GCOM-W1 AMSR2 intercalibration status of Tb product (L1B)

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JAXA/EORC

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AMSR science team TIM on 4-5 Sep. 2013 at Embassy Suites Mandalay Beach, CA, USA

GCOM-W1 "SHIZUKU"

Topics

- Inter-calibration with other radiometers
  - AMSR2 vs TMI/TRMM
    - Double difference approach
  - AMSR2 vs AMSR-E/AQUA
    - Direct comparison with 2rpm mode
    - Indirect comparison with 2011 L1B
- RFI(Radio Frequency Interference) identification on 6.9/7.3GHz

INTER-COMPARISON WITH OTHER RADIOMETERS

vs. TMI

vs. AMSR-E

vs TMI

Inter-comparison with TMI

- TRMM/TMI:
  - non-sun synchronous orbit, it is convenient to make collocation data with AMSR2.
  - observation condition, frequency and sat incidence angle, are close to AMSR2.
- Double difference:
  - cancels out Tb biases brought by differences such as observation frequency and satellite incidence angle.
- Approach
  - step 1: Make collocation dataset from AMSR-2 and TMI. (15mins and 0.1deg grid)
  - step 2: Compute SD(single difference) for both of AMSR-2 and TMI.

    SD = O(observed Tb) – C(computed Tb)
  - step 3: Compute DD(double difference)

    DD = SD(AMSR2) – SD(TMI)
  - Radiative transfer model is RTTOV. NWP dataset to input to RTM is JMA objective analysis.

AMSR2

Center frequency[GHz]	6.925	7.3	10.65	18.7	23.8	36.5	89
Band width [MHz]	350	350	100	200	400	1000	3000
Polarization	V/H	V/H	V/H	V/H	V/H	V/H	V/H
Nominal incidence ang. [deg]	55						55/54.5
IFOV[km] (Cross x along)	35 x 62	35 x 62	24 x 42	14 x 22	15 x 26	7 x 12	3 x 5

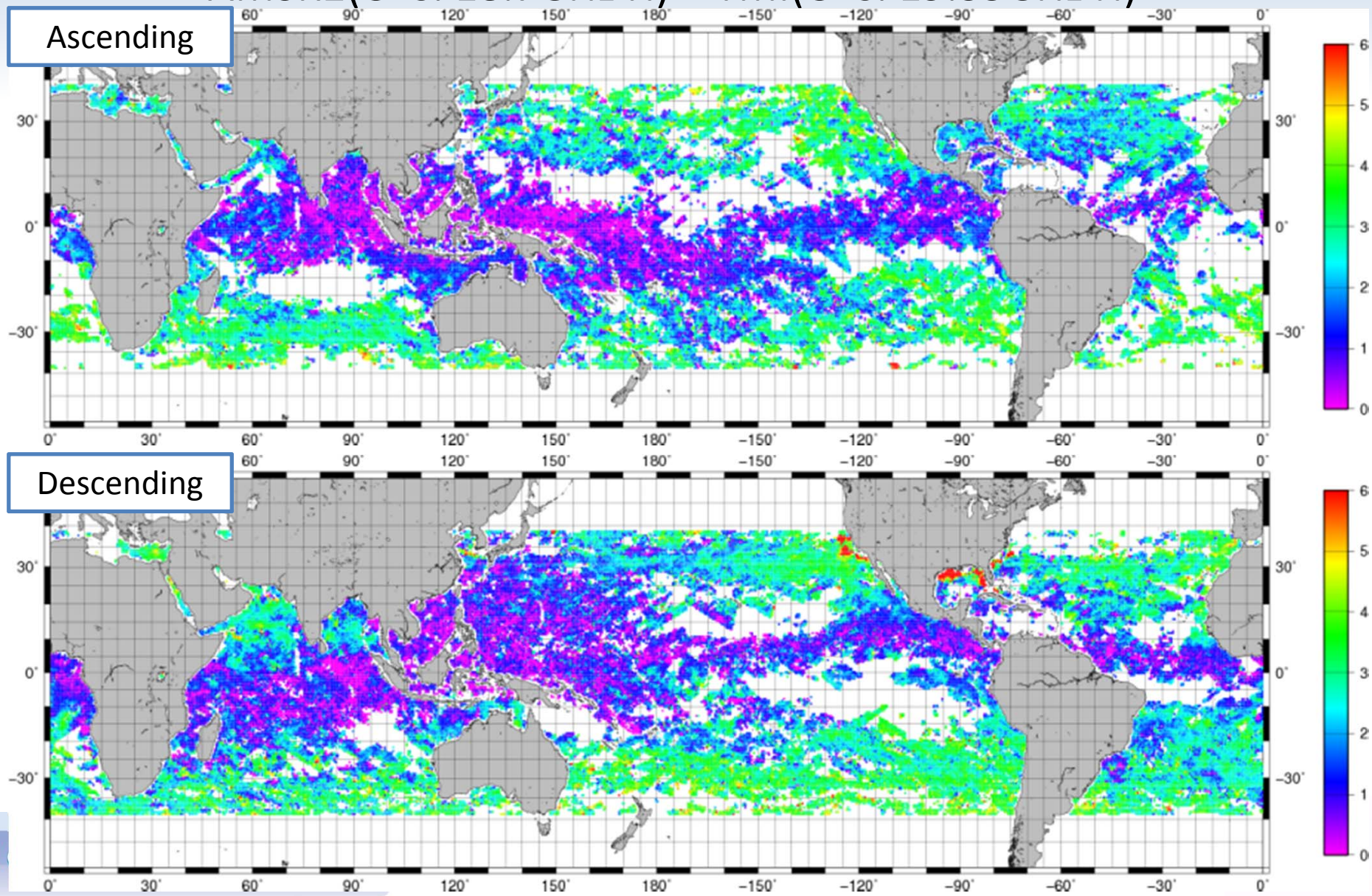
TMI

Center frequency[GHz]	-	-	10.65	19.35	21.3	37	85.5
Band width [MHz]	-	-	100	500	200	2000	3000
Polarization	-	-	V/H	V/H	V	V/H	V/H
Nominal incidence ang. [deg]	-	-	53.4				
IFOV[km] (Cross x along)	-	-	43 x 72	21 x 35	21 x 26	10 x 18	6 x 8

vs TMI

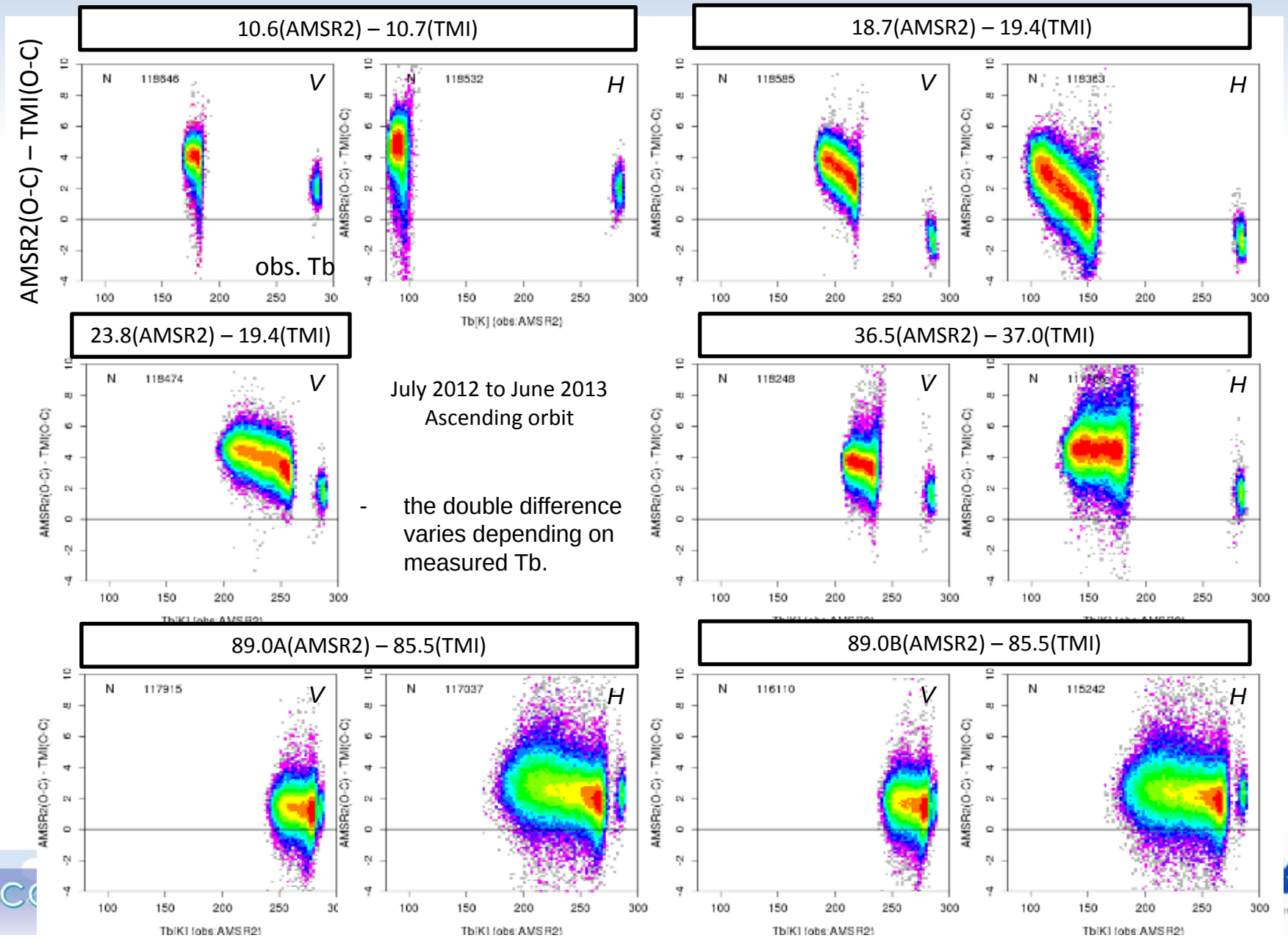
Example of collocation points

AMSR2(O-C: 18.7GHz H) – TMI(O-C: 19.35GHz H)



vs TMI

Double difference and measured Tb



July 2012 to June 2013
Ascending orbit

- the double difference varies depending on measured Tb.

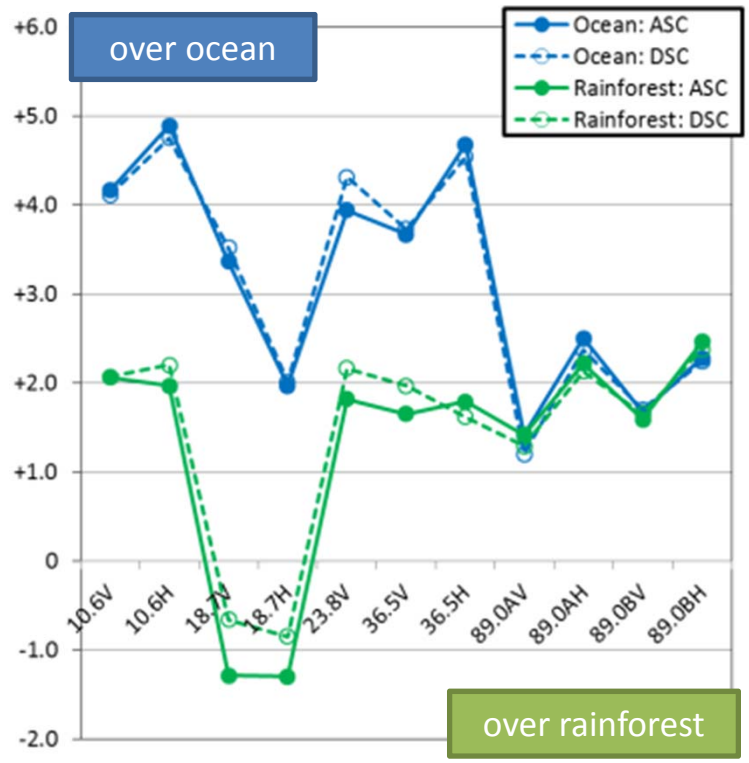
vs TMI

Double difference

- Cloud free ocean and rainforest area
- Jul. 2012 to June 2013
- AMSR2 Tbs are 0 to 5 degrees higher than TMI Tbs
- Tb differences over ocean and over rainforest areas are different from each other.
- The double differences based on ERA-Interim is almost same.

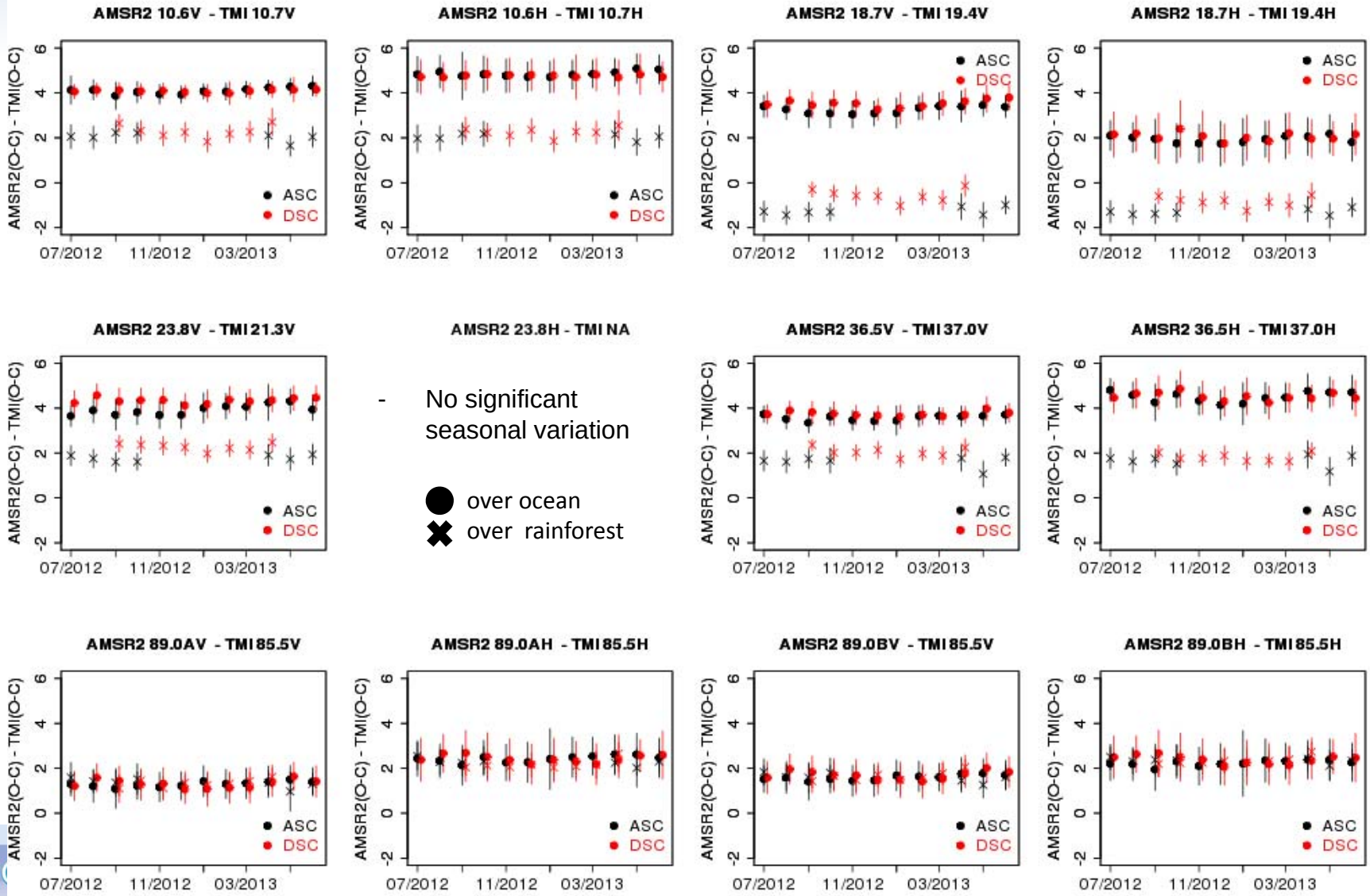
Ascending	ASC /JMA		rainforest	
	TB	ΔT / RMS	TB	ΔT / RMS
10.6V	180	+4.2 / 0.4	287	+2.1 / 0.5
10.6H	92	+4.9 / 0.7	285	+2.0 / 0.6
18.7V	206	+3.4 / 0.6	287	-1.3 / 0.5
18.7H	132	+2.0 / 0.9	285	-1.3 / 0.5
23.8V	238	+3.9 / 0.7	288	+1.8 / 0.5
36.5V	225	+3.7 / 0.5	285	+1.7 / 0.5
36.5H	161	+4.7 / 0.7	285	+1.8 / 0.5
89.0AV	270	+1.4 / 0.7	287	+1.4 / 0.6
89.0AH	243	+2.5 / 0.9	287	+2.2 / 0.6
89.0BV	270	+1.7 / 0.7	287	+1.6 / 0.6
89.0BH	242	+2.3 / 0.9	287	+2.5 / 0.6
Descending	DSC /JMA		rainforest	
	TB	ΔT / RMS	TB	ΔT / RMS
10.6V	180	+4.1 / 0.4	282	+2.1 / 0.5
10.6H	92	+4.8 / 0.7	280	+2.2 / 0.5
18.7V	206	+3.5 / 0.6	283	-0.7 / 0.5
18.7H	132	+2.0 / 1.0	281	-0.9 / 0.5
23.8V	238	+4.3 / 0.6	285	+2.2 / 0.4
36.5V	225	+3.7 / 0.5	281	+2.0 / 0.4
36.5H	161	+4.5 / 0.7	281	+1.6 / 0.4
89.0AV	271	+1.2 / 0.7	285	+1.3 / 0.5
89.0AH	244	+2.4 / 0.9	285	+2.1 / 0.6
89.0BV	271	+1.7 / 0.7	285	+1.7 / 0.6
89.0BH	243	+2.2 / 0.9	285	+2.4 / 0.6

AMSR2(O-C) – TMI(O-C)



vs TMI

Trend of AMSR2 - TMI



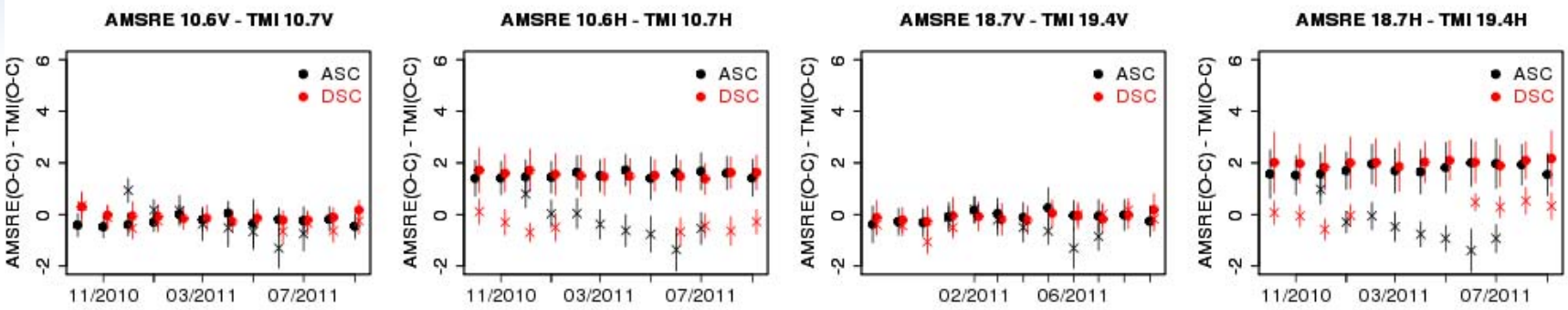
- No significant seasonal variation

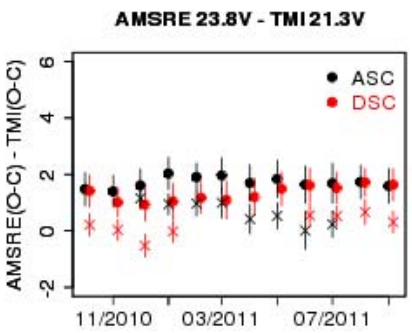
● over ocean

✖ over rainforest

vs TMI

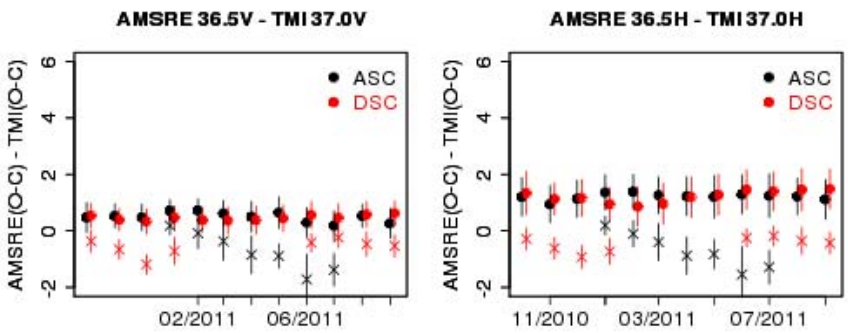
Trend of AMSR-E - TMI

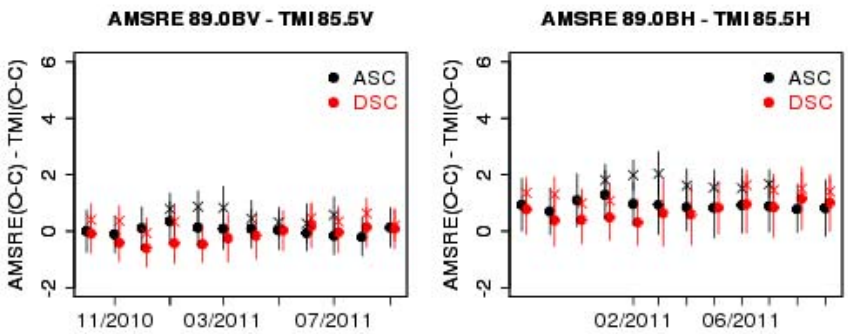




AMSRE 23.8H - TMI NA

● over ocean
✖ over rainforest



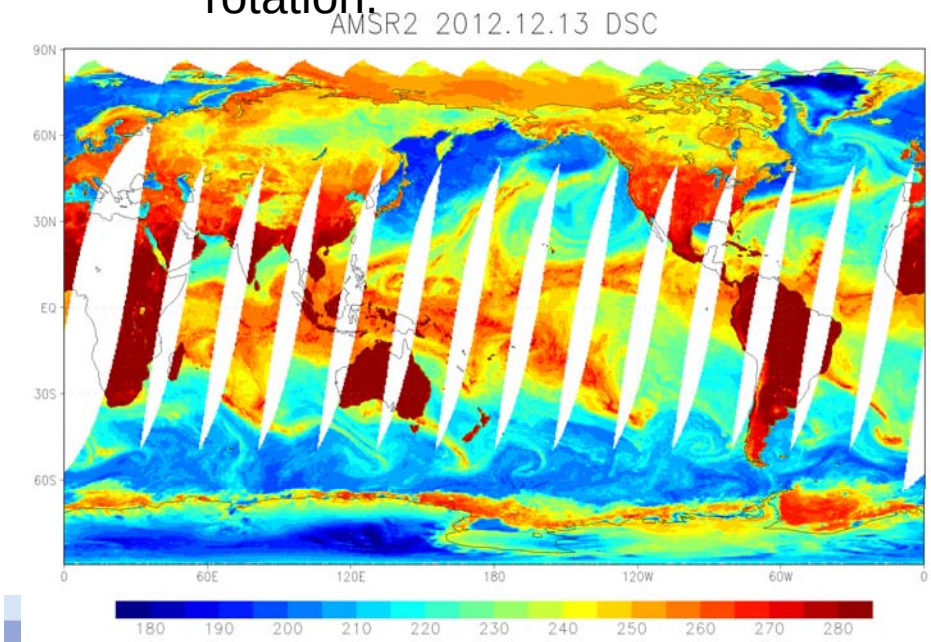


- Bias comparing with TMI is smaller than that of AMSR-2
- Seasonal variation of the bias over rainforest area is larger than that of AMSR-2

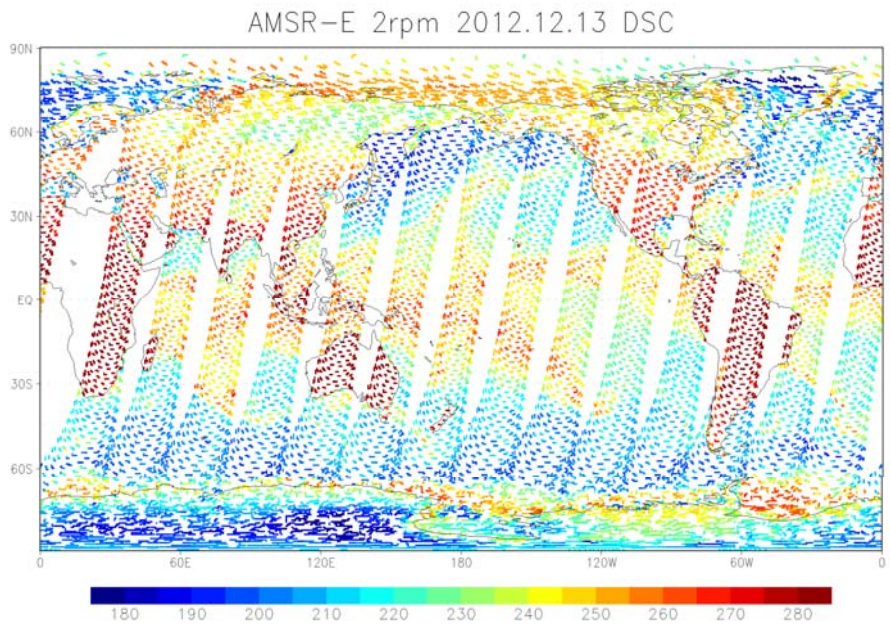
vs AMSR-E(1)

Direct comparison with AMSR-E Tb

- Observation frequencies are same except for 7.3GHz. Frequency correction is not required for comparison of AMSR-2 with AMSR-E. It enables wide Tb range comparison over land, ice, and ocean.
- AMSR-E observations resumed from December 4, 2012 with 2rpm rotation speed. Geolocation and Tbs are computed by modified software.
- Observation data is sparse but amount is reasonable for global-scale analysis.
- Geolocation and radiometric correction software modification have just finished. JAXA/EORC is checking effectivity of modified algorithm for slow rotation.



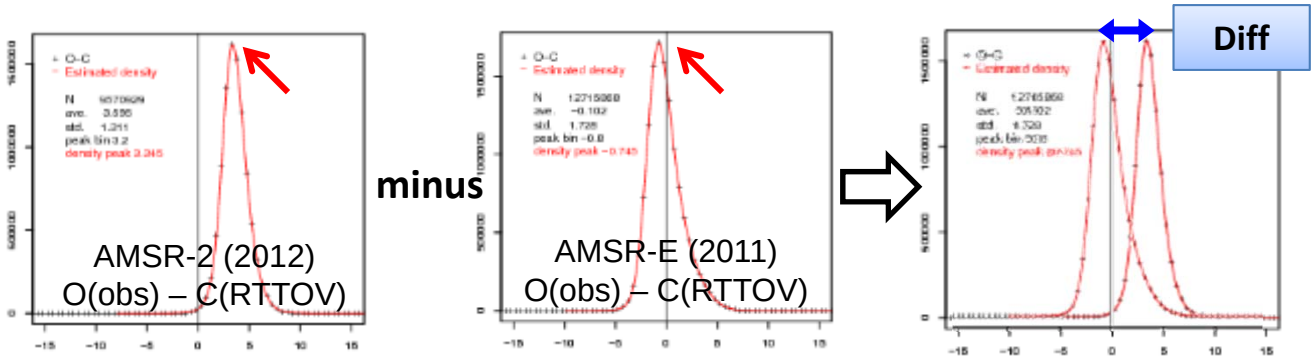
AMSR2 23V Descending



AMSR-E 2rpm 23V Descending

Indirect comparison with AMSR-E Tb

- Current AMSR2 is compared with past AMSR-E data.
- Approach
  - step 1: compute AMSR2 SD (obs.Tb – computed Tb) on cloud free ocean and rainforest.
  - step 2: obtain a typical SD from a histogram.
  - step 3: follow these steps also for AMSR-E L1B in 2011. Different year, same season. Data period is one year, Oct 2010 to Sep 2011 for AMSR-E and Jul 2012 to Jun 2013 for AMSR2.
  - step 4: SD(AMSR2) – SD(AMSRE) seems to show Tb difference between both satellites.



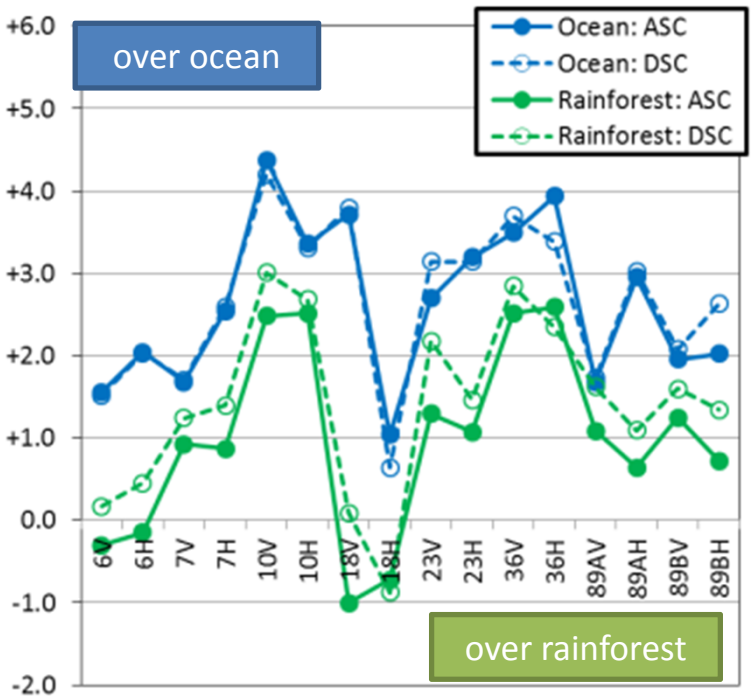
vs AMSR-E(2)

Indirect comparison with AMSR-E Tb

Ascending	AMSR-E(O-C)		AMSR-2(O-C)		ocean		rainforest	
	ocean	rainforest	ocean	rainforest	TB	ΔT	TB	ΔT
6V	-1.8	-4.0	-0.2	-4.3	171	+1.6	287	-0.3
6H	+0.1	-4.7	+2.2	-4.8	83	+2.0	286	-0.2
7V	-	-	-0.1	-3.1	171	+1.7	289	+0.9
7H	-	-	+2.7	-3.8	84	+2.5	287	+0.9
10V	-1.8	-5.4	+2.5	-2.9	178	+4.4	289	+2.5
10H	-0.2	-5.5	+3.2	-3.0	90	+3.4	288	+2.5
18V	+0.2	-2.6	+3.9	-3.6	202	+3.7	289	-1.0
18H	+1.3	-3.2	+2.4	-4.0	125	+1.0	288	-0.7
23V	+0.1	-2.6	+2.8	-1.4	231	+2.7	291	+1.3
23H	+1.3	-2.8	+4.5	-1.7	180	+3.2	290	+1.1
36V	-1.0	-2.9	+2.5	-0.3	221	+3.5	288	+2.5
36H	+0.1	-2.8	+4.0	-0.2	155	+3.9	287	+2.6
89AV	-	-	+2.0	-1.2	266	+1.7	290	+1.1
89AH	-	-	+4.7	-1.4	235	+3.0	289	+0.6
89BV	+0.3	-2.3	+2.2	-1.0	266	+2.0	290	+1.2
89BH	+1.7	-2.0	+3.7	-1.3	234	+2.0	289	+0.7

Descending	AMSR-E(O-C)		AMSR-2(O-C)		ocean		rainforest	
	ocean	rainforest	ocean	rainforest	TB	ΔT	TB	ΔT
6V	-1.9	-4.4	-0.4	-4.2	169	+1.5	279	+0.2
6H	+0.1	-5.3	+2.1	-4.8	83	+2.0	278	+0.5
7V	-	-	-0.2	-3.2	170	+1.7	280	+1.2
7H	-	-	+2.7	-3.9	84	+2.6	279	+1.4
10V	-1.8	-6.5	+2.4	-3.5	177	+4.2	280	+3.0
10H	-0.2	-6.4	+3.1	-3.7	89	+3.3	279	+2.7
18V	-0.0	-4.0	+3.8	-3.9	200	+3.8	281	+0.1
18H	+1.7	-3.9	+2.4	-4.8	122	+0.6	279	-0.9
23V	-0.5	-3.6	+2.6	-1.4	227	+3.1	284	+2.2
23H	+1.3	-3.3	+4.4	-1.8	173	+3.1	283	+1.5
36V	-1.1	-3.8	+2.6	-1.0	220	+3.7	280	+2.8
36H	+0.8	-3.3	+4.2	-1.0	153	+3.4	279	+2.3
89AV	-	-	+2.0	-1.1	263	+1.7	284	+1.6
89AH	-	-	+5.0	-1.4	231	+3.0	284	+1.1
89BV	+0.3	-2.8	+2.3	-1.2	263	+2.1	285	+1.6
89BH	+2.0	-2.5	+4.6	-1.1	231	+2.6	284	+1.3

SD(AMSR-2:2012)–SD(AMSR-E:2011)

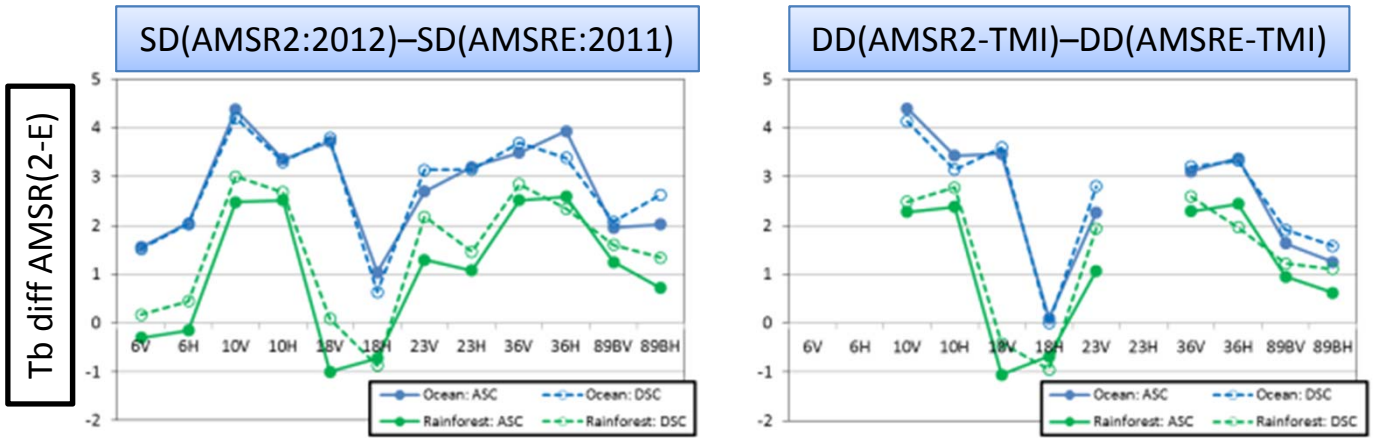


vs AMSR-E(2)

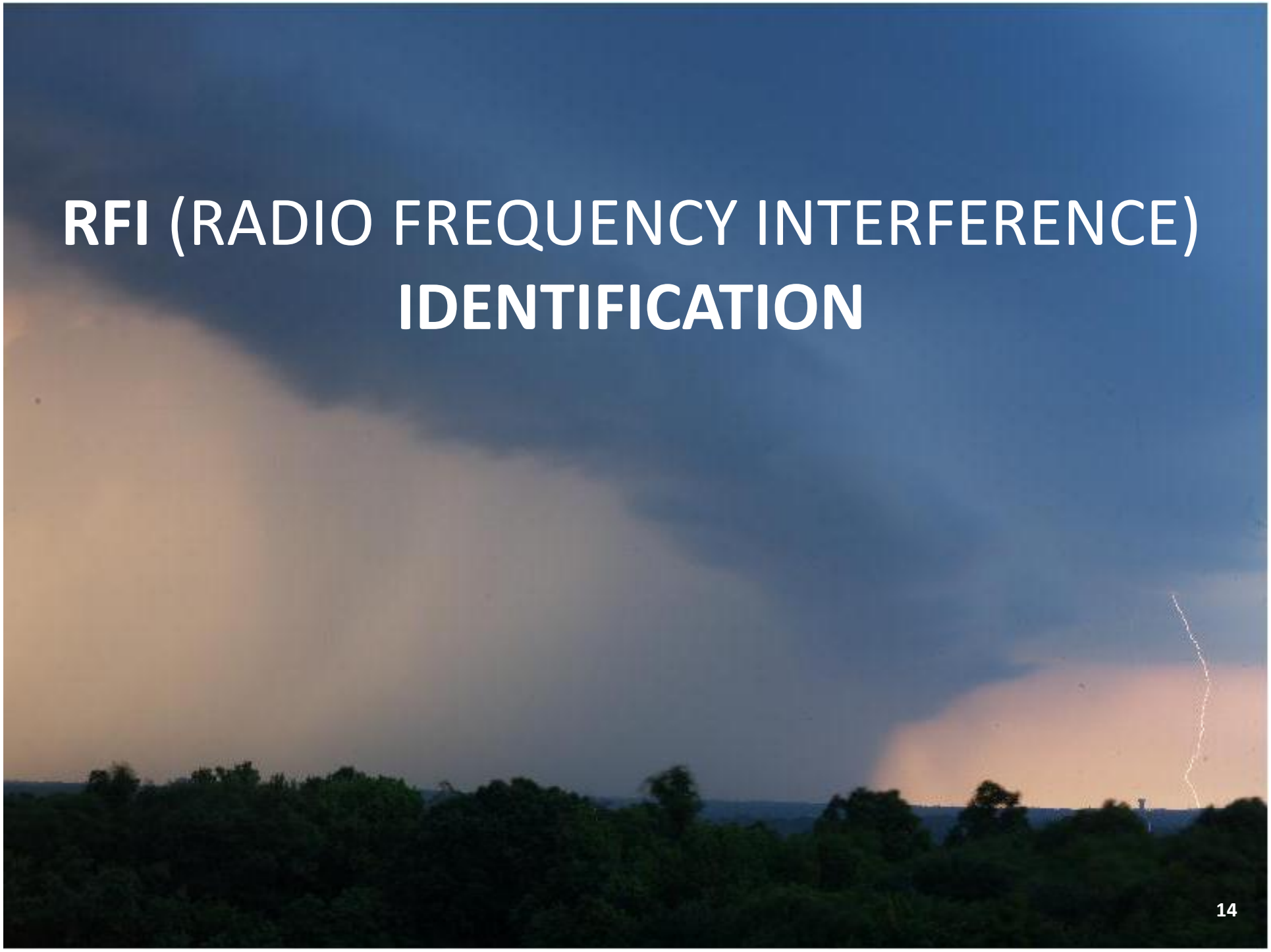
Consistency check

- Is the result of the AMSR2/AMSRE comparison reasonable?
- Following two differences are expected to be close result.
  - ① SD(AMSR2) – SD(AMSRE)
  - ② DD(AMSR2-TMI) – DD(AMSRE-TMI)
  - – if TMI SD for AMSR2 period statistically equals to the SD for AMSR-E period.

- AMSR2 relative biases by the indirect approach seems to be consistent with the result by the double difference.



RFI (RADIO FREQUENCY INTERFERENCE) **IDENTIFICATION**



C-band Radiometry and RFI

- RFI signals have been confirmed in 6.925, 10.65, and 18.7 GHz channels of many microwave radiometers.
- Advantages of C-band channels
  - Microwave SST that is being recognized very useful via the all-weather capability.
  - Important lower frequency channels for soil moisture retrieval from the aspects of data continuity and operational utilization.
- RFI signals have been observed by AMSR, AMSR-E and WindSat C-band channels particularly over land areas.
- RFI signals also have been observed over ocean such as near coasts, islands, and sometimes open oceans possibly due to sea surface reflection of satellite-origin emissions, although they are less problematic.

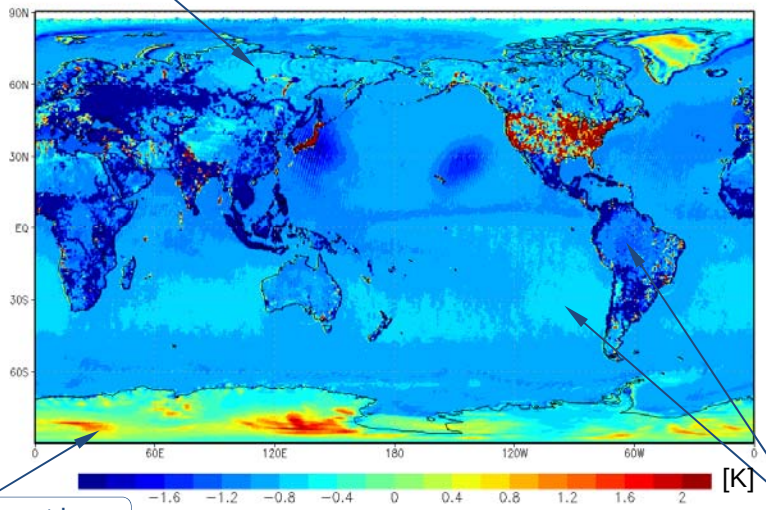
Statistics of Tb differeces: 6.9-7.3GHz

6 Months Statistics

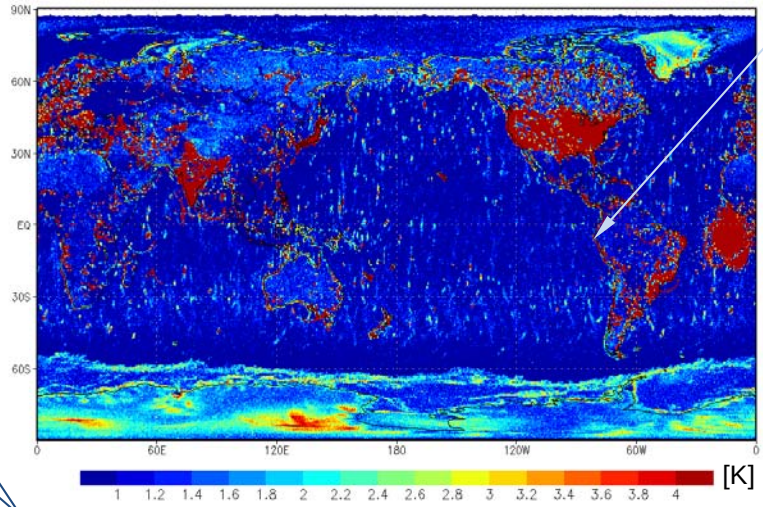
High latitudes and tropics are different

Disagreement at coastlines

Average



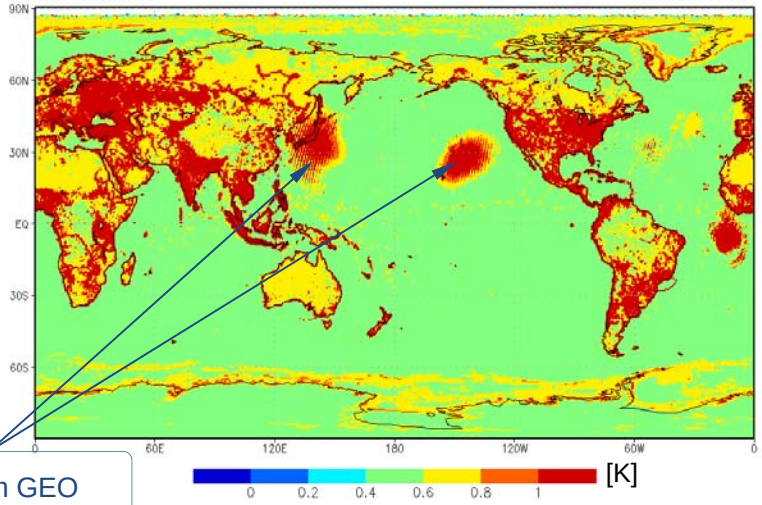
Maximum



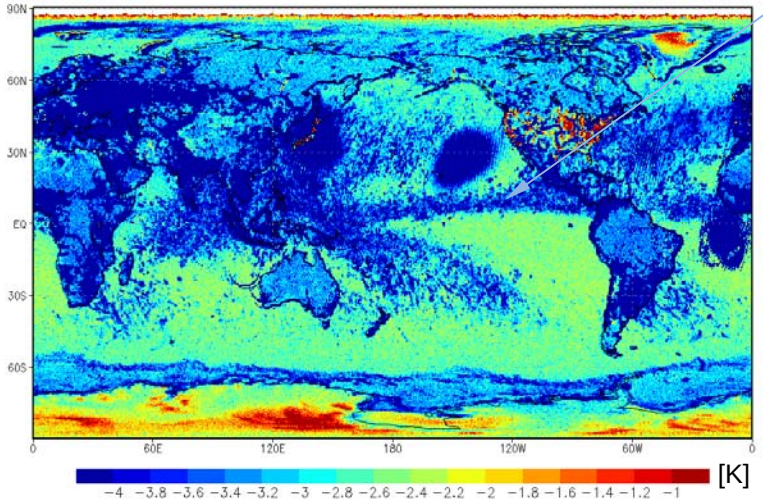
Tbs are higher at lower frequency

Ocean avg. ~ -0.8K
Land avg. ~ -1.1K

Standard deviation



Minimum



Strong precipitation

RFI from GEO

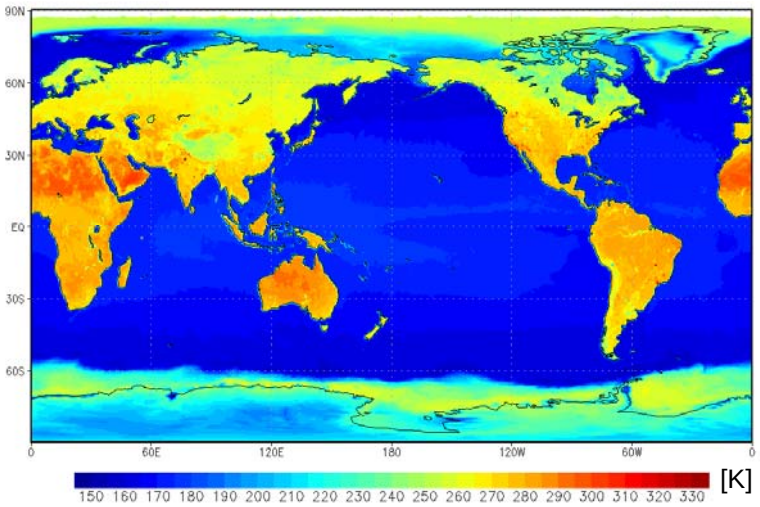
Statistics of Tb: 6.9GHz V-Pol

Land:
Diff < ±3.5K
Max < 330K

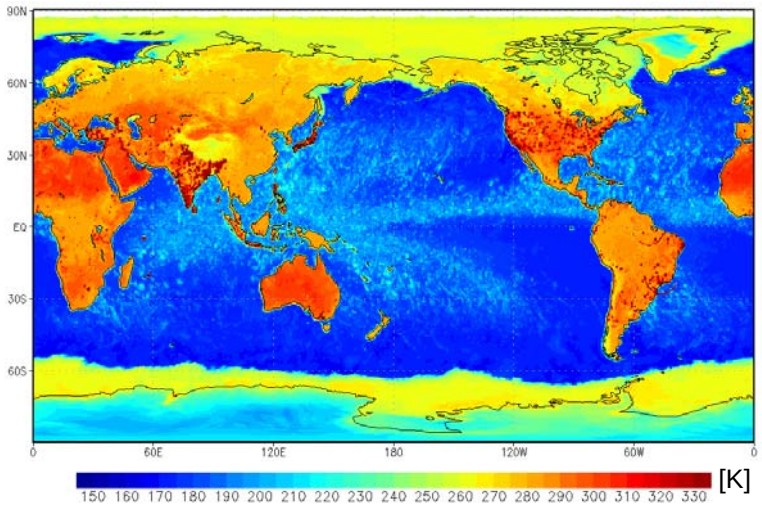
Ocean:
Diff < ±2.5K
Max < 200K

6 Months Statistics

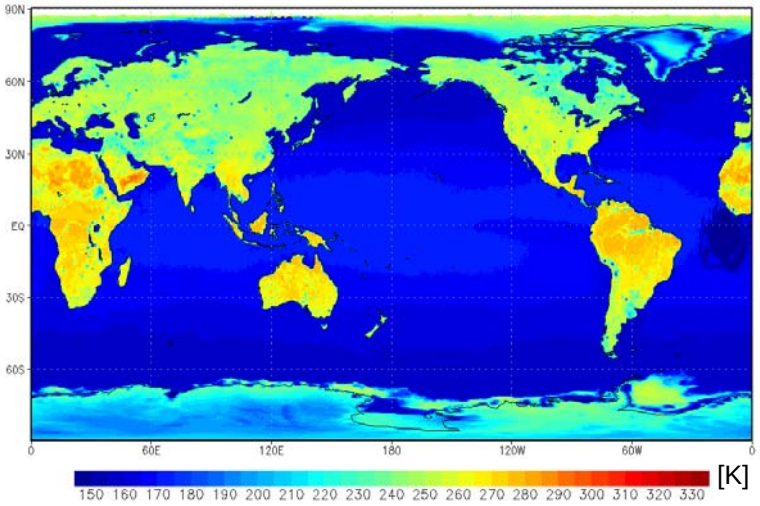
Average



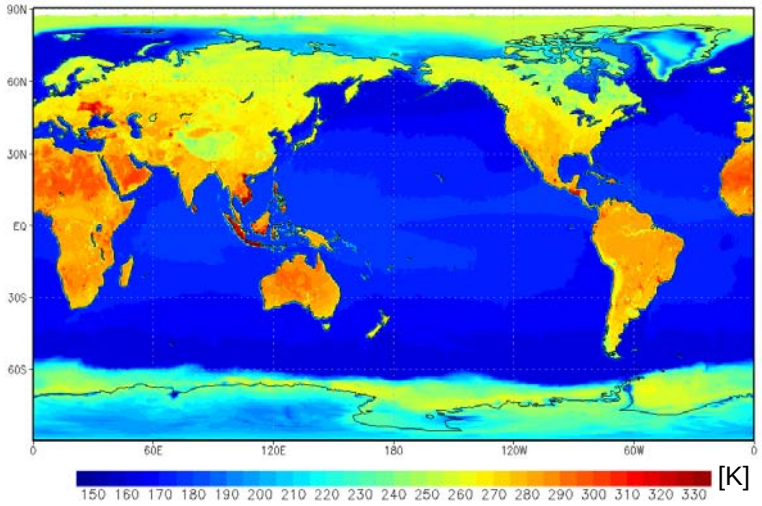
Maximum



Standard deviation



Minimum



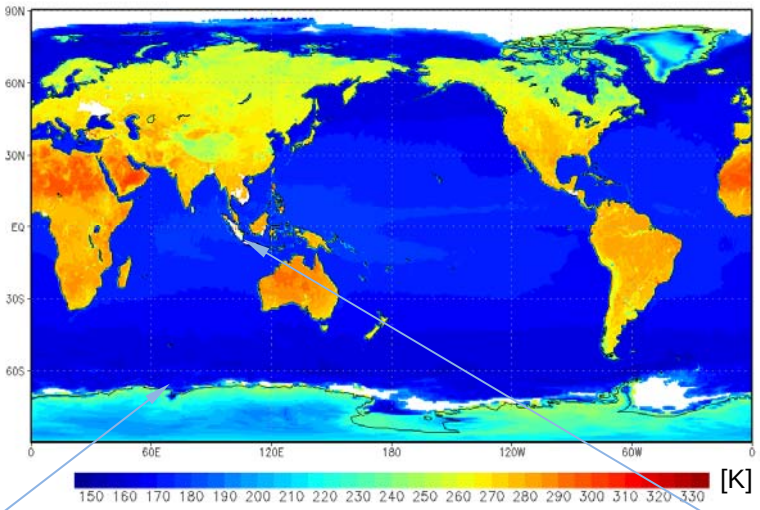
Statistics of Tb: 6.9GHz V-Pol

Land:
Diff < ±3.5K
Max < 330K

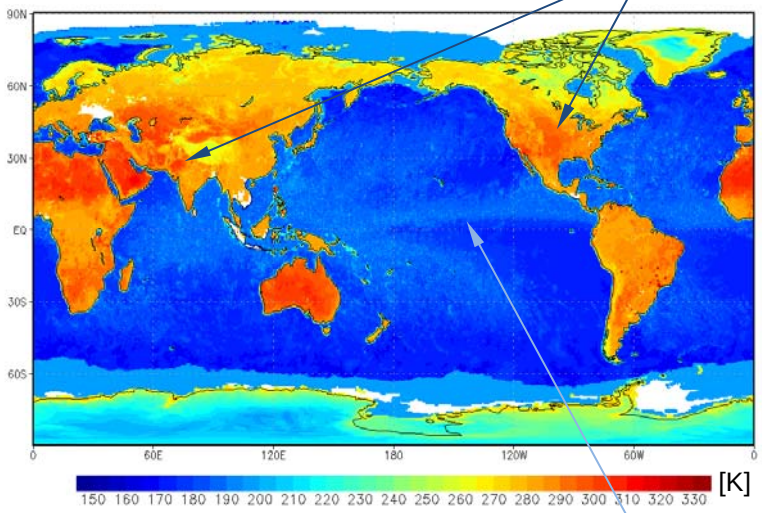
Ocean:
Diff < ±2.5K
Max < 200K

6 Months Statistics: Threshold applied

Average



Maximum



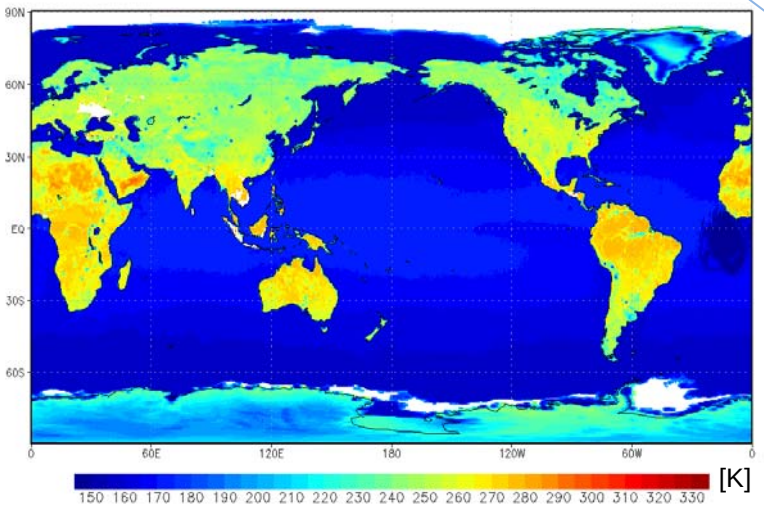
Significant RFIs reduced

Misjudged sea ice

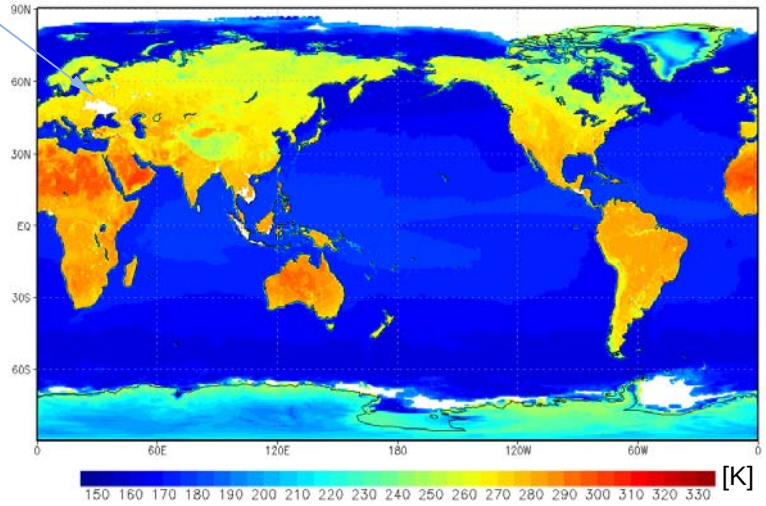
No data due to 7.3GHz RFI

Misjudged heavy precipitation

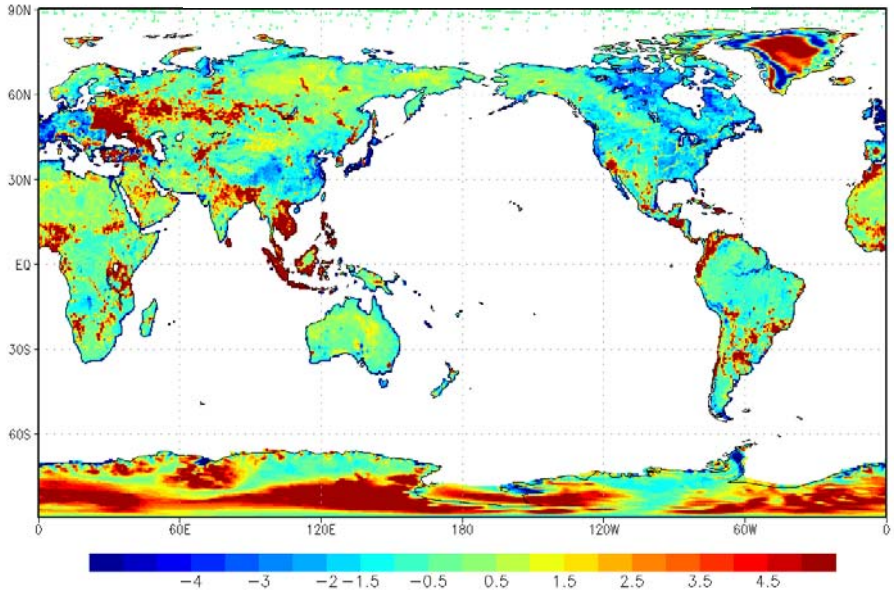
Standard deviation



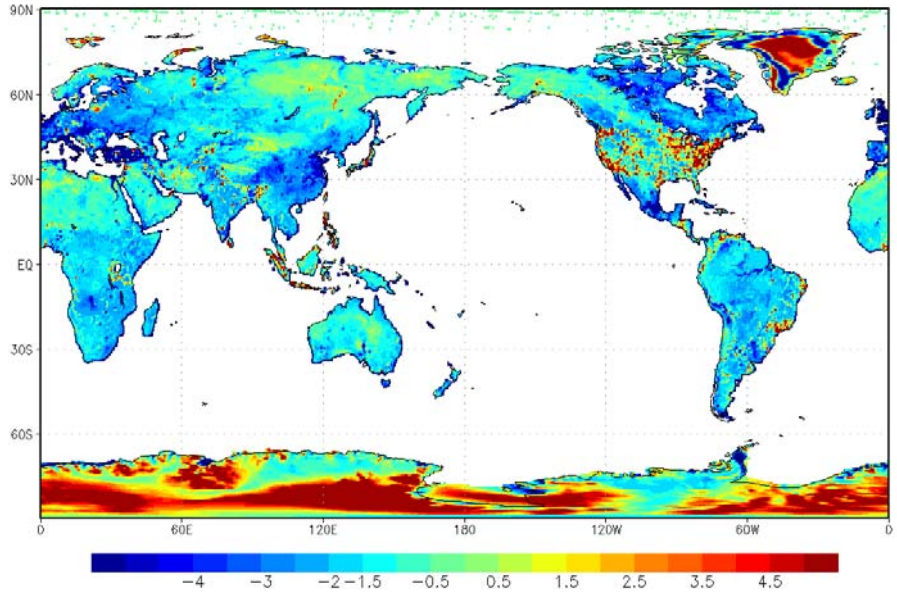
Minimum



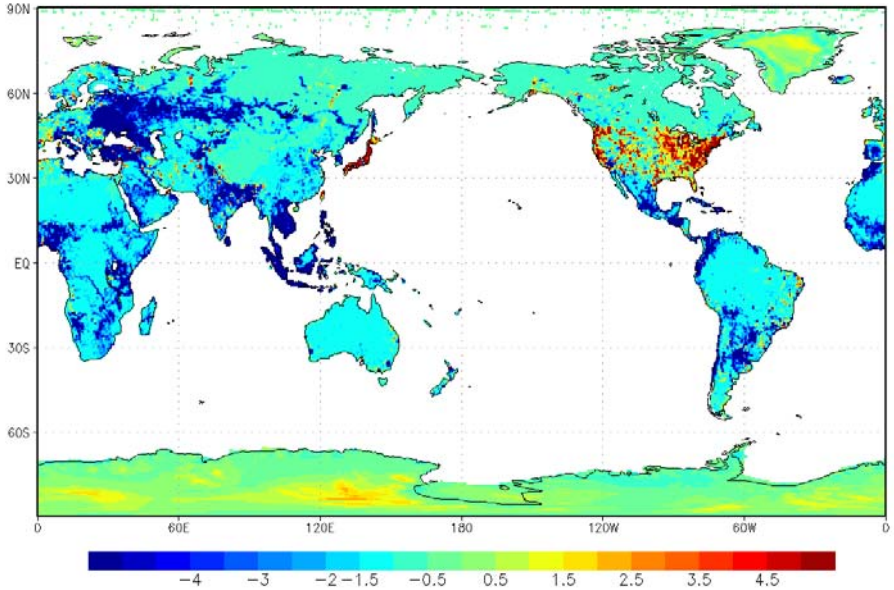
07V-10V Average [K]



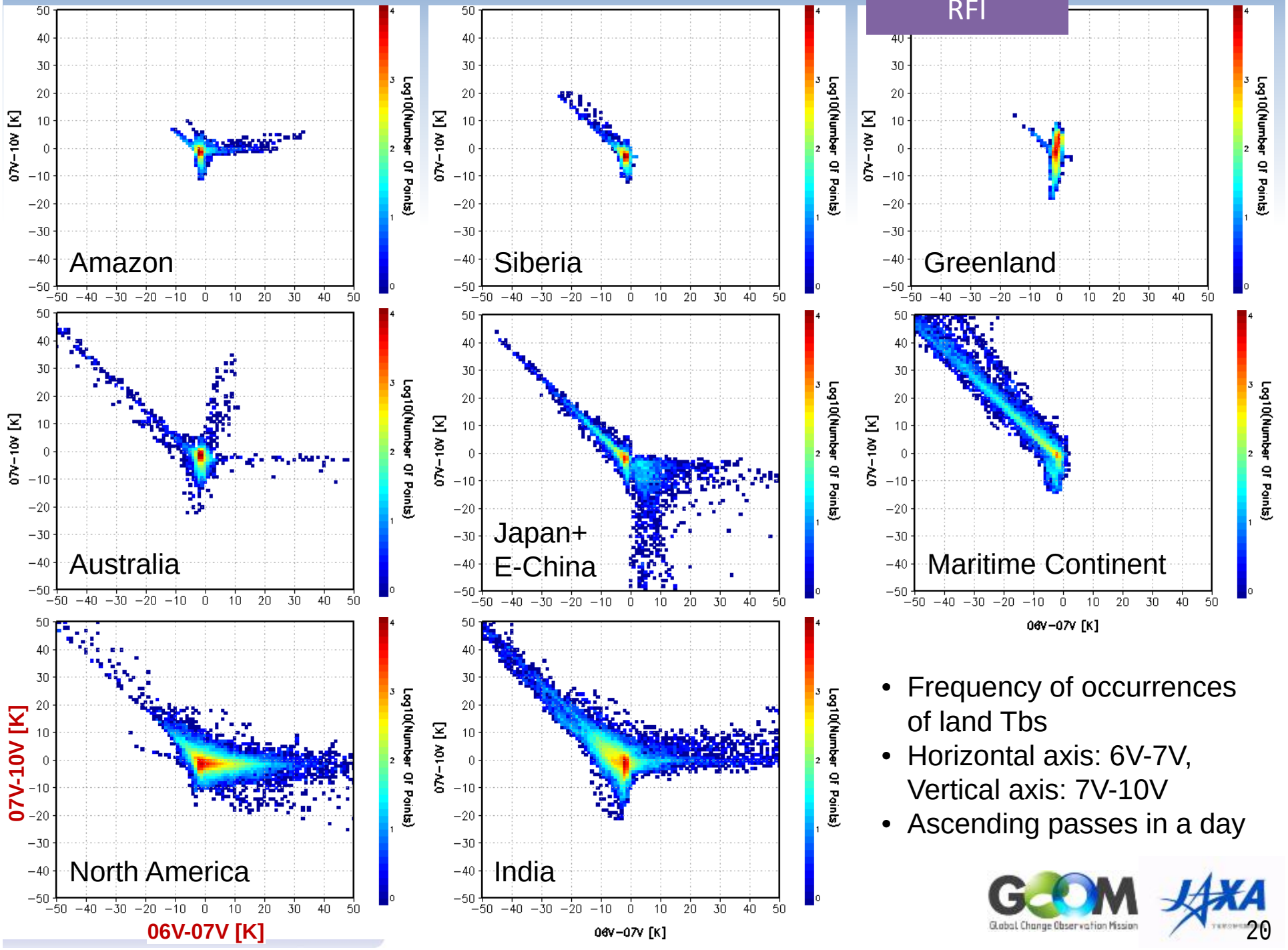
06V-10V Average [K]



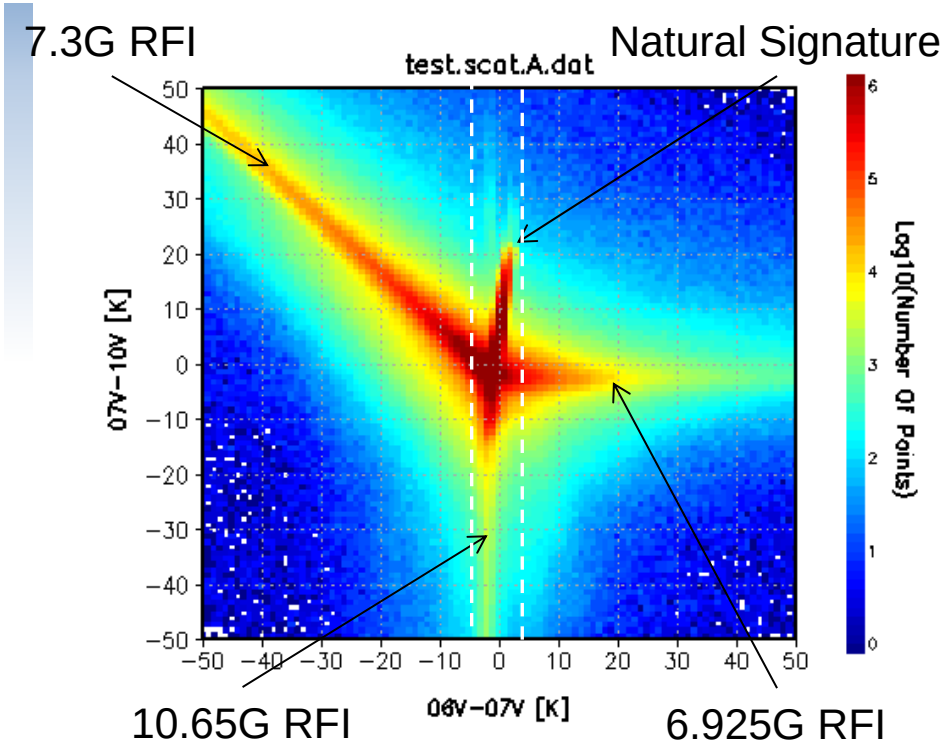
06V-07V Average [K]

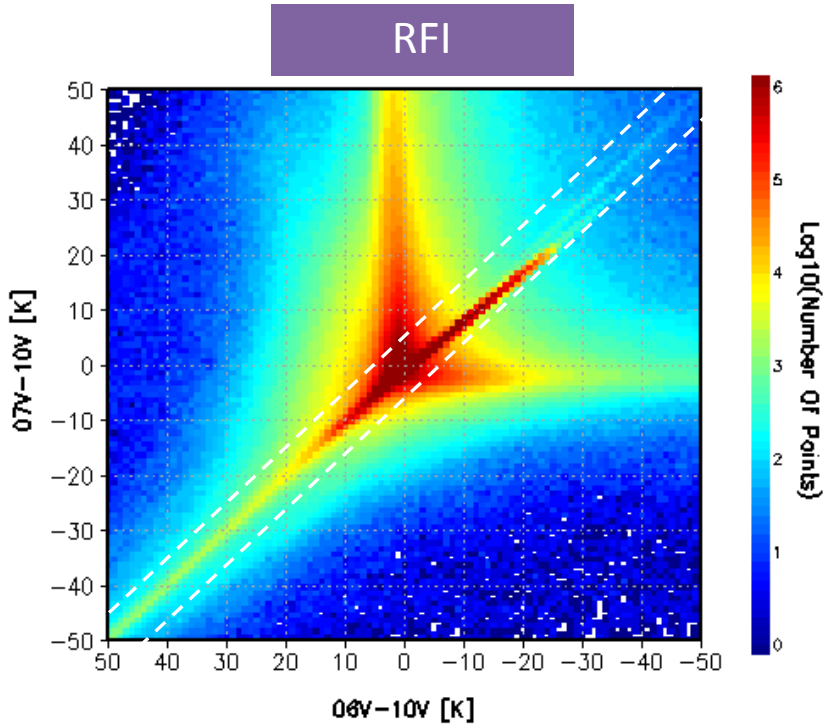


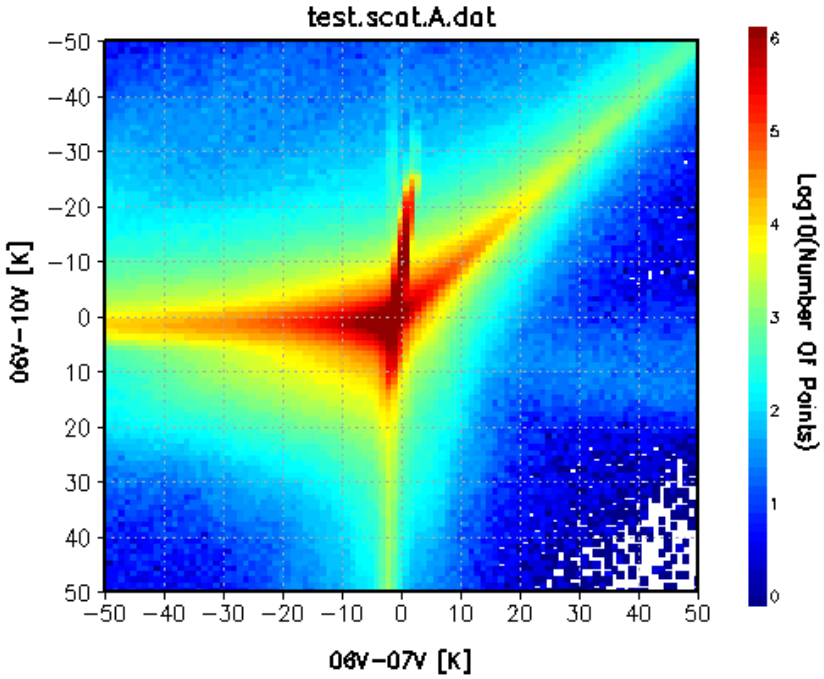
RFI



- Frequency of occurrences of land Tbs
- Horizontal axis: 6V-7V, Vertical axis: 7V-10V
- Ascending passes in a day



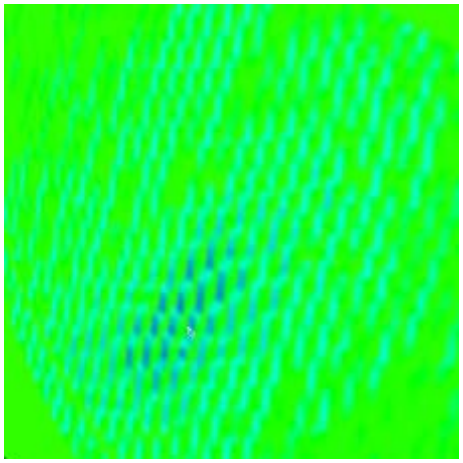


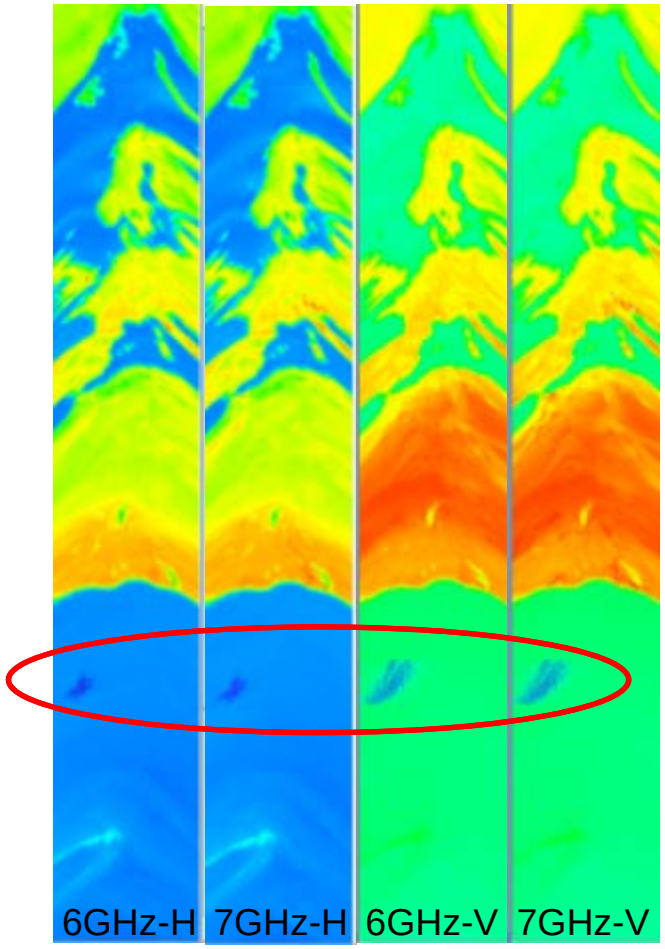


- Frequency of occurrences of land Tbs
- Horizontal axis: 6V-7V
- Vertical axis: 7V-10V
- Ascending passes
- July 23, 2012 to April 30, 2013

RFI-like Tb degradation

- 6/7GHz Tbs both of V and H polarization degrade around Ascension island in South Atlantic ocean.
- Tbs of on-board calibration reference (CSM and HTS) also show low temperature.
- This degradation was also observed at AMSR-E.
- Artificial source

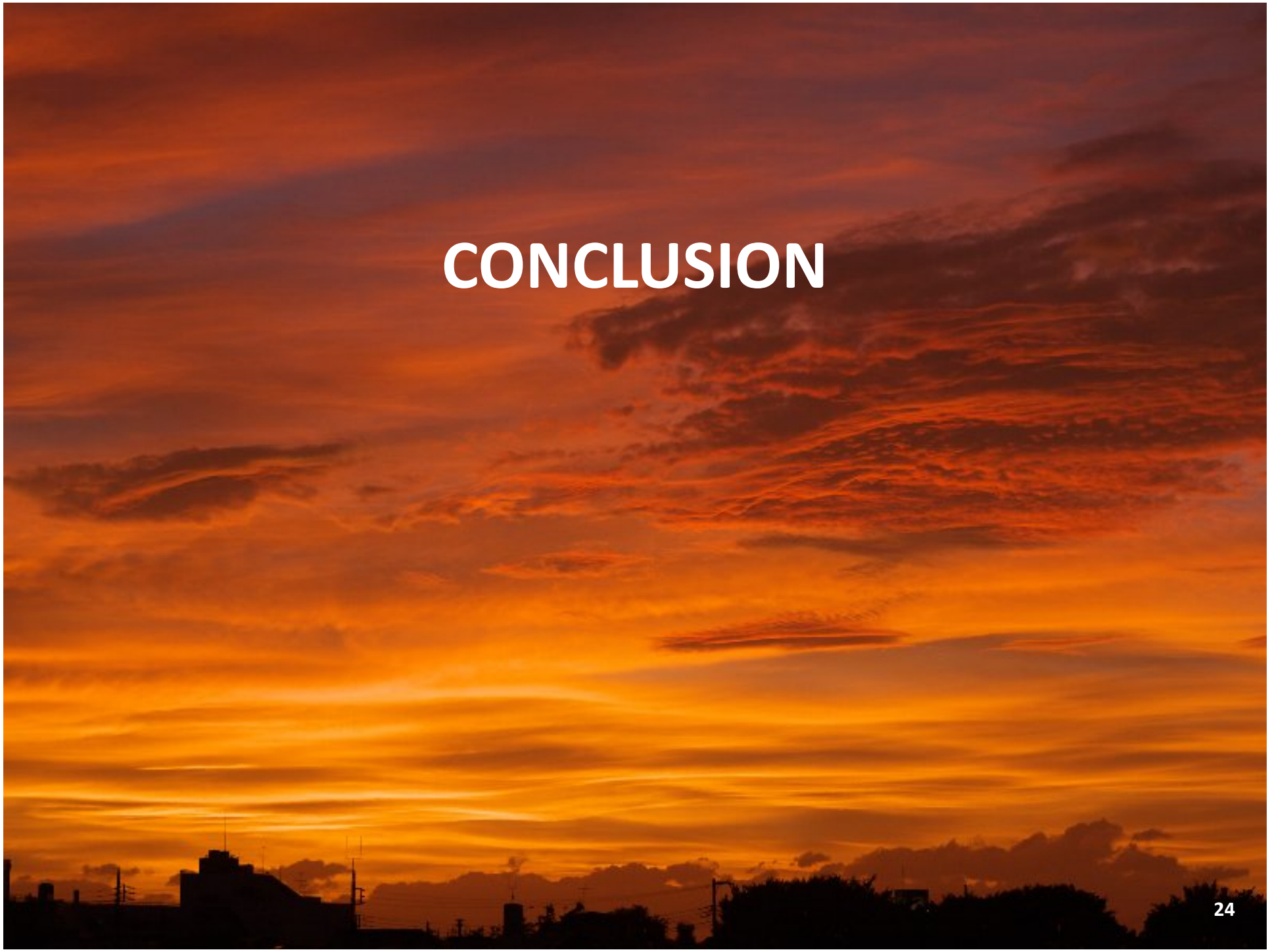




GCOM-W1 "SHIZUKU"

RFI identification Summary

- New 7.3 GHz channels were added to AMSR2 onboard GCOM-W1, which was successfully launched on May 2012.
- RFI signals at C-band channels of AMSR2 are being assessed. Although RFI signals in 7.3 GHz channels seem to be widespread, their geographical distribution differ from those of 6.9 GHz.
- Simple method to utilize Tb differece between 6.9 and 7.3 GHz channels is being tested to identify RFI areas. Further evaluation to add 10.65 GHz information will be performed to include quality flag information in L1 product in future.
- AMSR2 standard products were release in January and May 2013 for brightness temperature and geophysical products, respectively.



CONCLUSION

Conclusion

- Inter-comparison with other radiometers
  - AMSR-2 Tbs are 2 to 5K higher than the Tbs of AMSR-E and TMI
  - Inter-comparison results indicate the Tb difference has temperature gradient.
- RFI identification
  - Demonstration of RFI identification shows its potential to obtain RFI free image.
- Future work
  - Inter-comparison is continued to investigate Tb difference under collaboration with user communities including GPM XCAL group.

Thank you !