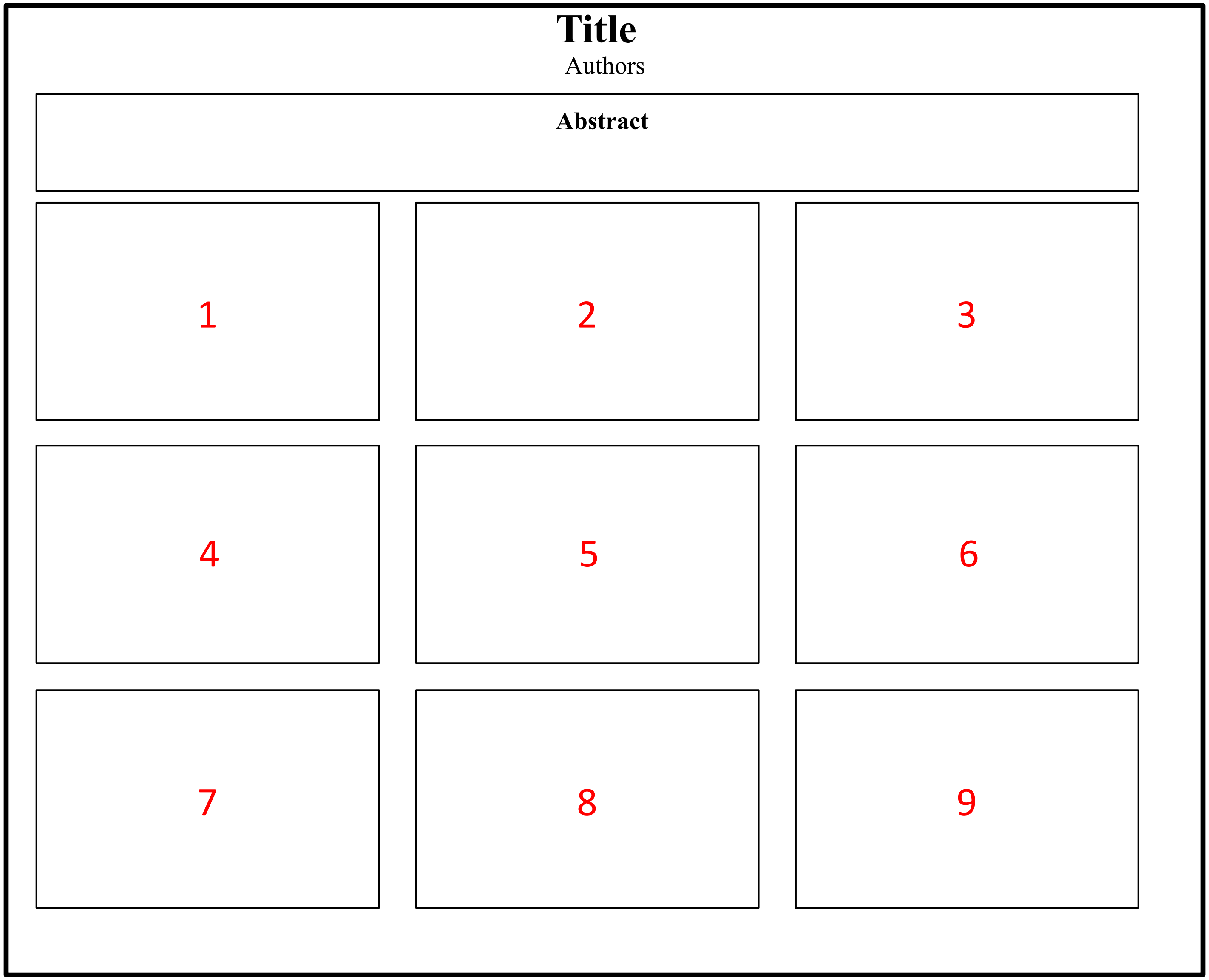
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# Inter-Satellite Microwave Radiometric Calibration for the GPM Constellation

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# Abstract

The goal of GPM is to reduce errors in rainfall estimates by using a constellation of satellites; however, for the merged product to be satisfactory, the rainfall retrievals from each must be consistent with the others. Achieving this consistency is a multi-step process, wherein the first step is to assure radiometric consistency among the various passive microwave sensors. Our goal is to achieve relative brightness calibration consistency between constellation members (at ± 0.1 K level) relative to the GPM consensus calibration. We will support the GPM Precipitation Processing System by developing X-CAL prescreening algorithms for new constellation microwave radiometers.

# Inter-satellite Radiometeric Calibration (X-CAL)

## Research Objective

- To develop methodologies for the inter-calibration of brightness temperature (Tb) measurements from passive microwave radiometers on cooperative satellites within a multi-satellite GPM constellation
  - Fundamental to this concept is the existence of the GPM Microwave Imager (GMI) in non-sun-synchronous orbit, which serves as a radiometric transfer standard for the other passive microwave sensors on cooperative constellation satellites

# Inter-satellite Radiometeric Calibration (X-CAL)

## This research builds upon our previous PMM science team experience with the X-CAL Working Group

- Pre-screening of new microwave radiometers will occur before incorporation into GPM constellation
  - New radiometers will be cross-calib with GMI and Tb differences (biases) will be characterized:
    - function of instrument and satellite parameters e.g., freq, antenna-scan angles, instrument temp, solar beta angle, spacecraft attitude, etc.
  - Afterwards, appropriate radiometric calibration correction algorithms will be applied in the Precipitation Processing System
- Provides an on-orbit adjustment of systematic calibration differences between a **given constellation radiometer** and the **GPM consensus calibration standard**
  - Results in brightness temperature (Tb) calibration to ± 0.1 K

# X-Cal Activities Prior to GPM Launch

Use **Megha-Tropiques** satellite in low earth orbit as proxi for **GPM Observatory**

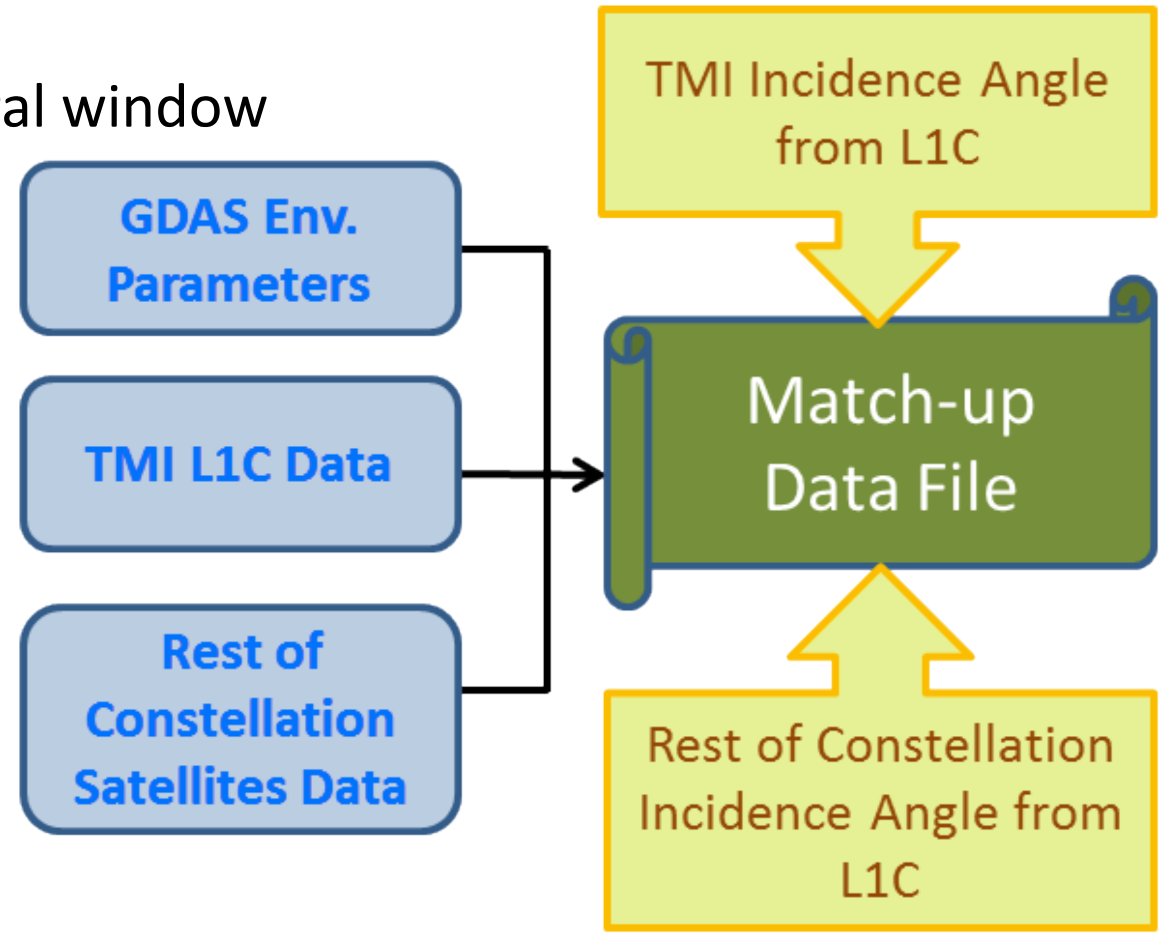
Use microwave imager **MADRAS** and microwave sounder **SAPHIR** as proxi for **GMI**

- Pre-screening of MADRAS compared to TRMM Microwave Imager (TMI)
  - MADRAS data are not currently available
  - Comparisons of TMI with AMSR-2 are presented as an example
- Pre-screening of SAPHIR to Microwave Humidity Sounder (MHS) on MetOp-4
  - Examples of MHS comparisons to SAPHIR are presented

# RADIOMETRIC X-CAL FOR IMAGER CHANNELS

## Ocean "Cold End" Tb Match-ups

- Clear-sky match-ups in 1° lat/Lng boxes
- ± 1 hr temporal window



# Example X-CAL for AMSR2 and TMI IMAGER CHANNELS

Cold End (ocean) Analysis for 2012-13

- Double Difference Tb Biases

Observed Tb difference = $(T_{AMSR2})_{\mathrm{obs}}$ - $(T_{TMI})_{\mathrm{obs}}$

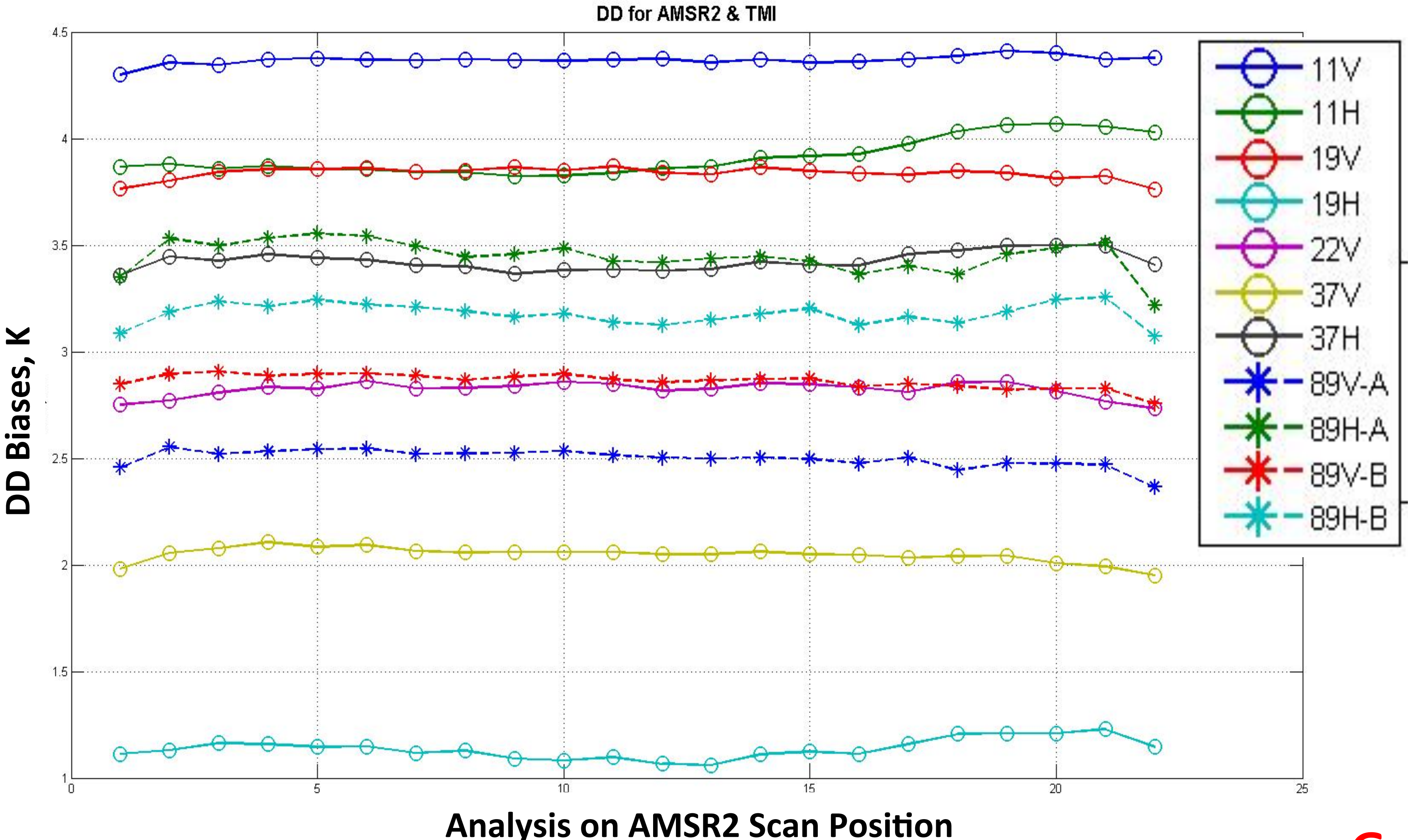
Thry Model Tb difference = $(T_{AMSR2})_{\mathrm{model}}$ - $(T_{TMI})_{\mathrm{model}}$

Double Difference Tb Bias

= Observed difference - RTM differences

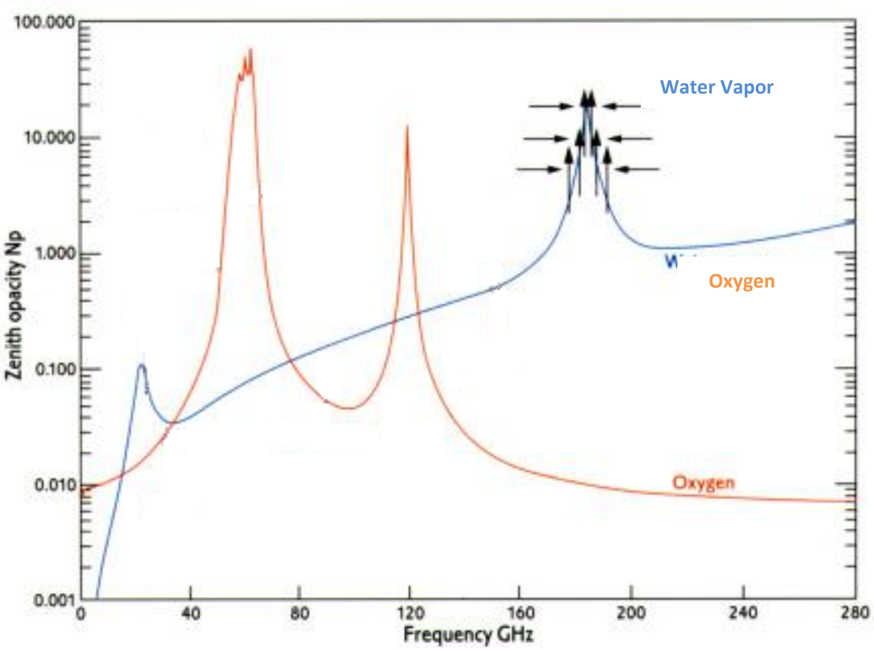
- TMI concensus calib: CC_1.1 applied

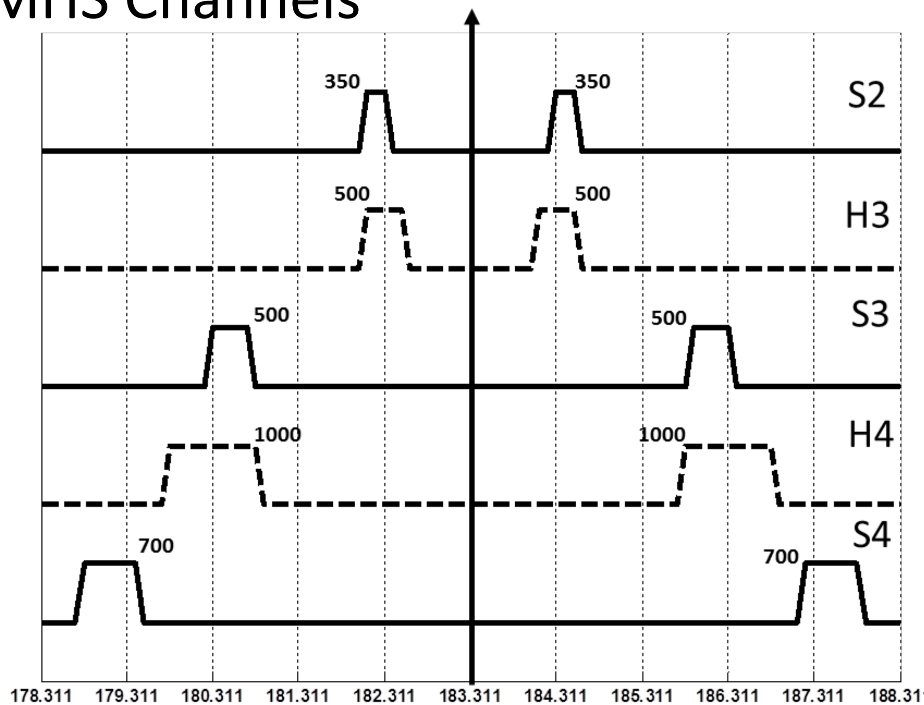
# RADIOMETRIC X-CAL FOR IMAGER CHANNELS



# RADIOMETRIC X-CAL for SAPHIR and MHS SOUNDER CHANNELS

SAPHIR & MHS Channels




| Saphir | | | |
|---|---|---|---|
| Channel | Central Frequecies (GHz) | Bandwidth | Pol. |
| S1 | **183.31±0.2** | 200 | H |
| S2 | **183.31±1.1** | 350 | H |
| S3 | **183.31±2.8** | 500 | H |
| S4 | **183.31±4.2** | 700 | H |
| S5 | **183.31±6.8** | 1200 | H |
| S6 | **183.31±11** | 2000 | H |

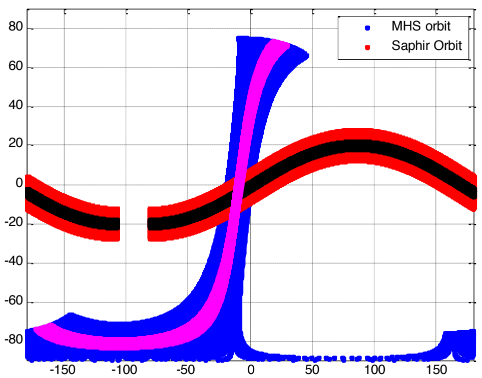
| MHS | | | | |
|---|---|---|---|---|
| Channel | Central Frequecies (GHz) | # Passbands | Bandwidth (MHz) | Pol. |
| H1 | **89** | 1 | 2800 | H |
| H2 | 157 | 1 | 2800 | H |
| H3 | **183.31±1.1** | 2 | 500 | H |
| H4 | **183.31±3** | 2 | 1000 | H |
| H5 | **190.311** | 1 | 2200 | V |

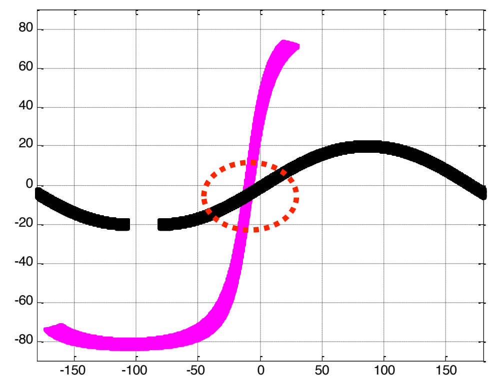
**Comparison 1 : S2 – H3**

**Comparison 2 : S3 – H4**

**Comparison 3 : S4 – H4**

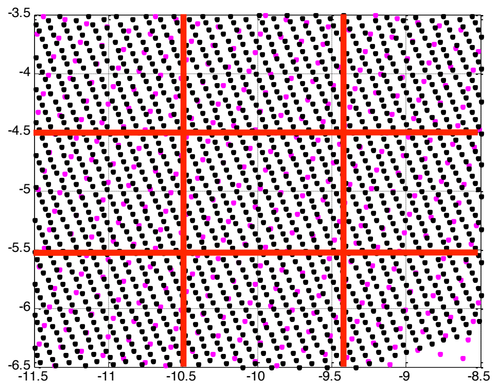
# SAPHIR and MHS Sounder Channels DD Calculated over 1° Boxes




**EIA <=15 for both sensors**

**3 x 3 degrees area selected for analysis**




RTM and
DD Calculation is
performed

**We averaged over 1 degree box**

# SAPHIR and MHS DD Tb Biases

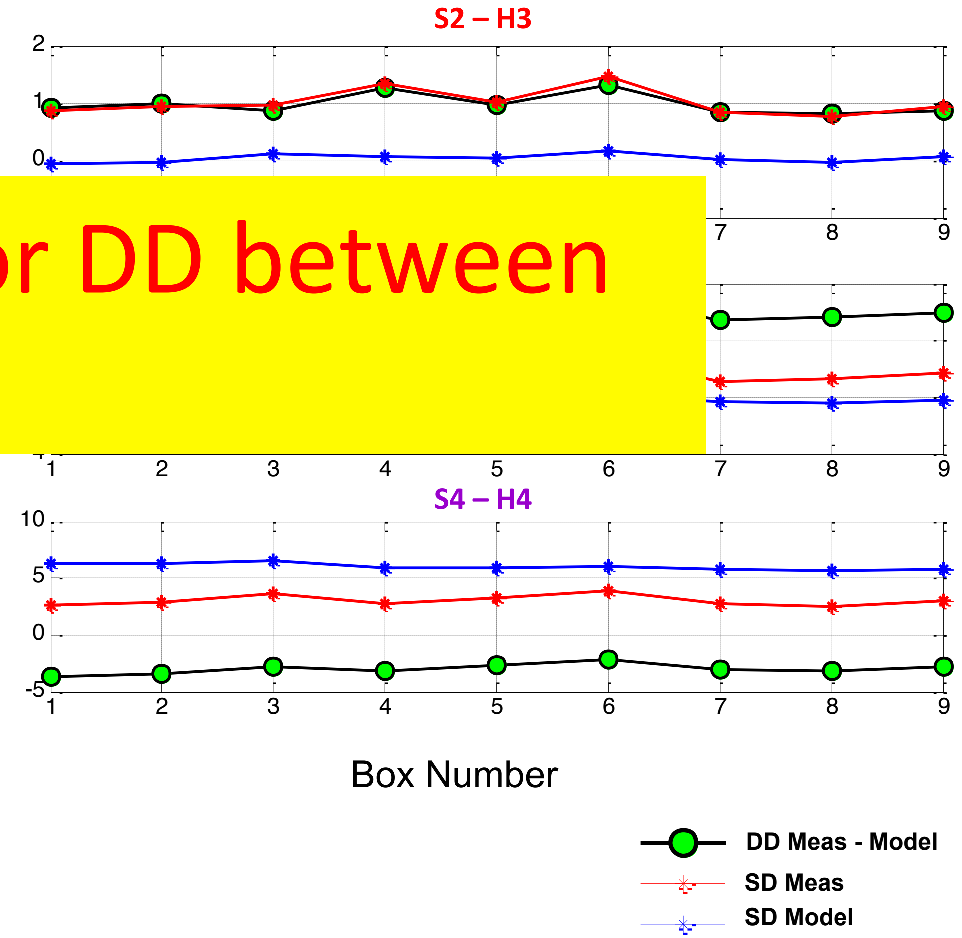
**Binned Averages**

S2 – H3

One graph for DD between channels

S4 – H4

Box Number




- EIA<=15
- ΔEIA = ±5°