Intercalibration using crossovers with TRMM

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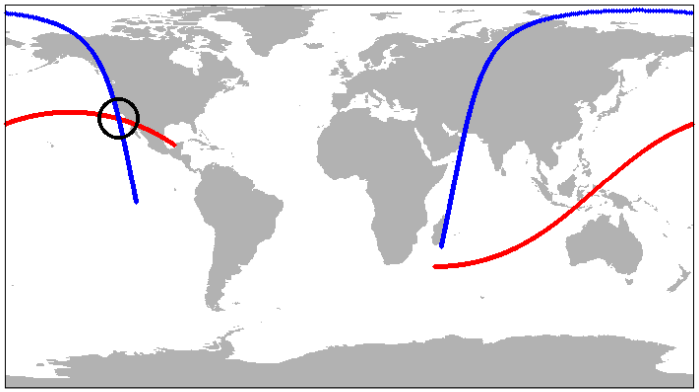
Introduction

- Intercalibration strategy is to compare several different approaches
  - Goal is to understand differences and use sensor information to select best solution
- One of the four techniques is based on coincident overpasses with common instrument: TRMM TMI
  - Cannot be used for whole period, but can provide verification of calibration from other techniques
- TMI and SSMI are similar, but not the same
  - View angle (Earth Incidence Angle); Channels slightly different (21.3 vs 22.235 GHz); Footprint sizes

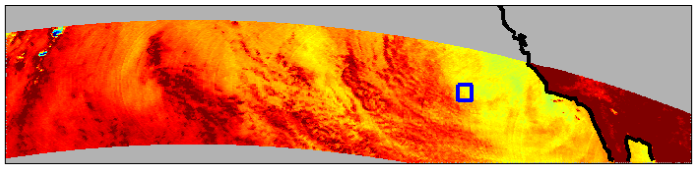
Obtaining matchups

- Get the matchups between SSMI and TMI
  - Obtain points where SSMI and TMI groundtracks cross within 30 minutes & 50km (exclude duplicates within 60 seconds of each other)
  - Calculate 1° average Brightness Temperature (Tb) for each sensor
  - Include only clear sky: require that SD(85GHz) < 5K
  - Used TMI V7 beta (ITE 200) which has some extra corrections over V6 (UCF correction)

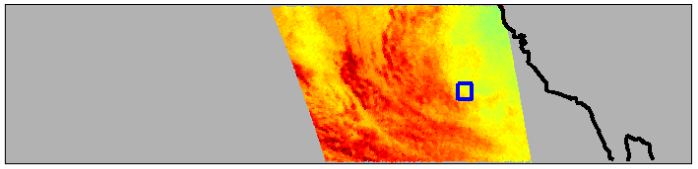
SSMI and TMI Ground tracks for 2-3am on 20 Nov 2004



TMI 85V

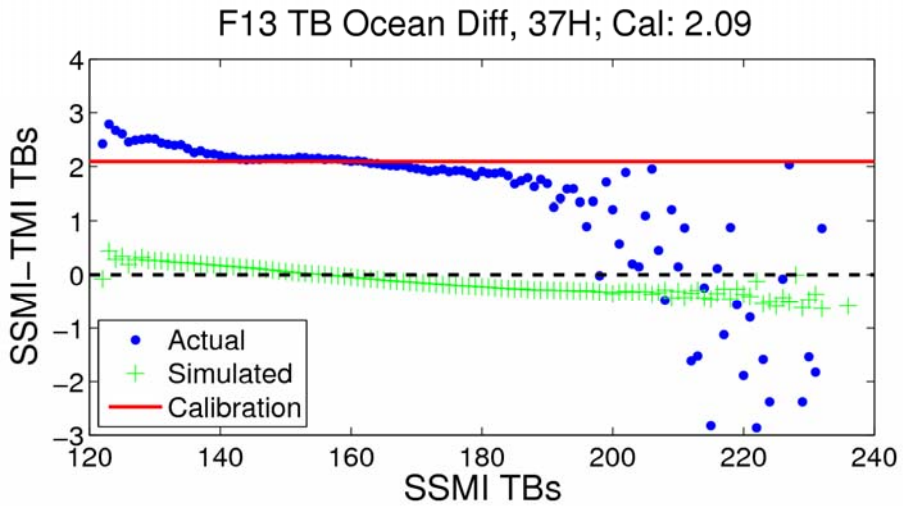


SSMI 85V



Removal of sensor dependent differences

- Use Elsaesser and Kummerow (2008) Optimal Estimation (OE) approach to retrieve clear sky geophysical parameters (Wind, TPW, LWP) from Tbs and SST (Reynolds)
  - Technique finds optimal geo parameters given Tbs based on inversion of a Radiative Transfer (RT) model
- Use OE to get Geophysical parameters from TMI Tbs
  - Use same RT model to simulate idealized TMI Tbs from geo parameters
  - Use RT again to simulate SSMI Tbs based on same geophysical parameters
- Compare difference between simulated Tbs ($SSMI_{sim}$-TMI_{sim}) with difference between actual Tbs (SSMI-TMI) to get calibration offsets



Green crosses show what SSMI-TMI should be if IA was the only difference

Blue circles show differences due to IA plus other factors (which we want to remove)

Calibration

Original L1C Calibration from GPM activity

Sat	19V	19H	22V	37V	37H	85V	85H
F11	-0.8	-2.1	-1.5	-0.3	-1.5	-1.4	-2.8
F13	-1.3	-2.1	-1.9	-1.2	-2.2	-0.8	-1.3
F14	-1.2	-1.7	-1.8	-1.8	-2.0	-0.9	-1.3
F15	-0.1	-1.9	-1.2	-0.9	-1.8	-0.1	-0.8

Latest Calibration (Includes calculated IA)

Sat	19V	19H	22V	37V	37H	85V	85H
F11	-1.0	-2.3	-1.6	-0.6	-2.0	-1.6	-3.0
F13	-1.3	-1.9	-1.9	-1.4	-2.1	-0.9	-1.4
F14	-0.5	-1.8	-1.2	-1.2	-2.1	-0.6	-1.1
F15	-0.3	-1.9	-1.4	-1.2	-2.0	-0.4	-1.0

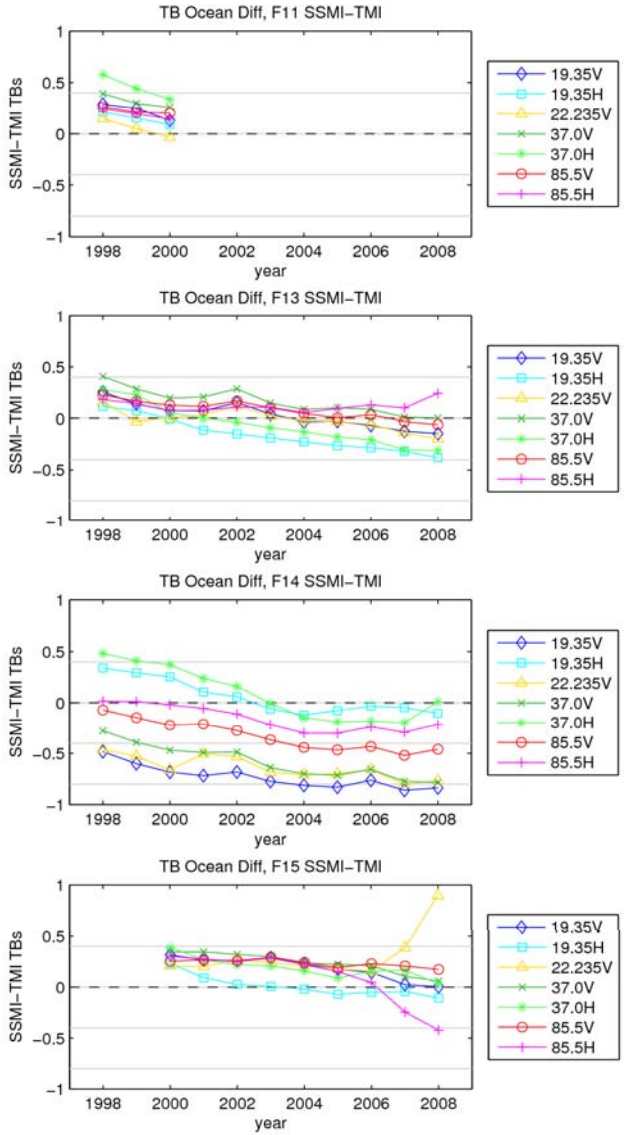
Difference

Sat	19V	19H	22V	37V	37H	85V	85H
F11	-0.2	-0.2	-0.1	**-0.3**	**-0.5**	-0.2	-0.2
F13	0.0	0.2	0.0	-0.2	0.1	-0.1	-0.1
F14	**0.7**	-0.1	**0.6**	**0.6**	-0.1	**0.3**	0.2
F15	-0.1	0.1	**-0.5**	-0.1	-0.1	-0.2	0.2

Problem: trend in calibration

- Original calibration was time averaged
  - Appears to be a trend in calibration when split by year
  - Magnitude is channel dependent, but is ~0.2-0.4K
- Trend is consistent amongst all SSMI, and does not match drift pattern
  - Source of trend is currently unknown

Trend (SE)	F13	F14	F15
19.35V	-0.45 (0.06)	-0.21 (0.08)	-0.34 (0.09)
19.35H	-0.36 (0.02)	-0.14 (0.1)	-0.23 (0.06)
22.235V	-0.46 (0.05)	-0.32 (0.11)	-0.28 (0.01)
37.0V	-0.4 (0.08)	-0.4 (0.11)	-0.3 (0.05)
37.0H	-0.48 (0.03)	-0.31 (0.24)	-0.25 (0.12)
85.5V	-0.34 (0.05)	-0.3 (0.09)	-0.16 (0.1)
85.5H	0.16 (0.1)	-0.14 (0.13)	-0.55 (0.15)



Remaining issues

- Technique is a powerful tool for intercalibration and is a useful check during TRMM period
- Need to include SSMIS in this analysis
- Need to understand the trend in the calibration
  - Relatively small, but significant
  - Source unknown, but does not seem to be related to SSMI drift or other known issues
- Change in Altitude and resulting effect on Incidence Angle is included, but changes in satellite attitude (roll, pitch, yaw) not known
  - Geolocation is an important next step in the project
  - Is there a trend in any geolocation parameters?
- We have not yet looked at Vicarious calibration: needs to be included