



# VIIRS SDR Quality Assurance, User Support, and Long-term Monitoring

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& EDR Teams



# Overview



## Achievements since the last review:

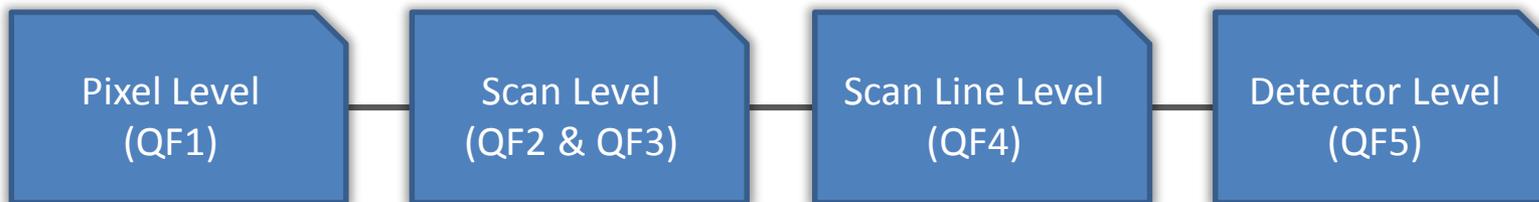
- Closed out all major issues since the provisional review
- Added multiple new QFs
- Validation of SDR and SDR GEO Quality Flags (QF)
  - Implemented and validated the correct flagging and filling of HAM/RTA synchronization loss, sector rotation, and OBC black-body warm up and cool down events
  - Detailed analysis of the implementation of calibration substitution algorithm for dual gain bands
  - Dual gain anomaly flagging limits generated every 2 months and LUT updated on an as needed basis
  - Detailed analysis verified the Moon in the keep-out-box (KOB) flagging with margin
  - Detailed analysis of data corruption near the north pole
- Developed global data quality flag monitoring through the ICVS
- Working closely with users to improve VIIRS SDR quality

## Verification and Validation by the SDR team members (NOAA/STAR/CI, NG, Aerospace & NASA) in collaboration with users:

- VIIRS SDR Quality Flags in general are Mature
  - Operational performance has been characterized
  - SDR QFs are deemed ready for use
- Work remains to resolve all identified issues:
  - Each has been brought to the program office and captured within a DR to be monitored and addressed
  - A path forward has been constructed for each open DR
- We are confident that the remaining issues do not pose a risk to maturity status

VIIRS SDR quality flags are designed to flag data for the 16 moderate resolution bands, 5 imagery resolution bands, and 1 DNB band at:

## SDR QF:



Each Band has its own set from QF1 to QF5. DNB is from QF1 to QF3  
 VIIRS SDR GEO quality flags are designed to flag data at:

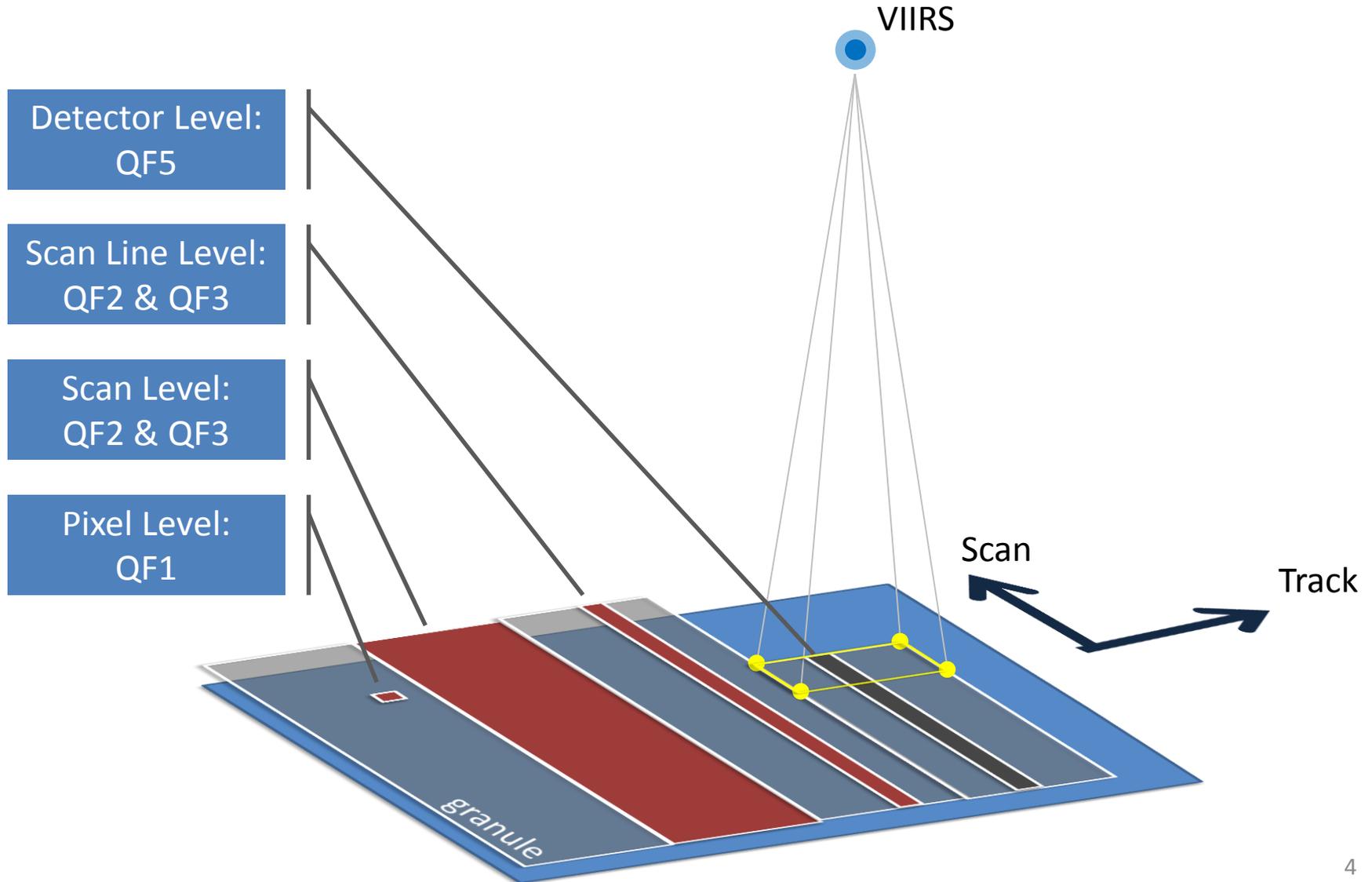
## SDR GEO QF:



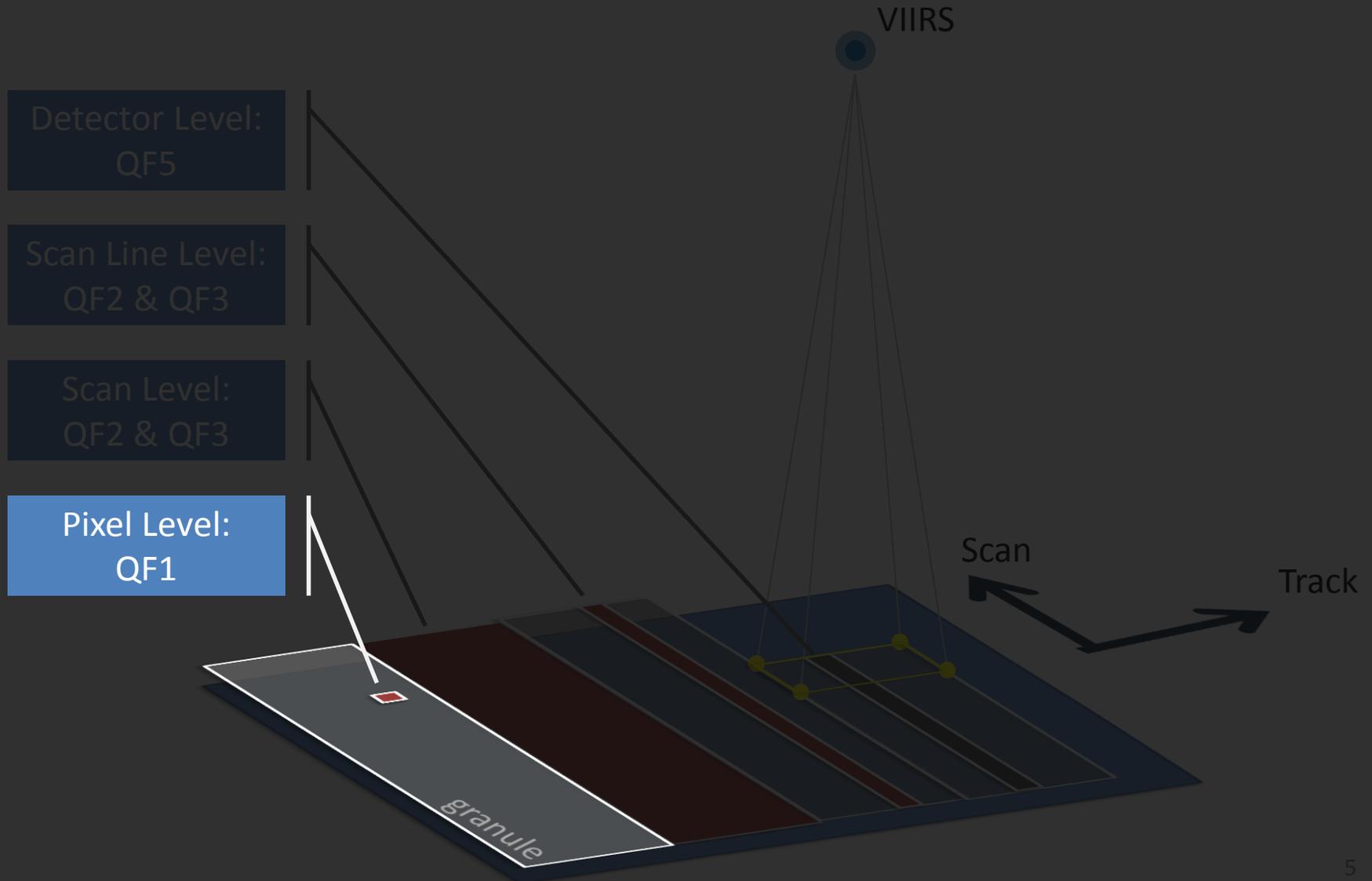
Each SDR GEO file (1 for M bands, 1 for I bands, and 1 for DNB) has its own set QFs

**We will focus on the SDR QF Maturity Assessment**

# SDR QF Visualization



# SDR QF Visualization



## SDR QF:

Pixel Level  
(QF1)

Quality Flag	
Name	Value
Good	0
Poor	1
No Calibration	2
Not Used	3



Quality – indicates calibration quality due to bad space view offsets, OBC view offsets, etc. or use of a previous calibration view

### Saturated Pixel Flag

Name	Value
None Saturated	0
Some Saturated	1
All Saturated	2
Not Used	3



Saturated Pixel – indicates the level of pixel saturation

### Missing Data Flag

Name	Value
All data present	0
EV RDR data missing	1
Cal data (SV, CV, SD, etc.) missing	2
Thermistor data missing	3



Missing Data – Data required for calibration processing is not available for processing  
Missing cal data leads to poor quality only when substitution is found. (i.e. QF4 is set to >0 value)

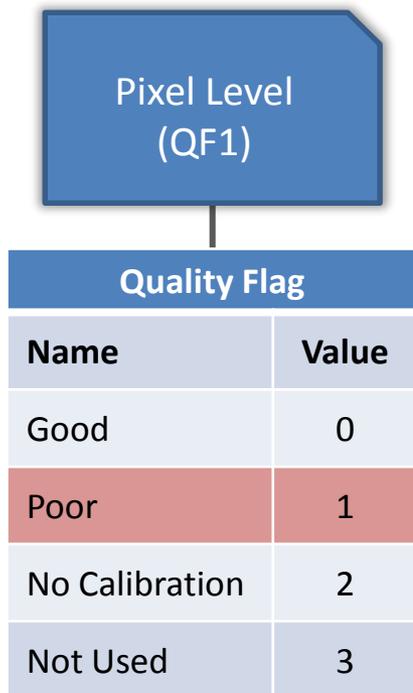
### Out of Range Flag

Name	Value
All data within range	0
Radiance out of range	1
Reflectance or EBBT out of range	2
Both Radiance and Reflectance/EBBT out of range	3



Out of Range – Calibrated pixel value outside of LUT threshold limits

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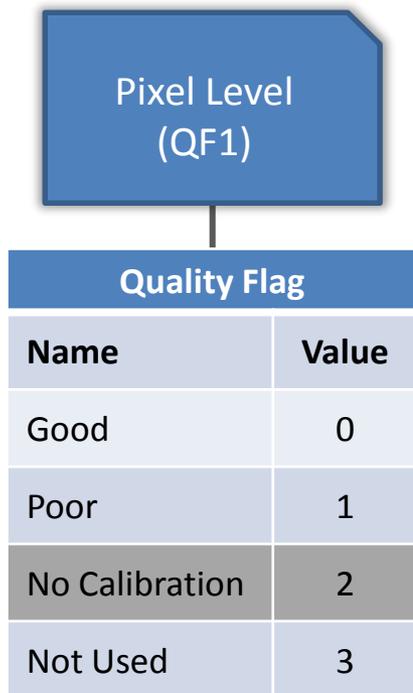
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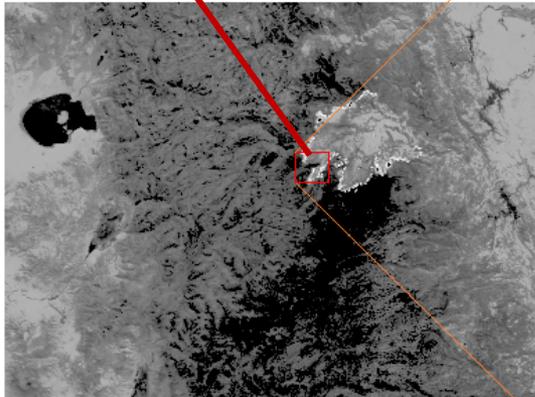
No calibration will trigger a fill value in the corresponding pixel

## 2013 California RIM Fire:

VIIRS Band: I04

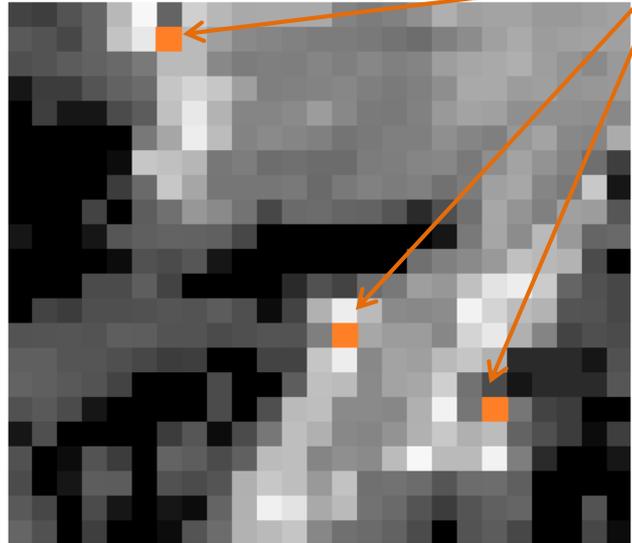
Example of VIIRS SDR QF1 flagging (saturation)

Active Fire

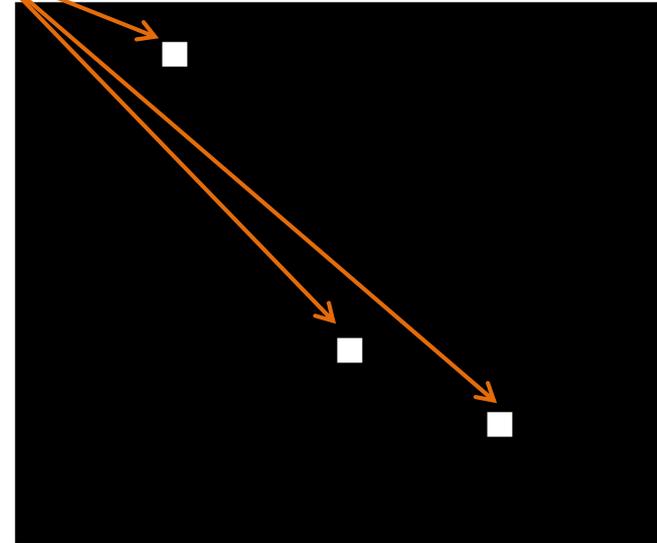


I04 over California  
(Aug 24, 2013)

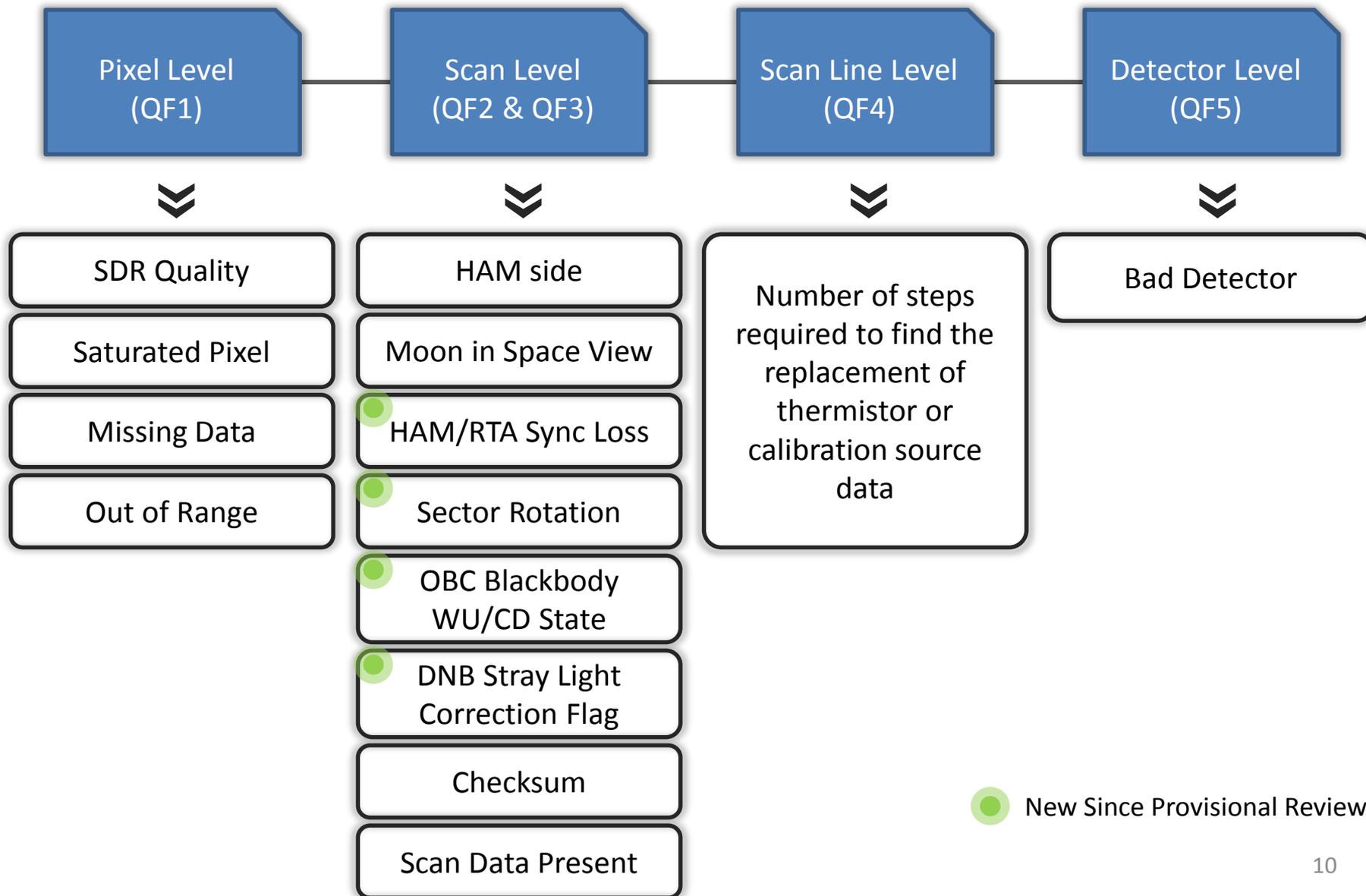
Saturated Pixels



Zoomed Image

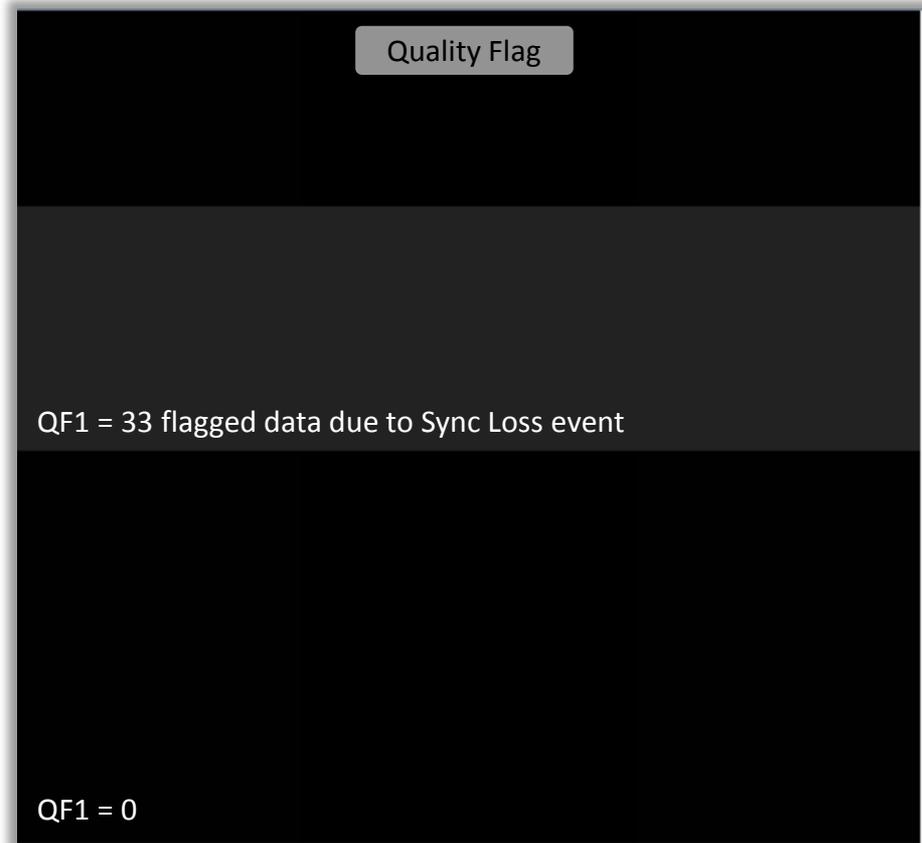
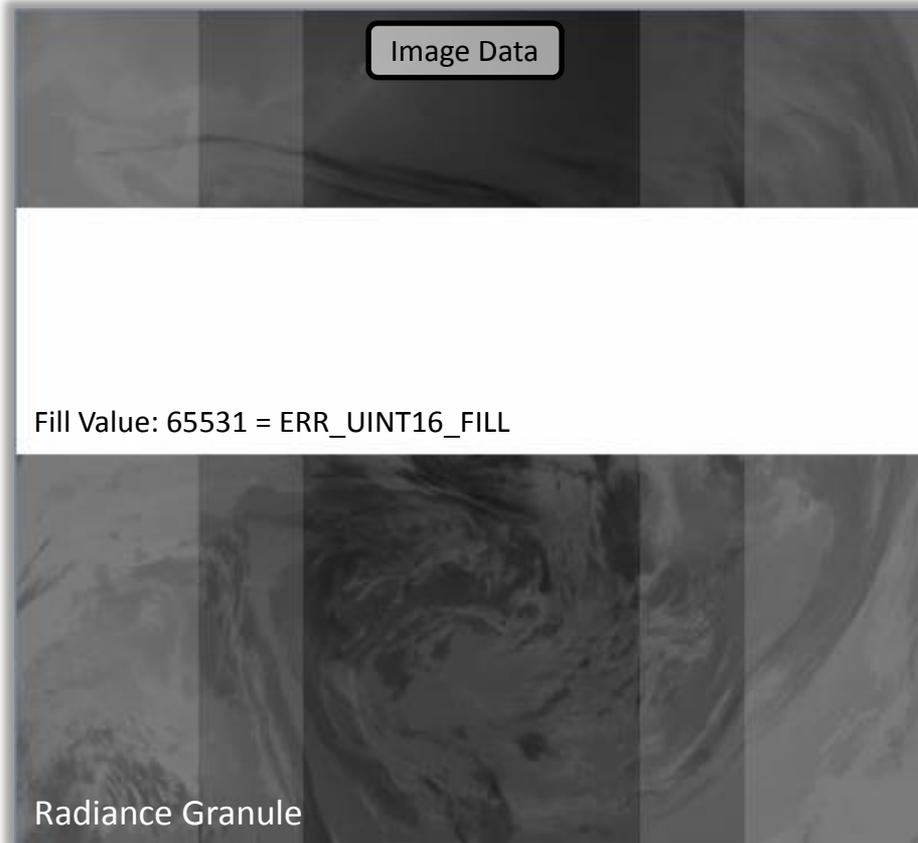


Saturation Flag (QF1)



## HAM/RTA Sync Loss Example: 23/Nov/13

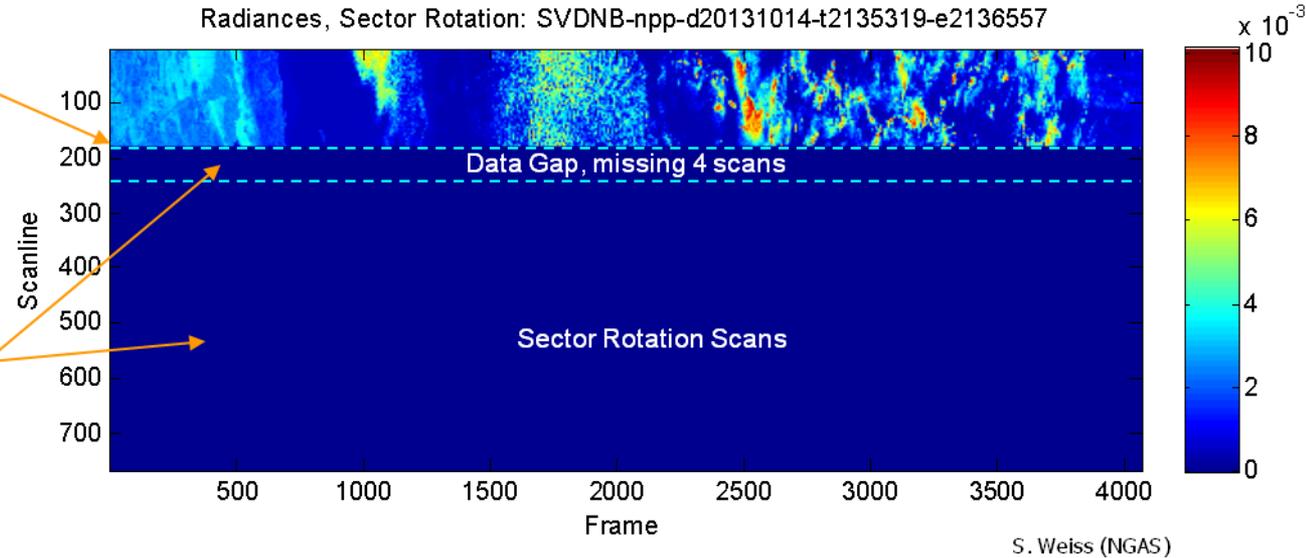
A new DR [7484] has been recently opened to address observed bit toggling in engineering packet after Sync Loss events



# SDR Cal Products are Properly Filled and Flagged During Sector Rotation Post Build Mx7.2

The sector rotation trigger occurs in Scan 11, Scan Start: 21:35:49. The 4 scan data gap occurs immediately after the trigger. First sector rotated scan occurs after data gap.

SDR Cal data products are set to FILL in the data gap that precedes the sector rotation and during the sector rotation.



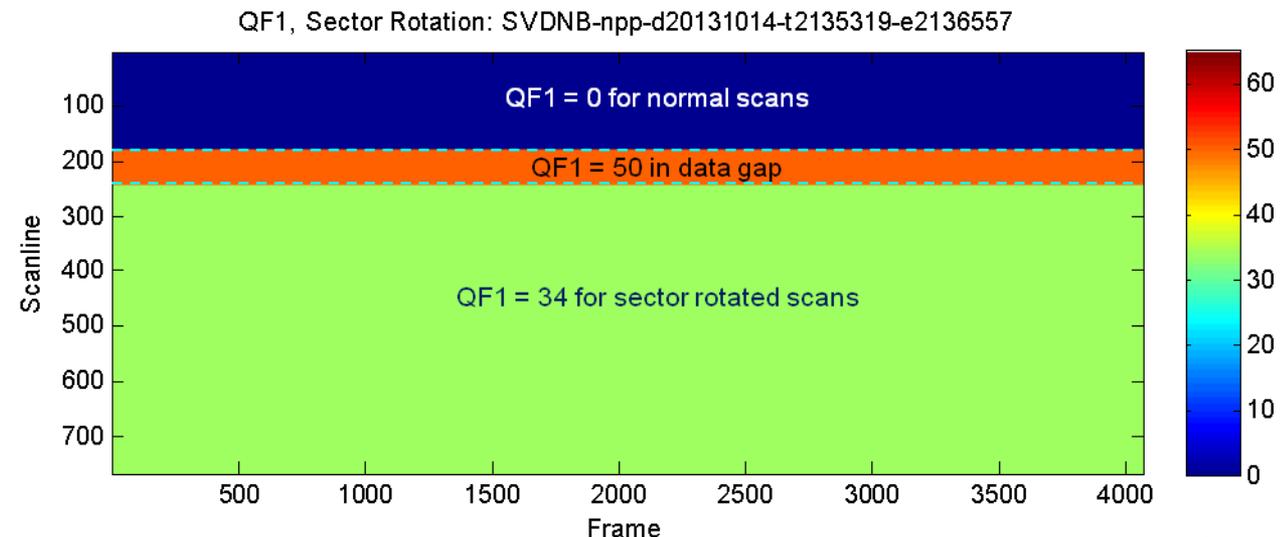
SDR Pixel Level QF1 pixels are being set appropriately during sector rotation.

QF1 = 50 in Data Gap:

- Pixel Quality Flag = No Cal
- Missing Pixel Flag = EV RDR and Cal missing

QF1 = 34 during Sector Rotation:

- Pixel Quality Flag = No Cal
- Missing Pixel Flag = Cal missing



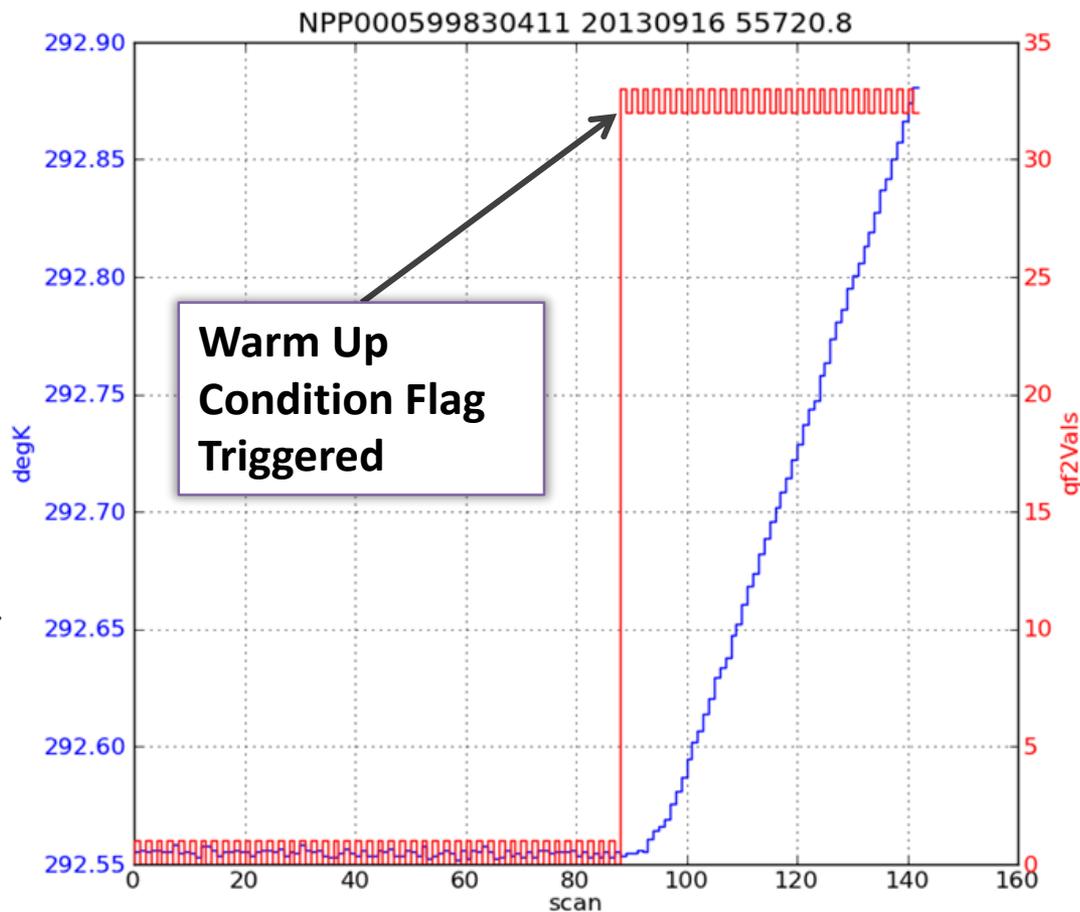
## Legend

- Temperature [K]
- QF2 Values

7.1 code shows appropriate flagging during warm up/cool down  
Nominal set point of 292.5 K



## BB Warm Up Example



- Eclipse QF implemented in the SDR GEO QF

Table 13 Scan Level Geolocation Quality Bytes *ref.: VIIRS OAD*

Byte	Bit	Flag Description	Result
QF1	0-1	Interpolation Stage	0: Nominal – E&A data available 1: Missing data <= Small gap 2: Small gap < Missing data <= Granule boundary 3: Missing data > Granule boundary
	2-3	HAM/RTA Encoder Flag	0: Good data – all encoder data is valid 1: Bad data – either HAM encoders, RTA encoders or both corrupted for the entire scan 2: Degraded data – either HAM encoders, RTA encoders or both are corrupted within the scan. 3: Missing data – Missing encoder data for the scan (dropped engineering packets)
	4	Above South Atlantic Anomaly	0: False 1: True
	5	Solar Eclipse	0: False 1: True
	6	Lunar Eclipse (DNB only)	0: False 1: True
	7	HAM Side	0: Mirror Side A 1: Mirror Side B

## Solar Eclipse Flag Validation Example:

S-NPP VIIRS Global True Color Image - November 3, 2013

(R,M5, G,M4, B,M3 (Updated 11-4-2013 13:44:18 UTC))

11/03/2013  
Solar Eclipse  
VIIRS M3, M4, M5

*Impact clearly visible*

- Lunar Eclipse Flag Validation Example:

10/18/2013  
Lunar Eclipse  
VIIRS DNB

*Impacted ~1 hour of DNB data - Sub-Visual*

day

night

Lunar Eclipse Flag = 1

## Objectives:

- Are QF flags and flag combinations triggered correctly
- Is the data appropriately flagged

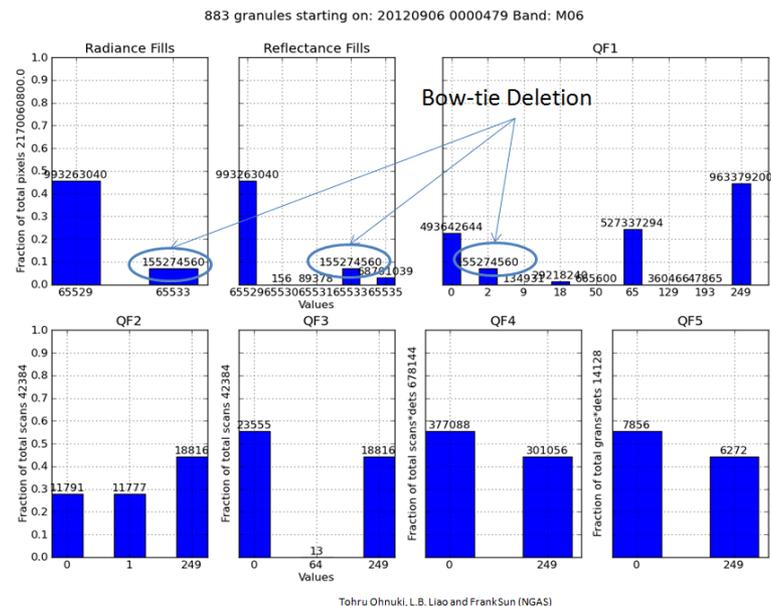
## Two approaches

- **Two 3-day surveys** of quality flags (QF) conducted to validate correct quality flagging (April 1-3 2013 and Oct 13-15 2013)
  - Generated a list of quality flags and flag combinations that were triggered & kept track of the fill values
  - Calculated the number of times each fill value and flag value occurred
- **Deep dive case studies**

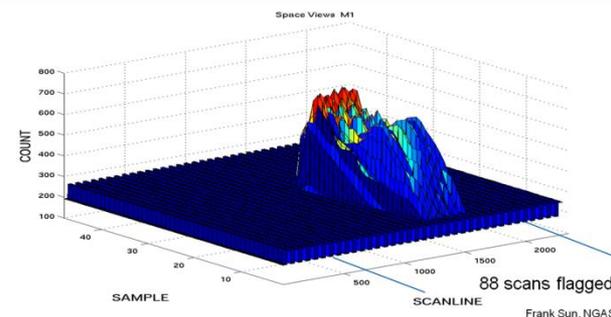
## Survey Results

- QFs are mature with the minor exceptions noted in the DR list (slides 19 & 20)
- QF1 = 50 requires further clarification
  - It can mean either thermistor data missing and no cal OR calpacket and RDR missing and no cal

## QF Survey Summary: 2012 09 06-09 Data, M6



## Verified Moon in SV keep-out-box Flagging w/ Margin



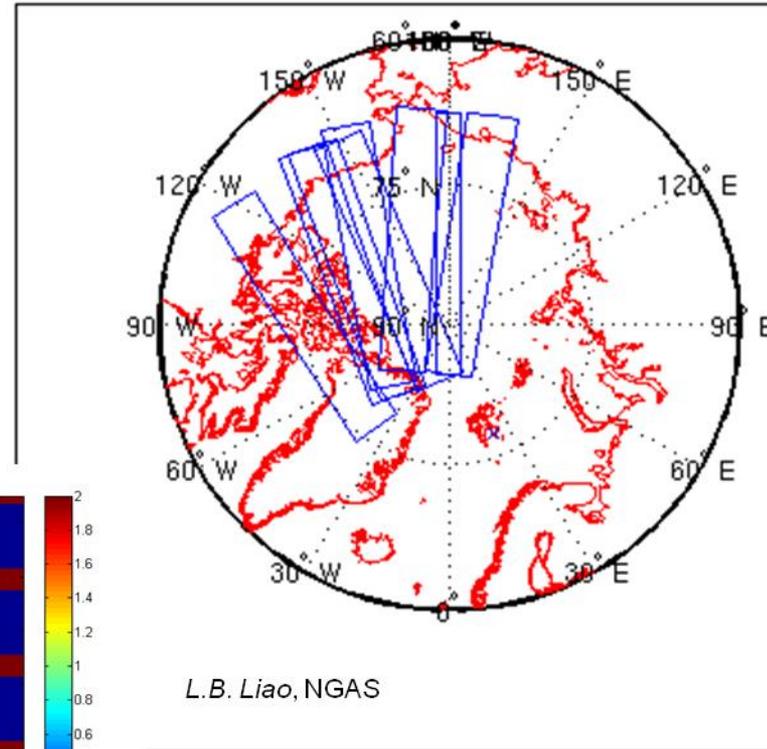
From left in scan direction: 1<sup>st</sup> granule, no elevated SV for all M-bands, 10 scans flagged; 2<sup>nd</sup> granule, 48 scans flagged, elevated SV seen in all M bands; 3<sup>rd</sup> granule, 30 scans flagged, elevated SV seen in all M bands

# Example Case Study: Data corruption over north pole (DR7481)

## Single scan of corrupt data after a data gap near the north pole:

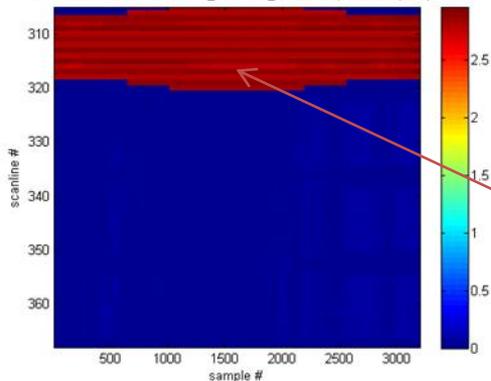
- 8 instances were observed in 2012
- 5 instances in the first 6 months of 2013
- Occurs possibly after contact with the ground station
- Currently testing the flagging criteria to ensure this event is fully captured

Locations of granules with corrupted data

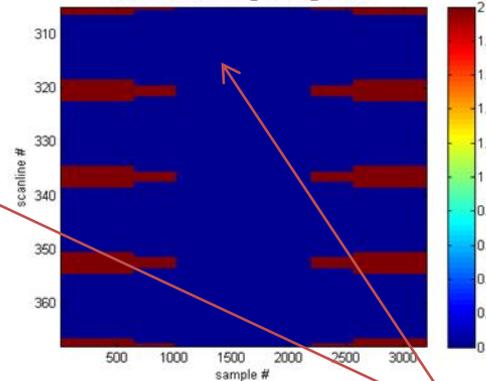


*L.B. Liao, NGAS*

M13 Radiance for d20130131\_t1824021\_e1825275 ( $W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$ )



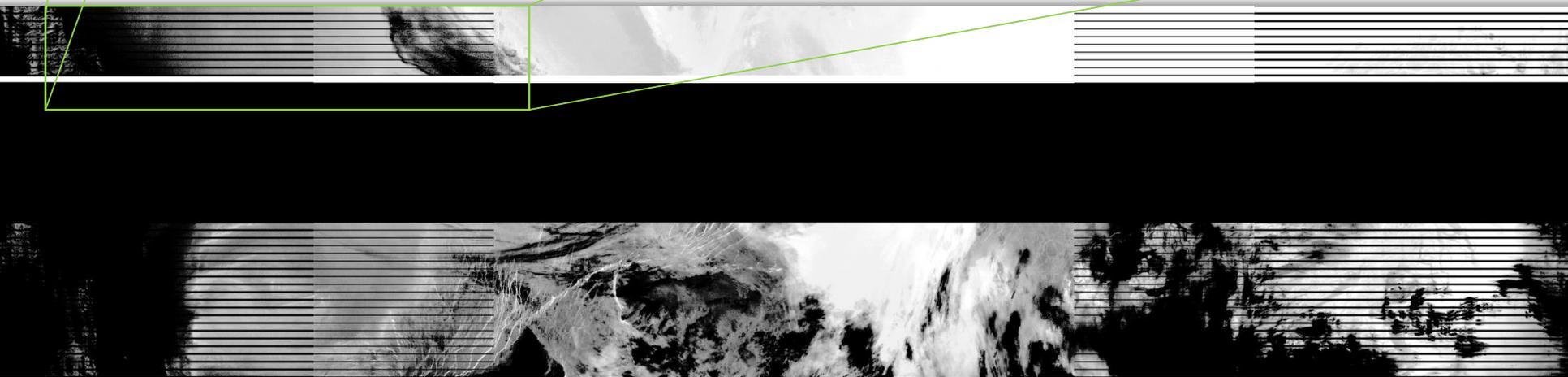
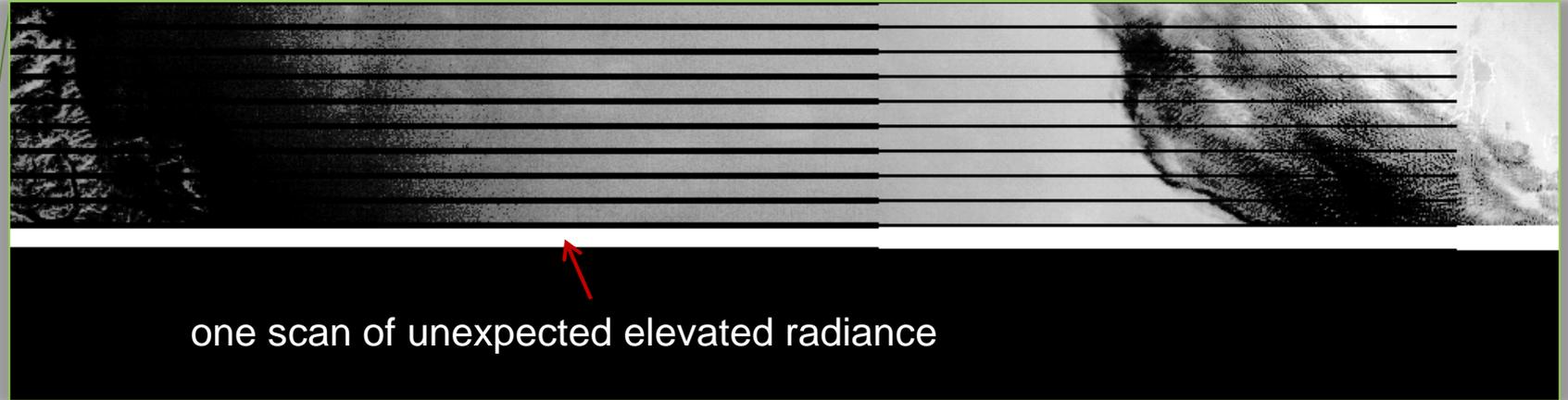
M13 QF1 for d20130131\_t1824021\_e1825275



Symptoms for M-bands : one scan of unexpected elevated radiance ( for M13  $\sim 2.5\ W/m^2/sr/\mu m$  instead of  $0.04\ W/m^2/sr/\mu m$ ) where QF1 indicates the quality is good. That is, QF1=0 when it should have been 33. In this instance, the incorrect radiance is actually due to the fact that calibration substitution had occurred. For some emissive bands, DN=4095 resulting in unusable data. I-bands will actually show DN ranging between 0 and 4095.

# Example of Data Corruption over the North Pole

M13: 29/Nov/12

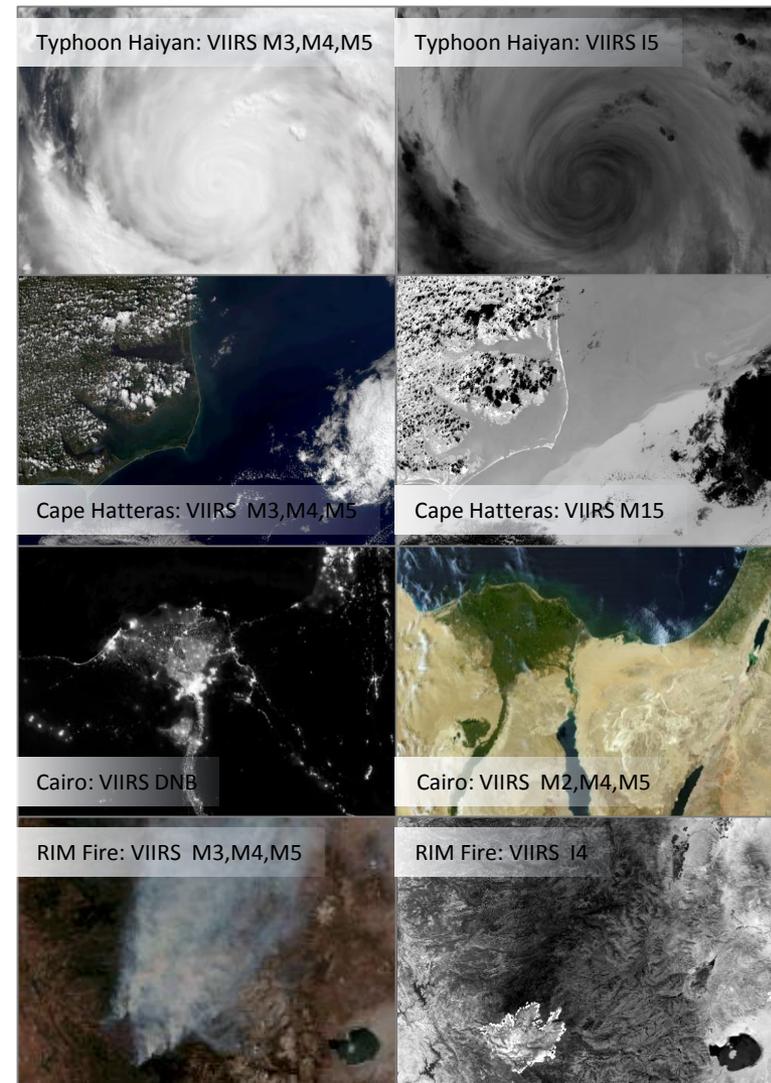


## SDR Team has demonstrated strong positive action in response to user inputs:

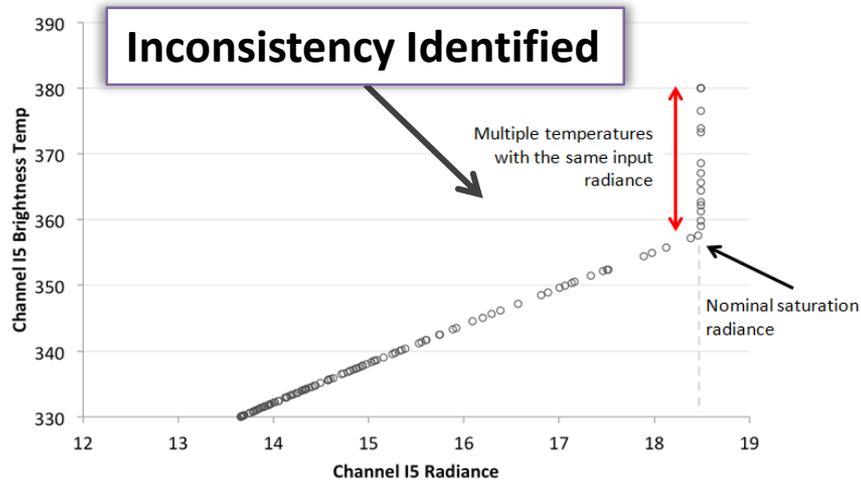
- Support spans from addressing:
  - Clear errors impacting data quality to questions that challenge the state-of-the-art of space-based imaging system performance
  - Ensure data quality
- Sea Surface Temperature EDR Team
- Ocean Color EDR Team
- Fire EDR Team

## Multiple teams have noted the importance of the QFs in their work:

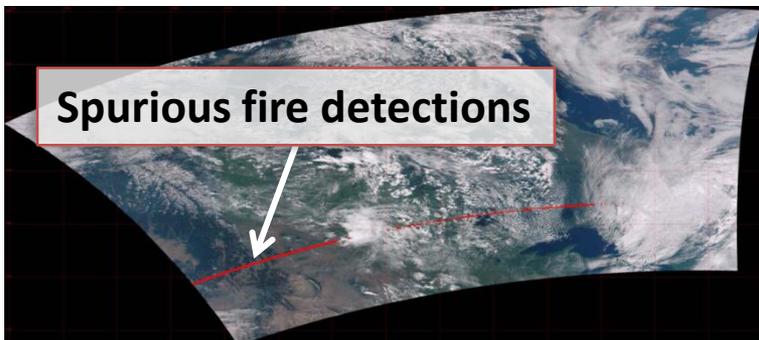
- Some “minor” issues remain open though are being addressed at the program level and will be monitored through completion
- SDR Team will continue to work closely with the users to identify and resolve issues throughout mission life



Images Courtesy: <https://cs.star.nesdis.noaa.gov/NCC/GalleryPage04>



Inconsistency in radiance & brightness temperature limits - DR 7294



- QF1=33 for M13 (poor quality & missing Cal data)
- Mismatch in gain stage - space view elevated the radiance high enough to be identified as fire
- DR 7448/ 7400

(Graphics Courtesy: Ivan Csiszar)

*In response to a question from the EDR Fire team lead:*

- Provided a listing of the updated post-launch saturation temperature limits, based on Lunar observations (courtesy of the NASA team)

## Post-Launch Saturation Temperature Limits

Band No.	Band Gain	Spec Tmax (K)	On Orbit Tmax 11/30/2013	Spec NEdT (K)	On Orbit NEdT (K)
I4	S	353	357	2.5	0.4
M12	S	353	357	0.396	0.12
M13	H	343	362	0.107	0.04
	L	634	--	0.423	
M14	S	336	352	0.091	0.06
M15	S	343	370	0.07	0.03
I5	S	340	377	1.5	0.4
M16	S	340	368	0.072	0.03



# List of Open DRs



DR	Title	Status
7294	Radiance and Reflectance/Brightness Temperature Upper Bounds and Quality Flagging Are Inconsistent	Upper bounds and quality flagging will be made consistent.
7449	Dual gain QF4 values appear to be set incorrectly after sector rotation	Cause is still being investigated. It could be resolved by code changes for DR7110
7448/7400	M13 QF1 values occasionally set to 33 for no obvious reason	3 lines code change proposed by Raytheon appears to fix the problem.
7080	EDRPR QF tables need to be corrected for old 16-scan/granule values	Analysis
7070	RTN Sev2 PCR (VIIRS SDRs' Scan-line quality flags are not applied under all required conditions)	Analysis
7022	Mismatch between Automatic QF definition in the OAD and the Software	Analysis
4969	VIIRS SDR QF1 fill value use of 249 may be confusing	Analysis
4968	VIIRS SDR QF1 ==99 Triggered	Analysis
4690	"poor" setting in DG anomaly not doc in EDR PR	Analysis
4500	M8 Quality Flags has erroneous good quality	Analysis



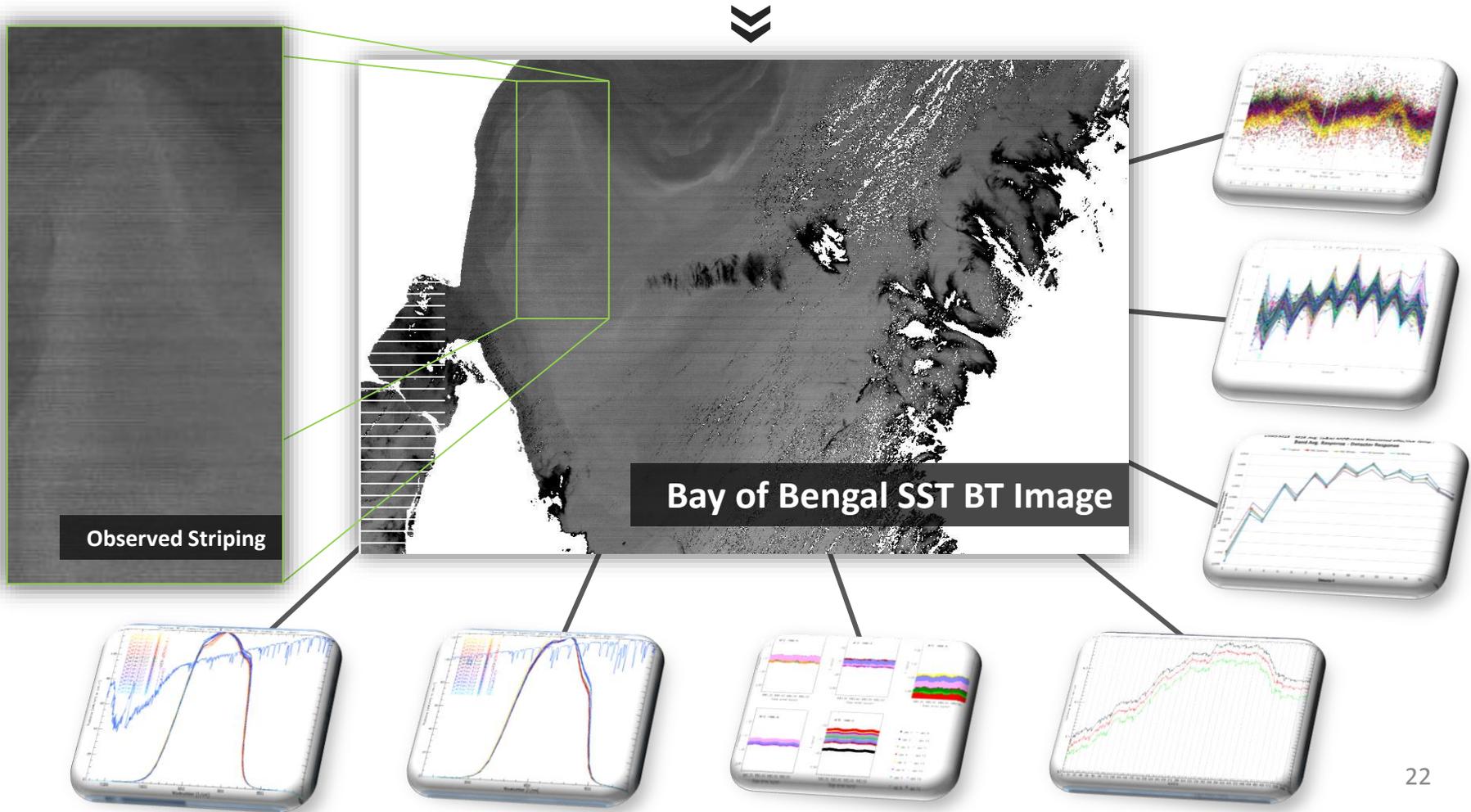
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DR	Title	Status
7110	VIIRS SDR QF4 Substitution Counts	Identified code bug and test in progress.
7111	VIIRS SDR QF1 Cal Data Substitution Flag	Partially fixed by DR5023. QF1 correct for reflective DG bands but incorrect for M13. M13 problems possibly resolved by code changes proposed for DR 7448/7400, needs additional testing.
7112	VIIRS SDR Dual Gain Band Calibration Substitution	This problem was fixed for within-granule calibration substitution under PCR31262 in Mx7.1. A new DR was opened for cross granule calibration substitution (DR7313).
7227	VIIRS SDR Sector Rotation Cal Substitution	Code to mark scans as poor +-2 within a sync loss event and +-7 within a sector rotation event under test.
7313	Incorrect dual-gain calibration due to missing Cal data in adjacent granule	Code change proposed in Find_SV_Scan_Index will cause the scans requiring substituted calibration data to be filled. Changes to correctly perform cross granule calibration substitution is more complicated and can be implemented if there is interest.
7481	Observed VIIRS data corruption after a data gap near the north pole	Test to consistently identify the data corruption is being developed.
7484	Observed toggling in the VIIRS engineering packet sync loss indicator as the instrument is recovering from sync loss	Investigating solutions for flagging.

# Research Support to Data Quality Improvements

- DPA requested the SDR team to investigate the observed SST striping issue (magnitude of striping is at the noise level [ $\sim 0.05$  K], but apparent in relatively uniform SST images)
- This issue is beyond maturity of the VIIRS SDR Review and challenges the state-of-the-art

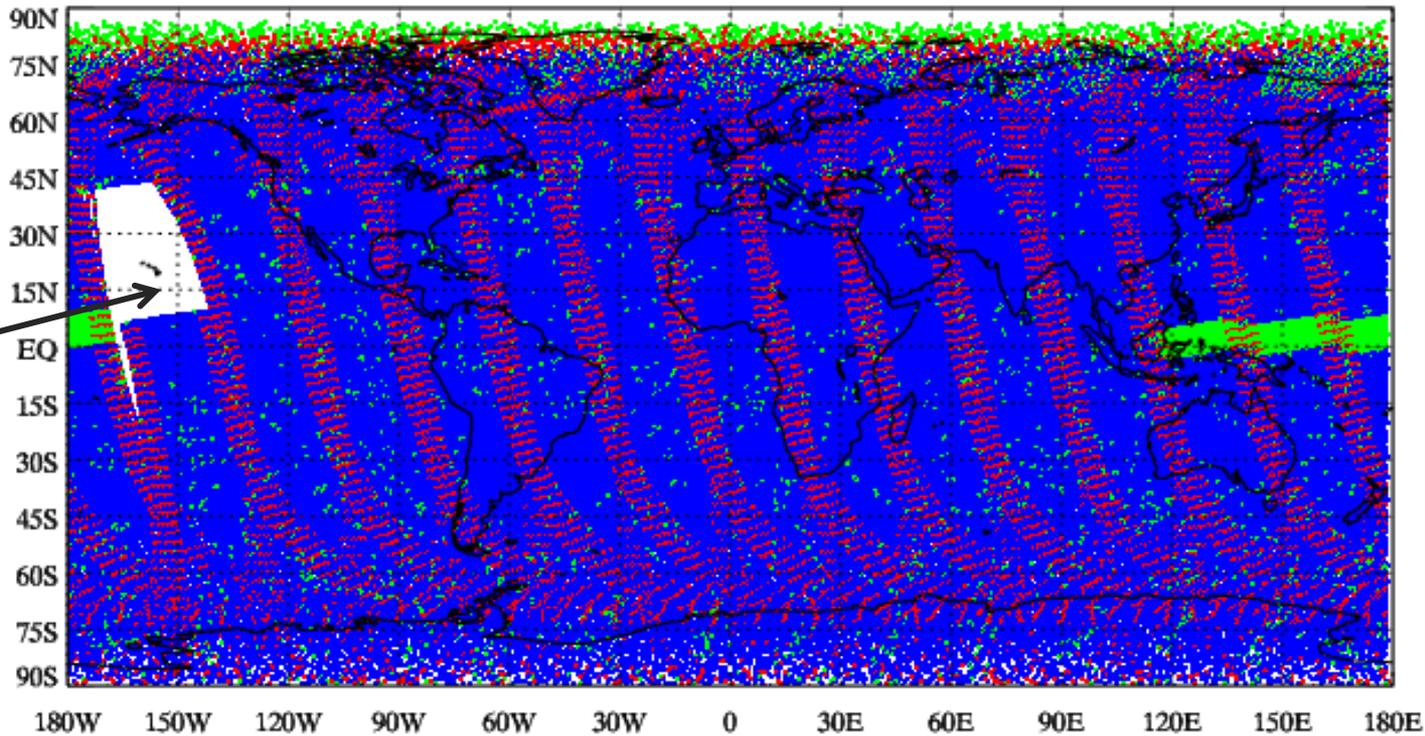


# Long-Term Monitoring: VIIRS Quality Flag Mapping (ICVS)

## VIIRS SDR Quality Flag

- good
- poor
- no calibration
- missing data

Missing VIIRS Earth View (EV) data due to lunar maneuver event [14/Oct/13]



## ICVS VIIRS SDR quality flag map:

- Produced for each band daily for both ascending and descending orbits
- Demonstrated to be an important tool to investigate VIIRS global data quality and to identify events that impact data quality
- Captured feedback from EDR teams to further enhance the monitoring capabilities to address user needs



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