The Development of AMSU-B/MHS FCDR's and TCDR's for Hydrological Applications

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Background

Passive microwave sounder and satellites

AMSU-B: NOAA-15, NOAA-16, NOAA-17

MHS: NOAA-18, NOAA-19, MetOp-A

Available Years

Satellite	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NOAA-15	May	X	X	X	X	X	X	X	X	X	X	X	X
NOAA-16			Sep	X	X	X	X	X	X	X	X	X	X
NOAA-17					Jun	X	X	X	X	X	X	Dec	
NOAA-18								May	X	X	X	X	X
MetOp-A									Oct	X	X	X	X
NOAA-19												Feb	X

AMSU-B (MHS) Channels

Window: 89, 150 (157) GHz

Water vapor: 183 +/-1, 183 +/-3, 183 +/-7 (190) GHz

(AMSU-A channels: 23.8, 31.4, 50.3, 89.0 GHz)

AMSU-B (MHS) Resolution: 16 km at nadir (90 FOV's)

Data were intended for operational weather prediction.

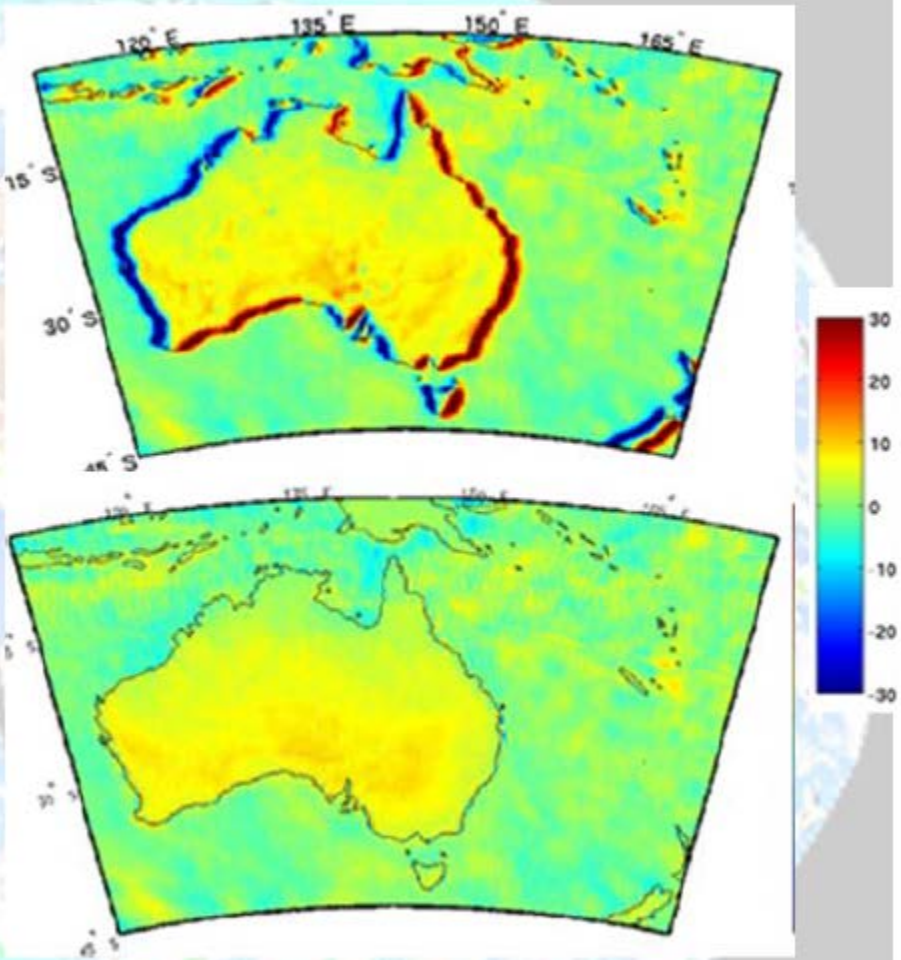
Goal: Create a data set better suited for climate and hydrological applications.

FCDR's
- Geolocation corrections
- Inter-satellite calibration

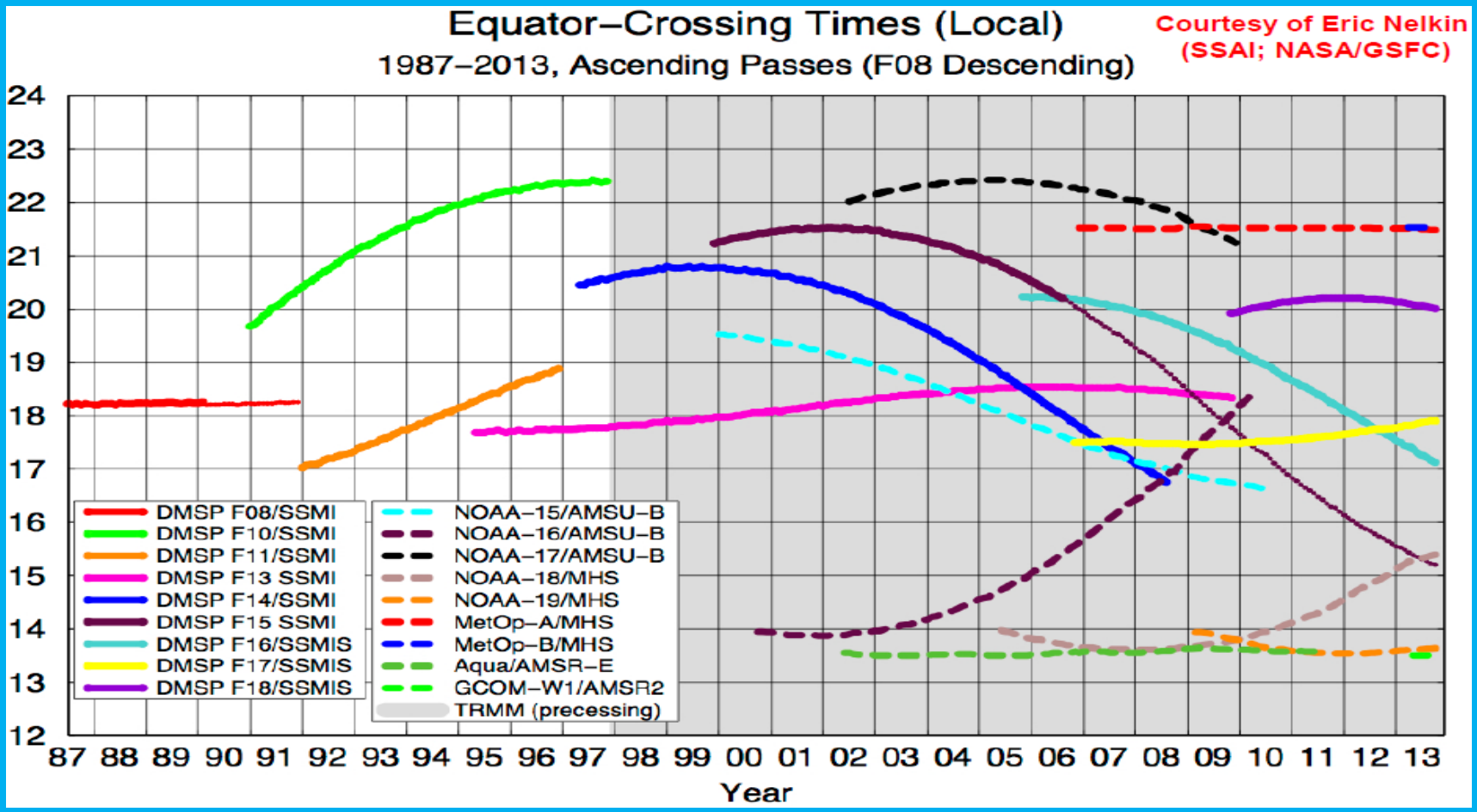
TCDR's

Geolocation

- Errors were larger for the earlier NOAA/POES than for current MetOp
  - AMSU-A problems greater than AMSU-B or MHS
- Empirical model to account for Pitch, Roll, Yaw
  - Eliminates Asc-Des differences across coastlines
  - LUT applied to L1B data on a daily basis



Moradi, I., H. Meng, R.R. Ferraro, S. Bilanow, 2013: Correcting geolocation errors for microwave instruments aboard NOAA satellites, *IEEE Trans. Geosci. Rem. Sens.*, 51, 3625-3637.


Equator–Crossing Times (Local)
1987–2013, Ascending Passes (F08 Descending)
Courtesy of Eric Nelkin
(SSAI; NASA/GSFC)
24
23
22
21
20
19
18
17
16
15
14
13
12
87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13
Year
DMSP F08/SSMI
DMSP F10/SSMI
DMSP F11/SSMI
DMSP F13 SSMI
DMSP F14/SSMI
DMSP F15 SSMI
DMSP F16/SSMIS
DMSP F17/SSMIS
DMSP F18/SSMIS
NOAA–15/AMSU–B
NOAA–16/AMSU–B
NOAA–17/AMSU–B
NOAA–18/MHS
NOAA–19/MHS
MetOp–A/MHS
MetOp–B/MHS
Aqua/AMSR–E
GCOM–W1/AMSR2
TRMM (precessing)

Inter-satellite calibration

Select reference satellites
NOAA-17 for AMSU-B

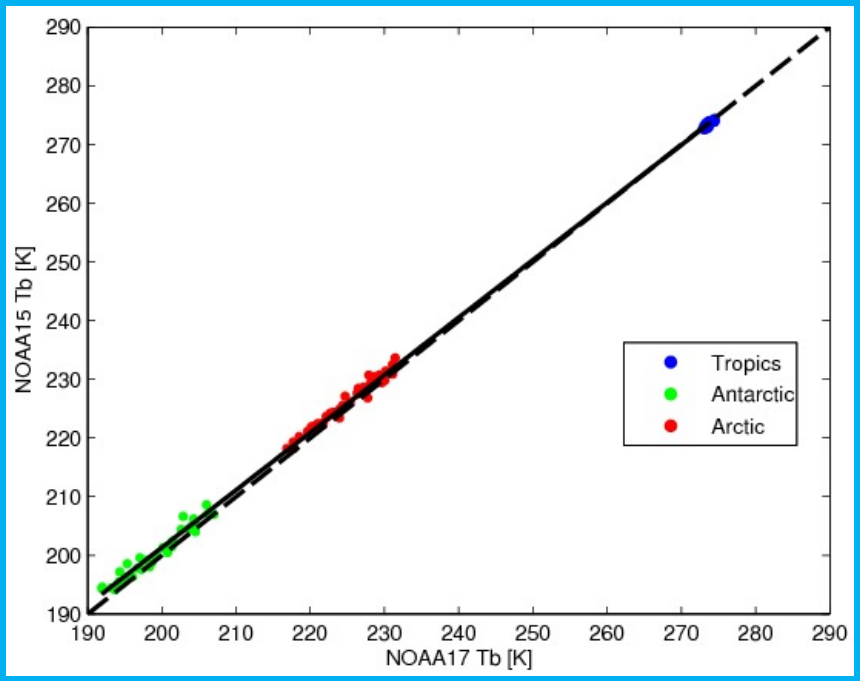
NOAA-18 for MHS

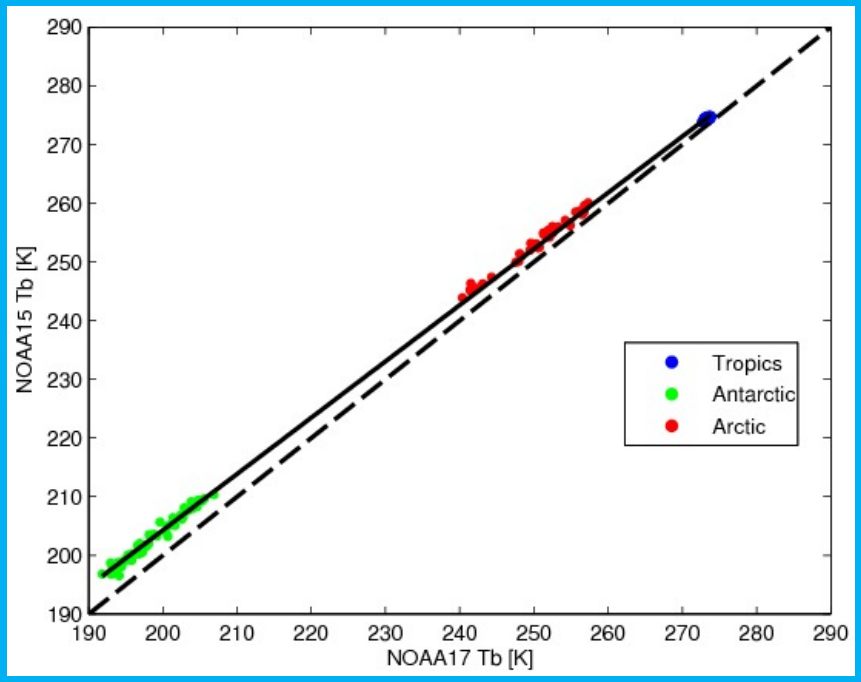
Satellite pairs
NOAA-15/NOAA-17 (June 2002 – Dec. 2009)
NOAA-16/NOAA-17 (June 2002 – Dec. 2009)

MetOp-A/NOAA-18
NOAA-19/NOAA-18

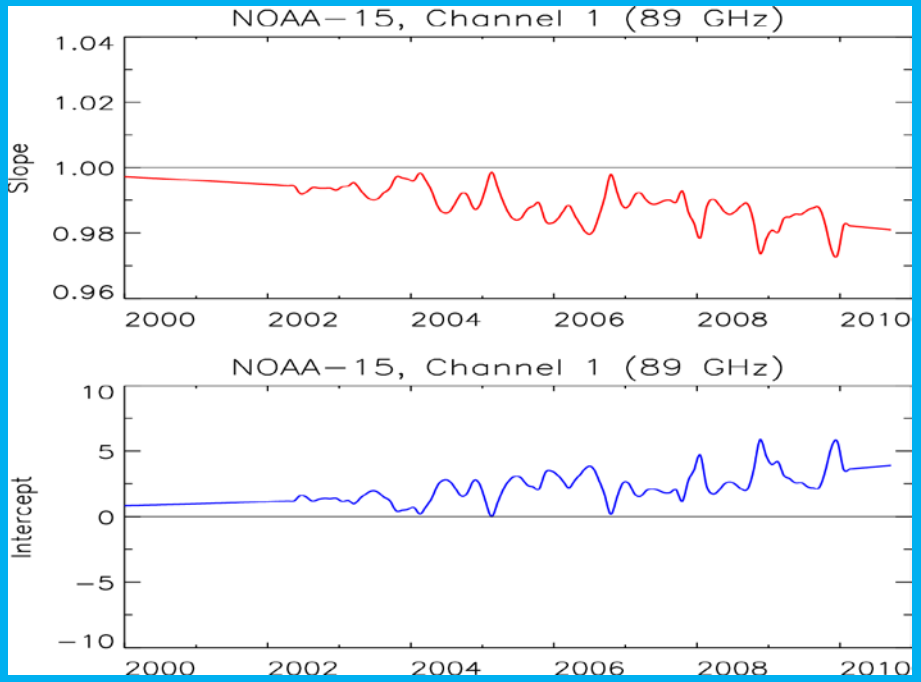
Create Scatterplots of TB's
Tropical, Ocean, Cloud-free
Antarctica
Arctic

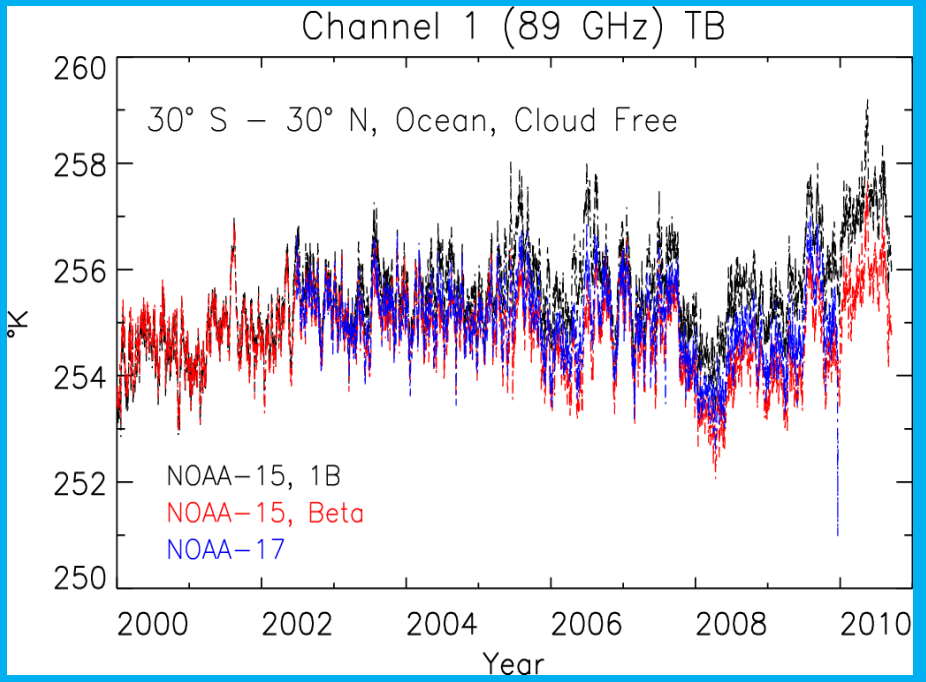
Monthly slope/intercept from scatterplot

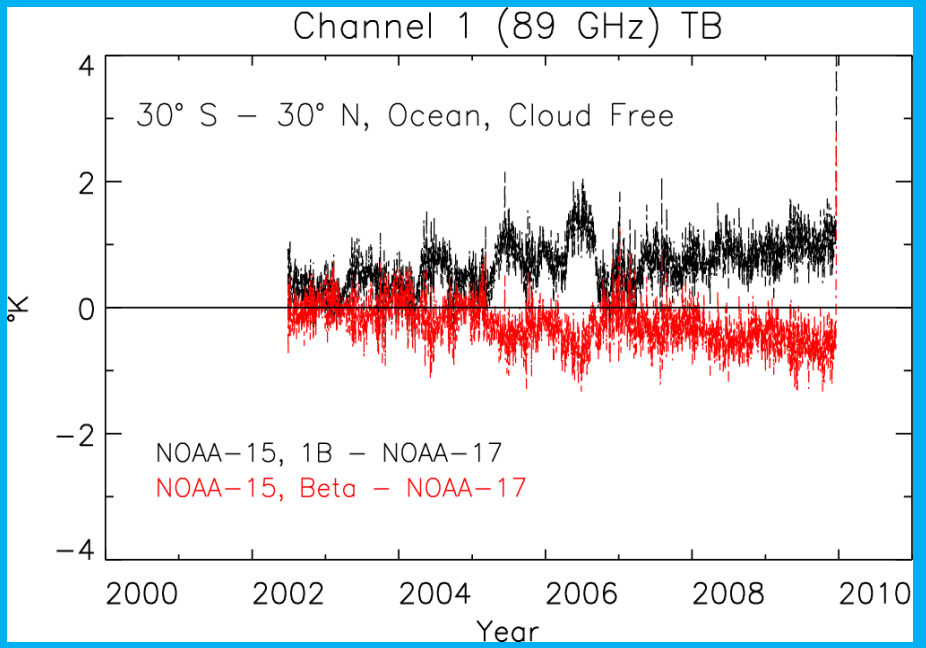


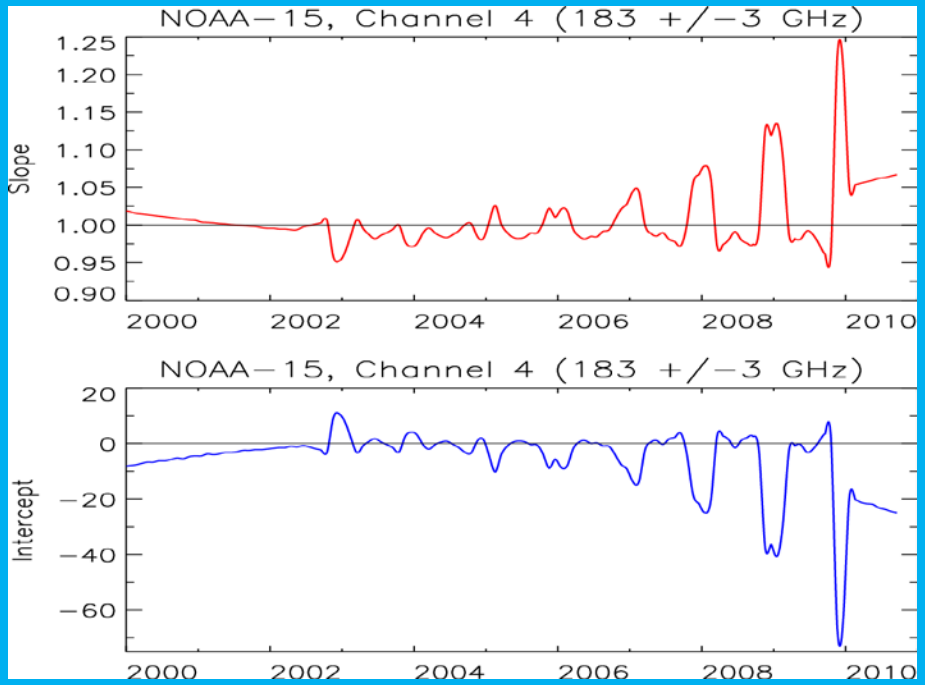


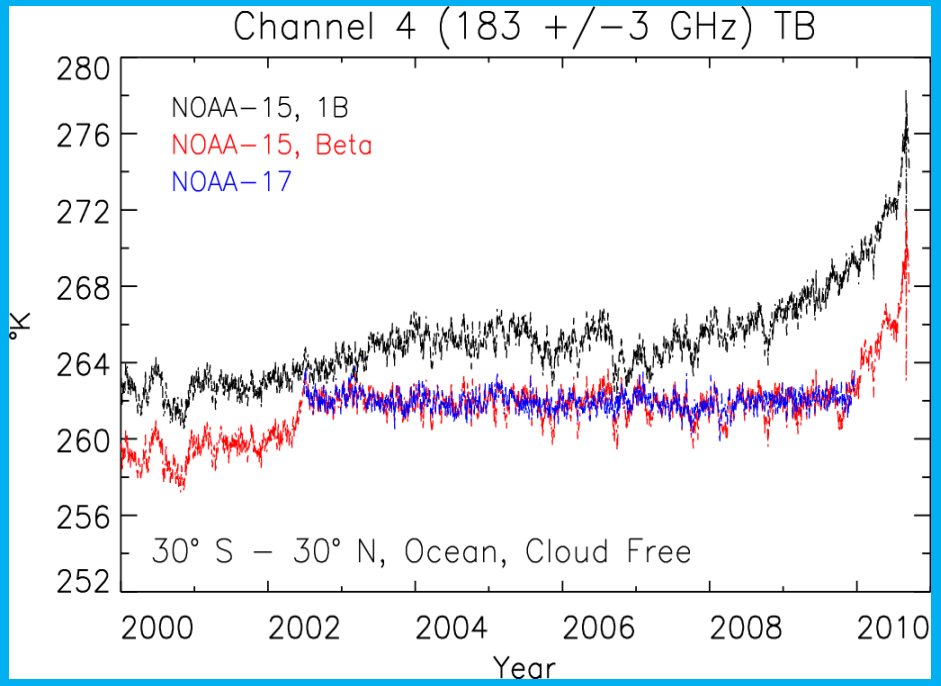
Monthly values were interpolated to daily
For pre- and post-overlap period (NOAA-15, NOAA-16)-- extrapolate

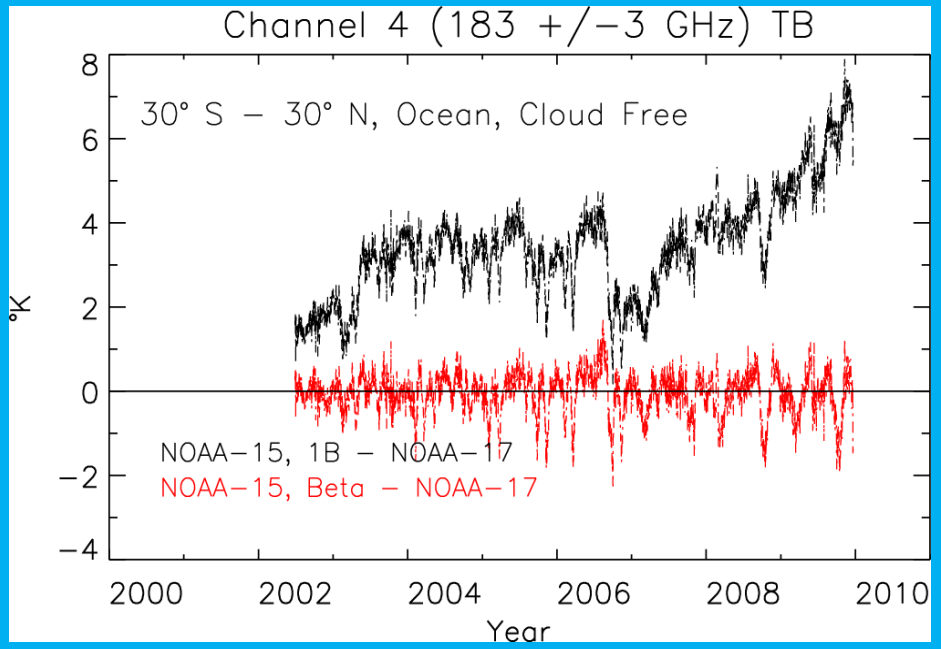

NOAA−15, Channel 1 (89 GHz)
Slope
1.04
1.02
1.00
0.98
0.96
2000
2002
2004
2006
2008
2010
NOAA−15, Channel 1 (89 GHz)
Intercept
10
5
0
−5
−10
2000
2002
2004
2006
2008
2010

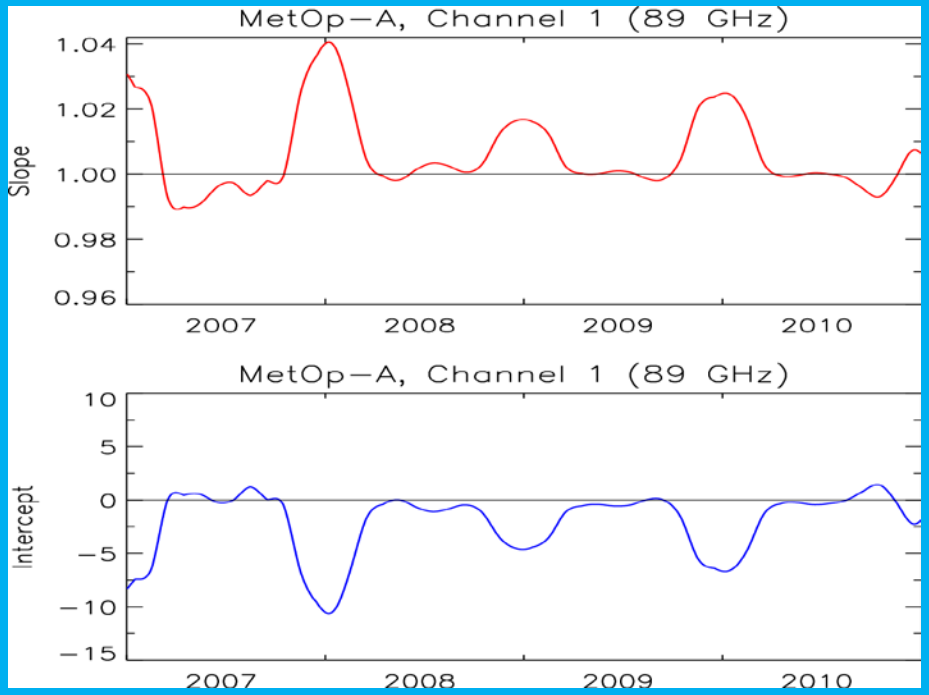

Channel 1 (89 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
260
258
256
254
252
250
NOAA−15, 1B
NOAA−15, Beta
NOAA−17
2000
2002
2004
2006
2008
2010
Year

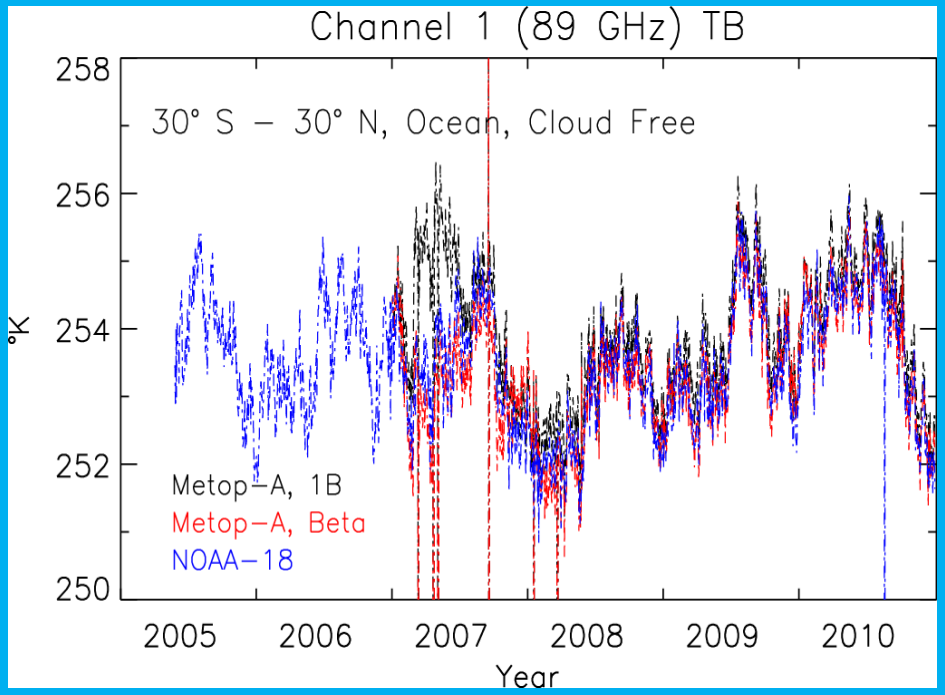

Channel 1 (89 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
4
2
0
−2
−4
NOAA−15, 1B − NOAA−17
NOAA−15, Beta − NOAA−17
2000
2002
2004
2006
2008
2010
Year

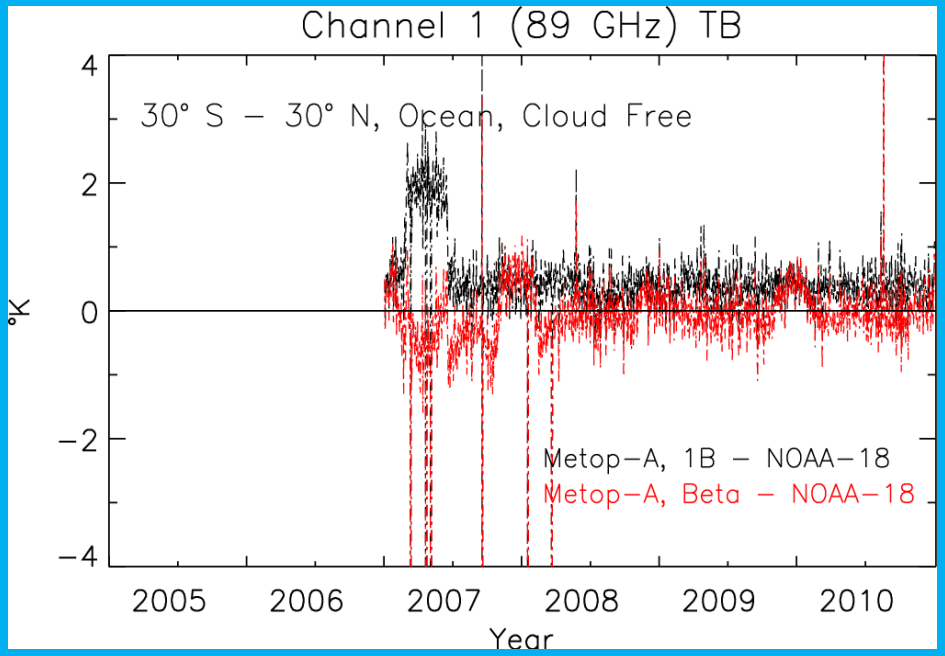

NOAA−15, Channel 4 (183 +/−3 GHz)
Slope
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
2000
2002
2004
2006
2008
2010
NOAA−15, Channel 4 (183 +/−3 GHz)
Intercept
20
0
−20
−40
−60
2000
2002
2004
2006
2008
2010

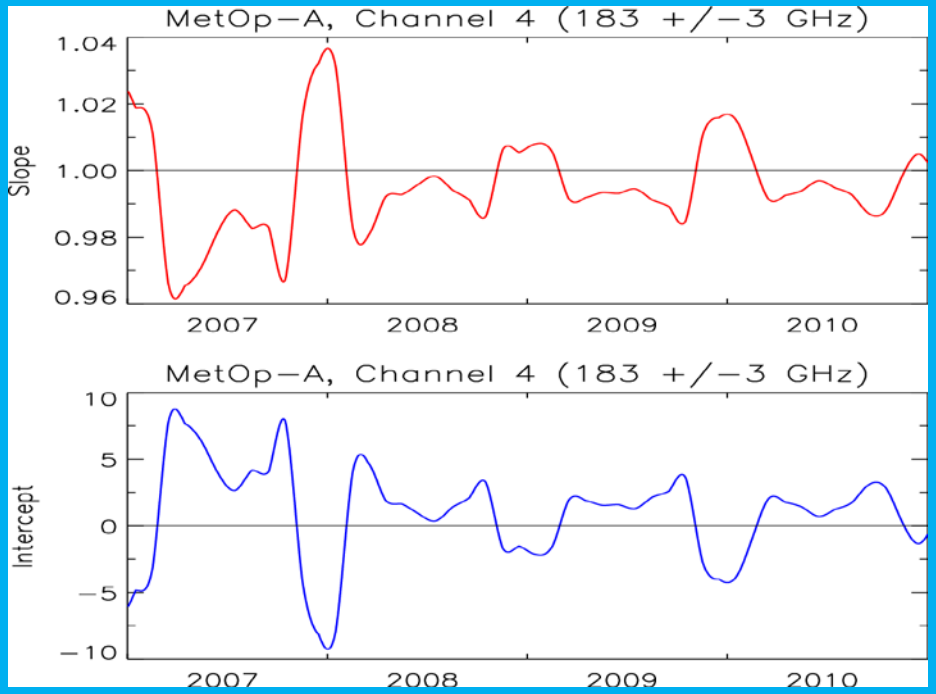

Channel 4 (183 +/−3 GHz) TB
NOAA−15, 1B
NOAA−15, Beta
NOAA−17
°K
280
276
272
268
264
260
256
252
30° S − 30° N, Ocean, Cloud Free
2000
2002
2004
2006
2008
2010
Year

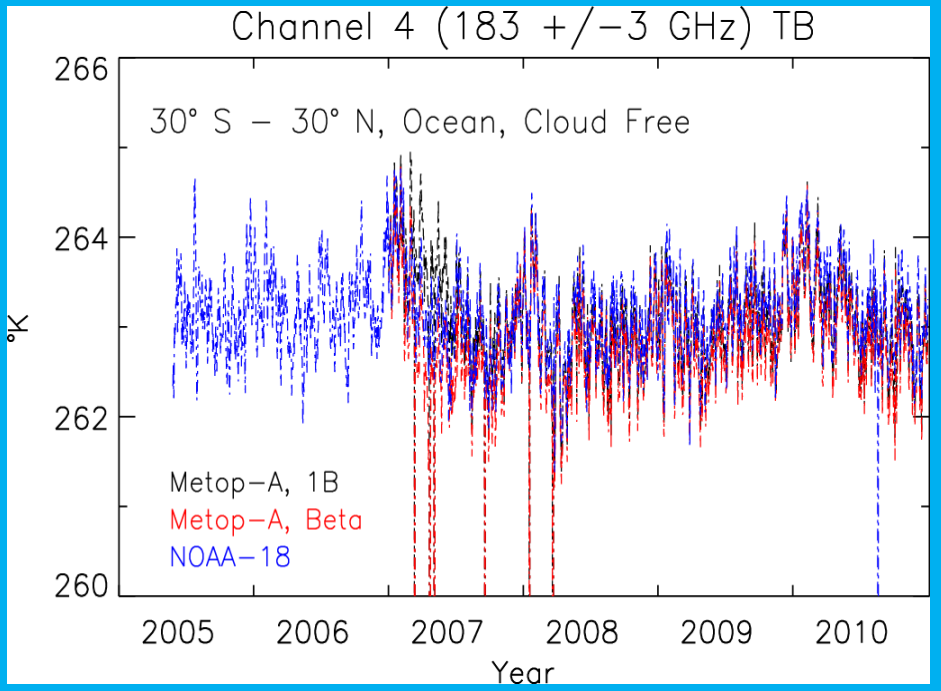

Channel 4 (183 +/−3 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
8
6
4
2
0
−2
−4
NOAA−15, 1B − NOAA−17
NOAA−15, Beta − NOAA−17
2000
2002
2004
2006
2008
2010
Year

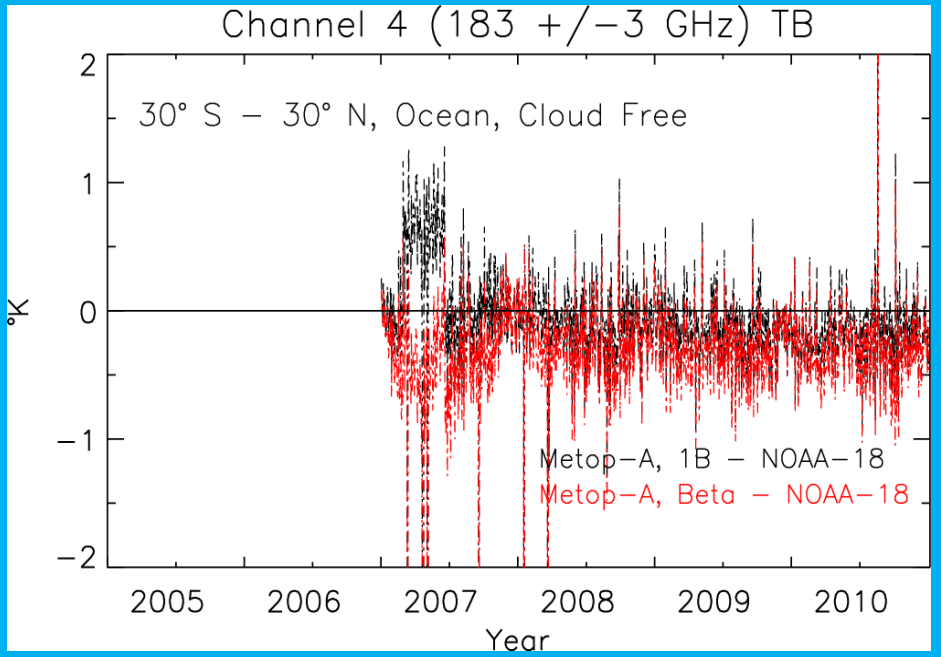

MetOp−A, Channel 1 (89 GHz)
Slope
1.04
1.02
1.00
0.98
0.96
2007
2008
2009
2010
MetOp−A, Channel 1 (89 GHz)
Intercept
10
5
0
−5
−10
−15
2007
2008
2009
2010


Channel 1 (89 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
258
256
254
252
250
Metop−A, 1B
Metop−A, Beta
NOAA−18
2005
2006
2007
2008
2009
2010
Year


Channel 1 (89 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
4
2
0
−2
−4
Metop−A, 1B − NOAA−18
Metop−A, Beta − NOAA−18
2005
2006
2007
2008
2009
2010
Year


MetOp−A, Channel 4 (183 +/−3 GHz)
Slope
1.04
1.02
1.00
0.98
0.96
2007
2008
2009
2010
MetOp−A, Channel 4 (183 +/−3 GHz)
Intercept
10
5
0
−5
−10
2007
2008
2009
2010


Channel 4 (183 +/−3 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
266
264
262
260
Metop−A, 1B
Metop−A, Beta
NOAA−18
2005
2006
2007
2008
2009
2010
Year


Channel 4 (183 +/−3 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
2
1
0
−1
−2
Metop−A, 1B − NOAA−18
Metop−A, Beta − NOAA−18
2005
2006
2007
2008
2009
2010
Year

TCDR's

AMSU-B/MHS (FCDR's)
AVN (GFS) data
Algorithm from MSPSS

AMSU-B/MHS TCDR products:

- Rain rate
- Snow cover
- Ice water path
- Snow water equivalent
- Effective diameter of ice particles

(all output is orbital, NetCDF4 files (same as FCDR's))

Short record (11 years); these data may be more useful when combined with data from other sensors such as AMSU-A, SSM/I, AMSR-E, and TRMM Microwave Imager

Current Status and Future Work

Level Beta data (FCDR's) for 2000 – 2010
Includes time, lat/lon, solar zenith angle, earth incidence angle, surface type, orbital mode, five TB's

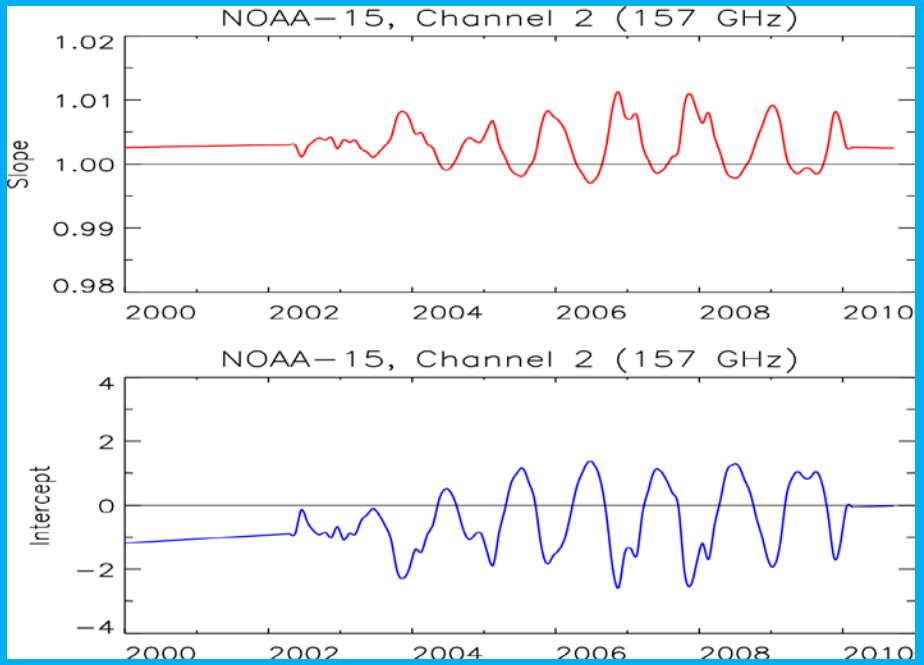
Deliver data sets, necessary documentation and software to NCDC

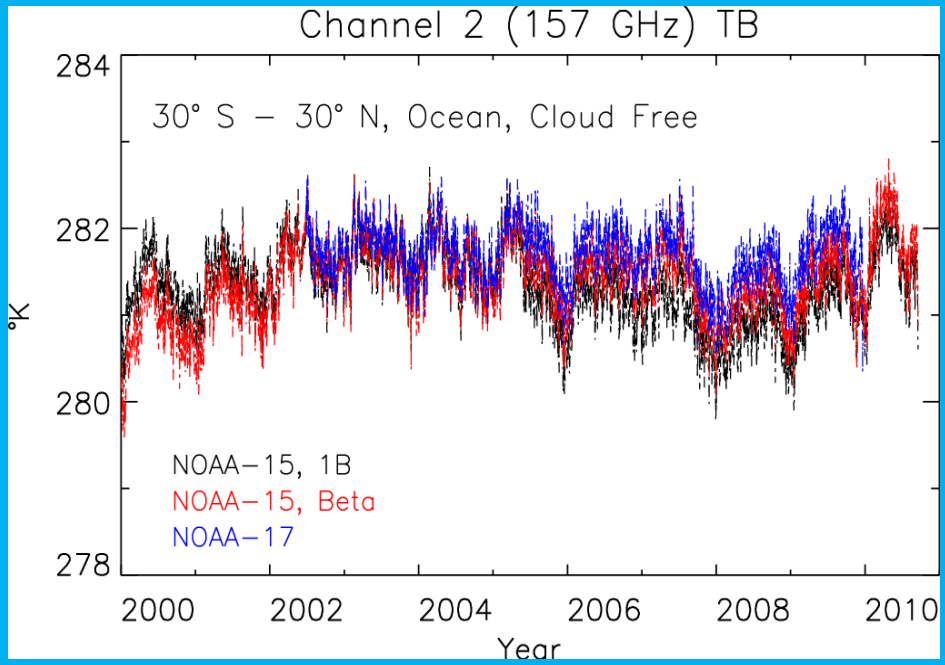
Develop TCDR's from level Beta TB's

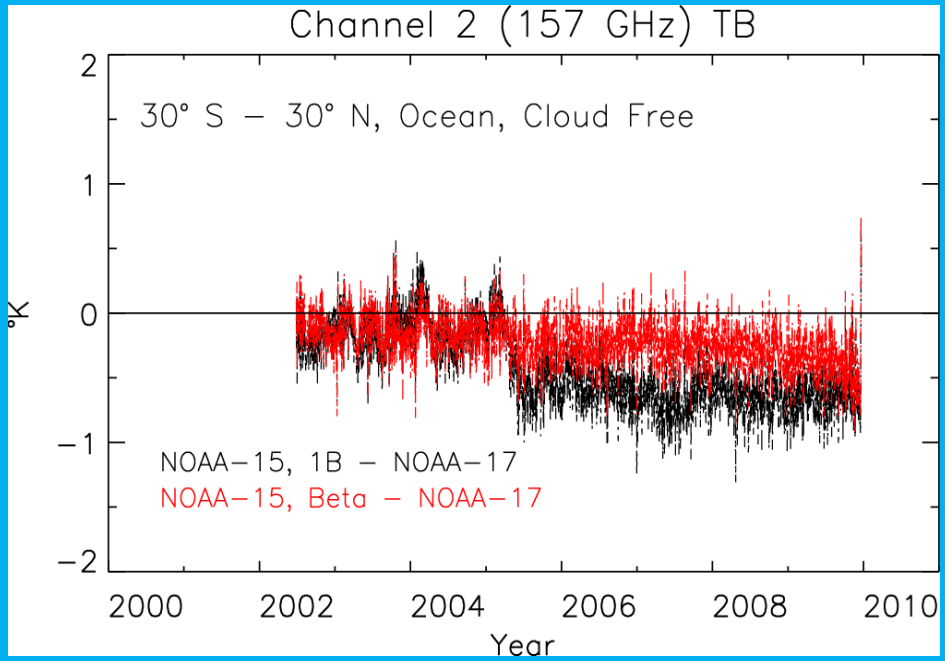
Validation of TCDR's will determine future corrections for satellite TB's

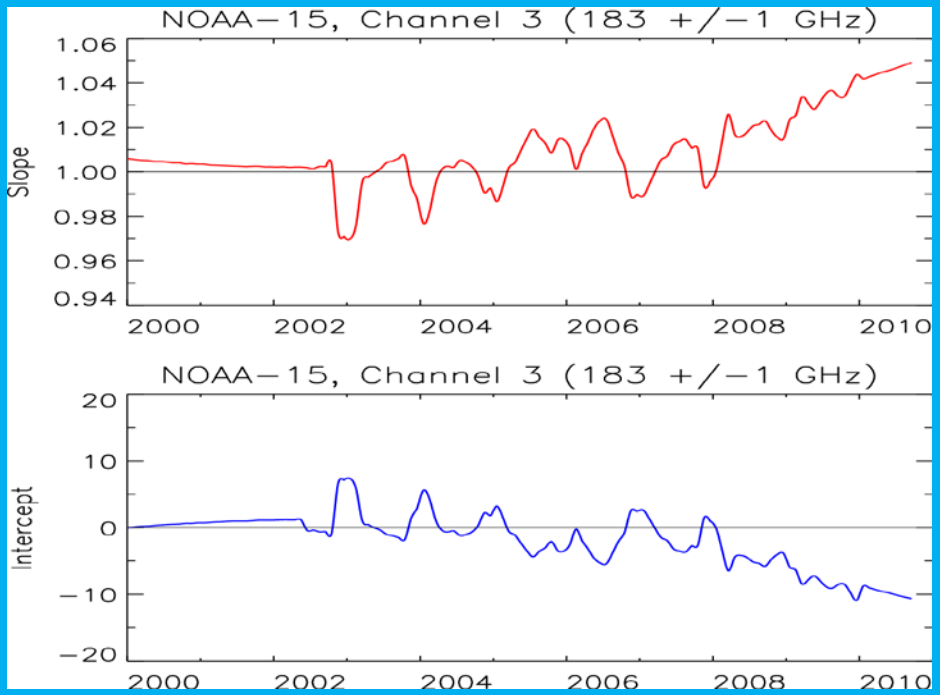
Expand the period past 2010.

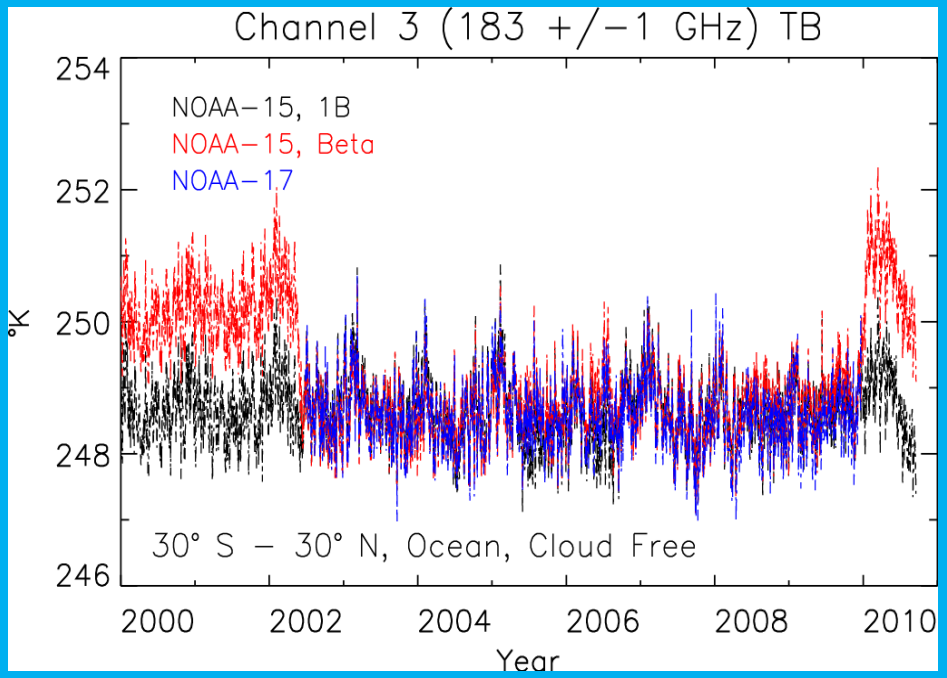
Backups

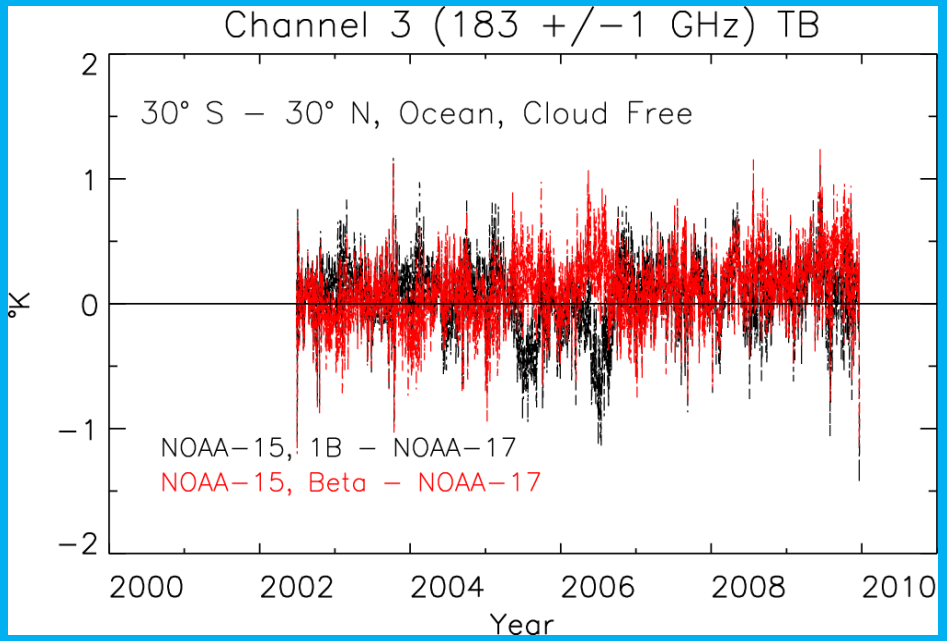

NOAA−15, Channel 2 (157 GHz)
Slope
1.02
1.01
1.00
0.99
0.98
2000
2002
2004
2006
2008
2010
NOAA−15, Channel 2 (157 GHz)
Intercept
4
2
0
−2
−4
2000
2002
2004
2006
2008
2010

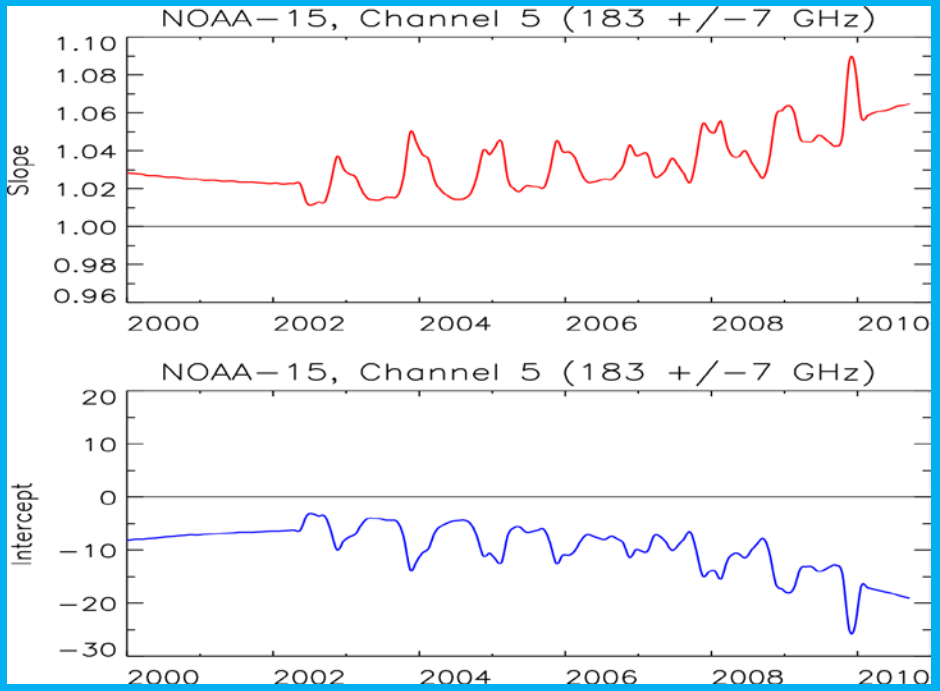

Channel 2 (157 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
284
282
280
278
NOAA−15, 1B
NOAA−15, Beta
NOAA−17
2000
2002
2004
2006
2008
2010
Year

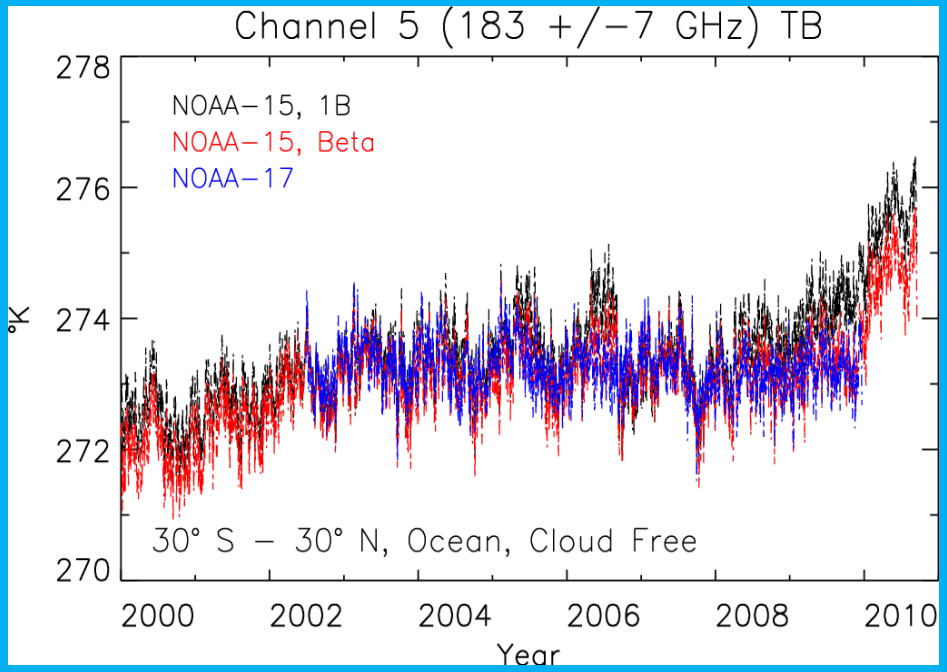

Channel 2 (157 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
2
1
0
−1
−2
NOAA−15, 1B − NOAA−17
NOAA−15, Beta − NOAA−17
2000
2002
2004
2006
2008
2010
Year

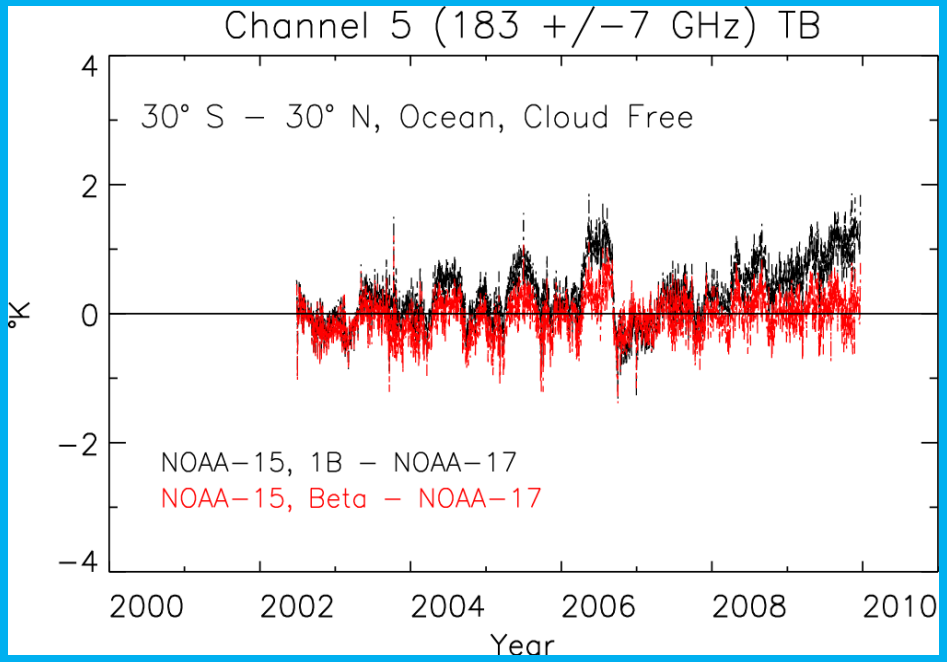

NOAA−15, Channel 3 (183 +/−1 GHz)
Slope
1.06
1.04
1.02
1.00
0.98
0.96
0.94
2000
2002
2004
2006
2008
2010
NOAA−15, Channel 3 (183 +/−1 GHz)
Intercept
20
10
0
−10
−20
2000
2002
2004
2006
2008
2010

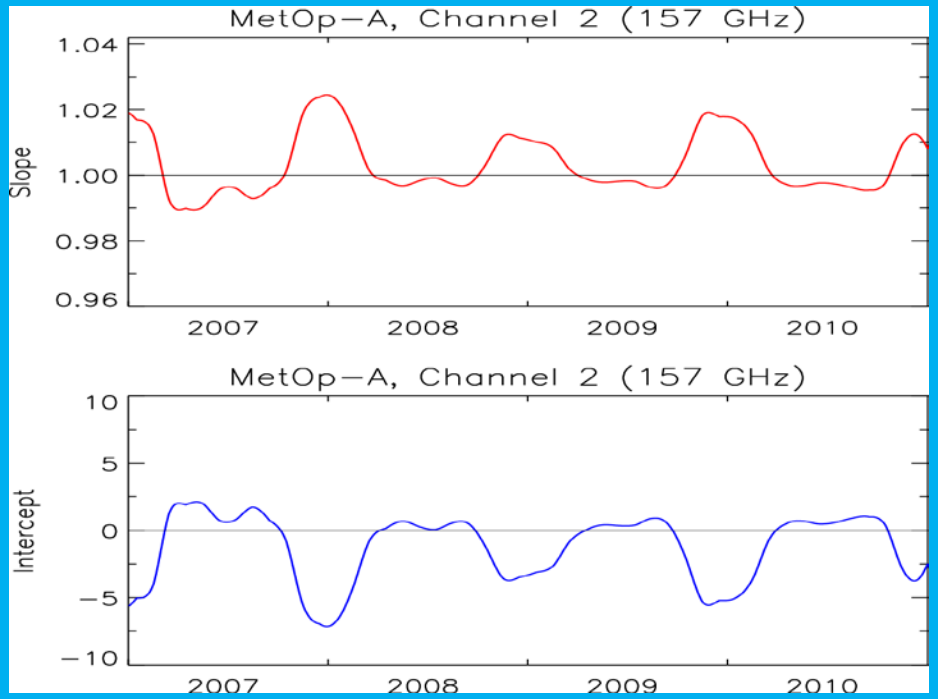

Channel 3 (183 +/−1 GHz) TB
°K
254
252
250
248
246
NOAA−15, 1B
NOAA−15, Beta
NOAA−17
30° S − 30° N, Ocean, Cloud Free
2000
2002
2004
2006
2008
2010
Year

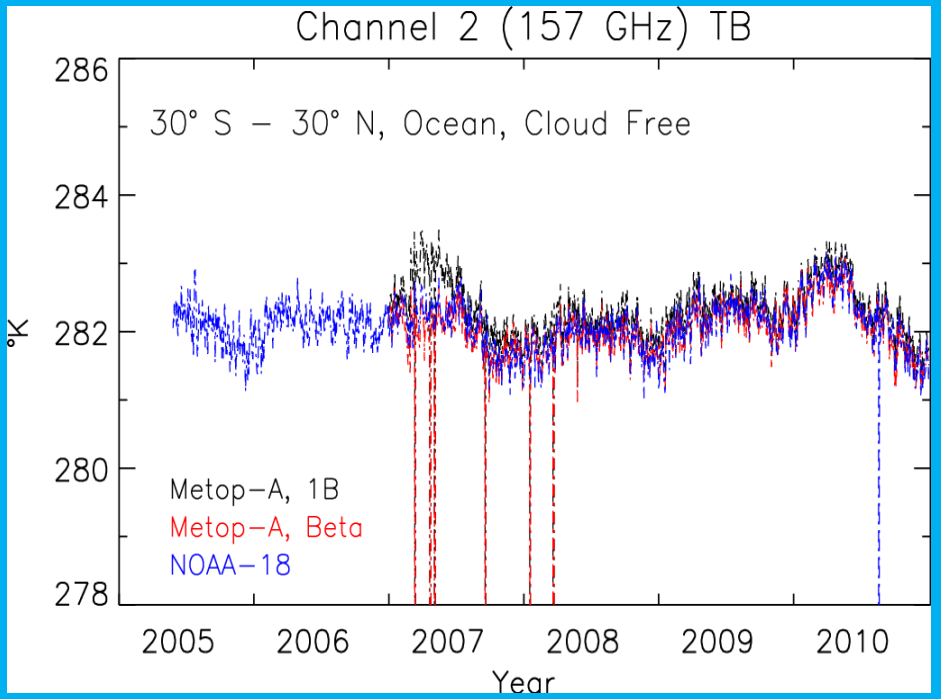

Channel 3 (183 +/−1 GHz) TB
°K
2
1
0
−1
−2
30° S − 30° N, Ocean, Cloud Free
NOAA−15, 1B − NOAA−17
NOAA−15, Beta − NOAA−17
2000
2002
2004
2006
2008
2010
Year

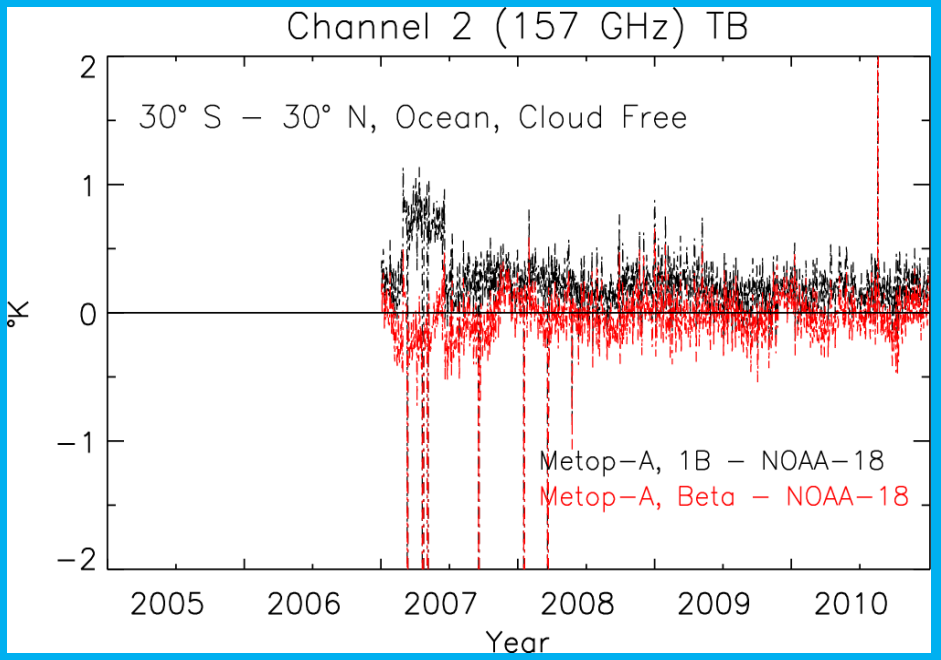

NOAA−15, Channel 5 (183 +/−7 GHz)
Slope
1.10
1.08
1.06
1.04
1.02
1.00
0.98
0.96
2000
2002
2004
2006
2008
2010
NOAA−15, Channel 5 (183 +/−7 GHz)
Intercept
20
10
0
−10
−20
−30
2000
2002
2004
2006
2008
2010

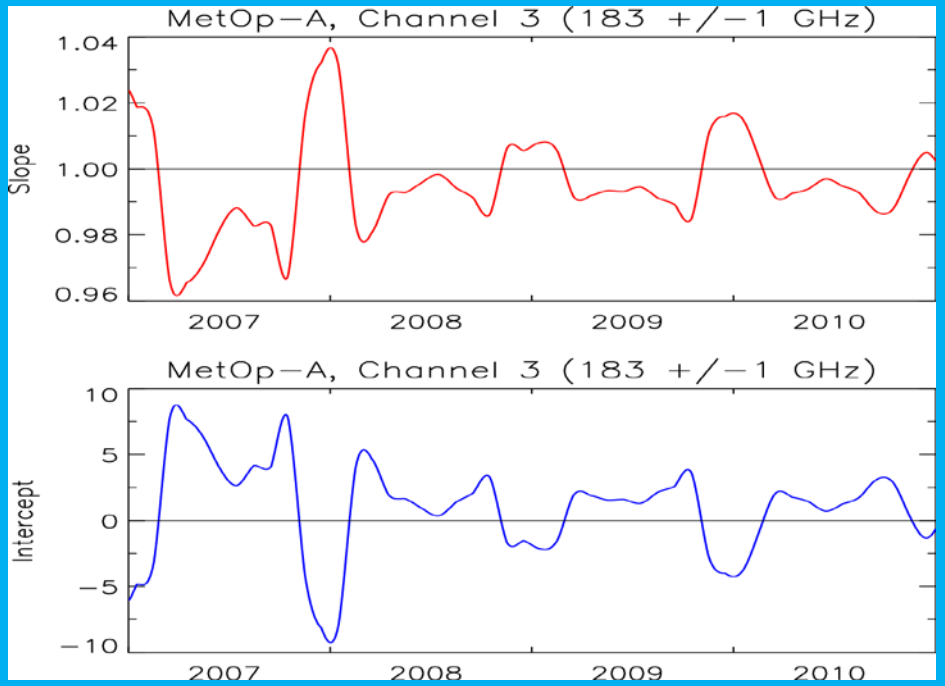

Channel 5 (183 +/−7 GHz) TB
NOAA−15, 1B
NOAA−15, Beta
NOAA−17
30° S − 30° N, Ocean, Cloud Free
°K
278
276
274
272
270
2000
2002
2004
2006
2008
2010
Year

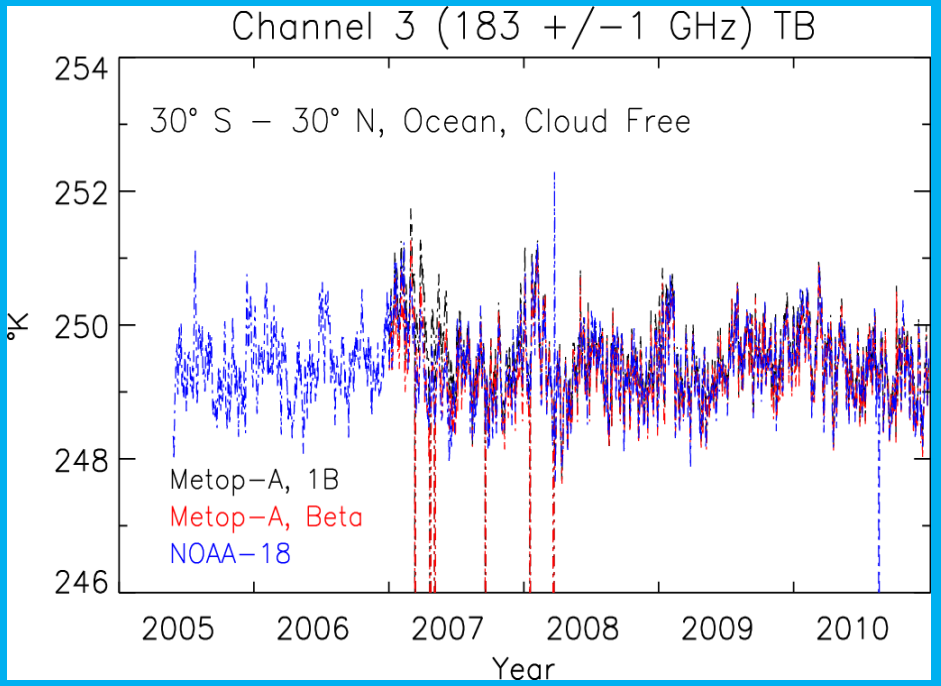

Channel 5 (183 +/−7 GHz) TB
30° S − 30° N, Ocean, Cloud Free
NOAA−15, 1B − NOAA−17
NOAA−15, Beta − NOAA−17
°K
4
2
0
−2
−4
2000
2002
2004
2006
2008
2010
Year

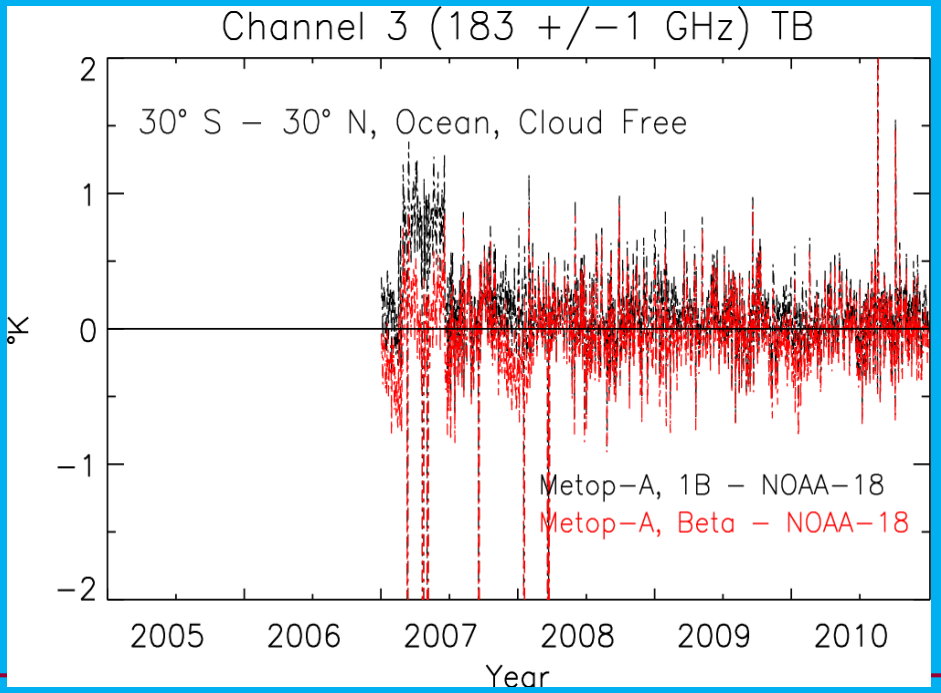

MetOp–A, Channel 2 (157 GHz)
Slope
1.04
1.02
1.00
0.98
0.96
2007
2008
2009
2010
MetOp–A, Channel 2 (157 GHz)
Intercept
10
5
0
–5
–10
2007
2008
2009
2010

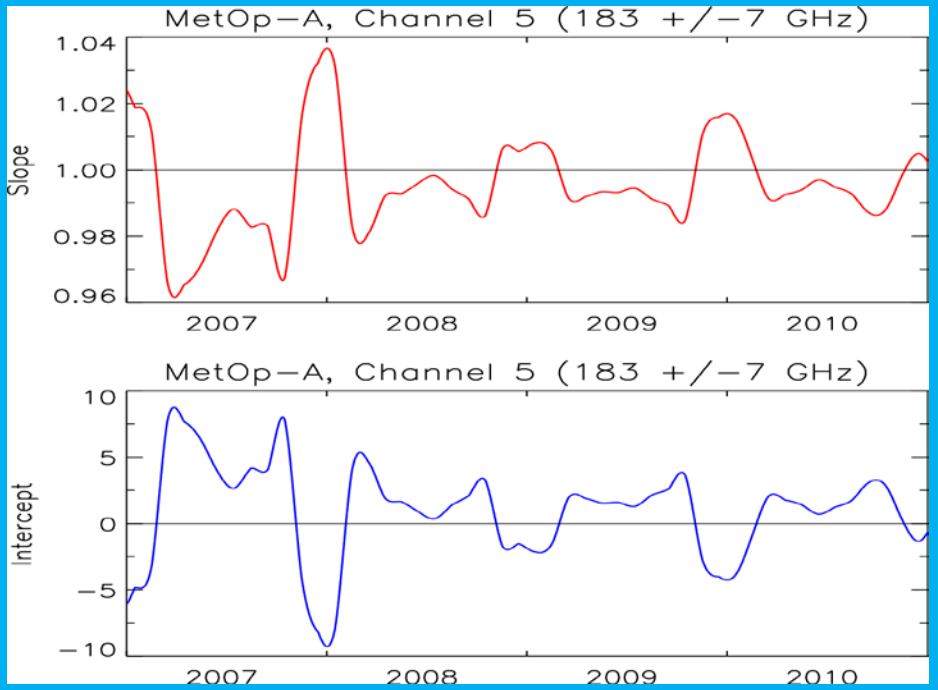

Channel 2 (157 GHz) TB
30° S – 30° N, Ocean, Cloud Free
°K
286
284
282
280
278
Metop–A, 1B
Metop–A, Beta
NOAA–18
2005
2006
2007
2008
2009
2010
Year

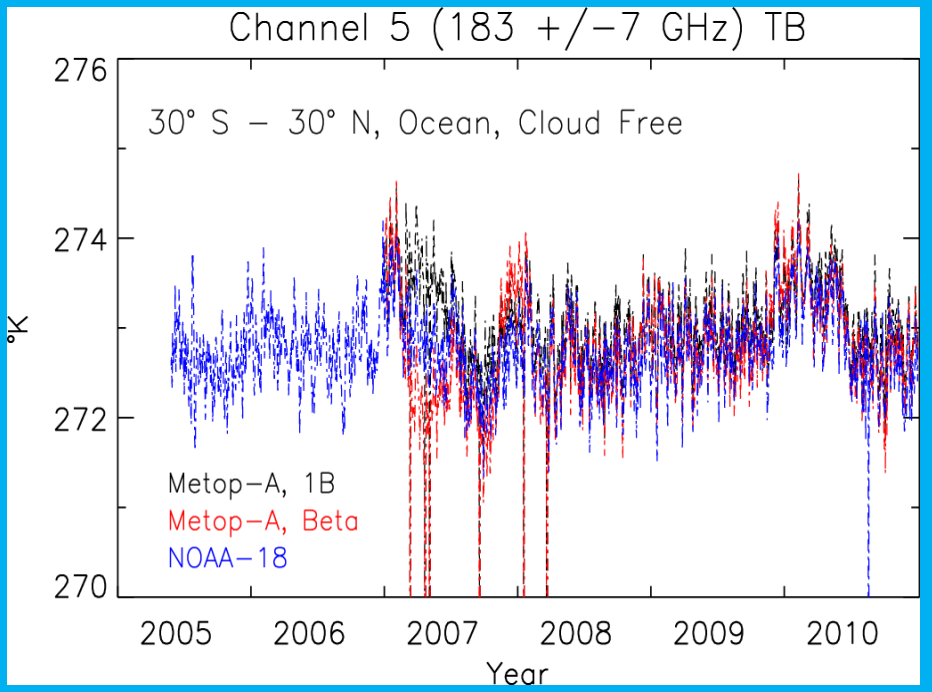

Channel 2 (157 GHz) TB
30° S – 30° N, Ocean, Cloud Free
°K
2
1
0
–1
–2
Metop–A, 1B – NOAA–18
Metop–A, Beta – NOAA–18
2005
2006
2007
2008
2009
2010
Year

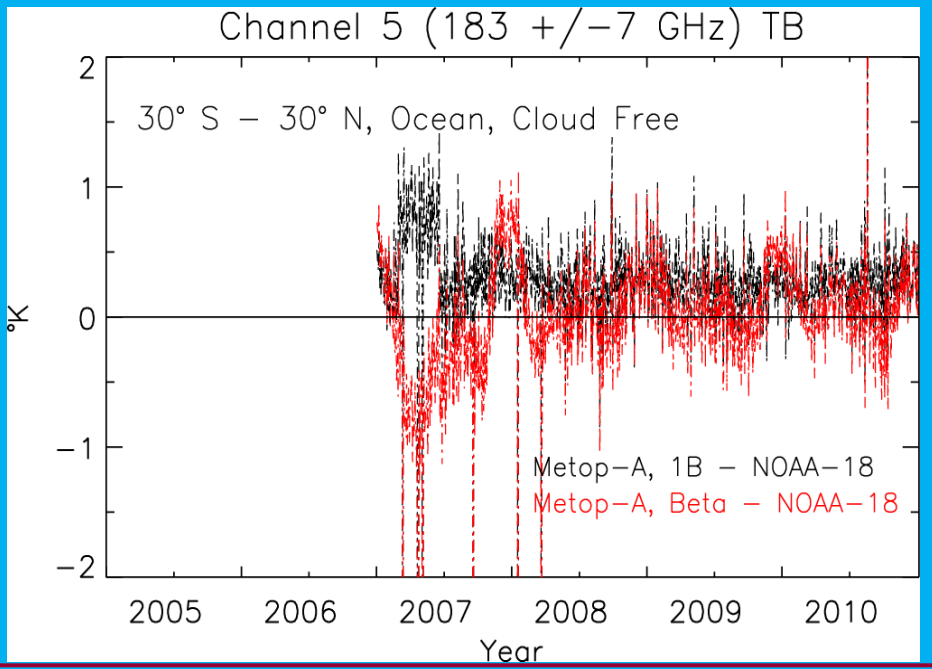

MetOp–A, Channel 3 (183 +/–1 GHz)
Slope
1.04
1.02
1.00
0.98
0.96
2007
2008
2009
2010
MetOp–A, Channel 3 (183 +/–1 GHz)
Intercept
10
5
0
–5
–10
2007
2008
2009
2010


Channel 3 (183 +/–1 GHz) TB
30° S – 30° N, Ocean, Cloud Free
°K
254
252
250
248
246
Metop–A, 1B
Metop–A, Beta
NOAA–18
2005
2006
2007
2008
2009
2010
Year


Channel 3 (183 +/–1 GHz) TB
30° S – 30° N, Ocean, Cloud Free
°K
2
1
0
–1
–2
Metop–A, 1B – NOAA–18
Metop–A, Beta – NOAA–18
2005
2006
2007
2008
2009
2010
Year


MetOp−A, Channel 5 (183 +/−7 GHz)
Slope
1.04
1.02
1.00
0.98
0.96
2007
2008
2009
2010
MetOp−A, Channel 5 (183 +/−7 GHz)
Intercept
10
5
0
−5
−10
2007
2008
2009
2010


Channel 5 (183 +/−7 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
276
274
272
270
Metop−A, 1B
Metop−A, Beta
NOAA−18
2005
2006
2007
2008
2009
2010
Year


Channel 5 (183 +/−7 GHz) TB
30° S − 30° N, Ocean, Cloud Free
°K
2
1
0
−1
−2
Metop−A, 1B − NOAA−18
Metop−A, Beta − NOAA−18
2005
2006
2007
2008
2009
2010
Year