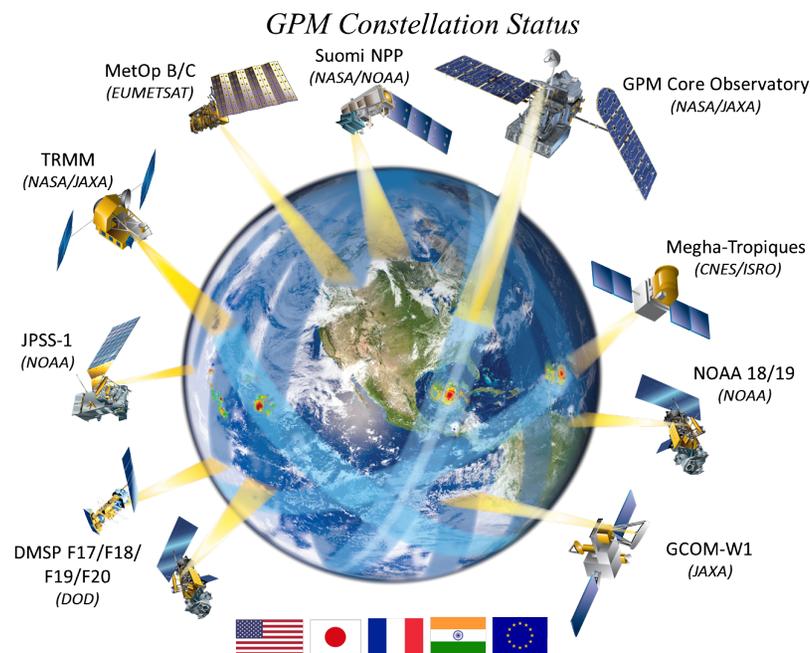


# The GPM Microwave Imager & Constellation : Algorithm Status



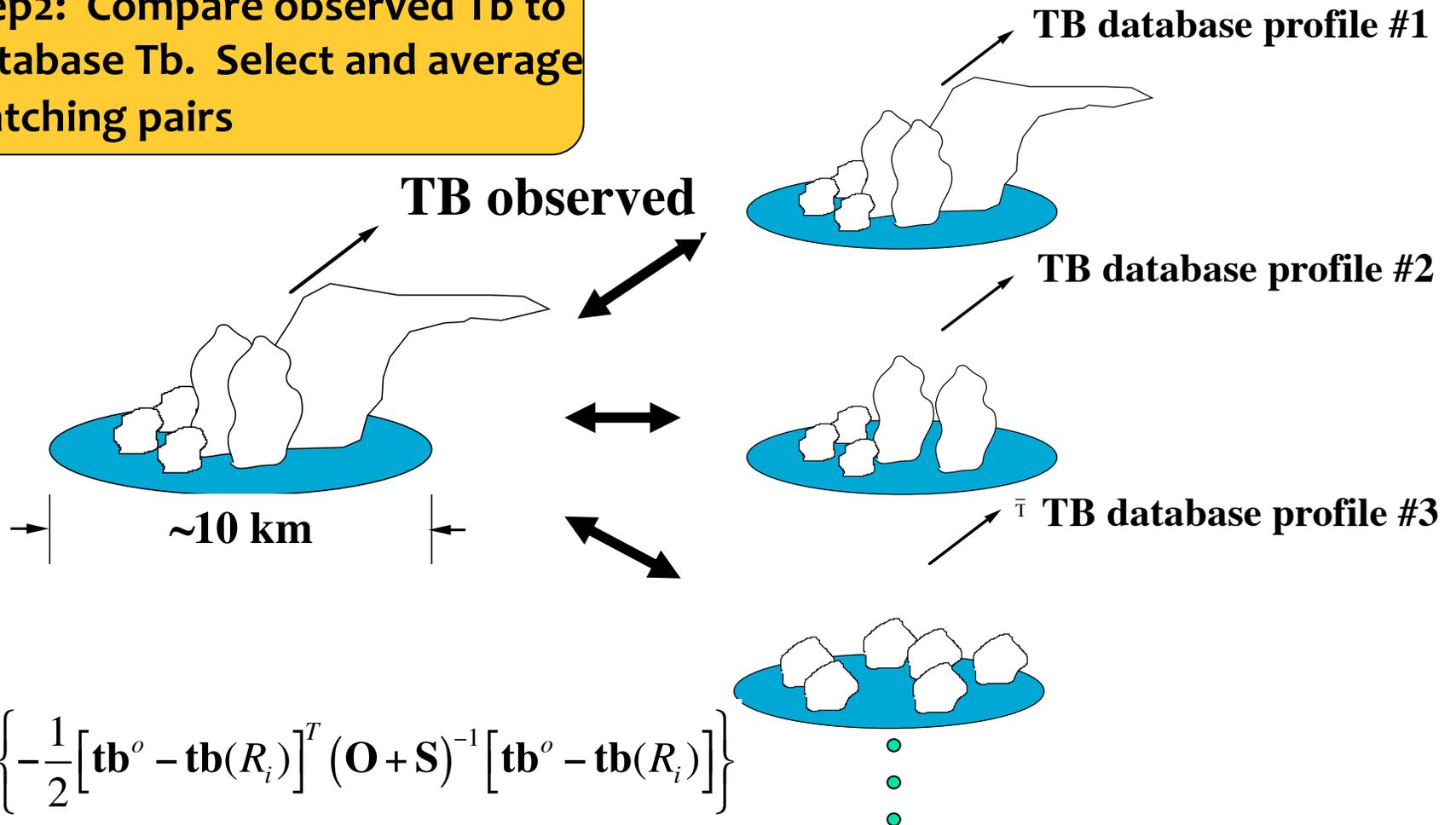
Christian Kummerow  
Dave Randel  
Paula Brown  
Veljko Petkovic  
Pierre Kirstetter

PMM Science Team Meeting  
November 5, 2018  
Indianapolis, IN

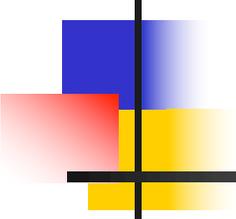
# The GPM radiometer algorithm

Step 1: Use GPM Satellite to derive set of “Observed” profiles that define an a-priori database of possible rain structures.

Step 2: Compare observed Tb to Database Tb. Select and average matching pairs



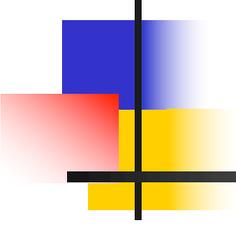
$$J_i = \exp \left\{ -\frac{1}{2} \left[ \mathbf{tb}^o - \mathbf{tb}(R_i) \right]^T (\mathbf{O} + \mathbf{S})^{-1} \left[ \mathbf{tb}^o - \mathbf{tb}(R_i) \right] \right\}$$



## *GPROF 2017: aka GMI version 5*

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- ✧ Over oceans, uses “Combined V04” rainfall + additional hydrometeor adjustments to get better Tb match at higher GMI frequencies.
- ✧ Uses GMI to extend rain rates to lower thresholds than detectable by DPR. Cloud Water is converted to drizzle to match CloudSat rain occurrence.
- ✧ Over land, uses “DPR Ku V04” rainfall + additional hydrometeor adjustments to get better Tb match at higher GMI frequencies.
- ✧ Over snow covered surfaces, uses “MRMS matchups with individual satellites” for a-priori databases
- ✧ Sets precipitation threshold to match rain occurrence in a-priori database. i.e. in each TPW and Water vapor bin, probability of rain is the same as Combined.



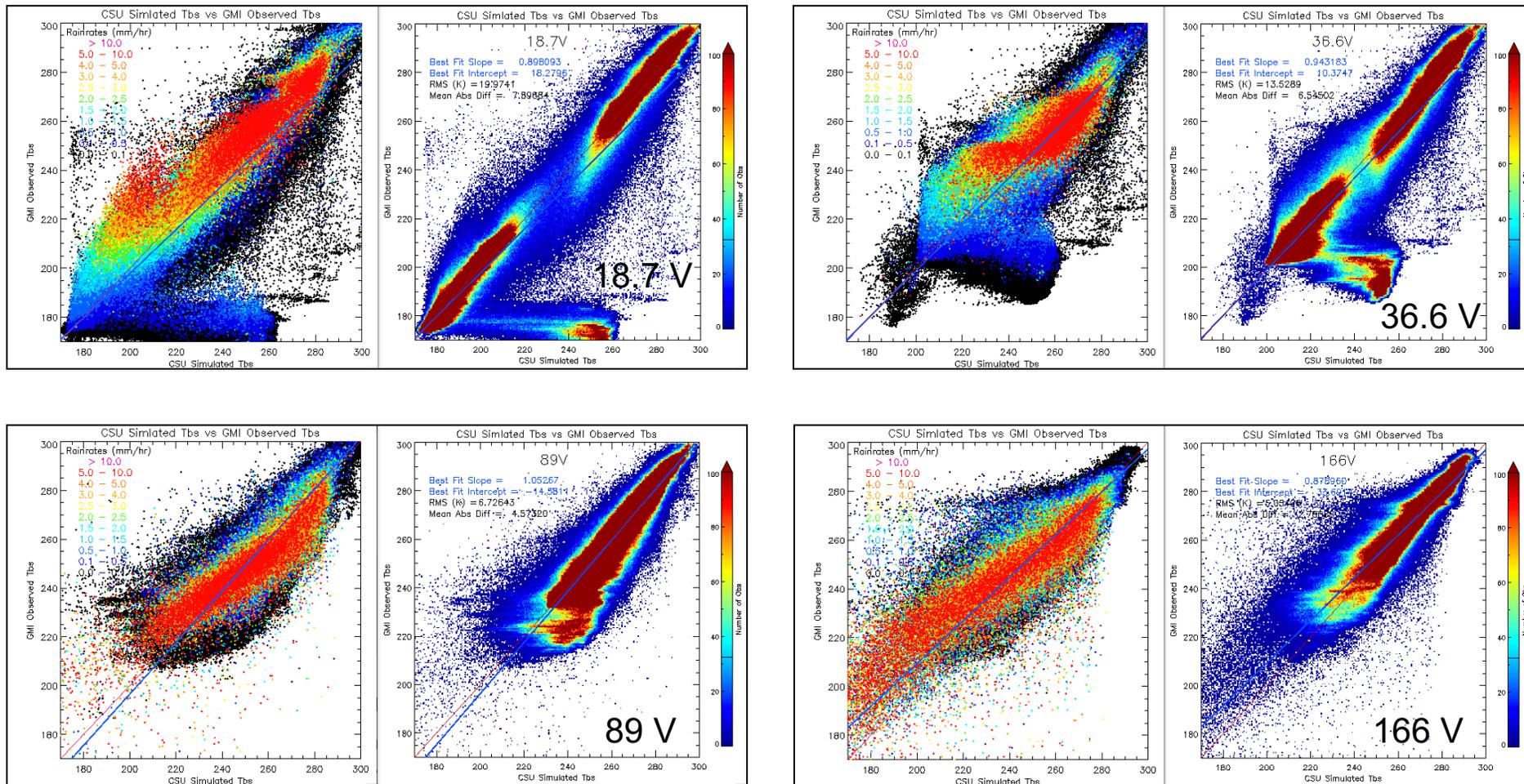
# *GPROF 2021: aka GMI version 7*

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- ✧ Use GPM CMB to create a-priori database.
- ✧ Transition database generation to be more operational
  - Use only standard product
  - Develop a documented methodology for creating database profiles
  - Develop a documented methodology for constellation databases
- ✧ Continue to work on well-known issues (Snow, orographic precipitation, and Convective/stratiform biases)
- ✧ Support parallel algorithm development efforts

# GMI Simulated vs. GMI Observed Tbs Using Combined Product Only October 1 - 10, 2018

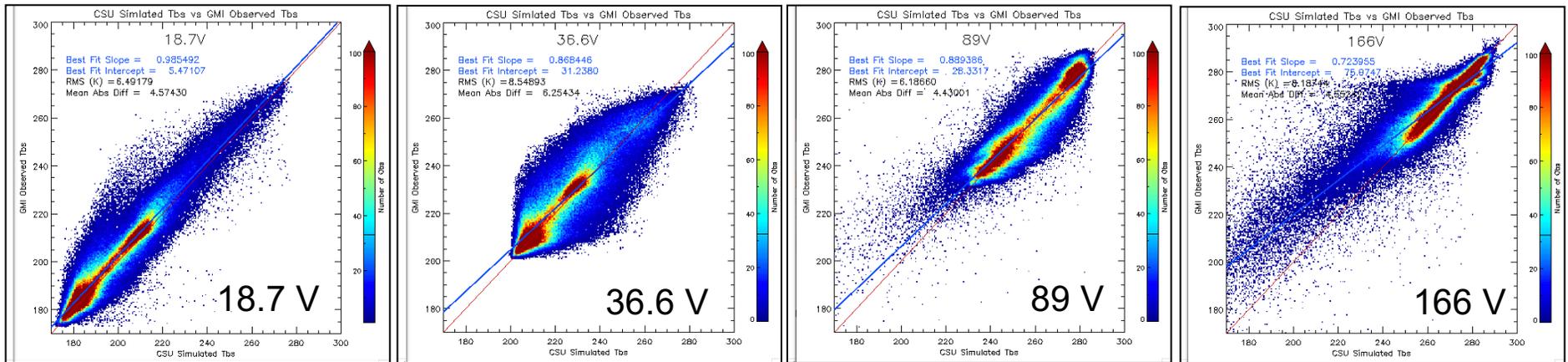
## All Surface Types, Global



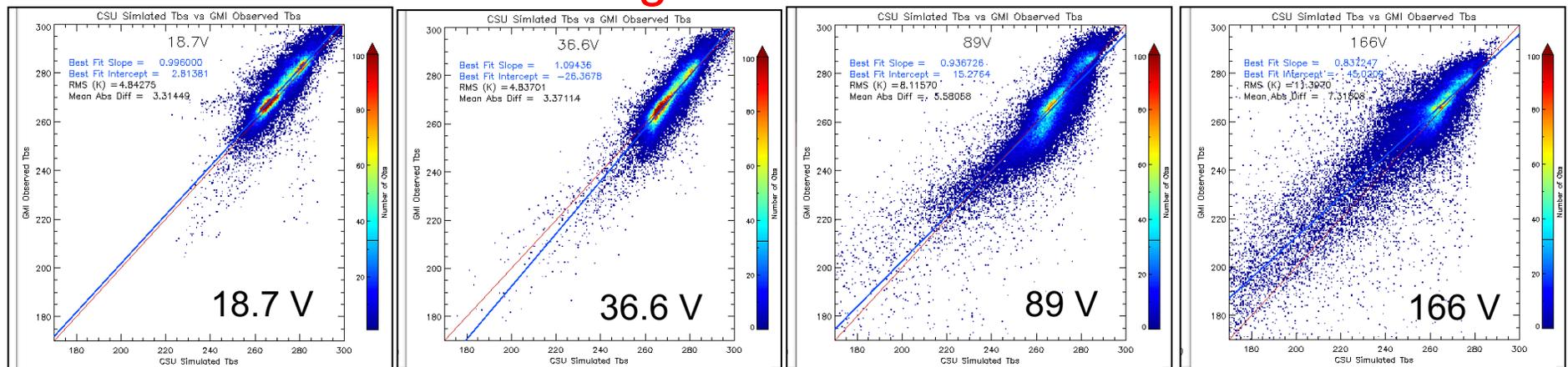
# GMI Simulated vs. Observed Tbs Using Only Combined Input for Precipitating Pixels

October 1-10, 2018

## OCEAN



## Vegetated Land

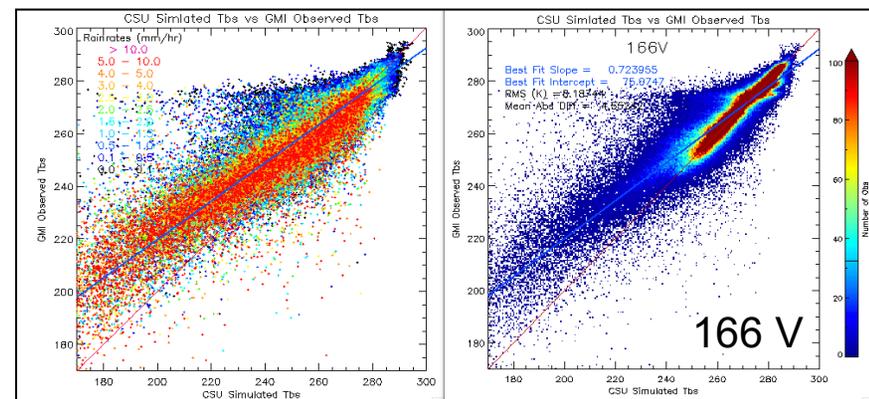
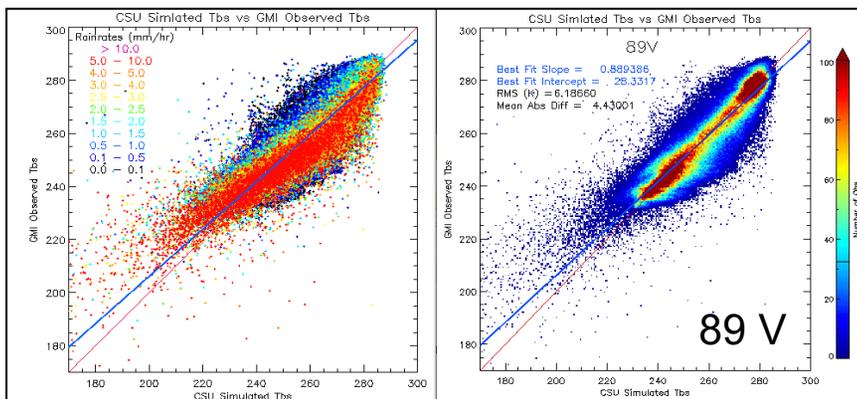
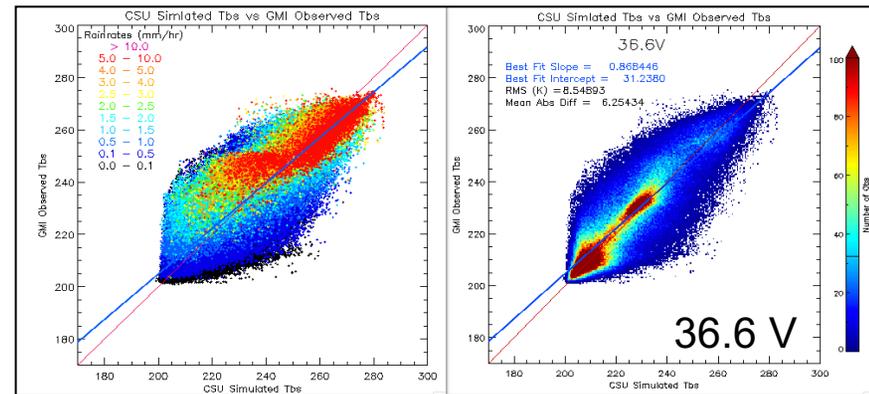
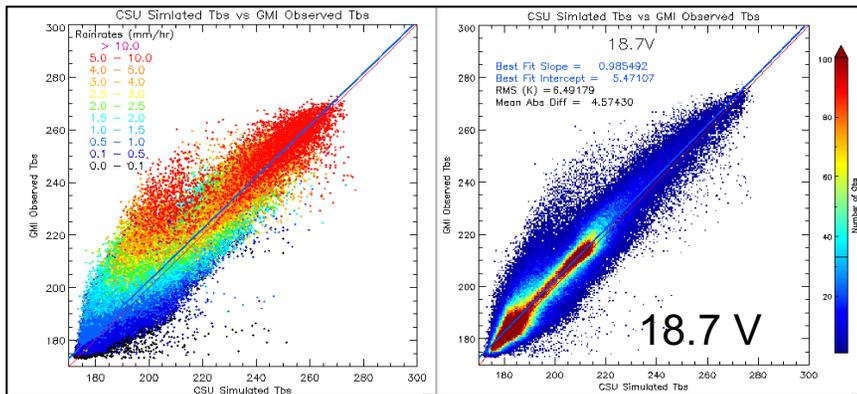


# GMI Simulated vs. Observed Tbs

## Using Only CMB only for Precipitating Pixels

October 1-10, 2018

### OCEAN

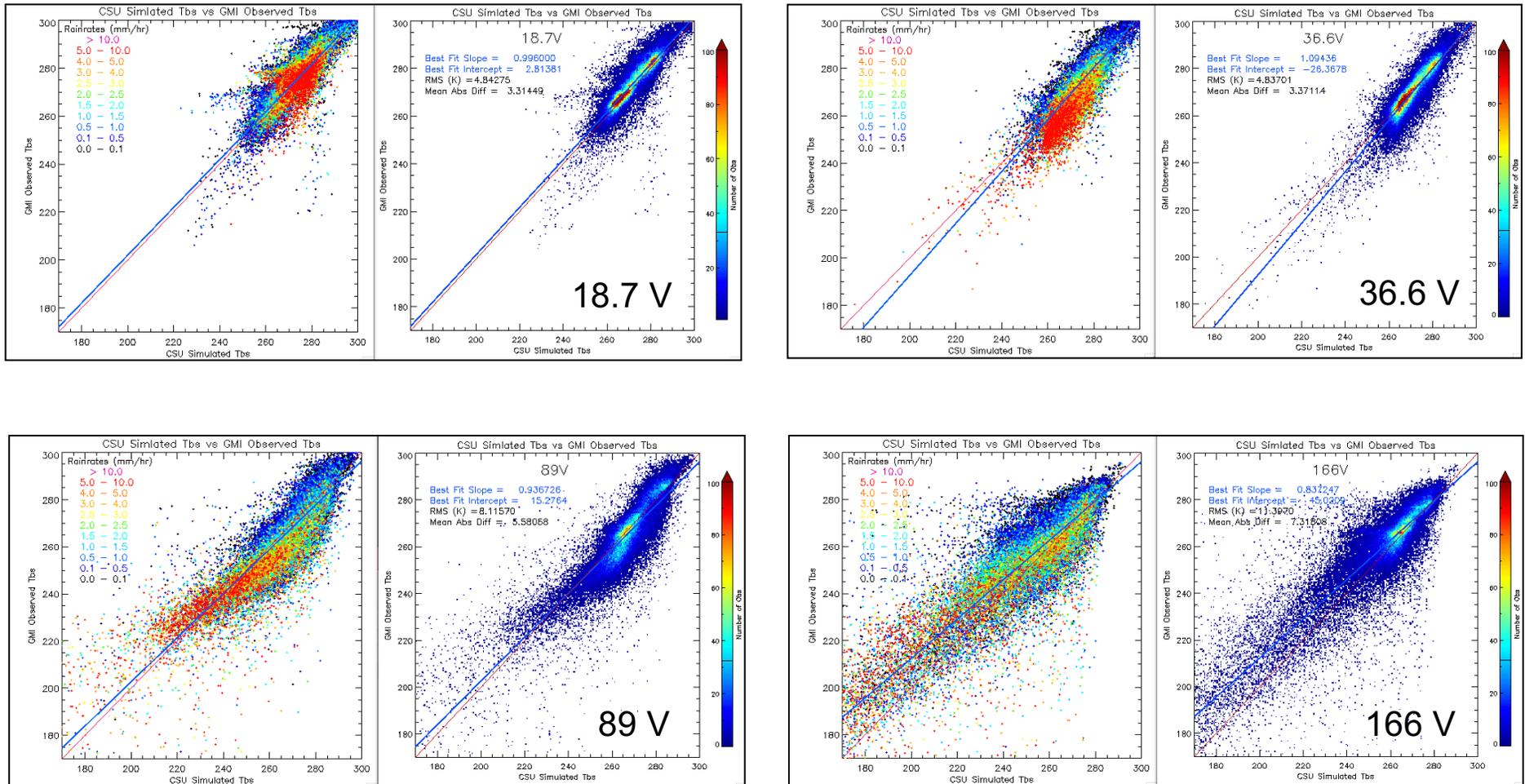


# GMI Simulated vs. Observed Tbs

## Using Only CMB only for Precipitating Pixels

October 1-10, 2018

### Vegetated Land

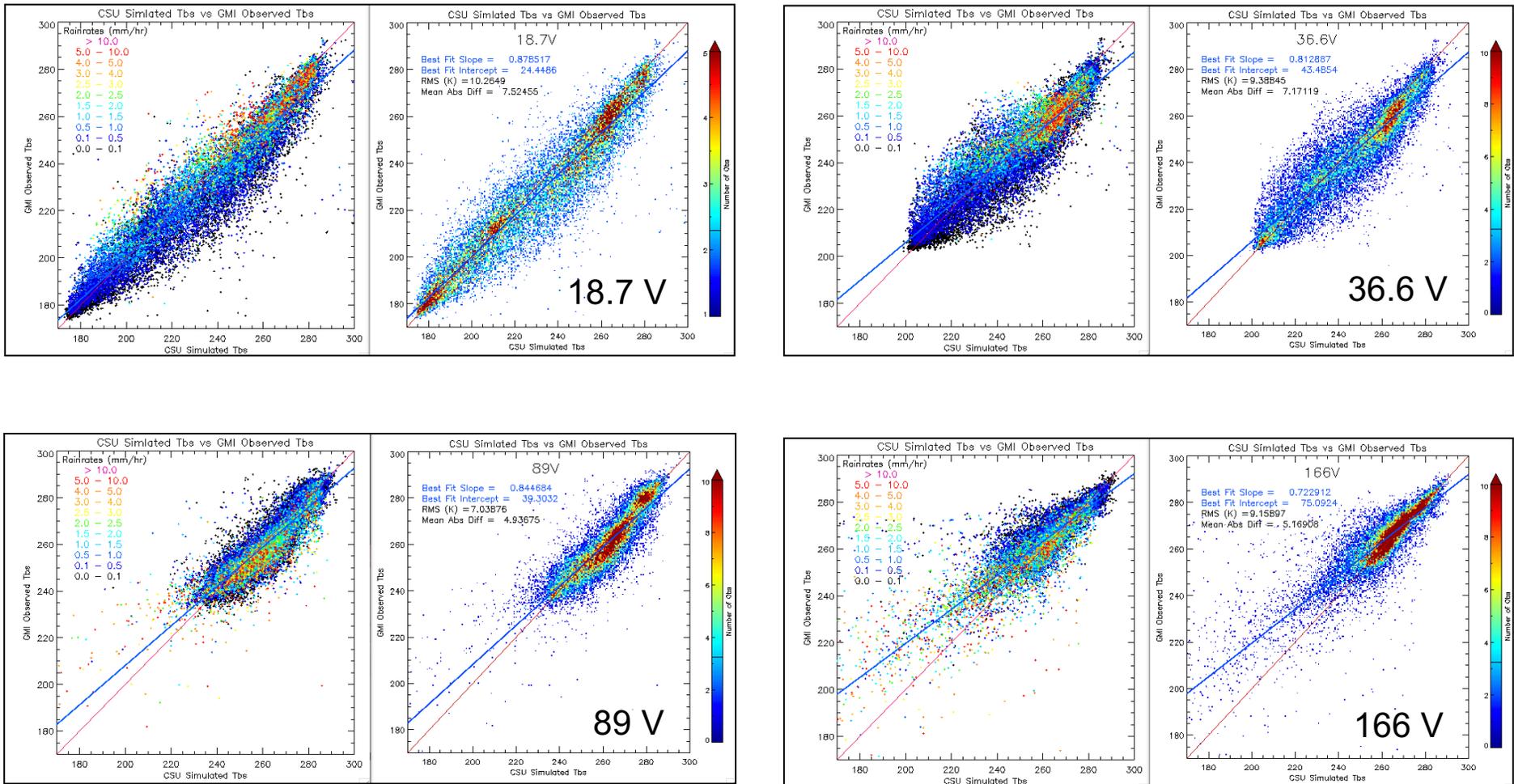


# GMI Simulated vs. Observed Tbs

## Using Only CMB only for Precipitating Pixels

October 1-10, 2018

### Coastlines

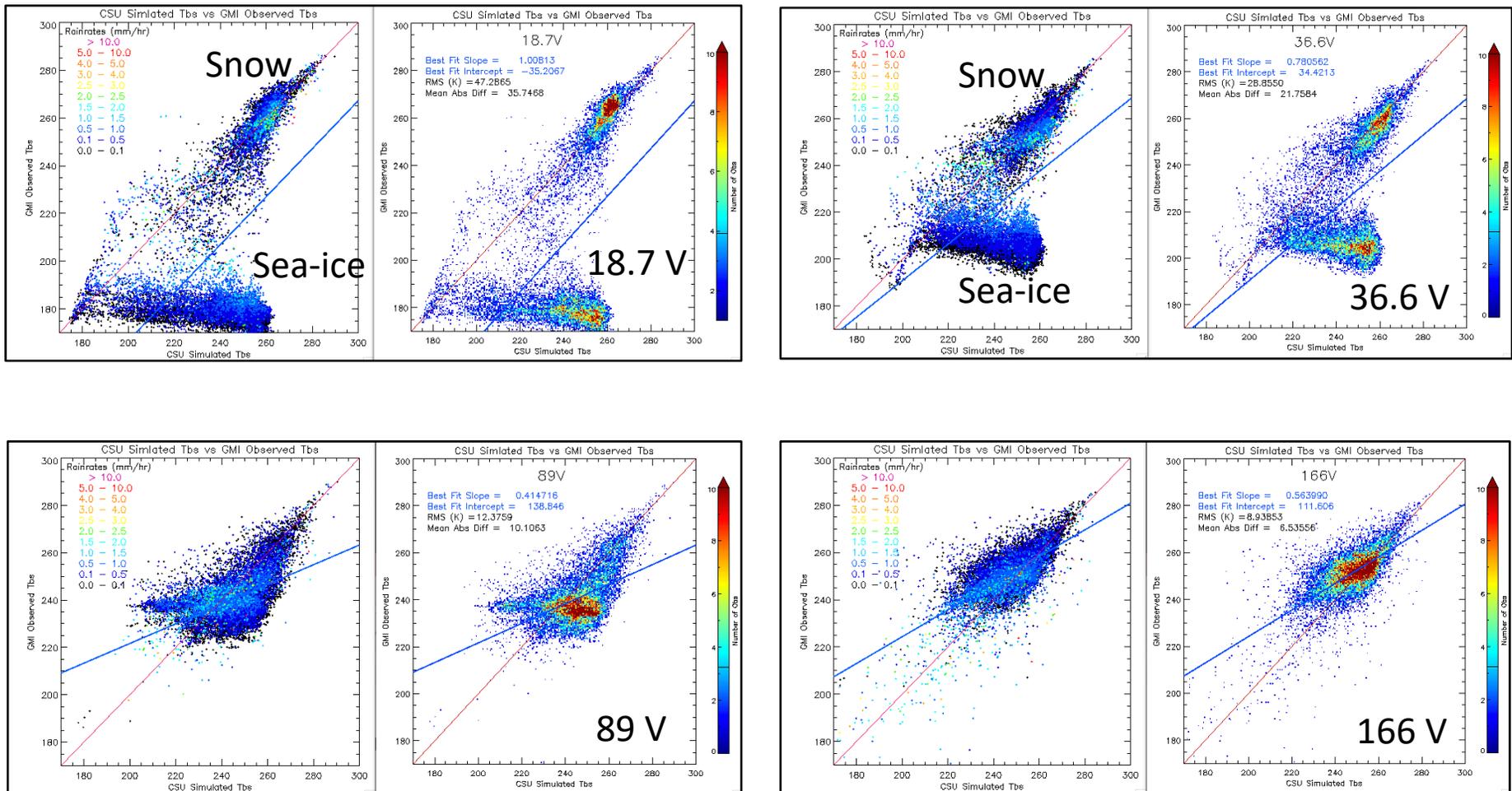


# GMI Simulated vs. Observed Tbs

## Using Only CMB only for Precipitating Pixels

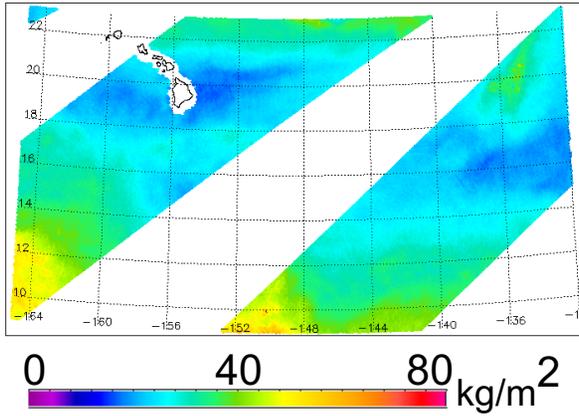
October 1-10, 2018

### Snow Covered and Sea-Ice

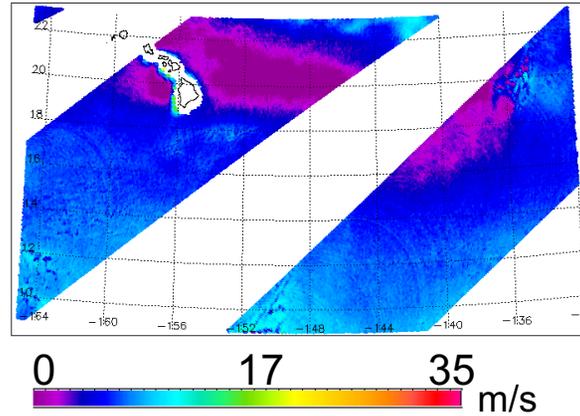


# Optimal Estimation (OE) vs Remote Sensing Systems (RSS)

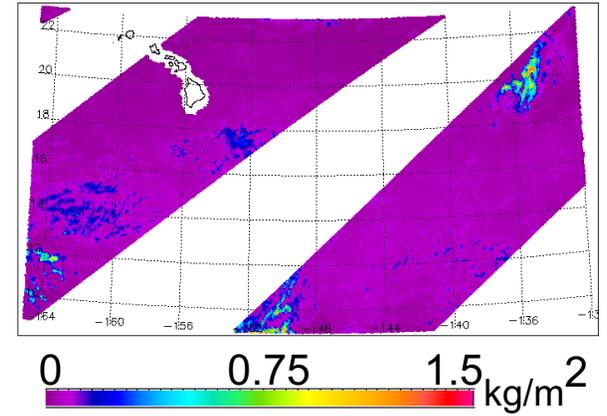
OE TPW



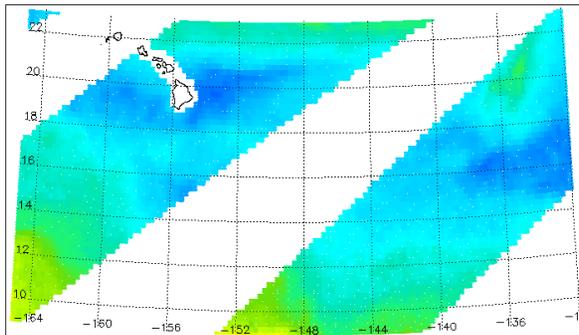
OE WIND



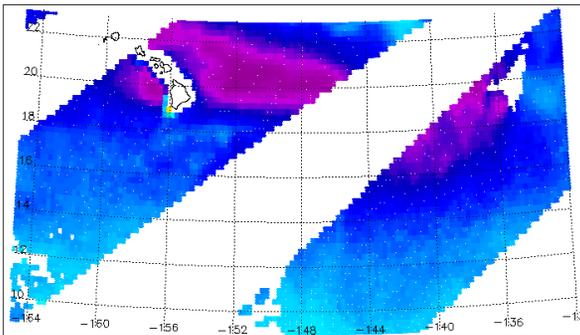
OE LWP



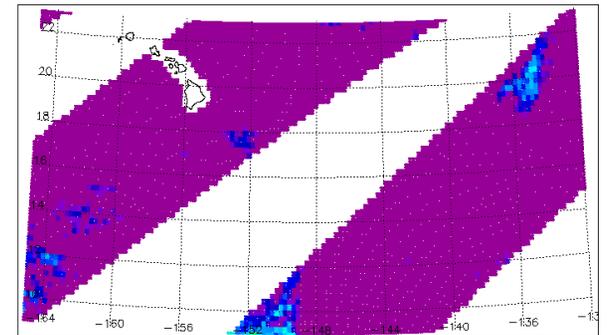
RSS TPW



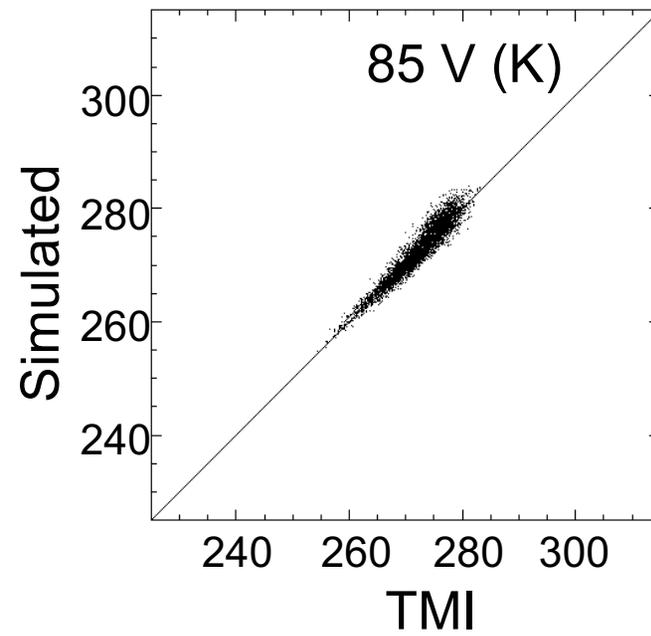
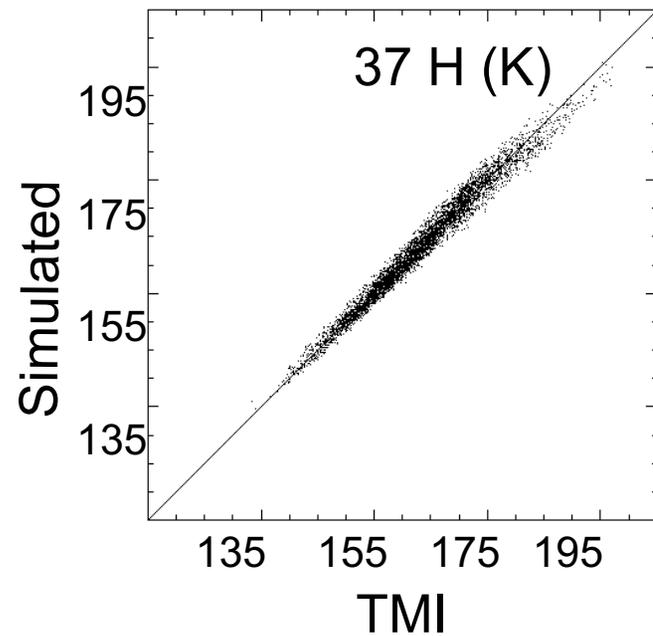
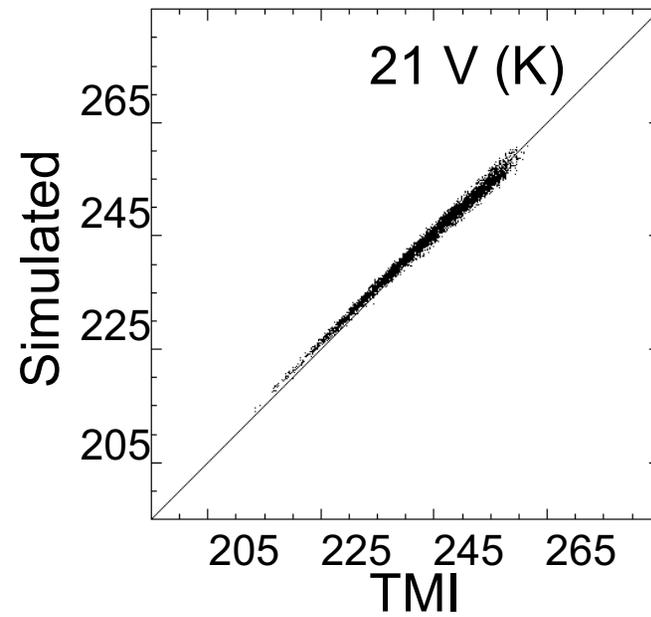
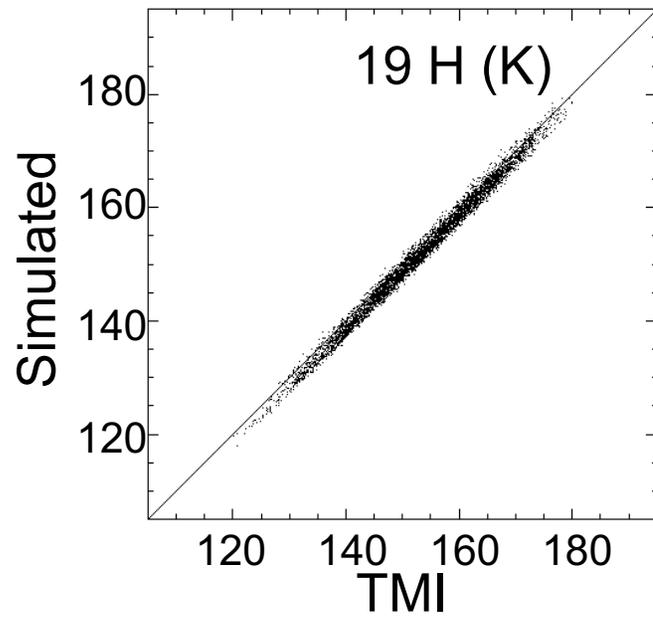
RSS WIND



RSS LWP



# *Simulated TBs vs Observed TBs*

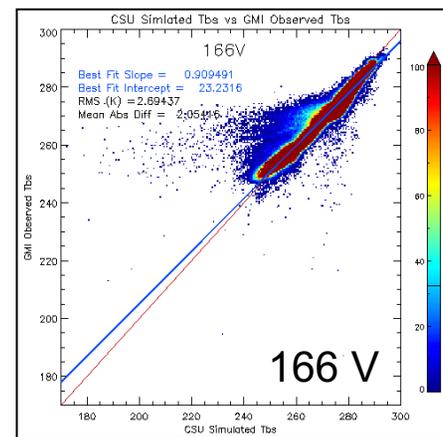
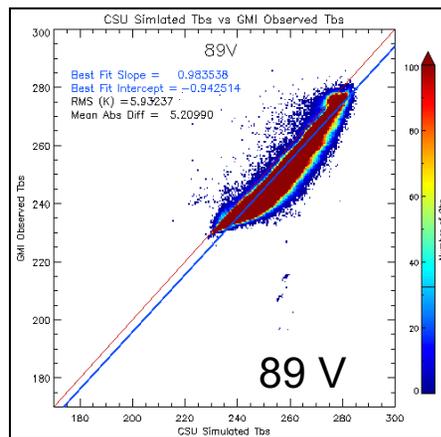
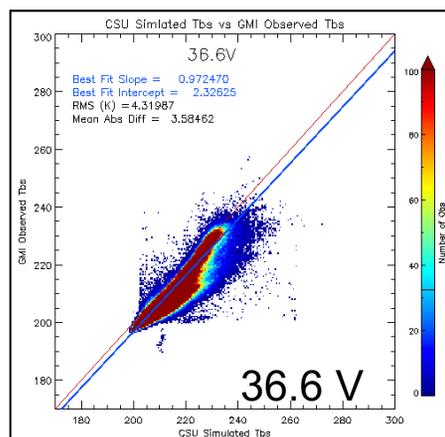
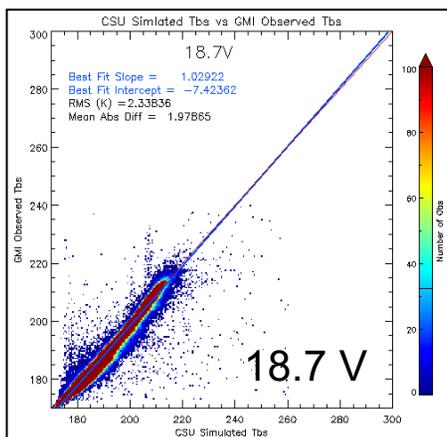


# GMI Simulated vs. Observed Tbs

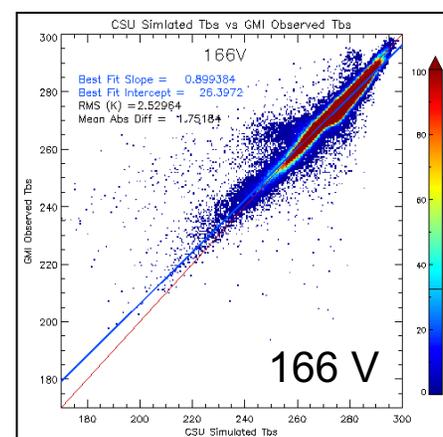
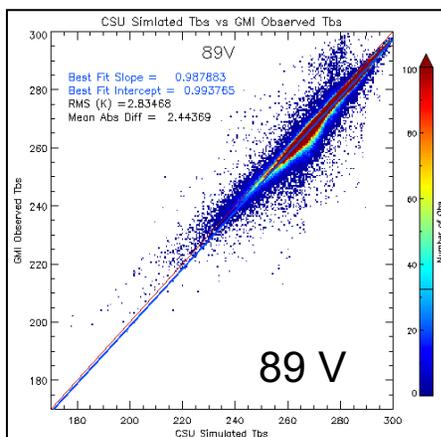
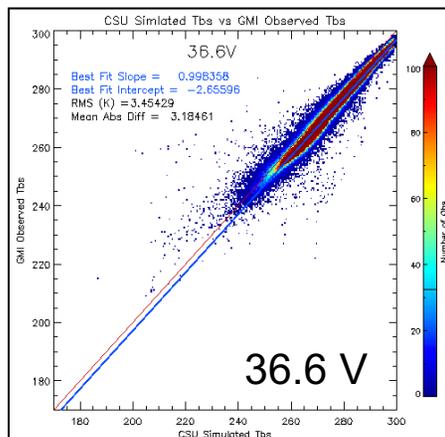
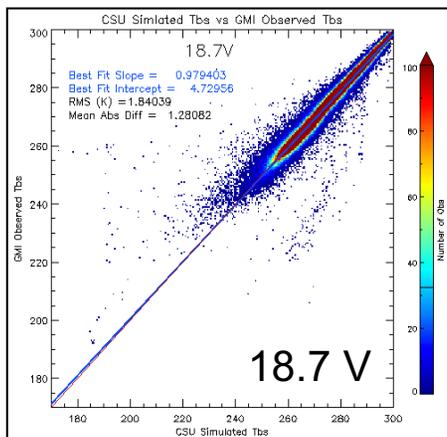
## Using Only MIRS Input for Non-Precipitating Pixels

October 1-10, 2018

### Ocean



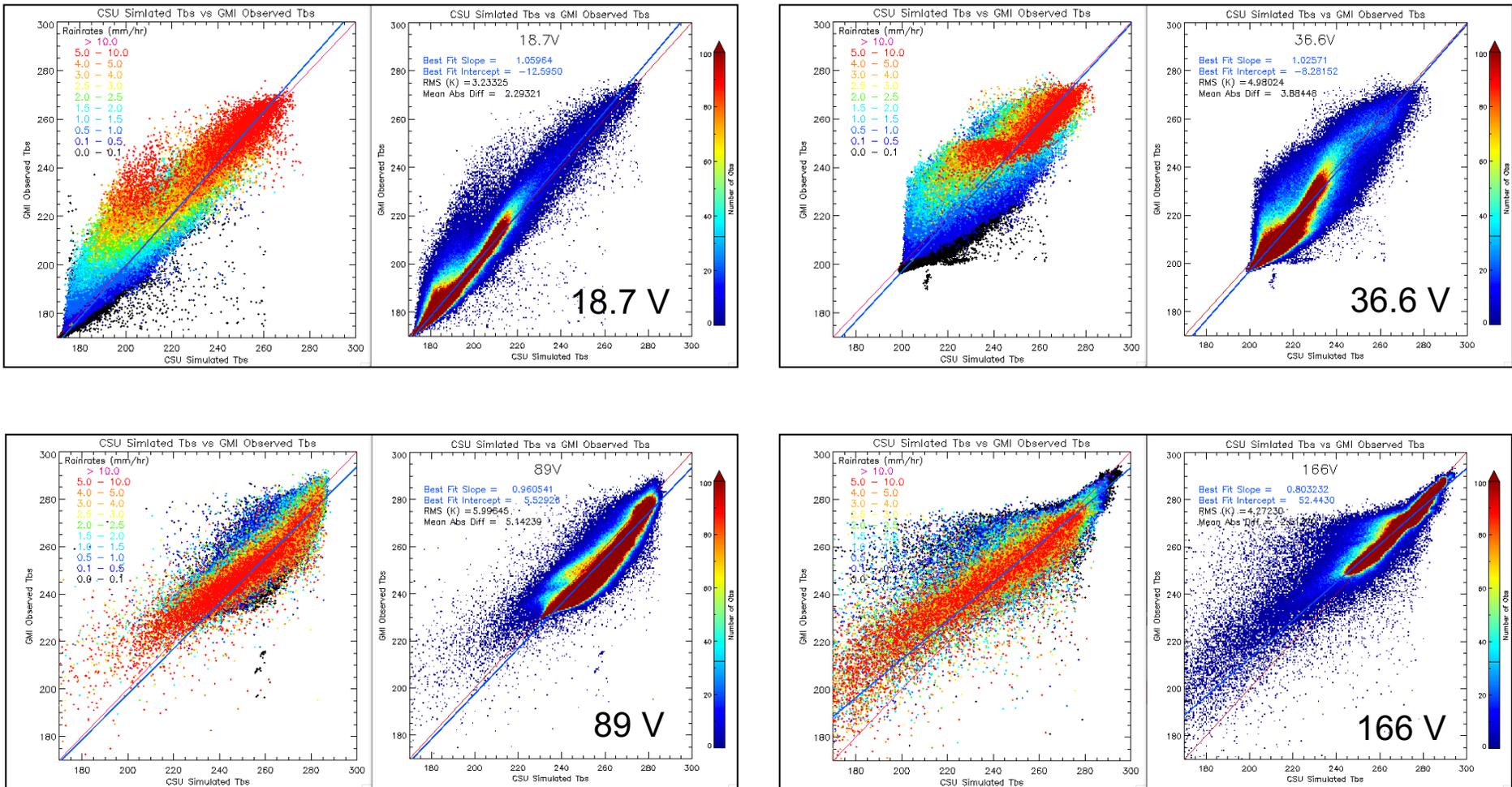
### Vegetated Land



# GMI Simulated vs. Observed Tbs Using MIRS (non-precipitating) and CMB (precipitating) Pixels

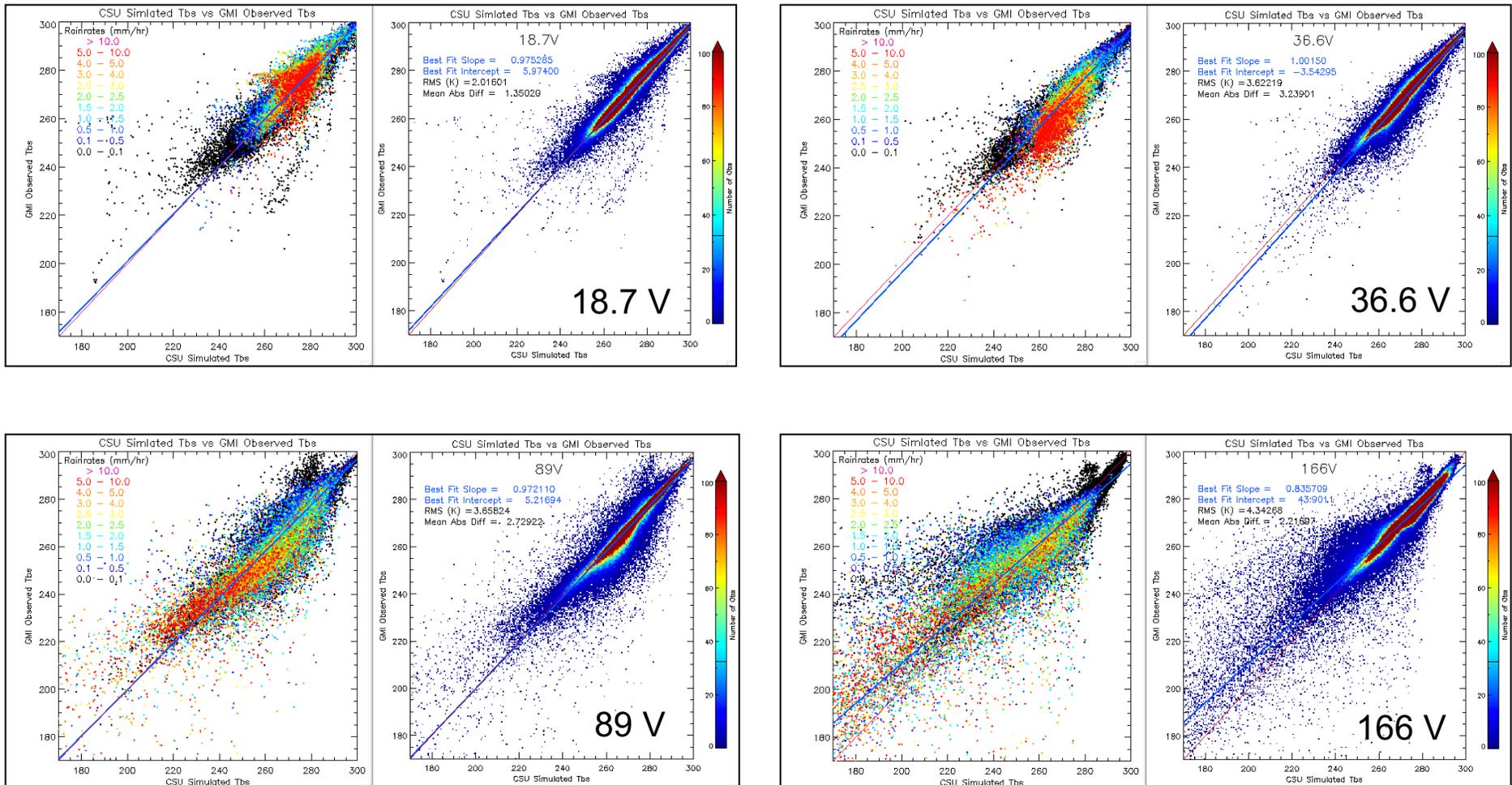
October 1-10, 2018

## Ocean



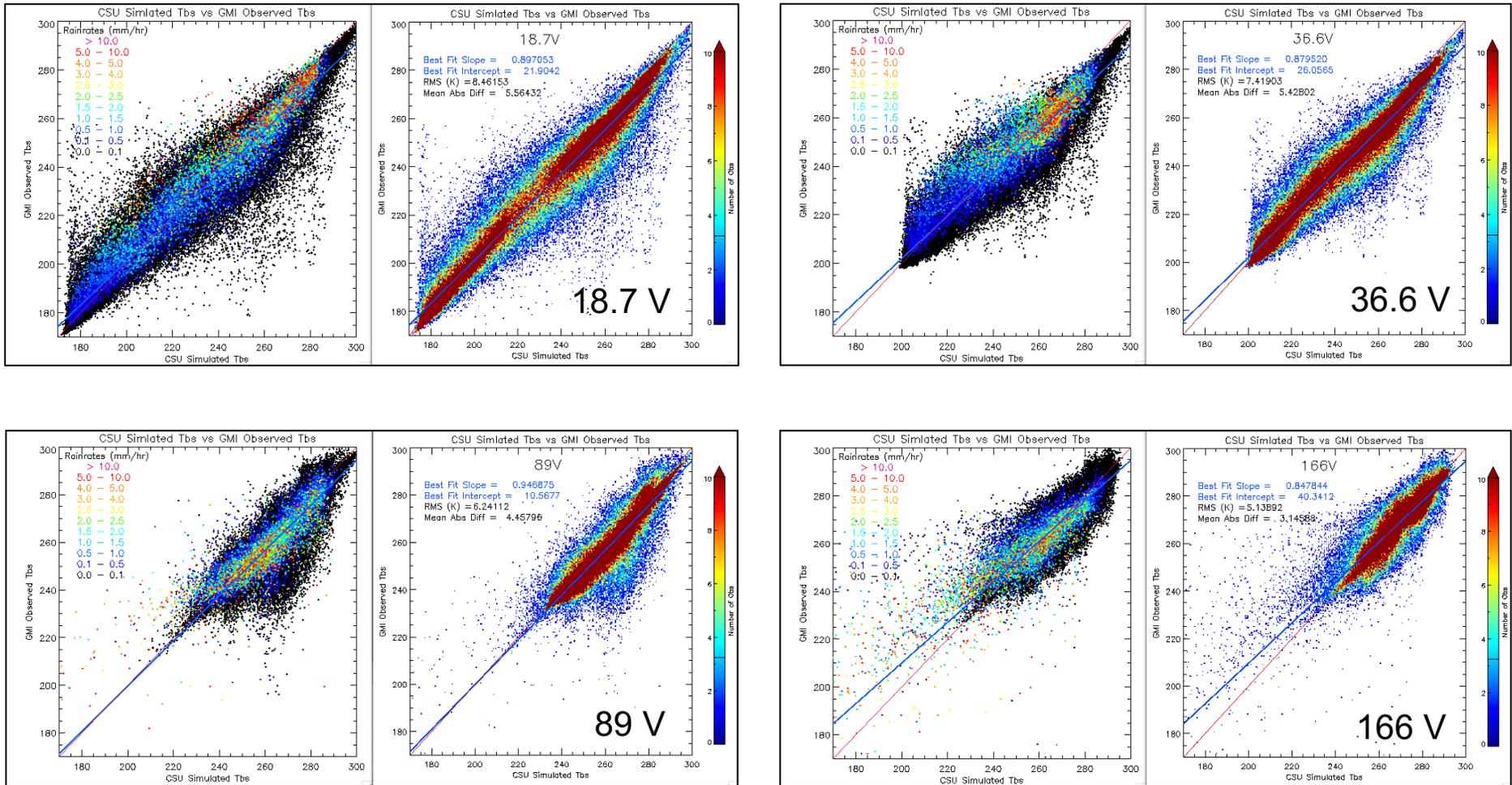
# GMI Simulated vs. Observed Tbs Using MIRS (non-precipitating) and CMB (precipitating) Pixels October 1-10, 2018

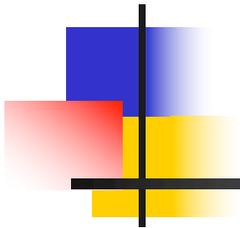
## Vegetated Land



# GMI Simulated vs. Observed Tbs Using MIRS (non-precipitating) and CMB (precipitating) Pixels October 1-10, 2018

## Coastlines





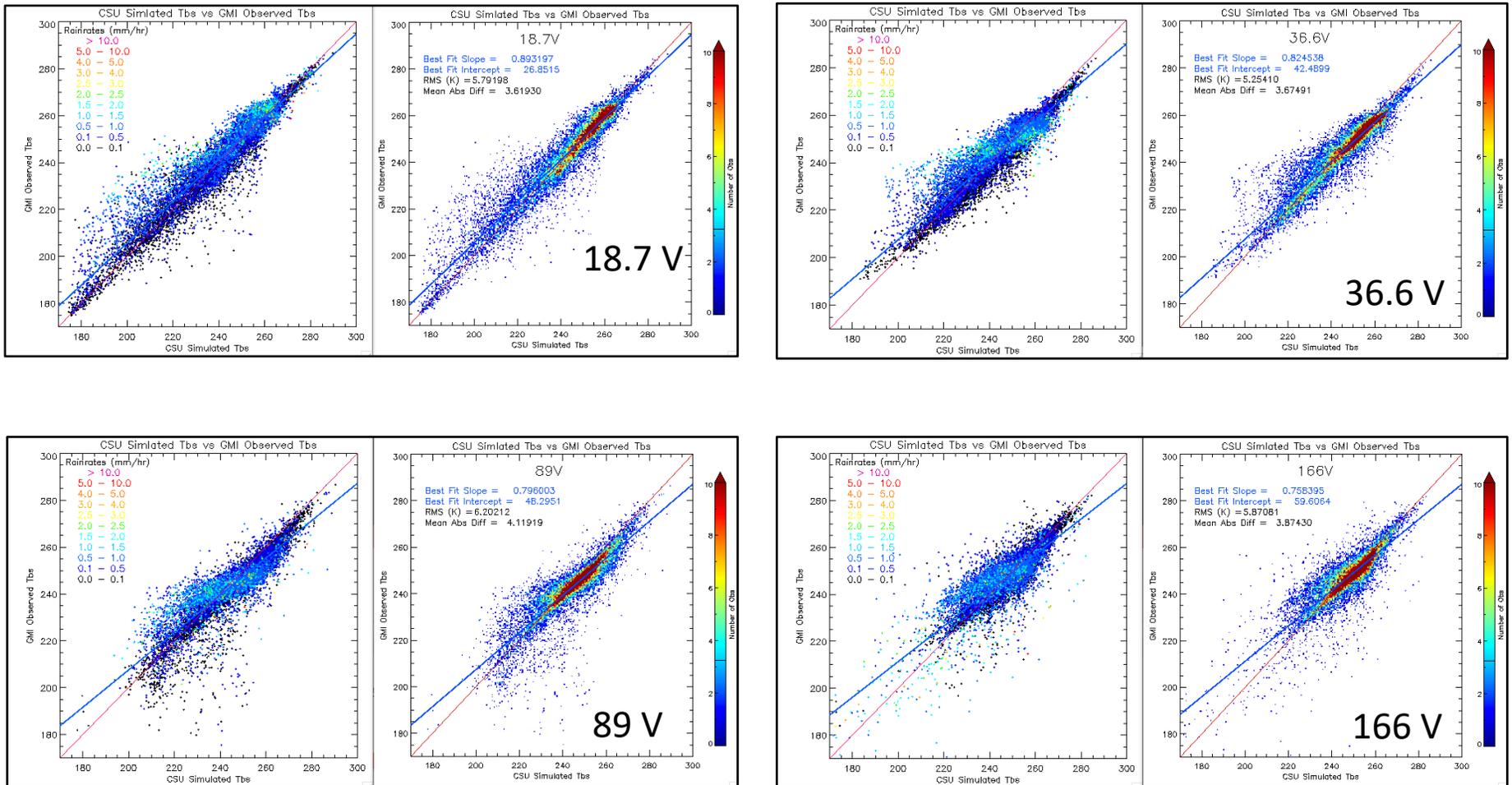
# GMI Simulated vs. Observed Tbs

## Using Combined Input for Precipitating Pixels

### Using MIRS Emissivities over Sea-ICE

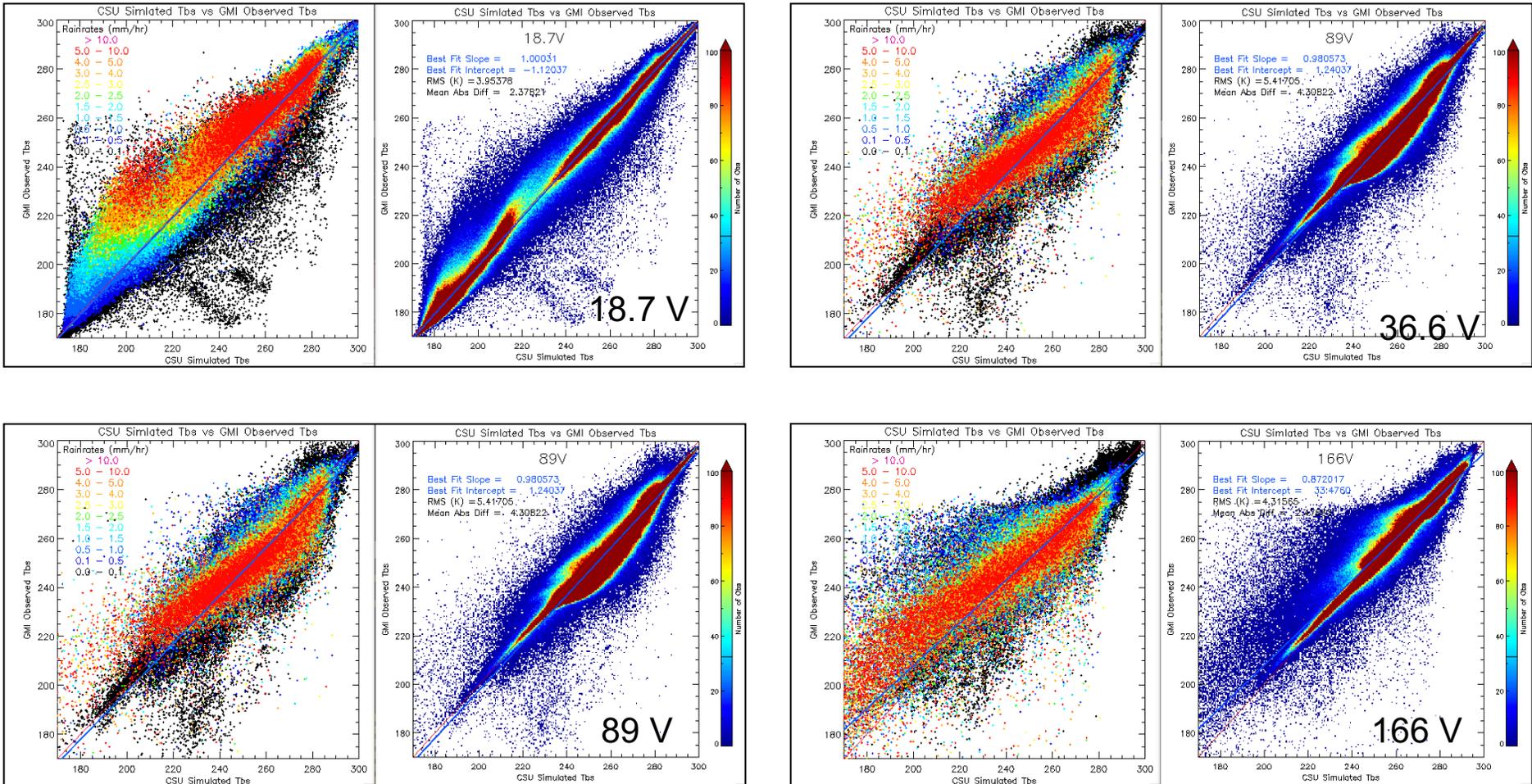
## Snow Covered and Sea-Ice – MIRS Emissivities Sea-Ice

October 1-10, 2018

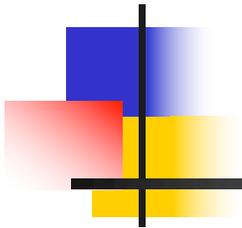


# GMI Simulated vs. GMI Observed Tbs Using COMBINED (Raining) and MIRS (Non-Raining) October 1 - 10, 2018

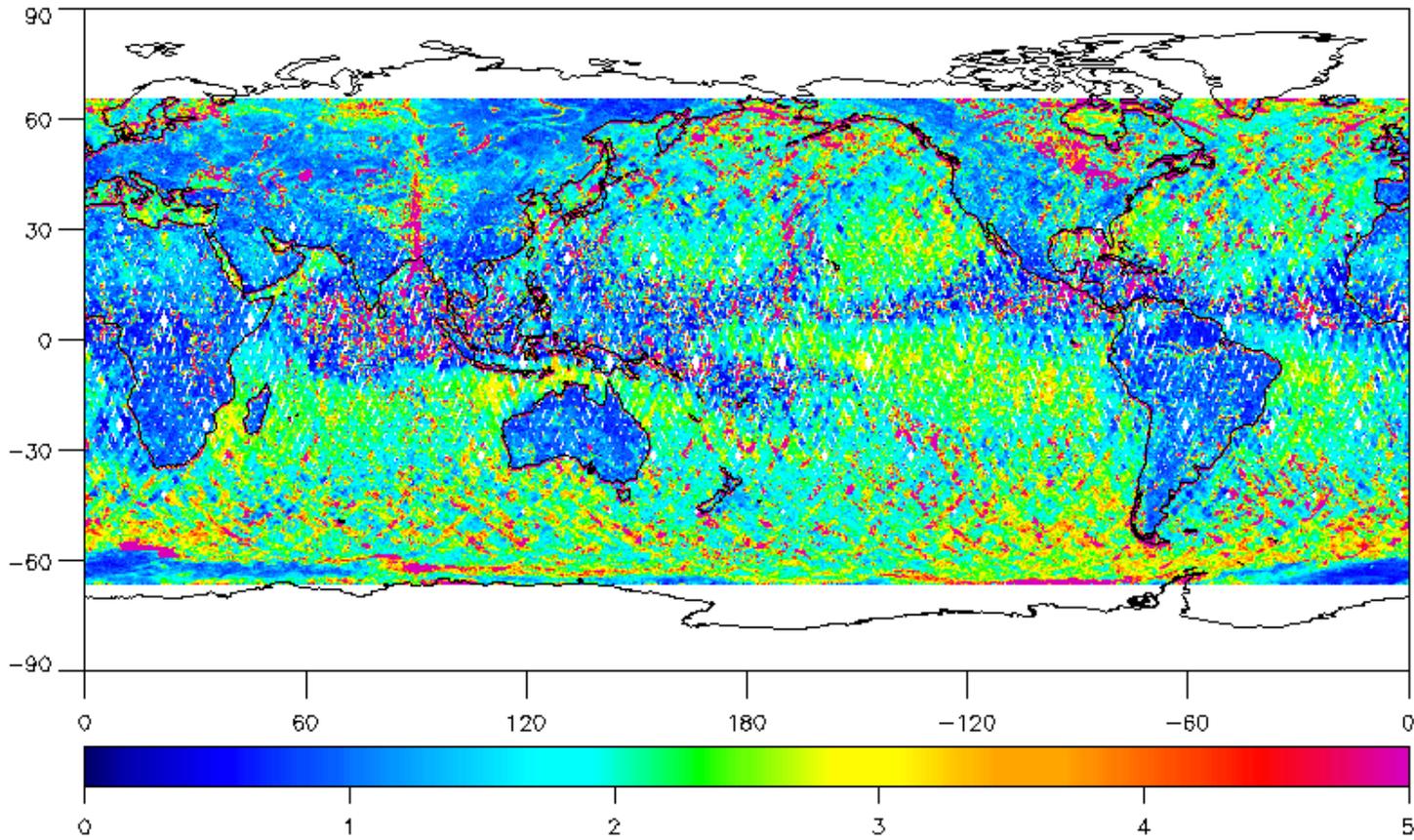
## ALL Surface Types and Global



Uses MIRS emissivities over sea-ice surfaces



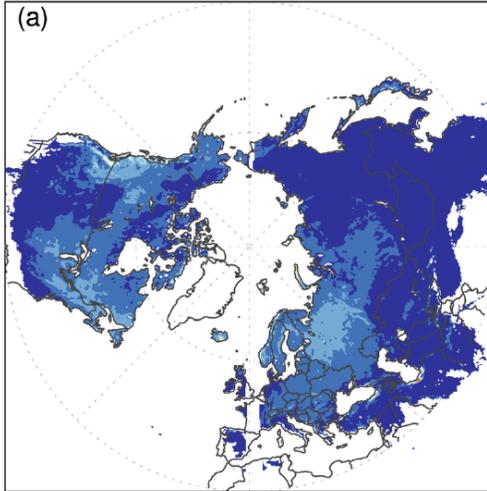
# Residual Tb Differneces October 1-10, 2018



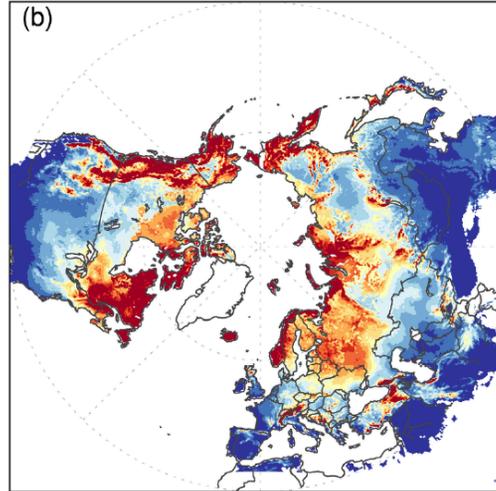
Absolute Difference (K)

# Snowfall and Orographic Precipitation

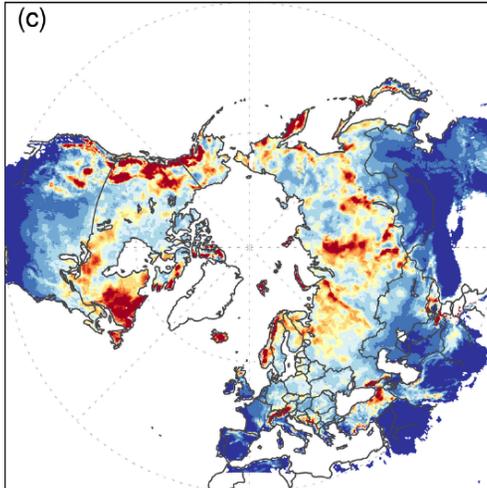
AMSR-E Observed Accumulated Snowfall



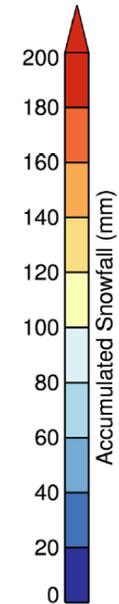
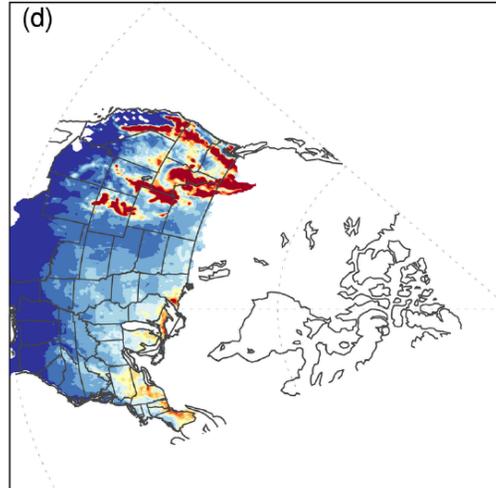
MERRA-2 Accumulated Snowfall



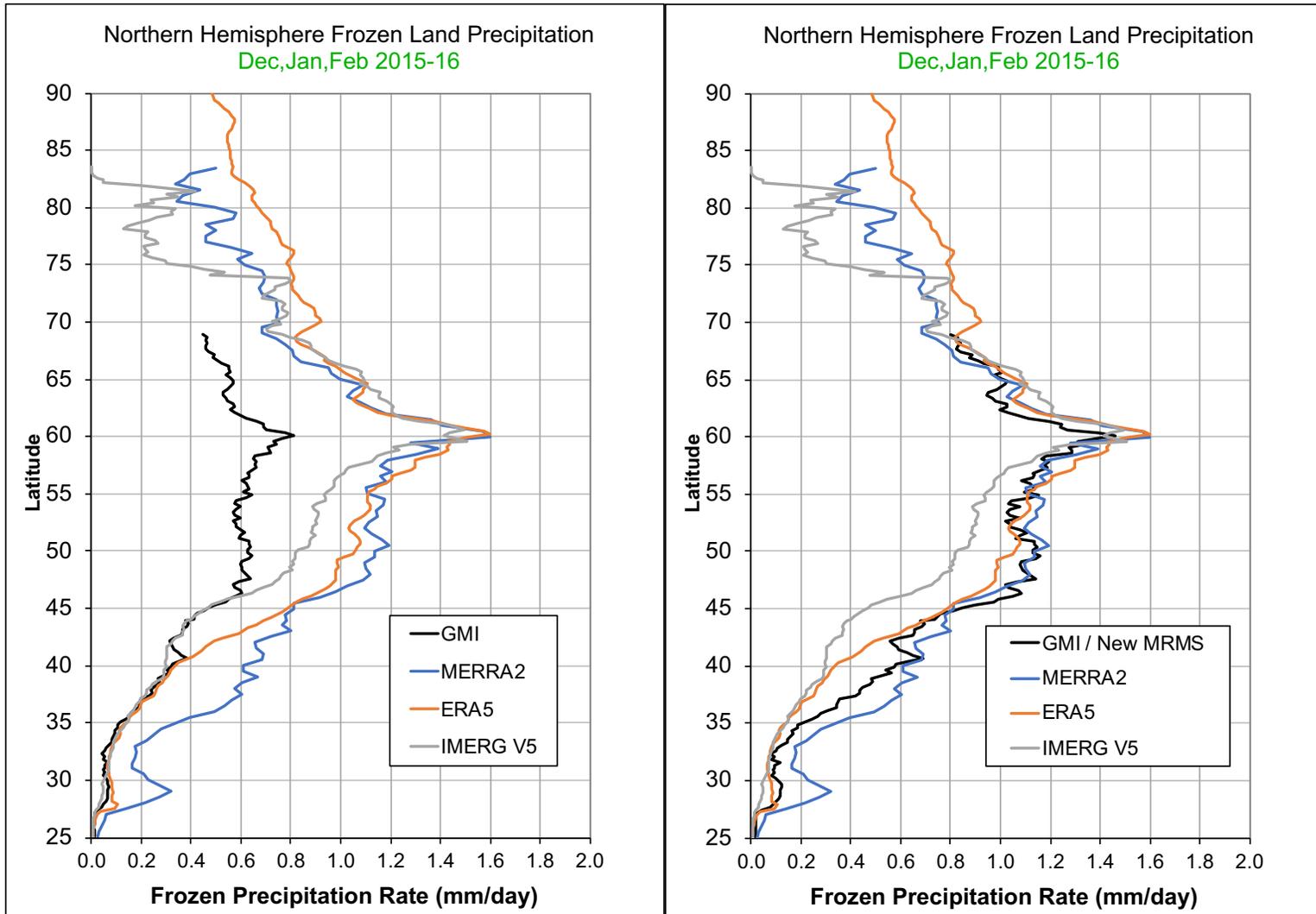
CMC Inferred Accumulated Snowfall



SNODAS Inferred Accumulated Snowfall



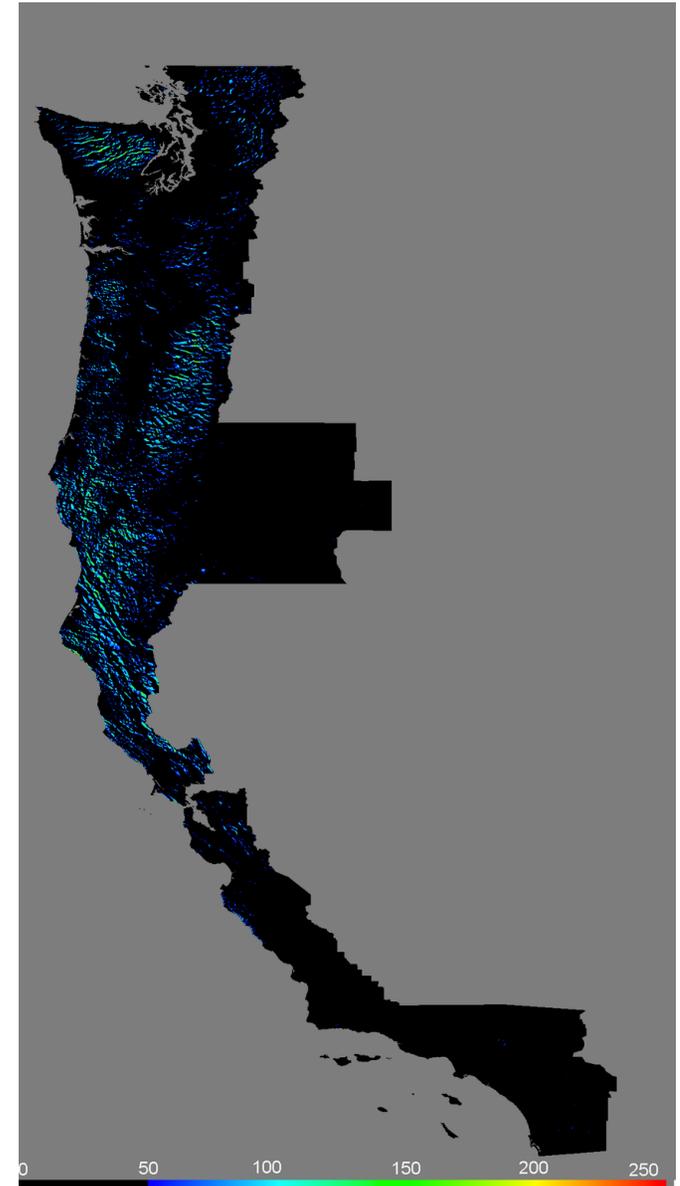
# Expected Snowfall Zonal Means



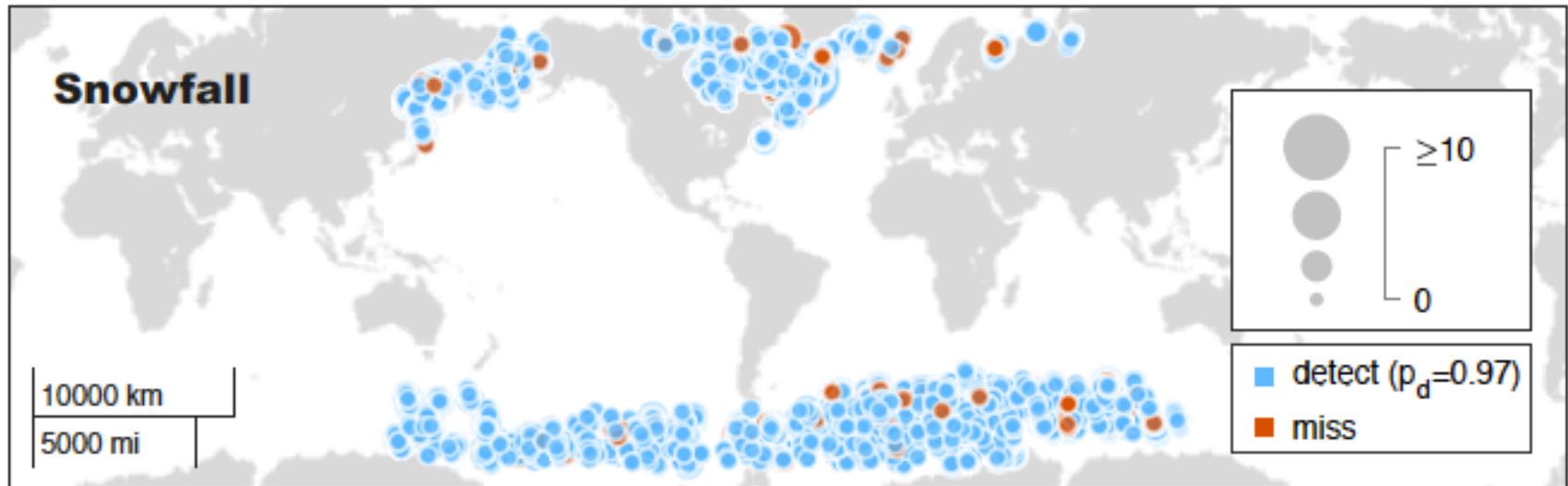
# Orographic Rain Index

Moisture transport and Slope

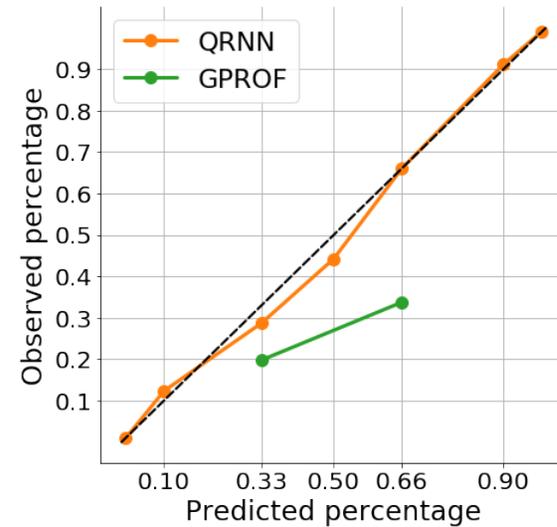
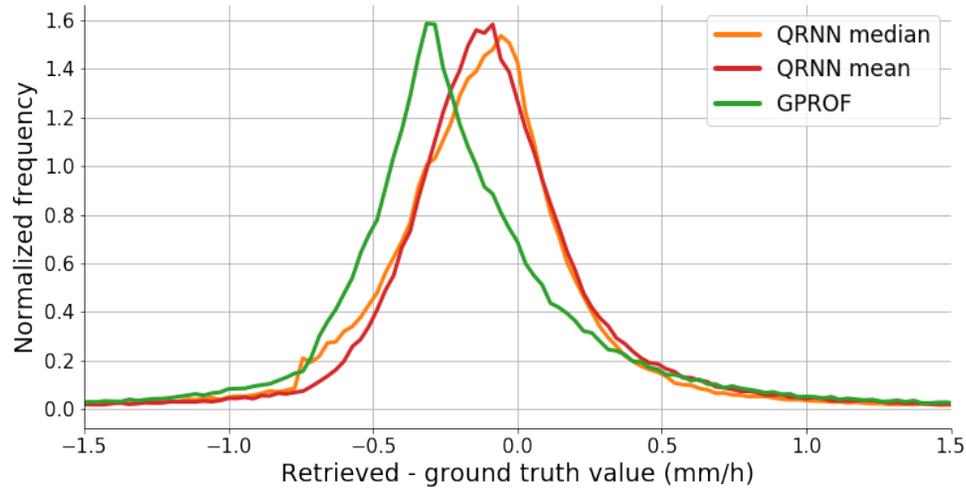
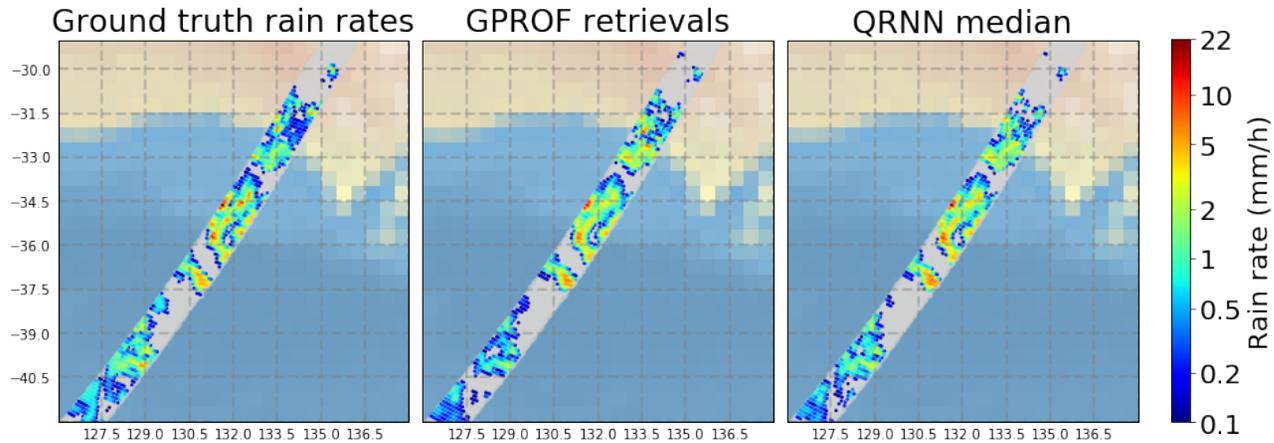
$$\text{ORI} = \text{TPW} * \text{Wind}_{850\text{mb}} \cdot \nabla \text{Hgt}$$

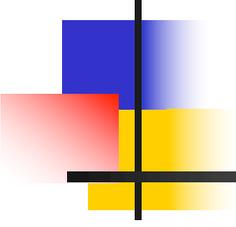


# Metric Learning from A. Ebtehaj



# QRNN from Eriksson/Norrestad/Freundshuh





# Summary

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*Working towards codifying database creation using standard, agency supported products.*

*Currently examining Tb outliers. Can eliminate if random*

*Tackling orographic enhancement with Bayesian scheme*

*Supporting various AI efforts*