

Obtaining High-temporal-resolution Vertical Structure of Precipitation from the GPM Constellation

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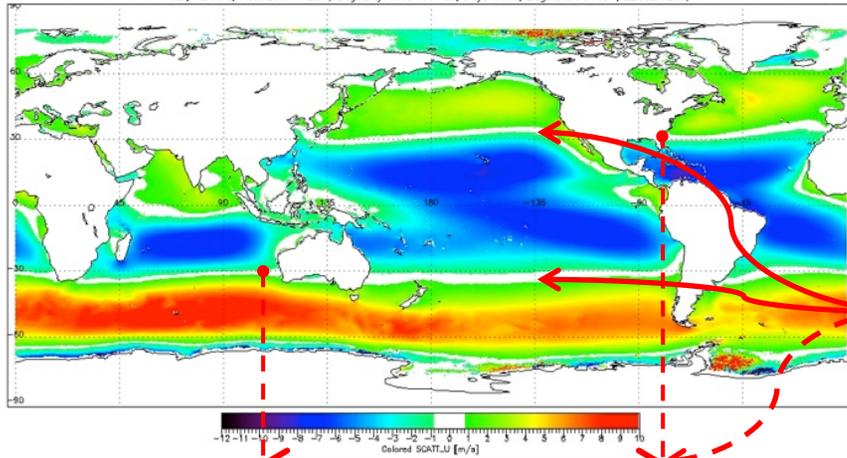


Weather question: Forecasting (& analysis) of tropical systems?

Climate question: Evolution of Hadley circulation?

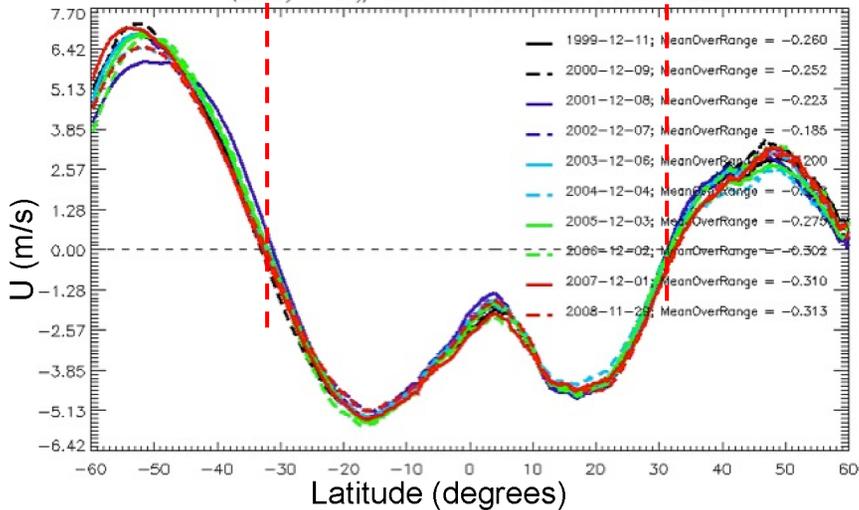
Zonal Component - 10 year mean

Year: YEAR99; Resolution=12km; BeginDay 1999-10-30; Days 3638; BeginOrbit 01887; _2weeks260;

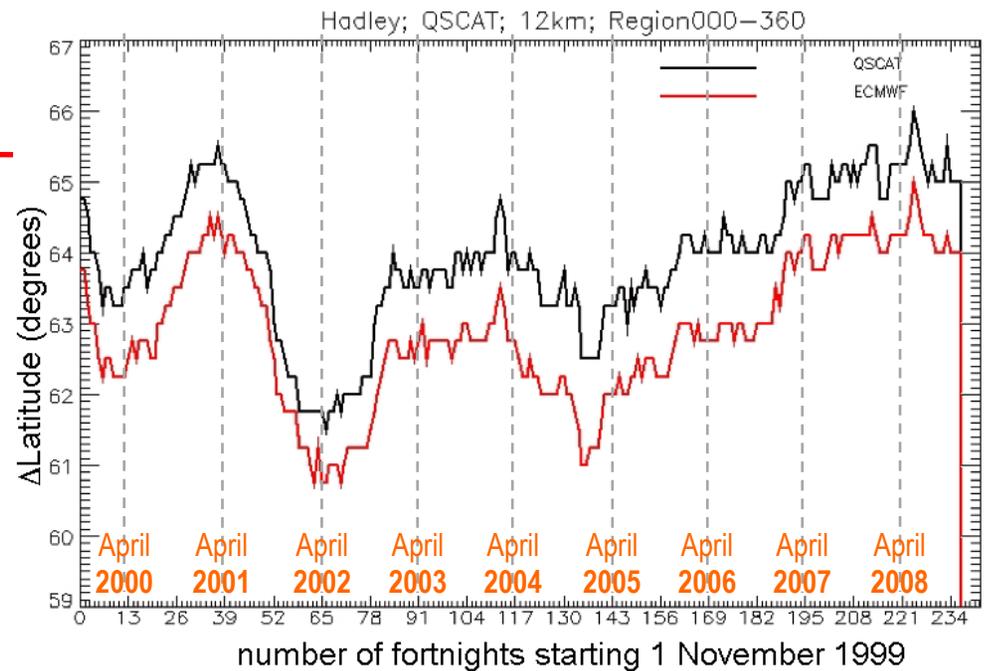


Zonal Component; Zonal Averages – means for 10 years

QSCAT; 12km; Global Oceans: 000 < LON < 360



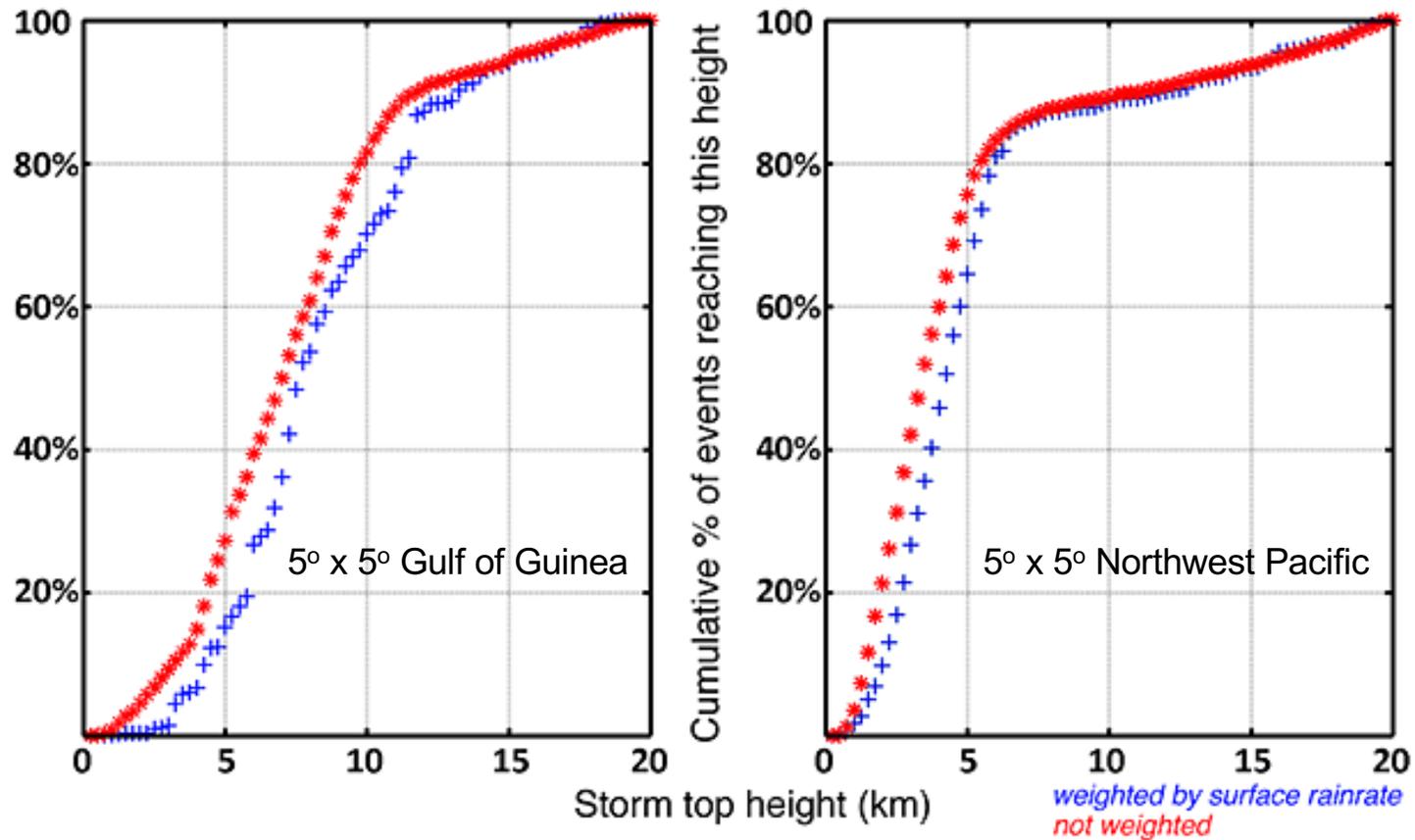
Observation of the Hadley circulation (from ocean-surface wind from scatterometry)



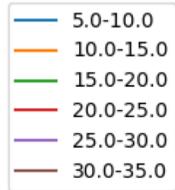
(S. Hristova-Veleva et al)

How did/does the precipitation evolve?

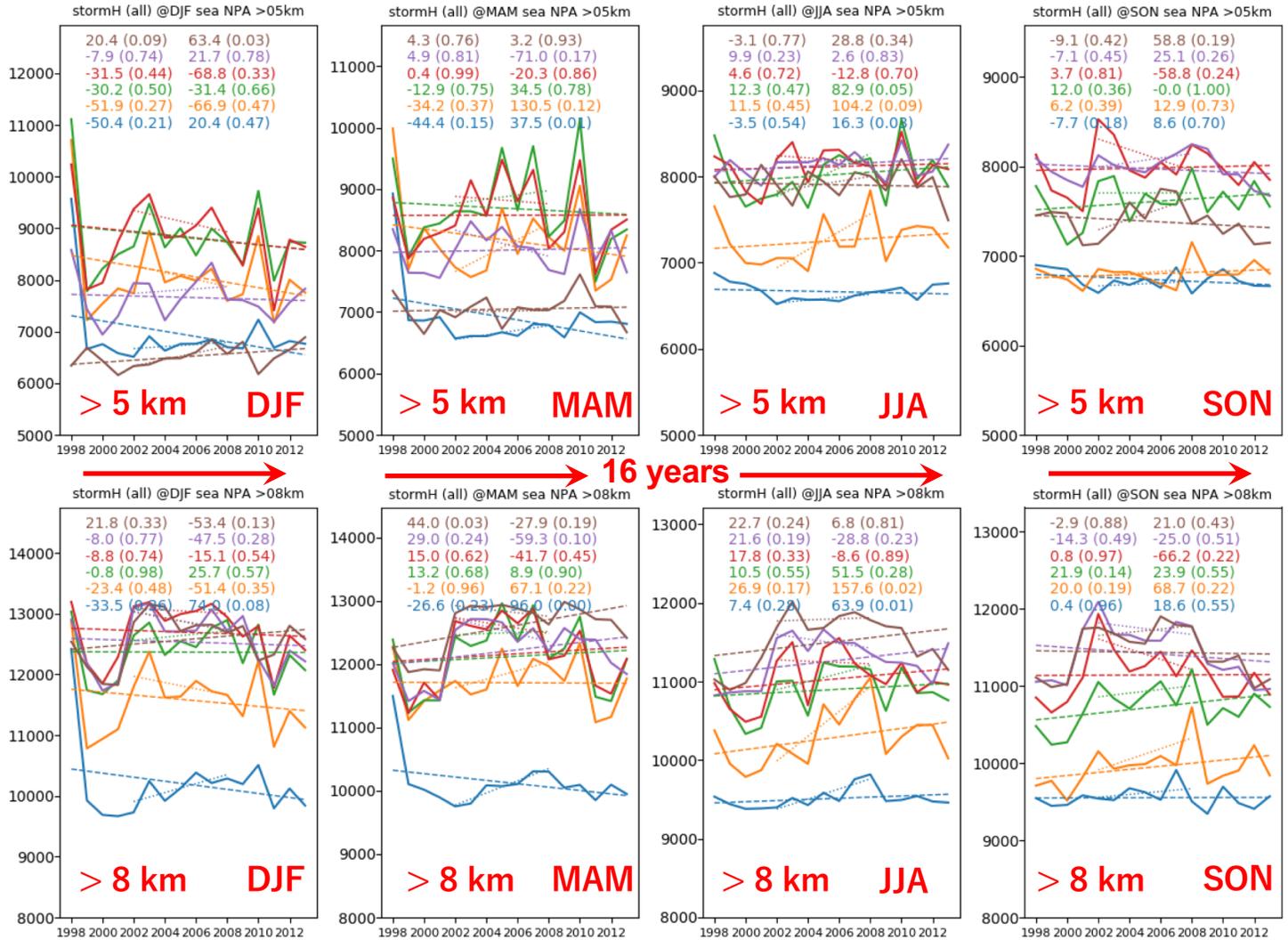
Prototypical top-height probability distributions according to TRMM radar



North Pacific



Annual-Average Cloud Top Height



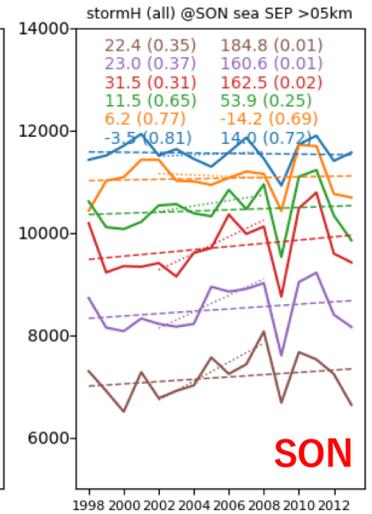
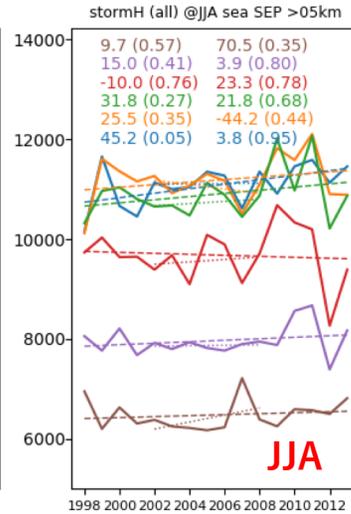
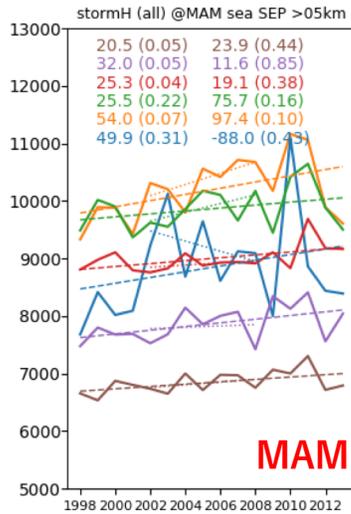
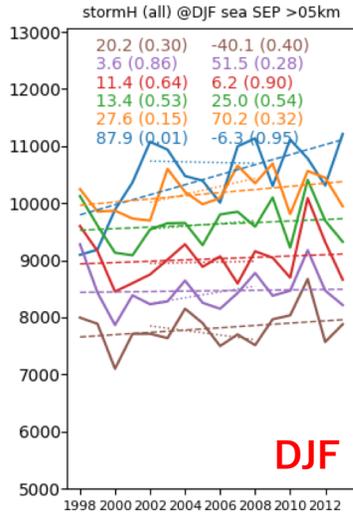
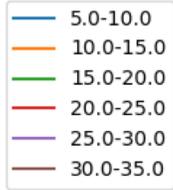
(N. Utsumi et al)

South Pacific - East

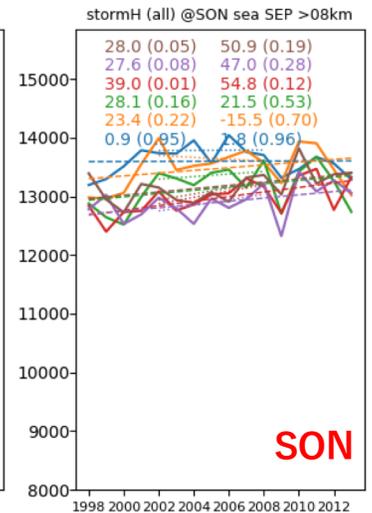
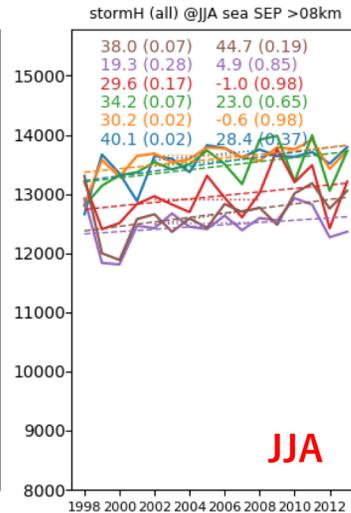
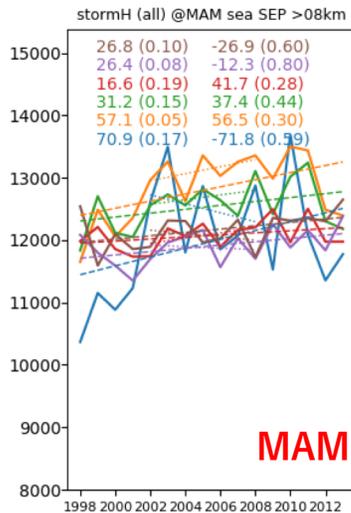
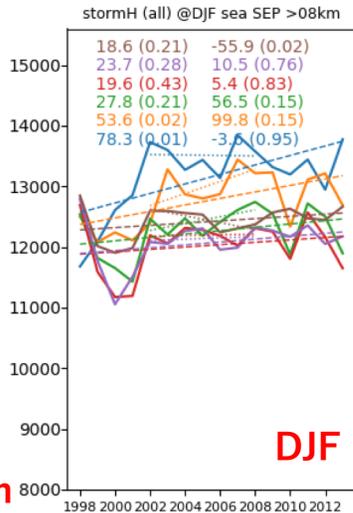


> 5 km

Annual-Average Cloud Top Height



> 8 km



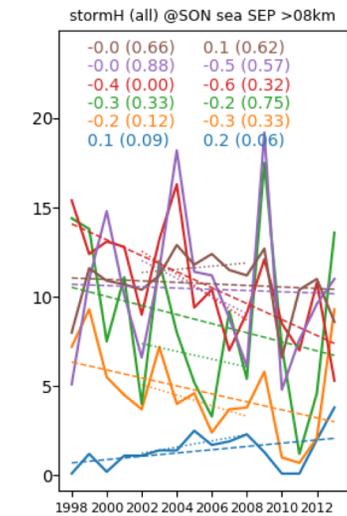
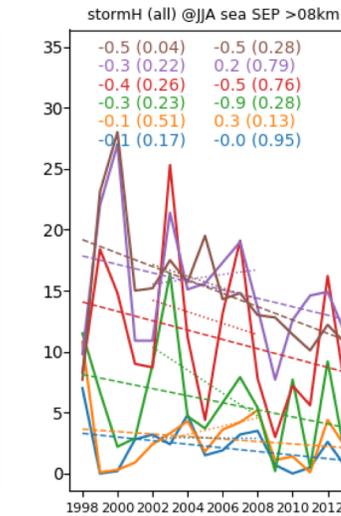
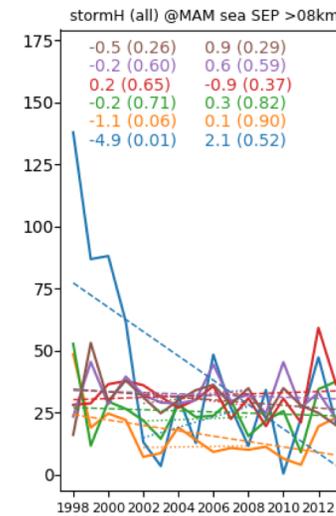
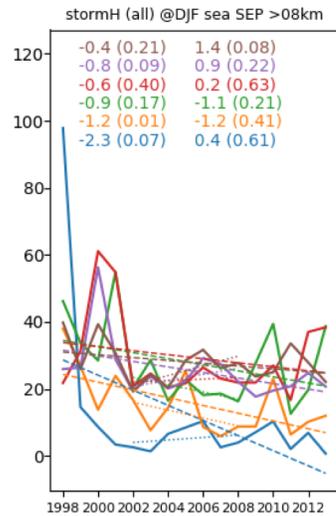
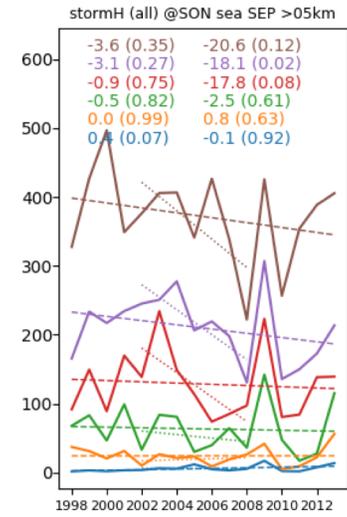
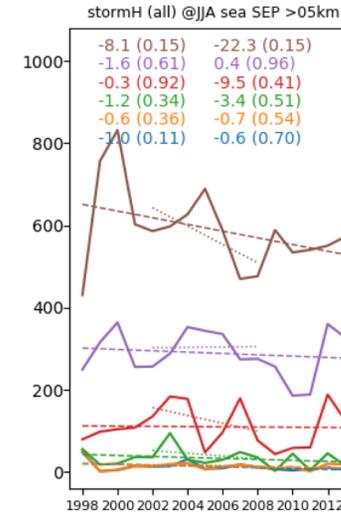
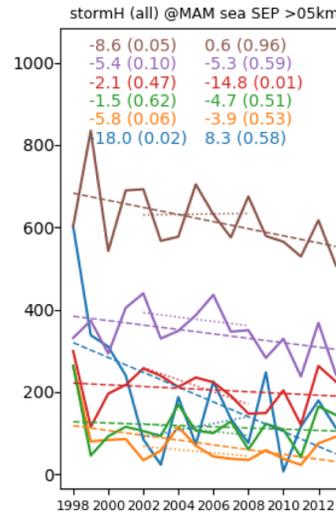
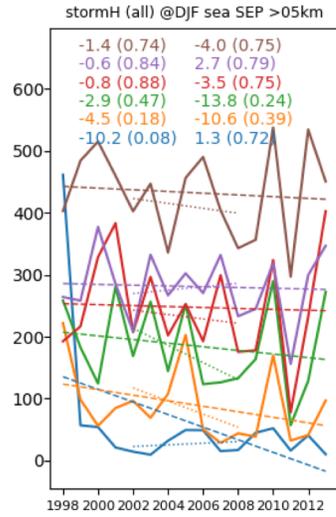
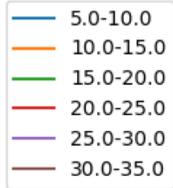
(N. Utsumi et al)

South Pacific - East



> 5 km

Cloud Top Height — total count



> 8 km

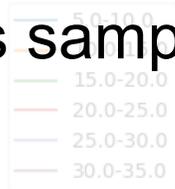
(N. Utsumi et al)

South Pacific - East

> 5 km

Total number of columns observed by TRMM radar every season in each 5° (lat) x 65° (lon) box is on the order of **100** (the exact sample size varies between 20 and 400)

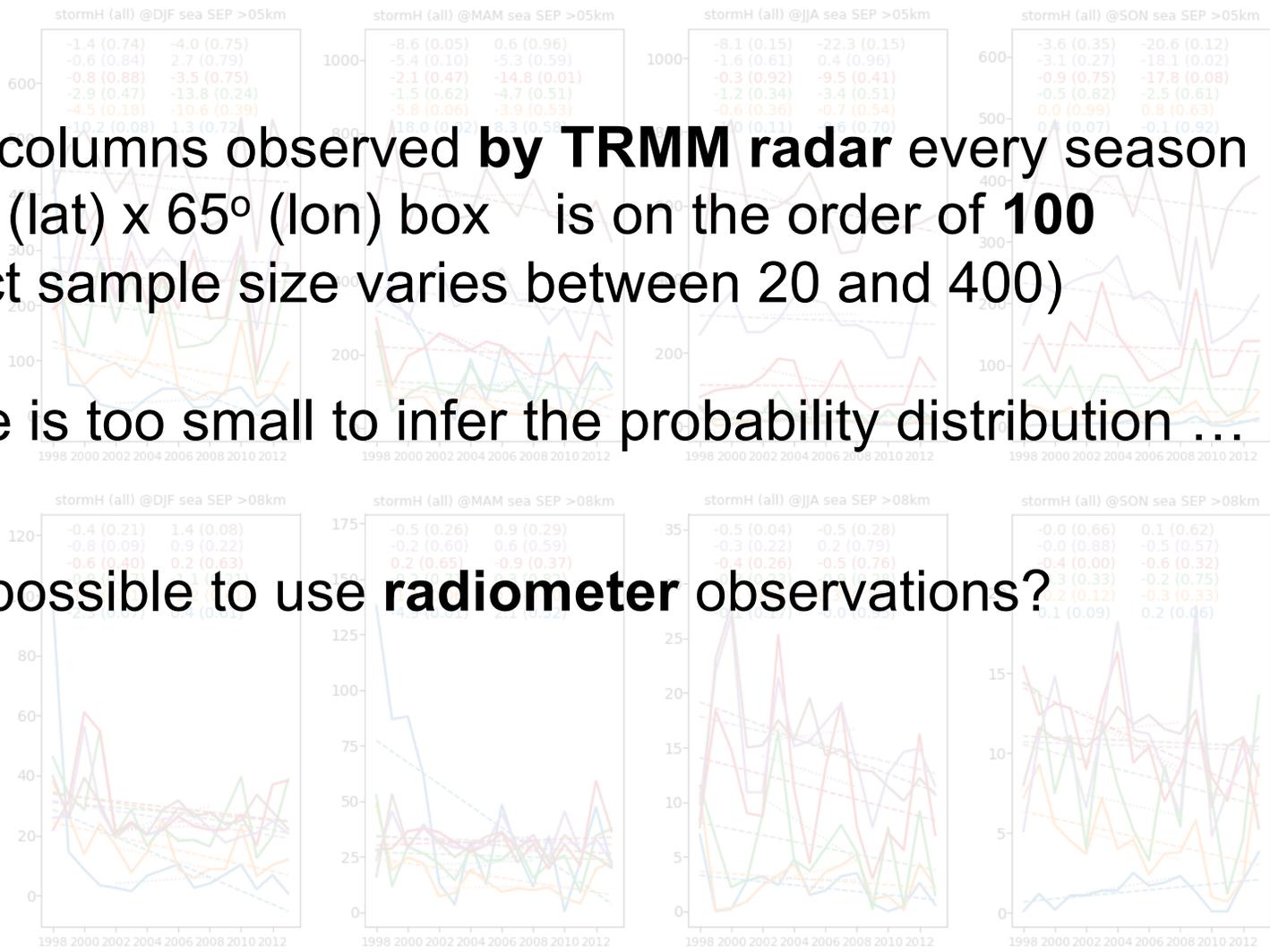
This sample size is too small to infer the probability distribution ...



Cloud Top Height - **trmm count**

> 8 km

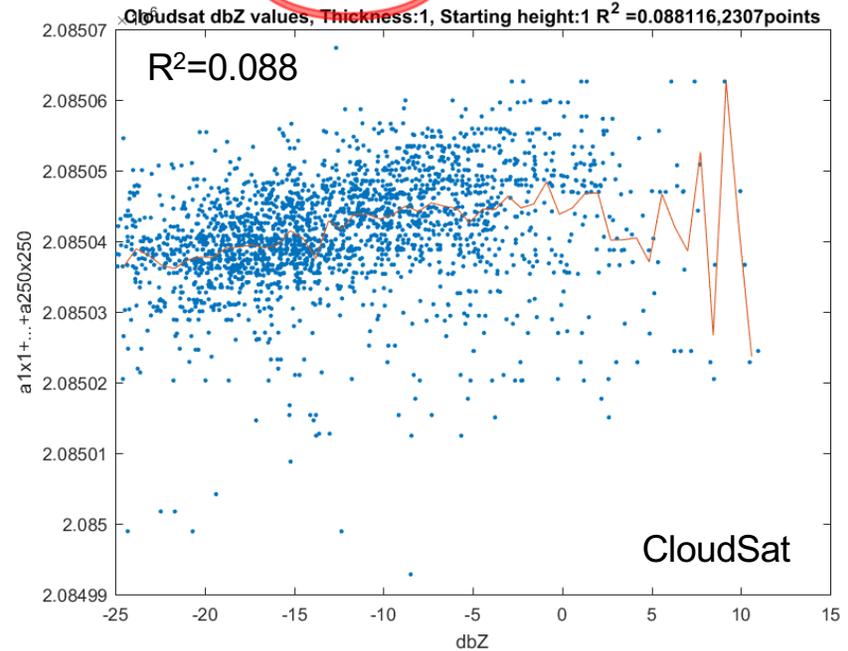
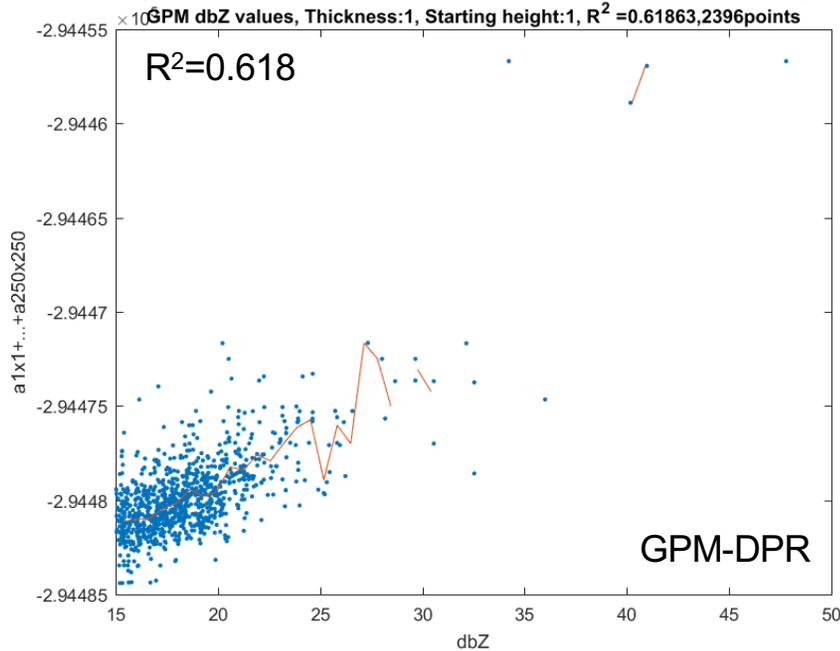
(N. Utsumi et al)



ANALYSIS of
coincident
GPM-HF + CloudSat

Are radiometers sensitive to “vertical structure”?
(what “vertical structure” can the radiometers see?)

Correlation of T_b with dbZ in layer 0-250m from top of cloud

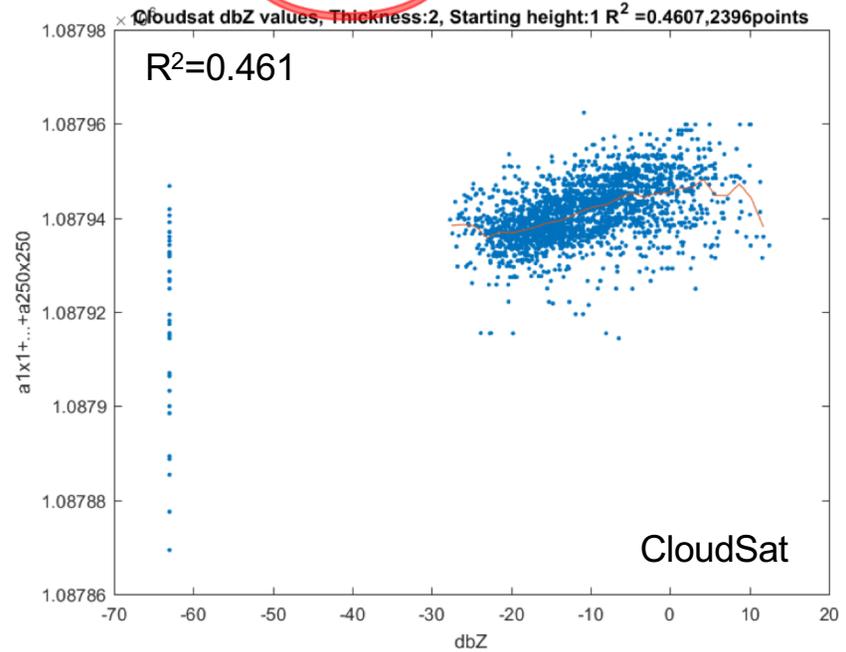
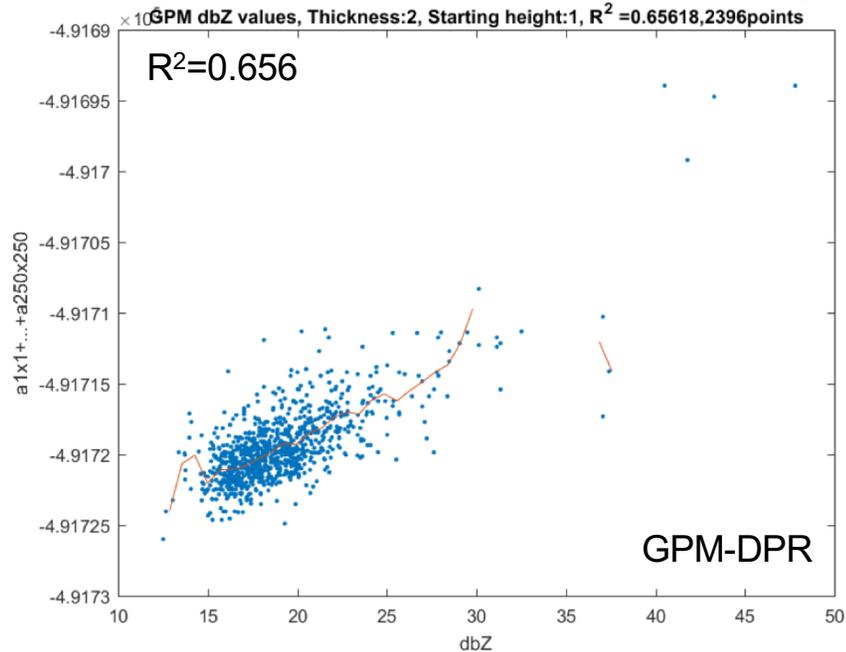


Vertical axis: combo of T_b , T_b^2 , $\log(T_b)$, $(T_b - T_{b-1})/(T_b + T_{b-1})$ that maximizes correlation with (horizontal axis:) vertically integrated dbZ
(GMI-“HF”: 89 GHz H-pol, 89V, 166H, 166V, 183.3 ± 3 , 183.3 ± 7)

ANALYSIS of
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GPM-HF + CloudSat

Are radiometers sensitive to “vertical structure”?
(what “vertical structure” can the radiometers see?)

Correlation of T_b with dbZ in layer 0-500m from top of cloud

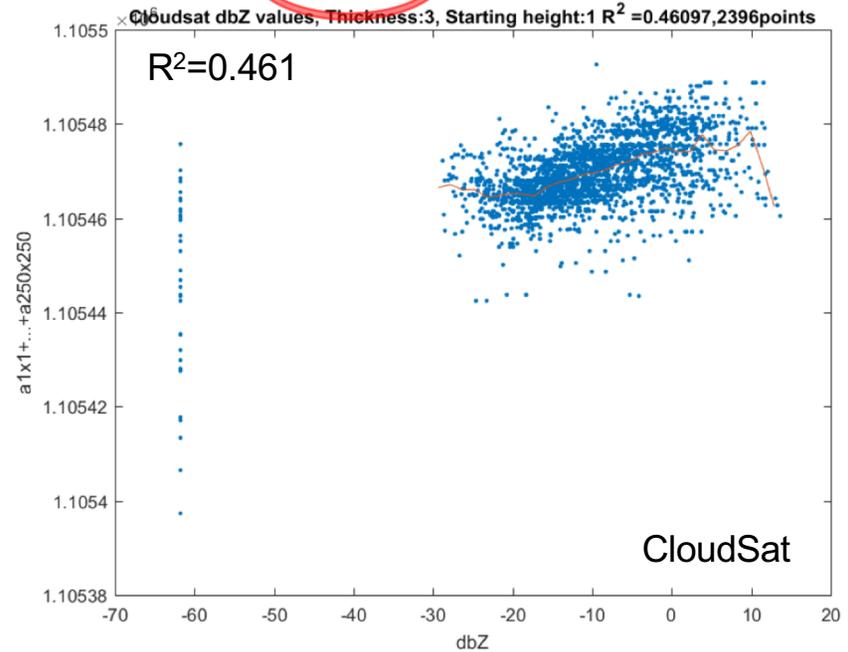
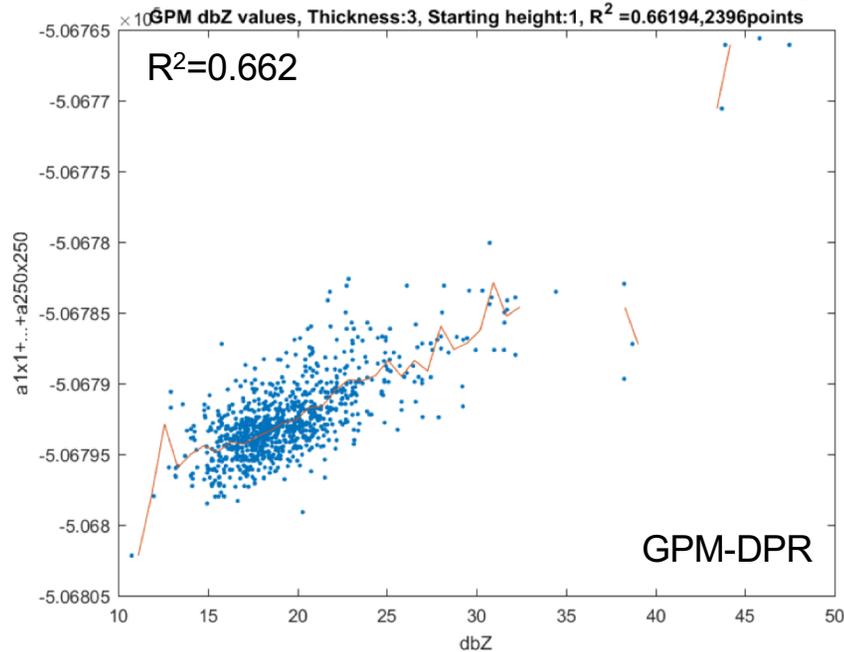


Vertical axis: combo of T_b , T_b^2 , $\log(T_b)$, $(T_b - T_{b-1})/(T_b + T_{b-1})$ that maximizes correlation with (horizontal axis:) vertically integrated dbZ
(GMI-“HF”: 89 GHz H-pol, 89V, 166H, 166V, 183.3 ± 3 , 183.3 ± 7)

ANALYSIS of
coincident
GPM-HF + CloudSat

Are radiometers sensitive to “vertical structure”?
(what “vertical structure” can the radiometers see?)

Correlation of T_b with dbZ in layer 0-750m from top of cloud

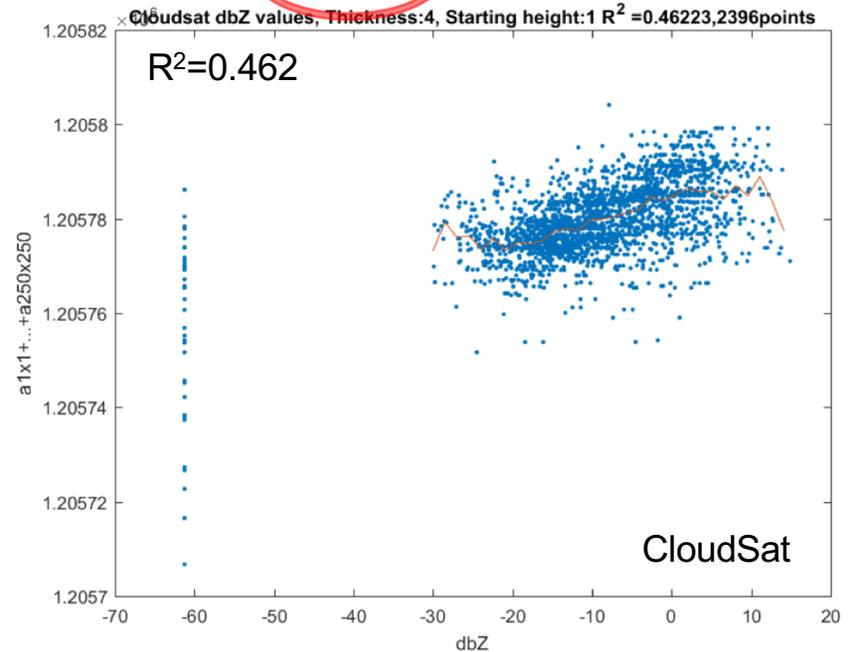
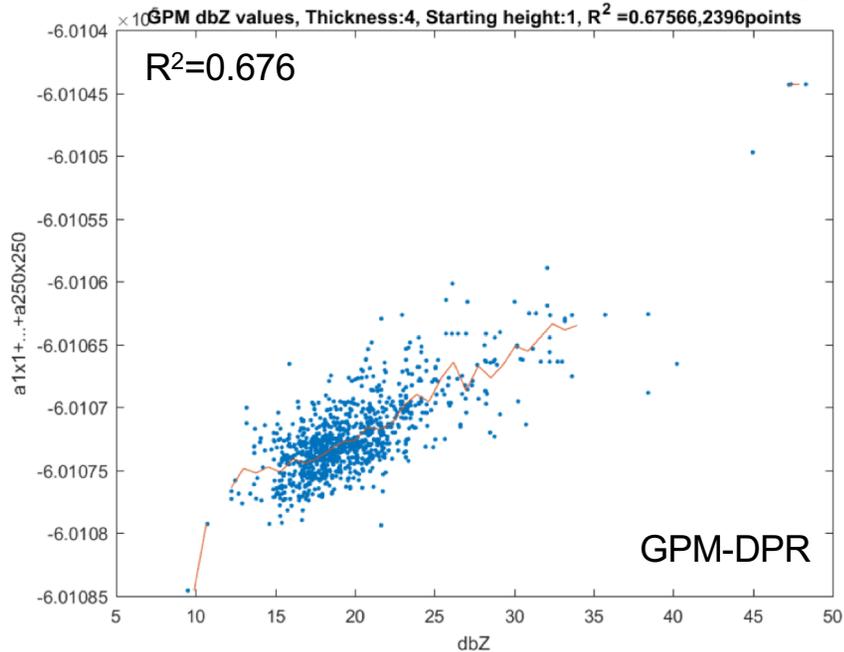


Vertical axis: combo of T_b , T_b^2 , $\log(T_b)$, $(T_b - T_{b-1}) / (T_b + T_{b-1})$ that maximizes correlation with (horizontal axis:) vertically integrated dbZ
(GMI-“HF”: 89 GHz H-pol, 89V, 166H, 166V, 183.3 ± 3 , 183.3 ± 7)

ANALYSIS of
coincident
GPM-HF + CloudSat

Are radiometers sensitive to “vertical structure”?
(what “vertical structure” can the radiometers see?)

Correlation of T_b with dbZ in layer 0-1000m from top of cloud

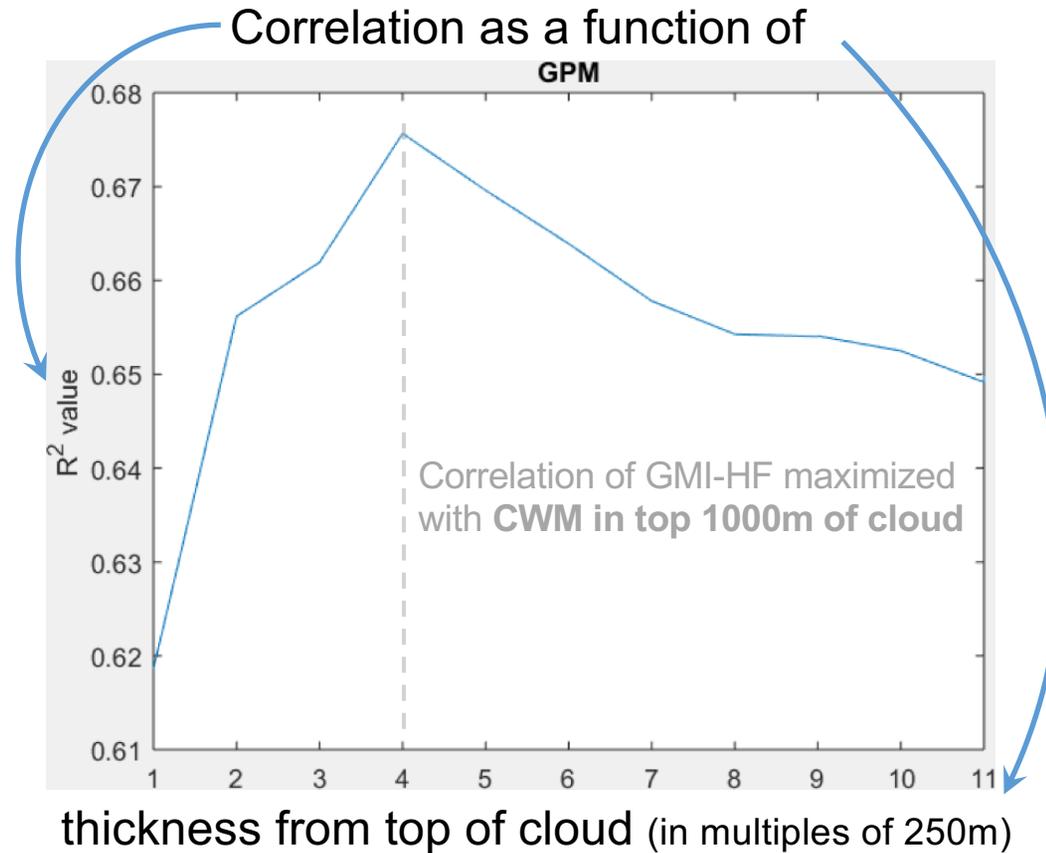


Vertical axis: combo of T_b , T_b^2 , $\log(T_b)$, $(T_b - T_{b-1})/(T_b + T_{b-1})$ that maximizes correlation with (horizontal axis:) vertically integrated dbZ
(GMI-“HF”: 89 GHz H-pol, 89V, 166H, 166V, 183.3 ± 3 , 183.3 ± 7)

ANALYSIS of
coincident
GPM-HF + CloudSat

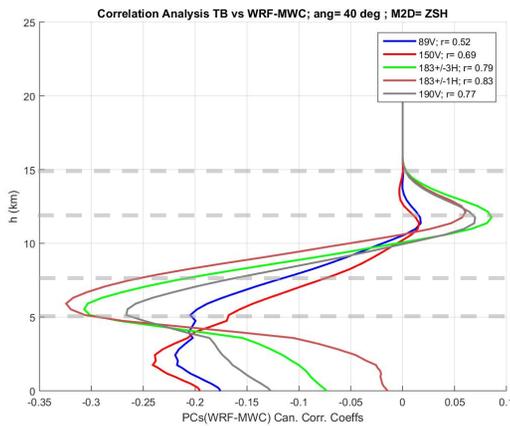
Are radiometers sensitive to “vertical structure”?
(what “vertical structure” can the radiometers see?)

Reason for GMI-“HF”:
finer horizontal resolution

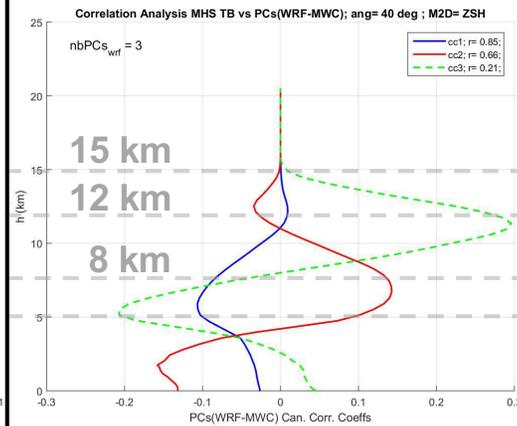


ANALYSIS of CRM simulations

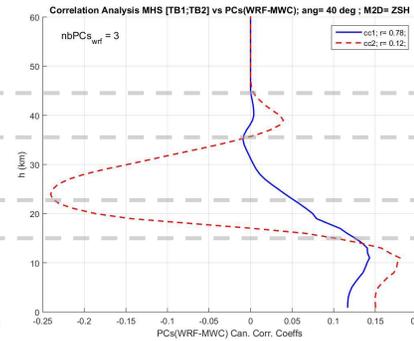
Are radiometers sensitive to “vertical structure”? (what “vertical structure” can the radiometers see?)



Coefficients of best combo of cwm(H) for each MHS channel

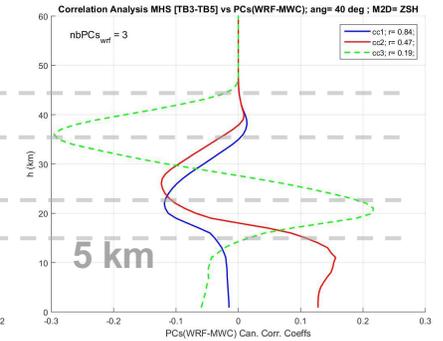


Coefficients of top 3 combos of cwm(H) for top 3 combos of 5 MHS channels



Coefficients of top 2 combos of cwm(H) for combos of MHS channels 1 & 2

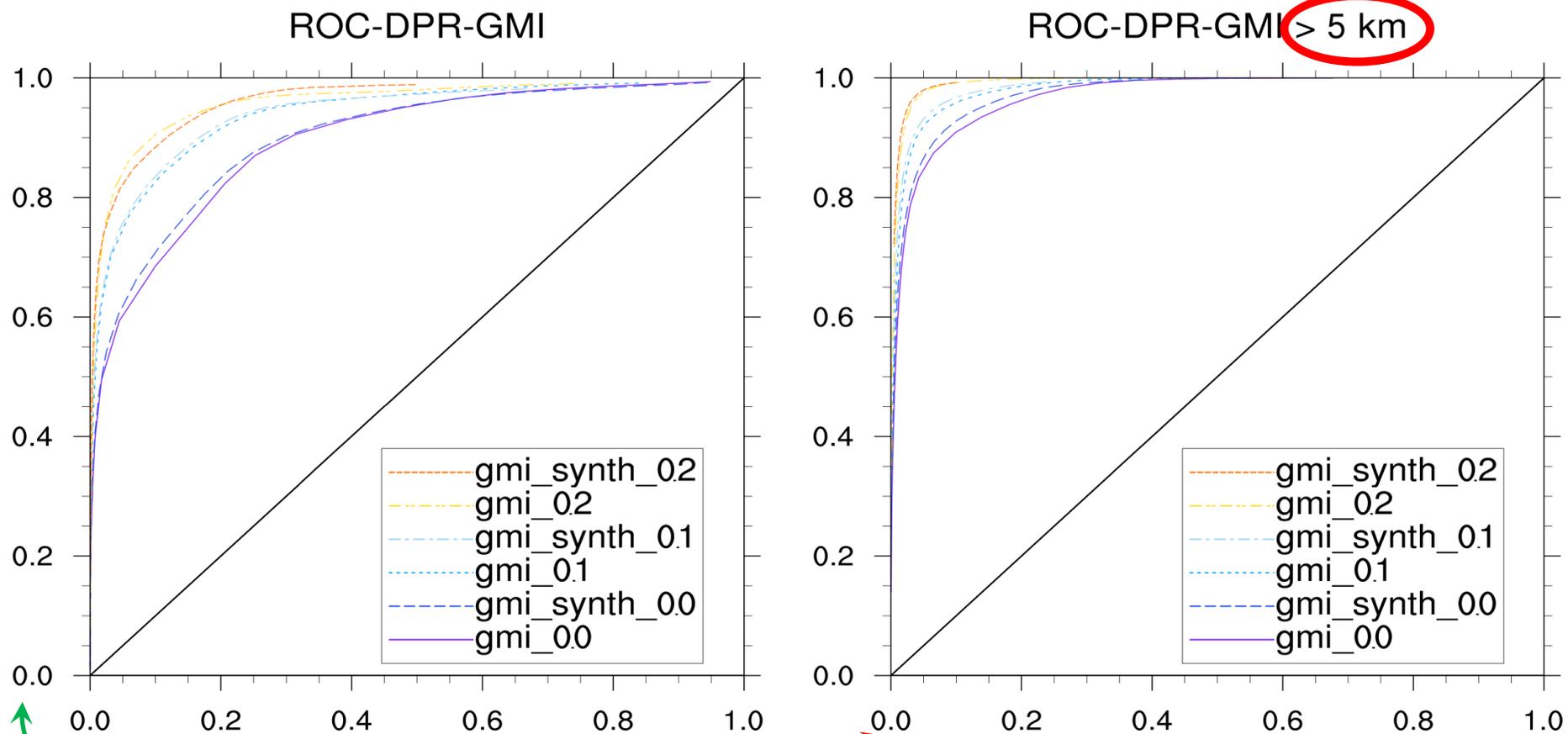
Coefficients of top 3 combos of cwm(H) for combos of MHS channels 3,4,5



Blue curves (“CC1”) represent combination with maximum correlation (and coefficients peak between 5 km and 8 km AMSL)

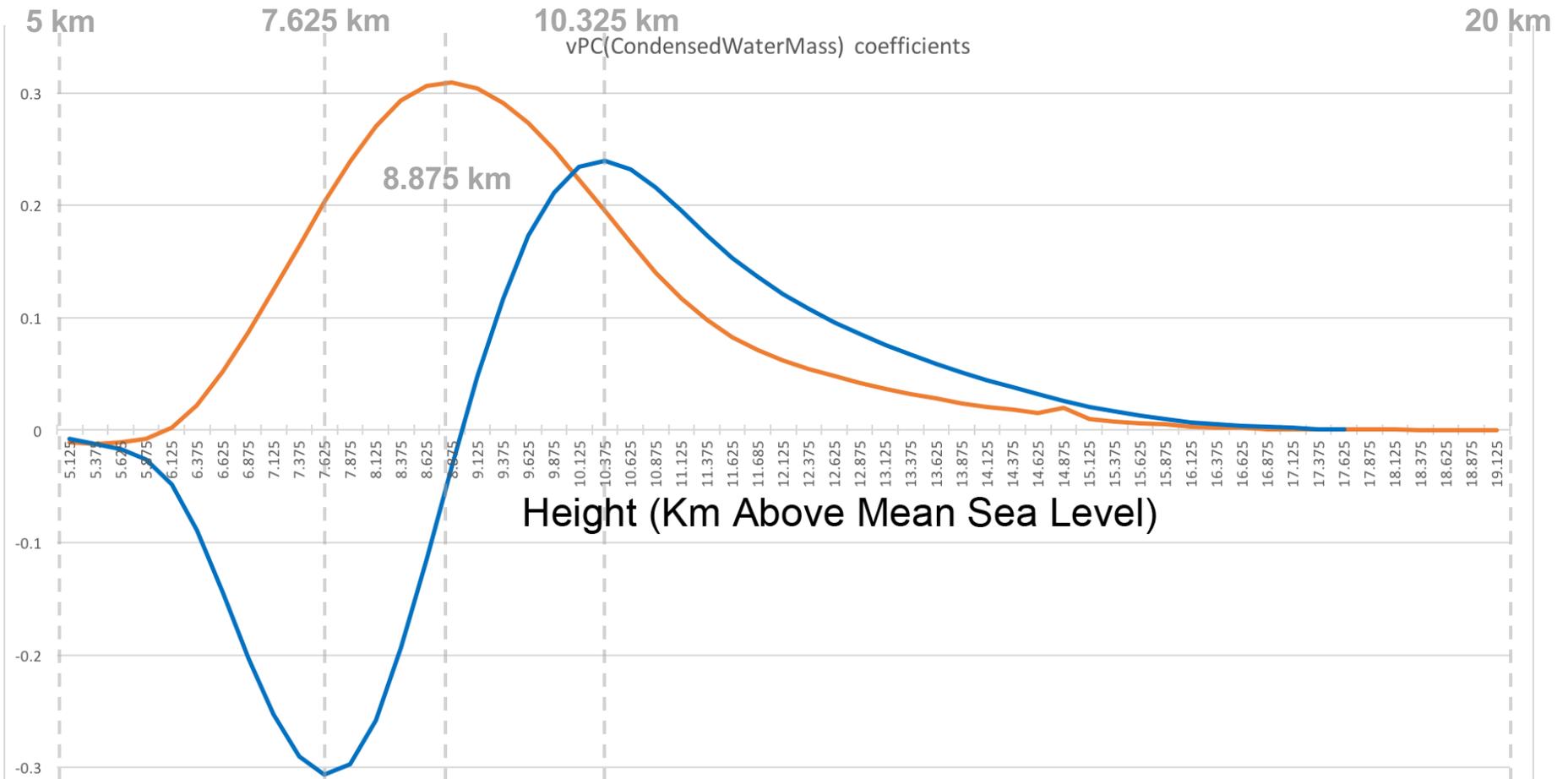
Red curves (“CC2”) represent coefficients of 2nd-best combination (and coefficients peak near 8 km AMSL)

Test 1: Detection by GMI-HF (trained on DPR – combined retrieval)

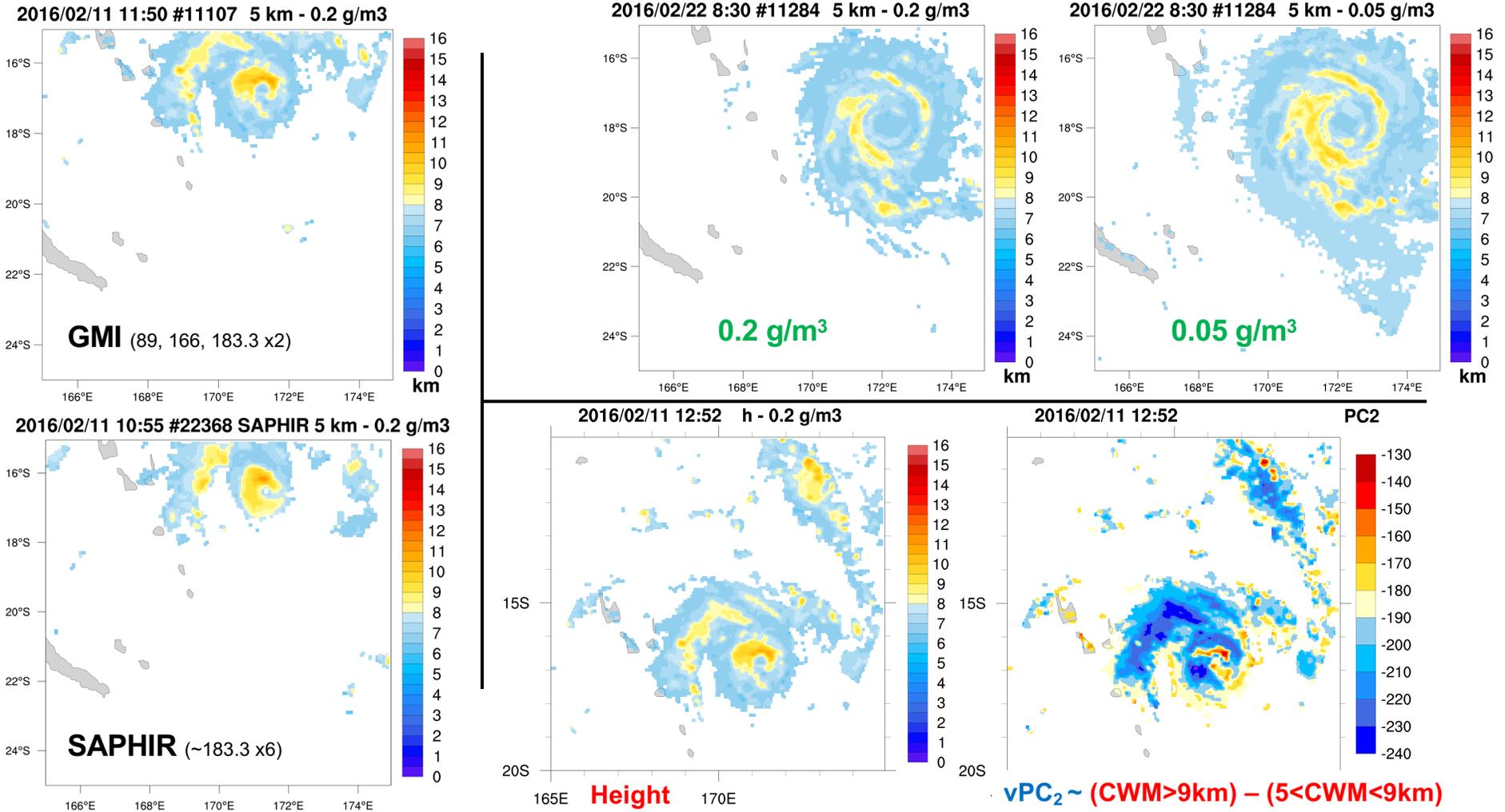


Probability of detection versus probability of false alarm as the threshold is varied (each curve is for a different cwm threshold; left panel is for all clouds, right is above 5km AMSL only)

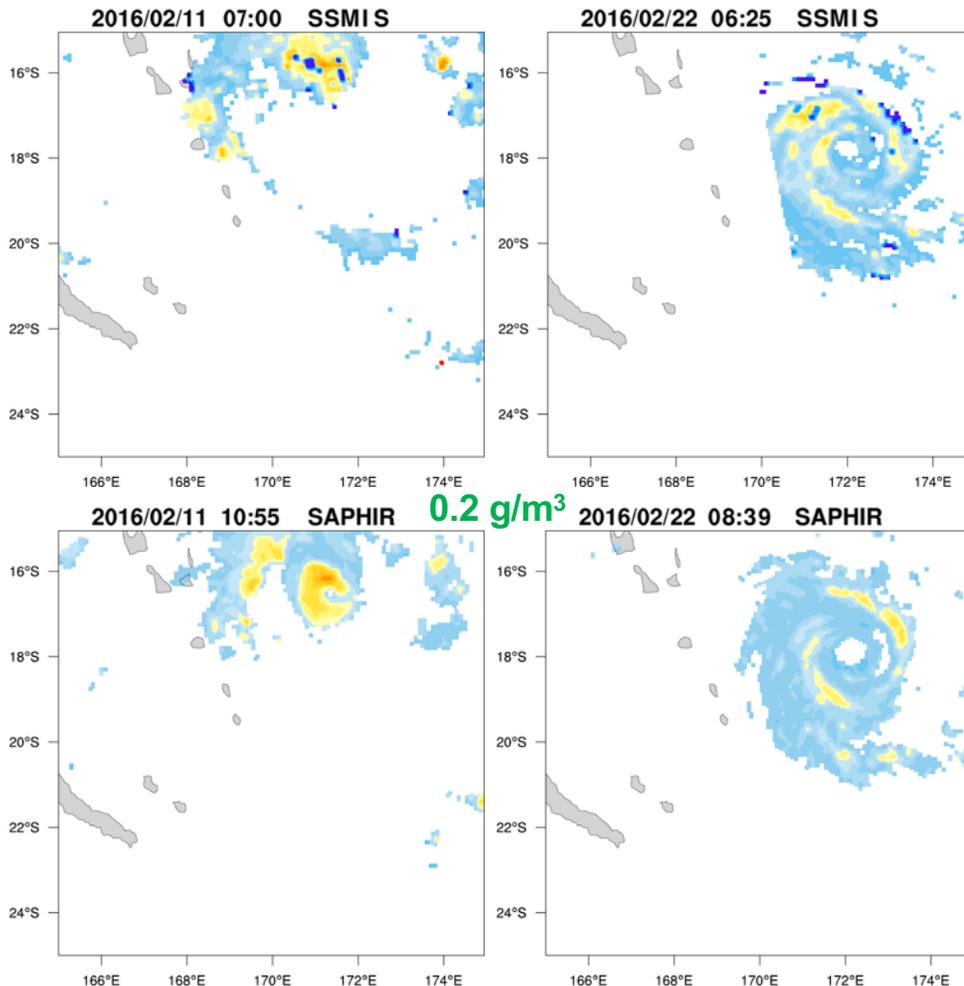
⇒ Try to estimate $H_{0.05}$, $H_{0.2}$, $H_{0.5}$, vPC_1 , vPC_2



Example: TC Winston – 3 comparisons (Bayesian retrieval with PC(T_b) inputs)



Example: TC Winston – 2 add'l comparisons



To do next:

- Populate radar-radiometer coincidence databases (need many more samples)
- **Evaluate Bayesian retrievals with different nonlinear-combination inputs**
- Estimate/filter 0.5-hourly evolution of estimated $H_{0.05}$, $H_{0.2}$, $H_{0.5}$, vPC_1 , vPC_2 , using IR guidance, and **validate it (i.e. quantify uncertainty using radar)**
- analyze microwave estimates within IR-defined storms x2 (for **nowcasting** and **climate-scale statistics**)

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Climate question: Evolution of Hadley circulation?