COMS/MI IR channel calibration using MODIS measurements

B.J. Sohn
School of Earth and Environmental Sciences
Seoul National University
Seoul, Korea

Background

Inter-calibration method for IR/WV channels

- Compare the observed IR or WV radiance with calculated radiance from well-calibrated polar orbiting satellites (here MODIS)
- Outputs : correlation coefficient, mean difference, standard deviation of the brightness temperature from GEO and LEO satellites
- Inter-calibration will serve as a monitoring tool

Background

- **Determination of calibration coefficient**

$$L_{ch} = \alpha_{ch} (C - C_0)$$

where, L_{ch} : expected radiance for a channel

α_{ch} : calibration coefficient

C : satellite observed count

C_0 : offset (space view)

- **Empirical relationship between L_{ch} and TB_{ch}**

$$TB_{ch} = b/(\ln L_{ch} - a)$$

where, a and b are regression coefficients

Background

Determining the calibration coefficient

$TB_{GEO}' = F(TB_{LEO})$

$L_{GEO}' = \exp(a + b/TB_{LEO}')$

$\alpha_{GEO}' = L_{GEO}' / (C' - C_0)$

where

TB_{LEO} : LEO (MODIS channel) brightness temperature

TB_{GEO}' : Predicted GEO brightness temperature from the observed LEO brightness temperature

F : transfer function

C_o' : offset count

α_{GEO}' :calibration coefficient

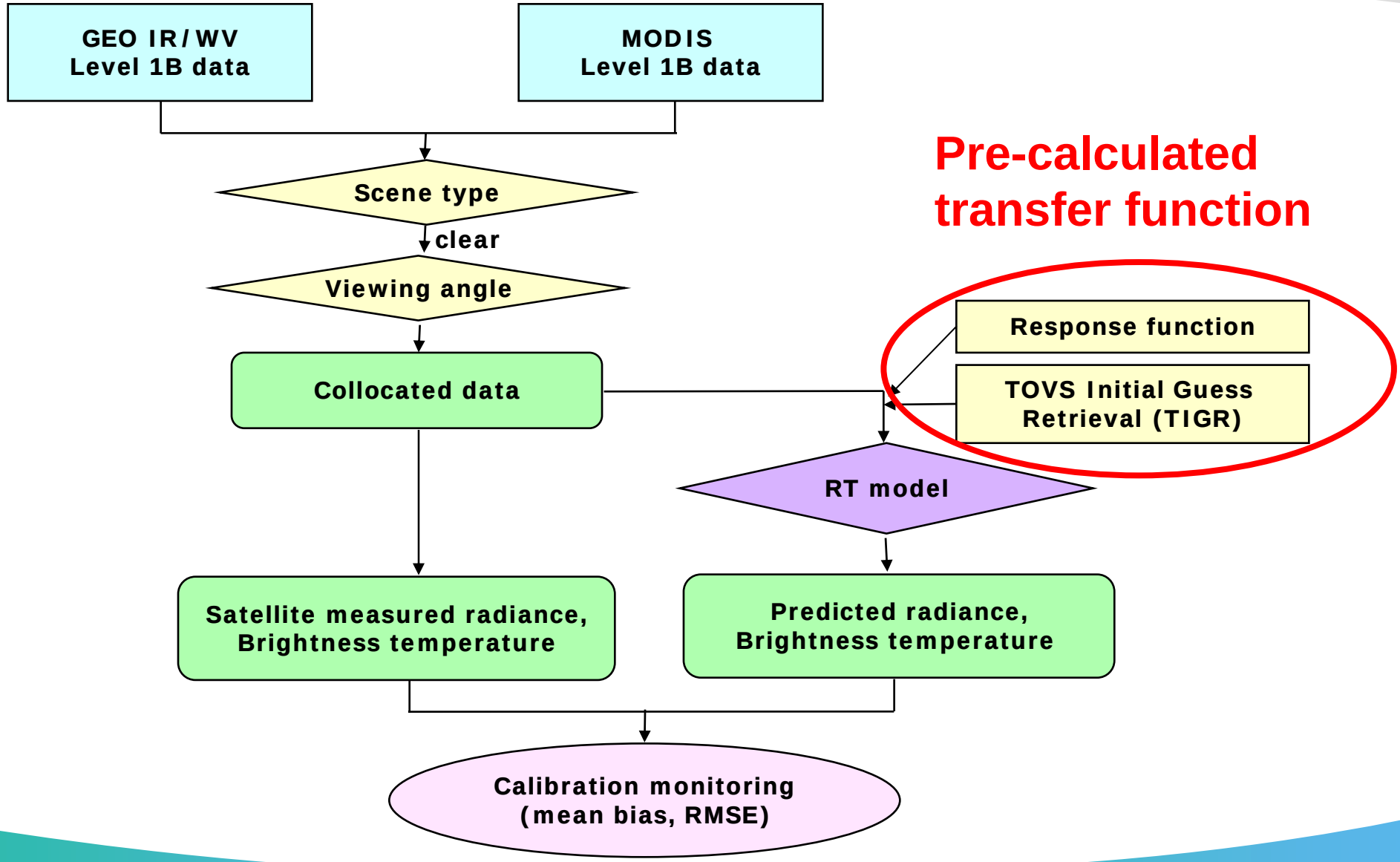
MTSAT-1R Application

For MTSAT-1R IR channels

$$TB'(MTSAT) = a + b * TB(MODIS)$$

Relate observed TB(MTSAT) to estimated TB'(MTSAT)

Algorithm Flowchart



Transfer Function *F*

IR1 (11μm, ocean)		
Viewing angle	Slope	y-intercept
0°	1.003188	-0.850543
5°	1.003195	-0.852462
10°	1.003220	-0.858697
15°	1.003235	-0.862841
20°	1.003277	-0.873897
25°	1.003323	-0.885553
30°	1.003375	-0.900002
35°	1.003445	-0.917410
40°	1.003509	-0.933933
45°	1.003572	-0.949870
50°	1.003604	-0.955924

IR2 (12μm, ocean)		
Viewing angle	Slope	y-intercept
0°	0.990593	2.371398
5°	0.990562	2.379241
10°	0.990531	2.386517
15°	0.990454	2.405886
20°	0.990352	2.430105
25°	0.990209	2.466162
30°	0.990038	2.508090
35°	0.989838	2.557302
40°	0.989593	2.618602
45°	0.989298	2.692350
50°	0.988955	2.780571

IR3 (WV, ocean)		
Viewing angle	Slope	y-intercept
0°	0.986269	2.737941
5°	0.986251	2.742074
10°	0.986252	2.741386
15°	0.986238	2.745167
20°	0.986232	2.746235
25°	0.986235	2.745126
30°	0.986230	2.746224
35°	0.986335	2.722092
40°	0.986622	2.655948
45°	0.987219	2.517559
50°	0.988698	2.175526

IR4 (NIR, ocean)		
Viewing angle	Slope	y-intercept
0°	0.997073	0.546246
5°	0.997056	0.550111
10°	0.997023	0.555839
15°	0. 996977	0.564240
20°	0.996896	0.580154
25°	0.996770	0.605603
30°	0.996625	0.633049
35°	0.996433	0.670985
40°	0.996166	0.726074
45°	0.995816	0.799164
50°	0.995353	0.898171

Collocated data sets

Data sets

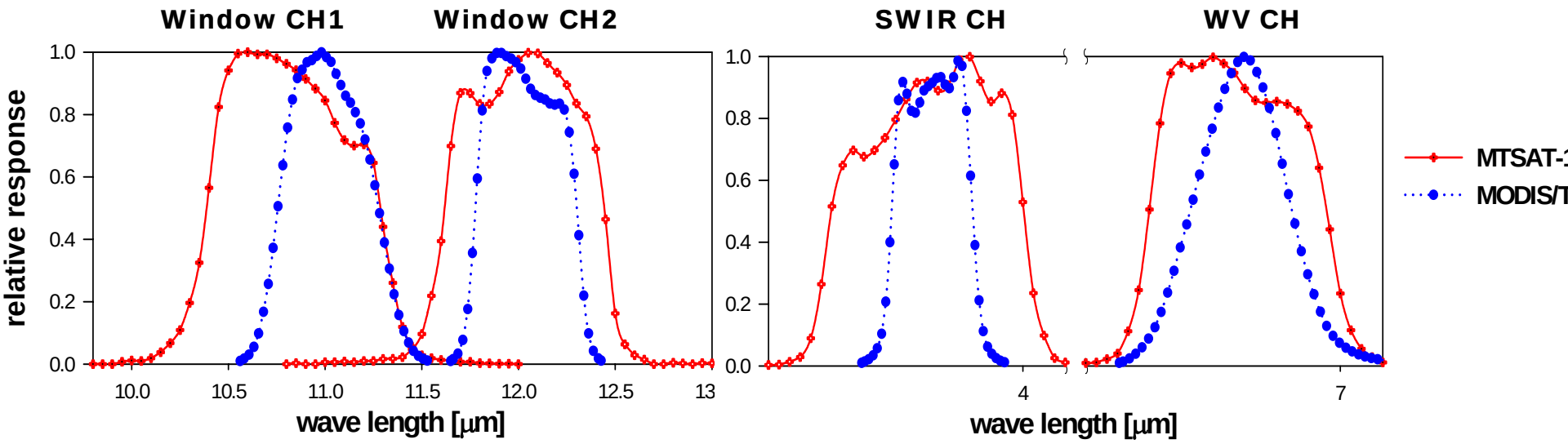
- Viewing angles ≤ 50°
- Viewing angle difference: ≤ |5°|
- Observation time difference: ≤ 5 min
- Only clear targets
- MTSAT-1R / MODIS data are smoothed to 0.2° grid resolution

- MTSAT-1R & Terra/MODIS
  - Period: August, 2005 & 2006
  - Region: 40°N ~ 40°S, 100°E ~ 180°E

- MSG-1/SEVIRI & Aqua/MODIS
  - Period: July, 2004
  - Region: 40°N ~ 40°S, 40°W ~ 40°E

MTSAT-1R & Terra/MODIS

◆Spectral response functions

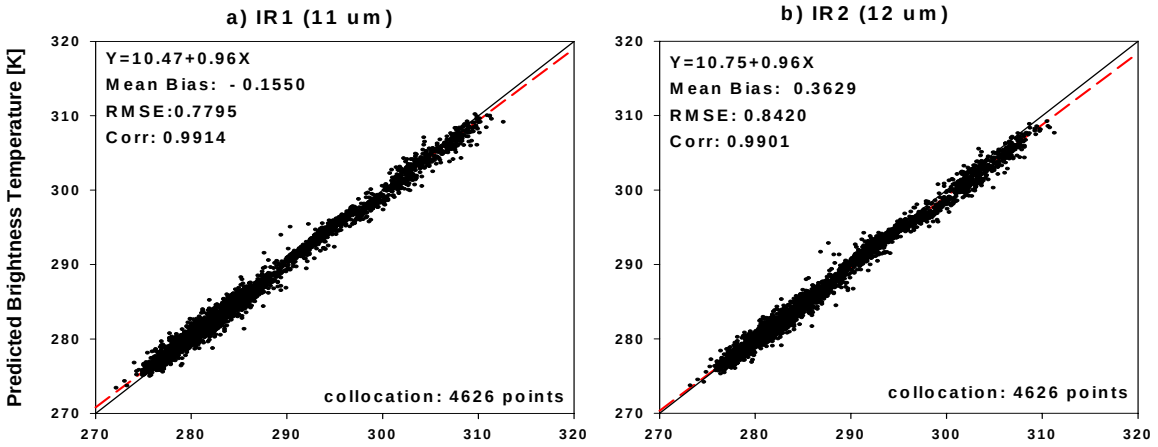


Instrument	Chs	Window CH1 [μm]	Window CH2 [μm]	Water Vapor CH [μm]	SWIR CH [μm]
MTSAT-1R	5	10.3-11.3	11.5-12.5	6.5-7.0	3.5-4.0
MODS/Terra	36	10.8-11.3	11.8-12.3	6.5-6.9	3.7-3.8

TB Intercomparison for MTSAT-1R

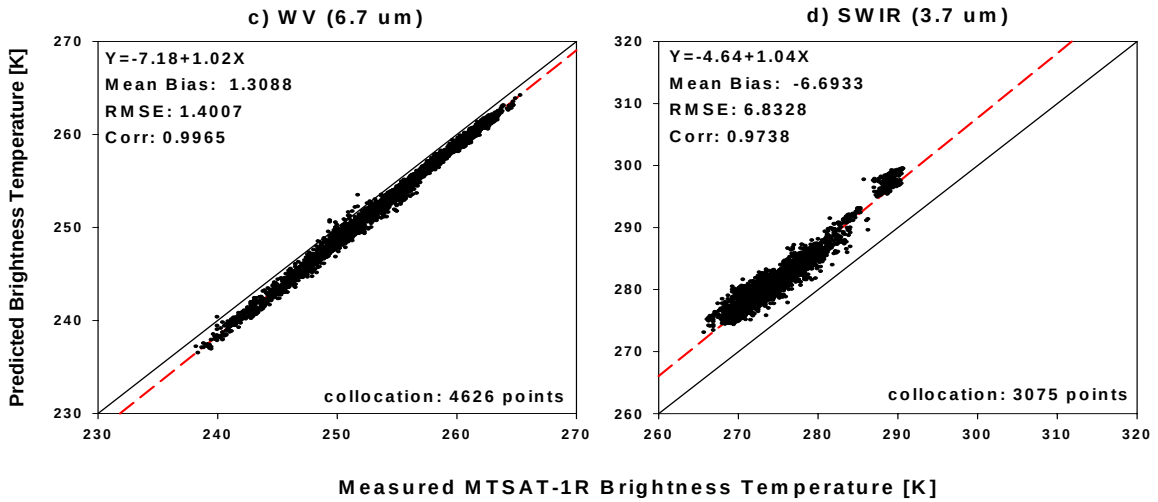
ugust 2005)

Window CH1



Window CH2

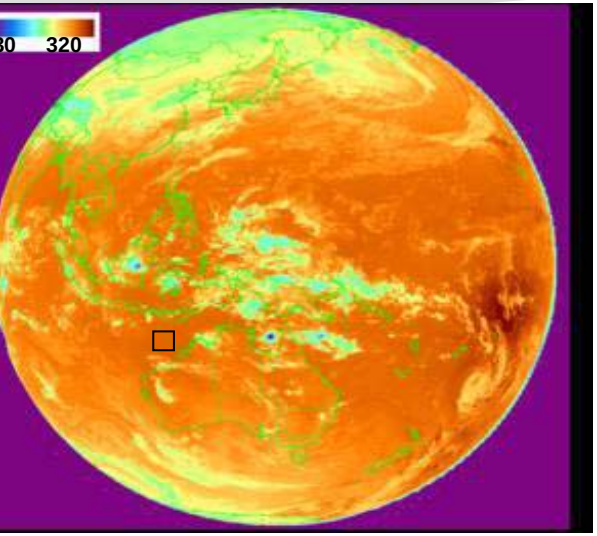
WV CH



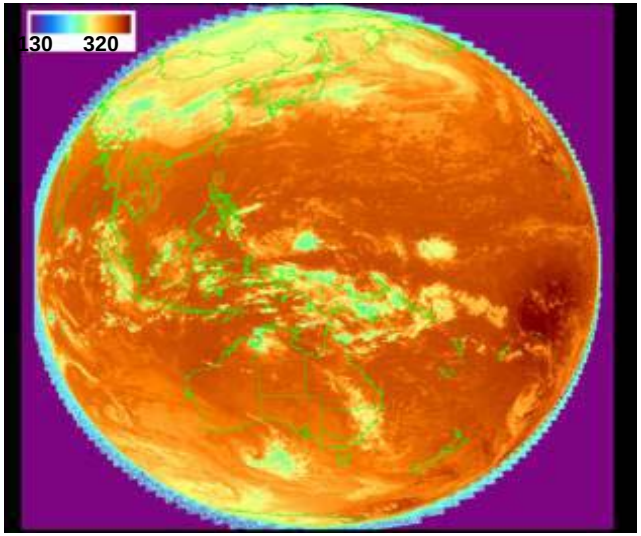
SWIR CH

	Window CH1	Window CH2	WV CH	SWIR CH
Mean bias	-0.16	0.36	1.31	-6.69
RMSE	0.78	0.84	1.40	6.83

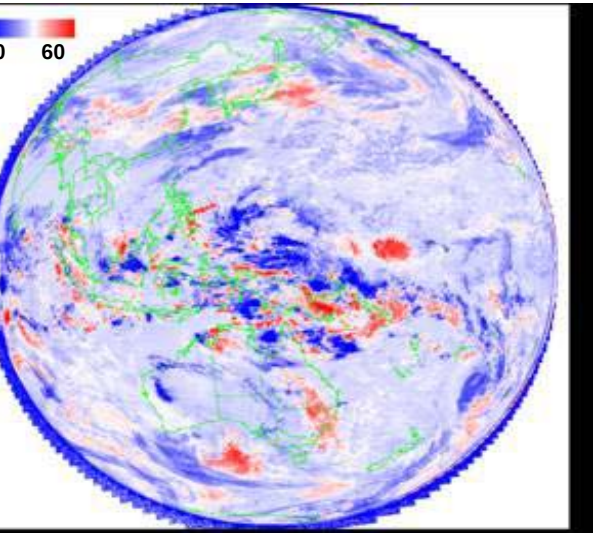
SWIR TB difference (Feb 14 - Feb 15, 2006)

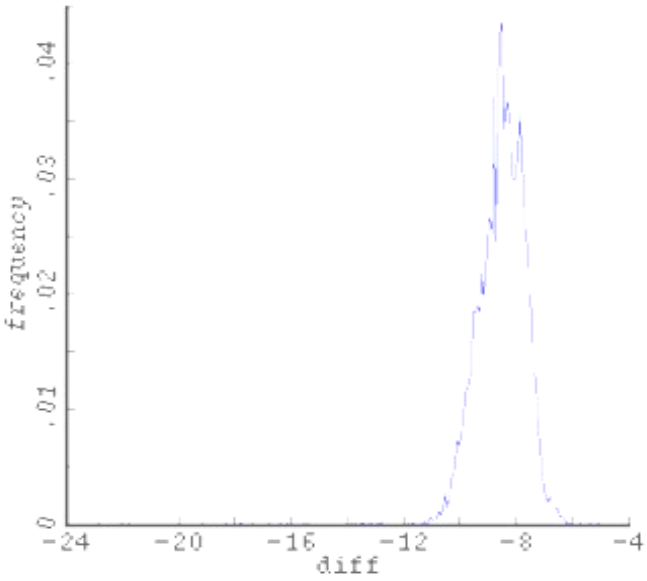


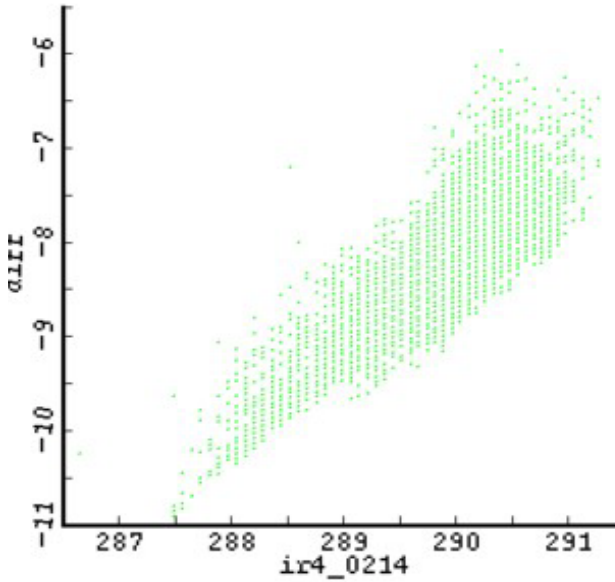
0214.1933 UTC



0215.1933 UTC



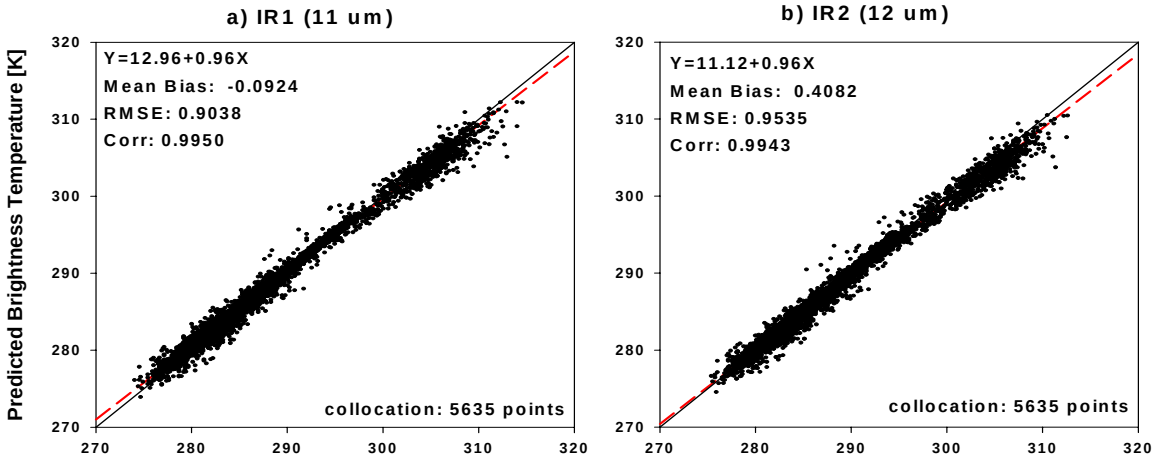




TB Intercomparison for MTSAT-1R

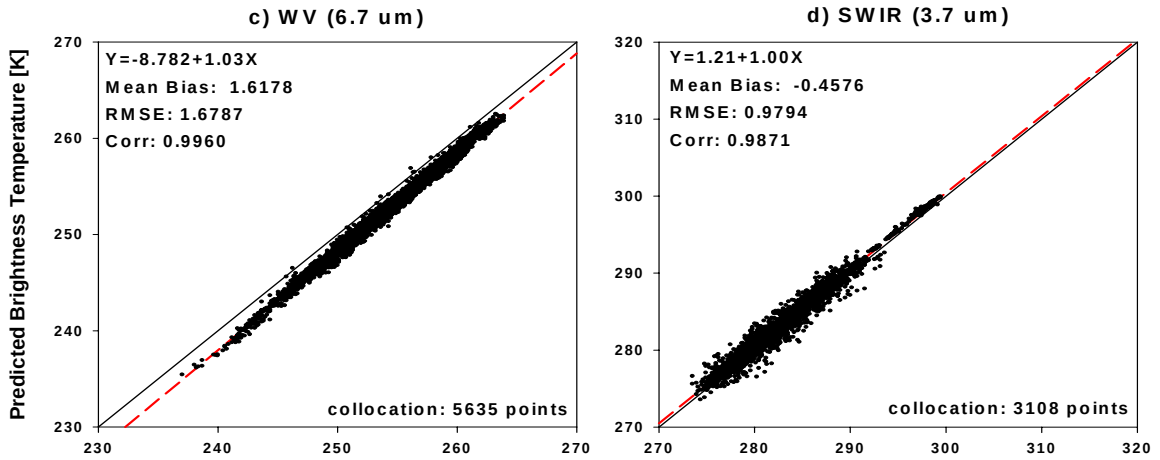
ugust 2006)

Window CH1



Window CH2

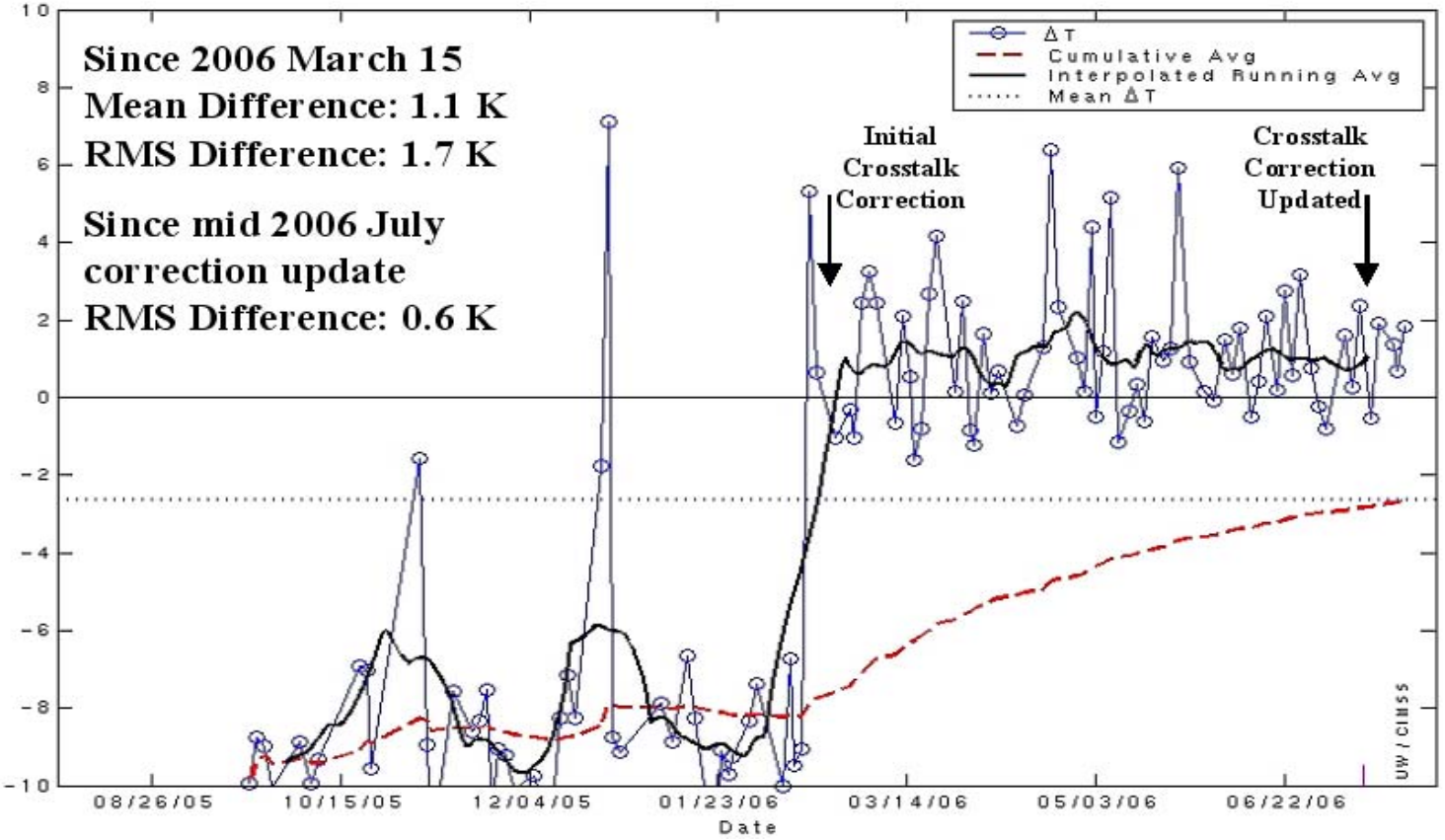
WV CH



SWIR CH

	Window CH1	Window CH2	WV CH	SWIR CH
Mean bias	-0.09	0.41	1.62	-0.46
RMSE	0.90	0.95	1.68	0.98

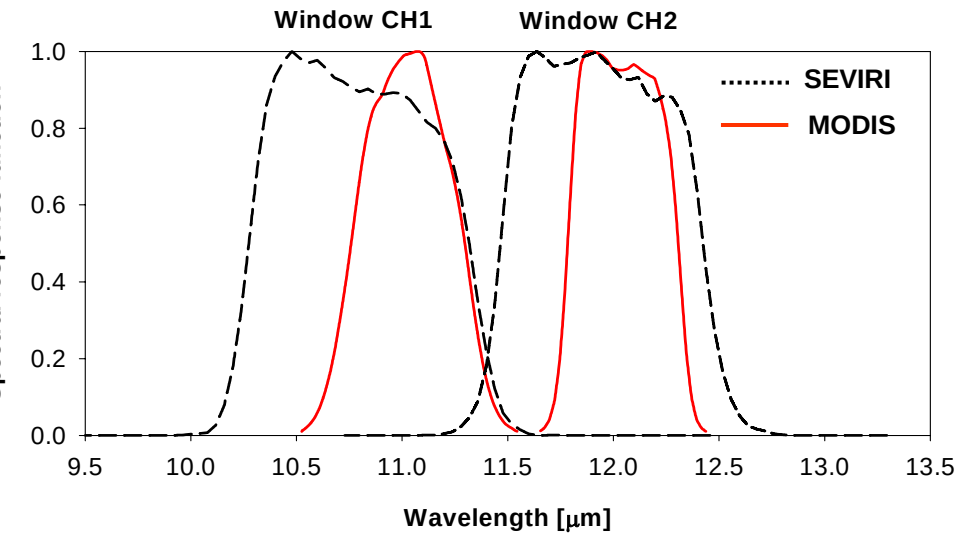
MTSAT-1R Crosstalk Correction

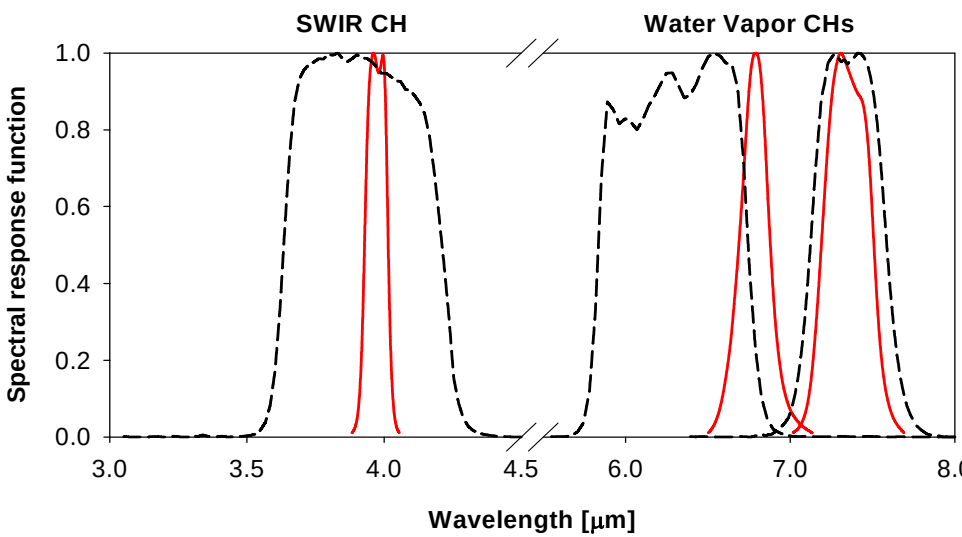


- MTSAT had a crosstalk problem in the shortwave band coming from the water vapor band
- There may still be a problem with the calibration in very cold temperatures where the crosstalk signal overwhelms the weak signal in that band at those temperatures

MSG-1/SEVIRI & Aqua/MODIS

◆Spectral response functions

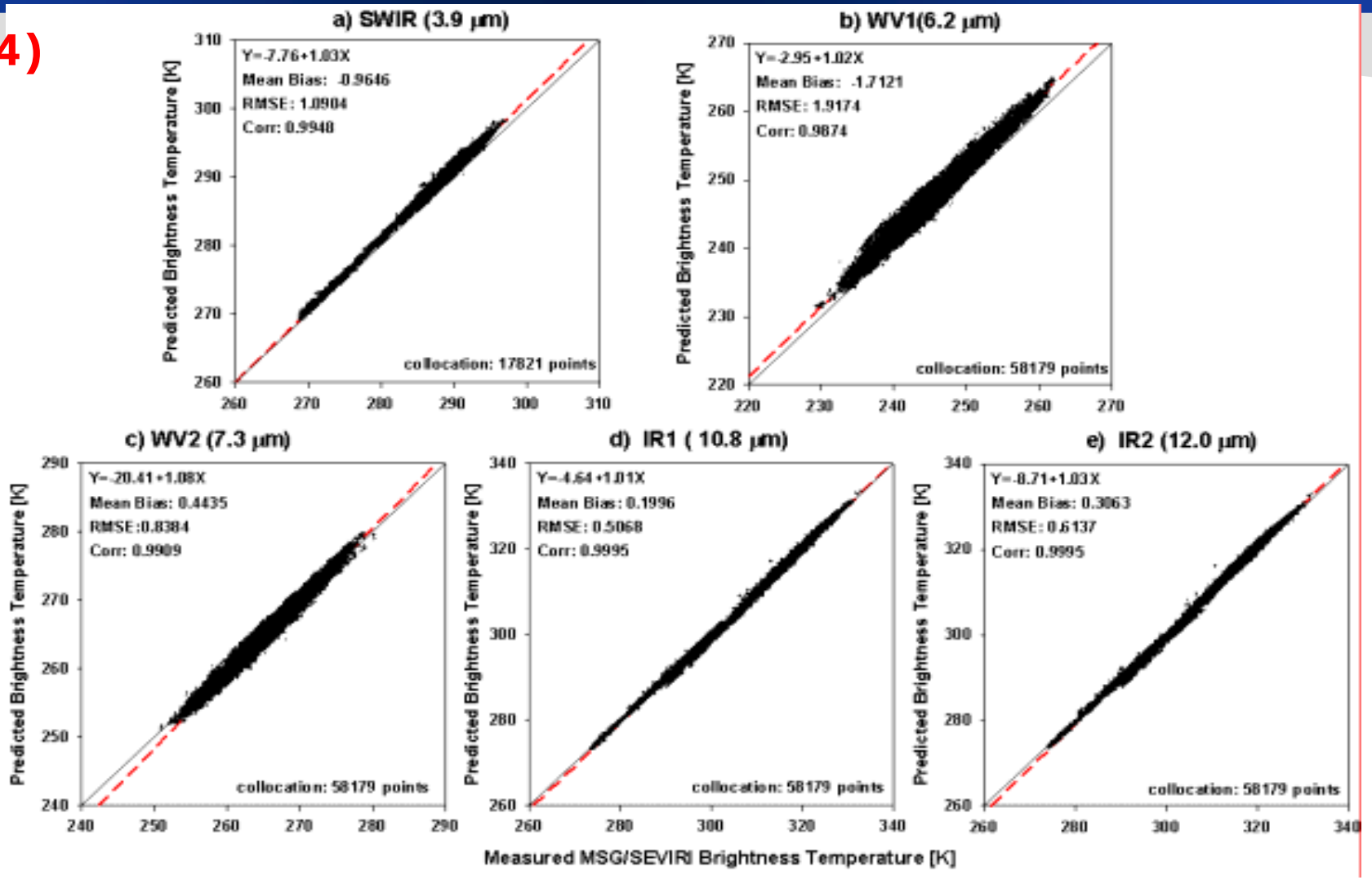




Instrument	Window CH1 [μm]	Window CH2 [μm]	Water Vapor CH1 [μm]	Water Vapor CH2 [μm]	SWIR CH [μm]
SEVIRI/MSG	9.8-11.8	11.0-13.0	5.4-7.2	6.9-7.9	3.5-4.4
MODS/Aqua	10.8-11.3	11.8-12.3	6.5-6. 9	7.2-7.5	3.9-4.0

TB comparison for MSG-1

uly 2004)



	Window CH1	Window CH2	WV CH1	WV CH2	SWIR CH
Mean bias	0.20	0.31	-1.71	0.44	-0.96
RMSE	0.51	0.61	1.92	0.84	1.09

Time series of calibration statistics