Potential Impacts of ATMS and MIS Data in NCEP Global Forecast System

Banghua Yan
University of Maryland/Earth Science System Interdisciplinary Center

Fuzhong Weng
NOAA/NESDIS/Center for Satellite Applications and Research

John Derber
NOAA/NCEP/Environmental Modeling Center

AMS, Jan. 18-21, 2010

Advanced Technique Microwave Sounder (ATMS) Characteristics

- 22 microwave sounding channels
- Cross-track scanning geometry
- 96 footprints across and covers ± 52.7 °

which include AMSU-A & MHS capability

Table ATMS Channel Characteristics

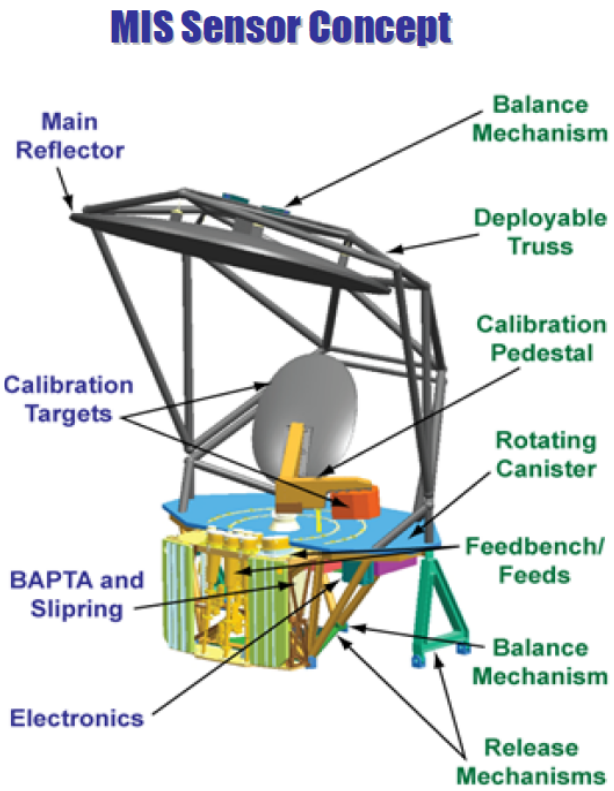
Channel	Center Frequency (GHz)	Temperature Sensitivity (NEΔT)	Static Beam Bandwidth θ_B (degrees)
1	23.8	0.9	5.2
2	31.4	0.9	5.2
3	50.3	1.2	2.2
4	51.76	0.75	2.2
5	52.8	0.75	2.2
6	53.596±0.115	0.75	2.2
7	54.40	0.75	2.2
8	54.94	0.75	2.2
9	55.50	0.75	2.2
10	57.2903	0.75	2.2
11	57.2903±0.217	1.20	2.2
12	57.2903±0.3222±0.048	1.20	2.2
13	57.2903±0.322±0.022	1.50	2.2
14	57.2903±0.322±0.010	2.40	2.2
15	57.2903±0.322±0.0045	3.60	2.2
16	87-91(88.20)	0.5	2.2
17	164-167	0.6	1.1
18	183.31±7	0.8	1.1
19	183.31±4.5	0.8	1.1
20	183.31±3	0.8	1.1
21	183.31±1.8	0.8	1.1
22	183.31±1.0	0.9	1.1

(reference: GSFC 429-00-06-03 CF15-50674-433)

Microwave Imager/Sounder (MIS) Characteristics

- Conical scanning geometry
- Atmospheric sounding: 50.3 – 57 GHz; 150/166.7 183.31 GHz
- Upper air sounding (60 – 63 GHz)
- Core imaging channels: 10 VH; 23V; 18VH; 89 VH
- Low frequency: 6.8 VH (with RFI mitigation)
- Polarimetric channels: 10 PM or LR; 18 PMLR; 37 PM

SSMIS Capability



(Reference:http://www.ipo.noaa.gov/instruments/MIS.pdf)

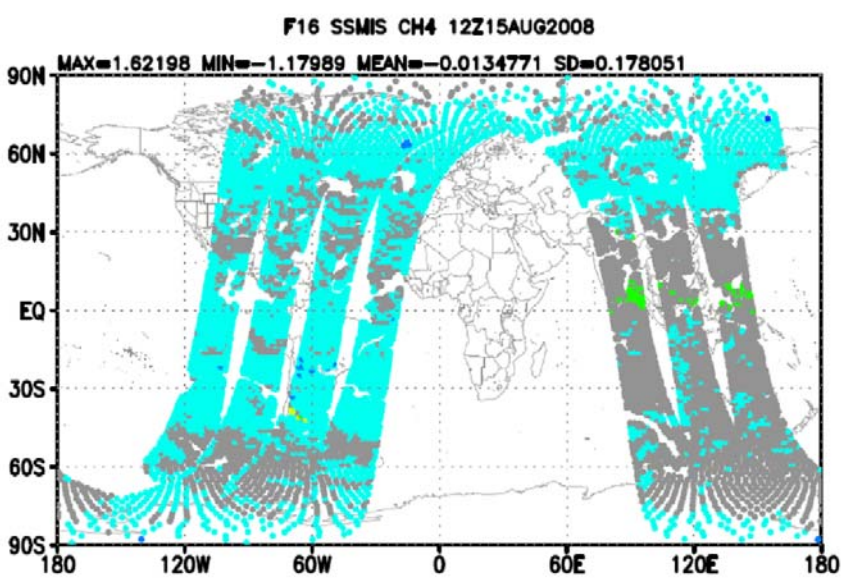
F 16 SSMIS Recalibration Algorithms

- **NRL/UK MetOffice SSMIS Unified Pre-processor (UPP data)**
  (Bell et al. 2008)
  - Correction of antenna emission for LAS
  - Correction of warm load anomaly
  - Linear mapping of SSMIS imager to its predecessor (SSM/I)
  - Doppler shift correction for UAS
  - Spatial averaging to reduce to the sub-Kelvin levels

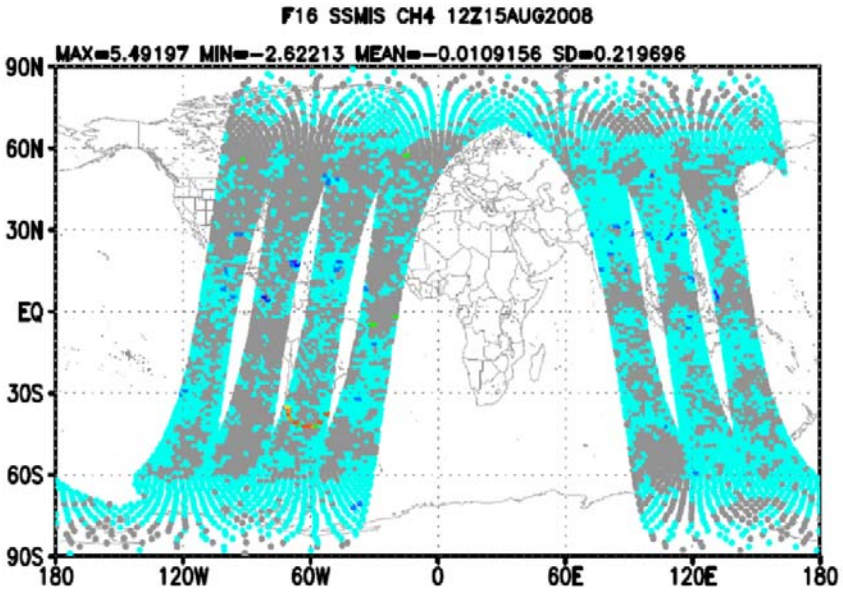
- **NOAA/NESDIS SSMIS Pre-processor (NESDIS Data)**
  (Yan and Weng 2009)
  - Correction of antenna emission for LAS
  - Correction of warm load anomaly
  - UAS bias removal using SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) measurements simulated as truth
  - Spatial filter for noise reduction
  - Linear mapping of SSMIS imager to its predecessor (SSM/I) using the F15 and F16 Simultaneous Conical Overpass observations
  - Inter-sensor calibration for SSMIS imager non-linearity (for climate reprocessing)

F16 SSMIS Biases (O-B) in GFS

UPP Data
(Bell et al. 2008)



NESDIS Data
(Yan and Weng 2009)



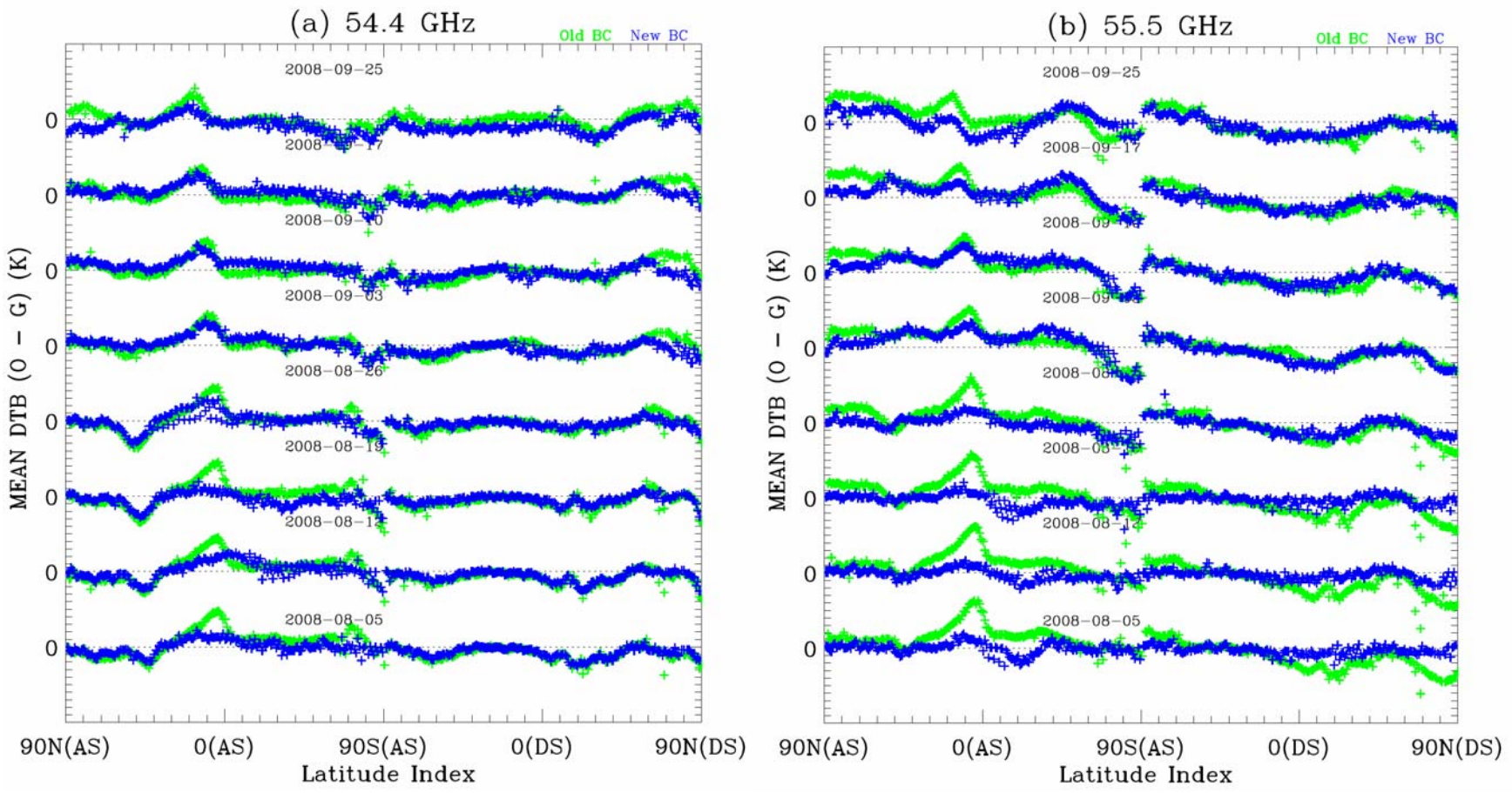
Note the same bias correction is applied to both data sets. Clearly, UPP data at this channel has bias more depending on satellite local passing time.

Bias Correction Algorithms

- **Current (EMC) Bias Correction Algorithm** (Derber and Wu 1998)
  - Correct angle dependent bias (cross-track scanning sensor)
  - Correct beam dependent bias (conical scanning sensor)
  - Remove systematic bias

- **New Bias Correction Algorithm** (Yan and Weng 2010)
  - Correct residual calibration bias at LAS channels in UPP data
  - Correct beam dependent bias (NESDIS SSMIS data)

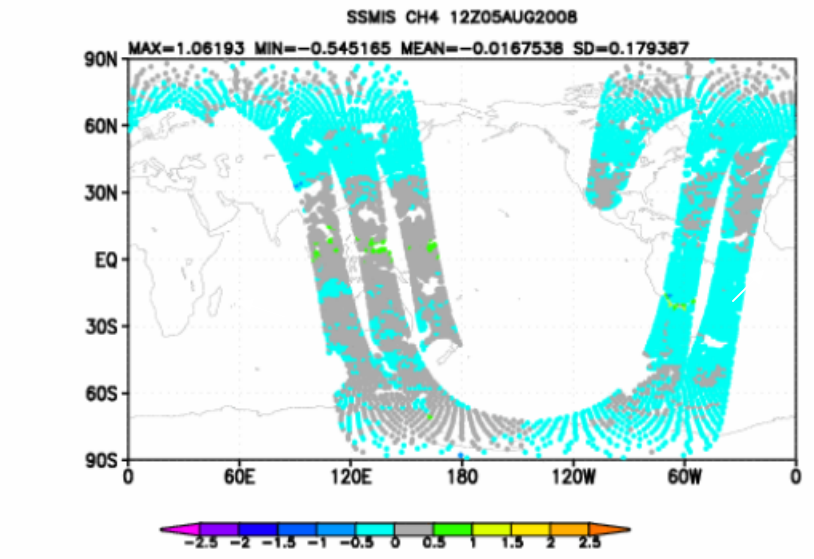
Comparison of Longitudinal-Mean Bias in TB w/wo New Bias Correction

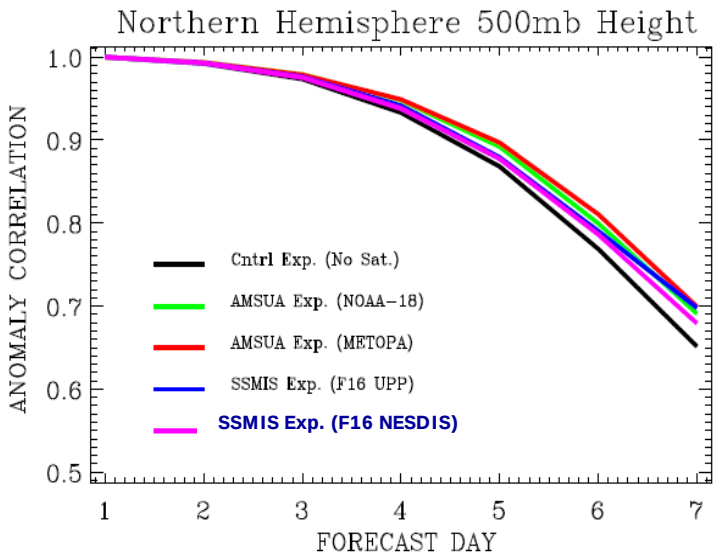


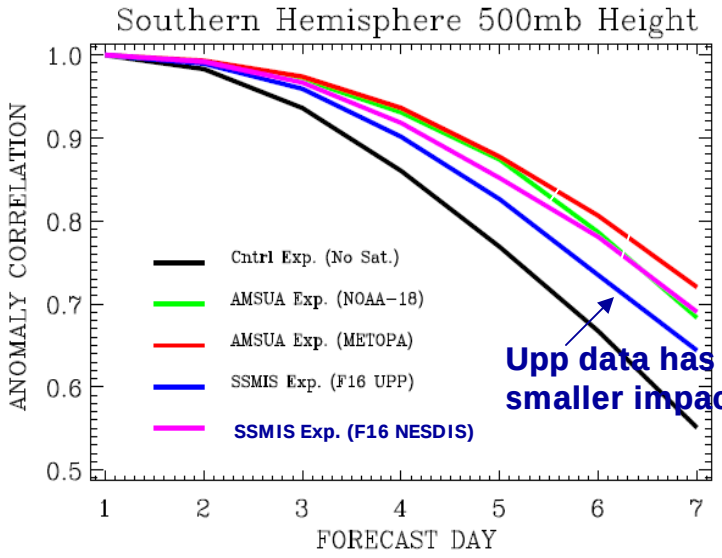
Impacts of AMSU-A and SSMIS LAS Data on Forecast Scores

- For northern hemispheric forecasts, impacts from both data sets are similar

- For southern hemispheric forecasts, the score from UPP data is much lower compared to that from NESDIS data

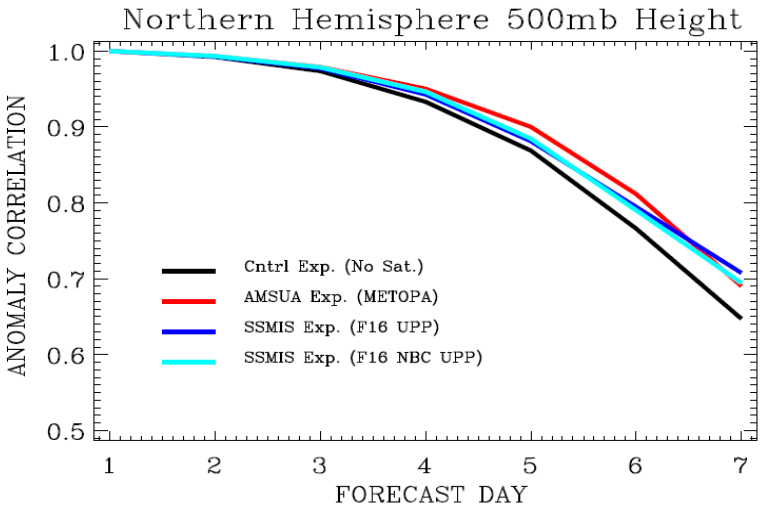


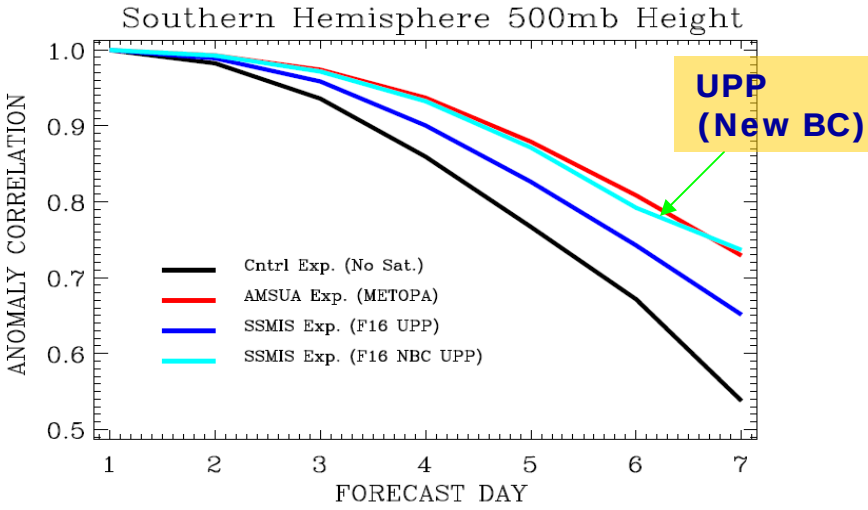




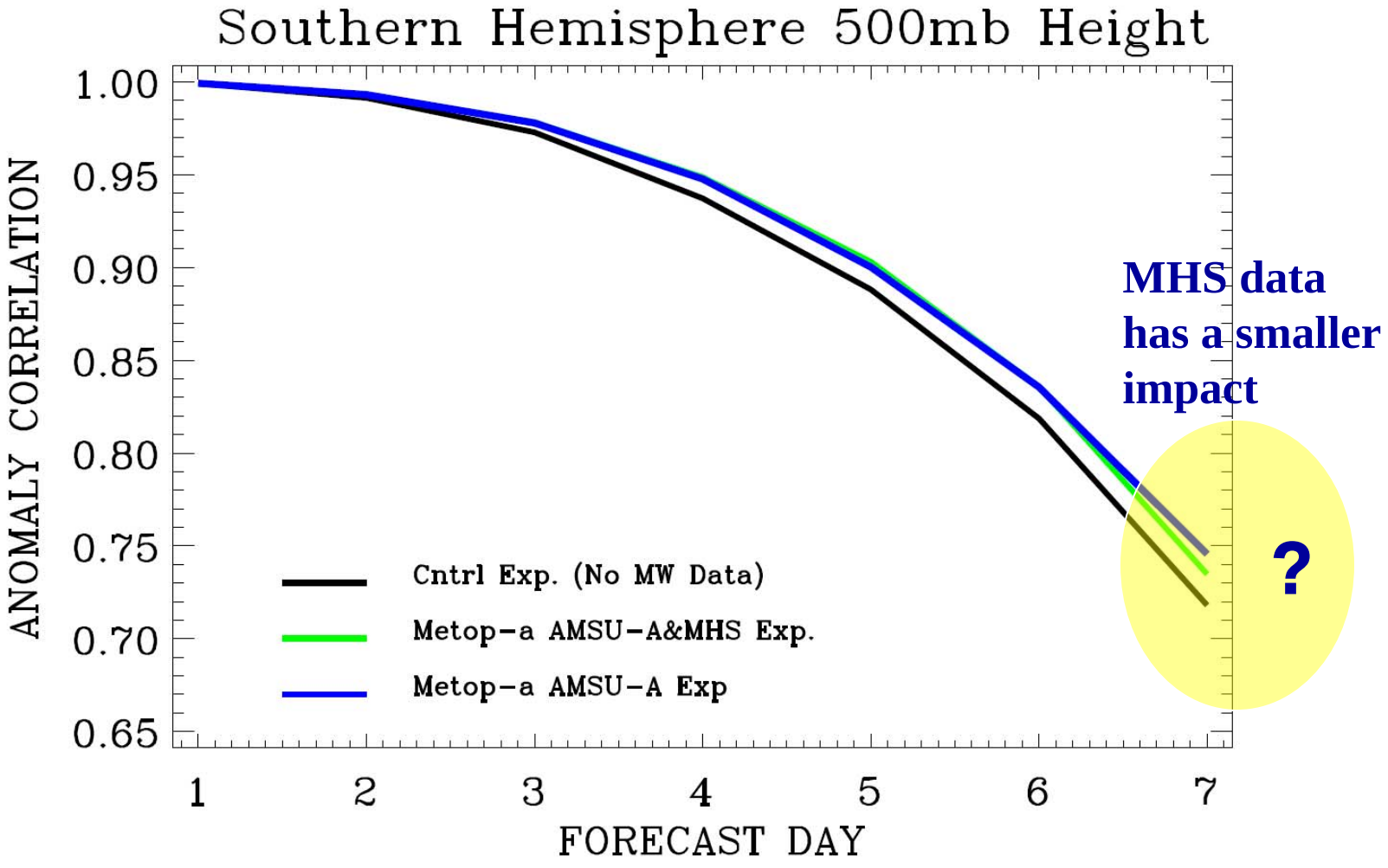
Impact of UPP LAS Data with New BC

- A new bias correction is developed which is a function of latitude and node
- Bias correction coefficients are generated based on weekly mean results
- New bias correction makes the UPP data produce much improved assimilation impact
- Conical scanning sensor SSMIS LAS (UPP) can produce impact similar to cross-track scanning sensor (AMSU-A)



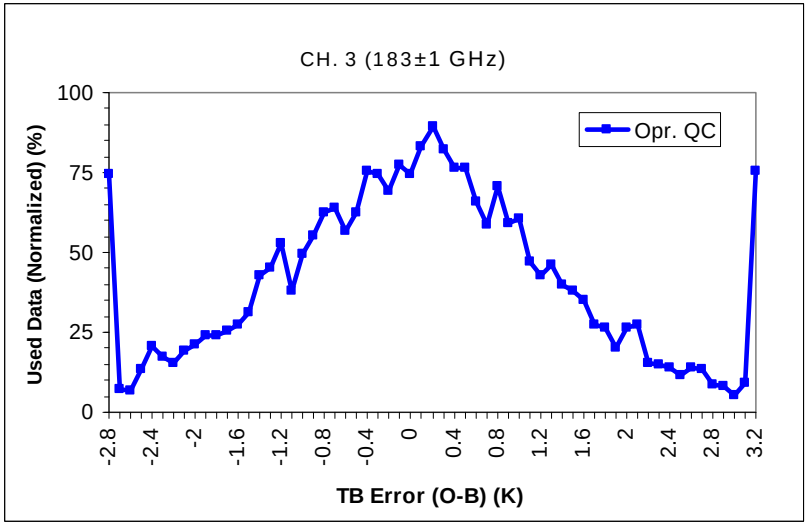


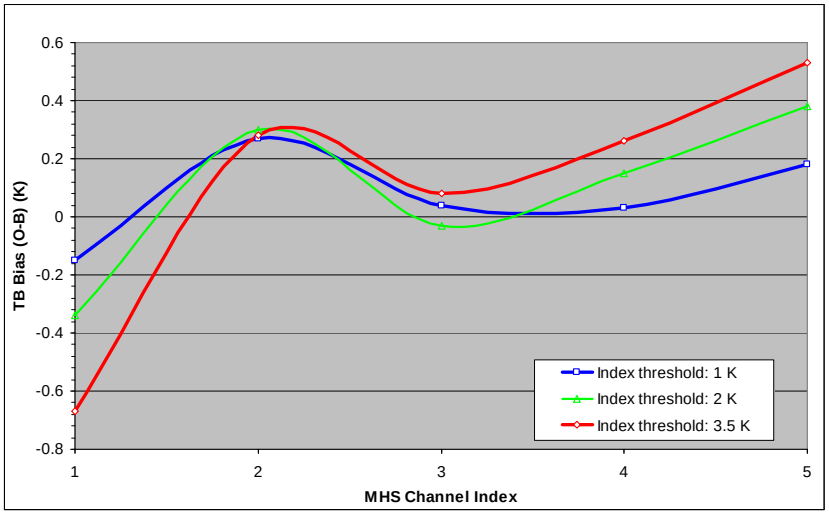
Assimilation Impact of MHS WV Channel Data Using Current GFS QC Scheme



Current GFS Quality Control for MHS (AMSU-B) Channels

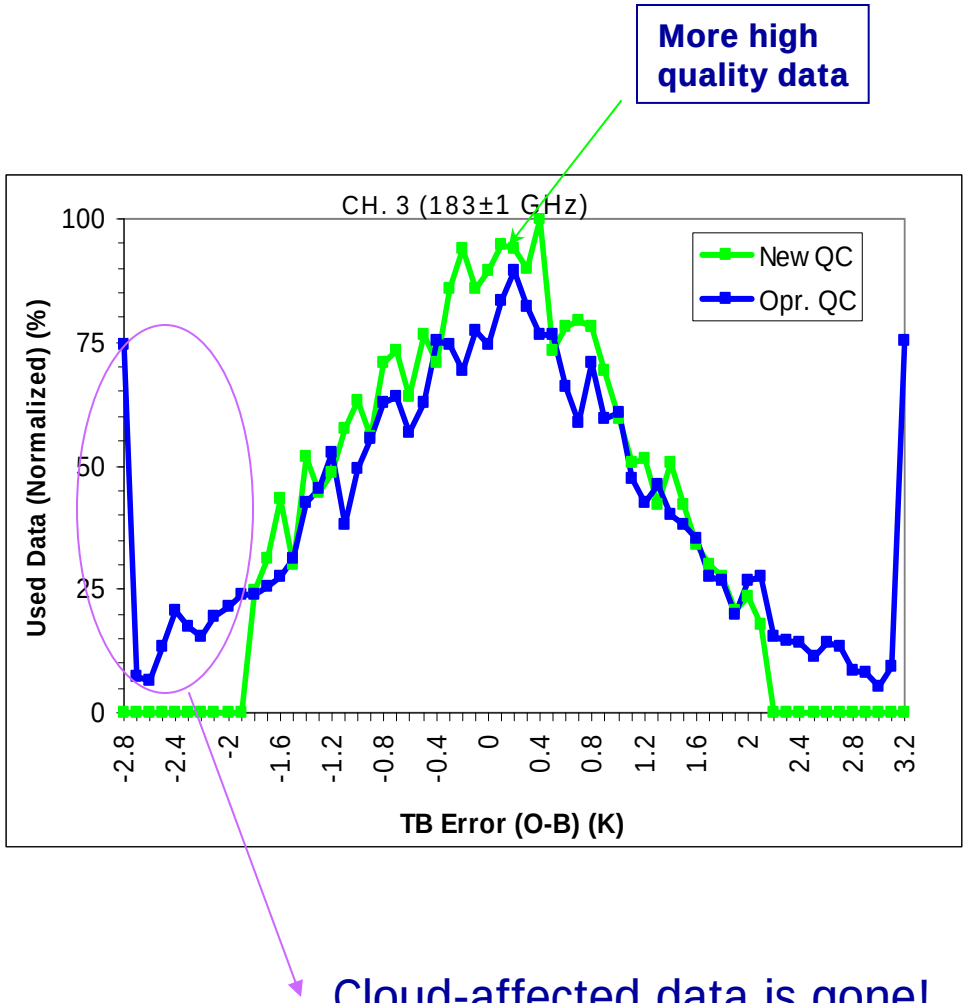
- Use an index from MHS 89 and 157 (150) GHz to check clouds/rain-affected data for each channel
- Use an index defined according to the TB biases at two window channels to check the data where RTM simulations are not accurate for each channel
- The index thresholds for gross error check are different for each channel, ranging from 2.5 to 3.5 K



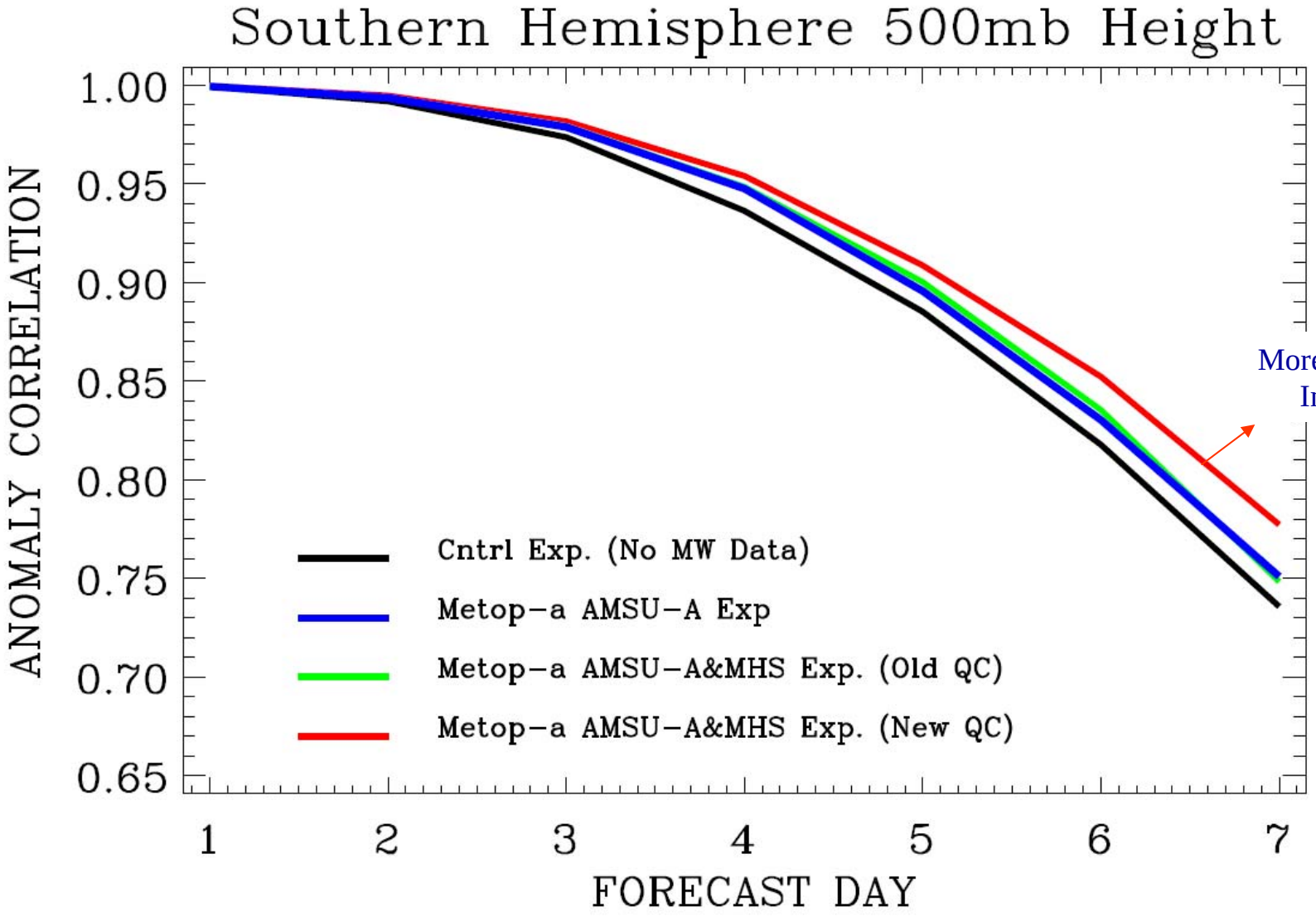


New Quality Control Scheme in MHS and SSMIS WV Channels

- Use new index from three WV channels to determine corresponding cloud/rain-affected data
- Use new index thresholds (2 K) for the gross error check at all five MHS channels (SSMIS WV channels)
- Detect ice clouds for three WV channels (Sun and Weng IWP algorithm) (to be done)

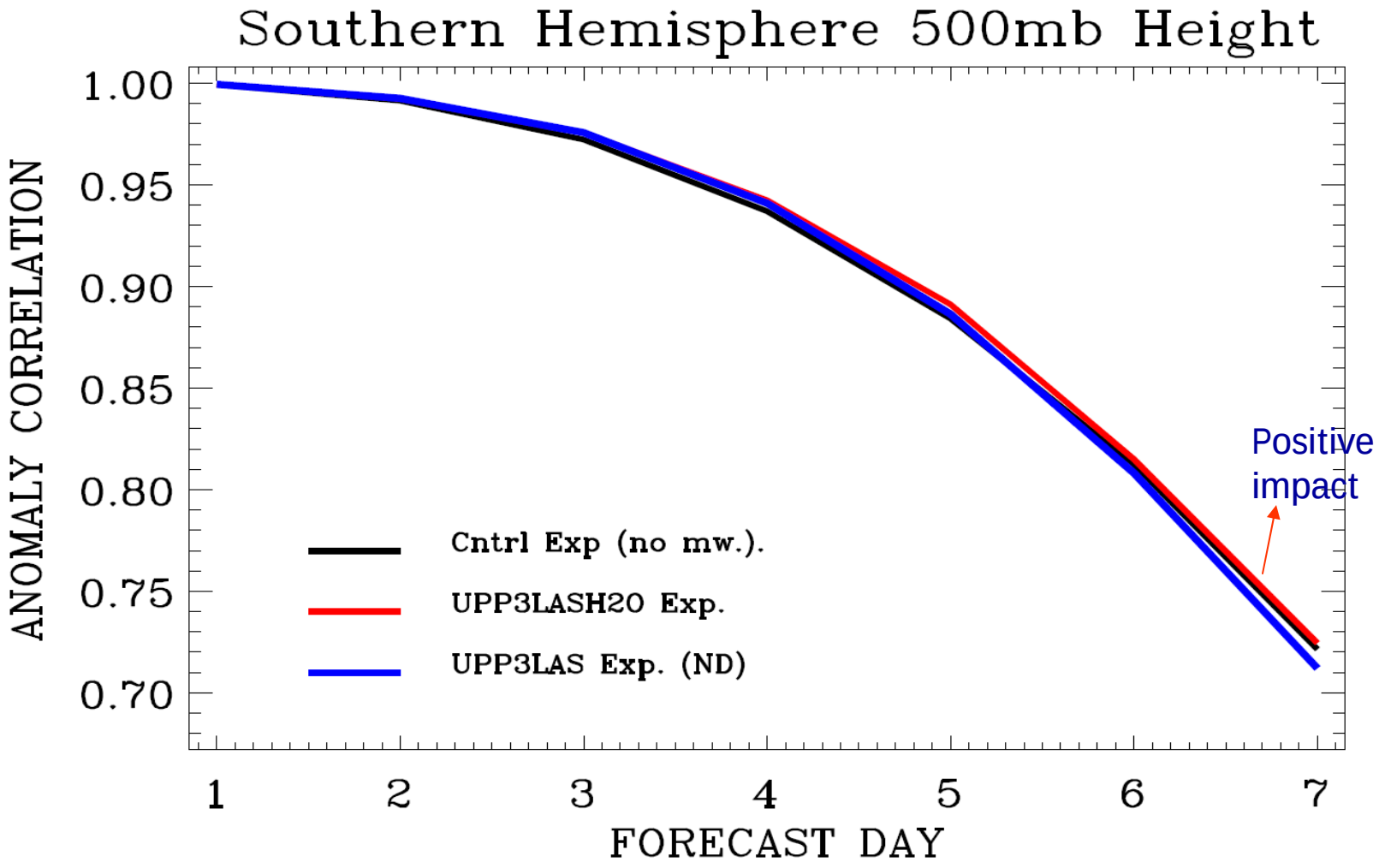


Impacts of METOP-A MHS Data (New QCs)



(35 days of exp.)

Impacts of UPP WV Data (New QCs)



(45 days of exp.)

Summary and Conclusions

- More positive impacts of the MIS LAS -like data are observed using the new bias correction scheme
- More positive impacts of the ATMS and MIS WV-like data are observed by using the new quality control scheme
- Impacts of MIS LAS-like data (conical scanning) on forecast skill can be similar to that of ATMS AMSU-A-like data (cross-track scanning)