Improved Quantitative Precipitation Forecasts by New MHS Cloud Detection Algorithm

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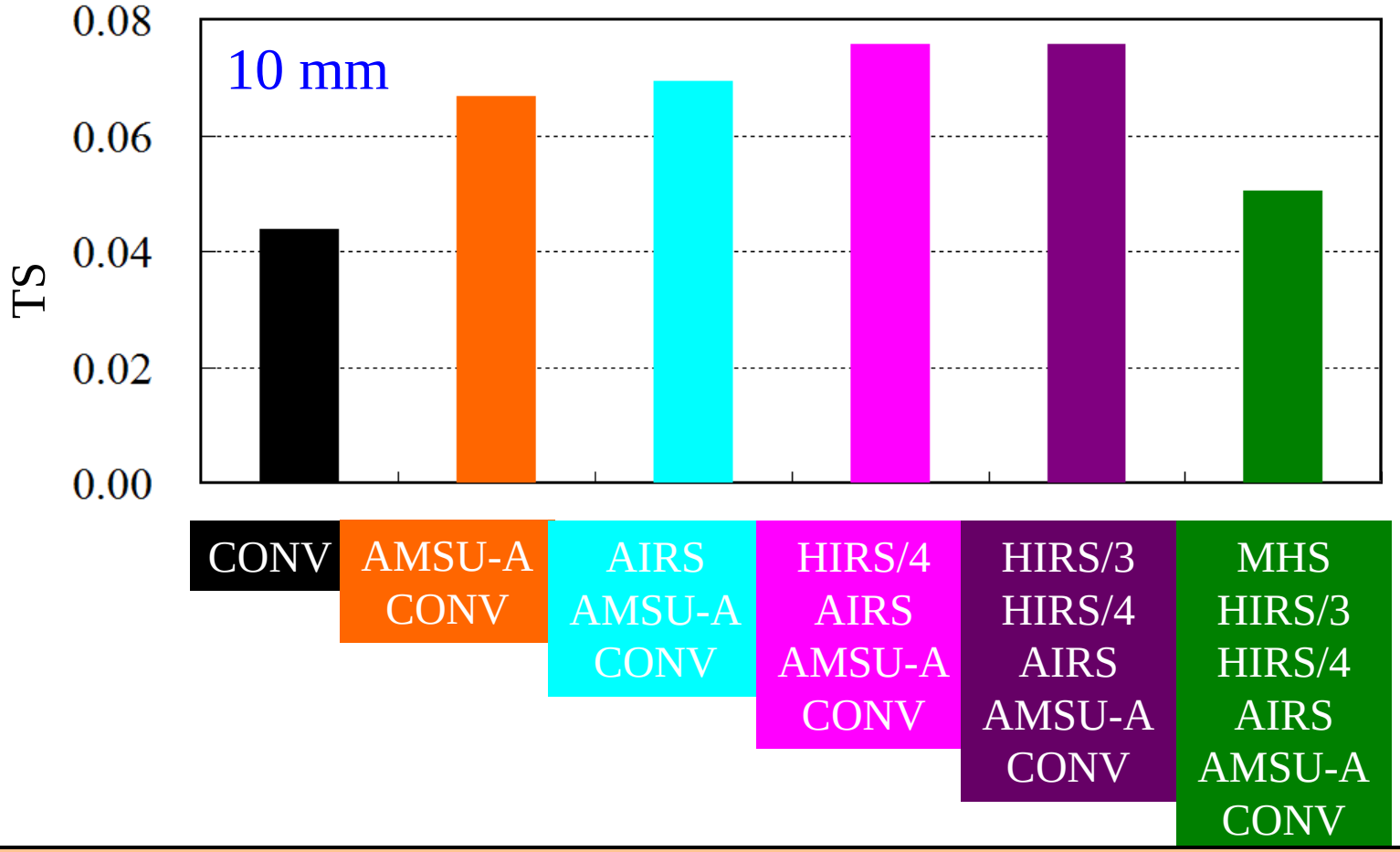
Threat Scores of 3-h Accumulative Rainfall



A negative impact of MHS data assimilation on QPFs near Gulf coastal (see Qin, Z., X. Zou and F. Weng, 2013: Evaluating added benefits of assimilating GOES imager radiance data in GSI for coastal QPFs. *Mon. Wea. Rev.*, **141**, 75-92.

Three Steps for MHS Data Rejection in GSI

Step I:

$$TPW_{index} > 1$$

Step II:

$$|O - B| > 3\left(e_i \times \left(1 - TPW_{index}^2\right) \times f_H \times \tau_i^{top}\right)$$

or: $|O - B| > 6\text{K}$

e_i is accuracy of obs.

f_H=2000/H, H is terrain height>2km

τ_i^{top} is ransmittance at model top

Step III:

All five channels if data of any other channel was removed by the first two QC steps

MHS QC in GSI

- An LWP index is calculated as follows:

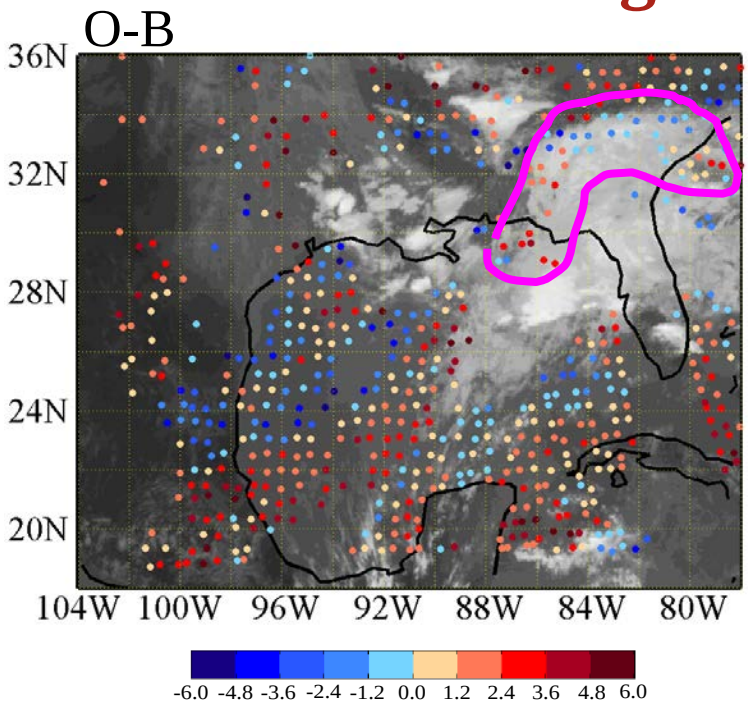
$$LWP_{index}^{ocean} = \begin{cases} 0.13 \times \left\{ \left(T_{b,1}^{o} - T_{b,1}^{m} \right) - 33.58 \times \dfrac{\left(T_{b,2}^{o} - T_{b,2}^{m} \right)}{300 - T_{b,2}^{o}} \right\}, & \text{if } T_{b,2}^{o} \le 300 \\ 9, & \text{otherwise} \end{cases}$$

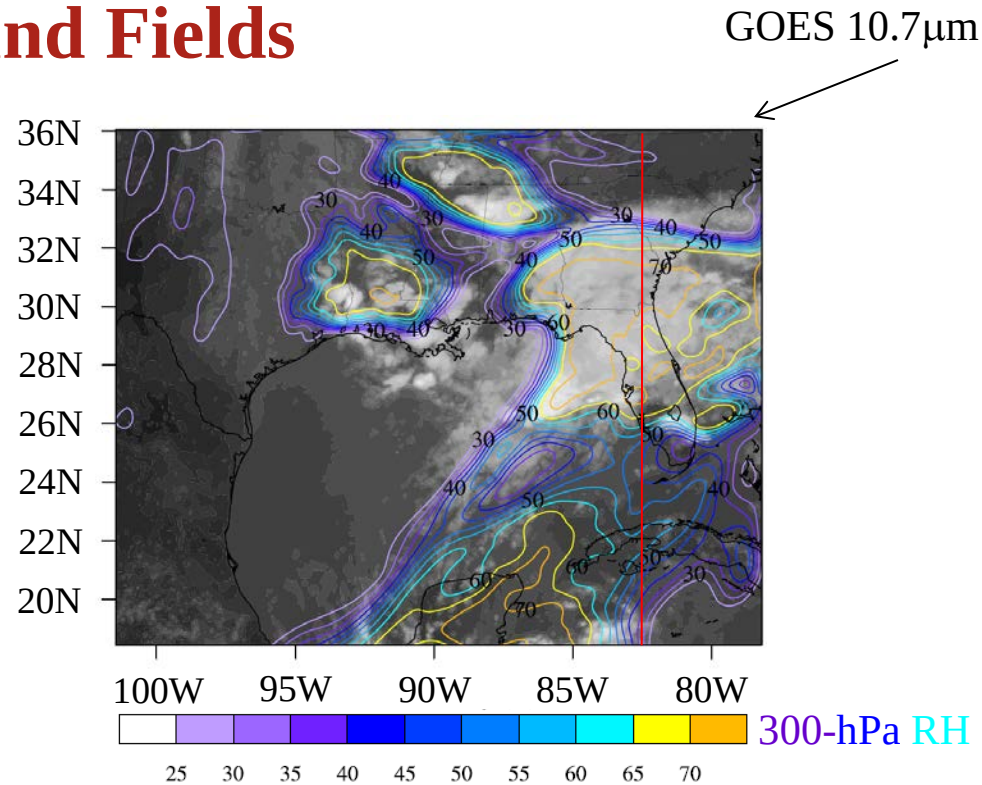
$$LWP_{index}^{land} = 0.85 \times \left(T_{b,1}^{o} - T_{b,1}^{m} \right) - \left(T_{b,2}^{o} - T_{b,2}^{m} \right)$$

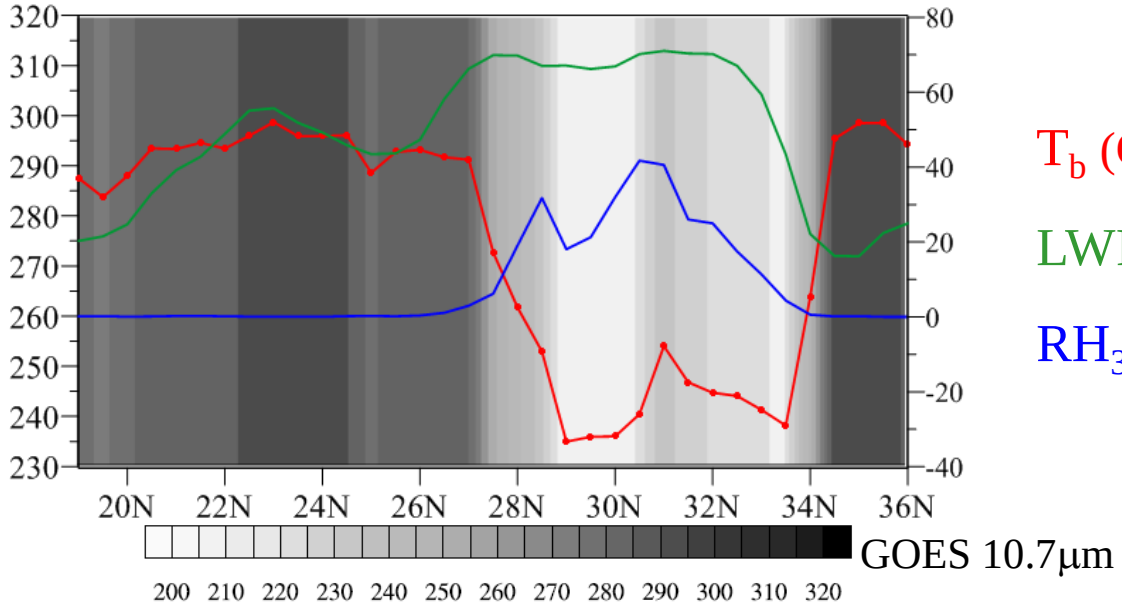
- An TPW index is calculated as follows:

$$TPW_{index} = \left\{ \left(T_{b,1}^{o} - T_{b,1}^{m} \right) - 7.5 \times LWP_{index} \right] \Big/ 10.0 \right\}^{2} + LWP_{index}^{2}$$

Background Fields







AMSU Retrieval of LWP and IWP

- Weng and Grody (2000) proposed an algorithm to derive cloud ice water path (**IWP**) using MHS measurements at 89 and 150 GHz.

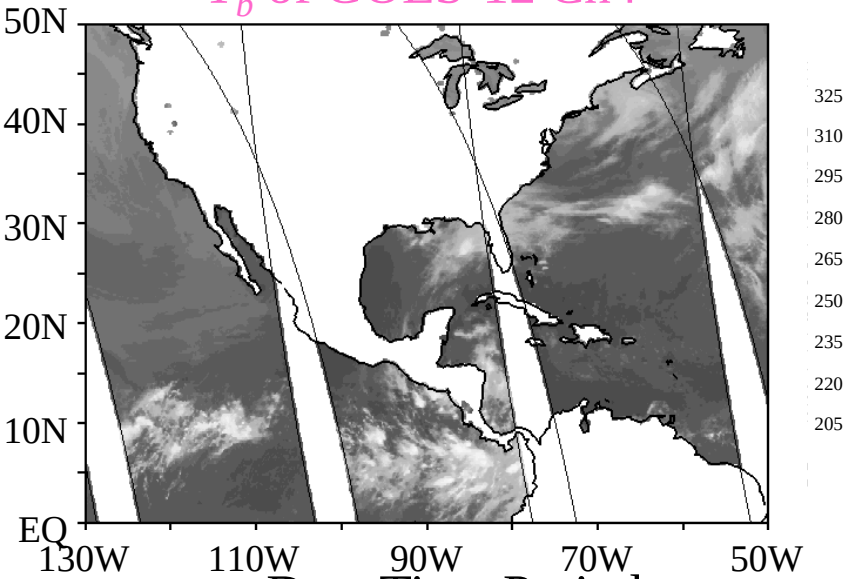
- Grody et al. (2001) provided an algorithm for retrieving liquid water path (**LWP**) over oceans using the AMSU measurements at 23.8 and 31.4 GHz **over ocean**.

- Weng et al. (2003) Improved algorithms' accuracy through adding an asymmetry correction.

The above AMSU physical retrieval of LWP and IWP products can be utilized to identify the cloud affected MHS radiances.

LWP and IWP over Ocean

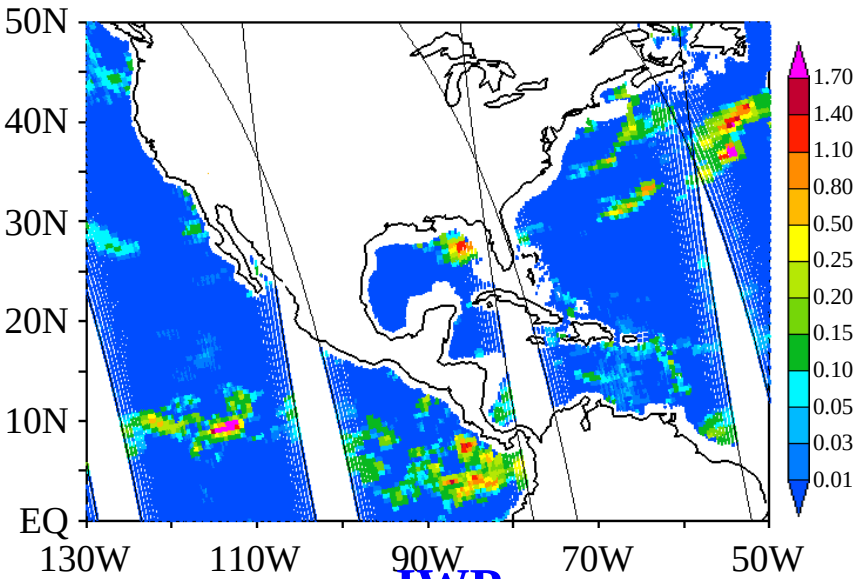
T_b of GOES-12 Ch4



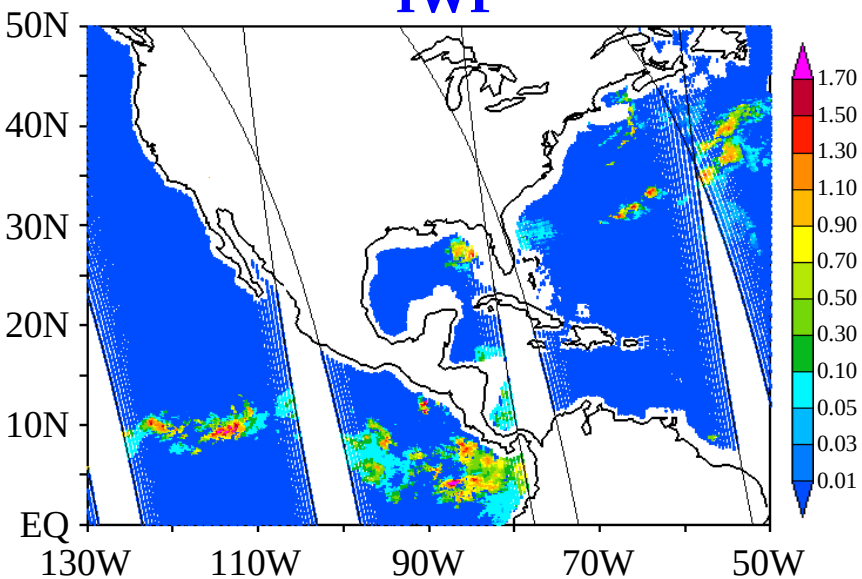
Data Time Period:

1606 UTC to 2115 UTC May 22

LWP



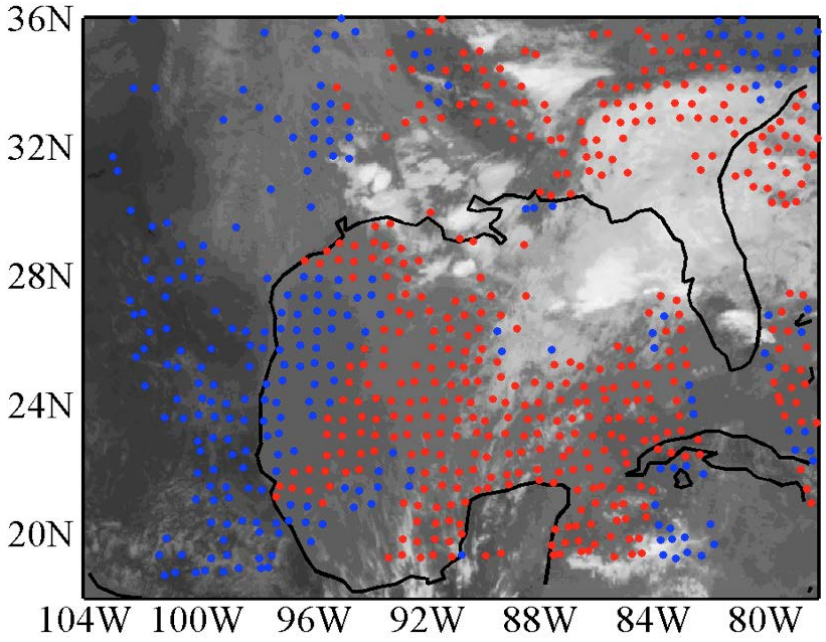
IWP



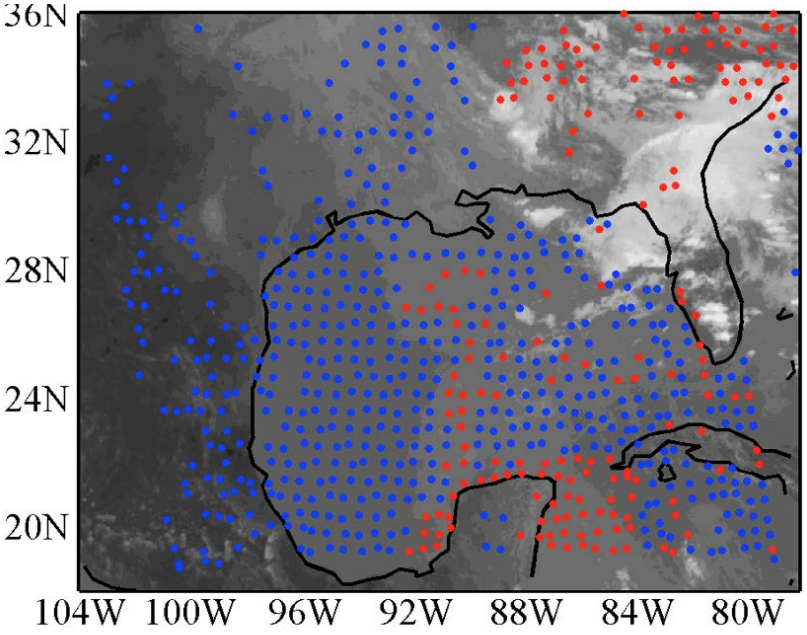
Spatial distributions of **LWP** and **IWP** match the features of low brightness temperature of GOES-12 channel 4. The MHS swaths are indicated by black curves.

Spatial Distributions of Cloudy Points Detected

1800 UTC May 22

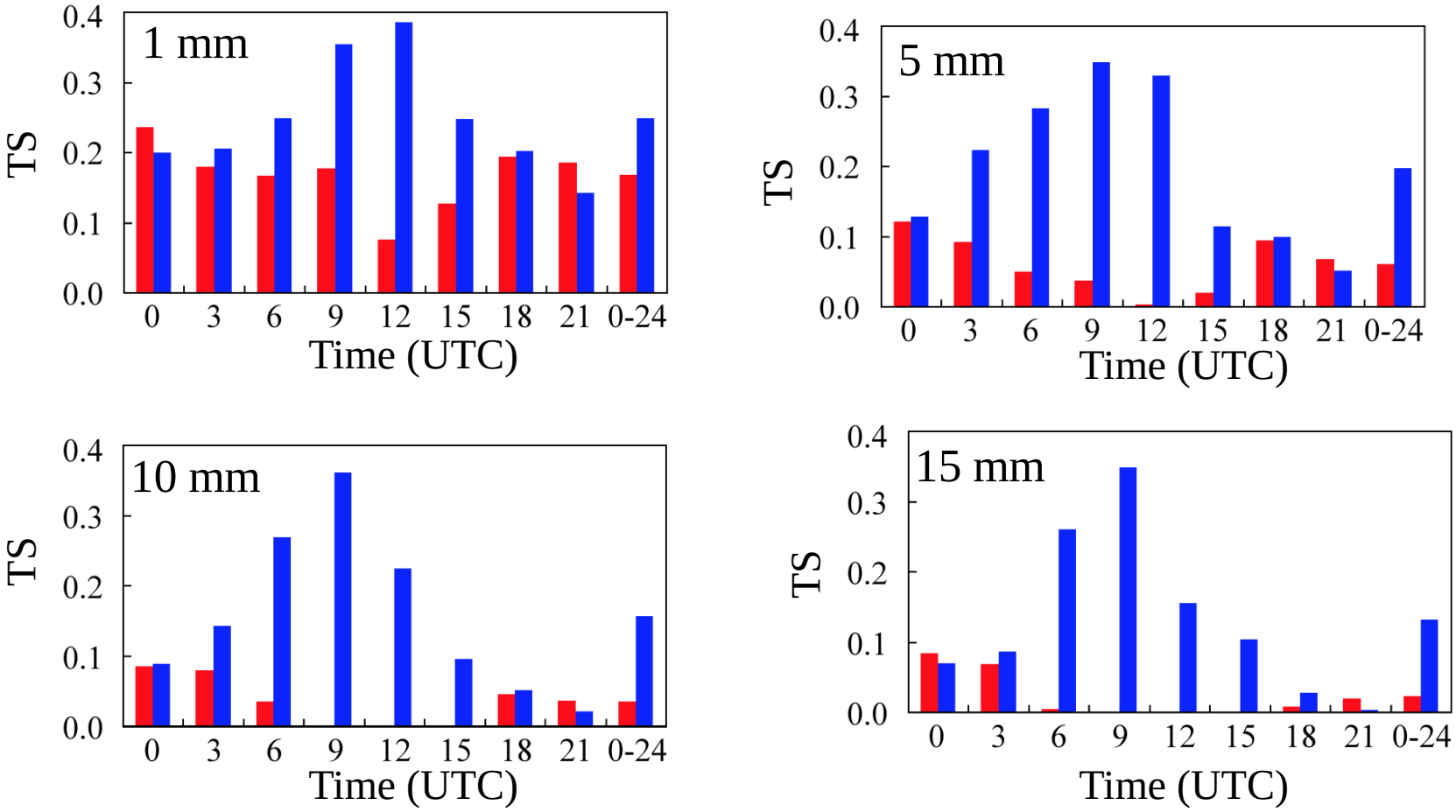


1800 UTC May 23



- Removed by the new QC
- Passed QC

Threat scores (TS) of 3-hour Accumulative Rainfall



EXP1:CONV+AMSU-A+MHS

EXP2:Same as EXP1 except for modified MHS QC

Summary and Future Work

- GSI QC fails to identify some cloudy MHS radiances near cloud edges
- A physical retrieval based algorithm is introduced to removes cloudy MHS radiances over ocean
- A new empirical algorithm is developed to remove cloudy MHS radiance over land
- Incorporate the proposed algorithm to GSI DA system
- Carry out high-resolution GOES imager radiance data assimilation