

# Geolocation Correction for the NOAA Passive Microwave Instruments

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# How to quantify the geolocation error?

## Main sources of the geolocation errors

### 1. Satellite attitude offset and sensor pointing errors

Satellite attitudes are known as Pitch, Roll and Yaw (in mathematics: Euler Angles)

and are included in the geolocation algorithm by a rotation matrix

### 2. Poor spacecraft ephemeris data

### 3. Satellite clock offset

The implemented correction method will take care of all sources of errors.

The method is just applicable to the microwave window channels

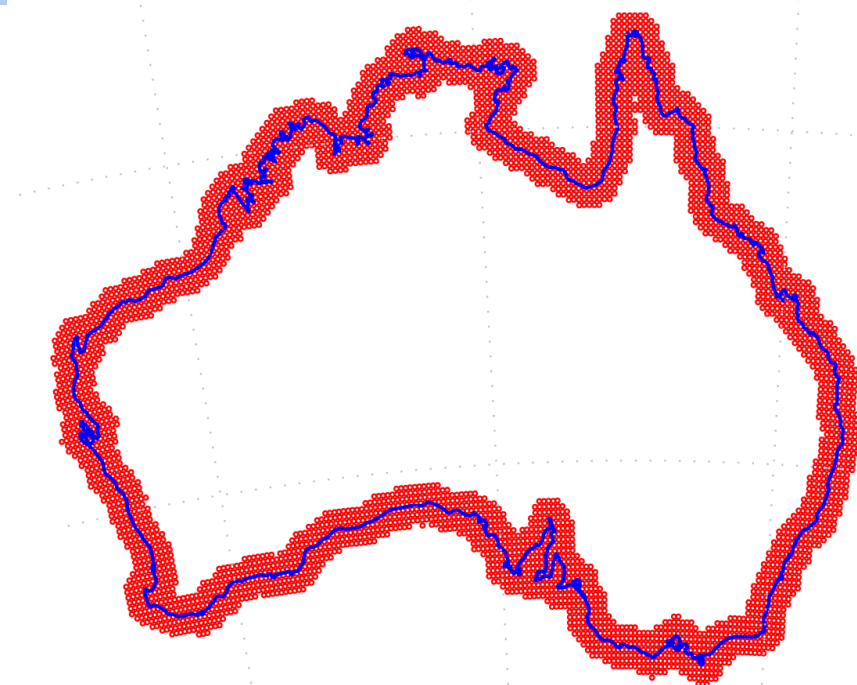
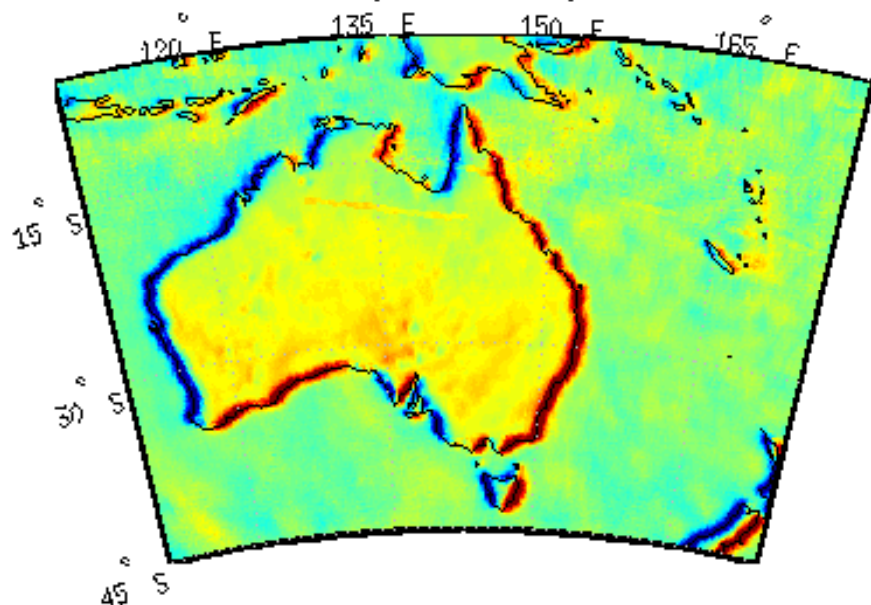
Channel No.	Frequency (GHz)	Polarization at nadir	Atmospheric transmission (tropical)	Atmospheric transmission (winter subarctic)
1	23.8	V	0.78	0.99
2	31.4	V	0.89	0.96
3	50.3	V	0.63	0.68
4	52.8	V	0.29	0.32
5	$53.596 \pm 0.115$	H	0.11	0.13
6	54.40	H	0.02	0.02
7	54.94	V	0.00	0.00
8	55.50	H	0.00	0.00
9	$57.290 = \nu$	H	0.00	0.00
10	$\nu \pm 0.217$	H	0.00	0.00
11	$\nu \pm 0.322 \pm 0.048$	H	0.00	0.00
12	$\nu \pm 0.322 \pm 0.022$	H	0.00	0.00
13	$\nu \pm 0.322 \pm 0.010$	H	0.00	0.00
14	$\nu \pm 0.322 \pm 0.0045$	H	0.00	0.00
15	89.0	V	0.61	0.91

# Quantifying the geolocation error

- No geolocation error  $\Rightarrow \Delta TB$ , ascending – descending, is very small (diurnal variation, environmental conditions, limb effect).
- Geolocation error  $\Rightarrow \Delta Tb$  is very large along the coast lines because the land TB is much higher than ocean TB
- ❑ *negative alongtrack offset  $\Rightarrow$  northern coastlines will have a cold edge, and southern coastlines will have a warm edge.*
- ❑ *negative crosstrack offset  $\Rightarrow$  western coastlines will have a cold edge and the eastern coastlines will have a warm edge*

# Sample difference map

NOAA-15 AMSU-A Channel 1, 1-1-2003 to 1-31-2003



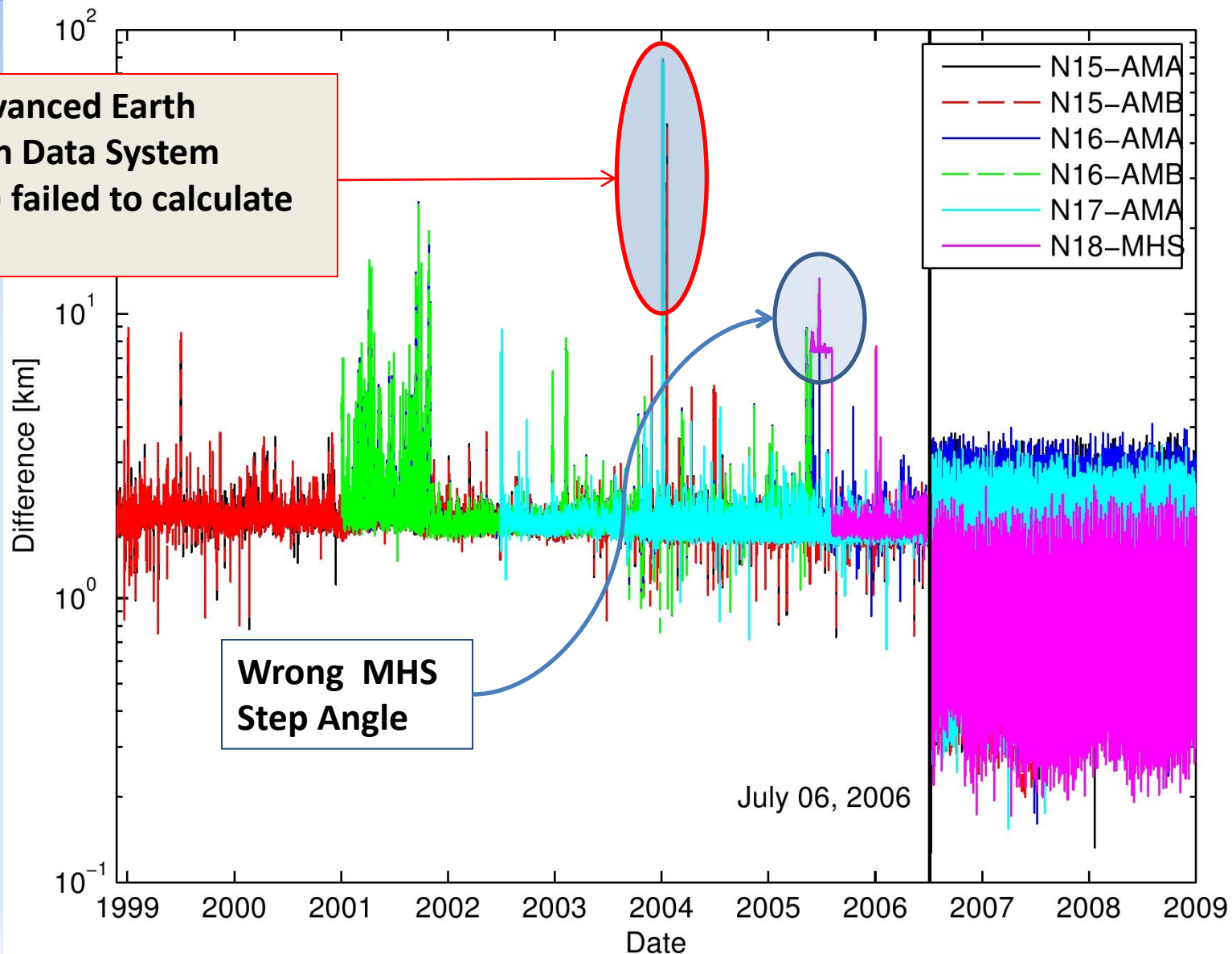
**Index = number of pixels along the coastlines where  $\Delta T_b > \text{threshold}$**

# NOAA Level 1b Geolocation Problems



# Difference between NOAA-L1b and new geolocation

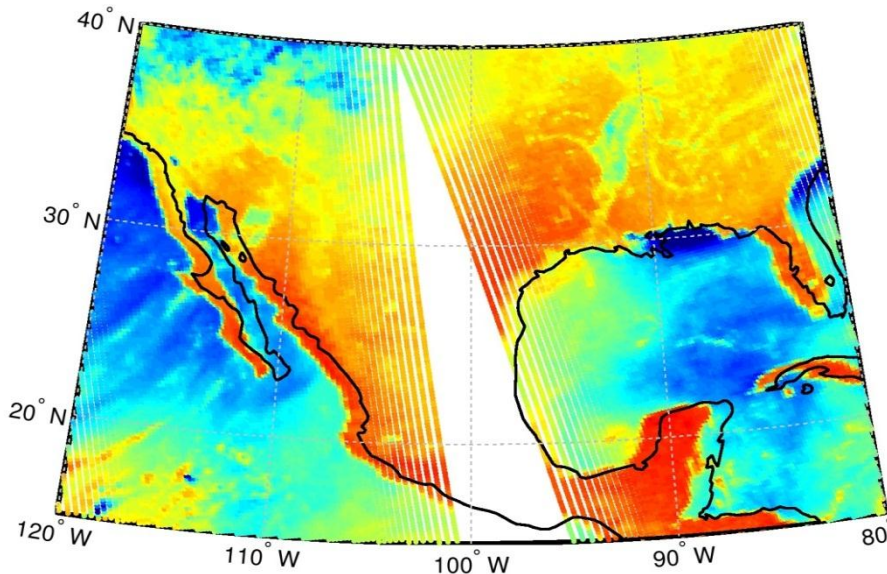
The Advanced Earth  
Location Data System  
(AELDS) failed to calculate  
GHA



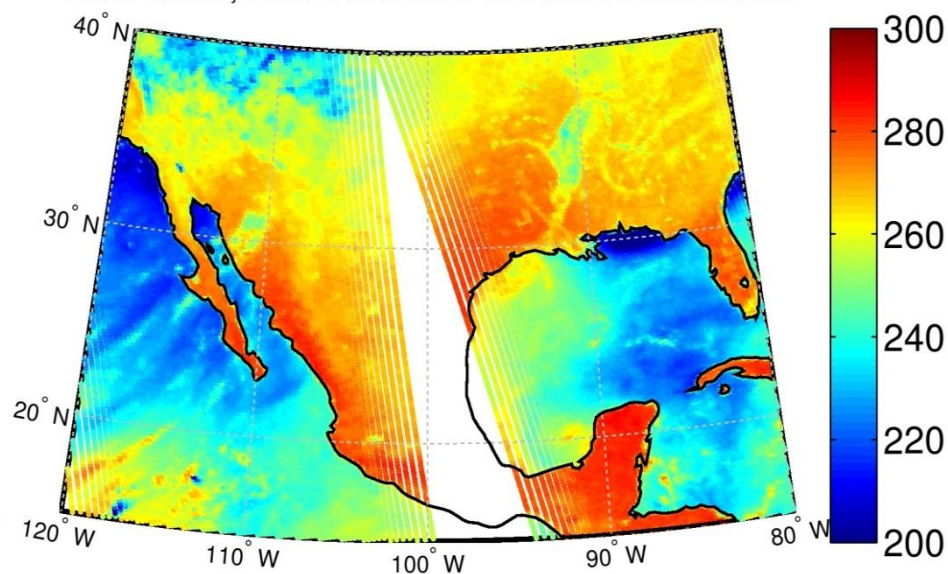
Wrong MHS  
Step Angle

July 06, 2006

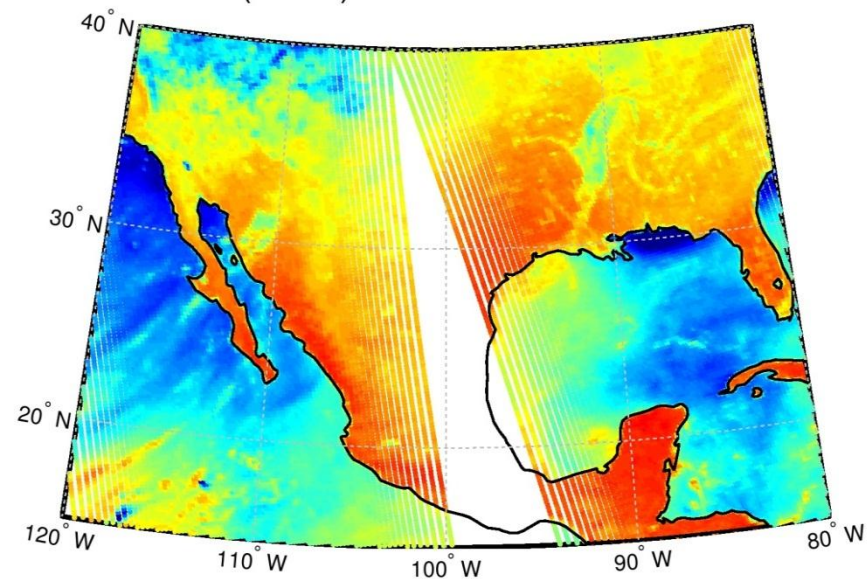
NOAA CLASS Data: AMBX.NK.D04001.S0000.E015



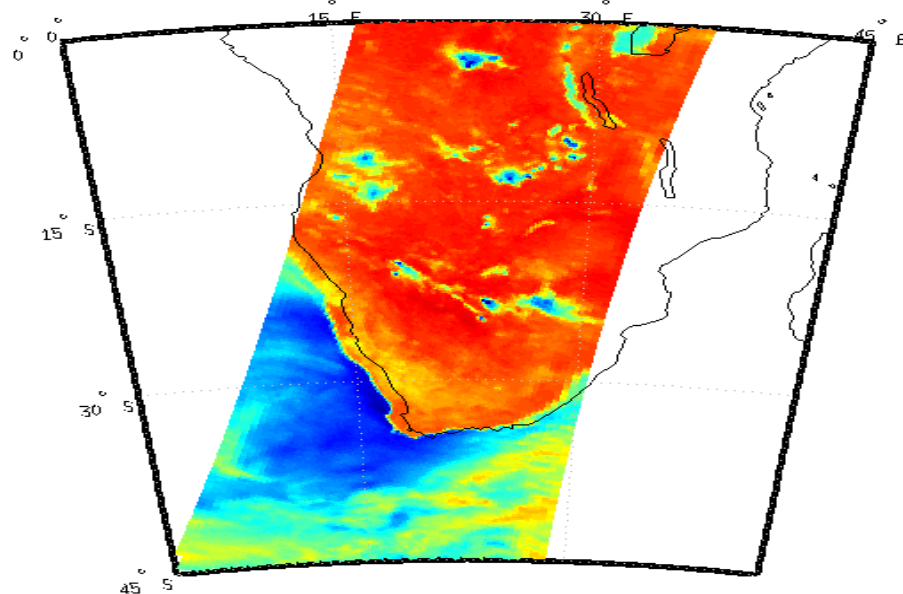
New Geo., AMBX.NK.D04001.S0000.E0153



NOAA CLASS (lon+1): AMBX.NK.D04001.S0000.E0153



NOAA 1b Geolocation Data, Swath: AMBX.NL.D04001.S0001.E0123

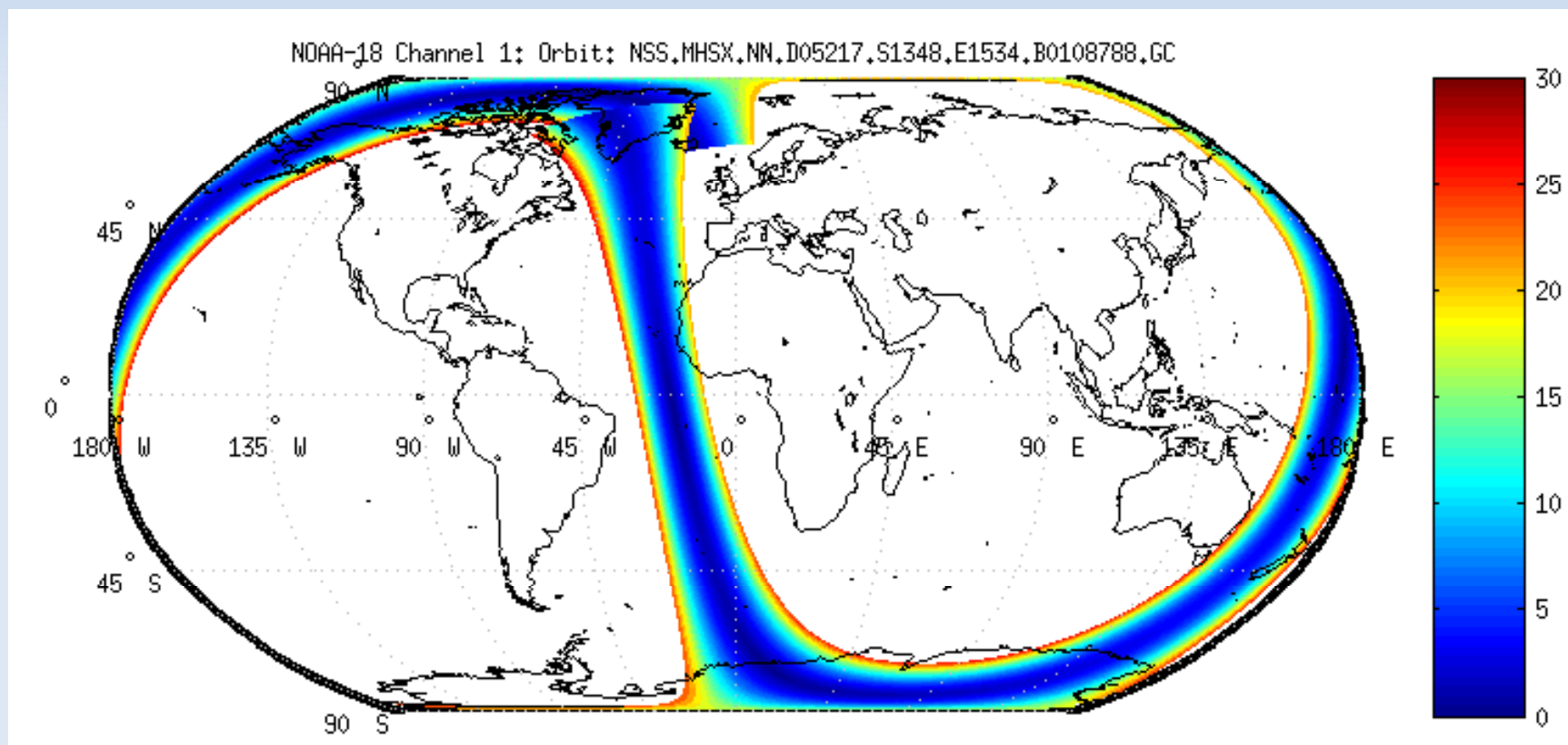




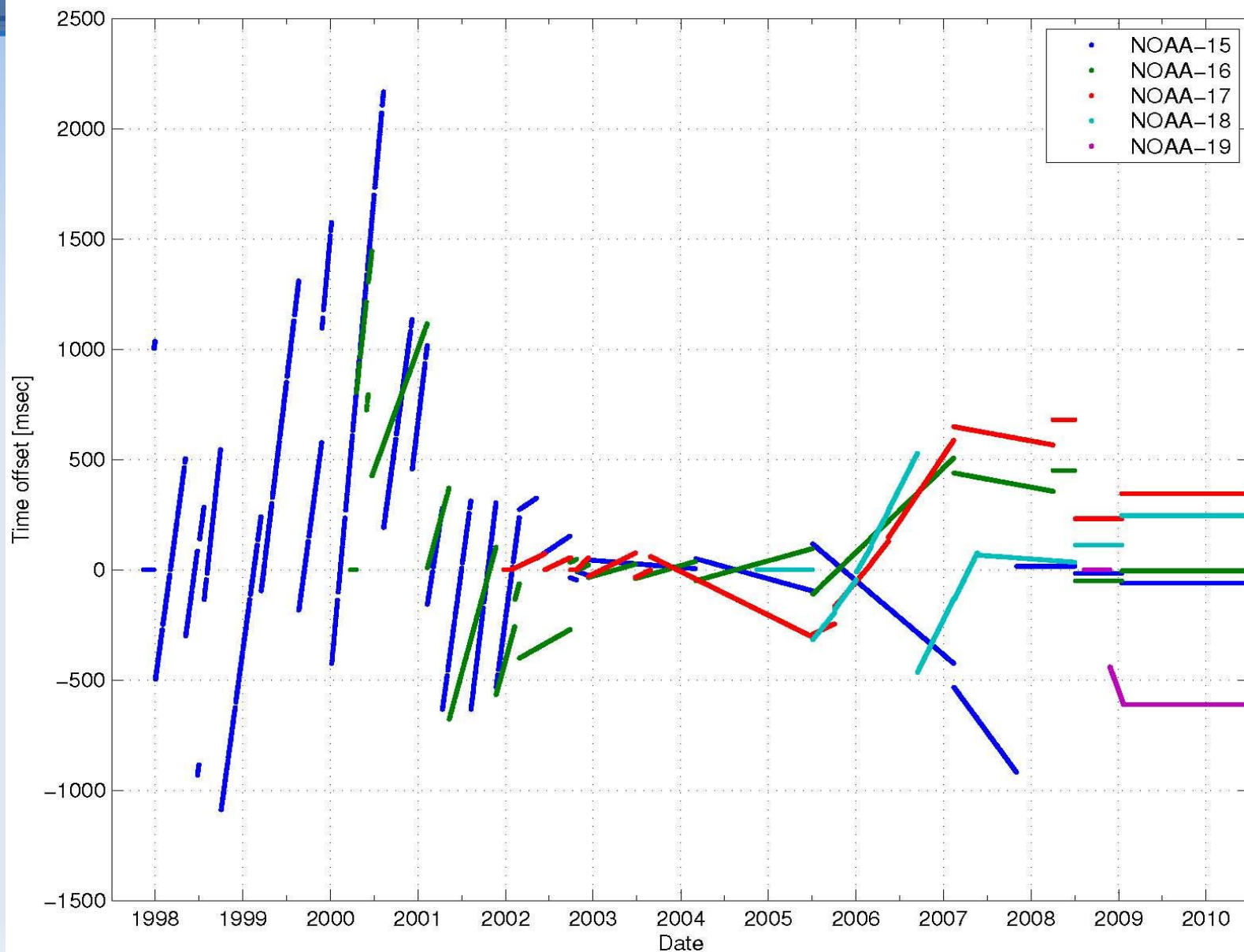
MHS Step Angle is 10/9 but was taken as 1.1 until 05-217.

**The first orbit with correct step angle is**

*SS.MHSX.NN.D05217.S1529.E1714.B0108889.GC*

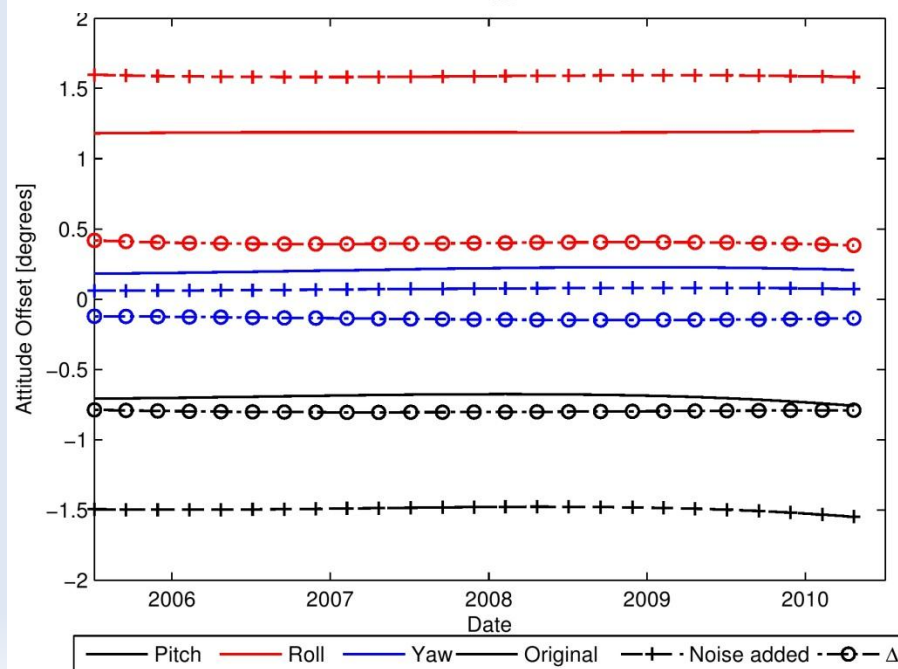
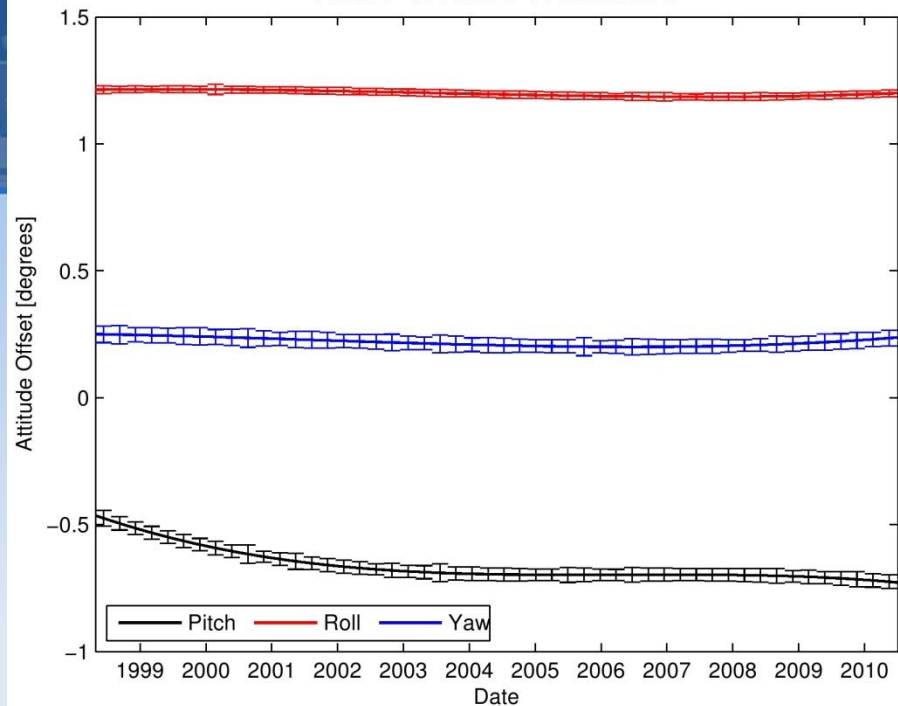


# Clock offset is not corrected for NOAA-17

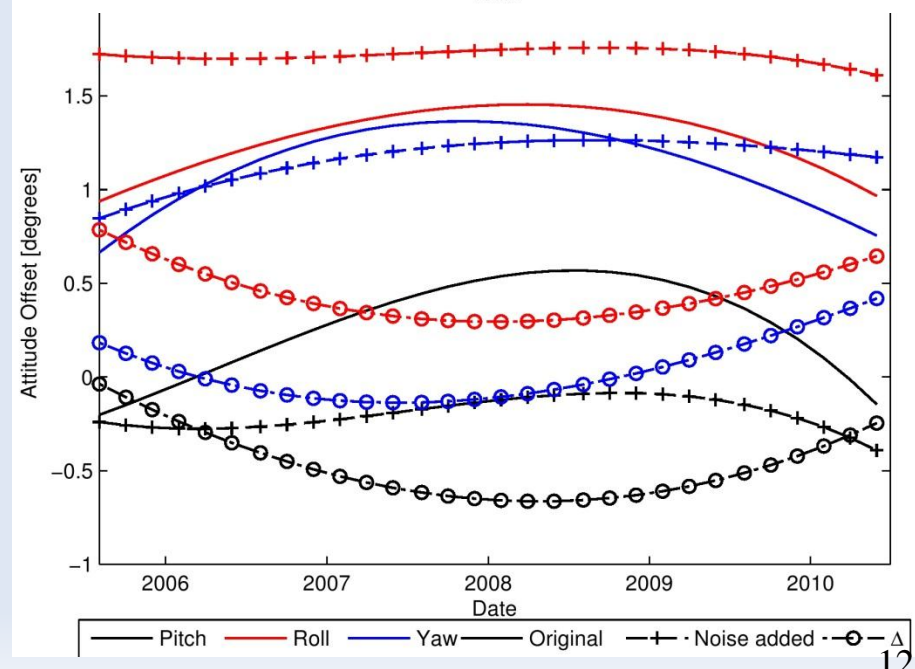
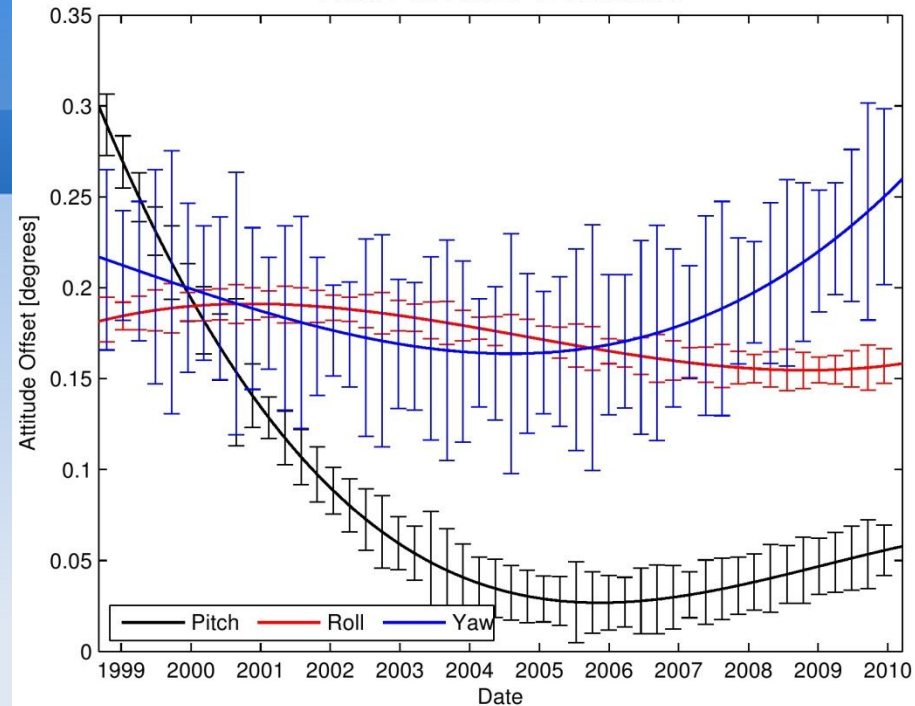


# Satellite Attitude and Sensor Mounting Errors

NOAA-15 AMSU-A Channel 1

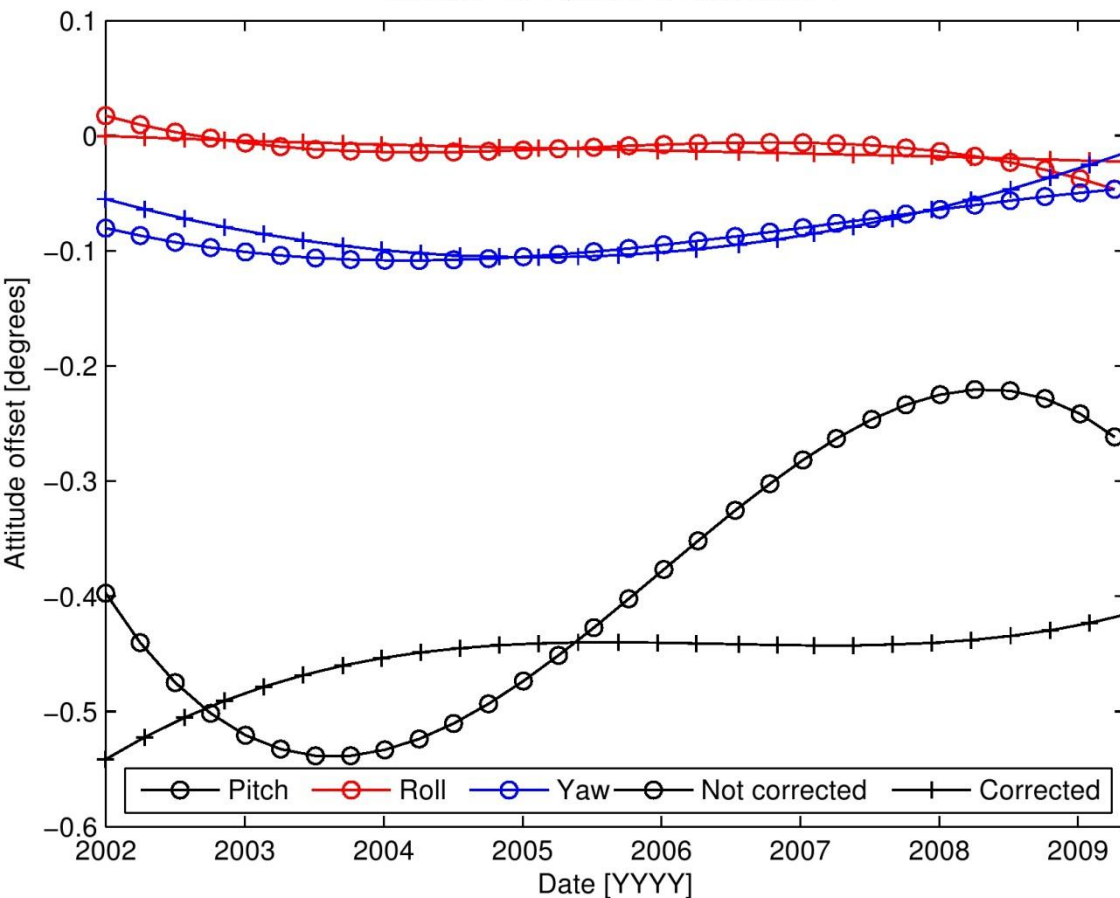


NOAA-15 AMSU-B Channel 1

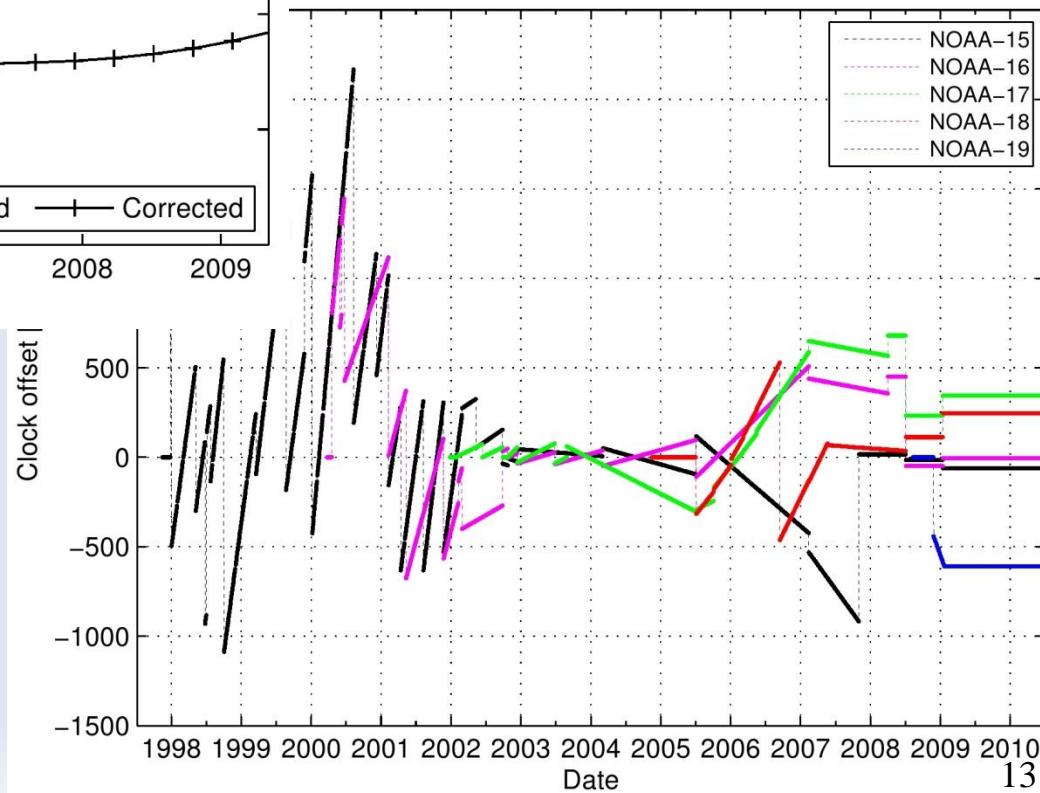




NOAA-17 AMSU-A Channel 1



**Before and after  
clock offset  
correction**

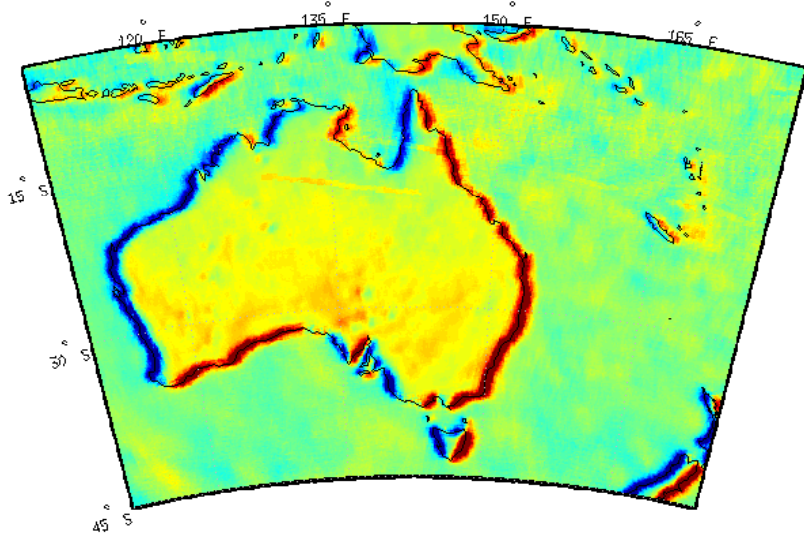


# Estimated values for the satellite attitudes and sensor mounting errors

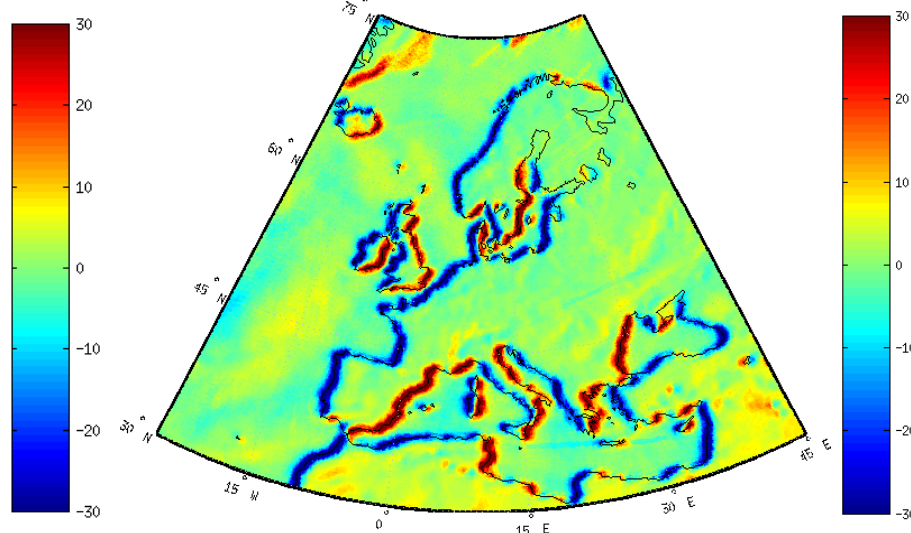
NOAA	Chann.	mean	std	Pitch				Roll				Yaw			
				$P_1$	$P_2$	$P_3$	$P_4$	$P_1$	$P_2$	$P_3$	$P_4$	$P_1$	$P_2$	$P_3$	$P_4$
15	1	2453337	1284	-0.02	0.03	-0.02	-0.70	0.00	0.00	-0.02	1.20	0.01	0.01	-0.02	0.21
15	3	2453337	1284	-0.01	0.04	-0.04	-0.49	-0.00	-0.00	-0.01	-0.11	0.01	-0.00	-0.00	0.15
15	15	2453337	1284	-0.01	0.04	-0.07	-0.45	0.00	0.00	-0.03	-0.11	0.01	-0.00	-0.00	0.11
15	b	2453348	1216	-0.01	0.05	-0.03	0.03	0.01	-0.00	-0.02	0.18	0.00	0.02	-0.00	0.16
16	1	2453738	1054	-0.01	0.04	-0.01	-0.52	-0.00	0.00	0.02	-0.26	-0.01	-0.02	-0.00	0.08
16	3	2453738	1054	-0.01	0.05	0.01	-0.55	0.01	0.01	-0.01	0.36	-0.02	-0.01	0.03	0.11
16	15	2453738	1054	-0.00	0.05	0.02	-0.64	0.01	0.01	-0.01	0.23	-0.02	-0.02	0.02	0.16
16	b	2453694	1055	-0.02	0.05	0.00	-0.09	0.00	0.01	0.01	0.03	-0.01	-0.03	-0.03	0.20
17	1	2454008	897	0.02	-0.00	-0.01	-0.44	-0.00	-0.00	-0.01	-0.01	-0.00	0.03	0.03	-0.10
17	3	2452694	140	0.03	-0.04	-0.07	-0.49	-0.02	0.01	0.03	0.08	-0.04	-0.00	0.08	-0.16
17	15	2452694	140	0.04	-0.07	-0.08	-0.15	-0.01	-0.00	0.03	0.09	-0.04	0.02	0.07	-0.10
17	b	2453820	788	0.02	-0.03	-0.03	-0.38	-0.01	0.01	0.01	-0.28	-0.01	0.01	0.03	0.07
18	1	2454538	592	-0.01	0.02	0.03	-1.23	0.00	0.00	-0.00	-0.20	-0.00	0.01	0.01	0.09
18	3	2454538	592	-0.02	0.03	0.06	-0.29	-0.00	-0.01	-0.00	0.01	0.00	0.02	0.01	0.07
18	15	2454538	592	-0.01	0.03	0.03	0.00	-0.01	0.01	-0.00	0.37	-0.01	0.01	0.03	0.07
18	b	2454586	563	-0.01	0.02	0.02	-0.19	-0.00	-0.01	0.01	-0.16	0.00	0.04	0.03	0.14
19	1	2455216	201	0.00	-0.01	0.00	-0.71	0.01	-0.01	-0.01	0.21	-0.01	-0.01	0.04	0.19
19	3	2455216	201	-0.02	0.02	0.01	-0.56	0.02	-0.03	-0.01	0.37	-0.03	-0.02	0.07	0.23
19	15	2455216	201	-0.00	0.04	-0.01	-0.58	0.02	-0.04	-0.03	0.23	-0.03	-0.01	0.06	0.17
19	b	2455218	200	0.01	-0.00	-0.02	-0.36	0.01	-0.02	-0.01	-0.07	-0.00	-0.02	0.05	0.39

# Before and After Correction

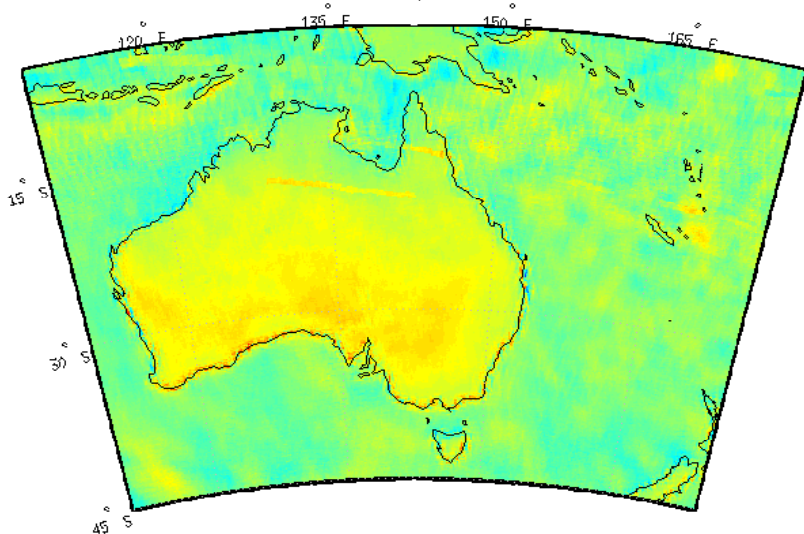
NOAA-15 AMSU-A Channel 1, 1-1-2003 to 1-31-2003



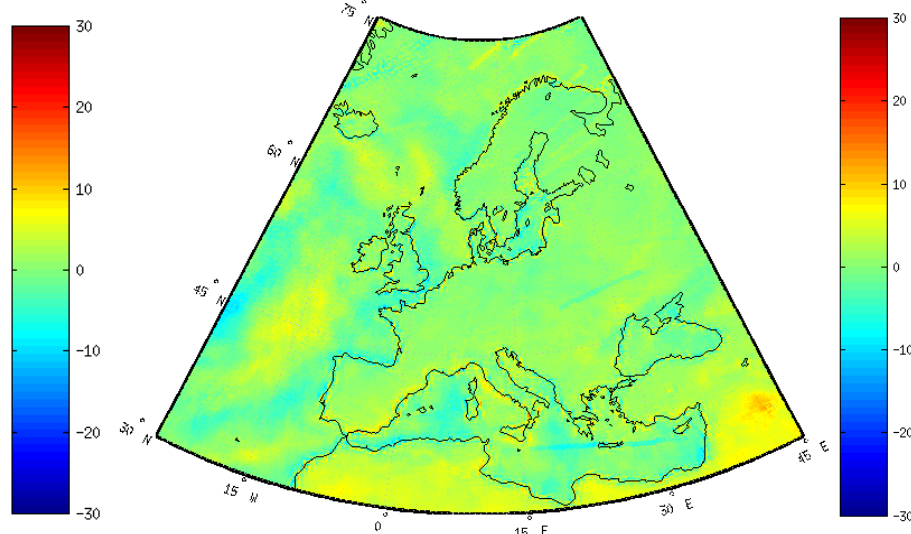
NOAA-15 AMSU-A Channel 1, 1-1-2003 to 1-31-2003



NOAA-15 AMSU-A Channel 1, 1-1-2003 to 1-31-2003



NOAA-15 AMSU-A Channel 1, 1-1-2003 to 1-31-2003





- NOAA AMSU/MHS geolocation is subject to inaccuracy that can be up to 70 km in some cases.
- The geolocation is affected by the sensor mounting and satellite attitudes offset which require correction
- The geolocation inaccuracy can seriously influence sensor/satellite pointing angles which are very important for RT calculations
- The quality of AMSU/MHS products is highly affected by the geolocation accuracy. The effect of any inaccuracy is especially important along the coast lines
- A method was developed to correct the geolocation errors. All AMSU-A/-B/MHS data will be corrected soon in the AMSU CDR project.





## Reference:

Moradi, I, Meng, H., Ferraro, R, Bilanow, S., 2012. Correcting geolocation errors for microwave instruments aboard NOAA satellites. IEEE Trans. Geoscience and Remote Sensing (to be submitted)