Assimilation of ATMS radiances into the JMA's global NWP system

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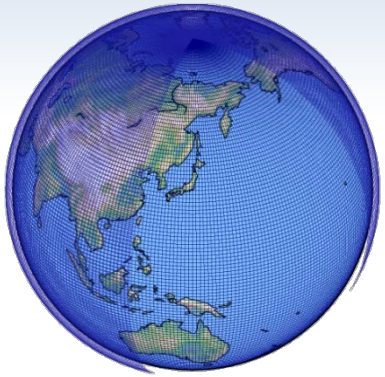
Two topics

- 1. Results of assimilation experiments of current NRT ATMS data

- 2. Evaluation of de-striped ATMS data
  - ITSC-19 NWP-WG Recommendation:
    - To use the de-striped ATMS data provided by Fuzhong Weng to assess impact of striping and to provide feedback to NESDIS.

1. RESULTS OF ASSIMILATION EXPERIMENTS OF CURRENT NRT ATMS DATA

Current Global NWP model at JMA



GSM: Global Spectral Model
TL959 (0.1875deg.) / 100 Layers up to 0.01 hPa
4D-Var (inner loop: TL319)
Assimilation window: 6 hr (-3~+3 hours)
RTM for assimilation: RTTOV 10.2

- Operationally used satellite data
  - NOAA15, 18, 19, Aqua, Metop-A, B / AMSU-A
  - NOAA18, 19, Metop-A, B / MHS
  - Megha-Tropiques / SAPHIR
  - Aqua / AIRS, Metop-A, B / IASI
  - GCOM-W1 / AMSR2
  - DMSP-F16, 17, 18 / SSMIS
  - MTSAT-2, Meteosat-7, 10, GOES-13, 15 / CSR, AMV
  - Aqua, Terra / MODIS / AMV, NOAA, Metop / AVHRR / AMV, LEO-GEO / AMV
  - Metop-A, B / ASCAT
  - Metop-A, B, COSMIC, GRACE-A, TerraSAR-X, C/NOFS / GNSS-RO

Channel selection for ATOVS and ATMS

AMSU-A and MHS

	Clear Sea	Clear Sea ice	Clear Land	Cloud Sea	Rain Sea
AMSU-A/ch4	x				
AMSU-A/ch5	x				
AMSU-A/ch6	x	x	x		
AMSU-A/ch7	x	x	x	x	
AMSU-A/ch8	x	x	x	x	
AMSU-A/ch9	x	x	x	x	x
AMSU-A/ch10	x	x	x	x	x
AMSU-A/ch11	x	x	x	x	x
AMSU-A/ch12	x	x	x	x	x
AMSU-A/ch13	x	x	x	x	x
AMSU-A/ch14	x	x	x	x	x
MHS/ch3	x		x		
MHS/ch4	x		x		
MHS/ch5	x		x		

ATMS

	Clear Sea	Clear Sea ice	Clear Land	Cloud Sea	Rain Sea
ATMS/ch5					
ATMS/ch6	x				
ATMS/ch7	x	x	x		
ATMS/ch8	x	x	x	x	
ATMS/ch9	x	x	x	x	
ATMS/ch10	x	x	x	x	x
ATMS/ch11	x	x	x	x	x
ATMS/ch12	x	x	x	x	x
ATMS/ch13	x	x	x	x	x
ATMS/ch14	x	x	x	x	x
ATMS/ch15	x	x	x	x	x
ATMS/ch18	x		x		
ATMS/ch19	x		x		
ATMS/ch20	x		x		
ATMS/ch21	x		x		
ATMS/ch22	x		x		

- Scene dependent selection of the channels
- Corresponding channels of ATMS were used in the assimilation experiments, except
  - + 2 WV channels (ch19, 21)
  - − 1 surface-sensitive channel (ch5)

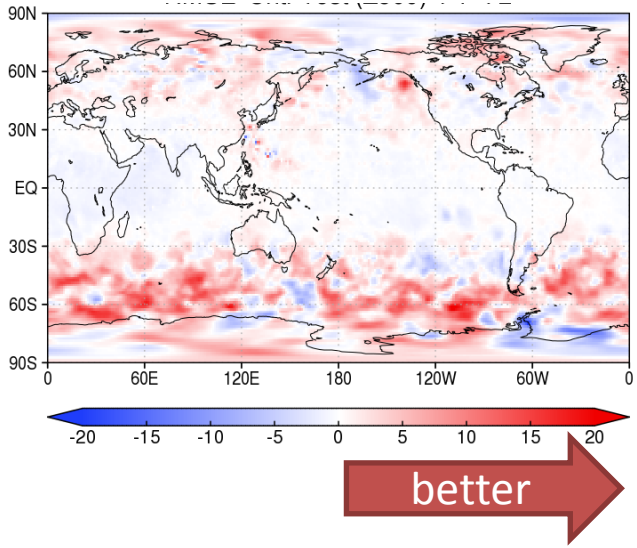
Setup of experiments

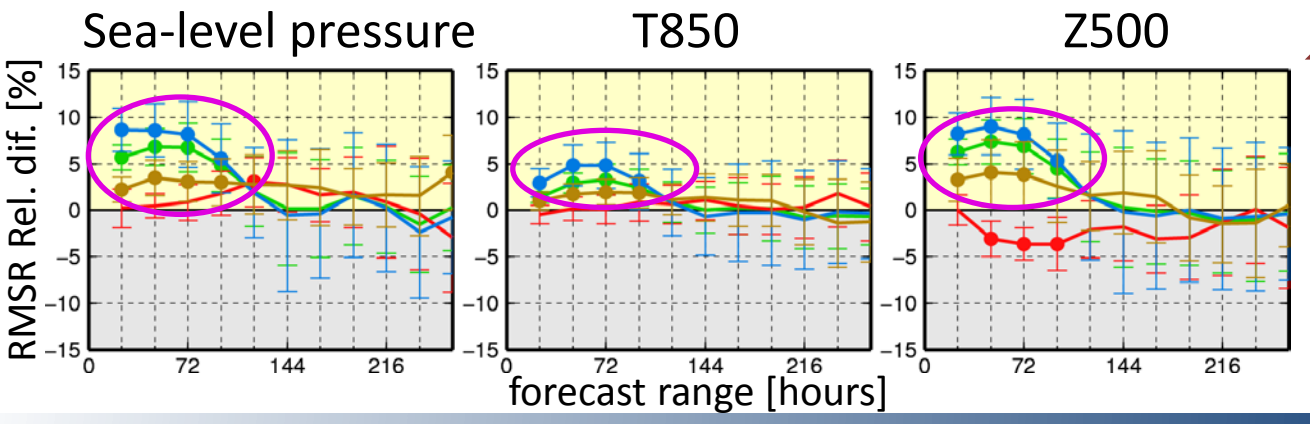
- Experiments to investigate the impacts of utilizing ATMS in the latest global DA system
  - Baseline: current operational system
    w/o AMSU-A and MHS
  - Test1: Baseline + ATMS
  - Control: Baseline + AMSU-A and MHS
  - Test2: Control + ATMS
- Period
  - Jul. 2014

Forecast score with ATMS
Test1 vs Baseline (no AMSU-A and MHS)

- Against initial fields, statistically significant positive impacts on short range forecast
  - positive impacts could be seen in FT=24~96h

Z500 RMSE dif. FT=72

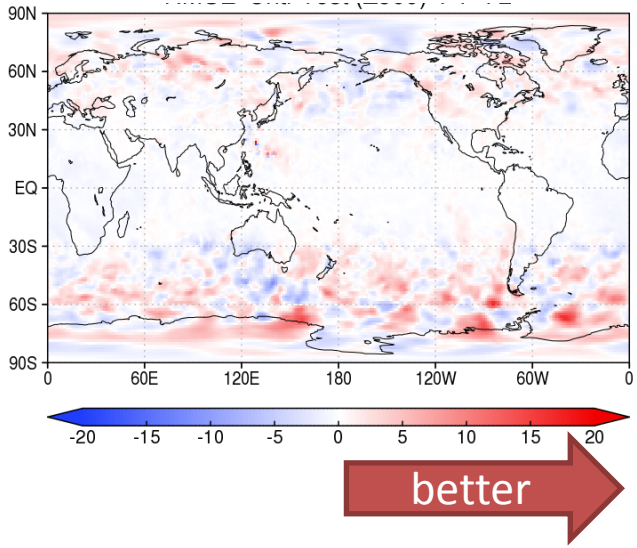


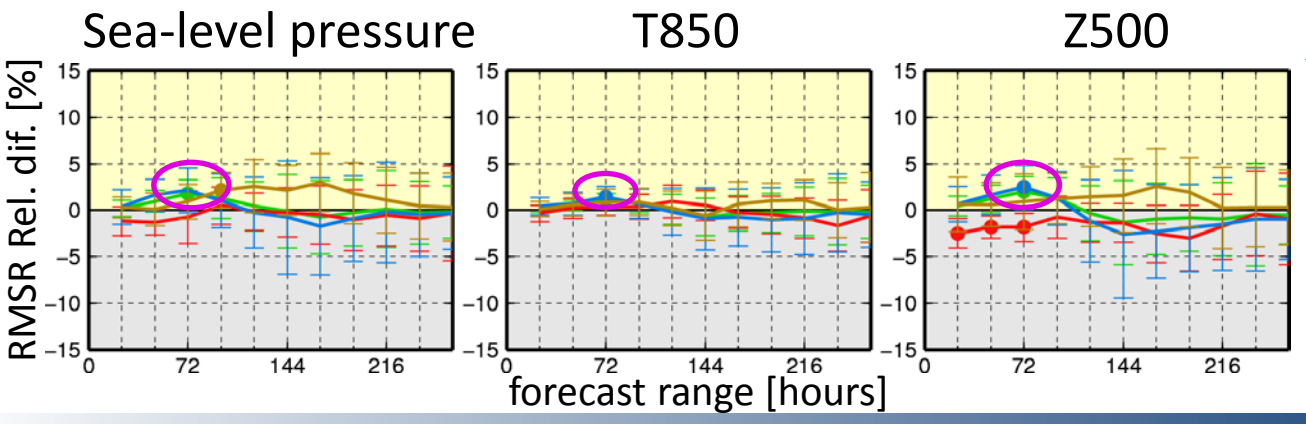


Forecast score with ATMS
Test2 vs Control (with AMSU-A and MHS)

- Against initial fields, impacts on short range forecast was neutral or slightly positive
  - statistically significant positive impact was seen only at FT=72h

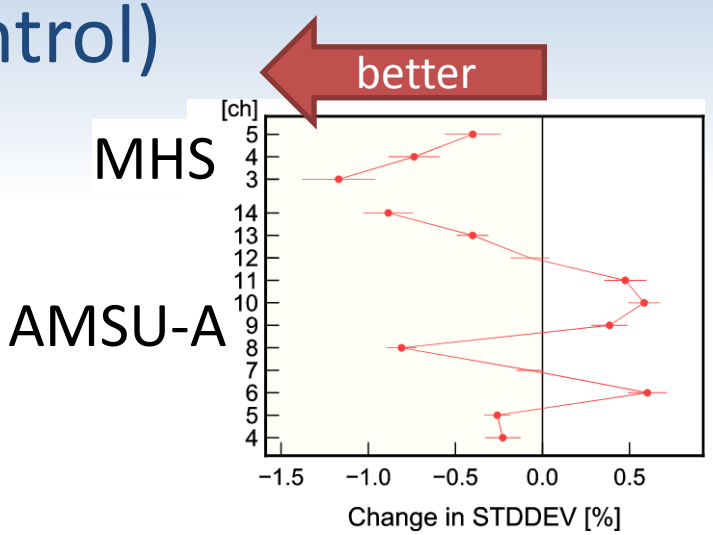
Z500 RMSE dif. FT=72





FG departure for AMSU-A and MHS (Test2 vs Control)

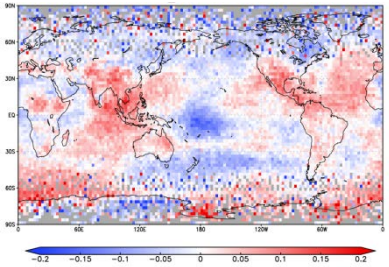
- Normalized difference of STDDEV in FG departures
  - for MHS
    - departure decreased
  - for AMSU-A
    - ch4, 5, 8, 13, 14: decreased
    - ch6, 9, 10, 11: increased



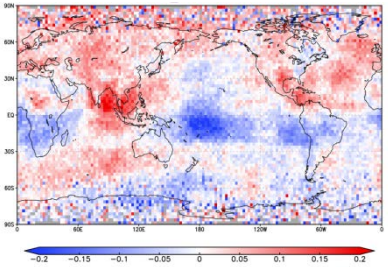
Negative values correspond to reduced STDDEV with ATMS assimilation. Error bars show a 95% confidence interval.

- FG departure maps were compared between ATMS and AMSU-A.
  - differences were found in some channels in polar regions

S-NPP/ATMS/ch10



NOAA-19/AMSU-A/ch9



Summary of the DA experiments

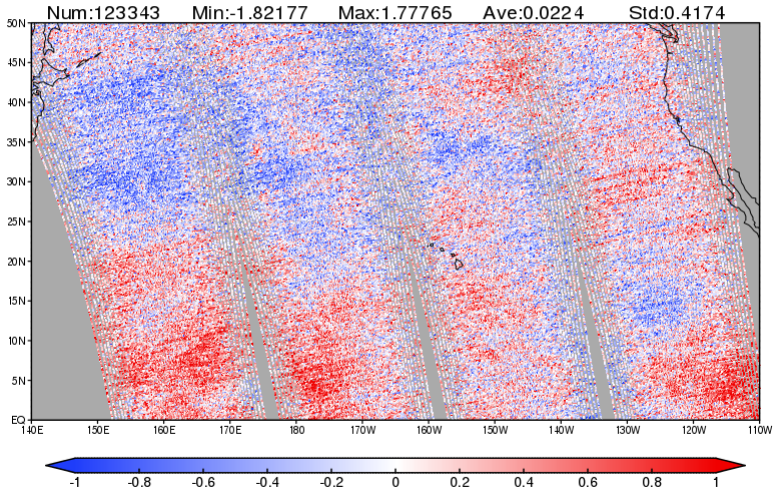
- Assimilation experiments for ATMS
  - w/o AMSU-A and MHS
    - statistically significant positive impacts on short range forecast against initial fields
  - with AMSU-A and MHS
    - small positive on forecast against initial fields
    - RMSE of FG departure from some AMSU-A channels were increased

- Further investigation of these AMSU-A channels are needed

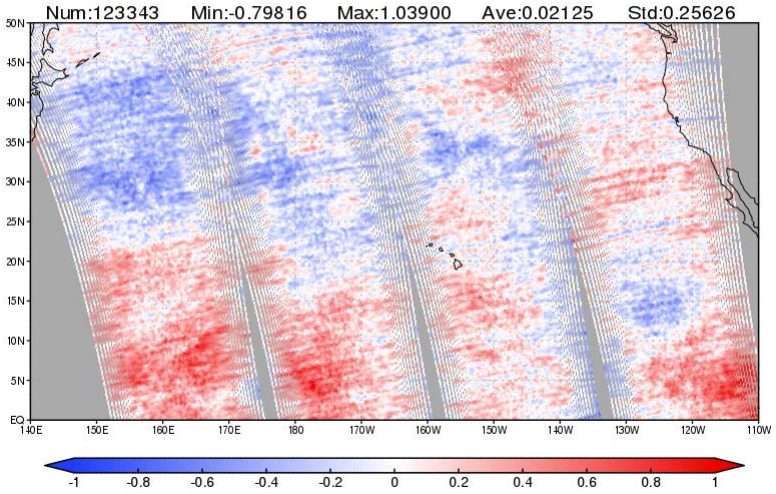
2. EVALUATION OF DE-STRIPED ATMS DATA

Beam correction
with current NRT ATMS data

current ATMS/ch10 FG departure



current ATMS/ch10 FG departure with beam correction

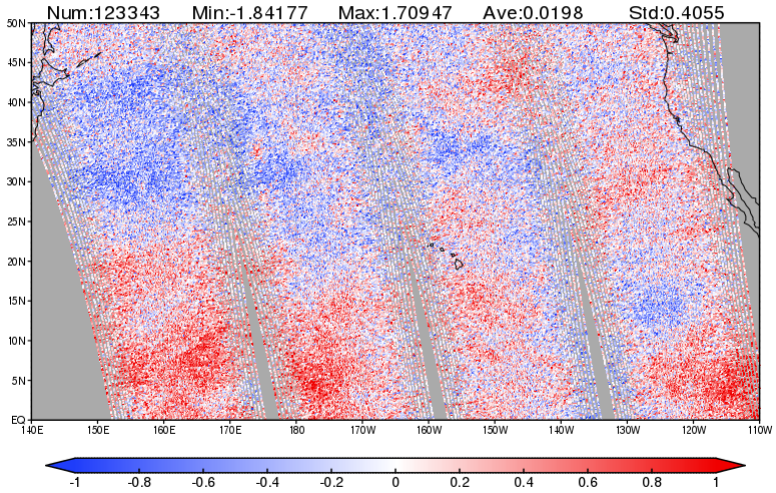


- FG departure for **ATMS/ch10** in the North Pacific area
- Two-dimensional Gaussian filter
  - STDDEV: 0.417 → 0.256
  - Manipulate the beam shape of ATMS
  - Implemented in AAPP (ATOVS and AVHRR Pre-processing Package)

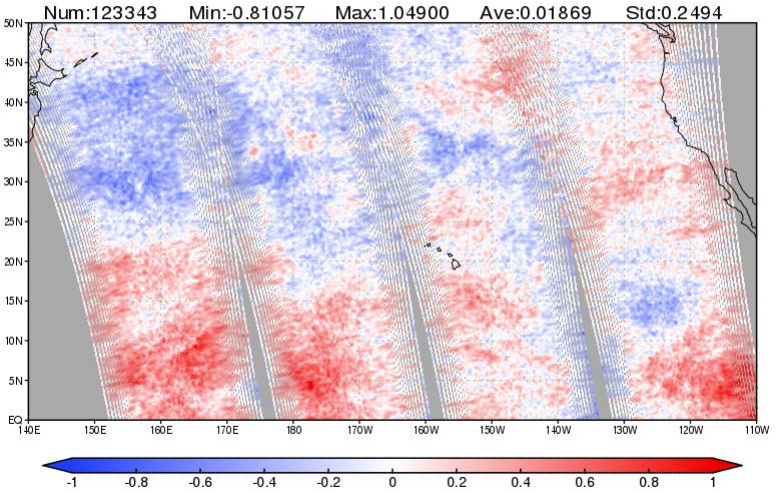
Beam correction with de-striped ATMS

provided by Dr. Fuzhong Weng

de-striped ATMS/ch10 FG departure



de-striped ATMS/ch10 FG departure with beam correction

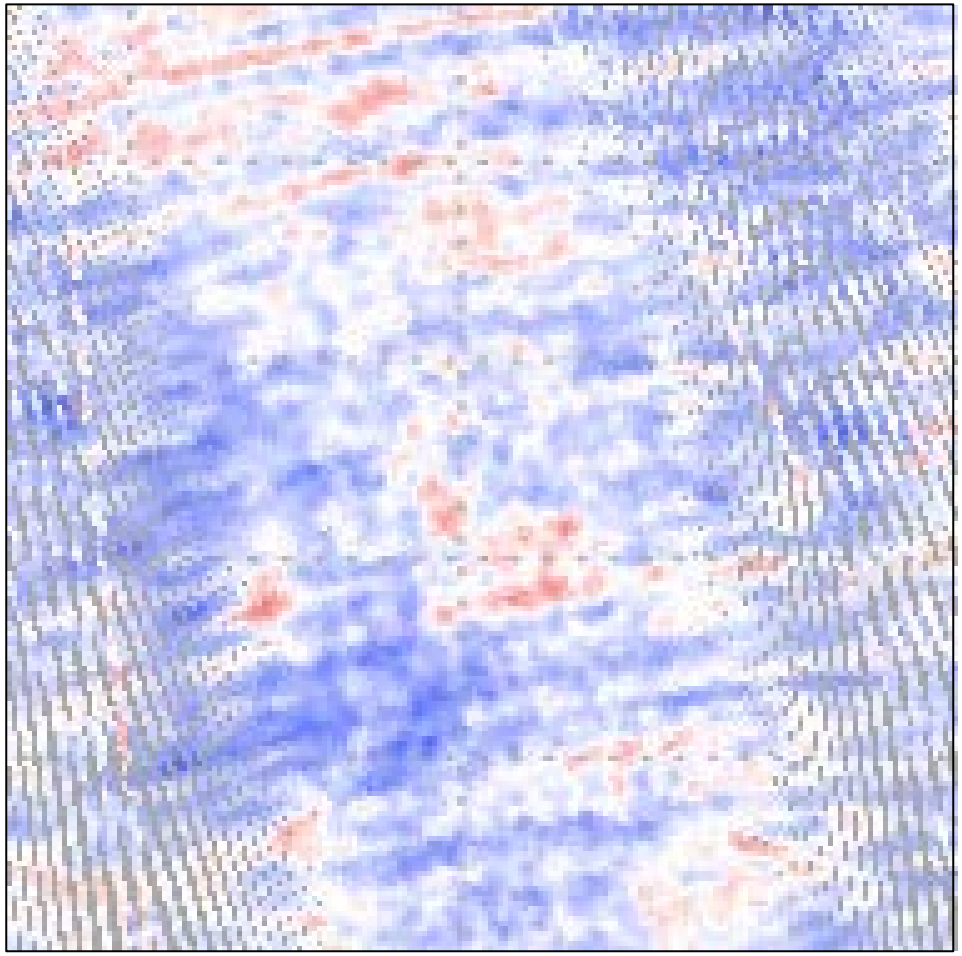


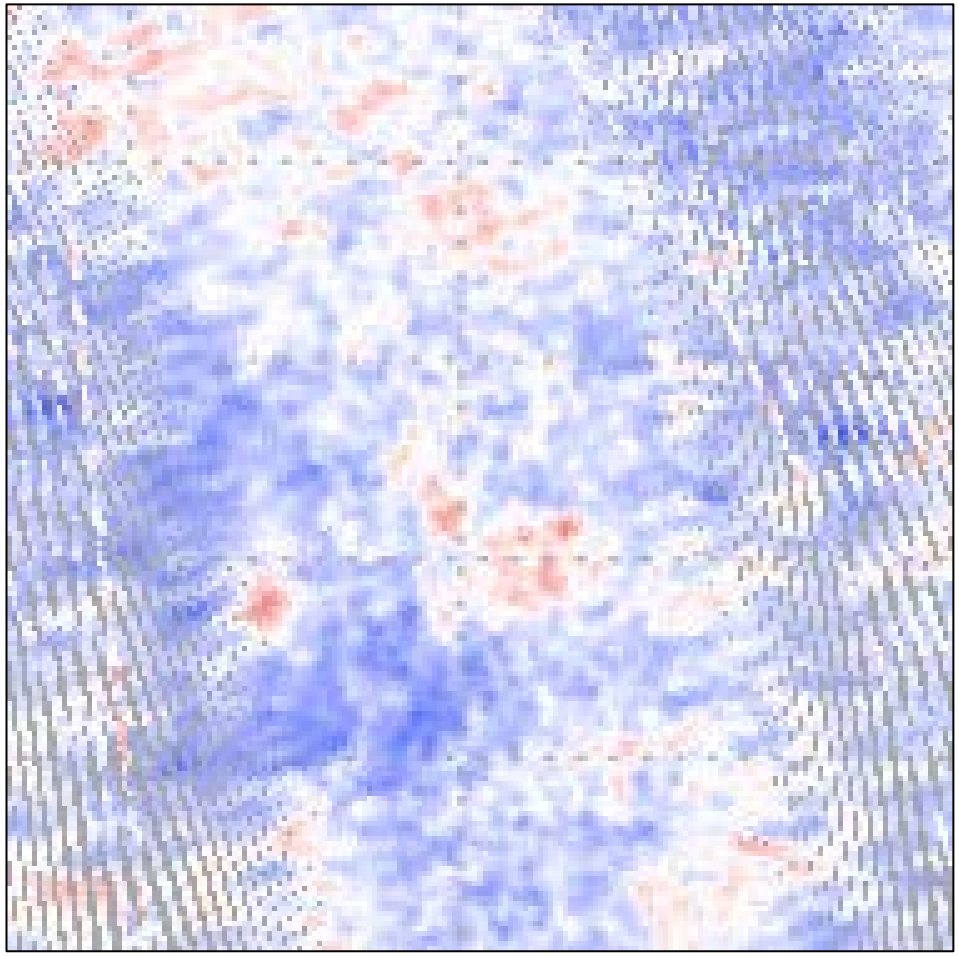
- Stripe noise was removed
- STDDEV of de-striped ATMS data became smaller than that of current NRT ATMS data
  - STDDEV current: 0.417 → beam corrected: 0.256
    → de-striped: 0.406 → de-striped, beam corrected: 0.249
- Similar results were found for the other channels

Zoomed in

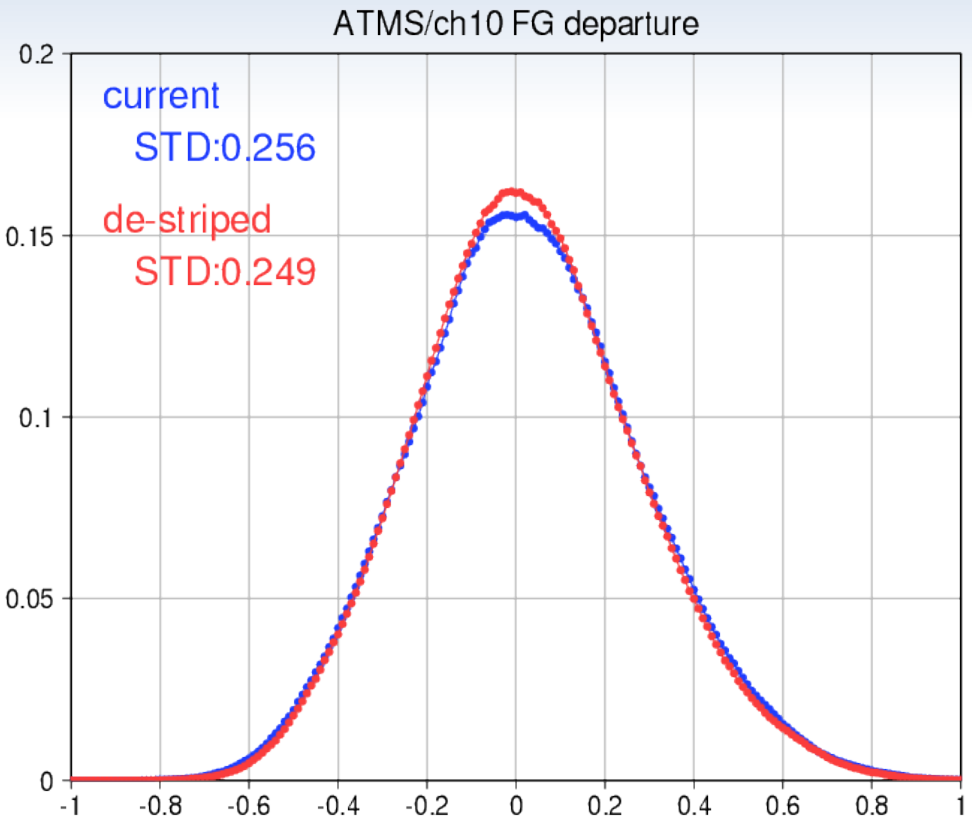
current ATMS/ch10 FG departure with beam correction

de-striped ATMS/ch10 FG departure with beam correction





Histogram for ATMS/ch10 FG departure



- FG departure for current and de-striped ATMS data
  - De-striped data shows smaller STDDEV than current data

Summary for the de-striped data evaluation

- Action to the NWP-WG Recommendation
- STDDEV of de-striped ATMS data became smaller than that of current NRT data

- OSE is not executed yet
  - The time period of the provided sample data was January 2013
  - NRT de-striped data or de-stripe algorithm is needed to assess impact for our latest model