MODIS Collection 6
MCST Proposed Changes to L1B

Introduction

- MODIS Collection History
  - – Collection 5 – Feb. 2005 - present
  - – Collection 4 – Jan. 2003 – early 2007
  - – Collection 3 – June 2001 – Jan. 2003
  - – Collection 2 – Terra launch – June 2001

Collection 6 Issues

- RSB
  - Detector Dependent RVS
  - m1 correction
  - Reprocess m1 (using current algorithm)
  - New LUT containing Polarization correction information
- TEB
  - a0/a2 Strategy
- QA
  - Fill Values instead of Interpolation for Inoperable Detectors
  - New QA LUT: Subframe level QA flags
  - Minor formatting error in ASCII LUT
- Space view DN=0

Collection 6 Issue Status

#	Issue	Change Type	Change Status	Test Data Produced	Notes
1	Fill vs Interpolation for inoperable detectors	Code	**Complete**	Yes	Code changes complete 1-day 'golden tile' data produced and available.
2	Noisy/Inoperable Subframe	Code, LUT	**Complete**	Limited	L1B code changes and new QA LUT complete. Limited test data produced.
3	A0/A2 Strategy	LUT	**Complete**	Limited	Initial V6 LUT derived. Limited set of test data produced.

Collection 6 Issue Status

#	Issue	Change Type	Change Status	Test Data Produced	Notes
4	Reprocess m1	LUT	**Complete**		Mission m1 reprocessed using current algorithm
5	m1 correction	LUT	**Complete**	Limited	Initial v6 LUT derived
6	Detector dependent RVS	LUT	**Complete**	Limited	Initial v6 LUT derived
7	Polarization correction information	LUT	**Pending**		Provide information for users to correct L1B data for polarization effects

Fill Value vs Interpolation

- Current v5 approach: Interpolation using the adjacent good detectors has been used since beginning of mission
  - Originally introduced in v2.4.3 on 06/12/2000

- Request from Land team to reconsider this decision and use fill values in v6

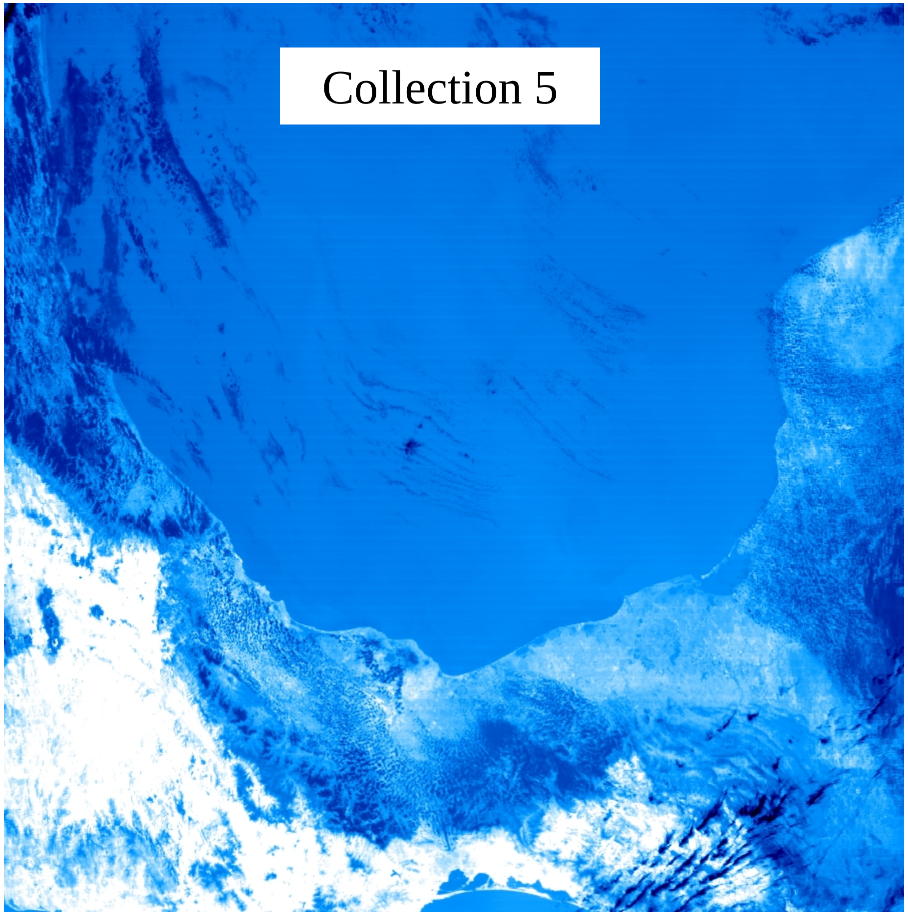
- Proposed change: Fill value instead of interpolation for inoperable detectors

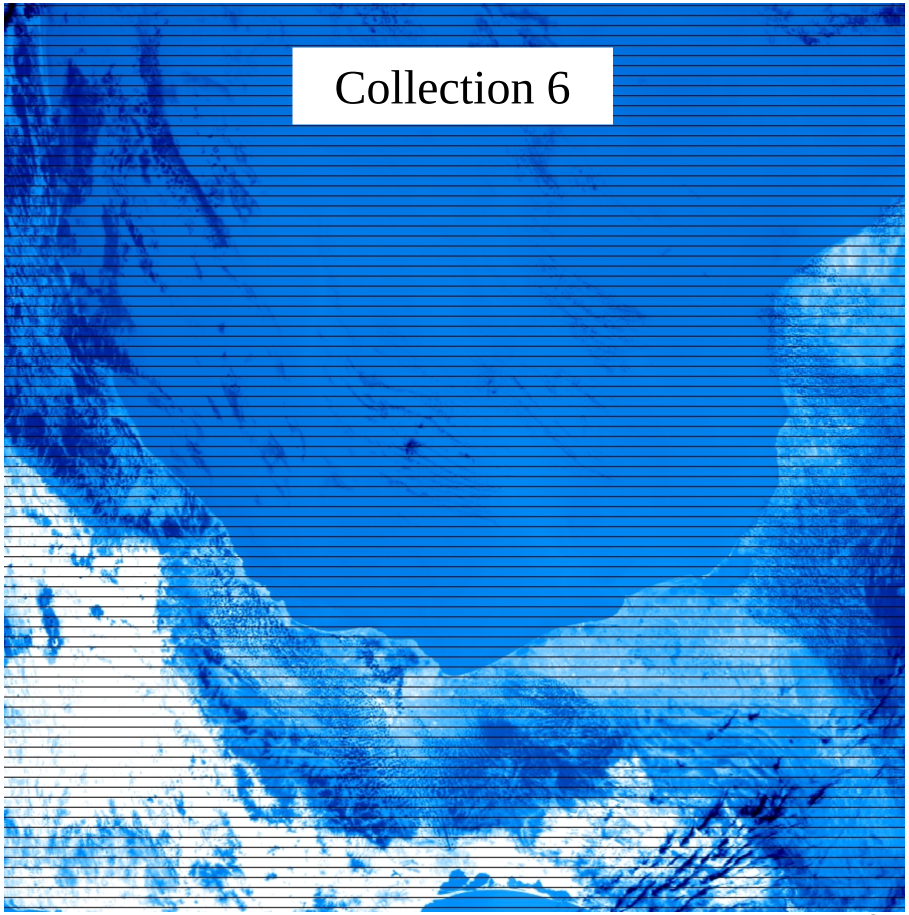
Fill Value vs Interpolation

- Bands impacted based on current QA LUT
  - Terra
    - B29 D6
  - Aqua
    - B5 D20
    - B6 D10, 12-16, 18-20
    - B36 D5

L1B Impact Example: Terra Band 29

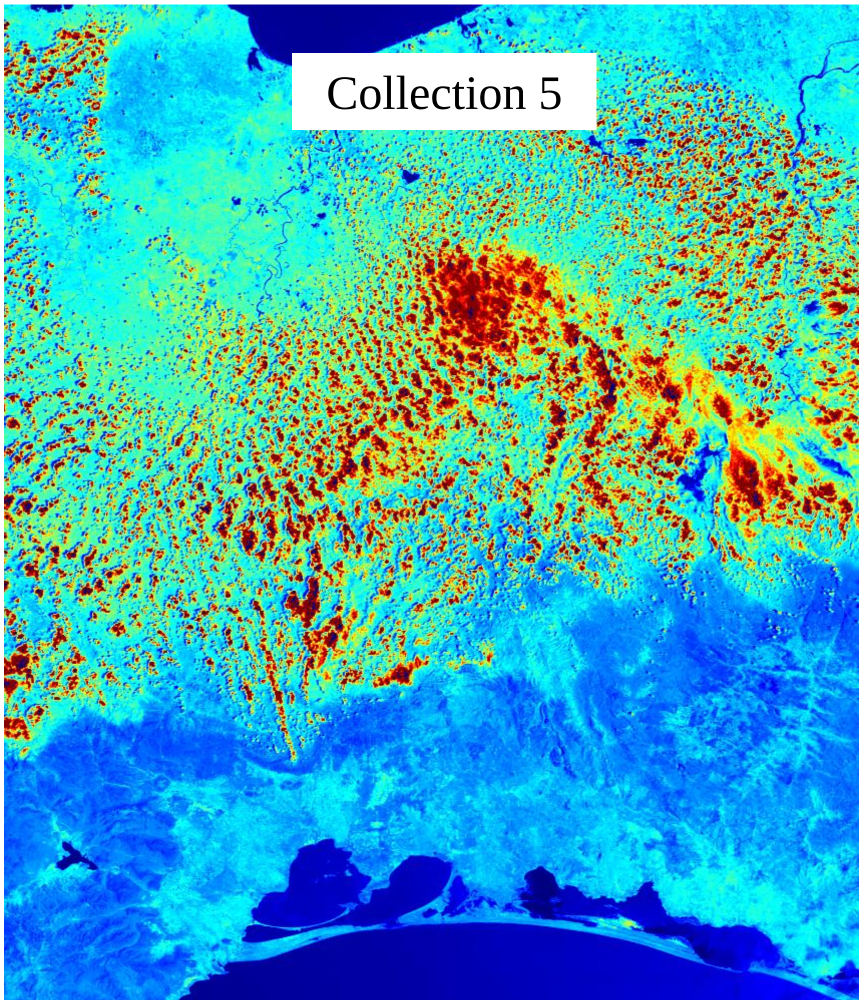
Terra Band 29 Detector 6: currently flagged as inoperable in QA

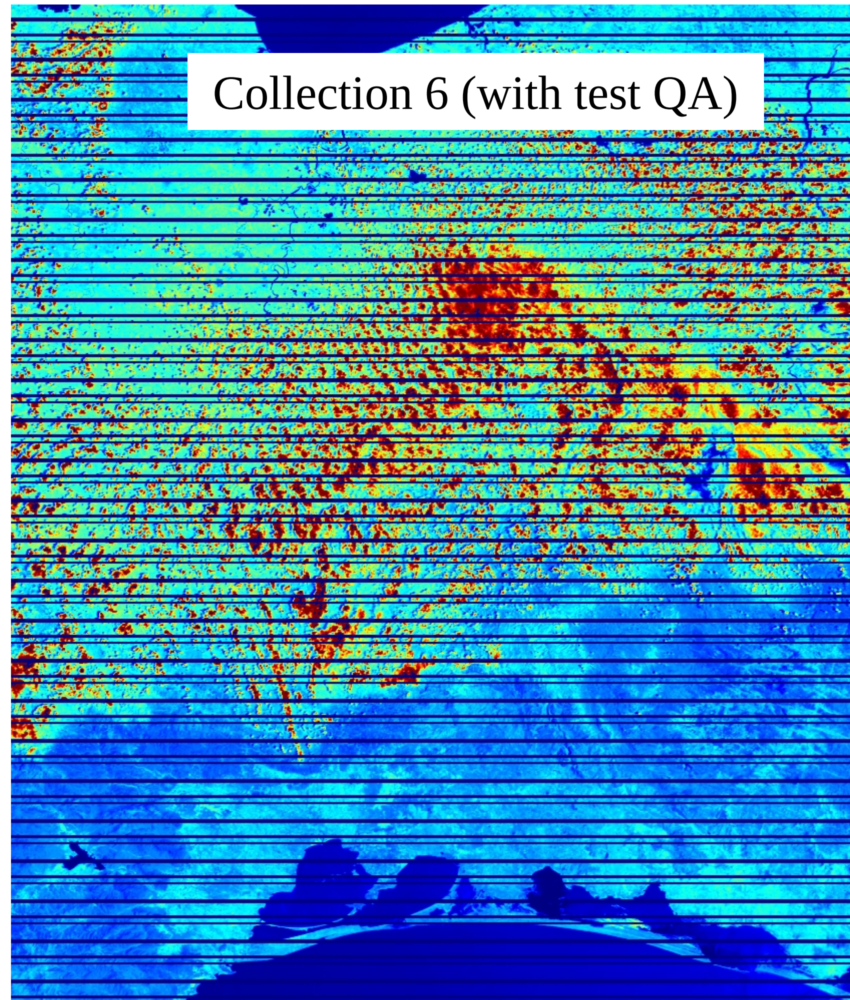




Impact on Aggregate L1B Products

Test scenario with multiple inoperable detectors in Terra Band 2





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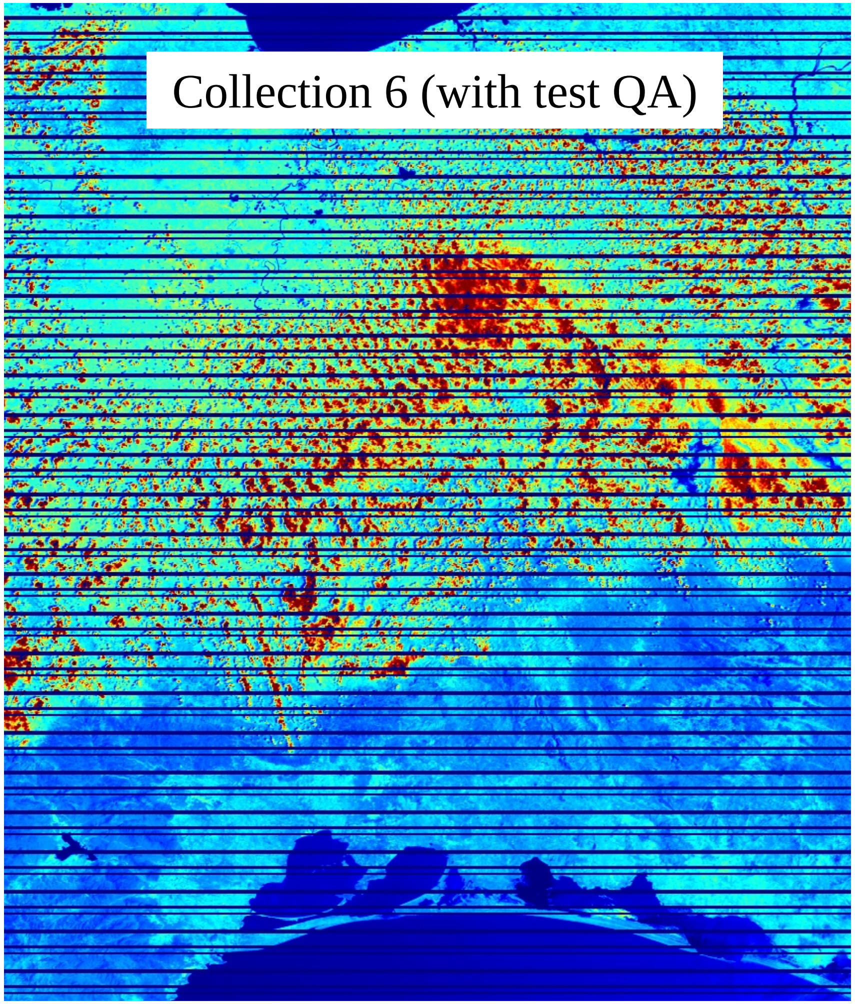

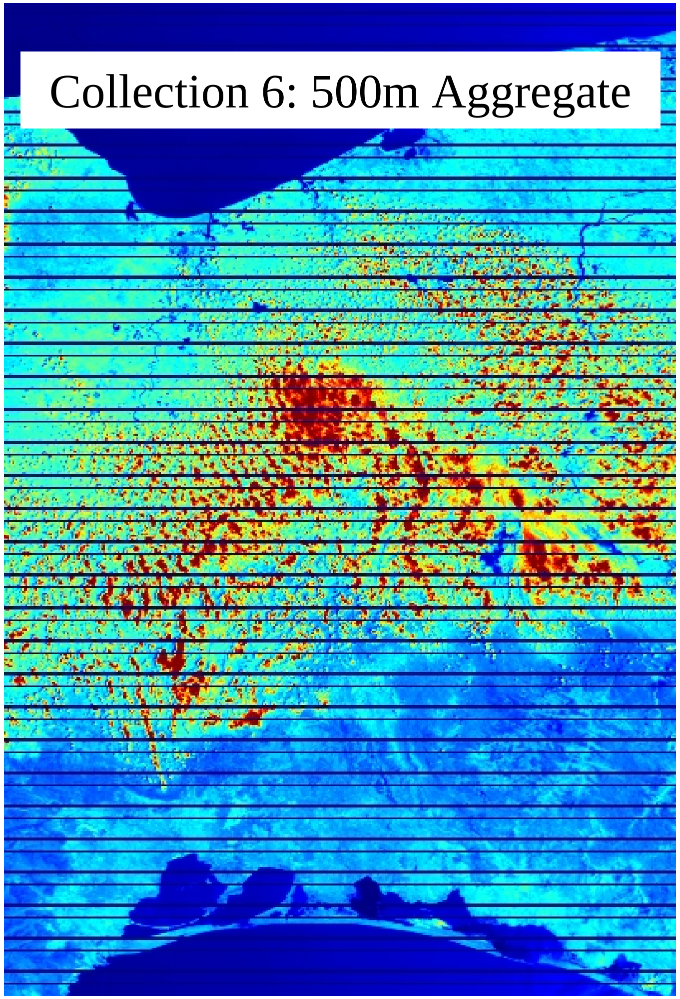

Impact on Aggregate L1B Products

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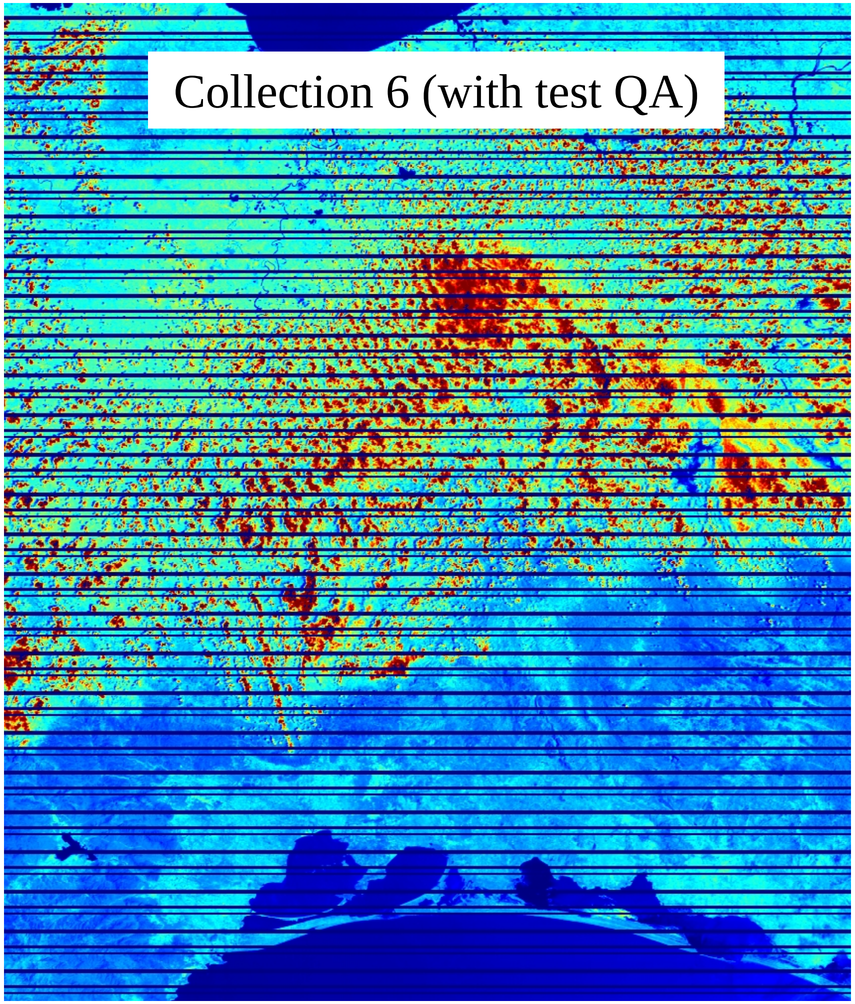
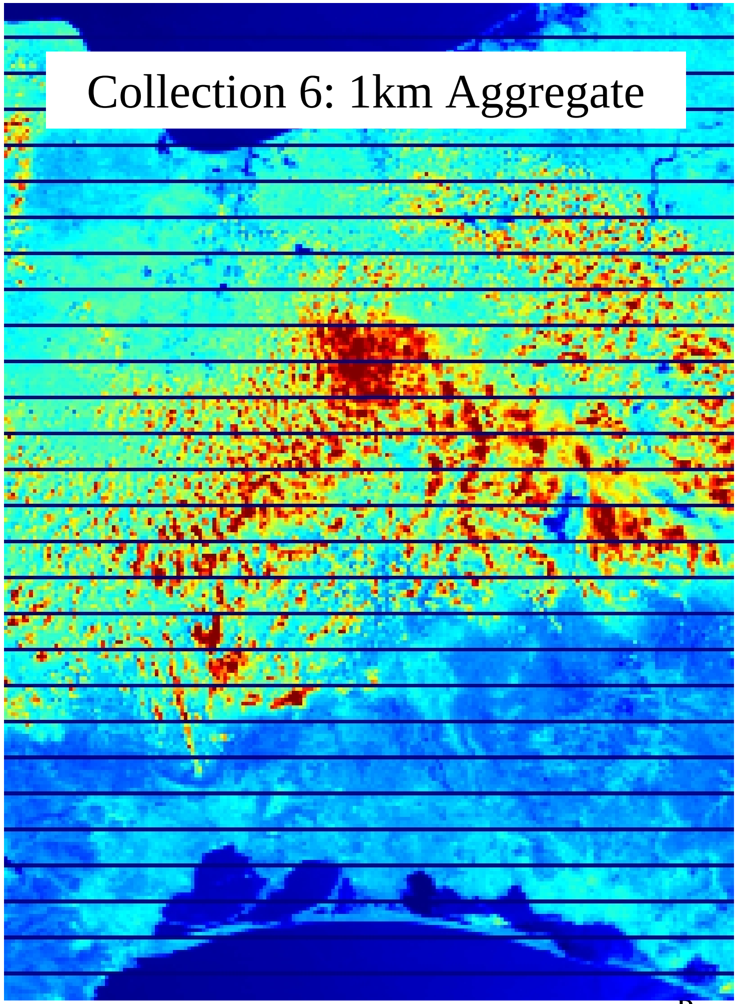




Fill Value vs Interpolation

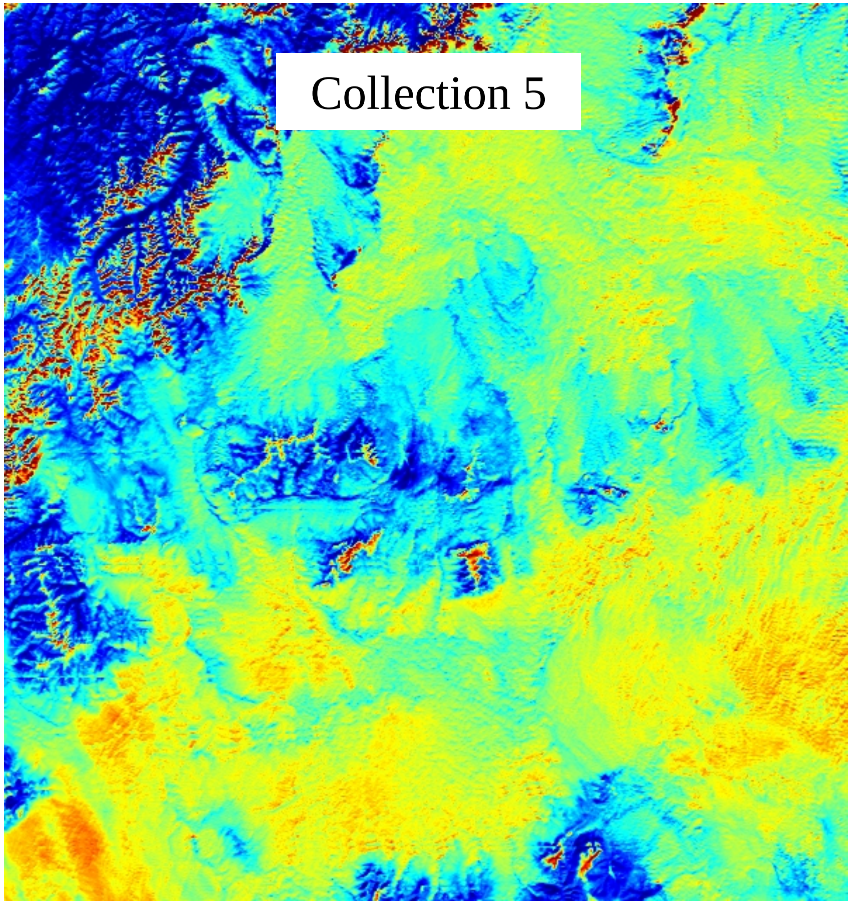
- v6 L1B code changes completed
- Test data is available through lads
  - http://ladsweb.nascom.nasa.gov (Archive set 108)
  - 1 day ‘Golden Tile’ granules (2007079)
  - At least one detector set as inoperable in each band
    - Multiple adjacent detectors in 250m & 500m bands

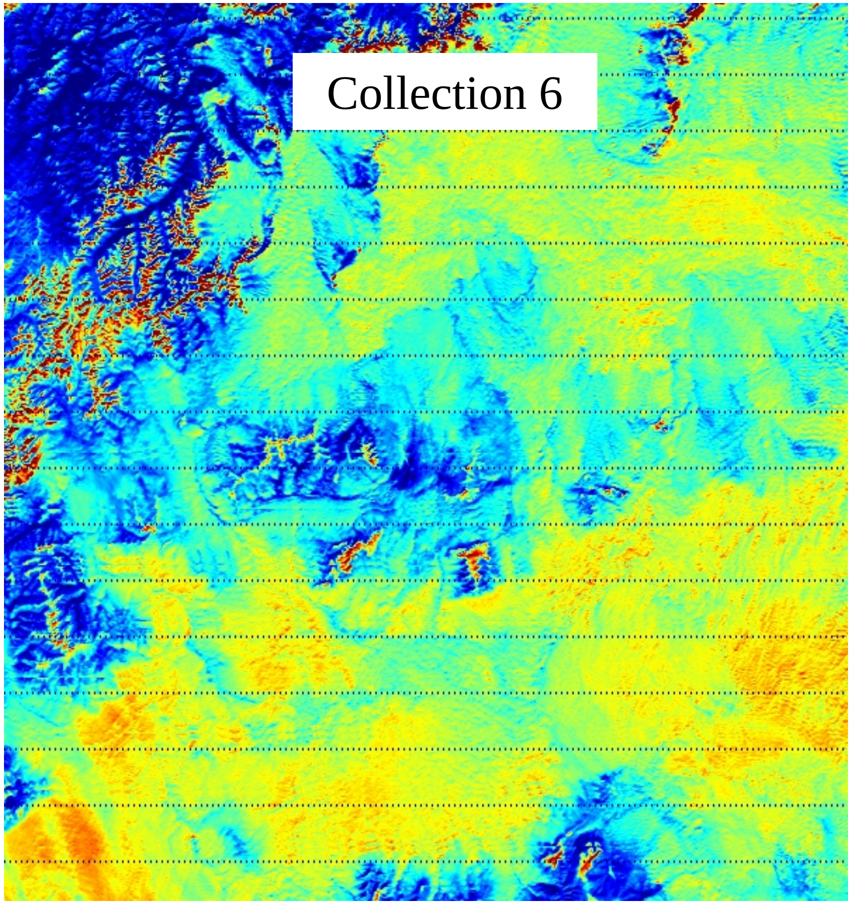
Subframe QA

- Current v5 approach
  - QA flags only set on a detector basis
- Terra B2 D29 & 30 subframe 1 have a known crosstalk issue.
- Proposed change:
  - Code change and new QA LUT to allow QA flag for noisy/inoperable to be set at subframe level
  - Noisy subframe – flag is set for user information, no impact on L1B
  - Inoperable subframe – Fill value in L1B

L1B Impact example: Terra Band 2

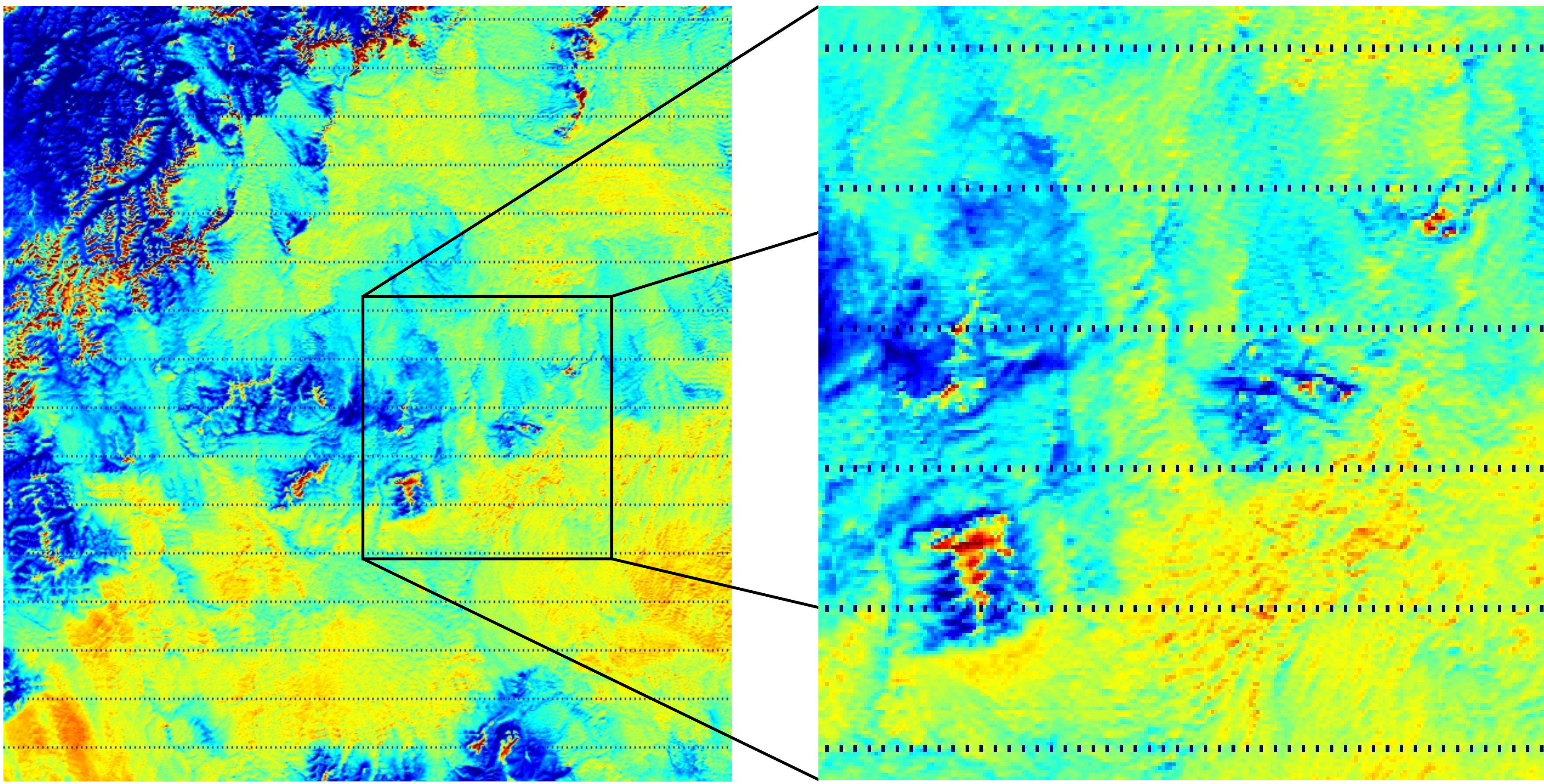
Collection 6 test data with Subframe 1, Detector 29 & 30 flagged as inoperable





L1B Impact Example: Terra Band 2

Collection 6 test data with Subframe 1, Detector 29 & 30 flagged as inoperable



Subframe QA

- Bands impacted:
  - Terra B2 D29 & 30 subframe 1
  - Subframes to be flagged as Noisy

- Initial v6 L1B code changes and new subframe QA LUT completed

Collection 6 A0/A2 Strategy

- Motivation
  - TEB Prelaunch BB calibration range 170-340 K
    - On-orbit BB calibration range 270-315 K
  - Issue: Aqua B31/32 & Terra TEB (gain change and config/elec changes mean we have no valid prelaunch calibration and have to rely on on-orbit calibration data from the warm-up/cool-down activities)
  - Historically, TEB has demonstrated good performance at typical scene temperatures.
  - A cold scene bias (~1K) has been observed and reported for Aqua B31 & 32 compared to AIRS for extreme low temperature scenes (~200K) using v5 data.

- Re-examination of A0/A2 strategy could yield improvements in temperature retrievals for low scene temperatures while minimizing impact at typical scene temperatures.

Proposed v6 A0/A2 Strategy

Aqua

	v4/v5*	**v6**
B20, 22-30	PL a0/a2	no change
B21	a0 = 0 and a2 = 0	no change
B31-32	Warm-up a0/a2	**a0 = 0, cool-down a2**
B33-36	a0 = 0, PL a2	no change

Terra

	v4/v5*	**v6**
B20, 22-30	Warm-up a0/a2	**Cool-down a0/a2**
B21	a0 = 0 and a2 = 0	no change
B31-32	Warm-up a0/a2	**a0 = 0, cool-down a2**
B33-36	a0 = 0, warm-up a2	a0 = 0, **cool-down a2**

*Changes in TEB between v4 & v5 included: On-orbit TEB RVS updated from Deep Space Maneuver (Terra), Cavity term average of 4 telemetry points instead of 1

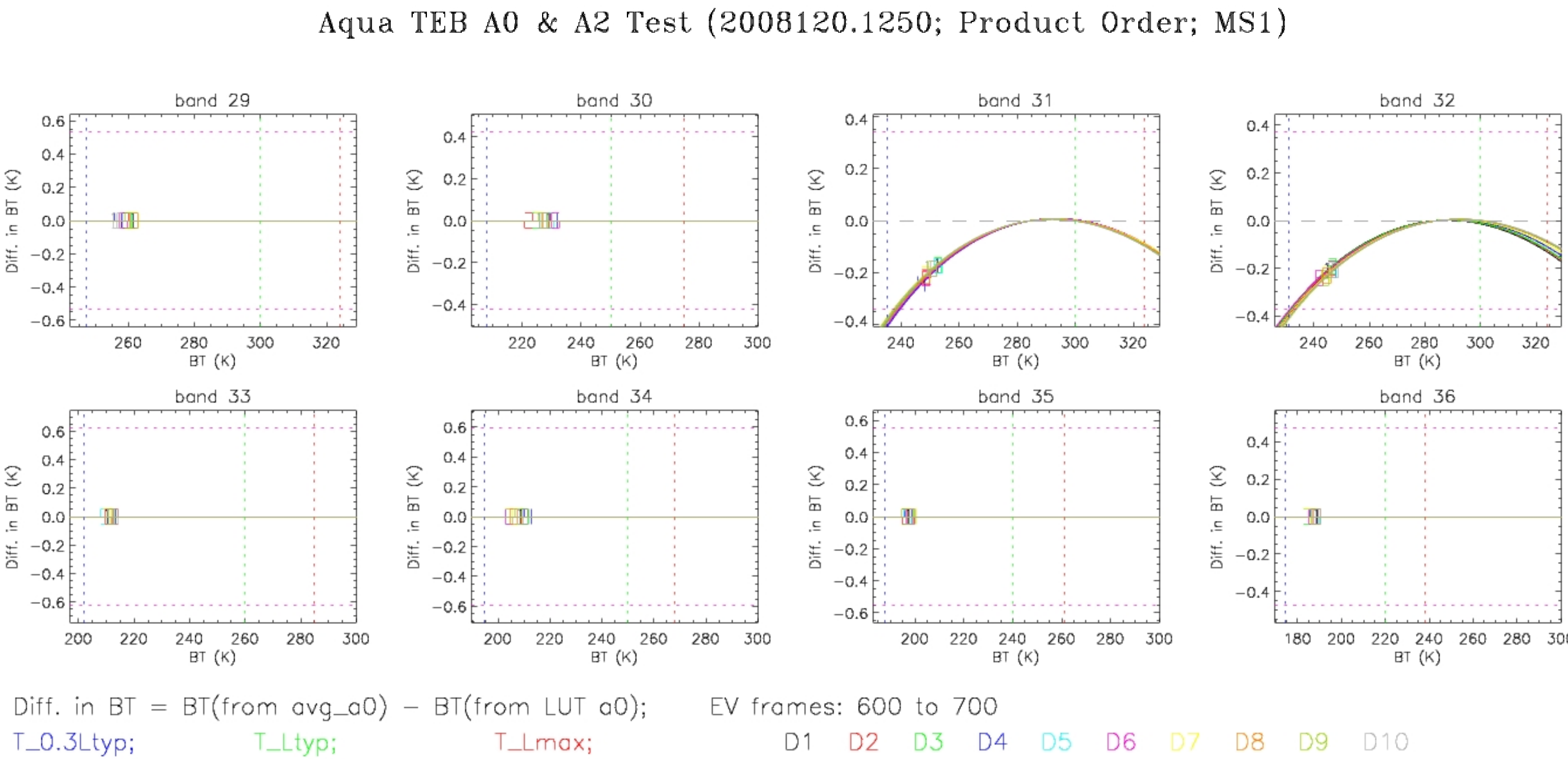
L1B Impact Assessment

- Compile new time dependent a0/a2 LUT using the v6 approach

Test Data Sets

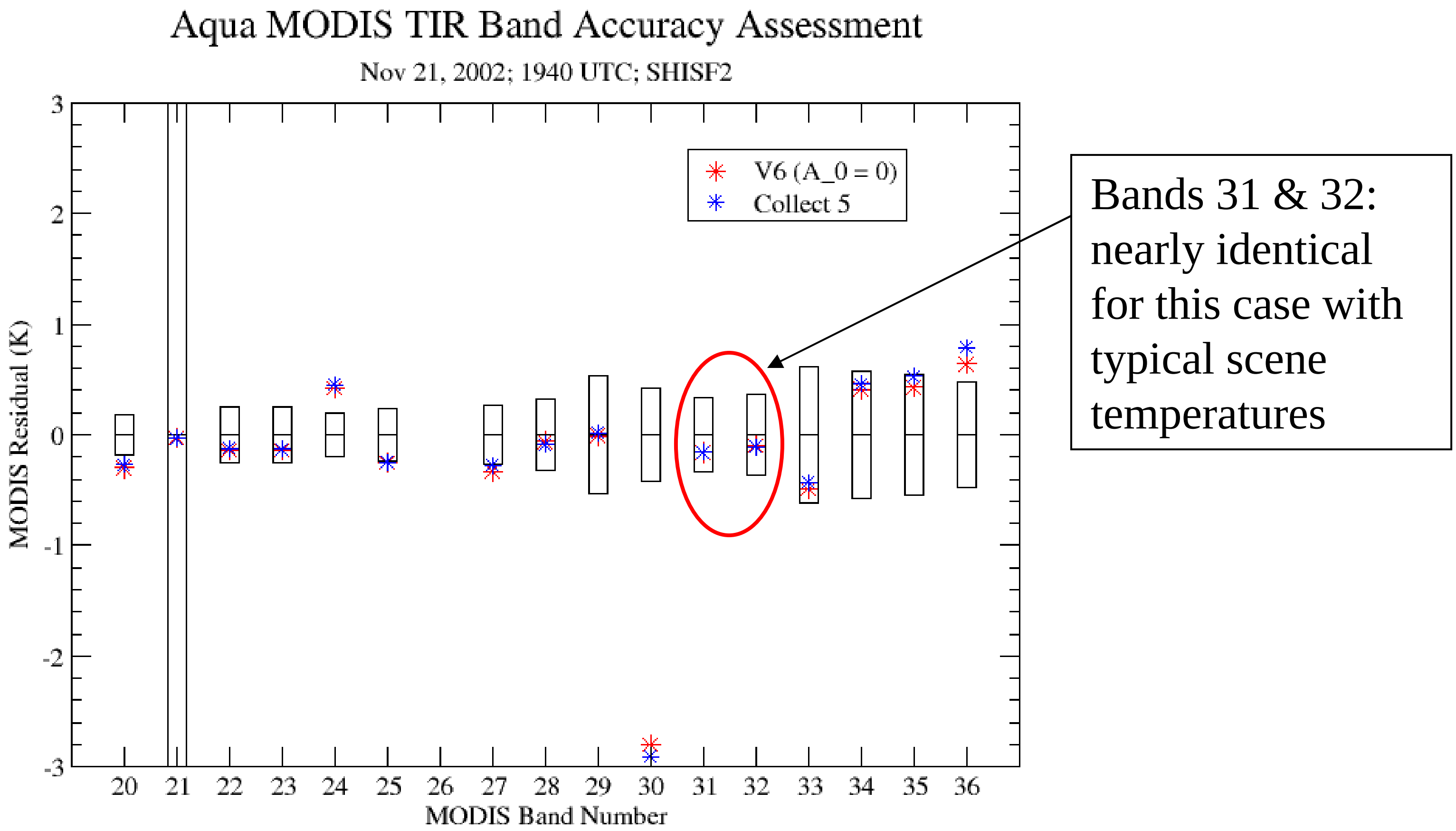
- L1A granules with v5 & v6 LUT with EV data filled to cover entire dynamic range
- Specific L1B granules coinciding with the Univ. Wisconsin ER-2 flights (MODIS Airborne Simulator)
- One orbit of L1B data sets (Terra: June 21, 2007; Aqua June 20, 2006)

Aqua L1B Impact Assessment



Aqua L1B Impact Assessment

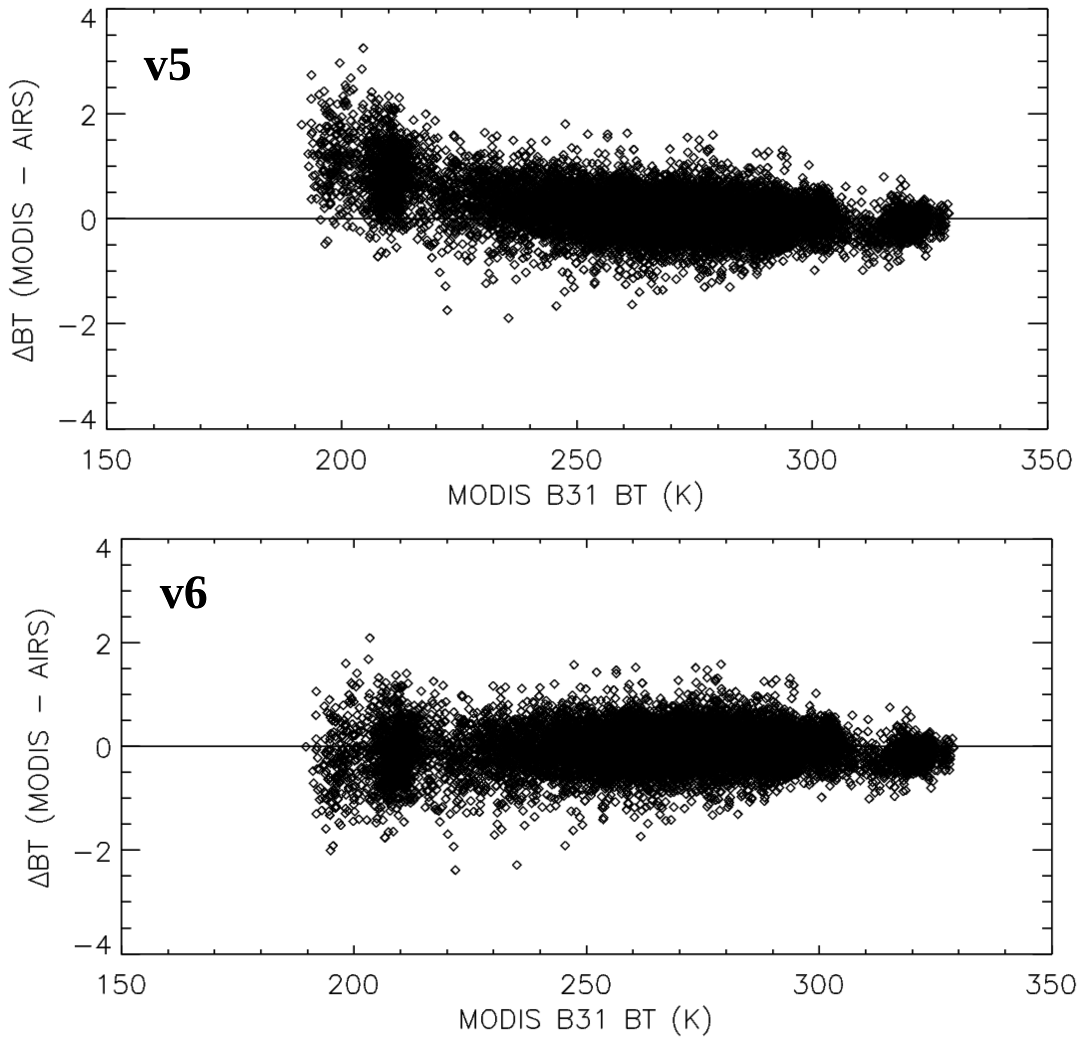
- ER-2 MAS comparison



Plot courtesy of Chris Moeller

Aqua L1B Impact Assessment

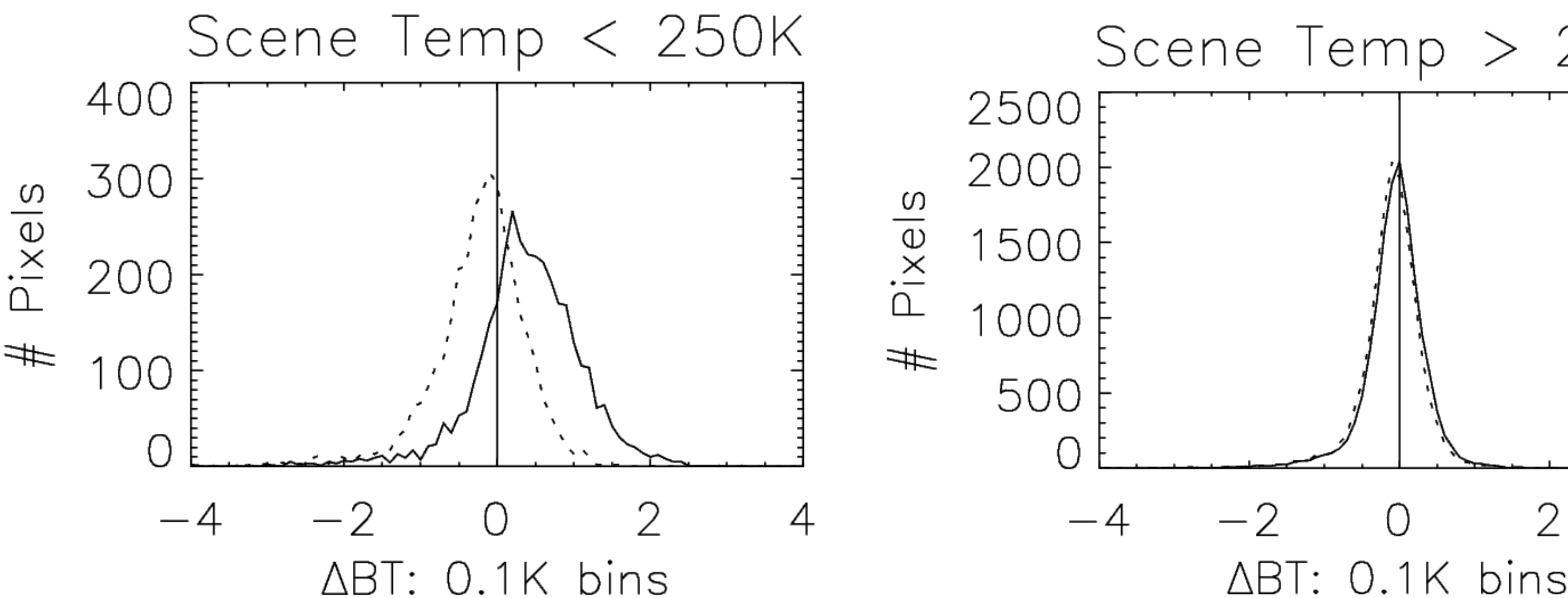
One orbit of granules – June 20, 2006 – near nadir footprints
MODIS resampled to AIRS footprint, AIRS spectra convoluted with MODIS bandpass



Aqua L1B Impact Assessment

Scene temperature dependence of Aqua MODIS/AIRS difference (B31)

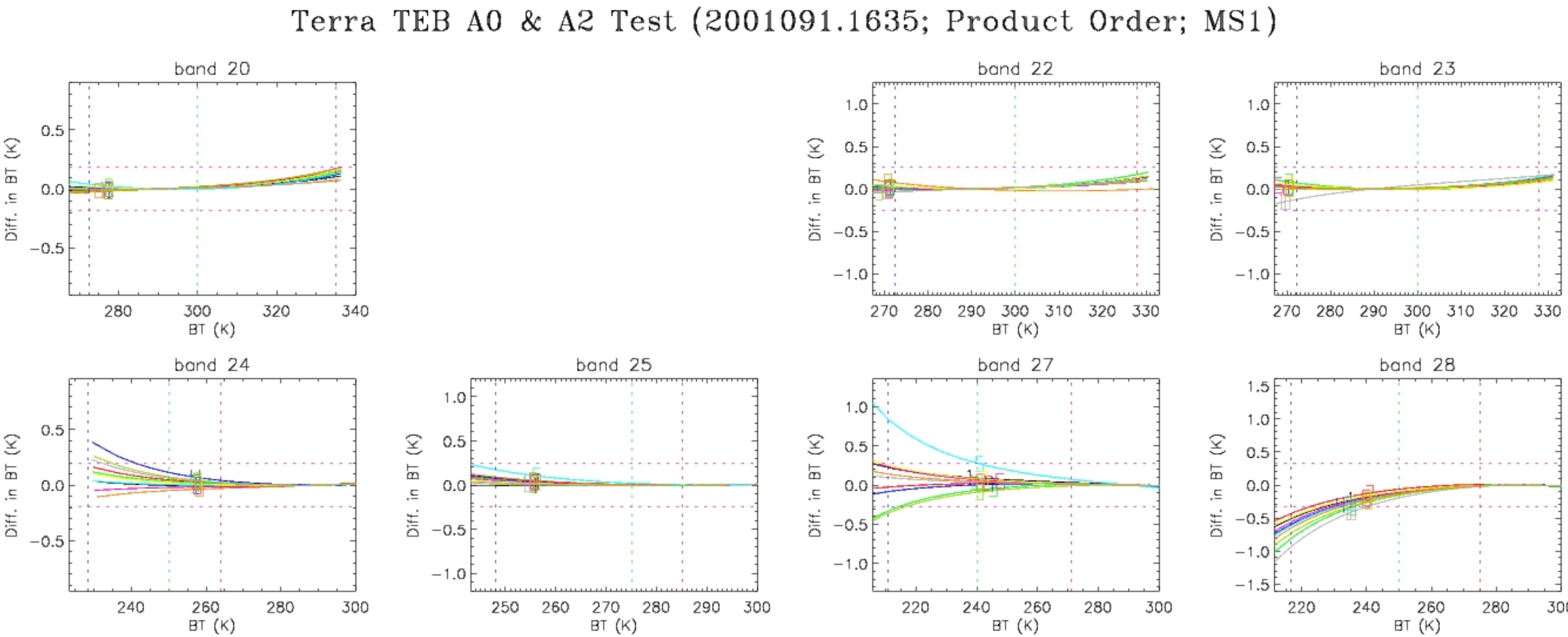
(near nadir AIRS footprints, one orbit)



Solid line: v5

Dashed line: v6

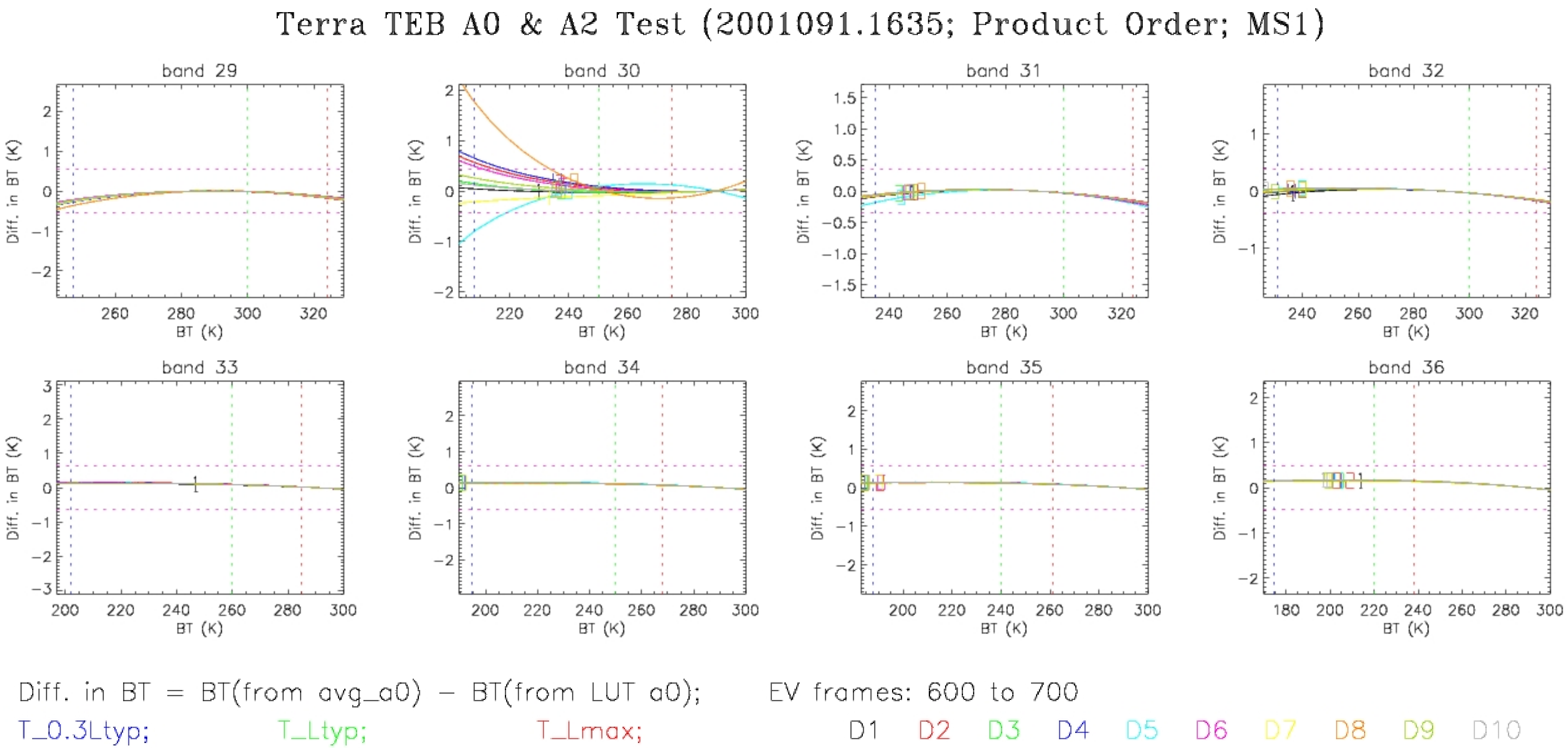
Terra L1B Impact Assessment



Diff. in BT = BT(from avg_a0) − BT(from LUT a0); EV frames: 600 to 700

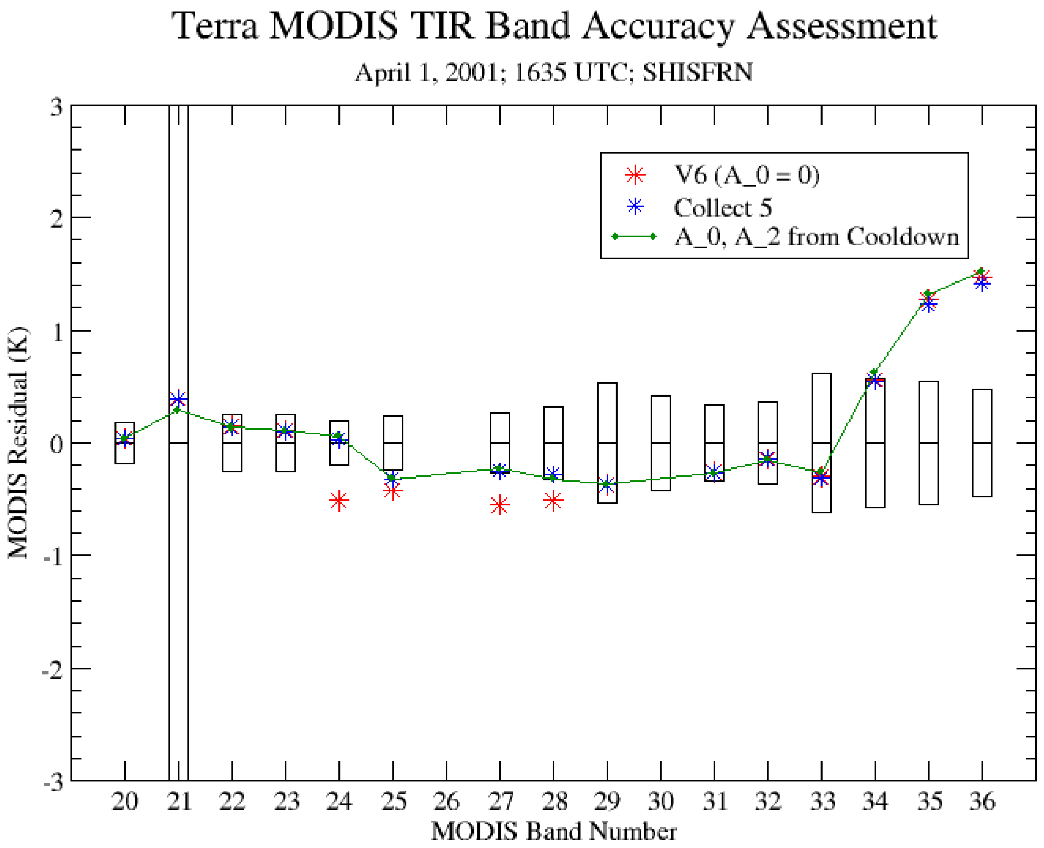
T_0.3Ltyp; T_Ltyp; T_Lmax; D1 D2 D3 D4 D5 D6 D7 D8 D9 D10

Terra L1B Impact Assessment



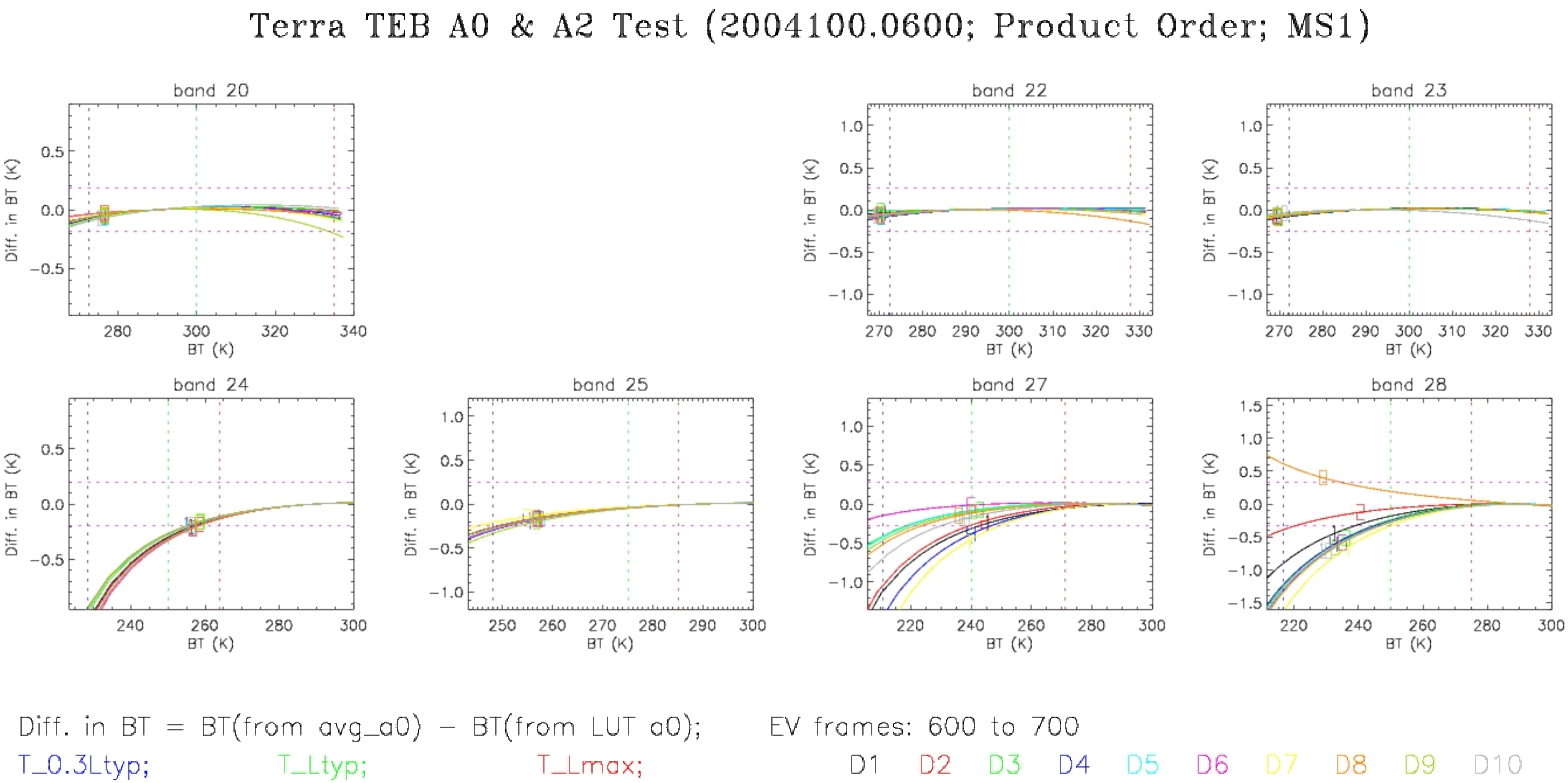
Terra L1B Impact Assessment

- ER-2 MAS comparison analysis

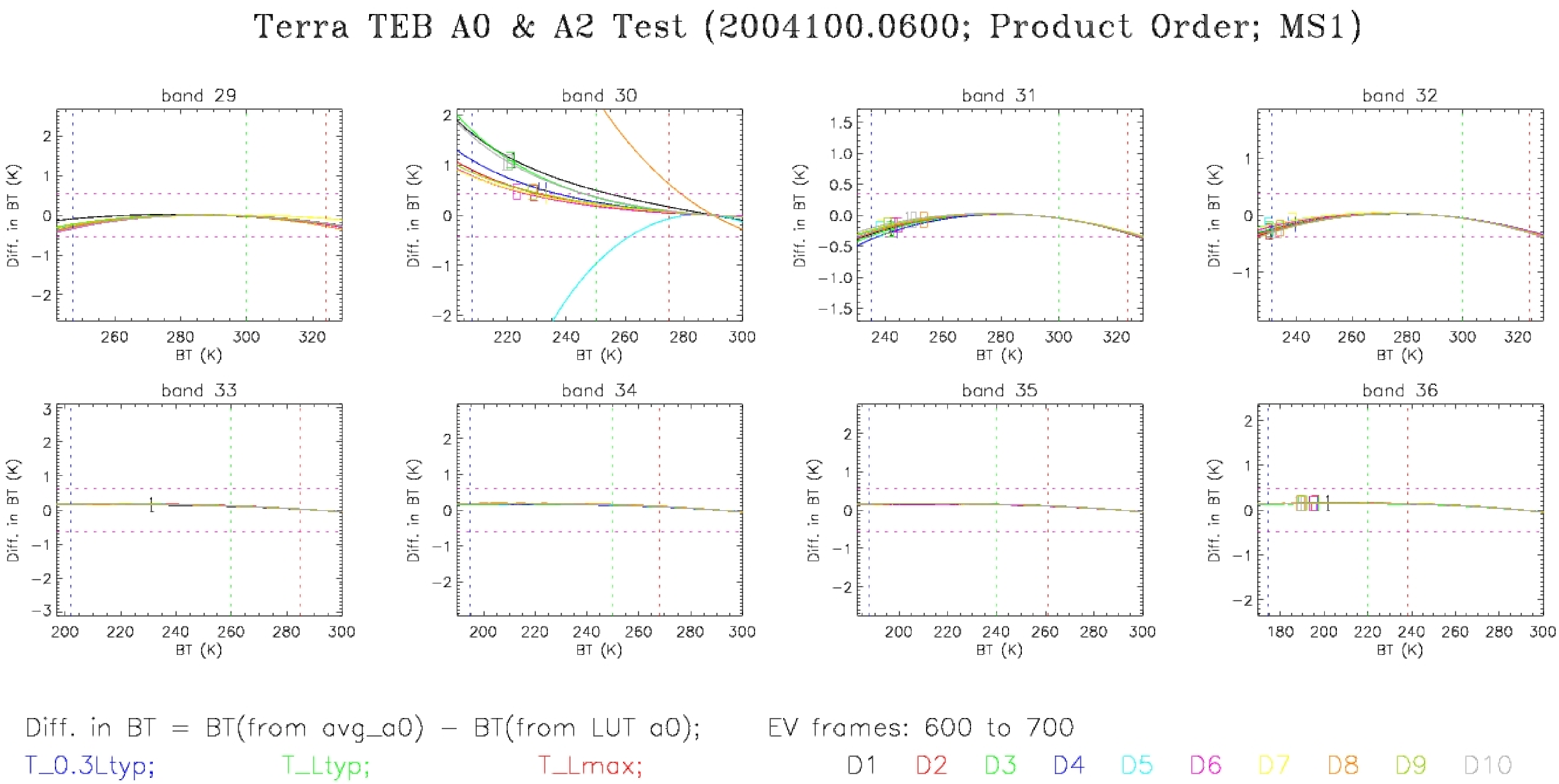


Plot courtesy of Chris Moeller

Terra L1B Impact Assessment



Terra L1B Impact Assessment



Terra L1B Impact Assessment

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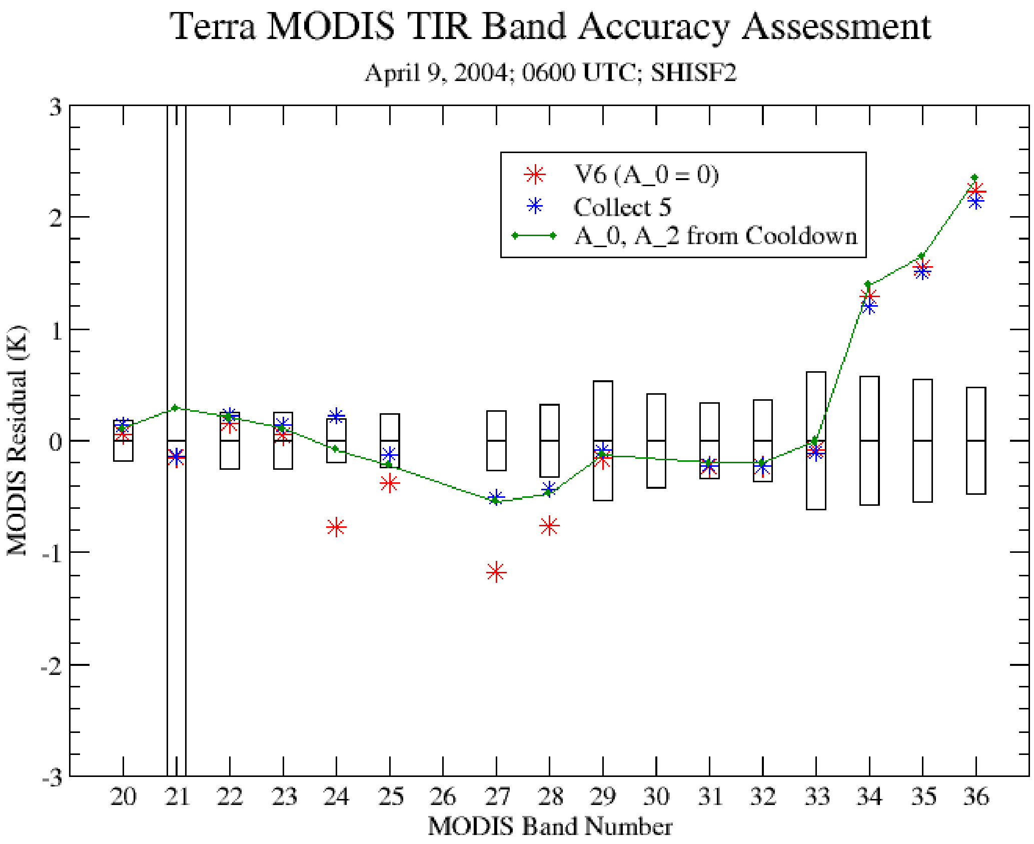
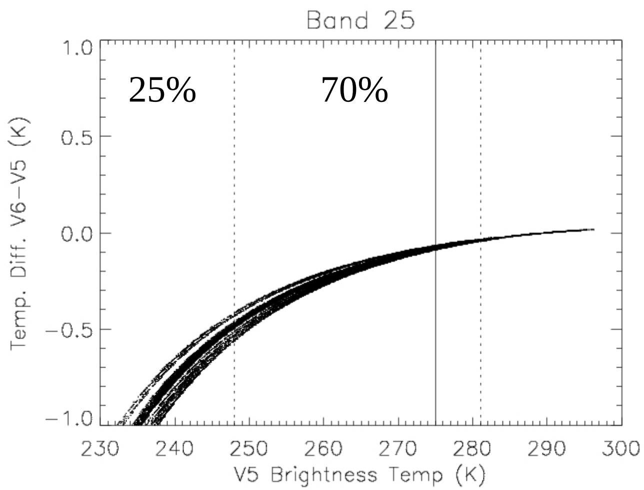
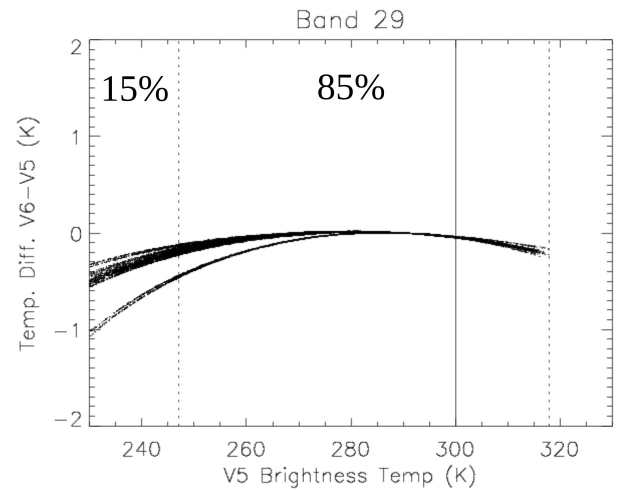


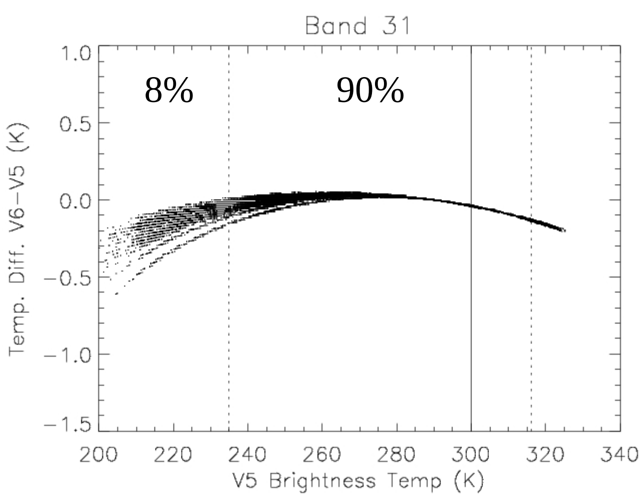
Plot courtesy of Chris Moeller

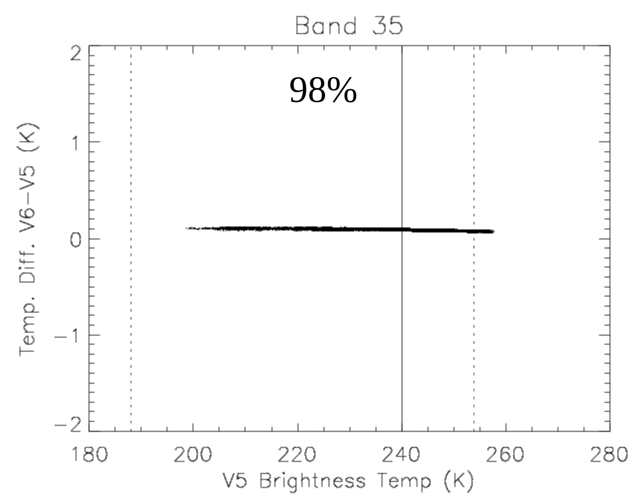
Terra L1B Impact Assessment

One orbit on June 21, 2007









Estimated L1B Impact

Band	T_{typ}	Terra			Aqua		
		ΔT @ $T(0.3L_{typ})$	ΔT @ $T(L_{typ})$	ΔT @ $T(0.9L_{max})$	ΔT @ $T(0.3L_{typ})$	ΔT @ $T(L_{typ})$	ΔT @ $T(0.9L_{max})$
20	300	- 0.10	+ 0.02	- 0.03			
22	300	- 0.05	+ 0.02	+ 0.01			
23	300	- 0.08	+ 0.02	0.00			
24	250	- 1.20	- 0.30	- 0.15			
25	275	- 0.40	- 0.08	- 0.04			
27	240	- 0.50	- 0.20	- 0.05			
28	250	- 0.70	- 0.15	- 0.02			
29	300	- 0.20	- 0.03	- 0.15			
30	250	+ 0.40	+ 0.15	+ 0.10			
31	300	- 0.20	- 0.04	- 0.14	- 0.40	0.00	- 0.05
32	300	- 0.20	- 0.04	- 0.14	- 0.40	0.00	- 0.05
33	260	+ 0.10	+ 0.08	+ 0.05			
34	250	+ 0.10	+ 0.08	+ 0.07			
35	240	+ 0.10	+ 0.08	+ 0.07			
36	220	+ 0.08	+ 0.08	+ 0.07			

A0/A2 Summary

- Initial time dependent LUTs derived and tested
  - Results indicate improved performance for low temperature scenes.
- To be completed: Verification of v6 Terra LUTs by analysis of each cool-down dataset
  - Intial LUTs derived from average a0/a2 from all CD events within a given configuration

RSB LUTs Improvements in MODIS L1B Collection 6

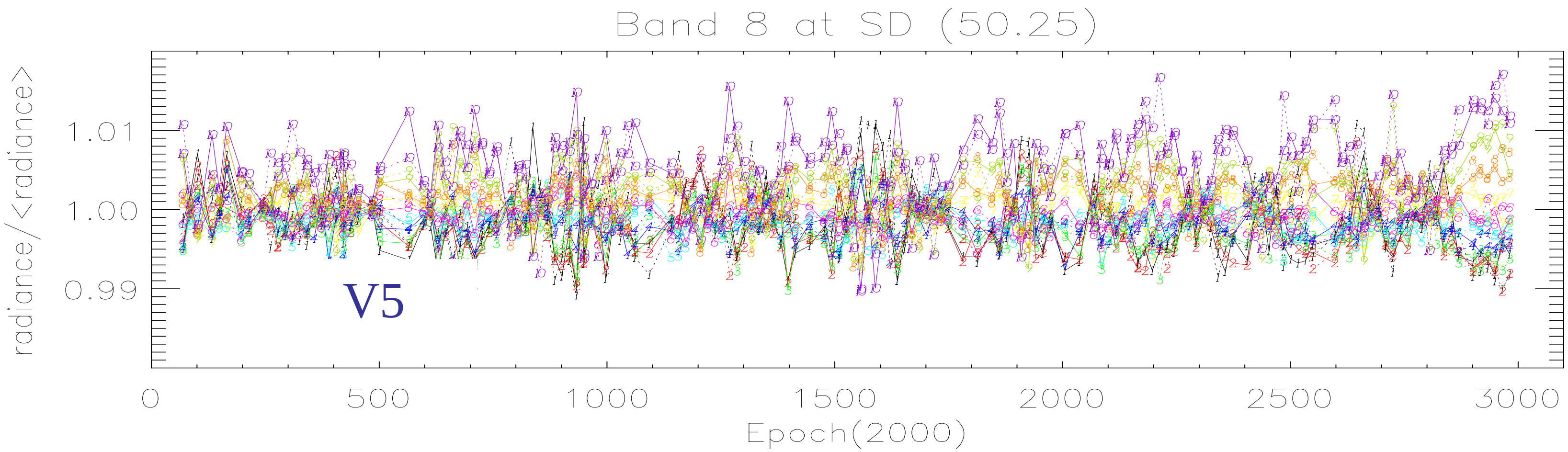
Outline

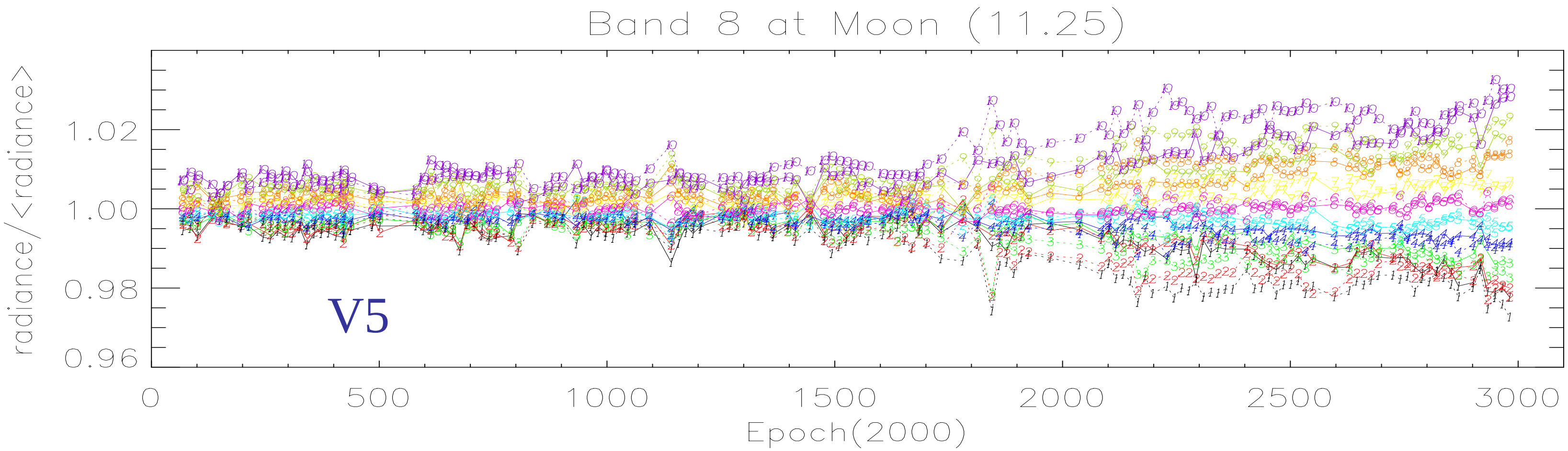
- Introduction
- Correction for detector bias in the SD m1
  - Algorithm
  - Results
- Detector dependent RVS
  - Algorithm
  - Results
- V6 and V5 RVS comparison
- Application to the EV data
- Summary

Introduction

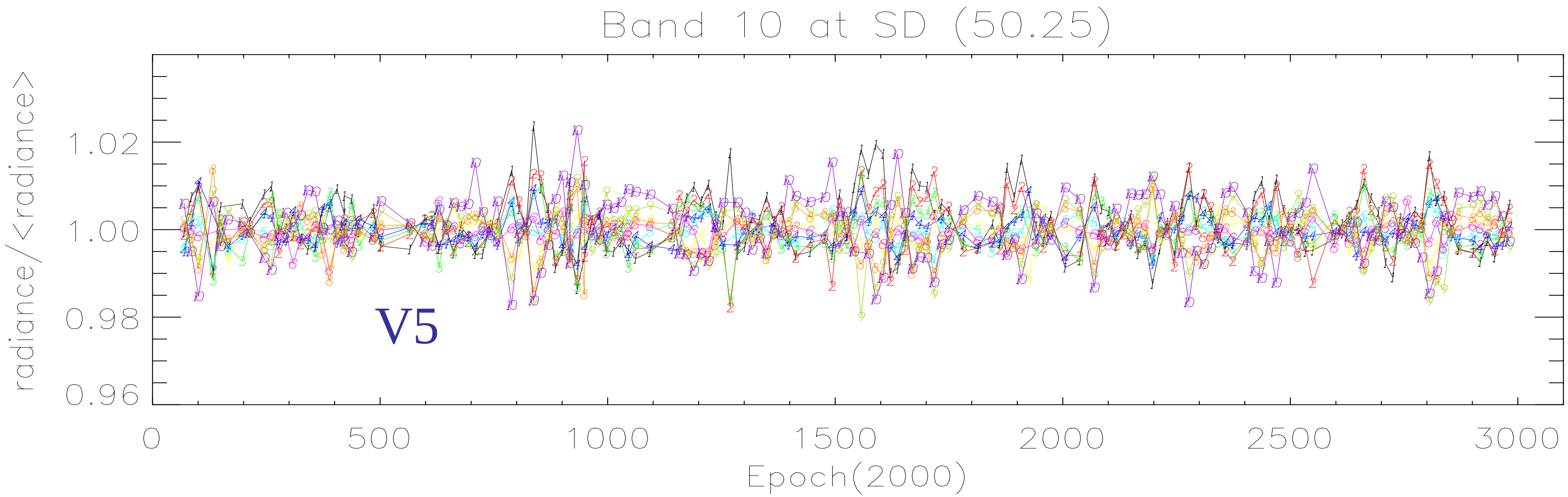
- m1:
  - Approximations used in our SD calibration
  - EV radiance detector difference trending at AOI of the SD
- RVS
  - Current V5 RVS is detector independent and derived from the detector averaged SD m1, lunar m1, and mirror side ratios
  - EV radiance detector difference trending at other AOI

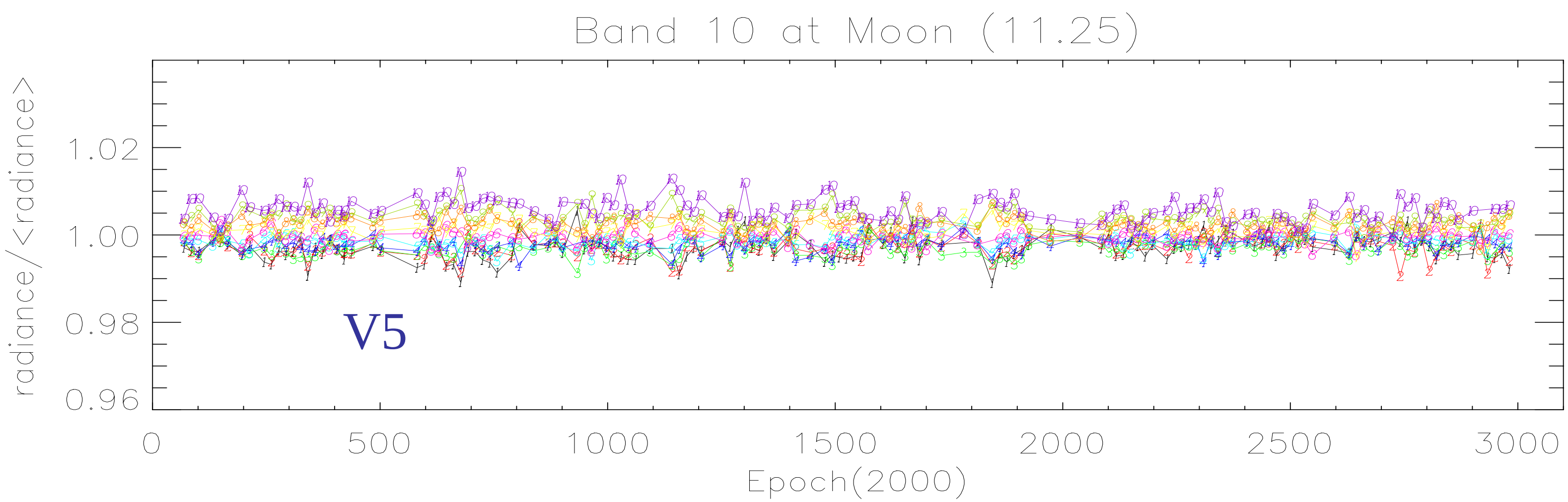
Introduction





Introduction





Correction for detector bias in SD m1

- MODIS calibration coefficients

$$m1' = m1 / R_{m1}$$

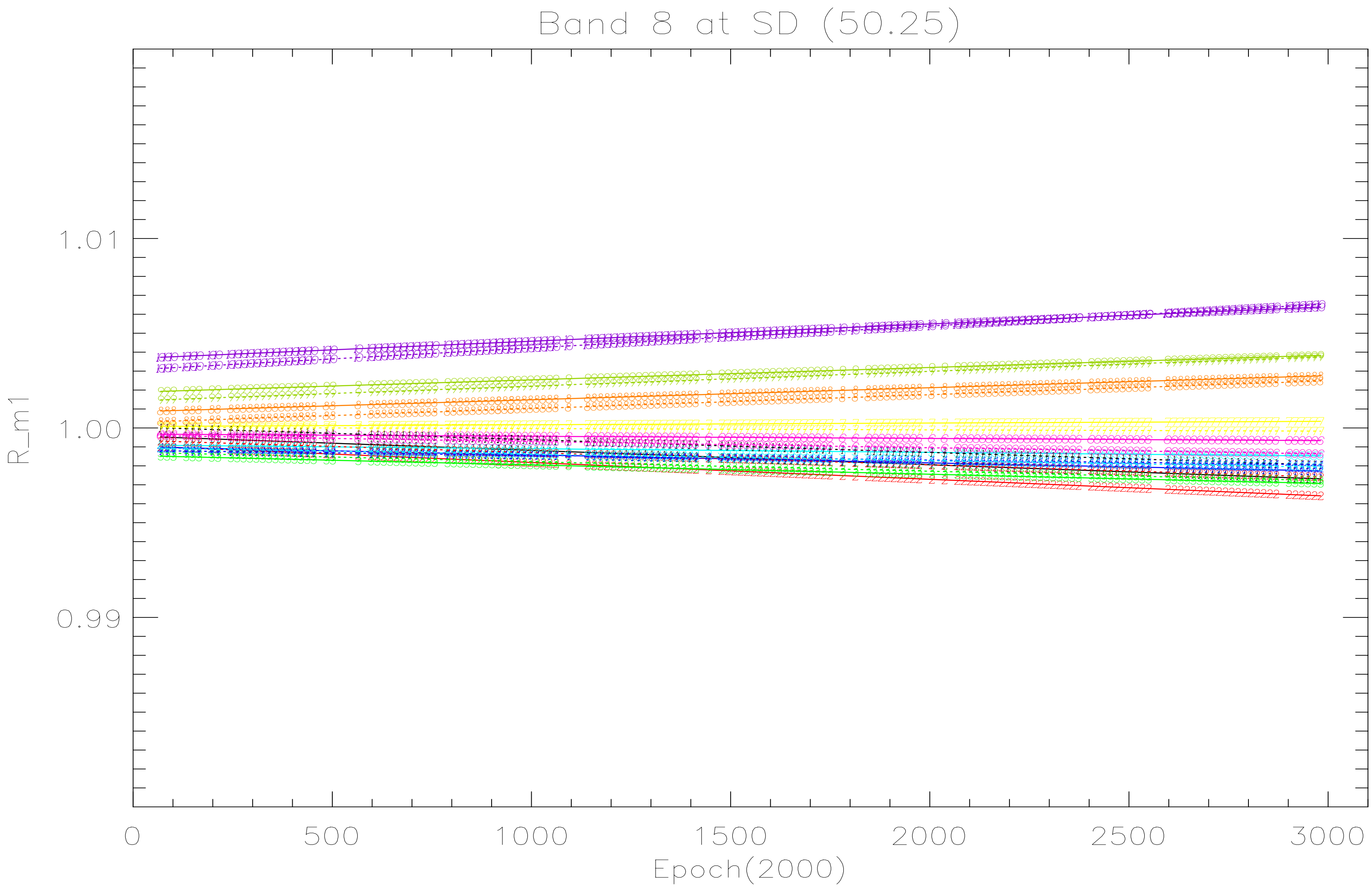
  - *m1*: Current calibration coefficients
  - *m1'*: Corrected calibration coefficients
  - R_{m1}: Correction for the calibration coefficients

- Correction:

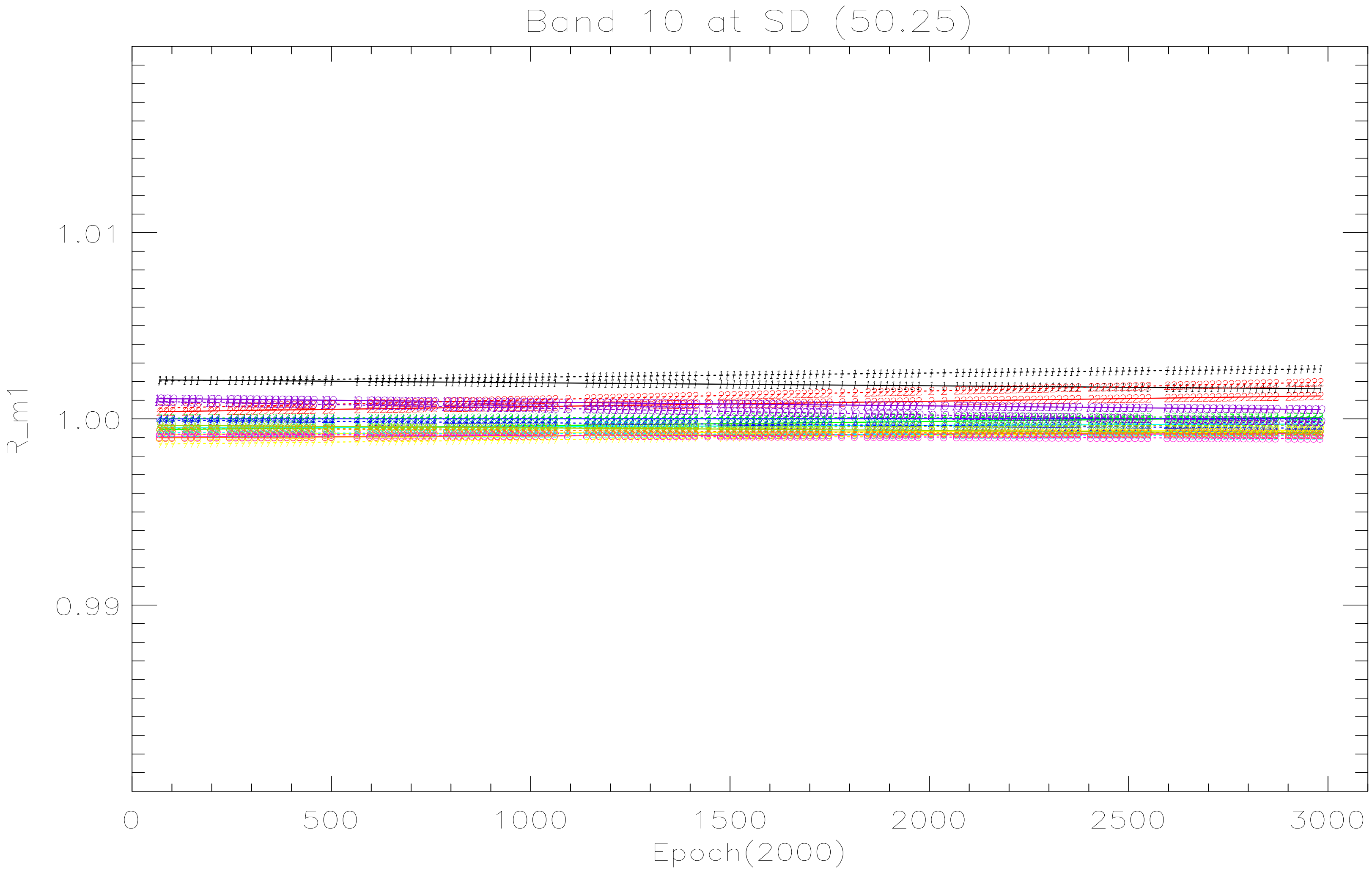
$$R_{m1} = \frac{L_{EV}}{\langle L_{EV} \rangle_d}$$

  - $\langle \ldots \rangle_d$: Averaged over detectors in the band

Correction for detector bias in SD m1



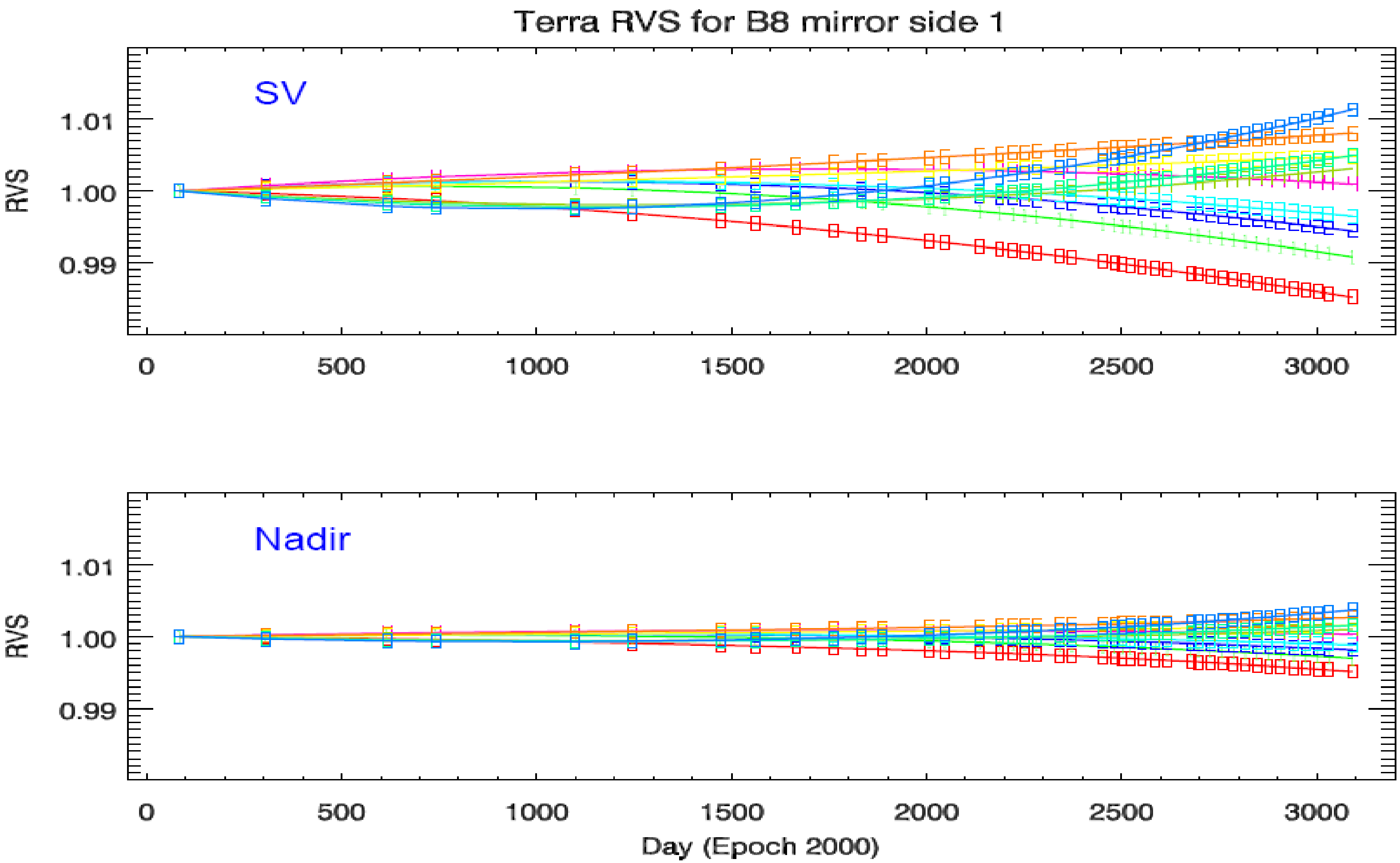
Correction for detector bias in SD m1



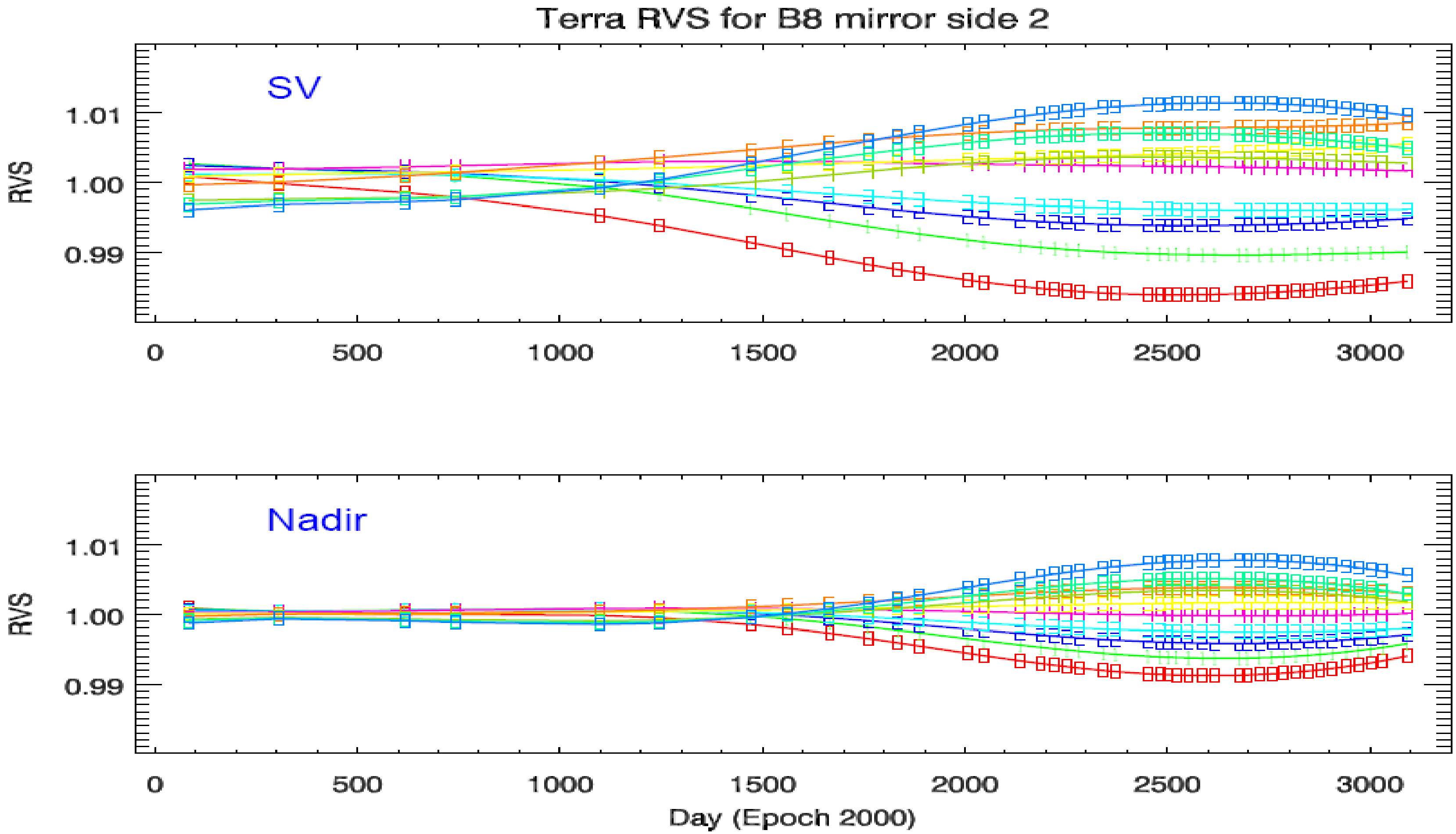
Detector dependent RVS

- **Algorithm**
  - **For MS1, the detector dependent RVS is derived from the SD and lunar m1 with a linear approximation**
  - **For MS2, the detector dependent RVS is derived from the EV, lunar, and SRCA dn mirror side ratios**
  - **Data fitted to smooth functions**
    - **The normalized detector dependent SD m1, lunar m1, and MS ratios are fitted to proper functions, which are, in general, composed of several of analytical functions smoothly connected**
    - **The detector differences of the SD m1, lunar m1, and MS ratios are fitted to a properly chosen polynomial for each band and detector**

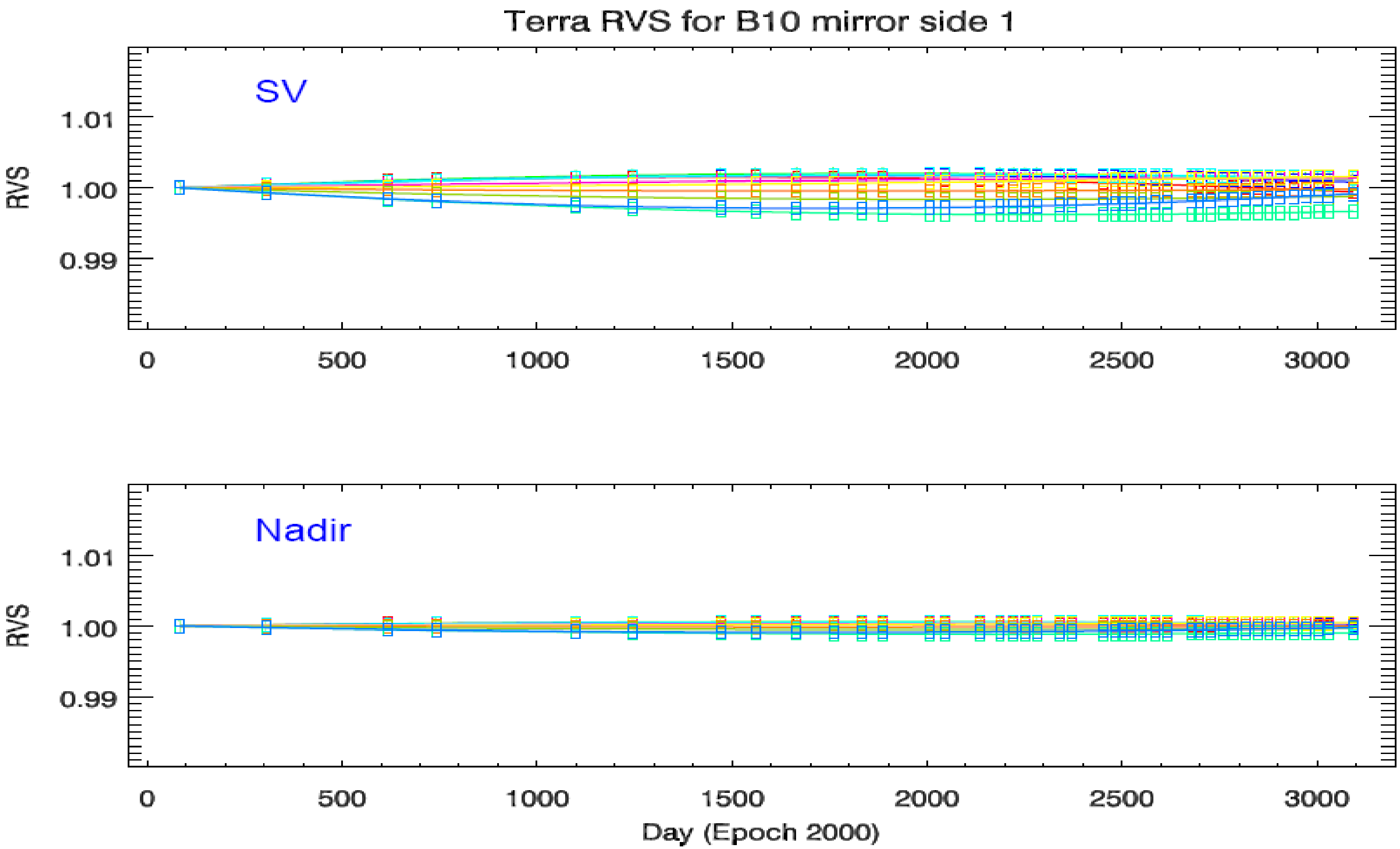
Detector dependent RVS



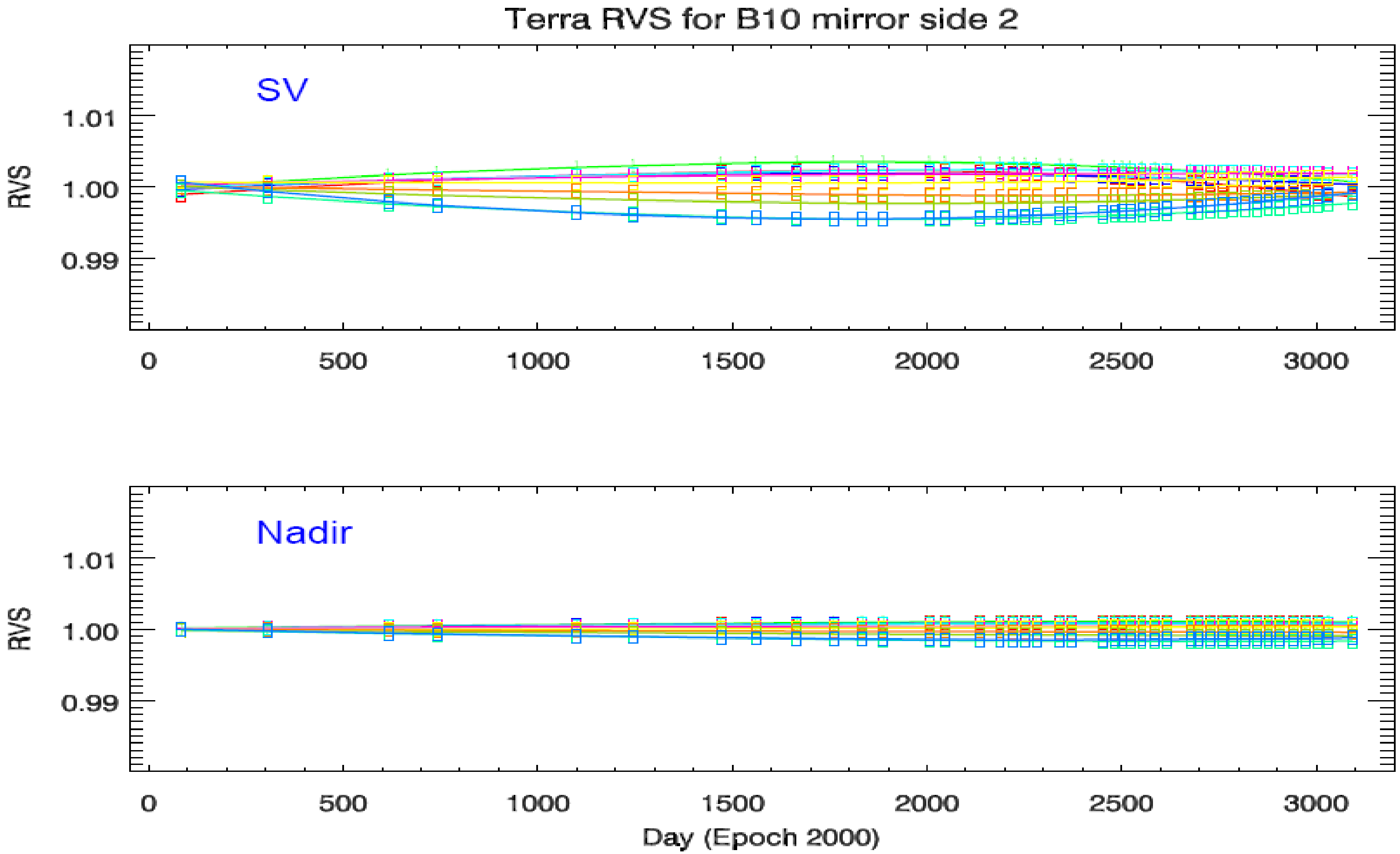
Detector dependent RVS



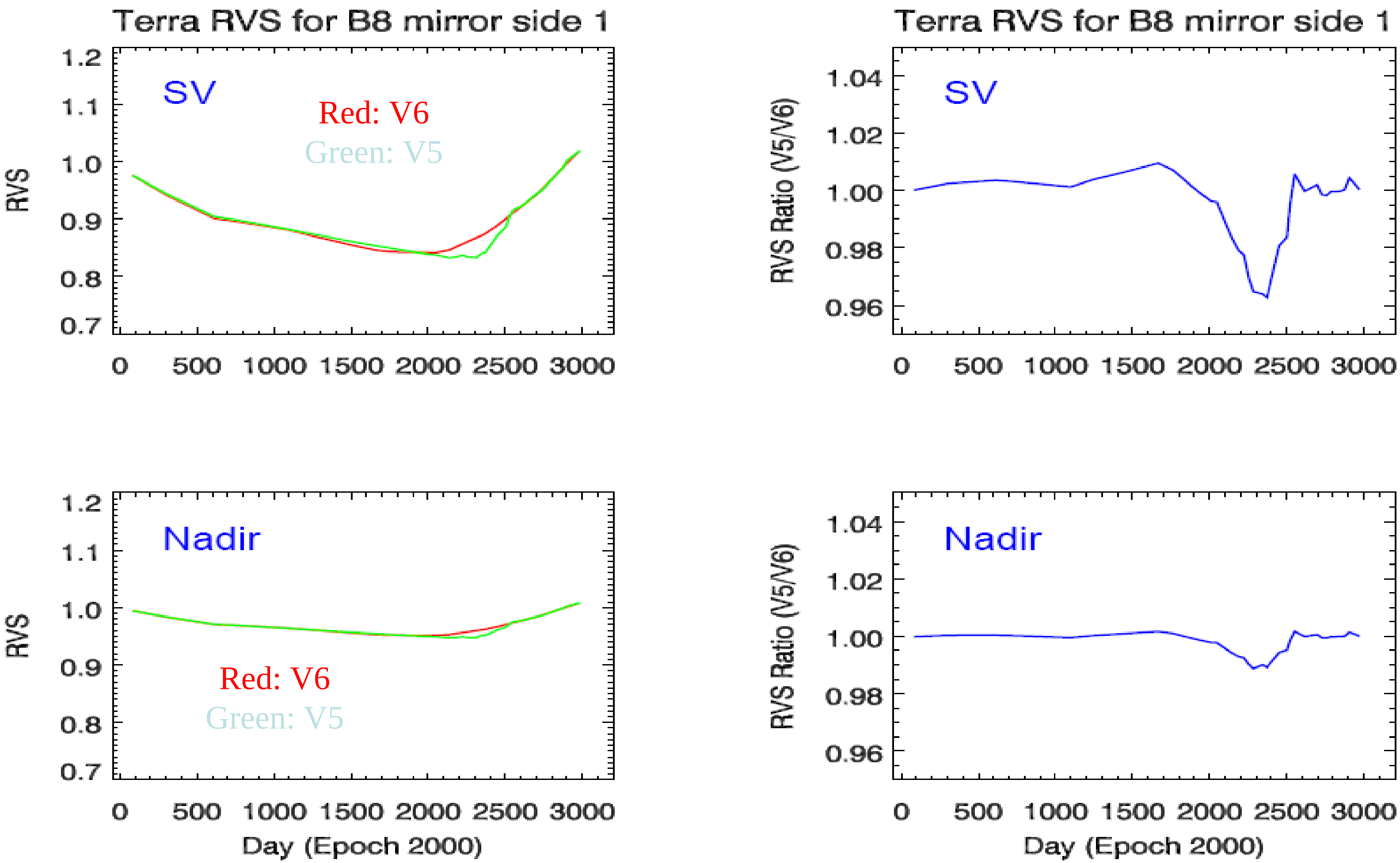
Detector dependent RVS



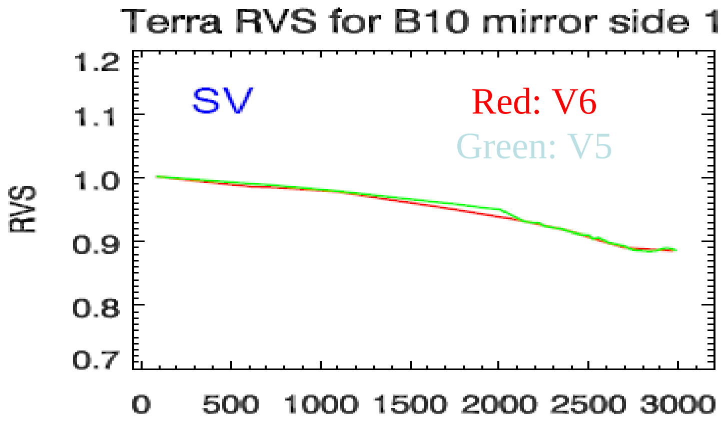
Detector dependent RVS

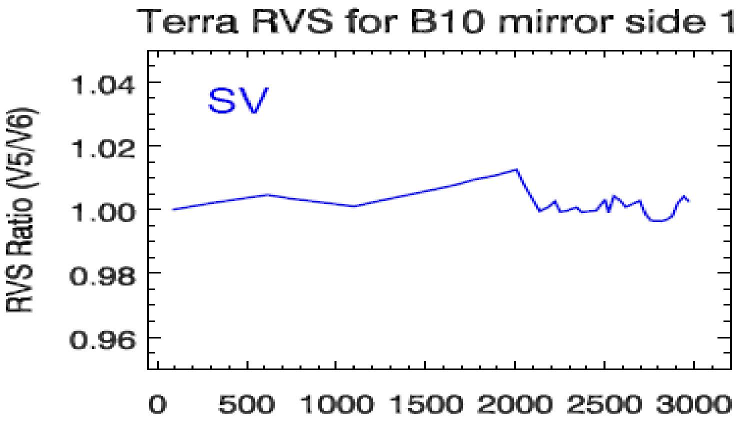


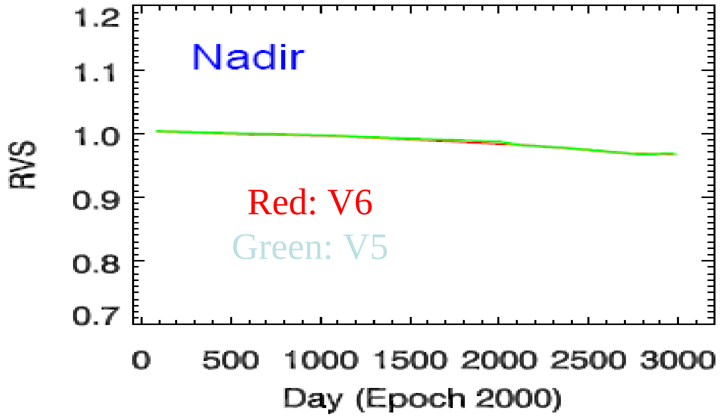
Terra RVS V5 and V6 Comparison

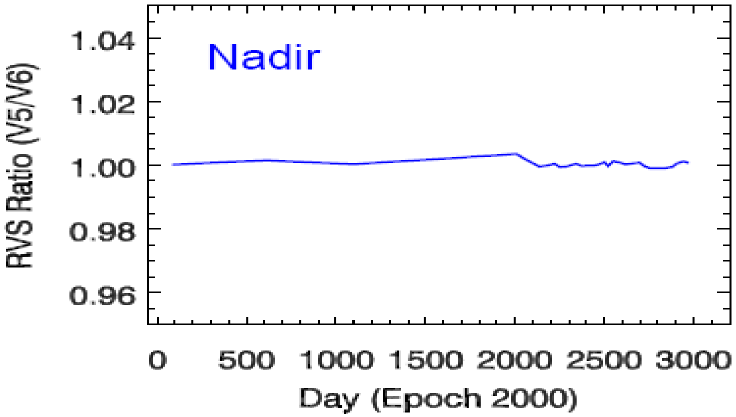


Terra RVS V5 and V6 Comparison

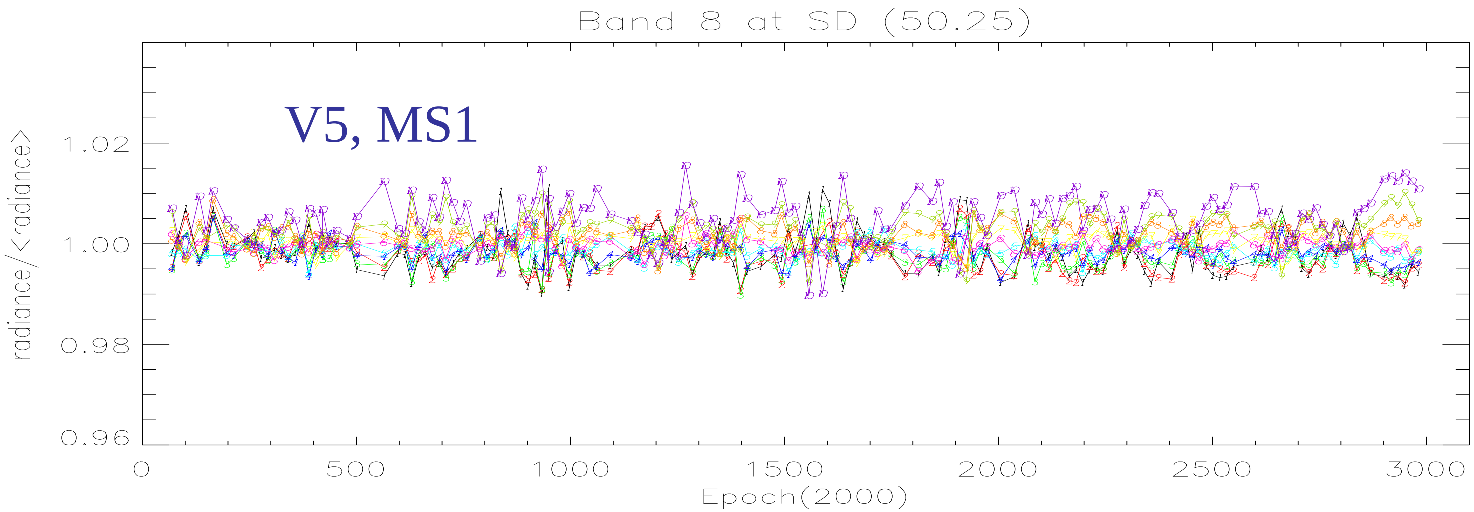


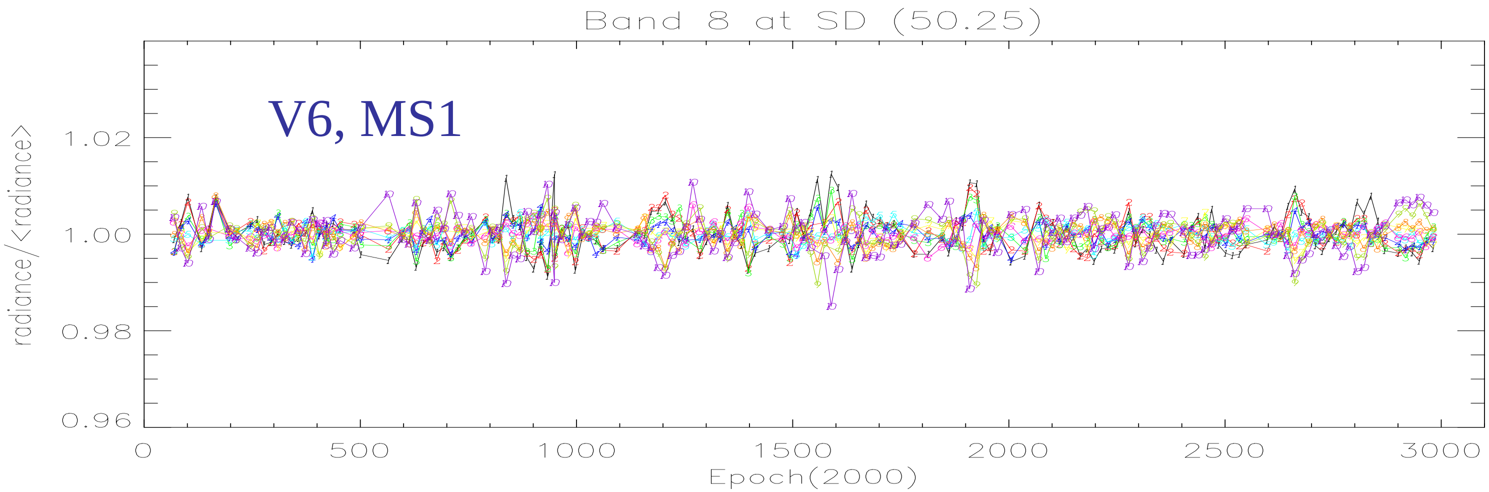






Application to EV data





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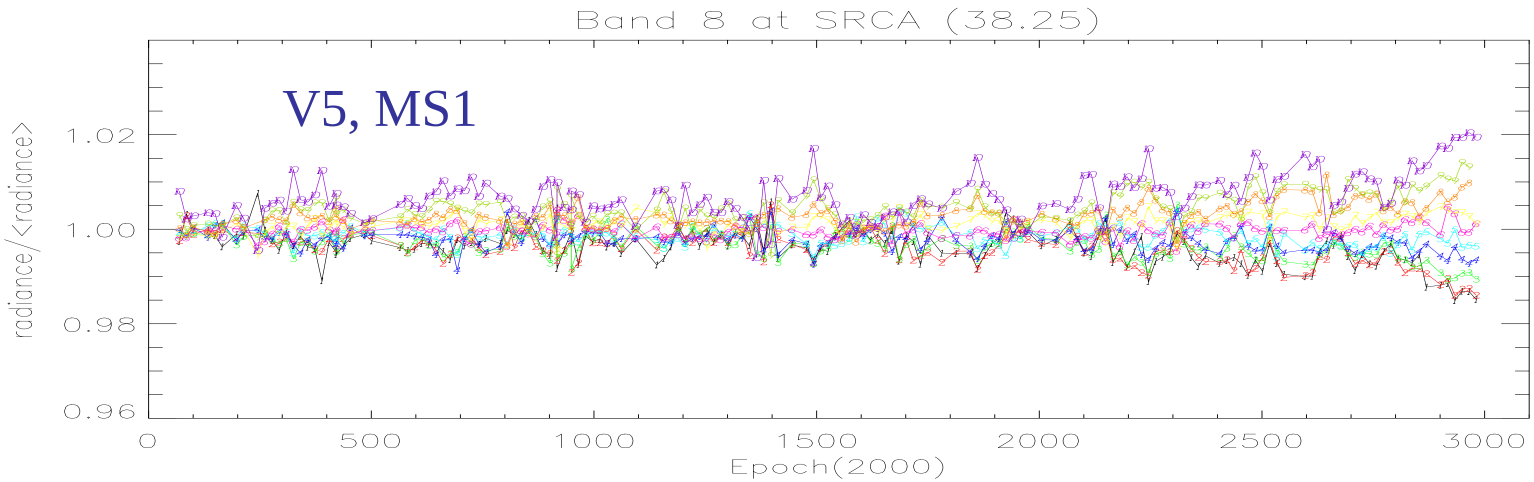
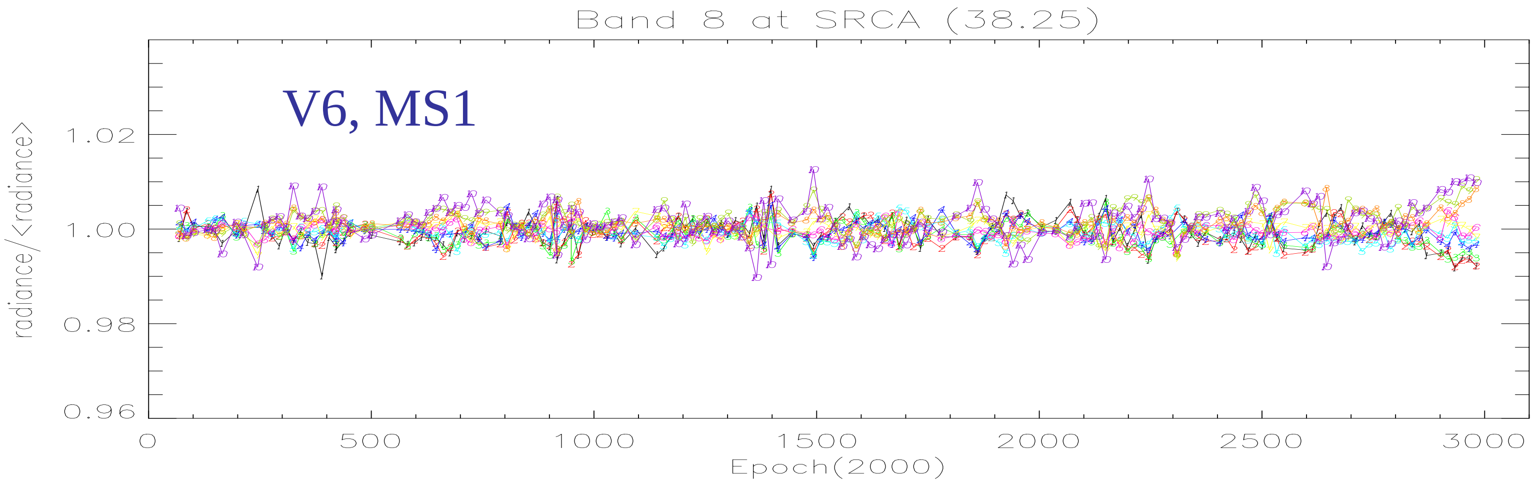
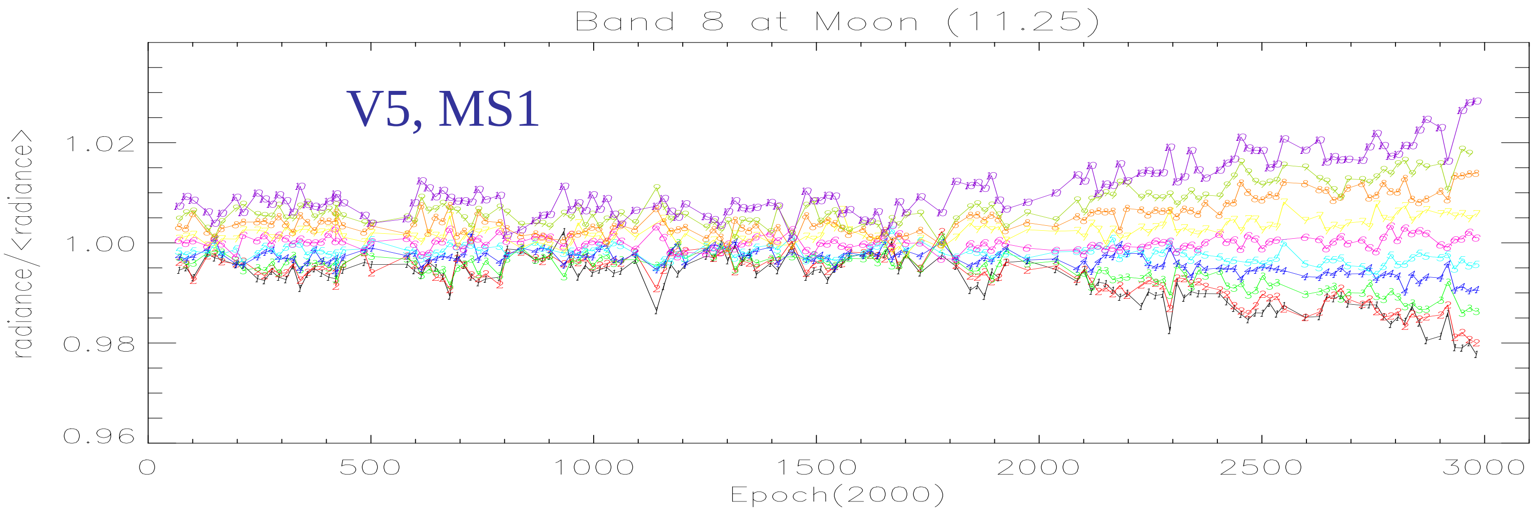
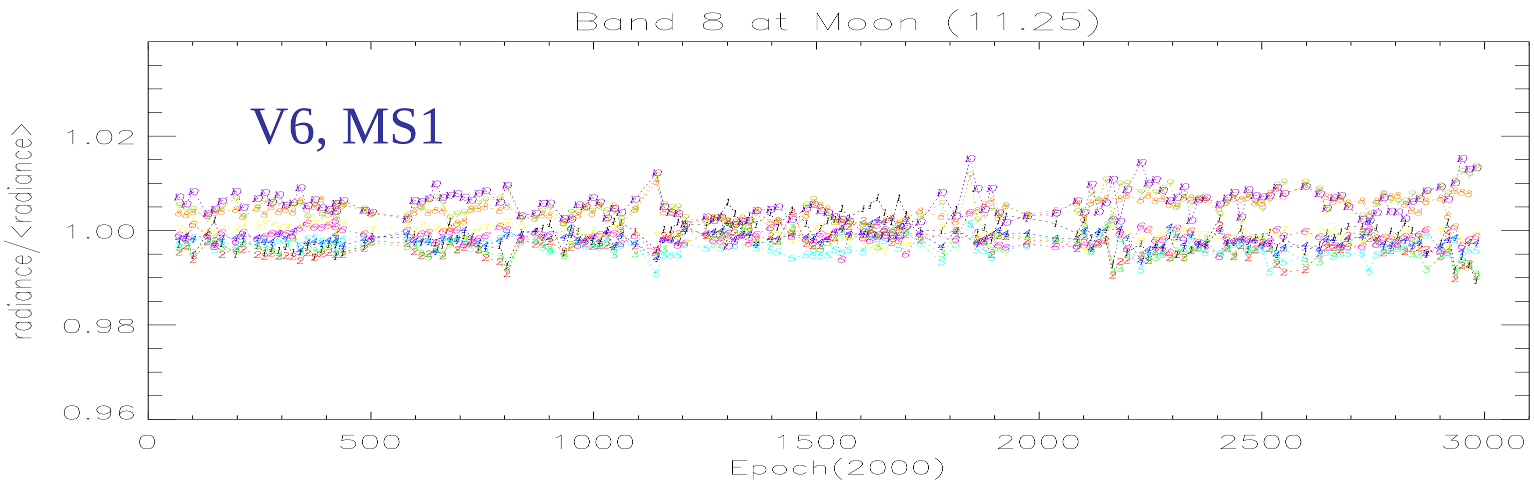




Application to EV data





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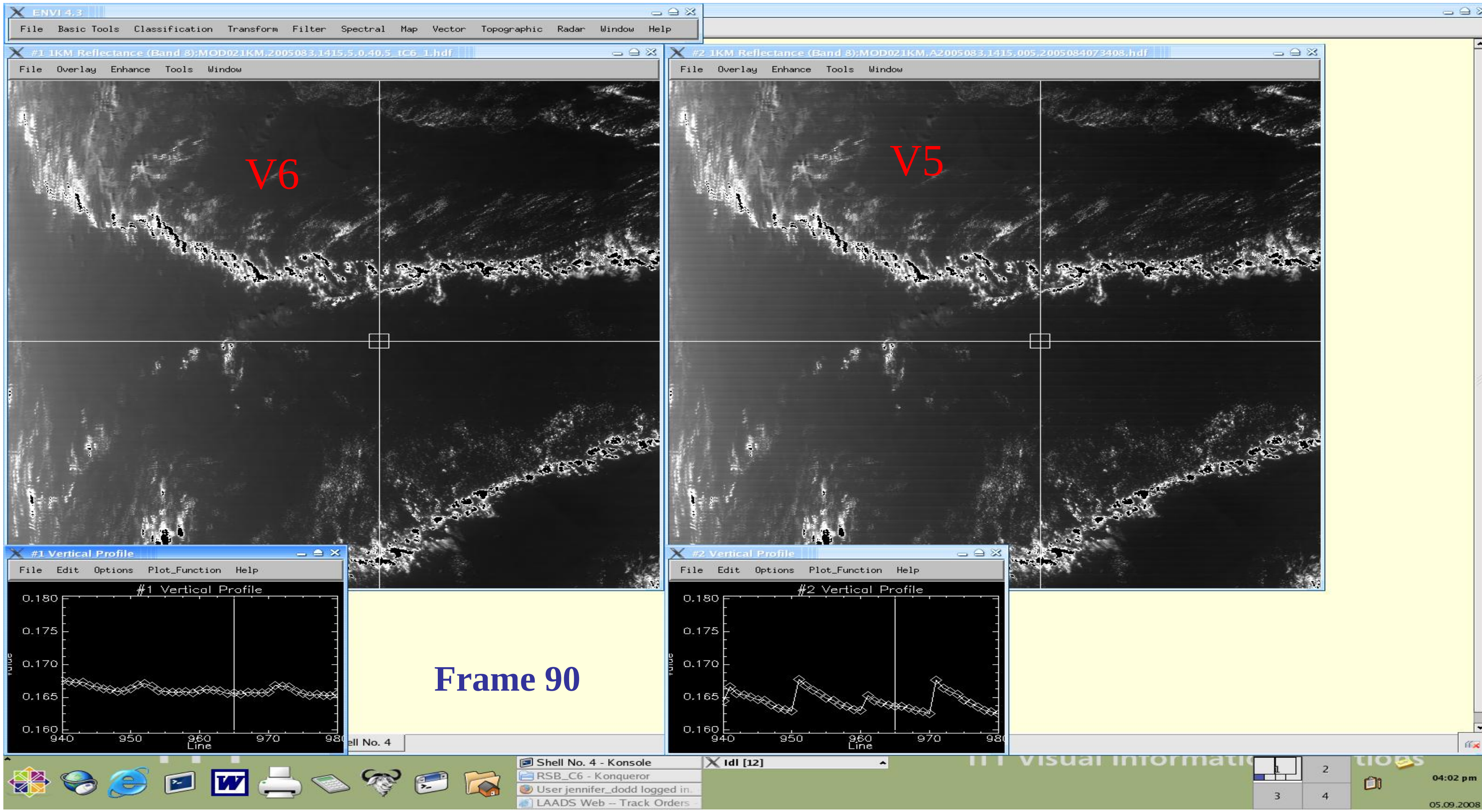

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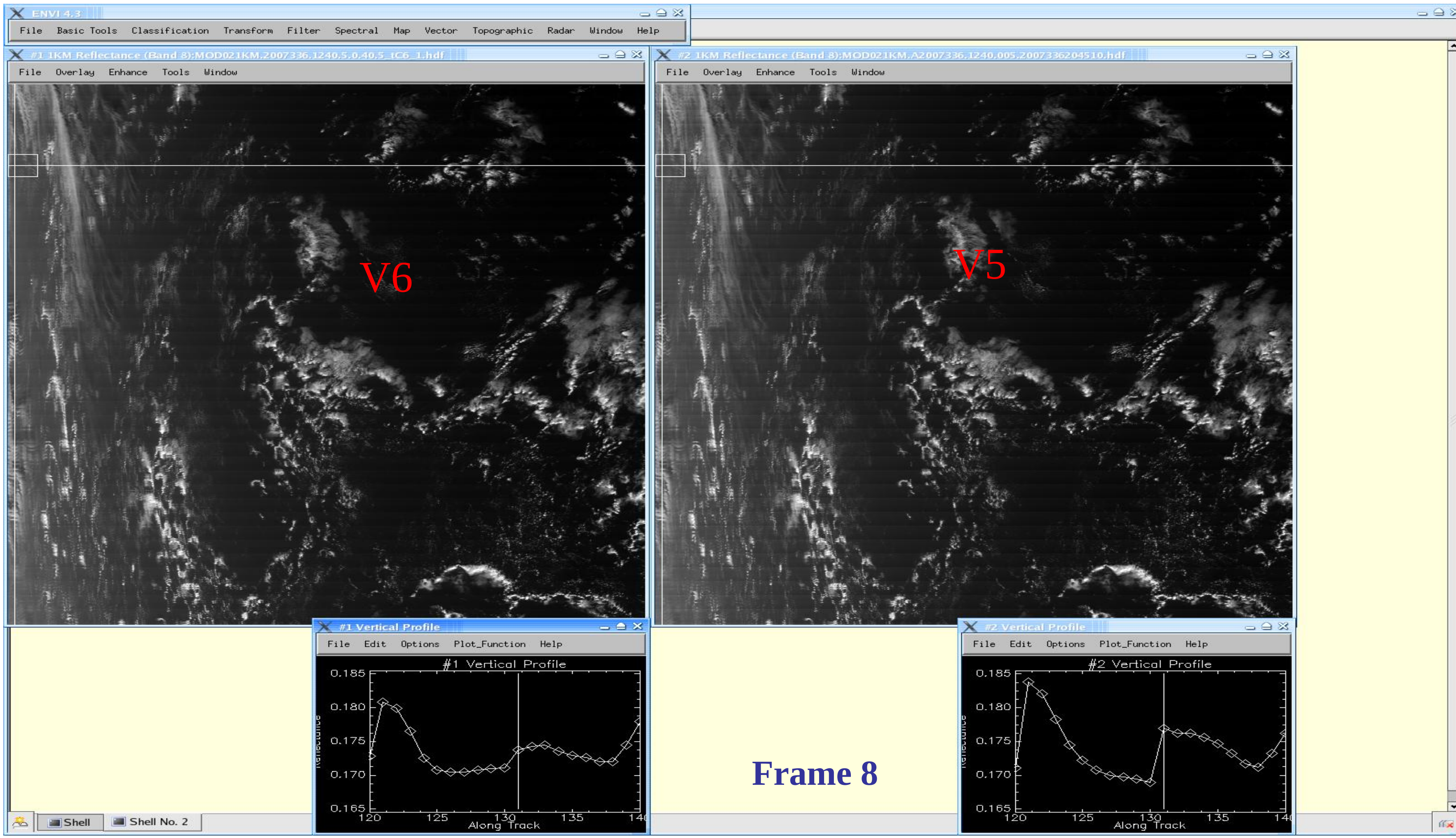

Summary

- Based on the EV radiance difference at AOI of the SD, correction for Terra RSB m1 detector bias is derived
  - The correction is within +/-0.5% for all bands early in the mission
  - The correction has increased by an additional +/-0.3% for Terra band 8, +/-0.2% for band 9
  - There are no obvious change for other bands
- Detector dependent RVS is derived for Terra RSB
  - Band 8 has the largest RVS detector difference, which increases with time and is now as large as 3.0% at the AOI of the SV
  - The largest RVS detector differences for bands 9, 3, and 10 are about 1.5%, 1.2%, and 0.8%, respectively, at the AOI of the SV
- Detector averaged V6 RVS matches the V5 RVS in general but it has corrected the errors in V5 due to various reasons occurred in the forward process
- The corrected m1 and detector dependent RVS greatly reduce the EV radiance detector difference and improve the MODIS L1B product quality.