

# Clear-Sky Radiance (CSR) Assimilation from Geostationary Infrared Imagers at NCEP

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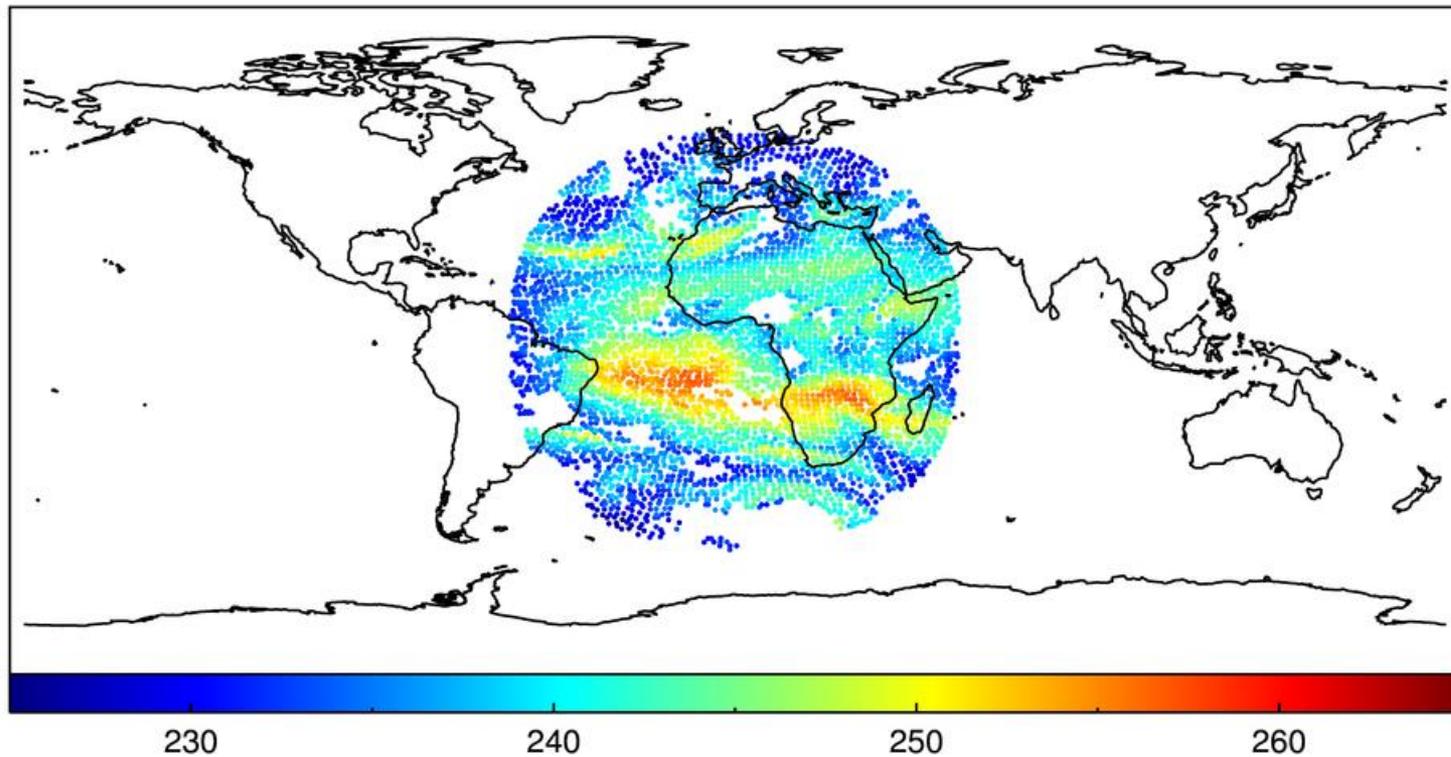
Andrew Collard (IMSG@NOAA/NCEP/EMC)

Thanks to Sharon Nebuda and Jim Jung at CIMSS, University of Wisconsin,  
Yangrong Lin and Sudhir Nadiga at NOAA/NCEP/EMC  
Qiang Zhao, Peter Keehn and Tom King at NOAA/NESDIS/STAR



# CSR Data Assimilated Operationally at NCEP

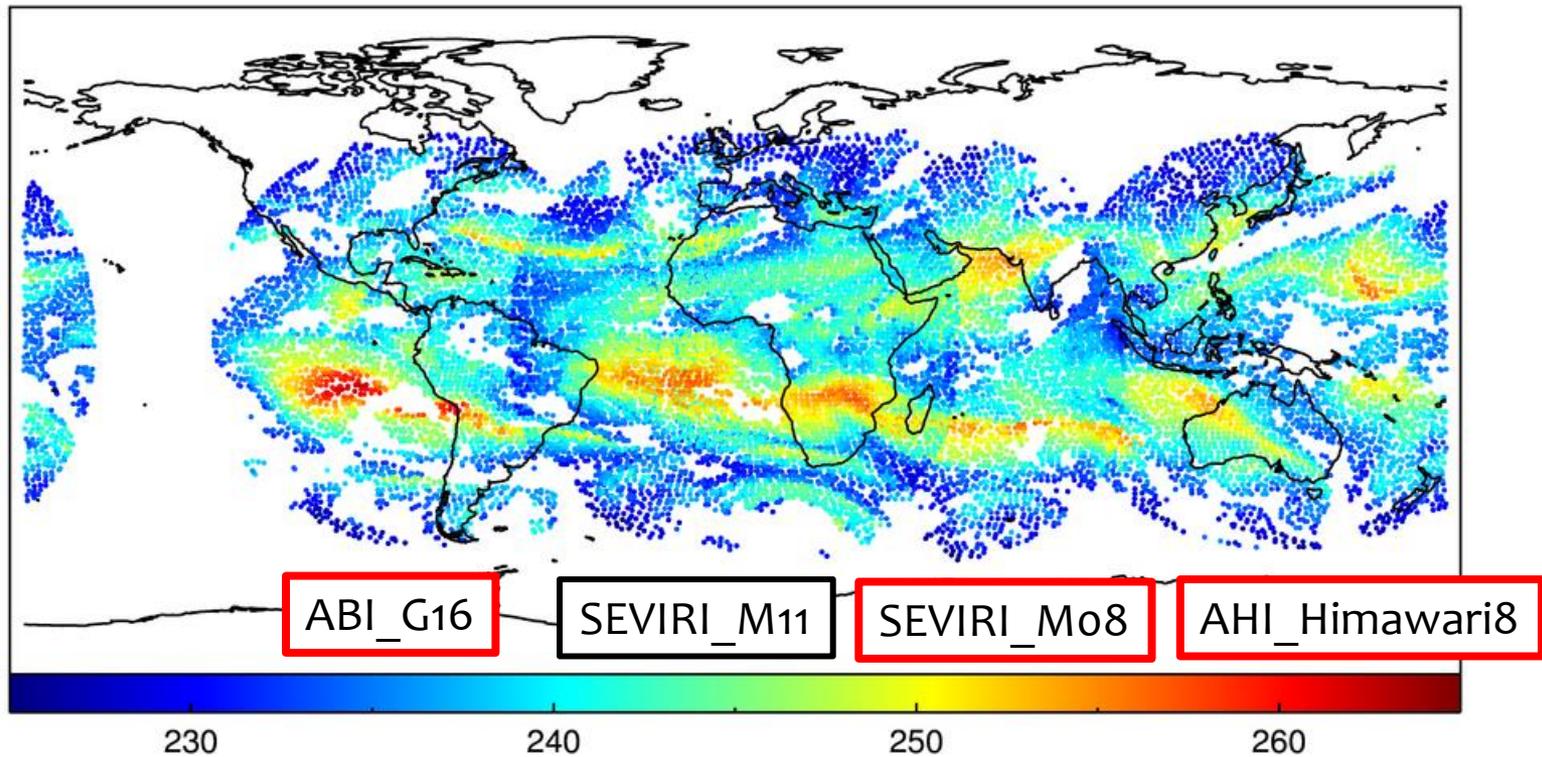
Observed Tb(K) SEVIRI\_M11 upper-level water vapor channel



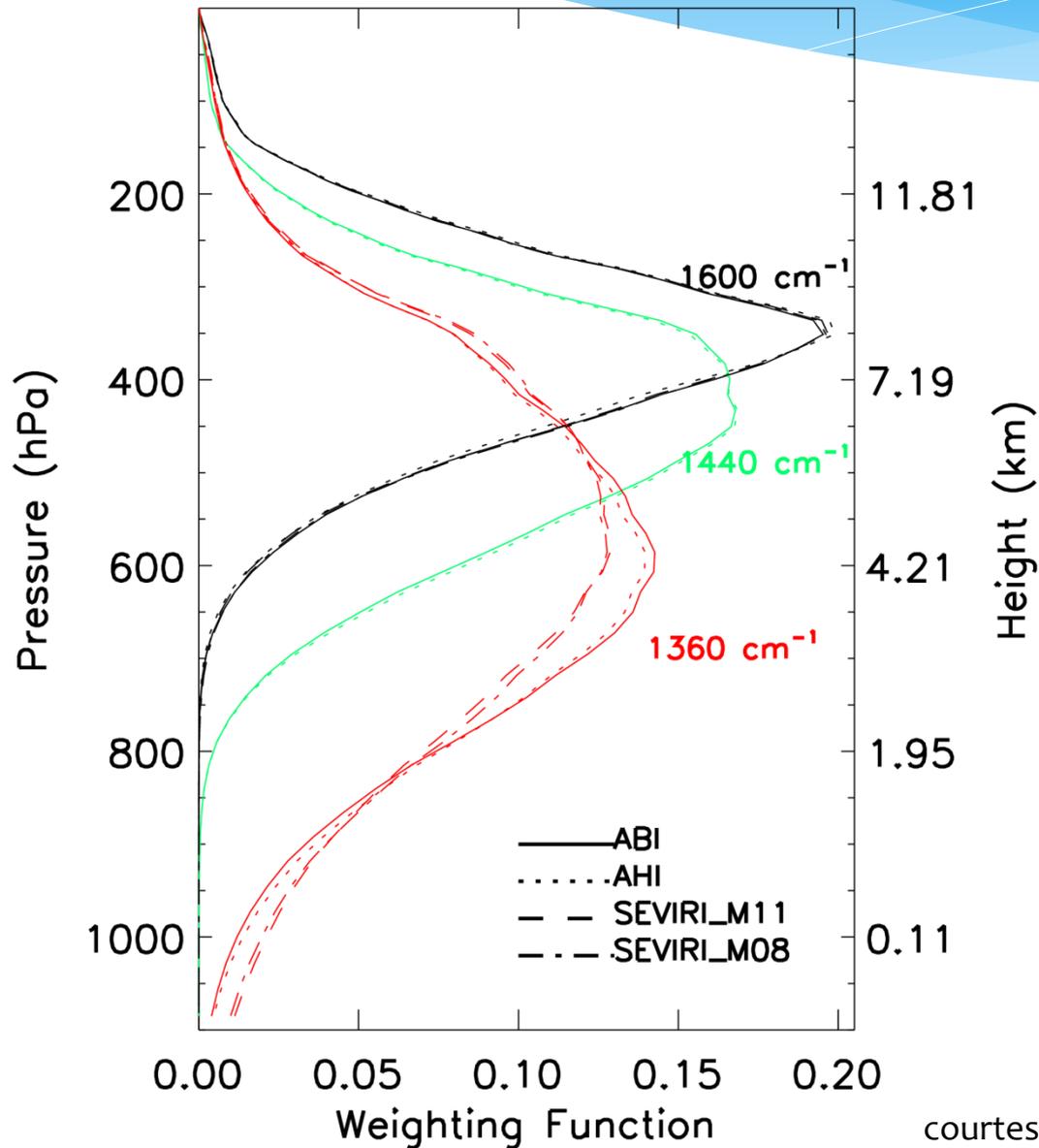
after thinning

# CSR Data to Be Assimilated Operationally at NCEP

Observed Tb(K) Geostationary Imagers upper-level water vapor channel



# Weighting Function for Water Vapor Channels



courtesy of Yong Chen



# Outline

- \* ABI\_G16 CSR product and its quality control
- \* Evaluation of CSR products from geostationary infrared imager instruments: ABI, AHI, SEVIRI
- \* Assimilation experiment configuration and results
- \* Summary and future plans

# ABI\_G16 CSR Product

- \* Clear-Sky Radiance (CSR) product is generated from the 2km pixels of the infrared **channels 7-16** combined with the GOES-R cloud mask. Within a 15x15 pixels segment, CSR is calculated as the averaged BT from clear pixels only. It was available to us for testing in Feb. 2018. This version used **Baseline cloud mask**.
- \* There were a few upgrades to this product. Most important one is the cloud mask upgrade. The CSR algorithm has not been changed since Dec. 2018. The data are basically stable but not in operations yet. It is planned to be **in operations in Nov. 2019**.
- \* ABI CSR product is provided with full-disc scan **every 10 minutes**, different from other CSR products available hourly.
- \* The BT standard deviation from clear-pixel data, and ratio of clear pixels (rclrsky) within averaging segment are reported. The **rclrsky is NOT channel-dependent** for ABI\_G16 CSR, which is different from SEVIRI and AHI CSR products.

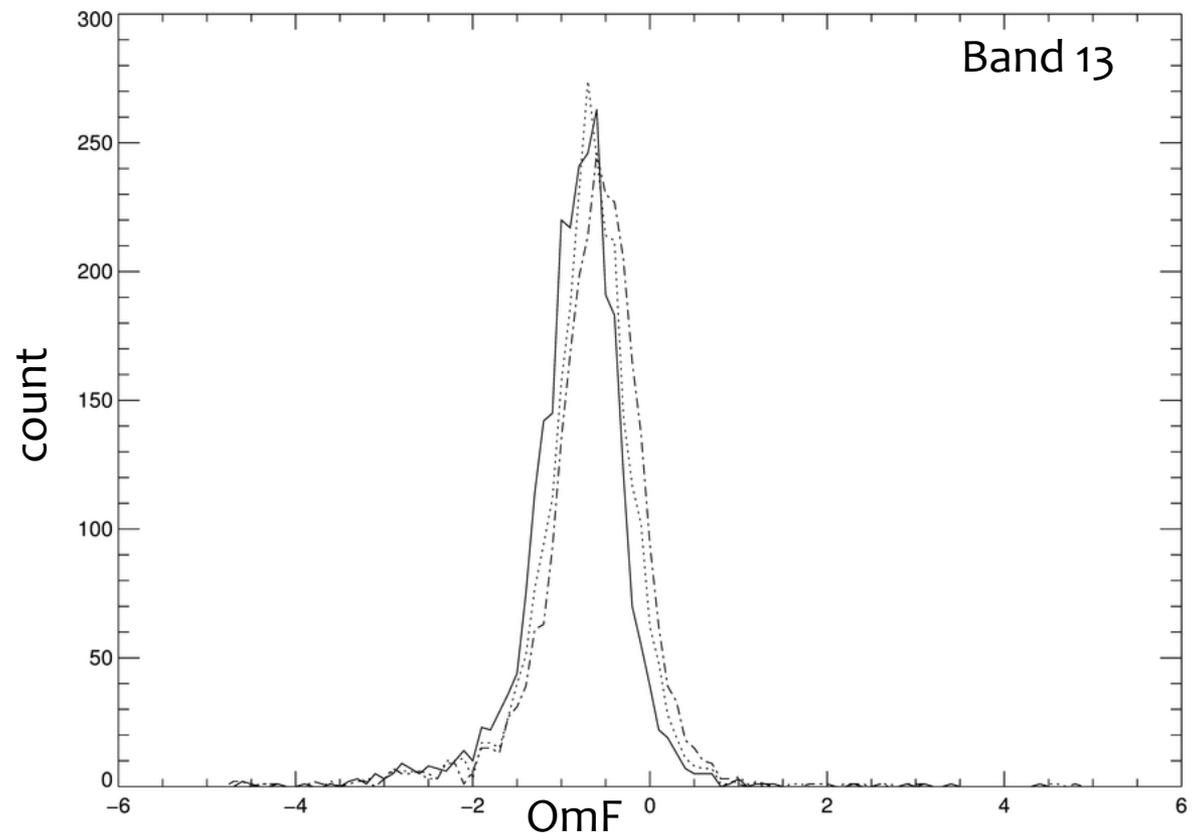


# Evaluation of ABI\_G16 CSR Data

## Compare CSR with NCEP GFS simulation

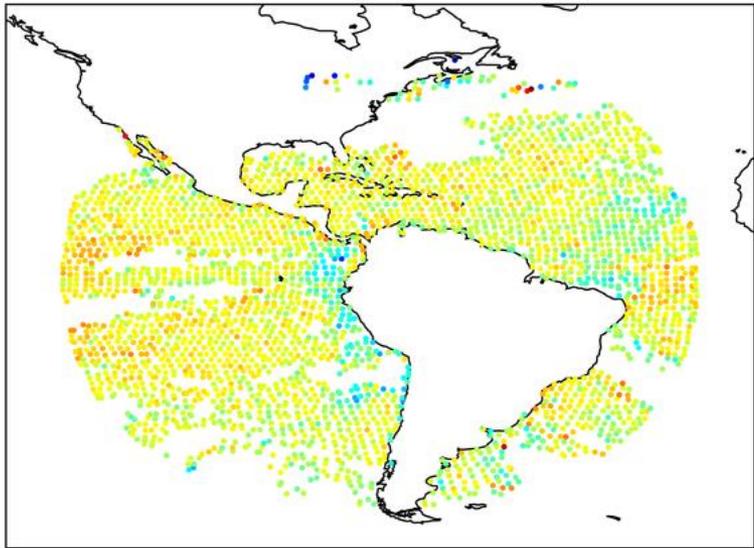
- CSR is thinned to 145km.
- Calculate simulated ABI\_G16 CSR using NCEP global forecast model as the background field and CRTM as forward model.
- Compare observed and simulated ABI\_G16 CSR (obs – fcst or **OmF**)

— all data over water  
..... rclrsky > 70% & over water  
- - - rclrsky and stdev used as thinning criteria

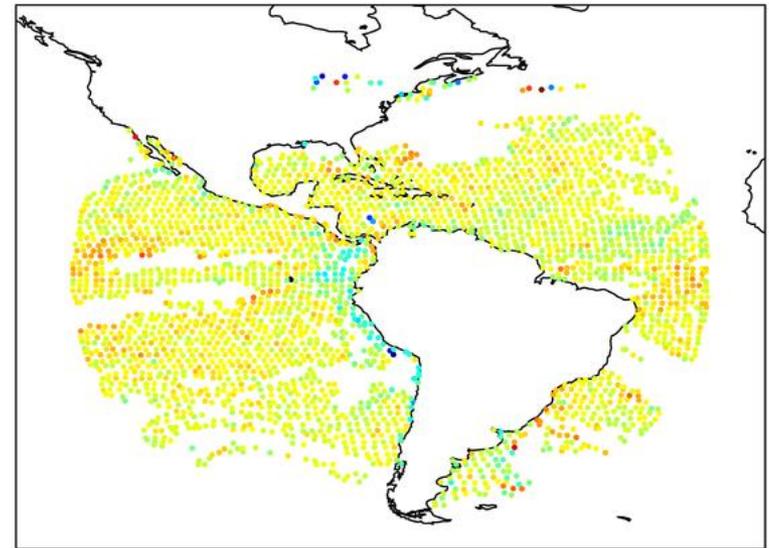


# ABI G16 CSR Data: Cloud Mask Impact

Obs - Fcst (OmF) for surface channel



Obs - Fcst (OmF) for surface channel



**Baseline cloud mask**

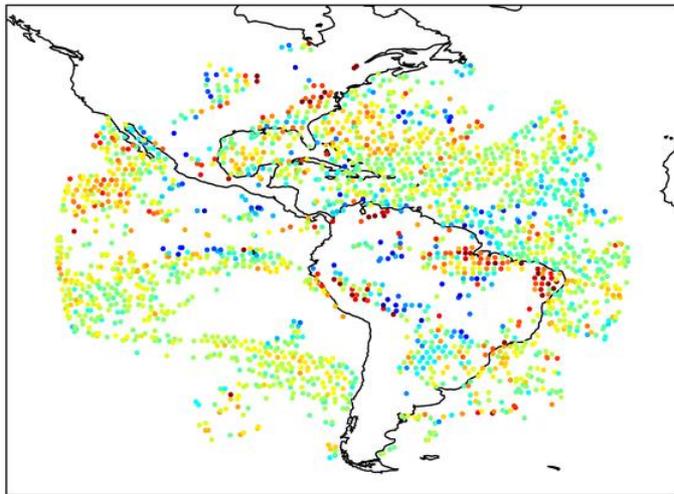
**Enterprise cloud mask**



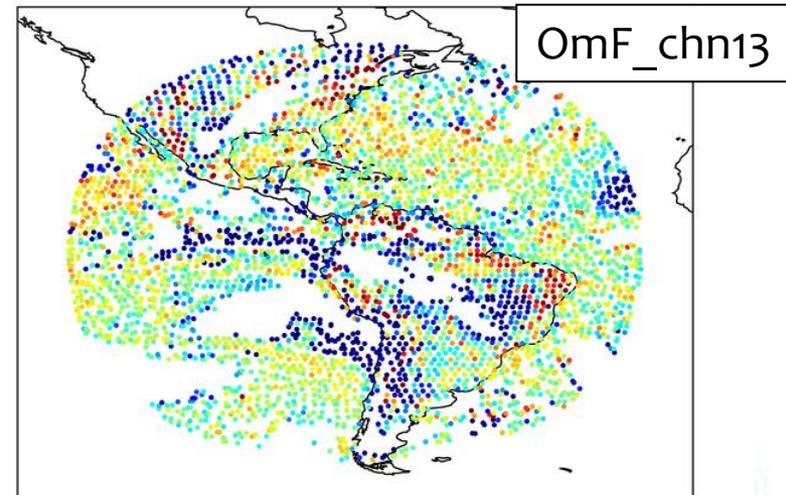
# Quality Control to ABI\_G16 CSR Data

- ❖ Enterprise version of the CSR still not being available in real time
- ❖ Additional cloud detections need to be performed to remove cloud contaminated data before assimilation is done.
- ❖ The QC we developed for ABI is used in both NCEP's global (FV3GFS) and regional data assimilation system (FV3-SAR, poster 3p.10) and in NOAA/ESRL/GSD RAP/HRRR system.

After QC

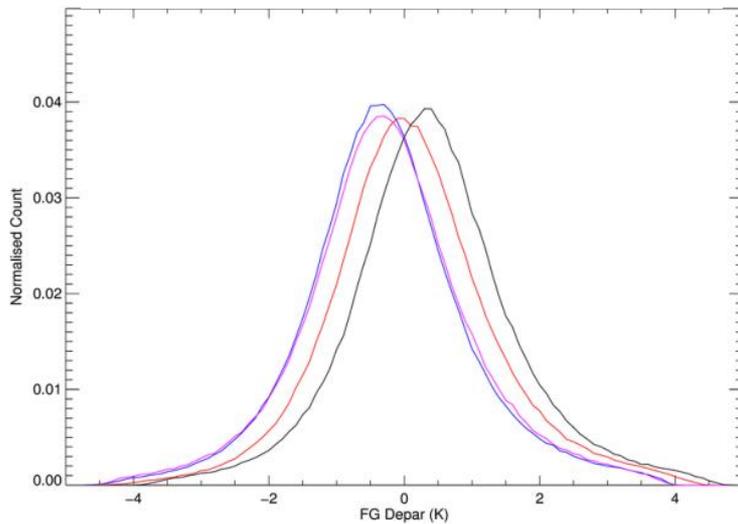


Before QC

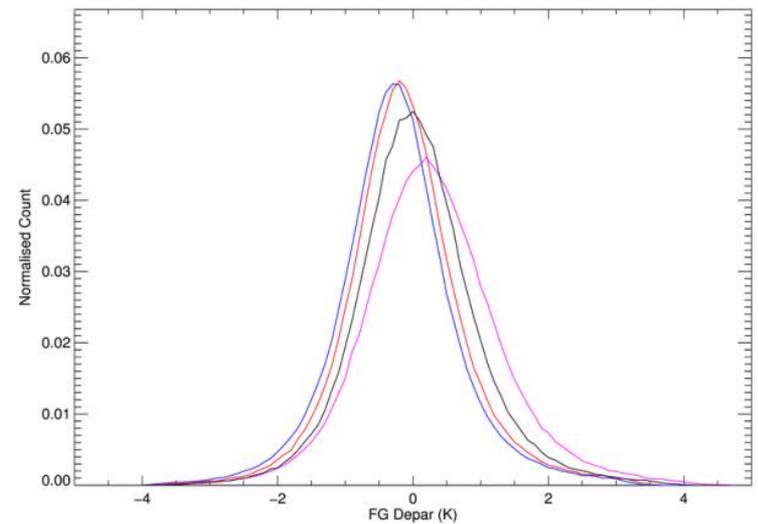


# OmF Histograms for ABI, AHI and SEVIRI

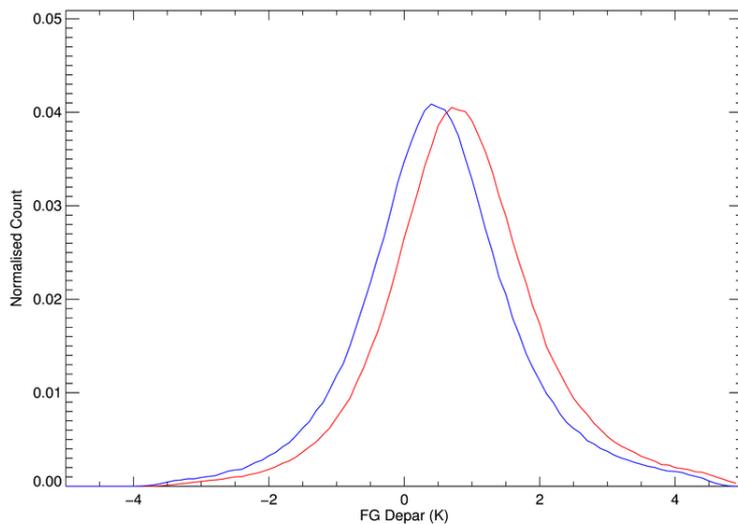
## upper-level water vapor channel



## lower-level water vapor channel



## mid-level water vapor channel



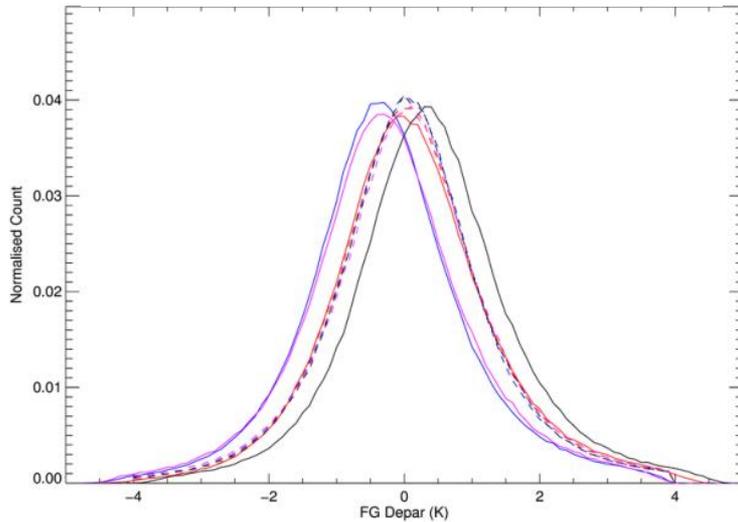
Red: abi  
Blue: ahi  
Magenta: seviri\_mo8  
Black: seviri\_m11

Data samples: May 1-30, 2019  
after quality control and  
before bias correction

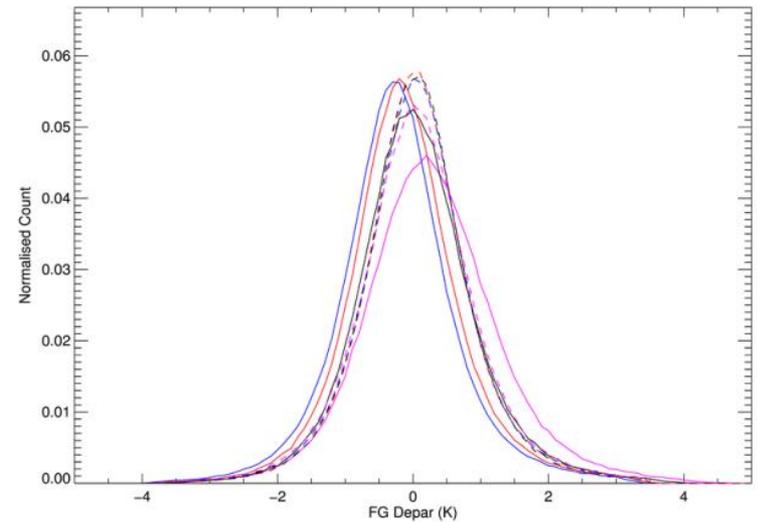


# OmF Histograms for ABI, AHI and SEVIRI

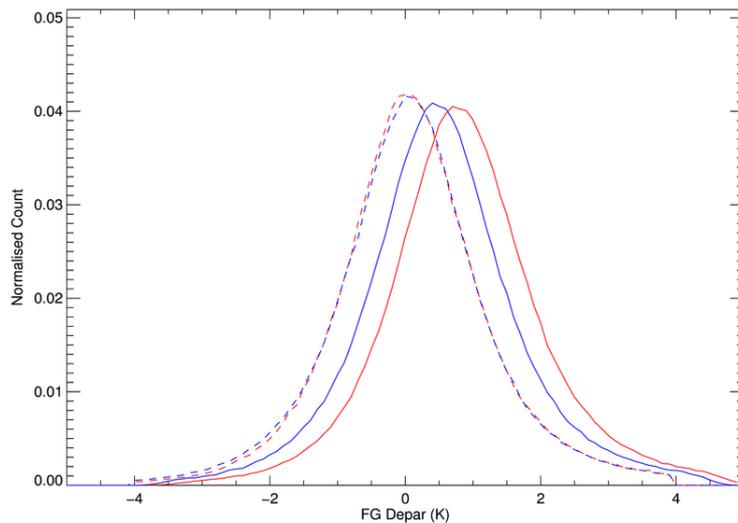
## upper-level water vapor channel



## lower-level water vapor channel



## mid-level water vapor channel



Red: abi  
Blue: ahi  
Magenta: seviri\_mo8  
Black: seviri\_m11

Solid: before bias correction  
Dashed: after bias correction



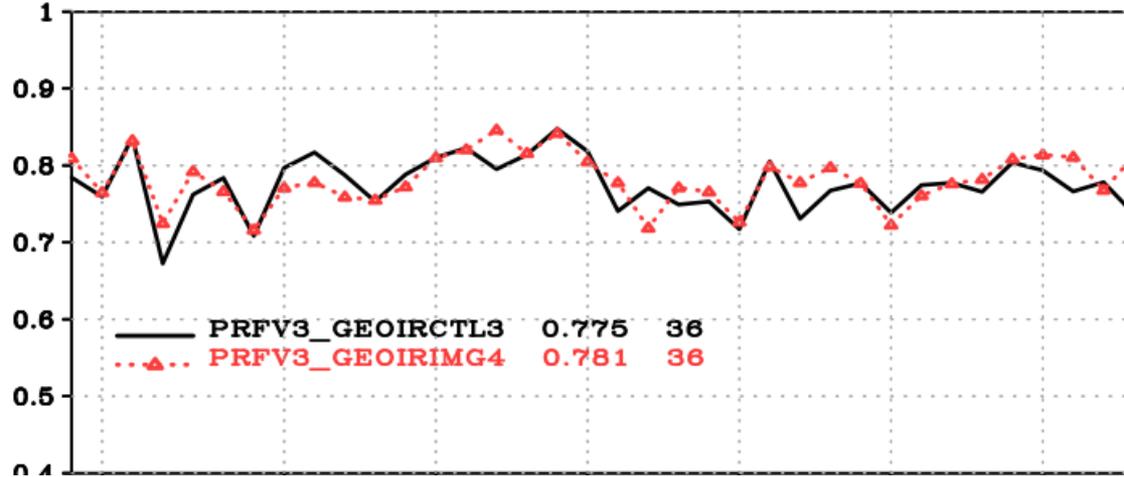
# Assimilation Experiment Configuration

- \* Model: Finite Volume Cubed-Sphere Dynamical Core Global Forecast System (FV3GFS) implemented on June 12, 2019.
- \* Hybrid 4DEnVar: operational configuration with reduced resolution C384 (~25km) and C192 for ensembles
- \* Full observation system: same data set used as in operation.
- \* Thin CSR data to 145km.
- \* **CNTL**: all the observations used in operation
- \* **EXP**: all the observations used in operation + CSRs from **ABI\_G16 + AHI\_Himawari8 + SEVIRI\_Mo8 water vapor channels** with tighter QC.
- \* Gross error check: 4.0, 4.0 and 3.5K for 3 water vapor channels and assigned obs errors are estimated from the OmF statistics.

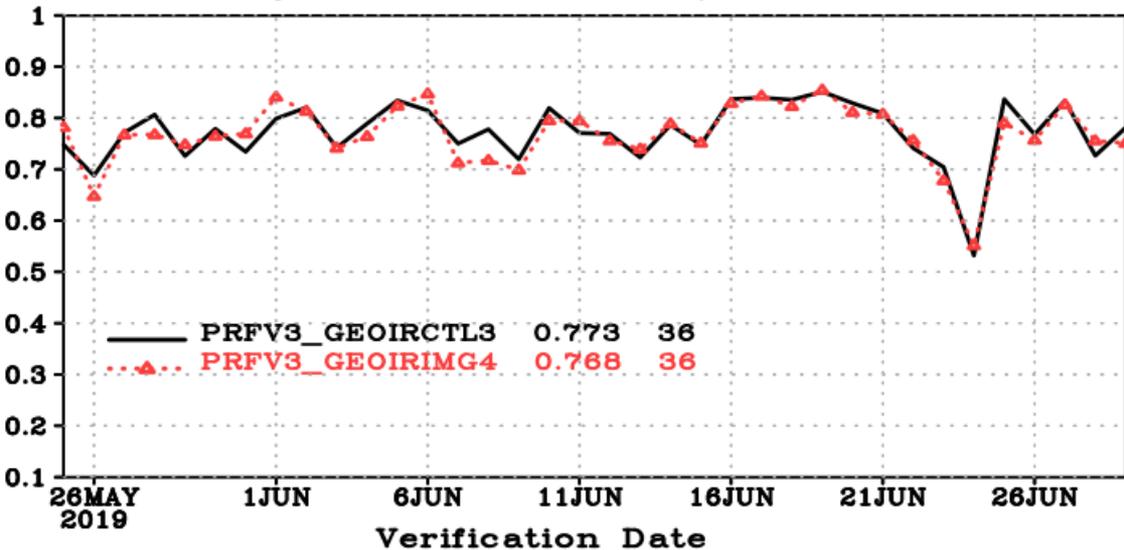


# Geostationary Imager CSR Data Impact

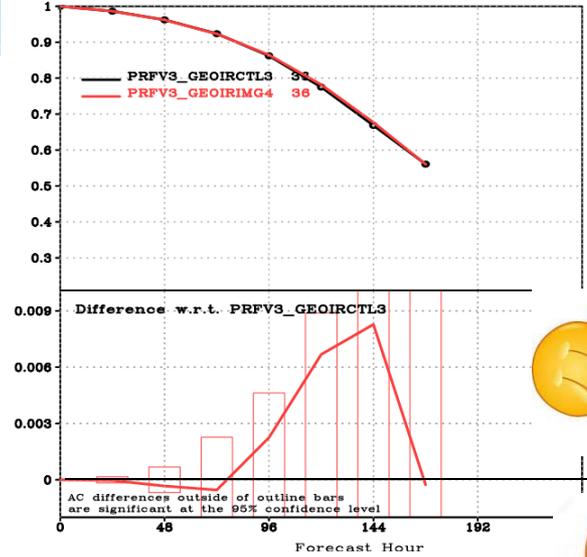
Anomaly Correl: T P500 G2/NHX 00 Z, fh120



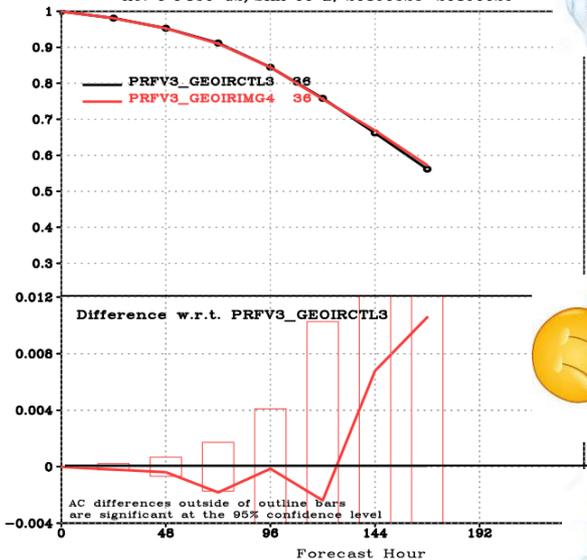
Anomaly Correl: T P500 G2/SHX 00 Z, fh120



AC: T P500 G2/NHX 00 Z, 20190526-20190629

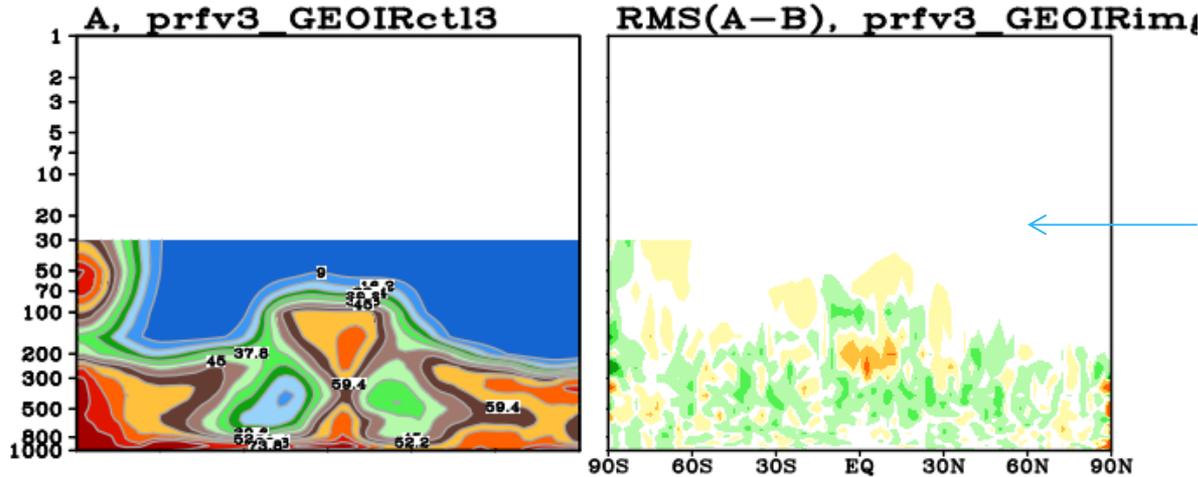


AC: T P850 G2/SHX 00 Z, 20190526-20190629

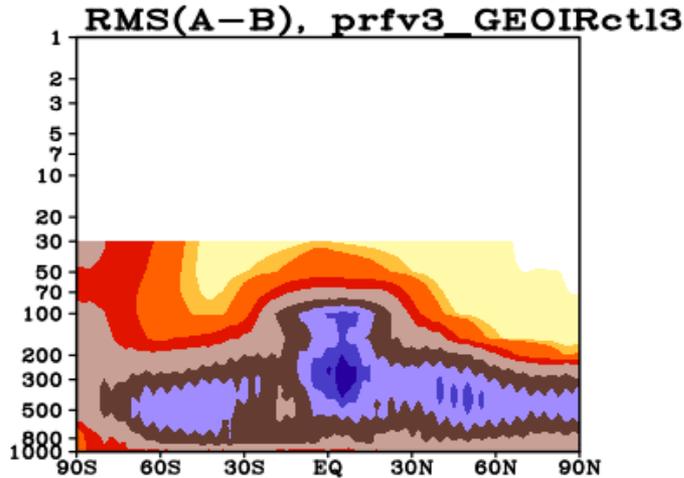


# Geostationary Imager CSR Data Impact

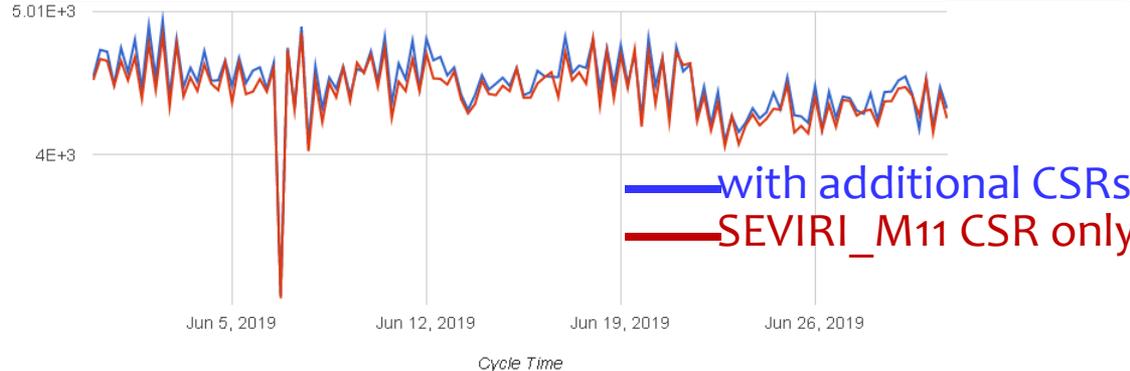
RMS of GDAS Analysis Increments, RH (%)  
 [00 06 12 18] Cycles, 00Z01May2019 ~ 18Z29Jun2019



Improvement on the  
**RH** when verified  
 against its own  
 analysis



## Data counts from MHS\_metop-a

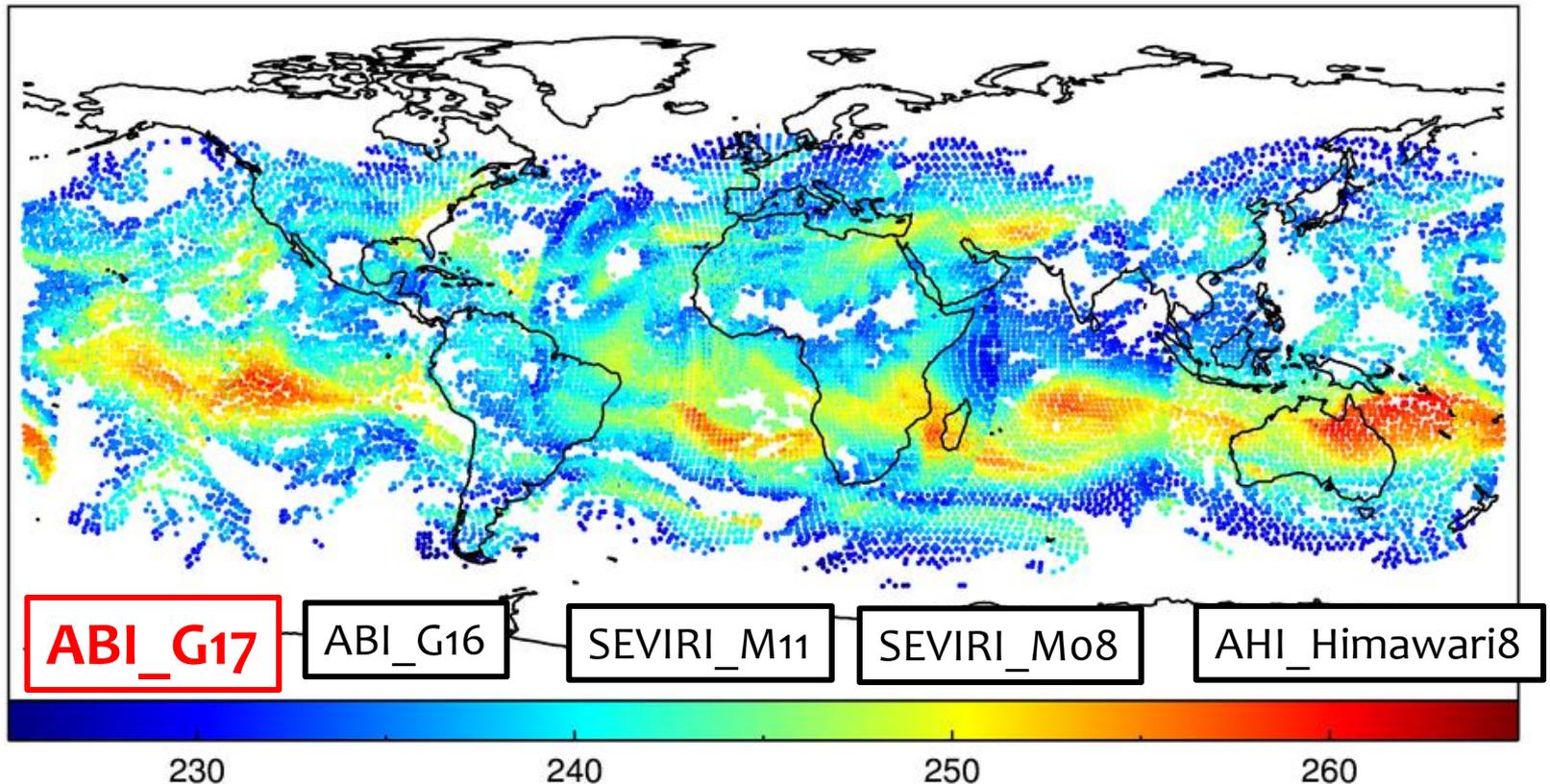


# Summary and Future Plans

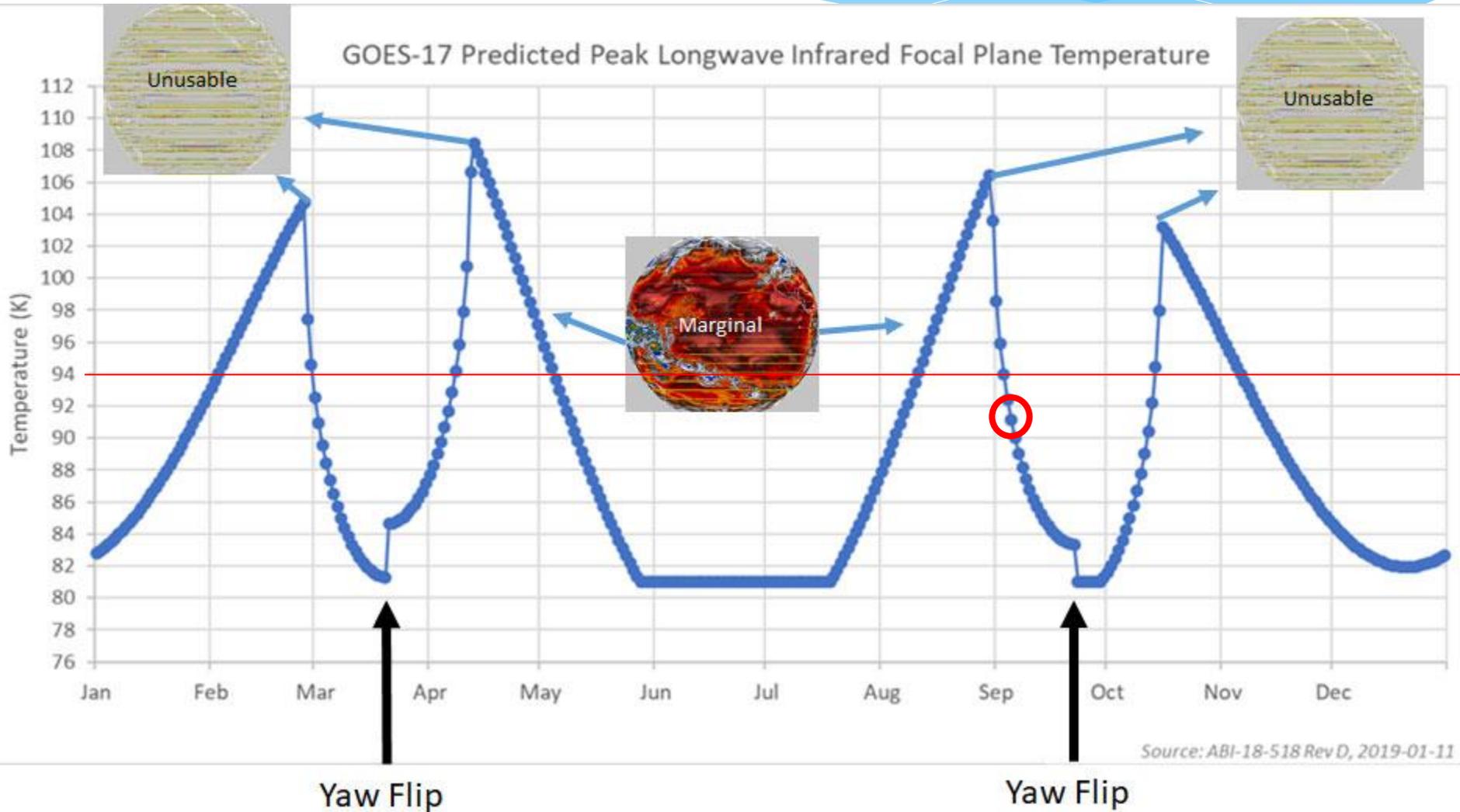
- \* The ABI\_G16 CSR enterprise version better than the baseline version but has stability issue. The baseline CSR OmF was studied. Several QC were developed to help remove cloud contaminated data.
- \* The CSRs from ABI\_G16, AHI\_himawari8, SEVIRI\_Mo8 in addition to the CSR from SEVIRI\_M11 have been tested in FV3GFS system. Results show neutral to slightly positive impact.
- \* ABI\_G17 CSR data are under development and will be evaluated in the future.
- \* All-Sky Radiance (ASR) products will be evaluated in the FV3GFS system: 5 cloud species: cloud water, cloud ice, snow, graupel and rain, which should improve all-sky OmF characteristics.

# ABI\_G17 CSR Data Initial View

Observed Tb(K) Geostationary Imagers upper-level water vapor channel

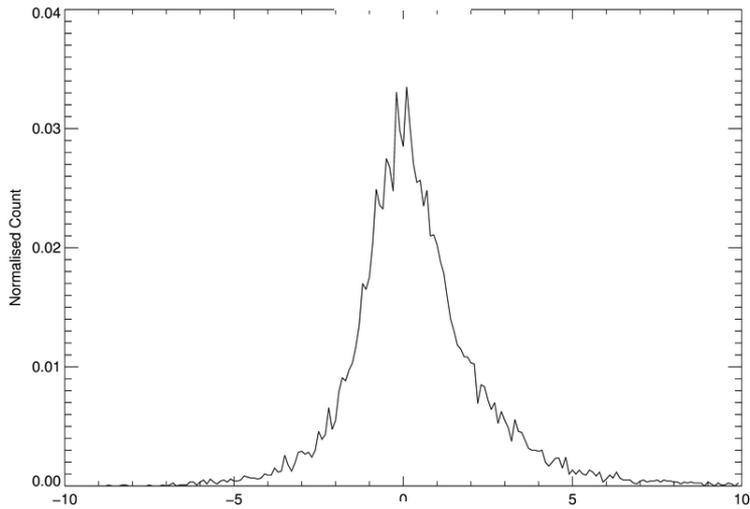


# G17 Predicted Peak Longwave IR Focal Plane Temperature

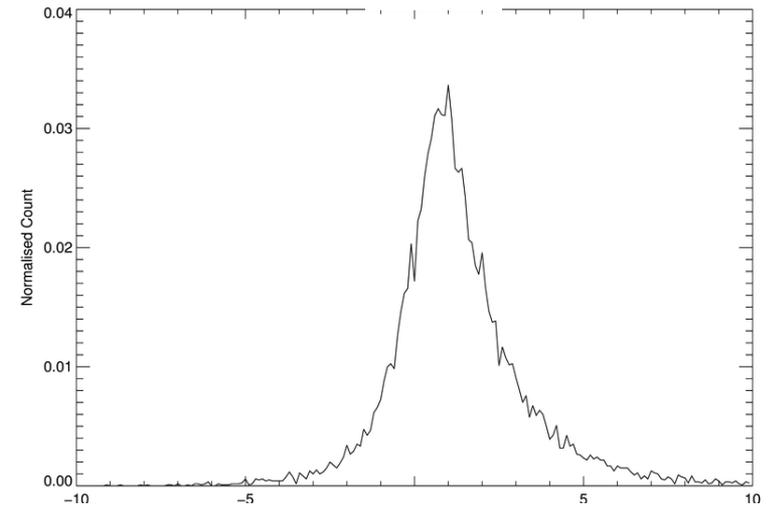


# ABI\_G17 CSR Data Initial View

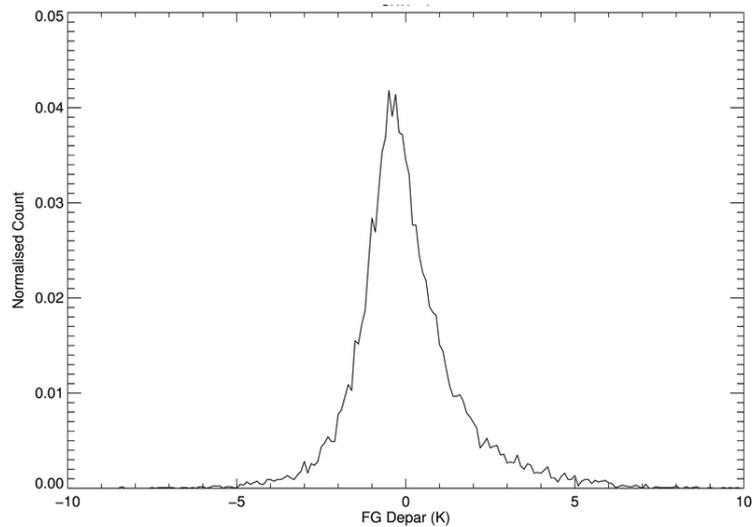
chn8



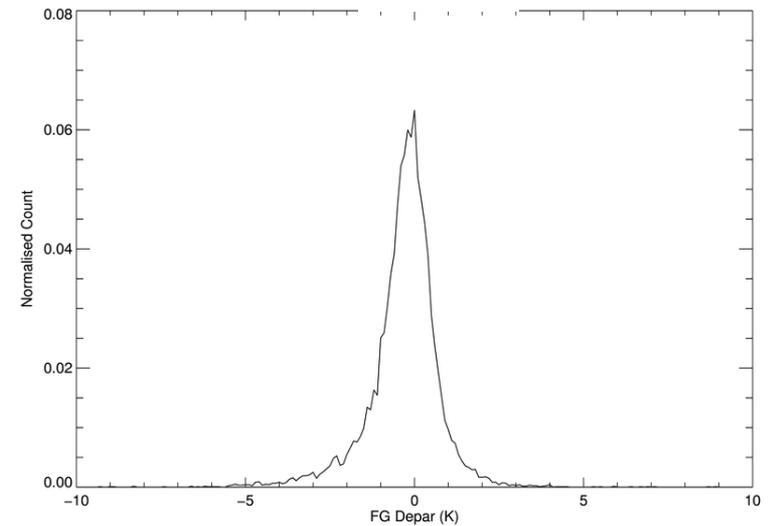
chn9



chn10



chn13



Thank you for listening!  
Questions/comments?

