Collect 5 Calibration Issues

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Recent MODIS Calibration Changes and Issues

- Collect 5 DSM RVS application for Terra (MSCN?)

- Aqua AIRS – MODIS comparisons

- 5um leak correction for Terra Aside 2

- TIR band destriping update (global training)

- Reminder about Aqua MODIS registration offsets (Ralf Bennartz)

- Terra B26 radiance change for Collect 5 due to change in 5um leak correction formulation
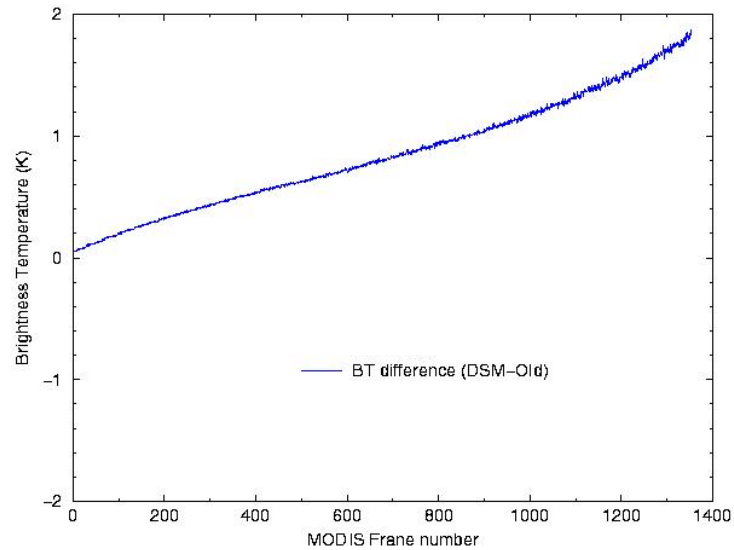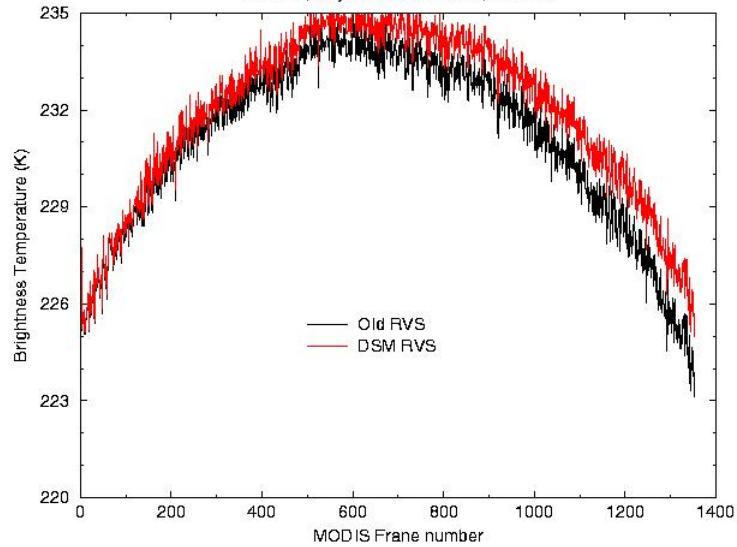
Terra MODIS DSM RVS

- Used for Thermal bands
- Largest impact in LWIR CO2 bands 34-36
- Cross-track asymmetry reduced
- Mirror-side striping reduced (exception: Bside)
- Examples from each of the major MODIS epochs (Aside 1, Bside, Aside 2)

Band 36 across track profiles using old and DSM RVS
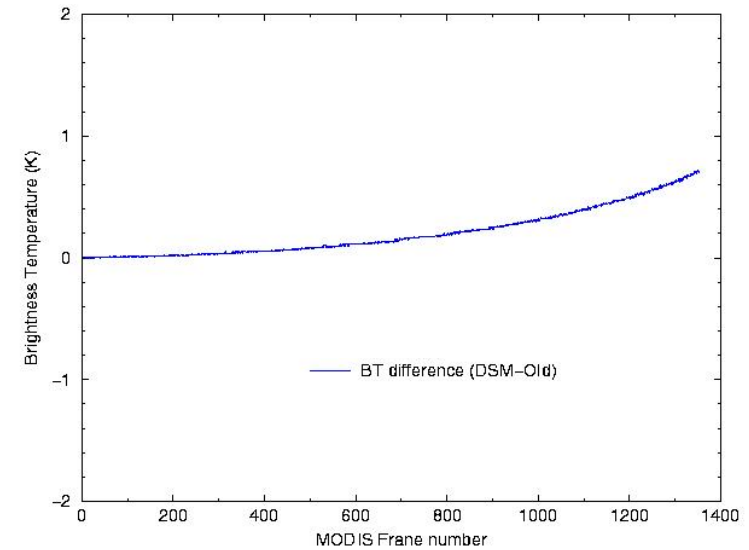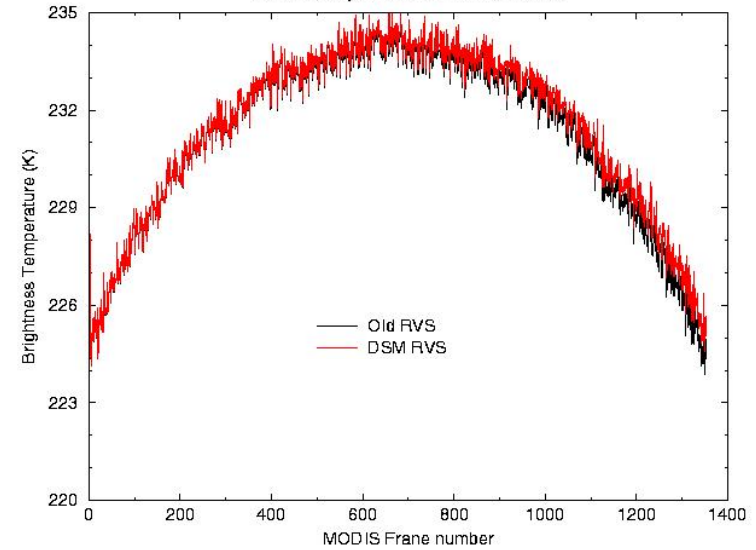## DSM RVS improves across track symmetry, esp Mirror Side 2
Mirror side 2   Mirror side 1

Terra MODIS DSM RVS Evaluation

Symmetry about NADIR, Mirror Side 1, Day 00136 1925 UTC, B36

Collect 4
Collect 5

BOS-EOS

Temperature Difference (K)

MODIS Frame Number

BOS
EOS

NADIR

MSCN pattern 1
Aside 1

Granule average
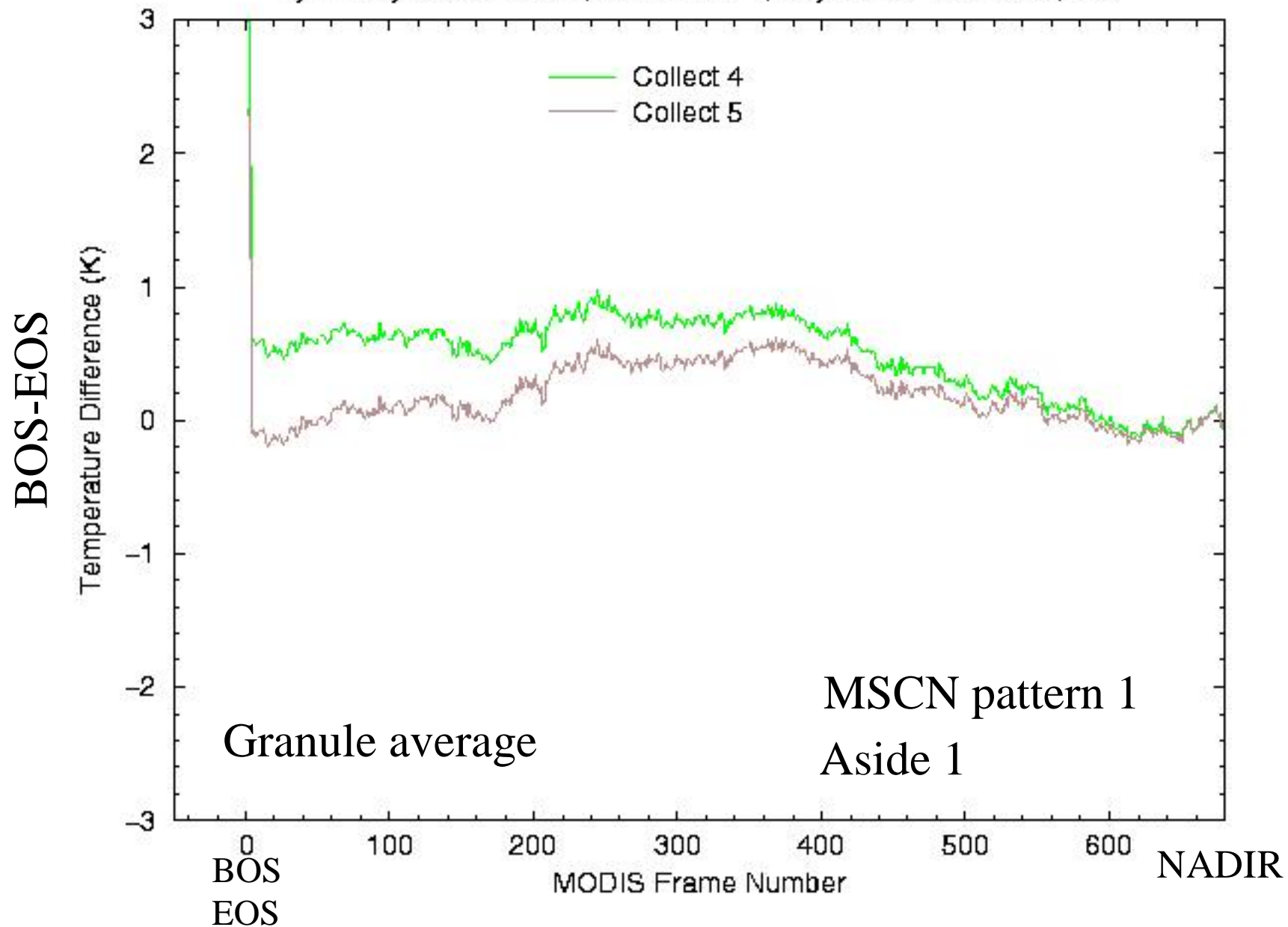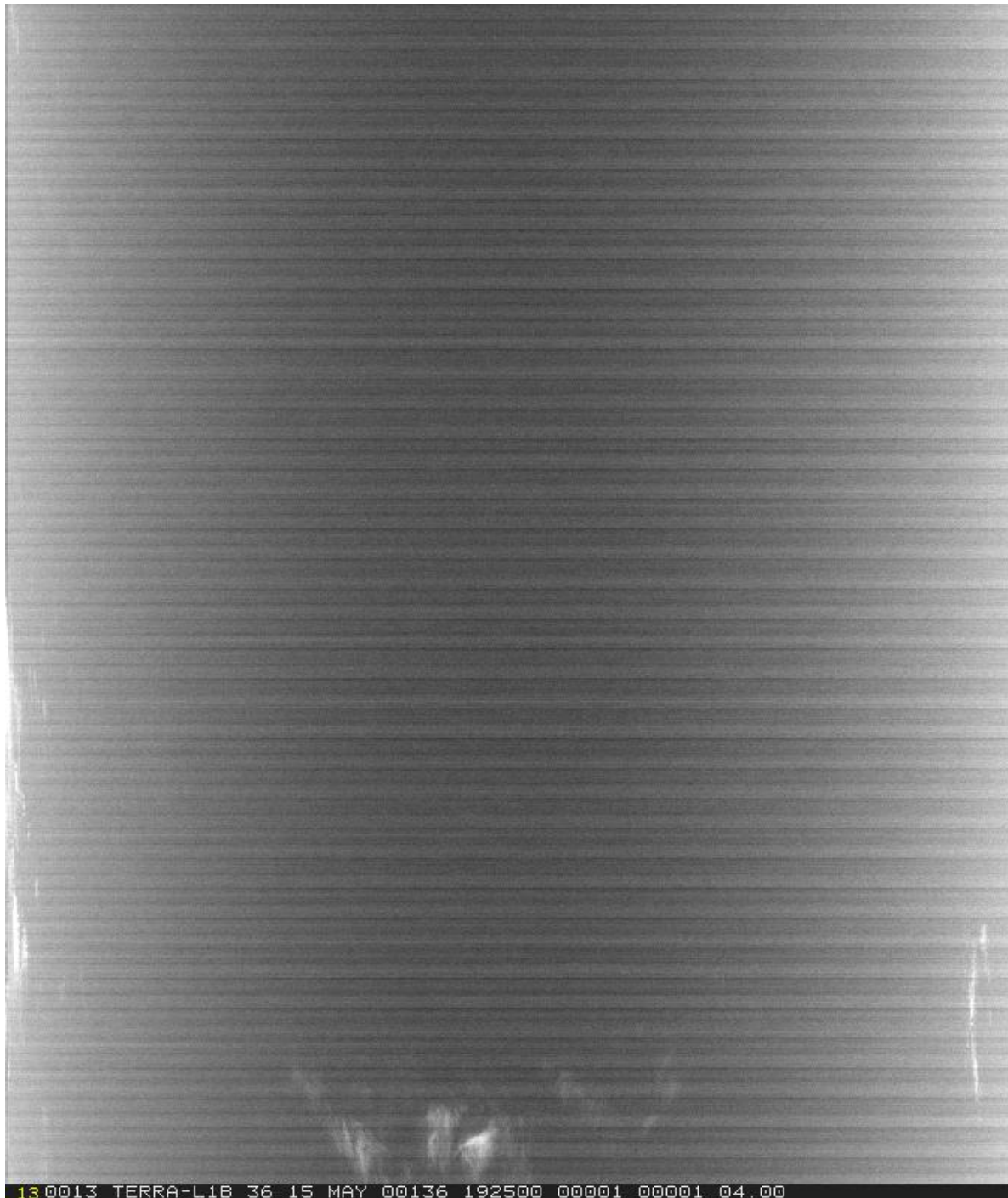
Terra MODIS DSM RVS Evaluation

Symmetry about NADIR, MIrror Side 2, Day 00136 1925 UTC, B36
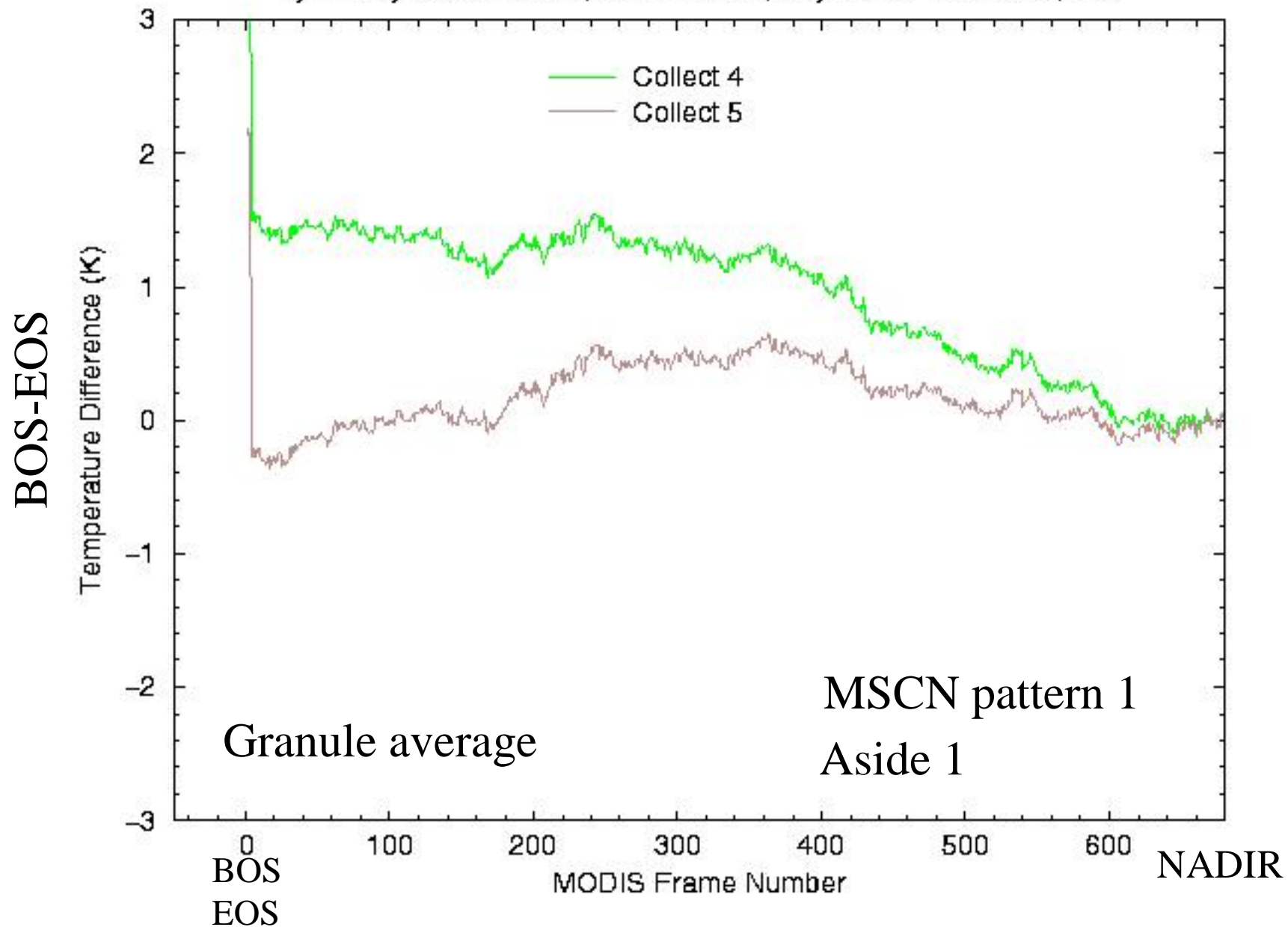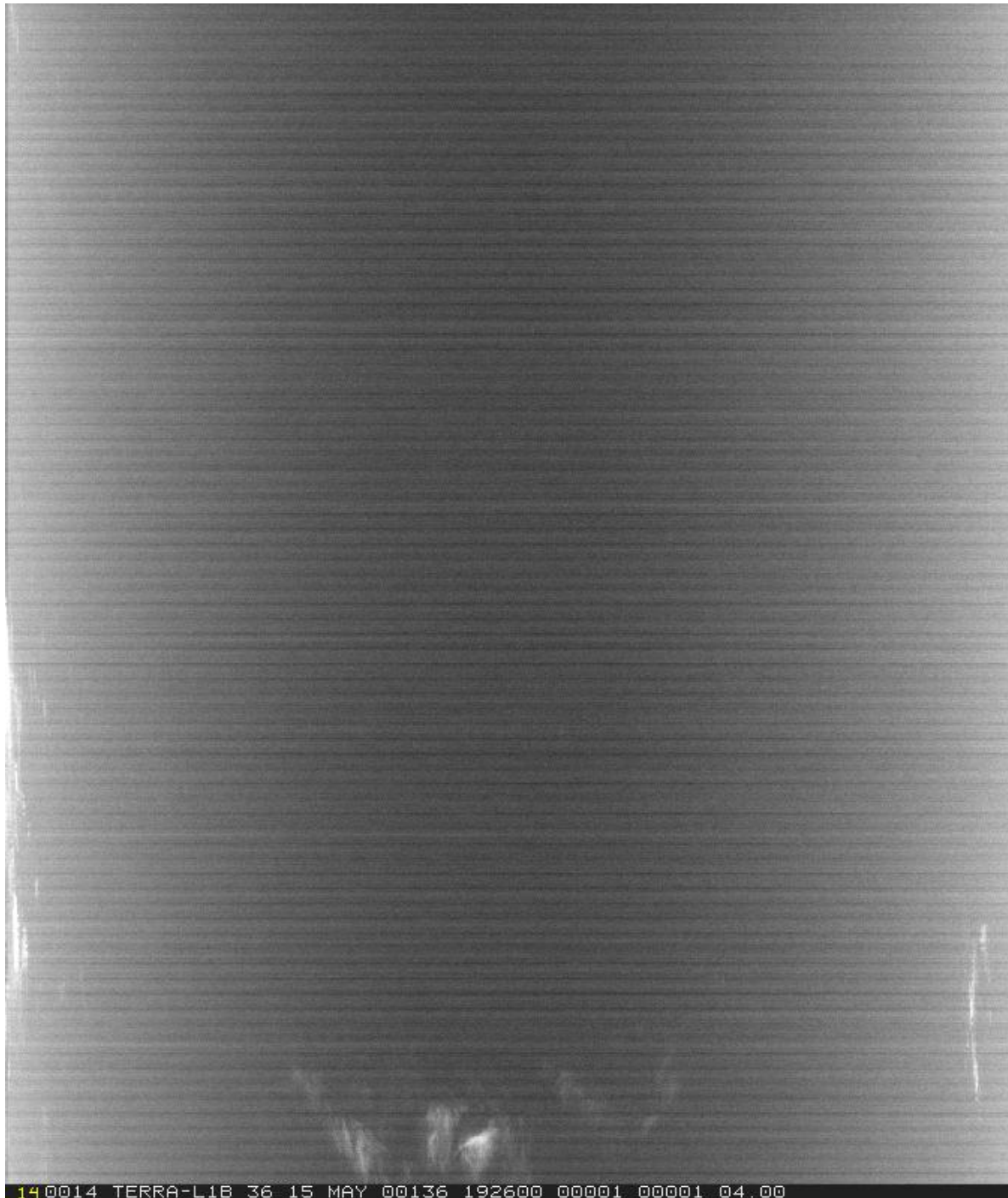
Aside 1
Collect 4

13 0013 TERRA-L1B 36 15 MAY 00136 192500 00001 00001 04.00

Aside 1
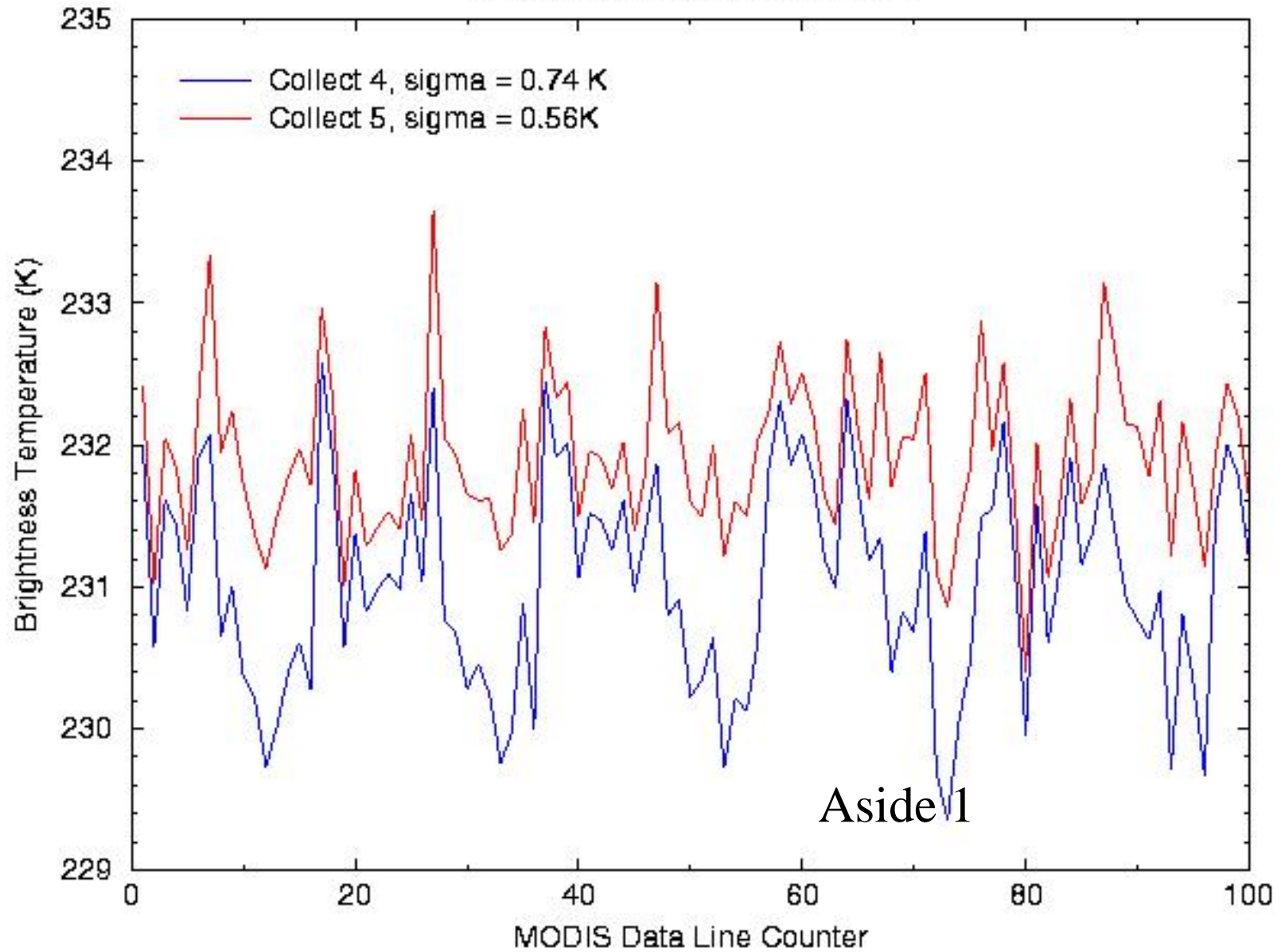Collect 5

14 0014 TERRA-L1B 36 15 MAY 00136 192600 00001 00001 04.00

Terra MODIS Along Track Profile

Day 00136, 1925 UTC, Band 36

Collect 4, sigma = 0.74 K
Collect 5, sigma = 0.56K

Brightness Temperature (K)

MODIS Data Line Counter

Aside 1

Terra MODIS DSM RVS Evaluation

Symmetry about NADIR, MIrror Side 1, Day 02141 0240 UTC, B36
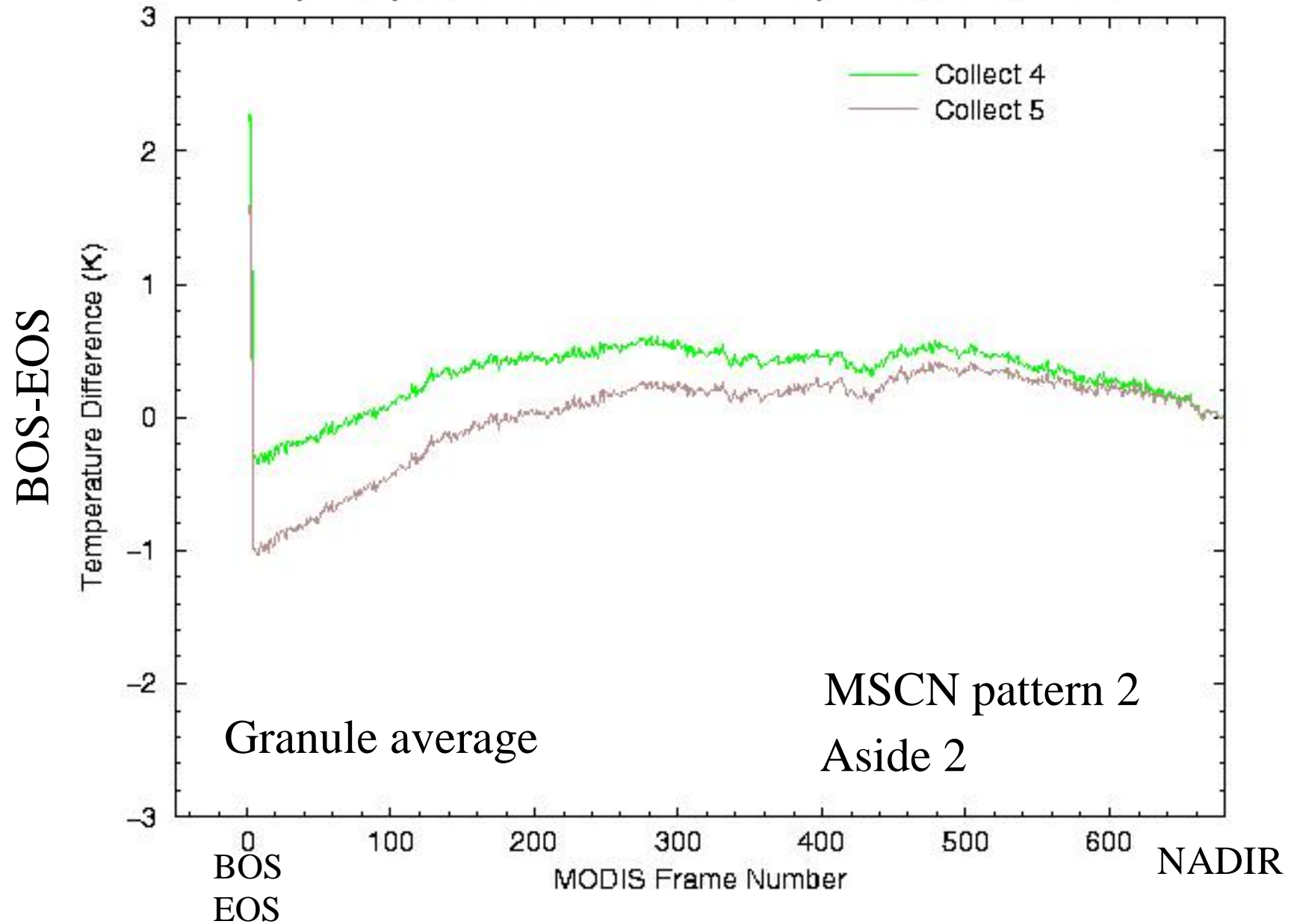
Terra MODIS DSM RVS Evaluation

Symmetry about NADIR, MIrror Side 2, Day 02141 0240 UTC, B36

Aside 2
Collect 4

17 0017 TERRA-L1B 36 21 MAY 02141 024000 03601 00001 04.00

Aside 2
Collect 5

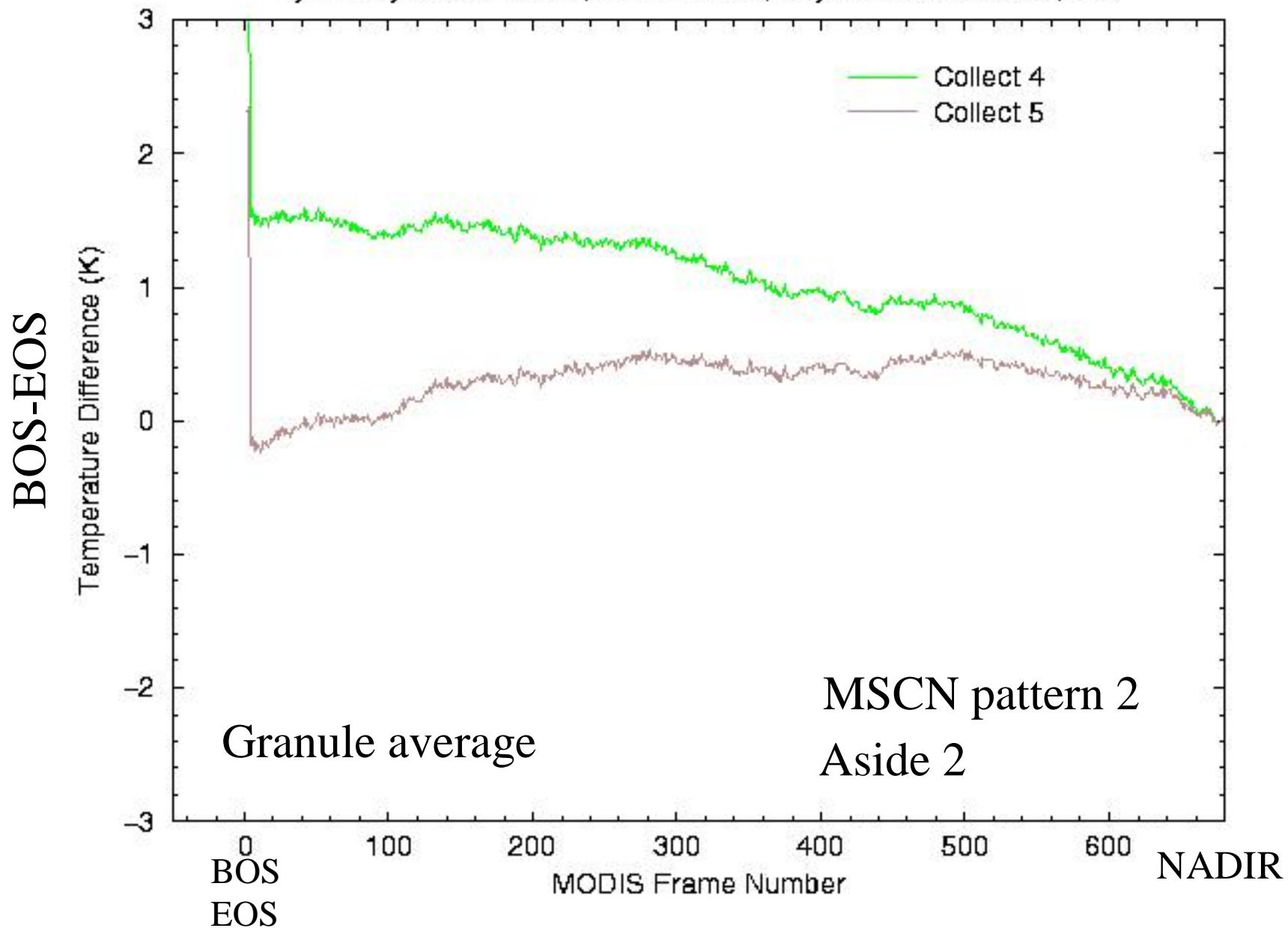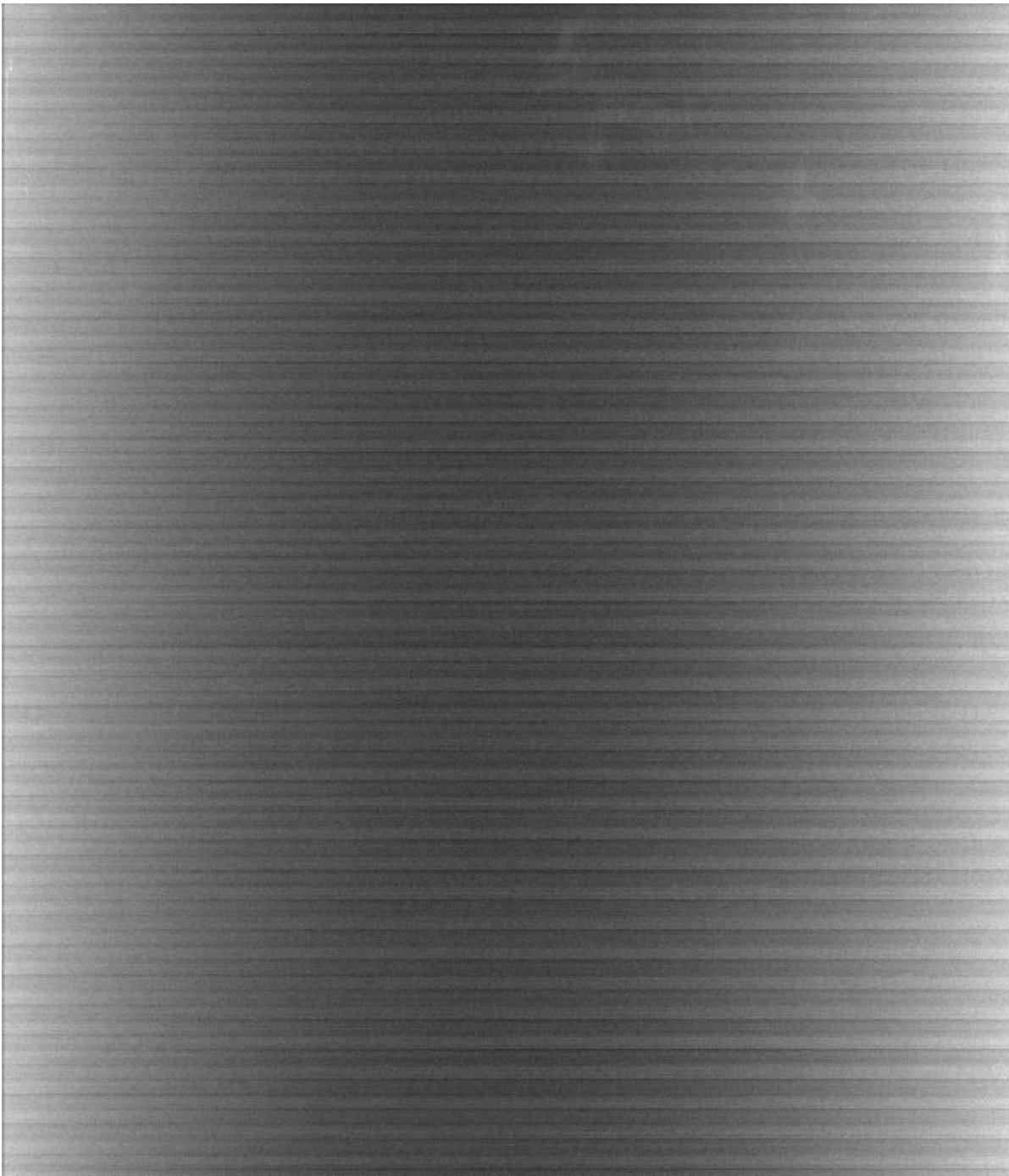18 0018 TERRA-L1B 36 21 MAY 02141 024100 03601 00001 04.00

Terra MODIS Along Track Profile

Day 02141, 0240 UTC, Band 36

Legend:
- Collect 4, sigma = 0.76 K
- Collect 5, sigma = 0.64 K

X-axis: MODIS Data Line Counter
Y-axis: Brightness Temperature (K)

Aside 2

Bside
Collect 4

5 0005 TERRA-L1B 36   2 DEC 00337 060000 02001 00001 04.00

Bside
Collect 5

6 0006 TERRA-L1B 36   2 DEC 00337 060100 02001 00001 04.00

Terra MODIS Along Track Profile

Day 02141, 0240 UTC, Band 36

Collect 4, sigma = 0.60 K
Collect 5, sigma = 0.79 K

Brightness Temperature (K)

MODIS Data Line Counter

Bside

Terra MODIS Clear Sky Radiance Bias (MODIS – model prediction)
Band 36 (14.2 um)

terra.03094.dailyorad.hdf BIAS BAND 36

−0.06   −0.01   0.04   0.10   0.15   0.20

Old RVS
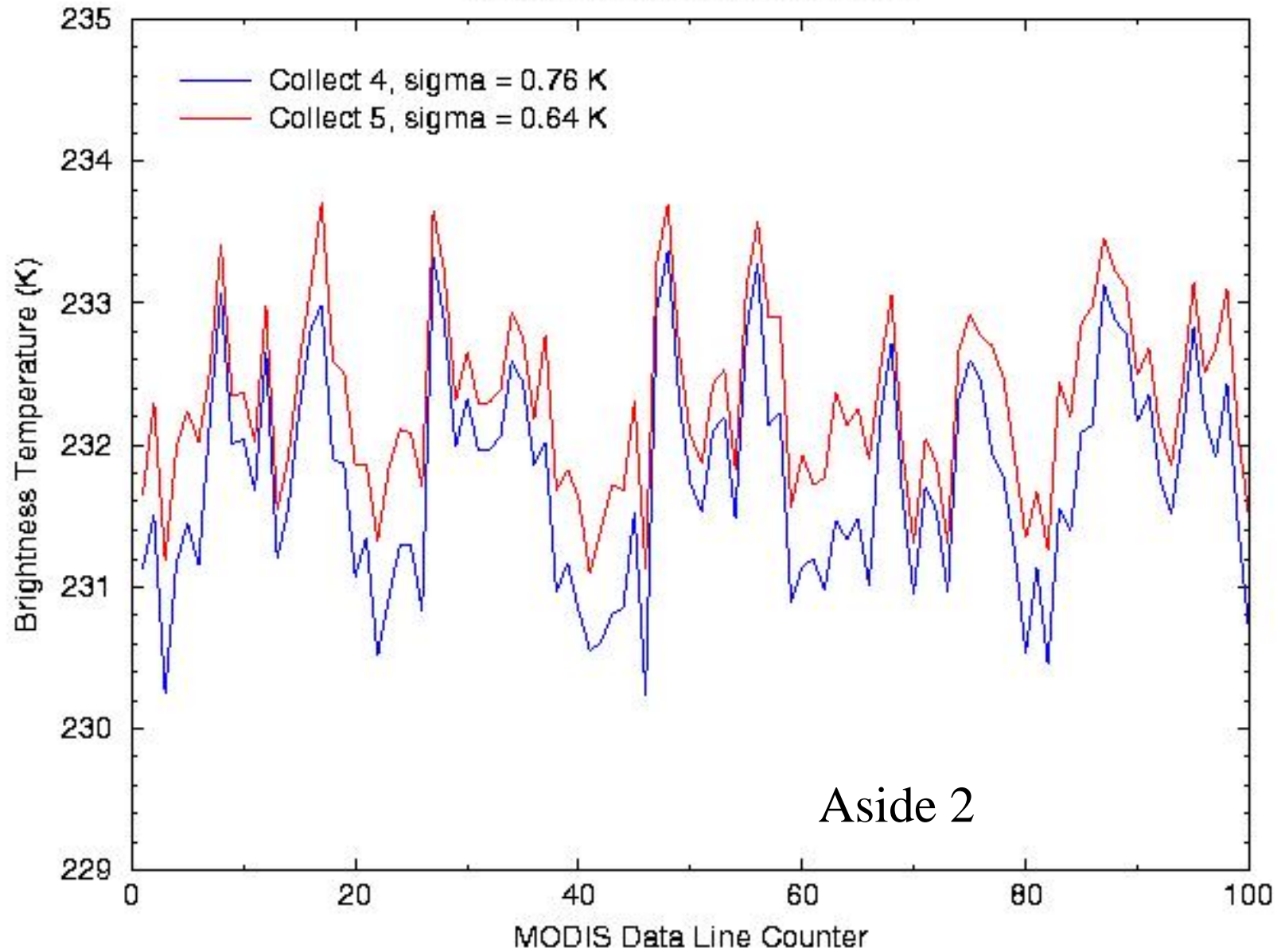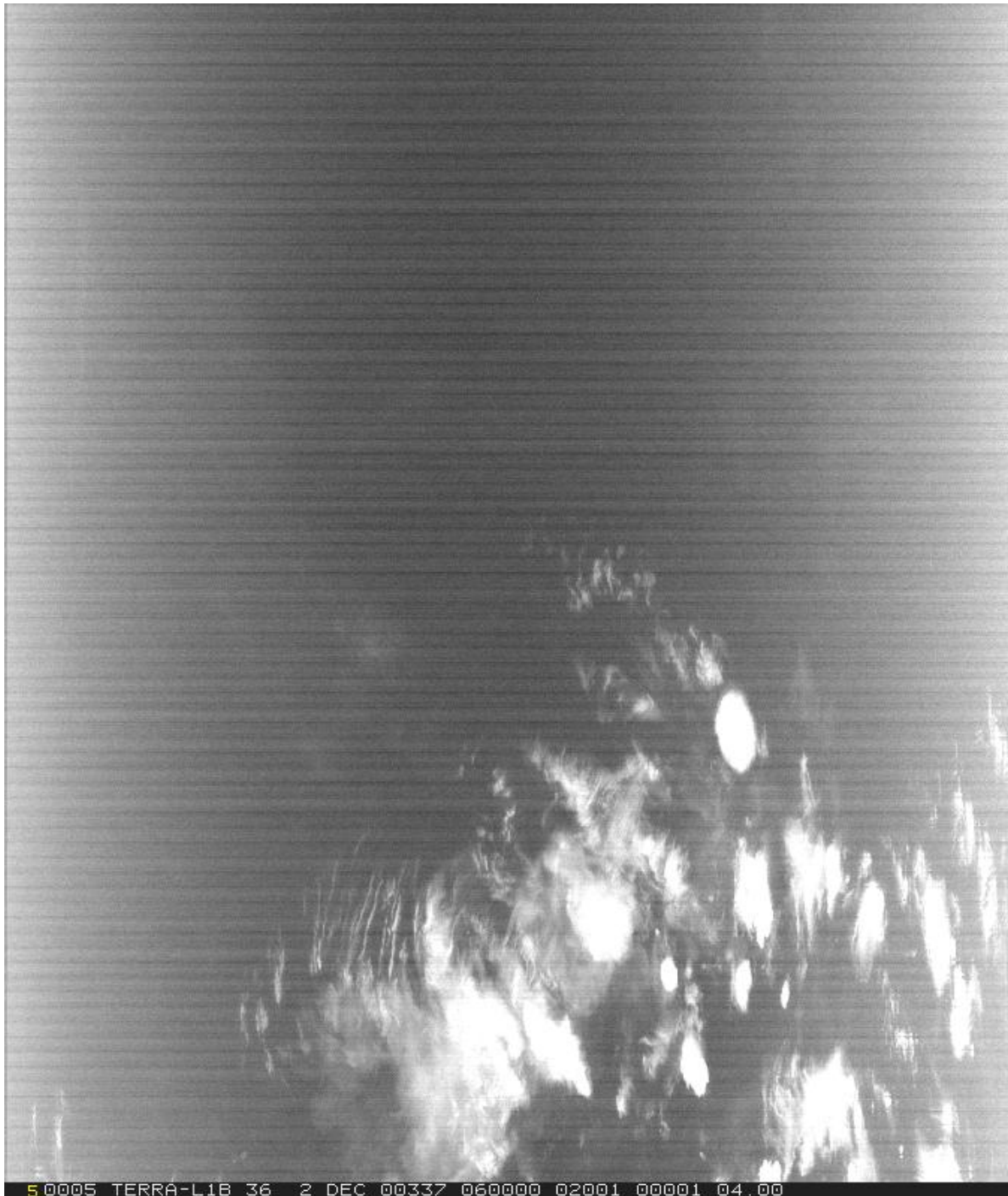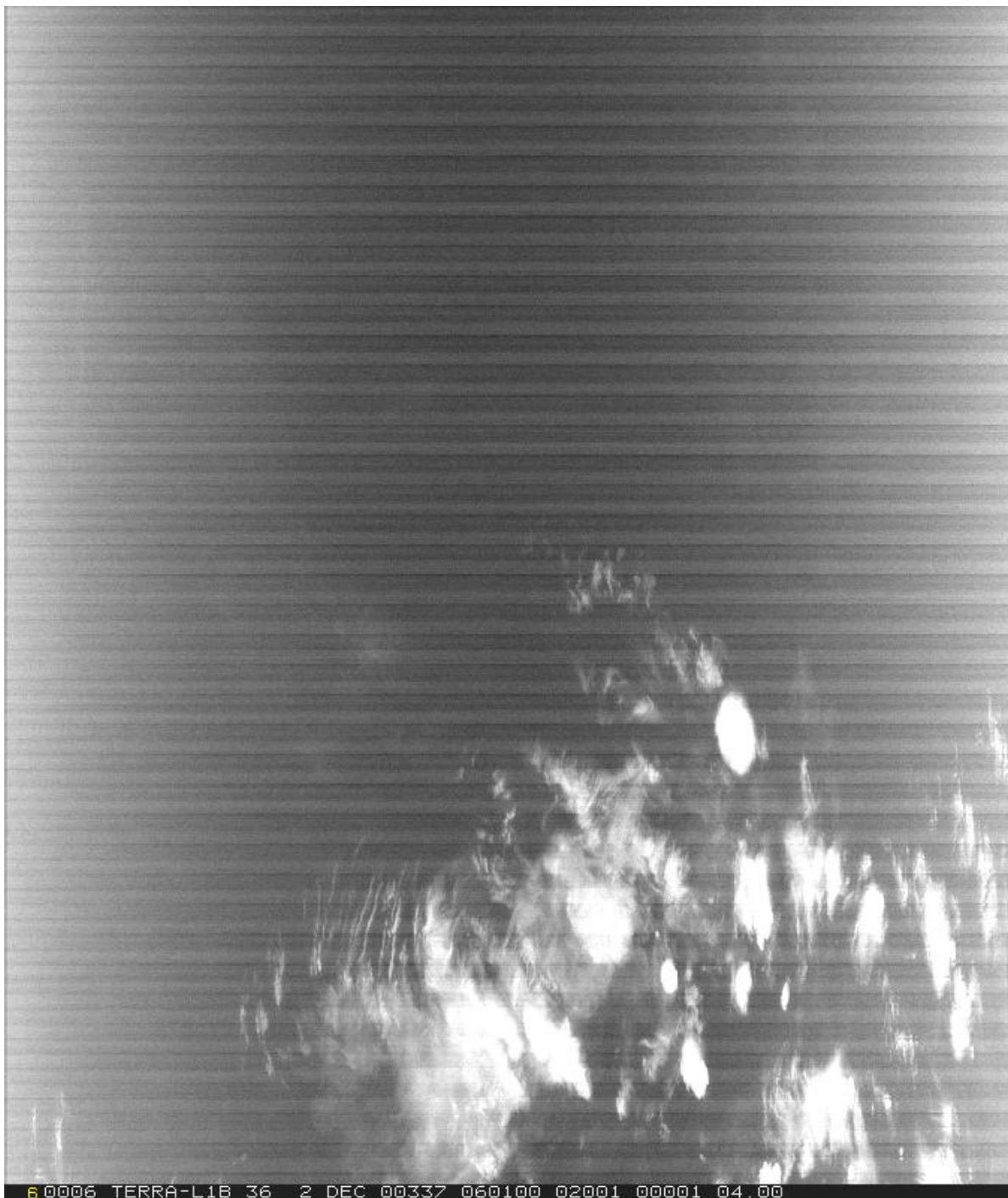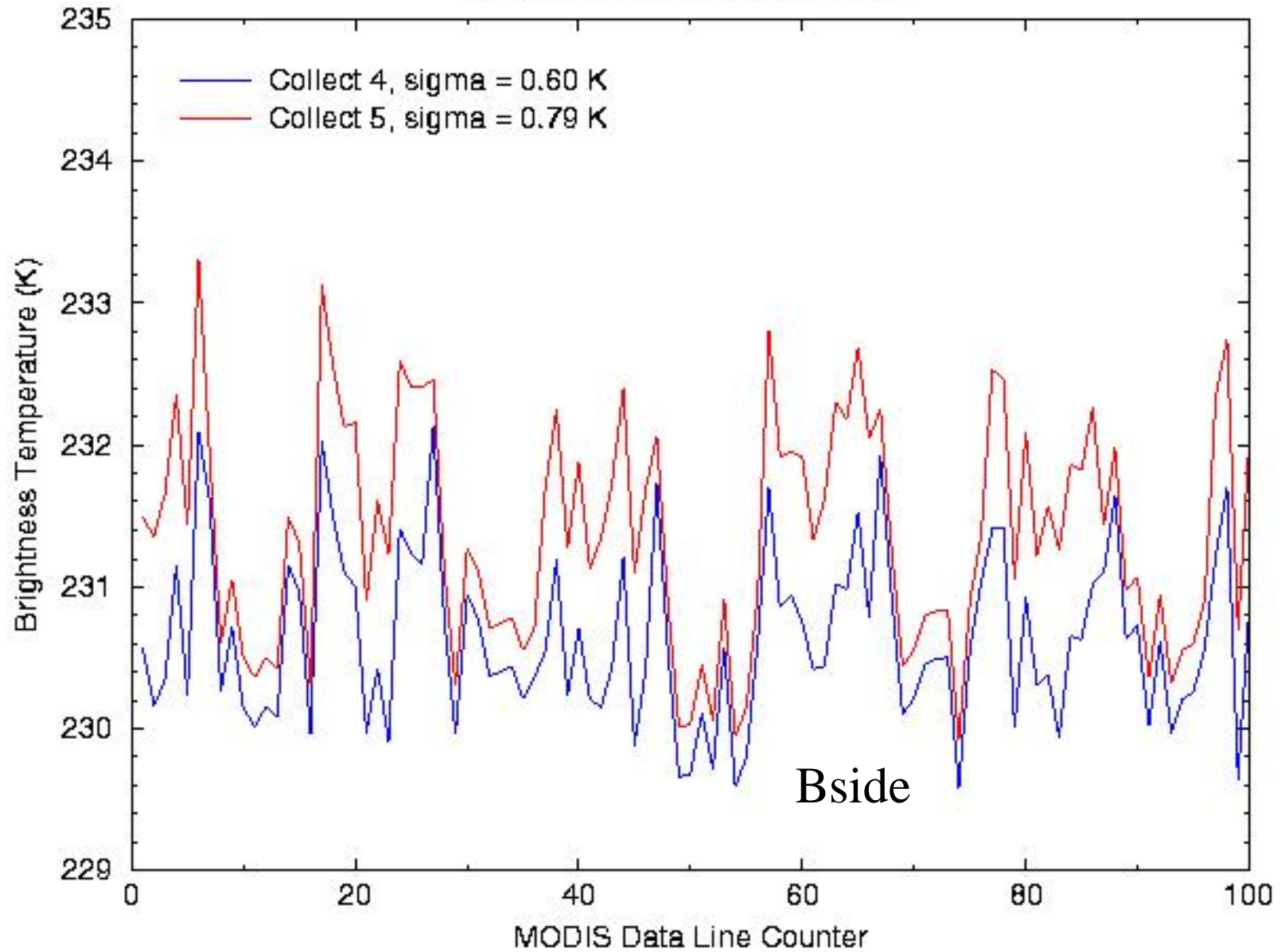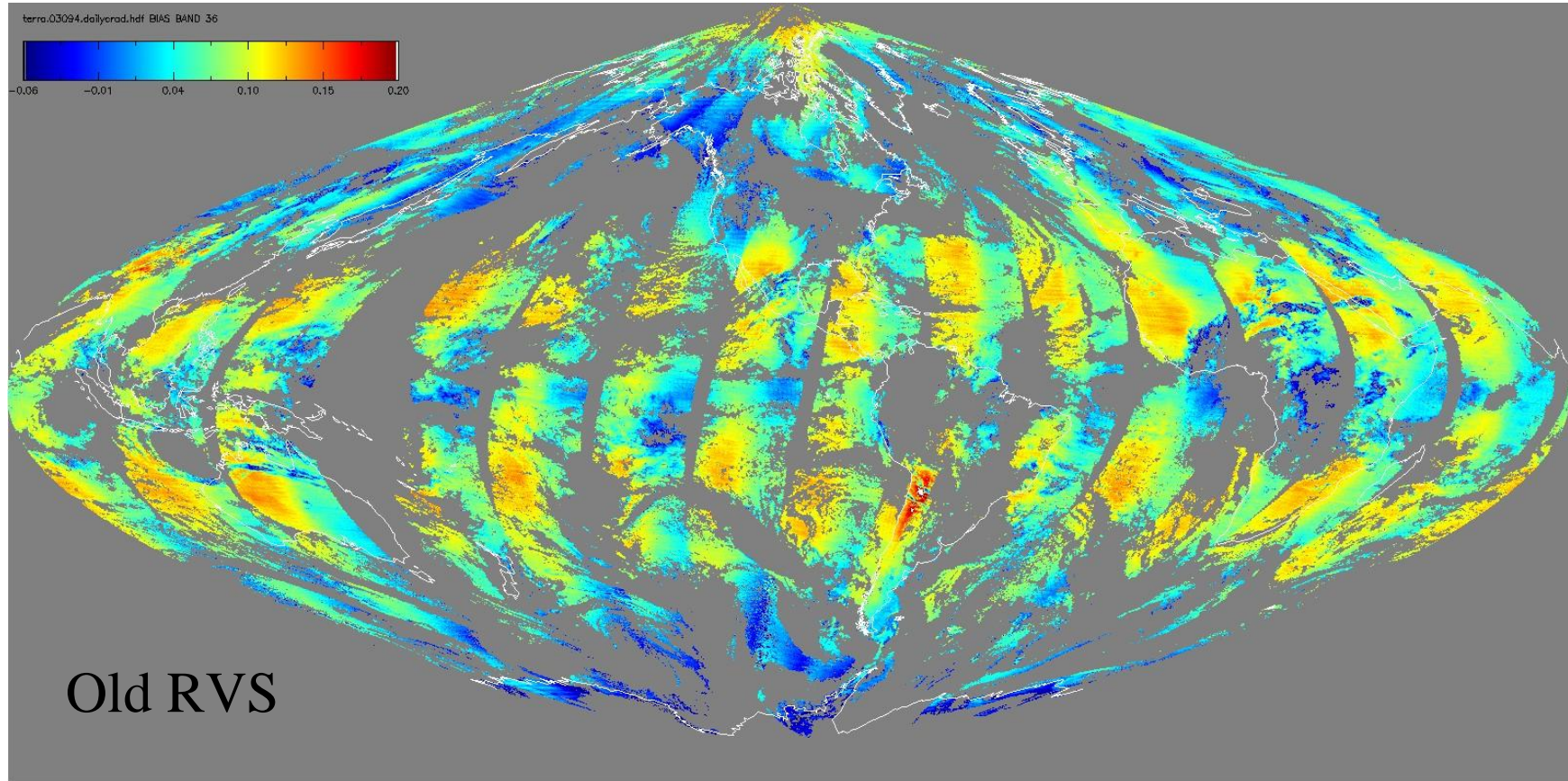
The biases have a distinct dependence on scan angle

Terra MODIS Clear Sky Radiance Bias (MODIS – model prediction) Band 36 (14.2 um)
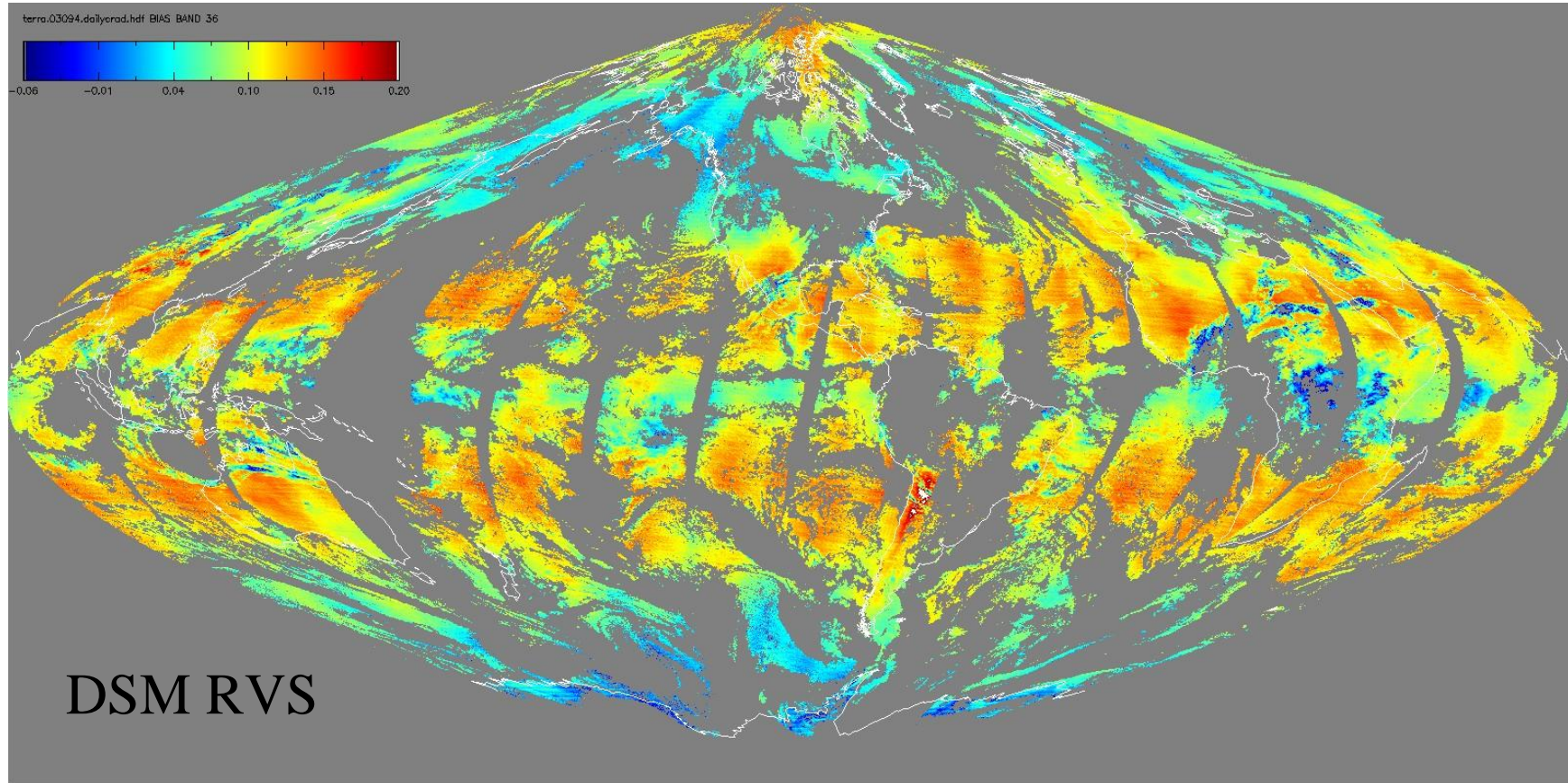

Using DSM RVS largely removes the bias dependence on scan angle

Aqua AIRS-MODIS Comparisons

- Global day of data analyzed…uniform scenes only
- Suggests a MODIS calibration bias as function of BT.
- Suggests a MODIS Scan Mirror RVS error.

The 1 km MODIS is collocated with AIRS by representing the AIRS FOVs as slightly oversized circular footprints, and computing the mean MODIS value within those footprints for each band.

Spatially uniform scenes are selected by requiring the standard deviation of the MODIS data within each AIRS footprint to be 0.2K or less.
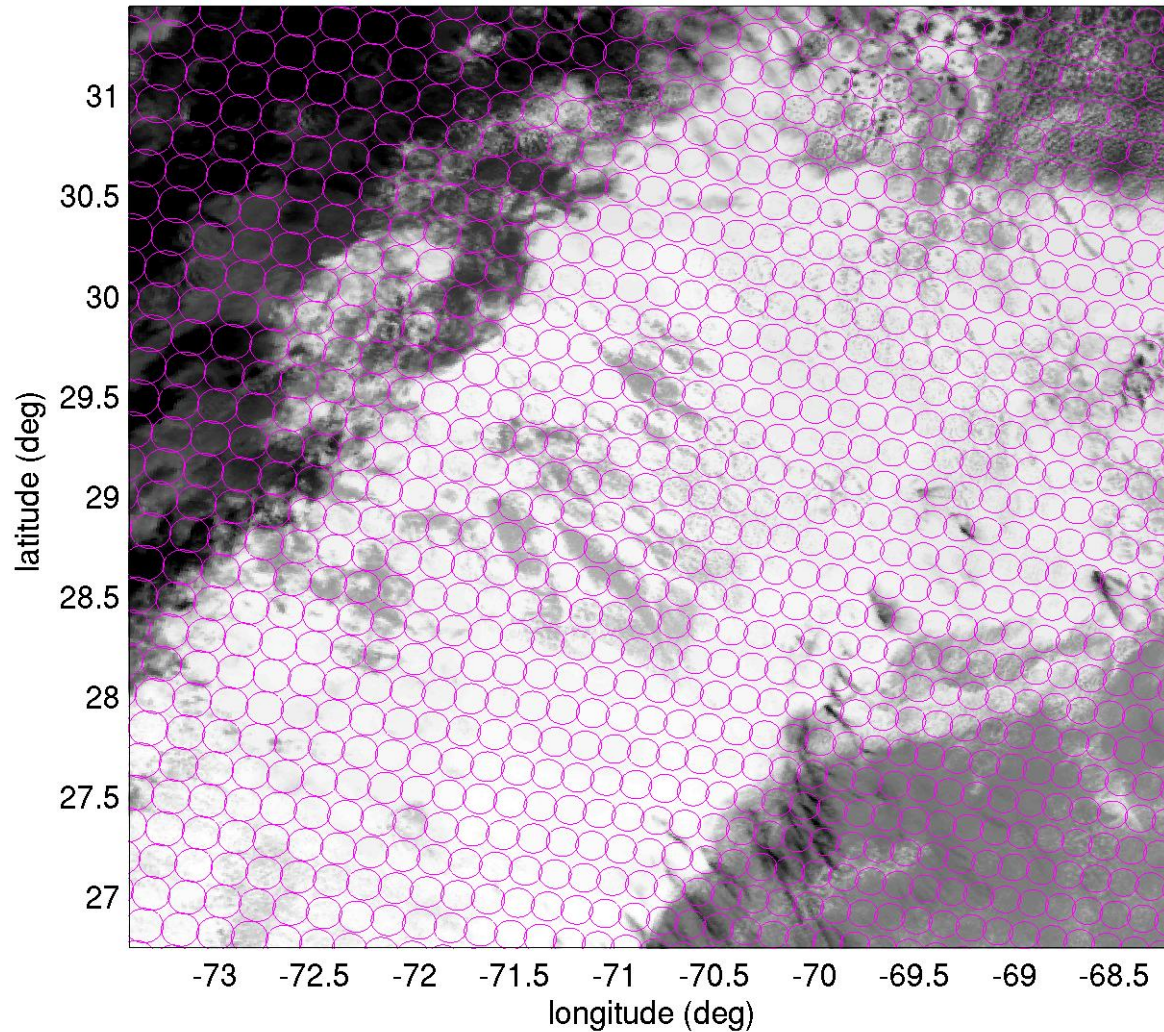
Example
comparisons for
band 34 (13.7 µm)
on 6 Sept 2002.
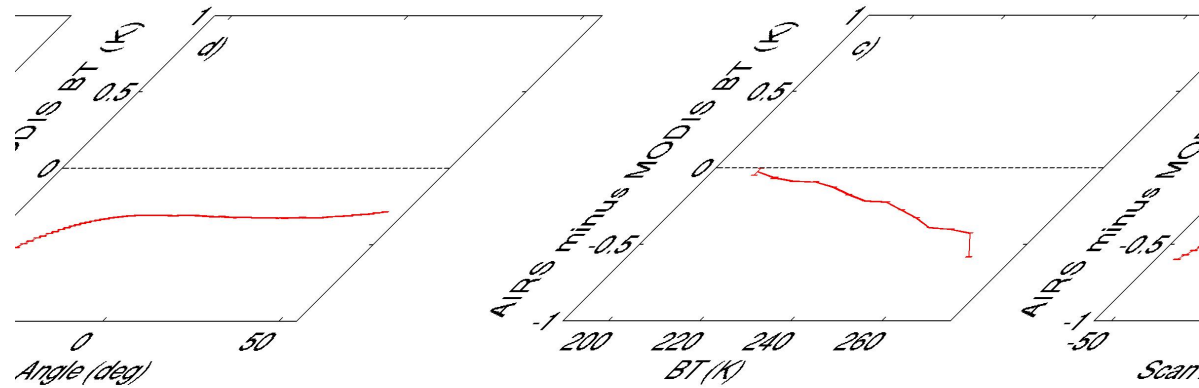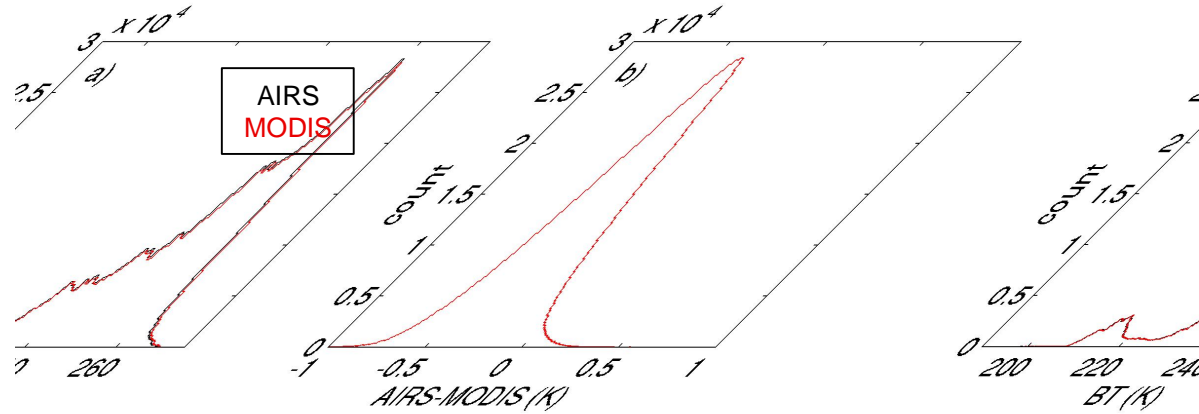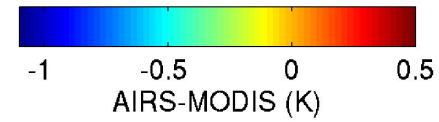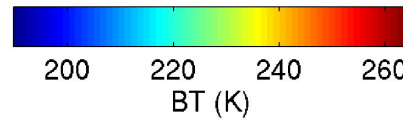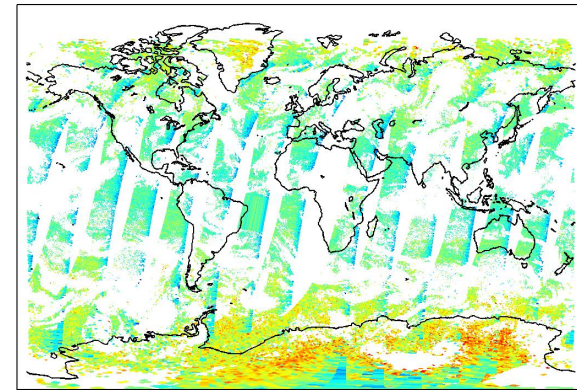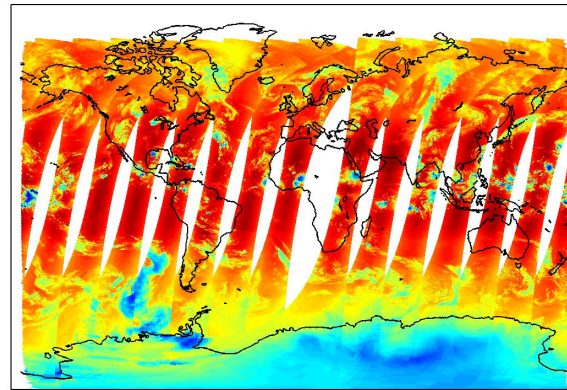
Brightness temperature differences as a function of scene temperature.
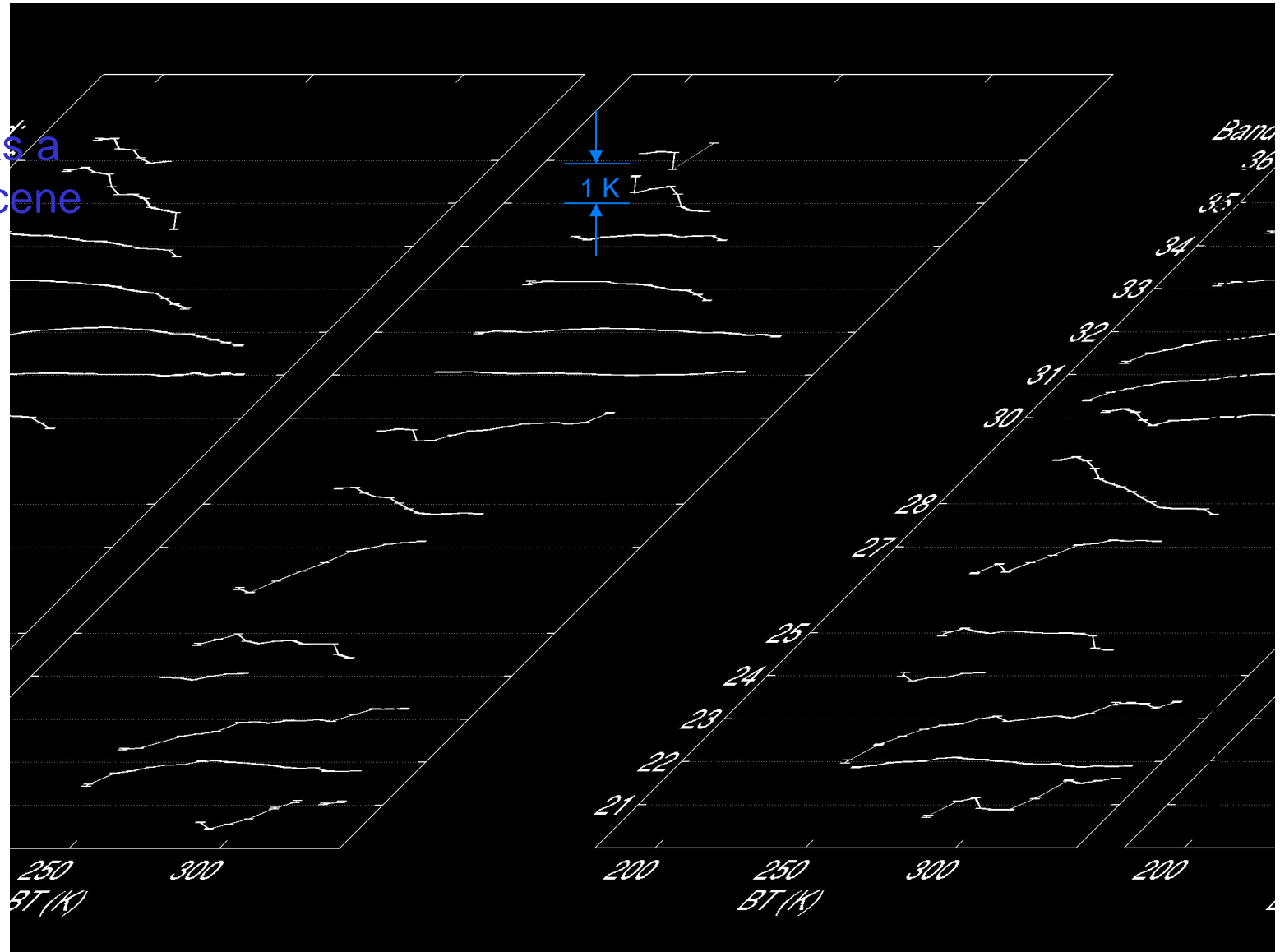
Q: What causes scene temperature dependence of bias??

Band 35 (13.9 µm) brightness temperature differences for one orbit of data on 6 Sept 2002 using the nominal MODIS SRF (black) and using the MODIS SRF shifted by +0.8 cm^{-1} (red).

Aqua MODIS Clear Sky Radiance Bias:
Band 36

aqua.2002249.dailycrad.hdf BIAS BAND 36

-0.06   −0.01   0.04   0.10   0.15   0.20

Observation - Model
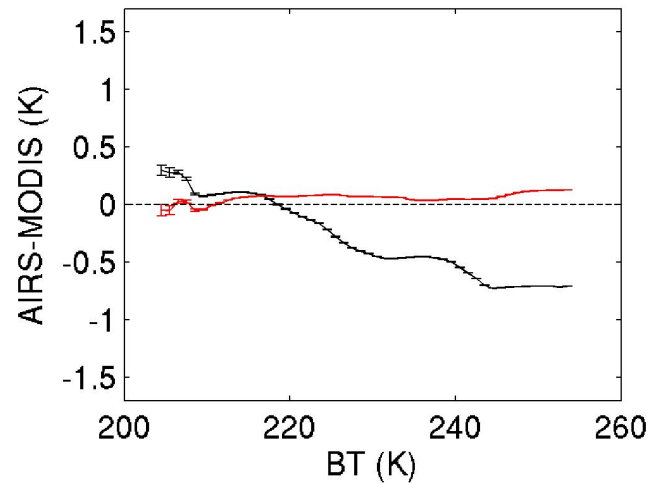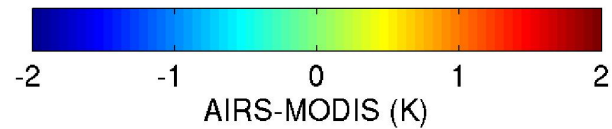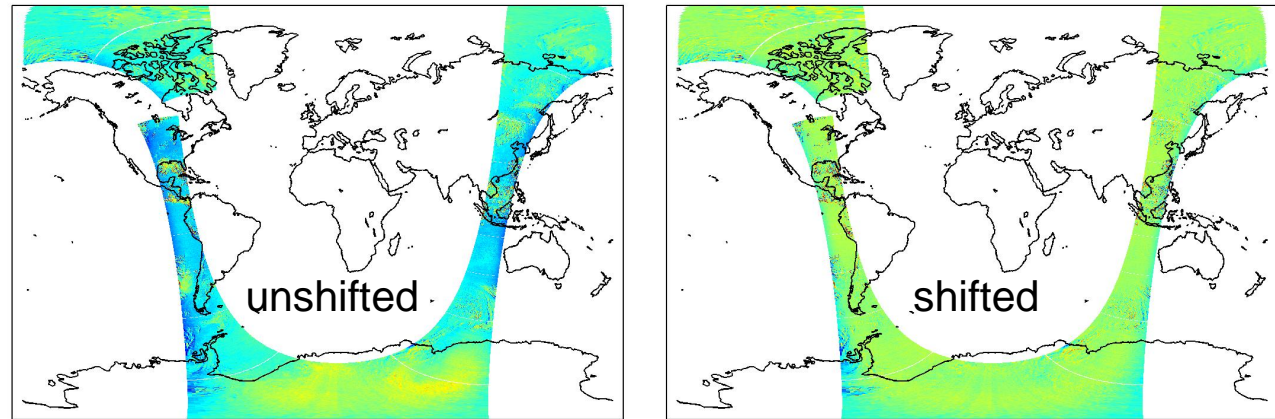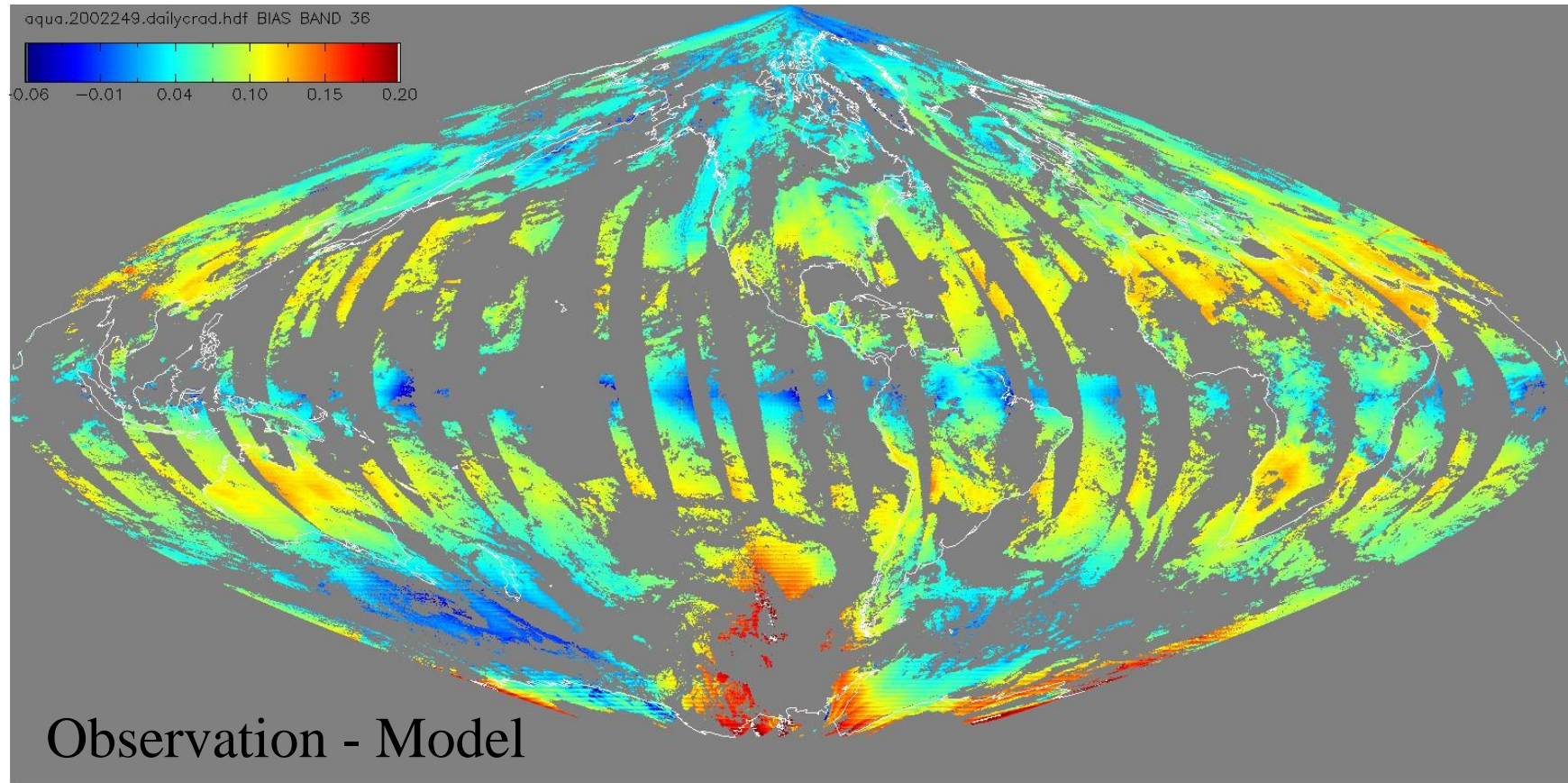
Before spectral shift

Aqua MODIS Clear Sky Radiance Bias: Band 36
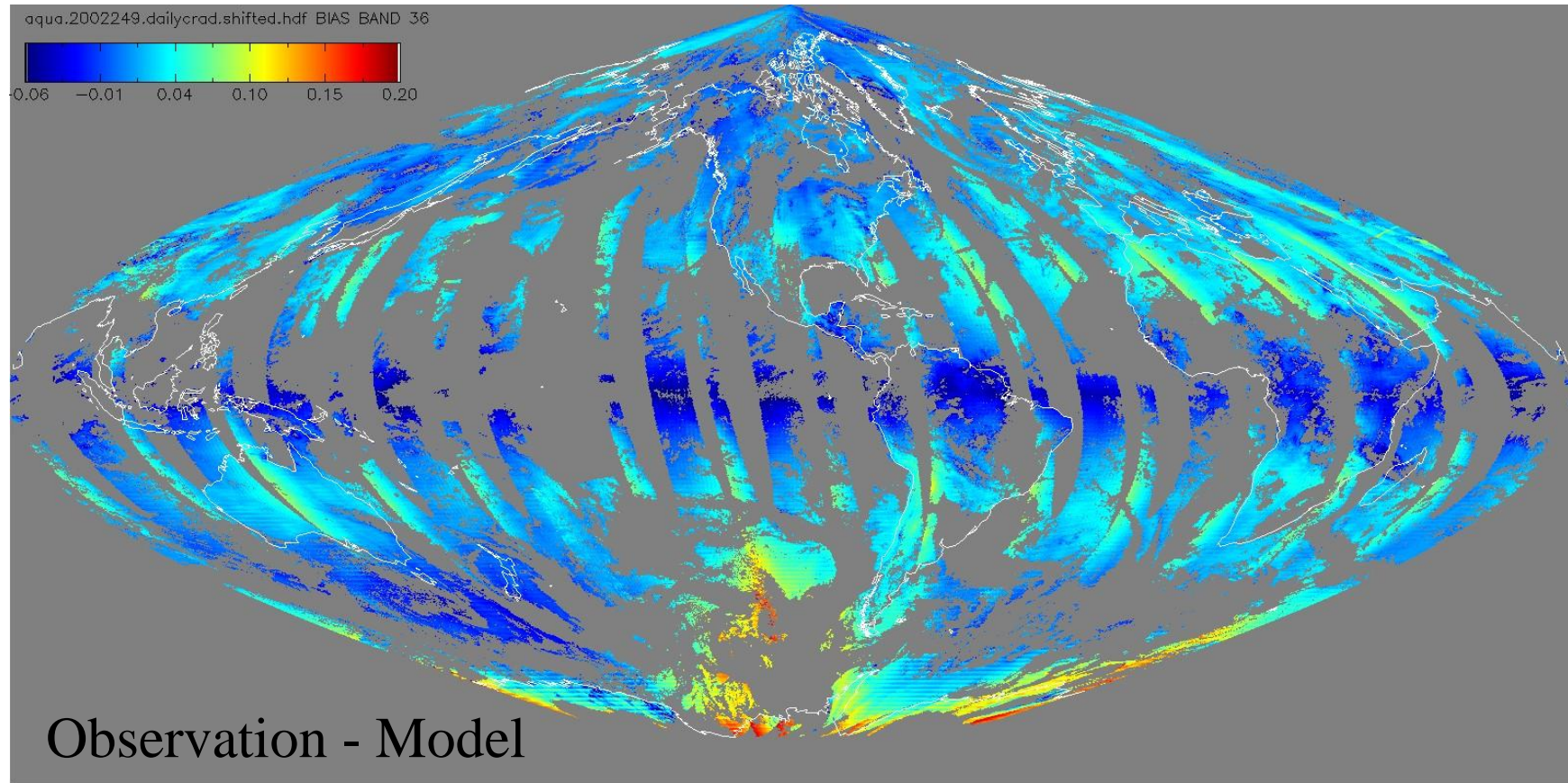
After spectral shift

Brightness temperature differences as a function of scan angle.
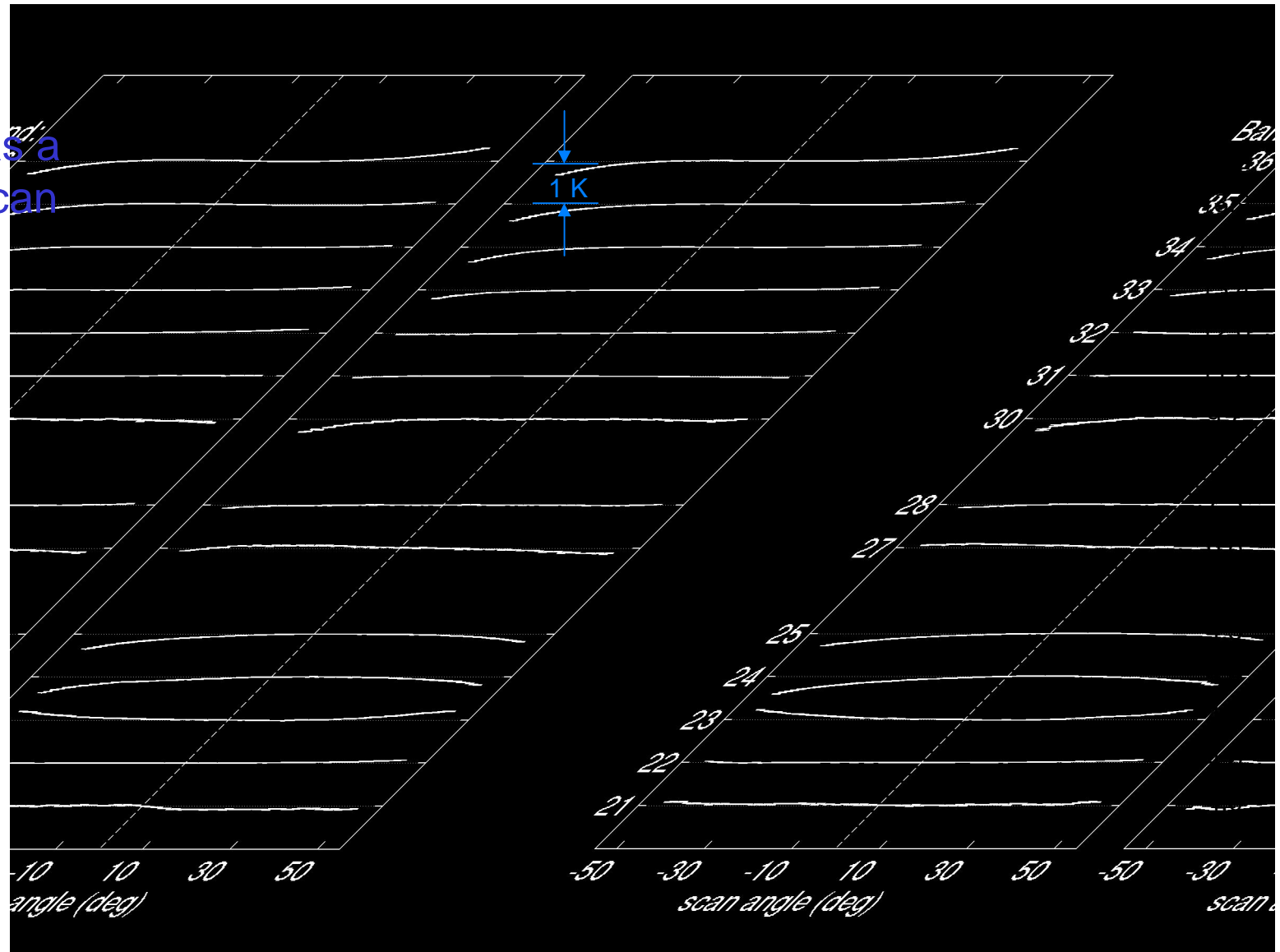
Daytime

Band: 24   33   34   35   36

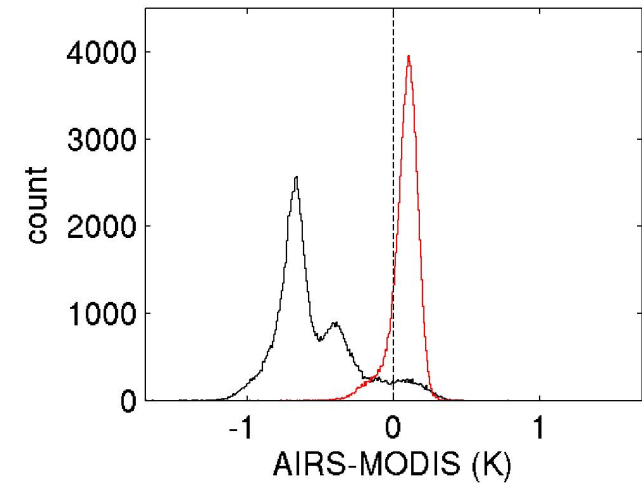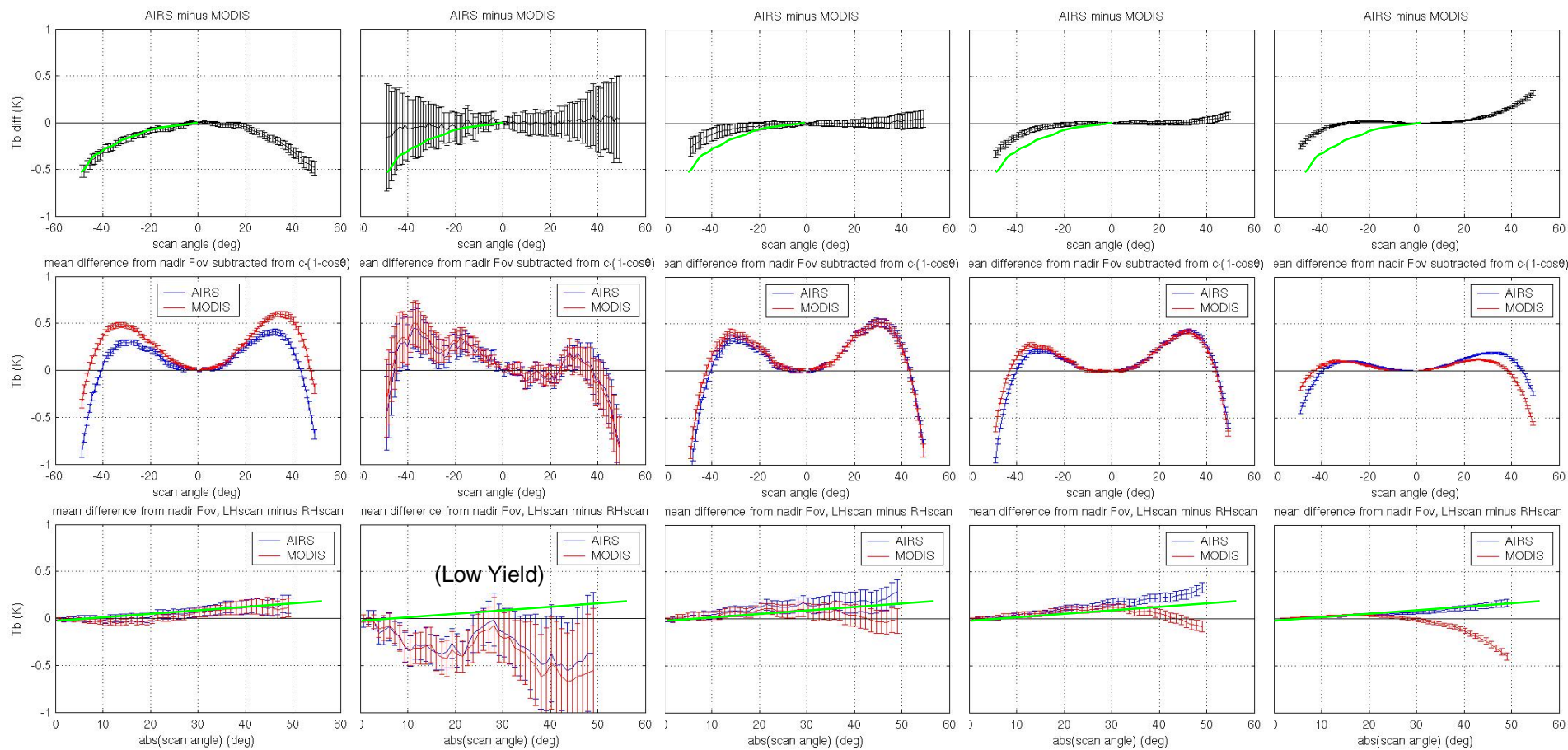Reference lines, from Band 24 curves

Nighttime

Band: 24   33   34   35   36
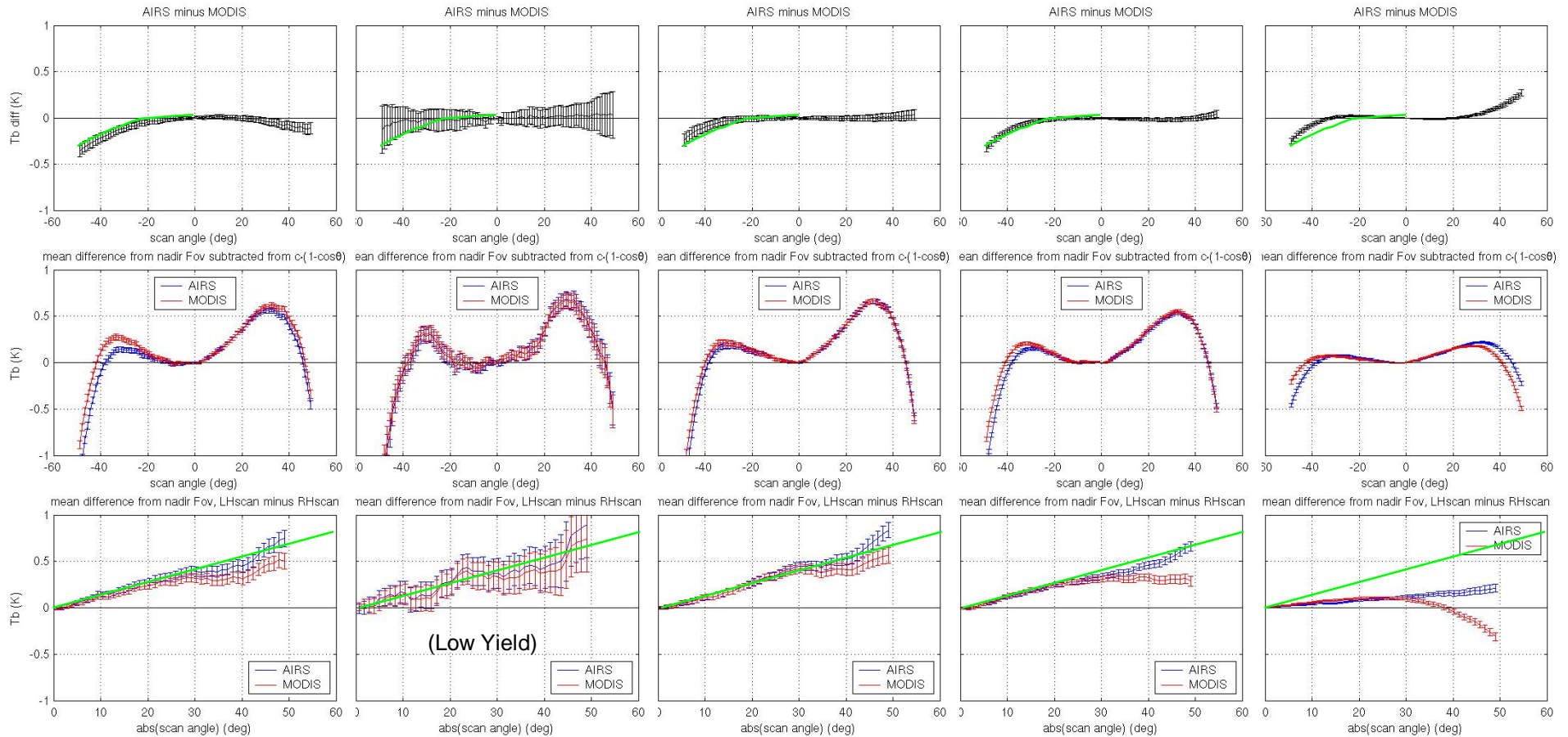
Reference lines, from Band 24 curves

Observations:

- For scan angles less than ~30 degrees, both AIRS and MODIS show scan asymmetry which is most likely due to local time differences from one side of the scan to the other. For AIRS and for band 24 of MODIS, this behavior has the same character for all scan angles (i.e. the linear behavior of the scan asymetry plots as a function of scan angle).

- For MODIS, the scan angle asymmetry has a different character at larger scan agles, beginning around 30 degrees off nadir, which is more pronounced for the longer wavelengths bands.

- For Band 24 Daytime, AIRS and MODIS show nearly the same scan asymmetry, yet still have differences (AIRS-MODIS) which increase with scan angle (i.e. the differences increase almost linearly with scan angle). More asymmetry is seen at night.

SWIR 5um Leak Correction: Terra Aside 2

- Terra MODIS Aside 2 nighttime B26 data reveals artifacts of thermal band features even after the 5um thermal leak correction has been applied in L1B. Aqua MODIS shows practically no features.

- Up to 1% (of Ltyp) effect in Terra MODIS B26.

- What about other Terra SWIR bands (B5-7)? We don't have routine nighttime data to inspect.

Aqua MODIS
Day 04270
0735 UTC

7.3 um

1.38 um

Hurricane Jeanne
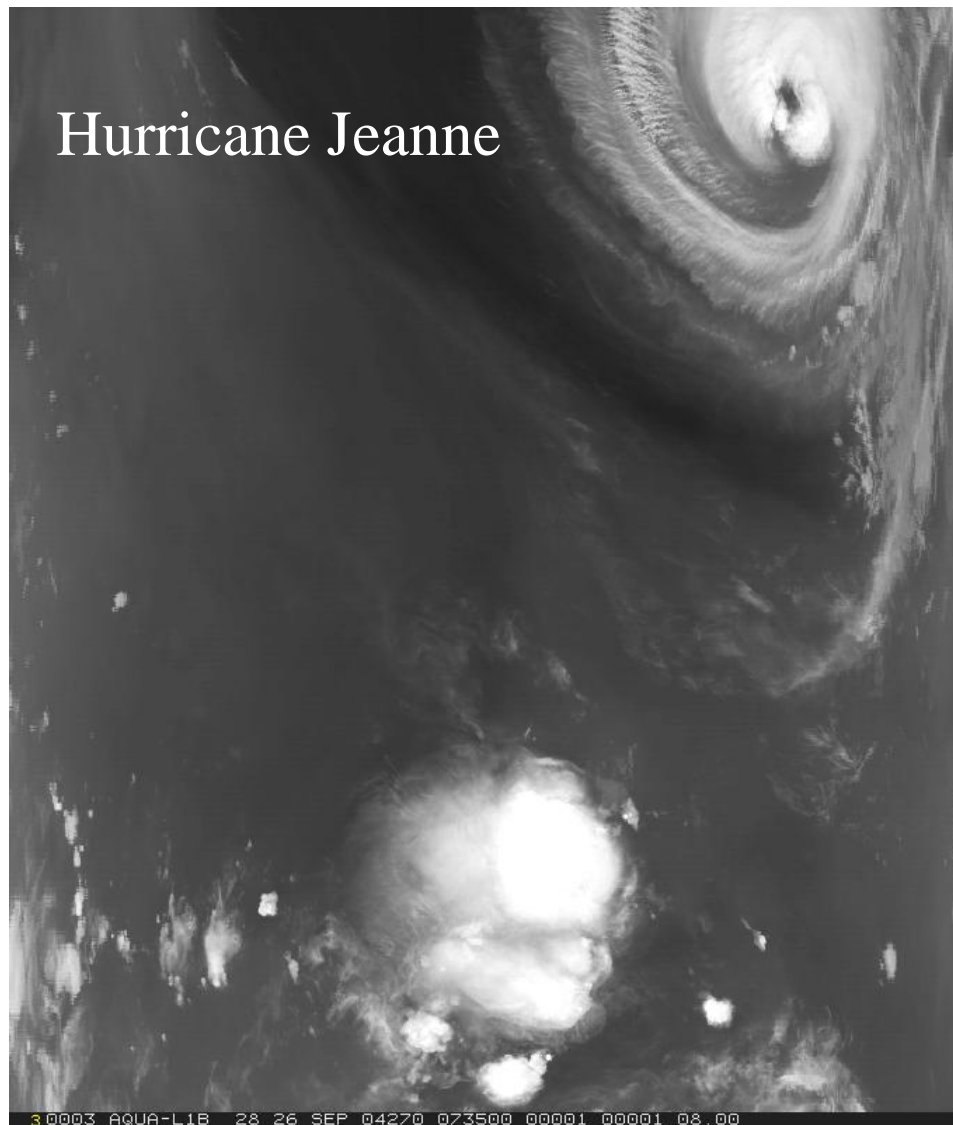
30003 AQUA-L1B   28 26 SEP 04270 073500 00001 00001 08.00

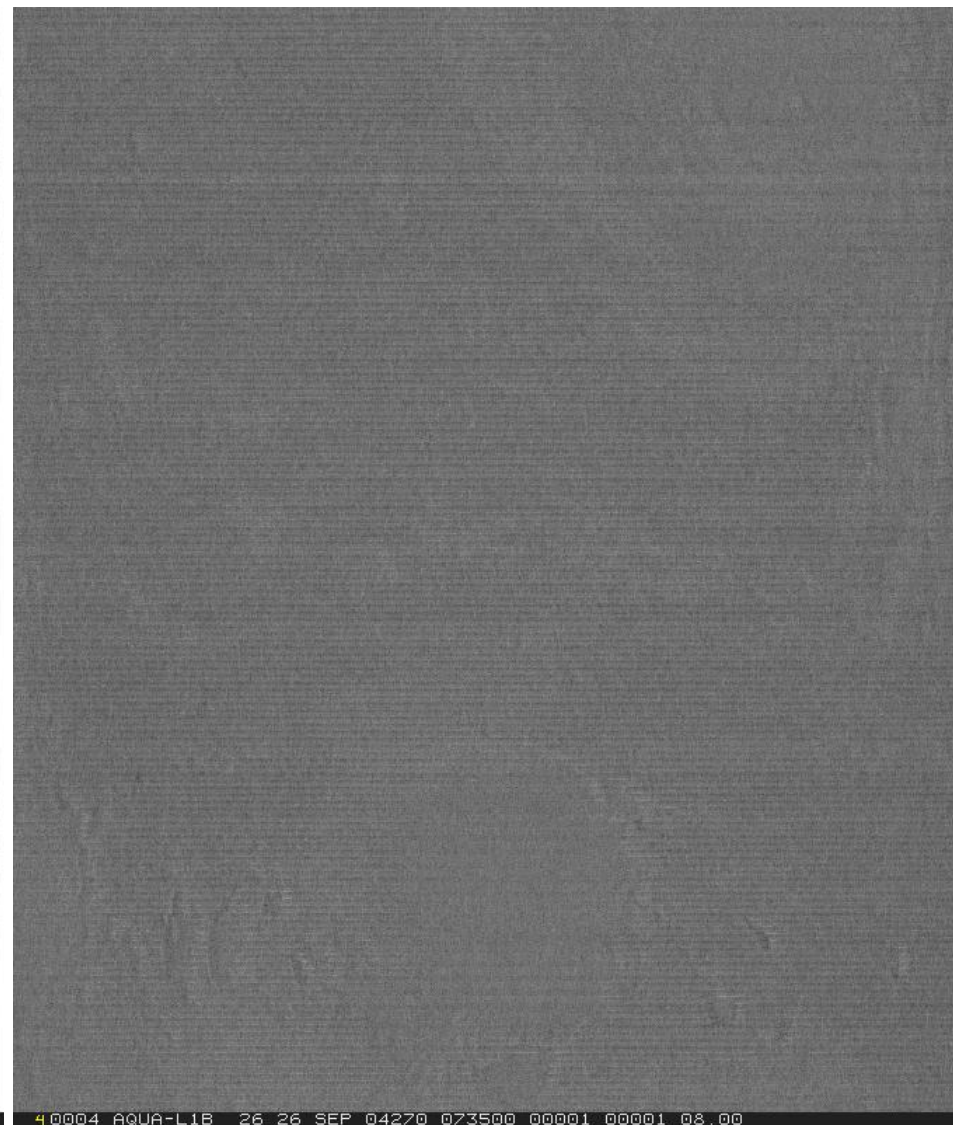40004 AQUA-L1B   26 26 SEP 04270 073500 00001 00001 08.00

TerraMODIS
Day 04270
0315 UTC

7.3 um

1.38 um
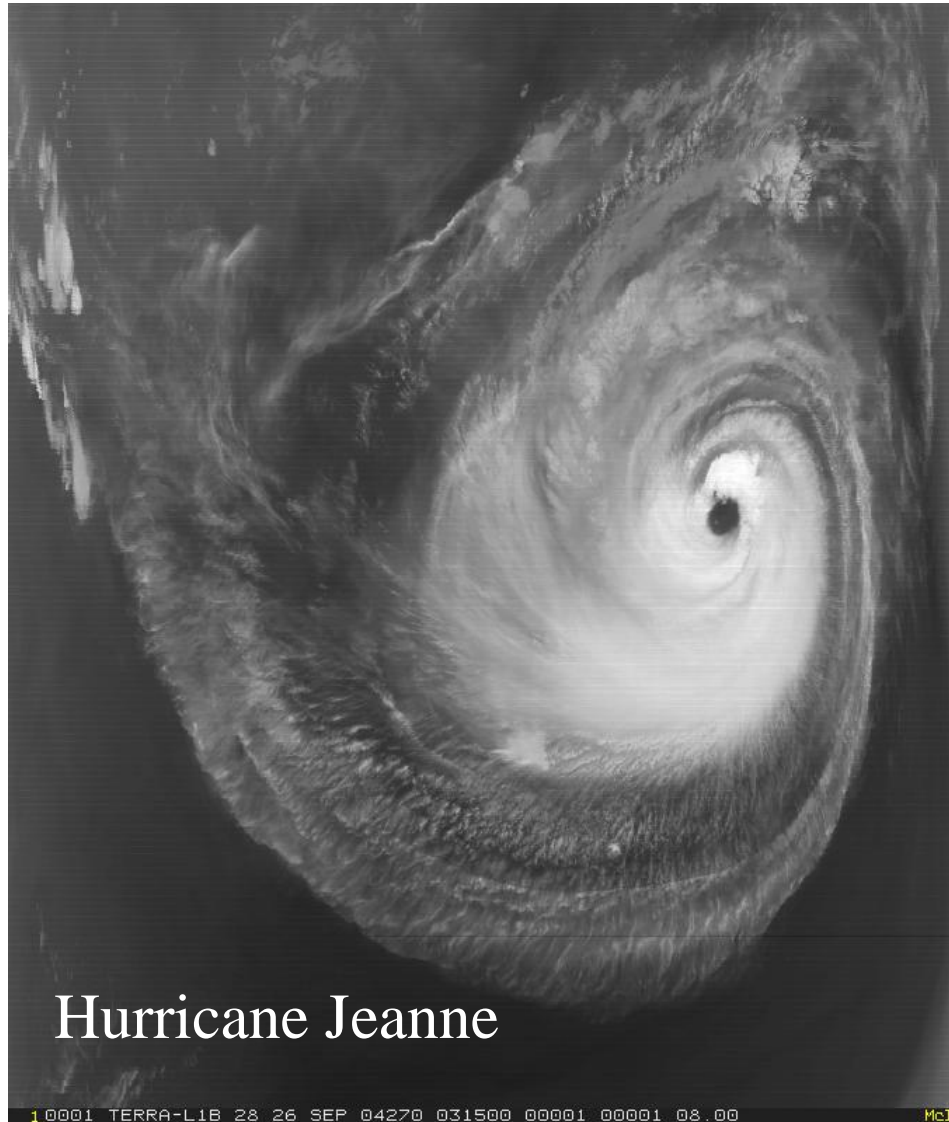
Hurricane Jeanne
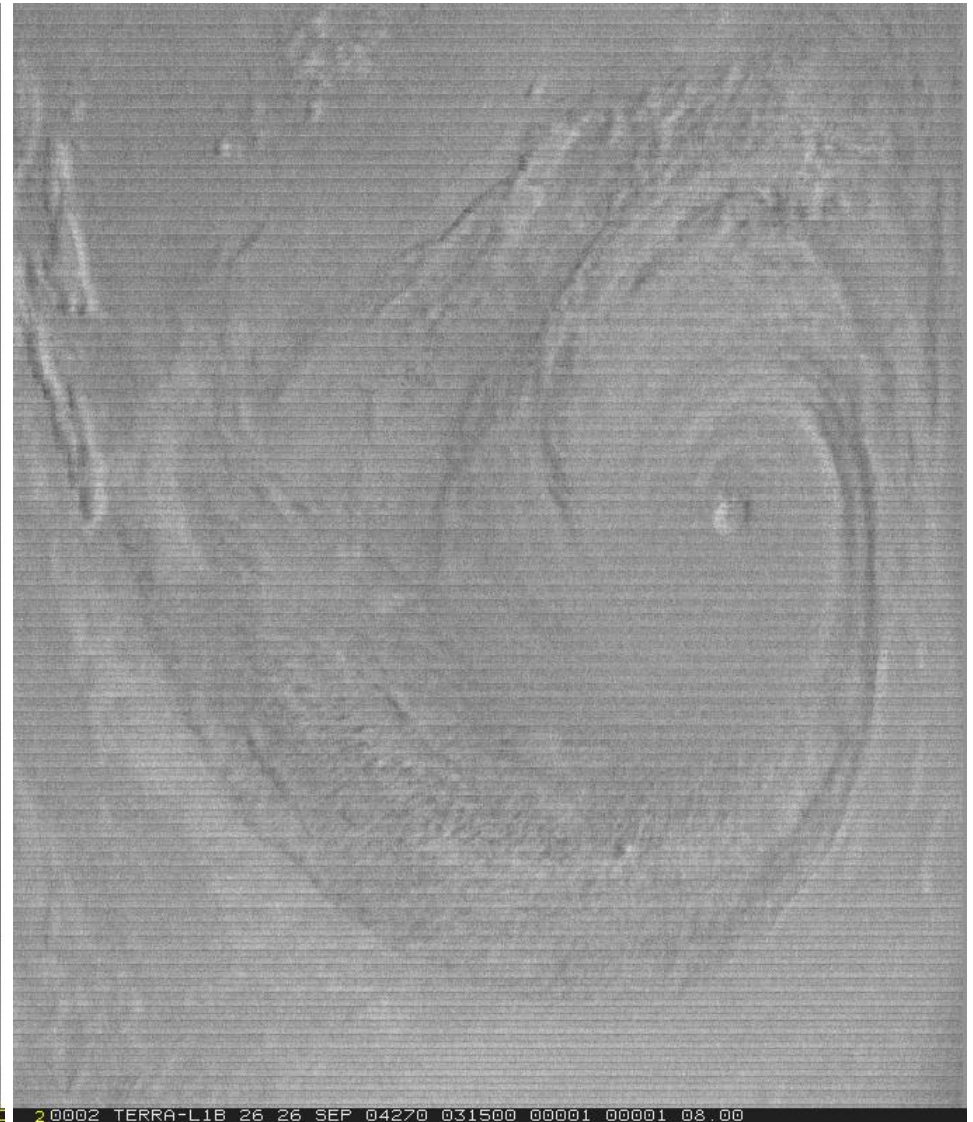
1 0001 TERRA-L1B 28 26 SEP 04270 031500 00001 00001 08.00   McID   2 0002 TERRA-L1B 26 26 SEP 04270 031500 00001 00001 08.00

MODIS Emissive Band Destriping Update: Granule vs. Global Analysis

- The Atmosphere Group products for collection 5 include destriping of all emissive bands (20-25, 27-36) and band 26.

- The destriping algorithm is granule-based, and for a small percentage of granules, the impact may be equivocal in bands 31 and 32. Granules with sharp transitions between warm and cool scenes (e.g. hot land, cool ocean) may have artifacts in the scene transition zone.

- We analyzed a complete day of data (Terra MODIS 2000337, collection 5) to develop the destriping LUT for bands 31 and 32, with the expectation that sampling a wider range of scenes would remove the artifacts.

Terra MODIS 2000337 0115 UTC (South Australia)
Band 31 - Band 32 Difference, No Destriping

BAND 31 — BAND 32 DIFF (K)

0.00   0.25   0.50   0.75   1.00   1.25
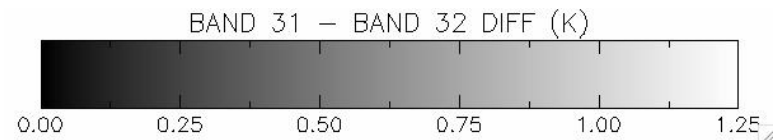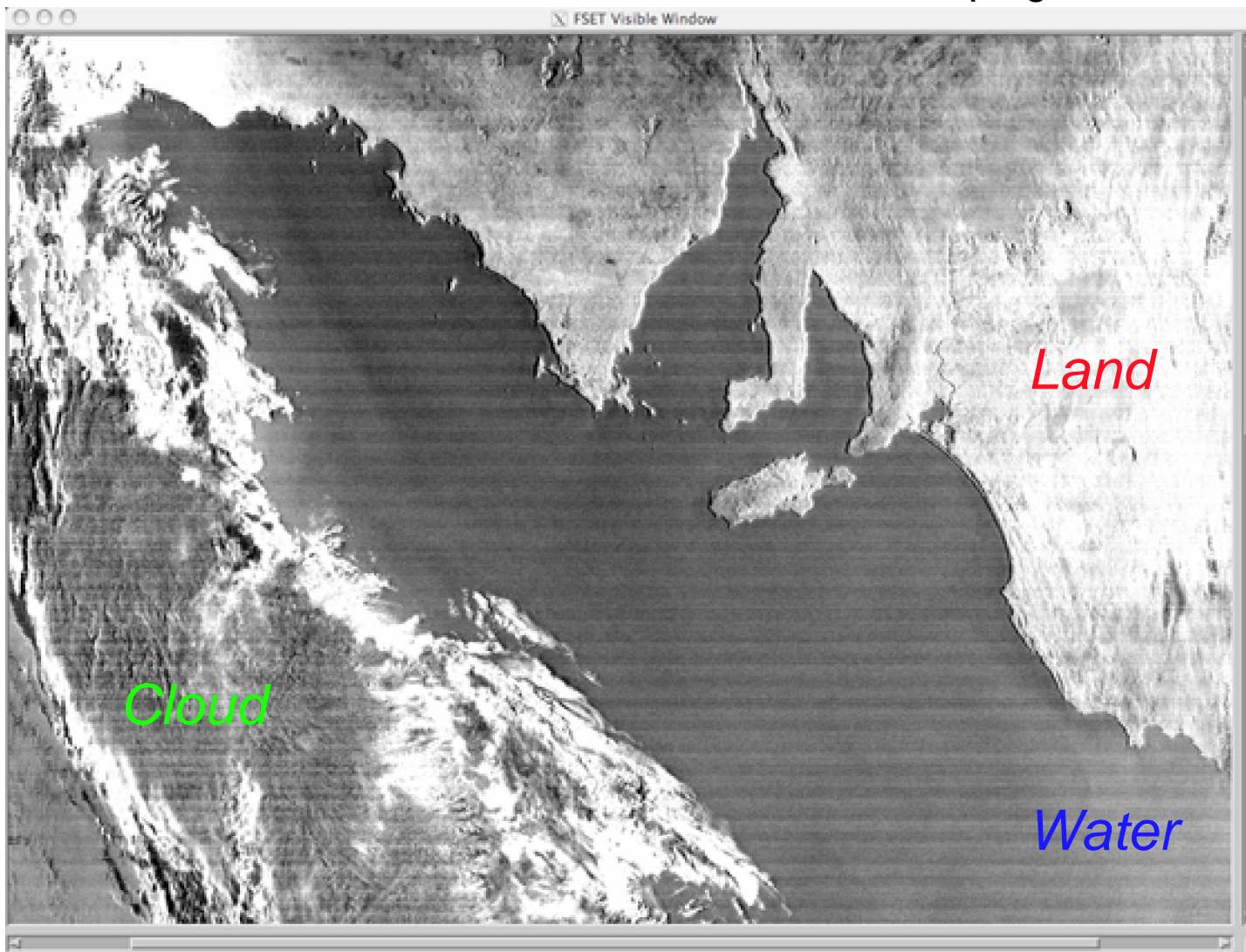
Band 31 - Band 32 Difference, Granule-Based Destriping

BAND 31 — BAND 32 DIFF (K)

0.00   0.25   0.50   0.75   1.00   1.25
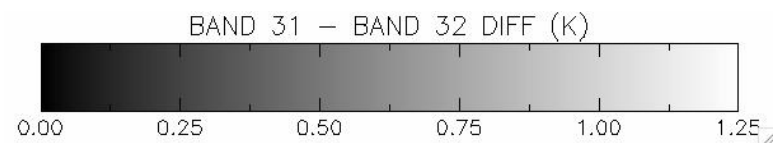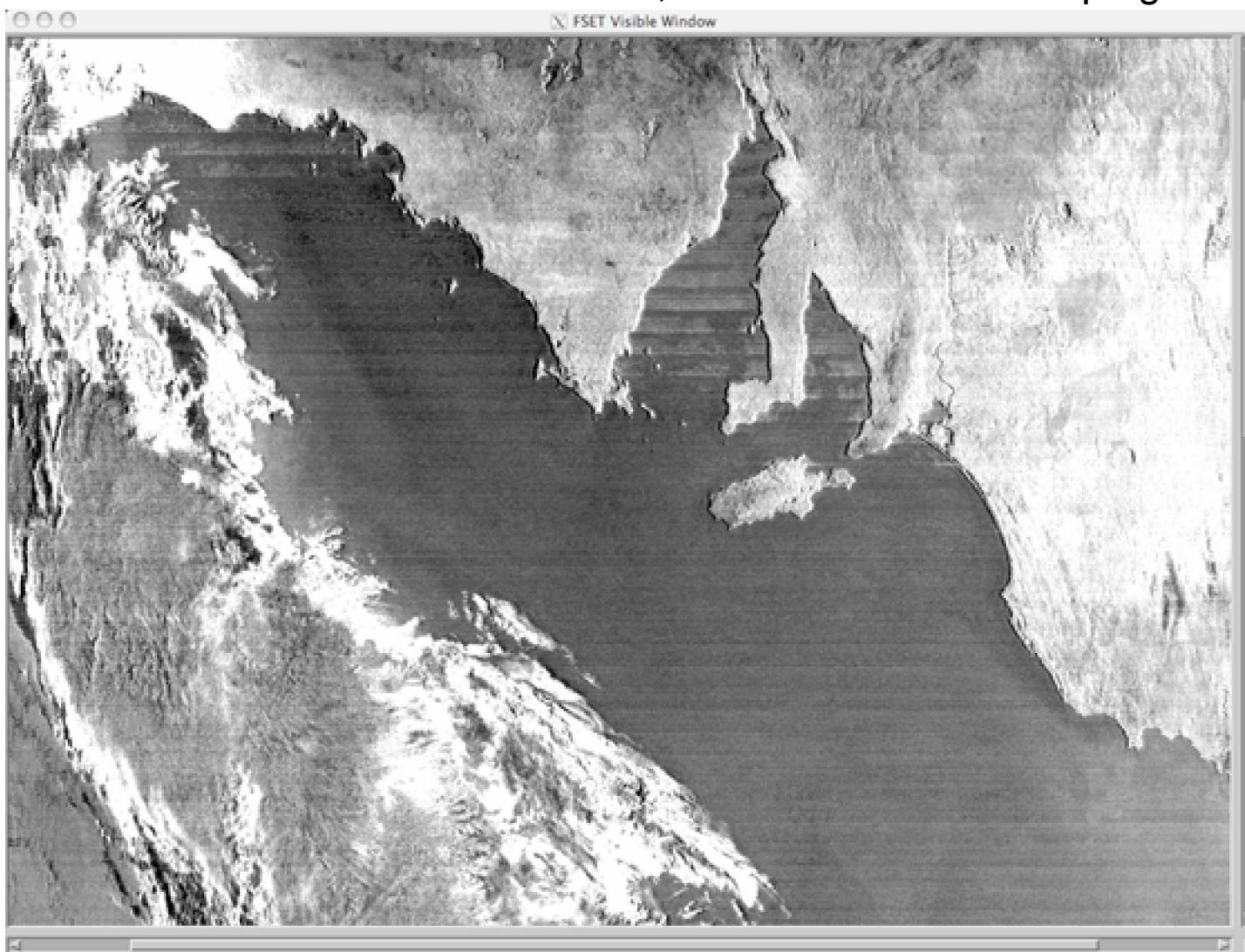
Band 31 - Band 32 Difference, Daily-Based Destriping

BAND 31 – BAND 32 DIFF (K)

0.00   0.25   0.50   0.75   1.00   1.25
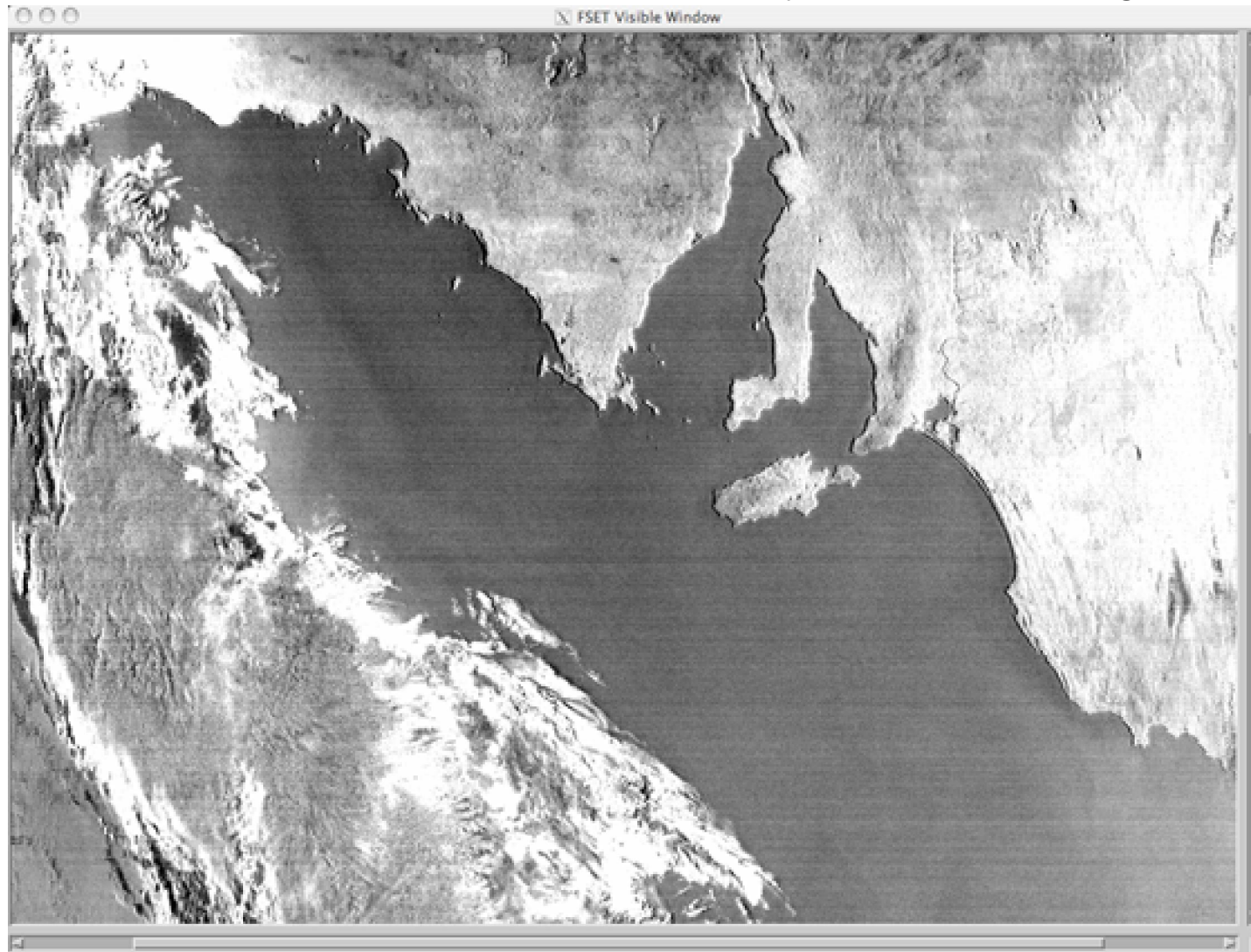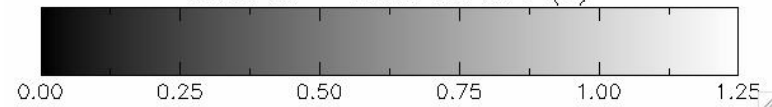
Backup slides

Instrument Overview

MODIS Four Focal Planes

S: scan direction; T: track direction
B13 and B14 have 2 columns of detectors for TDI high and low gain output

Operational Configurations (Terra MODIS)

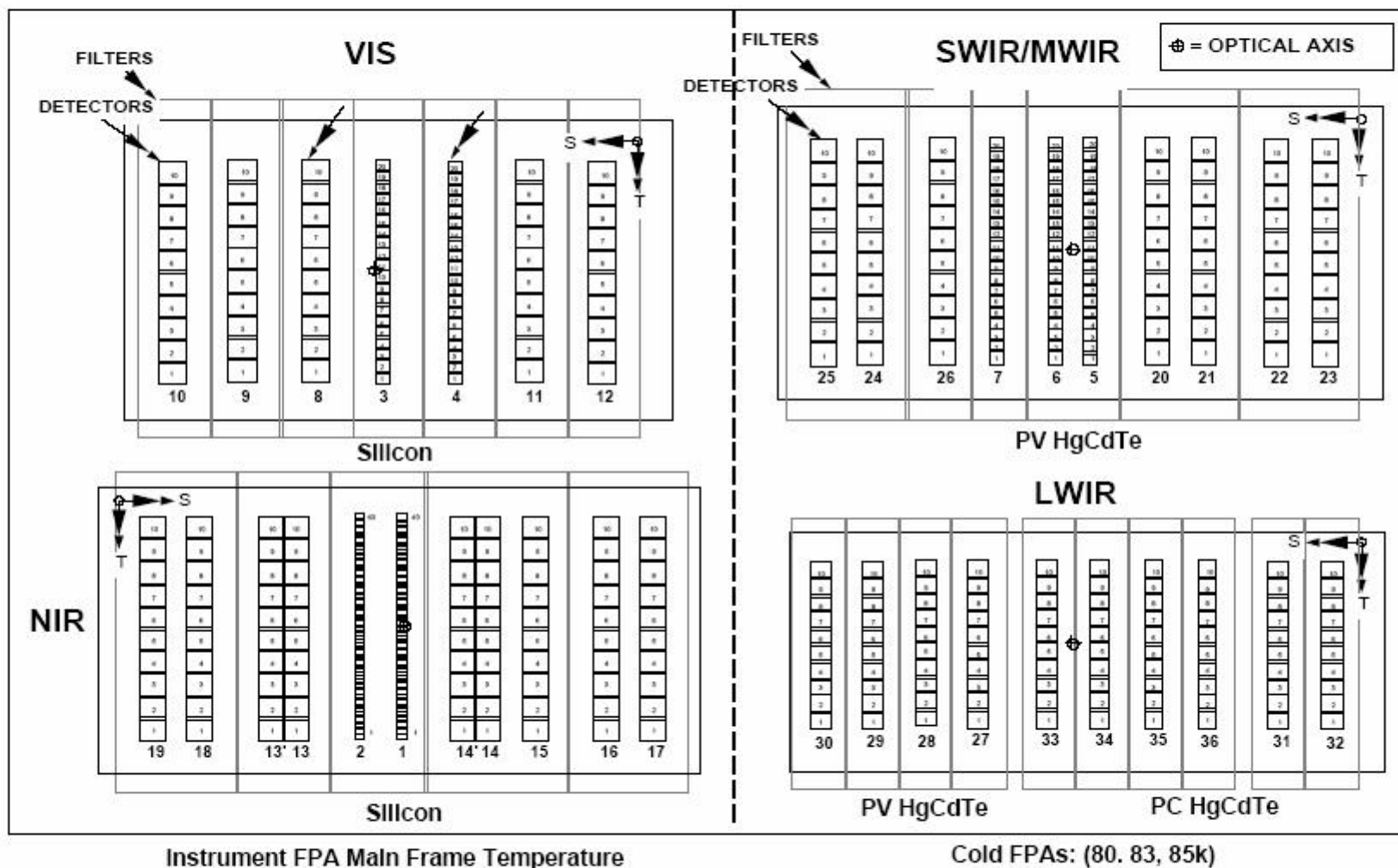| Date	Events	Description
Dec 18, 1999	Launch	Launched successfully
Feb 13, 2000	Science Mode	MODIS started science mode on A-side
Feb 24, 2000	Nadir Door Open	Terra MODIS First Light
June 2000	CFPA Lost Control	Ice began to cover radiative cooler surface
Aug 5, 2000	Formatter Anomaly	MODIS entered standby mode then safe mode
Aug 8, 2000	Outgas	Turned on outgas heater for two days (Back to science mode on Aug 19)
Oct 30, 2000	B-side Electronics	Transitioned to science mode on B-side
Jun 15, 2001	PS2 Anomaly	Powered supply 2 (B-side) off passing SAA
Jul 2, 2001	A-side Electronics	Returned to science mode on A-side with PS1
Mar 19, 2002	S/C Safe Hold	Anomaly during inclination maneuver (Back to science mode on Mar 23)
Sep 17, 2002	Formatter B	On A-side but cross-strapped to Formatter B
May 6, 2003	SD Door Failure	Set the SD open with screen down on July 2
Sep 24, 2003	SSR Anomaly	Science recording shuts down and is re-enabled
Nov 30, 2003	Formatter Anomaly	SFE reports Sync errors
Dec 16, 2003	ACE-B Anomaly	Anomaly due to Attitude Control Electronics (Back to science mode on Dec 22. Nadir door opened on Dec 24.
Jan 15, 2004	SFE Recycled	SFE Side-A was recycled
Feb 18, 2004	SFE Anomaly	SFE autonomously shuts down while passing through the SAA. Turned back on the same day

Terra MODIS MSCN in Y2000

TERRA MSCN

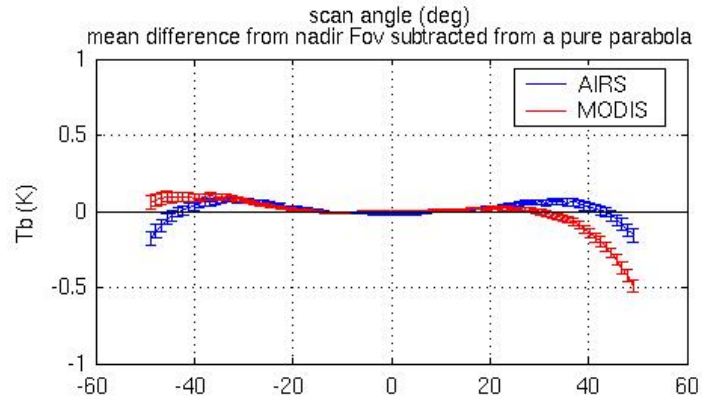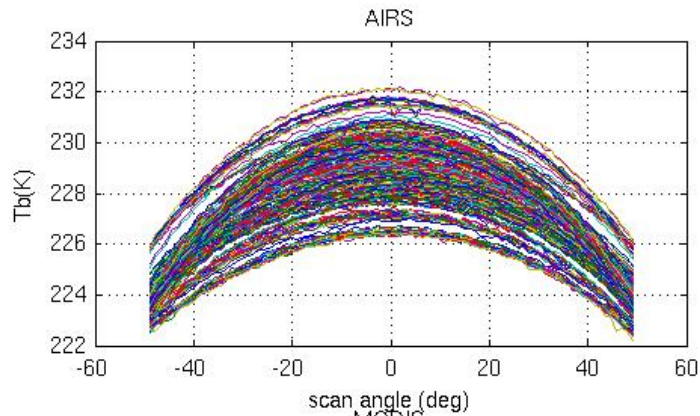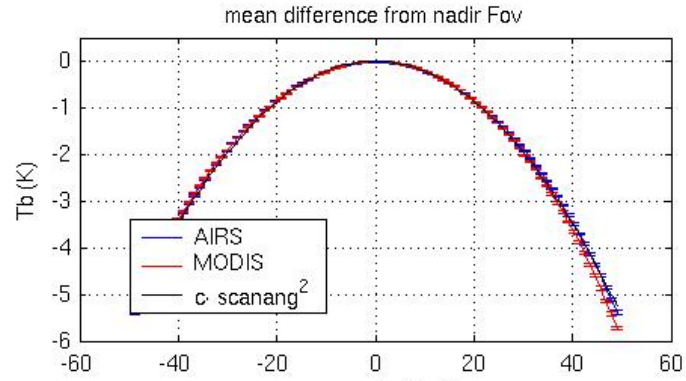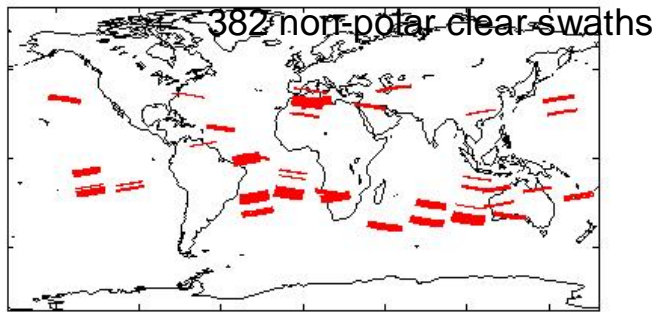Key: 2>1 | 2≥1 | 2≈1 | 2≤1 | 2<1   Pattern: P1 | P2

YEAR	DAY	B8 SD	B8 BB	B8 SV	B8 dnBB	B8 dnEV	B20 SD	B20 BB	B20 SV	B20 dnBB	B20 dnEV	B29 SD	B29 BB	B29 SV	B29 dnBB	B29 dnEV	B35 SD	B35 BB	B35 SV	B35 dnBB	B35 dnEV
2000	66	2≈1	2>1	2<1	2>1		2≥1	2>1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2<1	2<1	2≈1	2<1	P1
	72	2≈1	2>1	2<1	2>1		2≥1	2>1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≤1	2≤1	2≈1	2<1	P1
	80	2≈1	2>1	2<1	2>1		2≥1	2>1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≈1	2≈1	2≈1	2<1	P1
	87	2≈1	2>1	2<1	2>1		2>1	2>1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≈1	2≈1	2≈1	2<1	P1
	94-101	2≈1	2>1	2<1	2>1		2≥1	2≥1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≈1	2≈1	2≈1	2<1	P1
	106	2≈1	2>1	2<1	2>1		2≥1	2≥1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≤1	2≤1	2≈1	2<1	P1
	112	2≈1	2>1	2<1	2>1		2≥1	2≥1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≈1	2≈1	2≈1	2<1	P1
	120	2≈1	2>1	2<1	2>1		2>1	2>1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≤1	2≤1	2≈1	2<1	P1
	129	2≈1	2>1	2<1	2>1		2≥1	2>1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≤1	2≤1	2≥1	2<1	P1
	136	2≈1	2>1	2<1	2>1		2>1	2>1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≤1	2≤1	2≥1	2<1	P1
	150-171	2≈1	2>1	2<1	2>1		2≥1	2≥1	2<1	2>1	2≈1	2>1	2>1	2<1	2>1		2≈1	2≈1	2≈1	2≤1	P1
	178-200	2≤1	2<1	2>1	2<1		2≤1	2≤1	2>1	2<1	2≈1	2≤1	2≤1	2>1	2<1		2≈1	2≈1	2≈1	2≤1	P1
	206	2<1	2<1	2>1	2<1		2≤1	2≤1	2>1	2<1	2≈1	2≤1	2≈1	2≥1	2<1		2≈1	2≈1	2≈1	2≤1	P1
	212	2≤1	2<1	2>1	2<1		2≤1	2≤1	2>1	2<1	2≈1	2≤1	2≈1	2≥1	2<1		2≈1	2≈1	2≈1	2≤1	P1
	218	2<1	2<1	2>1	2<1		2<1	2<1	2>1	2<1	2≈1	2<1	2<1	2>1	2<1		2≥1	2≥1	2≈1	2≥1	P2
	231	2≤1	2≤1	2≥1	2≤1		2≥1	2≥1	2≤1	2≥1	2≈1	2≤1	2≤1	2≥1	2≤1		2>1	2>1	2≈1	2>1	P2
	238	2≤1	2≤1	2≥1	2≤1		2≥1	2≥1	2≈1	2≥1	2≈1	2≤1	2≈1	2≈1	2≈1		2>1	2>1	2≈1	2>1	P2
	245	2≤1	2≤1	2≥1	2≤1		2≈1	2≥1	2≈1	2≥1	2≈1	2≤1	2≈1	2≈1	2≈1		2>1	2>1	2≈1	2>1	P2
	253	2<1	2≤1	2≥1	2<1		2≈1	2≥1	2≈1	2≥1	2≈1	2≈1	2≈1	2≈1	2≈1		2>1	2>1	2≈1	2>1	P2
	260	2<1	2≤1	2≥1	2≤1		2≈1	2≥1	2≈1	2≥1	2≈1	2≈1	2≈1	2≈1	2≈1		2>1	2>1	2≈1	2>1	P2
	267	2<1	2≤1	2≥1	2≤1		2≥1	2≥1	2≈1	2≥1	2≈1	2≈1	2≈1	2≈1	2≈1		2>1	2>1	2≈1	2>1	P2
	273-287	2<1	2≤1	2≥1	2≤1		2≈1	2≥1	2≈1	2≥1	2≈1	2≈1	2≈1	2≈1	2≈1		2>1	2>1	2≈1	2>1	P2
	294	2≤1	2<1	2>1	2<1		2≥1	2≥1	2≤1	2≥1	2≈1	2≤1	2≈1	2≥1	2≤1		2>1	2>1	2≈1	2>1	P2
	304	2<1	2≤1	2>1	2<1		2≈1	2≥1	2≈1	2≥1	2≈1	2≤1	2≈1	2≥1	2≤1		2>1	2>1	2≈1	2>1	P2
	305	2≤1	2≈1	2≈1	2≈1		2≈1	2≤1	2≥1	2≤1	2≈1	2≈1	2≈1	2≈1	2≈1		2<1	2<1	2≥1	2<1	P1
	306	2≤1	2≈1	2≈1	2≈1		2≈1	2≤1	2≥1	2≤1	2≈1	2≥1	2≥1	2≈1	2≈1		2<1	2<1	2≥1	2<1	P1
	309	2≈1	2≈1	2≈1	2≈1		2≈1	2≈1	2≥1	2≤1	2≈1	2≈1	2≥1	2≥1	2≈1		2<1	2<1	2≥1	2<1	P1
	314	2<1	2≈1	2≈1	2≈1		2≈1	2≤1	2≥1	2≤1	2≈1	2≈1	2≥1	2≈1	2≈1		2<1	2<1	2≥1	2<1	P1
	319	2<1	2≈1	2≈1	2≈1		2≈1	2≈1	2≥1	2≤1	2≈1	2≈1	2≥1	2≈1	2≈1		2<1	2<1	2≥1	2<1	P1
	323	2<1	2≈1	2≥1	2≤1		2≈1	2≈1	2≥1	2≤1	2≈1	2≈1	2≥1	2≈1	2≈1		2<1	2<1	2≥1	2<1	P1
	330-351	2<1	2≈1	2≥1	2≤1		2≈1	2≤1	2≥1	2≤1	2≈1	2≈1	2≥1	2≈1	2≈1		2<1	2<1	2≥1	2<1	P1
	358-365	2<1	2≈1	2≥1	2≤1		2≤1	2≤1	2≥1	2≤1	2≈1	2≈1	2≥1	2≈1	2≥1		2<1	2<1	2≥1	2<1	P1

Terra MODIS MSCN in Y2001-2002

Terra MODIS MSCN in Y2003-2004

Band 36 (14.2µm) Scan Angle Asymmetry

Borrowed from Dave Tobin, SSEC, UW