Advanced Technology Microwave Sounder (ATMS) Sensor Data Record (SDR) Error Budget

ATMS SDR Science Team

December 18, 2013

1. Characterization of ATMS Calibration Accuracy

1.1 Radiometric Calibration Uncertainty Specification

Table 1. Requirements of ATMS Channel Radiometric Calibration Accuracy [1]

Channel	Accuracy (K)
1-2	1.00
3-15	0.75
16-22	1.00

1.2 Pre-launch Radiometric Uncertainty Budget

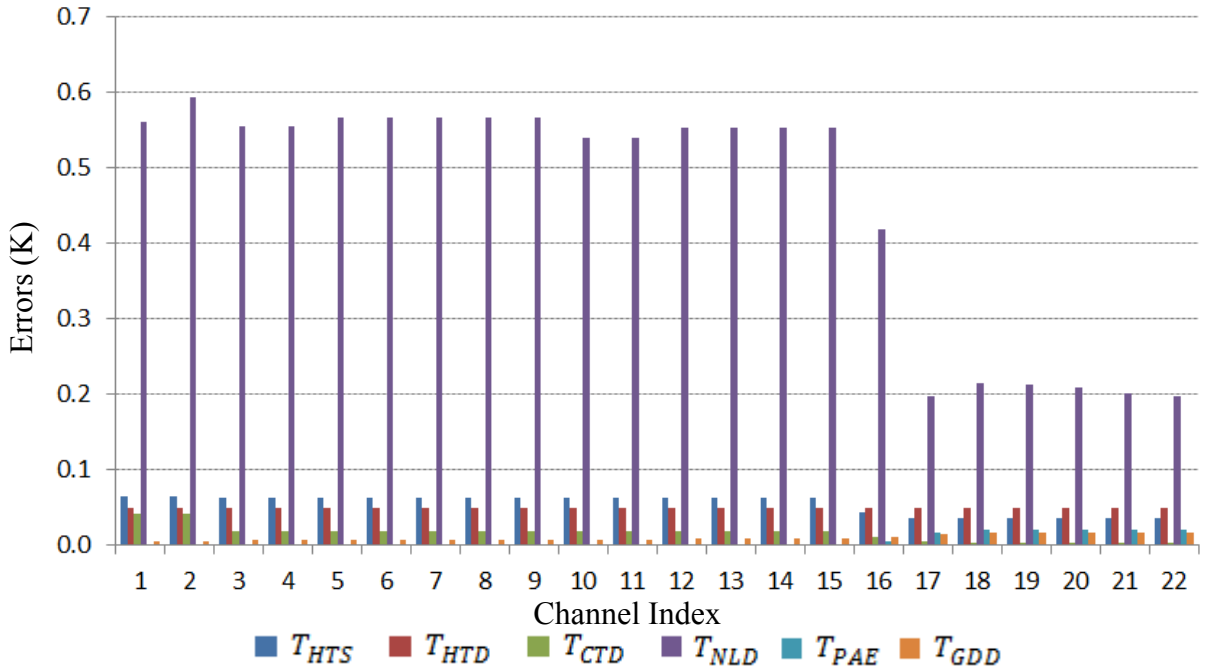


Figure.1: Pre-launch radiometric uncertainty budget [2] for the nominal case given as a function of channel index

T_{HTS}: Hot Target Static (HTS) Error
T_{HTD}: Hot Target Dynamic (HTD) Error
T_{CTD}: Cold Target Dynamic (CTD) Error
T_{NLD}: Nonlinearity Dynamic (NLD) Error
T_{PAE}: Planck Approximation Error (PAE)
T_{GDD}: Gain Drift Dynamic (GDD) Error

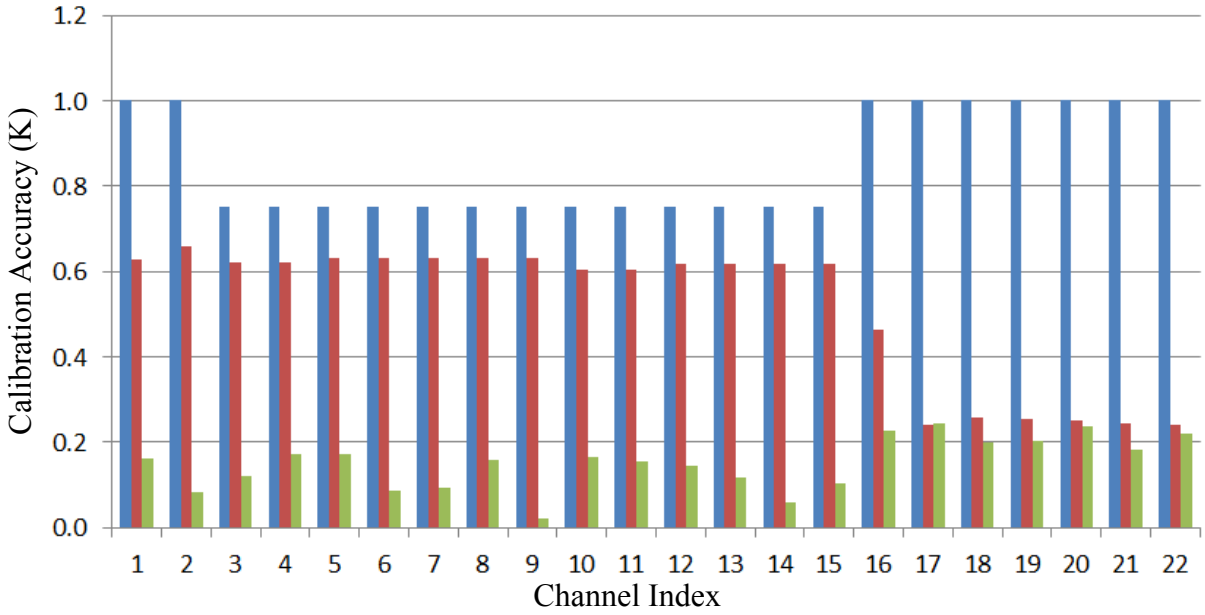
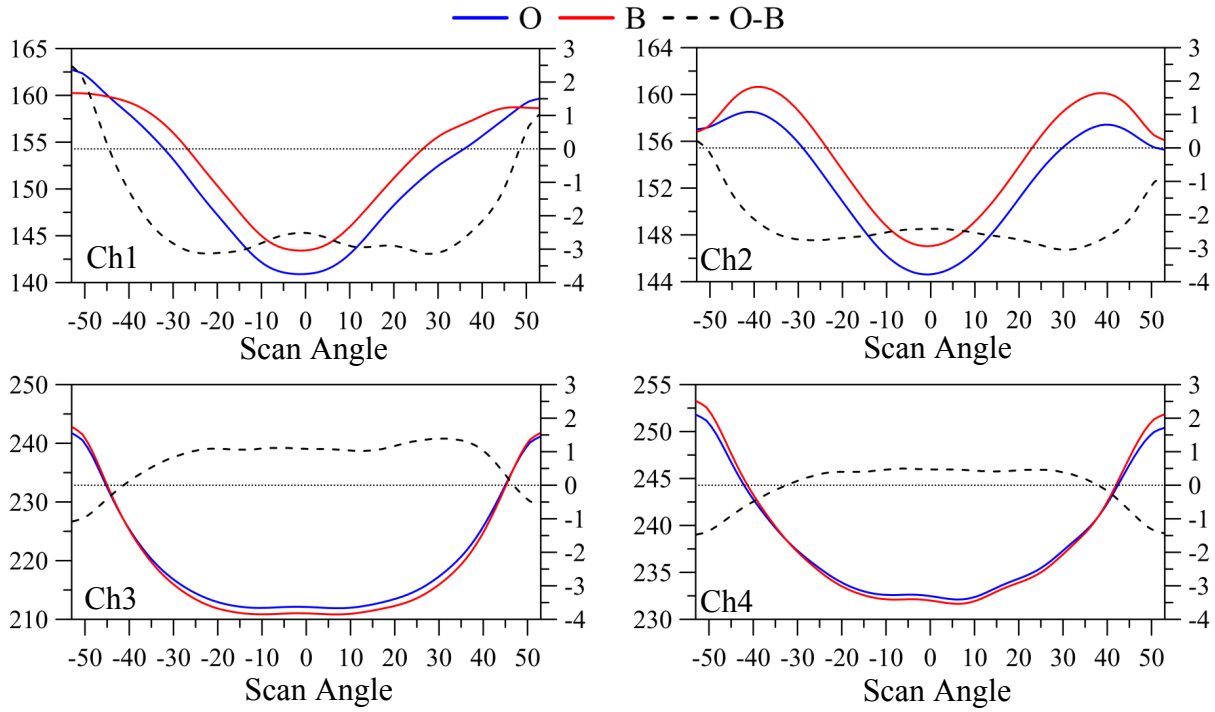
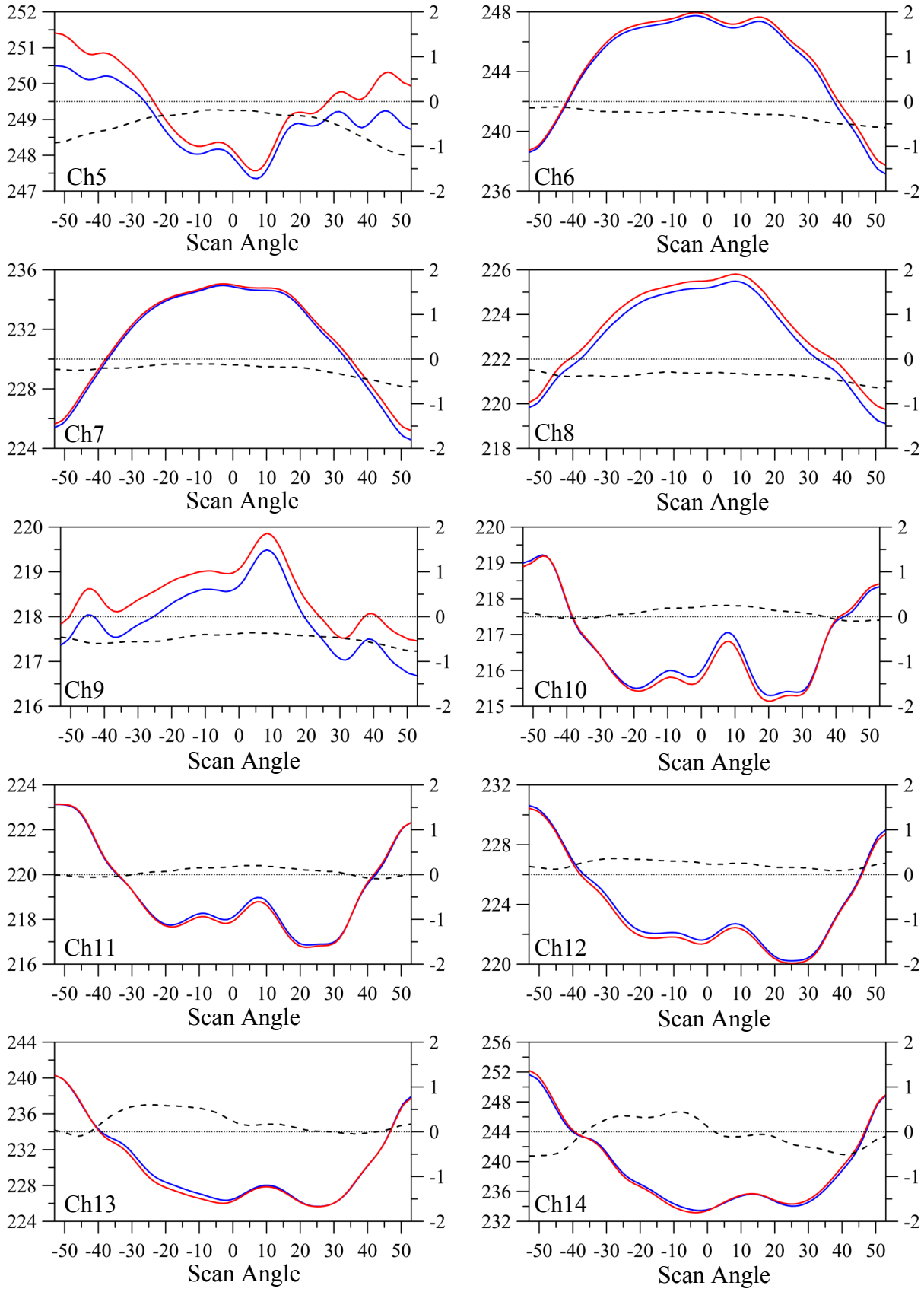


Figure.2: ATMS channel calibration accuracy: blue – specification values [2, 3]; red – values combined from the above nominal case in Figure 1; green – values obtained from prelaunch Thermal Vacuum (TVAC) calibration test

1.3 ATMS Bias Characterization from on-orbit Data




Ch5
Ch6
Ch7
Ch8
Ch9
Ch10
Ch11
Ch12
Ch13
Ch14
Scan Angle
-50 -40 -30 -20 -10 0 10 20 30 40 50

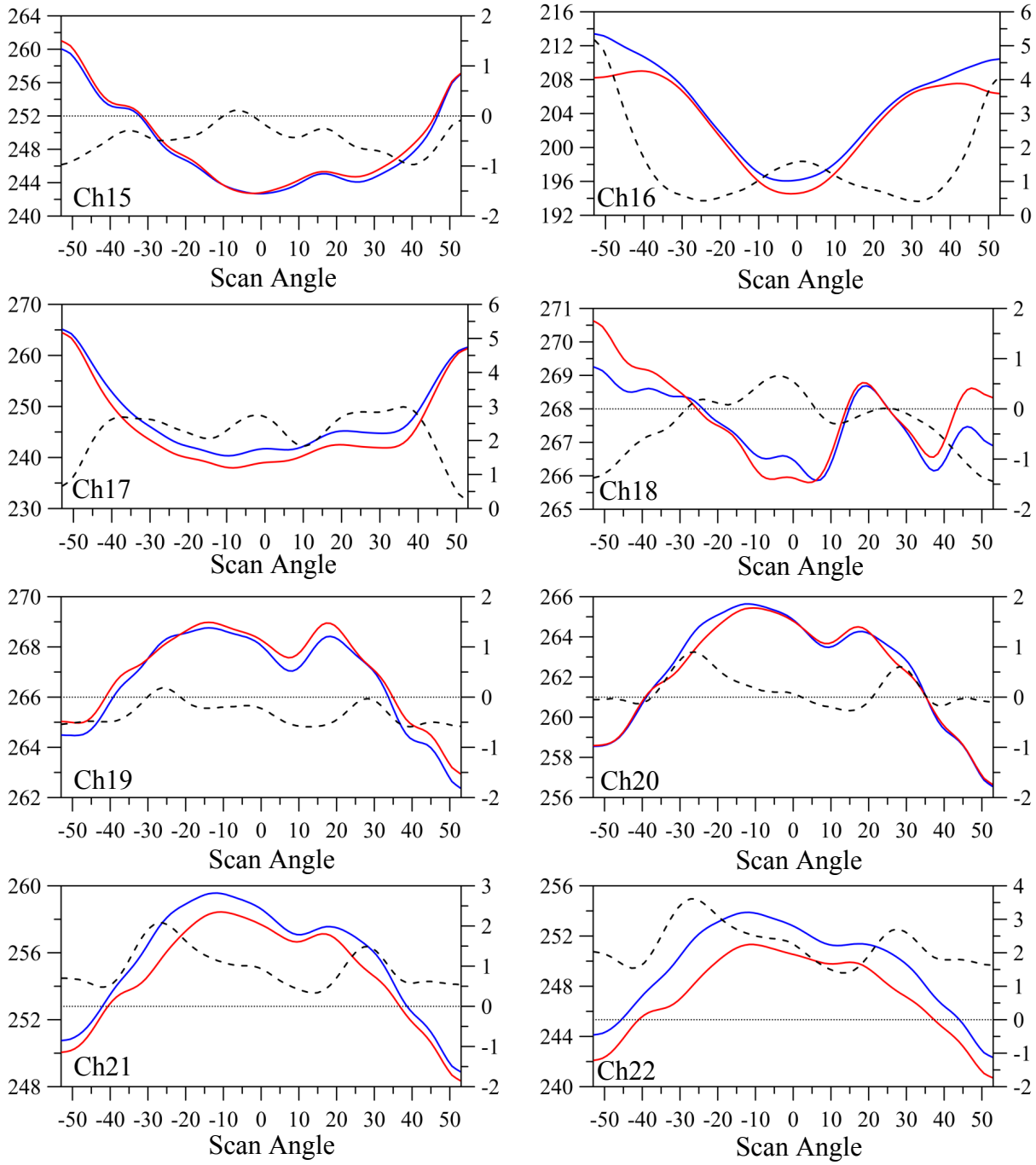
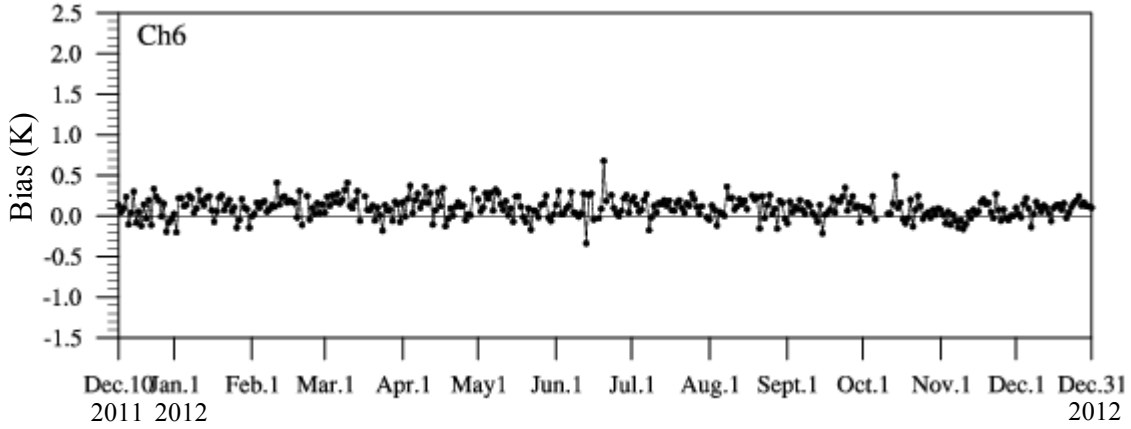
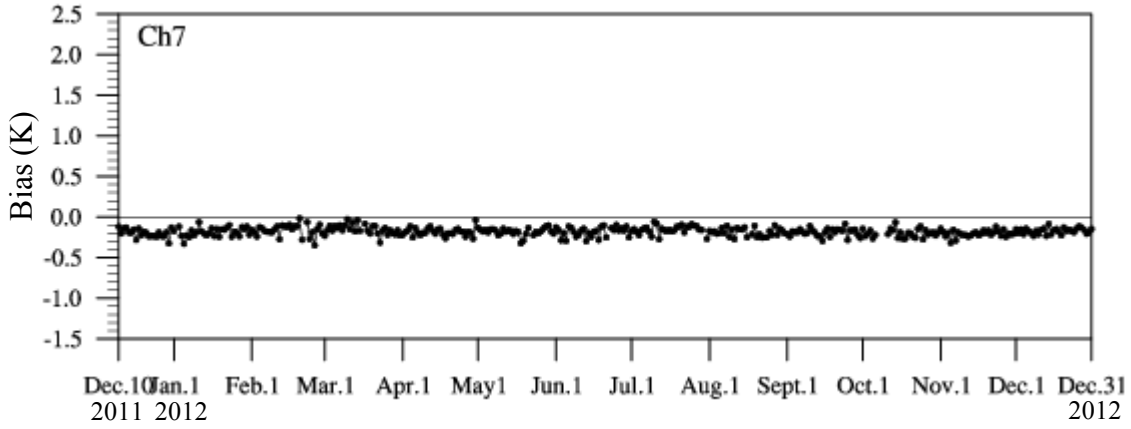
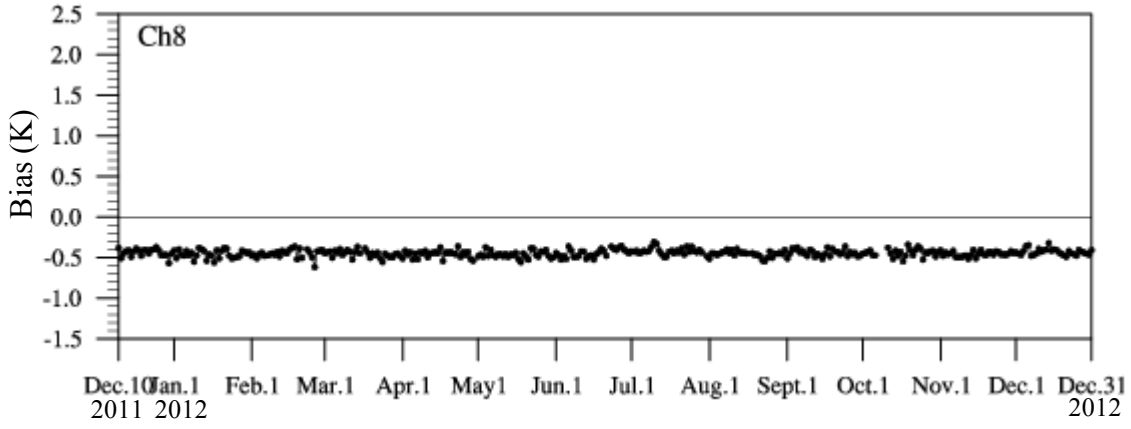
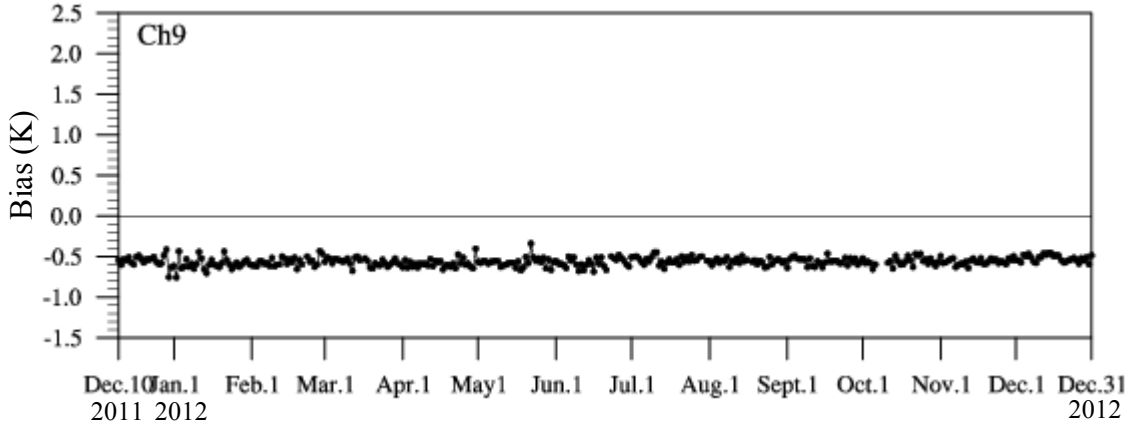


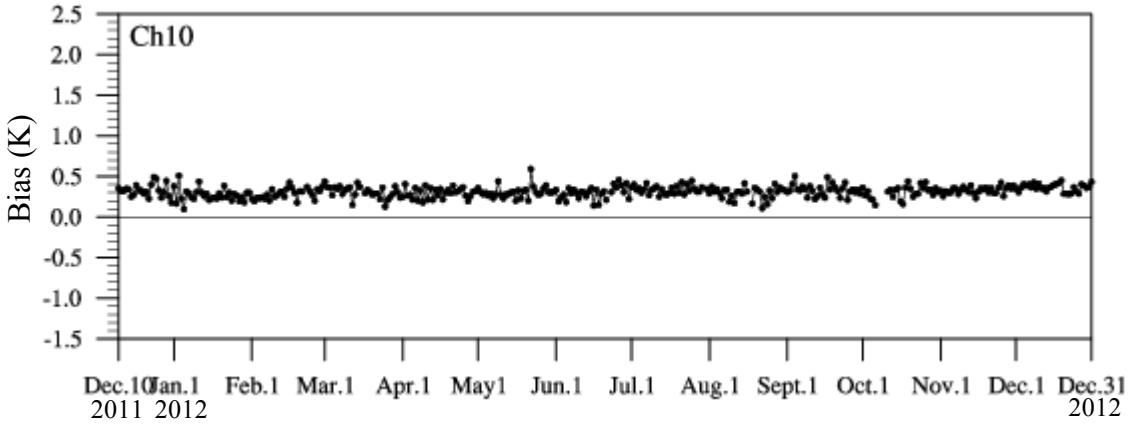
Figure.3: ATMS TDR (O), simulation (B) and the difference between O and B under calm, dry clear-sky for all 22 channels

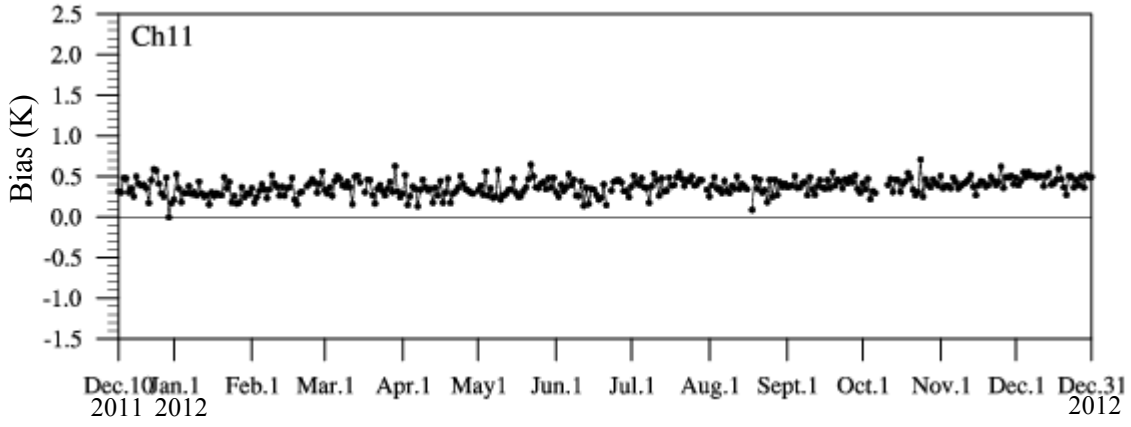

Ch6
Bias (K)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Dec.10 Jan.1 Feb.1 Mar.1 Apr.1 May1 Jun.1 Jul.1 Aug.1 Sept.1 Oct.1 Nov.1 Dec.1 Dec.31
2011 2012 2012


Ch7
Bias (K)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Dec.10 Jan.1 Feb.1 Mar.1 Apr.1 May1 Jun.1 Jul.1 Aug.1 Sept.1 Oct.1 Nov.1 Dec.1 Dec.31
2011 2012 2012


Ch8
Bias (K)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Dec.10 Jan.1 Feb.1 Mar.1 Apr.1 May1 Jun.1 Jul.1 Aug.1 Sept.1 Oct.1 Nov.1 Dec.1 Dec.31
2011 2012 2012


Ch9
Bias (K)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Dec.10 Jan.1 Feb.1 Mar.1 Apr.1 May1 Jun.1 Jul.1 Aug.1 Sept.1 Oct.1 Nov.1 Dec.1 Dec.31
2011 2012 2012


Ch10
Bias (K)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Dec.10 Jan.1 Feb.1 Mar.1 Apr.1 May1 Jun.1 Jul.1 Aug.1 Sept.1 Oct.1 Nov.1 Dec.1 Dec.31
2011 2012 2012


Ch11
Bias (K)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Dec.10 Jan.1 Feb.1 Mar.1 Apr.1 May1 Jun.1 Jul.1 Aug.1 Sept.1 Oct.1 Nov.1 Dec.1 Dec.31
2011 2012 2012

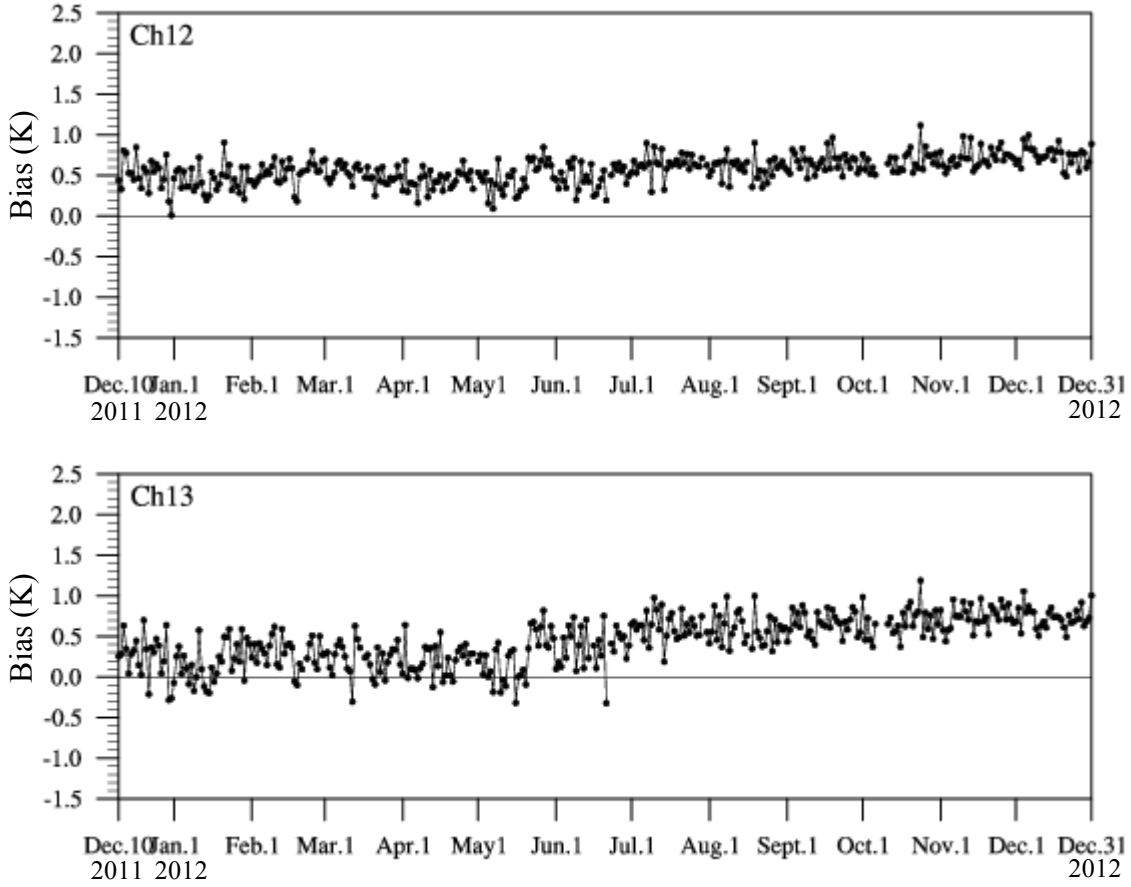
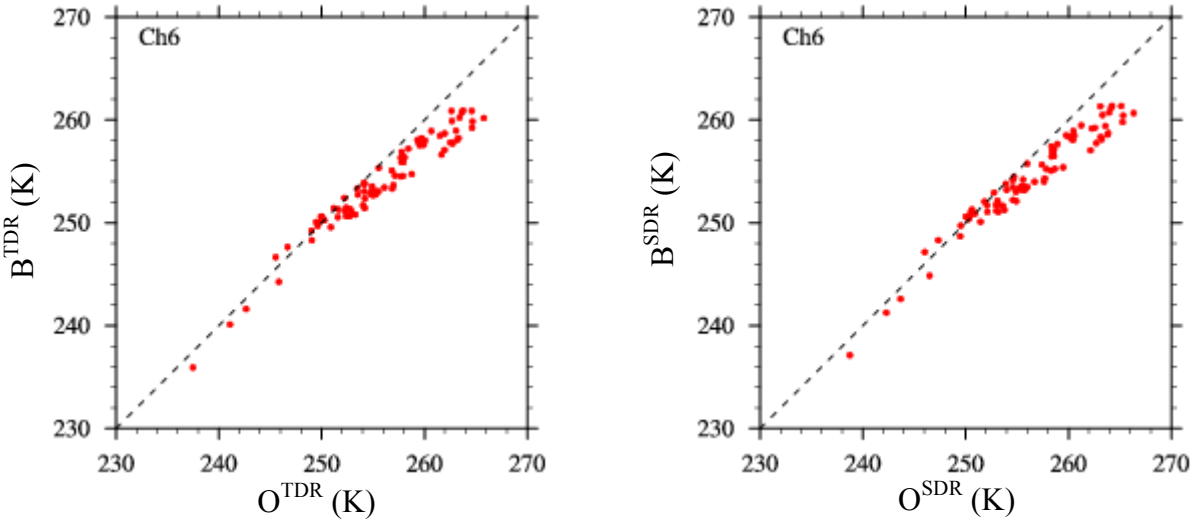
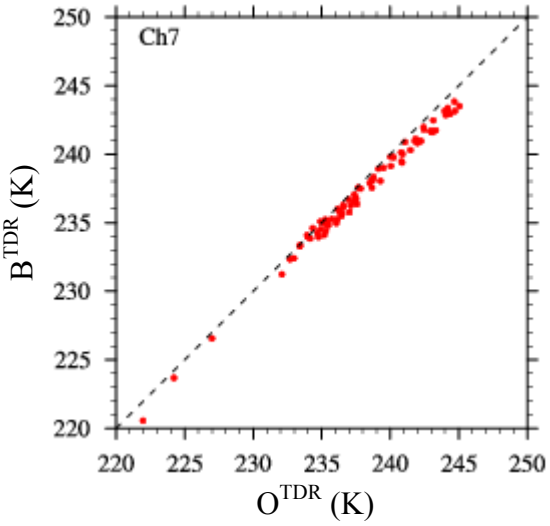
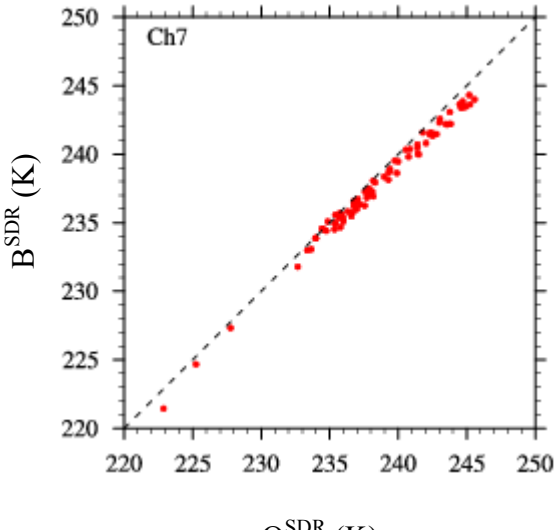
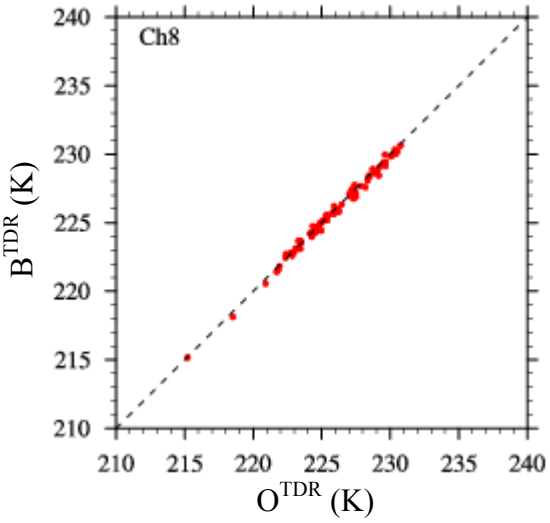


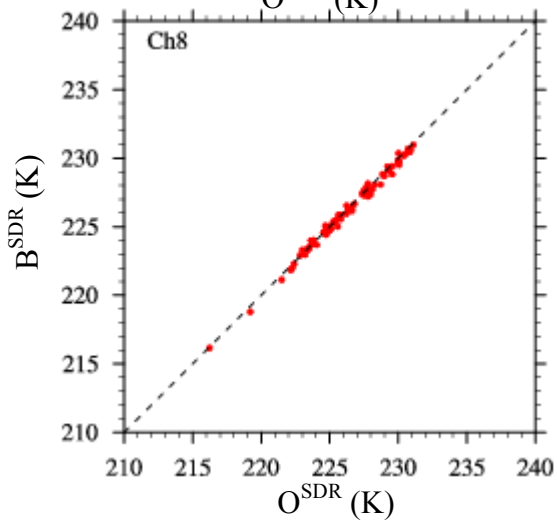
Figure.4: Time series of biases of the daily mean differences between ATMS observations and GPS RO simulations (O-BGPS) [6] calculated for collocated data under clear-sky conditions over ocean and between 60S-60N from December 10, 2011 to December 31, 2012.

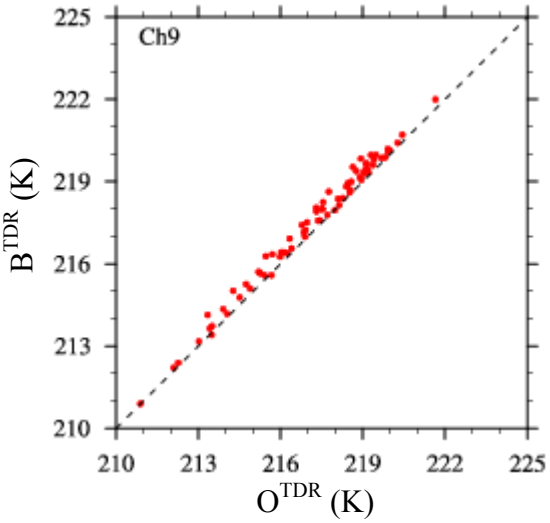


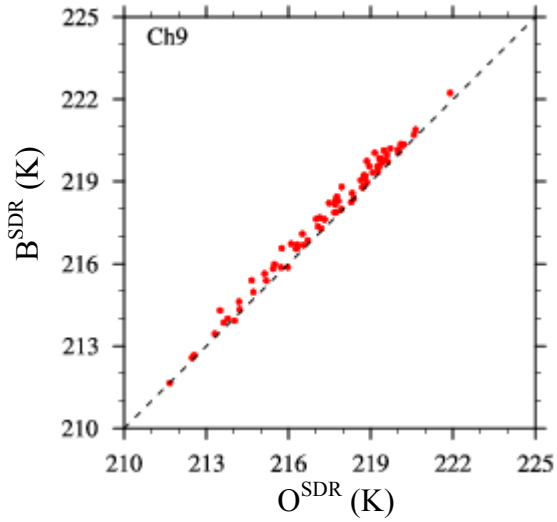

Ch7
250
245
240
235
230
225
220
220 225 230 235 240 245 250
B^TDR (K)
O^TDR (K)

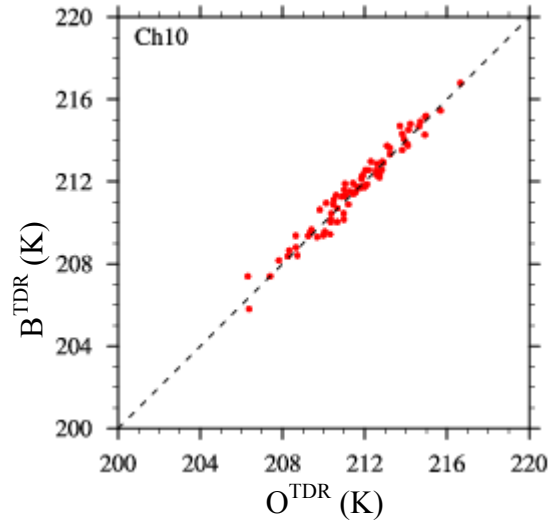

Ch7
250
245
240
235
230
225
220
220 225 230 235 240 245 250
B^SDR (K)
O^SDR (K)

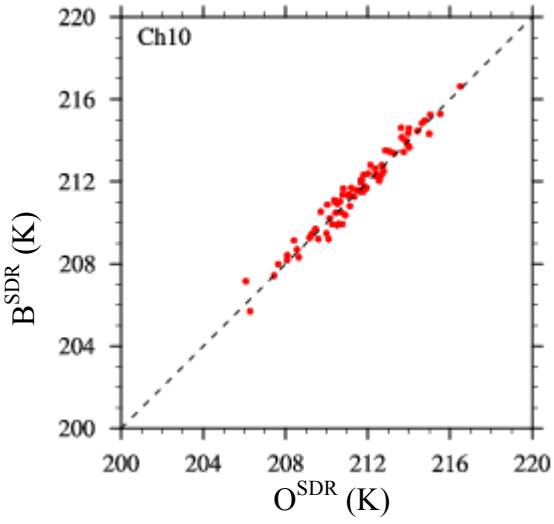

Ch8
240
235
230
225
220
215
210
210 215 220 225 230 235 240
B^TDR (K)
O^TDR (K)

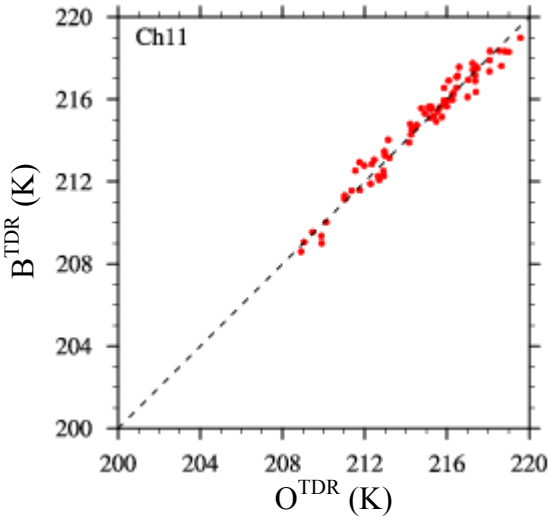

Ch8
240
235
230
225
220
215
210
210 215 220 225 230 235 240
B^SDR (K)
O^SDR (K)

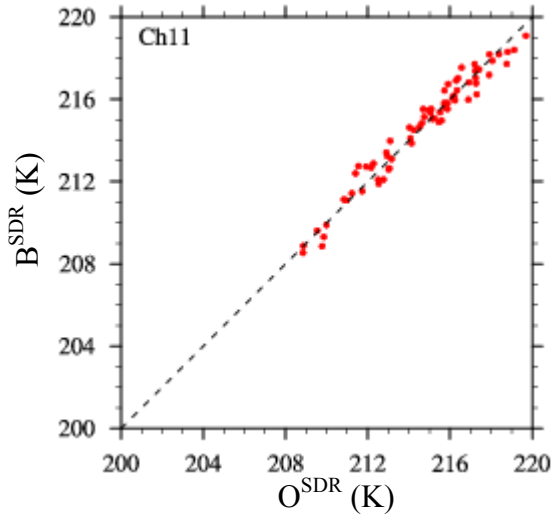

Ch9
225
222
219
216
213
210
210 213 216 219 222 225
B^TDR (K)
O^TDR (K)

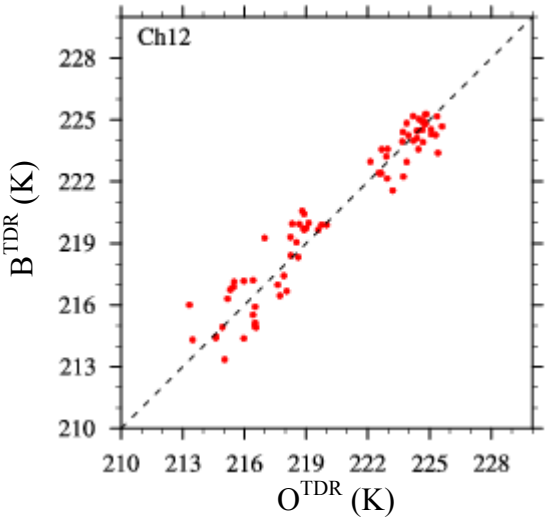

Ch9
225
222
219
216
213
210
210 213 216 219 222 225
B^SDR (K)
O^SDR (K)

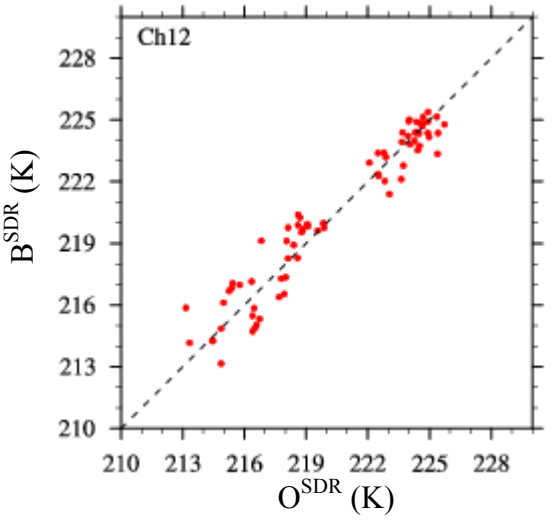

Ch10
220
216
212
208
204
200
200 204 208 212 216 220
B^TDR (K)
O^TDR (K)


Ch10
220
216
212
208
204
200
200 204 208 212 216 220
B^SDR (K)
O^SDR (K)


Ch11
220
216
212
208
204
200
200 204 208 212 216 220
B^TDR (K)
O^TDR (K)


Ch11
220
216
212
208
204
200
200 204 208 212 216 220
B^SDR (K)
O^SDR (K)


Ch12
228
225
222
219
216
213
210
210 213 216 219 222 225 228
B^TDR (K)
O^TDR (K)


Ch12
228
225
222
219
216
213
210
210 213 216 219 222 225 228
B^SDR (K)
O^SDR (K)

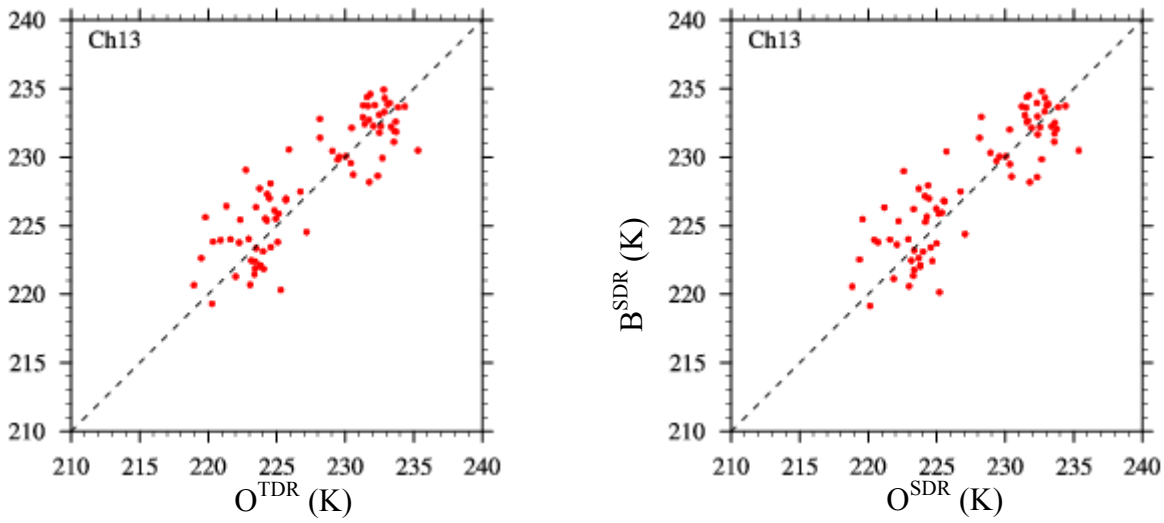


Figure.5: ATMS channels 6-13 scatter plot of B^{TDR} against O^{TDR} (left) and B^{SDR} against O^{SDR} (right) from the 86 ARM SGP radiosonde and ATMS matchups.

2. Instrument Noises

2.1 Prelaunch Channel Noise Sensitivity (NEDT) from TVAC

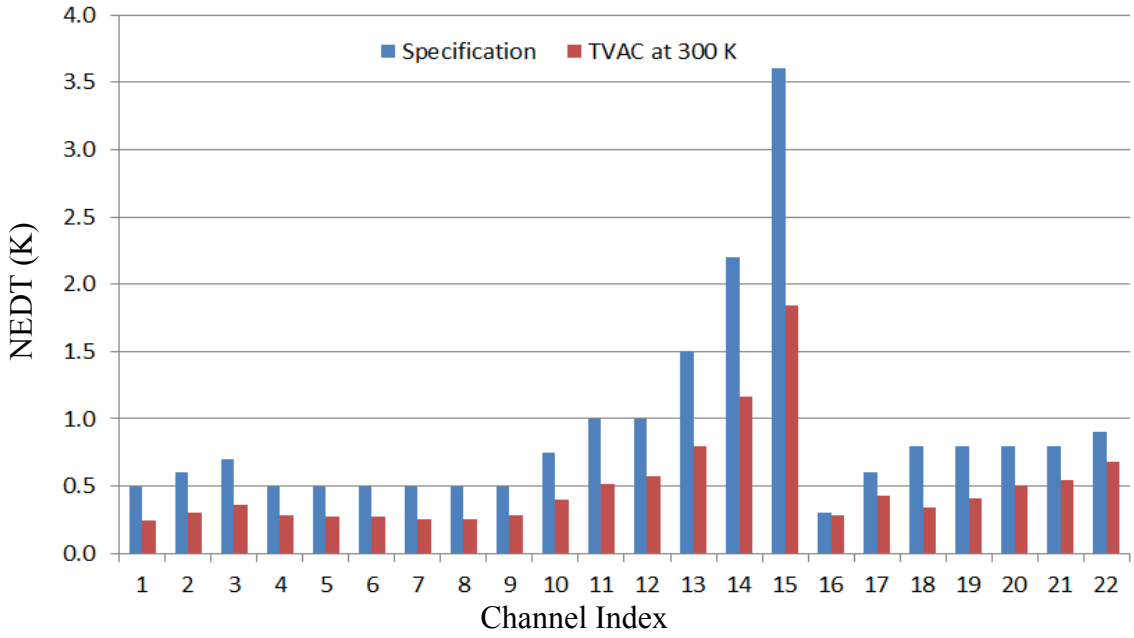
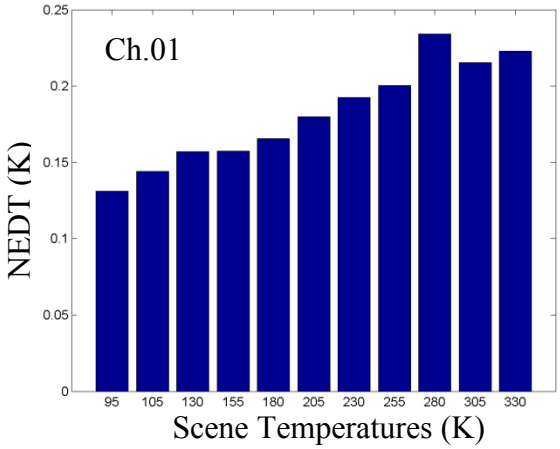
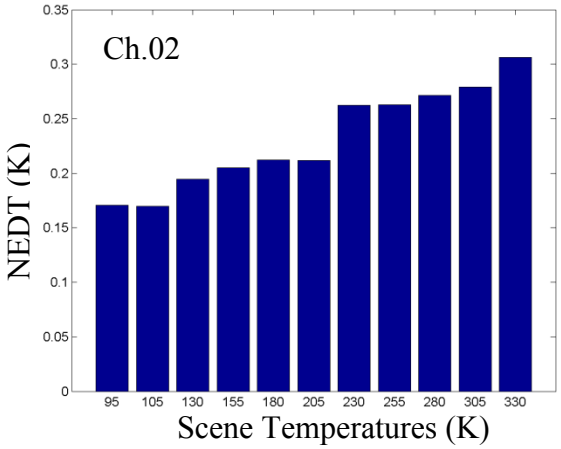
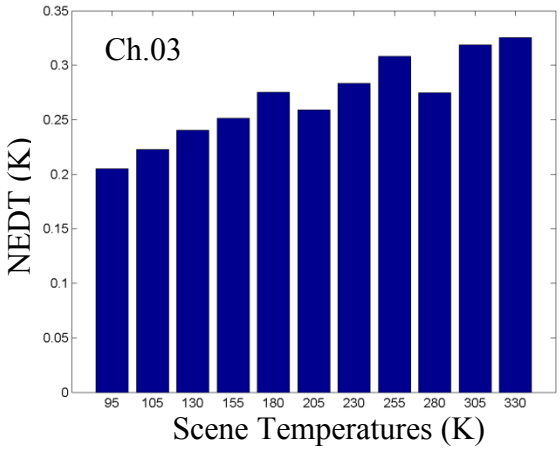
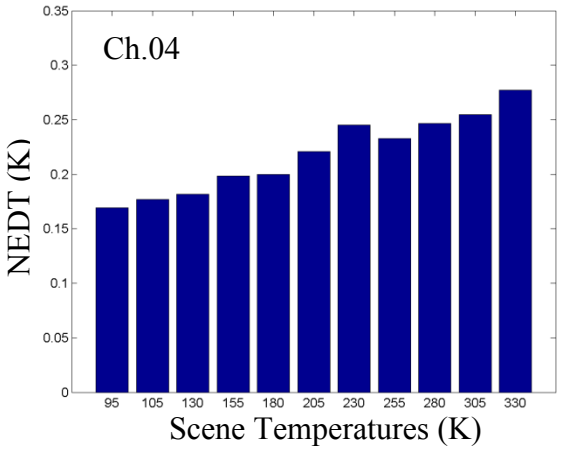


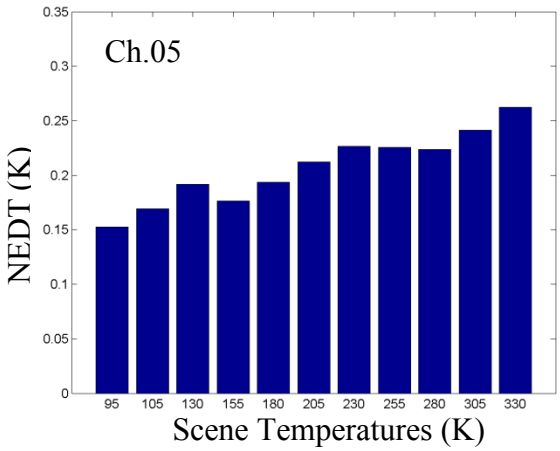
Figure.6: ATMS prelaunch channel NEDT values [4-6]: blue – from specification; red – TVAC at 300 K

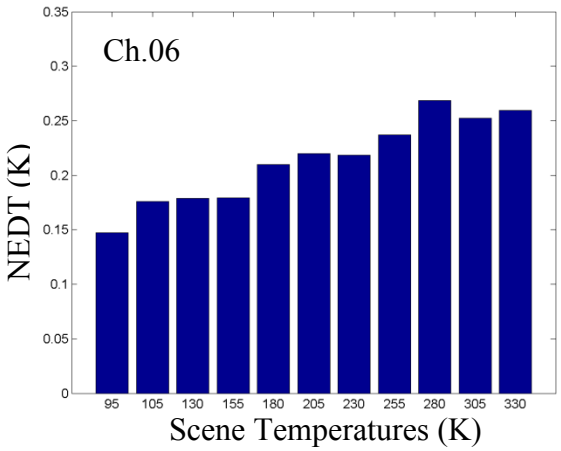

Ch.01
NEDT (K)
0
0.05
0.1
0.15
0.2
0.25
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

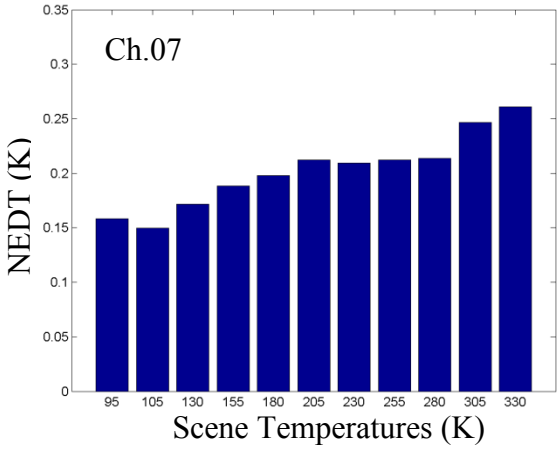

Ch.02
NEDT (K)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

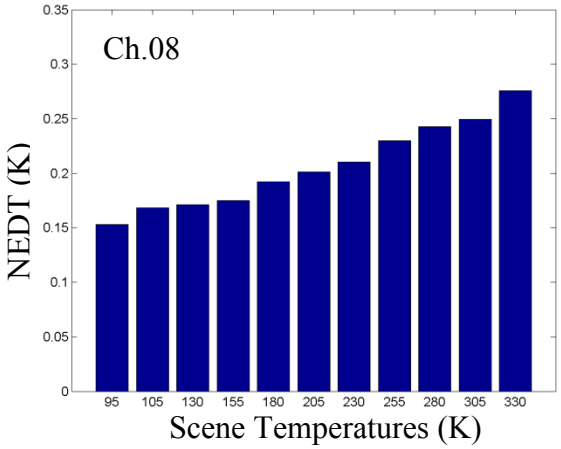

Ch.03
NEDT (K)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

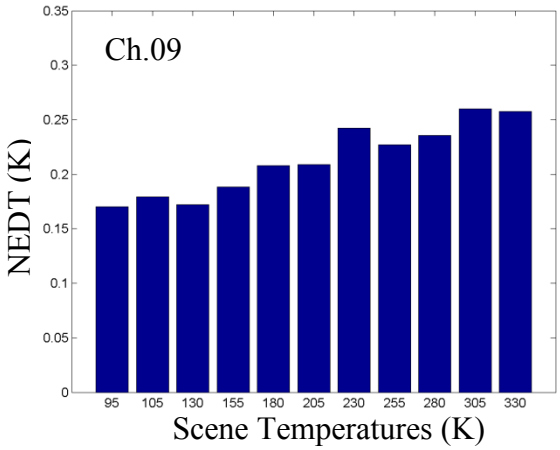

Ch.04
NEDT (K)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

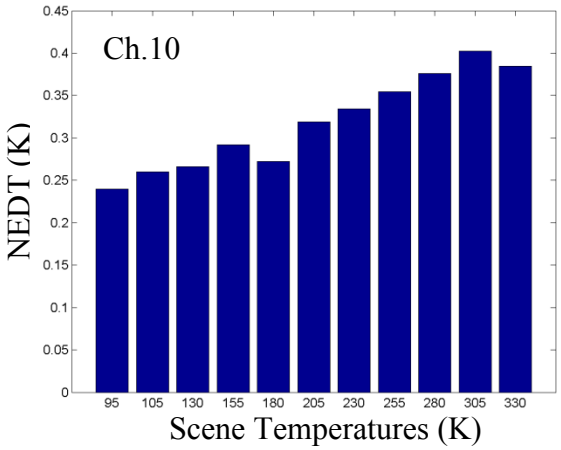

Ch.05
NEDT (K)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

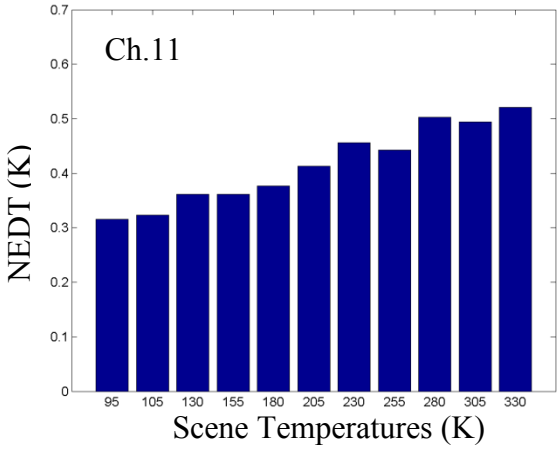

Ch.06
NEDT (K)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

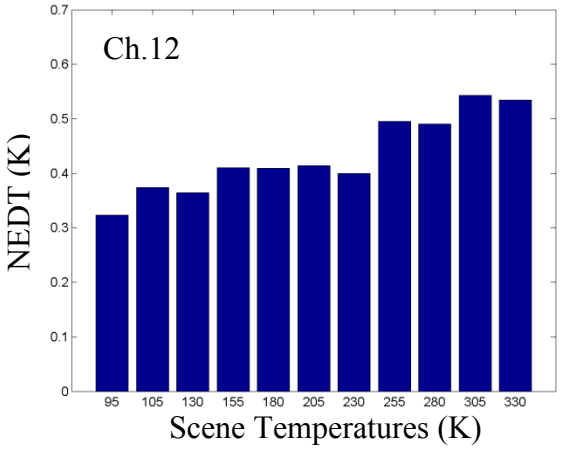

Ch.07
NEDT (K)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

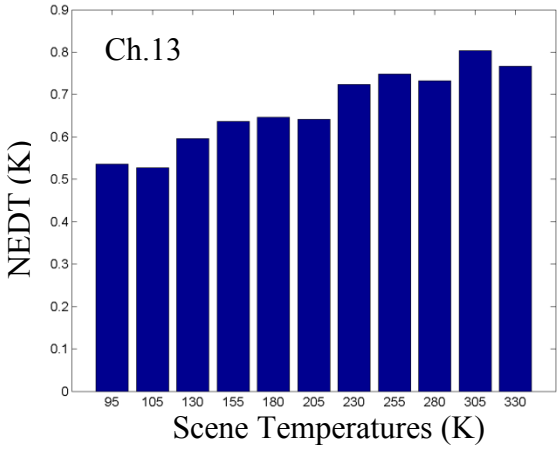

Ch.08
NEDT (K)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

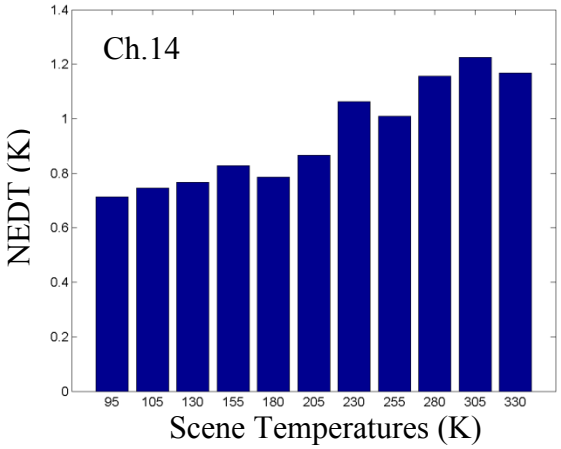

Ch.09
NEDT (K)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

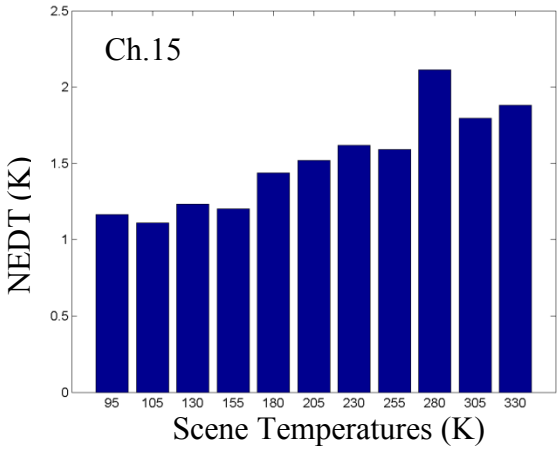

Ch.10
NEDT (K)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

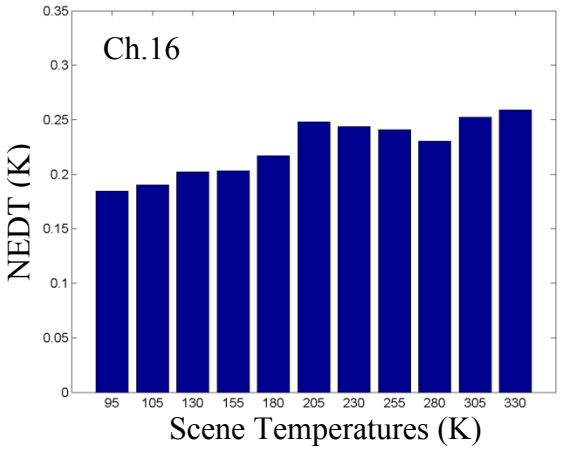

Ch.11
NEDT (K)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

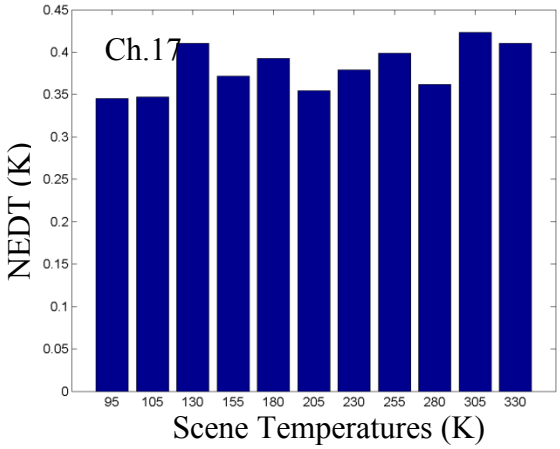

Ch.12
NEDT (K)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

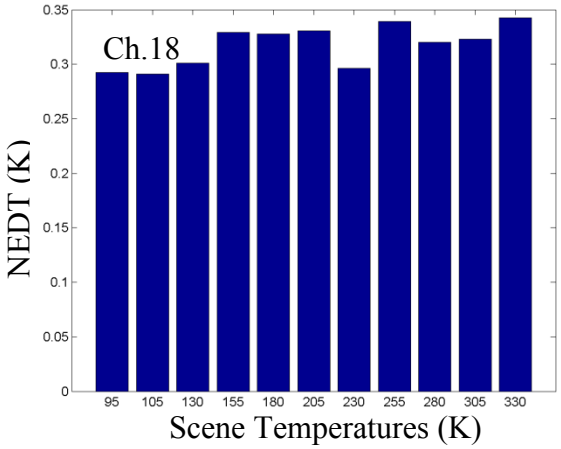

Ch.13
NEDT (K)
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)


Ch.14
NEDT (K)
0 0.2 0.4 0.6 0.8 1 1.2 1.4
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)


Ch.15
NEDT (K)
0 0.5 1 1.5 2 2.5
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)


Ch.16
NEDT (K)
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)


Ch.17
NEDT (K)
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)


Ch.18
NEDT (K)
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35
95 105 130 155 180 205 230 255 280 305 330
Scene Temperatures (K)

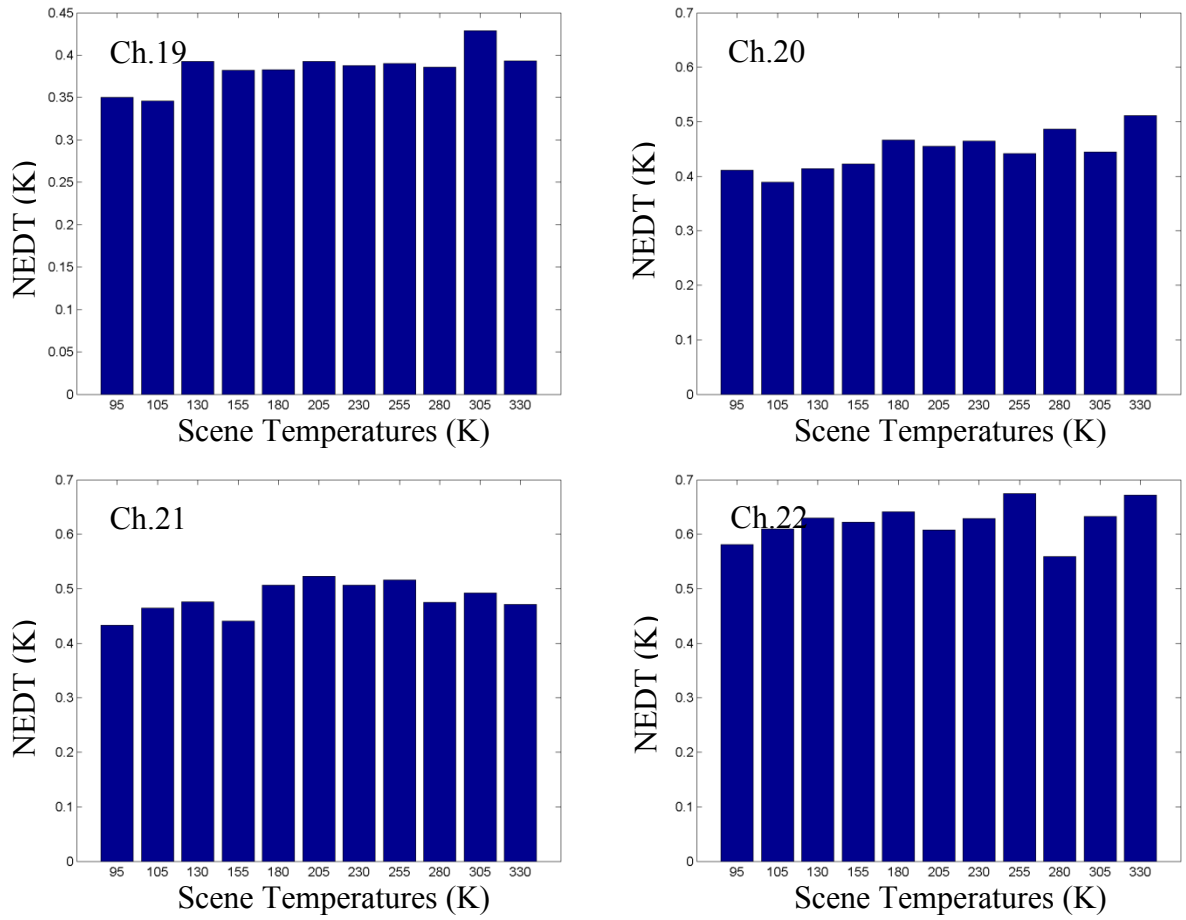


Figure.7: NEDT values of all 22 ATMS channels vs. scene temperatures. Data is from TVAC test for ATMS CP is at 5 ^{o}C and RC1.

2.2 Post-launch Channel Noise Sensitivity (NEDT) from in-orbit Data

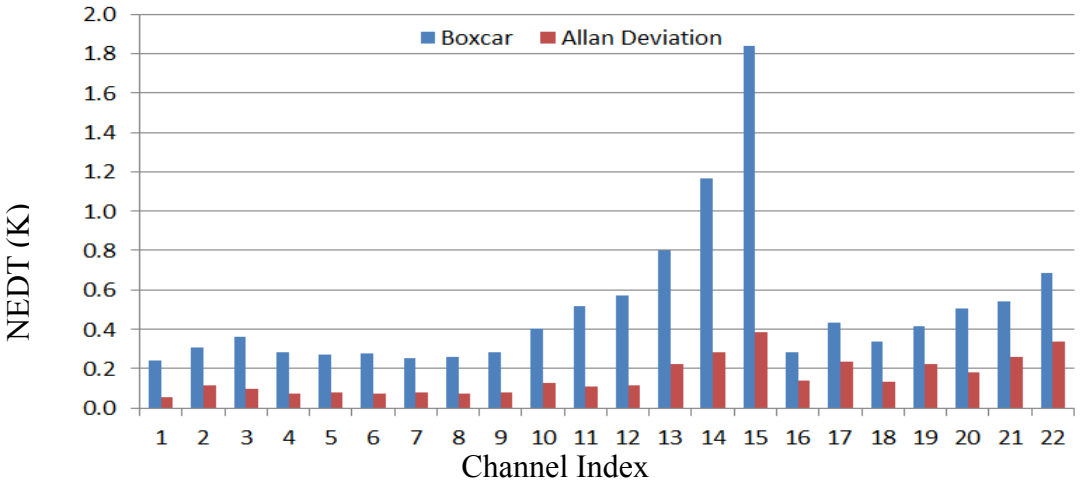


Figure.8: ATMS post-launch in-orbit channel NEDT values computed by the standard deviation and Allan deviation: blue - from standard deviation; red - Allan deviation [7].

2.3 ATMS Striping Noise from Pitch Maneuver Data

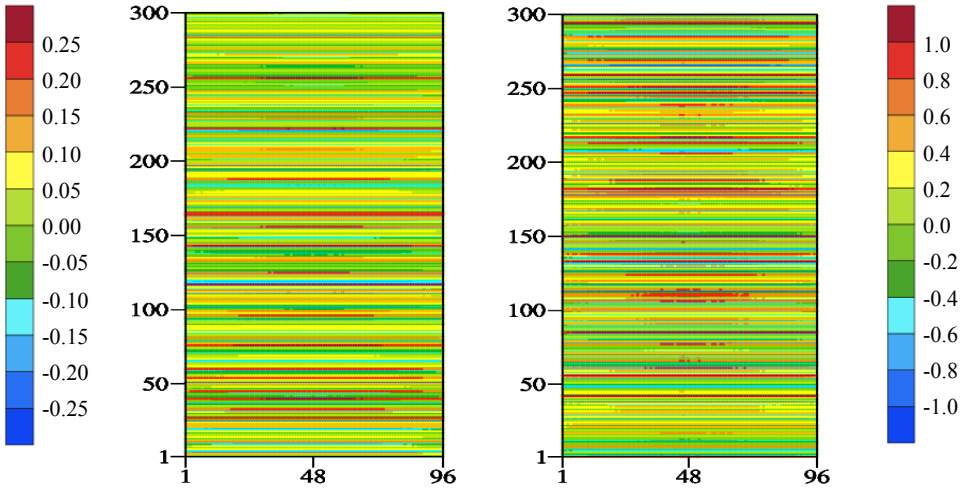


Figure 9: ATMS channel 10 (left panel) and 22 (right panel) striping noise computed from the pitch maneuver data for a swath portion on February 24, 2012.

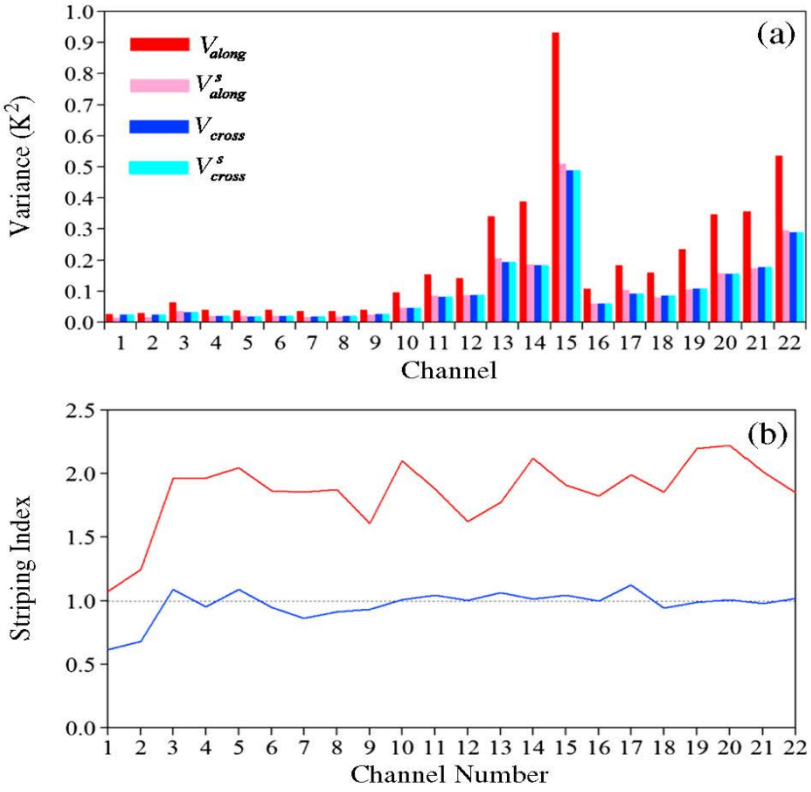


Figure 10: ATMS striping index computed from the pitch maneuver data for a swath portion on February 24, 2012. Red and blue bars represent along- and cross-track variances of original brightness temperatures; and pink and cyan represents the variances after striping mitigation.

3. Geolocation Error

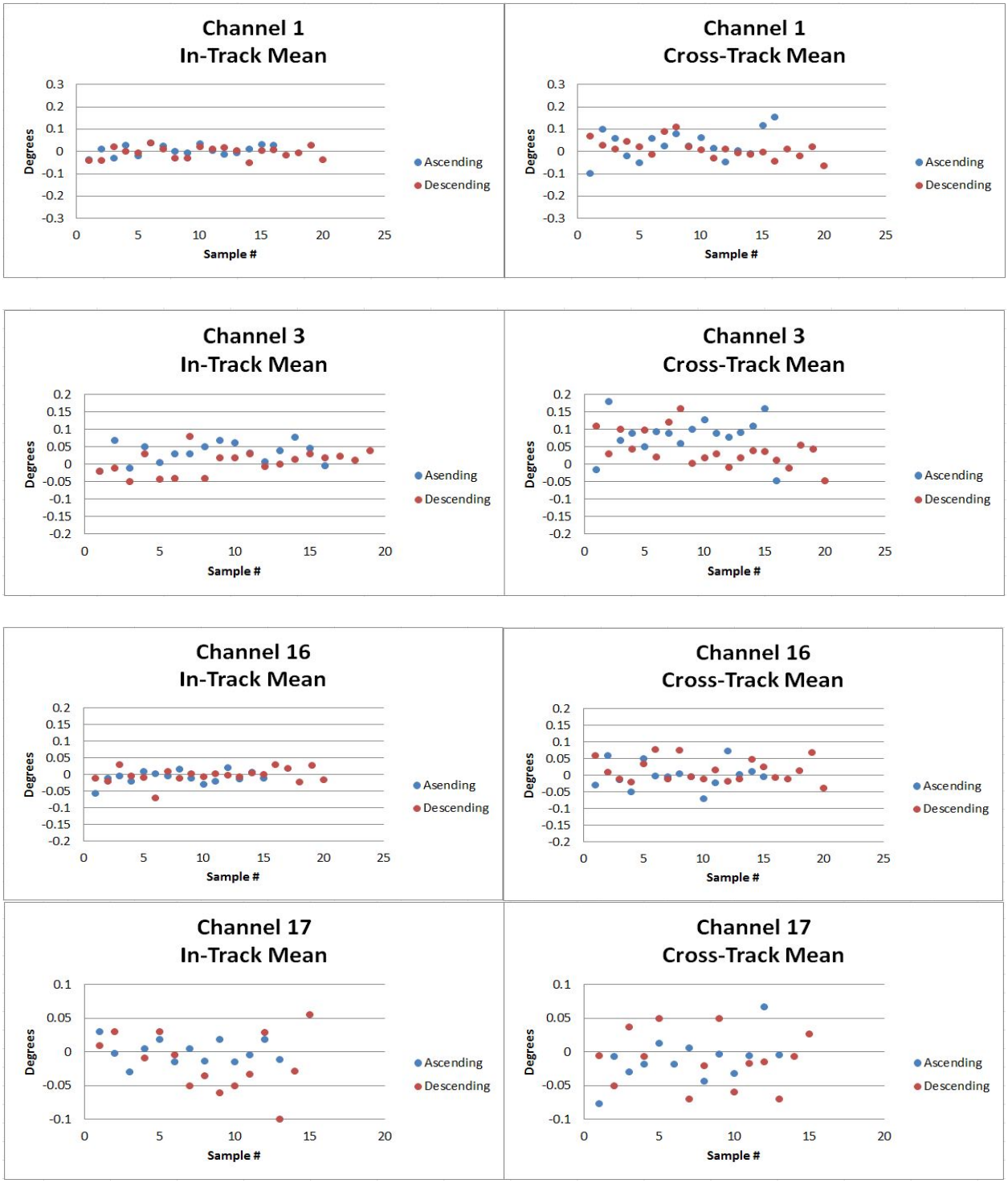


Figure.11: In-track and cross-track mean errors for "edge of scan" geolocation verification analysis: channel 1 ($\pm 0.3^{o}$), channel 3 ($\pm 0.2^{o}$), channel 16 ($\pm 0.2^{o}$), and channel 17 ($\pm 0.1^{o}$)

4. References

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