Designing a Human-in-the-Loop Process for Maintaining Optimal Calibration of GOES-R ABI Visible Channels

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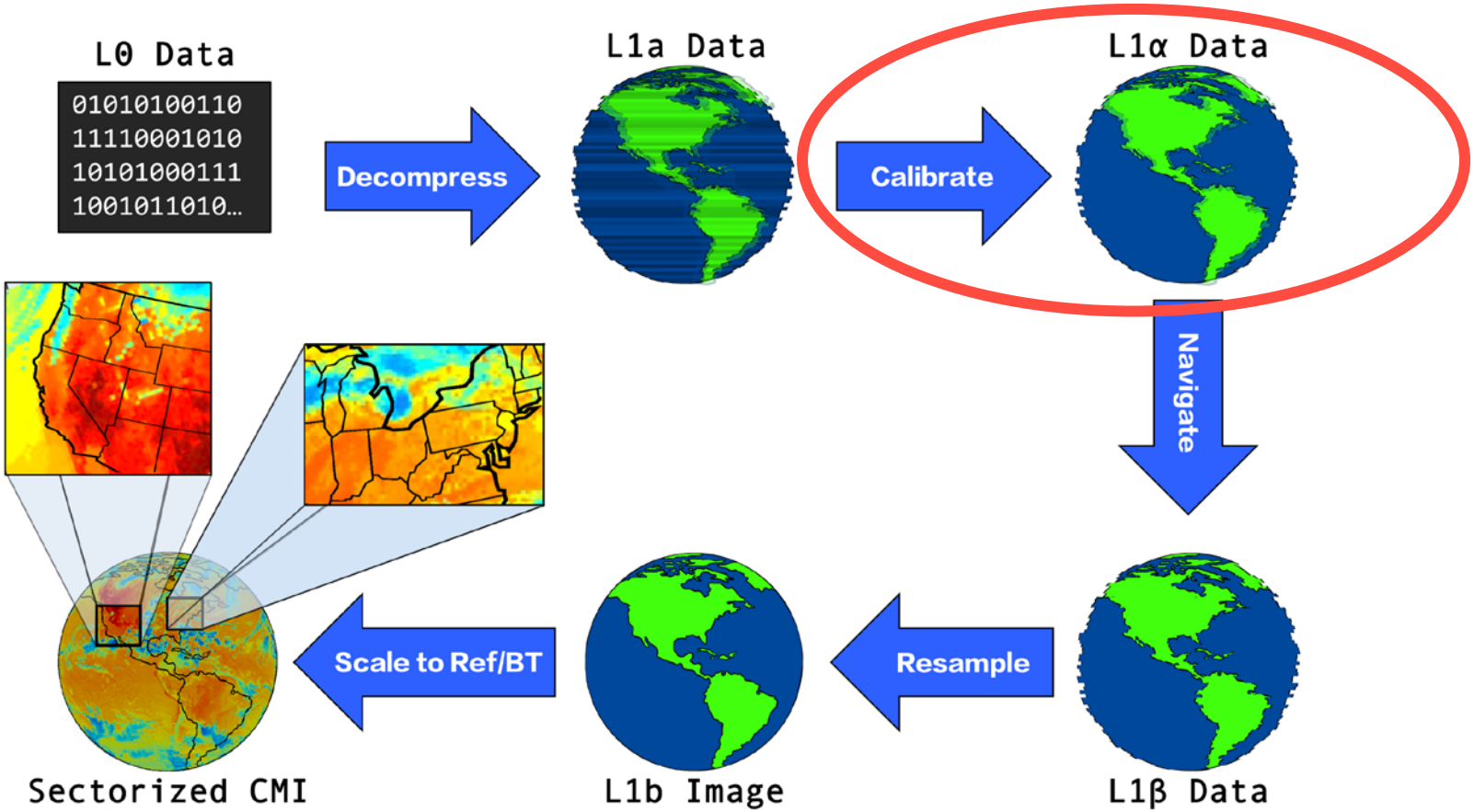
Outline

- Overview of calibrating GOES-R ABI on-orbit data
- Rationale for Human-in-the-Loop
- Overview of Ground System processing of calibration data
- Two methods to implement Human-in-the-Loop

ABI VNIR Calibration

Overview of ABI Calibration



Cartoon depiction of ABI calibration workflow

Overview of ABI Calibration

Generic form of ABI VNIR calibration equation

$$L = \frac{m \cdot dC + Q \cdot dC^2}{\rho_{EW} \cdot \rho_{NS}}$$

Q: determined for each detector during pre-launch testing

- Can be updated on-orbit through Look-Up Table (LUT) change

m: updated periodically on-orbit

- 10 IR channels: views of the internal blackbody once every Timeline (nominally every 15 min)
- 6 VNIR channels: views of the on-board Solar Calibration Target (SCT) on a diminishing cadence

Why we want a Human-in-the-Loop

Solar Calibration Schedule

2017: Many G16 Cal Events in the first year on-orbit

January

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

June

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

July

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

August

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

September

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

October

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

November

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

December

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Solar Calibration Schedule

2018: Beginning the 2nd year events become rare

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	1	2	3	4	5	6
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VNIR Gains Since Launch

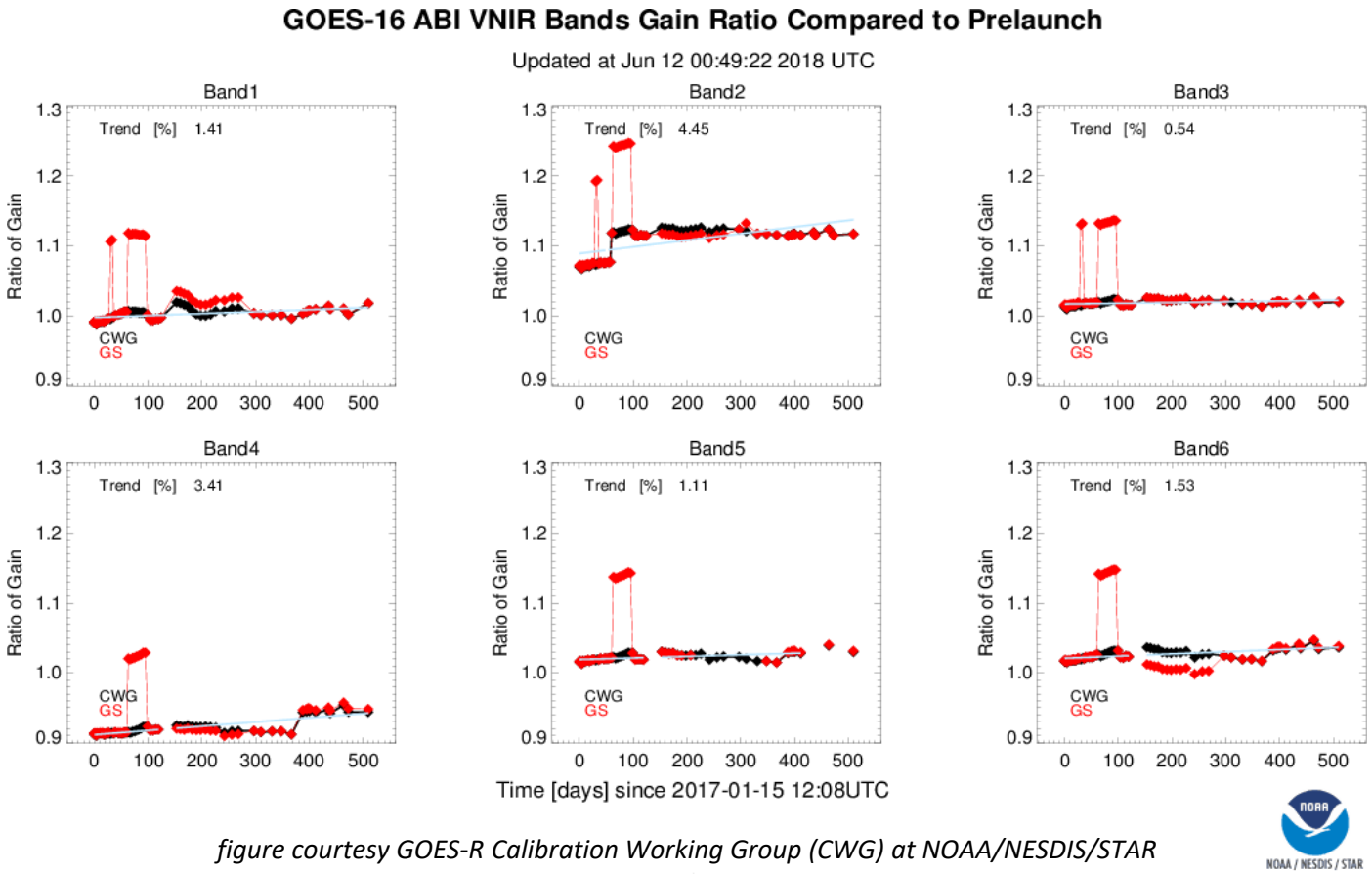
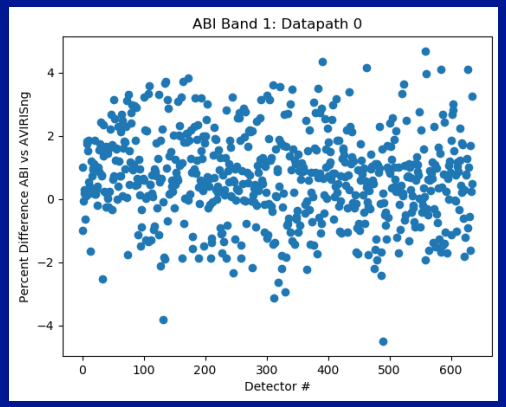
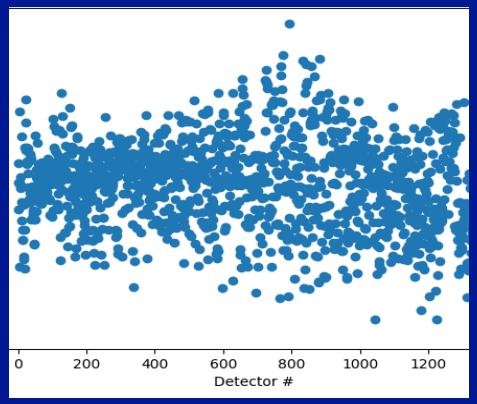


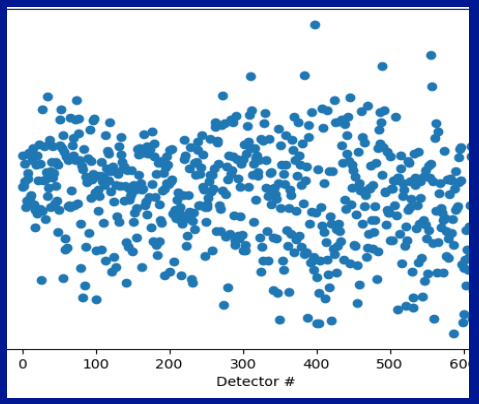
figure courtesy GOES-R Calibration Working Group (CWG) at NOAA/NESDIS/STAR

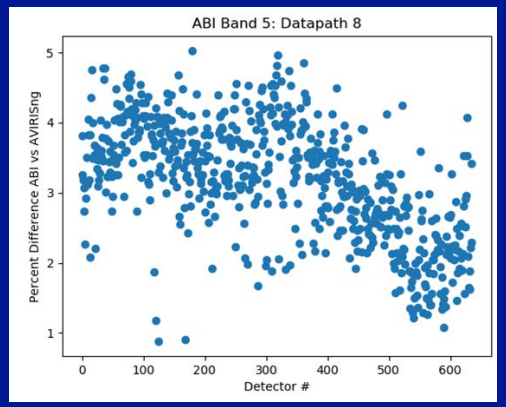
- Gains have stabilized, CWG trends the changes over time
- For any given new SCT event the changes may be in the noise, therefore no update needed

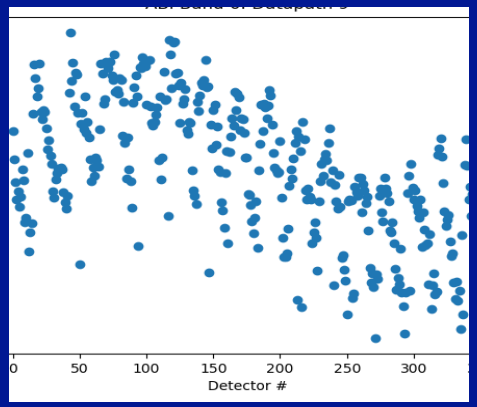
ABI Independent Detector-Level Validation Results: Sonoran Desert March 28, 2017











North-South Scan (NSS) results from Padula et al. show the detector-detector bias residuals.

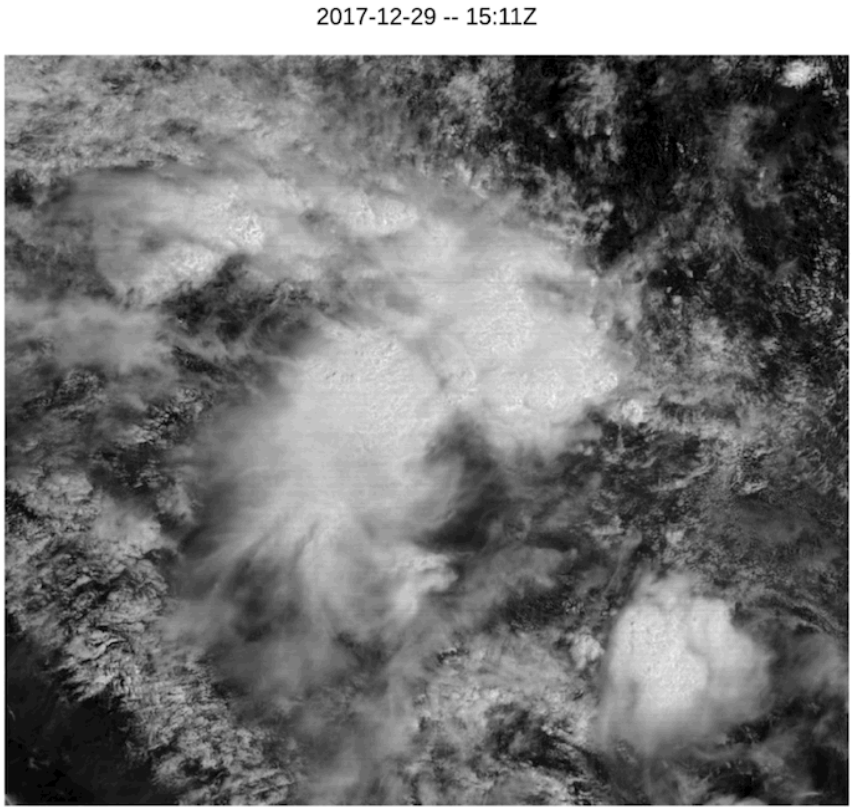
Testing underway to determine the utility of NSS to mitigate striping.

- **ABI detector-level performance showed inter-channel variability ≤ 3 % (k=1) for each channel**
- **Ch 5 & Ch 6 demonstrate some systematic effects to be further investigated**

figures courtesy Padula et al. | slide courtesy Jon Fulbright

Detector-to-Detector Non-Uniformity

- Detector-to-detector non-uniformity is one cause of striping
- North-South Scans may help mitigate this on a per-detector basis
- Could be implemented as modified gains based off most recent SCT event

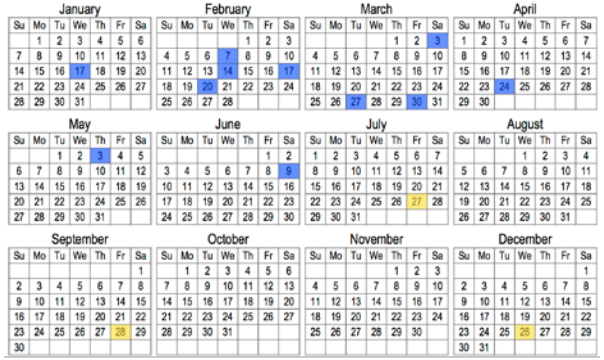


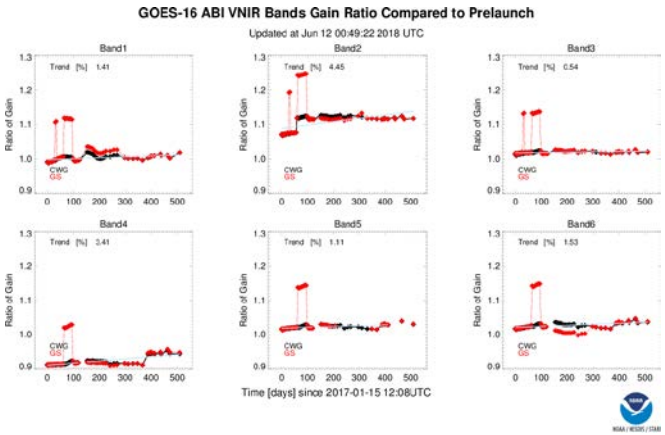
G16 ABI ch01 imagery over N. America

Summary of Rationale

- Reasons for Human-in-the-Loop include:

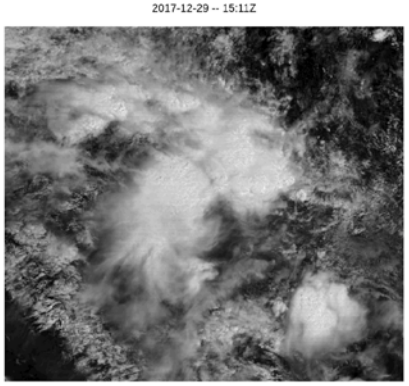
diminishing SCT cadence





SCT results show lack of significant change

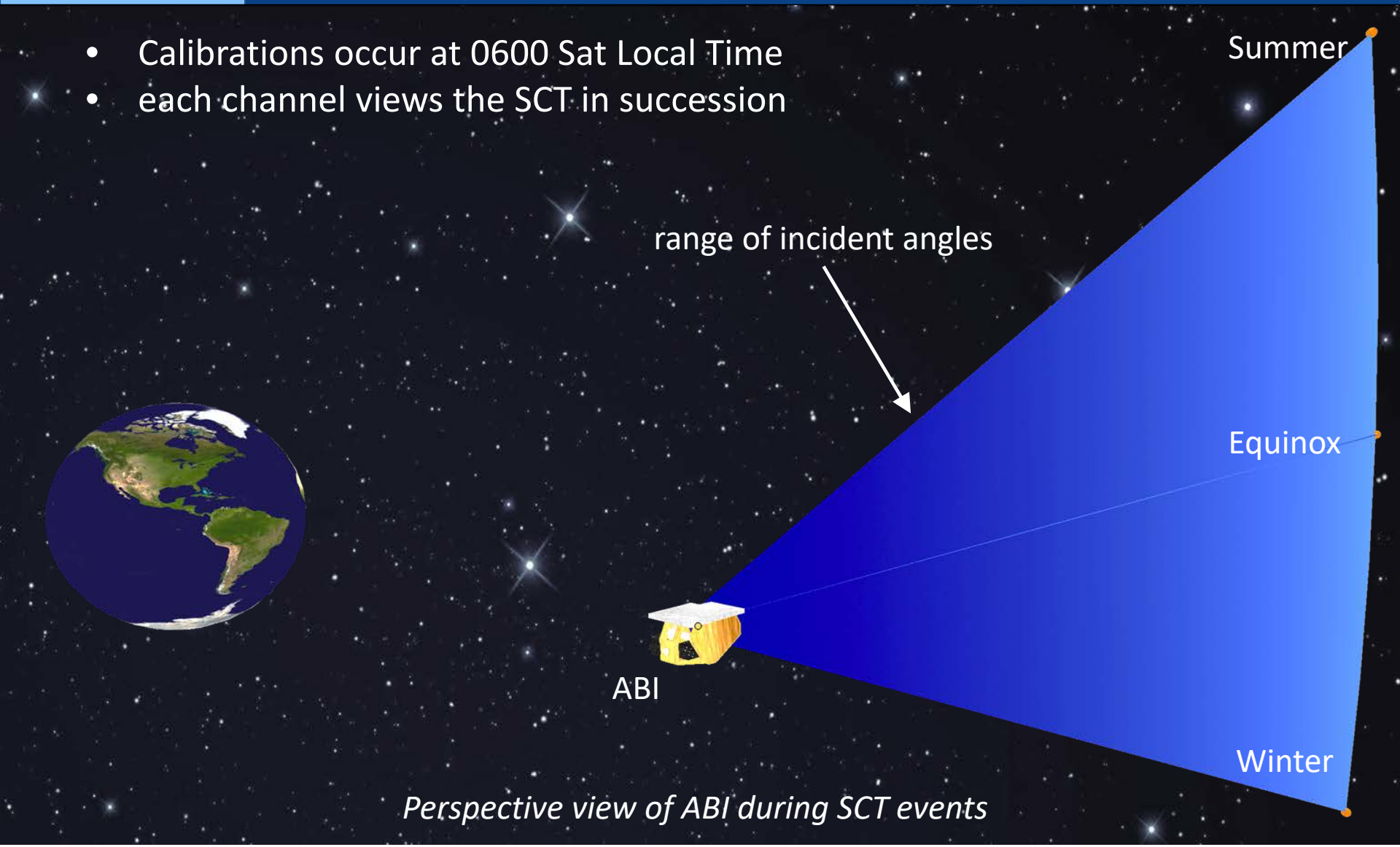
striping mitigation



Processing Gains:
Inserting a Human-in-the-loop

On-Orbit VNIR Calibration

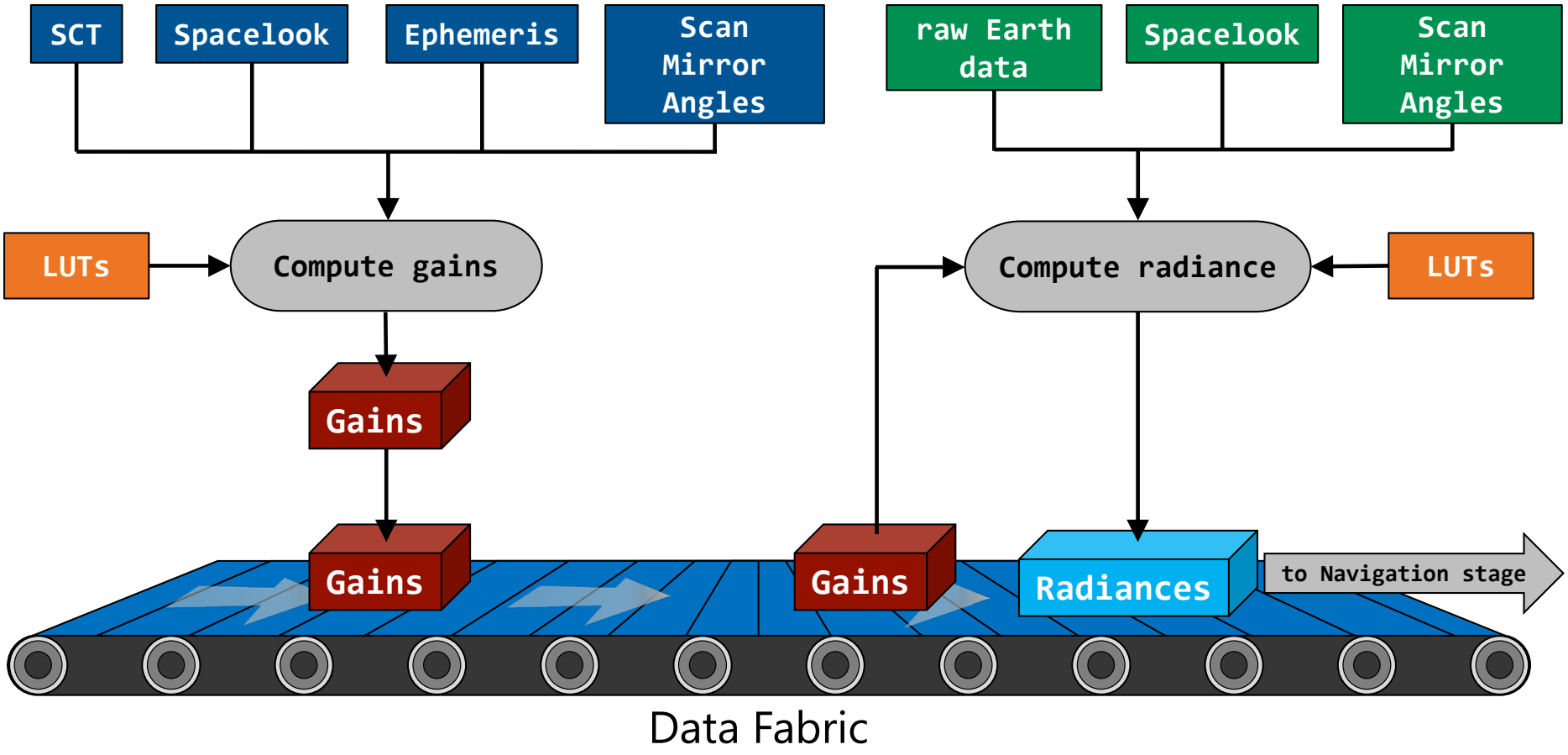
- Calibrations occur at 0600 Sat Local Time
- each channel views the SCT in succession



Perspective view of ABI during SCT events

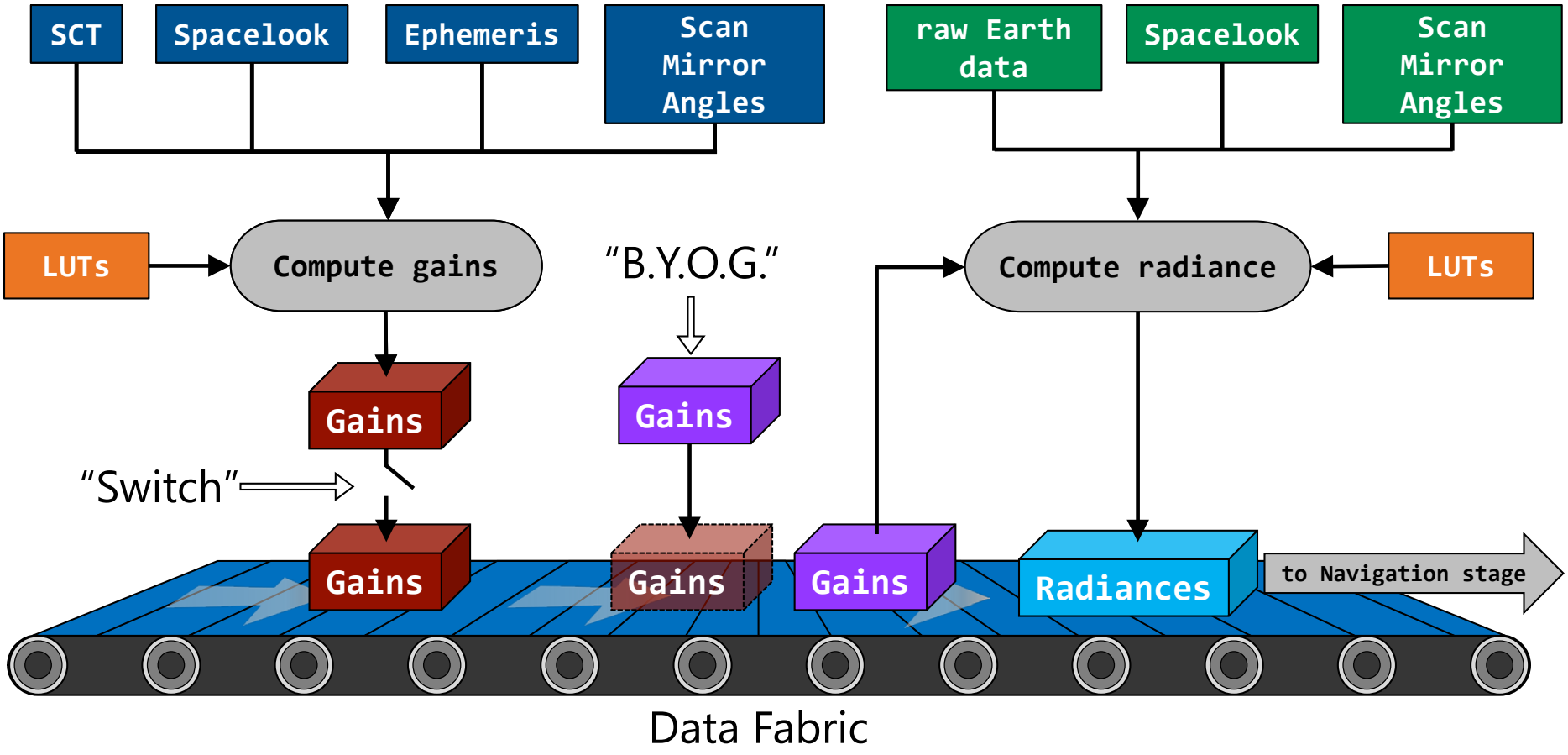
Ground Segment Processing

- Schematic of SCT calculation, implementation and use in the Ground System
- Currently, gains are implemented automatically after SCT event



Introduction of Human-in-the-Loop

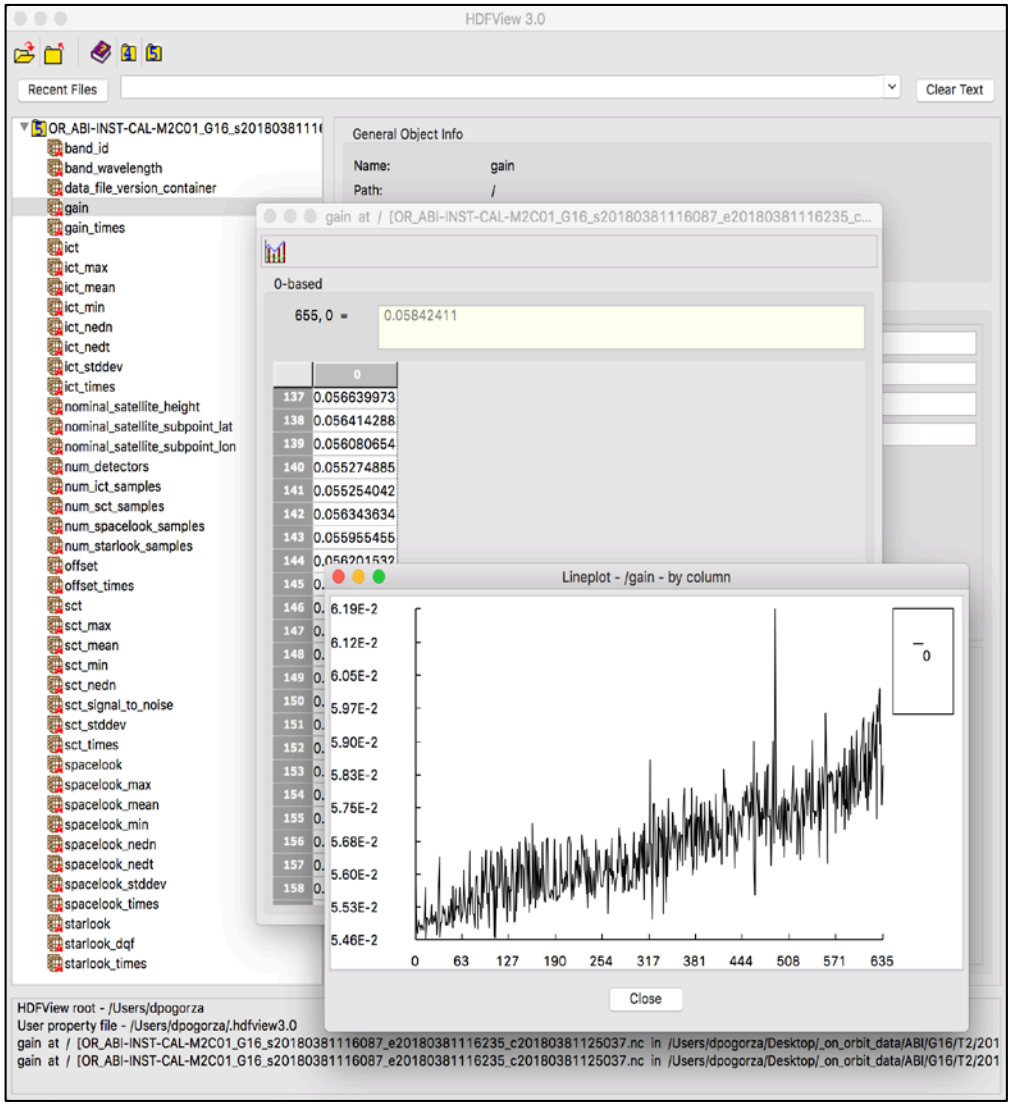
- Two methods in work to introduce Human-in-the-Loop
  1. "Switch": Compute new gains but do not deploy until instructed
  2. "Bring-Your-Own-Gains (B.Y.O.G.)": Deploy gains computed offline



The Switch

- The process:
  1. Solar Calibration event occurs
  2. Ground System computes new gains and distributes as Instrument Cal files
  3. CWG assesses results
  4. Go/No-Go decision is given
  5. Algorithm Action Review Team (AART) will deploy gains in Development Environment (DE)
  6. Outputs are reviewed
  7. Gains promoted to Operational Environment (OE)

- Not yet functioning in the Ground System but is in work



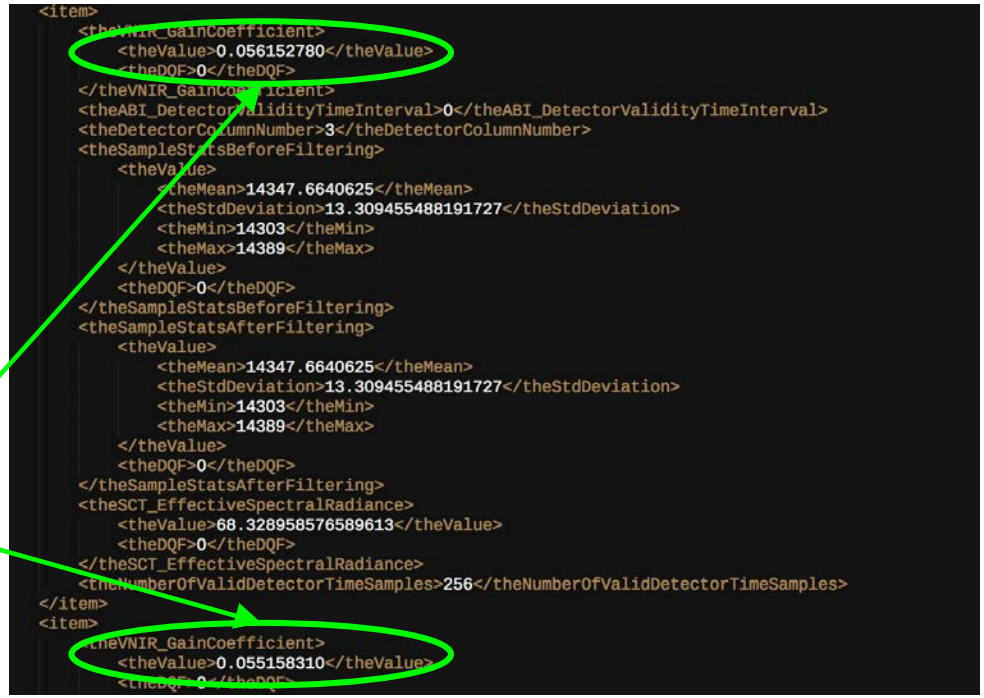
example of an ABI ch01 Solar Calibration Instrument Calibration file viewed in HDFView

Bring-Your-Own-Gains

- The process:
  1. CWG or Field Campaign team generates new set of gains
  2. Gains are converted into XML format read by data fabric
  3. Enter new gains into CM via the AART
  4. Coordinate with Data Operations Support Team to deploy in the DE
  5. Assess results
  6. Promote to the OE
- Capability currently exists
- Next steps focus on coordination and testing

<insert gains here>

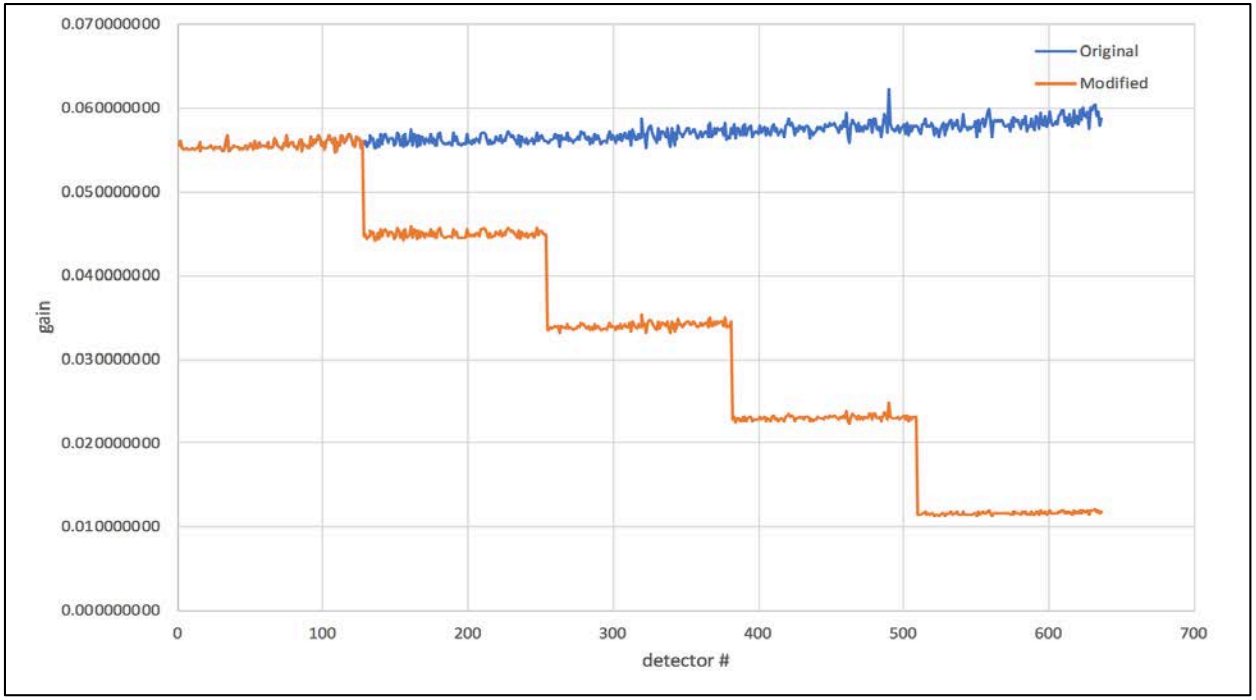
VNIR gains after conversion to data fabric format



Demonstration

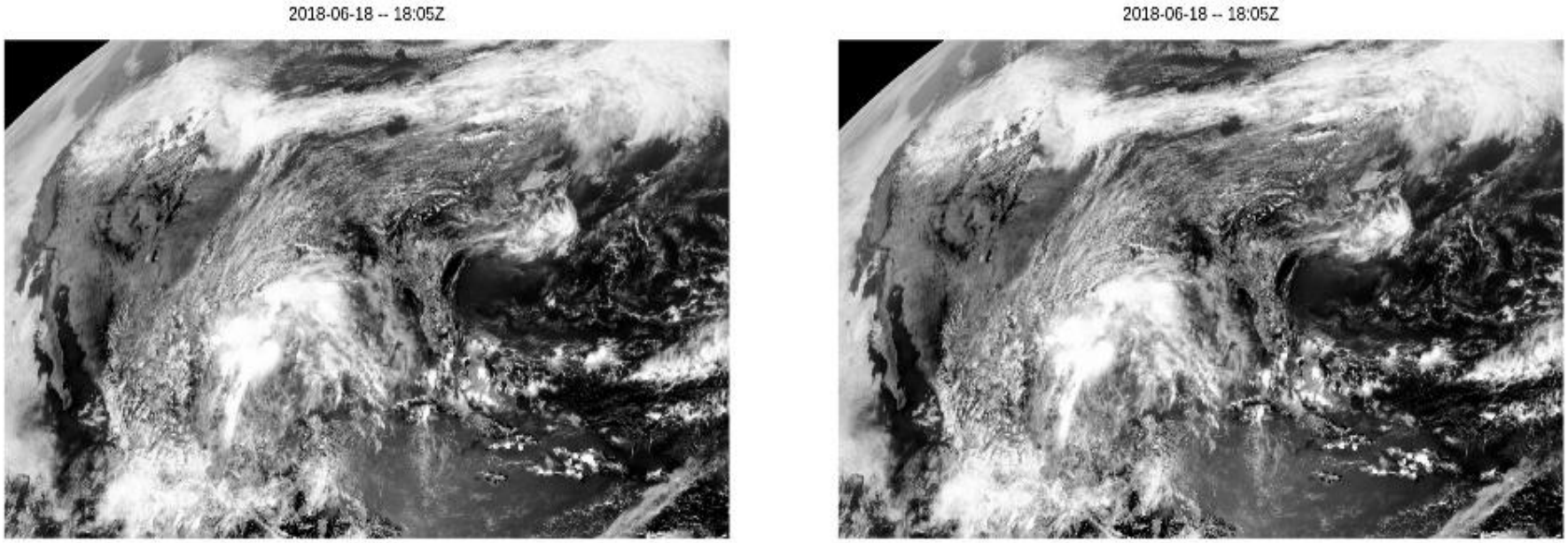
Proof-of-Concept

- Modified nominal channel 01 gains with stair-step function
- Deployed to the Development Environment
- Ran for two hours
- Reverted to nominal gains



ch01 gains: original (blue) and modified (orange)

Proof-of-Concept



ABI ch01 CONUS L1b imagery: Nominal gains in the Operational Environment (left) and modified gains in the Development Environment (right)

Summary

- VNIR calibration maintained via SCT events
- Stability, error-mitigation and de-striping is reason for Human-in-the-Loop
- Bring-Your-Own-Gains is in place
- Switch in work