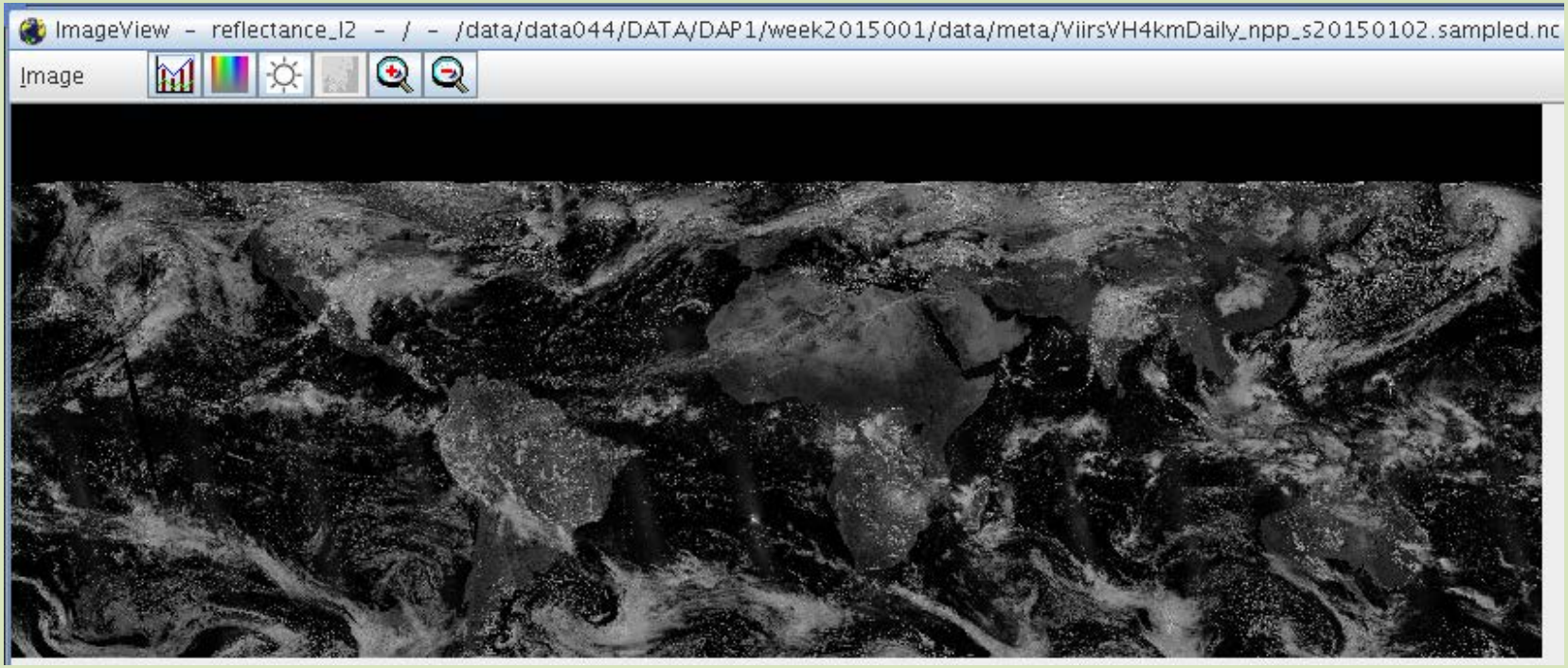
GVH4kmFinalSM_npp_s201411120000000_e201411182359599_c201501272008006.sampled.nc
GVH4kmFinalVH_npp_s201411120000000_e201411182359599_c201501272008025.sampled.nc
GVH4kmInitialSM_npp_s201501010000000_e201501072359599_c201501272008052.sampled.nc
GVH4kmInitialVH_npp_s201501010000000_e201501072359599_c201501272008076.sampled.nc
ViirsVH4kmDaily_npp_s20150101.sampled.nc
ViirsVH4kmDaily_npp_s20150102.sampled.nc
ViirsVH4kmDaily_npp_s20150103.sampled.nc
ViirsVH4kmDaily_npp_s20150104.sampled.nc
ViirsVH4kmDaily_npp_s20150105.sampled.nc
ViirsVH4kmDaily_npp_s20150106.sampled.nc
ViirsVH4kmDaily_npp_s20150107.sampled.nc

Merged Daily map 2015001

Image Band 2

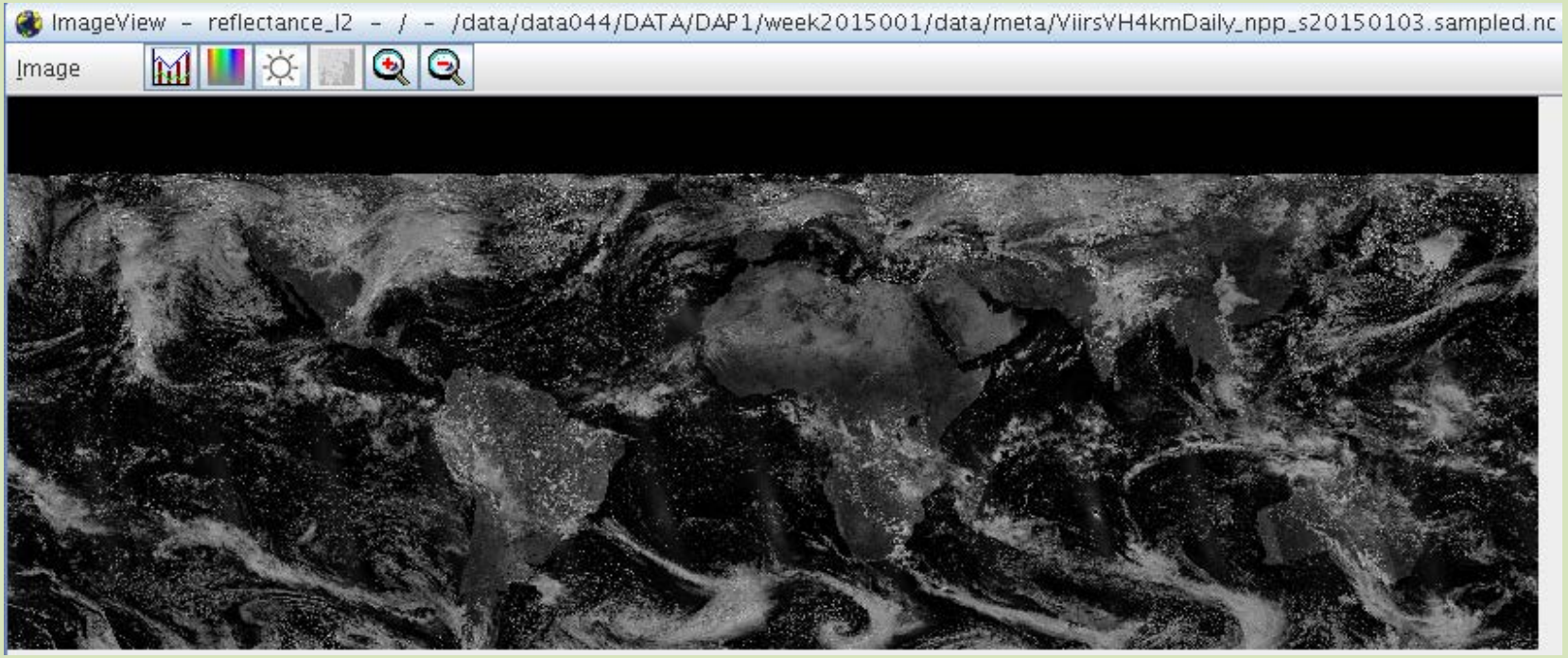


Merged Daily map 2015002



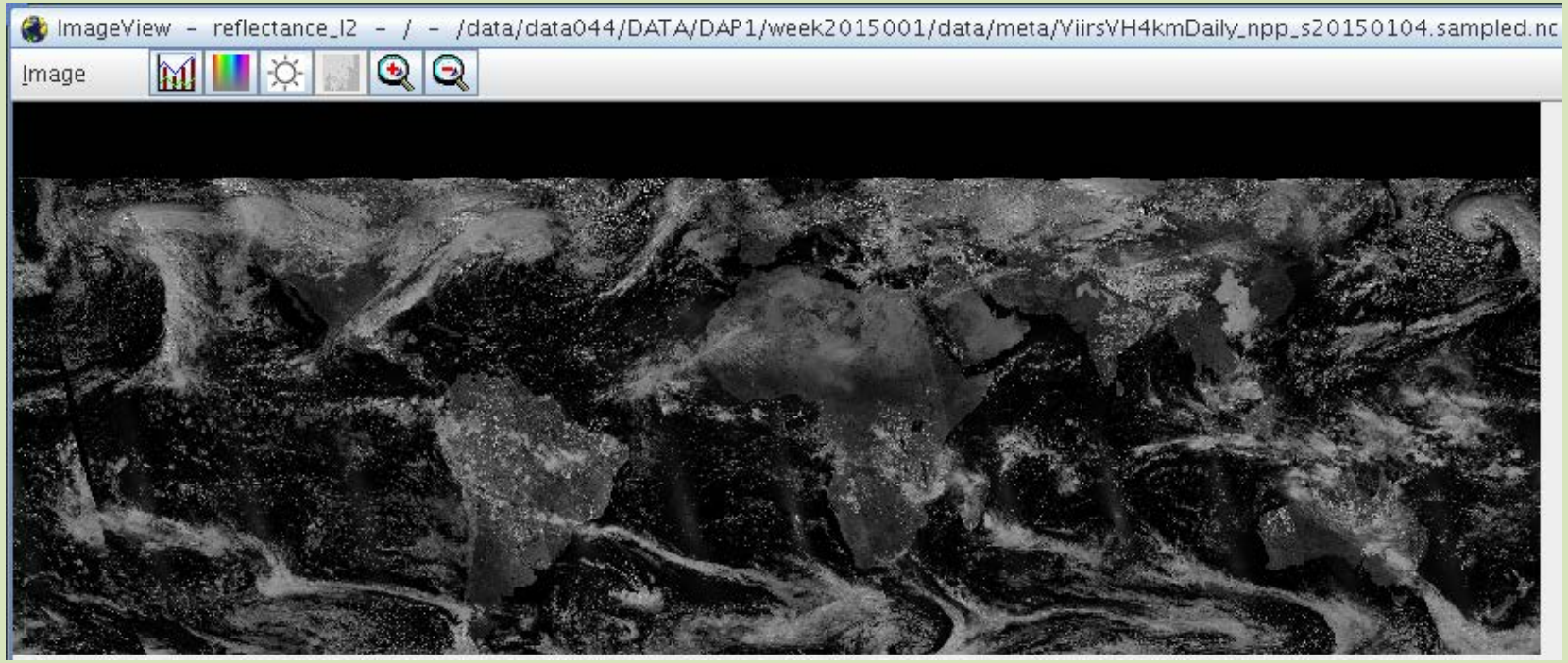
Merged Daily map 2015003

Image Band 2



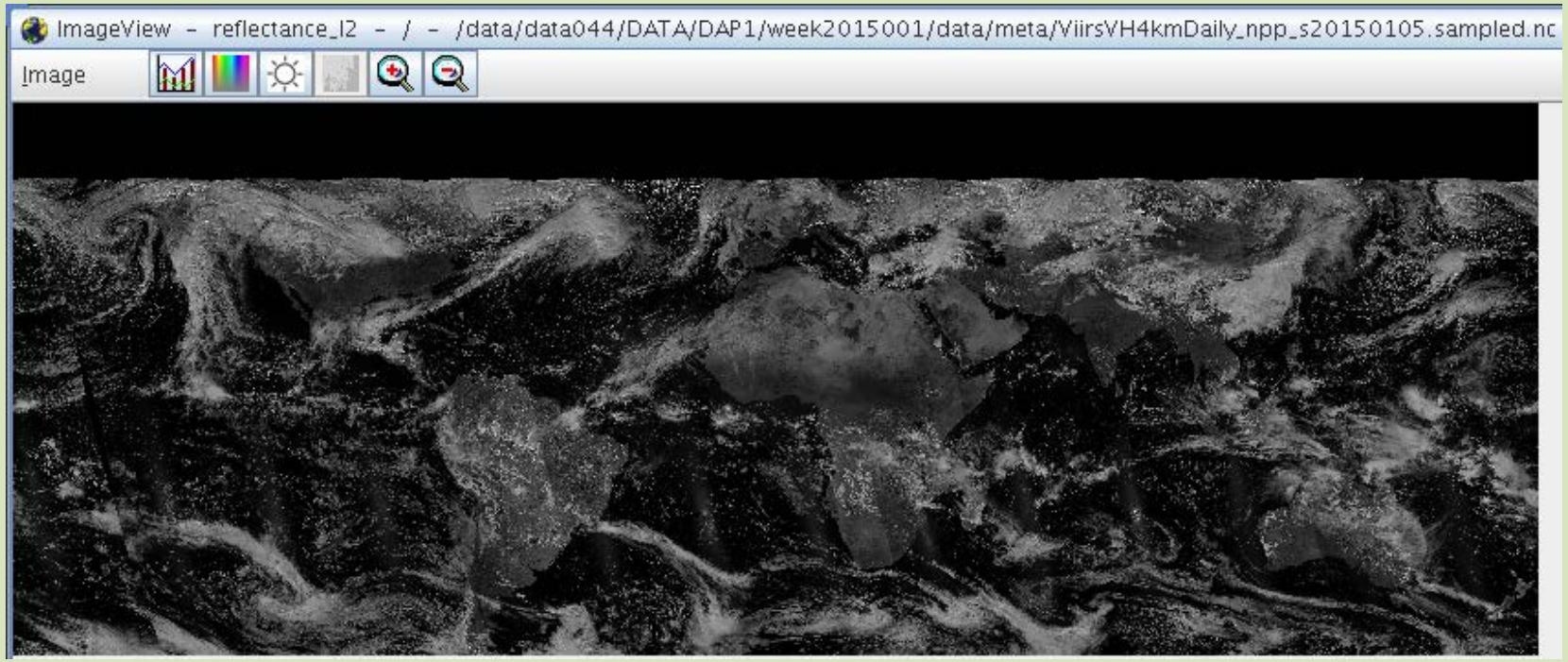
Merged Daily map 2015004

Image Band 2



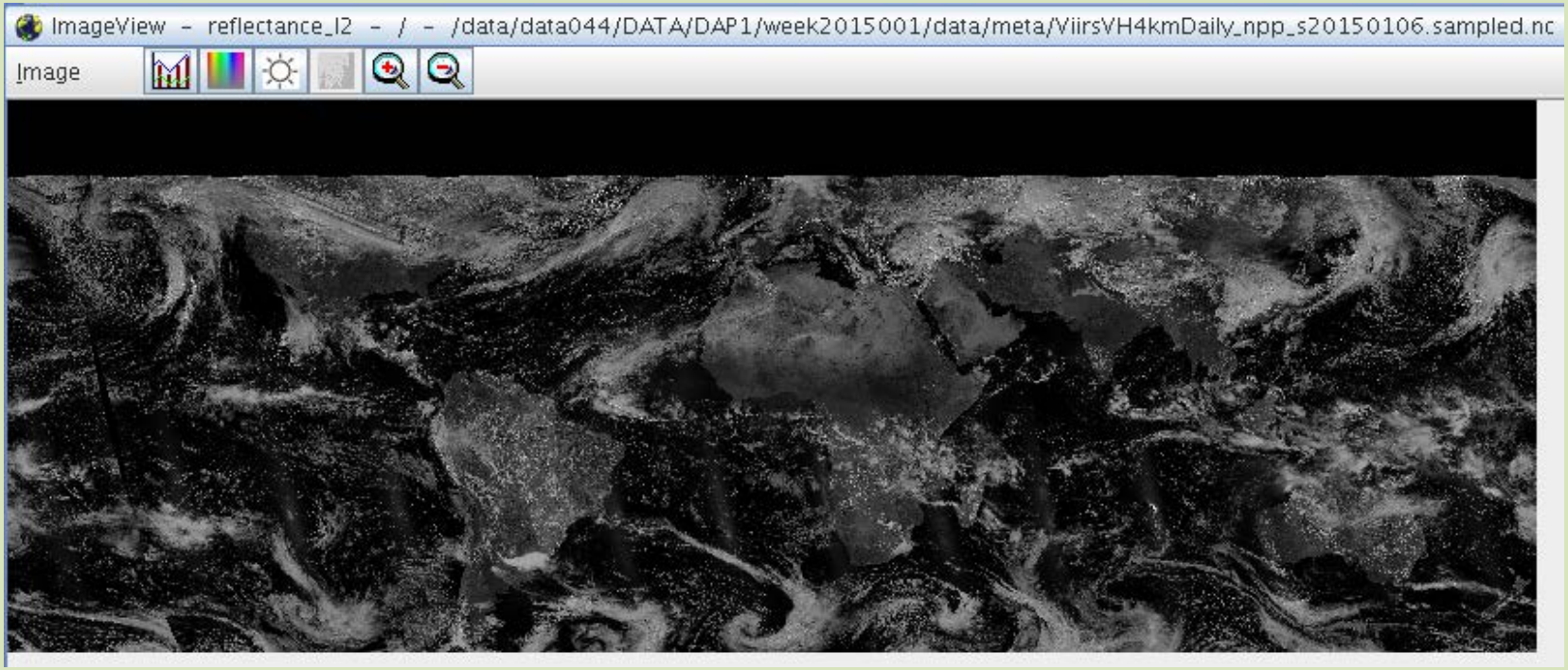
Merged Daily map 2015005

Image Band 2



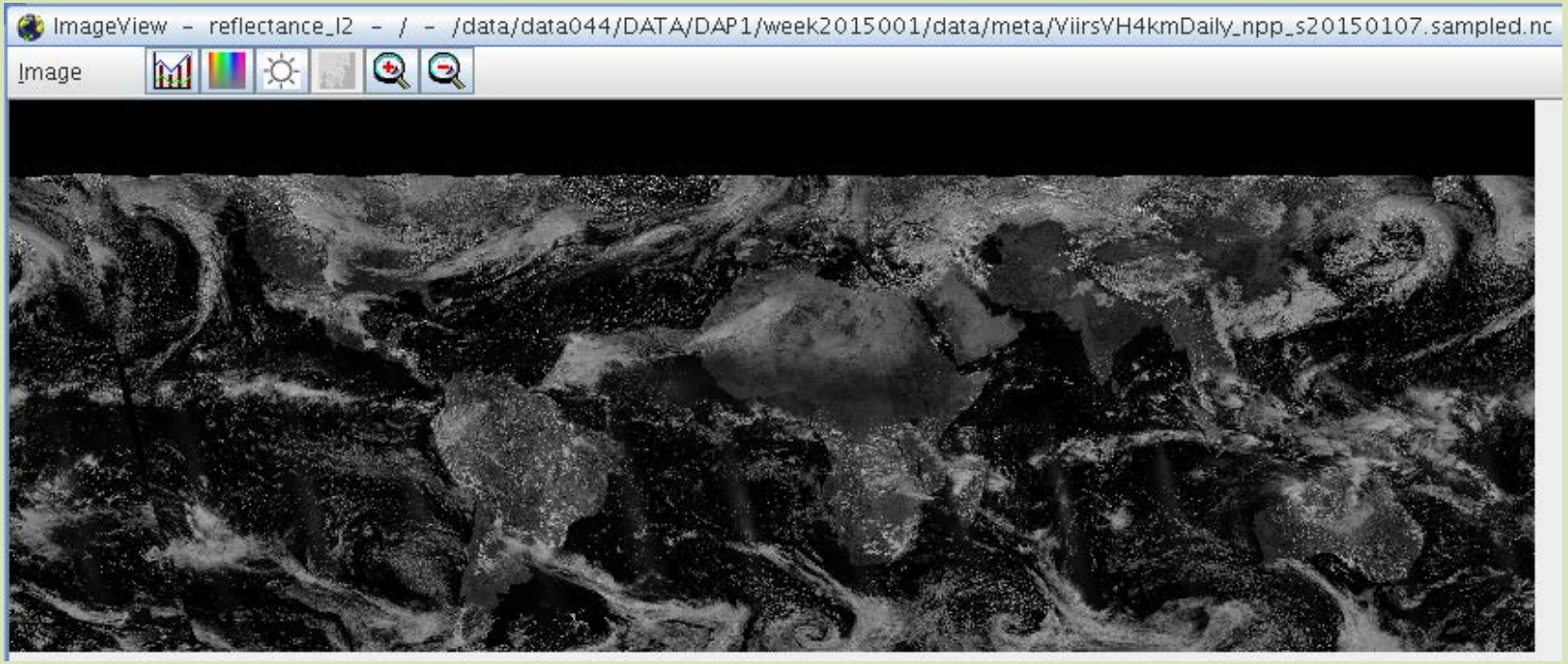
Merged Daily map 2015006

Image Band 2



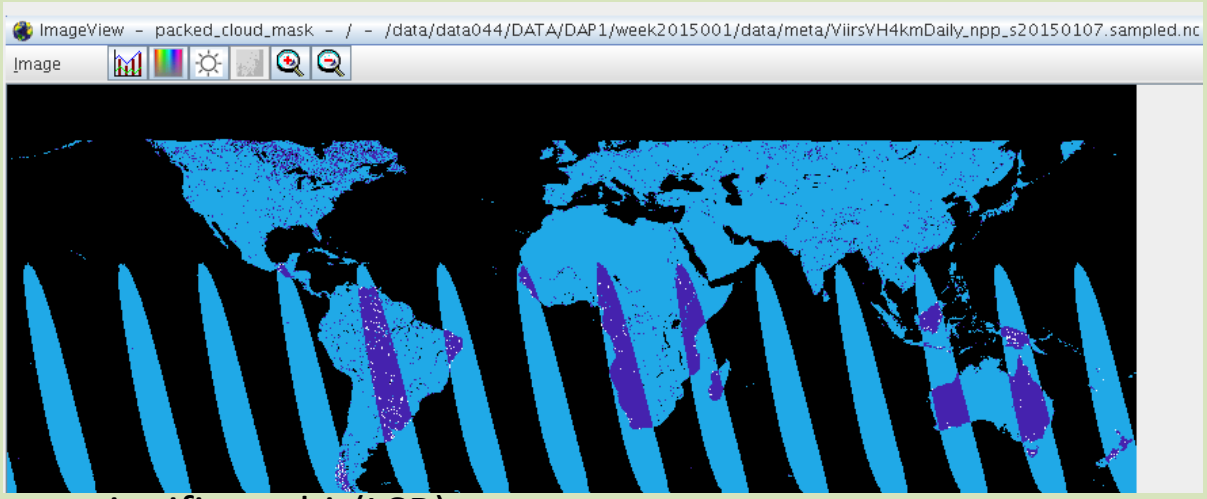
Merged Daily map 2015007

Image Band 2



Merged Daily map 2015007

0-6 bits of “packed_cloud_mask”



From the least significant bit(LSB):

0: invalid(1) / valid(0)

1: day(1) / night(0)

2: land(1) / water(0)

3: coast(1)/ no-coast(0)

4: glint(1)/ no-glint(0)

5: snow(1) / no-snow(0) (reserved bit, not set)

6~7: cloud mask(0~3), clear(0),partial-clear(1),partial-cloudy(2),cloudy(3)

Merged Daily map 2015007

Image Band 1 - reflectance

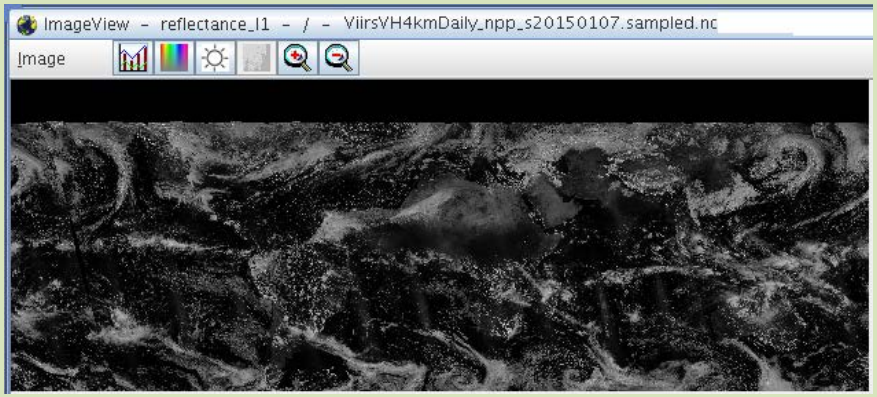
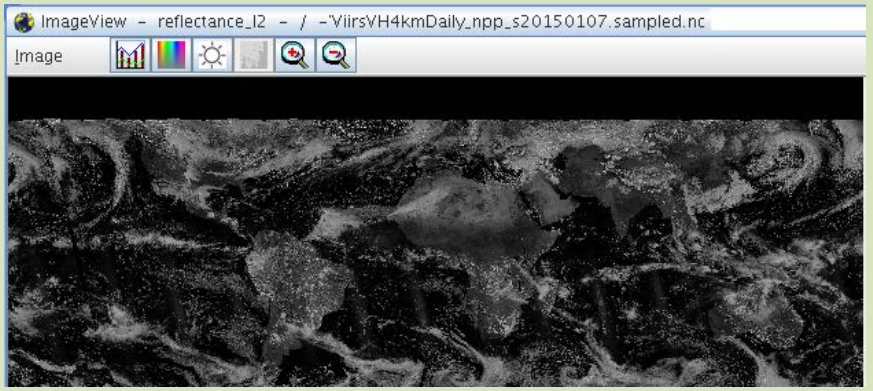


Image Band 1 - reflectance



MOD band 3 - reflectance

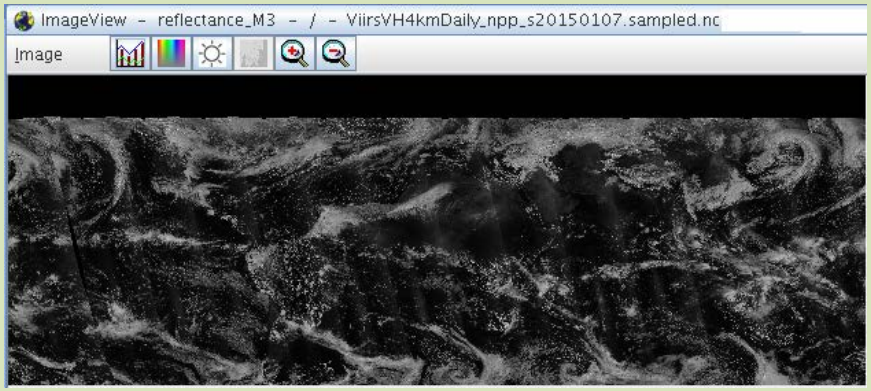
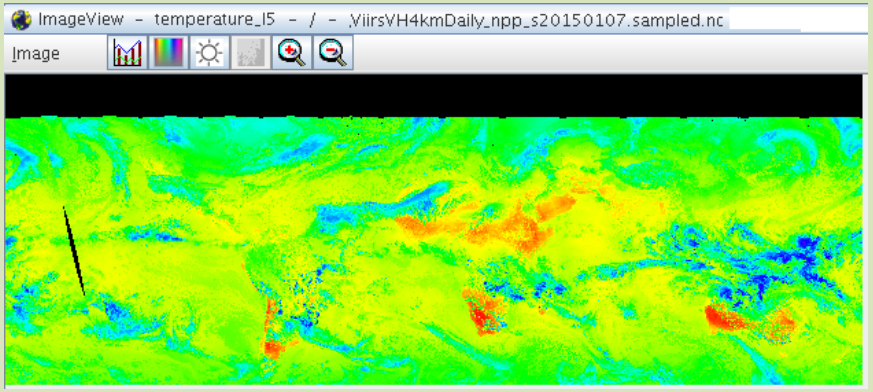


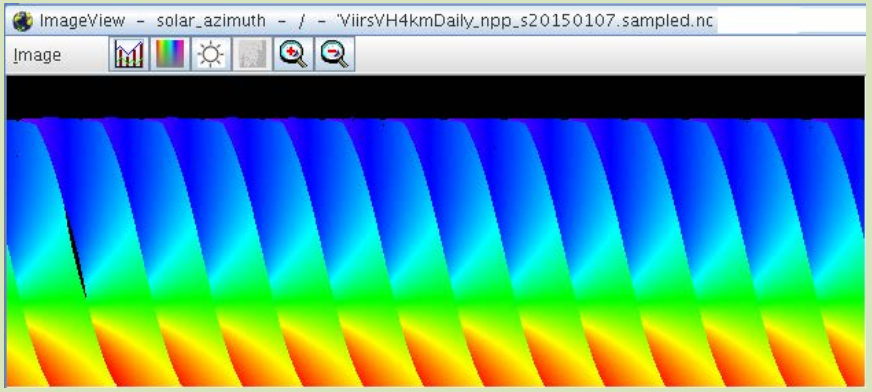
Image Band 5 -temperature



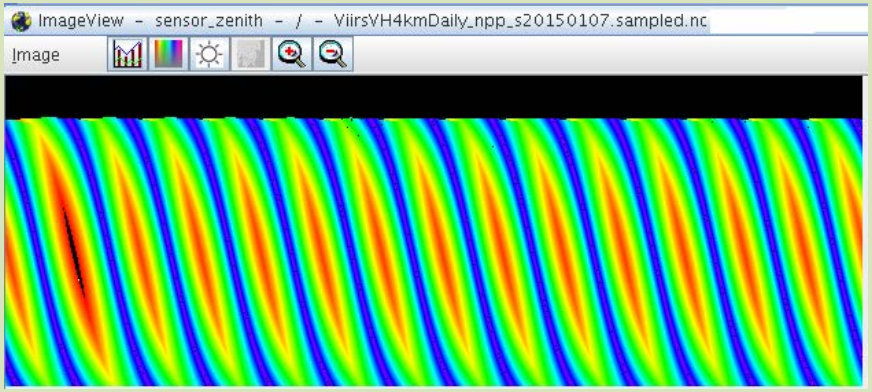
Merged Daily map 2015007

Sensor Azimuth

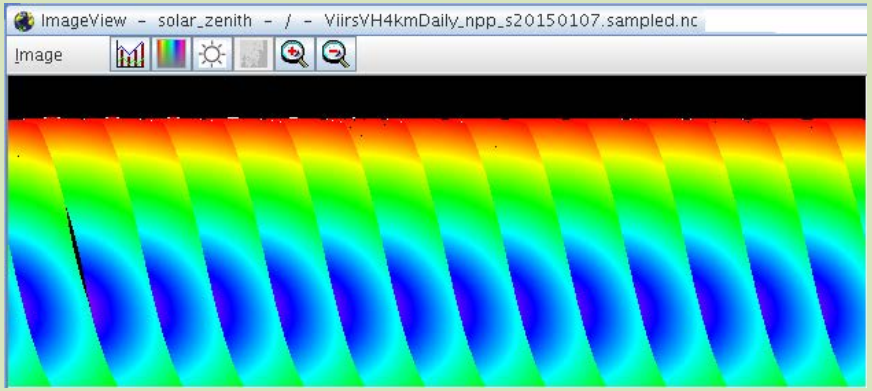
Solar Azimuth



Sensor Zenith

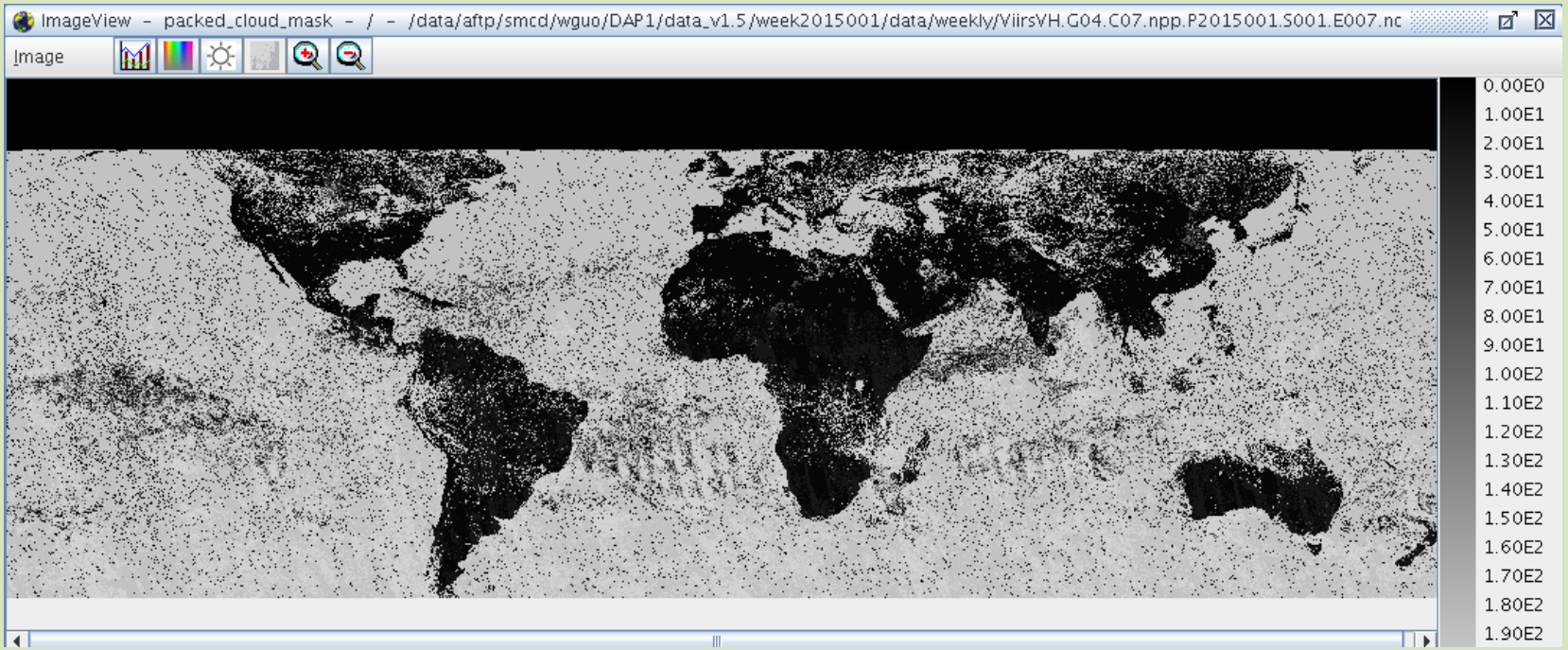


Solar Zenith



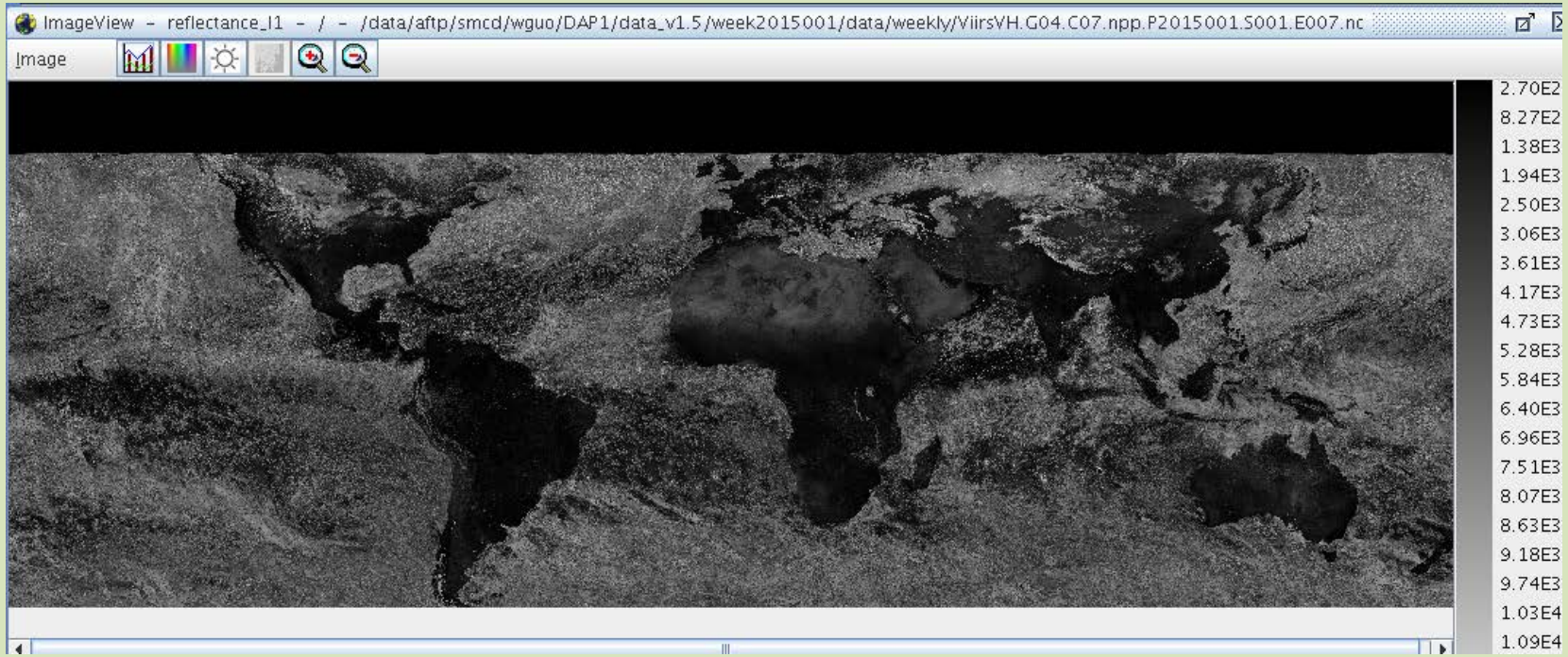
Weekly composite 2015 week1

Cloud mask : 6-7 bits of “packed_cloud_mask”



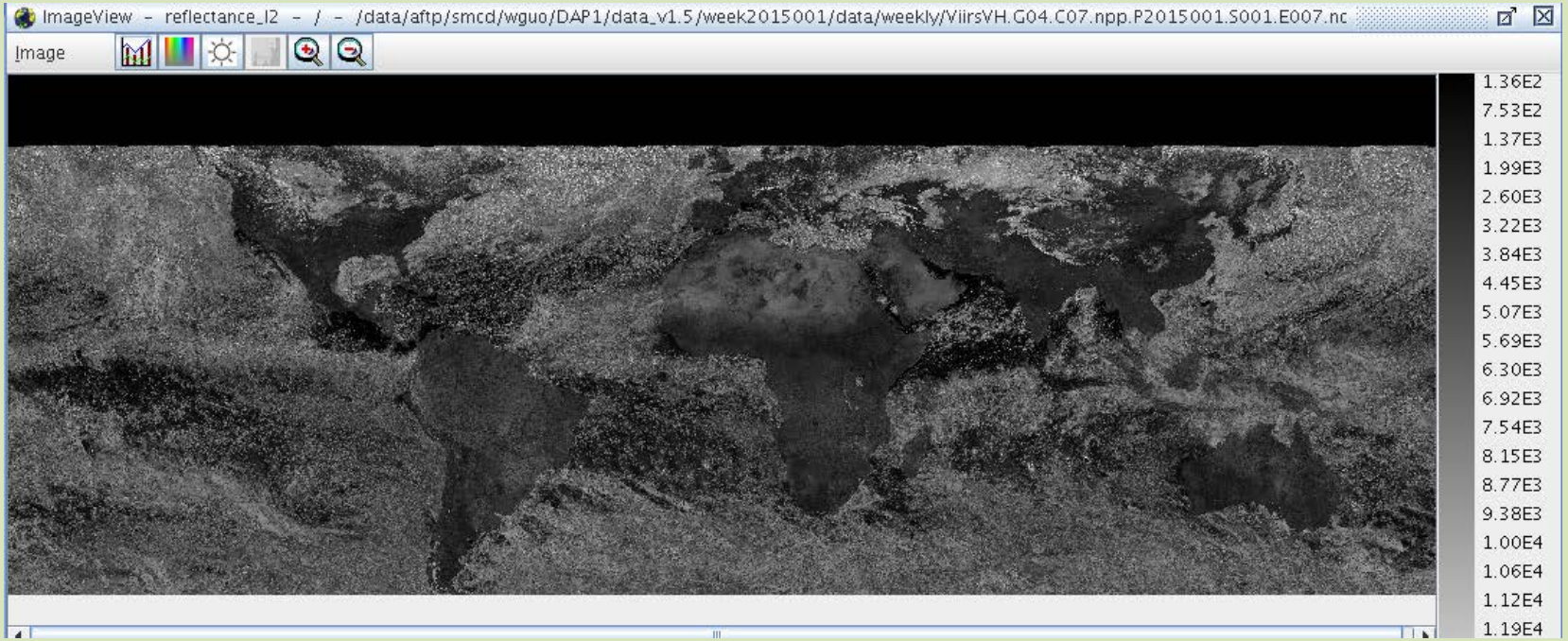
Weekly composite 2015 week1

Reflectance of band I-1



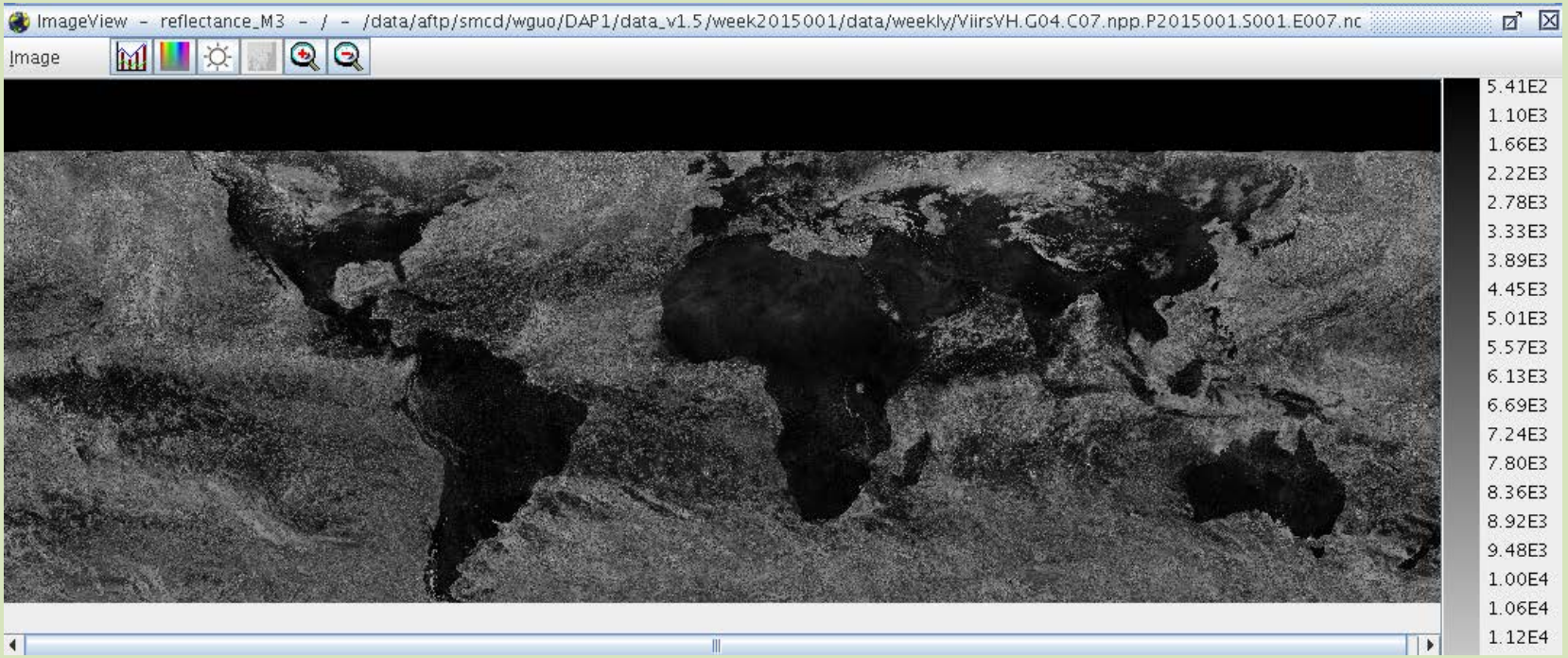
Weekly composite 2015 week1

Reflectance of band I-2



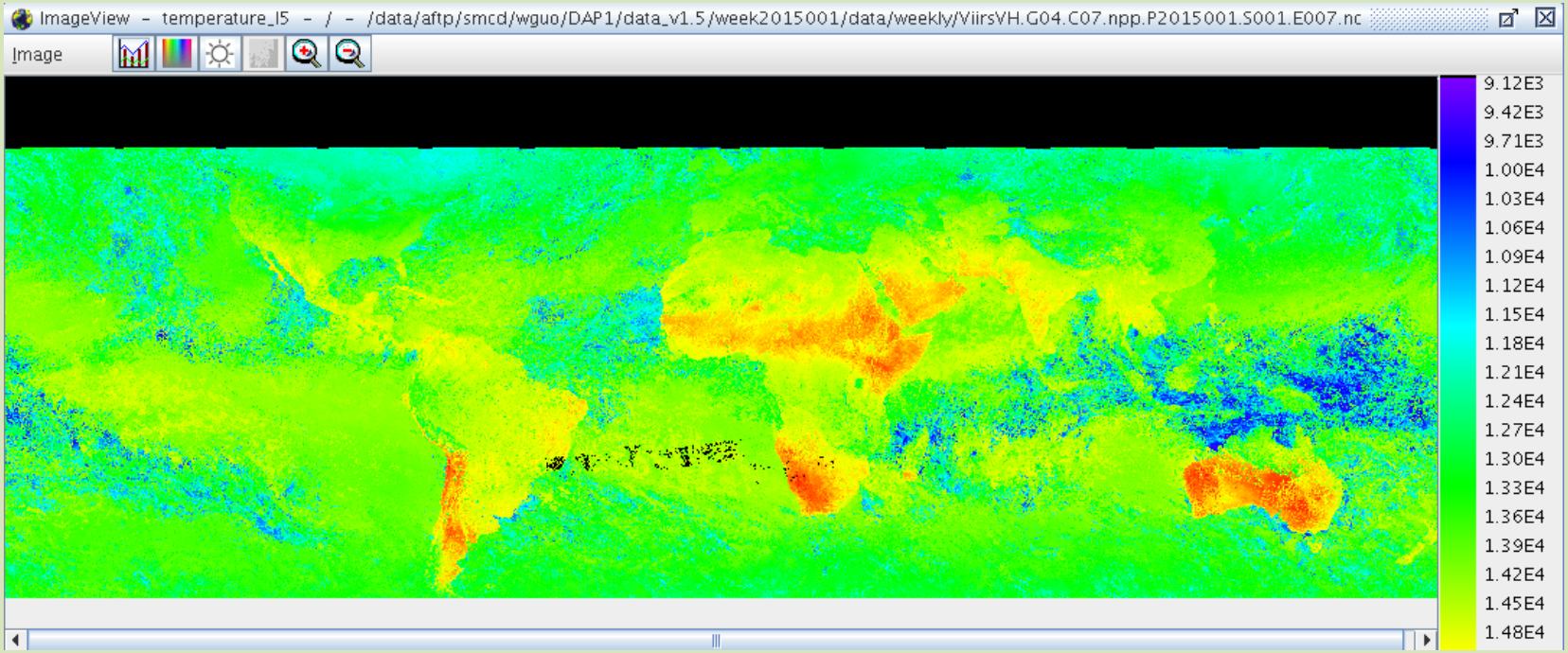
Weekly composite 2015 week1

Reflectance of band M3



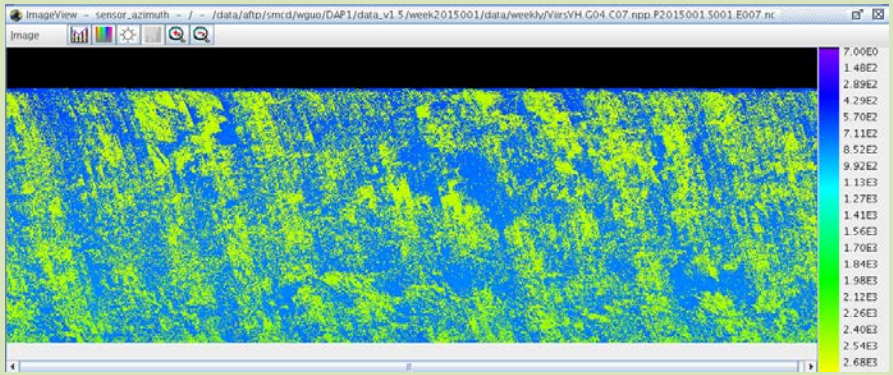
Weekly composite 2015 week1

Temperature of band I-5

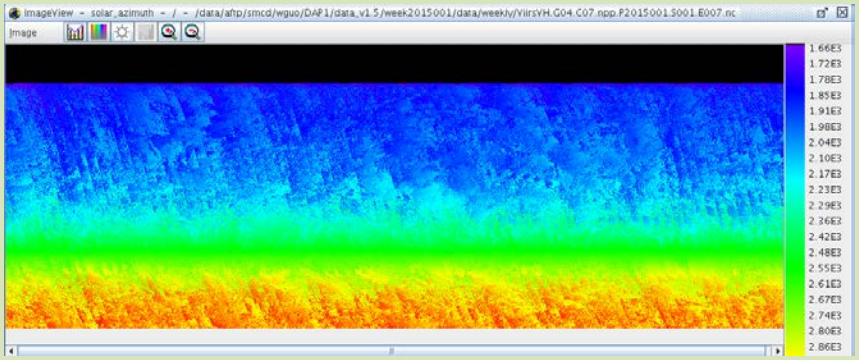


Weekly composite 2015 week1

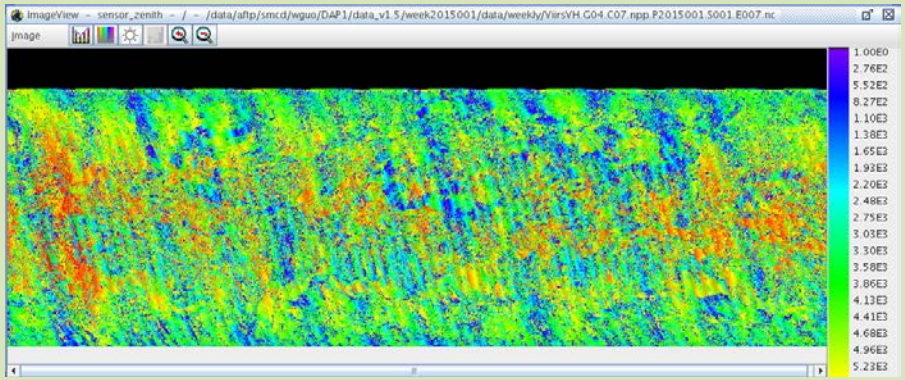
Sensor Azimuth



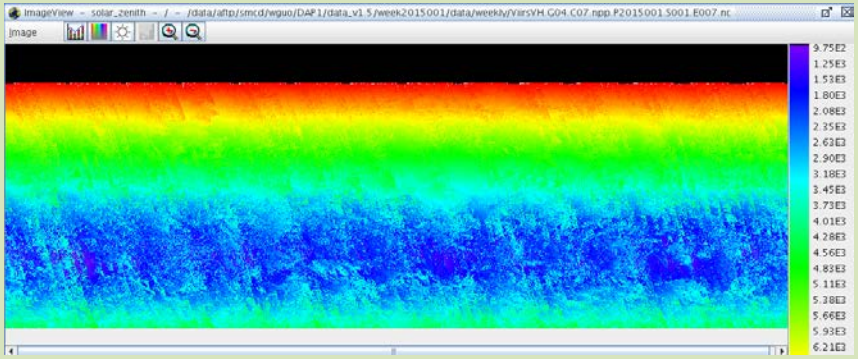
Solar Azimuth



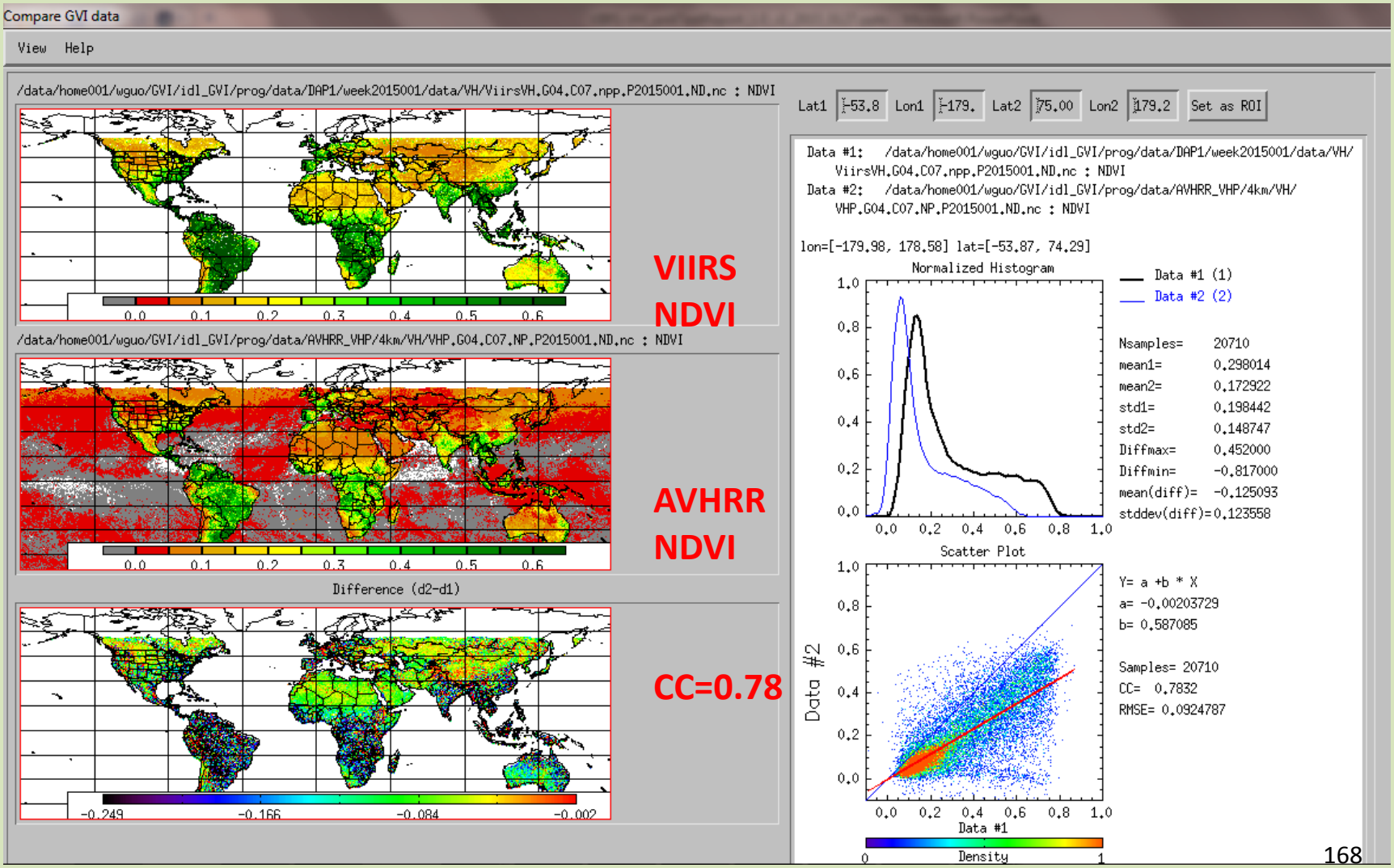
Sensor Zenith



Solar Zenith

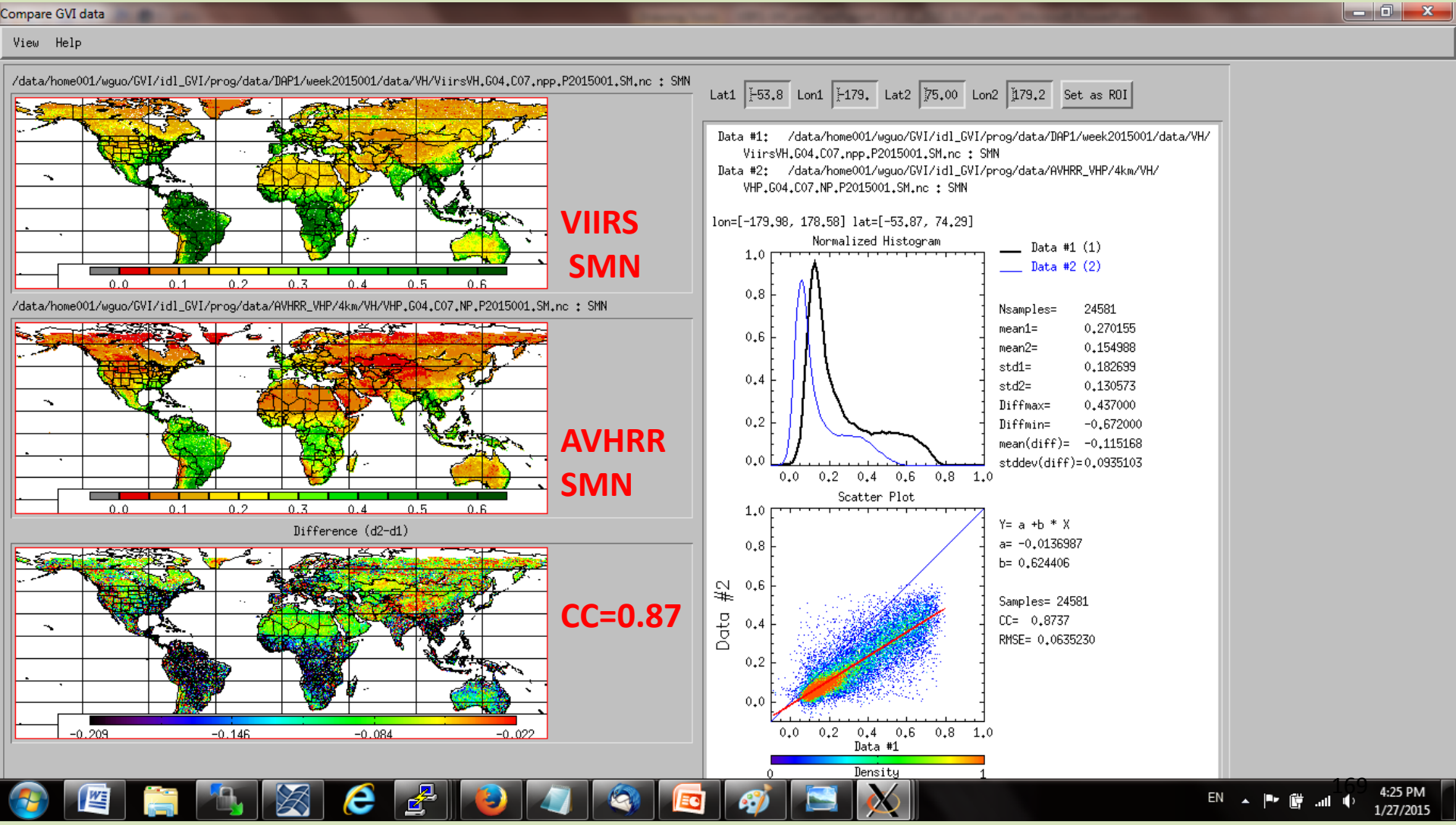


NDVI from ND file 2015 week 1

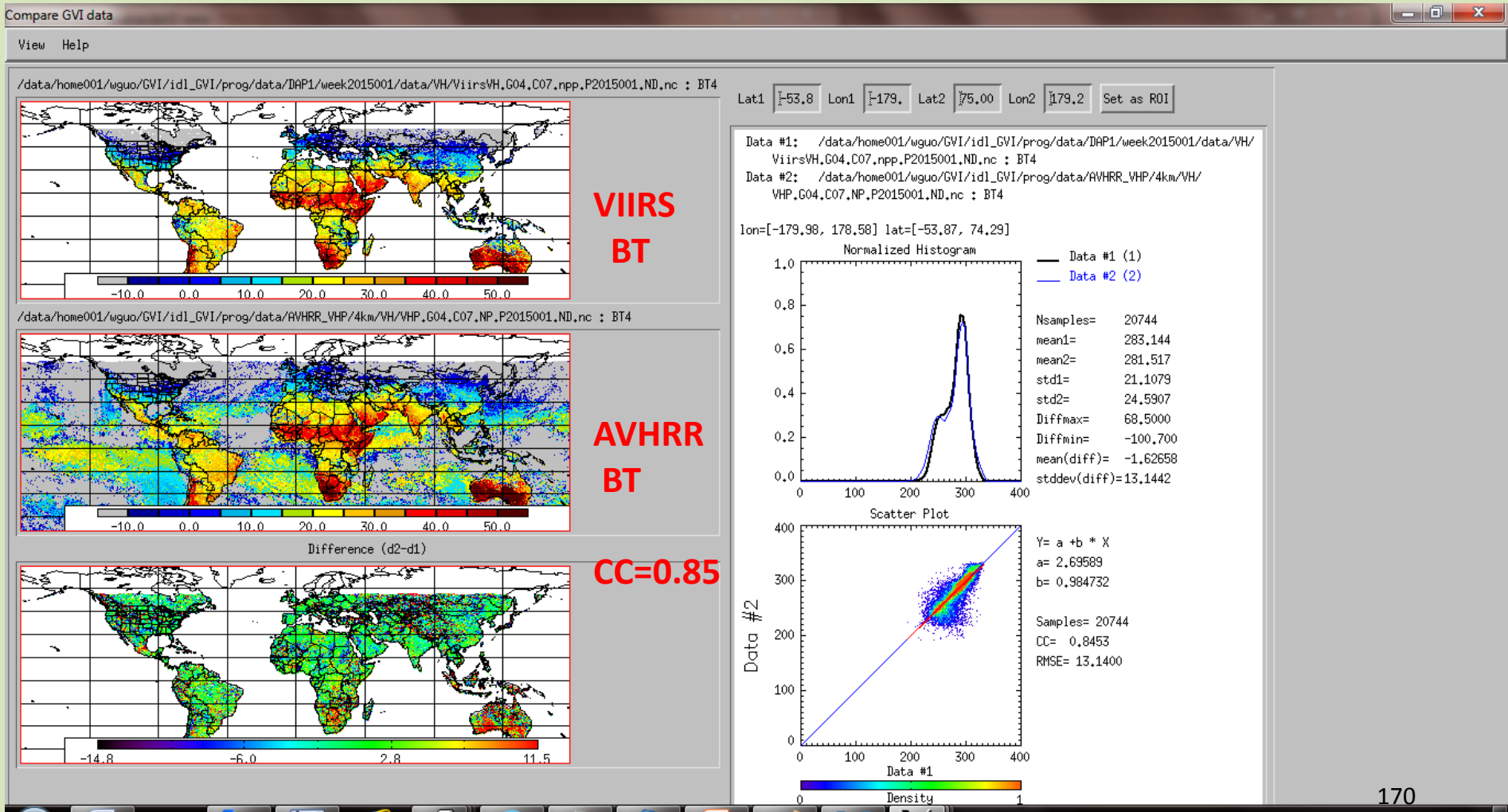


SMN from SM file
2015 week 1

Office Of Satellite and Product Operations

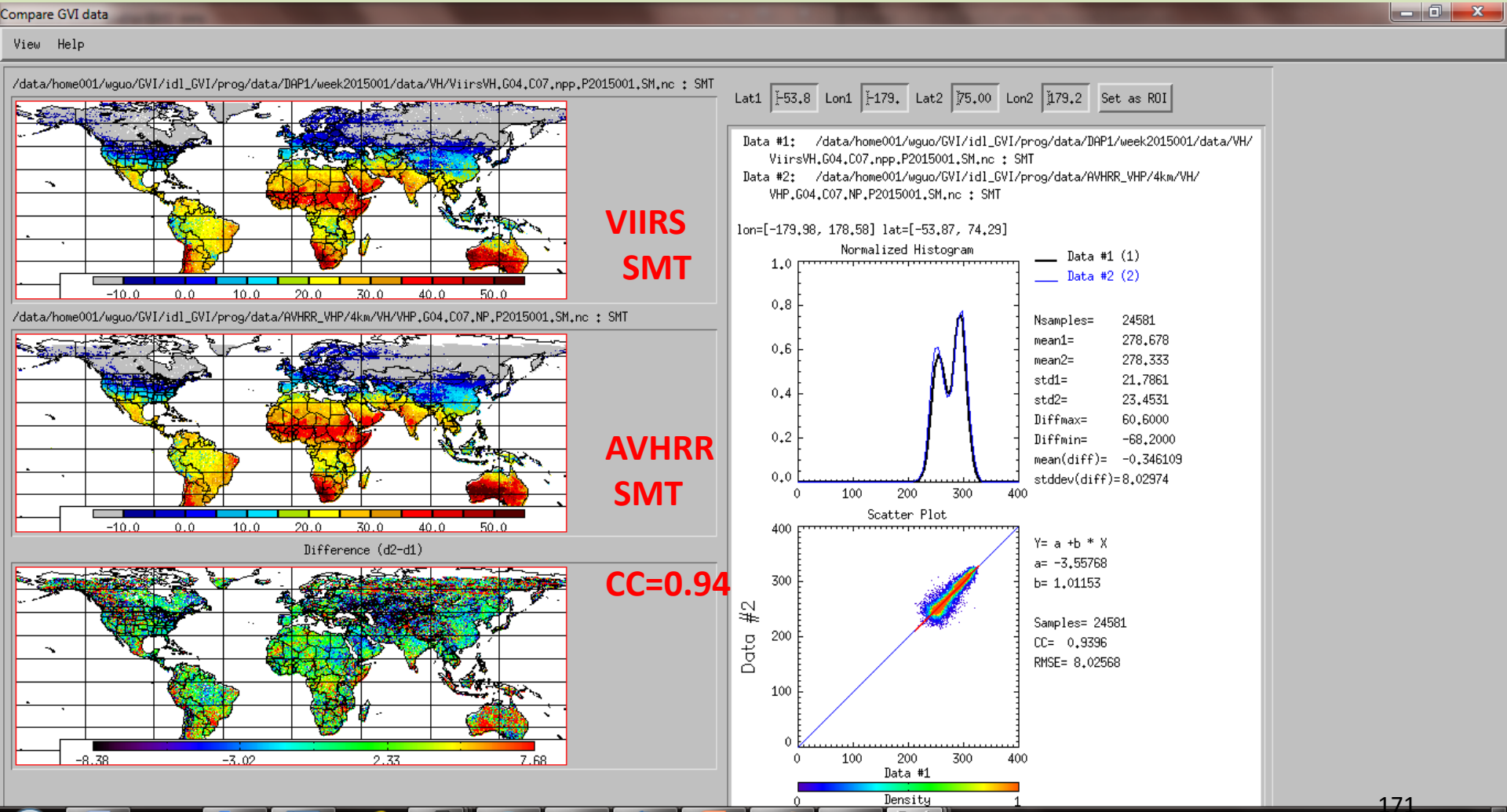


BT from ND file
2015 week 1

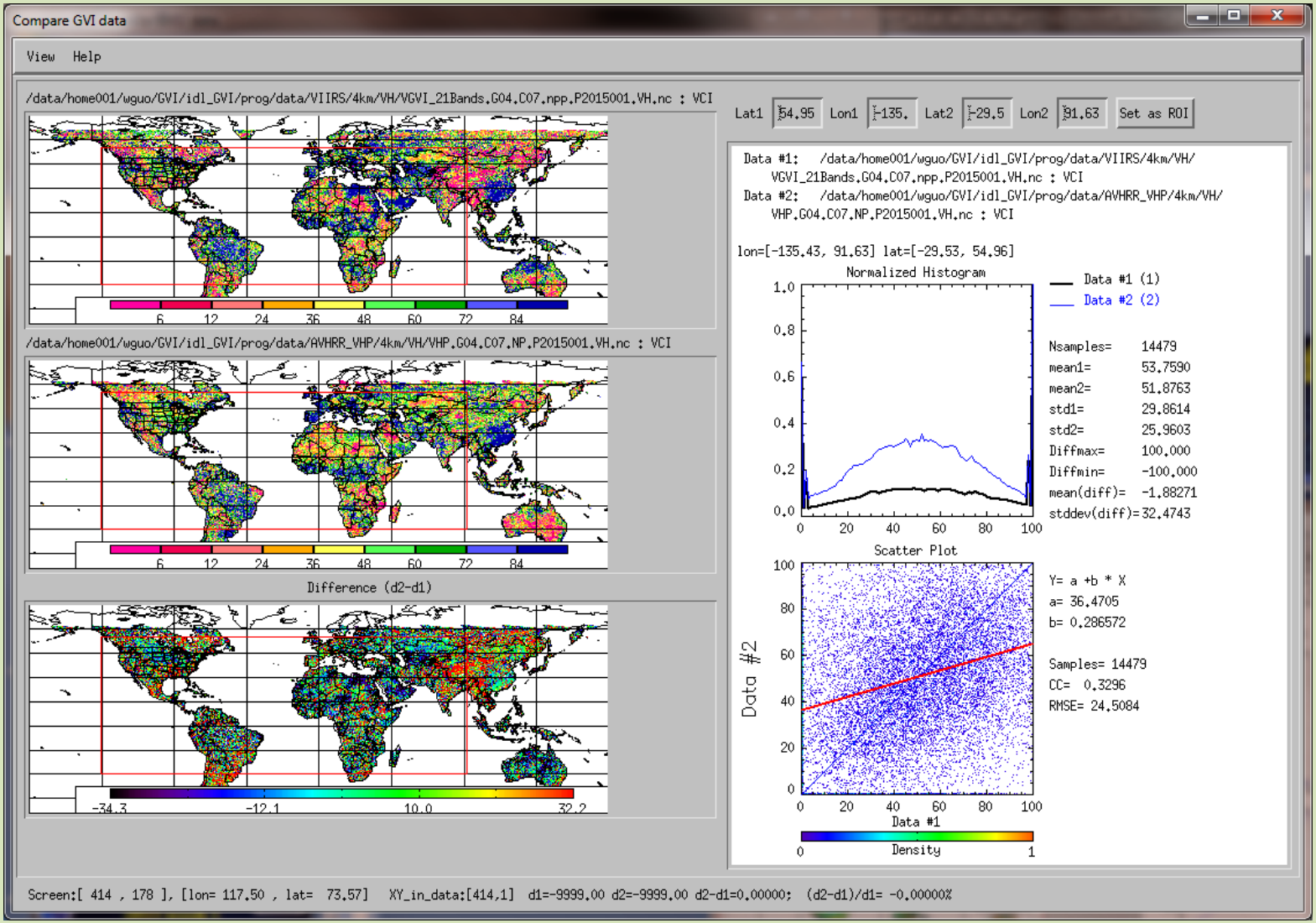


SMT from SM file 2015 week 1

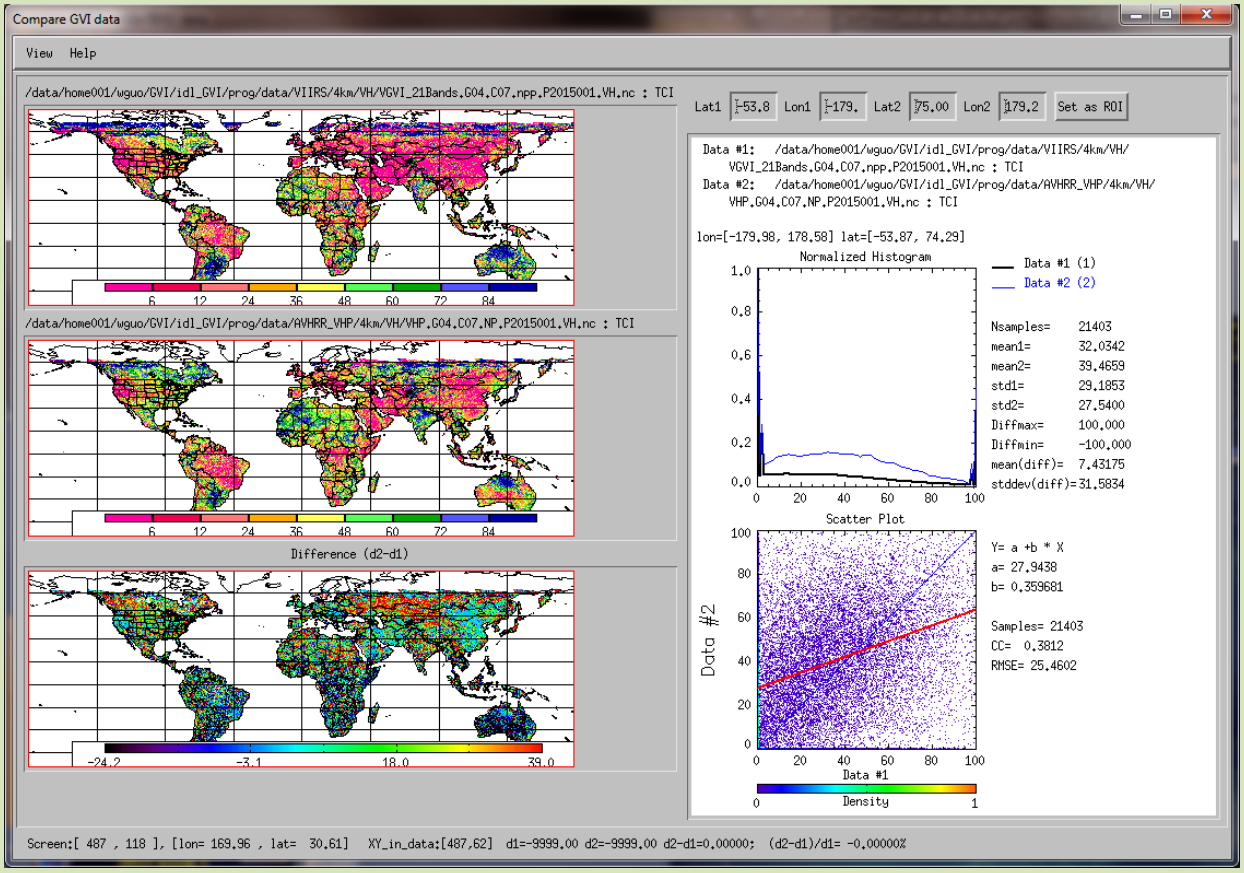
Office Of Satellite and Product Operations



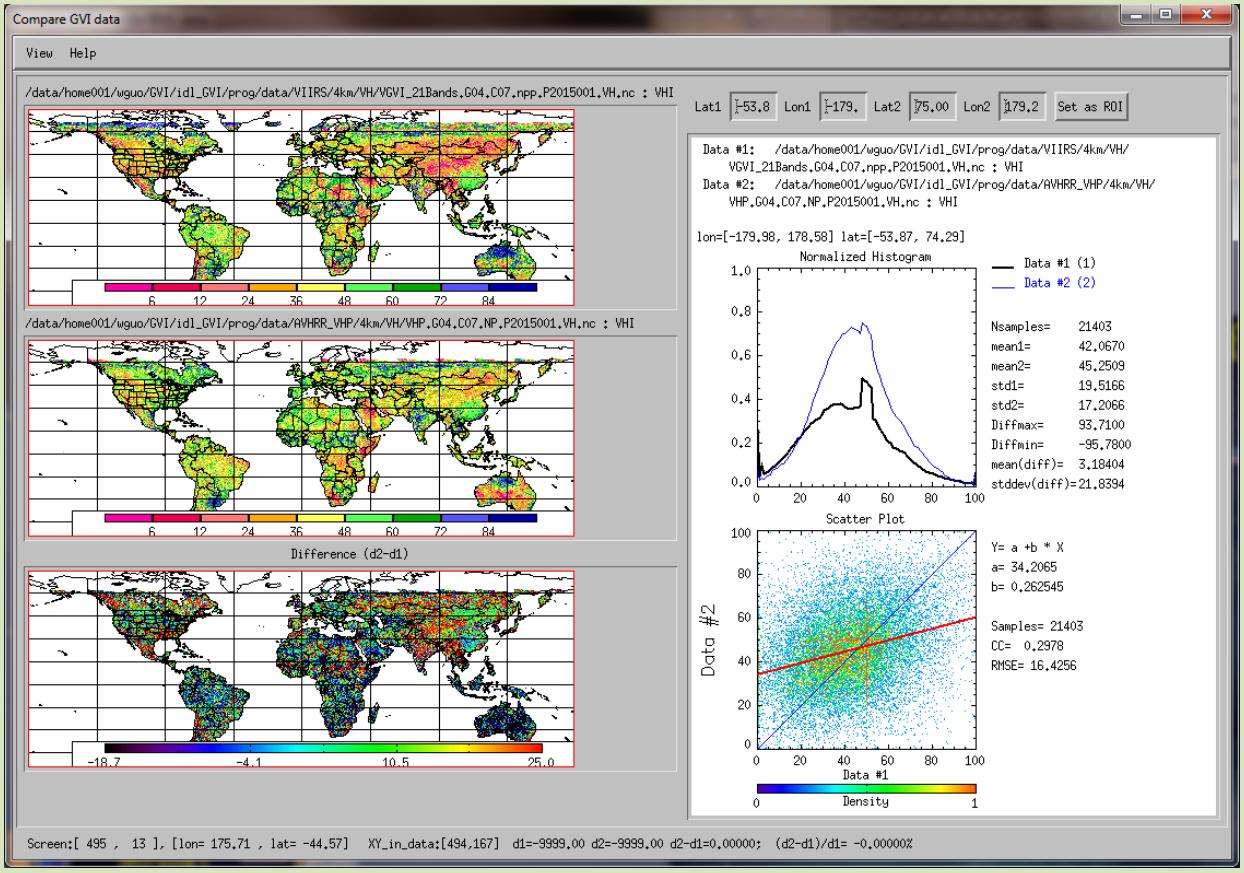
VCI from VH file
2015 week 1



TCI from VH file 2015 week 1



VHI from VH file 2015 week 1



Weekly procedure
CPU time used

20150202.173512.00467573 EVENT="All tasks"

STATUS= OK, completed normally (use 8.634 minutes)

About 8.6 minutes

- Verified ND file by off line product generated by STAR