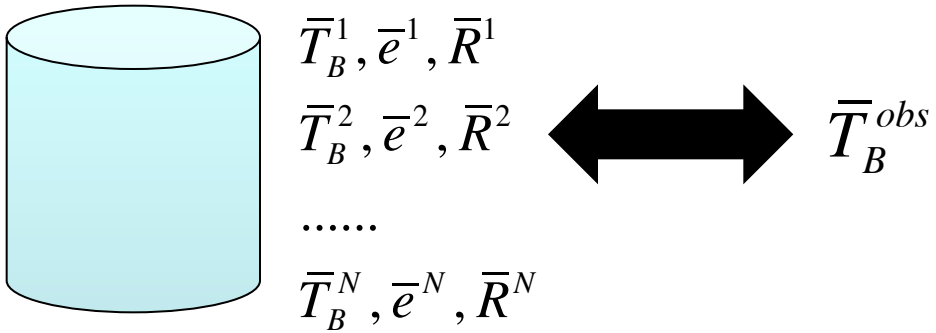
Estimating Non-Raining Surface Parameters for Use With GPM Constellation Radiometer Precipitation Algorithms

Joe Turk

PMM LSWG Telecall, 16 October 2015

Purpose

- Future radiometer-based algorithms are envisioned to be physically based, and apply common physics across all platforms/sensors
- Therefore the emissivity vector needs to be specified for each sensor type, in the forward direction (simulation)
- And some way of "connecting" to the surface and meteorological properties used for populating the a-priori database, when carrying out the inverse (retrieval), that is efficient and applicable everywhere



A-priori database ***Observations***

Need an efficient means to "connect" surface (and meteorological) conditions at the time of the retrieval, to corresponding conditions within the database

Current GPROF does this thru a monthly "classification index" and interpolated ancillary (model) fields

Step 1 (one time)

15-mo GMI+DPR NS/MS/HS (3x3 DPR about each GMI), everywhere w/o regard to surface

→ Add reanalysis fields (surface, pressure levels)

→ "No clouds" as determined by the NS/HS profile → Compute emissivities for 9 S1 channels → "Clear" scene database

→ "Cloudy" scene database with N(Ku) and N(Ka) in the column

Refinement of earlier technique:

Turk, F.J., Haddad, Z.S. & You, Y., 2014, Principal components of multifrequency microwave land surface emissivities. Part I: Estimation under clear and precipitating conditions, *J. Hydrometeorol*.

Step 2 (one time)

Tens of millions of state vectors, globally, under "clear" conditions

$$\begin{bmatrix} e_{10H} \\ e_{10V} \\ \cdots\cdots \\ e_{89H} \\ T_s \\ T_{vap} \end{bmatrix}$$

"Clear" scene database → EOF analysis → Determine relations between nonlinear TB combinations and EOFs of clear state vector elements → Apply relations to both datasets → Discriminant analysis with selected EOFs

"Cloudy" scene database → Allow observations exceeding N(Ku) and N(Ka) thresholds (knowing that they will give "wrong" answers → Apply relations to both datasets

Apply to observations

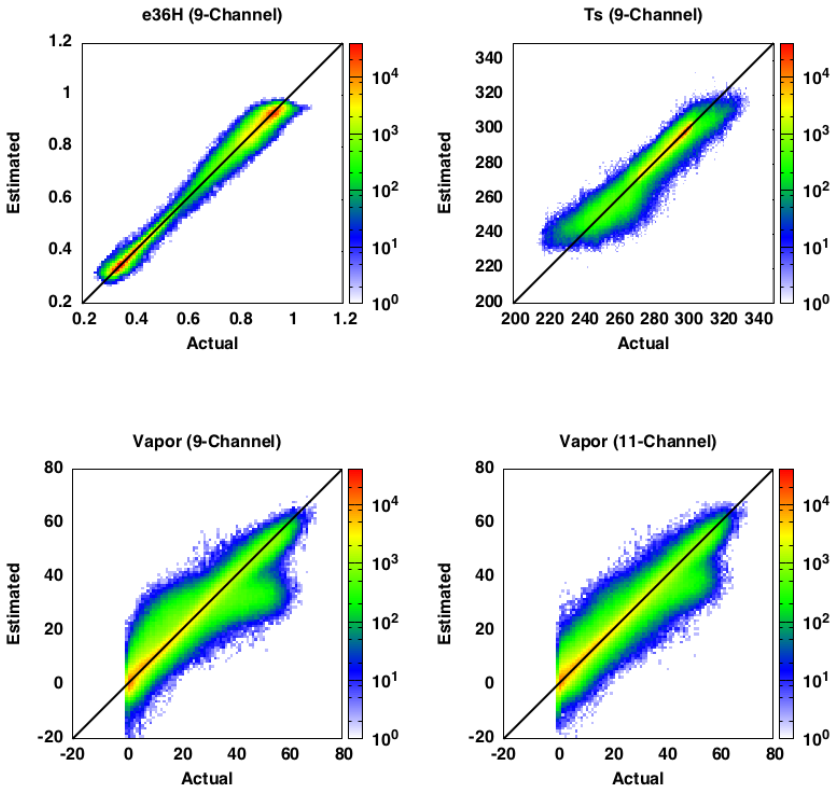
GMI (SSMI, SSMIS, AMSR) TB → discriminant analysis to determine POD("no clouds")

high → Estimate EOFs of state vector → Reconstruct state vector

low → "previous time" search (research…)

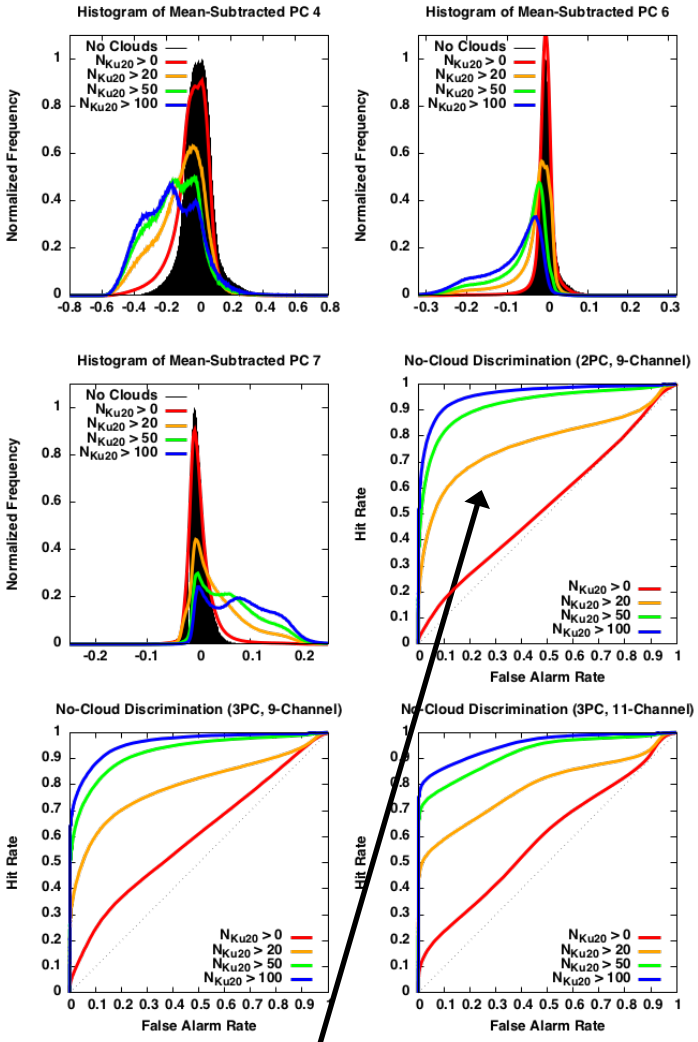
Different set of coefficients for each sensor, esp. SSMI, SSMIS w/o 10 GHz

Reconstructed State Vector

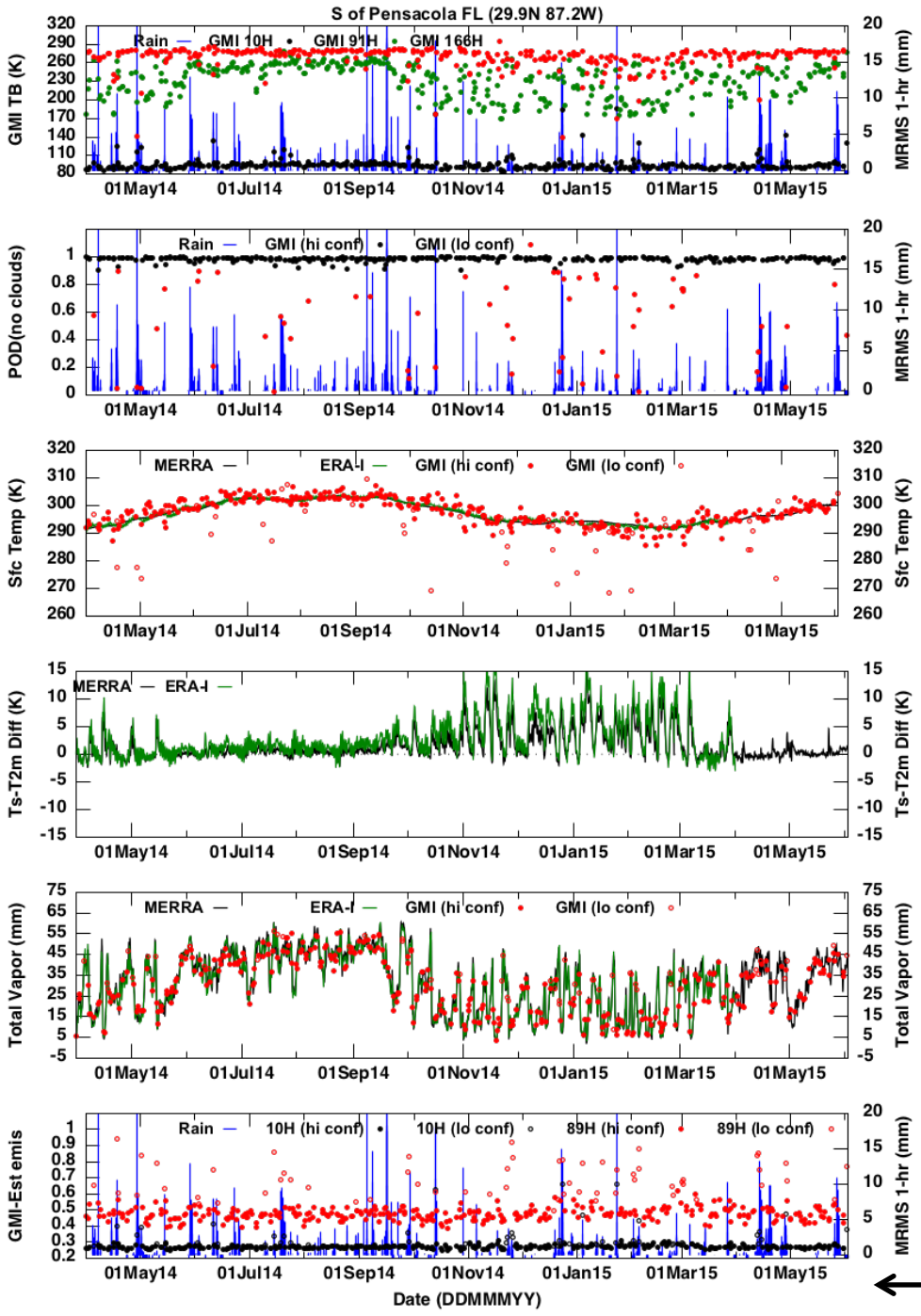


"Clear" scene agreement is improved slightly (esp total vapor) with inclusion of 166 GHz channels

Discrimination Performance Based on N(Ku) > 20 dB



2 EOF-based discriminant, using 9-channels in the regression, is a good compromise, also since S2 channels not always available



Rain/Surface Timeseries: S of Pensacola FL (ocean)

Zoom into 8-week period
1 May 2014 – 1 Jul 2014

TB 166H
89H 10H

red symbols indicate reduced confidence (POD < 0.9)

Ts MERRA ERA-I
Estimated

MRMS 1-hr accumulations (blue impulses)

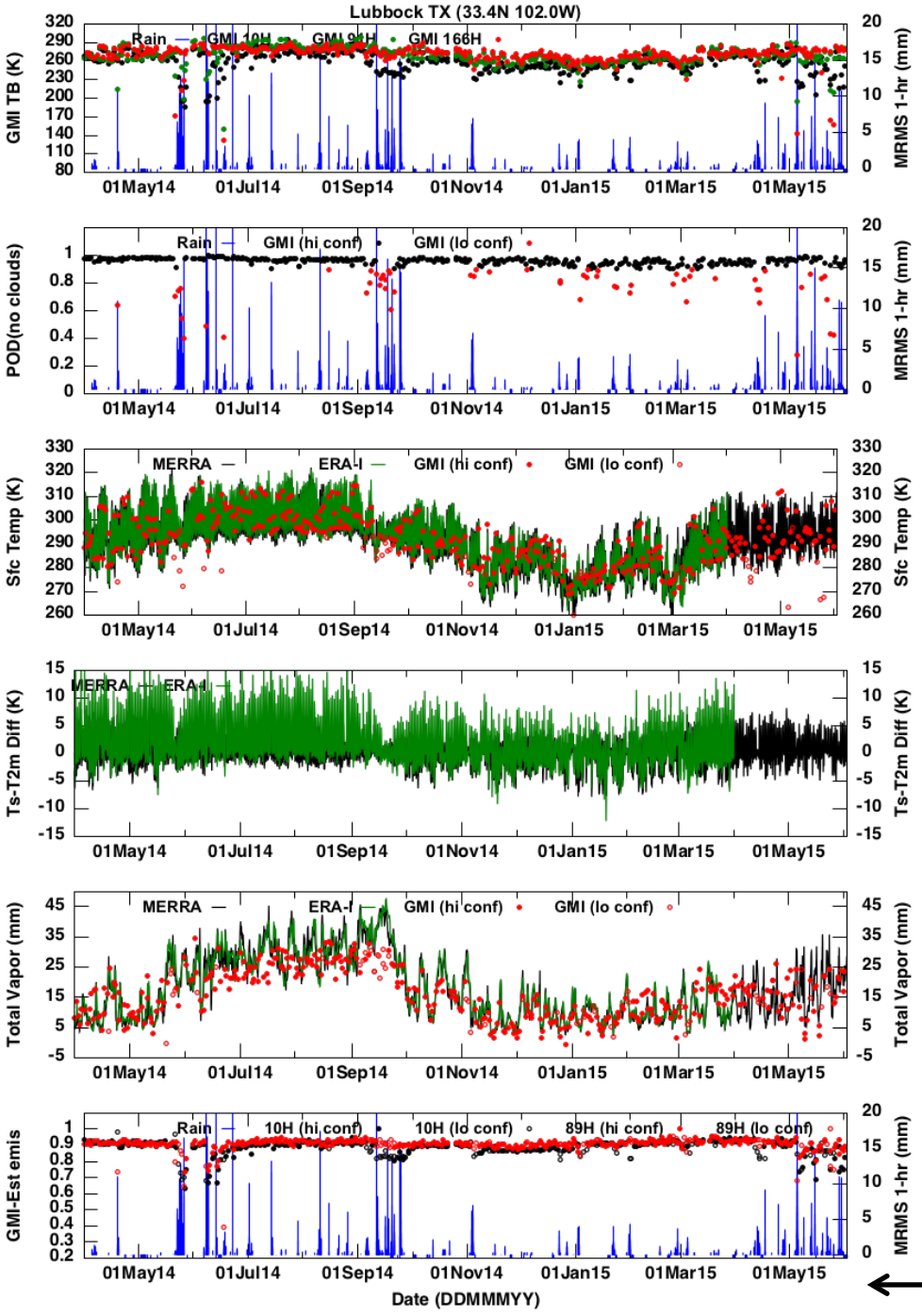
Ts-T2m MERRA
ERA-I

Total Vapor MERRA
ERA-I Estimated

e10H **e89H**
(open circles= reduced confidence)

14 months
1 Apr 2014 – 1 Jun 2015

Rain/Surface Timeseries: West Texas



TB 166H
89H 10H

clay/sandy, well-drained

red symbols indicate reduced confidence (POD < 0.9)

Ts MERRA ERA-I
Estimated

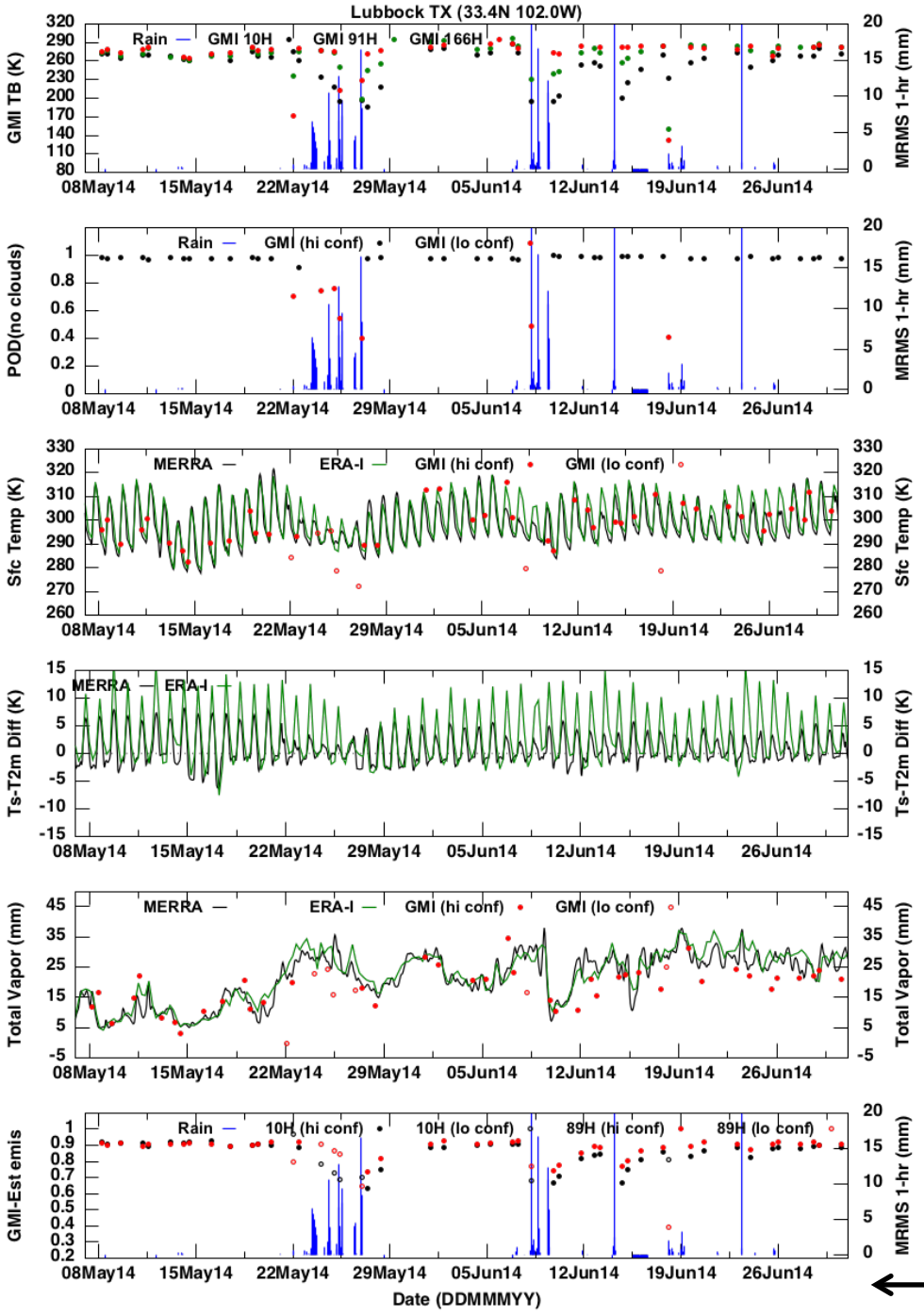
MRMS 1-hr accumulations (blue impulses)

Ts-T2m MERRA
ERA-I

Total Vapor MERRA
ERA-I Estimated

e10H **e89H**
(open circles= reduced confidence)

14 months
1 Apr 2014 – 1 Jun 2015



Rain/Surface Timeseries: West Texas

TB 166H
89H 10H

Zoom into 8-week period
1 May 2014 – 1 Jul 2014

red symbols indicate reduced confidence (POD < 0.9)

Ts MERRA ERA-I
Estimated

MRMS 1-hr accumulations (blue impulses)

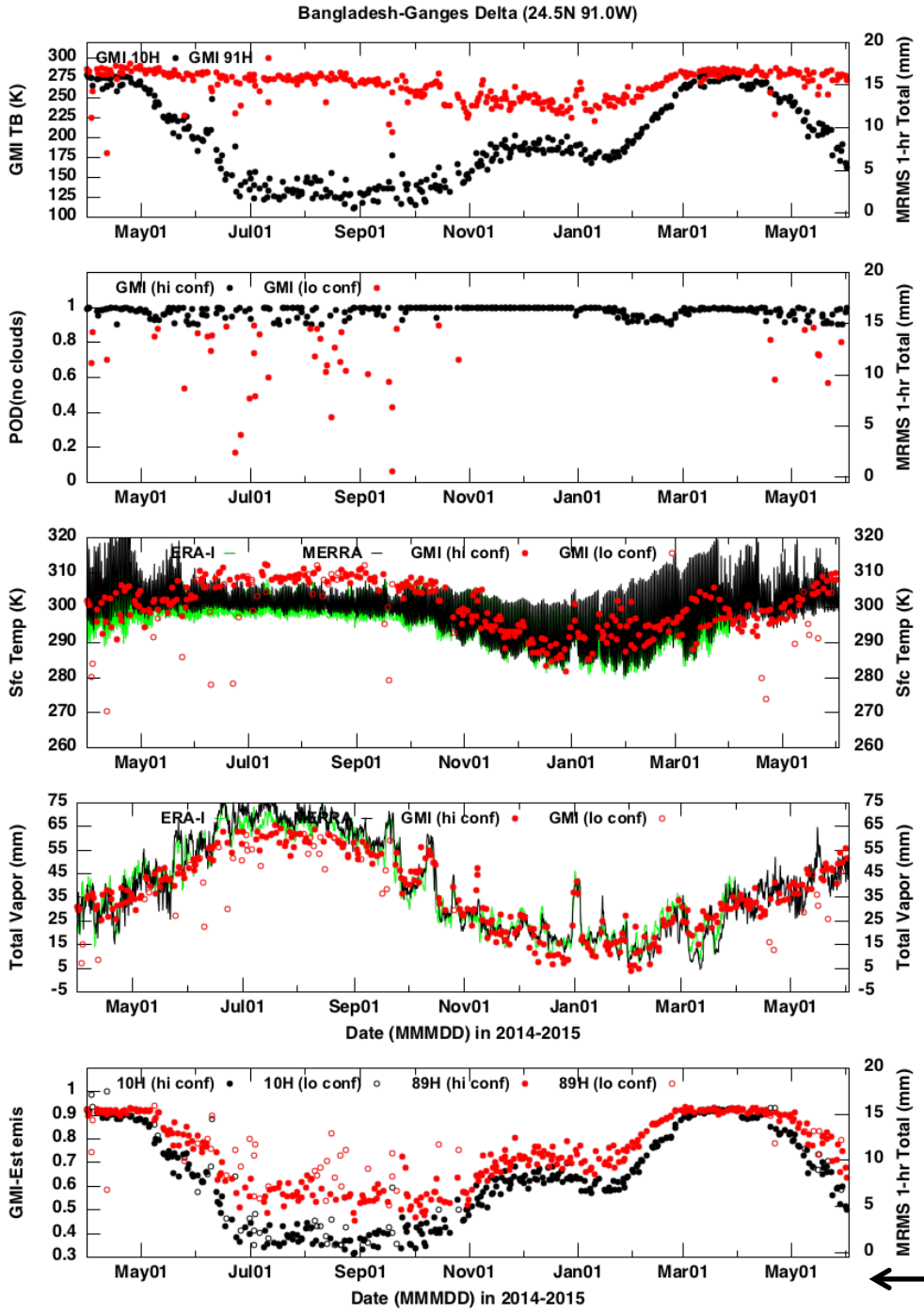
Ts-T2m MERRA
ERA-I

Total Vapor MERRA
ERA-I Estimated

e10H **e89H**
(open circles= reduced confidence)

Zoom into 8-week period
1 May 2014 – 1 Jul 2014

Rain/Surface Timeseries: Bangladesh/Ganges



TB 166H
89H 10H

delta region

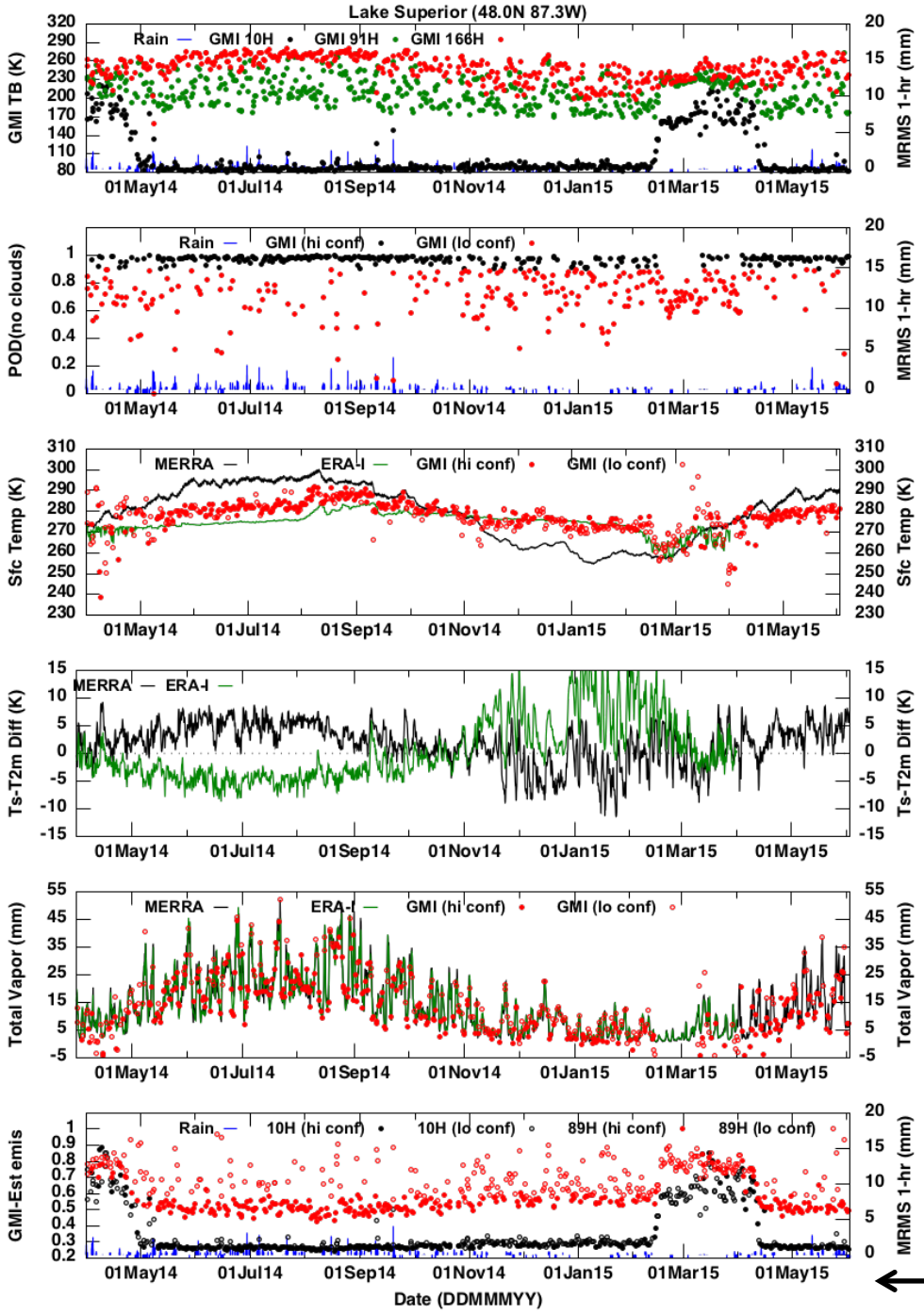
red symbols indicate reduced confidence (POD < 0.9)

Ts MERRA ERA-I Estimated

Total Vapor MERRA ERA-I Estimated

e10H **e89H** (open circles= reduced confidence)

14 months
1 Apr 2014 – 1 Jun 2015



Rain/Surface Timeseries: Middle of Lake Superior

TB 166H
89H 10H

ice formation/break-up

red symbols indicate reduced confidence (POD < 0.9)

Ts MERRA ERA-I Estimated

MRMS 1-hr accumulations (blue impulses)

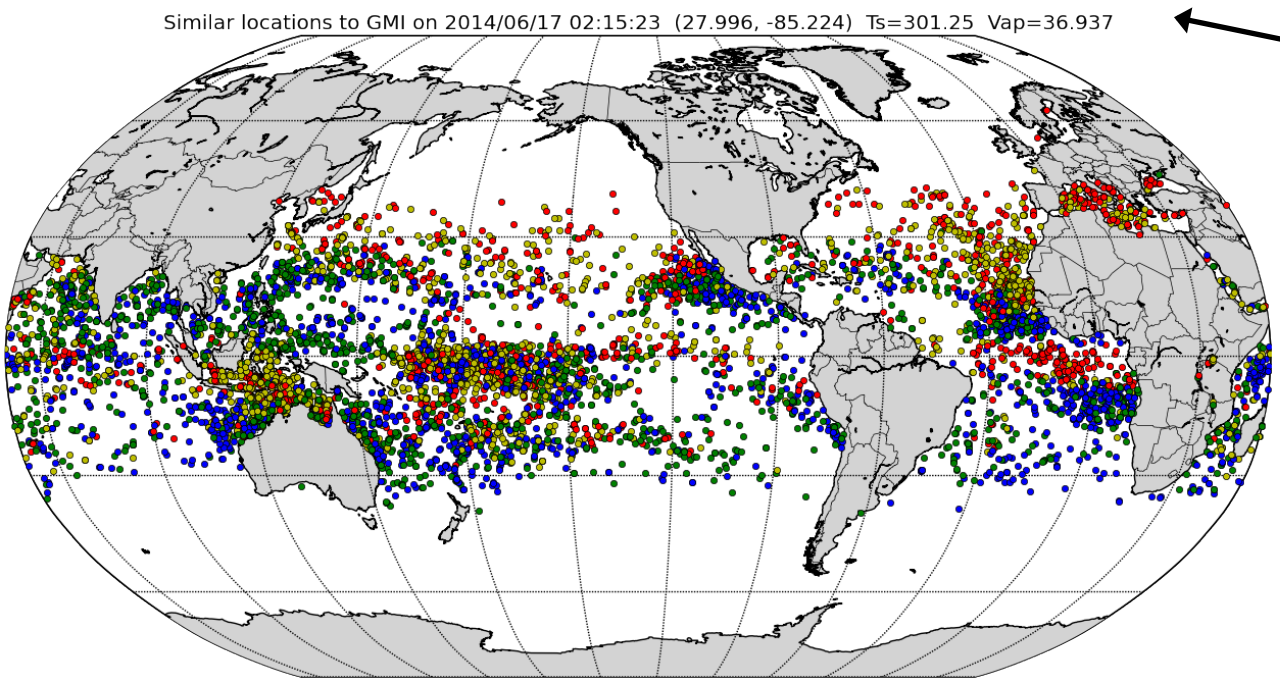
Ts-T2m MERRA ERA-I

Total Vapor MERRA ERA-I Estimated

e10H **e89H** (open circles= reduced confidence)

14 months
1 Apr 2014 – 1 Jun 2015

Applicability to Database Search (didn't search entire database)



Gulf of Mexico

17 June 2014

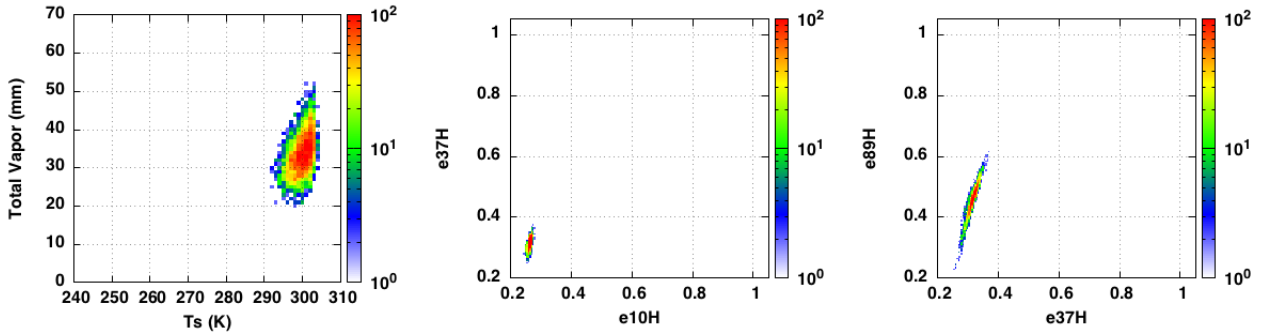
DJF MAM
JJA SON

Search for "nearby" entries in leading EOF-space:

$$r = \sqrt{\frac{1}{N}\sum[(u^{obs} - u_i^{sim})/\sigma_i]^2} \quad N = 3$$

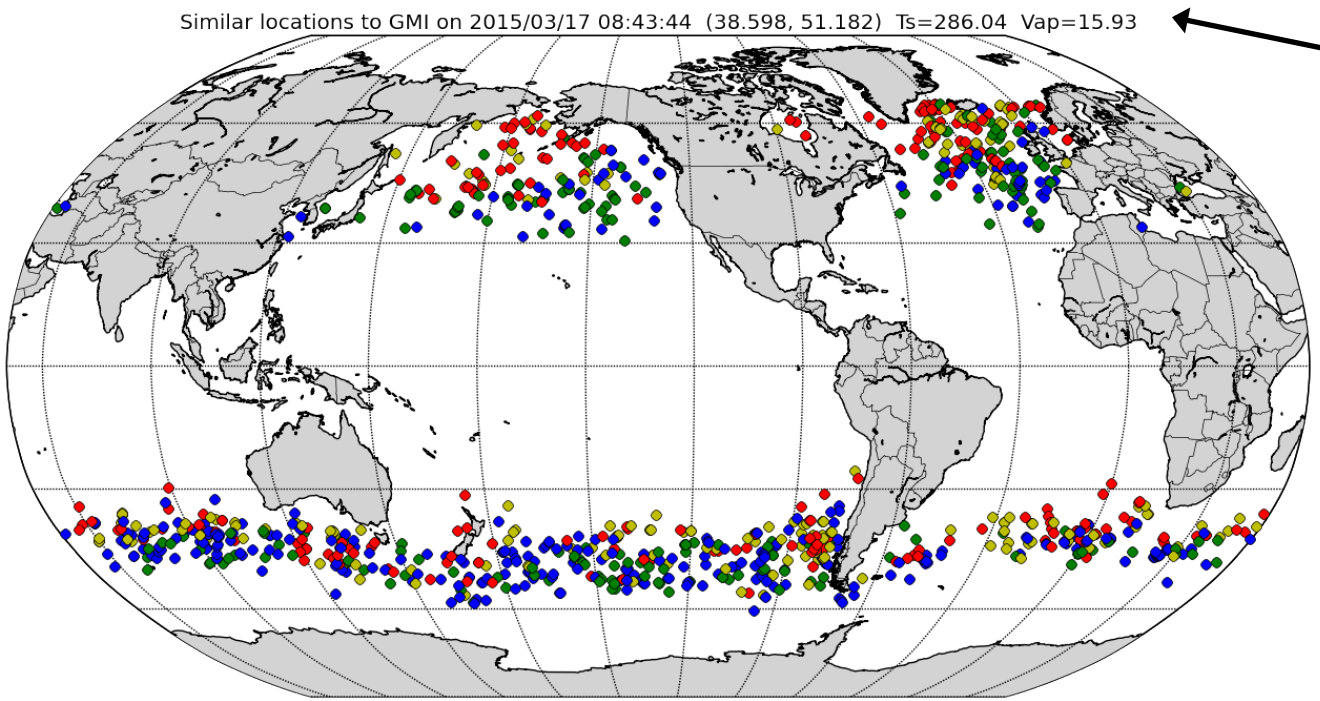
Throughout the process, the only time that latitude/longitude was ever consulted, was to plot the points on the map

Associated variability in surface and WV state variables



suggests possible alternate ways to index databases (transformation of variables)

Applicability to Database Search (didn't search entire database)



Center of the Caspian Sea

17 March 2015

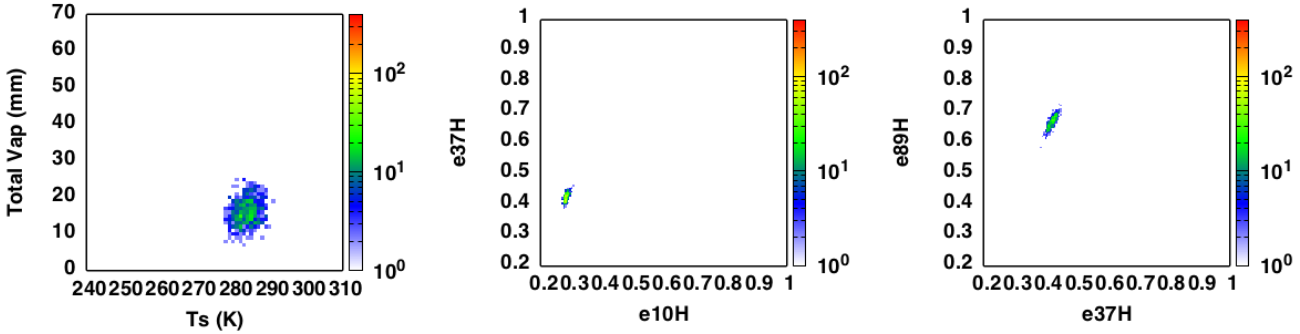
DJF MAM
JJA SON

Search for "nearby" entries in leading EOF-space:

$$r = \sqrt{\frac{1}{N}\sum[(u^{obs} - u_i^{sim})/\sigma_i]^2} \quad N = 3$$

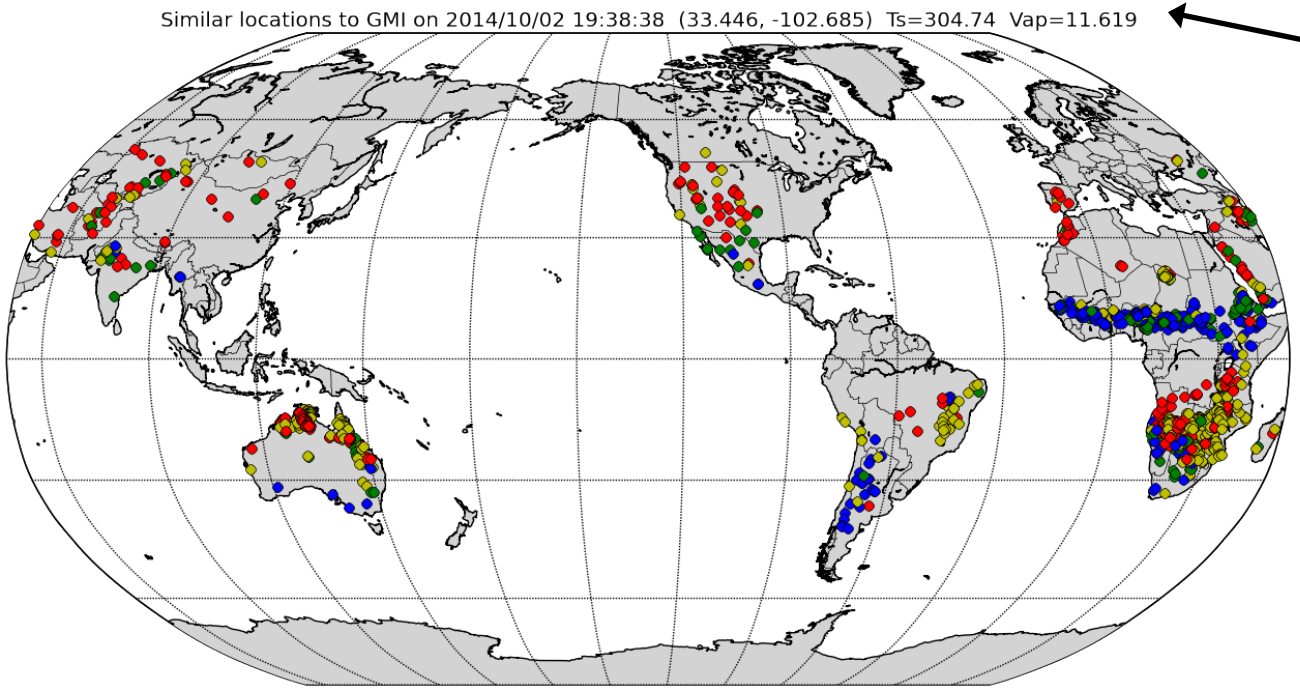
Throughout the process, the only time that latitude/longitude was ever consulted, was to plot the points on the map

Associated variability in surface and WV state variables



suggests possible alternate ways to index databases (transformation of variables)

Applicability to Database Search (didn't search entire database)



West Texas

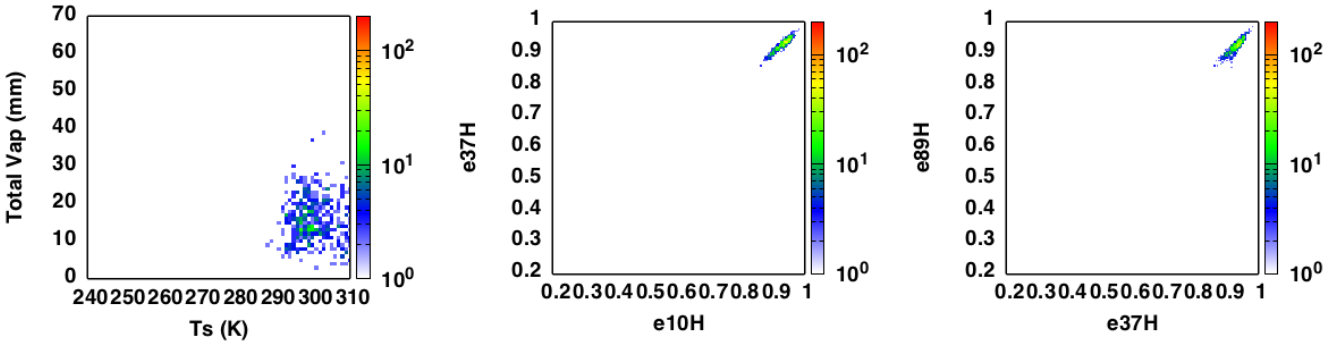
2 October 2014

DJF MAM
JJA SON

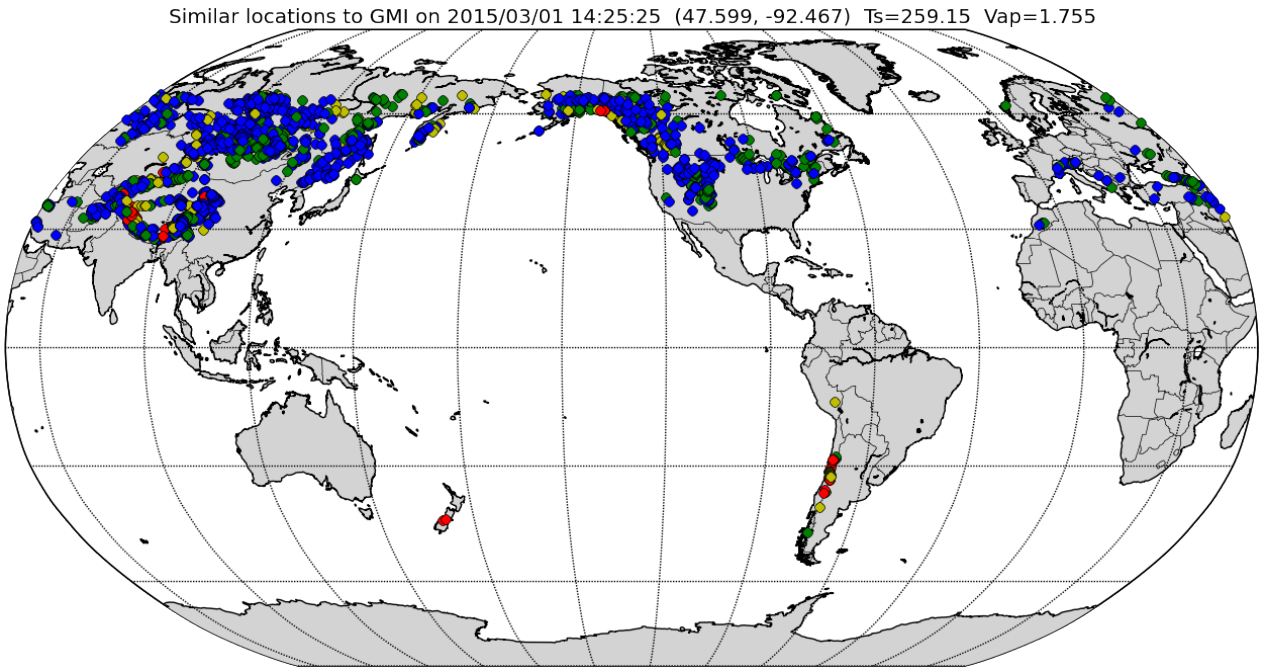
Search for "nearby" entries in leading EOF-space:

$$r = \sqrt{\frac{1}{N}\sum[(u_i^{obs} - u_i^{sim})/\sigma_i]^2} \quad N = 3$$

Associated variability in surface and WV state variables is carried



Applicability to Database Search (didn't search entire database)



NE Minnesota, snow-covered

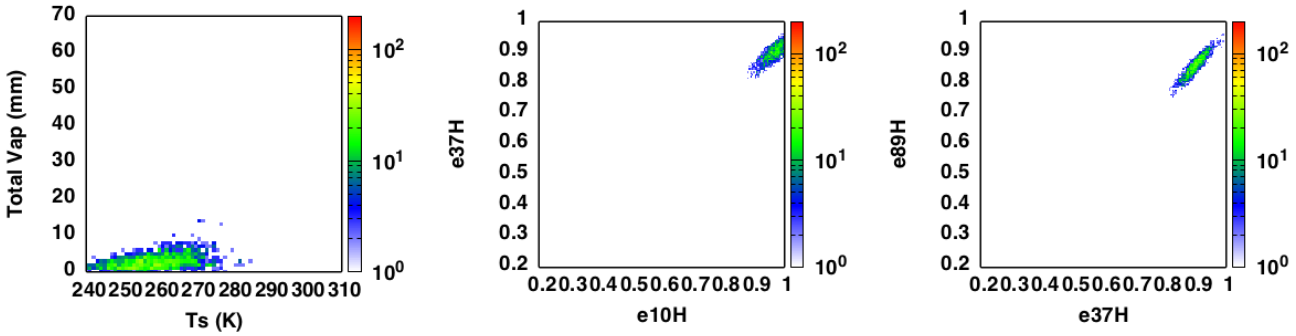
1 March 2015

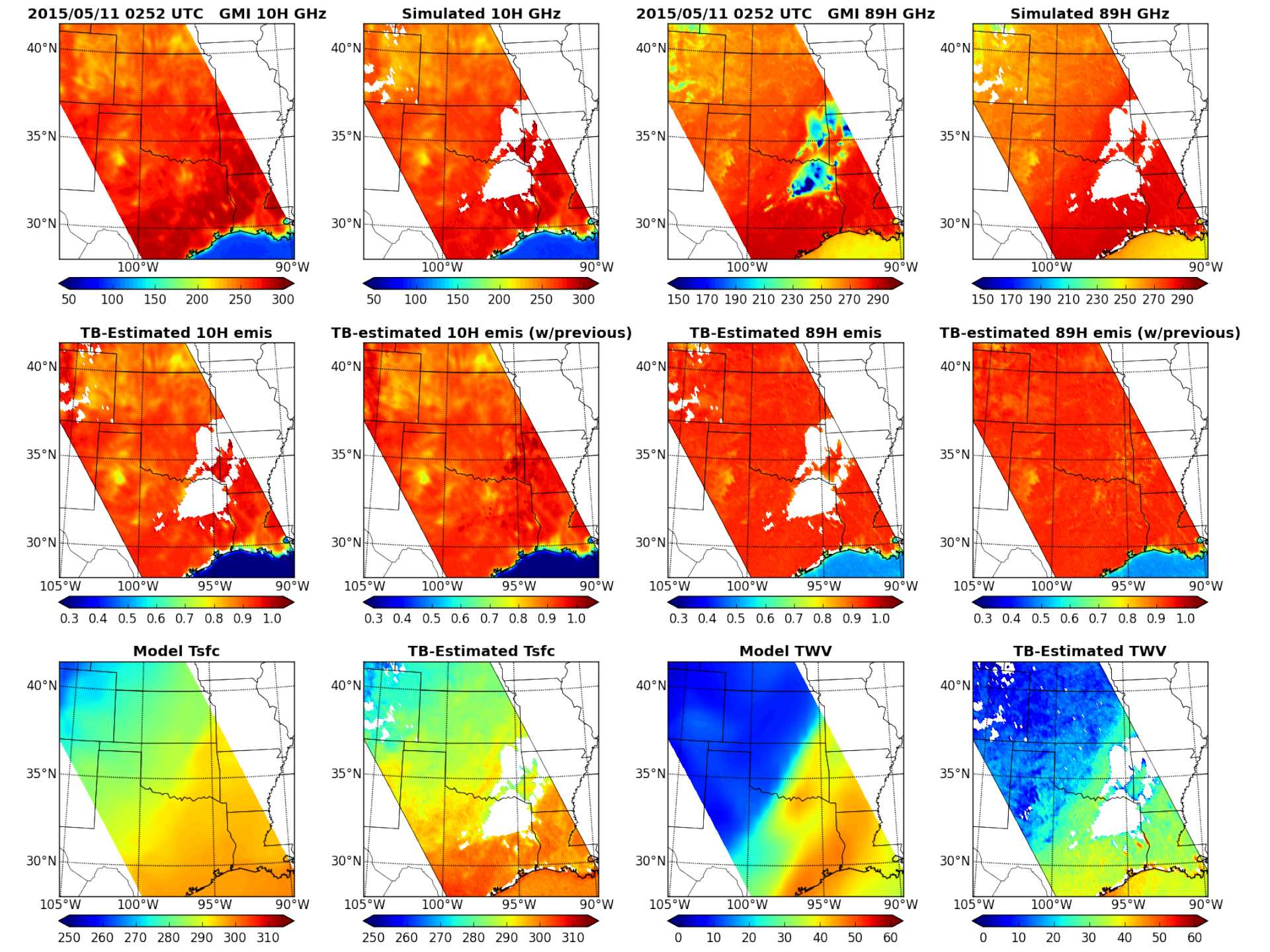
DJF MAM
JJA SON

Search for "nearby" entries in leading EOF-space:

$$r = \sqrt{\frac{1}{N}\sum[(u^{obs} - u_i^{sim})/\sigma_i]^2} \quad N = 3$$

Associated variability in surface and WV state variables




2015/05/11 0252 UTC GMI 10H GHz
Simulated 10H GHz
2015/05/11 0252 UTC GMI 89H GHz
Simulated 89H GHz
TB-Estimated 10H emis
TB-estimated 10H emis (w/previous)
TB-Estimated 89H emis
TB-estimated 89H emis (w/previous)
Model Tsfc
TB-Estimated Tsfc
Model TWV
TB-Estimated TWV
40°N
35°N
30°N
105°W
100°W
95°W
90°W
50 100 150 200 250 300
150 170 190 210 230 250 270 290
0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
250 260 270 280 290 300 310
0 10 20 30 40 50 60