The Combined Radar-Radiometer Algorithm—
GPM Version 05 -> GPM Version 06 / TRMM Version 08

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with support from

the Radar and Radiometer Algorithm Teams, the GV Team,
WG's, and Precipitation Processing System Personnel
(special kudos to Larry Woltz and Patty McCaughey)

The Path to GPM V06 / TRMM V08

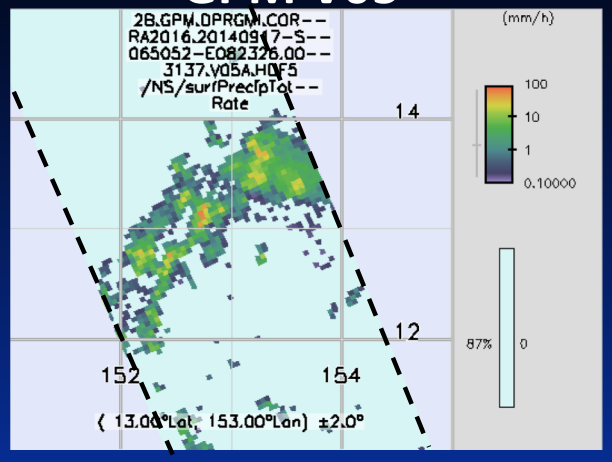
The main goal for V06 was to try to replicate the GPM algorithm for TRMM applications:

- ♦ L2 algorithm core is the same, a software switch changes processing from GPM to TRMM; L3 similarly developed.
- ♦ deconvolution was adjusted for TRMM radiometer channels.
- • switched from SRT PIA to “hybrid” PIA for single radar wavelength applications.

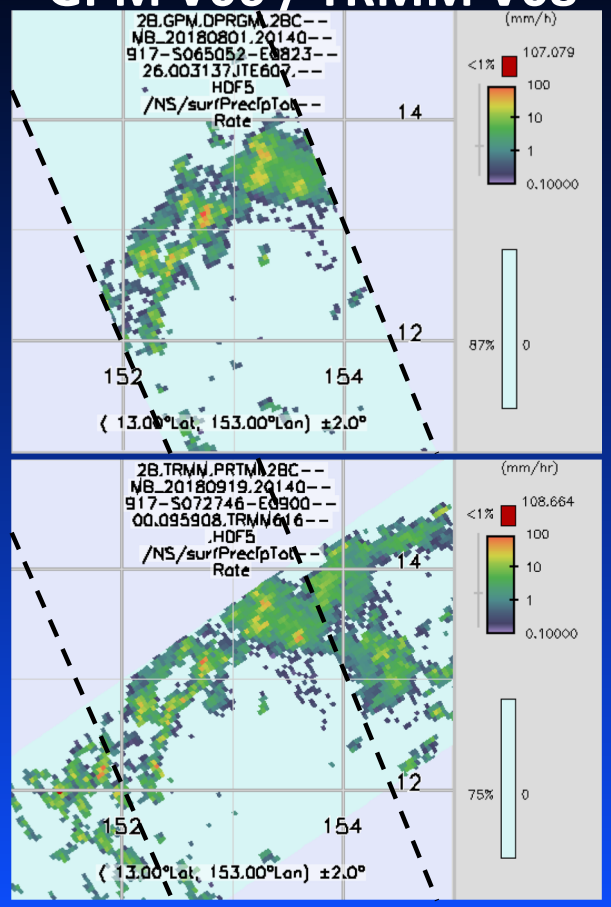
→ Want consistency between GPM and TRMM records, if possible.

V05 and V06/08 Precipitation Rates on 09/17/2014

GPM V05



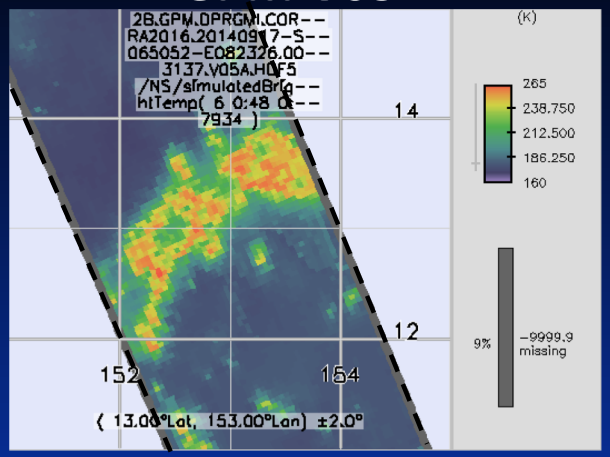
GPM V06 / TRMM V08



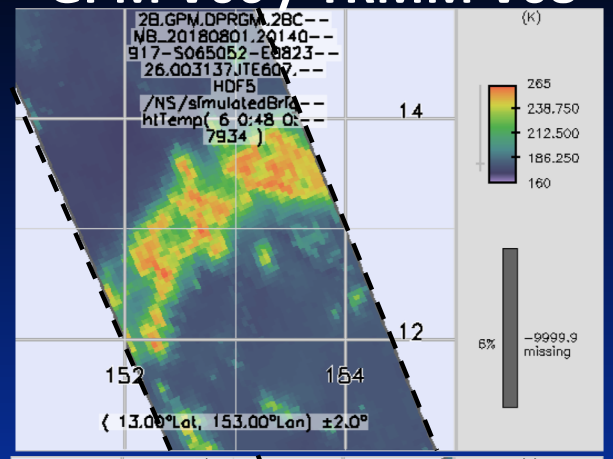
- slight change of GPM V05 to GPM V06.
- TRMM V08 is similar to V06.

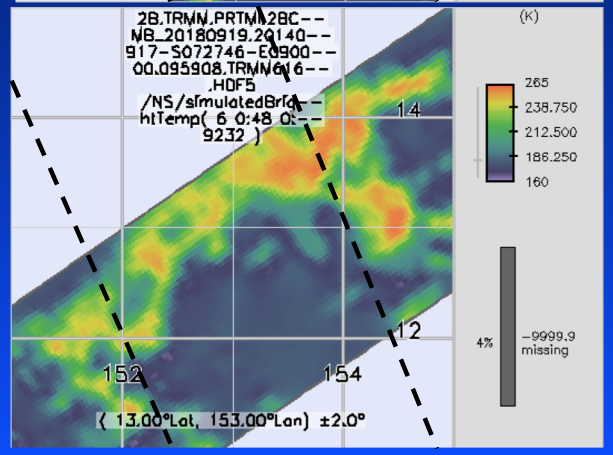
V05 and V06/08 Simulated 37 GHz H Brightness Temperatures

GPM V05



GPM V06 / TRMM V08

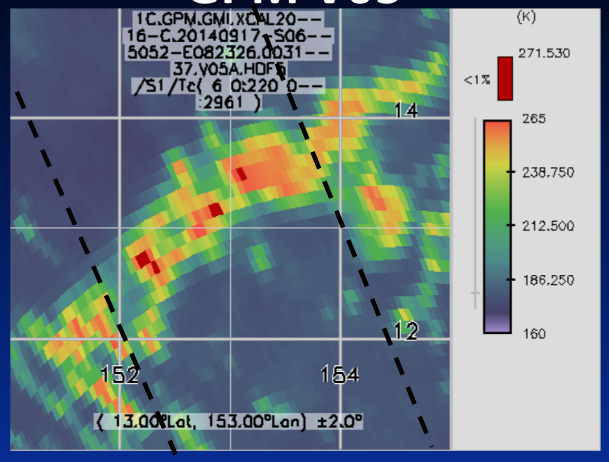




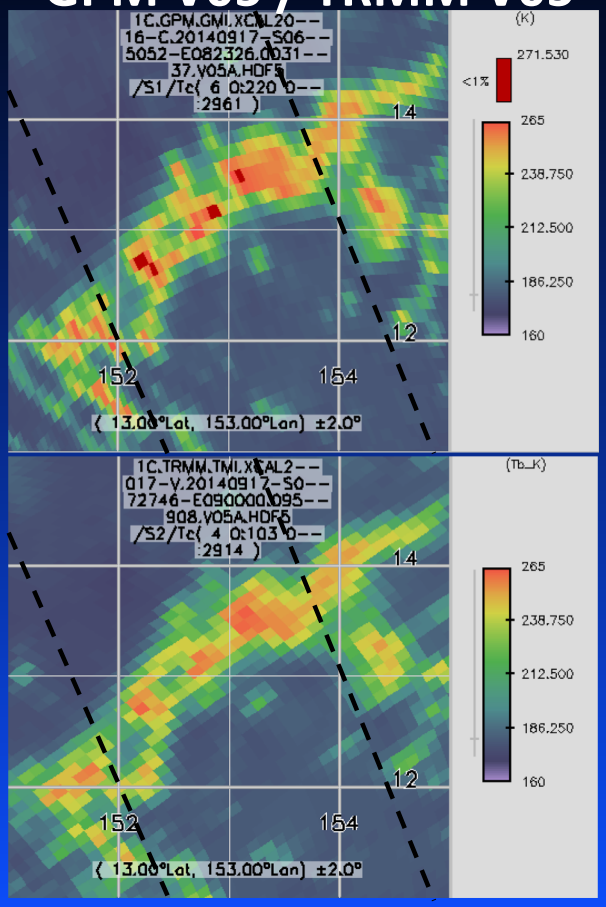
- TRMM has slightly lower resolution than GPM.

Level 1C 37 GHz H Brightness Temperatures

GPM V05



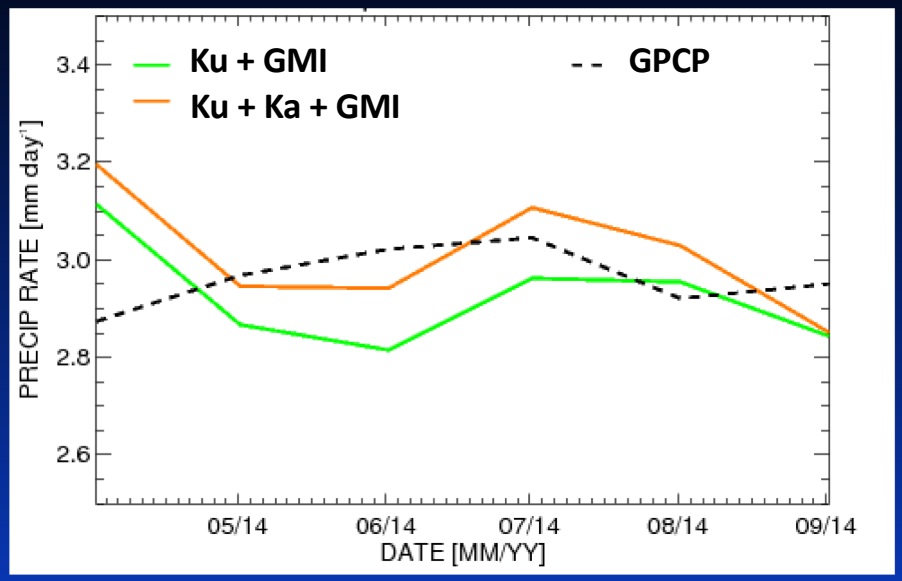
GPM V05 / TRMM V05



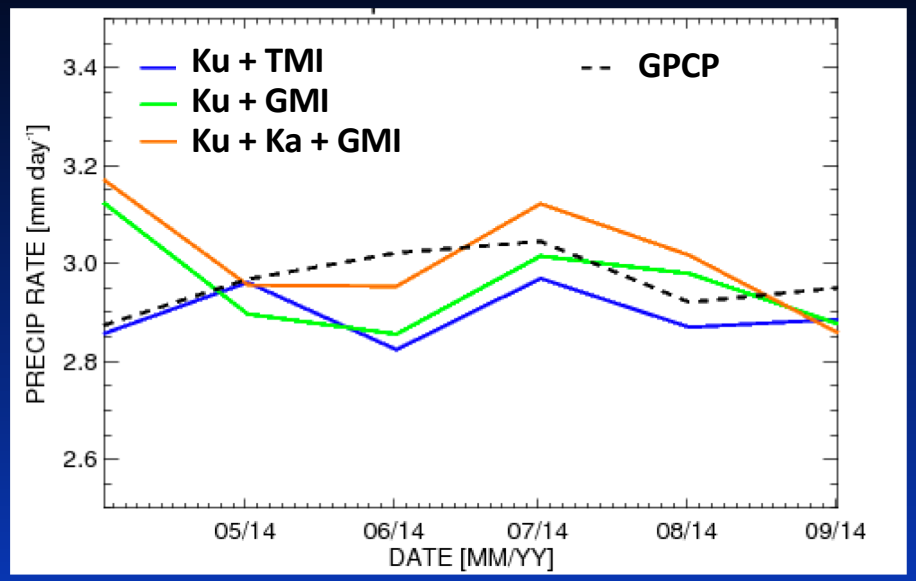
- reasonable fit to TRMM/GPM precipitation.

Precipitation Rate Time Series over TRMM Domain

GPM V05



GPM V06 / TRMM V08

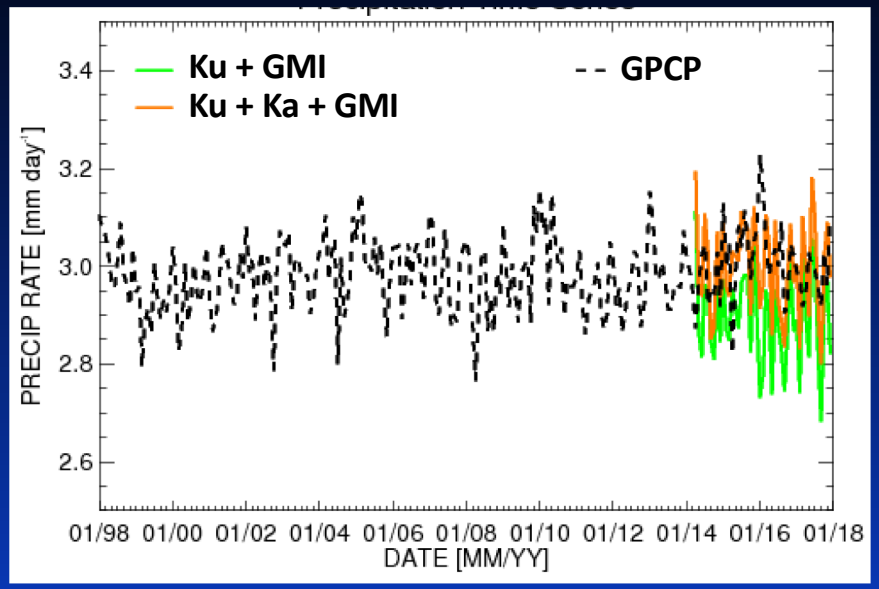


- overall, not much change of GPM V05 to GPM V06 in global trends.
- TRMM V08 is pretty consistent with GPM V06 in general magnitude.

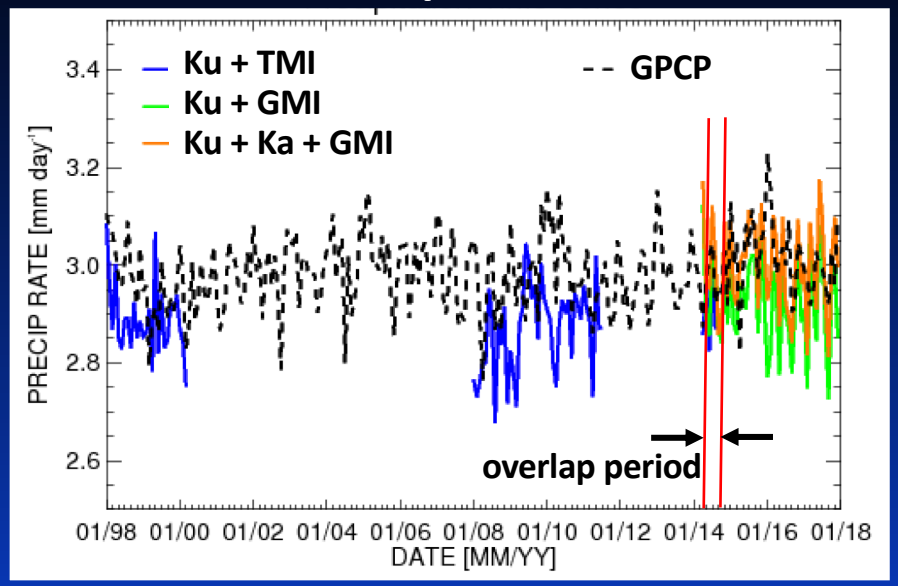
GPCP estimates courtesy Dave Bolvin

Precipitation Rate Time Series over TRMM Domain

GPM V05



GPM V06 / TRMM V08

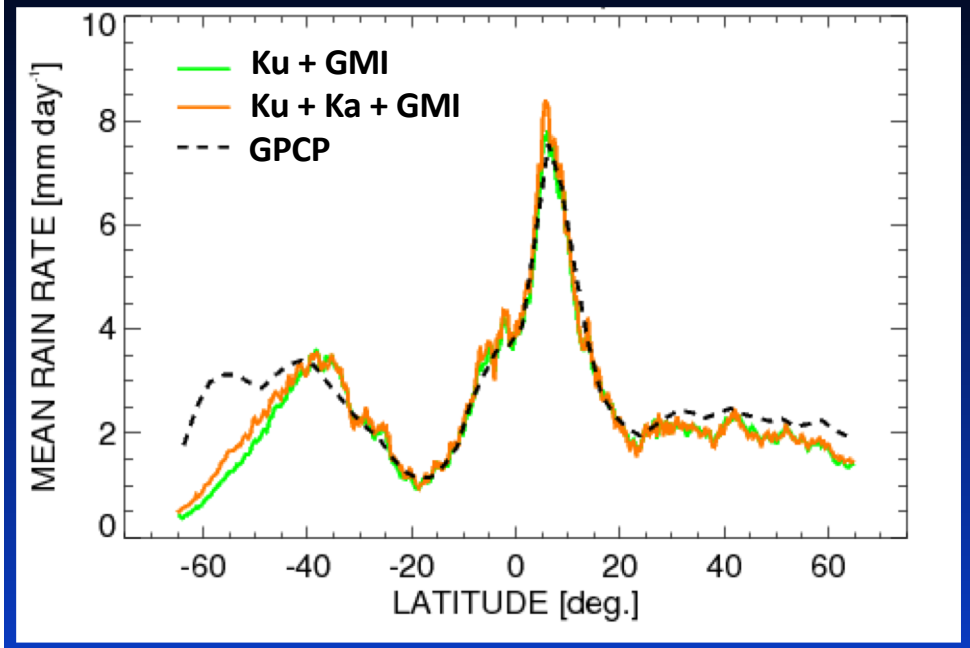


- TRMM is lower than GPCP in general magnitude.
- Sampling quite different.

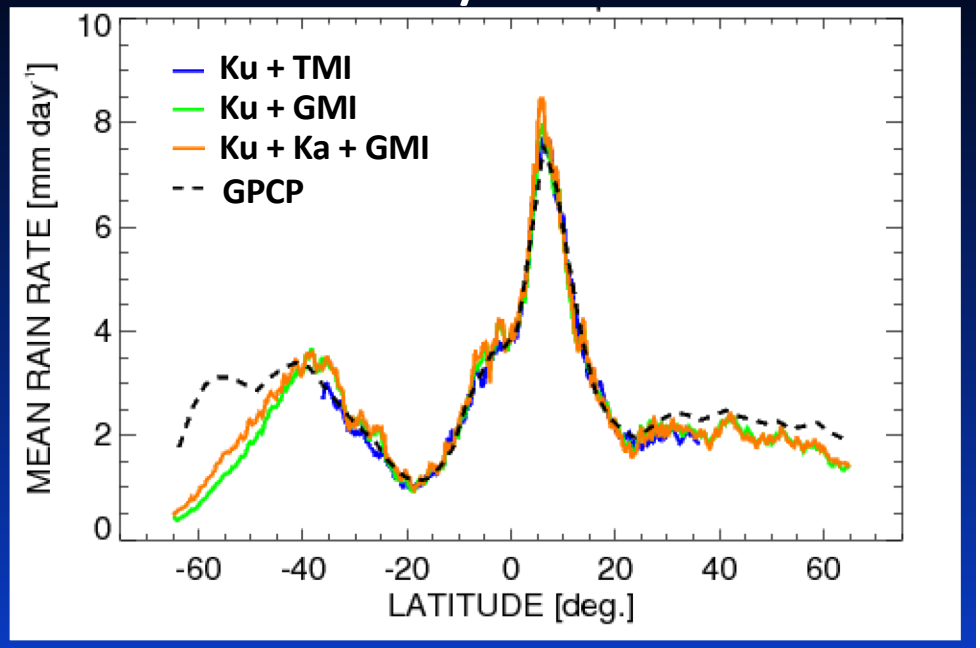
GPCP estimates courtesy Dave Bolvin

April – September, 2014, Zonal Means

GPM V05



GPM V06 / TRMM V08



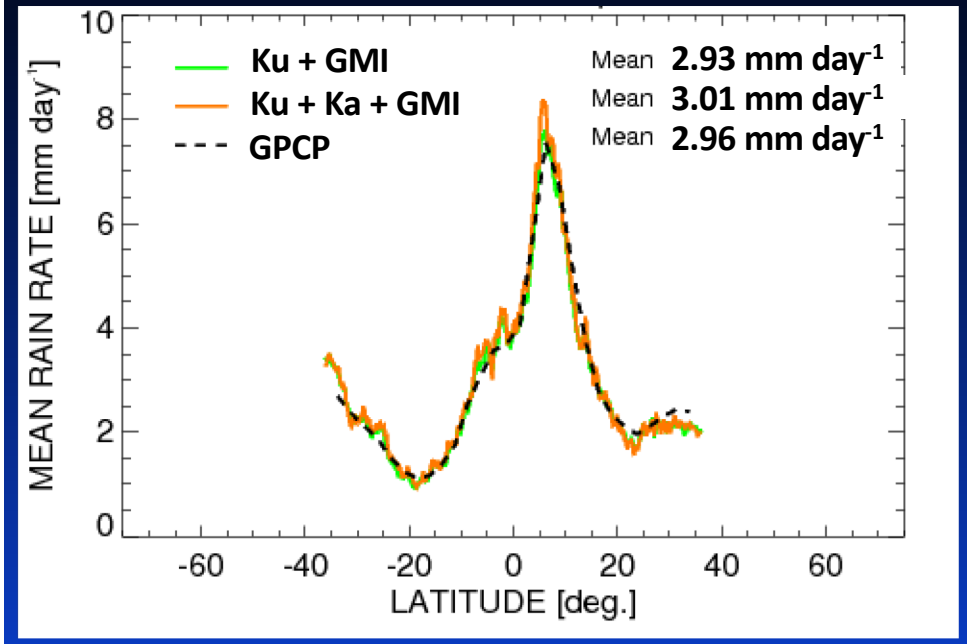
- as in GPM V05, V06 higher-latitude means are somewhat deficient due to low rain signal in the radar observations.

- otherwise, pretty consistent.

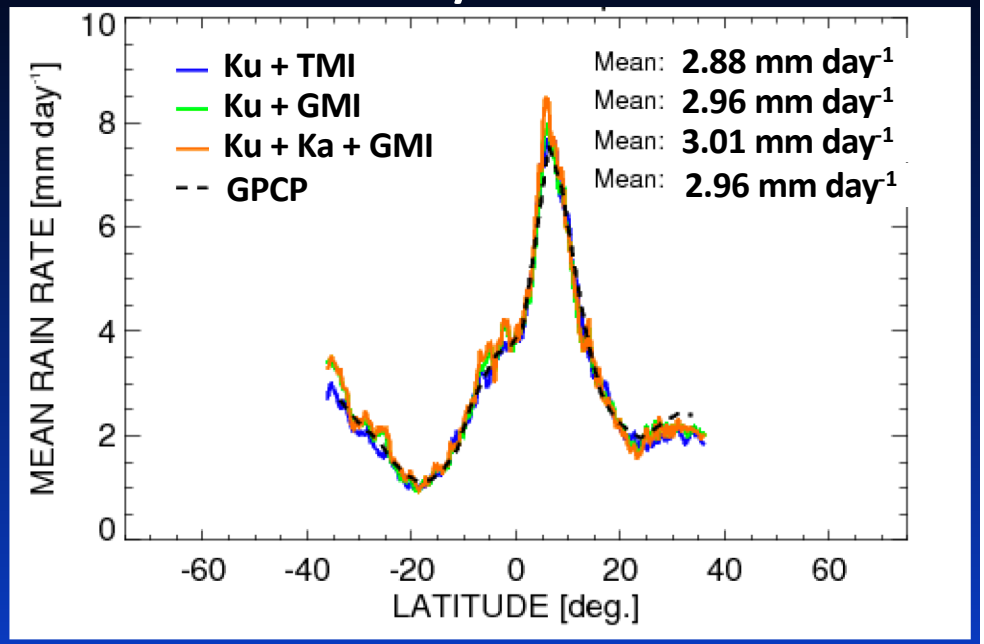
GPCP estimates courtesy Dave Bolvin

April – September, 2014, Zonal Means over TRMM Domain

GPM V05



GPM V06 / TRMM V08



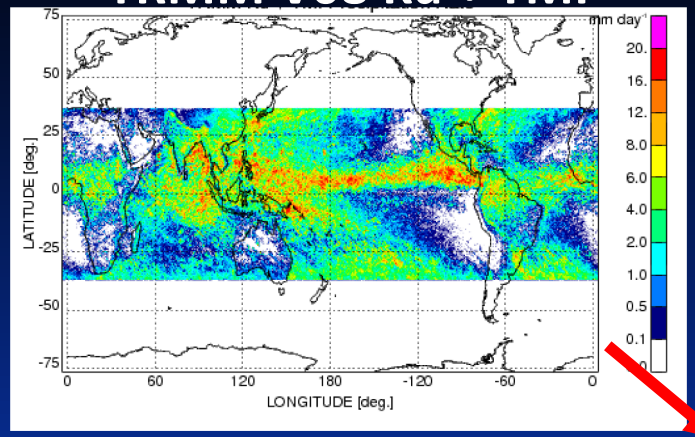
- again, GPM V06 mean values are similar to V05.
- TRMM mean is 3% lower than GPM.

GPCP estimates courtesy Dave Bolvin

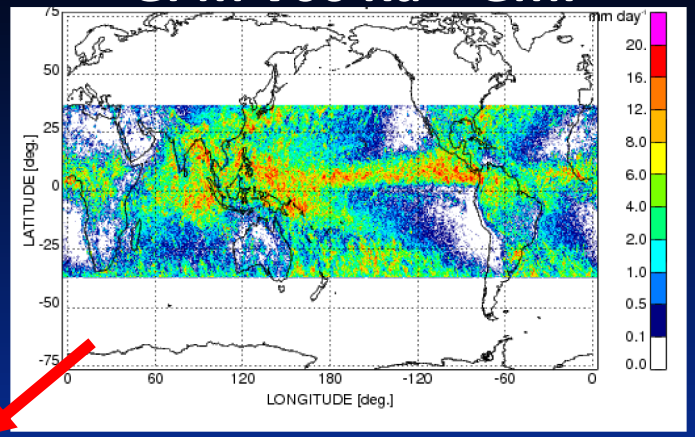
April – September, 2014, Average Plan Views

0.25°

TRMM V08 Ku + TMI

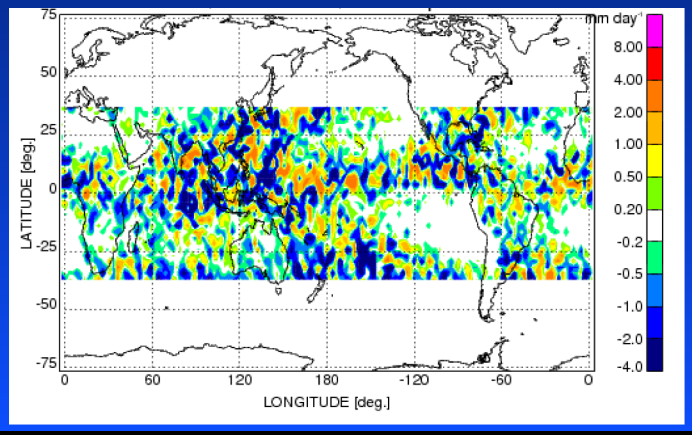


GPM V06 Ku + GMI



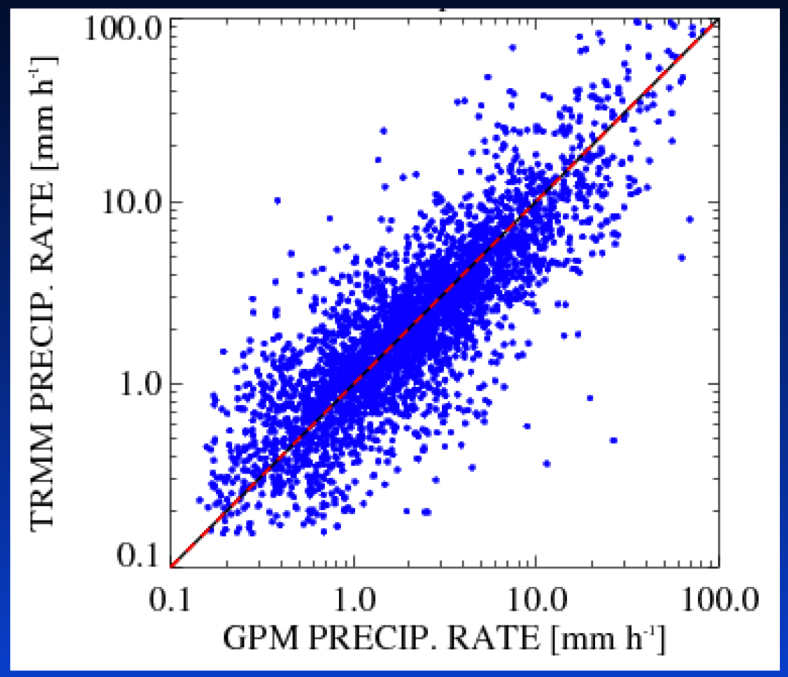
2.5°

TRMM V08 – GPM V06

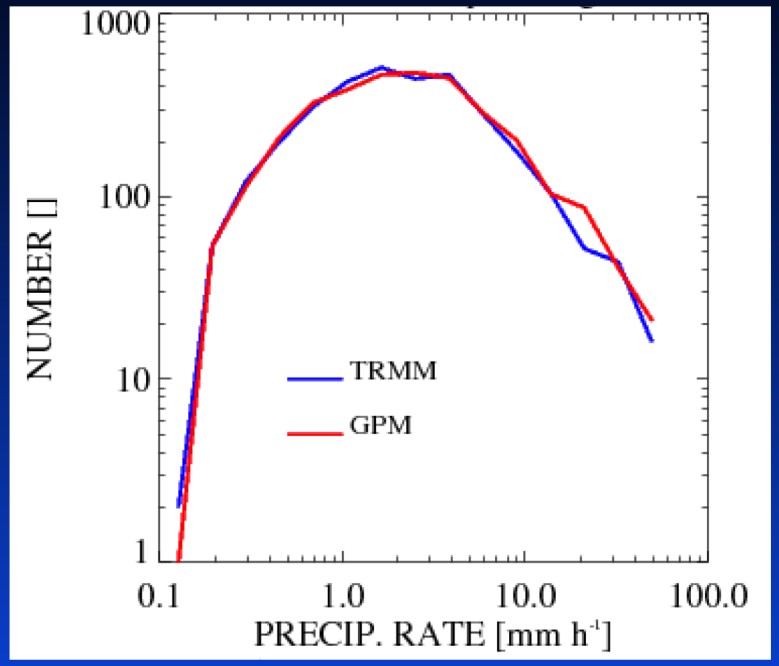


April – September, 2014, ”Matched” Footprints

TRMM V08 vs. GPM V06

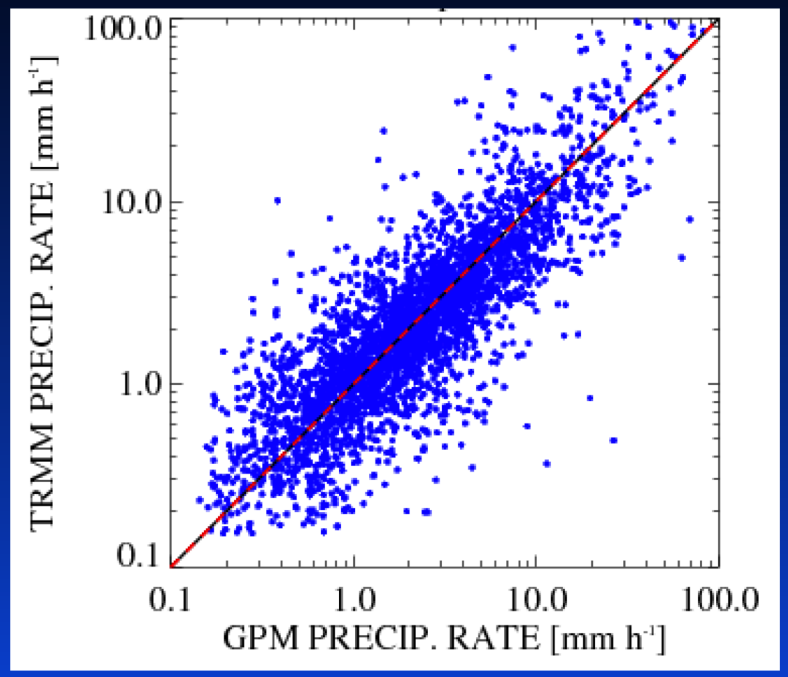


Histograms (where both see rain)

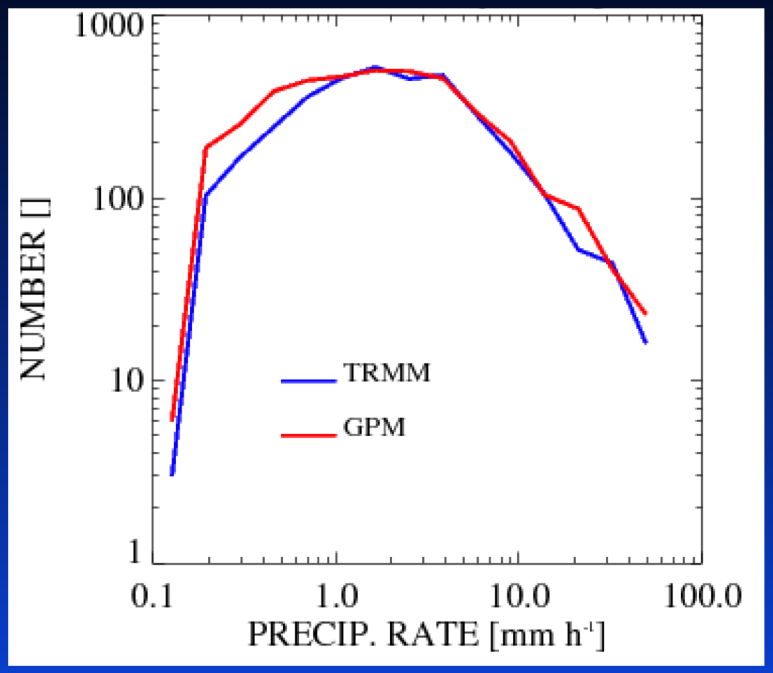


April – September, 2014, ”Matched” Footprints

TRMM V08 vs. GPM V06



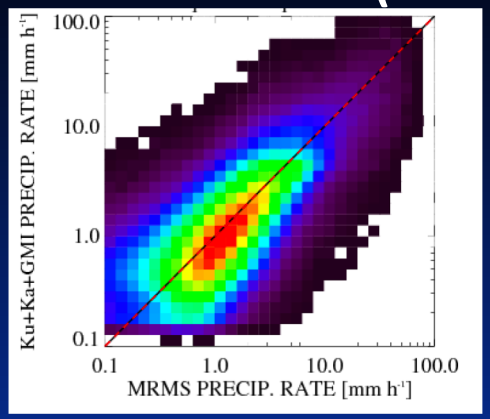
Histograms (where at least 1 sees rain)



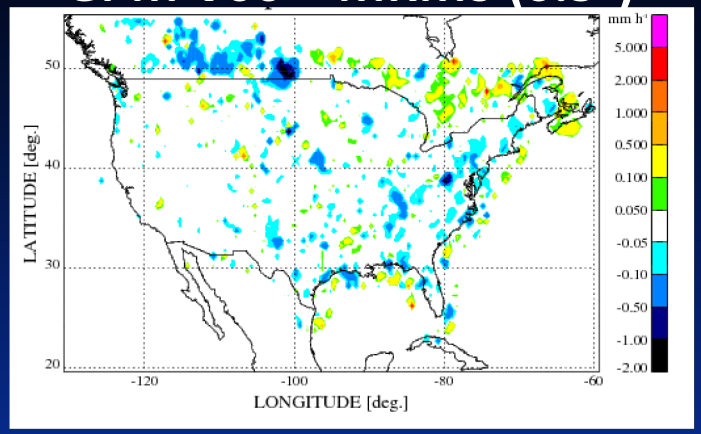
- radar “sensitivity” contributes ~2.6% to difference in unconditional mean R.
- more thorough investigation gives 1.9% difference (Hamada and Takayabu *JAOT* 2016)

September, 2014 - August, 2015, GPM vs MRMS Comparisons

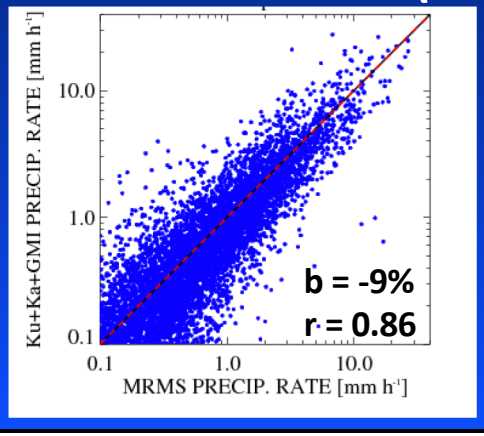
GPM V06 vs. MRMS (Footprint)



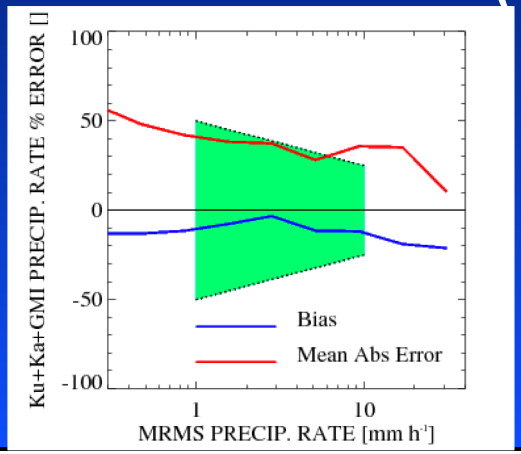
GPM V06 – MRMS (0.5°)



GPM V06 vs. MRMS (0.5°)



GPM V06 Error vs. MRMS (0.5°)



Synopsis, and Looking Ahead

- Succeeded in creating TRMM V08 algorithm that shares the same core as GPM V06.
- TRMM estimates sensitive to deconvolution; more testing needed.

◆ Radiometer-based estimates when radar signal fails to detect precip.

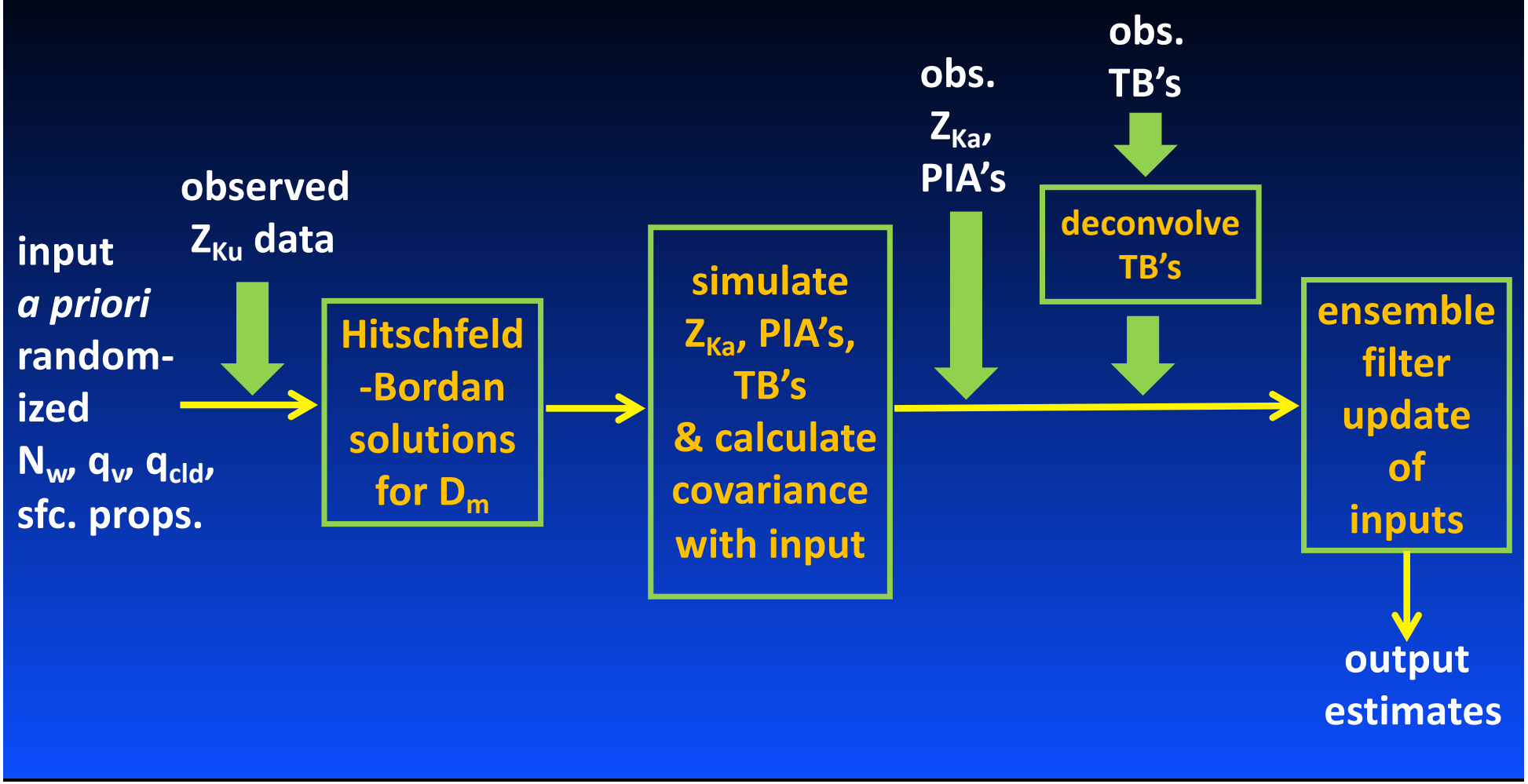
◆ Improved physics of ice/mixed-phase precipitation, multiple scat., etc.

◆ Need to link *a priori* assumptions to meteorological conditions – 2 step process.

◆ Outer swath HS Ka-band application will be implemented.

extras

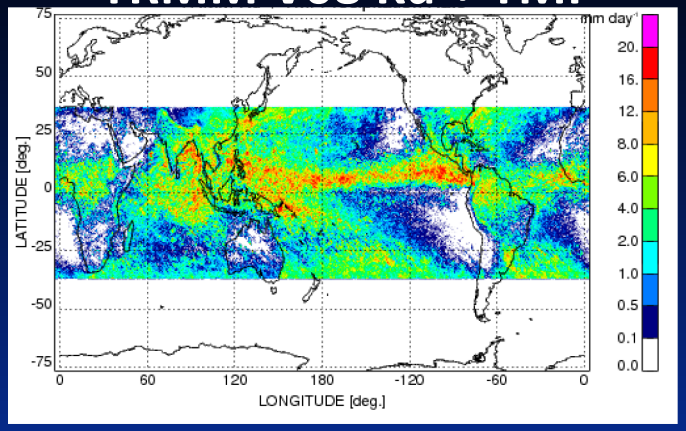
Combined Algorithm Block Diagram --- Ensemble Filter



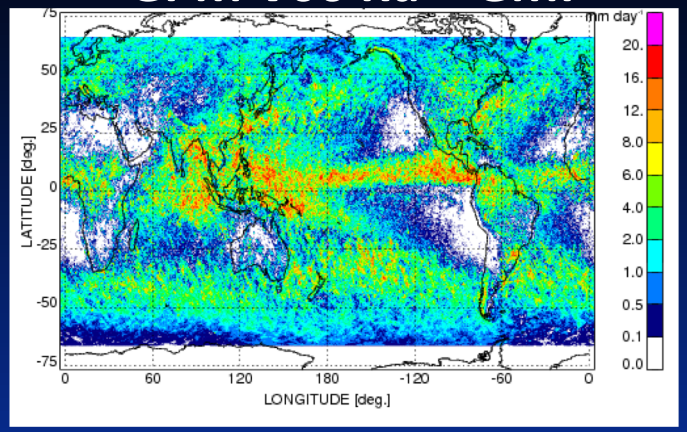
April – September, 2014, Average Plan Views

0.25°

TRMM V08 Ku + TMI

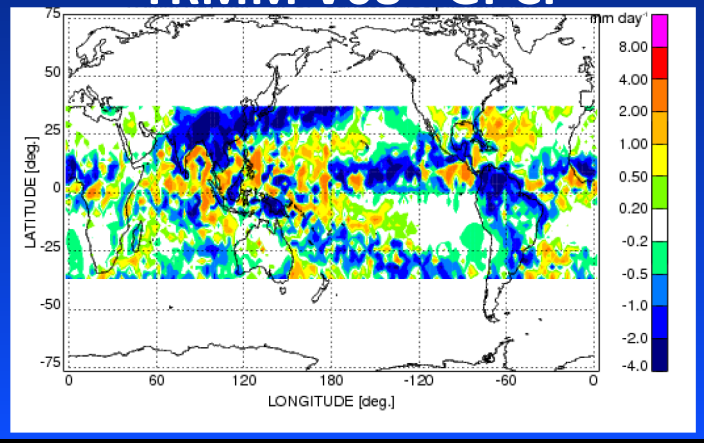


GPM V06 Ku + GMI

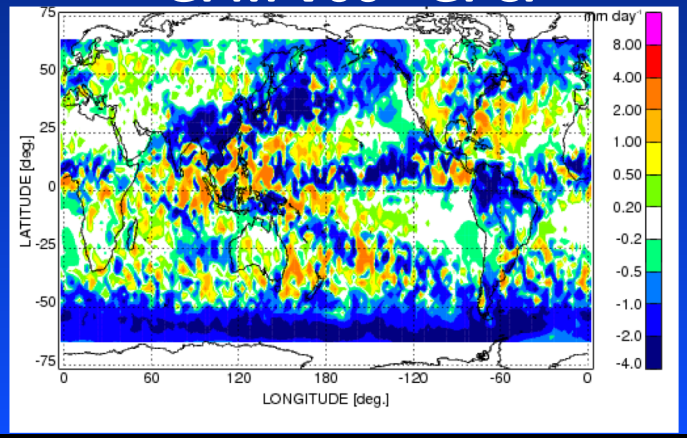


2.5°

TRMM V08 - GPCP

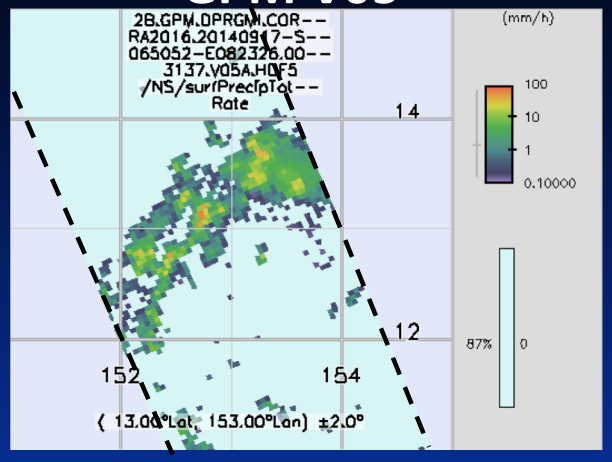


GPM V06 - GPCP

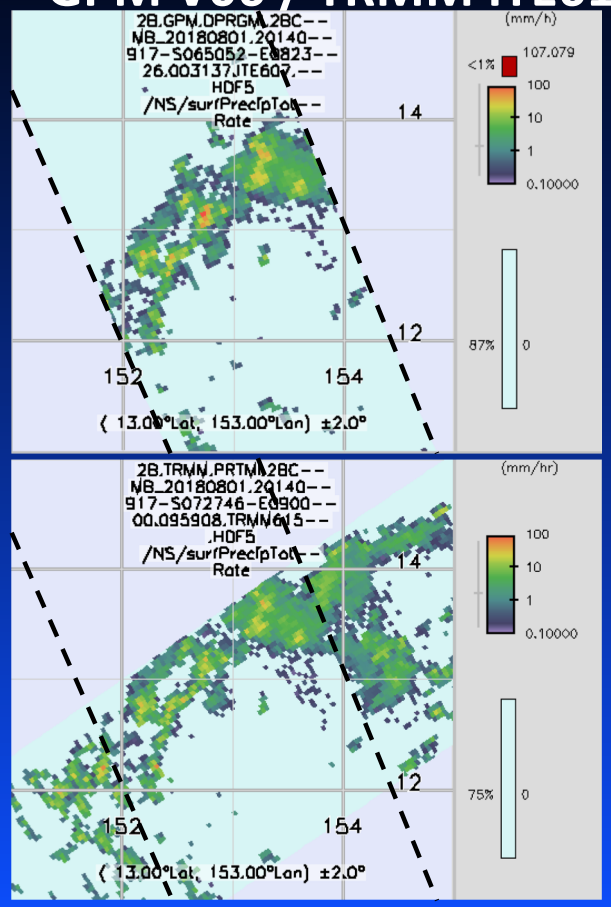


V05 and V06/08 Precipitation Rates on 09/17/2014

GPM V05



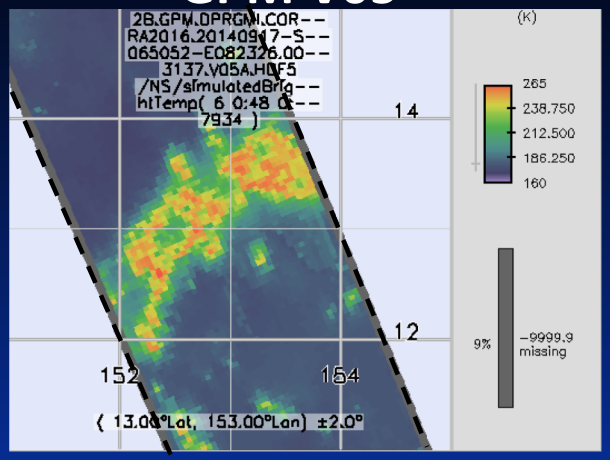
GPM V06 / TRMM ITE615



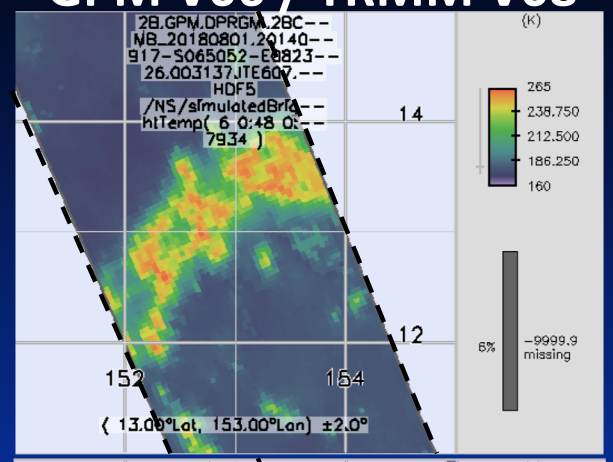
- slight change of GPM V05 to GPM V06.
- TRMM V08 is similar.

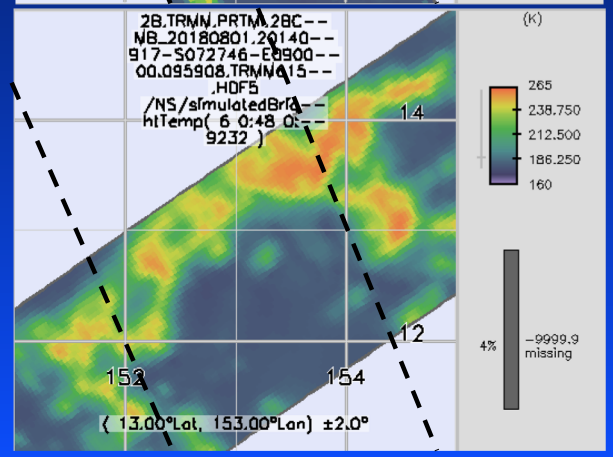
V05 and V06/08 Simulated 37 GHz H Brightness Temperatures

GPM V05



GPM V06 / TRMM V08

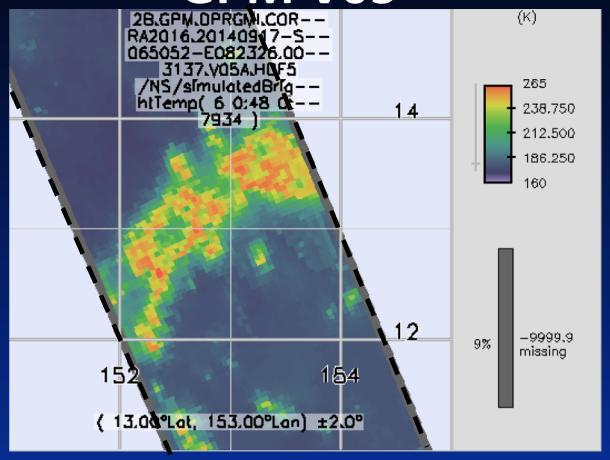




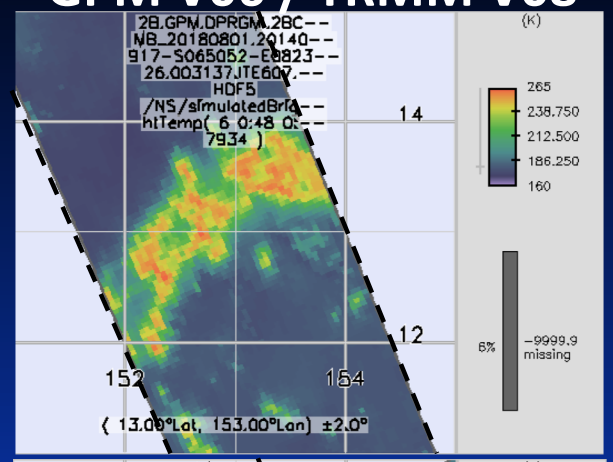
- TRMM has slightly lower resolution than GPM.

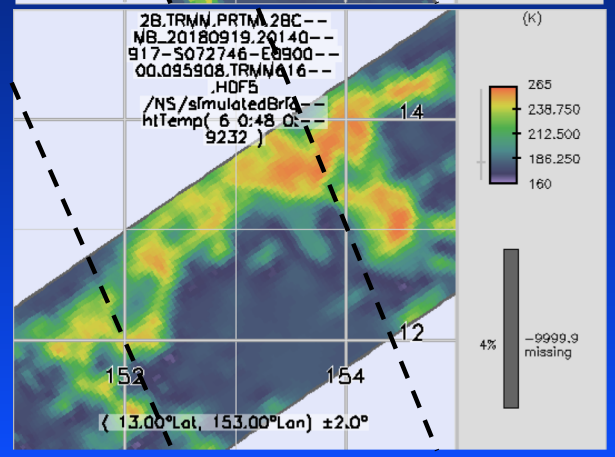
V05 and V06/08 Simulated 37 GHz H Brightness Temperatures

GPM V05



GPM V06 / TRMM V08





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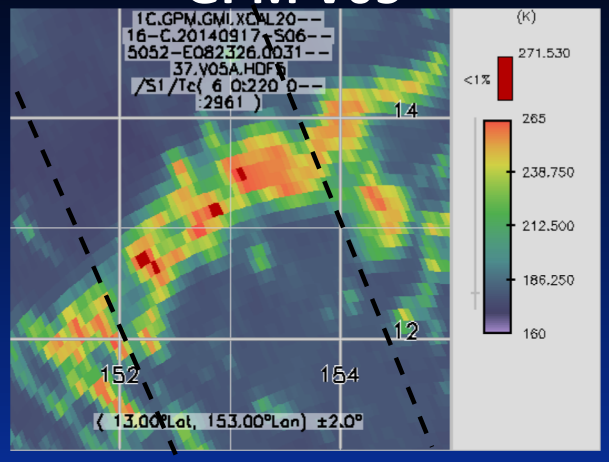
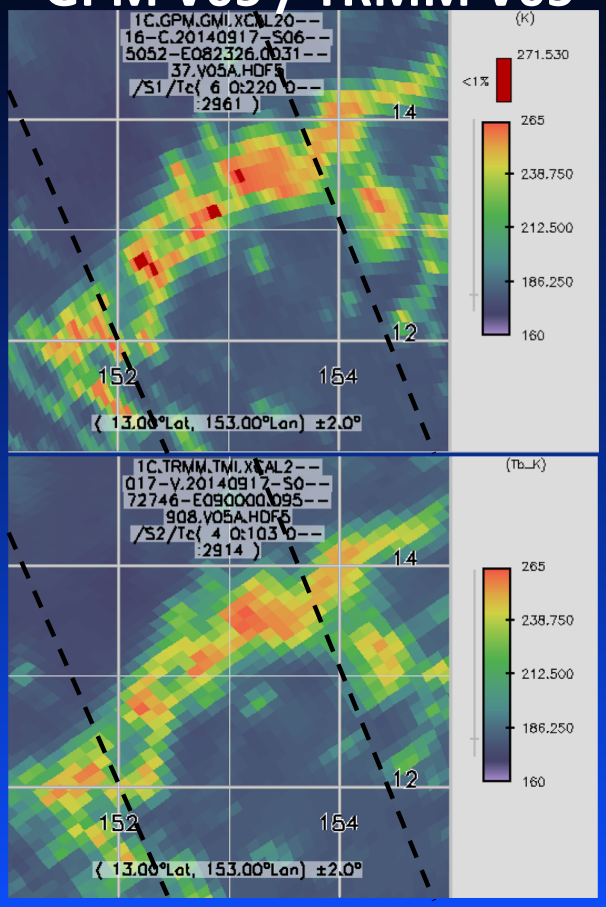
Level 1C 37 GHz H Brightness Temperatures

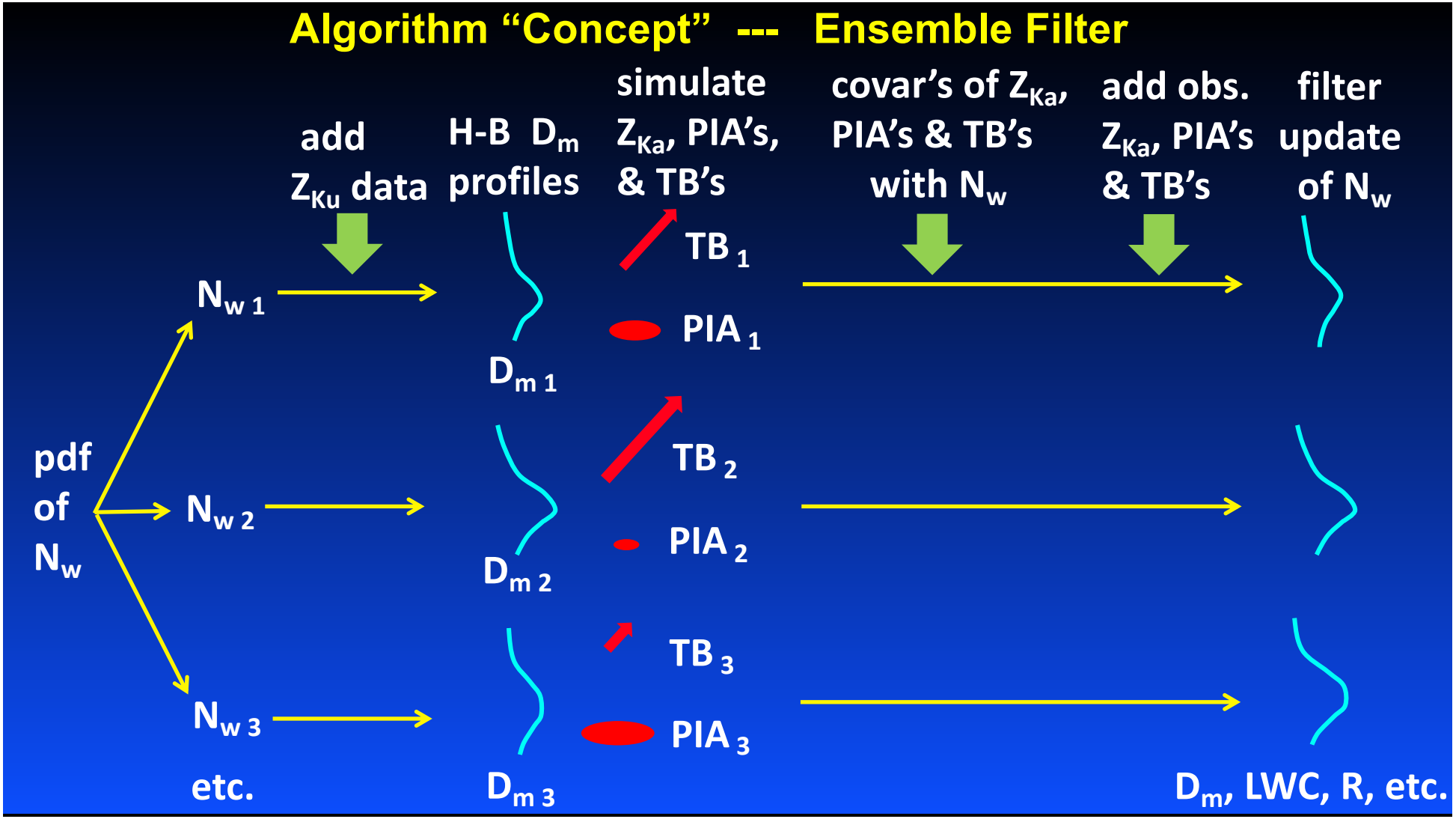
GPM V05



GPM V05 / TRMM V05



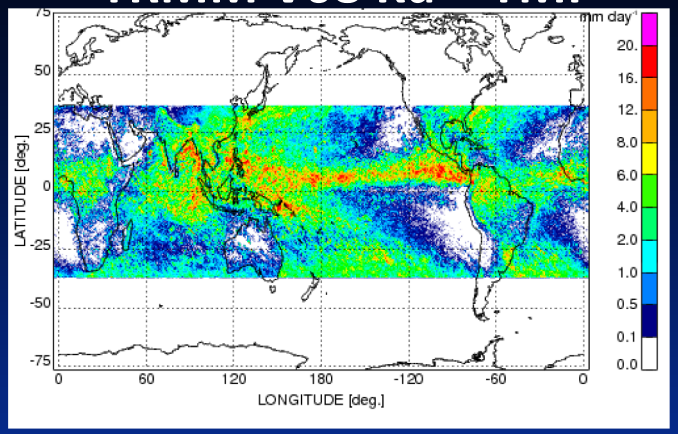
- reasonable fit to TRMM/GPM precipitation.


Algorithm "Concept" --- Ensemble Filter
add Z_{Ku} data
H-B D_m profiles
simulate Z_{Ka}, PIA's, & TB's
covar's of Z_{Ka}, PIA's & TB's with N_w
add obs. Z_{Ka}, PIA's & TB's
filter update of N_w
pdf of N_w
$N_{w\,1}$
$N_{w\,2}$
$N_{w\,3}$
etc.
$D_{m\,1}$
$D_{m\,2}$
$D_{m\,3}$
TB_1
PIA_1
TB_2
PIA_2
TB_3
PIA_3
D_m, LWC, R, etc.

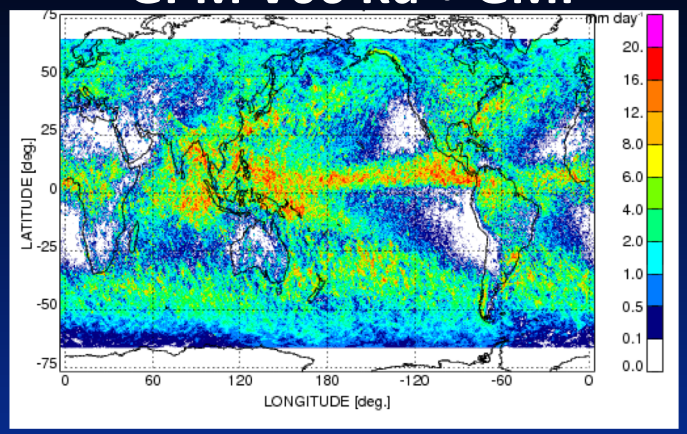
April – September, 2014, Average Plan Views

0.25°

TRMM V08 Ku + TMI

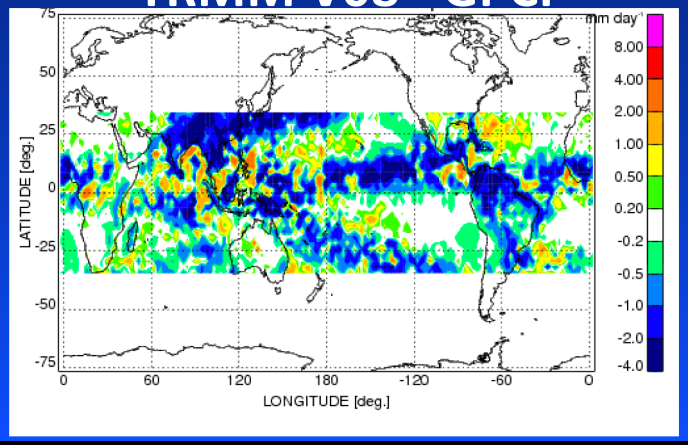


GPM V06 Ku + GMI

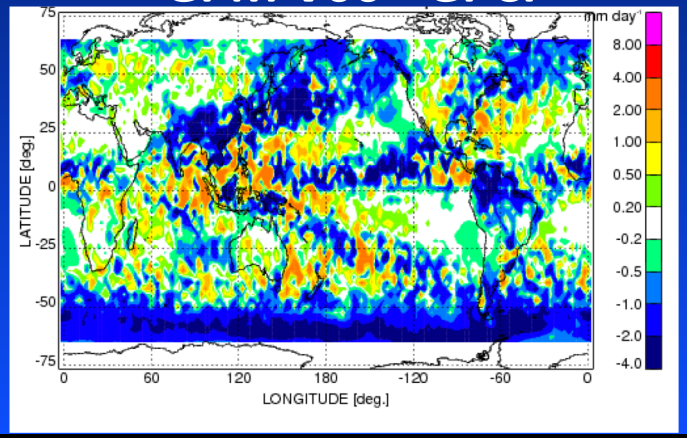


2.5°

TRMM V08 - GPCP



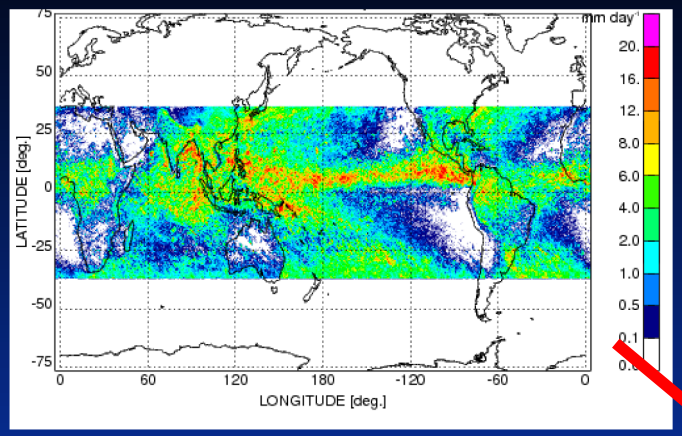
GPM V06 - GPCP



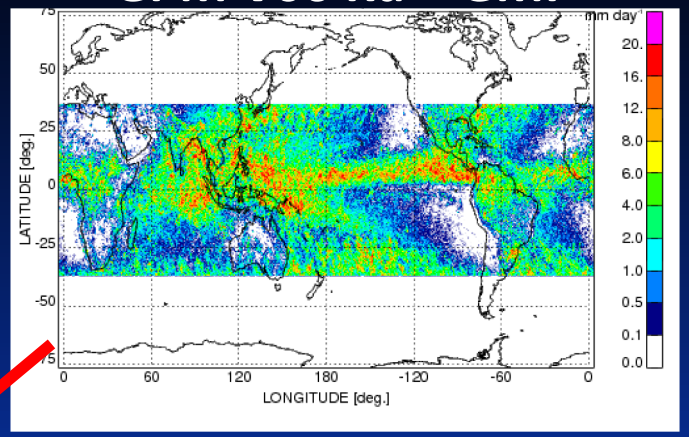
April – September, 2014, Average Plan Views

0.25°

TRMM V08 Ku + TMI

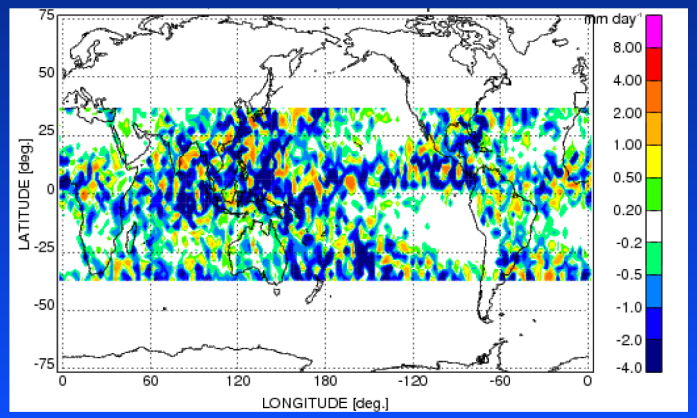


GPM V06 Ku + GMI



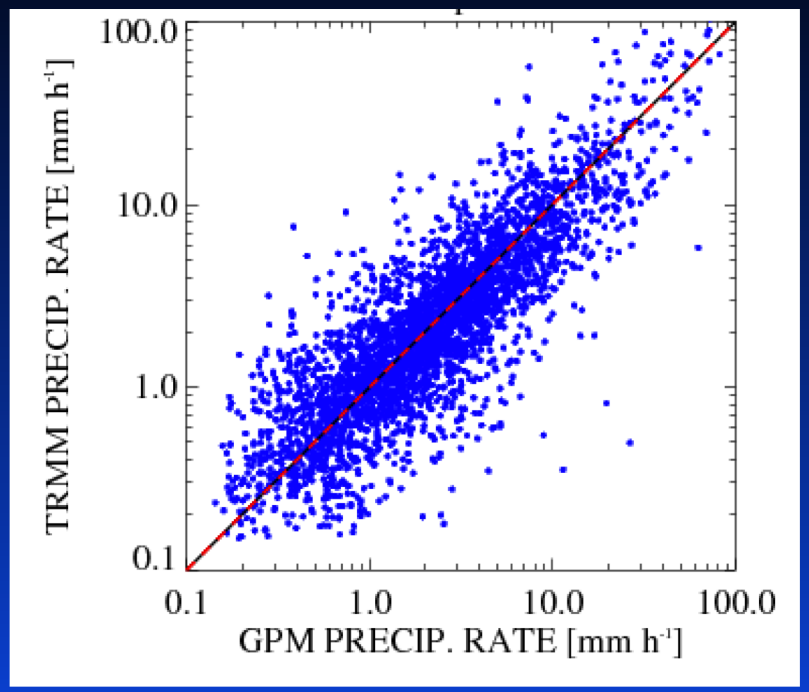
2.5°

TRMM V08 – GPM V06

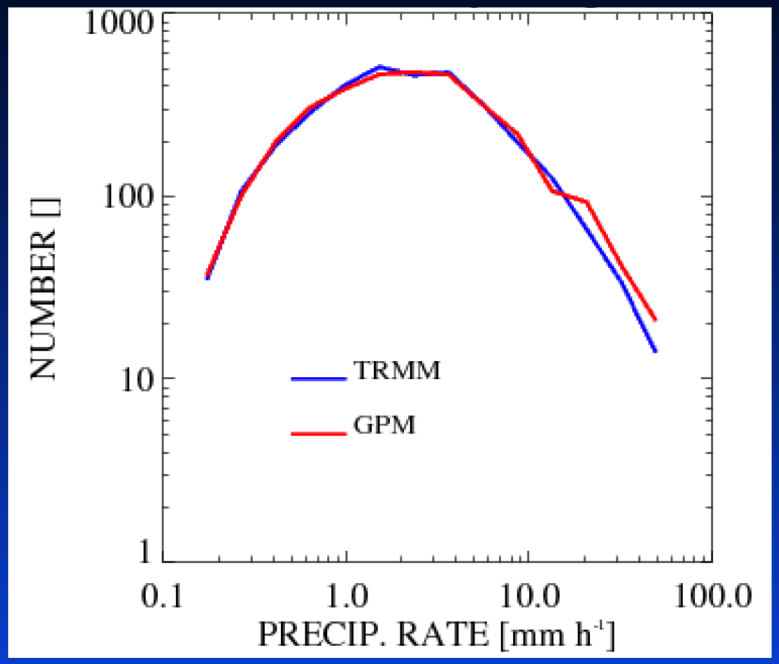


April – September, 2014, ”Matched” Footprints

TRMM V08 vs. GPM V06

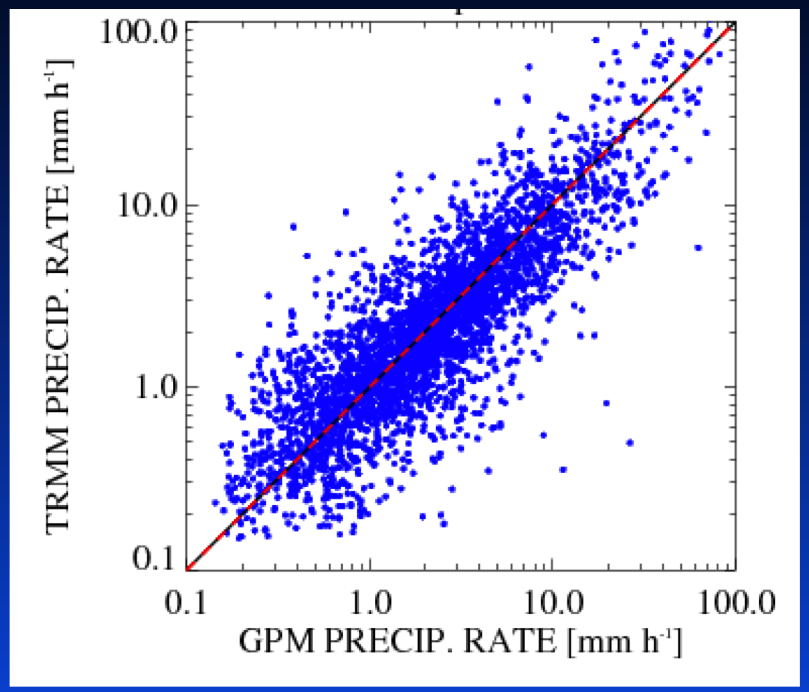


Histograms (where both see rain)

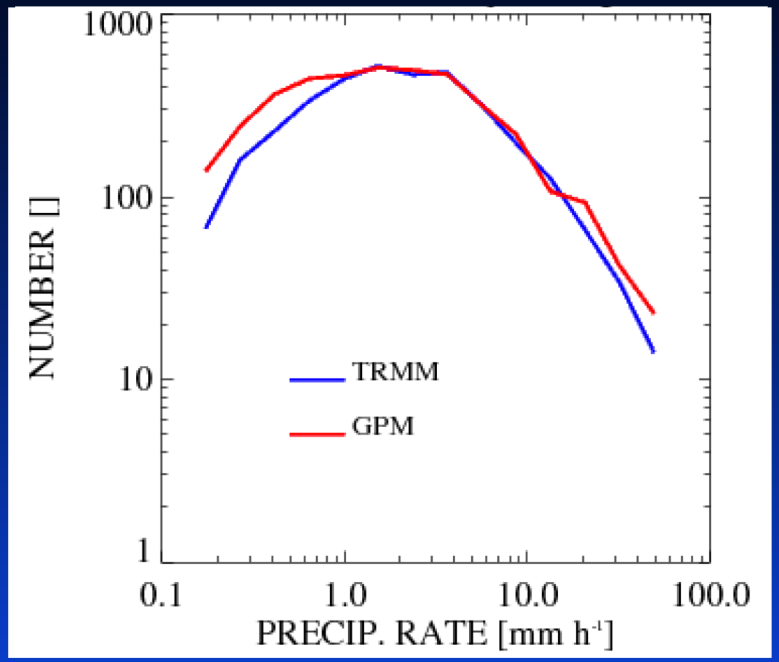


April – September, 2014, ”Matched” Footprints

TRMM V08 vs. GPM V06



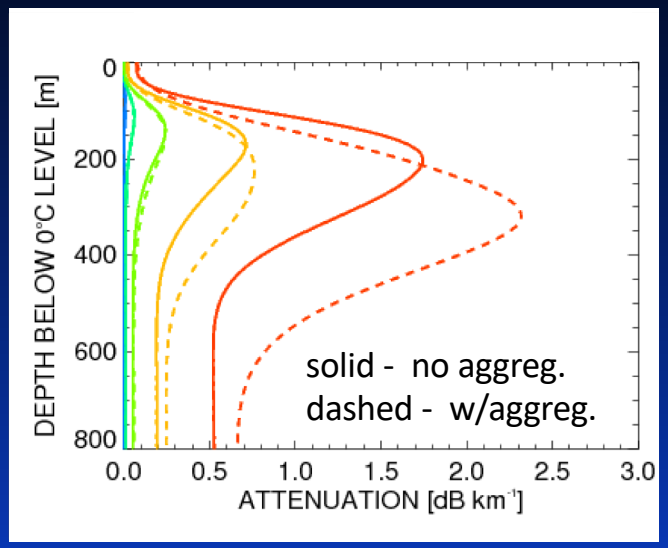
Histograms (where at least 1 sees rain)



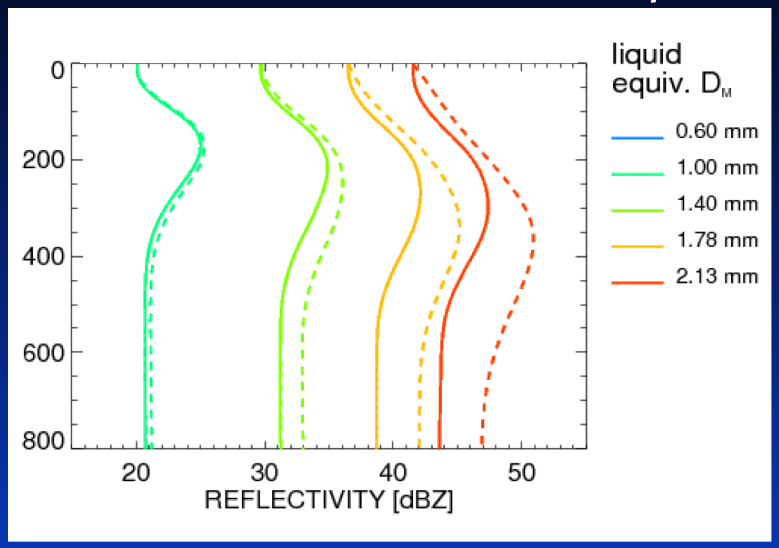
- radar “sensitivity” contributes ~2% to difference in unconditional rain rate.
- but, this is a limited sample.

Effect of Aggregation on Attenuation/Reflectivity

13.6 GHz Attenuation



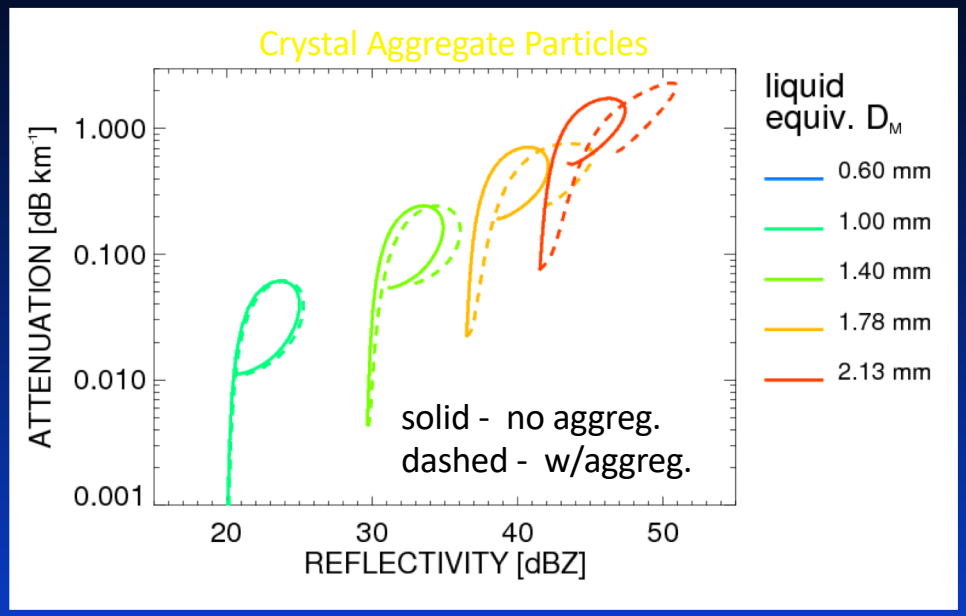
13.6 GHz Atten. Reflectivity



solid- no aggregation
dashed- with aggregation

Effect of Aggregation on Attenuation/Reflectivity

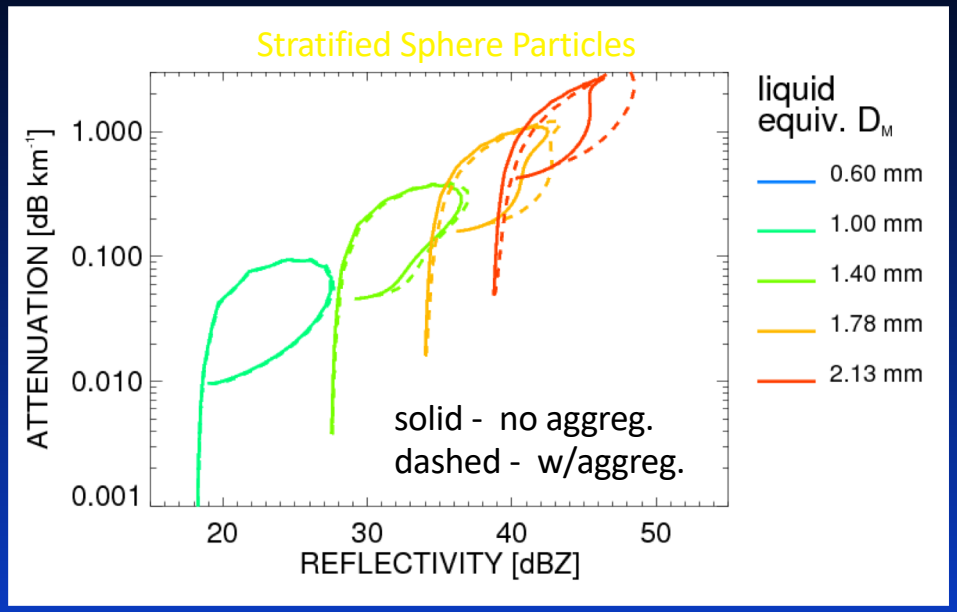
13.6 GHz Attenuation vs. Reflectivity



solid- no aggregation
dashed- with aggregation

Effect of Aggregation on Attenuation/Reflectivity

13.6 GHz Attenuation vs. Reflectivity



solid- no aggregation
dashed- with aggregation