



# Inter-Calibration of AMSU-A Window Channels

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## Background

AMSU FCDR for hydrological products – Window channels

One critical step toward stable CDR

## SNO Overview

### Sensitivity and Problem

Sensitivity of heterogeneity

Warm target contamination

### Correction

Sequential adjusting process

Major equations, important variables

Iterative search and result coefficients

Impacts of the correction

Correction of N16 Ch3 drift

### Performance of TCDR

### Ongoing Work

Possible frequency shift of N15 Ch15

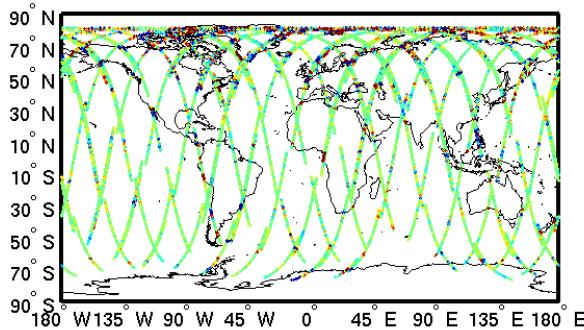
Diurnal cycle

## SNO Temporal Pattern

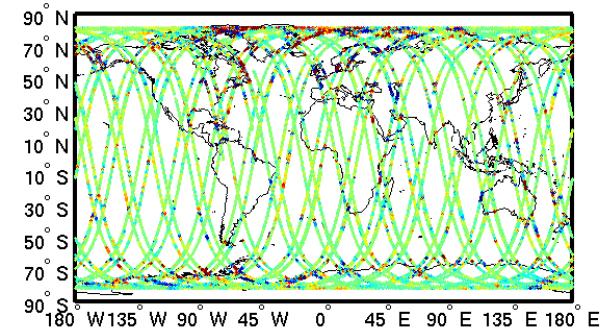
Overlap-Interval	N16	N17	N18	M02	N19
N15	1 – 8.14	4.5 – 104	1 – 7.31	1 – 31.7	1 – 7.14
N16		1 – 8.44	3 – 82	1 – 11.2	2 – 66
N17			1 – 7.66	2 – 40	1 – 7.52
N18				1 – 9.81	8 – 326
M02					1 – 9.62

# Global SNO Spatial Distribution with DTB

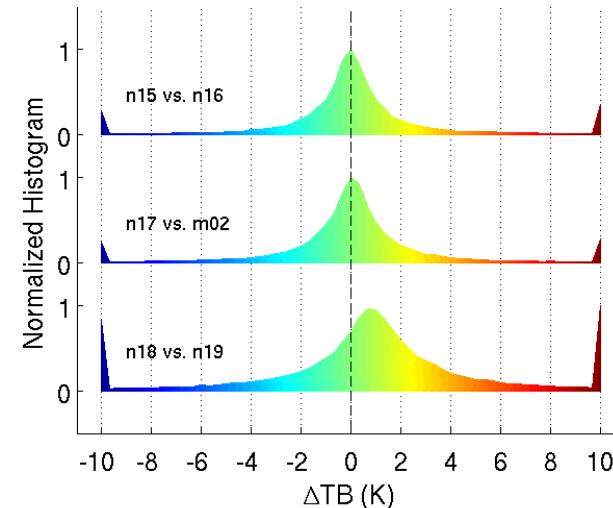
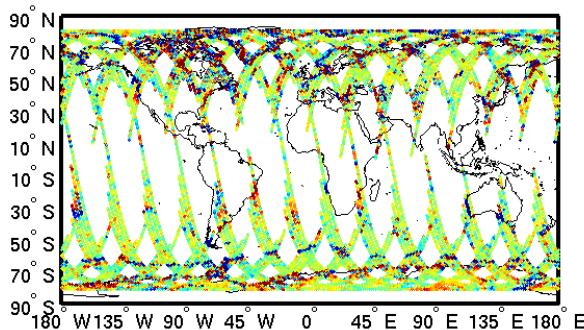
$\Delta\text{TB}$ : n15 vs. n16



$\Delta\text{TB}$ : n17 vs. m02



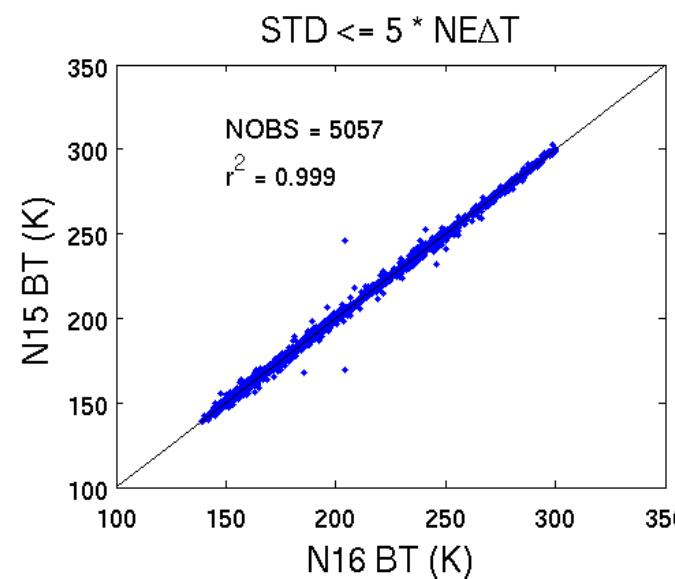
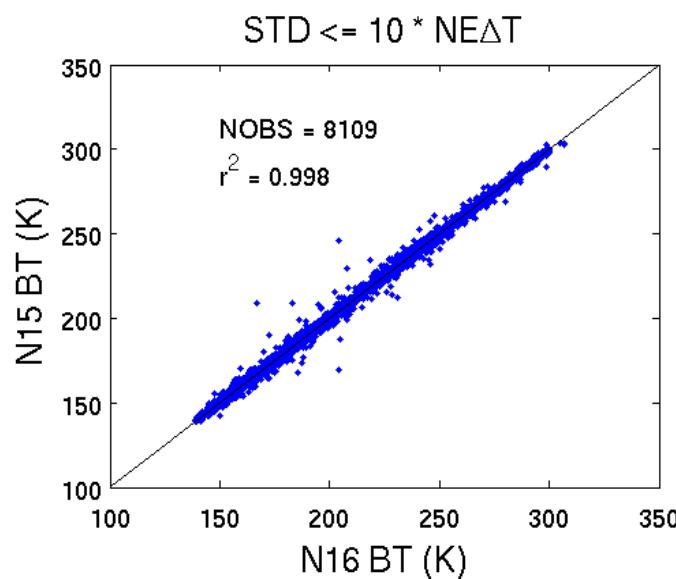
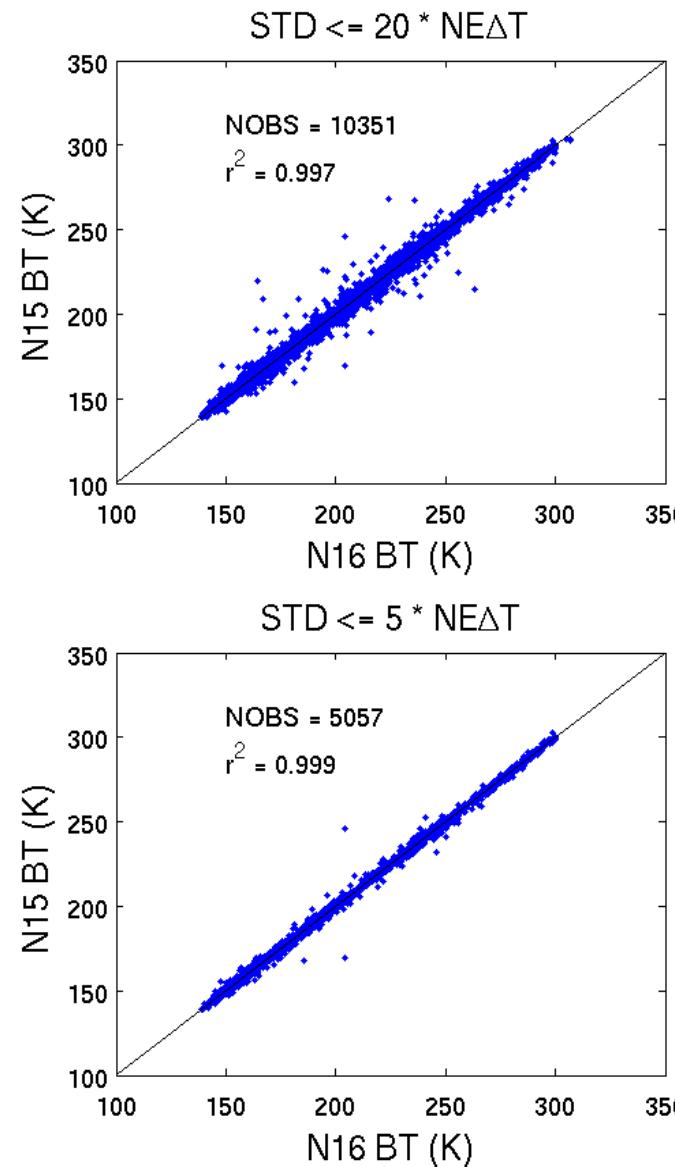
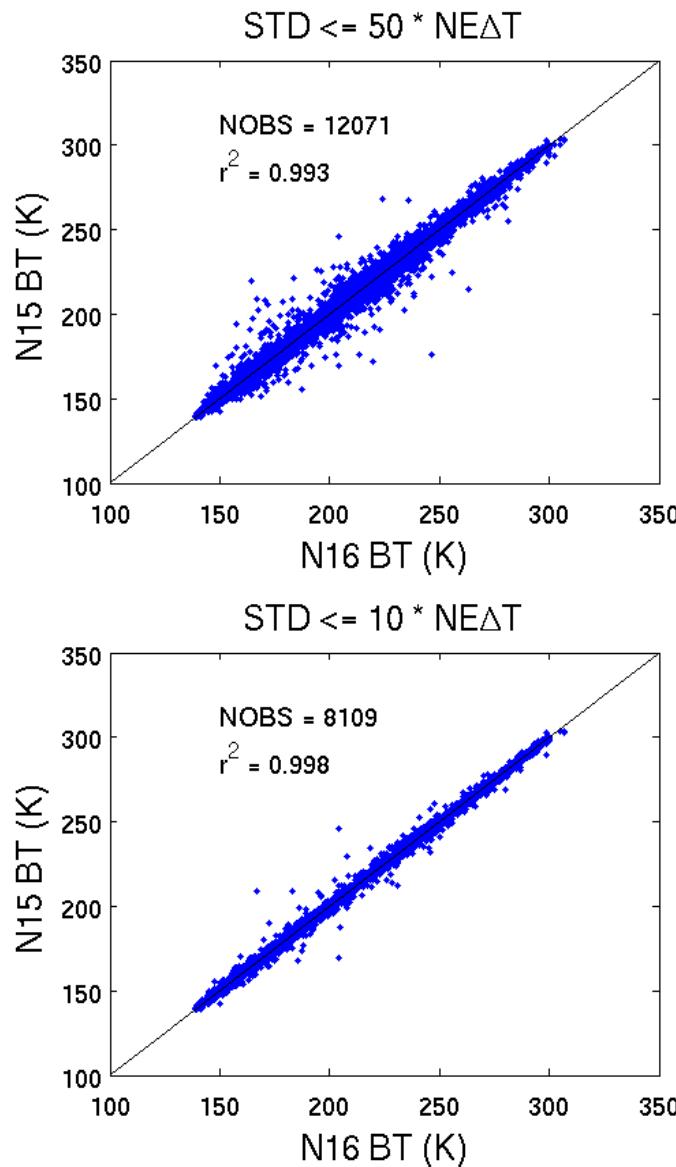
$\Delta\text{TB}$ : n18 vs. n19



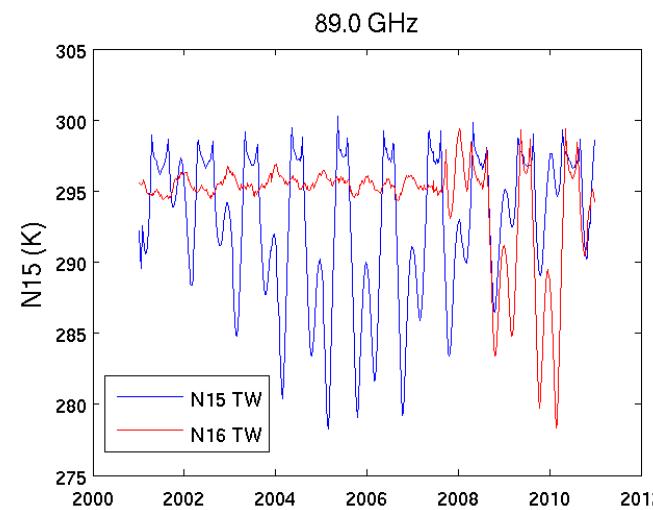
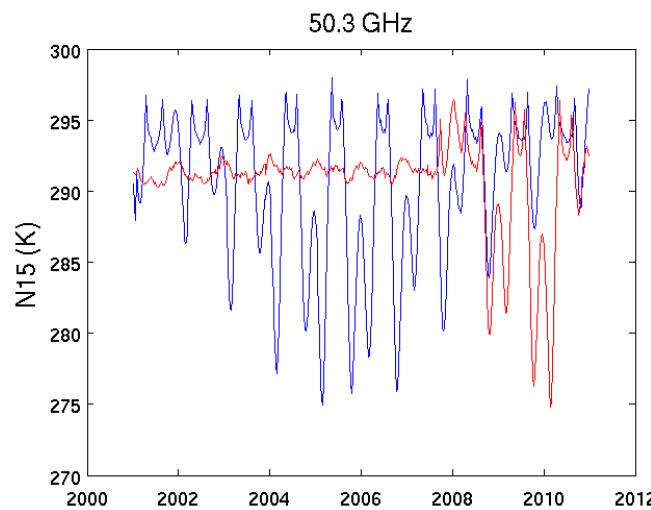
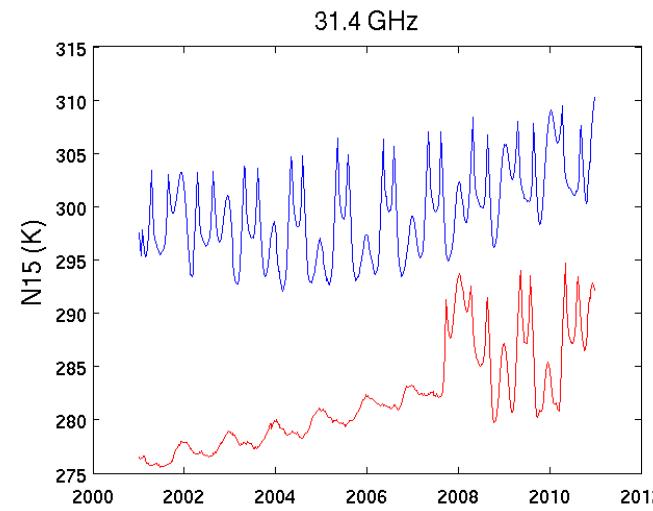
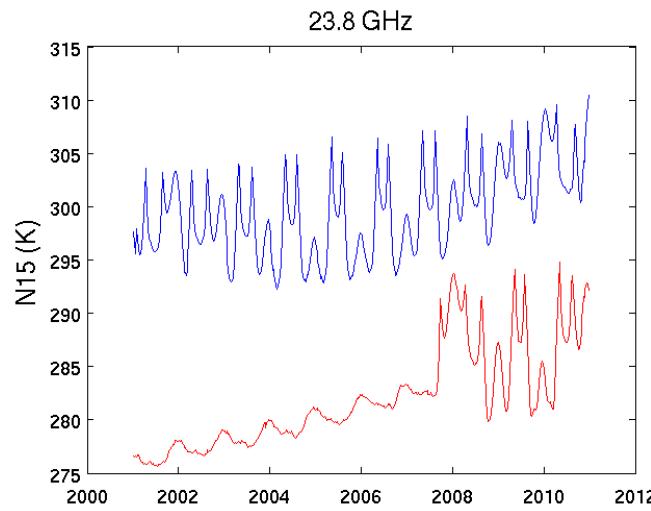
## SNO DTB vs. Factors Correlation Coefficients

Correlation Coefficients	23.8 GHz	31.4 GHz	50.3 GHz	89 GHz
NOBS	53531	53531	53534	53506
Distance	0.19	0.18	0.15	0.18
P1 TB STD	0.53	0.53	0.47	0.43
P2 TB STD	0.55	0.55	0.50	0.44
Time Difference	-0.01	-0.01	-0.01	-0.01

# Test STD Threshold using Brightness Temperature Scatter Plot, Chan 1, 2008



# Warm Target Contamination



## Correction Process

Focusing on Dr. Cheng-Zhi Zou's sequential adjusting process, applied for AMSU sounding channel CDR

1. Generate intermediate SNO data set  
Increase from 30 variables to 142 for each SNO events
2. Calculate SNO coefficients ( $\alpha$ ,  $\beta$ ,  $a_0$ ,  $a_1$ )
3. Set  $\delta R_{N15} = 0$ , and  $\mu_{N15}$ , calculate  $\delta R_k$ ,  $\mu_k$ ,  $k = 1$  to 5
4. Generate level-1c radiances for all six satellites using recalibration coefficients
5. Compute tropical ocean mean time series of  $\Delta T_b$  for available overlaps between pairs
6. Change the value of  $\mu_{N15}$  and repeat steps 3, 4, and 5
7. Stop when summation of root mean square of  $\Delta T_b$  is minimum

## Major Inter-Calibration Equations

$$I. \quad Z_j = \beta Z_k + \alpha + \zeta$$

$$II. \quad \begin{cases} \sum_{i=1}^N \Delta R_{L,i} = a_0 + a_1 \sum_{i=1}^N Z_{k,i} \\ \sum_{i=1}^N Z_{k,i} \Delta R_{L,i} = a_0 \sum_{i=1}^N Z_{k,i} + a_1 \sum_{i=1}^N Z_{k,i}^2 \end{cases}$$

$$III. \quad \begin{cases} a_0 = \Delta \delta R + \alpha \mu_j \\ a_1 = -\mu_k + \beta \mu_j \end{cases}$$

Other:

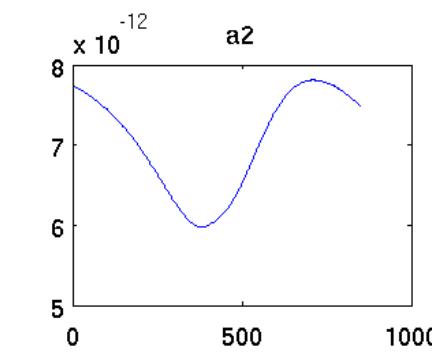
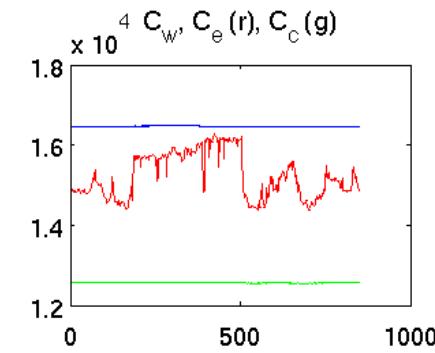
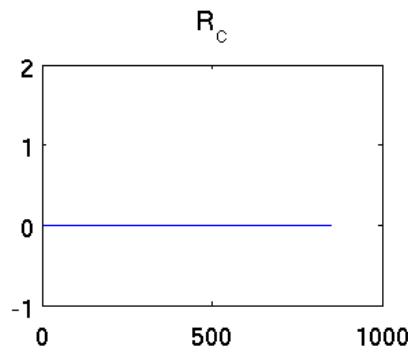
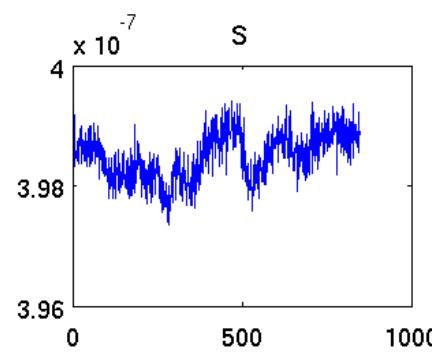
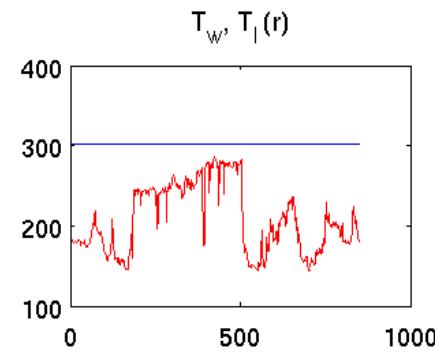
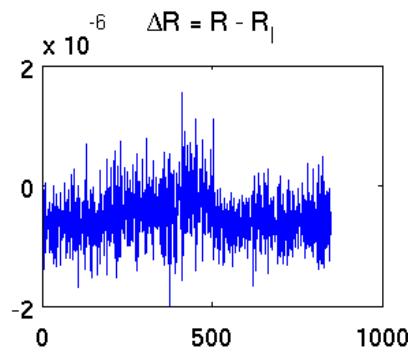
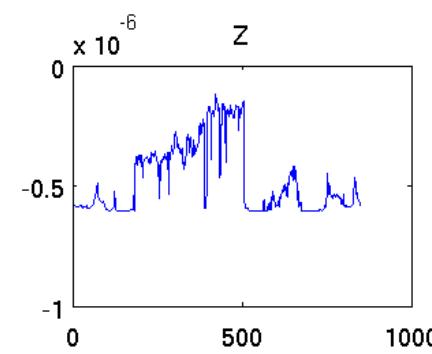
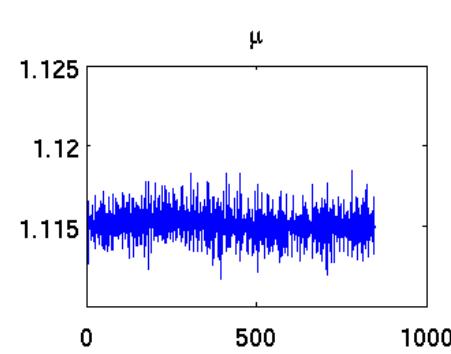
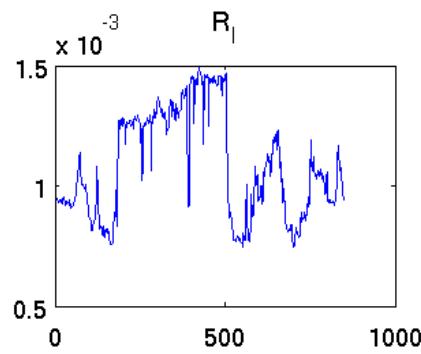
$$R = R_L - \delta R + \mu Z$$

$$R_L = R_c + S(C_e - C_c)$$

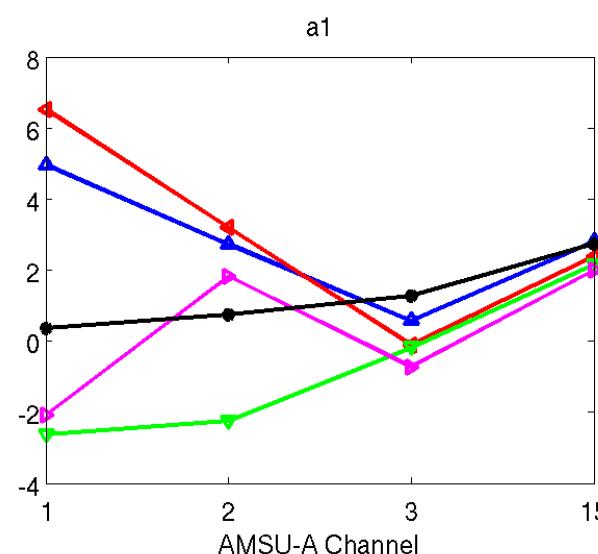
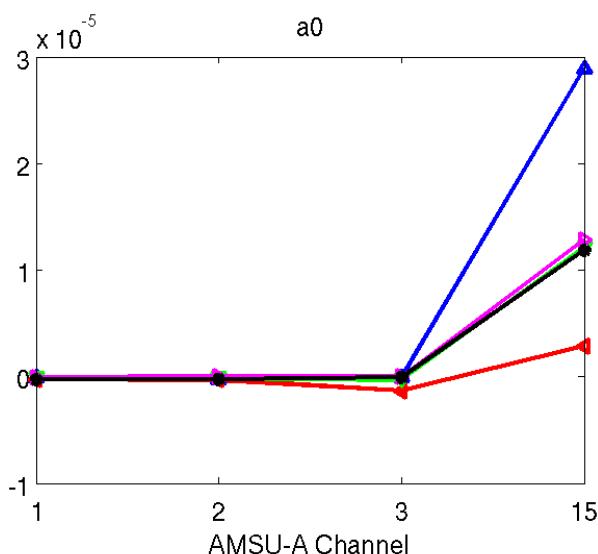
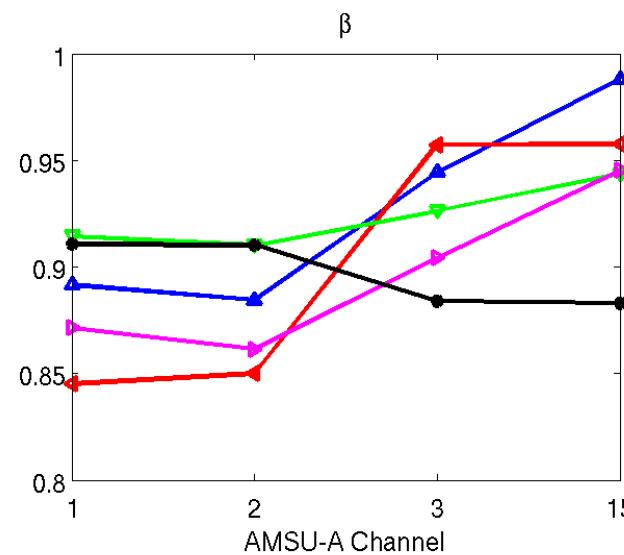
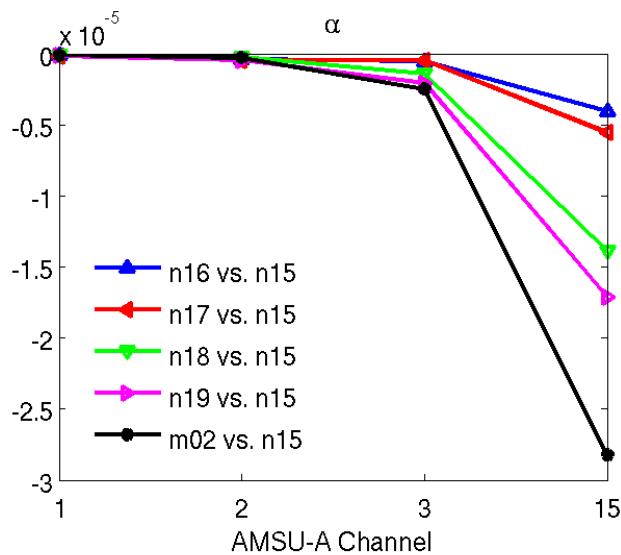
$$S = \frac{R_w - R_c}{C_w - C_c}$$

$$Z = S^2 (C_e - C_c) (C_e - C_c)$$

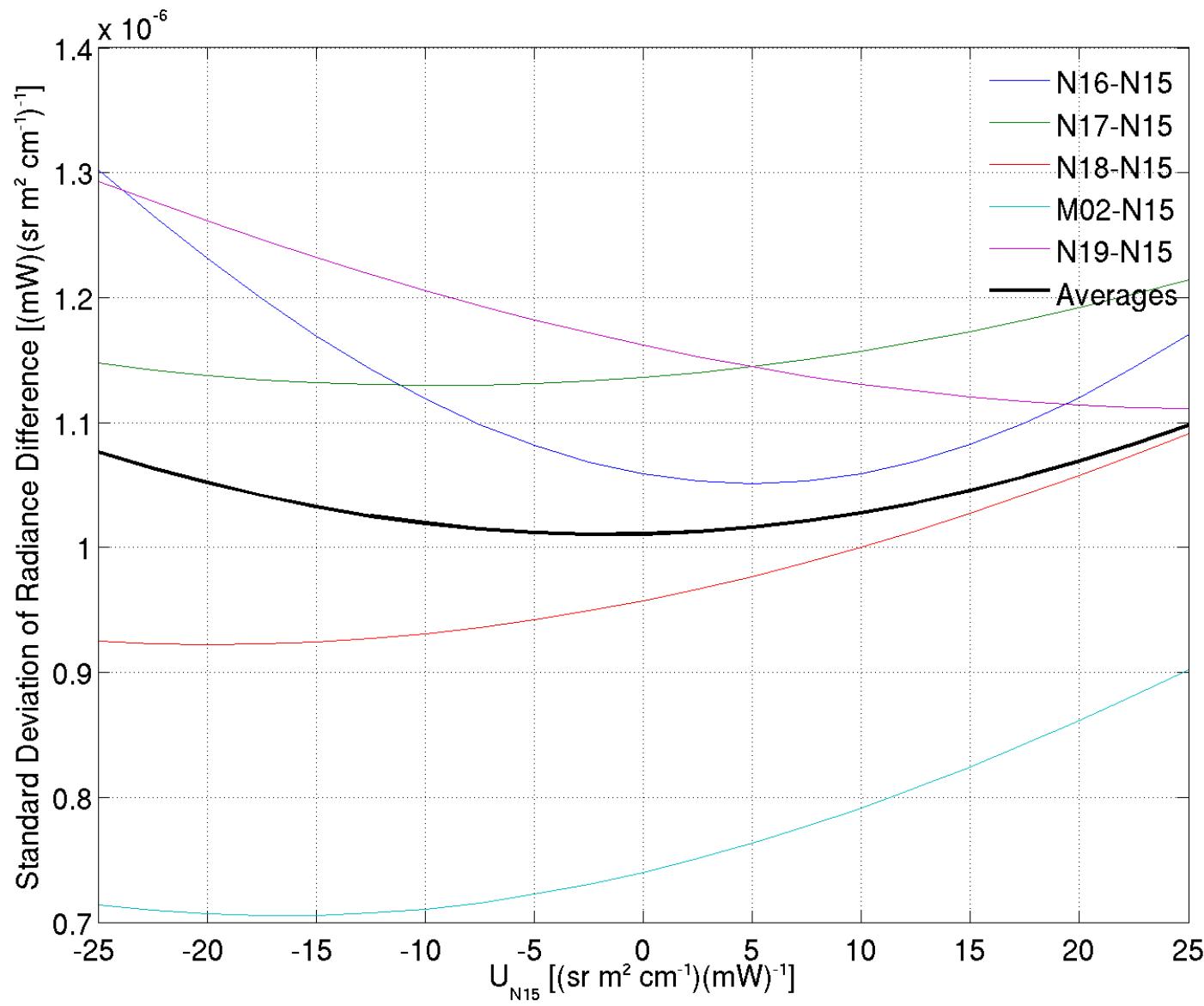
# Relative Variables in a Swath, N15, Channel 1, Nadir



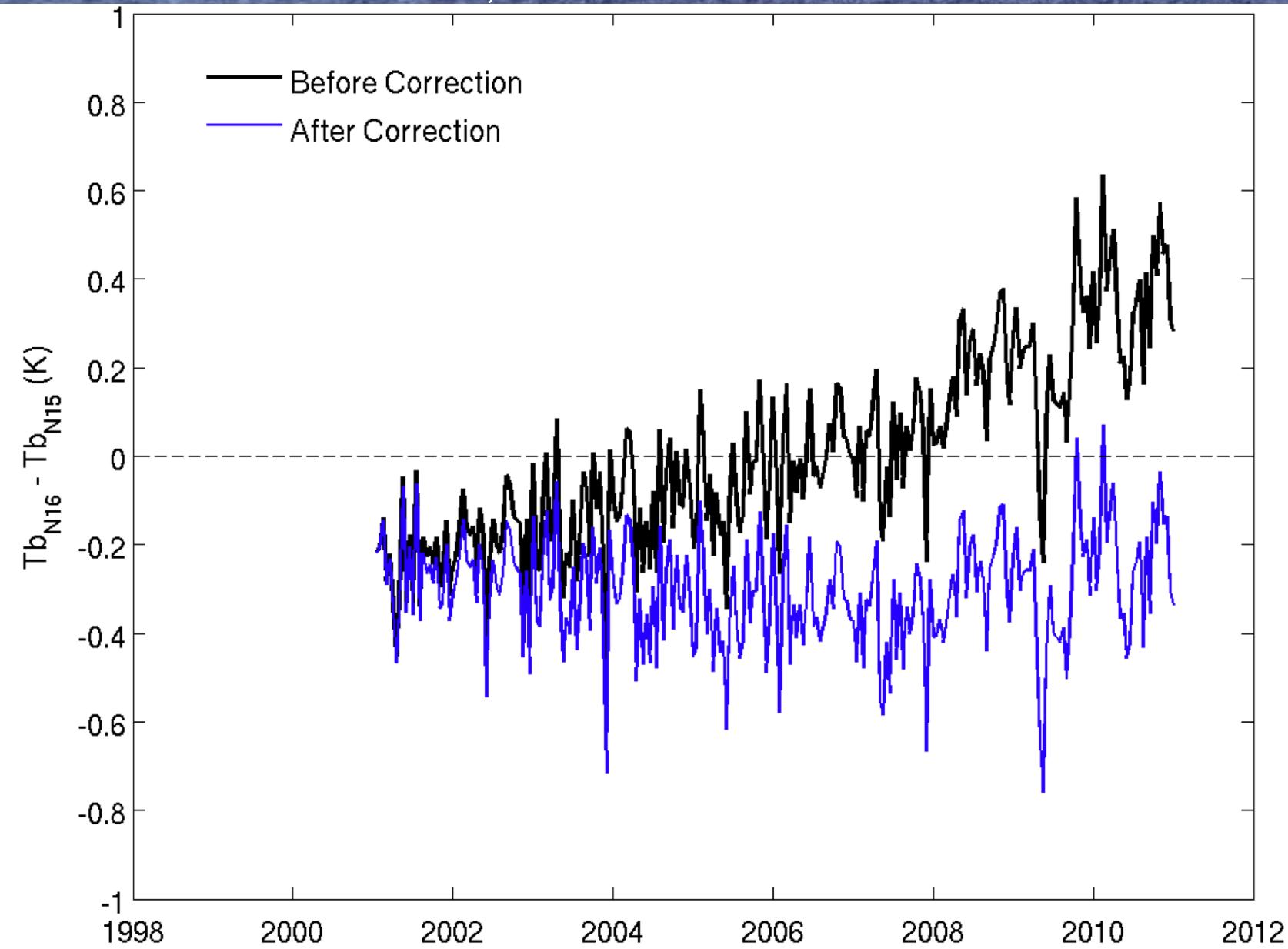
# Coefficients of Alpha, Beta, A0 and A1 from SNO Series



# Iterative Search for Mu of N15, Channel 1



## Bias Drift Correction of N16, Channel 3



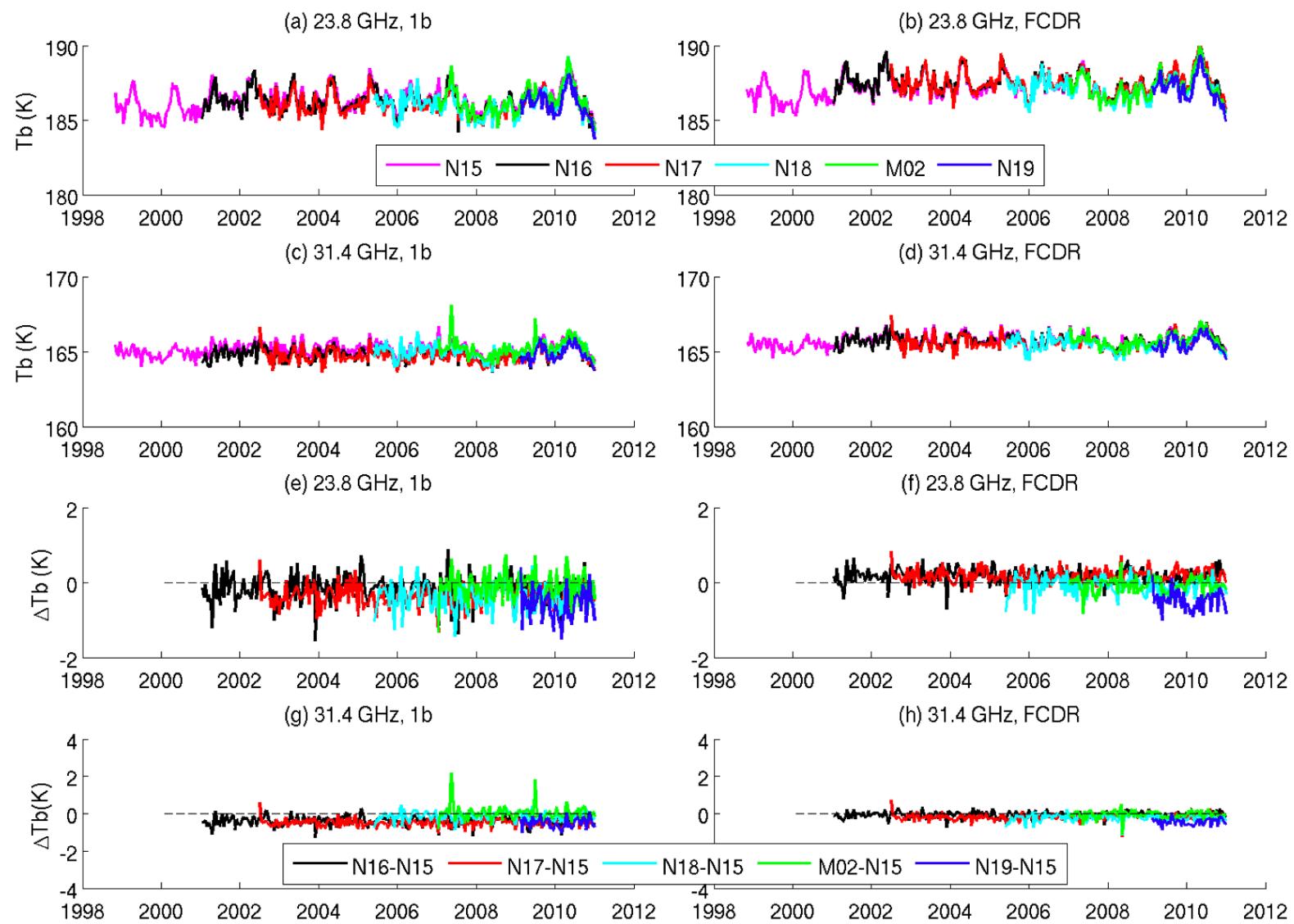
## Comparison of Optional and Prelaunch $\mu_{N15}$

	Ch1	Ch2	Ch3	Ch15
Optional Mu_N15	-3.0087	-1.0512	-2.3778	(-3.9801)
Prelaunch Mu_N15	0.9802	-0.0723	0.0555	-0.0016
	1.1284	0.3094	0.0806	-0.0404
	1.1098	-0.0502	0.0484	0.2949
Reference Temperature	266.55	266.55	270.56	270.54
for Prelaunch Mu_N15	284.65	284.65	291.18	291.18
	302.85	302.85	311.91	311.24

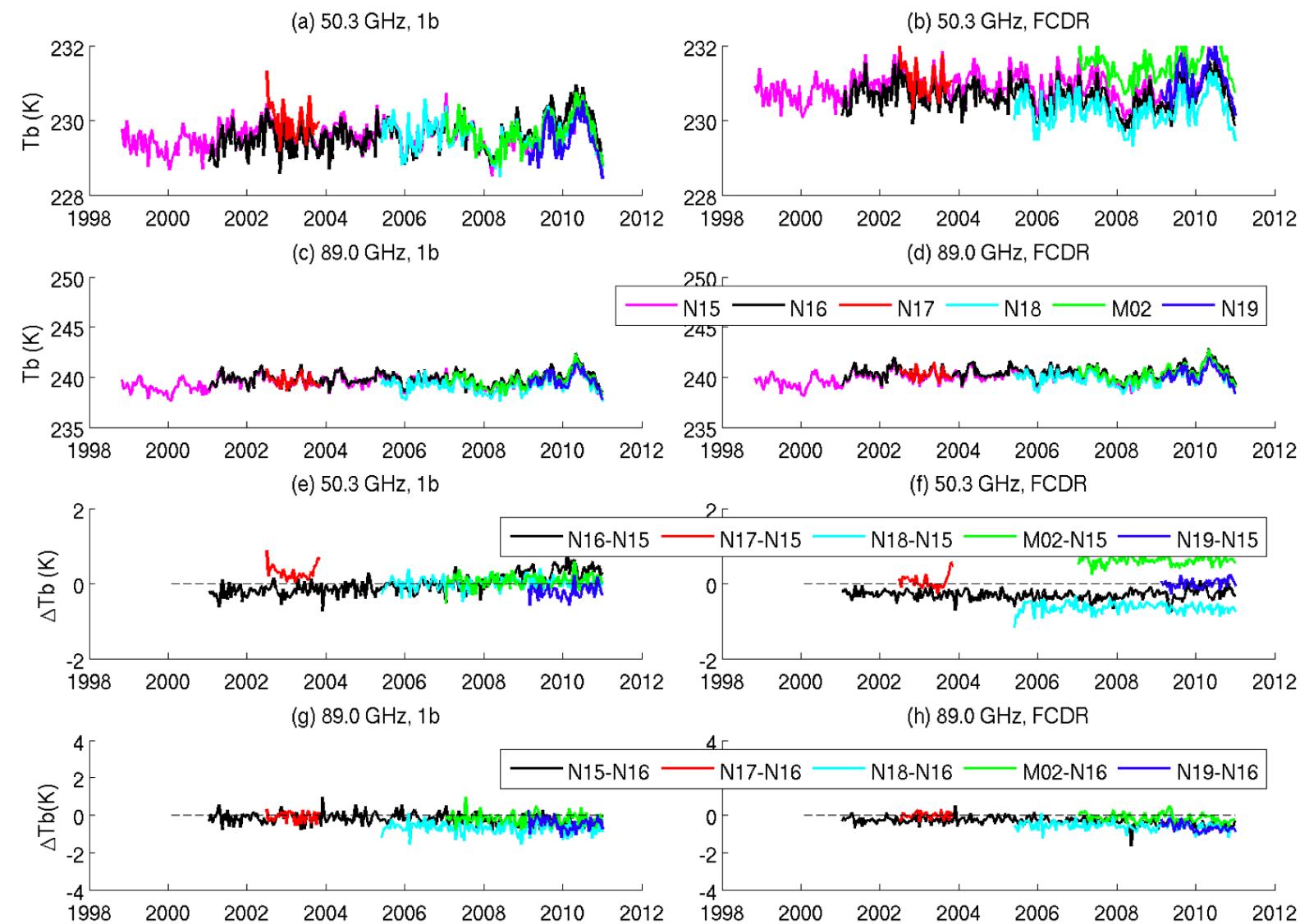
## Optimal $\mu$ and $\delta R$

		N15	N16	N17	N18	M02	N19
Mu	Ch1	-3.00870	-7.25050	-7.22996	-0.88067	-0.98053	0.10012
	Ch2	-1.05123	-3.35409	-2.84701	1.51212	-1.28394	-2.30045
	Ch3	-2.37781	-2.31567	-2.20964	-2.09040	-2.62705	-1.28555
	Ch15	0	-0.16528	-0.25743	0.36618	0.21446	0.25637
dR	Ch1	0	-3.8739E-07	-5.4593E-07	1.6748E-06	-4.6346E-07	-3.9312E-07
	Ch2	0	-6.0094E-07	-6.1988E-07	-2.7920E-07	-5.2695E-07	-4.7723E-07
	Ch3	0	-1.4956E-06	-1.7496E-06	1.0513E-05	-5.9528E-06	-4.7437E-06
	Ch15	0	0	-7.2202E-07	-2.9265E-06	-6.7153E-06	-2.0168E-06

# Tropical Ocean Mean Tb/DTb, Ch 1 & 2



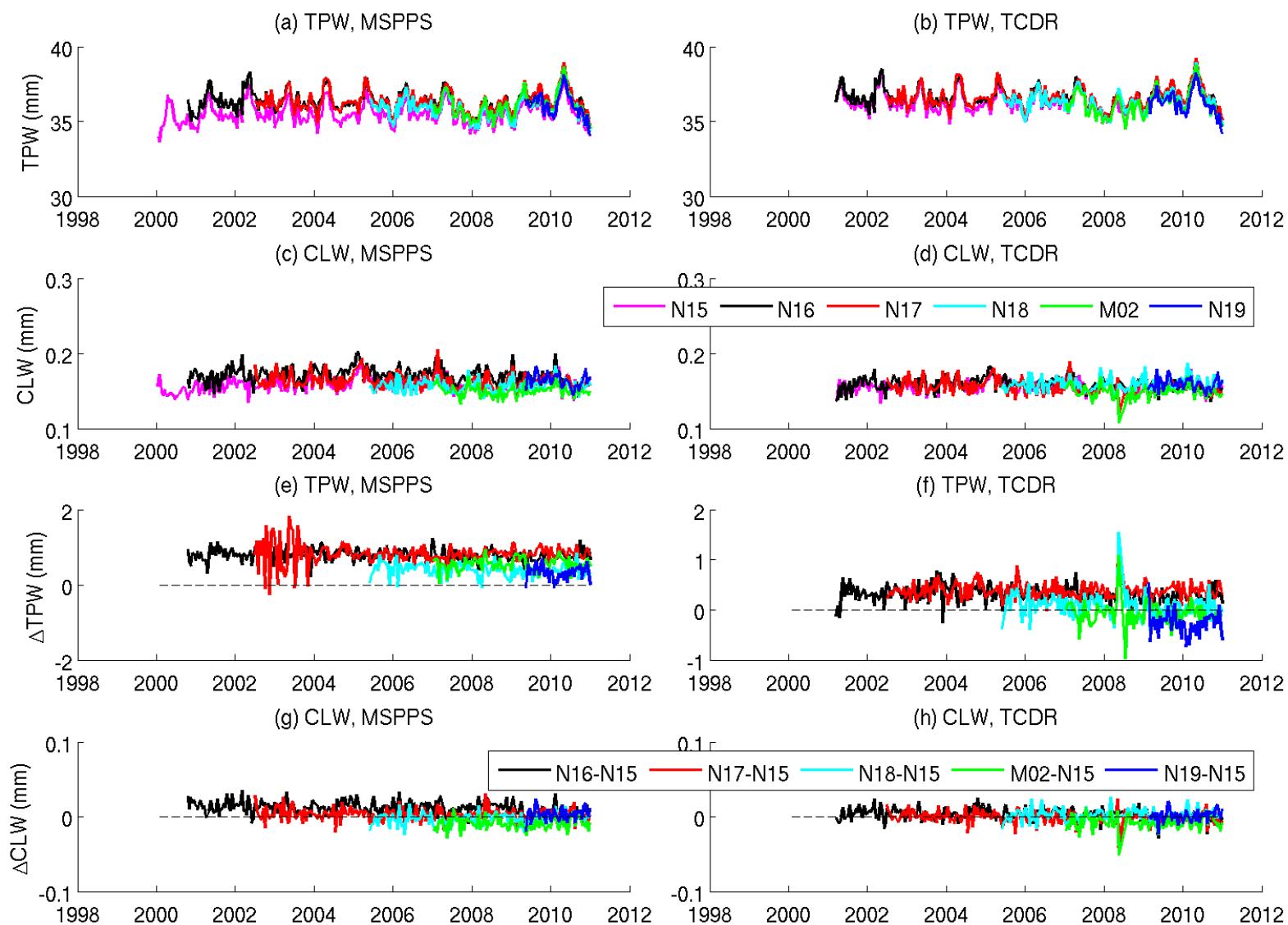
# Tropical Ocean Mean Tb/DTb, Ch 3 & 15



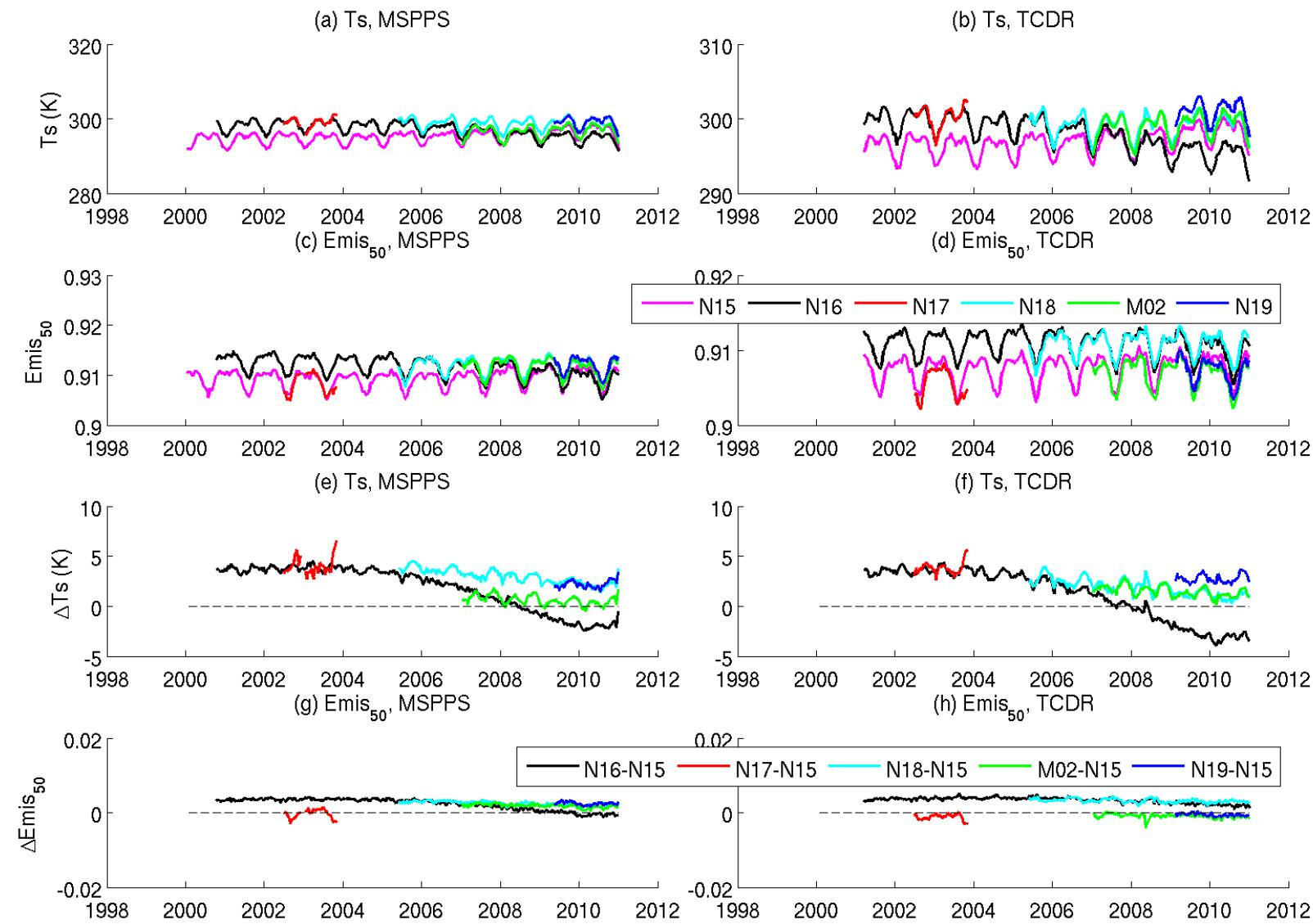
## Tropical Ocean STD of Delta Tb

	Before					After			
Channel	23.8	31.4	50.3	89.0	23.8	31.4	50.3	89.0	
N16-N15	0.374	0.263	0.267	0.315	0.217	0.193	0.126	0.227	
N17-N15	0.285	0.217	0.191	0.225	0.191	0.191	0.171	0.132	
N18-N15	0.386	0.259	0.168	0.337	0.239	0.197	0.130	0.242	
M02-N15	0.370	0.384	0.167	0.328	0.215	0.207	0.108	0.227	
N19-N15	0.424	0.276	0.174	0.374	0.263	0.187	0.115	0.208	

# Tropical Ocean TPW and CLW, Mean and Difference



# Tropical Surface Temperature and Land Emissivity, Mean and Difference



## Conclusion and Ongoing Work

1. We explored SNO characteristics among specified NOAA and MetOP satellites
2. Heterogeneity problem has been identified and threshold has been tested
3. The sequential adjusting process has been applied to correct warm target contamination
4. The quality of ocean and land products is improved
5. Our ongoing work relates to frequency shift and diurnal cycle