Green Vegetation Fraction (GVF)

System Readiness Review

August 22, 2013

Prepared By:

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Rory Moore (Raytheon)
Ken Jensen (NDE)

GVF SRR Agenda

Project Plan	8:30 – 8:45	Marco Vargas
CTR Report	8:45 – 9:00	Tom King
System Overview	9:00 – 9:50	Marco Vargas Tom King
System Description	9:50 – 11:00	Zhangyan Jiang, Junchang Ju
Break	11:00 – 12:00	
System Verification	12:00 – 12:45	Tom King
System Readiness	12:45 – 1:15	Tom King
Project Status	1:15 – 2:20	Tom King
Summary and Conclusions	2:20 – 2:30	Marco Vargas

1) Project Plan
2) CTR Report
3) **System Overview**
4) System Description
5) System Verification
6) System Readiness
7) Project Status
8) Summary and Conclusions

Section 1 – Project Plan

Presented by

Marco Vargas
STAR Development Lead

GVF Product Team

- Development Lead: Marco Vargas
- Product Area Lead: Hanjun Ding
- Development Scientist: Marco Vargas, Ivan Csiszar, Zhangyan Jiang, Junchang Ju, Kevin Gallo
- Development Programmer: Junchang Ju, Zhangyan Jiang
- Development Tester: Kevin Gallo, Zhangyan Jiang, Junchang Ju
- Configuration Management: Junchang Ju, Zhangyan Jiang
- QA: Rory Moore, Ken Jensen (support ended 8/13/13)

GVF
Development Project Plan

- The Development Project Plan (DPP) is a standard artifact of the STAR EPL process.
  - The DPP identifies project objectives, stakeholder roles and tasks, resources, milestones, schedule, and budget
  - DPP version 3.2 is an artifact for the SRR. SRR reviewers can access this document at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php
  - The DPP was presented in detail at the Gate 3 Review. Here, we focus on changes to the plan since the last review (CTR).

GVF Project Plan - Changes Since CTR

- Post-SRR work tasks added
  - » Complete system testing
  - » Produce and deliver a Linux DAP
  - » Delta SRR

GVF Stakeholders - Suppliers

- Hardware
  - » STAR (IBM servers for development)
  - » NDE (SADIE for development/testing)
- Personnel
  - » AER (1.25 FTE) Work covered by SciTech 2 contract
- Data
  - » SCDR – VIIRS granule files (IVISR – surface reflectance, GIMGO – geolocation of imagery resolution bands)

GVF Stakeholders - Developers

- Lead: Marco Vargas (STAR)
- Scientists: Marco Vargas, Ivan Csiszar (STAR), Kevin Gallo (STAR), Zhangyan Jiang (AER), Felix Kogan (STAR)
- Programmers: Junchang Ju (AER), Zhangyan Jiang
- V&V: Junchang Ju, Zhangyan Jiang
- Documentation: Marco Vargas, Rory Moore (Raytheon), Ken Jensen (NDE), Zhangyan Jiang, Junchang Ju

GVF Stakeholders - Operators

- Product Area Lead: Hanjun Ding (OSPO)
- DAP Integration and Test: Dylan Powell (NDE), Angela Sigmund (NDE), Mimi Hailu (NDE)
- Transition to Operations: Yufeng Zhu (SSAI), Hanjun Ding
- Operations: Yufeng Zhu, Hanjun Ding
- Science Maintenance: Marco Vargas (STAR)
- Reactive Maintenance: NDE / OSPO
- Documentation: NDE / OSPO

GVF Stakeholders - Users

- NCEP EMC Land Group: Contact (Mike Ek, Weizhong Zheng, Yihua Wu)
  - » Update product requirement, evaluation of product quality, and at least one of the product development reviews (e.g., CDR).
- CLASS: Contact (Phil Jones, NCDC)
  - » CLASS will archive the GVF NOAA-Unique NDE product as described in TTA number: NDE13-001

GVF Stakeholders – SRR Reviewers

- Hanjun Ding (OSPO - Lead)
- Zhaohui Cheng (OSPO QA)
- George Lawless (OSPO Security)
- Yufeng Zhu (SSAI)

GVF Stakeholders – SRR Review Consultants

- Dylan Powell (NDE)
- Angela Sigmund (NDE)
- Ken Jensen (NDE)
- Michael Ek (NCEP)
- Priyanka Roy (STAR/NDE)
- Tom Schott (OSD)
- Jim Silva (OSD)
- Geof Goodrum (OSD)
- Kevin Berberich (OSD)
- Ricky Irving (OSPO)
- Ivan Csiszar (STAR)

GVF Stakeholders – Management and Support

- STAR Division Chief: Fuzhong Weng
- STAR Branch Chief: Ivan Csiszar
- OSPO Division Chief: Dave Benner
- OSPO Branch Chief: Ricky Irving
- NDE Program Manager: Jim Silva
- NDE Project Manager: Ken Jensen
- NPP Products Manager: Tom Schott
- STAR/NDE Liaison: Priyanka Roy
- CM/DM: Zhangyan Jiang, Junchang Ju
- STAR Quality Assurance: Rory Moore (until 8/13/2013)
- OSPO Quality Assurance: Zhaohui Cheng

GVF IMP – Project Milestones

- Gate 3 Review – Oct 7, 2010
- Project Requirements Review – Dec 7, 2011
- Critical Design Review – Apr 3, 2012
- Delta Critical Design Review – Jul 19, 2012
- Test Readiness Review – Jan 31, 2013
- Code Test Review – Jun 6, 2013
- DAP # 1 Delivery to NDE – Jul 16, 2013
- **System Readiness Review – Aug 22, 2013**
- DAP # 2 Delivery to NDE (Sep 2013)
- Transition to Operations (Sep-Nov 2013)
- Operational Decision Briefing (Nov 20, 2013)
- Commencement of Operations (Dec 2013)

GVF Timeline – Build Phase Has Been Completed

Raytheon

CMMI Development to Transition to Operations

Start	Gate 3	PRR	Delta CDR	TRR	CTR	SRR	Operations
06/14/10	10/07/10	12/07/11	07/19//12	01/31/13	06/13	08/13	12/13

- Jun 14, 2010: Began deployment of CMMI practices during step 5 of STAR EPL product life cycle
- Jun-Sep 2010: CMMI-compliant GVF Development Project Plan (DPP)
- Oct 7, 2010: Gate 3 Management Review. GVF project successfully completes PLAN Phase.
- Dec 7, 2011: Project Requirements Review (PRR).
- Jul 19, 2012: Delta CDR. Conclusion of DESIGN Phase.
- Jan 31, 2013: Test Readiness Review (TRR).
- Apr-May 2013: Unit testing
- Jun 6, 2013: Code Test Review (CTR).
- Jun-Jul 2013: System integration and testing
- Jul 2013: DAP # 1 delivery to NDE
- **Aug 2013: System Readiness Review (SRR). Conclusion of BUILD Phase. WE ARE HERE.**
- Sep 2013: DAP # 2 delivery to NDE
- Nov-Dec 2013: SPSRB Operational Decision, followed by commencement of operations.
- Dec 2013: DAP # 3 delivery to NDE (Linux DAP)

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2) **CTR Report**

3) System Overview

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Section 2 –
Code Test
Review Report

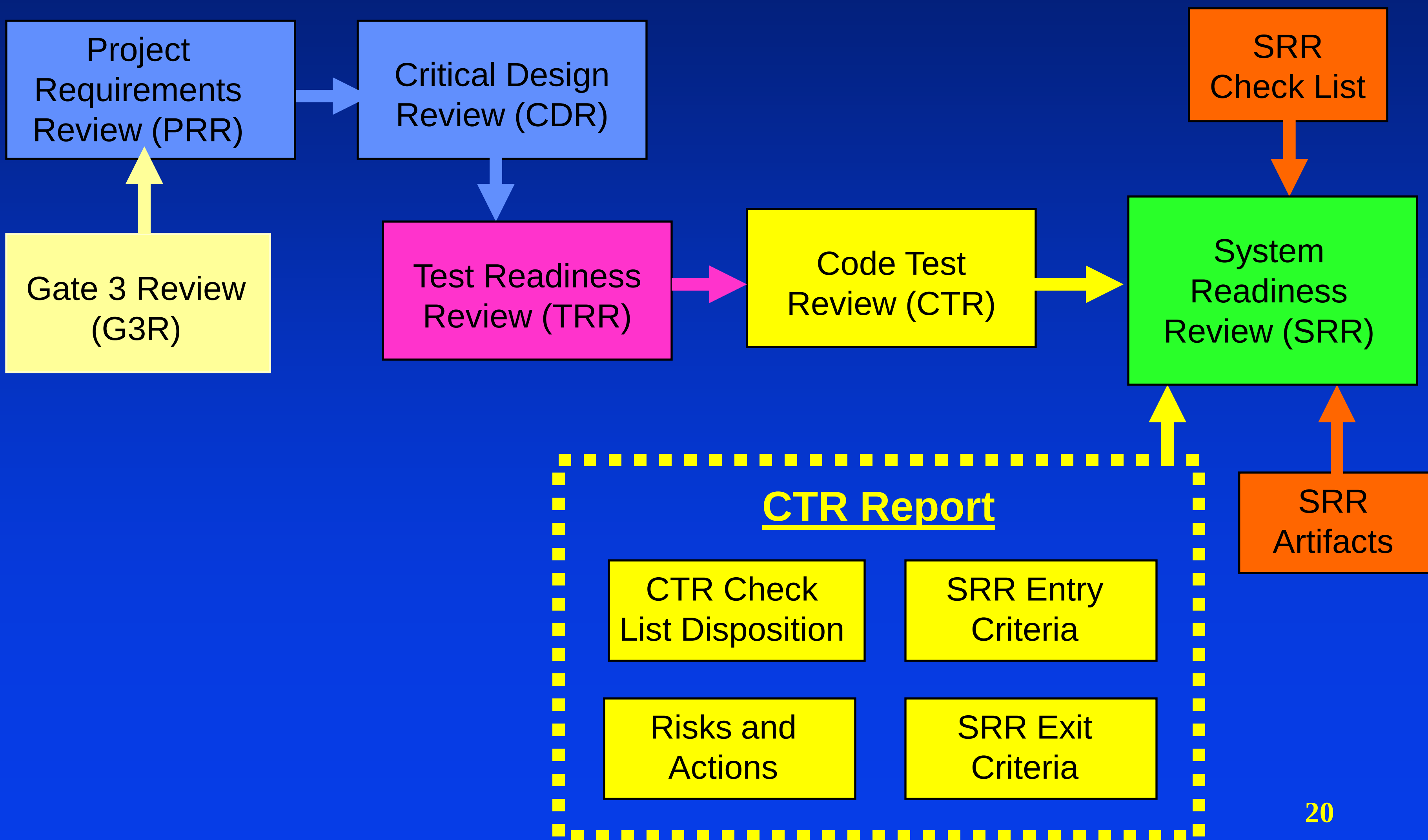
Presented by

Tom King

CTR Report

- The Code Test Review Report (CTRR) is the approved report of the SRR reviewers
  - » The CTRR reports the status of the SRR entry criteria and exit criteria
  - » The CTRR includes an assessment of risk items, with recommendations for risk mitigation. Status of the risk items will be addressed later in this SRR
  - » The CTRR has established the entry criteria and exit criteria for the GVF SRR
  - » The CTRR can be accessed at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

The CTR Report Closes the CTR and Sets Up the SRR



CTR Report – CTR Check List Disposition

- The CTR Report includes the disposition status for each of 161 CTR check list items (CLI)
  - » 154 of the 161 CLI received a "Pass" disposition with no identified risk.
  - » 1 of the 161 CLI received a "Conditional Pass" disposition and a specific action that will be discussed in Section 7.
  - » 6 of the 161 CLI received a "Defer" disposition with associated risks and actions, to be discussed in Section 7.

GVF CTR – Entry Criteria # 1 - 5

- Entry # 1 - A Test Readiness Review Report (TRRR) has been written. The CTR reviewers have access to the review version of the TRRR. STATUS: PASS
- Entry # 2 - A Development Project Plan (DPP) has been written. The CTR reviewers have access to the review version of the DPP. STATUS: PASS
- Entry # 3 - An Operations Concept Document (OCD) has been written. The CTR reviewers have access to the review version of the OCD. STATUS: PASS
- Entry # 4 - A Requirements Allocation Document revision (RAD) has been written. The CTR reviewers have access to the review version of the RAD. STATUS: PASS
- Entry # 5 - A Software Architecture Document (SWA) has been written. The CTR reviewers have access to the review version of the SWA. STATUS: PASS

GVF CTR – Entry Criteria # 6 - 10

- Entry # 6 - A Detailed Design Document (DDD) has been written. The CTR reviewers have access to the review version of the DDD. STATUS: PASS
- Entry # 7 - A Verification and Validation Plan (VVP) has been written. The CTR reviewers have access to the review version of the VVP. STATUS: PASS
- Entry # 8 - A Unit Test Plan (UTP) has been written. The CTR reviewers have access to the review version of the UTP. STATUS: PASS
- Entry # 9 - Pre-operational code units, external interfaces, ancillary data, unit test data and unit test results are in the development test environment. The CTR reviewers have access to this code, test data and test results. STATUS: PASS
- Entry # 10 - A Unit Test Report (UTR) has been written. The CTR reviewers have access to the review version of the UTR. STATUS: PASS

GVF CTR – Entry Criteria # 11 - 14

- Entry # 11 - A System Test Plan (STP) has been written. The CTR reviewers have access to the review version of the STP. STATUS: PASS
- Entry # 12 - A Project Status Report (PSR) has been written. The CTR reviewers have access to the review version of the PSR. STATUS: PASS
- Entry # 13 - A Project Baseline Report (PBR) has been written. The CTR reviewers have access to the review version of the PBR. STATUS: PASS
- Entry # 14 - A Code Test Document (CTD) has been written. The CTR reviewers have access to the review version of the CTD. STATUS: PASS

GVF CTR – Exit Criteria # 1 - 5

- Exit # 1 – TRR "Conditional Pass" items have been satisfactorily disposed of . STATUS: PASS
- Exit # 2 - TRR “Defer" items have been satisfactorily disposed of . STATUS: PASS
- Exit # 3 – Changes to the project plan since TRR are approved. STATUS: PASS
- Exit # 4 – Changes to the operations concept since TRR are approved. STATUS: PASS
- Exit # 5 – Requirements allocation changes since TRR are approved. STATUS: PASS

GVF CTR – Exit Criteria # 6 - 9

- Exit # 6 – Changes to external interfaces since TRR are approved. STATUS: PASS
- Exit # 7 – Changes to the software architecture since TRR are approved. STATUS: PASS
- Exit # 8 – Changes to the detailed design since TRR are approved. STATUS: PASS
- Exit # 9 – Changes to the test plans since TRR are approved. STATUS: PASS

GVF CTR – Exit Criteria # 10

- Exit # 10 - Unit test results and UTR are satisfactory. STATUS: CONDITIONAL PASS
- Reviewer comment: Have you tested all possible lines of code?
- ACTION CTR-9.1.11.1: Determine whether code coverage and memory leakage should be tested
- STATUS: This action was completed after CTR – see Section 7.

GVF CTR – Exit Criteria # 11 - 14

- Exit # 11 – The system test plan and STP are satisfactory. STATUS: PASS
- Exit # 12 – The project baseline and PBR are satisfactory. STATUS: PASS
- Exit # 13 – The CTRR documents the current status of project risks, actions, and TRR exit criteria. STATUS: PASS
- Exit # 14 – Project risks and actions are acceptable. The project is ready for system integration and system testing. STATUS: PASS

GVF SRR – Entry Criteria # 1 - 6

- Entry # 1 - A Code Test Review Report (CTRR) has been written. The SRR reviewers have access to the review version of the CTRR.
- Entry # 2 - A Development Project Plan (DPP) has been written. The SRR reviewers have access to the review version of the DPP.
- Entry # 3 - An Operations Concept Document (OCD) has been written. The SRR reviewers have access to the review version of the OCD.
- Entry # 4 - A Requirements Allocation Document revision (RAD) has been written. The SRR reviewers have access to the review version of the RAD.
- Entry # 5 - An Algorithm Theoretical Basis Document (ATBD) has been written. The SRR reviewers have access to the review version of the ATBD.
- Entry # 6 - A Software Architecture Document (SWA) has been written. The SRR reviewers have access to the review version of the SWA.

GVF SRR – Entry Criteria # 7 - 11

- Entry # 7 – A Detailed Design Document (DDD) has been written. The SRR reviewers have access to the review version of the DDD.
- Entry # 8 - An Internal Users Manual (IUM) has been written. The SRR reviewers have access to the review version of the IUM.
- Entry # 9 - An External Users Manual (EUM) has been written. The SRR reviewers have access to the review version of the EUM.
- Entry # 10 - A System Maintenance Manual (SMM) has been written. The SRR reviewers have access to the review version of the SMM.
- Entry # 11 - Pre-operational code units, external interfaces, ancillary data, and system test data have been integrated into a product processing system in the development test environment. The SRR reviewers have access to the product processing system.

GVF SRR – Entry Criteria # 12 - 17

- Entry # 12 - A Unit Test Plan (UTP) has been written. The SRR reviewers have access to the review version of the UTP.
- Entry # 13 - A System Test Plan (STP) has been written. The SRR reviewers have access to the review version of the STP.
- Entry # 14 - A Verification and Validation Report (VVR) has been written. The SRR reviewers have access to the review version of the VVR.
- Entry # 15 - A Project Status Report (PSR) has been written. The SRR reviewers have access to the review version of the PSR.
- Entry # 16 - A System Readiness Document (SRD) has been written. The SRR reviewers have access to the review version of the SRD.
- Entry # 17 - A Project Baseline Report (PBR) has been written. The SRR reviewers have access to the review version of the PBR.

GVF SRR – Exit Criteria # 1 - 5

- Exit # 1 – CTR "Conditional Pass" items have been satisfactorily disposed of.
- Exit # 2 – CTR “Defer" items have been satisfactorily disposed of.
- Exit # 3 - Project plan and DPP are satisfactory
- Exit # 4 - The operations concept and OCD are satisfactory.
- Exit # 5 - The requirements allocation and RAD are satisfactory.

GVF SRR –
Exit Criteria # 6 - 10

- Exit # 6 – The algorithm and ATBD are satisfactory.
- Exit # 7 - The design documents (SWA and DDD) are satisfactory.
- Exit # 8 - The test plans (UTP and STP) are satisfactory.
- Exit # 9 - The operations documents (IUM, EUM, and SMM) are satisfactory.
- Exit # 10 – System test results and VVR are satisfactory.

GVF SRR – Exit Criteria # 11 - 13

- Exit # 11 – The project baseline and PBR are satisfactory
- Exit # 12 – The SRRR and PSR document updated status of project status, risks and actions. The risk status is acceptable.
- Exit # 13 – The integrated product processing system is ready for transition to operations

GVF CTRR – Project Risks

- 21 open project risks are identified in the CTRR
  - » Each risk includes a Risk History, Risk Assessment, Risk Mitigation Plan, and a list of actions to implement the mitigation plan (“associated” actions)
- 79 associated open actions were identified
- The status of the 21 risks and 79 actions will be addressed in Section 7

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Section 3 –
System Overview

Presented by

Marco Vargas (STAR)
Tom King

Section 3.1 – Operations Concept

Presented by

Marco Vargas (STAR)

Operations Concept - Overview

- Before requirements are developed for a product and product system, the developers should know the intentions of the customers and/or users of the product. They must have the answers to the following questions:
  - » What is the product?
  - » Why is this product being produced?
  - » How will this product be used?
  - » How should this product be produced?
- The answers to the preceding questions should be derived from customer/user needs and expectations and production constraints

  Operations Concept Document (OCD) v1r4, an SRR artifact, describes how the users' vision can be realized in an operational environment. It can be obtained at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php
- OCD Document Guidelines in STAR EPL process asset DG-6.1:

  http://www.star.nesdis.noaa.gov/star/EPL_index.php

What is the Product?

- The GVF system will produce a daily rolling weekly global GVF map (in geographic projection on 0.036 degree grids (~ 4 km resolution at the equator) in Plate Caree Lat/Lon projection. This is called the “GVF Global Product”.
- The GVF system will also produce a daily rolling weekly GVF regional map on a 0.009 degree (~ 1 km) Lat/Lon grid, updated weekly. This is called the “GVF Regional Product”.

Product Requirements (1)

- The GVF Global Product will meet the following specifications (per grid):
  - » Has global coverage
  - » Has a spatial horizontal resolution of 4 km at the Equator;
  - » Classifies the grid as fractional cover of green vegetation;
  - » Has a measurement range of 0 – 100 %
  - » Has an accuracy error of 10%
  - » Has a data latency < 1 day immediately after the 7-day compositing period, updated weekly
  - » Data are stored for geographic grids and data files are in netCDF4 and GRIB2 formats

Product Requirements (2)

- The GVF Regional Product will meet the following specifications (per grid):
  - » Has a spatial horizontal resolution of 1 km at the Equator;
  - » Classifies the grid as fractional cover of green vegetation;
  - » Has a measurement range of 0 – 100 %
  - » Has an accuracy error of 10% at 4 km resolution
  - » Has a data latency < 1 day immediately after the 7-day compositing period, updated weekly
  - » Data are stored for geographic grids and data files are in GRIB2 format

Why Are The Products Being Produced? (1)

- The current Global Vegetation Processing System (GVPS) operationally produces weekly GVF data from AVHRR at 16 km resolution for use by NCEP/EMC. Currently, GVF data are produced from NOAA-19 AVHRR. There needs to be however preparation for the transition to the VIIRS instrument and ensure continuous provision of GVF data, taking also advantage of the improved VIIRS characteristics compared to AVHRR.
- The NCEP requirements clearly state that “NESDIS must sustain production of this real-time weekly product from future polar-orbiting satellites, especially including NPOESS (at current or better spatial and temporal resolution)” and “The resolution of the Green Vegetation Fraction data needs to keep pace with the NWP/land model development. The North American Mesoscale model is currently being tested at 4 km resolution and will be operational in the coming years.”

Why Are The Products Being Produced? (2)

- The NOAA NPP Data Exploitation (NDE) program is aimed at deriving NOAA-Unique Products (NUP) from NPP (National Polar-orbiting Partnership) data to serve the specific needs of NOAA users.
- NDE will receive the pre-operational GVF system from STAR for integration and test in its Algorithm Development Environment (SADIE) and its System Test Environment (STE). NDE will integrate, test, and transition the GVF System to OSPO as a NOAA-Unique Product (NUP).

Why Are The Products Being Produced? (3)

- OSPO will work with NDE to prepare the system for operations until the system is declared operational by SPSRB, after which the system will be promoted to operations on the NDE Production Environment (PE-1). OSPO is responsible for product validation in advance of the SPSRB Operational Decision Briefing and for product O&M after it is declared operational.
- The GVF Global Product files are to be archived at CLASS as described in TTA number: NDE13-001. These data files and related information will then be made available to users through CLASS interface.
- Metadata for the archive will comply with the NDE DAP standards for metadata.

How Will The Products Be Used? (1)

- GRIB2 product files will be pushed to the NCO supercomputers, from which NCEP EMC will pull the files. The filename should include the start and end time (i.e., date, hour) of the observations that are included in the gridded data file.
- NetCDF4 product files are to be archived at CLASS as described in TTA number: NDE13-001. These data files and related information will then be made available to users through CLASS interface. Metadata for the archive will comply with the NDE DAP standards for metadata.

How Will The Products Be Used? (2)

- NDE will be responsible for preparing the GVF system for operations. This includes integration and testing of the GVF system, development of production rules, working with the OSPO PAL on validation of latency, and assisting the OSPO PAL to validate quality
- OSPO will be responsible for operations and maintenance of the GVF system after it is declared operational by SPSRB. This will include ingestion of the required input data, production of the GVF products, and distribution of the GVF products to authorized users.

How Should The Products Be Produced?

- There will be five distinct environments
  - » Development Environment (STAR)
    - – Development, unit testing, system integration and testing of pre-operational code
  - » Integration and Test Environment (SADIE)
    - – Integration and system testing of pre-operational code
  - » System Test Environment (NDE_TEST)
    - – System testing
  - » Production Environment (NDE PE-1)
    - – Operational code is run to generate the products
  - » Distribution Environment
    - – Products are pushed to end users and the archive

Development Environment – Function (1)

- A test system will be established in the STAR Development Environment. Science code will be written for the purpose of testing algorithm alternatives. Landsat data and MODIS-based proxy VIIRS data will be used for the tests.
- Following algorithm selection and CDR approval, pre-operational code to implement the selected algorithm will be developed on the same Linux server, following SPSRB C++ coding standards.

Development Environment – Function (2)

- Unit testing and code refinement will occur in the Development Environment. Code will be modified (refined) as needed to achieve successful completion of the unit tests in accordance with a Unit Test Plan (UTP). Upon approval of the unit test results, refined pre-operational code and unit test data will be delivered to NDE as part of DAP # 1.
- System integration and testing will then occur in the Development Environment. The system test will be conducted to ensure that the system meets all functional and performance requirements. Code will be modified as needed to achieve successful completion of the system test in accordance with a System Test Plan (STP). Upon approval of the system test results, the integrated pre-operational GVF system and test data will be delivered to NDE as part of DAP # 2.

Development Environment – Capabilities (1)

- IBM AIX server (STAR Collaborative Environment)
  - Capable of hosting conversion of science code, unit testing, and system testing
  - 45 GB memory
  - 5 TB hard drive
  - 5 TB data storage
  - NESDIS network connection
  - C++ compiler
  - HDF/NetCDF libraries
  - ENVI
  - Subversion CM tool

Development Environment – Capabilities (2)

- Linux server (dedicated for GVF)
  - » 32 GB memory
  - » 10 TB hard drive
  - » NESDIS network connection
  - » C++ compiler
  - » HDF/NetCDF libraries
  - » IDL
  - » ENVI
  - » Subversion CM tool

Development Environment – Capabilities (3)

- Data link from GRAVITE
  - » VIIRS Surface Reflectance RIP granule file
  - » VIIRS Geolocation granule files
- Data link from SCDR
  - » VIIRS Surface Reflectance RIP granule file
  - » VIIRS imagery resolution Geolocation granule file
- Data link from USGS EDC
  - » Landsat ETM imagery

Development Environment – Resources and Limitations

- Personnel
  - » Zhangyan Jiang (AER) – Code and test data development and testing
  - » Junchang Ju (AER) – Code development, testing, and CM. Landsat validation.
  - » Ivan Csiszar (STAR) – Development Scientist support
  - » Marco Vargas (STAR) – IPT Lead
  - » Kevin Gallo (STAR) – V&V
  - » Hanjun Ding (OSPO) – Development Scientist support
- Limitations
  - » All required hardware, data, and personnel resources are available, but Ivan's availability is limited due to new responsibilities outside of the project.

Integration Environment SADIE – Function

- The GVF system will be initially delivered to NDE as DAP # 1. The code received from STAR in DAP # 1 will be installed in the NDE Science Algorithm Development and Integration Environment (SADIE).
- Production rules will be written and code modified as needed to ensure that the system will run properly within the NDE Data Handling System (DHS).
- At OSPO’s discretion, the unit tests that were conducted in the Development Environment can be repeated to ensure that the software units function as expected in the SADIE.
- After system testing in the Development Environment, the GVF system will be re-delivered to NDE as DAP # 2. The code received from STAR in DAP # 2 will be installed in SADIE to complete integration.

Integration Environment SADIE – Capabilities

- TBS by NDE

Integration Environment SADIE – Resources and Limitations

- Personnel
  - » Hanan Jordan (NDE) – NDE baseline CM
  - » Dylan Powell (NDE) – integration and testing
  - » Angela Sigmund (NDE) – integration and testing
- Limitations
  - » TBD, in consultation with NDE.

SADIE – Interface with Development Environment

- The GVF pre-operational system will be delivered from the STAR Development Environment to NDE as DAP # 1, DAP # 2, and DAP # 3.

GVF DAP # 1

- DAP # 1 is a preliminary delivery to allow NDE to begin integration at the earliest possible moment. DAP # 1 content includes:
  - » Pre-operational code – Unit-tested C++ code to produce VIIRS GVF products on an IBM/AIX platform from the identified input data, including make files and scripts.
  - » Unit Test Plan (UTP) – A GVF UTP will provide the plan for testing the functionality and performance of each software unit in the VIIRS GVF product processing system (unit testing).
  - » Unit test data – GVF unit test data will include all input data that was used in the unit tests, all intermediate files created during the unit tests, and all output files created during the unit tests.
  - » Unit Test Report (UTR) – A GVF UTR will document the results of testing of each software unit to verify that the requirements allocated to the unit's software components are satisfied.
  - » System Test Plan (STP) – A GVF STP will provide the plan for testing to demonstrate, using verification and validation methods, system readiness for operations (system testing).

GVF DAP # 2

- DAP # 2 is the final delivery of the IBM application that is intended for promotion to operations. Its content includes:
  - » Integrated Source code – C++ code to produce GVF products on an IBM/AIX platform from the identified input data, including make files and scripts. The code will consist of defined software units that have been integrated, system-tested and refined as needed to achieve a successful system test.
  - » UTP update (as needed) – Revised UTP that contains changes to the unit test plan since DAP # 1 delivery.
  - » STP update (as needed) – Revised STP that contains changes to the system test plan since DAP # 1 delivery.
  - » Unit test data update (as needed) – GVF unit test data update will include all unit test data that was added after DAP # 1 delivery.
  - » System test data – GVF system test data will include all intermediate files created during the system test daily and weekly runs, all output files created during the system test weekly runs, and associated GVF "truth".

GVF DAP # 2 – SPSRB Documents

- DAP # 2 will also include the required SPSRB documents. Document standards, guidelines and template can be found on the SPSRB website (http://projects.osd.noaa.gov/spsrb/standards_data_mtg.htm).
  - » Algorithm Theoretical Basis Document (ATBD) – A GVF ATBD will provide product developers, reviewers and users with a theoretical description (scientific and mathematical) of the algorithm that is used to create VIIRS GVF products that meet user requirements.
  - » System Maintenance Manual (SMM) - A GVF SMM will provide operations and maintenance personnel with information that will enable them to maintain the GVF system.
  - » External User's Manual (EUM) - A GVF EUM will provide product users with information that will enable them to acquire the product, understand its features, and validate its quality against requirements.
  - » Internal User's Manual (IUM) - A GVF IUM will provide analysts from the OSPO Satellite Analysis Branch (SAB) with information on the product processing system that will enable them to effectively and reliably operate interactive tools such as Graphical User Interfaces (GUI).

GVF DAP # 2 – Additional Documents

- DAP # 2 will also include additional documentation to support transition, operations, and maintenance:
  - » Verification and Validation Report (VVR) - A GVF VVR will provide the results of unit testing and system testing to ensure that the requirements specified for the GVF product processing system are satisfied by the completed system and that the final developed system will satisfy the users' needs and expectations
  - » Operations Concept Document (OCD) - A GVF OCD will provide the scenario for operational product generation, distribution, and use, including production rules.
  - » Requirements Allocation Document (RAD) - A GVF RAD will contain the basic and derived requirements for the work products and the allocation of the requirements to system components and product components
  - » Software Architecture Document (SWA) – A GVF SWA will describe the external interfaces and internal data flows of the VIIRS GVF software system.
  - » Detailed Design Document (DDD) – A GVF DDD will provide a detailed description of the design of each software unit

GVF DAP # 3

- DAP # 3 is the delivery of the Linux application that is intended for promotion to operations in the NDE 2.0 system (c. 2015). Its content includes:
  - » Integrated Source code – C++ code to produce GVF products on a Linux platform from the identified input data, including make files and scripts.
  - » UTP update (as needed) – Revised UTP that contains changes to the unit test plan since DAP # 2 delivery.
  - » STP update (as needed) – Revised STP that contains changes to the system test plan since DAP # 2 delivery.
  - » Unit test data update (as needed) – GVF unit test data update will include all unit test data that was added after DAP # 2 delivery.
  - » System test data update (as needed) – GVF system test data update will include all system test data that was added after DAP # 2 delivery.
  - » VVR update (as needed) – Revised VVR that contains changes to the test plans and results since DAP # 2 delivery.
  - » SPSRB document updates (as needed) – Updates to ATBD, SMM, EUM, and IUM as needed to describe the Linux application.

NDE System Test Environment – Function

- The integrated pre-operational GVF IBM application will be installed in the NDE System Test Environment (STE) for DAP testing.
- At NDE's discretion, in consultation with the OSPO PAL, the system test that was conducted in the STAR Development Environment will be repeated to ensure that the system generates the correct output in the NDE STE before promotion to operations.

NDE System Test Environment – Capabilities

- TBS by NDE

NDE System Test Environment – Resources and Limitations

- Personnel
  - » Hanan Jordan (NDE) – NDE baseline CM
  - » Mimi Hailu (NDE) – system testing
  - » Yufeng Zhu (SSAI) – monitor system test
  - » Hanjun Ding (OSPO) – monitor system test
- Limitations
  - » TBS, in consultation with NDE.

NDE System Test Environment – Interface with SADIE

- The GVF IBM application (NDE 1.0 system) will be promoted from SADIE to the NDE STE following the standard NDE procedure. This will occur after DAP # 2 I&T.
- The GVF Linux application (NDE 2.0 system) will be promoted from SADIE to a future NDE test environment following the standard NDE procedure. This will occur after DAP # 3 I&T.

Production Environment – Function

- The GVF IBM application (NDE 1.0 system) will be promoted and run in the NDE Production Environment (PE-1) after it is fully tested in the NDE STE. The GVF system will share the resource with other NDE operational applications that are also running. The NDE Operations operator will monitor the GVF products generation and distribution under a 24/7/365 base.
- The plan for promoting the GVF Linux application (NDE 2.0 system) to operations is TBD.

Production Environment – Capabilities

- PE-1 specs **TBS** by NDE
- Data link from CLASS (TBR)
  - » VIIRS Surface Reflectance RIP granule file
- Data link from IDPS
  - » VIIRS imagery resolution Geolocation granule file

Production Environment – Resources and Limitations

- Personnel
  - » Hanjun Ding (OSPO) – PAL
  - » Hanan Jordan (NDE) – NDE baseline CM
  - » **TBS** (OSPO) – NDE baseline CM
  - » Dylan Powell (NDE) – reactive maintenance
  - » Angela Sigmund (NDE) – reactive maintenance
  - » Yufeng Zhu (SSAI) – reactive maintenance
  - » Marco Vargas (STAR) – science maintenance
- Limitations
  - » The procedure for reactive maintenance after January 2014 is TBD

Production Environment – Interface with System Test Environment

- The GVF system-tested, integrated pre-operational system will be delivered from the NDE STE to PE-1 in accordance with standard NDE procedures (TBS).

Distribution Environment – Function

- Distribution of selected GVF products to CLASS will be in accord with a Submission Agreement. TTA number NDE13-001.
- Distribution of GVF products to external customers (primarily NCEP EMC) is TBD

Distribution Environment – Capabilities and Resources

- Personnel
  - » Donna McNamara (OSPO) – product distribution
  - » Hanjun Ding (OSPO) – product oversight
- Limitations
  - » TBS

Distribution Environment – Interface with Production Environment

- The Production Environment server will be able to access directly to the Distribution Environment server.
- The GVF products will be placed in the distribution zone on the operational server, and will be pushed to the NCO supercomputers for users to access.

Production Scenarios – Inputs and Environments

- Input Data will include:
  - » NPP VIIRS - Data links maintained by NDE
- Available production environments
  - » GVF Operations will occur on IBM/AIX machines.
  - » The system will be maintained by NDE and ESPC maintenance personnel.

Production and Delivery Scenarios (1)

- Swath surface reflectance and geolocation (with sun-sensor geometry angles) data from NPP-VIIRS are input via ingest of VIIRS granule files, as they become available.
- Ancillary data (land/sea mask, Global EVI Max/Min values, and GVF Climatology) are input from internal static databases.
- A daily surface reflectance map on the internal GVF grid (0.003 degree Lat/Lon in Plate Caree projection) for bands I1, I2, and M3 will be produced once per day. This run shall be called the "GVF Daily Run."
- All VIIRS observations collected during a calendar day (0000 – 2400 UTC) will be processed to produce a gridded daily surface reflectance map at TBD UTC the following day. This GVF Daily Run primarily grids the observations; for locations where multiple observations are available, the best gridded observation is selected and retained using a compositing algorithm. The time at which the run will be initiated will depend on VIIRS data latency, so is deferred for now. Since NDE will store VIIRS granule files for 4 days, it is feasible to delay production until, say, 2300 UTC.

Production and Delivery Scenarios (2)

- Daily production runs will be scheduled, executed, and managed by the NDE Data Handling System (DHS).
- Once the GVF Daily Run is finished for the 7th day of the week, the daily surface reflectance maps of the 7 days are composited to produce a weekly surface reflectance map using the compositing algorithm. This run is the first of a sequence of steps together called the “GVF Weekly Run.”
- Weekly production runs will be scheduled, executed, and managed by the NDE Data Handling System (DHS).
- Weekly production includes subsequent calculation of EVI, filling the EVI gaps, removal of high frequency noise from EVI time series (EVI smoothing, updated for the last 15 weeks with a new week arrival), calculation of GVF from the smoothed EVI, filling of GVF gaps from a GVF Climatology database, and aggregation of GVF to the resolutions needed for the output products.

Production and Delivery Scenarios (3)

- The generated weekly GVF global maps are converted to the needed formats (netCDF4, GRIB2 and GeoTIFF). Associated metadata are derived and written to the netCDF4 file. GRIB2 conversion is via a back-end process (STAR toolkit). Geo-TIFF is sent to NDE/OSPO for QC monitoring. GRIB2 is sent to the Distribution server for distribution to users. NetCDF4 are pushed to CLASS.
- A status report for each weekly run is written. Status report determines whether the outputs from the run are acceptable for distribution.
- In the new scenario of daily rolling weekly GVF production as required by the user NCEP, the GVF Weekly Run is invoked every day, ingesting the daily composite surface reflectance data of the previous 7 days. Other than the fact that the input daily data for any two adjacent daily rolling weekly runs overlap by 6 days, the daily rolling weekly run is the same as the non-overlapping weekly run.

Production Scenarios – Monitoring and Maintenance

- The NDE DHS will include product monitoring capability for maintaining the integrity and quality of the generated operational GVF products.
- Global EVI Max/Min and GVF Climatology will be updated periodically by STAR as part of science maintenance. The procedure for making this update will be described in the GVF ATBD.
- GVF is a daily update, so will be monitored in the same way as Daily products.

Distribution Scenarios (1)

- GVF Global Product files will be produced once per day. The files will be placed on the distribution server for push to users at or before 2359 (TBR) UTC each day.
- GVF Regional Product files will be produced once per day. The files will be placed on the distribution server for push to users at or before 2359 (TBR) UTC each day.
- **TBR:** If any GRIB2 product file is not available at the normal time, notification by email will automatically be sent to the following authorized users:
  - NCEP EMC (Mike Ek)
- GRIB2 product files will be pushed to the NCO supercomputers, from which NCEP EMC will pull the files. The authorized users will be informed of this policy through the data access agreement.

Distribution Scenarios (2)

- The following support documentation will be distributed to NCEP EMC Land Group:
  - » ATBD
  - » External Users Manual (EUM)
  - » Verification and Validation Report (VVR)

- **TBR:** The following support documentation will be archived at CLASS:
  - » ATBD
  - » EUM

User Interaction

- The ESPC help desk will serve as the operational point of contact to provide 24/7 service support for users, which means to provide information about the GVF data products to the user community and resolving their issues through coordination with NDE and the Land Surface PAL (Product Area Lead).
- The Land Surface PAL and NDE will coordinate further with the STAR GVF scientists for any product quality issue when identified and communicate with users.

Section 3.2 –
System Requirements

Presented by

Tom King

Requirements Allocation Document

- Requirements Allocation Document (RAD)
  - » RAD v1r5, an SRR artifact, can be obtained at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php
  - » RAD Document Guidelines in STAR EPL process asset DG-6.2 at http://www.star.nesdis.noaa.gov/star/EPL_index.php
- The RAD contains the basic and derived requirements for the work products.
- RAD v1r5 includes the allocation of the requirements to system components and product components, at a detailed design level of detail

Project Requirements Have Been Established and Refined

- Established at Preliminary Design Review (PDR)
  - » Requirements Allocation Document (RAD) v1r0
- Refined for Critical Design Review (CDR)
  - » Requirements Allocation Document (RAD) v1r1
- Modified for delta CDR
  - » Requirements Allocation Document (RAD) v1r2
- Modified for Test Readiness Review (TRR)
  - » Requirements Allocation Document (RAD) v1r3
- Modified for Code Test Review (CTR)
  - » Requirements Allocation Document (RAD) v1r4
- Modified for Code Test Review (SRR)
  - » Requirements Allocation Document (RAD) v1r5

GVF Basic Requirements (1)

0) The Green Vegetation Fraction (GVF) NOAA-Unique Product development project shall adopt the standard practices of the STAR Enterprise Product Lifecycle (EPL), as established in the STAR EPL process assets v3.0

1) The GVF system shall generate a global gridded Weekly GVF product, called the "GVF Global Product"

2) The GVF system shall generate a regional gridded Weekly GVF product, called the "GVF Regional Product"

3) The GVF system shall have a data ingest capability

4) The GVF system shall implement the GVF Algorithm to generate a retrieval of GVF

GVF
Basic Requirements (2)

5) The GVF system shall generate a metadata product for the NCDC CLASS archive facilities.

6) The GVF system shall have QC monitoring capability

7) The GVF developers shall produce fully functional software units in the STAR Development Environment

8) The GVF refined pre-operational system shall be transitioned from the STAR Development Environment to the NDE SADIE

9) The GVF developers shall deliver to NDE a Delivered Algorithm Package (DAP) # 2

GVF
Basic Requirements (3)

10) The GVF developers shall deliver to NDE a Delivered Algorithm Package (DAP) # 3

11) The GVF developers shall perform validation of the GVF products

12) The GVF system shall comply with OSPO Code Review Security check lists

13) The GVF developers shall specify IT resource needs for operations

New Requirements Since CDR

1 basic requirement has been added since the CTR

- GVF-R 10.0

16 derived requirements have been added since the CTR

- GVF-R 9.2
- GVF-R 9.4
- GVF-R 10.1
- GVF-R 10.2
- GVF-R 10.3
- GVF-R 10.4
- GVF-R 10.5
- GVF-R 10.6
- GVF-R 10.7
- GVF-R 10.8
- GVF-R 10.9
- GVF-R 10.10
- GVF-R 10.11
- GVF-R 10.12
- GVF-R 10.13
- GVF-R 10.14

New Basic Requirement 10.0

- GVF-R 10.0: *The GVF developers shall deliver to NDE a Delivered Algorithm Package (DAP # 3)*
  - » Characterization: Basic, Product, Operational
  - » Analysis: This basic requirement is traced to an NDE need for code and documentation to support operations, maintenance, and distribution

New Derived Requirements 9.2 and 9.4

- GVF-R 9.2: *DAP # 2 shall include a revised UTP that contains changes to the unit test plan since DAP # 1 delivery.*
  - » Characterization: Derived, System, Operational
  - » Analysis: The UTP will be updated if there have been any changes to the unit test.

- GVF-R 9.4: *DAP # 2 shall include all unit test data that was added after DAP # 1 delivery.*
  - » Characterization: Derived, System, Operational
  - » Analysis:

New Derived Requirements 10.1 and 10.2

- GVF-R 10.1: *DAP # 3 shall include integrated, system tested C++ code to produce VIIRS GVF products on a Linux platform from the identified input data, including make files and scripts*
  - » Characterization: Derived, System, Operational
  - » Analysis: N/A

- GVF-R 10.2: *DAP #3 shall include a revised UTP that contains changes to the unit test plan since DAP # 2 delivery.*
  - » Characterization: Derived, System, Operational
  - » Analysis: The UTP will be updated if there have been any changes to the unit test.

New Derived Requirements 10.3 and 10.4

- GVF-R 10.3: *DAP # 3 shall include a revised STP that contains changes to the system test plan since DAP # 2 delivery.*
  - » Characterization: Derived, System, Operational
  - » Analysis: The STP will be updated if there have been any changes to the system test.

- GVF-R 10.4: *DAP # 3 shall include all unit test data that was added after DAP # 2 delivery.*
  - » Characterization: Derived, System, Operational
  - » Analysis: N/A

New Derived Requirements 10.5 and 10.6

- GVF-R 10.5: *DAP # 3 shall include all system test data that was added after DAP # 2 delivery.*
  - » Characterization: Derived, System, Operational
  - » Analysis: N/A
- GVF-R 10.6: *DAP #3 shall include a VVR update*
  - » Characterization: Derived, System, Operational
  - » Analysis: The VVR will add new test results since the DAP # 2 delivery

New Derived Requirements 10.7 and 10.8

- <u>GVF-R 10.7:</u> *DAP #3 shall include an ATBD update*
  - » Characterization: Derived, System, Operational
  - » Analysis: The ATBD will add new validation results since the DAP # 2 delivery.

- <u>GVF-R 10.8:</u> *DAP # 3 shall include a SMM update for the Linux system*
  - » Characterization: Derived, Product, Operational
  - » Analysis: The SMM will follow SPSRB Version 2 document standards

New Derived Requirements 10.9 and 10.10

- GVF-R 10.9: *DAP # 3 shall include an EUM update for the Linux system*
  - » Characterization: Derived, Product, Operational
  - » Analysis: The EUM will follow SPSRB Version 2 document standards
- GVF-R 10.10: *DAP # 3 shall include an IUM update for the Linux system*
  - » Characterization: Derived, Product, Operational
  - » Analysis: The IUM will follow SPSRB Version 2 document standards

New Derived Requirements 10.11 and 10.12

- GVF-R 10.11: *DAP # 3 shall include a Delivery Memo*
  - » Characterization: Derived, System, Operational
  - » Analysis: The Delivery Memo will comply with NDE DAP standards

- GVF-R 10.12: *DAP # 3 shall include a README text file*
  - » Characterization: Derived, System, Operational
  - » Analysis: The README text file will comply with NDE DAP standards

New Derived Requirements 10.13 and 10.14

- GVF-R 10.13: *The DAP # 3 contents shall be in a gzipped tar file that follows the NDE DAP naming convention.*
  - » Characterization: Derived, System, Operational
  - » Analysis: N/A

- GVF-R 10.14: *The GVF development team shall ensure NDE has the information needed to acquire DAP # 3*
  - » Characterization: Derived, System, Operational
  - » Analysis: N/A

Requirements Removed Since CTR

- 2 derived requirements have been removed since the CTR
  - GVF-R 5.3
  - GVF-R 5.7

Removed Requirements 5.3 and 5.7

- GVF-R 5.3: *GVF global statistics shall be written to a separate TXT file.*
  - » DELETED. Statistics files will not be archived.
- GVF-R 5.7: *GVF regional metadata shall be written to a separate TXT file.*
  - » Characterization: Product, Operational
  - » DELETED. Statistics files will not be archived.

Requirements Revised Since CTR

5 derived requirements have been revised since the CDR

- » GVF-R 3.1.1
- » GVF-R 3.1.2
- » GVF-R 3.1.4
- » GVF-R 9.1
- » GVF-R 9.5

Revised Requirements 3.1.1 and 3.1.2

- GVF-R 3.1.1: *The NPP VIIRS data shall be ingested from CLASS and IDPS*
  - » Characterization: Derived, System, Operational
  - » Analysis: VIIRS data are needed daily and will be obtained from CLASS and IDPS
- GVF-R 3.1.2: *The NPP VIIRS data shall include the Surface Reflectance RIP granule file (IVISR), ingested from CLASS*
  - » Characterization: Derived, System, Operational
  - » Analysis: Needed for the GVF retrieval. See the GVF ATBD for a discussion. Need to determine if CLASS RIP will meet Daily Production latency requirement.

Revised Requirements 3.1.4 and 9.1

- GVF-R 3.1.4: *The NPP VIIRS data shall include the imagery resolution Geolocation granule file (GIMGO), ingested from IDPS*
  - » Characterization: Derived, System, Operational
  - » Analysis: Needed for the GVF retrieval. See the GVF ATBD for a discussion.
- GVF-R 9.1: *DAP # 2 shall include integrated, system tested C++ code to produce VIIRS GVF products on an IBM/AIX platform from the identified input data, including make files and scripts*
  - » Characterization: Derived, System, Operational
  - » Analysis: It has been determined that GVF will be an IBM application on the NDE 1.0 system.

Revised Requirement 9.5

- GVF-R 9.5: *DAP # 2 shall include all intermediate files created during the system test daily and weekly runs, all output files created during the system test weekly runs, and associated GVF “truth”.*
  - » Characterization: Derived, System, Operational
  - » Analysis: These are needed for validation of product accuracy

Requirements/Needs Matrix

- The requirements are traced to stakeholder needs and expectations in a Requirements/Needs Matrix (RNM)
- The RNM links each basic requirement to a specific customer/user need or expectation
- Adjustments to basic requirements should only be made following an analysis of the impact on customer/user needs and expectations.
- As requirements are further developed and refined, the impact on customer/user needs and expectations can be analyzed through the use of this matrix.
- The RNM is documented as a Microsoft Excel worksheet in the file “GVF_ RNM_1.5.xls”. The file can be found at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

GVF RNM Version 1.5

		Requirements Driver								
Requirement Number	**Requirement Statement**	STAR EPL	PSDI Needs	NCEP EMC Needs	NDE Needs	CLASS Needs	GVF Algorithm Needs	OSPO Needs	QC Monitoring Needs	Validation Team Needs
0.0	The NDE Green Vegetation Fraction (NDE GVF) development project shall adopt the standard practices of the STAR Enterprise Product Lifecycle (EPL), as established in the STAR EPL process assets v3.0, except for specific tailored practices to be itemized in derived requirements.	STAR/SMCD CMMI Initiative	SPSRB Process							
1.0	The GVF system shall generate a global gridded Weekly GVF product, called the "GVF Global Product"			SPSRB User Request #0812-009	NOAA-Unique Products	Archive Product				
2.0	The GVF system shall generate a regional gridded Weekly GVF product, called the "GVF Regional Product"			Requested during the Development Phase	NOAA-Unique Products					
3.0	The GVF system shall have a data ingest capability						Algorithm data input requirements			
4.0	The GVF system shall implement the GVF Algorithm to generate a retrieval of GVF			SPSRB User Request #0812-009	NOAA-Unique Products					
5.0	The GVF system shall generate a metadata product for the NCDC CLASS archive facilities.				NOAA-Unique Products	Metadata for Archive Product				
6.0	The GVF system shall have QC monitoring capability							Run status	Quality, latency, visualization	
7.0	The GVF developers shall produce fully functional software units in the STAR Development Environment							Ease of transition		
8.0	The GVF refined pre-operational system shall be transitioned from the STAR Development Environment to the NDE SADIE.				DAP I&T					Unit test plan, unit test data, System test plan, system test data
9.0	The GVF developers shall deliver to NDE a Delivered Algorithm Package (DAP) # 2			User documentation	DAP I&T	Archived documents		Operations documentation		
10.0	The GVF developers shall deliver to NDE a Delivered Algorithm Package (DAP) # 3				Linux DAP			Linux application		
11.0	The GVF developers shall perform validation of the GVF products			Product validation	NOAA-Unique Products					
12.0	The GVF system shall comply with OSPO Code Review Security check lists							Security		
13.0	The GVF developers shall specify IT resource needs for operations							IT Planning		

Allocation of Requirements

- To ensure that the system design will meet requirements, the requirements are allocated to components of the software system
- The software system is an integrated collection of software elements, or code, that produce well-defined output products from a well-defined set of input data, thereby implementing the algorithm that has been developed to meet product requirements and system requirements
- These software elements are identified as components of the product processing system

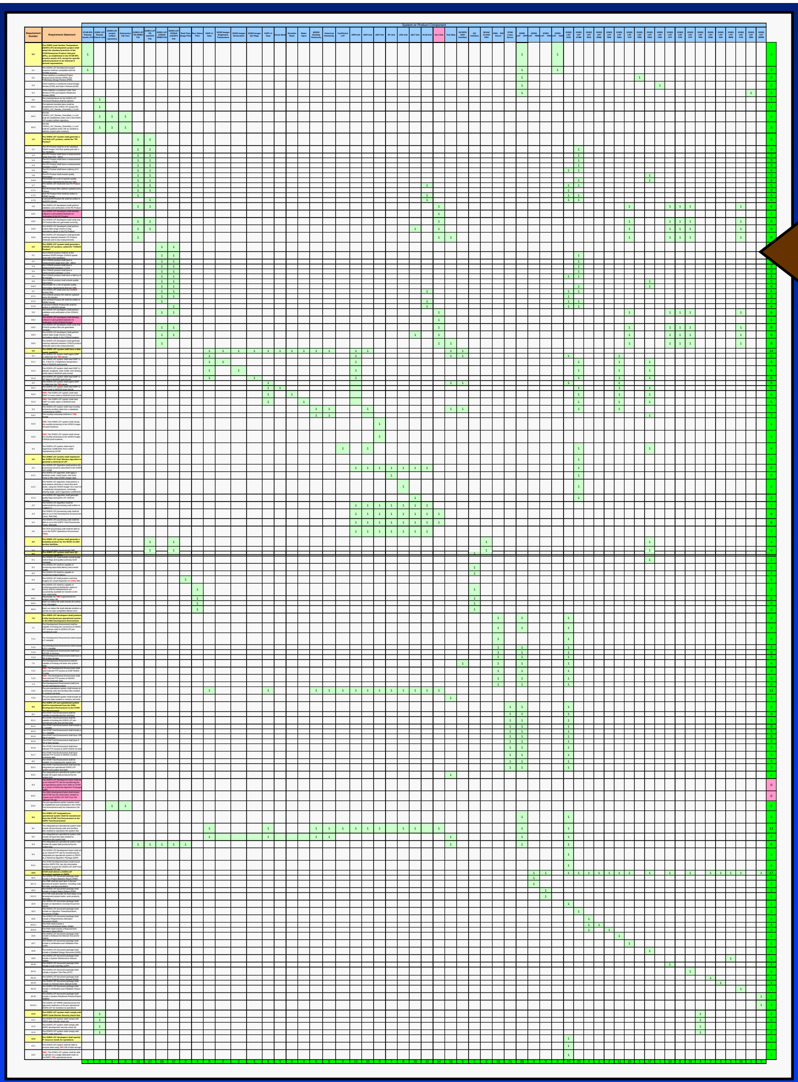
Requirements Allocation – Overview

- 161 requirements (basic and derived) are identified in the RAD
- Requirements allocation associates each of these requirements with one or more system and product components of the system design.
- The detailed design includes 81 of these components.
- The Detailed Design Allocation consists of the allocation of the 161 requirements to the 81 detailed design components.

Requirements Allocation Sheet (RAS)

- The allocation of requirements to components forms a matrix, called the Requirements Allocation Sheet (RAS)
- The RAS for the GVF Detailed Design Allocation is documented as a Microsoft Excel worksheet in the file "GVF_RAS_1.4.xls "
- This file can be found in the GVF artifact repository at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

GVF Detailed Design Allocation



- The GVF Detailed Design Allocation is best presented as a spreadsheet that is a matrix with 161 rows (requirements) and 81 columns (components)
- We call this the Requirements Allocation Sheet (RAS)
- For details, see the file GVF_RAS_1.4 at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

1) Project Plan

2) CTR Report

3) System Overview

4) **System Description**

5) System Verification

6) System Readiness

7) Project Status

8) Summary and Conclusions

Section 4 –
System Description

Presented by

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Junchang Ju (AER)

Section 4.1 – Algorithm

Presented by

Zhangyan Jiang (AER)

Algorithm Theoretical Basis

- Purpose: Provide product developers, reviewers and users with a theoretical description (scientific and mathematical) of the algorithm that is used to create a product that meets user requirements.

- Documented in the Algorithm Theoretical Basis Document (ATBD)
  - » ATBD Guidelines in DG-1.1 at http://www.star.nesdis.noaa.gov/star/EPL_index.php
  - » ATBD v2r0, an SRR artifact, is available at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

Algorithm Objectives (1)

- The current Global Vegetation Processing System (GVPS) operationally produces weekly GVF data from AVHRR at 16 km resolution for use by NCEP/EMC. Currently, GVF data are produced from NOAA-19 AVHRR. There is a need for preparation for the transition to the VIIRS instrument and ensure continuous provision of GVF data, taking also advantage of the improved VIIRS characteristics compared to AVHRR.

- The NCEP requirements clearly state that “NESDIS must sustain production of this real-time weekly product from future polar-orbiting satellites, especially including NPOESS (at current or better spatial and temporal resolution)” and “The resolution of the Green Vegetation Fraction data needs to keep pace with the NWP/land model development. The North American Mesoscale model is currently being tested at 4 km resolution and will be operational in the coming years.”

Algorithm Objectives (2)

- The GVFP algorithm is to meet the user request from NOAA-NCEP/EMC, numbered as #0812-009 in the NESDIS Satellite Products and Services Review Board (SPSRB) Request Tracking System, which requests a gridded daily rolling weekly GVF product at 4 km horizontal resolution (global scale) and a gridded daily rolling weekly GVF product at 1 km horizontal resolution (regional scale) in Lat/Lon projection.

Retrieval Strategy

- The basic retrieval strategy of the GVFP system is to produce green vegetation fraction from VIIRS observations.
- Daily VIIRS surface reflectance data are composited weekly and EVI is calculated based on the composited data.
- GVF is then calculated by comparison of weekly EVI to the global maximum and minimum EVI values.

Instrument Characteristics – SNPP

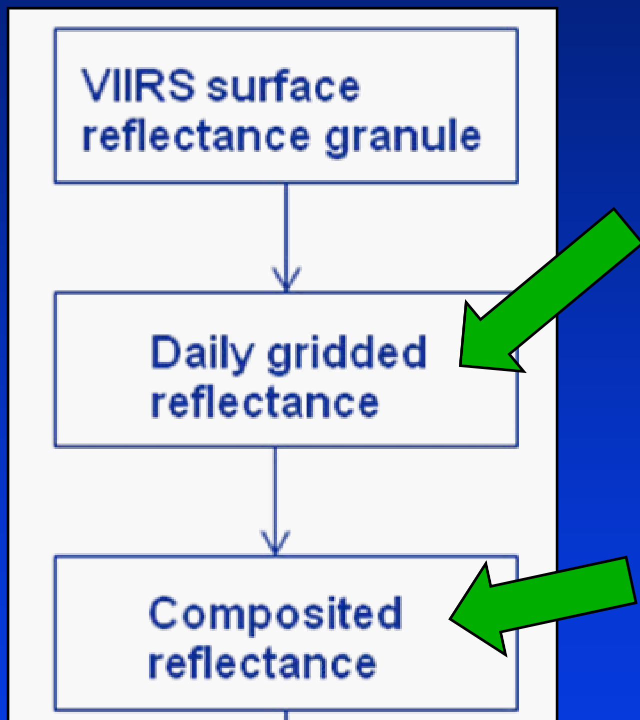
- VIIRS is one of five instruments onboard the SNPP satellite that launched on Oct. 28, 2011. It is intended to be the product of a convergence between DoD, NOAA and NASA in the form of a single visible/infrared sensor capable of satisfying the needs of all three communities, as well as the research community beyond.
- As such, VIIRS will require three key attributes:
  - » high spatial resolution with controlled growth off nadir
  - » minimal production and operational cost
  - » a sufficient number of spectral bands to satisfy the requirements for generating accurate operational and scientific products
- Calibration is performed onboard using a solar diffuser for short wavelengths and a blackbody source and deep space view for thermal wavelengths. The nominal altitude for the SNPP satellite is 824 km. The VIIRS scan will therefore extend to 56 degrees on either side of nadir.

Instrument Characteristics - VIIRS Spectral Bands

- There are nine moderate (M) resolution bands and three imagery (I) resolution bands in the VIIRS Visible/Near Infrared (VNIR) and Short Wave Infrared (SWIR) spectral bands
- The nadir resolutions for the M and I bands are 750 m and 375 m, respectively.
- The GVF algorithm uses the VIIRS bands I1, I2 and M3 as input data.

Band Name	Center	Width* (microns)	Resolution (m)
M1	0.415	0.020	750
M2	0.445	0.020	750
M3	**0.490**	**0.020**	**750**
M4	0.555	0.020	750
I1	**0.640**	**0.075**	**375**
M5	0.673	0.021	750
I2	**0.865**	**0.039**	**375**
M7	0.865	0.039	750
M8	1.240	0.020	750
I3	1.610	0.060	375
M10	1.610	0.060	750
M11	2.250	0.050	750

Daily Processing



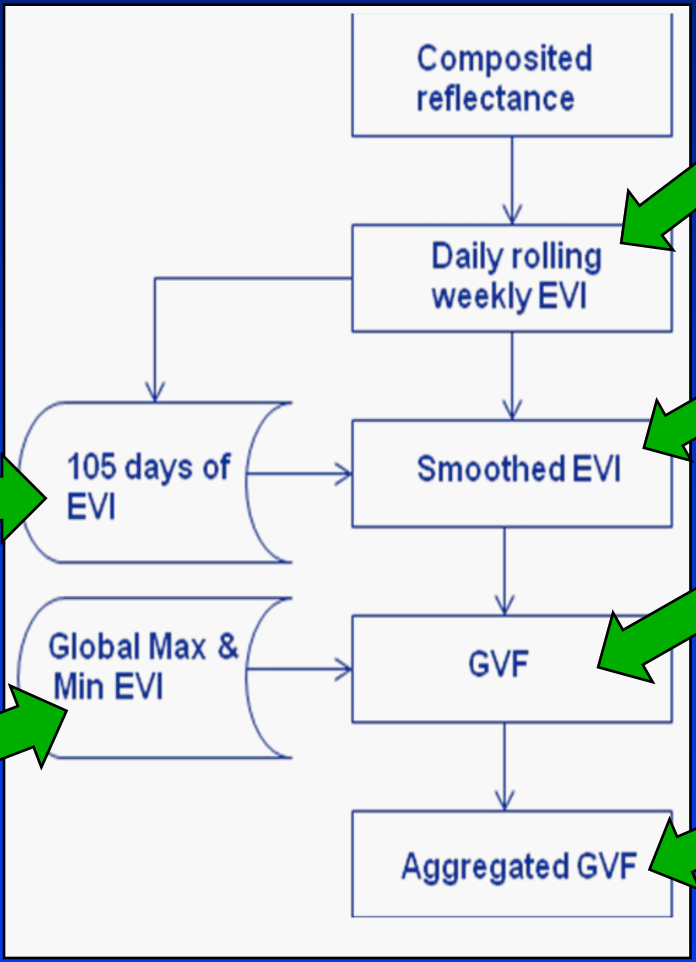
VIIRS swath surface reflectance data in bands I1, I2, and M3 during a calendar day (0000-2400 UTC) are mapped to the native GVF geographic grid (0.003 degree Plate Carree projection) to produce a gridded daily surface reflectance map.

At the end of a 7-day period, the daily surface reflectance maps of the 7 days are composited to produce a weekly surface reflectance map using the MVA SAVI compositing algorithm, which selects, at each GVF grid point (pixel), the observation with maximum view angle adjusted SAVI value in the 7 day period. The 7-day compositing is calculated daily using data in the previous 7 days as input data, which is called daily rolling weekly compositing. Cloud mask information of composited pixels is saved.

Weekly Processing

15 non-overlap daily rolling weekly EVI accumulated in the recent 15 weeks

Max EVI is the EVI value for 100% GVF. Min EVI is the EVI value for 0% GVF.



EVI is calculated from the daily rolling weekly composited VIIRS surface reflectance data in bands I1, I2 and M3.

High frequency noise in EVI is reduced by applying a 15-week (105 days) digital smoothing filter on EVI.

GVF is calculated by comparing the smoothed EVI against the global maximum and minimum EVI values assuming a linear relationship between EVI and GVF.

GVF is aggregated to 0.009 degree and 0.036 degree resolution for output maps.

Algorithm Inputs – VIIRS Surface Reflectance

- The VIIRS surface reflectance Retained Intermediate Product (RIP) is a granule file (IVISR) that contains reflectance data in twelve VIIRS spectral bands

- The GVFP algorithm uses the red (I1), NIR (I2) and blue (M3) reflectance data to calculate EVI and derive GVF from EVI.

- Details of VIIRS surface reflectance RIP are available at http://npp.gsfc.nasa.gov/science/sciencedocuments/ATBD_122011/474-00034_VIIRS-SurfReflect-ATBD_Rev-_22Apr2011.pdf

Algorithm Inputs – VIIRS Geolocation

- The VIIRS imagery resolution geolocation file (GIMGO) include latitude and longitude and sun-view geometry information corresponding to the VIIRS Surface Reflectance RIP imagery bands.

- The GVFP algorithm uses the latitude and longitude information in gridding and the sun-view geometry information in compositing.

- Because the imagery resolution bands are nested 2x2 with the moderate resolution bands, the M3 band is mapped to the appropriate grid without the need for the moderate resolution geolocation

Algorithm Inputs – MODIS Land Mask Data

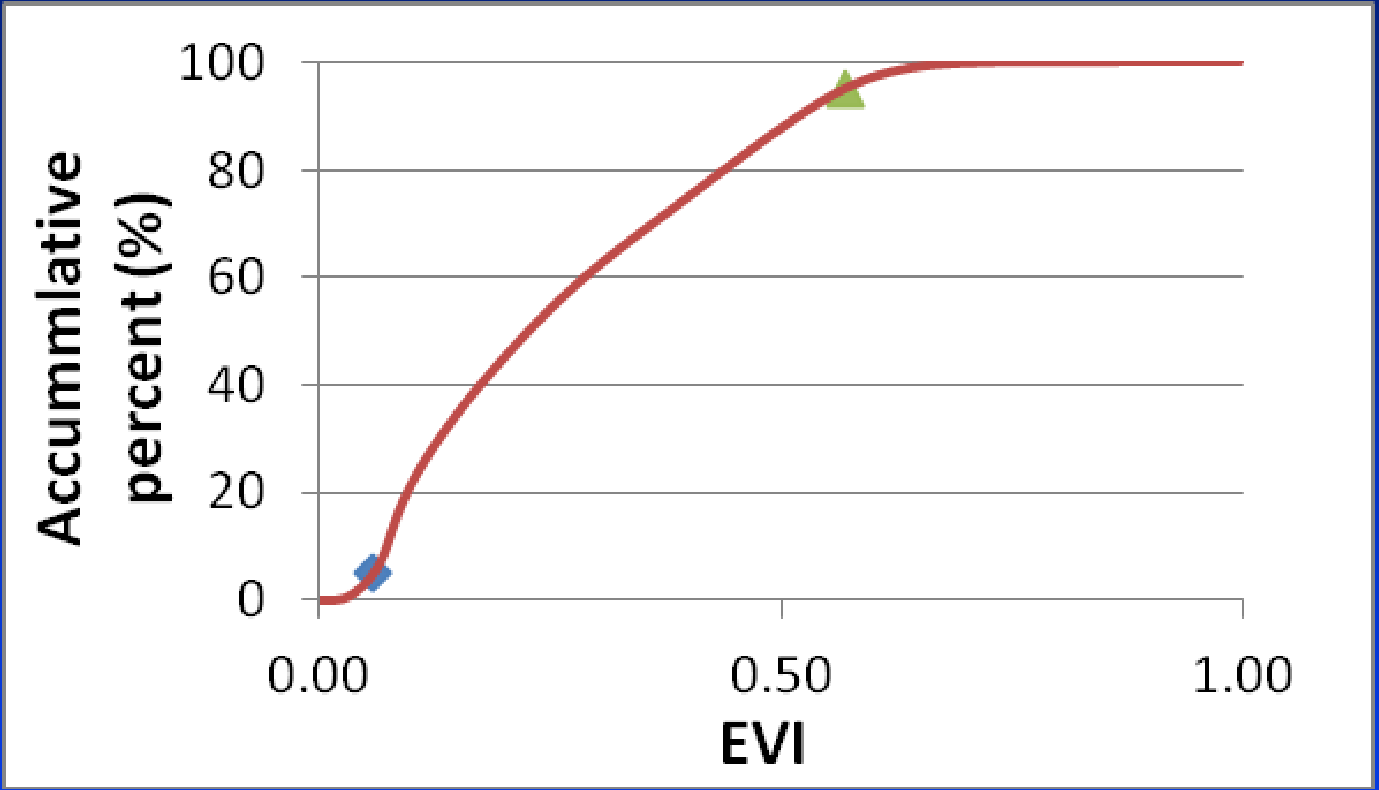
- The Moderate Resolution Imaging Spectroradiometer (MODIS) 250-m land-water mask (MOD44W) was reprojected to the lat/lon projection and resampled to the GVF grid resolution

- The land-water mask is used as a static input of the GVFP system to mask water pixels.

Algorithm Inputs – Global Maximum and Minimum of EVI

- The global minimum EVI (EVI_0) is the theoretical EVI value for bare soils where GVF=0 and the global maximum EVI (EVI_∞) is the theoretical EVI value for dense vegetation where GVF=1.
- Both are global constants, independent of vegetation and soil types.
- The global values are based on SNPP VIIRS weekly EVI data between 8/1/2012 and 8/3/2013. T
- he VIIRS EVI_∞ is 0.6766 and EVI_0 is 0.0900, taken as the 5th and 95th percentiles from the probability distribution function of the weekly EVI maps

Derivation of Global Maximum and Minimum of EVI



Global EVI accumulated probability distribution function of the weekly EVI maps in four months at different seasons.

Relation of Vegetation Index to GVF

- Vegetation indices are spectral transformations of two or more bands designed to enhance the contribution of vegetation properties and allow reliable spatial and temporal inter-comparison of terrestrial photosynthetic activity and canopy structural variations (Huete et al., 2002).
- Many studies showed that NDVI is highly related to GVF (Jiang et al., 2006; Leprieur et al., 2000; Gutman and Ignatov, 1998; Carlson and Ripley, 1997; Baret et al., 1995; Wittich and Hansing, 1995).
- Some researchers found that there is a linear relationship between NDVI and GVF (Gutman and Ignatov, 1998; Wittich and Hansing, 1995; Kustas et al., 1993; Phulpin et al., 1990; Ormsby et al., 1987).
- But others found the NDVI-GVF relationship to be nonlinear since the sensitivity of NDVI decreases with the increase of vegetation density and becomes saturated easily (Jiang et al., 2006; Leprieur et al., 2000; Purevdorj et al., 1998; Carlson and Ripley, 1997; Baret et al., 1995; Dymond et al., 1992).

Algorithm Functions – Gridding

- The GVFP algorithm starts from VIIRS surface reflectance RIP granules and grids the data, using nearest-neighbor method, onto a global GVFP 0.003° (333-m) grid.
- This grid is based on the Plate Carree map projection and consists of 120,000×60,000 grid points (pixels) in the global map, which spans from 90° (north edge) to -90° (south edge) in the latitudinal and from -180° (west) to 180° (east) in longitude directions.

Algorithm Functions – Compositing

- Daily I1, I2, and M3 surface reflectance data in a seven-day period are composited at 1-day interval (daily rolling weekly).
- A daily rolling weekly compositing period can start at any day of a year and covers seven days. The next compositing period shifts one day after the last seven-day period. At the end of a year, a compositing period cover some days in the next year if there are not enough days left in the year.
- The end result of composting over a seven-day period is a single NetCDF file containing, for each 0.003 degree grid point, red (I1), NIR (I2), and blue (M3) reflectance, sensor and solar zenith angles, relative azimuth angle

Compositing Procedure (1)

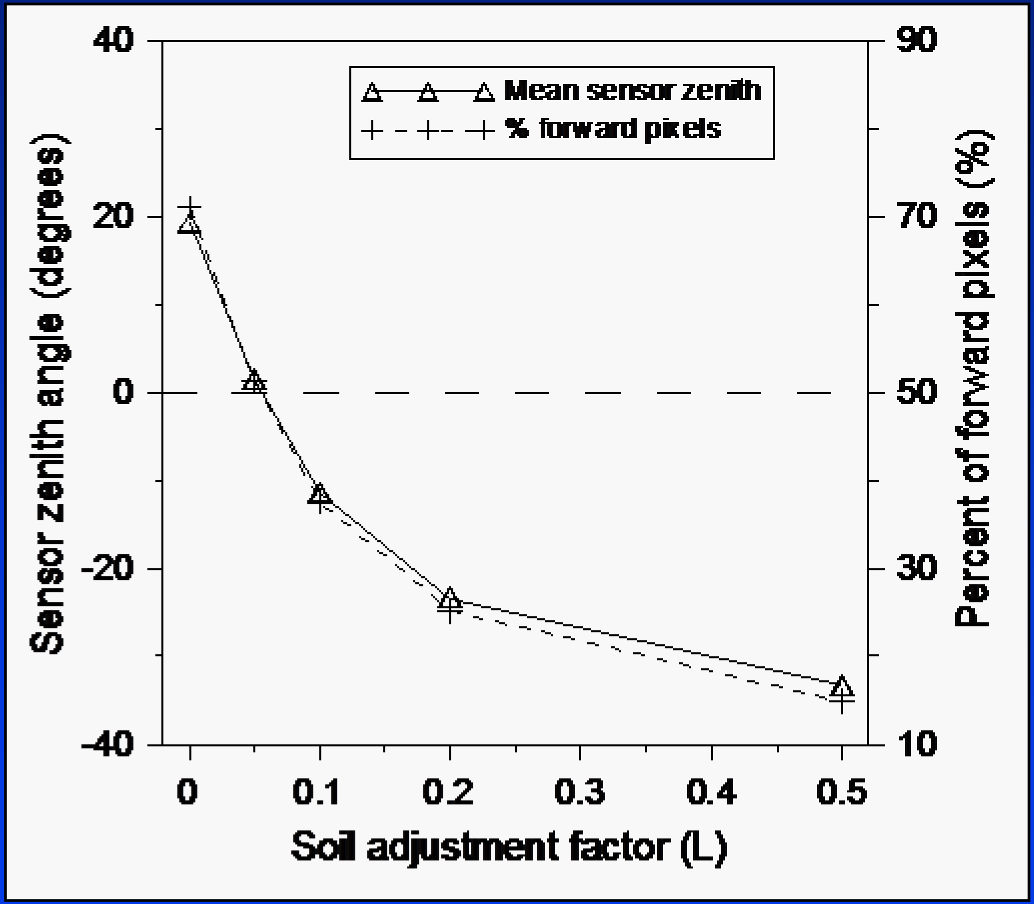
- It is well documented that MVC based on NDVI favors observations in the forward scatter direction, creating a bias and resulting in low red and NIR reflectances because of shadowing effect (Cabral et al., 2003; Carreiras et al., 2003; van Leeuwen et al., 1999; Stoms et al., 1997; Cihlar et al., 1994; Huete et al., 1992; Gutman, 1991).
- To reduce the bias, the soil-adjusted vegetation index (SAVI), with varying soil adjustment factor (L) values, is proposed and tested for MVC using the MYD09GA data (i.e. VIIRS surface reflectance proxy data) (Jiang et al., 2012).

$$SAVI = (1+L)\frac{\rho_{NIR} - \rho_{red}}{\rho_{NIR} + \rho_{red} + L}$$

- It was found that L had great impact on the selection of the composited data. With the increase of the L value from 0 to 0.5, the bias shifted from the forward scatter direction to the backscatter direction (See Figure on next slide).

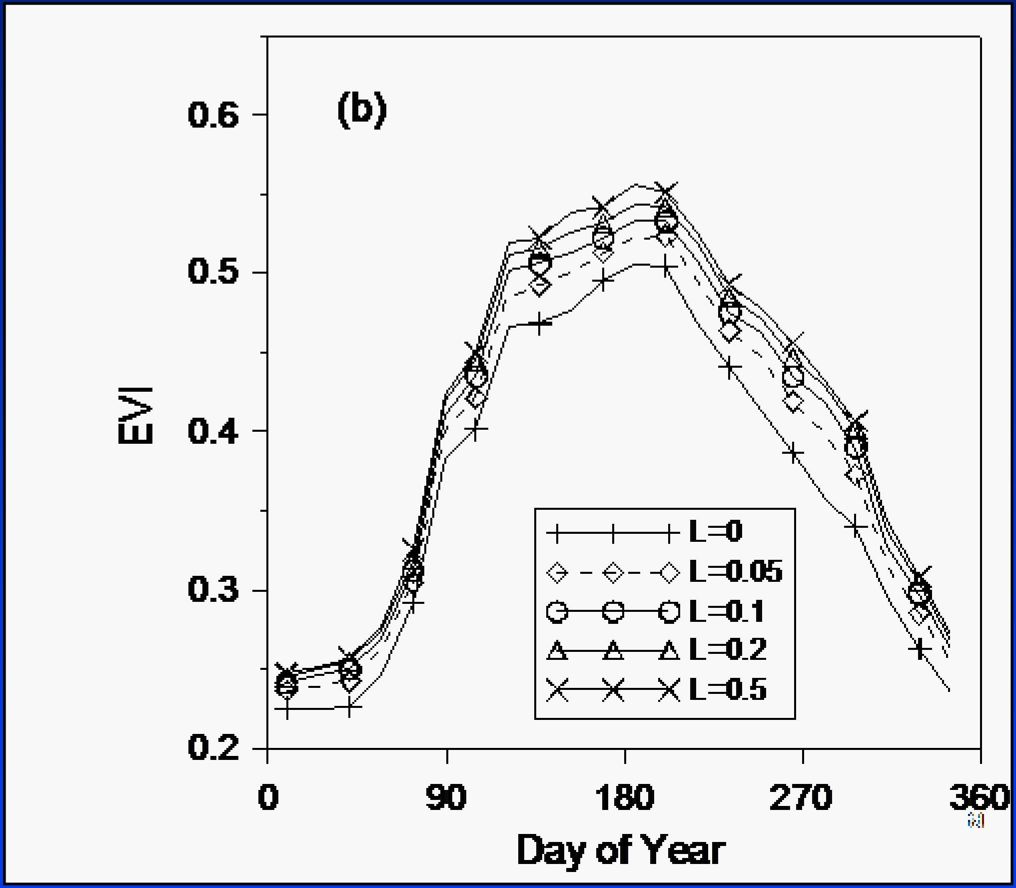
Compositing Procedure (2)

- Yearly mean sensor zenith angles and yearly mean percentage of forward scatter direction pixels of the maximum SAVI composited images over the tile H10V05 in 2007 as functions of the soil adjustment factor (L) values.
- The SAVI with L=0.05 was found to be the optimal vegetation index used in compositing to minimize the bias between the two directions



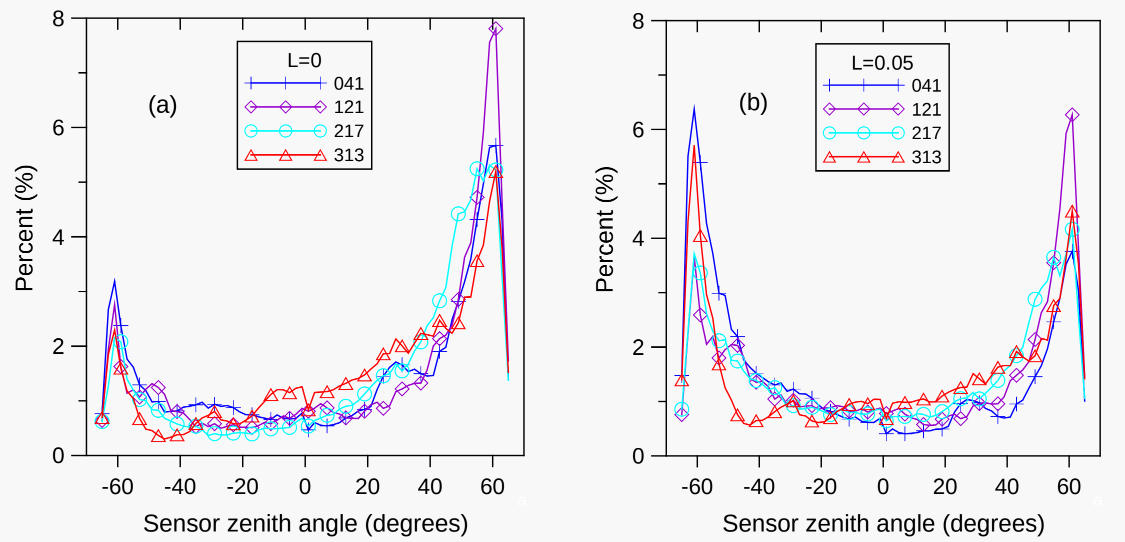
Compositing Procedure (3)

- Mean EVI values composited based on SAVI are greater than those composited based on NDVI (L=0)



Compositing Procedure (4)

- Although the bias in the view angle directions can be successfully minimized by the MVC based on SAVI (L=0.05), most of pixels composited by MVC are from high sensor zenith angles, regardless of whatever L values are used in compositing
- In some cases, the maximum NDVI is selected at the expense of optimal view geometry since sensor zenith angles selected by MVC are often further off-nadir than necessary to ensure cloud-free viewing (Stoms et al, 1997).
- This is an inherent limitation of MVC since more vegetation canopies and fewer gaps among canopies can be observed from high view zenith angles than from the nadir view.



Histograms of the sensor zenith angles composited by the traditional MVC based on NDVI (L=0) (a) and by the MVC based on SAVI (L=0.05) in different seasons (compositing periods beginning at DOYs 041, 121, 217 and 313) in 2007 over the tile H10V05.

Compositing Procedure (5)

- Thus, sensor zenith angles should be taken into account in compositing such that observations close to the nadir view are given a priority under clear sky conditions and observations at off-nadir view should be selected only if nadir view observations are cloudy. So, in compositing, SAVI should be adjusted according to the sensor zenith angle for each observation. The view-angle adjusted SAVI (VA-SAVI) is:

$$\text{VA-SAVI} = \text{SAVI} - \text{C} \times \text{SZ}^2$$

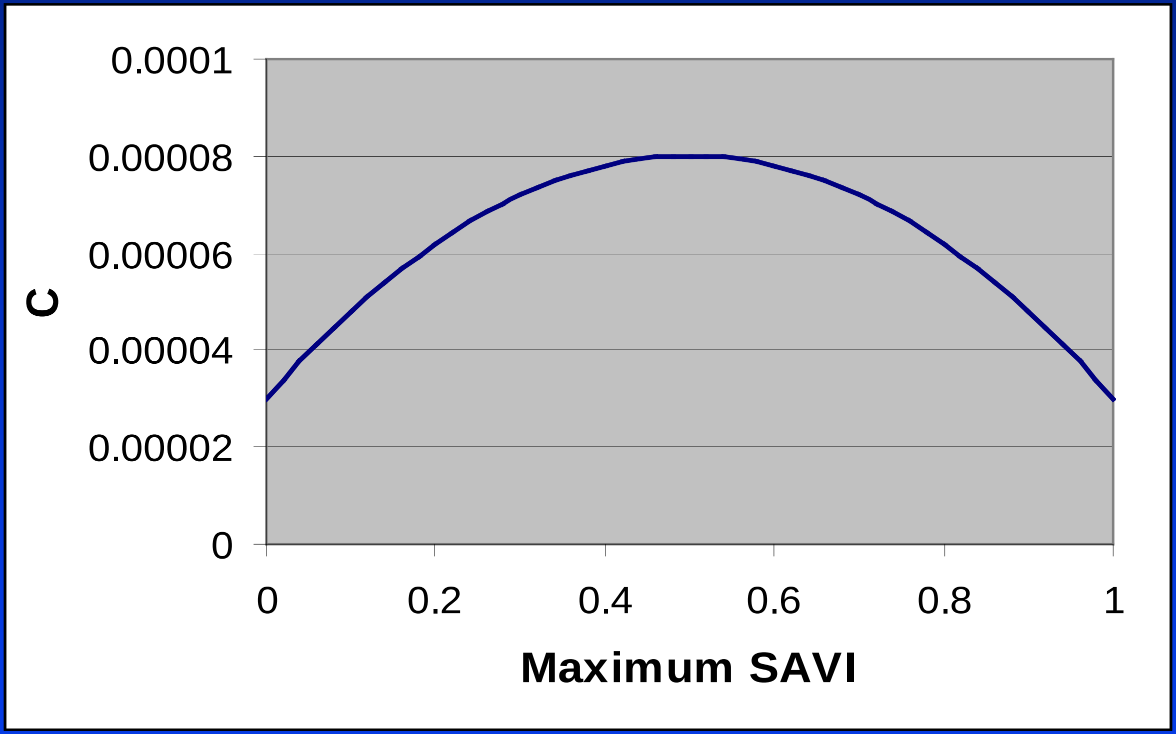
where SZ is the sensor zenith angle in degrees and C is a coefficient that accounts for the view angle variation of SAVI.

- The view angle variation of SAVI and other VIs is associated with the bidirectional reflectance distribution function (BRDF) of surface. The BRDF effects are prominent over heterogeneous surface with intermediate vegetation density and insignificant over homogeneous surface, such as bare soil or fully vegetated area.
- So C is a function of vegetation density, which can be estimated by the maximum SAVI (SAVI_{max}) in a compositing period for a pixel:

$$\text{C} = 0.00008 - 0.0002(\text{SAVI}_{max} - 0.5)^2$$

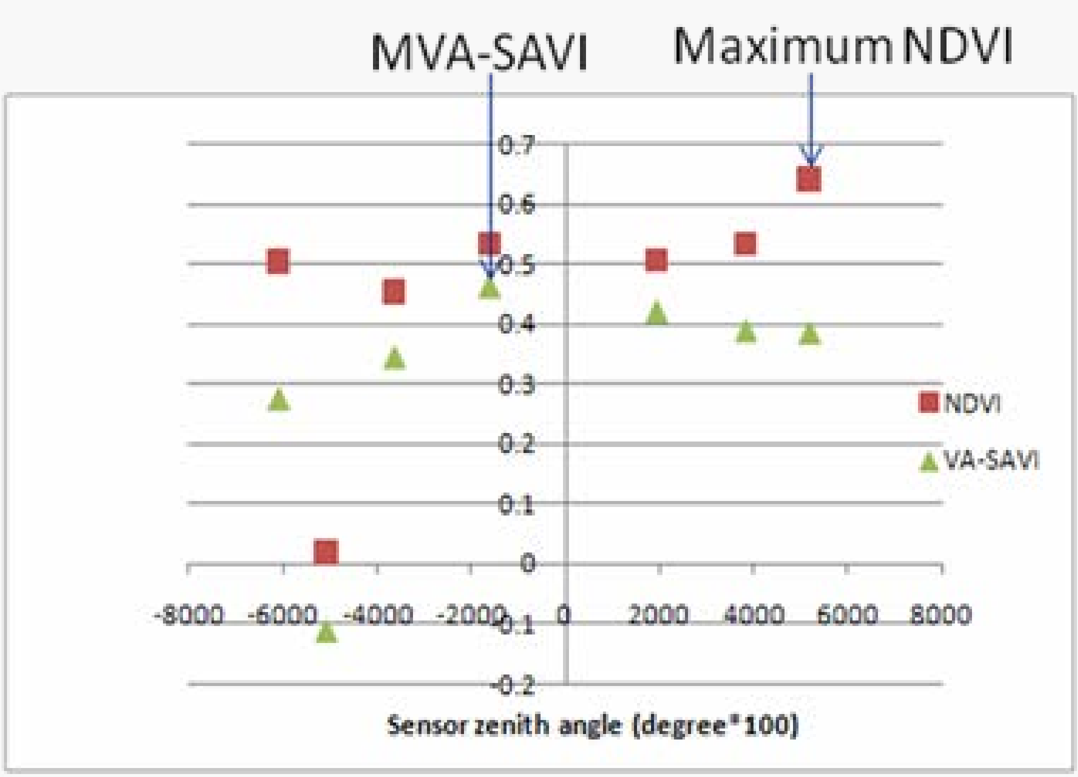
Compositing Procedure (6)

- The C value is highest (0.00008) when $SAVI_{max}$ = 0.5 and becomes 0.3 when $SAVI_{max}$ = 1 or 0
- The C values are very small because the unit of sensor zenith angles is degrees.



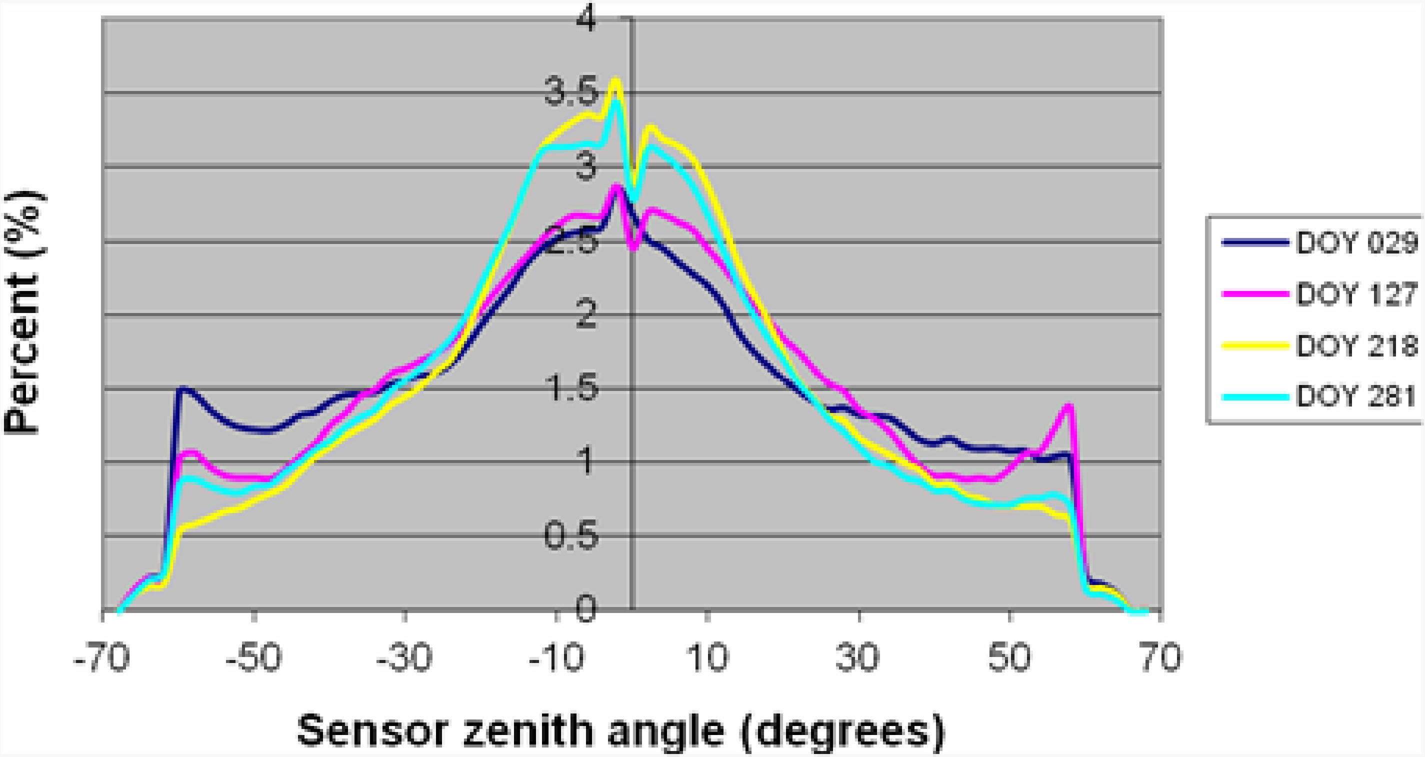
Compositing Procedure (7)

- Instead of selecting the maximum NDVI, the compositing algorithm selects the maximum view-angle adjusted SAVI (MVA-SAVI) in a compositing period for each pixel.
- MVC selects the maximum NDVI observation at sensor zenith angle 52° in the forward scatter direction.
- Whereas the MVA-SAVI compositing method selects the observation closest to the nadir view since VA-SAVI values are reduced according to the sensor zenith angles.
- The higher sensor zenith angles, the smaller VA-SAVI values.



Comparison of the maximum value compositing and the maximum view angle adjusted SAVI compositing. In the compositing period, only one day of observation is cloudy and the other six days are cloud-free

Compositing Procedure (8)



Histograms of sensor zenith angles composited by the MVA-SAVI method at different seasons. The peaks of the histograms of sensor zenith angles composited by the MVA-SAVI method are close to the nadir at different seasons, indicating that observations close to the nadir view are likely selected than the off-nadir observations.

GVF From NDVI

- The Gutman and Ignatov (1998) derived GVF from AVHRR NDVI based on a linear relationship between NDVI and GVF:

$$GVF = (NDVI - NDVI_0) / (NDVI_\infty - NDVI_0)$$

  where $NDVI_0$ and $NDVI_\infty$ are the NDVI values for bare soil and dense green vegetation respectively.

- The current GVPS was developed in NOAA/STAR to generate real-time weekly 16-km global GVF from AVHRR GVI data based on the Gutman and Ignatov's method (Jiang et al. (2010)).
- Details of GVPS are available at http://www.star.nesdis.noaa.gov/smcd/emb/vci/gvps/index.php

GVF From EVI (1)

- EVI was developed to optimize the vegetation signal with improved sensitivity in high biomass regions and improved vegetation monitoring through a de-coupling of the canopy background signal and a reduction in atmosphere influences.
- With the availability of blue bands, EVI data can be produced from the VIIRS sensor. This represents a potential advance over the AVHRR NDVI
- EVI not only gains its heritage from the soil-adjusted vegetation index (SAVI) (Huete, 1988) and the atmospherically resistant vegetation index (ARVI) (Kaufman and Tanré, 1994), but also improves the linearity with vegetation biophysical parameters, encompassing a broader range in leaf area index (LAI) retrievals (Houborg et al., 2007).
- It has been shown to be strongly linear related and highly synchronized with seasonal tower photosynthesis measurements in terms of phase and amplitude, with no apparent saturation observed over temperate evergreen needleleaf forests (Xiao et al., 2004), tropical broadleaf evergreen rainforests (Huete et al., 2006), and particularly temperate broadleaf deciduous forests (Rahman et al., 2005; Sims et al., 2006).

GVF From EVI (2)

- With the improved linearity and sensitivity in high biomass regions, EVI is suitable to derive GVF.
- The suitability of EVI for estimation of GVF based on the Gutman and Ignatov's method was tested and compared with the heritage TOA NDVI and TOC NDVI using the MYD09GA data.
- It was found that GVF derived from EVI has a smaller error and bias than those derived from TOA NDVI and TOC NDVI.
- Results from this study are presented later

EVI Calculation (1)

- EVI values are calculated from the weekly composited VIIRS red (I1), NIR (I2), and blue (M3) reflectance. The equation for EVI takes the form:

$$EVI = G\frac{\rho_{NIR} - \rho_{red}}{\rho_{NIR} + C_1\rho_{red} - C_2\rho_{blue} + L}$$

where ρ_{NIR}, ρ_{red}, ρ_{blue} are the top of canopy (TOC) NIR, red and blue reflectances respectively, L is the canopy background adjustment that addresses nonlinear, differential NIR and red radiant transfer through a canopy, and C1, C2 are the coefficients of the aerosol resistance term, which uses the blue band to correct for aerosol influences in the red band.

- The coefficients adopted in the EVI algorithm are, L=1, C1=6, C2 = 7.5, and G (gain factor) = 2.5 (Huete, et al., 2002; Liu and Huete, 1995).

EVI Calculation (2)

- Due to the use of blue band, the denominator of the EVI equation could be equal to, or very close to, 0 and EVI values are abnormal under certain circumstance. For example, when ρ_{red} =0.2380, ρ_{NIR}=0.2255 and ρ_{blue}=0.3538, the EVI value becomes infinite.

- A two-band EVI (EVI2) without a blue was developed by Jiang et al. (2008), which is robust under any circumstance and has the best similarity with the 3-band EVI. :

$$EVI2 = 2.5 \frac{\rho_{NIR} - \rho_{red}}{\rho_{NIR} + 2.4\rho_{red} + 1}$$

- If EVI values are larger than 0.9 or smaller than -0.1, then the EVI values are replaced by EVI2 values

High Frequency Noise

- Cloud, ozone, dust, and other aerosols generally reduce the contrast of NIR and red reflectance over vegetated surface observed from space, which leads to undesirable variation in vegetation index products (Goward et al., 1991; Holben, 1986).
- Variation in viewing and sun geometry can lead to variation of EVI time series due to the BRDF effects of land surface.
- Sims et al. (2011) observed that EVI was highest for large view angles in the backscatter direction and lowest for larger view angles in the forward scatter direction and conclude that EVI was significantly affected by view angle variations.
- Because the variations in EVI caused by these effects occur on time scales much shorter than the weekly compositing period, they show up as high frequency noise

EVI Smoothing

- To reduce the high frequency noise in the EVI time series caused by the cloud, aerosol and BRDF effects, the smoothing method used in the NOAA Vegetation Health Product (VHP) system is used (http://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/index.php).
- The method stems from a statistical approximation of the vegetation annual time series.
- The idea was to:
  - » (a) single out the seasonal cycle
  - » (b) suppress high frequency noise
  - » (c) enhance medium and low frequency variations related to large-scale and persistent weather fluctuations.
- This technique considers smoothing the weekly time series with a combination of a compound median filter and the least squares technique (Kogan et al., 2011; Kogan et al. 1990).

GVF Calculation

- GVF values are calculated from smoothed weekly EVI:

$$GVF = (EVI - EVI_0) / (EVI_\infty - EVI_0)$$

where EVI_0 and EVI_∞ are the global minimum and maximum EVI. The equation is modified from the Gutman and Ignatov's method.

- For pixels with EVI values greater than EVI_∞, the GVF values will be set as 1. Similarly, when $EVI < EVI_0$, then GVF=0.

GVF Gap Filling

- There is no VIIRS reflectance data in high latitude area in winter because of no sunlight, resulting in gaps in VIIRS GVF.
- To fill the gaps in winter, a GVF climatology was created from MODIS Vegetation Continuous Field product and MODIS Land Cover product. Both MODIS products are produced yearly, at nominally 250m and 500m resolutions respectively.
- From the year 2010 land cover product, pixels with the evergreen needle-leaf, evergreen broad-leaf, and mixed forest land cover types were identified. The tree fraction data were retrieved from the MODIS Vegetation Continuous Field product. By combining these two products, the fractions of evergreen needle-leaf, evergreen broad-leaf trees in each pixel were calculated.
- For mixed forests pixels, 50% of the tree fraction is assumed to be evergreen tree fraction. In theory, evergreen tree fraction is the GVF for cold regions where there is no other evergreen vegetation.
- All 0.003° GVF gaps (if present) are filled with GVF climatology.

GVF Aggregation

- The GVF previously calculated at the 0.003 degree grid is aggregated 3x3 to a 0.009 degree grid (~ 1 km) for output to regional 1km files.
- The GVF previously calculated at the 0.003 degree grid is aggregated 12x12 to a 0.036 degree grid (~ 4 km) for output to global 4km files.
- Pixels with a “cloud” designation are excluded from the aggregations
- If all pixels in a grid have a “cloud” designation, the cloud pixels are aggregated and the grid is tagged with a “cloudy” QC flag.

Algorithm Output

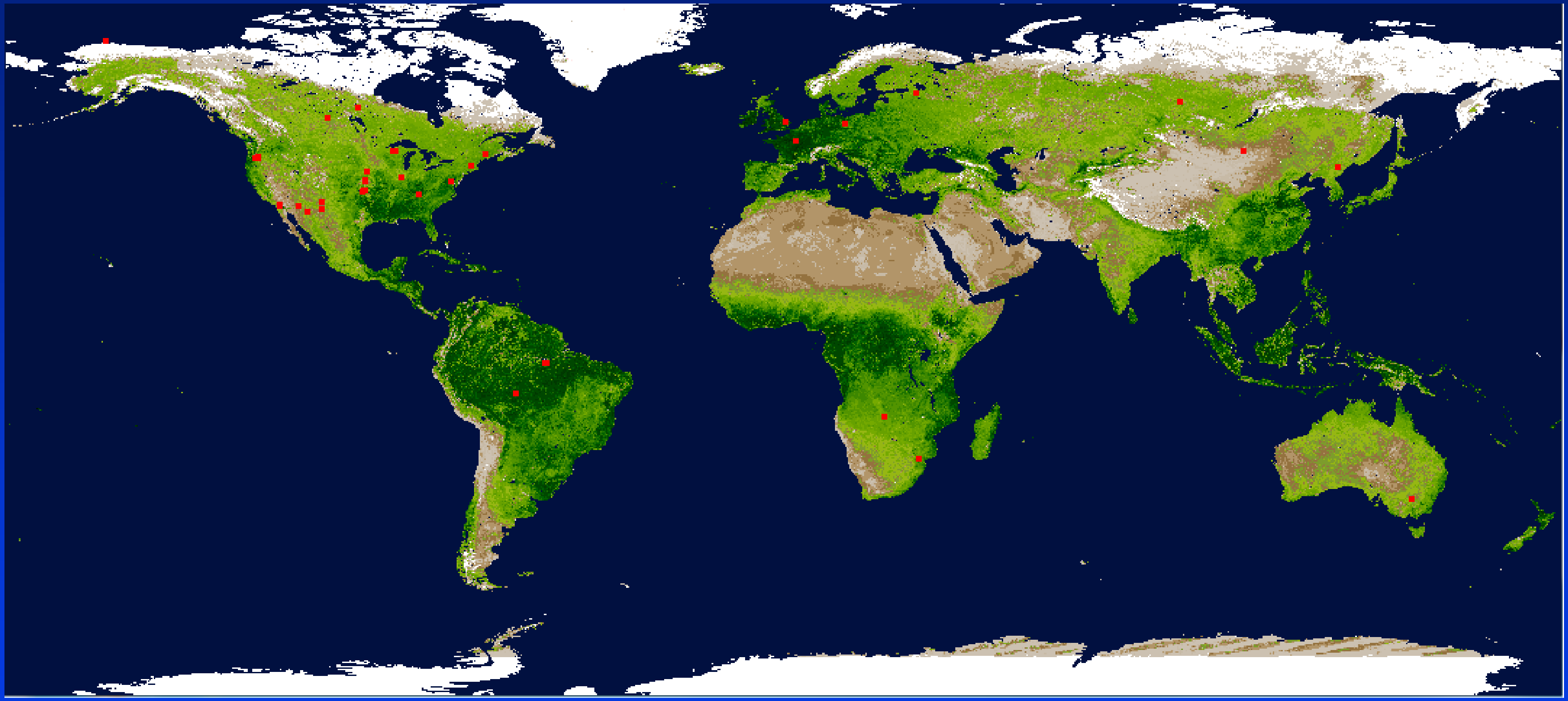
- The outputs of Green Vegetation Fraction Processing (GVFP) algorithm include:

- Daily Rolling Weekly 4-km GVF on a global geographic projection grid stored in a NetCDF file and a GRIB2 file, respectively.
- Daily Rolling Weekly 1-km GVF regional maps in geographic projection stored in GRIB2 files.
- Color-coded browse images of the global and regional GVF maps, stored in Geo-TIFF file format.
- Metadata: Major metadata will be saved as file attributes in each NetCDF file. GVF statistical data (mean and standard deviation over selected areas), which are useful for OSPO to monitor the GVF product data quality and processing status, are saved in a text file.

Performance of the EVI-Based Approach - Test Cases

- To test the performance of the GVFP algorithm, weekly GVF data were produced using the Gutman and Ignatov's method from TOA NDVI and TOC NDVI, respectively.
- Weekly TOA and TOC NDVI were composited using the traditional MVC method.
- Four months of weekly GVF data were produced based on the three different vegetation index datasets, i.e. TOA NDVI, TOC NDVI and EVI, respectively.
- Reference GVF data were derived from 129 Landsat/ETM+ images distributed globally over 30 EOS land validation core sites and in different seasons using a decision-tree classification method.

Performance of the EVI-Based Approach – Validation Sites

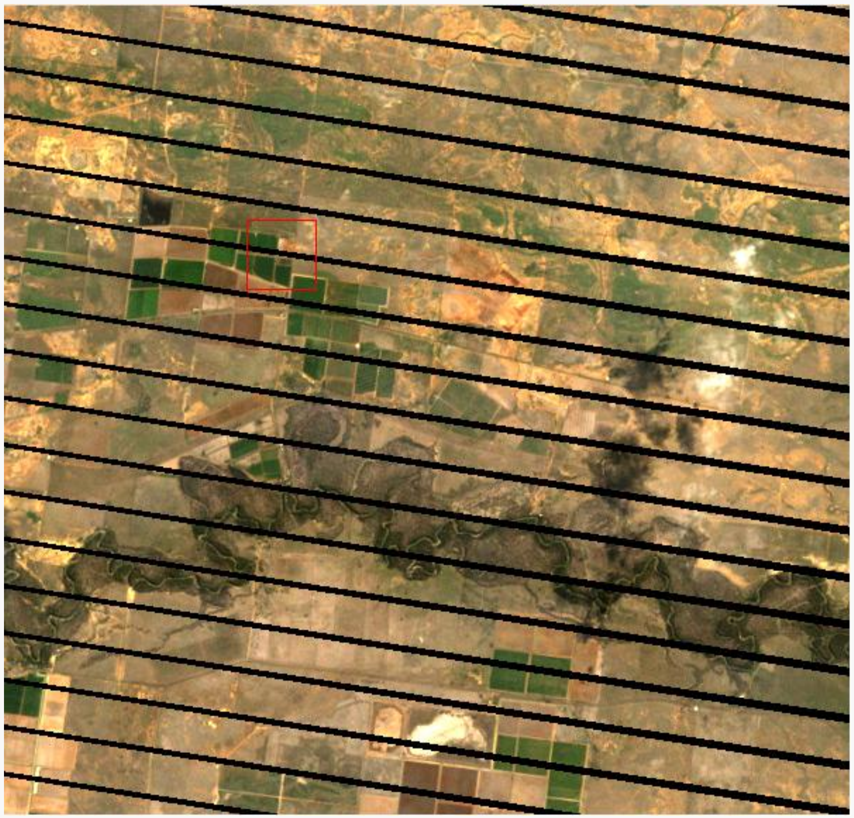


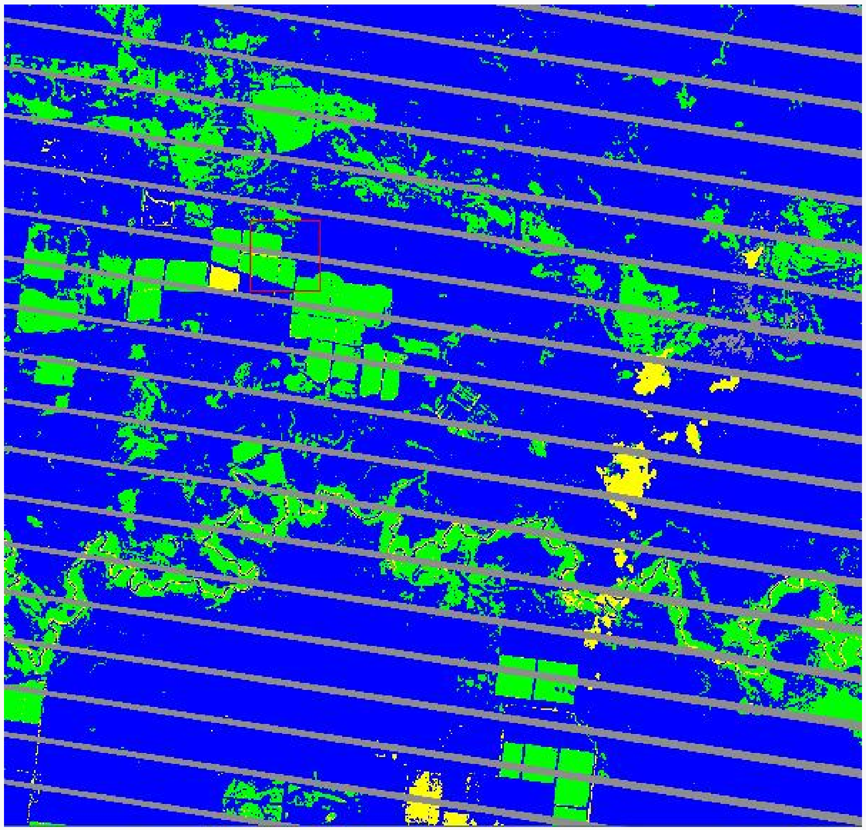
- The EOS Land Validation Core Sites are intended as a focus for land product validation over a range of biome types (http://landval.gsfc.nasa.gov/coresite_gen.html)

Classification Tree

- The classification tree is a robust classifier with good accuracy and has been used to generate the standard MODIS land cover classification MOD12 (Friedl et al. 2002) and MODIS vegetation continuous field MOD44 (Hansen et al. 2002).
- The routine *rpart* in the open-source statistical package ***R*** is used to generate the classification tree rules from the training data.
- The R rules are then implemented as a C function to classify the Landsat data for efficiency.

Landsat Classification Map





Landsat true color image (a) and the classification map (b). Green: vegetation; Blue: bare soil; Yellow: cloud. Green agricultural lands and natural vegetation areas are classified as vegetation successfully by visual examination.

Error Estimates (1)

- The Landsat classification maps were re-projected to a 4-km geographic projection grid.
- GVF “truth” for each 4-km grid were calculated as the fraction of Landsat pixels within the grid that are classified as vegetation
- This was compared with the GVF data derived from TOC EVI, TOC NDVI and TOA NDVI to estimate GVF error for each of the three indices.

Error Estimates (2)

- Mean absolute error and accuracy were calculated from a dataset of 119,441 cloud-free 4-km pixels

Mean absolute error $= \frac{1}{n}\sum \left| GVF_{VI} - GVF_{Landsat} \right|$

Accuracy = $\frac{1}{n}\sum \left(GVF_{VI} - GVF_{Landsat} \right)$

	Mean absolute error	Accuracy
GVF from TOA NDVI	0.26	0.24
GVF from TOC NDVI	0.20	0.19
GVF from TOC EVI	0.17	0.09

The Table shows that:

- GVF from TOC EVI has the smallest Mean absolute error
- GVF from TOC EVI performs especially best for Accuracy.
- Only the TOC EVI approach meets the Accuracy < 10% requirement

Sensor Radiometric Performance (1)

- The S-NPP was launched on October 28, 2011. Following a series of spacecraft and sensor activation and checkouts, the first VIIRS image was acquired on November 21, 2011, and all 22 VIIRS bands were producing early images by January 20, 2012.
- Since launch, the VIIRS SDR calibration/validation has been progressing well. A team of experts from NOAA, NASA, the Aerospace Corporation (Aerospace), University of Wisconsin, MIT/Lincoln Laboratory, and other industry partners have worked intensively and performed a thorough evaluation of the VIIRS on-orbit performance with 58 cal/val tasks.
- These tasks include 7 tasks for Functional Performance & Format evaluation (FPF), 7 tasks for Calibration System Evaluation (CSE), 4 tasks for Image Quality Evaluation (IQE), 25 tasks for radiometric evaluation (RAD), 9 tasks for Geometric Evaluation (GE), and 5 tasks for Performance and Telemetry Trending (PTT). Descriptions of these tasks can be found in the VIIRS SDR Operational Concept (OPSCON) document (DeLuccia and Cao, 2011).

Sensor Radiometric Performance (2)

- The VIIRS instrument post-launch calibration/validation process undergoes three phases:
  - » Early orbit checkout (EOC)
  - » Intensive Calibration/Validation (ICV)
  - » Long-term Monitoring (LTM).

- Typically, EOC is the first 3-6 months after the instrument is turned on. ICV is the period from the end of EOC to plus approximately 2-6 months. LTM is the period from the end of ICV until the end of the mission when the data is mature for operational use, although anomalies and upgrades are still expected (Cao et. al., 2013).

Sensor Radiometric Calibration (1)

- To meet the radiometric performance requirements through the entire mission, onboard calibration devices are essential for VIIRS.
- The calibration source for RSB (Reflective Solar Bands) is a full aperture SD (Solar Diffuser) that is illuminated once per orbit as the satellite passes from the dark side to the sunlit side of the earth in the high latitudes of the southern hemisphere. An attenuation screen covers the opening, but there is no door or other optical element between the SD and the sun.
- The Bidirectional Reflectance Distribution Function (BRDF) of the SD and the transmittance of the attenuation screen are measured pre-launch and verified on-orbit through observations made during spacecraft maneuvers.
- Given the angles of incidence, the reflected solar radiance can be computed and is used as a reference to produce calibrated reflectance and radiance.
- The space view (SV) provides the offset measurements needed for the calibration.

Sensor Radiometric Calibration (2)

- Based on post-launch calibration/validation, the VIIRS SD is stable over most of the visible and near-infrared spectrum but shows a moderate degradation towards the blue spectral region.
- For example, an ~10% SD degradation has been observed for the first six months in the 0.412 -m spectral region, primarily due to ultraviolet radiation on the SD, while little degradation is observed in the longer wavelength such as the 0.865um spectral region.
- This VIIRS SD degradation is more pronounced than that of Aqua MODIS which is ~2.6% per year at 0.412 μm mainly due to the more frequent SD exposure to the sun light since there is no SD door.

Sensor Radiometric Calibration (3)

- The SD degradation is monitored by the SD stability monitor (SDSM), which is a separate device with 8 detectors (from 0.412 μm to 0.926 μm).
- The faster degradation in the longer wavelength is likely due to preferential bombardment by high energy particles which affects more in the longer wavelength than in the shorter wavelength because these particles can penetrate deeper in the detector layers of the focal plane array.
- For the RSB, the calibration uncertainty in spectral reflectance for a scene at typical radiance is expected to be less than 2%. This performance has been demonstrated in pre-launch testing in the laboratory, but on orbit performance requires additional effort by using the onboard SD and vicarious calibration at desert and ocean sites, as well as inter-comparisons with other satellite instruments.
- Additionally, the monthly lunar calibration through a spacecraft roll maneuver is part of the post-launch calibration strategy to ensure that the sensor degradation is independently verified (Cao et. al., 2013).

Sensor Noise Characterization (1)

Band No.	Spectral Range (microns)	Band Gain	Ltyp or Ttyp (Spec)	Lmax or Tmax	Pre-launch SNR or NEdT (K)	On Orbit SNR or NEdT (K)
M3	0.477 - 0.496	H	32	107	690	628
		L	123	702	1111	988
I1	0.597 - 0.679	S	22	718	240	214
I2	0.842 - 0.881	S	25	349	304	264

Post-launch results from on-orbit calibration data show that VIIRS noise performance is excellent, exceeding specifications for all bands.

Performance Estimates - Latency

- Since this a weekly product with 24 hour latency requirement, it is not expected to be a problem to meet the latency requirement
- This will be confirmed by the system test

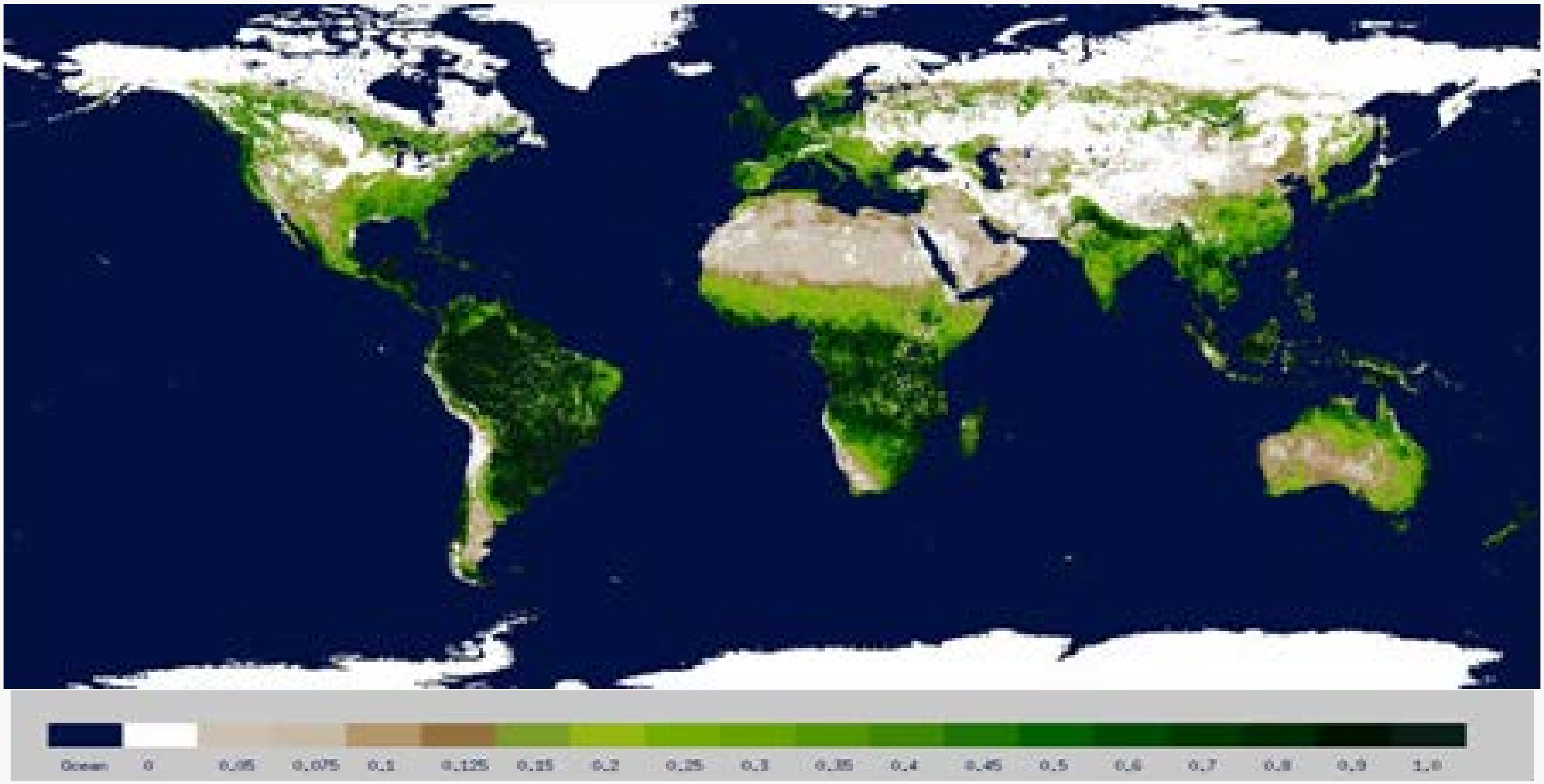
Performance Estimates - Quality

- The results from the test cases are our best indication that the GVFP algorithm has the potential to meet the Accuracy requirement
- Note that the test case results were based on GVF retrievals from MODIS data.
- Accuracy estimates for GVF retrievals from VIIRS data will be made as part of the system test, which is in progress

Sample Results (1)

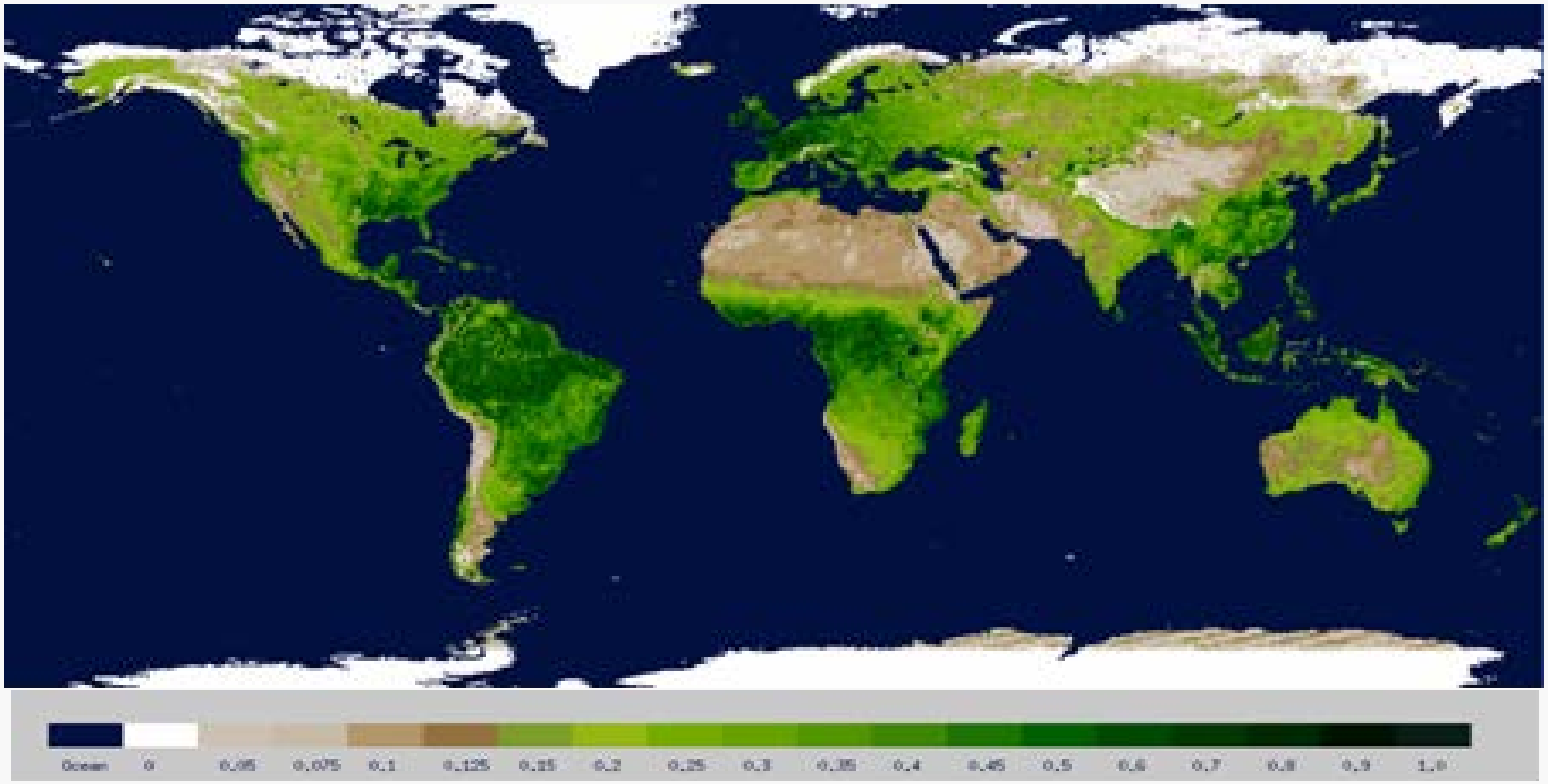
- We present in the following slides examples of weekly GVF maps produced from our test retrievals in four different seasons.
- The retrieved GVF maps generally exhibit a good dynamic range from 0-1, indicating that this algorithm is capable of retrieving the required range of GVF values from the satellite sensor.
- The spatial patterns shown in the maps are also consistent with global dry/wet patterns of climate regimes and seasonal variations.

Sample Results (2)



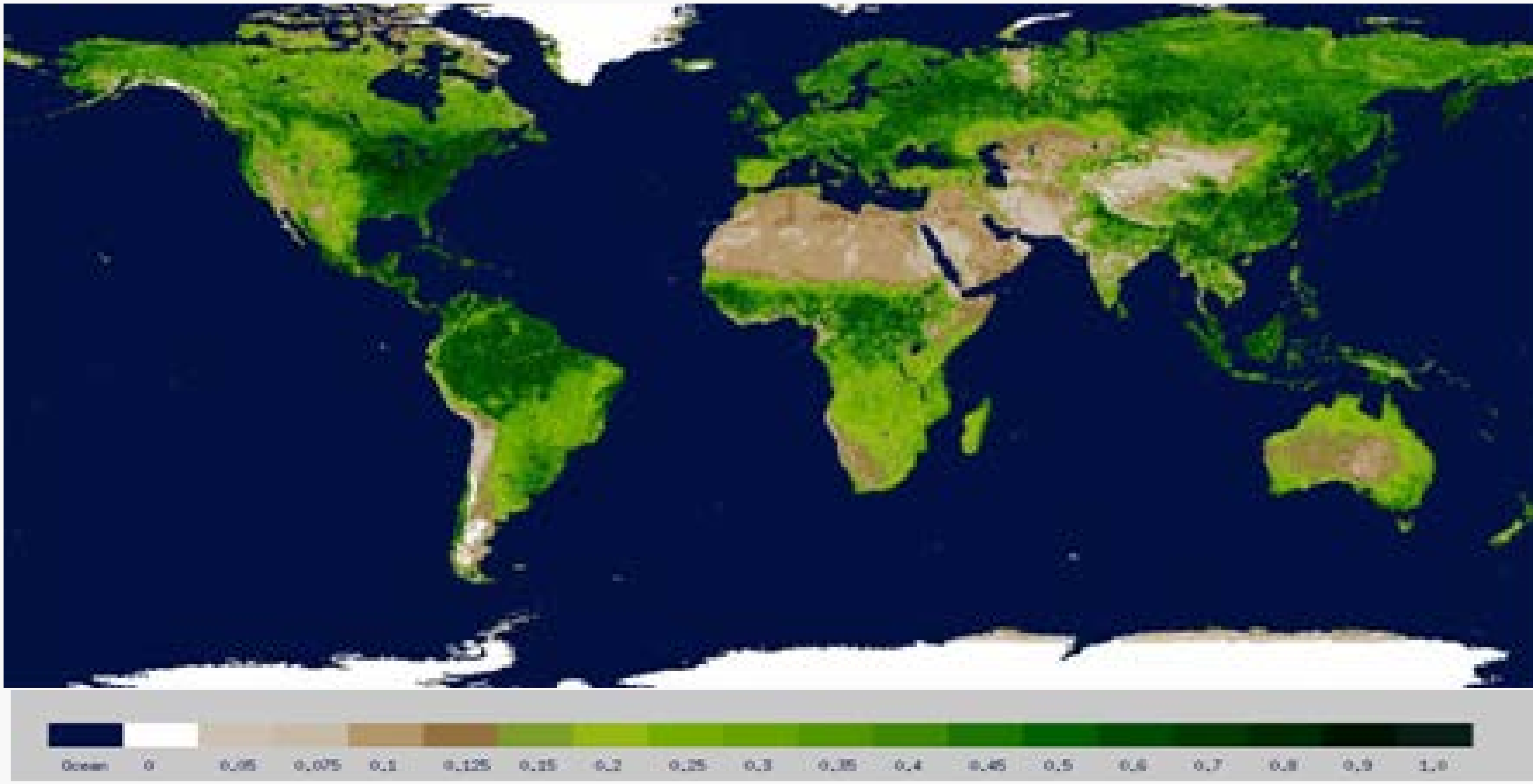
Weekly 4-km Green Vegetation Fraction maps produced by the GVFP algorithm in February (DOY 029-035)

Sample Results (3)



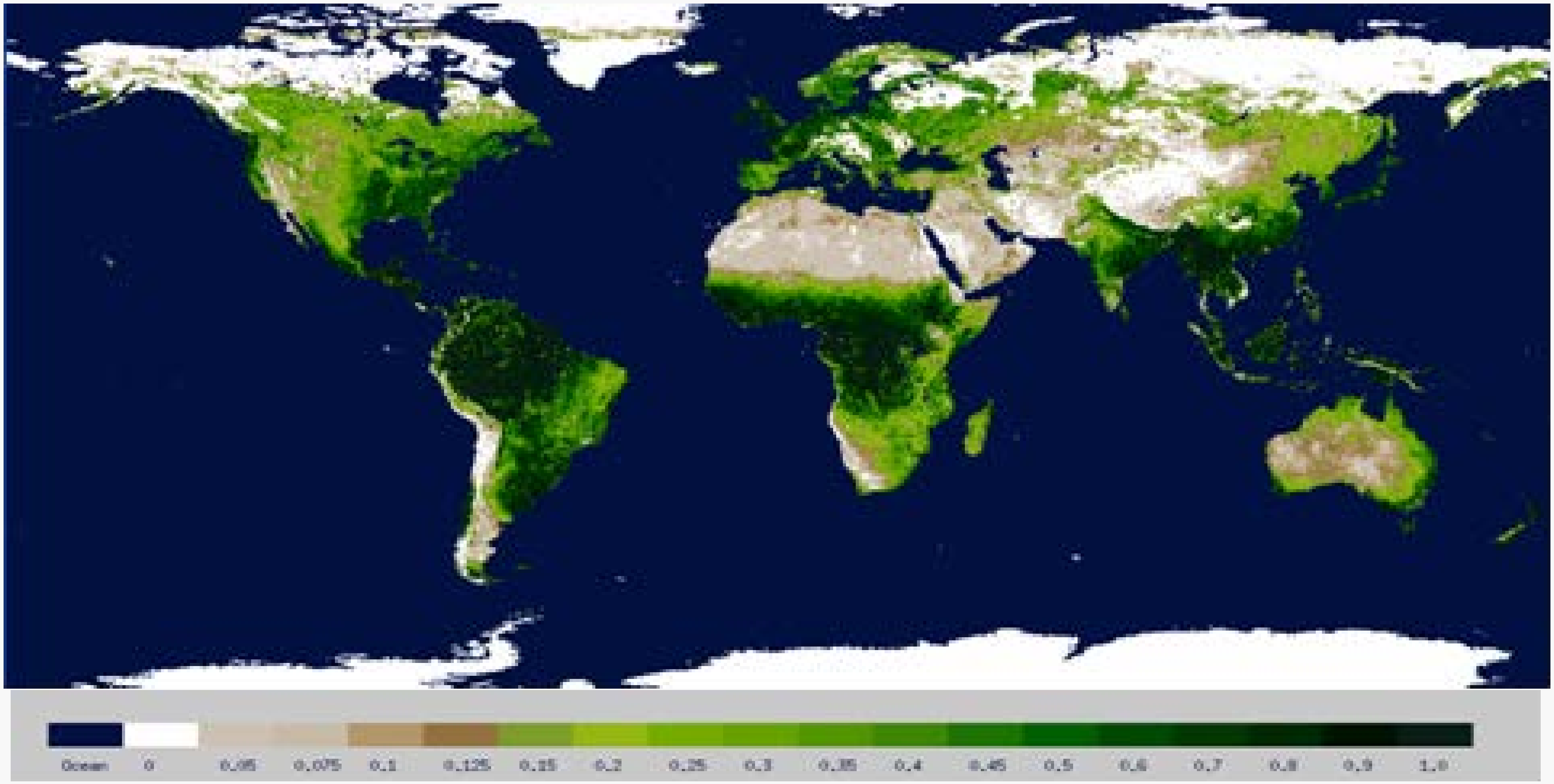
Weekly 4-km Green Vegetation Fraction maps produced by the GVFP algorithm in May (DOY 120-126)

Sample Results (4)



Weekly 4-km Green Vegetation Fraction maps produced by the GVFP algorithm in August (DOY 211-217)

Sample Results (5)



Weekly 4-km Green Vegetation Fraction maps produced by the GVFP algorithm in October (DOY 295-301)

Validation

- Validation will be performed by system testing. This is in progress.

Assumptions

- EVI change is slow and smooth from week to week. Abnormal jumps in EVI time series will be considered as noise and be removed.

Limitations

- The GVFP algorithm will calculate green vegetation fraction for all areas including snow and high latitude areas (i.e., these are not filtered out)
- But for the high latitude area in the North Hemisphere in winter, there is no reliable data from the VIIRS sensor onboard the Suomi NPP satellite due to the lack of sunlight, or extremely high solar zenith angle (>80 degrees)
- For pixels in this region, GVF is assigned a value based on the GVF Climatology.

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Section 4.2 – System Design

Presented by

Junchang Ju (AER)

Software Architecture

- The software system is an integrated collection of software elements, or code, that produce well-defined output products from a well-defined set of input data, thereby implementing the algorithm that has been developed to meet product requirements and system requirements
- These software elements are identified as components of the product processing system
- The software architecture organizes these components into an integrated framework that describes the structure of the system and the external and internal data flows between software elements

Changes to Software Architecture Since CTR

- DVI sub-unit revised for alternative EVI calculation
- GVF Climatology updated
- GG sub-unit added (Gap filling)

Software Architecture Documentation

- The software architecture is described in the Software Architecture Document (SWA)
  - SWA Guidelines in STAR EPL process asset DG-1.2 at http://www.star.nesdis.noaa.gov/star/EPL_index.php
  - SWA v1r4, an SRR artifact, is available at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php
  - Purpose: Provide a description of the software components and data flows for the processing code that will implement the algorithm for the retrieval of GVF data products

Software Detailed Design

- The software detailed design describes the project system's software functionality and design characteristics at a level of detail that covers, for each software element:
  - » Its purpose
  - » Allocation to project requirements
  - » External interfaces
  - » Decomposition into sub-elements
  - » Functional sequence
  - » Design Language
  - » Input and Output File Descriptions

Software Detailed Design Documentation

- The detailed design of each software unit is described in a Detailed Design Document (DDD)
- DDD Guidelines are provided in STAR EPL process asset DG-8.1 at http://www.star.nesdis.noaa.gov/star/EPL_index.php
- DDD v1r4, an SRR artifact, is available at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

Detailed Design
Software Architecture

Raytheon

Context Layer - 0	External Interfaces
System Layer - 1	Flows Between Units
Unit Layer - 2	Flows Within Units
Sub-Unit Layer - 3	Flows Within Sub-Units

The Context Layer

- The Context Layer describes the flows between the system and its external interfaces

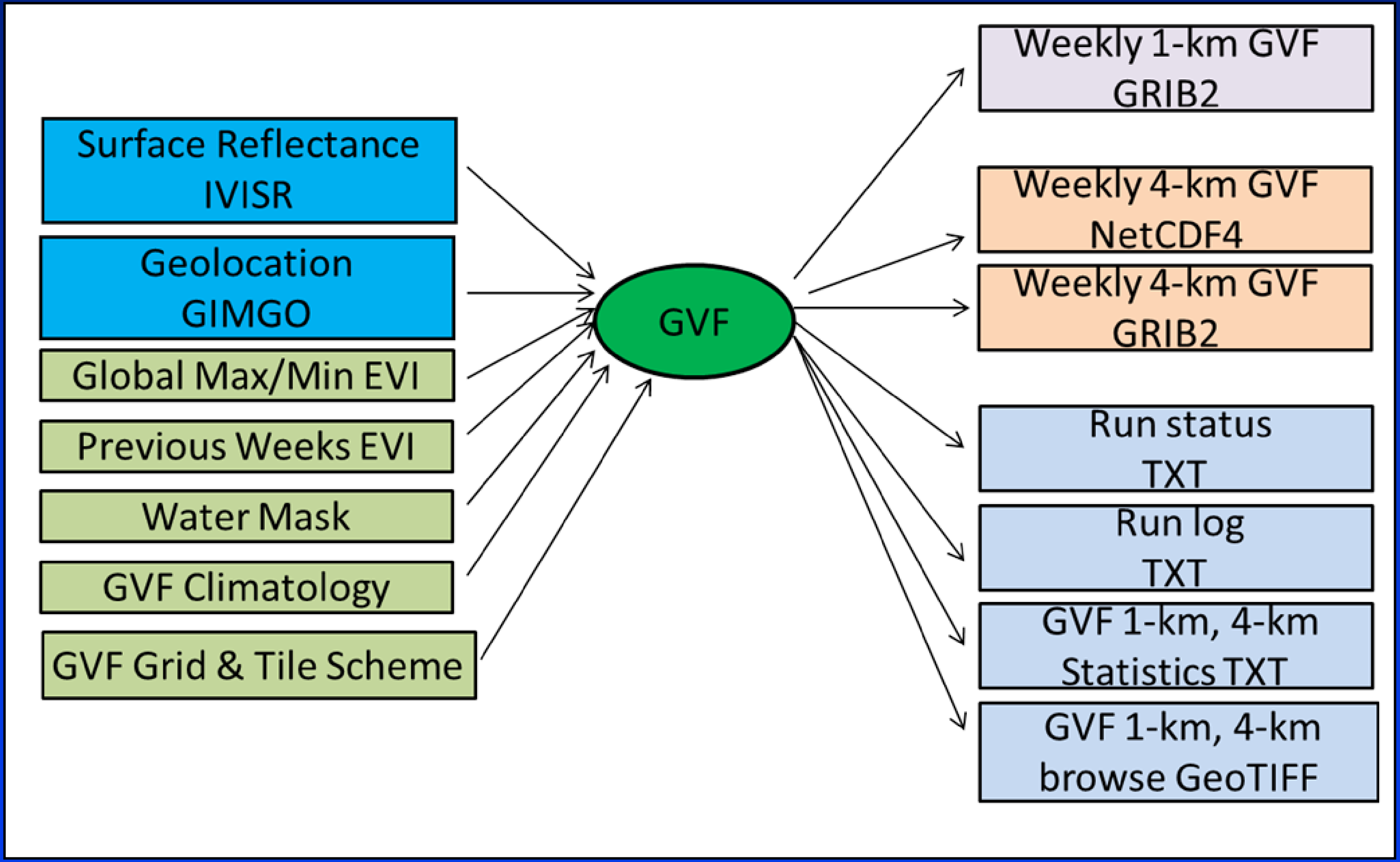
GVF External Inputs

Item	Type	Source	Description
GVF Grid and Tile Scheme	Input	GVF	The origin and spatial resolution and partition of the GVF coordinate system
Surface reflectance (IVISR)	Input	NPP/JPSS	VIIRS surface reflectance in I1, I2, and M3 bands (IVISR granule file). The QF data layers of surface reflectance include the cloud mask adapted from the official cloud mask IICMO granule.
Geolocation (GIMGO)	Input	NPP/JPSS	VIIRS geolocation and solar-view geometry for imagery resolution I1, I2 bands (GIMGO granule file). The moderate resolution geolocation granule is not explicitly needed for the moderate resolution M3 band because of the nesting of imagery resolution pixels within moderate resolution pixels and the nearest-neighbor resampling used in gridding by this project.
Global Max/Min EVI	Input	GVF	The global maximum and minimum EVI values for the VIIRS instrument. Two numbers. Plus the allowed range of EVI calculation – values outside of this range are re-calculated with the alternate formula.
Compositing coefficients L, C1 and C2	Input	GVF	The coefficients used in the maximum view angle adjusted SAVI compositing.
Water Mask Tile	Input	GVF	Derived from MODIS global water mask (MOD44W) by projecting to the internal GVF grid.
Previous Weeks Weekly EVI	Input	GVF	Weekly EVI for previous14 weeks on 0.003° grid in HDF5. This is produced by the GVF production system as intermediate output and saved locally.
GVF climatology	Input	GVF	Evergreen tree fraction, produced from MODIS Vegetation Continuous Field and MODIS Land Cover Type. This will be used to fill the winter time GVF gaps at high latitude.

GVF External Outputs

Item	Type	Source	Description
Weekly 1-km GVF GRIB2	Output	GVF	Weekly GVF on 0.009° grid in GRIB2
Weekly 4-km GVF NetCDF4	Output	GVF	Weekly GVF on 0.036° grid in NetCDF4
Weekly 4-km GVF GRIB2	Output	GVF	Weekly GVF on 0.036° grid in GRIB2
GVF status TXT	Output	GVF	The execution status report of GVF processes. Used in monitoring the production process at OSPO (not for distribution)
GVF log TXT	Output	GVF	The execution progress report of major GVF processes. Used in monitoring the production process at OSPO (not for distribution)
Weekly 1-km GVF Statistics TXT	Output	GVF	Statistics of 1-km GVF on 0.009° grid for selected areas and sites. Used in monitoring the production process at OSPO (not for distribution)
Weekly 4-km GVF Statistics TXT	Output	GVF	Statistics of 4-km GVF on 0.036° grid for selected areas and sites. Used in monitoring the production process at OSPO (not for distribution)
GVF 1-km browse GeoTIFF	Output	GVF	Weekly 1-km GVF browse image in GeoTIFF used in monitoring the production process at OSPO (not for distribution)
GVF 4-km browse GeoTIFF	Output	GVF	Weekly 4-km GVF browse image in GeoTIFF used in monitoring the production process at OSPO (not for distribution)

GVF Context-Layer



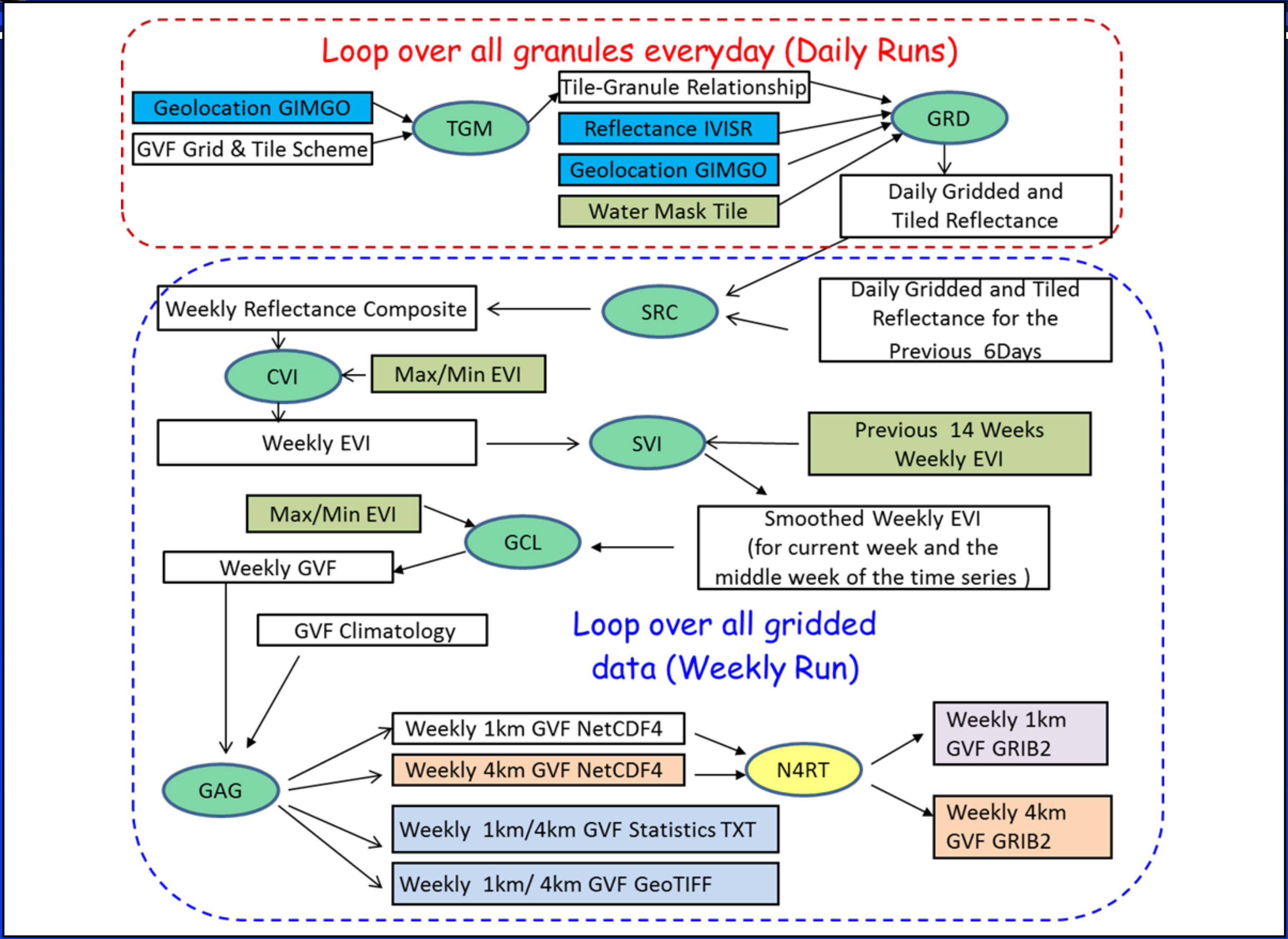
The System-Layer

- 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.

The System-Layer – Software Units

- The system layer of the GVF software consists of six processing units and their data flows:
  - Tile-Granule Mapper (TGM)
  - Surface Reflectance Gridder (GRD)
  - Surface Reflectance Compositor (SRC)
  - Calculate EVI (CVI)
  - Smooth EVI (SVI)
  - GVF Calculator (GCL)
  - GVF Aggregator (GAG)
- The System layer data flows are shown in the next slide

GVF System-Layer Data Flows



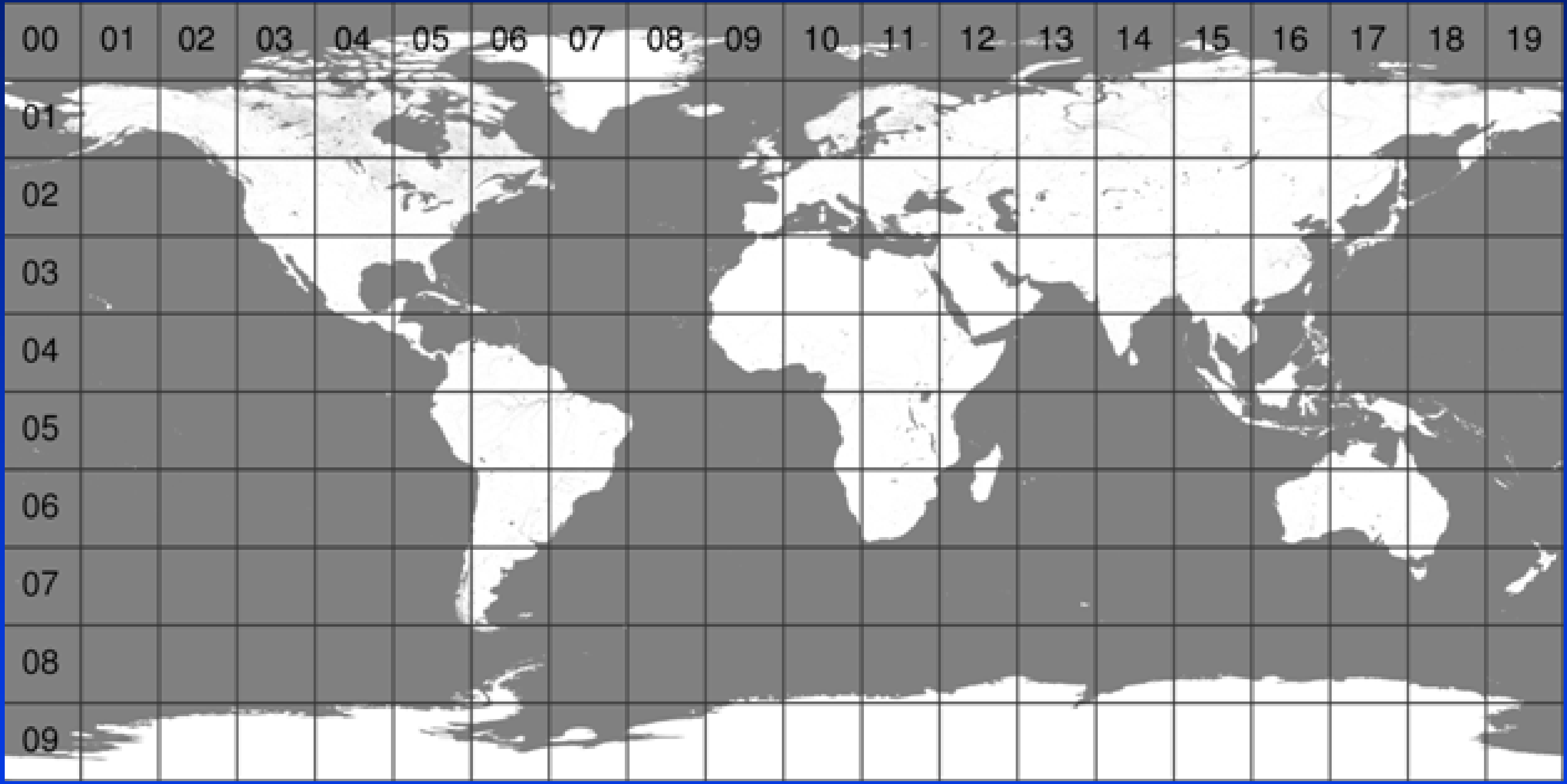
System-Layer Components – TGM Processing Unit

- Tile-Granule Mapper (TGM)
  - » Derives the spatial relationship between each tile and the input granules that specifies for each tile which input granules fall on the tile.
  - » This relationship is critical for a tile-based gridding of VIIRS observations.
  - » The 0.003° GVF grid is subset into 18° x 18° tiles. Once TGM has established the spatial relationship, all subsequent processing will be tile-based.

Grids and Tiles

- The GVF grid system is defined in a latitude/longitude projection at a 0.003^0 spatial resolution, approximately 333 meters near the equator. This resolution is a compromise of the VIIRS imagery resolution band nadir resolution in the along-track and across-track directions.
- Due to the huge data volume globally at 0.003^0, the GVF grid is subset into square tiles, 20 tiles horizontally and 10 tiles vertically. As a result, each tile is 18^0 x 18^0, with 6000 x 6000 pixels (see next slide).
- After the GRD unit projects the VIIRS observations from granules into the predefined GVF grids, all subsequent processing is carried out in tiles, before GVF values are aggregated to regional and global resolutions.

The GVF Tile Scheme



The upper-left corner of the tile map is 180° W, 90° N. Each tile is 18° x 18°, with 6000 x 6000 0.003° pixels. The background of the GVF tiles is created from the MODIS water mask (MOD44W). Only tiles that contain land and are not Antarctic (termed Tiles of Interest (TOI)) are processed.

System-Layer Components – GRD Processing Unit

- Surface reflectance gridder (GRD)
  - » For a given tile of the GVF grid system, grids I1, I2, M3 bands surface reflectance from the granules that fall on the given tile. Processes each tile in a loop over all granules falling on the given tile for the day.

System-Layer Components – SRC Processing Unit

- Surface reflectance compositor (SRC)
  - » Composites the multiple gridded surface reflectance observations of 7 days with a GVF-specific compositing rule.
  - » Compositing is needed primarily in selecting the best observation from the gridded surface reflectance data of 7 days. It may also be needed in producing the gridded daily surface reflectance data; for locations where multiple observations are available for a day, the best observation is selected using the compositing rule and written into the gridded daily data.

System-Layer Components – CVI, SVI, GCL Processing Units

- Calculate EVI (CVI)
  - » Calculates weekly EVI from the weekly reflectance composite.
  - » Processes each tile in a loop.
- Smooth EVI (SVI)
  - » Temporally gap fills and smoothes the weekly EVI using the daily rolling weekly EVI of the current week and the previous 14 weeks.
  - » Processes each tile in a loop.
- GVF Calculator (GCL)
  - » Calculates weekly 0.003 degree GVF after the weekly EVI has been time series gap filled and smoothed. Processes each tile in a loop.

System-Layer Components – GAG Processing Unit

- GVF Aggregator (GAG)
  - » Uses GVF climatology to fill winter GVF gaps.
  - » Aggregates the 0.003° GVF multiple tiles to the 0.009° regional GVF product and 0.036° global product in NetCDF4 format.
  - » Generates and writes statistics of 0.036° and 0.009° GVF for selected areas and sites in TXT format
  - » Generates GVF Geo-TIFF browse images at 0.036° and 0.009° resolution.

System-Layer Components – Unit Data Flows (1)

- Daily Gridded Reflectance
  - » Data Flow: From GRD Unit to SRC Unit
  - » Description: Surface reflectance in I1, I2, and M3 bands mapped onto the tiles of the GVF grid (0.003 degrees), with water pixels filtered out, cloud mask information and sun-view geometry information is retained. Separate file for each tile. Due to lateral overlap of two adjacent orbital data, multiple observations of the same location are possible during a day, especially for high latitude regions, therefore the daily gridded reflectance may be the best of the gridded reflectance observations in a day, selected using a compositing rule.
- Weekly Updated Reflectance Composite
  - » Data Flow: From SRC Unit to CVI Unit
  - » Description: I1, I2, and M3 band surface reflectance composite generated from daily gridded reflectance of the last 7 days. Separate file for each tile.

System-Layer Components – Unit Data Flows (2)

- Weekly EVI
  - » Data Flow: From CVI Unit to SVI Unit
  - » Description: The unsmoothed weekly EVI for the current week derived from the weekly reflectance composite. It inherits the cloud mask in the input composite but discards the sun-view geometry information.
- Previous 14 Weeks Weekly EVI
  - » Data Flow: From CVI Unit (for previous weeks) to SVI Unit
  - » Description: The unsmoothed weekly EVI for the previous 14 weeks. Separate files for each tile.

System-Layer Components – Unit Data Flows (3)

- Smoothed Weekly EVI
  - » Data Flow: From SVI Unit to GCL Unit
  - » Description: The gap filled and smoothed EVI by using a time series of weekly EVI from the current week and the past 14 weeks. Smoothed EVI is generated for current week and the middle week of the time series, and will be used to calculate GVF for respective weeks.
- Weekly GVF
  - » Data Flow: From GCL Unit to GAG Unit
  - » Description: Weekly GVF derived from the smoothed EVI on the GVF grid (0.003º), in HDF5 format. This is the intermediate product from which the final, coarser resolution GVF products will be derived. Separate file for each tile.

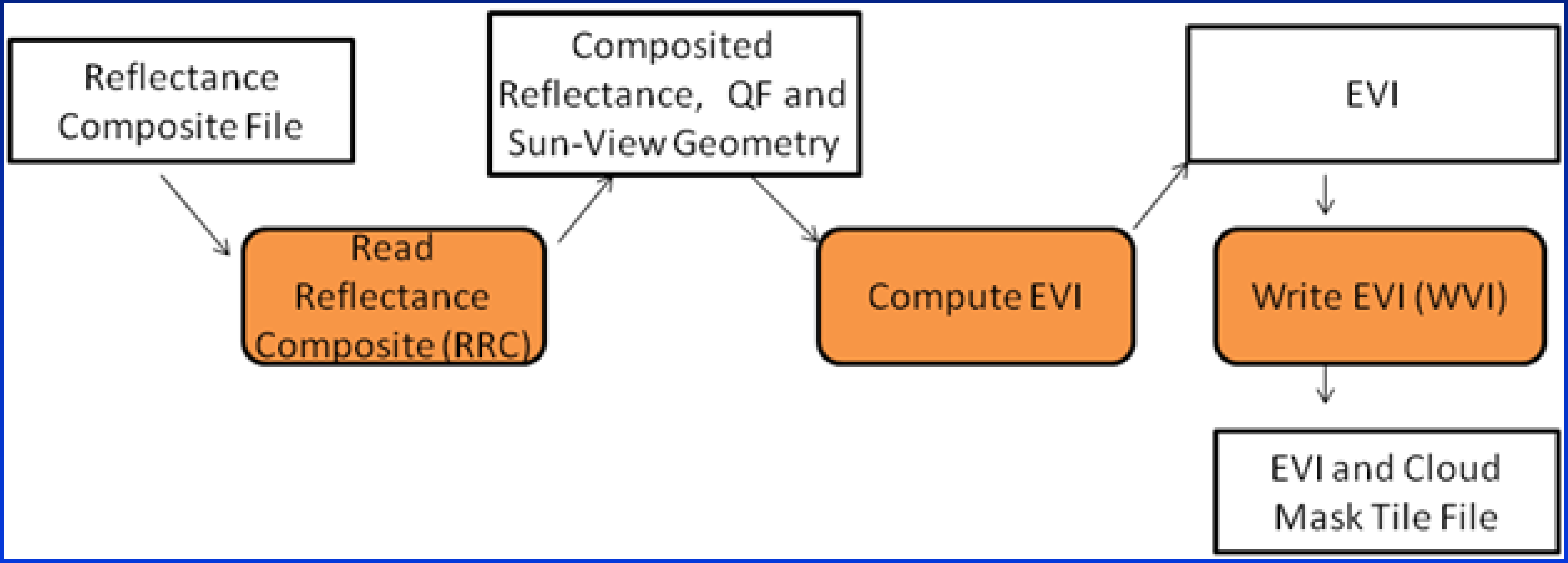
The Unit Layer

- 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.
- Typically, sub-units are identified
- Data flows for each unit were presented in detail at the CTR, and are described in the SWA
- Changes to the Unit-Layer data flows are described in the following slides

The Sub-Unit Layer

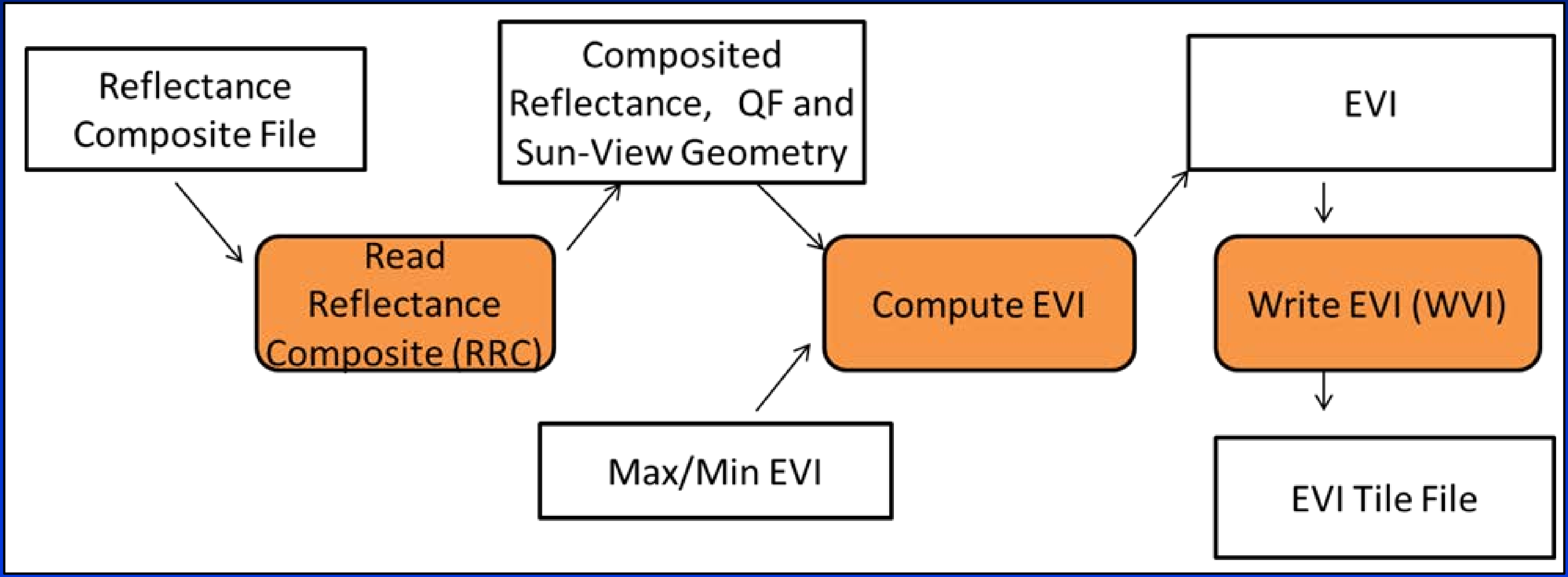
- The Sub-Unit Layer software architecture provides the internal data flows for each of the Unit Layer software Sub-units.
- In this layer, the data flows within sub-units are described.
- Sub-unit layer data flows for each unit were presented in detail at the CDR, and are described in the SWA
- Changes to the sub-unit data flows are described in the following slides

CVI Unit (Previous)



The CVI unit calculates weekly EVI from weekly surface reflectance composite and saves the EVI and cloud mask accompanying reflectance data.

CVI Unit (Revised)

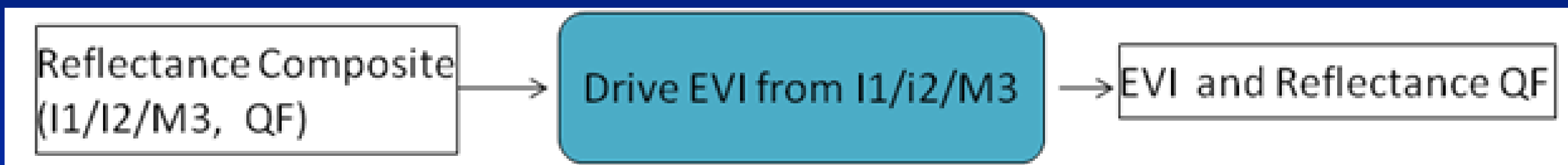


The CVI unit calculates weekly EVI from weekly surface reflectance composite and saves the EVI.

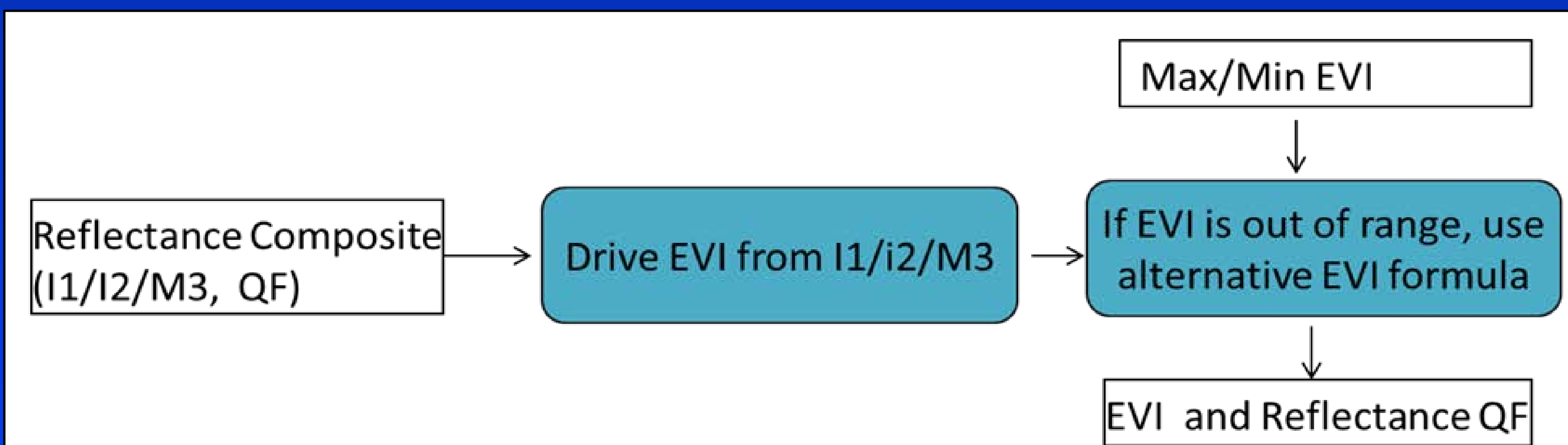
Max/Min EVI is used to select pixels that need EVI calculation with the alternative formula.

Derive EVI (DVI) Sub-Unit

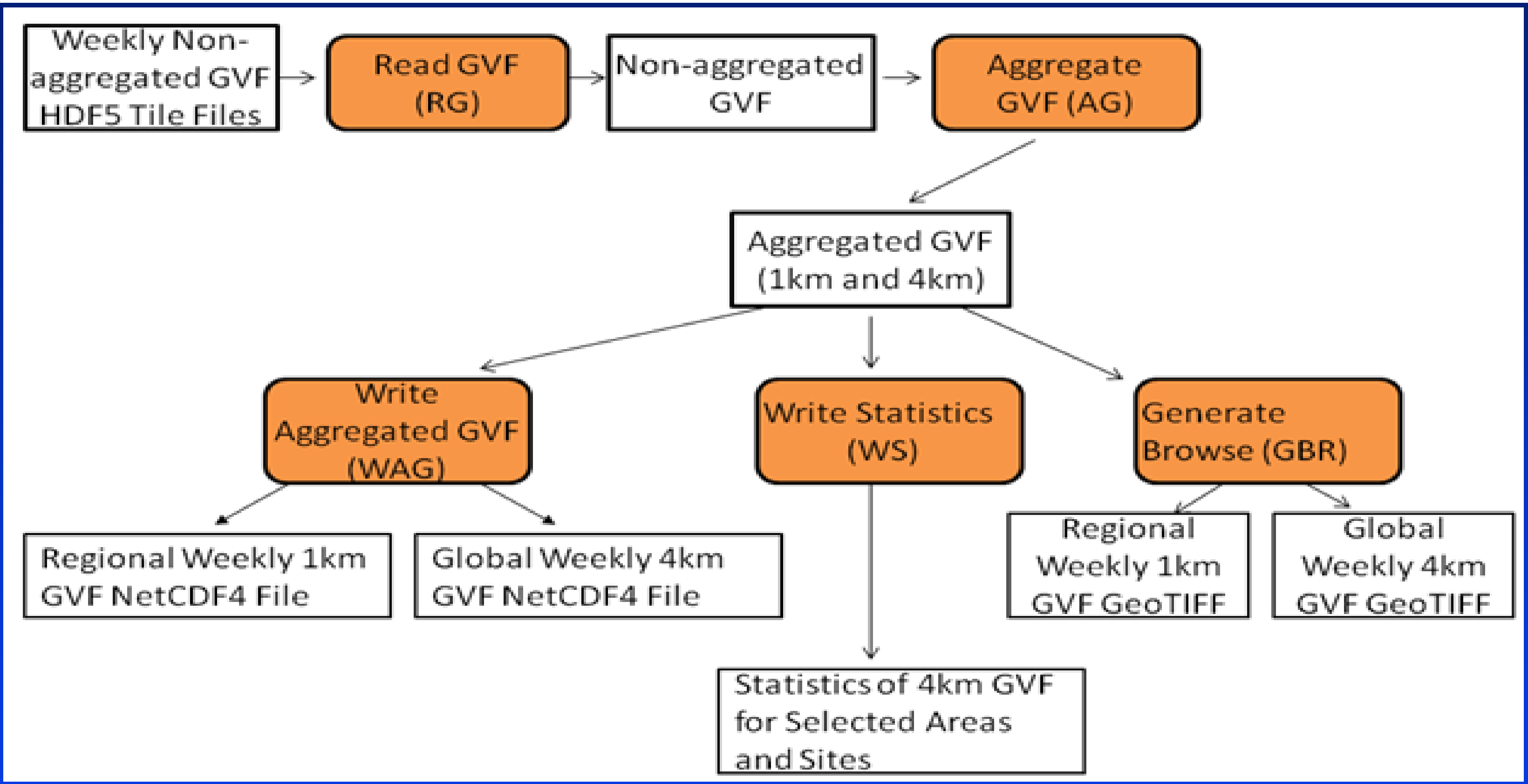
Previous



Revised: Max/Min EVI is used to select pixels that need EVI calculation with the alternative formula.

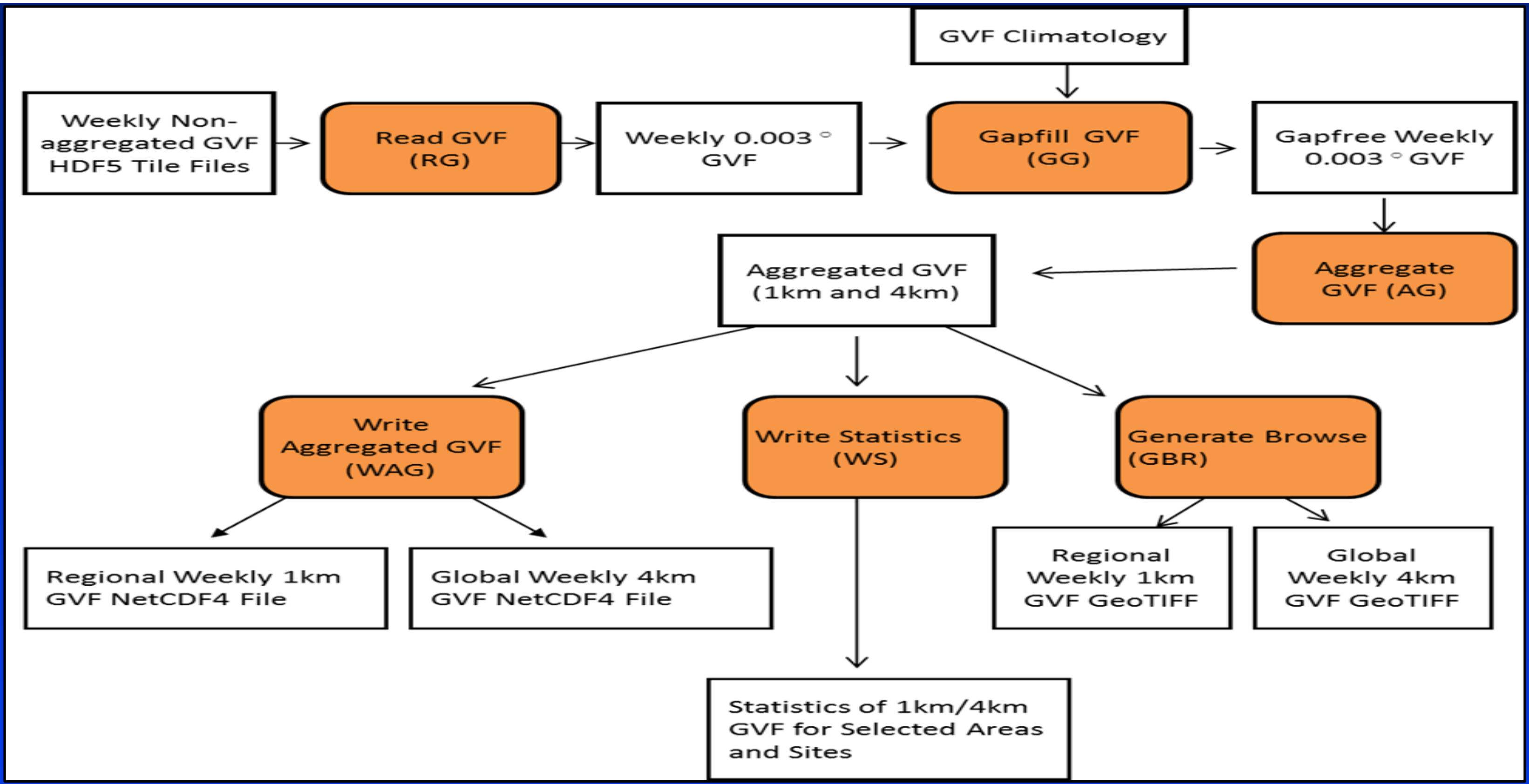


GAG Unit (Previous)



The GAG unit reads the GVF in HDF5 at the GVF grid resolution and aggregates it to the regional 1-km (0.009○) and global 4-km (0.036○) GVF products in NetCDF4 format. For production monitoring purpose, it t also generates and write statistics of the 4-km GVF for selected areas and sites to XML, and generates 1-km and 4-km GVF browse image in GeoTIFF

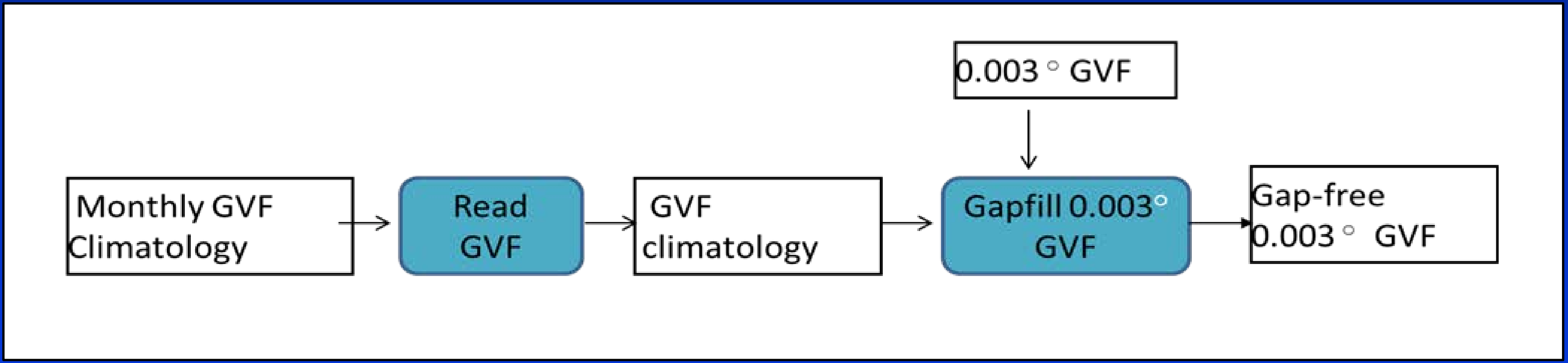
GAG Unit (Revised)



The GAG unit reads the GVF in HDF5 at the GVF grid resolution, fills in gaps with GVF Climatology, and aggregates it to the regional 1-km (0.009○) and global 4-km (0.036○) GVF products in NetCDF4 format. For production monitoring purpose, it t also generates and write statistics of the 4-km GVF for selected areas and sites to XML, and generates 1-km and 4-km GVF browse image in GeoTIFF

NEW - Gapfll GVF (GG) Sub-Unit

New: GVF Climatology is used to fill GVF gaps



1) Project Plan
2) CTR Report
3) System Overview
4) System Description
5) **System Verification**
6) System Readiness
7) Project Status
8) Summary and Conclusions

Section 5 –
System Verification

Presented by

Tom King

Verification and Validation

- Verification is the formal process of confirming that the requirements specified for a specific product or system are satisfied by the completed product or system.
- Validation is a process of evaluation, integration, and test activities conducted to ensure that the final developed system will satisfy the needs and expectations of customers, users, and operators
- In a well-designed system, needs and expectations are completely captured by the requirements allocation. In that case, there is no meaningful distinction between verification and validation
- The methods and planned activities for verification and validation of the project's process and products constitutes the project verification and validation plan

Verification and Validation Plan

- The Verification and Validation Plan (VVP) describes the verification plan
  - » Items (work products) to be verified
  - » Verification methods and activities for each item
  - » Verification risks
- The VVP describes the validation plan
  - » Validation environments
  - » Validation of requirements
  - » Validation of operator needs
  - » Validation of user needs
  - » Validation of products
- The VVP for the GVF Detailed Design Allocation is documented in the file "GVF_VVP_1.4.doc "
- A VVP Appendix is documented as a Microsoft Excel worksheet in the file "GVF_VVP_Appendix_1.4.xls "
  - Both files can be found at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

Removed Verification Items

- There was 1 verification items removed since the CTR. Item # 11, Weekly 1-km GVF Statistics TXT File

Added Verification Items

- There was 1 verification item added since the CTR. Item # 50, DAP #3.

Verification Items 1 - 10

1) STAR EPL Process Assets v3.0
2) GVF Review Check Lists
3) GVF Artifact Repository
4) Subversion CM Tool
5) GVF Global GRIB2 File
6) GVF Global NetCDF4 File
7) Weekly 4-km GVF Statistics TXT File
8) GVF Global TIFF File
9) GVF Regional GRIB2 Files
10) GVF Regional NetCDF4 File

Verification Items 11 - 20

11) GVF Regional TIFF File
12) Log File
13) Run Status File
14) GVF 1-km Browse GeoTIFF File
15) GVF 4-km Browse GeoTIFF File
16) VIIRS Surface Reflectance File
17) VIIRS Geolocation File
18) Water Mask Tile
19) Global Max/Min EVI
20) GVF Climatology

Verification Items 21 - 30

21) GVF Grid and Tile Scheme
22) Previous 14 Weeks EVI
23) TGM Unit
24) Imagery Geolocation
25) Tile-Granule Relationship
26) GRD Unit
27) Surface Reflectance
28) Water Mask
29) Gridded Reflectance Tile File
30) SRC Unit

Verification Items 31 - 40

31) Gridded Reflectance

32) Weekly Reflectance Composite

33) Reflectance Composite Files

34) CVI Unit

35) Weekly EVI

36) Weekly EVI Tile File

37) SVI Unit

38) Smoothed Weekly EVI

39) Updated Previous 7 Weeks EVI

40) GCL Unit

Verification Items 41 - 50

41) Non-aggregated GVF
42) Weekly GVF File
43) GAG Unit
44) Gap-Free GVF
45) Aggregated GVF
46) 1-km Statistics
47) 4-km Statistics
48) DAP # 1
49) DAP # 2
50) DAP #3

Verification Items 51 - 60

51) SCDR Interface

52) Unit Test Data

53) STAR/SADIE Interface

54) STAR/USGS Interface

55) System Test Data

56) GVF Development Server

57) GVF Development Project Plan (DPP)

58) GVF Project Baseline Report (PBR)

59) GVF Project Status Report (PSR)

60) GVF Gate 3 Document (G3D)

Verification Items 61 - 70

61) GVF Project Requirements Document (PRD)

62) GVF Operations Concept Document (OCD)

63) GVF Algorithm Theoretical Basis Document (ATBD)

64) GVF Requirements Allocation Document (RAD)

65) GVF Requirements / Needs Matrix (RNM)

66) GVF Requirements Allocation Sheet (RAS)

67) GVF Software Architecture Document (SWA)

68) GVF Verification and Validation Plan (VVP)

69) GVF Detailed Design Document (DDD)

70) GVF Critical Design Document (CDD)

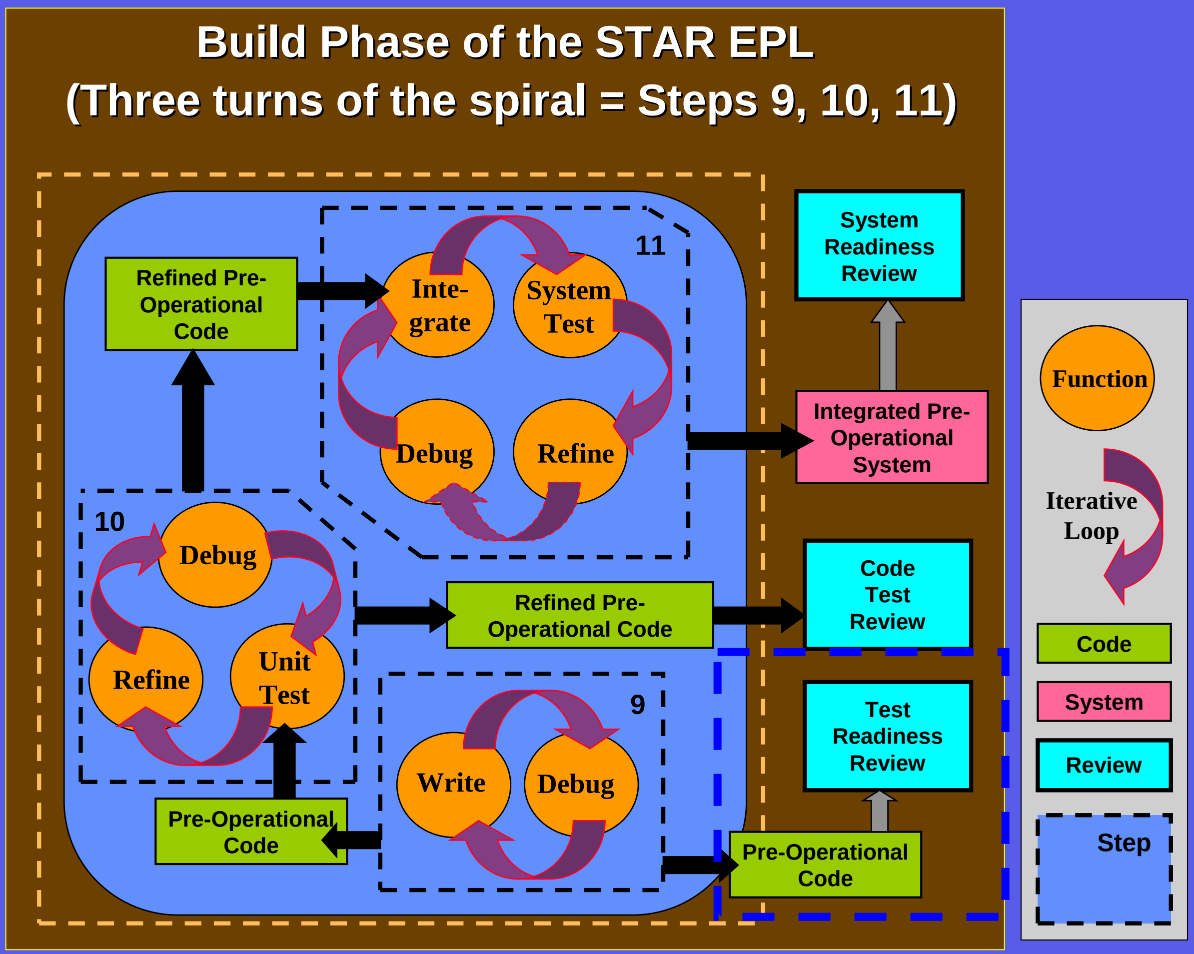
Verification Items 71 - 81

71) GVF Unit Test Plan (UTP)
72) GVF Test Readiness Document (TRD)
73) GVF Unit Test Report (UTR)
74) GVF System Test Plan (STP)
75) GVF Code Test Document (CTD)
76) GVF External Users Manual (EUM)
77) GVF Internal Users Manual (IUM)
78) GVF System Maintenance Manual (SMM)
79) GVF Verification and Validation Report (VVR)
80) GVF System Readiness Document (SRD)
81) GVF System Readiness Review Report (SRRR)

Unit Testing

- Unit testing is performed to confirm that the software functions as designed and produces the expected outputs
- It is the first instance of formal verification and validation, which is intrinsic to the Build Phase

Unit Testing Within the Build Phase

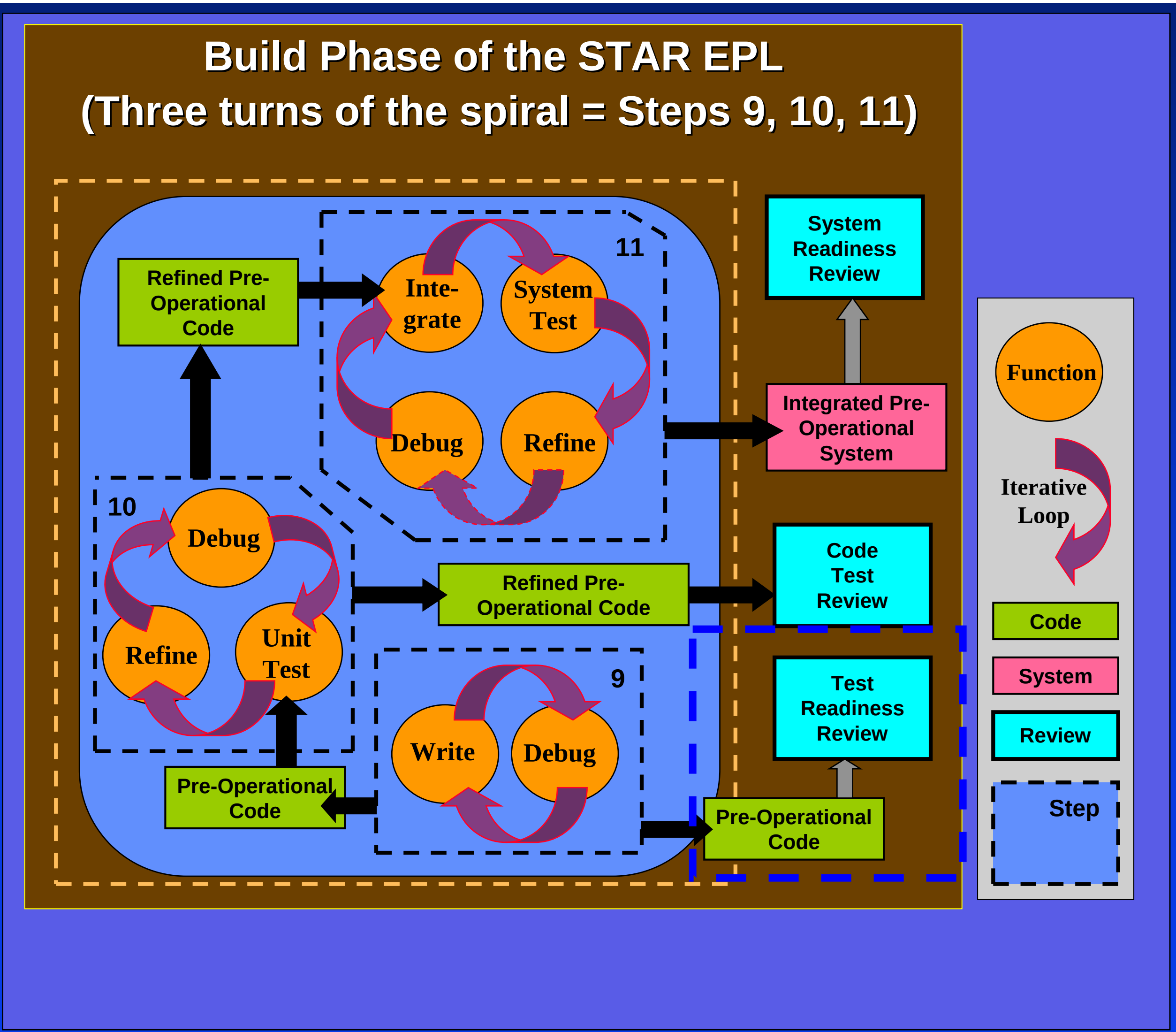


- Code development, testing, and integration is inherently iterative
  - Unit code is written and debugged until it can be compiled and run to produce expected outputs (Step 9)
  - Test data are developed to test the code's functional performance and quality of outputs (Step 9)
  - Unit tests reveal deficiencies that are corrected through code refinement (Step 10) ✔
  - Refined units are integrated into an end-to-end pre-operational system that is tested and refined until all requirements are met (Step 11)

System Testing

- System testing is a comprehensive test of the integrated product processing system and all of its components to ensure that all system requirements and product requirements are satisfied. These components include code, test data, products, and all supporting documents.
- Verification of code involves the end-to-end execution of the integrated software units in an environment that mimics the intended operations environment as closely as possible.
- Verification of test data is coordinated with code verification via inspection of the input s and outputs of the end-to-end code execution.
- Verification of supporting documentation is by inspection of the documents to confirm that they meet the requirements allocated to them.
- Validation of products involves a demonstration that they meet quality and latency requirements

System Testing Within the Build Phase

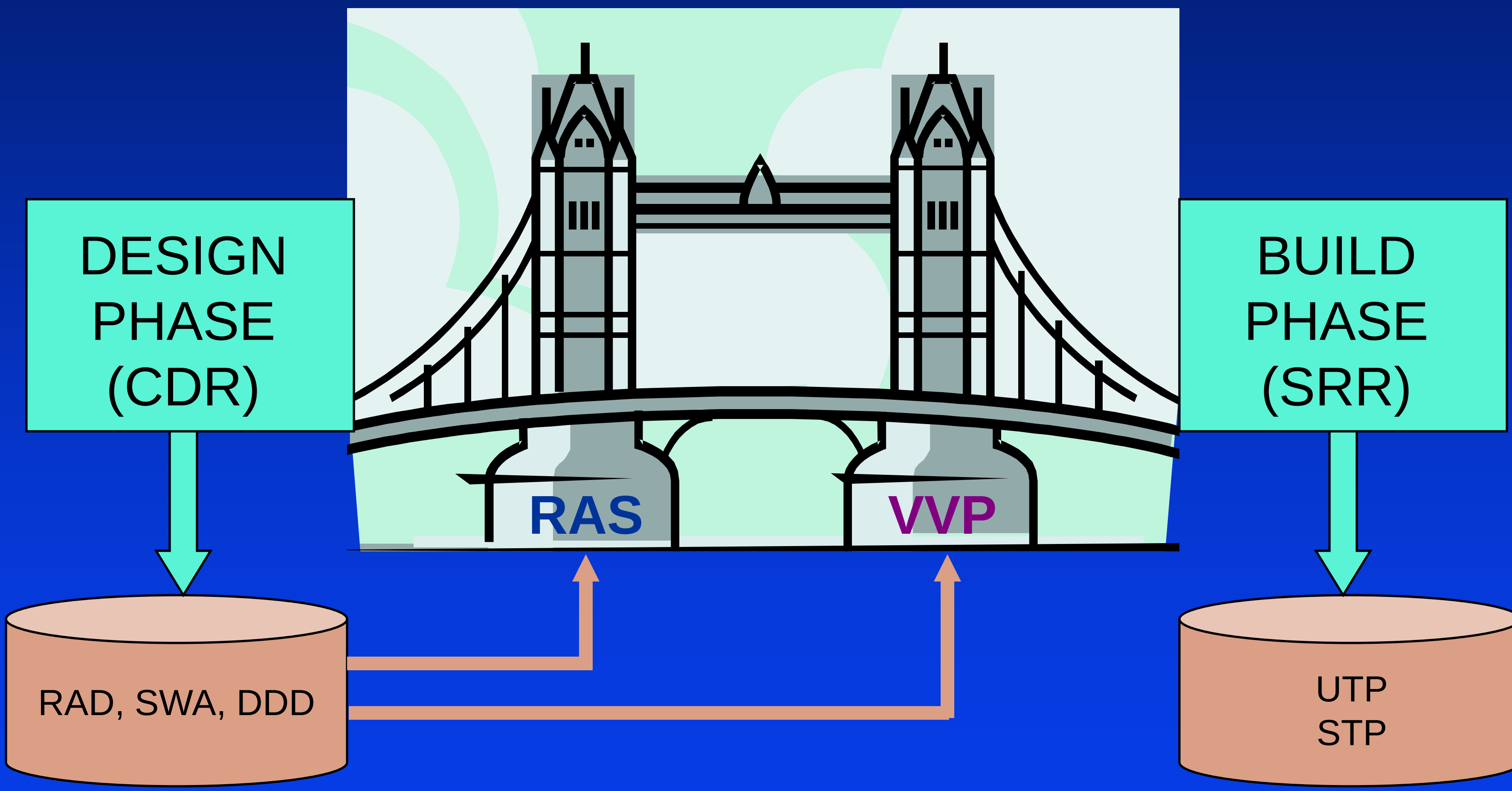


- Code development, testing, and integration is inherently iterative
  - Unit code is written and debugged until it can be compiled and run to produce expected outputs (Step 9)
  - Test data are developed to test the code's functional performance and quality of outputs (Step 9)
  - Unit tests reveal deficiencies that are corrected through code refinement (Step 10)
  - Refined units are integrated into an end-to-end pre-operational system that is tested and refined until all requirements are met (Step 11) <u>WE ARE HERE</u>

Test Plans

- Once the requirements have been established , allocated to components of the system design, and documented in the RAS and VVP, a unit test plan (UTP) and system test plan (STP) can be developed
- The unit test plan is focused on tests to confirm that the code meets its functional requirements
- The system test plan is focused on tests to confirm that the system (code, test data, documentation) meets its operational requirements
- Once this is done, the project is ready for formal system verification

The RAS and VVP Provide the Bridge from the Design to the Test Plans



Unit Test Plan

- Unit testing is to be performed in accordance with a unit test plan
- The unit test plan includes:
  - » A specification of the software units to be tested
  - » A description of the unit test data
  - » A description of the unit test environment
  - » A description of the unit test configuration and its build procedures
  - » A description of procedures to follow to prepare for unit testing
  - » A detailed description of the test activities and sequence of test steps for each unit in the software architecture

Unit Test Plan Documentation

- The unit test plan document (UTP) is a Microsoft Word file "GVF_UTP_1.2.doc"
  - » The UTP describes the test setup, including test data, test environment, test configuration build, and test preparation
  - » For each unit in the software architecture, the UTP describes the unit's purpose and function, data flows, programs, test sequence, and test risks
  - » The file can be found in the GVF artifact repository at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php
- There is an Appendix to the UTP, documented as a Microsoft Excel file "GVF_UTP_Appendix_1.1.xls "
  - » The UTP Appendix provides the detailed test activities for each unit in the software architecture
  - » This file can be found in the GVF artifact repository at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_CTR.php

Unit Test Data Description

- Unit test data includes:
  - » Instrument data: VIIRS surface reflectance and geolocation data in granules and are dynamic
  - » Ancillary data. Relatively static although they may need to be updated over the time. Examples are Water mask, Global Max/Min EVI, GVF Climatology, and Color lookup table.
  - » Additionally, sample output for the given input is provided for comparison. All the test data are saved in a parent directory /data//data049/jju/npp_data/utp/ on the NESDIS/STAR computer network

GVF Unit Test Data

Test data type	Location	Data volume and format	Units to be tested on
Eight days' VIIRS surface reflectance (IVISR) and imagery resolution geolocation (GIMGO) in granules.	input/20120901/IVISR input/20120901/GIMGO input/20120902/IVISR input/20120902/GIMGO ... … input/20120908/IVISR input/20120908/GIMGO	Approxmately 500 granules in HDF5 , 285 GB a day. Totally 2.3 TB for 8 days.	TGM GRD SRC CVI

Test data type	Location	Note
Water mask in GVF grid system	watermask/	Only 0.3 GB in 200 tiles of the GVF grid. Static. Used in all processing units. Saved under /data/data049/jju/npp_data/utp/
Global minimum/maximum EVI values. Filename: EVI.MinMax.txt	in the calcGVF code directory	Global minimum/maximum EVI values used in deriving GVF. More detail later.
Color lookup table. Filename:GVF_global_lut.dsr	in the bin2tiff code directory	Color lookup table used in generating GeoTIFF image of GVF. More detail later.
Areas for statistics. Filename: Areas_for_Statistics.txt	in the aggGVF code directory	Area latitude/longitude range for areas to generate the GVF statistics on. More detail later.

Unit Test Environment

- The test will be performed on the development machine rhw 1048 in NOAA/NESDIS/STAR network.
- This is a Linux server with 32 GB of memory and 10 TB of data storage.

Unit Test Configuration Build

- All unit tests will be performed from the same build.
- All codes are stored at
  - » The GVF source code and configuration script is saved in directory /data/home001/jju/GVF/rhw1048/. Let this directory be called Code Parent Directory. It has three sub-directories:
  - » /data/home001/jju/GVF/rhw1048/code
  - » /data/home001/jju/GVF/rhw1048/compile
  - » /data/home001/jju/GVF/rhw1048/run
- The code for all processing units is saved in the "code" directory. Under this directory, all the C++/C code, and shell scripts are saved into different subdirectories roughly corresponding to the GVF processing units.

Unit Test Configuration Build Libraries

- HDF5, NetCDF and GeoTIFF libraries are required
- For this Linux test environment, the directories of these libraries and associated header files, and the designated compilers and compiling options are specified in a file “export_linux_path.sh” in /data/home001/jju/GVF/rhw1048/compile/.

Error Handling

Error	Affected Unit	Expected Result
Error in writing to disk	All units	Reports the error and aborts. Probably disk full.
No input granule data	TGM	Report error and exit.
A GIMGO file is corrupted	TGM	TGM ignores this GIMGO granule and the corresponding IVISR. Continue with next granule. will be ignored when
An IVISR granule is corrupted	GRD	This granule is ignored. Continue with next granule.
Error reading a gridded reflectance tile	SRC	Reports the error and ignores this file.
Error reading a weekly composite tile	CVI	Ignore this tile and continue with next tile. (SO DEFINITELY I NEED TO CHECK THE ERROR NUMBER IN SCRIPT)
Error reading a weekly EVI file	SVI	Ignore this tile and continue with next tile.
There is no valid data for all 15 weeks of EVI	SVI	Should fill with climatology, which does not exist yet. Current ly, leave it blank.
Error reading a smoothed EVI tile	GCL	Print message, continue with next tile
Error reading a before-aggregation GVF tile	GAGG	Print error message, and abort.

- The successful completion of the system depends on the correctness of the input datasets.
- Errors may occur if the input dataset contains unexpected errors or unexpected changes of structure.
- It is necessary to check every call to open, read, manipulate or write files in the log file.

System Test Plan (1)

- System testing is to be performed in accordance with a system test plan
- The System Test Plan (STP) contains the plan for testing to ensure that the requirements specified for the product processing system are satisfied by the completed system (Verification) and that the final developed system will satisfy the users' needs and expectations (Validation).
- The purpose of the system test is to demonstrate, using verification and validation methods, system readiness for operations.

System Test Plan (2)

- The STP builds on the project's Verification and Validation Plan (VVP) and Unit Test Plan (UTP).
- The VVP describes the work products to be verified and validated, the requirements for each selected work product and the verification and validation methods for each selected work product. The purpose of the VVP is to support requirements development and design development by ensuring that the project requirements and system design are feasible and testable.
- The UTP provides a detailed plan for testing the ability of the system's software units to function as designed and produce output that will meet the requirements allocated to the unit components.
- The STP extends the scope of the UTP, providing a detailed plan for the verification and validation of every requirement of the entire product processing system.

System Test Plan Documentation

- The system test plan document (STP) is a Microsoft Word file “GVF_STP_1.1.doc”
- An Appendix to the STP is a Microsoft Excel file “GVF_STP_Appendix_1.1.xls”. It provides detailed system test activities, traceable to requirements and components.
- Both files can be found in the GVF artifact repository at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

Validation of Requirements

- Requirements validation is concerned with ensuring that the requirements and requirements allocation provide a satisfactory balance between customer/user/operator needs and expectations, NESDIS mission goals, technical feasibility, the available resources and external constraints.
- Basic requirements are validated by a demonstration that a balance has been established between customer/user/operator needs and expectations, and constraints on the production, distribution and performance of products.
- Derived requirements are validated by a demonstration that they are the best set of requirements to satisfy the basic requirements.
- Requirements allocations are validated by a demonstration that the solution and design provides a feasible, satisfactory implementation for meeting the requirements.
- Requirements validation is performed as part of the standard Requirements Development process that was described in Section 4 of this SRD. Documentation of the results of this process is found in the RAD, RNM, and RAS.
- Therefore, validation of requirements consists of reviewer approval of the RAD, RNM, and RAS.

Validation of Operator Needs

- Operator needs include a fully functional integrated pre-operational GVF system for easy transition to the Production environment, QC monitoring capability, compliance with security requirements, and documentation that can be used to assist in operations and maintenance (O&M)
- Validation of operator needs involves the testing of each component that is traceable to a basic requirement driven by an operator need.
- For the GVF system, these are basic requirements 3.0, 6.0, 7.0, 8.0, 9.0, 10.0, 12.0, and 13.0, and their derived requirements.
- If requirements traceability and requirements allocation were developed correctly, each operator need should be validated by the set of system test activities traceable to requirements 3.0, 6.0, 7.0, 9.0, 10.0, 12.0, and 13.0,

Validation of User Needs

- User needs include global and regional gridded GVF maps, metadata, and documentation that can be used to assist in acquiring, understanding, and using these products.
- Validation of operator needs involves the testing of each component that is traceable to a basic requirement driven by an operator need.
- For the GVF system, these needs are captured by Basic Requirements 1.0, 2.0, 4.0, 5.0, 10.0, and 11.0, and their derived requirements. .
- If requirements traceability and requirements allocation were developed correctly, each user need should be validated by the set of system test activities traceable to requirements 1.0, 2.0, 4.0, 5.0, 10.0, and 11.0.

Validation of Products

- Product requirements are a subset of user requirements. For the GVF system, these are Basic Requirements 1.0, 2.0, and 5.0, and their derived requirements.

- Validation of products therefore consists of the validation of these basic requirements and their derived requirements (i.e., it is a subset of the validation of user needs).

System Test Activities

- Detailed system test activities are provided in the STP Appendix

System Test Sequence

- The system test is performed throughout the Development Phase (STAR EPL steps 5- 11) and will continue during Transition to Operations.
- Test "events" during the Development Phase include:
  - » Gate 3 Review
  - » Project Requirements Review
  - » Critical Design Review
  - » Test Readiness Review
  - » Code Test Review
  - » Execution of Integrated Code
  - » System Readiness Review

System Test Sequence – Gate 3 Review

- Gate 3 Review system test activities consists of all activities whose success criteria is the approval of the Gate 3 Reviewers
- This involves confirmation that the Gate 3 Review artifacts meet the requirements allocated to them.

System Test Sequence – Project Requirements Review

- PRR system test activities consists of all activities whose success criteria is the approval of the PRR Reviewers
- This involves confirmation that the PRR artifacts meet the requirements allocated to them.

System Test Sequence – Critical Design Review

- CDR system test activities consists of all activities whose success criteria is the approval of the CDR Reviewers and delta CDR Reviewers
- This involves confirmation that the CDR artifacts meet the requirements allocated to them.

System Test Sequence – Test Readiness Review

- TRR system test activities consists of all activities whose success criteria is the approval of the TRR Reviewers
- This involves confirmation that the TRR artifacts meet the requirements allocated to them.

System Test Sequence – Code Test Review

- CTR system test activities consists of all activities whose success criteria is the approval of the CTR Reviewers
- This involves confirmation that the CTR artifacts meet the requirements allocated to them.

System Test Sequence – System Readiness Review

- SRR system test activities consists of all activities whose success criteria is the approval of the SRR Reviewers
- This involves confirmation that the SRR artifacts meet the requirements allocated to them.

System Test Sequence – Execution of Integrated Code

- System test execution of integrated code will commence June 3 and continue through July
- Results will be analyzed and documented for SRR
- VIIRS data from SCDR will be processed, starting from 100 days previously (~ Feb 10). This will provide more than 5 months of data.
- Landsat truth data must also be acquired and processed in parallel with the VIIRS data

System Test Environment

- The execution of integrated code will be conducted in the STAR Development Environment
- The runs will be performed on the development machine rhw1048 in NOAA/NESDIS/STAR network. This is a Linux server with 32 GB memory and 10 TB data storage
- 4 GB memory and 4TB storage is needed for the runs. The large volume of storage requirement is a direct result of providing 8 days' surface reflectance and geolocation data for test; a disk space of 400 GB will be sufficient for real-time operation.

System Test Configuration Build – Source Code

- The GVF source code and configuration script is saved in directory /data/home001/jju/GVF/rhw1048/. Let this directory be called Code Parent Directory.   It has three sub-directories:
  - » /data/home001/jju/GVF/rhw1048/code
  - » /data/home001/jju/GVF/rhw1048/compile
  - » /data/home001/jju/GVF/rhw1048/run

- The code for all processing units is saved in the “code” directory. Under this directory, all the C++/C code, and shell scripts are saved into different subdirectories roughly corresponding to the GVF processing units. In particular, the “bin” and “common” subdirectories store codes that are shared by different processing units

System Test Data - IVISR and GIMGO (1)

- The test data can be grouped into two categories: instrument data and ancillary data.
- Instrument data are the VIIRS I1, I2, and M3 band surface reflectance and imagery resolution geolocation data in granule files (IVISR and GIMGO)
- The instrument data for the system test will be downloaded from the STAR Central Data Repository (SCDR), which retains VIIRS data for approximately 100 days and updates daily.

System Test Data - IVISR and GIMGO (2)

- There are approximately 500 granules for each day that need ~285 GB disk space.
- We download a week of VIIRS data each time and delete them when they are processed for generation of GVF products in the system test
- Instrument data between 02/10/2013 and 07/30/2013 will be used for the GVF system test

System Test Data - Ancillary Data

Test data type	Location	Note
Water mask in GVF grid system	watermask/	Only 0.3 GB in 200 tiles of the GVF grid. Static. Used in all processing units. Saved under /data/data049/jju/npp_data/utp/
Global minimum/maximum EVI values. Filename: parameter.h	Code/common directory	Global minimum/maximum EVI values used in deriving GVF. More detail later.
Color lookup table. Filename:GVF_global_lut.dsr	bin2tiff code directory	Color lookup table used in generating GeoTIFF image of GVF. More detail later.
Areas for statistics. Filename: Areas_for_Statistics.txt	aggGVF code directory	Area latitude/longitude range for areas to generate the GVF statistics on. More detail later.

System Test Data - Landsat (1)

- Landsat data will be used to derive independent GVF data for validation of the accuracy of the SNPP GVF products.
- The procedure for generating GVF “truth” from Landsat data is described in the GVF ATBD.

System Test Data - Landsat (2)

- 30 EOS land validation core sites distributed globally are selected as test sites
- Landsat images covering the sites between February and July 2013 will be downloaded from USGS and saved in a directory /data/data049/zjiang/Landsat_data

System Test Libraries

- The GVF production system requires HDF5, NetCDF4, and GeoTIFF libraries. The VIIRS input and the water mask are saved in HDF5, and the output of all GVF intermediate processing is saved in HDF5. The final GVF output is saved in NetCDF4. Color-code GVF browse image is produced in GeoTIFF for production monitoring.
- For this Linux test environment, the directories of these libraries and associated header files, and the designated compilers and compiling options are specified in a file "export_linux_path.sh" in /data/home001/jju/GVF/rhw1048/compile/. The content of this file is as follows:

$ cat export_linux_path.sh

System Test Configuration Build Procedure (1)

- The GVF production system requires HDF5, NetCDF4, and GeoTIFF libraries. The VIIRS input and the water mask are saved in HDF5, and the output of all GVF intermediate processing is saved in HDF5. The final GVF output is saved in NetCDF5. Color-code GVF browse image is produced in GeoTIFF for production monitoring.
- The executables of all processing units are generated by running a single compiling script , compile.sh, in directory /data/home001/jju/GVF/rhw1048/compile/, once the library paths have been set up properly.
- The script compile.sh calls two other scripts to set up the execution environment and to compile the codes. Before compiling, the shell script, export_linux_path.sh (or export_aix_path.sh depending on operating system), must be updated as described in the previous section. Compiling in AIX requires an additional header file “xcoff.h” in various C++ source files; the “#include” line for this header file in the source code can be commented out or uncommented, by calling a script linux.sh or aix.sh, depending on the operating system.

System Test
Configuration Build Procedure (2)

- To compile the code in a Linux environment, first update the library paths, compiler, compling options in “export_linux_path.sh,” and edit the file “compile.sh” to make sure it calls “export_linux_path.sh” and “linux.sh.”

  $ sh compile.sh

- The above script invokes the makefile in each subdirectory. If any error occurs, the script will stop. The possible causes are library path, compiling options.   If the script return status is 0, the compilation is successful.

System Test
Run Procedure

- A subdirectory “run” under the Code Parent Directory is created in which to run the executables. Temporary files or directories will be generated in the “run” directory and will be deleted after a successful run.
- The GVF production consists of a sequence of steps and each step needs to know its input and output directory names. The information is provided in the script setenv.sh in the /data/home001/jju/GVF/rhw1048/run directory. This script must be run by $ source setenv.sh before any processing unit is run.
- To avoid the hassle of running this script every day, its content can be put into the login setup file .bashrc, but currently it is a script by itself. The content of setenv.sh: $ cat setenv.sh.

Execution of Integrated Code - Procedure

- Run snpp_GVF to generate global and regional GVF products.
- Check all the log files for the running status.
- Validate the accuracy of the SNPP global GVF product by comparing with coincident Landsat derived GVF at 30 EOS land validation core sites distributed globally.
- Check the latency of the global and regional GVF products.
- Check the quality of real-time and updated GVF products.
- Check the quality of Geo-Tiff GVF browse images.
- Check the accuracy of the statistic text files.

System Test Limitations and Risks

- The version number of the libraries used by SNPP GVF on rhw1048 might be different from those on NDE server. Same or higher versions of these libraries are recommended.
- The product latency might be different between the test server and the operational server.
- The driver of GVF system runs on NDE might be different from the ones used on this test.
- Most of the test data obtained from SCDR will not be available for repeating the system test in the NDE Test Environment.

1) Project Plan
2) CTR Report
3) System Overview
4) System Description
5) System Verification
6) **System Readiness**
7) Project Status
8) Summary and Conclusions

Section 6 –
System Readiness

Presented by

Tom King

Verification and Validation Report

- Unit test results are documented in the Verification and Validation Report (VVR)
- The VVR is a critical artifact for a project's System Readiness Review (SRR). It documents the results of testing to ensure that the requirements specified for the product processing system are satisfied by the completed system (Verification) and that the final developed system will satisfy the users' needs and expectations (Validation).
- The VVR is a Microsoft Word file "GVF_VVR_1.0.doc". The file can be found in the GVF artifact repository at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

Unit Test Results - Documentation

- Unit test results were presented at the CTR
- Additional testing was conducted after the CTR, to test functional changes to the code since the CTR. These changes include:
  - » Alternative EVI calculation for anomalous regions
  - » Adding the gap-filling (GG) sub-unit
- Results from the additional testing are documented in the VVR.

New Unit Test Results

- Results from new CVI and GAG unit test sequences will be provided

System Test Results – Gate 3 Review

- All Gate 3 Review system test activities were assigned to the Gate 3 Reviewers
- The Gate 3 Review Report (G3RR) documents the approval of all items by the reviewers

System Test Results – Project Requirements Review

- All PRR system test activities were assigned to the PRR Reviewers
- The PRR Report (PRRR) documents the approval of all items by the reviewers

System Test Results – Critical Design Review

- All CDR system test activities were assigned to the CDR Reviewers
- The CDR Report (CDRR) documents the approval of all items by the reviewers

System Test Results – Test Readiness Review

- All TRR system test activities were assigned to the TRR Reviewers, including the OSPO code reviewers
- The TRR Report (TRRR) documents the approval of all items by the reviewers

System Test Results – Code Test Review

- All CTR system test activities were assigned to the CTR Reviewers
- The CTR Report (CTRR) documents the approval of all items by the reviewers

System Test Results – Execution of Integrated Code

- All Execution of Integrated Code system test activities were assigned to STAR
- Many activities remain to be completed.

System Test Results – System Readiness Review

- Verification activities by SRR Reviewers are pending the conclusion of the SRR presentation and the writing of the SRR Report

System Test Results – Validation of Operator Needs

- Results from system test activities to validate operator needs are provided in the VVR Appendix “System Test” tab (Column J).
- Entries with blue fill have been successfully completed.
- Entries with white fill are pending SRR Reviewer approval, and will be updated in a future revision of the VVR.

Configuration Management

- A project baseline has been established
- Configuration items in the project baseline include code, test data, and documents
- Maintenance of the baseline is accomplished by a sequence of planned baseline builds (BB)
  - » The current baseline has been established in the project artifact repository through BB 3.2
- The project plan identifies the configuration items that are included in each baseline build
- Revisions to configuration items (planned and unplanned) are controlled manually by Yuling Liu (CICS)

Project Baseline Report

- The project's baseline and change history is maintained in a Project Baseline Report (PBR).
- The PBR includes the change history, approval status, and location of every Configuration Item in the project's baseline.
- The PBR is updated with each baseline build
- PBR_3.4, an SRR artifact, can be accessed at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php

GVF Baseline Build 3.4 - Code

- BB 3.4 includes the refined pre-operational code that is ready for integration and system testing. This code, described in the GVF DDD, is located on the rhw9101 server in directory /data/home001/jju/GVF/rhw1048/. Let this directory be called Code Parent Directory.

- It has three sub-directories:

  /data/home001/jju/GVF/rhw1048/code

  /data/home001/jju/GVF/rhw1048/compile

  /data/home001/jju/GVF/rhw1048/run

GVF Baseline Build 3.4 – Directory Structure (1)

Directory	Code filename	Code type
bin	doy.c	C
	isleap.c	C
	month_day.c	C
	shift_date.sh	BASH script
	Makefile	
common	AllGranule.cpp	C++
	AllGranule.h	header file
	error.cpp	C++
	EVI.cpp	C++
	GeoLoc.cpp	C++
	GVFCommonDef.h	header
	GVF.cpp	C++
	GVFUtil.cpp	C++
	most_recent.sh	BASH script
	observation.h	header
	SRTile.cpp	C++
	SurflRefl.cpp	C++
	WaterMask.cpp	C++

GVF Baseline Build 3.4 – Directory Structure (2)

Directory	Code filename	Code type
GranuleOnTile	GranuleOnTile_main.cpp	C++
	GranuleIndex.cpp	C++
(TGM unit)	pairInput.sh	BASH script
	Makefile	
DailyGrid	DailyGrid_main.cpp	C++
(GRD unit)	run.daily.alltiles.sh	BASH script
	run.daily.subset.sh	BASH script
	Makefile	
WeeklyComposite	WeeklyComposite_main.cpp	C++
	run.weekly.alltiles.sh	BASH script
(SRC unit)	run.weekly.subset.sh	BASH script
	Makefile	
calcEVI	calcEVI_main.cpp	C++
	run.calcEVI.sh	BASH script
(CVI unit)	Makefile	

GVF Baseline Build 3.4 – Directory Structure (3)

Directory	Code filename	Code type
TSsmooth (SVI unit)	TSsmooth_main.cpp	C++
	Filter.cpp	C
	run.TSsmooth.sh	BASH script
	Makefile	
calcGVF (GCL unit)	calcGVF_main.cpp	C++
	EVI.MinMax.txt	ASCII
	run.calcGVF.sh	BASH script
	Makefile	
aggGVF (GAG unit)	nc4GVF.cpp	C++
	aggGVF_main.cpp	C++
	Areas_for_Statistics.txt	ASCII
	run_aggGVF.sh	BASH script
	Makefile	
bin2tiff (GAG unit)	GVFtiff.cpp	C++
	GVFtiff_main.cpp	C++
	VI_global.dsr	ASCII
	Makefile	

GVF Baseline
Build 3.4 – Input Test Data

- BB 3.4 includes the input unit test data. This data, described in the GVF UTP, consists of 8 days of all the daytime VIIRS surface reflectance and geolocation data

    input/20120901/IVISR
    input/20120901/GIMGO
    input/20120902/IVISR
    input/20120902/GIMGO
    … …
    input/20120908/IVISR
    input/20120908/GIMGO

GVF Baseline
Build 3.4 – Ancillary Data

- BB 3.4 includes the ancillary data used for the unit test. This data, described in the GVF UTP, consists of 8 days of :
  - 200 water mask files in the tiled GVF grid system saved in directory watermask/
  - code/calcGVF/EVI.MinMax.txt
  - code/bin2tiff/GVF_global_lut.dsr
  - code/aggGVF/Areas_for_Statistics.txt

GVF Baseline Build 3.4 – Intermediate Files

- BB 3.4 includes all intermediate daily and weekly files created during unit testing
- These are listed in PBR Table 3.1

GVF Baseline Build 3.4 – Documents (1)

Filename	File Type	File Description
GVF_CTRR_1.0	Microsoft Word	CodeTest Review Report (CTRR)
GVF_DPP_3.2	Microsoft Word	Development Project Plan (DPP)
FY14_ Green_Veg_Fraction_V5_SRR	Microsoft PowerPoint	FY14 SPSRB Project Plan (DPP Appendix A)
GVF_IMS_3.2	Microsoft Excel	Integrated Master Schedule (DPP Appendix B)
GVF_Review_Check_Lists_3.2	Microsoft Excel	Check List Items for each GVF review (DPP Appendix C)
GVF_OCD_1.4	Microsoft Word	Operations Concept Document (OCD)
GVF_RAD_1.5	Microsoft Word	Requirements Allocation Document (RAD)
GVF_RNM_1.5	Microsoft Excel	Requirements / Needs Matrix (RNM) - Appendix to RAD
GVF_RAS_1.4	Microsoft Excel	Requirements Allocation Sheet (RAS) – Appendix to RAD

GVF Baseline Build 3.4 – Documents (2)

Filename	File Type	File Description
GVF_ATBD_2.0	Microsoft Word	Algorithm Theoretical Basis Document (ATBD)
GVF_SWA_1.4	Microsoft Word	Software Architecture Document (SWA)
GVF_DDD_1.4	Microsoft Word	Detailed Design Document (DDD)
GVF_VVP_1.4	Microsoft Word	Verification and Validation Plan (VVP)
GVF_VVP_Appendix_1.4	Microsoft Excel	VVP Appendix
GVF_UTP_1.2	Microsoft Word	Unit Test Plan (UTP)
GVF_UTP_Appendix_1.2	Microsoft Excel	UTP Appendix

GVF Baseline Build 3.2 – Documents (3)

Filename	File Type	File Description
GVF_STP_1.1	Microsoft Excel	System Test Plan (STP)
GVF_STP_Appendix_1.1	Microsoft Word	STP Appendix
GVF_EUM_1.0	Microsoft Word	External User's Manual (IUM)
GVF_VVR_1.0	Microsoft Word	Verification and Validation Report (VVR)
GVF_PSR_3.3	Microsoft Excel	Project Status Report (PSR)
GVF_SRD_1.0	Microsoft PowerPoint	System Readiness Document (SRD) - Review slide package
GVF_PBR_3.4	Microsoft Word	Project Baseline Report

1) Project Plan
2) CTR Report
3) System Overview
4) System Description
5) System Verification
6) System Readiness
7) **Project Status**
8) Summary and Conclusions

Section 7 – Project Status

Presented by

Tom King

GVF - Project Status Report

- The Project Status Report (PSR) is a Microsoft Excel file that describes the status of project risks and associated risk mitigation actions
  - Reviewers can access PSR version 3.4 at https://www.star.nesdis.noaa.gov/smcd/emb/gvf/NPP/GVFdoc_SRR.php
  - Guidelines for the PSR are found in STAR EPL process assets DG-5.2 and DG-5.2.A
  - Reviewers can access this document at http://www.star.nesdis.noaa.gov/star/EPL_index.php

GVF Project Status - Suppliers

- All HW for development is in place.
- Funding through Dec 2013 is approved. Funding through Oct 2013 is on the contract.
- VIIRS data from SCDR are available

GVF Project Status - Stakeholders

- All personnel for development are in place.
- All personnel for transition to operations are in place.
- NCEP EMC is involved as planned. Vince Wong attended the PRR and CDR. Mike Ek and Weizhong Zheng attended the TRR and CTR, and will attend the SRR.
- Reviewers for Gate 3 Review, PRR, CDR, delta CDR, TRR, and CTR have completed their review activities
- SRR Reviewers are in place
- Management and support personnel are in place

GVF Project Status – Deliverables

- DAP # 1 was delivered to NDE July 2013
- DAP # 2 delivery to NDE will occur at the end of Development step 11, following System Readiness Review (SRR)
- DAP # 3 delivery to NDE will occur in Dec 2013

GVF Project Status – Integrated Master Plan

- Milestones through SRR have been accomplished.
- IMP Tasks 1.0 - 26.0 were accomplished
- IMP Tasks 27.0 - 29.0 have been completed for SRR.
- IMP Task 30.0 is being performed by the SRR.
- IMP Tasks 31.0 - 34.0 will be performed after the SRR.

GVF Project Status – Budget

- Cost expenditures to date are in line with expectations. There are no cost risks identified at this time.
- Funding is available to cover work through October 2013. Additional funding to cover work through December 2013 has been approved.
- Earned Value (EV) is 93% of the Planned Value (PV), meaning that the project had accomplished 93% of what was expected for the cost to date.

GVF – Risks at CTR

- There are 23 open risks to be reviewed at the SRR
  - » 21 of these are open risks from the CTR
  - » 2 additional Candidate Risks have been identified by the developers
- The risks will be reviewed in order from “High” to “Medium” to “Low”, as they were assessed by the CTR Reviewers or the Developers (Candidate Risks)
- The following slides contain, for each risk item:
  - » A risk statement
  - » Risk assessment (Severity and Probability)
  - » Risk mitigation recommendation
  - » Status of actions identified to mitigate the risk

High Risks and Associated Actions

High Risks After CTR – Risk # 51

- RISK # 51 – OSPO access to NDE Test Environment is not established
- Risk Assessment: HIGH (Severity = 8, Probability = 10, Score = 80).
- Risk Mitigation: PAL to work with NDE on validation in NDE Test Environment
- New Risk Assessment: HIGH (Severity = 8, Probability = 10, Score = 80).
  - No risk reduction since CTR

Open Action for Risk # 51

- ACTION CTR-14: Work with NDE on validation in NDE Test Environment – Open.

Medium Risks and Associated Actions

Medium Risks After CTR – Risk # 19

- RISK # 19 – Operations concept is not completely developed
- Previous Risk Assessment: MEDIUM (Severity = 4, Probability = 5, Score = 20).
- Risk Mitigation:
  - » Determine a time retention policy for VIIRS SDRs
  - » Submit a "Request to Archive" to NCDC
  - » Complete a DSA with NCDC
- New Risk Assessment: MEDIUM (Severity = 3, Probability = 7, Score = 21)
  - » Severity reduced from 4 to 3 by the completion or withdrawal of actions CDR-3.3.1.1, CDR-3.4.1.7, TRR-3.4.5.1, CTR-3.2.6.1, and CTR-3.2.7.2. Probability increased from 5 to 7, as many actions remain open.

Closed Actions for Risk # 19

- ACTION CDR-3.3.1.1: Determine whether or not to write metadata to a separate XML file - Completed. Metadata in NetCDF4 only.
- ACTION CDR-3.4.1.7: Confirm with EMC that they do not need daily archiving of Weekly GVD NetCDF4 files. - Completed. Daily archiving is needed.
- ACTION TRR-3.4.5.1: Revise OCD to show VIIRS Surface Reflectance RIP (IVISR) source will be CLASS - Completed.
- ACTION CTR-3.2.6.1: Confirm that NCEP EMC can ftp pull product files from NDE - Withdrawn. NCEP will pull from NCO.
- ACTION CTR-3.2.7.2: Confirm NDE to NCEP distribution procedure – Completed. NDE will push to NCO.

Open Actions for Risk # 19

- ACTION CDR-3.4.1.1: Confirm that a Geo-TIFF library is not needed - Open
- ACTION CTR-3.2.7.1: Establish NDE capability to ingest SR RIP from CLASS - Open
- ACTION CTR-3.2.7.3: Confirm NDE to CLASS distribution procedure - Open
- ACTION CTR-3.2.7.4: Confirm automated notifications to NCEP of anomalous production runs - Open
- ACTION CTR-3.2.7.5: Confirm the items to be archived at CLASS - Open

Medium Risks After CTR – Risk # 31

- RISK # 31 – VIIRS Surface Reflectance RIP will not be available in time to meet latency requirement.
- Previous Risk Assessment: MEDIUM (Severity = 7, Probability = 5, Score = 35).
- Risk Mitigation:
  - » Determine latency of Surface Reflectance RIP from CLASS
  - » If possible, secure an alternative source of Surface Reflectance RIP
  - » Modify the production schedule and/or latency requirement to accommodate Surface Reflectance RIP latency
- New Risk Assessment: MEDIUM (Severity = 7, Probability = 5, Score = 35). No risk reduction since CTR

Open Action for Risk # 31

- ACTION PRR-2.3.1.1: Secure an operational source of VIIRS Surface Reflectance RIP that will meet latency requirements - OPEN
  - This action must be carried over to Transition. Not feasible to do this within the Development schedule.

Medium Risks After CTR – Risk # 37

- RISK # 37 – Algorithm will not meet the GVF quality requirement
- Previous Risk Assessment: MEDIUM (Severity = 10, Probability = 2, Score = 20)
- Risk Mitigation:
  - » Consider removing cloudy pixels from the time series smoothing by eliminating the current week EVI from the smoothing for that pixel.
  - » Re-evaluate the method for determining Global EVI Max/Min
  - » Consider making a new determination of L value in the SAVI equation, based on VIIRS data.
  - » Characterize bias in GVF due to variance in the "green-ness" of the vegetation.
  - » Consider interpolation of GVF when there are no day-time observations in winter.
- New Risk Assessment: NONE (Severity = 10, Probability = 0, Score = 0). Probability reduced from 2 to 0 by the withdrawal of action CTR-4.1.2.1. Risk can be transferred to Risk # 53.

Closed Action for Risk # 37

- ACTION CTR-4.1.2.1: Produce a GVF Climatology that is useable for gap filling. – Withdraw. Captured by action CTR-16.

Medium Risks After CTR – Risk # 46

- RISK # 46 – VIIRS SR RIP is not available from CLASS in time for operations
- Previous Risk Assessment: MEDIUM (Severity = 8, Probability = 4, Score = 32).
- Risk Mitigation:
  - » None. To be addressed by NDE.
- New Risk Assessment: HIGH (Severity = 8, Probability = 7, Score = 56).
  - » Probability increased from 4 to 7, as there has been no progress. Actions need to be identified and closed.

Medium Risks After CTR – Risk # 47

- RISK # 47 – Unable to test latency of data from CLASS
- Previous Risk Assessment: MEDIUM (Severity = 3, Probability = 10, Score = 30).
- Risk Mitigation: Run system test with input data from SCDR and measure latency AFTER ingest of data.
- New Risk Assessment: MEDIUM (Severity = 3, Probability = 10, Score = 30). No risk reduction since CTR

Open Actions for Risk # 47

- ACTION CTR-1: Run system test with input data from SCDR and measure latency after ingest of data - In progress. Will be completed during transition.
- ACTION CTR-2: Report latency performance in the VVR In progress. Will be completed during transition.

Medium Risks After CTR – Risk # 49

- RISK # 49 – Insufficient VIIRS data for EVI Global Max/Min Climatology
- Previous Risk Assessment: MEDIUM (Severity = 3, Probability = 10, Score = 30).
- Risk Mitigation: Continue to acquire VIIRS SR RIP from SCDR until climatology is completed.
- New Risk Assessment: LOW (Severity = 3, Probability = 5, Score = 15). Probability reduced from 10 to 5 by the completion of action CTR-10.

Closed Action for Risk # 49

- ACTION CTR-10: Finalize EVI Global Max/Min Climatology - Completed

Open Action for Risk # 49

- ACTION CTR-9: Acquire VIIRS SR RIP data for additional season - Open

Medium Risks After CTR – Risk # 50

- RISK # 50 – System test data sets are not complete
- Previous Risk Assessment: MEDIUM (Severity = 2, Probability = 10, Score = 20).
- Risk Mitigation:
  - » Identify the system test data sets.
  - » Describe the system test data in the STP.
  - » Continue to acquire VIIRS SR RIP and GIMGO from SCDR for system test.
- New Risk Assessment: NONE (Severity = 2, Probability = 0, Score = 0). Probability reduced from 10 to 5 by the completion of actions CTR-11, CTR-12, and CTR-13

Closed Actions for Risk # 50

- ACTION CTR-11: Identify the system test data sets - Completed
- ACTION CTR-12: Describe the system test data in the STP – Completed
- ACTION CTR-13: Continue to acquire VIIRS SR RIP and GIMGO from SCDR for system test - Completed

Medium Risks
After CTR – Risk # 52

- RISK # 52 – Monitoring and maintenance level for this product should be daily
- Previous Risk Assessment: MEDIUM (Severity = 5, Probability = 5, Score = 25).
- Risk Mitigation: OCD must indicate that the Daily update of Weekly GVF needs to be monitored as a Daily product
- New Risk Assessment: NONE (Severity = 0, Probability = 5, Score = 0). Severity reduced to 0 by the completion of action CTR-15. Risk can be closed.

Closed Actions for Risk # 52

- ACTION CTR-15: OCD must indicate that the Daily update of Weekly GVF needs to be monitored as a Daily product - Completed

Medium Risks After CTR – Risk # 53

- RISK # 53 – Available GVF Climatology is not useable
- Previous Risk Assessment: MEDIUM (Severity = 3, Probability = 10, Score = 30
- Risk Mitigation:
  - STAR and NCEP to consult on an approach for developing a GVF Climatology
  - STAR to implement GVF Climatology approach to produce a GVF Climatology ancillary data set.
- New Risk Assessment: LOW (Severity = 3, Probability = 3, Score = 9). Severity reduced from 10 to 3 by the partial completion of action CTR-16.

Open Action for Risk # 53

- ACTION CTR-16: Establish a useable GVF Climatology - Open. Close to being completed.

Medium Candidate Risks

Medium Candidate Risks – Risk # C37

- RISK # C37 – QA support for Development has ended
- Risk Assessment: MEDIUM (Severity = 2, Probability = 10, Score = 20).
- Risk Mitigation: TBD
- Candidate Actions: TBD

Medium Candidate Risks – Risk # C38

- RISK # C38 – Currently available funding will only last through October 2013
- Risk Assessment: MEDIUM (Severity = 2, Probability = 10, Score = 20).
- Risk Mitigation: Expedite additional funding that is already approved.
- Candidate Actions: TBD

Low Risks and Associated Actions

Low Risks After TRR – Risk # 7

- RISK # 7 – User involvement is less than expected
- Previous Risk Assessment: LOW (Severity = 3, Probability = 1, Score = 3).
- Risk Mitigation:
  - » Maintain communication with all users
  - » Monitor user involvement with respect to the plan
  - » Identify and mitigate user involvement risks
- New Risk Assessment: NONE (Severity = 3, Probability = 0, Score = 0)
  - » Probability reduced to 0 by the completion of actions G3R-16, G3R-17, and G3R-19, and the withdrawal of action G3R-2.3.1.2. Risk can be closed.

Closed Actions for Risk # 7

- ACTION G3R-16: Maintain communication with all users - Completed
- ACTION G3R-17: Monitor user involvement with respect to the plan - Completed
- ACTION G3R-19: Identify and mitigate user involvement risks during the Build phase - Completed
- ACTION G3R-2.3.1.2: Consider adding JCSDA to the list of users - Withdrawn

Low Risks After TRR – Risk # 11

- RISK # 11 – STAR EPL process adds extra work for documentation and reviews, resulting in a schedule delay
- Previous Risk Assessment: LOW (Severity = 1, Probability = 3, Score = 3).
- Risk Mitigation:
  - » Determine tasks so that the GVF schedule risk is acceptable
  - » Assign tasks so that FTE load for each person is manageable
  - » Integrate tasks into the GVF IMP and IMS
  - » Review and approve the IMP and IMS at the Gate 3 Review
  - » Monitor project schedule periodically to identify and relieve schedule delays.
- New Risk Assessment: NONE (Severity = 0, Probability = 3, Score = 0)
  - » Severity reduced to 0 by the completion of actions G3R-2.8.2.1, G3R-2.8.2.2, G3R-2.8.2.3, and G3R-3.6.2.4, and the withdrawal of action G3R-3.6.2.3 Risk can be closed.

Closed Actions for Risk # 11

- ACTION G3R-2.8.2.1: Monitor actual earned value on a monthly basis. - Completed
- ACTION G3R-2.8.2.2: Revise future task duration estimates, based on actual durations of previous tasks. - Completed
- ACTION G3R-2.8.2.3: Produce a revised IMS, based on revised task duration estimates. - Completed
- ACTION G3R-3.6.2.3: Report the project's Earned Value status at the CTR – Withdrawn. OBE.
- ACTION G3R-3.6.2.4: Report the project's Earned Value status at the SRR. - Completed

Low Risks After TRR – Risk # 15

- RISK # 15 – Landsat truth data may be limited
- Previous Risk Assessment: LOW (Severity = 4, Probability = 1, Score = 4).
- Risk Mitigation:
  - » Determine whether the available Landsat truth data is sufficient to cover all biomes and seasons
  - » Arrange for backup truth data sources from comparable high resolution satellite sources (CEOS), if needed
  - » Include the use of backup truth data in the STP, if needed.
- New Risk Assessment: NONE (Severity = 4, Probability = 0, Score = 0)
  - » Probability reduced to 0 by the completion of action PRR-1. Risk can be closed..

Closed Action for Risk # 15

- ACTION PRR-1: Identify truth data for the system test, concurrent with the real VIIRS data
  - » Completed. Will need new Landsat data concurrent with the VIIRS system test data (Feb 10 - Aug 10 2013). Landsat data are identified in the STP. In progress, to be completed during transition.

Low Risks After TRR – Risk # 21

- RISK # 21 – Operator involvement is less than expected.
- Previous Risk Assessment: LOW (Severity = 3, Probability = 1, Score = 3).
- Risk Mitigation:
  - » Revise list of operations stakeholders to include Dylan Powell and Hanan Jordan
  - » Monitor operator involvement during the Design phase
  - » Monitor operator involvement during the Build phase.
- New Risk Assessment: NONE (Severity = 3, Probability = 0, Score = 0)
  - » Probability reduced to 0 by the completion of action G3R-48. Risk can be closed.

Closed Actions for Risk # 21

- ACTION G3R-48: Monitor operator involvement during the Build phase - Completed

Low Risks After CTR – Risk # 23

- RISK # 23 – Project costs exceed available funding
- Previous Risk Assessment: LOW (Severity = 8, Probability = 2, Score = 16).
- Risk Mitigation:
  - » Assess budget risks at the CDR
  - » Produce a mitigation plan for each budget risk identified at the CDR
  - » Identify budget risk mitigation actions at the CDR.
- New Risk Assessment: LOW (Severity = 8, Probability = 1, Score = 8)
  - » Probability reduced from 2 to 1 by the completion of actions CDR-3 and CDR-4. Remaining risk is low and will be accepted.

Closed Actions for Risk # 23

- ACTION CDR-3: Monitor development costs during the build phase – Completed. Cost status will be reported at the SRR
- ACTION CDR-4: Report cost risks in PSR updates – Completed. Reported in PSR V3.3.

Low Risks After CTR – Risk # 29

- RISK # 29 – Test plans are not established.
- Previous Risk Assessment: LOW (Severity = 5, Probability = 2, Score = 10).
- Risk Mitigation:
  - » Describe the plan for verification and validation in the Verification and Validation Plan (VVP)
  - » Review and approve the VVP at the Critical Design Review (CDR)
  - » Produce a Unit Test Plan (UTP), based on the VVP
  - » Review and approve the UTP at the Test Readiness Review (TRR)
  - » Produce a System Test Plan (UTP), based on the VVP
  - » Review and approve the STP at the Code Test Review (CTR)
- New Risk Assessment: NONE (Severity = 5, Probability = 0, Score = 0).
  - » Probability reduced to 0 by the completion of actions PRR-17 and CTR-5.1.6.1. Risk can be closed.

Closed Actions for Risk # 29

- ACTION PRR-17: Review and approve the STP at the CTR – Completed
- ACTION CTR-5.1.6.1: Determine whether error handling is sufficiently tested – Completed. Error handling is sufficient.

Low Risks After CTR – Risk # 30

- RISK # 30 – Production of SPSRB documents will be affected because NDE personnel cannot work on them.
- Previous Risk Assessment: LOW (Severity = 4, Probability = 1, Score = 4).
- Risk Mitigation:
  - » Documents are produced by STAR and OSPO
  - » Document review at the SRR
- New Risk Assessment: MEDIUM (Severity = 4, Probability = 5, Score = 20)
  - » Probability increased from 1 to 5, as the SMM and IUM have not yet been produced.

Open Action for Risk # 30

- ACTION PRR-20: Review and approve SPSRB documents at the SRR.
  - » Open

Low Risks
After CTR – Risk # 33

- RISK # 33 – OSPO personnel may not be ready for O&M, due to lack of access to NDE test environments
- Previous Risk Assessment: LOW (Severity = 5, Probability = 2, Score = 10).
- Risk Mitigation:
  - » Provide GVF operations stakeholders with access to the GVF code, test plans, test data, and test results
- New Risk Assessment: MEDIUM (Severity = 5, Probability = 5, Score = 25).
  - » Probability increased from 2 to 5, as action CDR-25 remains open

Open Action for Risk # 33

- ACTION CDR-25: Deliver system test data and system test plan from the Development Environment to OSPO reviewers
  - » System test data are still being developed

Low Risks
After CTR – Risk # 34

- RISK # 34 – Use of EVI Max/Min values derived from MODIS data during the first year of operations will introduce a bias to the calculated GVF
- Previous Risk Assessment: LOW (Severity = 2, Probability = 2, Score = 4)
- Risk Mitigation:
  - » When calibrated, navigated VIIRS granule files are available, develop a VIIRS-based EVI Max/Min to replace the current MODIS-based values
- New Risk Assessment: NONE (Severity = 2, Probability = 0, Score = 0). Probability reduced to 0 by the completion of action CDR-13. Risk can be closed.

Closed Action for Risk # 34

- ACTION CDR-13: Develop an operational VIIRS-based EVI Max/Min to replace the provisional VIIRS-based values - Completed

Low Risks After CTR – Risk # 38

- RISK # 38 – Design is not complete at CDR
- Previous Risk Assessment: LOW (Severity = 2, Probability = 2, Score = 4)
- Risk Mitigation:
  - » Revise the SWA and DDD to show the complete and correct data flows Re-evaluate the method for determining Global EVI Max/Min
  - » Ensure that the output files from the GAG unit are compatible with the required input to the GRIB2 formatting toolkit.
  - » Ensure that the code can read the NDE Process Control File (PCF)
  - » Add DDD Section 4 (File Format Descriptions)
  - » Ensure that tiles that contain no land pixels are excluded from processing.
- New Risk Assessment: LOW (Severity = 2, Probability = 2, Score = 4) No risk reduction since CTR

Open Action for Risk # 38

- ACTION CDR-7.5.1.3: Ensure that the code can read the NDE Process Control File (PCF) - Open

Low Risks
After CTR – Risk # 48

- RISK # 48 – Code for GG sub-unit is not completed or reviewed
- Previous Risk Assessment: LOW (Severity = 1, Probability = 10, Score = 10).
- Risk Mitigation:
  - » Complete GG sub-unit code
  - » Document and review the code.
  - » GG sub-unit code testing
  - » Document results of code testing
- New Risk Assessment: LOW (Severity = 1, Probability = 10, Score = 10). No risk reduction since CTR.

Closed Actions for Risk # 48

- ACTION CTR-6: Add GG sub-unit test to UTP - Completed

Open Actions for Risk # 48

- ACTION CTR-3: Complete GG sub-unit code – Open
- ACTION CTR-4: Document GG sub-unit in the DDD - Open
- ACTION CTR-5: Review GG sub-unit code - Open
- ACTION CTR-7: Do the GG sub-unit test. - Open
- ACTION CTR-8: Report GG sub-unit test results in VVR for review at SRR. - Open

Risk Summary – 9 Risks Can Be Closed

Risk Number	Risk Statement	Developer Comments
7	User involvement is less than expected	Probability reduced to 0 by the completion of actions G3R-16, G3R-17, and G3R-19, and the withdrawal of action G3R-2.3.1.2. Risk can be closed.
11	STAR EPL process adds extra work for documentation and reviews, resulting in a schedule delay.	Severity reduced to 0 by the completion of actions G3R-2.8.2.1, G3R-2.8.2.2, G3R-2.8.2.3, and G3R-3.6.2.4, and the withdrawal of action G3R-3.6.2.3. Risk can be closed.
15	Landsat truth data may be limited	Probability reduced to 0 by the completion of action PRR-1. Risk can be closed.
21	Operator involvement is less than expected	Probability reduced to 0 by the completion of action G3R-48. Risk can be closed.
29	Test plans are not established	Probability reduced to 0 by the completion of actions PRR-17 and CTR-5.1.6.1. Risk can be closed.
34	Use of EVI Max/Min values derived from MODIS data during the first year of operations will introduce a bias to the calculated GVF	Probability reduced to 0 by the completion of action CDR-13. Risk can be closed.
37	Algorithm will not meet the GVF quality requirement	Probability reduced from 2 to 0 by the withdrawal of action CTR-4.1.2.1. Risk can be transferred to Risk # 53.
50	System test data sets are not complete	Probability reduced from 10 to 0 by the completion of actions CTR-11, CTR-12, and CTR-13
52	Monitoring and maintenance level for this product should be daily	Severity reduced to 0 by the completion of action CTR-15. Risk can be closed.

Risk Summary – 2 Open High Risks

- Risk # 46 - VIIRS SR RIP is not available from CLASS in time for operations (Score = 56)
- Risk # 51 - OSPO access to NDE Test Environment is not established (Score = 80)

Actions to reduce open risks are documented in the PSR

Risk Summary – 7 Open Medium Risks

- Risk # 19 - Operations concept is not completely developed (Score = 21)
- Risk # 30 - Production of SPSRB documents (Score = 20)
- Risk # 31 - VIIRS Surface Reflectance RIP will not be available in time to meet latency requirement. (Score = 35)
- Risk # 33 - OSPO personnel may not be ready for O&M, due to lack of access to NDE test environments (Score = 25)
- Risk # 47 - Unable to test latency of data from CLASS (Score = 30)
- Risk # C37 - QA support for Development has ended (Score = 20)
- Risk # C38 - Currently available funding will only last through October 2013 (Score = 20)

Actions to reduce open risks are documented in the PSR

Risk Summary – 5 Open Low Risks

- Risk # 23 - Project costs exceed available funding (Score = 8)
- Risk # 38 - Design is not complete at CDR (Score = 4)
- Risk # 48 - Code for GG sub-unit is not completed or reviewed (Score = 10)
- Risk # 49 - Insufficient VIIRS data for EVI Global Max/Min Climatology (Score = 15)
- Risk # 53 - Available GVF Climatology is not useable. (Score = 9)

Actions to reduce open risks are documented in the PSR

Risk History (1)

Risk Number	Risk Statement	Status After G3R	Status After PRR	Status After CDR	Status After TRR	Status After CTR	Status At SRR
1	Real VIIRS data not available for unit testing	7	0	0	0	0	0
2	Real VIIRS data not available for system testing	25	0	0	0	0	0
3	Surface Type EDR data not available for unit testing	10	0	0	0	0	0
4	Surface Type EDR data not available for system testing	14	0	0	0	0	0
5	Vegetation Index EDR data not available for unit testing	20	0	0	0	0	0
6	Vegetation Index EDR data not available for system testing	21	0	0	0	0	0
7	User involvement is less than expected	15	15	6	3	3	0
8	Second development contractor has not been identified	16	0	0	0	0	0
9	Developers do not have access to SADIE	5	0	0	0	0	0
10	Developers do not have access to NDE STE	20	6	10	10	0	0
11	STAR EPL process adds extra work for documentation and reviews, resulting in a schedule delay.	20	20	3	3	3	0
12	Insufficient training in the STAR EPL process	9	4	4	4	0	0

Risk History (2)

Risk Number	Risk Statement	Status After G3R	Status After PRR	Status After CDR	Status After TRR	Status After CTR	Status At SRR
13	Review teams have not been established.	21	14	10	10	0	0
14	Ivan's planned FTE load may need to be reduced because of new responsibilities	50	0	0	0	0	0
15	Landsat truth data may be limited	16	8	8	8	4	0
16	Developer ftp access to GRAVITE has not been established	10	0	0	0	0	0
17	ESPC SAN time retention may not be sufficient for users	9	9	3	0	0	0
18	Development server failure	7	0	0	0	0	0
19	Operations concept is not completely developed	21	9	25	25	6	21
20	Supplier agreements are not sufficiently established	21	0	0	0	0	0
21	Operator involvement is less than expected	10	10	6	6	6	0
22	Product requirements are incomplete	24	10	6	6	0	0
23	Project costs exceed available funding	16	16	8	40	16	8
24	PDR and CDR are combined, resulting in detailed design being performed before preliminary design is reviewed		20	0	0	0	0

Risk History (3)

Risk Number	Risk Statement	Status After G3R	Status After PRR	Status After CDR	Status After TRR	Status After CTR	Status At SRR
25	CDR and Gate 4 Review are combined, necessitating a combined Technical/Management Review Team.		10	0	0	0	0
26	VIIRS Cloud Mask quality may be insufficient		14	1	0	0	0
27	Request to Archive process for NUP is not clear to OSPO		40	0	0	0	0
28	Transition from NDE Operations to ESPC is affected by the non-availability of the system when OSPO training for NDE occurs		15	15	0	0	0
29	Test plans are not established		25	20	10	5	0
30	Production of SPSRB documents will be affected because NDE personnel cannot work on them.		12	12	12	4	20
31	VIIRS Surface Reflectance RIP will not be available in time to meet latency requirement.		35	35	35	35	35
32	NCEP EMC needs for a GVF Regional Product are not completely established			25	0	0	0
33	OSPO personnel may not be ready for O&M, due to lack of access to NDE test environments			25	10	10	25
34	Use of EVI Max/Min values derived from MODIS data during the first year of operations will introduce a bias to the calculated GVF			20	20	4	0

Risk History (4)

Risk Number	Risk Statement	Status After G3R	Status After PRR	Status After CDR	Status After TRR	Status After CTR	Status At SRR
35	Requirement to change pre-operational code in SADIE via NDE change control process will increase the time needed for code refinement during unit testing			25	0	0	0
36	Code will not run properly when Production Environment switches to a Linux environment in 2016.				30	0	0
37	Algorithm will not meet the GVF quality requirement				20	20	0
38	Design is not complete at CDR				20	4	4
39	Degradation in VIIRS I2 band results in failure to meet required GVF accuracy				40	0	0
40	CLASS archive of GVF products is not funded				40	0	0
41	IMSG – STAR contract for scientific services has not been awarded and may cause loss of development resources				0	0	0
42	Possible 1 month delay due to the migration of the STAR IT environment in 2012				0	0	0
43	Loss of Junchang Ju				30	0	0
44	Additional funds may not be available in time to prevent interruption of future work.				25	0	0

Risk History (5)

Risk Number	Risk Statement	Status After G3R	Status After PRR	Status After CDR	Status After TRR	Status After CTR	Status At SRR
45	NETCDF Re-formatting toolkit may not be available.				25	0	0
46	VIIRS SR RIP is not available from CLASS in time for operations				32	32	56
47	Unable to test latency of data from CLASS					30	30
48	Code for GG sub-unit is not completed or reviewed at CTR					10	10
49	Insufficient VIIRS data for EVI Global Max/Min Climatology					30	15
50	System test data sets are not complete					20	0
51	OSPO access to NDE Test Environment is not established					80	80
52	Monitoring and maintenance level for this product should be daily					25	0
53	Available GVF Climatology is not useable.					30	9
C37	QA support for Development has ended						20
C38	Currently available funding will only last through October 2013						20

Risk Summary – Risk Score

	Status After G3R	Status After PRR	Status After CDR	Status After TRR	Status After CTR	Status At SRR
Total OPEN Risks	23	19	20	25	21	15
Total HIGH Risks	0	1	0	3	1	2
Total MEDIUM Risks	10	4	7	10	8	8
Total LOW Risks	13	14	13	12	12	5
Total CLOSED Risks	0	12	15	21	33	40
Total Established Risk Score	387	292	267	464	377	313
Total Candidate Risks						2
Total Candidate Risk Score						40

Total Risk Score at SRR is 83% of the Total Risk Score established at the CTR (does not include the new Candidate Risks)

1) Project Plan
2) CTR Report
3) System Overview
4) System Description
5) System Verification
6) System Readiness
7) Project Status
8) **Summary and Conclusions**

Section 8 –
Summary and Conclusions

Presented by

Marco Vargas (STAR)

Review Objectives Have Been Addressed

- Project plan has been reviewed
- TRR Report has been reviewed
- Operations concept has been reviewed
- Algorithm has been reviewed
- Requirements have been reviewed
- System design components have been reviewed
- Test plans have been reviewed
- Test results have been reviewed
- Deliverable items have been reviewed
- Risks and Actions have been reviewed

Open Actions (1)

Action Statement	Assigned To	Due Date	Developer Comments
Confirm that a Geo-TIFF library is not needed	NDE	CDR	Open. Ken to talk to Dylan Powell.
Establish NDE capability to ingest SR RIP from CLASS	NDE	Transition	Open
Confirm NDE to CLASS distribution procedure	NDE	SRR	Open. Ken to talk to Kevin Berberich.
Confirm automated notifications to NCEP of anomalous production runs	NDE	SRR	Open. Ken to check.
Confirm the items to be archived at CLASS	NDE	SRR	Open. Will documentation be archived? Ken to talk to Kevin Berberich.
Review and approve SPSRB documents at the SRR	SRR Reviewers	SRR	Open.
Secure an operational source of VIIRS Surface Reflectance RIP that will meet latency requirements	Ding, NDE	TBD	This action must be carried over to Transition. Not feasible to do this within the Development schedule.
Deliver system test data and system test plan from the Development Environment to OSPO reviewers	Ju	CTR	Open.
Ensure that the code can read the NDE Process Control File (PCF)	NDE	Delta CDR	Open. Ken to talk to Dylan Powell.

Open Actions (2)

Action Statement	Assigned To	Due Date	Developer Comments
Run system test with input data from SCDR and measure latency after ingest of data.	Jiang	SRR	In progress. Will be completed during transition.
Report latency performance in the VVR	Jiang	SRR	In progress. Will be completed during transition.
Complete GG sub-unit code	Ju	SRR	Open
Document GG sub-unit in the DDD	Ju	SRR	Open
Review GG sub-unit code	OSPO QA/Security	SRR	Open. When can this be done?
Do the GG sub-unit test.	Jiang	SRR	Open
Report GG sub-unit test results in VVR for review at SRR.	Jiang	SRR	Open
Acquire VIIRS SR RIP data for additional season.	Jiang	10/31/2013	Open. After SRR.
Work with NDE on validation in NDE Test Environment	Ding	Transition	Open
Establish a useable GVF Climatology	Ju	SRR	Open. Close to being completed.

Completing the Development Phase

- Complete the gapfill code and unit test
- Produce SMM and IUM
- Finalize DAP # 2 and deliver DAP # 2 to NDE
- Assist NDE with installation and acceptance of code and test data in SADIE
- Complete the system test. Document results in ATBD and VVR.
- Produce a Linux DAP and deliver to NDE

Open Discussion

- The review is now open for free discussion