15th International Winds Workshop, April 12-16, 2021 virtual

Use of GOES-17 AMV in the JMA's Global NWP System

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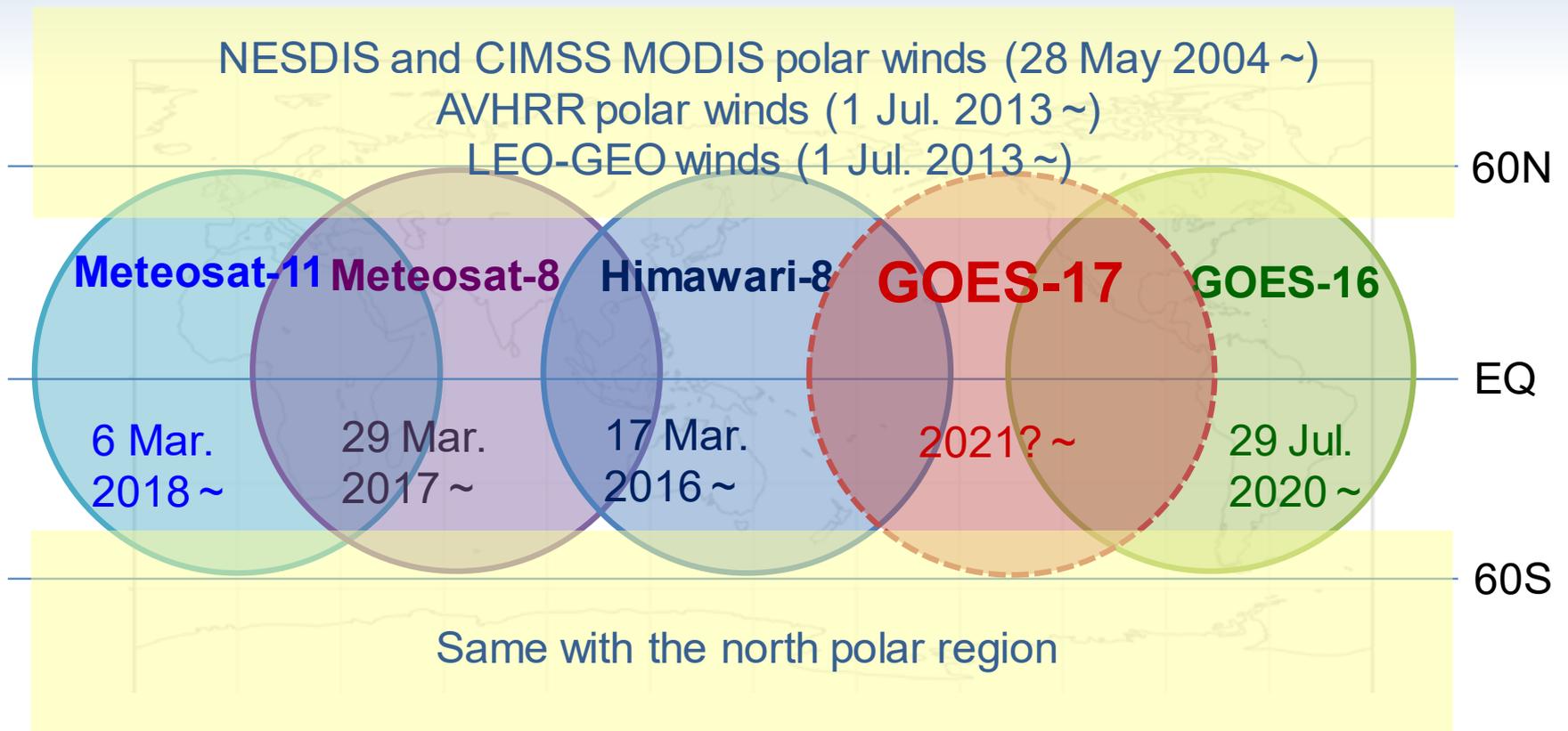*Numerical Prediction Development Center*

Outline

- Overview of JMA's global NWP system and AMVs utilized in the system

- Comparison between GOES-17 and GOES-16 AMVs
    - Time filtering for GOES-17 AMV

- Optimizing QI thresholds
    - From OBS-FG statistics

- Results of observing system experiments (OSEs)

- Summary and plan

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JMA's global NWP system configuration

	Global NWP System
Purposes	Daily forecasts Tropical cyclone information One-week forecasts
Forecast: Global Spectral Model (GSM)	
Grid Size	0.1875 deg. (TL959)
Vertical Levels/Top	100 / 0.01 hPa
Forecast Range (Initial Time)	132 hours (06, 18 UTC) 264 hours (00, 12 UTC)
Analysis: Hybrid LETKF/4D-Var Assimilation	
Grid Size	Outer: TL959 (~20 km) Inner: TL319 (~55 km)
Vertical Levels/Top	100 + surface / 0.01 hPa
Iterations	Outer: 2 Inner: Approx. 35
Ensemble Size for LETKF	50 members
Data Cut Off Time	Early Analysis: +2h20m Cycle Analysis: +7h50m (06, 18 UTC) 　　　　　　　　　+11h50m (00, 12UTC)

Status of operational AMVs usage for NWP in JMA

NESDIS and CIMSS MODIS polar winds (28 May 2004 ~)
AVHRR polar winds (1 Jul. 2013 ~)
LEO-GEO winds (1 Jul. 2013 ~)

60N

Meteosat-11 **Meteosat-8** **Himawari-8** **GOES-17** **GOES-16**

EQ

6 Mar. 2018 ~ 29 Mar. 2017 ~ 17 Mar. 2016 ~ 2021? ~ 29 Jul. 2020 ~

60S

Same with the north polar region

GOES-16 AMV has been assimilated into JMA's operational global NWP system since 29 July 2020.

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Preliminary investigation to use GOES-17 AMV in NWP

It is announced that there is an issue in cooling system of GOES-17/ABI and some degradation are emerged in the imagery during some hours before and after the vernal and autumnal equinoxes.

https://www.goes-r.gov/users/GOES-17-ABI-Performance.html

Before running observing system experiment (OSE) of the GOES-17 AMV, we investigated the difference from the GOES-16 AMV and examined a preprocess method for use in the operational NWP system.

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Comparison between GOES-17 and GOES-16 AMVs

GOES-17

GOES-16

Matching up nearest vectors within 0.05 deg / 0.05 deg (lat/lon)

U-comp.

V-comp.

GOES-16 IR (m/s)

GOES-17 IR (m/s)

GOES-16 IR (m/s)

GOES-17 IR (m/s)
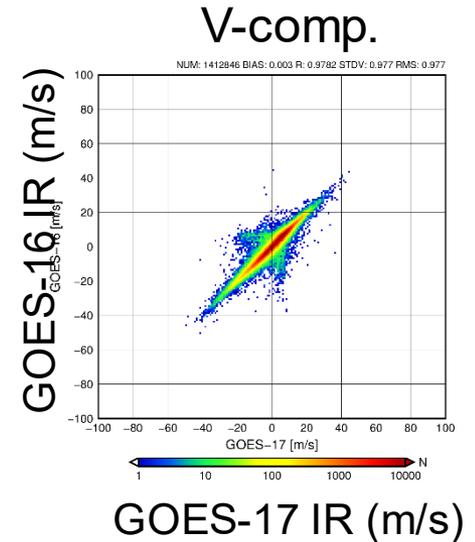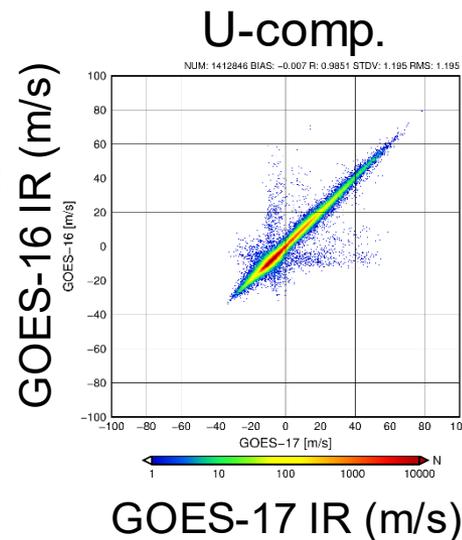
Number of matched-up AMVs (1 – 31 Aug. 2020)
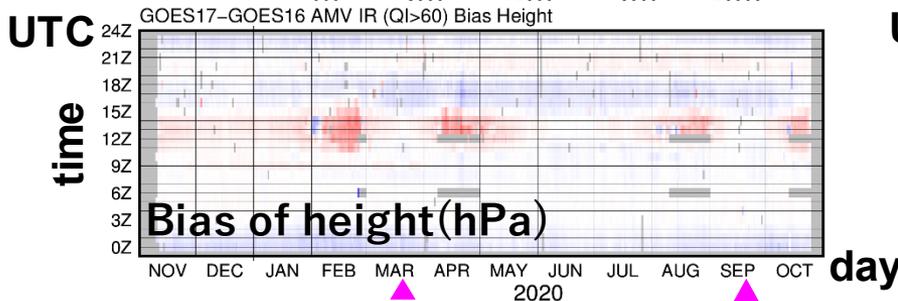(GOES-16 and -17 IR AMV, <400hPa)

Comparison between GOES-17 and GOES-16 AMVs

Residual statistics for every hour (GOES-17 - GOES-16)
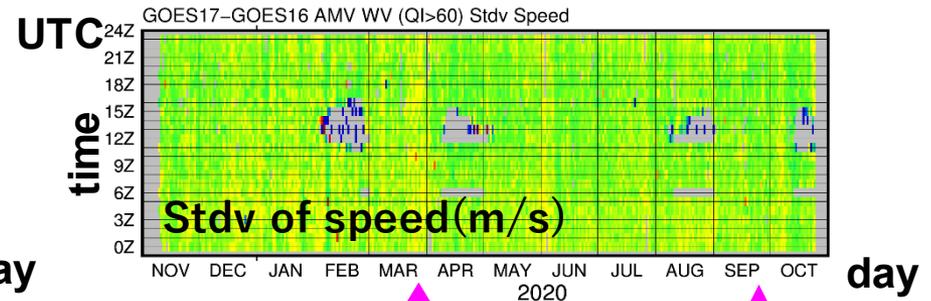
validation term: Nov. 11, 2019 – Oct. 25, 2020

GOES17–GOES16 AMV IR (QI>60) Number of collocation

# of collocations
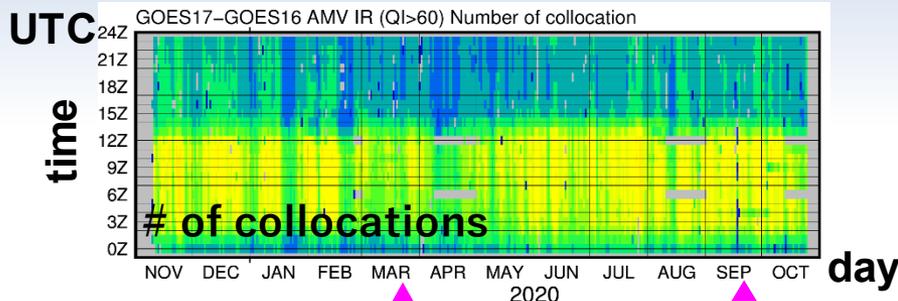
IR AMV (QI>60)

Differences are confirmed between G-17 and G-16 AMVs for about four months before and after equinox seasons.

▲ vernal/autumnal equinox day

GOES17–GOES16 AMV IR (QI>60) Bias Height

Bias of height(hPa)

GOES17–GOES16 AMV IR (QI>60) Stdv Height

Stdv of height(hPa)

GOES17–GOES16 AMV IR (QI>60) Bias Speed

Bias of speed(m/s)

GOES17–GOES16 AMV IR (QI>60) Stdv Speed

Stdv of speed(m/s)

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Comparison between GOES-17 and GOES-16 AMVs

Residual statistics for every hour (GOES-17 - GOES-16)

validation term: Nov. 11, 2019 – Oct. 25, 2020

GOES17–GOES16 AMV WV (QI>60) Number of collocation

# of collocations
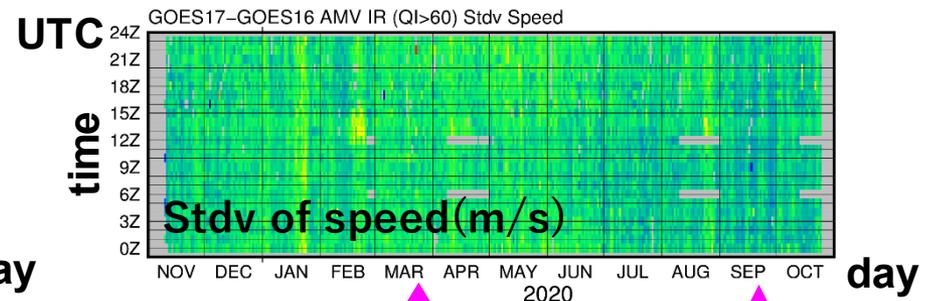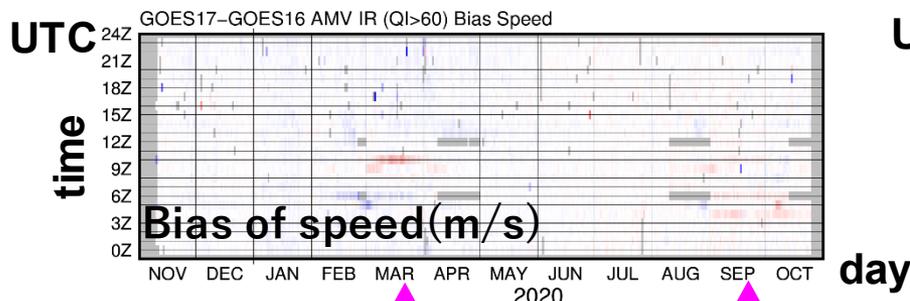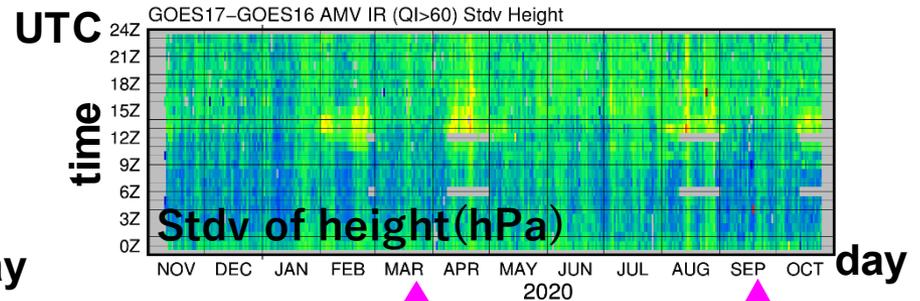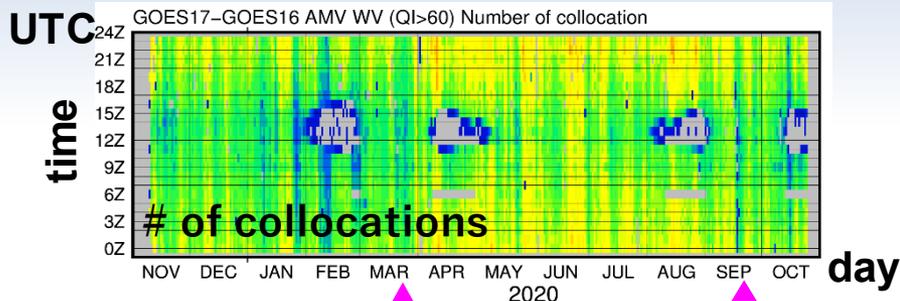
WV AMV (QI>60)

Differences or missing are confirmed between G-17 and G-16 AMVs for about four months before and after equinox seasons.

▲ vernal/autumnal equinox day

GOES17–GOES16 AMV WV (QI>60) Bias Height

Bias of height(hPa)

GOES17–GOES16 AMV WV (QI>60) Stdv Height

Stdv of height(hPa)

GOES17–GOES16 AMV WV (QI>60) Bias Speed

Bias of speed(m/s)

GOES17–GOES16 AMV WV (QI>60) Stdv Speed

Stdv of speed(m/s)

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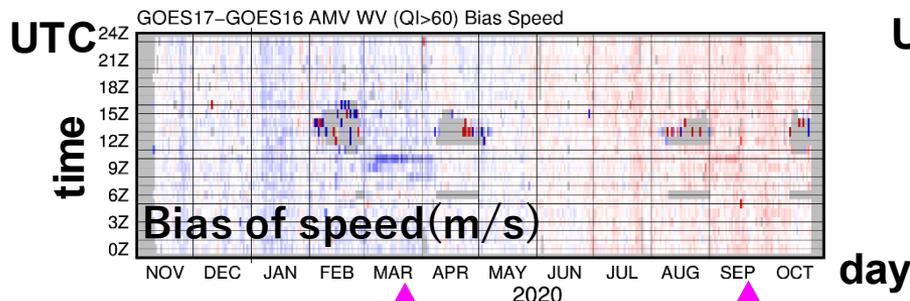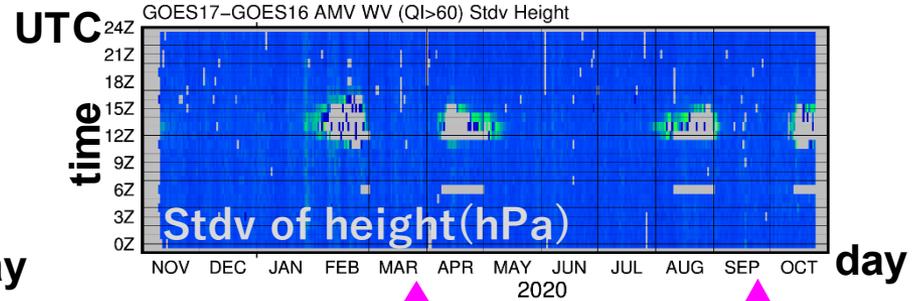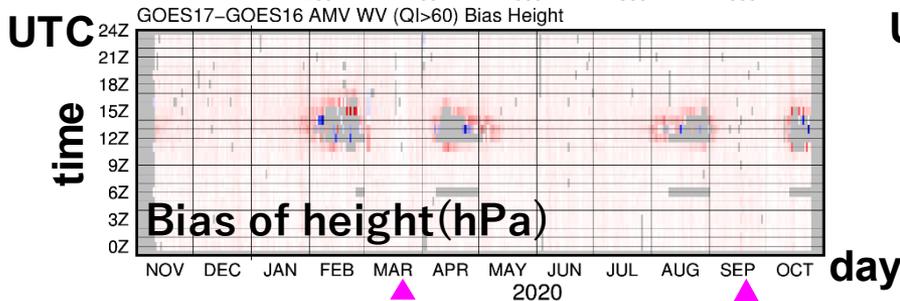
Time filtering for "estimated not good" AMVs

GOES-17 – GOES-16 IR AMV QI>60   **GOES-17 – GOES-16** IR AMV QI>90

Bias of height   ### Bias of height
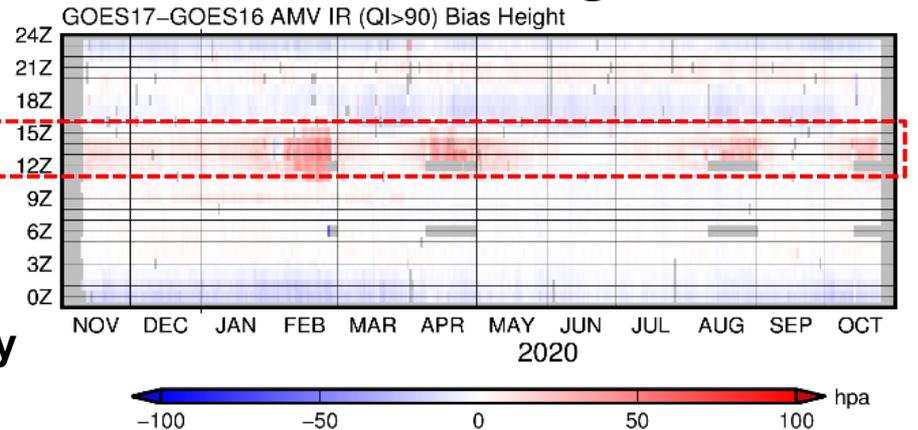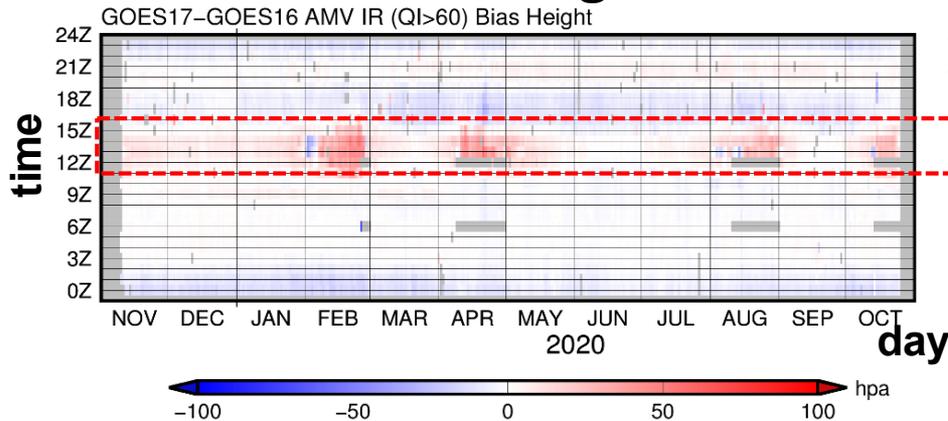
validation term: Nov. 11, 2019 – Oct. 25, 2020

- Difference between GOES-16 and 17 AMVs were seen 11-16 UTC in even months except for June and December.
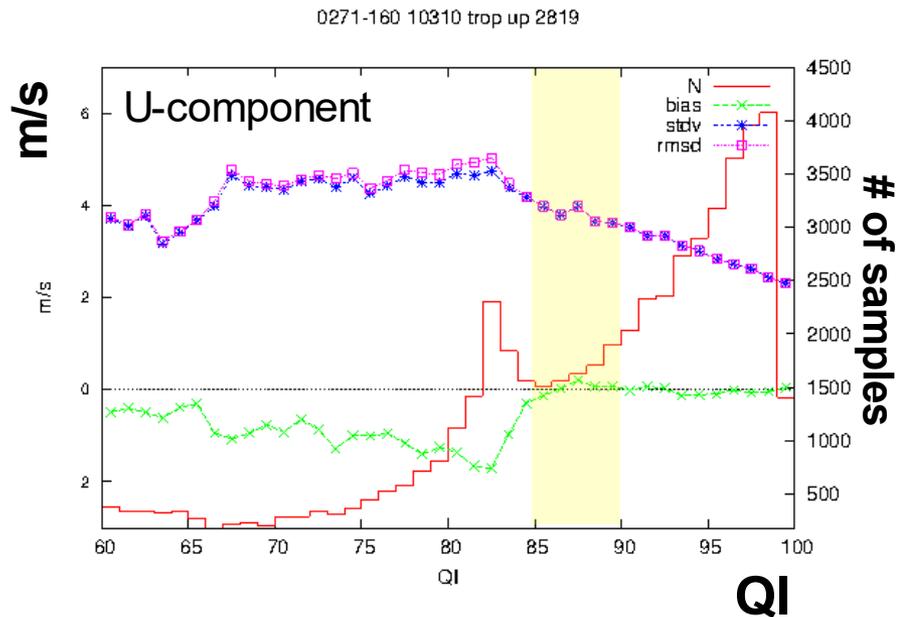- QI threshold -> not very effective for the degradation

➡ to use GOES-17 AMV except during 11-16UTC throughout the year

Optimizing QI threshold for GOES-17 and GOES-16 AMVs

QI dependency of OBS-FG statistics

GOES-17 IR AMV（*tropics <400hPa*）

GOES-16 IR AMV（*tropics <400hPa*）
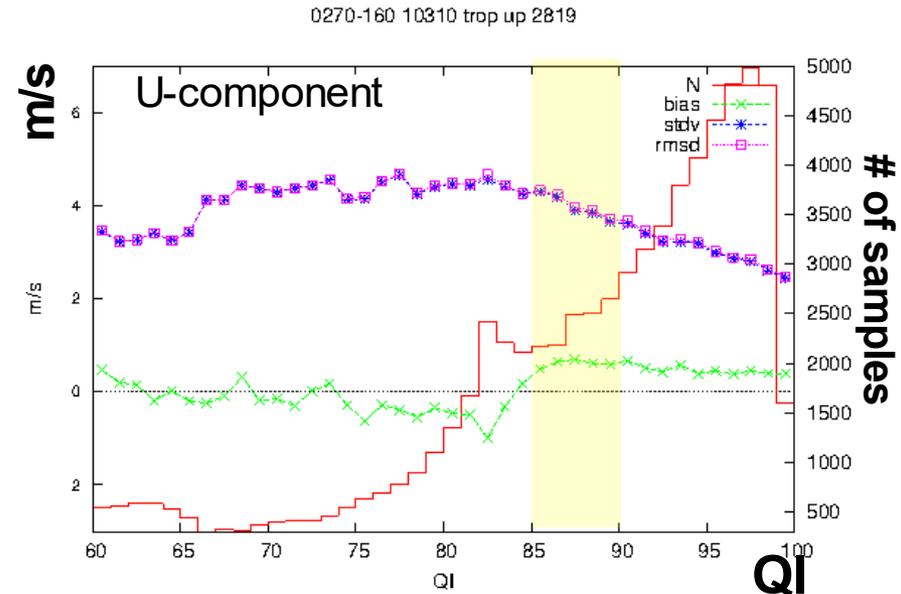
Speed bias and standard deviation are reduced where QI is above about 85. QI thresholds are selected from 85 to 90 for both GOES-16 and -17 AMVs.

N：QI histogram

OBS-FG Bias of U (m/s)

OBS-FG Standard dev. (m/s)

OBS-FG RMSD (m/s)

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OSEs settings

	Specification (Main differences)
Control (CNTL)	A scheme of the 200 km thinning of OPE-AMVs in the 6 hour time window
TEST1	CNTL + GOES-17 AMV (Not Use of AMVs in the middle troposphere)
TEST2	CNTL + GOES-17 AMV (Not Use of AMVs in the middle troposphere) + Not using GOES-17 AMV during 11-16UTC
TEST3	CNTL + GOES-17 AMV (Not Use of AMVs in the middle troposphere) + Not using GOES-17 AMV during 11-16UTC + Quality control using with QI (QI > 87)

Period: 2020 Summer
Assimilation from 10 July to 11 September, 2020
Forecast from 21 July to 11 September, 2020

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Change of standard deviation of OBS-FG against CNTL (U component wind of RAOB)

Validation Period: one month (1 to 31 August, 2020)

better ← → worse

	TEST1	TEST2	TEST3
	w/o time filtering, QI >60	w/ time filtering, QI >60	w/ time filtering, QI >87

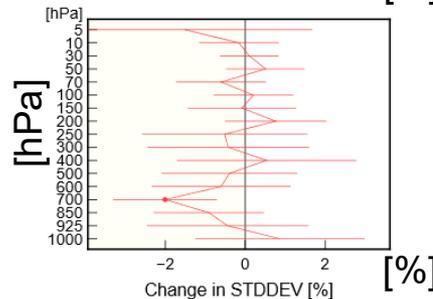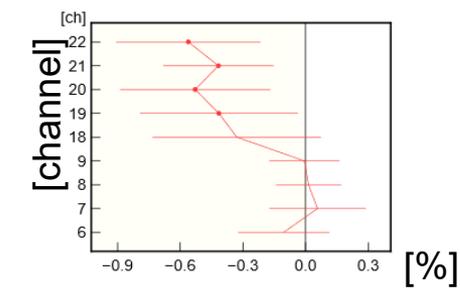Consistency between first guess and RAOB winds were almost neutral using GOES-17 AMV.

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Change of standard deviation of OBS-FG against CNTL (ATMS radiances)

Validation Period: one month (1 to 31 August, 2020)
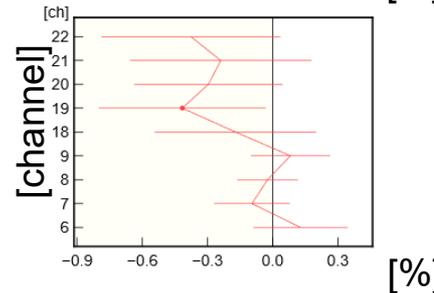
better ⟵ ⟶ worse

TEST1
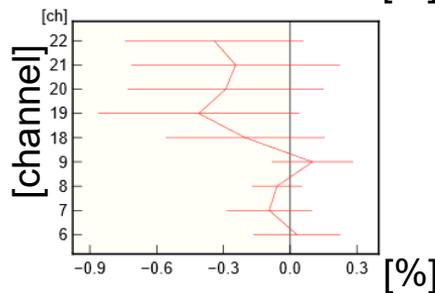w/o time filtering, QI >60

TEST2
w/ time filtering, QI >60
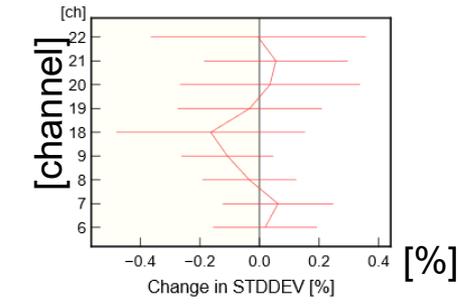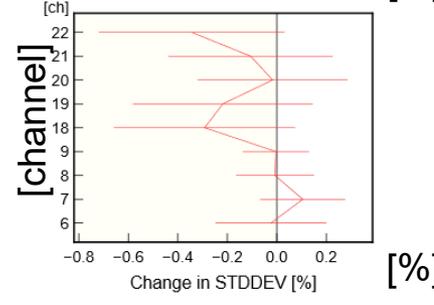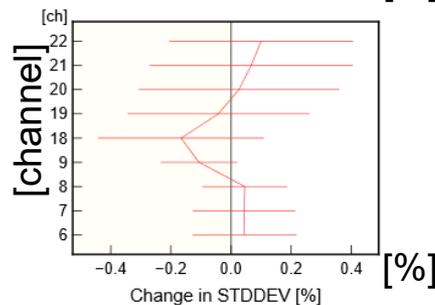
TEST3
w/ time filtering, QI >87

Northern Hemisphere
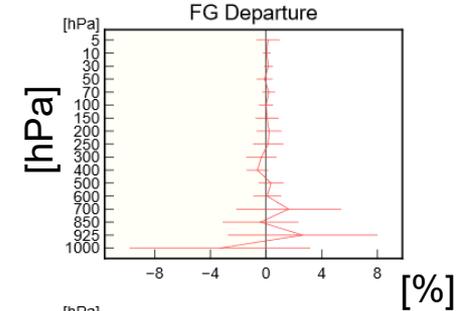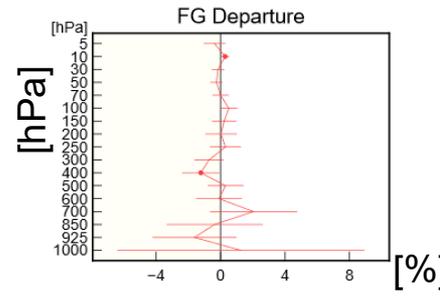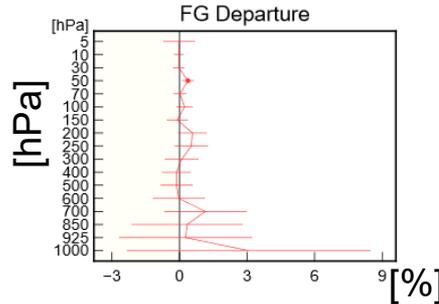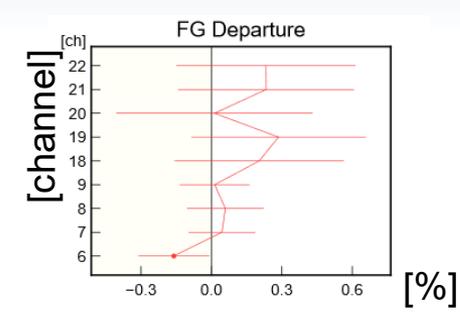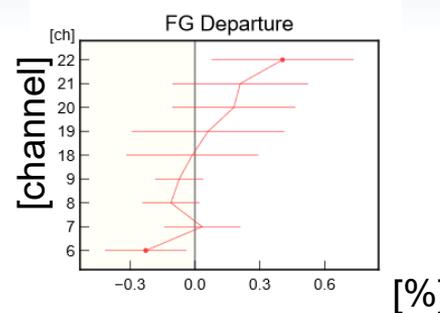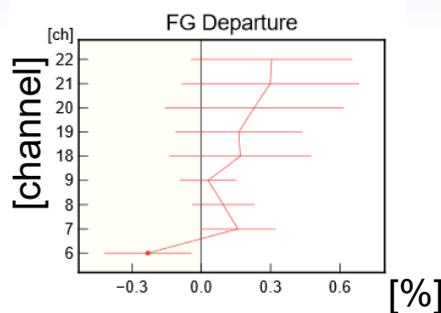
Tropics

Southern Hemisphere

Time filtering and increasing QI threshold were effective in improving consistency with microwave radiance (ATMS) especially in the tropics.

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Change of Analysis and forecast fields
RMSE improvement ratio (Wind Vector)

Verification is calculated using forecasts from 12 UTC initials and ERA5 analysis.
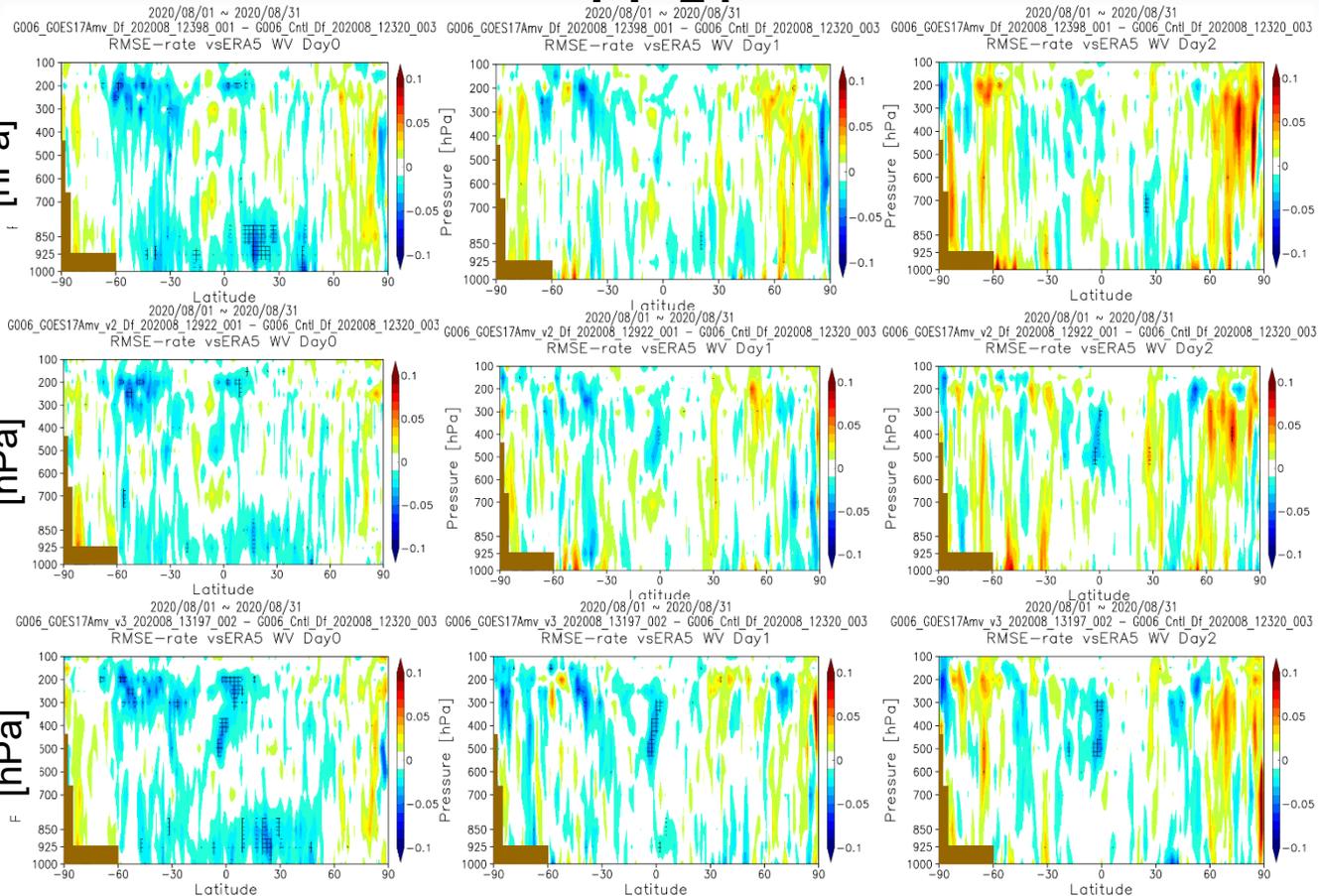
improved ⬅️➡️ **degraded**

Validation Period: one month (1 to 31 August, 2020)

$$\frac{\text{RMSE}_\text{test} - \text{RMSE}_\text{Cntl}}{\text{RMSE}_\text{Cntl}}$$

FT=0   **FT=24**   **FT=48**

TEST1
w/o time filtering,
QI >60

TEST2
w/ time filtering,
QI >60

TEST3
w/ time filtering,
QI >87

Analysis and early forecast fields (~ FT=48) are significantly improved, especially in the southern hemisphere and tropical troposphere.

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Change of Analysis and forecast fields
RMSE improvement ratio (Geopotential Height)

Verification is calculated using forecasts from 12 UTC initials and ERA5 analysis.

improved ⬅️➡️ **degraded**

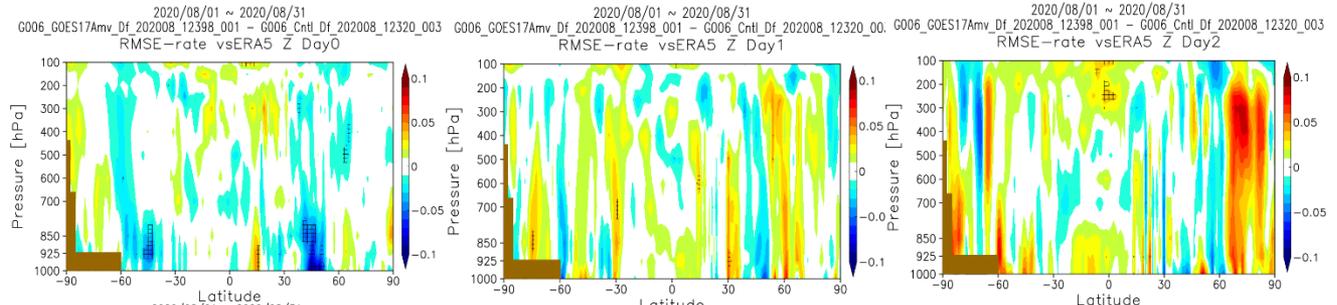Validation Period: one month (1 to 31 August, 2020)
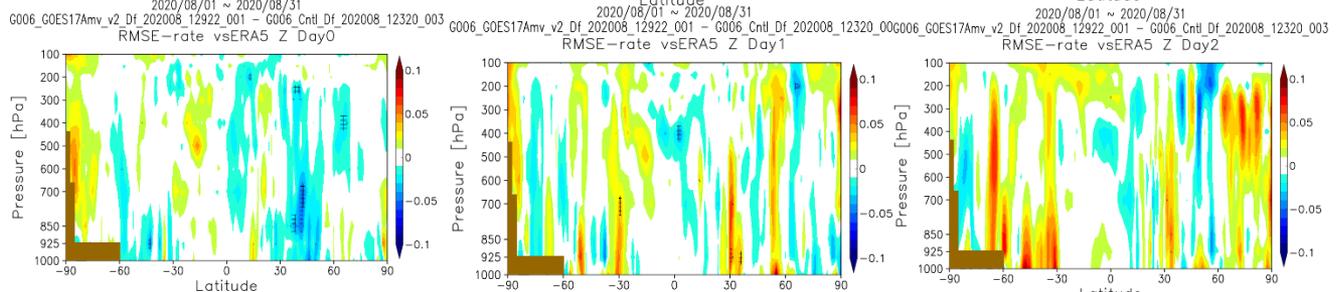
$$\frac{RMSE_{test} - RMSE_{Cntl}}{RMSE_{Cntl}}$$

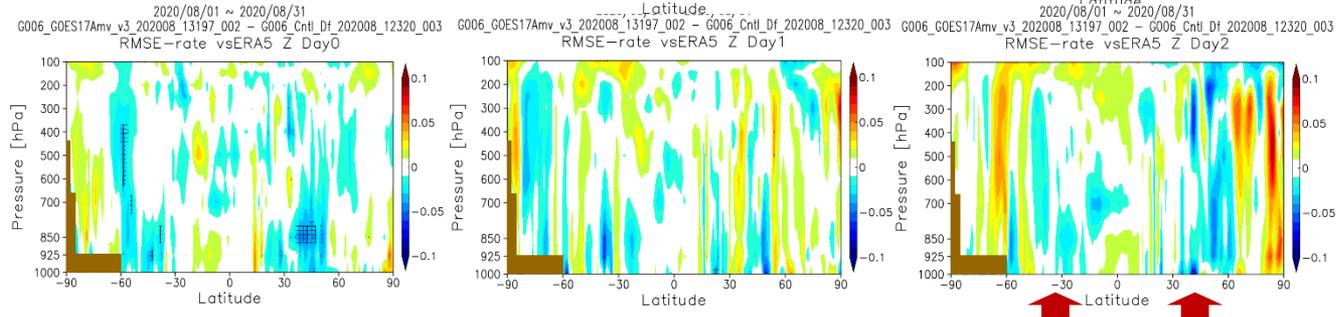|	FT=0	FT=24	FT=48

TEST1
w/o time filtering,
QI >60

TEST2
w/ time filtering,
QI >60

TEST3
w/ time filtering,
QI >87

Degraded trend seen at mid-latitudes in forecast field is suppressed by increasing QI threshold.

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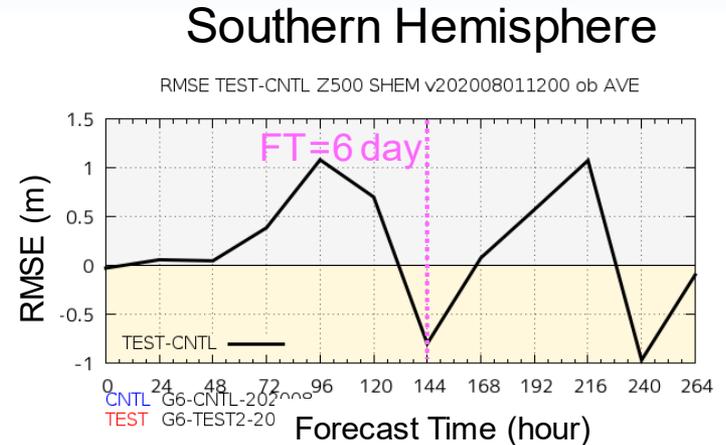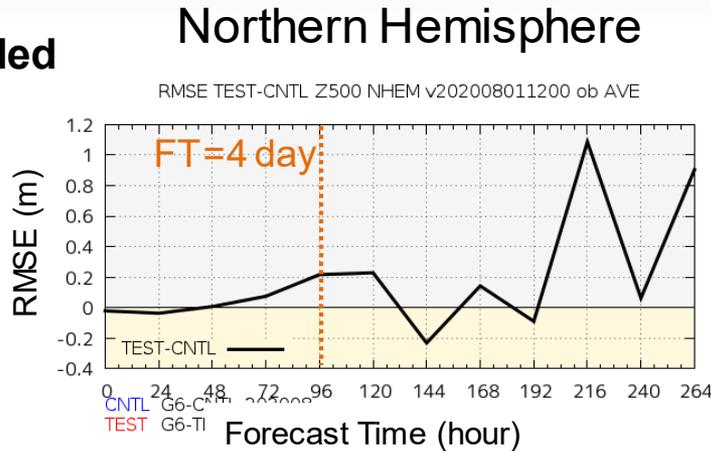# RMSE differences between Test and Control (Z500)

Verification is calculated using RAOB as a reference
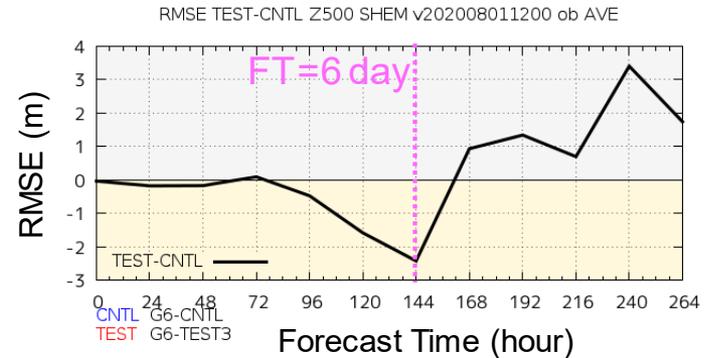
Validation Period: one month (1 to 31 August, 2020)

better   degraded

Northern Hemisphere

Southern Hemisphere
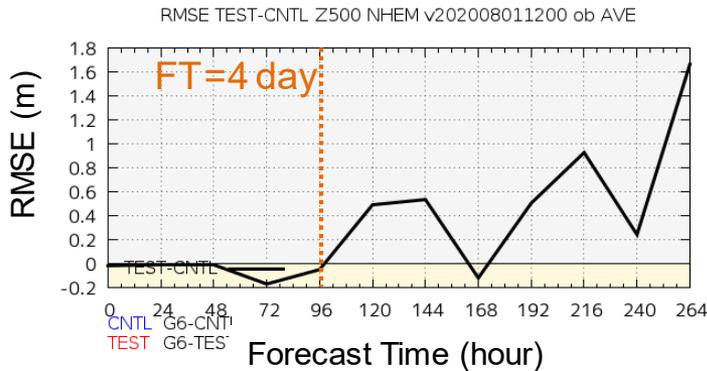
TEST2
w/ time filtering,
QI >60

TEST3
w/ time filtering,
QI >87

QC using QI (not forecast) has a positive effect on relatively long term forecast (~2-6 days).
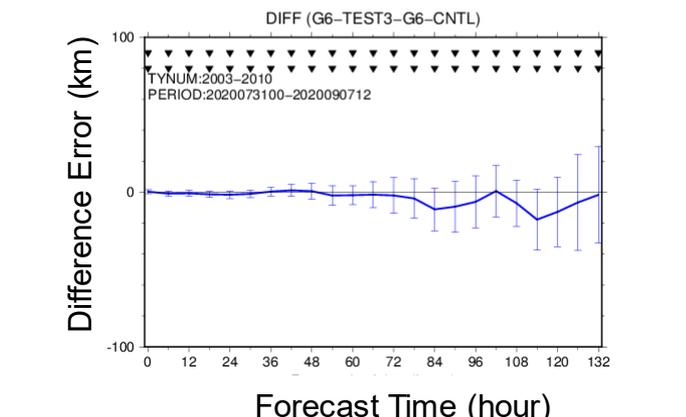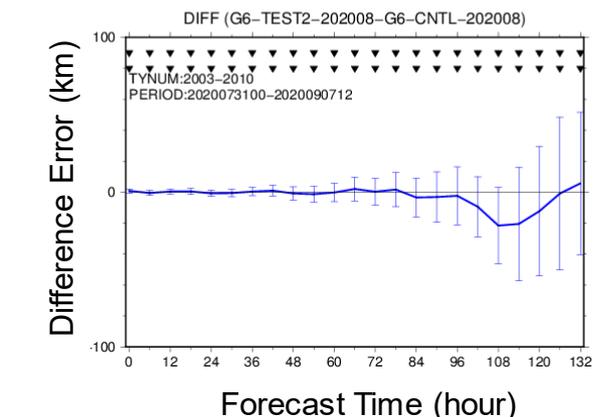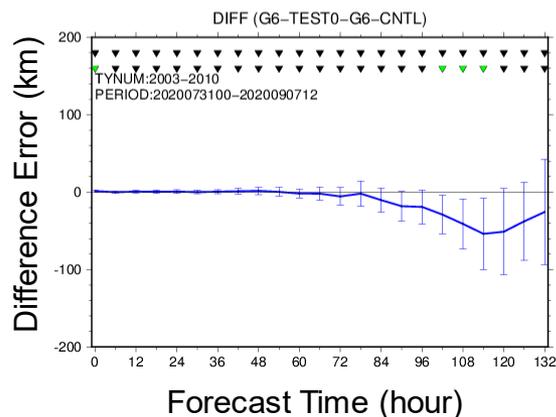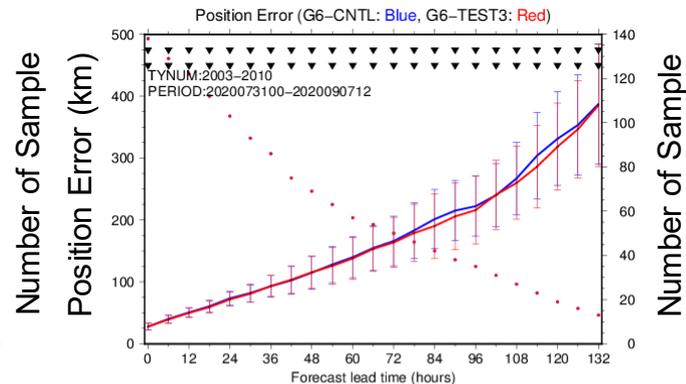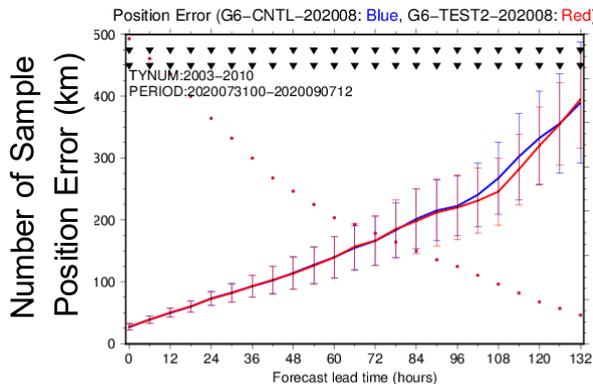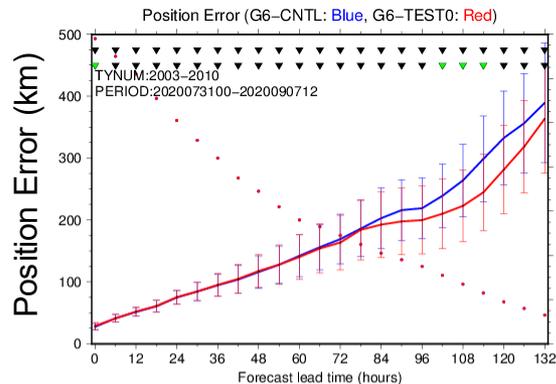
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Track forecast error of typhoons (northwest pacific)

7 typhoons in the summer of 2020

TEST1 vs Control
w/o time filtering,
QI >60

TEST2 vs Control
w/ time filtering,
QI >60

TEST3 vs Control
w/ time filtering,
QI >87

The impact of GOES-17 AMVs seem not to be significant for typhoon position prediction (in northwest pacific area) in these OSEs.

Summary and Plan

Result of OSEs with GOES-17 AMV

- The analysis and short-term forecast field have a positive effect especially in the troposphere.

- Consistency between first guess and other observations, especially microwave sounders such as ATMS and MHS, is improved.

- Time filtering and raising QI threshold reduce the degradation trends seen at mid-latitude in the forecast field.

- ➢ The time filtering and the optimized QI thresholds will be applied in 2021 to preprocessing to use GOES-17 AMV in JMA's operational global NWP system.