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TMI to MADRAS X-CAL Cold End Analysis

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Overview

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- **Data from PPS**
  - V00A: 50 days: Oct-Dec 2011
  - V00B: 46 days: June-Nov 2012
  - We use L1C & Base files (For TSE & β)
- **Analysis as a function of:**
  - By Month
  - Time Since Eclipse (TSE)
  - Scan Angle
  - Solar Beta Angle (β)

Definitions

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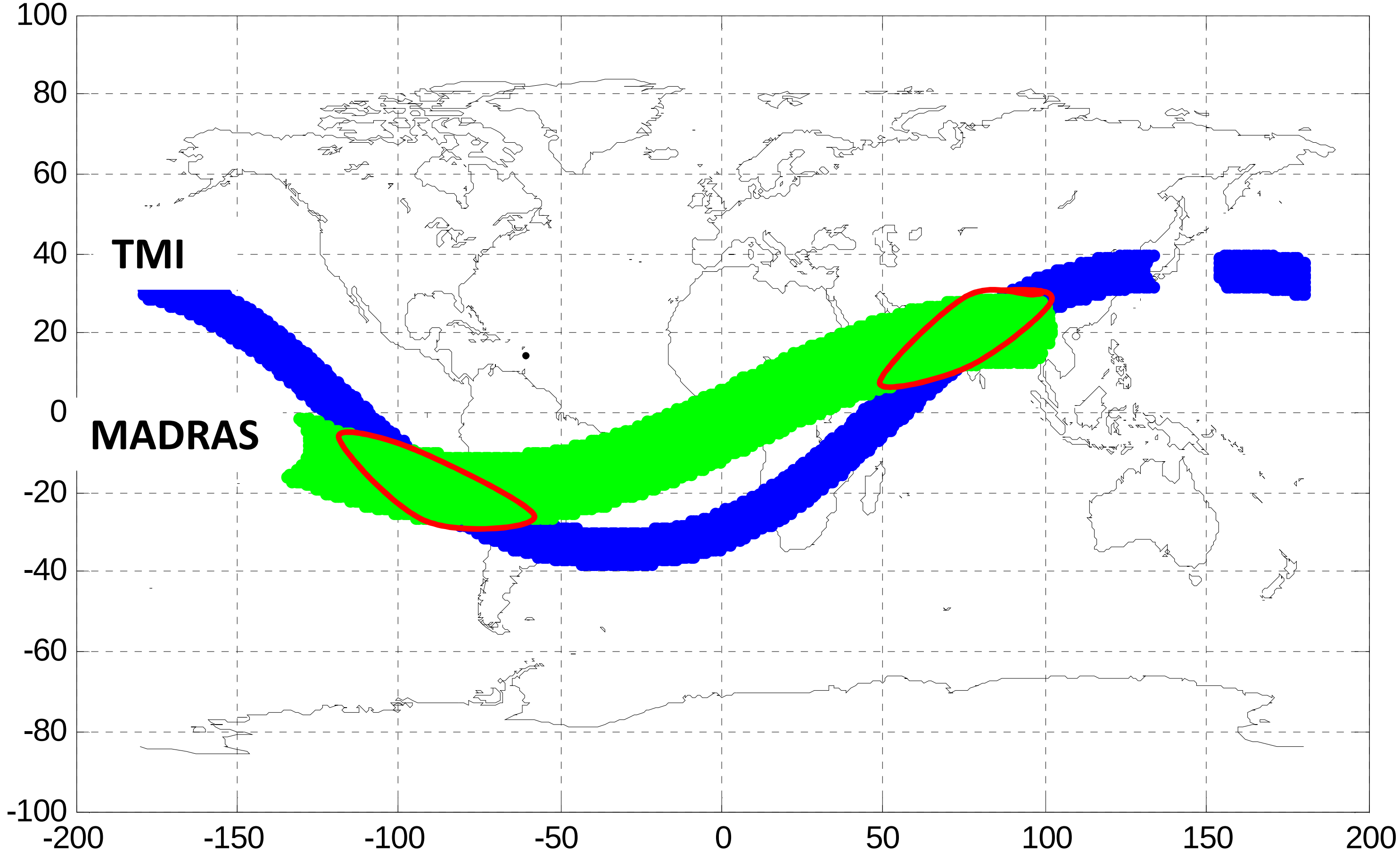
- DD=Double Difference
- SSD=Sensor Single Difference
- OSD=Observed Single Difference
- MSD= Model Single Difference
- DD = $SSD_{Target} - SSD_{Reference}$
  - $(T_{Obs} - T_{Model})_{MADRAS} - (T_{Obs} - T_{Model})_{TMI}$
- or DD = OSD – MSD
  - $DD=(T_{MADRAS} - T_{TMI})_{Obs} - (T_{MADRAS} - T_{TMI})_{Model}$
- TMI CC_1.1 applied for Low Res Channels
  - Recall that CC_1.1 for 85.5GHz does not exist, yet

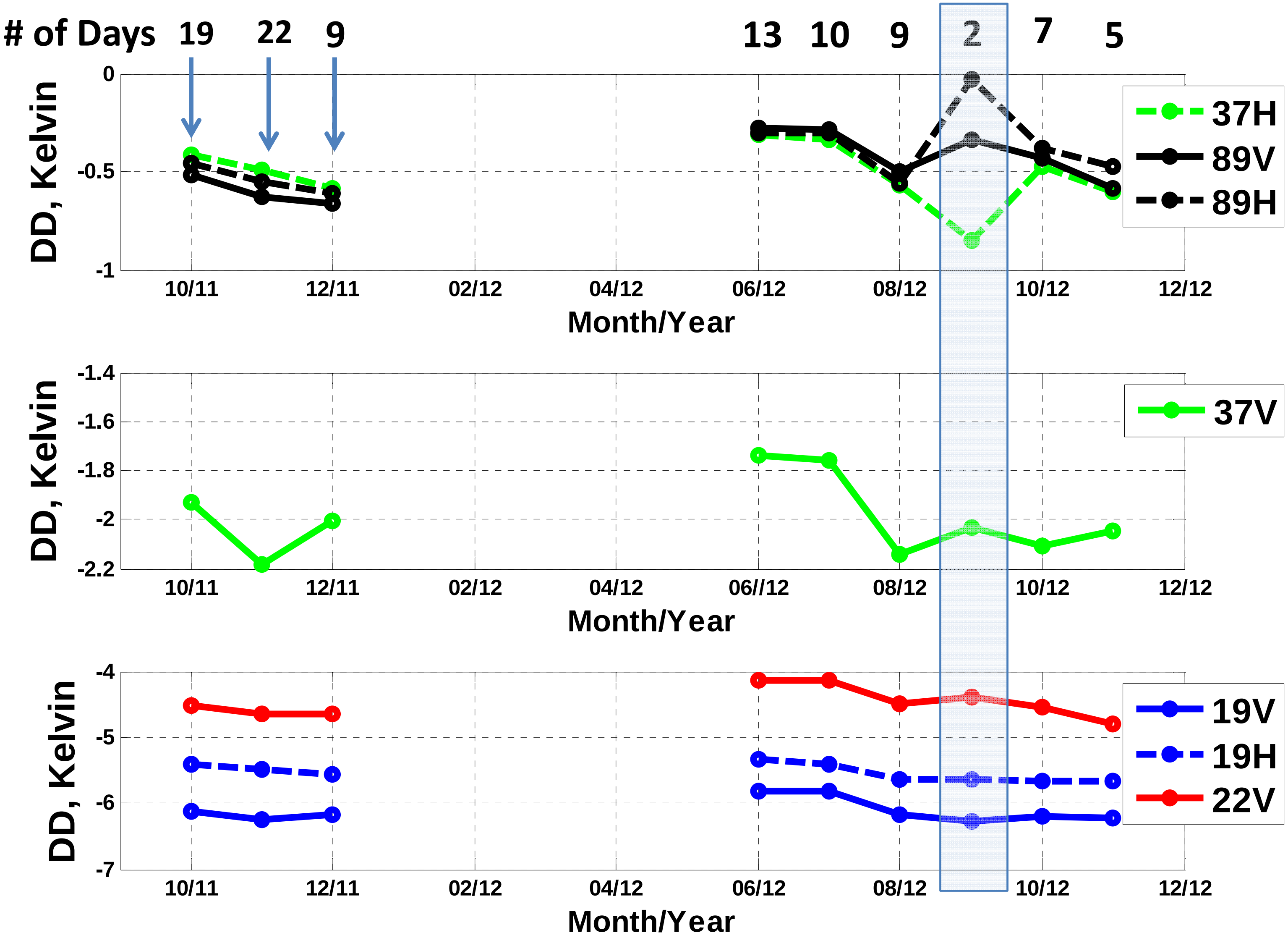
How is X-CAL Performed?

- In the simplest case, two radiometers simultaneously view a homogeneous clear-sky ocean scene and compare the observation difference ΔTb_{obs}
- However most radiometers are similar <u>BUT NOT identical;</u> therefore the observed brightness temperature differences are not necessarily calibration biases
- Thus, we use Radiative Transfer Tb Models (RTM) to calculate the theoretical expected ΔTb_{RTM}
- Finally, we calculate the double difference between the observed and expected ΔTb's, which we call the radiometric bias

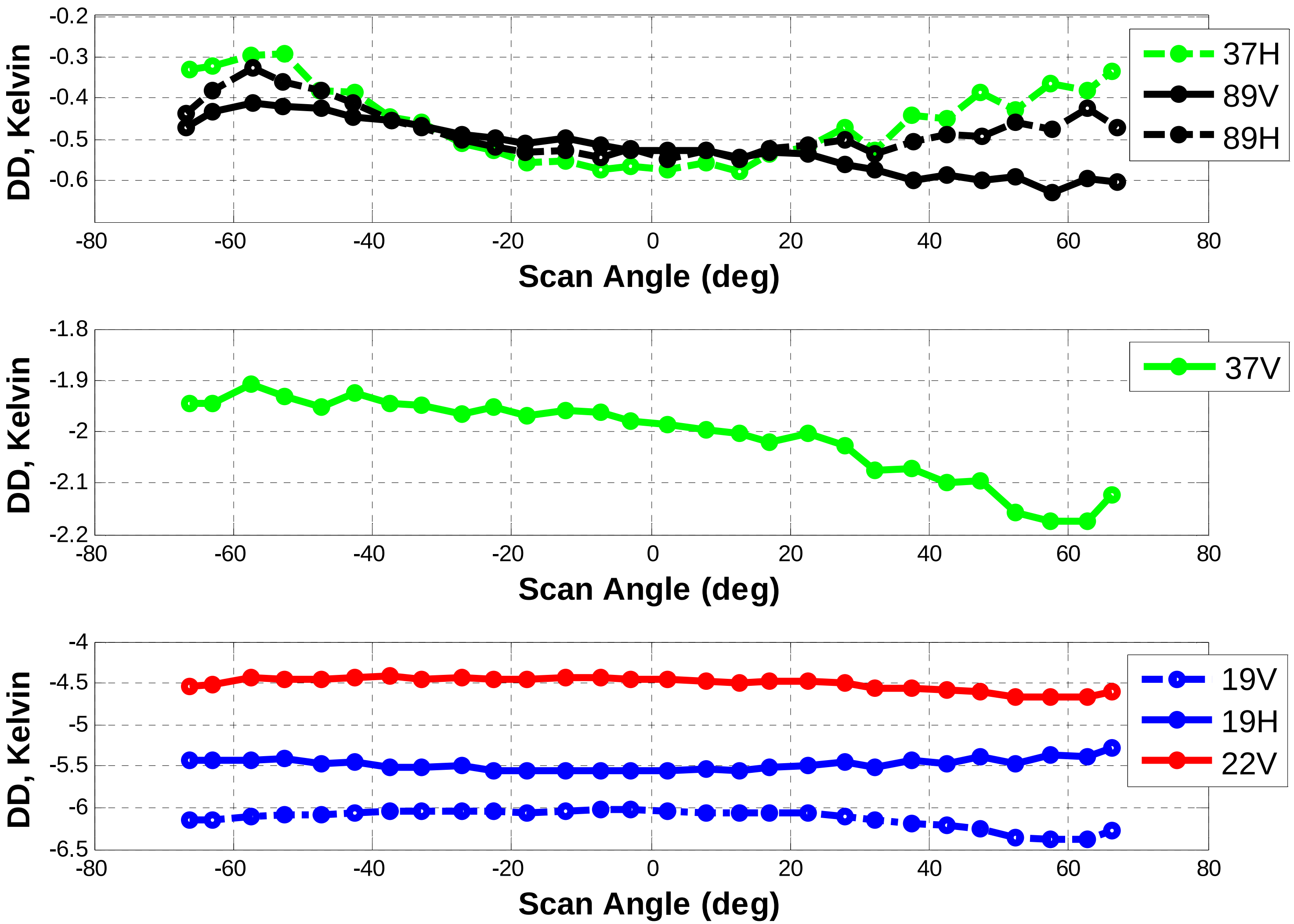
MADRAS and TMI Orbits



Monthly DD - 2012



Scan Angle Dependence (All Months)



Scan angle -70:70, bin size: 5 deg.

Day/Night Orbit Segments

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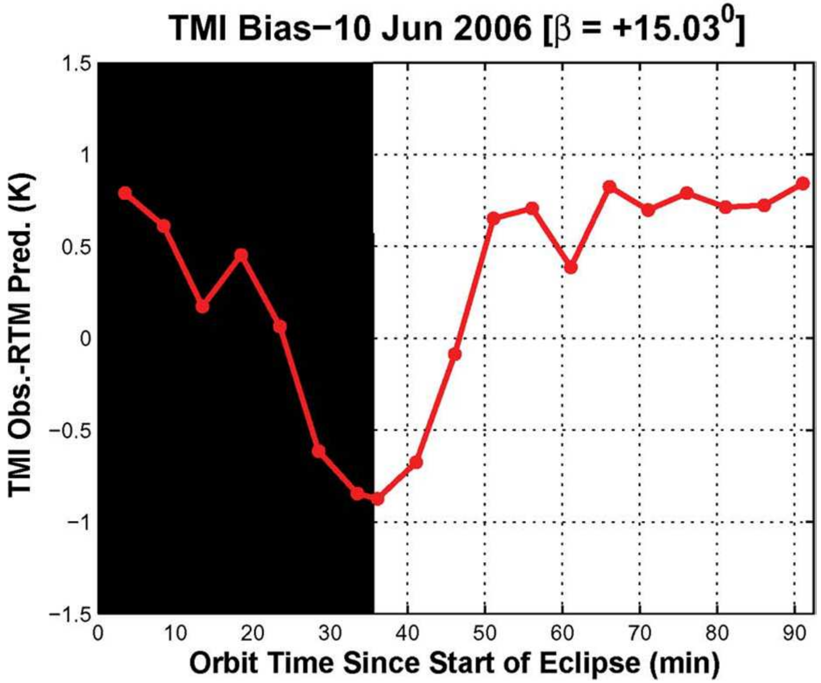
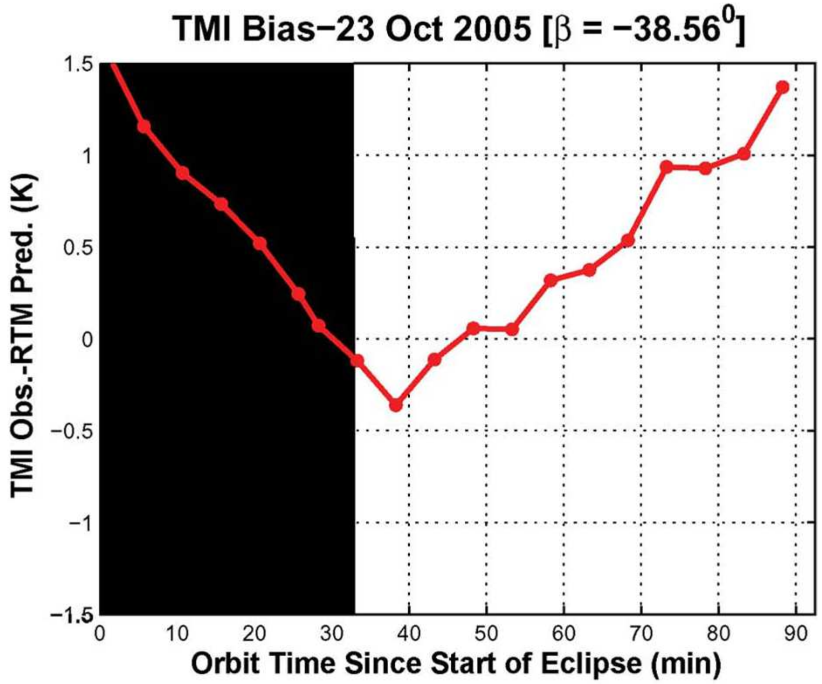
- On TRMM, the TRMM Microwave Imager (TMI) had a slightly emissive main reflector
- This produced a time varying radiometric bias due to the reflector emission
  - There was a repeating orbital pattern of reflector physical temperature as spacecraft entered into and exited from solar eclipse
    - Because of orbit precession, the reflector temp changed slowly day by day
    - Also the satellite yaw was reversed by 180° when the solar beta angle changed sign (~ 23 days)
  - Radiometric bias = (reflector emissivity) x reflector temp

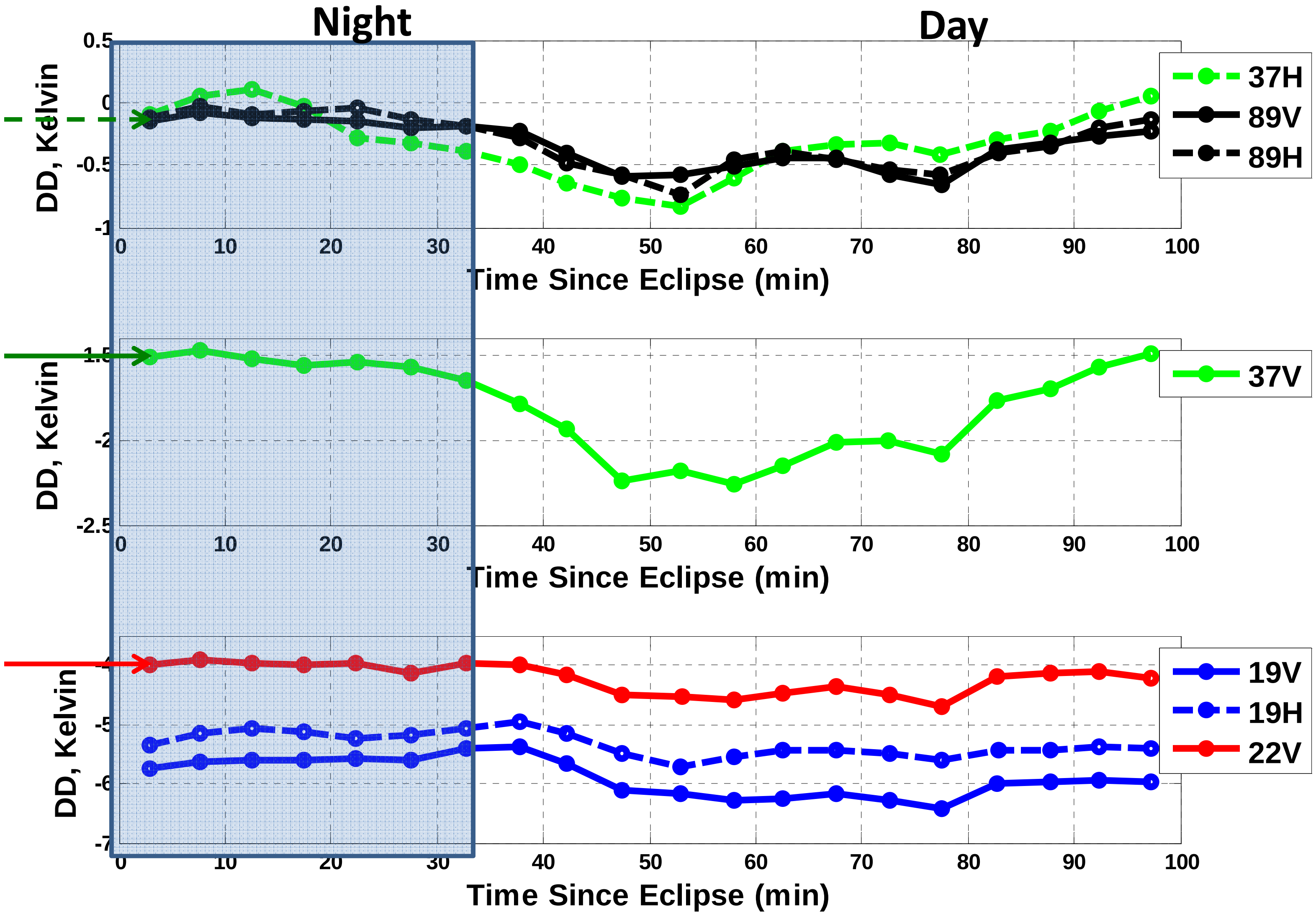
TMI Time Since Eclipse (TSE) Dependence of Radiometric Bias





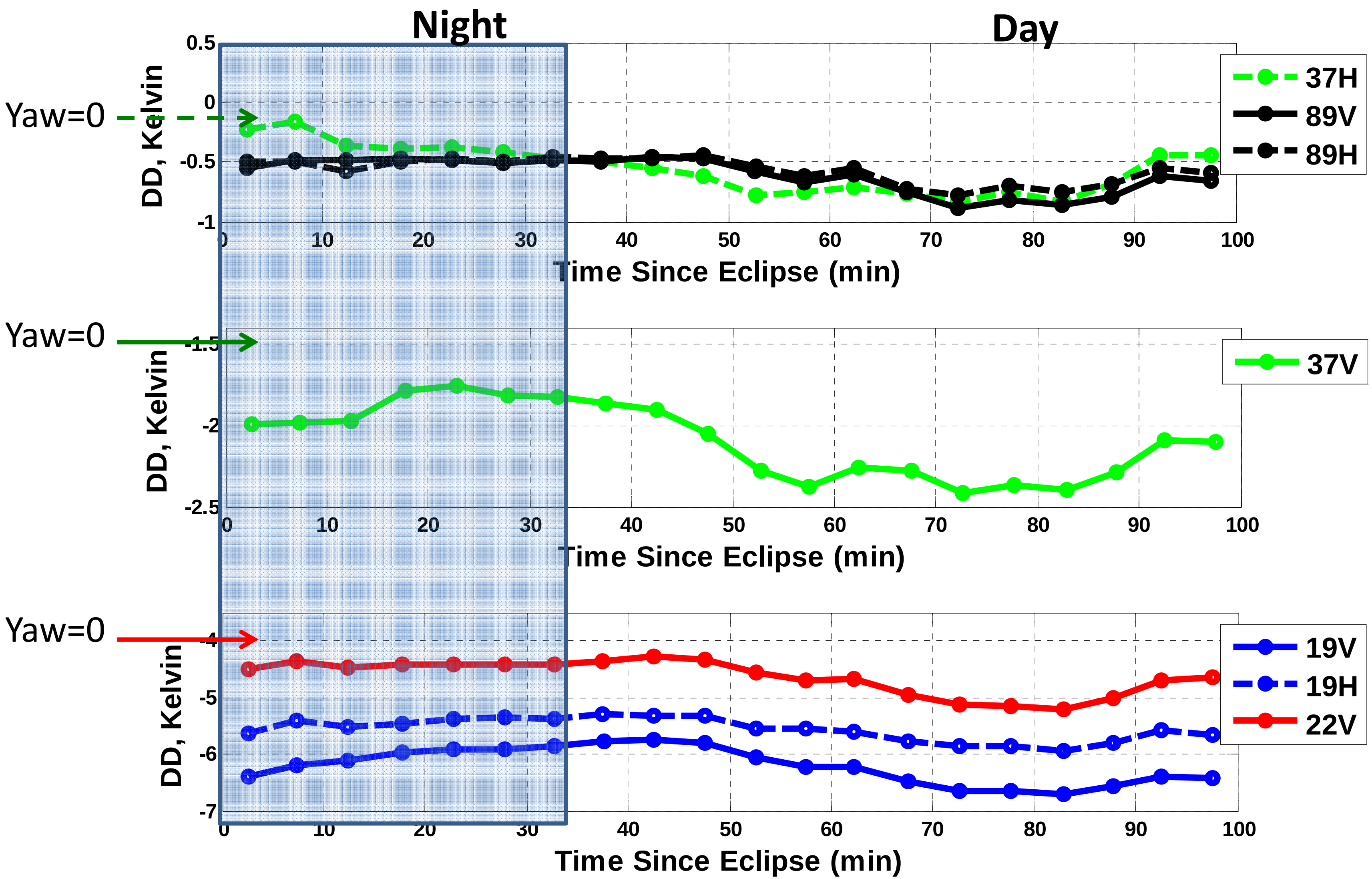
* Figs from: K. Gopalan, et al, "A Time-Varying Radiometric Bias Correction for the TRMM Microwave Imager", IEEE TGARS, 2009

MADRAS TSE Dependence for Yaw= 0°



bin size: 5 min.

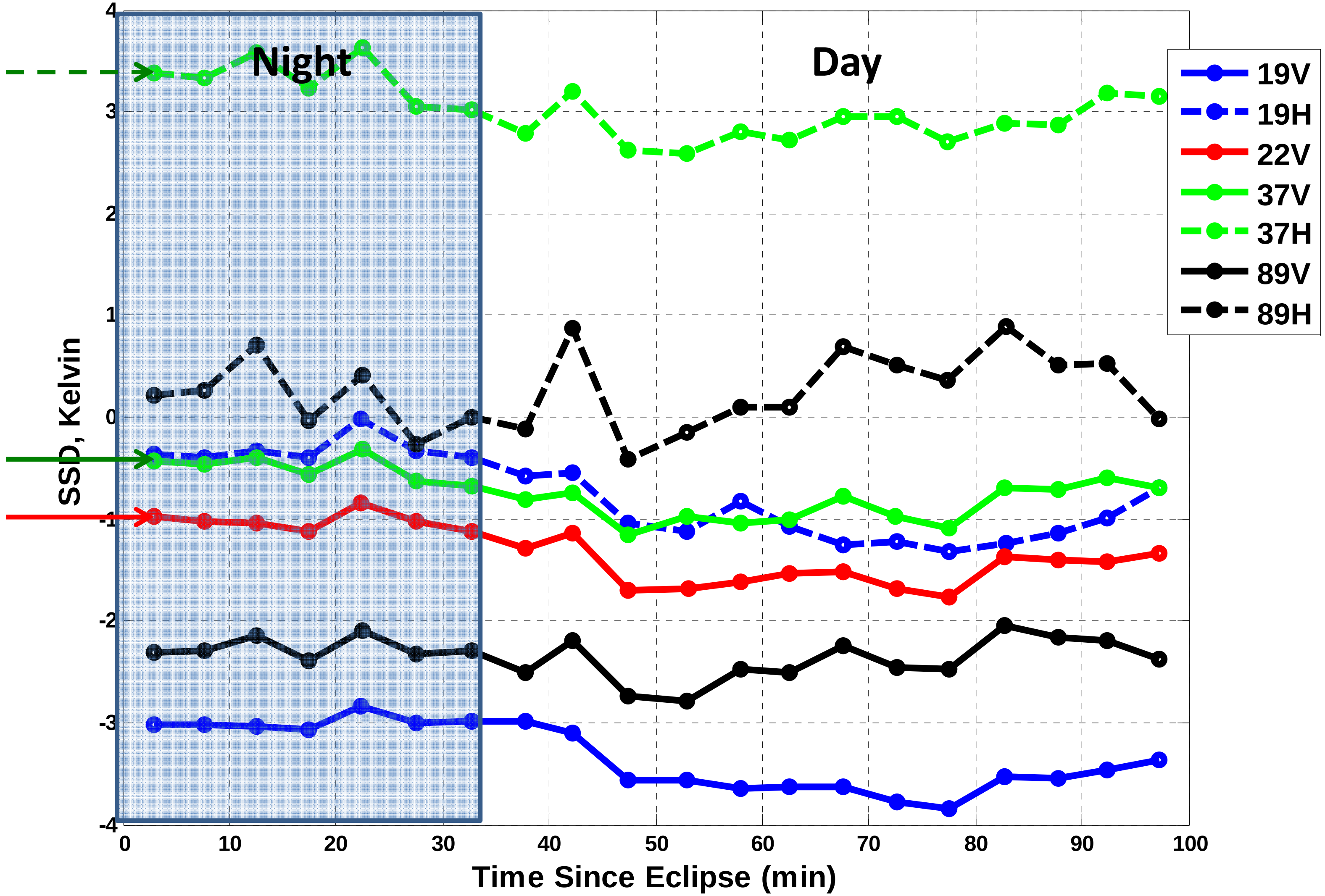
MADRAS TSE Dependence for Yaw=180°



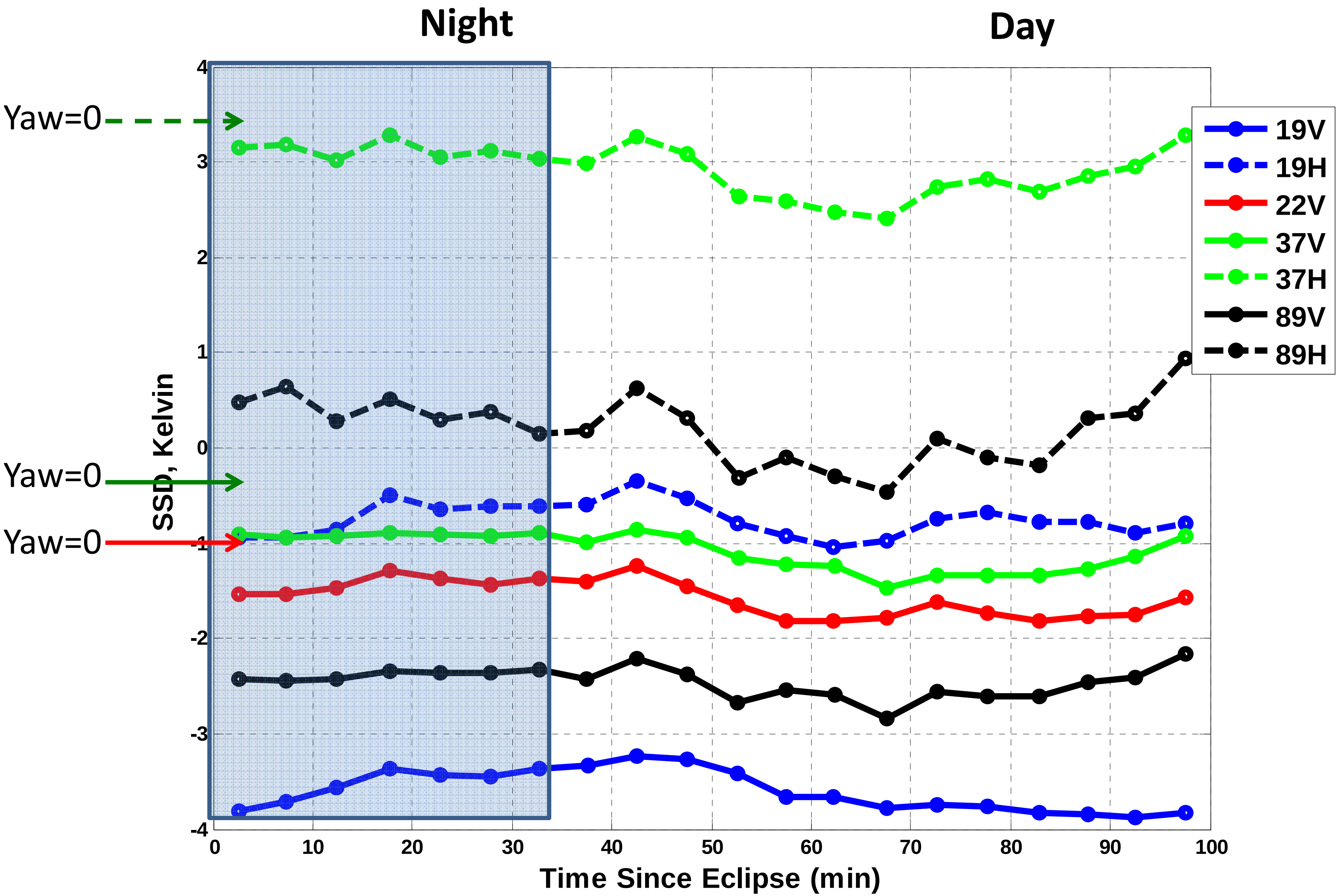
bin size: 5 min.

MADRAS TSE Variation Yaw= 0°

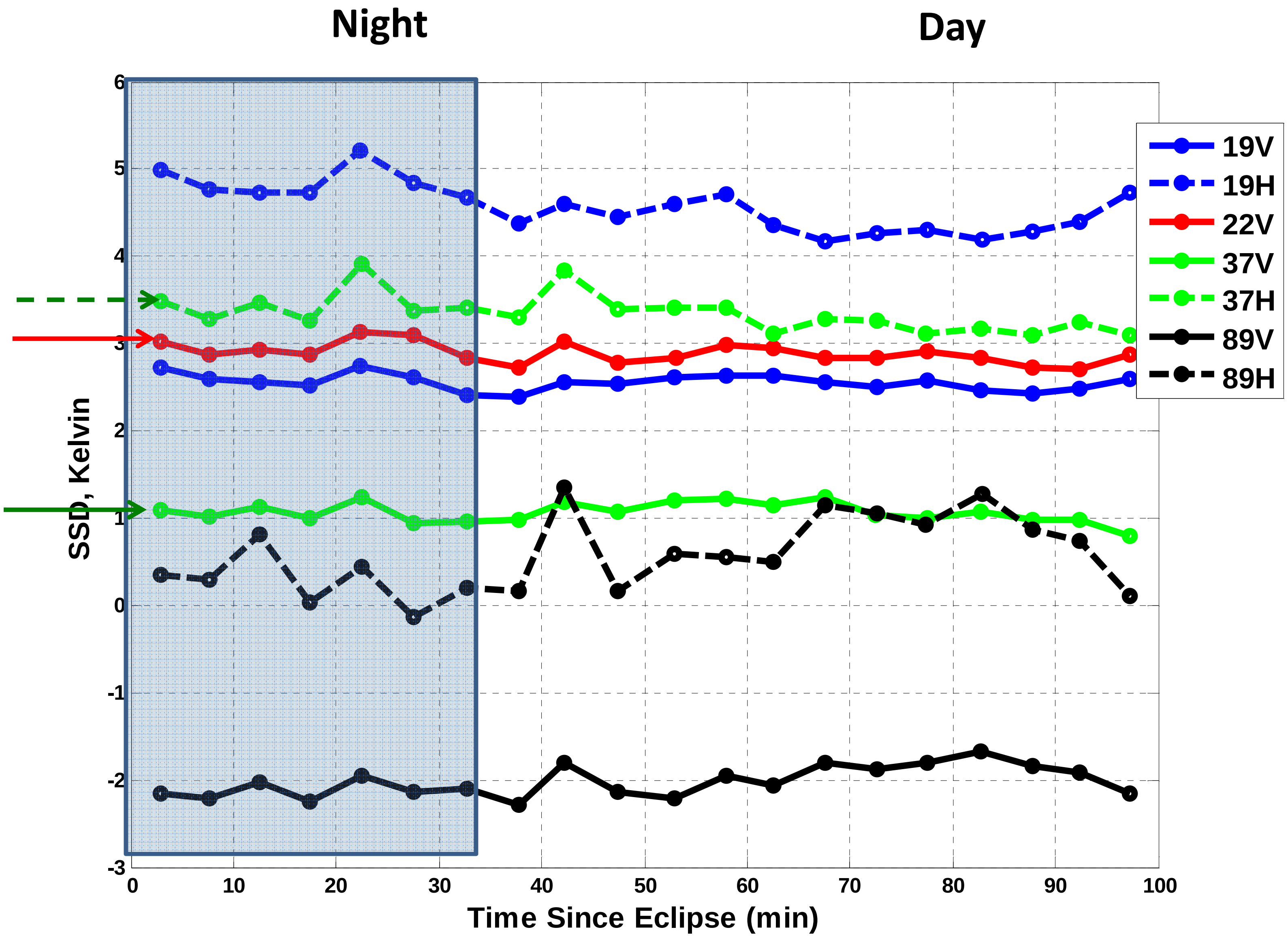
SSD = Tb_{obs} - Tb_{model}



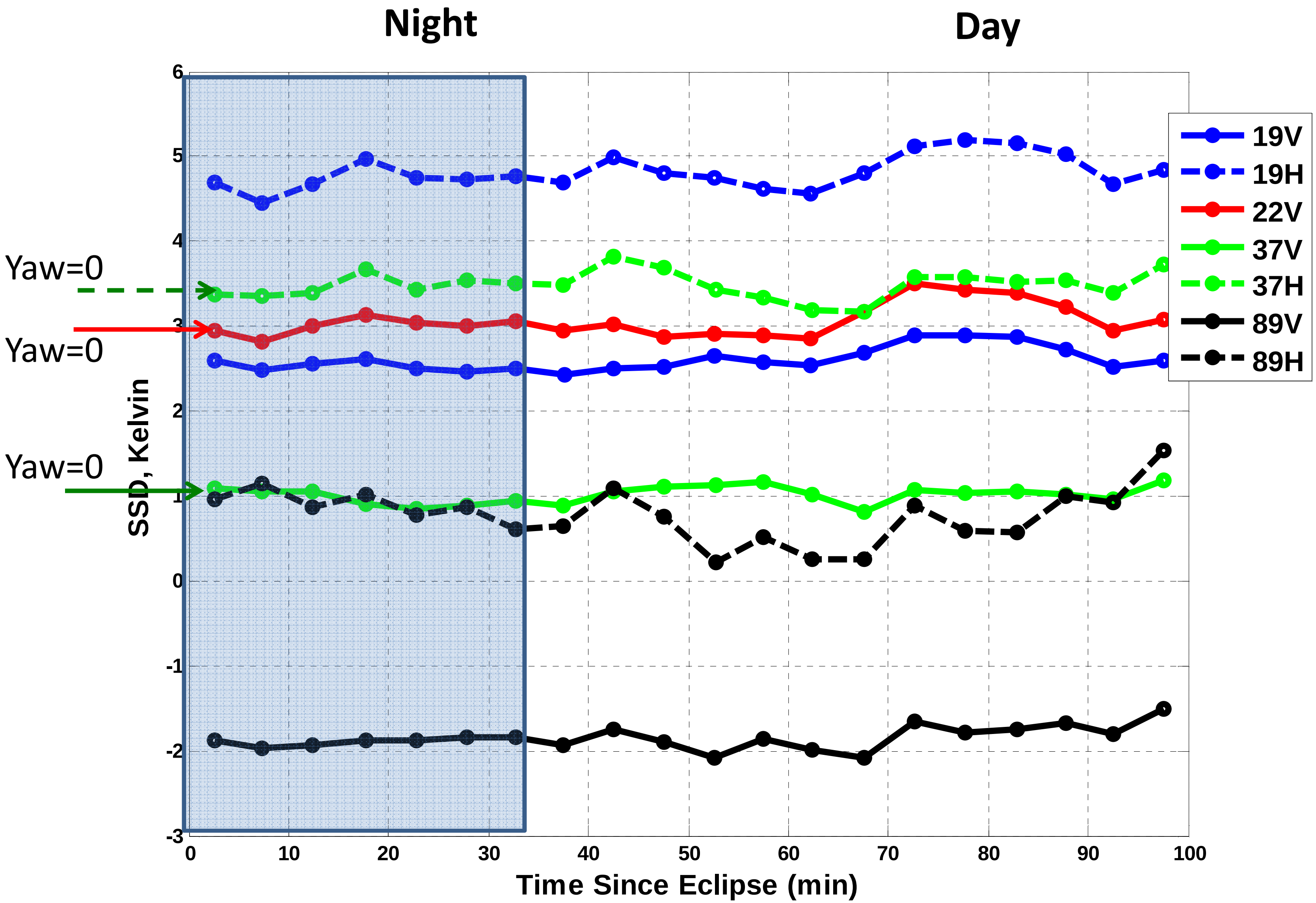
MADRAS TSE Variation (SSD) Yaw=180°



TMI TSE Dependence (SSD) Yaw= 0°



TMI TSE Dependence (SSD) Yaw=180°



MADRAS DD Night/Day

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Channels	DD for Night Yaw=180	DD for Night Yaw=0	DD for Day Yaw=180	DD for Day Yaw=0
Ch=19V	-6.04	-5.66	-6.24	-5.98
Ch=19H	-5.43	-5.24	-5.60	-5.39
Ch=22V	-4.44	-4.06	-4.72	-4.31
Ch=37V	-1.85	-1.61	-2.18	-1.91
Ch=37H	-0.35	-0.17	-0.65	-0.42
Ch=89V	-0.46	-0.15	-0.66	-0.41
Ch=89H	-0.47	-0.05	-0.60	-0.42

MADRAS DD vs Solar beta Angle

Megha Tropiques Solar Beta Angle

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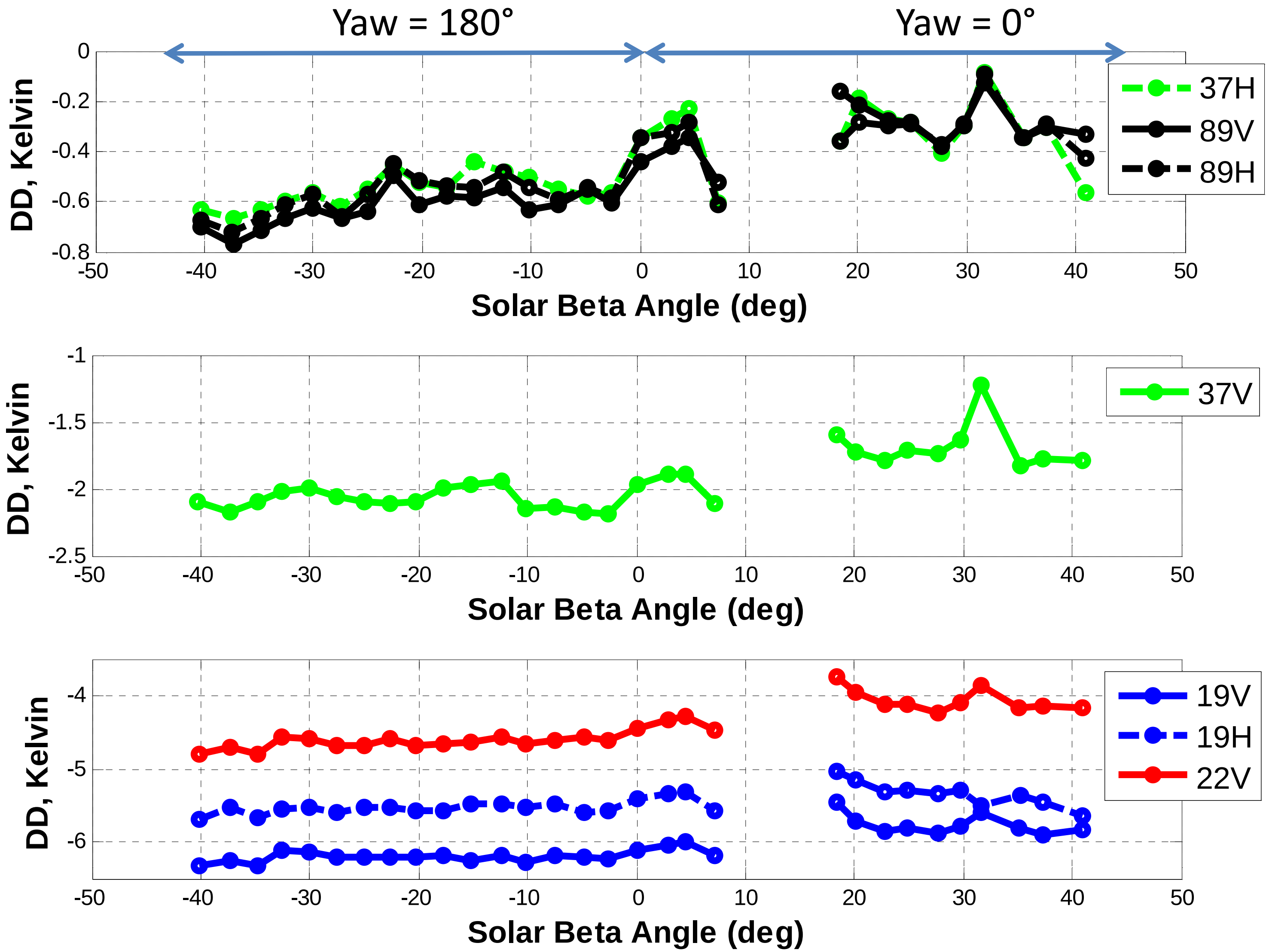


Beta bin size: 2.5 deg.

Summary MADRAS DD Relative to TMI

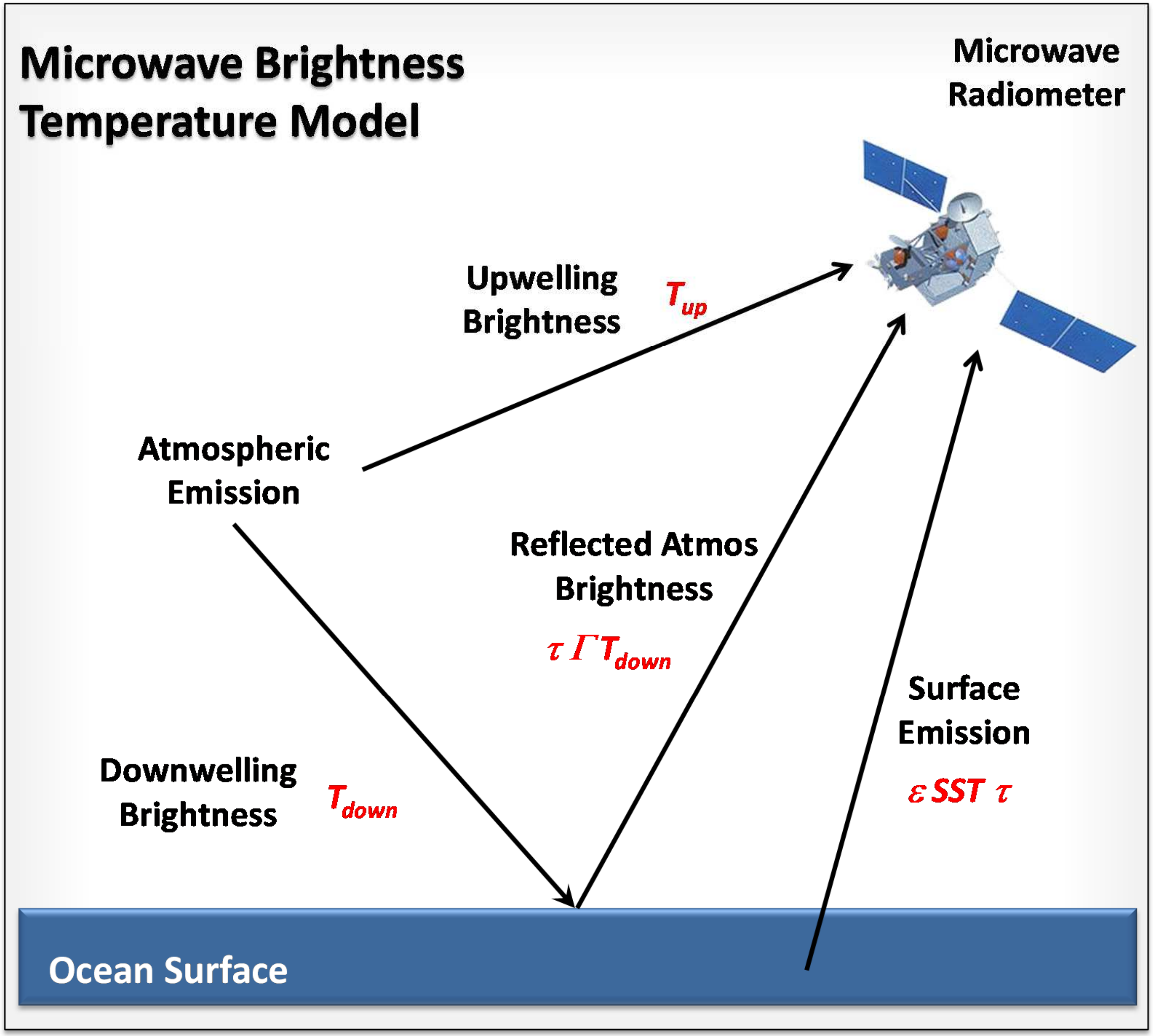
Channels	DD	DD (CC_1.1 Applied)	MADRAS Tb (K)
Ch=19V	-5.59	-6.12	192
Ch=19H	-3.30	-5.49	125
Ch=22V	-2.75	-4.50	225
Ch=37V	0.41	-2.01	216
Ch=37H	1.42	-0.47	156
Ch=89V	-0.52	NA	265
Ch=89H	-0.48	NA	237

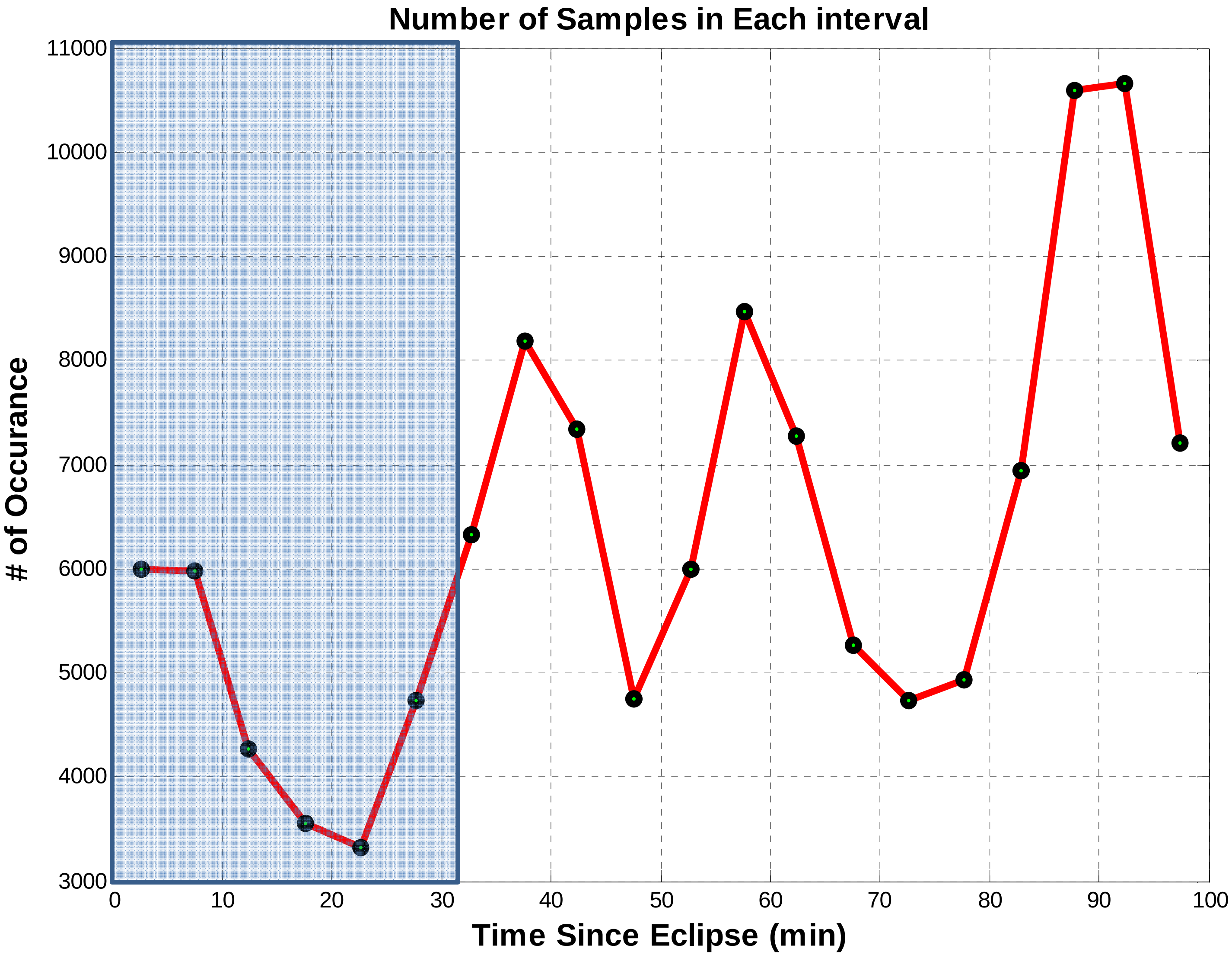
Summary

- Preliminary comparisons with TMI are encouraging
- MADRAS appears stable in time although double difference biases appear reasonable large (up to 6 K)
  - More contiguous data is required!
    - Present data set: 50 days (2011) & 46 days (2012)
- Considering MADRAS pre-screening
  - Variations in Scan Angle are ≤ 0.4 K
  - Variations in TSE are ≤ 1 K
  - Variations in β angle are < 0.4 K
- A concern is MADRAS dependence on Time Since Eclipse
  - Variation is not similar to a slightly emissive reflector
    - DD is larger during might
  - Is MADRAS temperature controlled during eclipse?

Back-up Slides

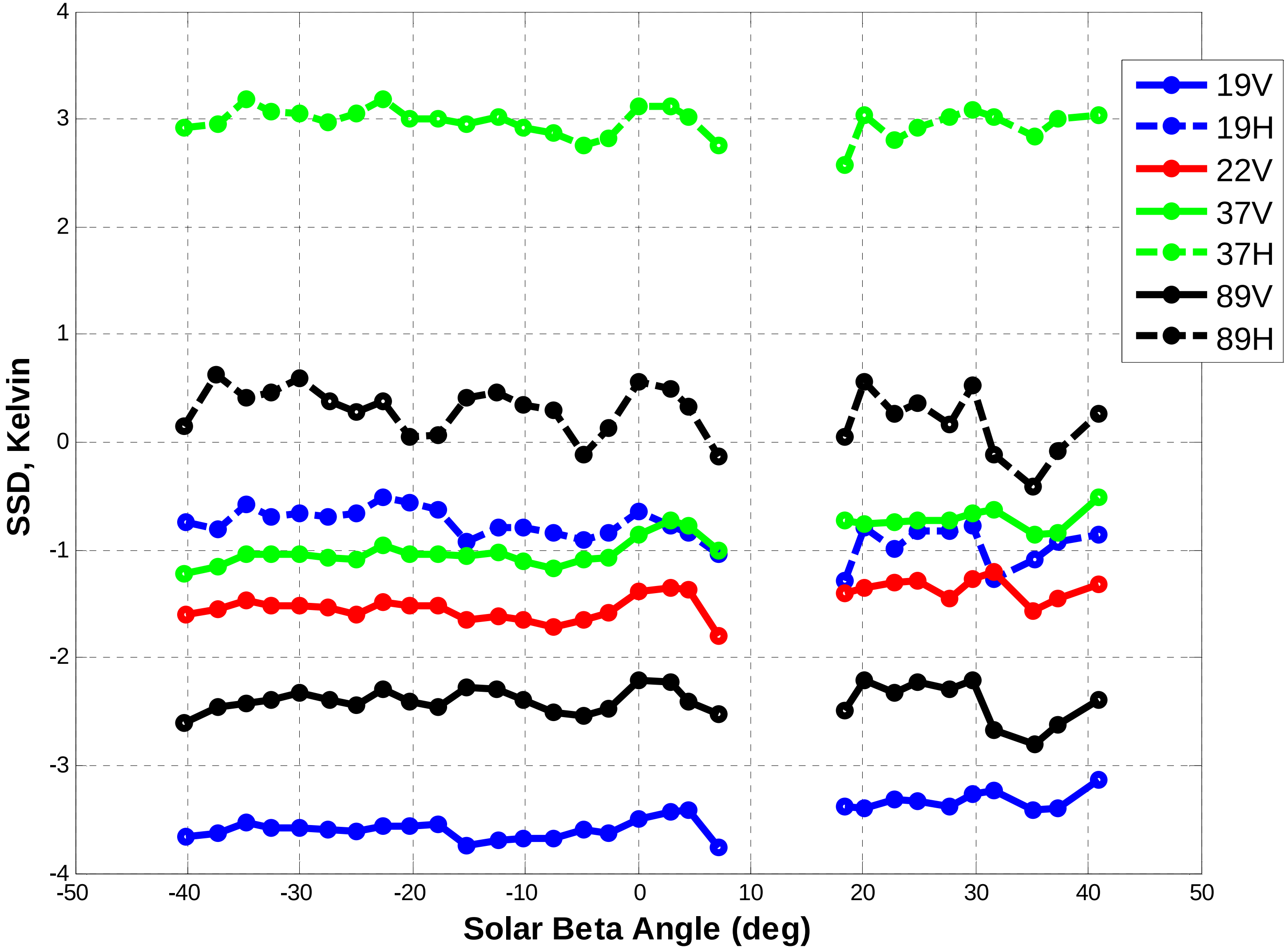
Microwave Radiative Transfer Model



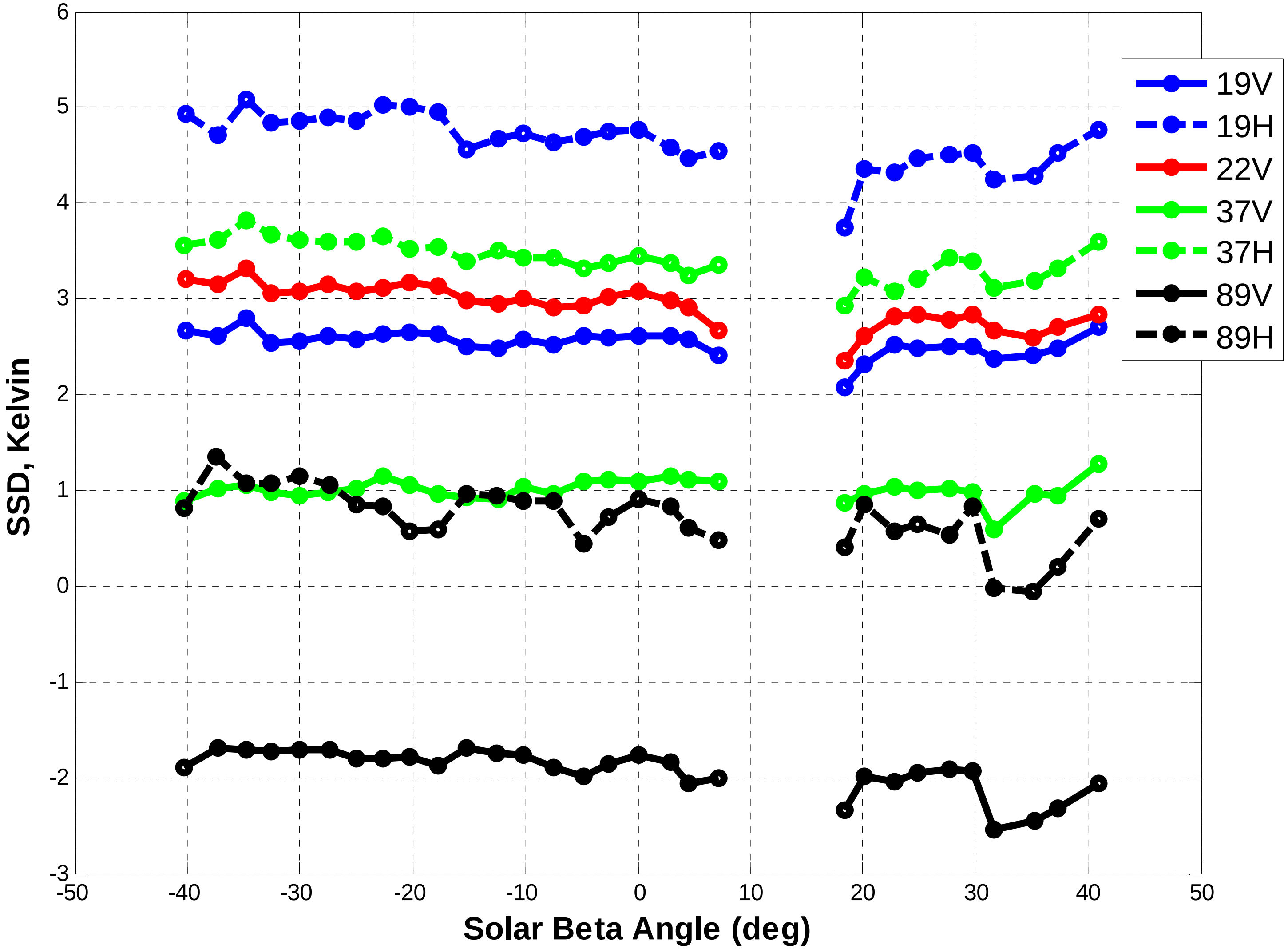


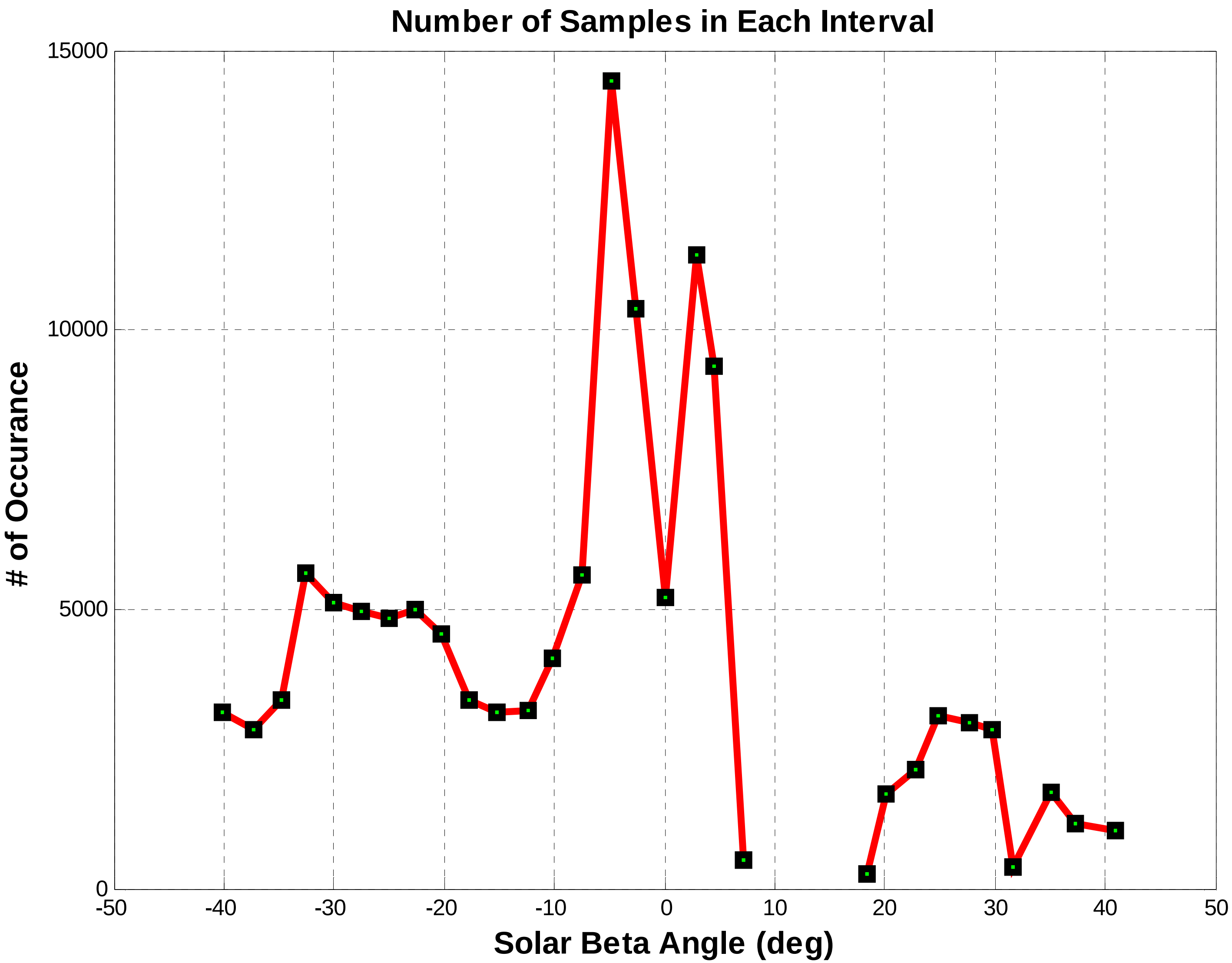
Number of Samples in Each interval
11000
10000
9000
8000
7000
6000
5000
4000
3000
# of Occurance
0
10
20
30
40
50
60
70
80
90
100
Time Since Eclipse (min)

MADRAS (SSD) Dependence on Solar Beta Angle



TMI (SSD) Dependence on Solar Beta Angle





Number of Samples in Each Interval
15000
10000
5000
0
-50
-40
-30
-20
-10
0
10
20
30
40
50
# of Occurance
Solar Beta Angle (deg)

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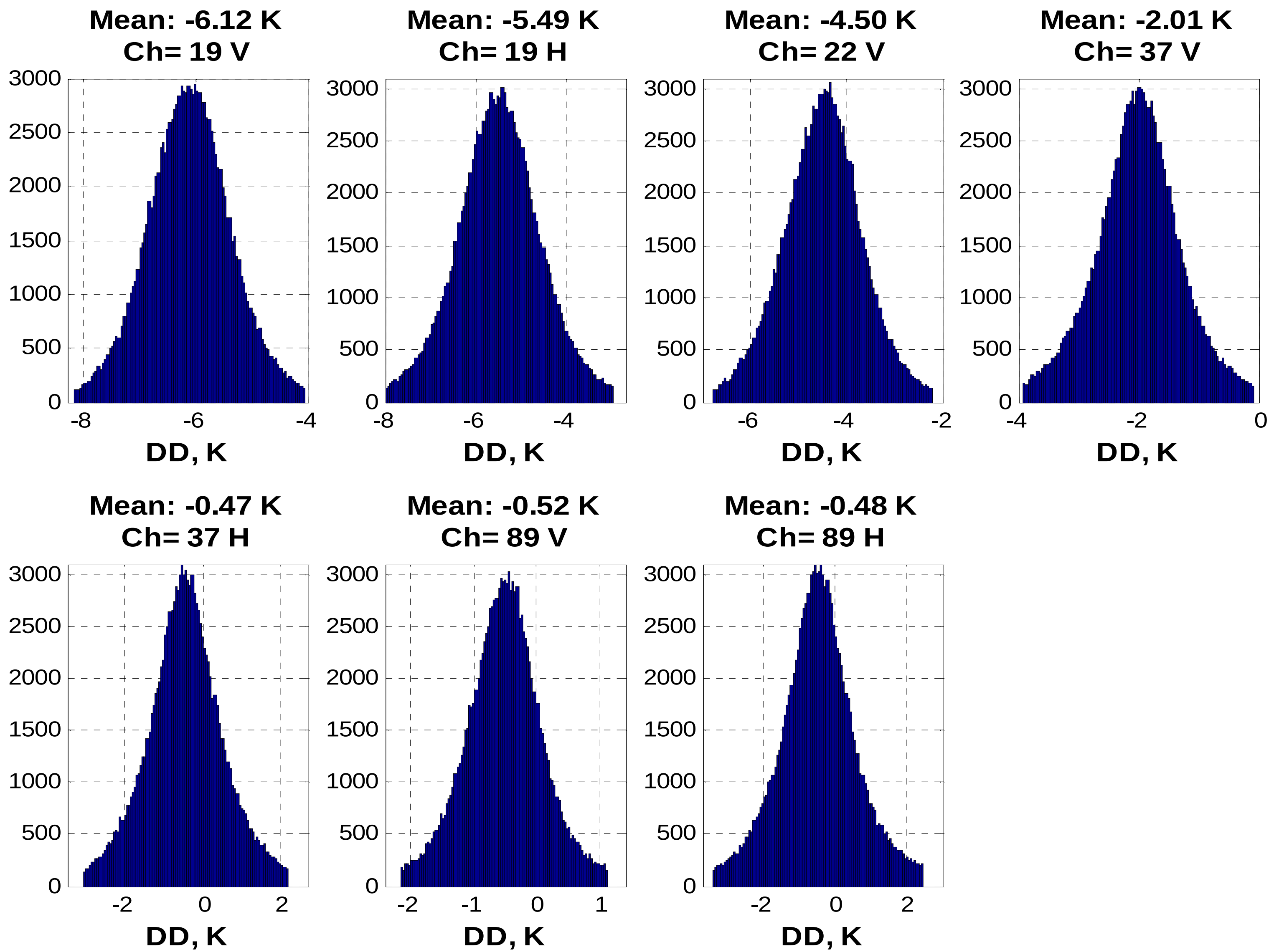
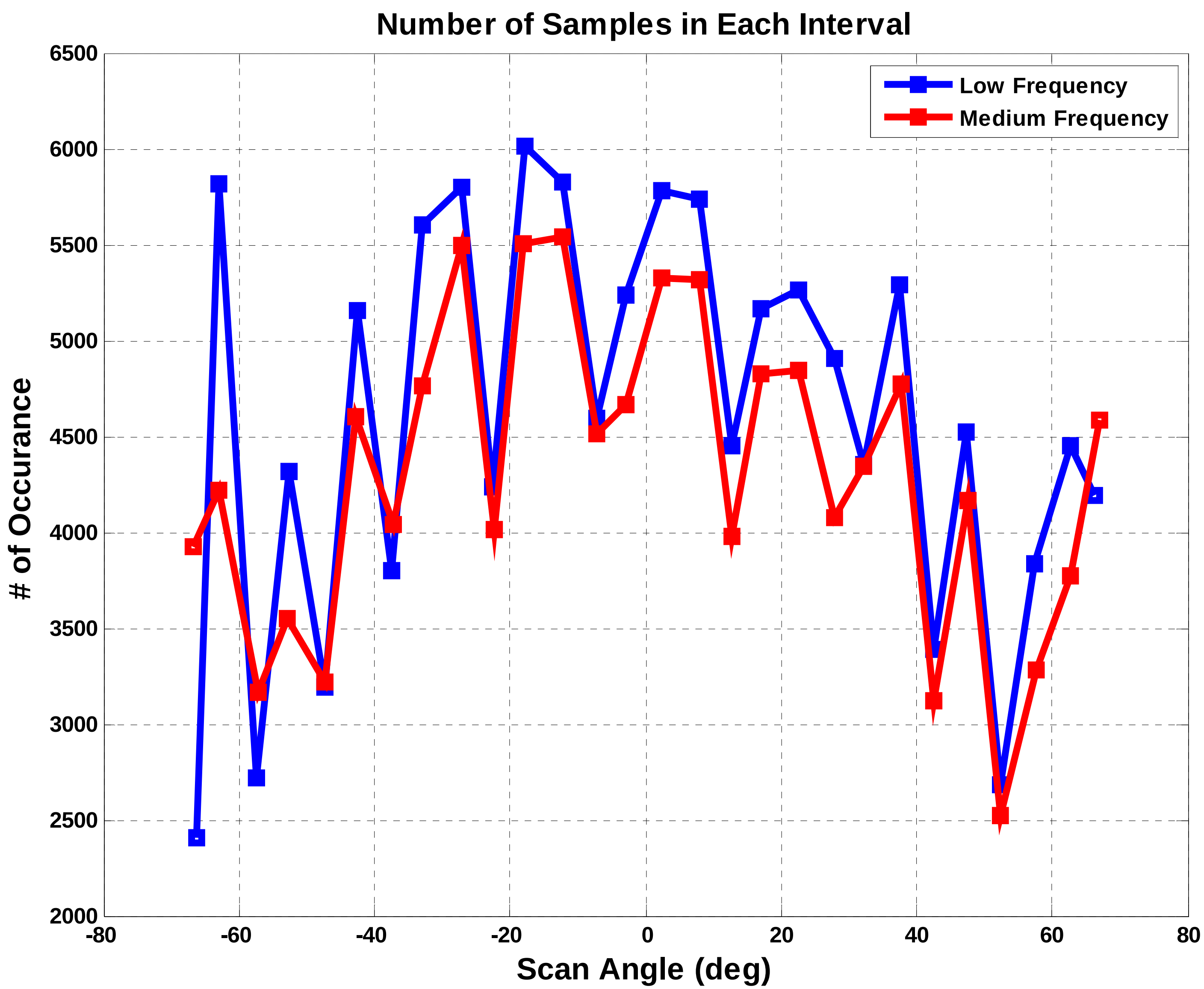
DD For Different Channels




Number of Samples in Each Interval
Low Frequency
Medium Frequency
# of Occurance
Scan Angle (deg)
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
-80
-60
-40
-20
0
20
40
60
80

DD for Different Months

Channels	June	July	Aug.	Sep.	Oct.	Nov.
# of Days	13	10	9	2	7	5
Ch=19V	-5.83	-5.81	-6.17	-6.27	-6.19	-6.23
Ch=19H	-5.33	-5.40	-5.65	-5.64	-5.66	-5.66
Ch=22V	-4.14	-4.13	-4.49	-4.39	-4.56	-4.81
Ch=37V	-1.74	-1.76	-2.14	-2.03	-2.11	-2.05
Ch=37H	-0.31	-0.34	-0.57	-0.85	-0.48	-0.60
Ch=89V	-0.28	-0.29	-0.50	-0.34	-0.43	-0.58
Ch=89H	-0.30	-0.30	-0.56	-0.03	-0.38	-0.48