Validated Stage 1 Science Maturity Review for Surface Reflectance

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Outline

- Algorithm Cal/Val Team Members
- Product Requirements
- Evaluation of algorithm performance to specification requirements
  - Evaluation of the effect of required algorithm inputs
  - Quality flag analysis/validation
  - Error Budget
- Documentation
- Identification of Processing Environment
- Conclusion
- Path Forward

VIIRS Surface Reflectance Team

Name	Organization	Major Task
Eric Vermote	NASA GSFC	SR EDR Algorithm Lead
Alexie Lyapustin	NASA GSFC	SR Cal Val Lead
Sadashiva Devadiga	NASA GSFC Sigma Space Corp	SR QA Lead
Ivan Csiszar	NOAA/STAR	STAR Land EDR Chair

Product Requirements

Attribute	Threshold	Objective
Geographic coverage	Land, Cloud Clear.	Global, All atmospheric condition
Vertical Coverage	NA	NA
Vertical Cell Size	NA	NA
Horizontal Cell Size	Nadir Moderate Resolution: 0.75km Image Resolution: 0.375 km	
Mapping Uncertainty		
Measurement Range		
Measurement Accuracy*	0.01 + 10%	0.005 + 5%
Measurement Precision		
Measurement Uncertainty		

* *The performance is dependent on both the spectral band and the magnitude of the reflectance (increased surface brightness results in a multiplicative error of 5%).*

Data Product Maturity Definition

Validated Stage 1:

Using a limited set of samples, the algorithm output is shown to meet the threshold performance attributes identified in the JPSS Level 1 Requirements Supplement with the exception of the S-NPP Performance Exclusions

- Product performance has been demonstrated to comply with the specification using a small number of independent measurements obtained from selected locations, period and associated ground-truth/field program efforts.
- Product is ready for use by centrals and in scientific publications.
- Improved versions could be available as further validation effort over representative conditions continue.

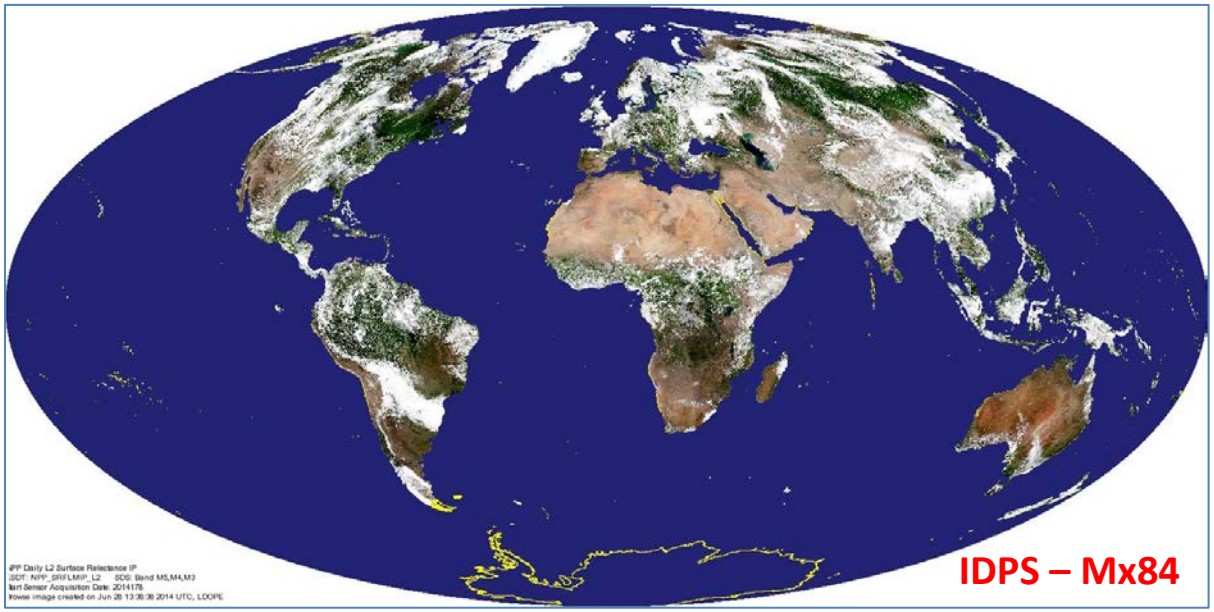
Evaluation of Algorithm Performance

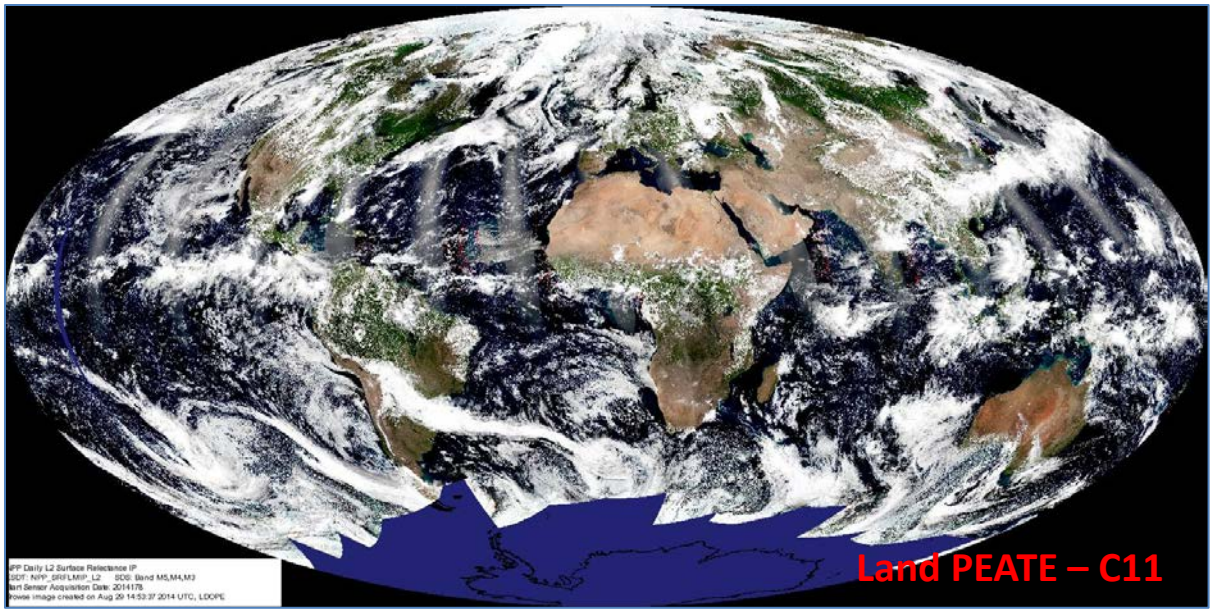
- Findings/Issues since Provisional Review
  - SRIP not retrieved when SDR is flagged as poor quality: Band quality value "Poor" for each SDR band (bits 0-1: 0: Good, 1: Poor, 2: No Calibration) in most cases results from flagging of dual gain anomaly. SDR values from dual gain anomaly are good and retrieved SRIP under this condition has been found to be good.
  - Software bug failing to initialize following variables could result in incorrect value for aerosol quantity flag in QF7 of SRIP when band4 is not retrieved: roatm = NA_FLOAT32_FILL); xrorayp = NA_FLOAT32_FILL; rho_atm_rho_mol = 0.0;
  - Out of range aerosol values (retrieved but are outside of the set upper and lower limits) and retrieved high AOT values are unreliable or incorrect. SRIP is not retrieved when AOTIP is flagged as out of range and SRIP cannot be reliably corrected for aerosol if the retrieved AOT is incorrect.
  - AOT is flagged as not retrieved when ephemeral water flag is turned ON in Cloud Mask. SRIP is not retrieved.
  - Dust model wasn't reliable. SRIP retrieved using the dust model was found to be of poor quality.

Evaluation of Algorithm Performance

- Improvements since Provisional – The IDPS operational version of the SRIP and AOTIP algorithms were revised at Land PEATE to mitigate the issues and the revised algorithm was used to generate improved products in the C11 reprocessing at Land PEATE.
  - Bypass SDR quality flag – good quality SRIP retrieved
  - Remove the ephemeral water flag check in AOTIP – good quality SRIP retrieved.
  - Retrieve SRIP when retrieved AOT is out of range. This change could not reliably fix the issue.
  - While calculating the AOT over land skip the dust model.
  - No LUT updates

Evaluation of Algorithm Performance

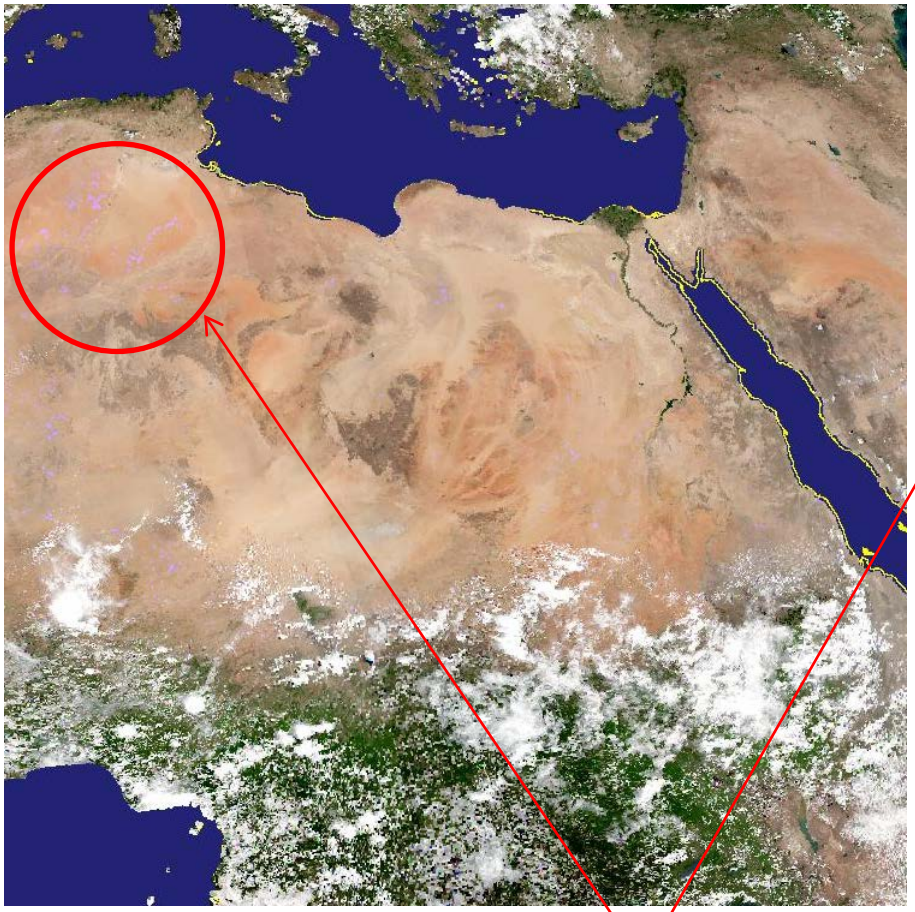




- Global browse of Surface Reflectance IP generated using RGB composite of bands 5, 4, and 3 in SRIP – Data Day 2014178
- IDPS operational version doesn't process ocean pixels.
- IDPS version of SRIP generated using Mx84 build version of the algorithm.
- C11 reprocessing used proposed changes to SRIP and AOTIP algorithm.

Evaluation of Algorithm Performance

IDPS – Mx84

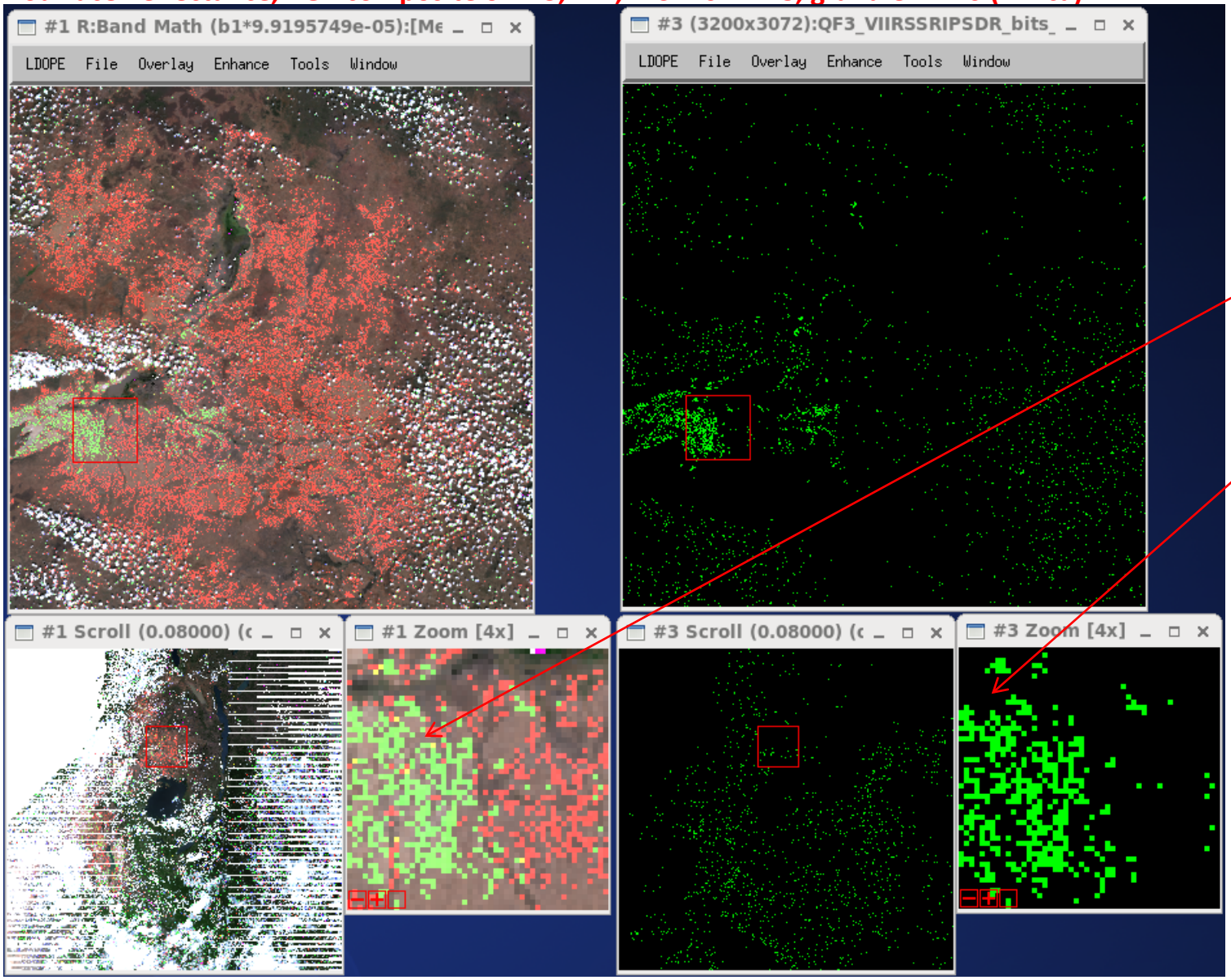


Land PEATE – C11

One or more bands not retrieved in IDPS version due to bad SDR quality, but is retrieved in C11 reprocessing by ignoring the SDR QF

Evaluation of Algorithm Performance

Surface Reflectance, RGB composite of M5, M4, M3: 2014178, granule 11:20 (Africa)



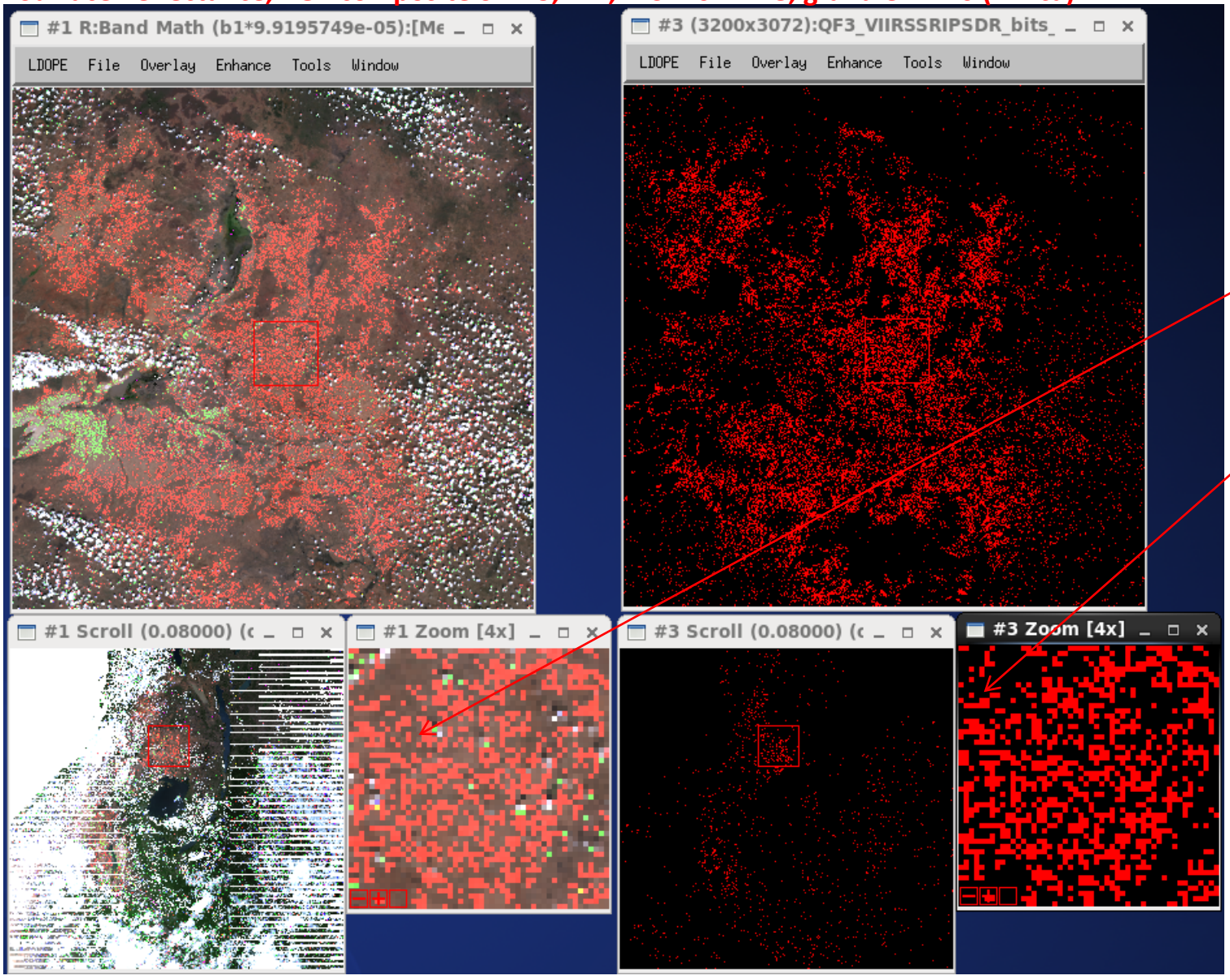
Example: SDR Quality Flag Issue

M4 (Green band) not retrieved in IDPS version.

The SDR quality flag indicate bad quality for M4 SDR (Byte 2, Bit 3)

Evaluation of Algorithm Performance

Surface Reflectance, RGB composite of M5, M4, M3: 2014178, granule 11:20 (Africa)



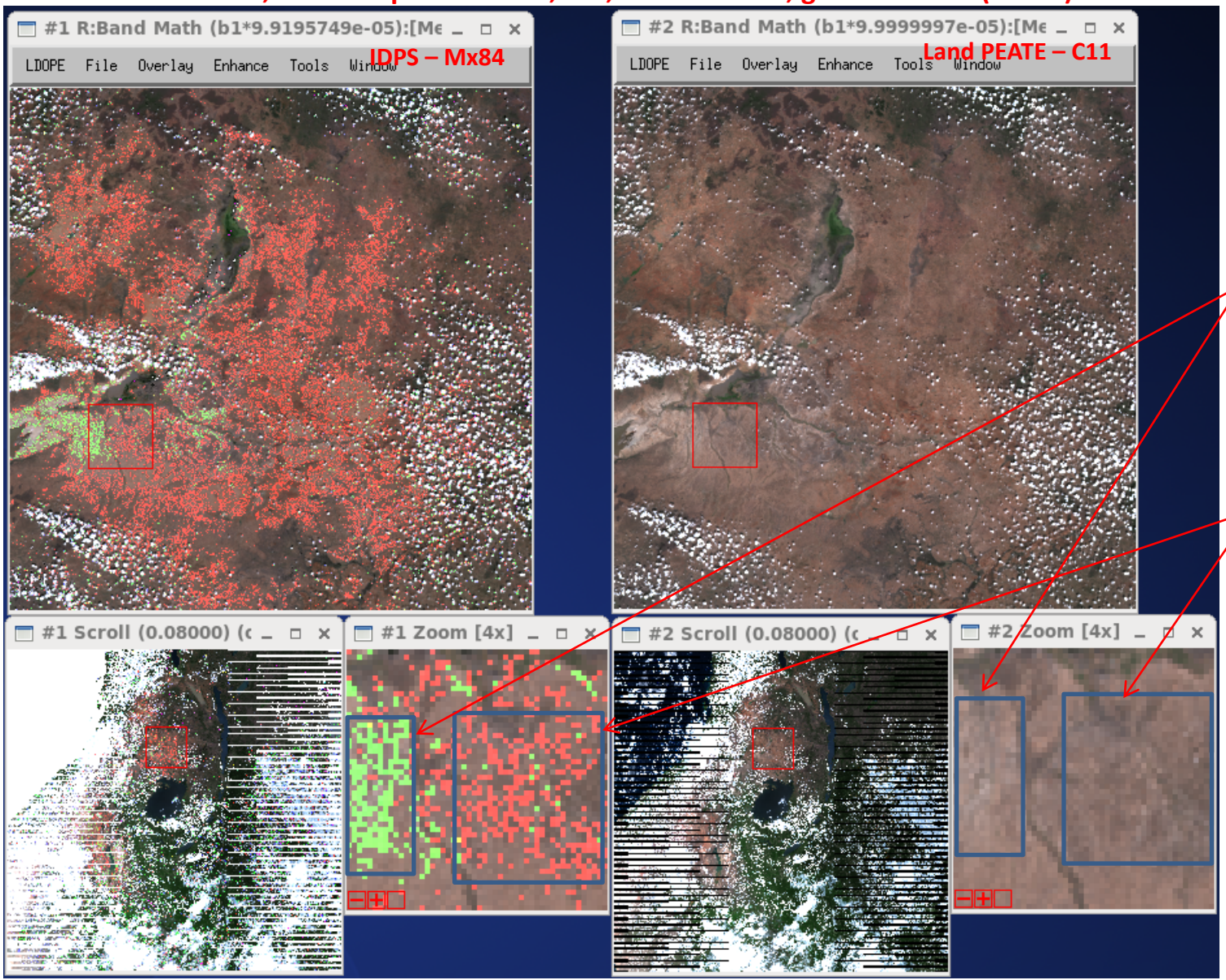
Example: SDR Quality Flag Issue

M5 (Red band) not retrieved in IDPS version.

The SDR quality flag indicate bad quality for M**5** SDR (Byte 2, Bit 4)

Evaluation of Algorithm Performance

Surface Reflectance, RGB composite of M5, M4, M3: 2014178, granule 11:20 (Africa)



Example: SDR Quality Flag Issue

M4 (Green band) not retrieved in IDPS version, but retrieved in C11

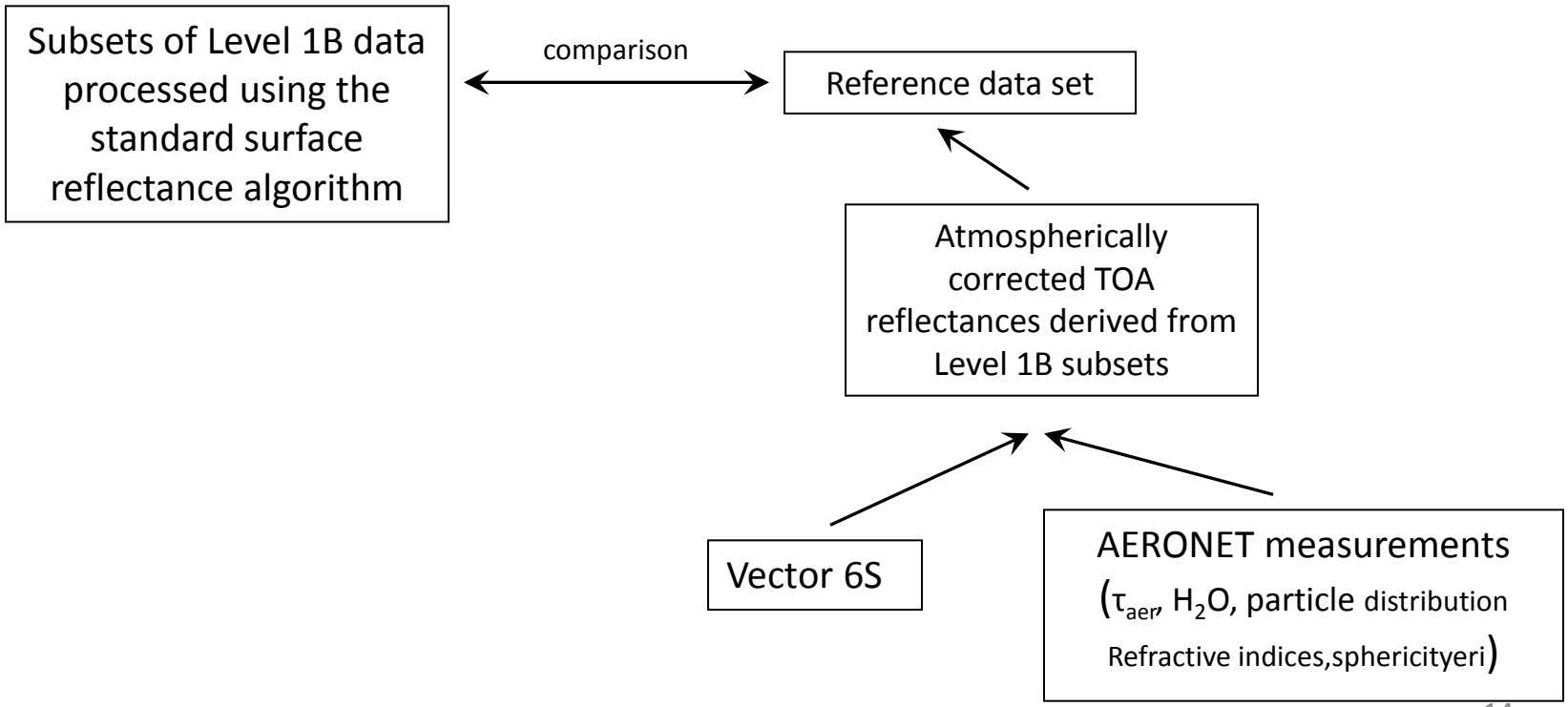
M5 (Red band) not retrieved in IDPS version, but retrieved in C11

Evaluation of Algorithm Performance

- Cal/Val Activities for evaluating algorithm performance:
  - Test / ground truth data sets
  - Validation strategy / method
  - Validation results

Evaluation of Algorithm Performance

Methodology for evaluating the performance of surface reflectance product (generic)



Evaluation of Algorithm Performance

Validation Metrics

- Accuracy (A) = the bias

$$A = \frac{1}{N} \times \sum_{i=1}^{N} \varepsilon_i$$

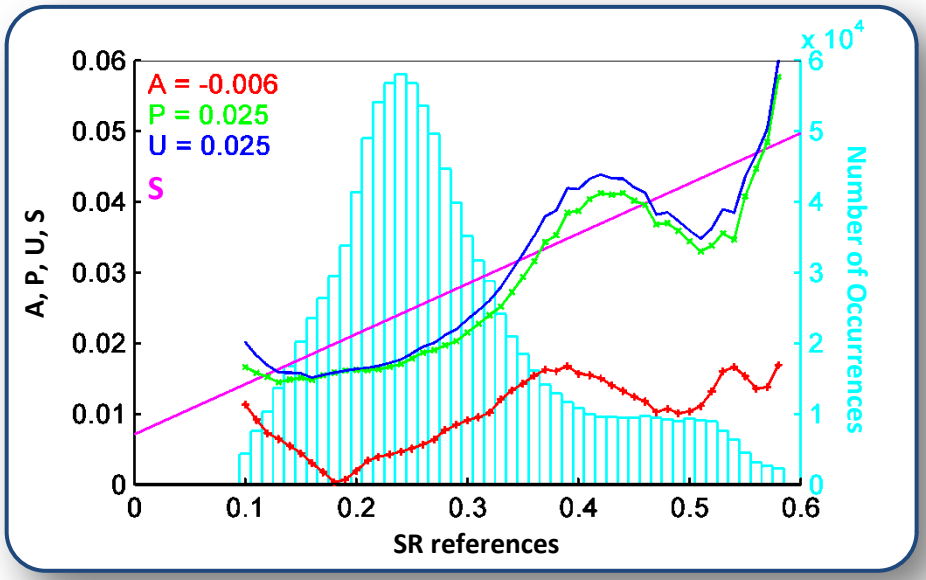
- Precision (P) = the repeatability

$$P = \sqrt{\frac{1}{N-1} \times \sum_{i=1}^{N} (\varepsilon_i - A)^2}$$

- Uncertainty (U) = the actual statistical deviation

$$U = \sqrt{\frac{1}{N} \times \sum_{i=1}^{N} \varepsilon_i^2}$$

$$U^2 = \frac{\sum_{i=1}^{N} \left(\mu_i^e - \mu_i^t - A + A\right)^2}{N} = \frac{N-1}{N} P^2 + A^2$$

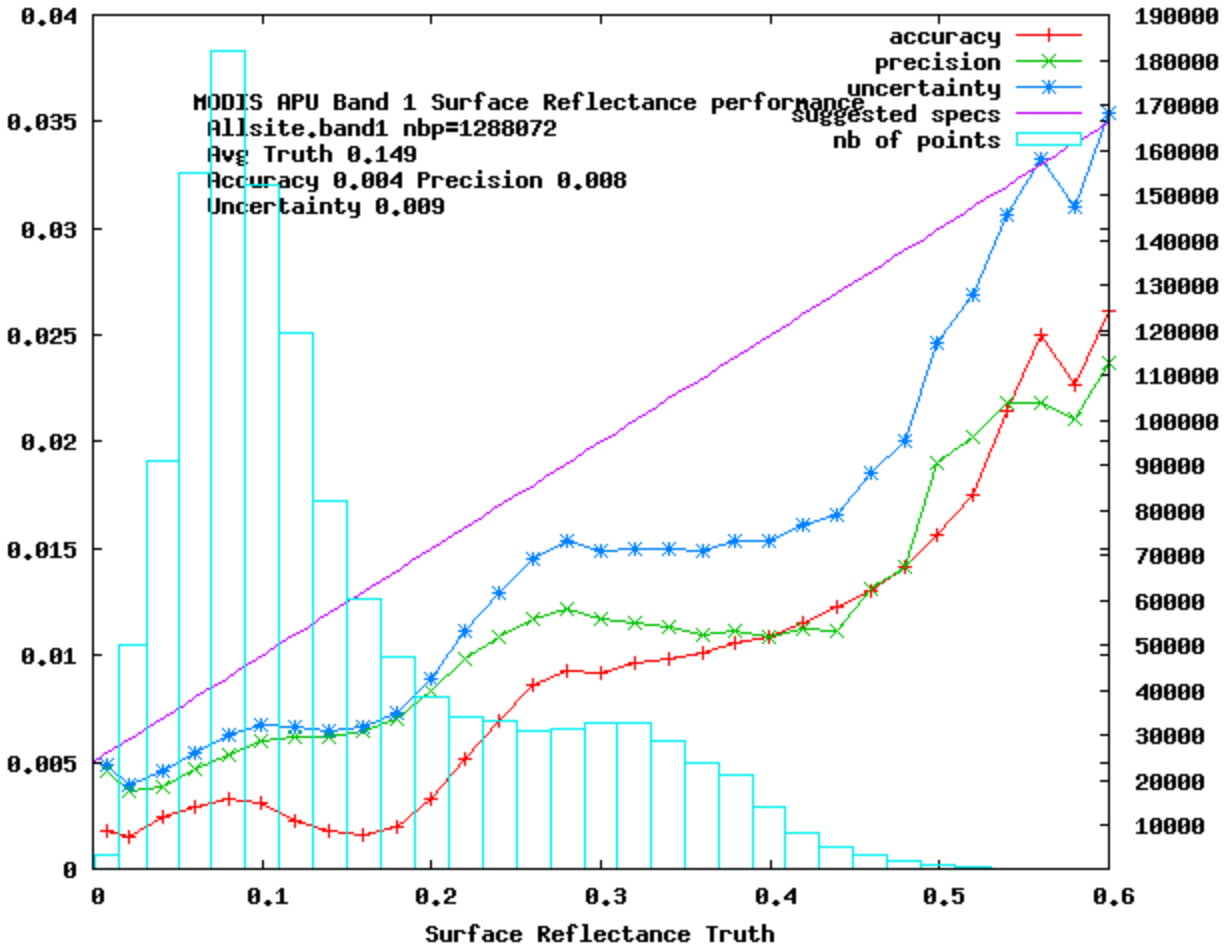


- Specification (S) = Uncertainty requirement

From Vermote and Kotchenova, 2008

Evaluation of Algorithm Performance

MODIS Collection 5



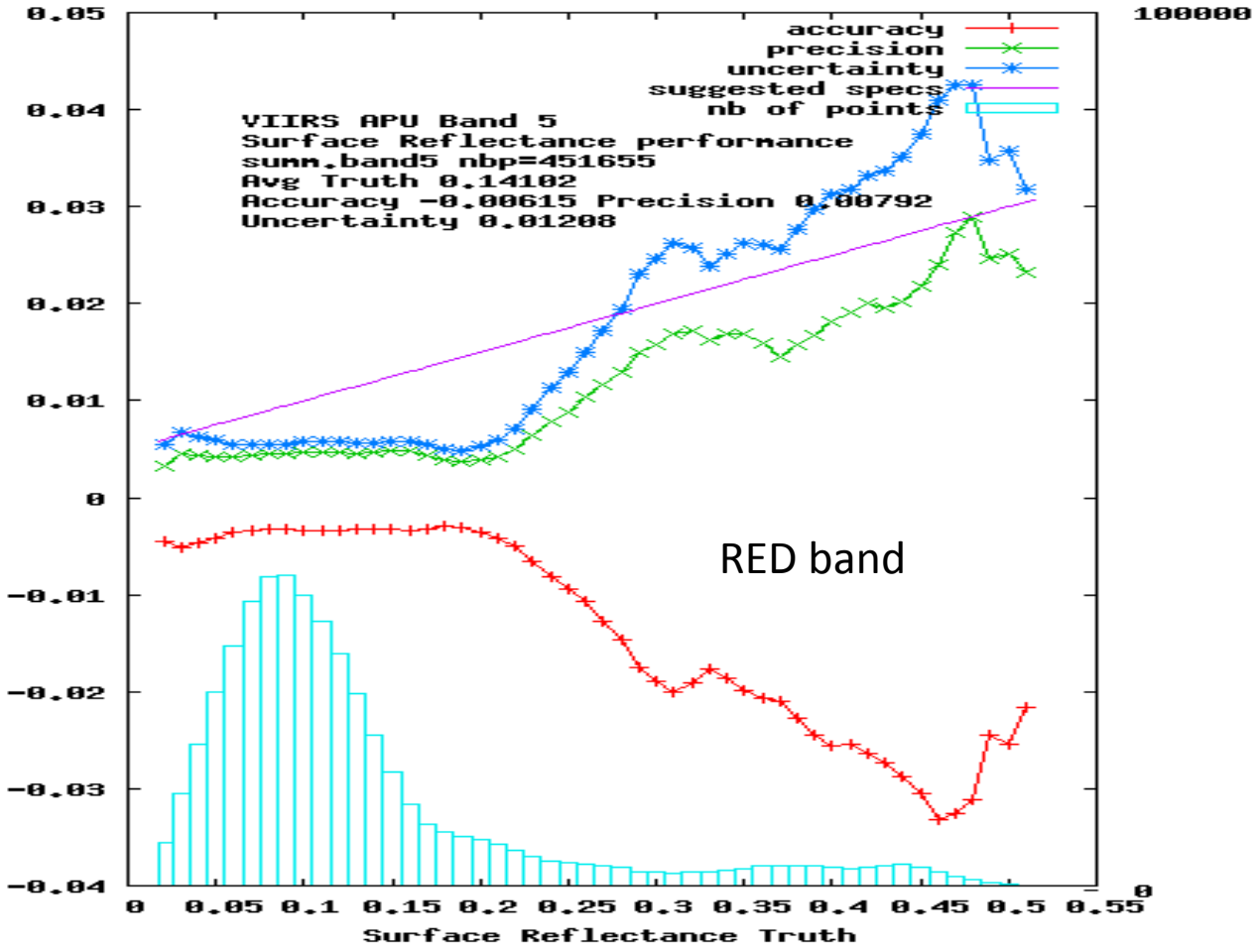
1,3 Millions 1 km pixels were analyzed for each band.

Red = Accuracy (mean bias)
Green = Precision (repeatability)
Blue = Uncertainty (quadatric sum of A and P)

On average well below magenta theoretical error bar

Evaluation of Algorithm Performance

VIIRS C11 reprocessing



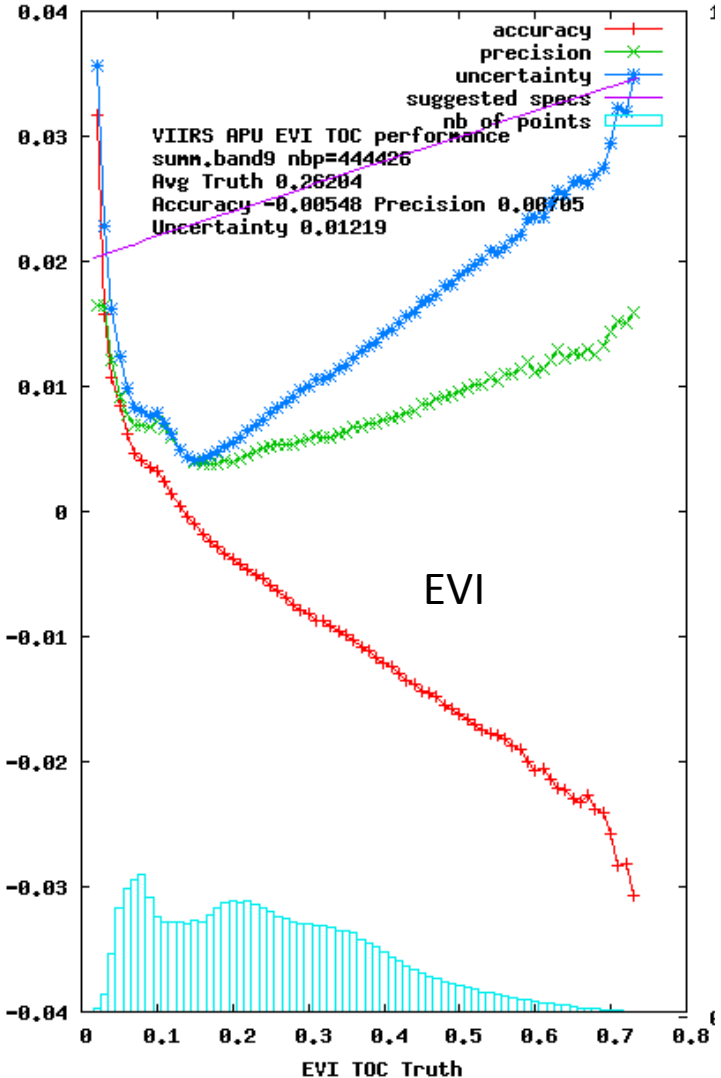
450000 pixels were analyzed for each band.

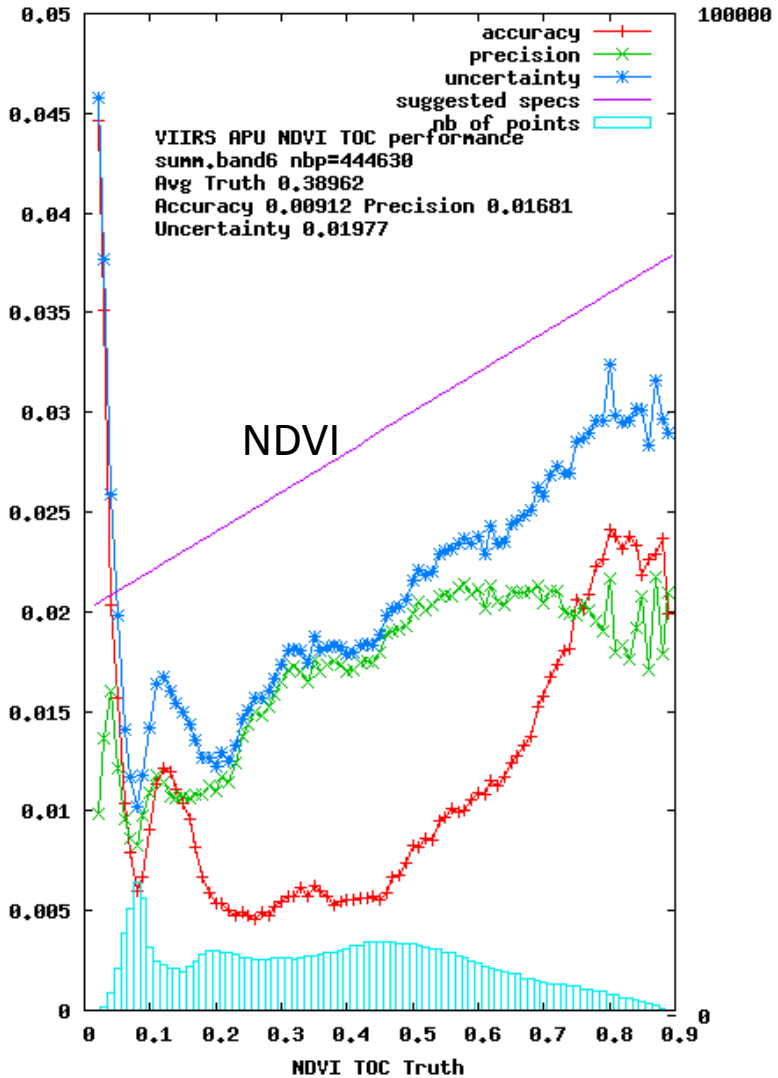
Red = Accuracy (mean bias)
Green = Precision (repeatability)
Blue = Uncertainty (quadatric sum of A and P)

On average well below magenta theoretical error bar

Evaluation of Algorithm Performance

VIIRS C11 reprocessing





Documentation

- The following documents will be updated and provided to the EDR Review Board before AERB approval:
  - Current or updated ATBD
  - Current or updated OAD
  - README file for CLASS
  - Product User's Guide (Recommended)

Identification of Processing Environment

- IDPS or NDE build (version) number and effective date – date the future build version addressing the identified DRs is in operation at IDPS
- Algorithm version – Build version that would implement the DRs identified in the following slides
- Version of LUTs used – operational version on the effective date
- Version of PCTs used – operational version on the effective date
- Description of environment used to achieve validated stage 1 – C11 reprocessing from Land PEATE

DRs – SRIP

Following DRs should be implemented in the IDPS SRIP process

DR#	Description	Status
DR XXXX (Land - SRIP)	Band quality value of "Poor" for each SDR band (bits 0-1: 0: Good, 1: Poor, 2: No Calibration) in most cases results from flagging the case of dual gain anomaly. SDR values from dual gain anomaly are good and retrieved SRIP under this condition has been found to be good.	Not submitted

DR XXXX (Land – SRIP)	In the SRIP process this Initialization is missing
	roatm = NA_FLOAT32_FILL; xrorayp = NA_FLOAT32_FILL;
	rho_atm_rho_mol = 0.0;
	It affects only if band 4 is not retrieved. The Aerosol Quantity flag in QF7 may not be correct.
		Not submitted

DRs - AOTIP

Following DRs should be implemented in the IDPS AOTIP process

DR#	Description	Status
DR XXXX (Land – AOTIP)	Dust model is not working. Skip the dust model while retrieving AOTIP	Not submitted
DR XXXX (Land – AOTIP)	AOTIP sets the AOT Quality as “Not produced” if the Ephemeral Water flag in VCM is tuned ON in VCM. Bypass this check so the AOTIP would retain the default value (high) for the quality flag.	Not submitted
DR XXXX (Land – AOTIP)	AOTIP retrieval at the extreme range may not be correct. C11 reprocessing used the entire retrieved range by ignoring the out of range flag. Quality of SRIP from this change to AOITP didn’t improve. DR recommends that retrieval approach be fixed. **This may have been addressed by the DRs 7595, 7596, 7597, 7598, and 4724**	Not submitted

Conclusion

- Cal/Val results summary:
  - Team recommends algorithm validated stage 1 maturity provided that all identified DRs are implemented

Path Forward

- Planned further improvements – Update VIIRS SR (and aerosol) algorithm to MODIS collection 6