CGMS-39 JMA-WP-05
Prepared by JMA
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Discussed in WG II

JMA's ATMOSPHERIC MOTION VECTORS

In response to CGMS Recommendations 38.14 and 38.15

This document reports on the recent status of JMA's AMVs from MTSAT-2 and MTSAT-1R, and outlines responses to Recommendations 38.14 and 38.15

JMA's Meteorological Satellite Center increased the frequency of AMV dissemination via the GTS in March 2011. Although AMV data from MTSAT-2 computed on an hourly basis were previously used only internally, they are now disseminated every hour via the GTS in BUFR format.

In response to CGMS Recommendation 38.14, this report outlines the results of an impact experiment conducted during the THORPEX T-PARC campaign of 2008 on Rapid Scan AMVs derived from MTSAT-2 and used in JMA's NWP. It was found that the assimilation of these AMVs improved typhoon track forecasting. In line with Recommendation 38.15, JMA plans to examine the efficiency of the NWC-SAF portable AMV software package. This test is expected to significantly contribute to the improvement of JMA's AMVs.

JMA currently computes Rapid Scan AMVs from images taken at five-minute intervals by MTSAT-1R. These vectors will be useful for the development of next-generation AMVs applicable to JMA's follow-on satellite observations.

1 INTRODUCTION

This working paper reports on the Atmospheric Motion Vectors (AMVs) produced by the Meteorological Satellite Center (MSC) of the Japan Meteorological Agency (JMA) using images from MTSAT-2 and MTSAT-1R. The status of the AMV production and dissemination plan is covered in Section 2, AMV quality is detailed in Section 3, responses to Recommendations 38.14 and 38.15 are dealt with in Section 4, and JMA's recent activities in regard to AMVs are outlined in Section 5.

2 STATUS OF THE DATA PRODUCTION AND DISSEMINATION PLAN

Table 1 lists the details of MTSAT-2 AMV dissemination. JMA generates four types of AMV from MTSAT-2 Infrared (IR: 10.8 micrometers), Water Vapor (WV: 6.8 micrometers), Visible (VIS: 0.63 micrometers) and Short-wave Infrared (IR4: 3.8 micrometers) images (referred to below as IR AMVs, WV AMVs, VIS AMVs and IR4 AMVs, respectively). IR, VIS and WV AMVs are disseminated via the Global Telecommunication System (GTS) in Binary Universal Form for data Representation (BUFR) format. Short-wave Infrared AMVs are operationally assimilated into to JMA's NWP system.

On 15 March, 2011, JMA started to disseminate hourly derived MTSAT-2 AMVs via the GTS in BUFR format. In Table 1, the newly added hourly MTSAT AMVs disseminated via GTS are highlighted in yellow. MTSAT-2 AMVs are currently derived from three successive MTSAT-2 images taken at intervals of 15, 30 and 60 minutes. The AMVs derived from the images taken at 60-minute intervals have a slightly slower BIAS than those derived from the 15- and 30-minute-interval images.

In line with the implementation of annual maintenance for the MTSAT ground system's transmitting and receiving antenna, JMA/MSC plans to switch operations from MTSAT-2 to MTSAT-1R for the period from 7 November, 2011, to 16 December, 2011. During this time, JMA will disseminate MTSAT-1R AMVs.

Table 1: MTSAT Atmospheric Motion Vector products generated by JMA

AMV type	Level of height *	Time (UTC)	Image sector	Image interval (minutes)	Distribution
Infrared: IR (10.8 micrometers)	High, middle, low	00, 06, 12, 18	Full disk	15	BUFR via GTS
	High, middle, low	03, 09, 15, 21	Northern Hemisphere	30	BUFR via GTS
	High, middle, low	02, 04, 05, 08, 10, 11, 14, 16, 17, 20, 22, 23	Northern Hemisphere	30	BUFR via GTS
	High, middle, low	01, 07, 13, 19	Northern Hemisphere	60	BUFR via GTS
	High, middle, low	01, 02, 03, 04, 05, 07, 08, 09, 10, 11, 13, 14, 15,16, 17, 19, 20, 21, 22, 23	Southern Hemisphere	60	BUFR via GTS
Water Vapor: WV (6.8 micrometers)	High, middle	00 , 06 , 12 , 18	Full disk	15	BUFR via GTS
	High, middle	03 , 09 , 15 , 21	Northern Hemisphere	30	BUFR via GTS
	High, middle	02, 04, 05, 08, 10, 11, 14, 16, 17, 20, 22, 23	Northern Hemisphere	30	BUFR via GTS
	High, middle	01, 07, 13, 19	Northern Hemisphere	60	BUFR via GTS
	High, middle	01, 02, 03, 04, 05, 07, 08, 09, 10, 11, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23	Southern Hemisphere	60	BUFR via GTS
Visible: VIS (0.63 micrometers)	Low	00, 06	Full disk	15	BUFR via GTS
	Low	03, 09, 21	Northern Hemisphere	30	BUFR via GTS
	Low	02, 04, 05, 08, 22, 23	Northern Hemisphere	30	BUFR via GTS
	Low	01, 07	Northern Hemisphere	60	BUFR via GTS
	Low	01, 02, 03, 04, 05, 07, 08, 21, 22, 23	Southern Hemisphere	60	BUFR via GTS
Short-wave Infrared: IR4 (3.8 micrometers)	Low	12,18	Full disk	15	Internal use only
	Low	08-11, 14-17, 20-23	Northern Hemisphere	30	Internal use only
	Low	07, 13, 19	Northern Hemisphere	60	Internal use only
	Low	09, 10, 11, 13, 14, 15, 16, 17, 19, 20	Southern Hemisphere	60	Internal use only

3 STATUS OF AMV QUALITY

This section describes the quality of MTSAT AMVs and recent related changes.

3.2 MONTHLY QUALITY OF AMVs

- IR high-level (> 400 hPa) and low-level AMVs

  This section reports on the monthly quality of six-hourly IR and WV AMVs produced from July 2005 to June 2011 based on standard CGMS AMV statistics. To evaluate the quality of the AMVs, they are compared with sonde observations.

  Figures 1 and 2 show time-series representations of monthly statistics (Root Mean Square Vector Difference (RMSVD), wind speed bias (BIAS) and number) for high-level (above 400 hPa) IR AMVs. In these statistics, AMVs with Quality Indicator (QI) values above 0.85 are applied. In accordance with the sonde observation time, AMVs at 00 and 12 UTC are used. Figure 1 shows no change in the statistical quality and characteristics of IR AMVs upon the switchover to MTSAT-2 in August 2010.

Figure 1

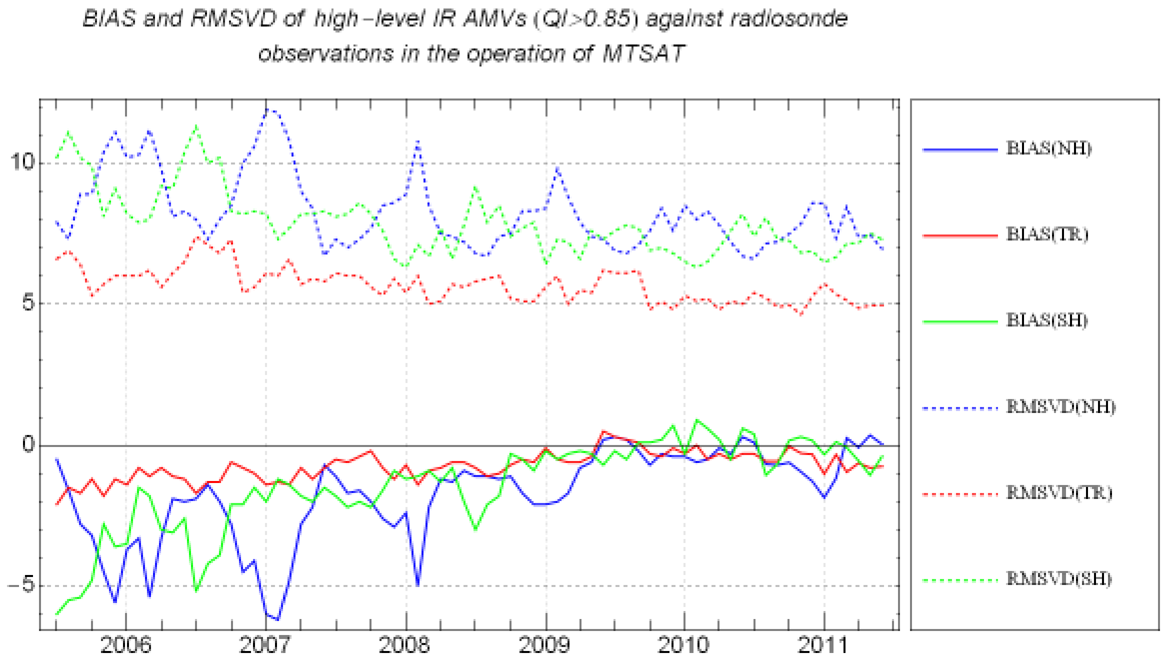


Figure 2

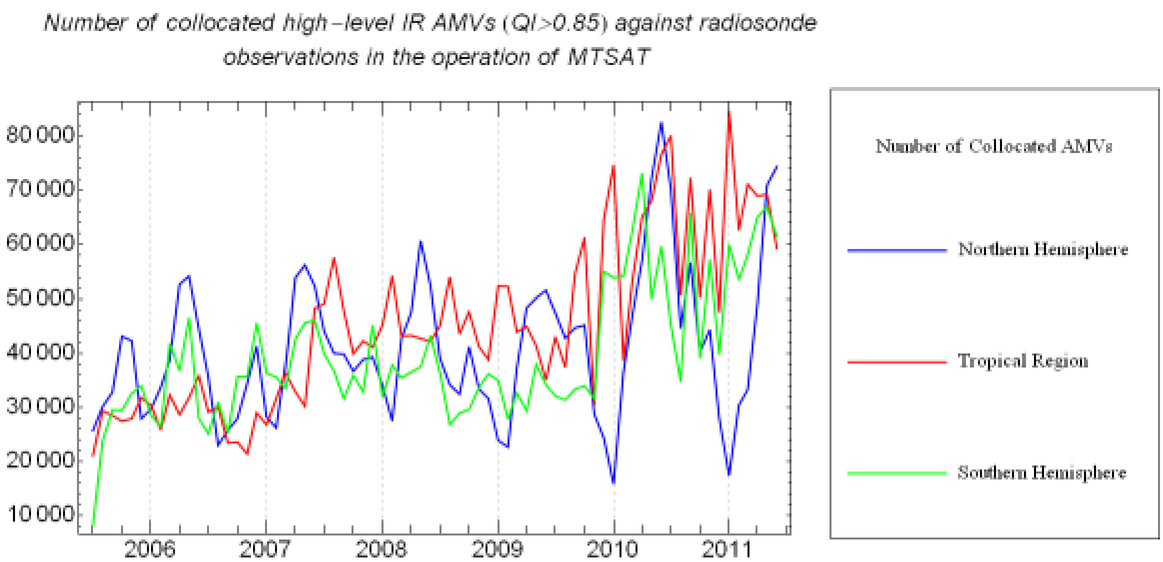


Figure 3

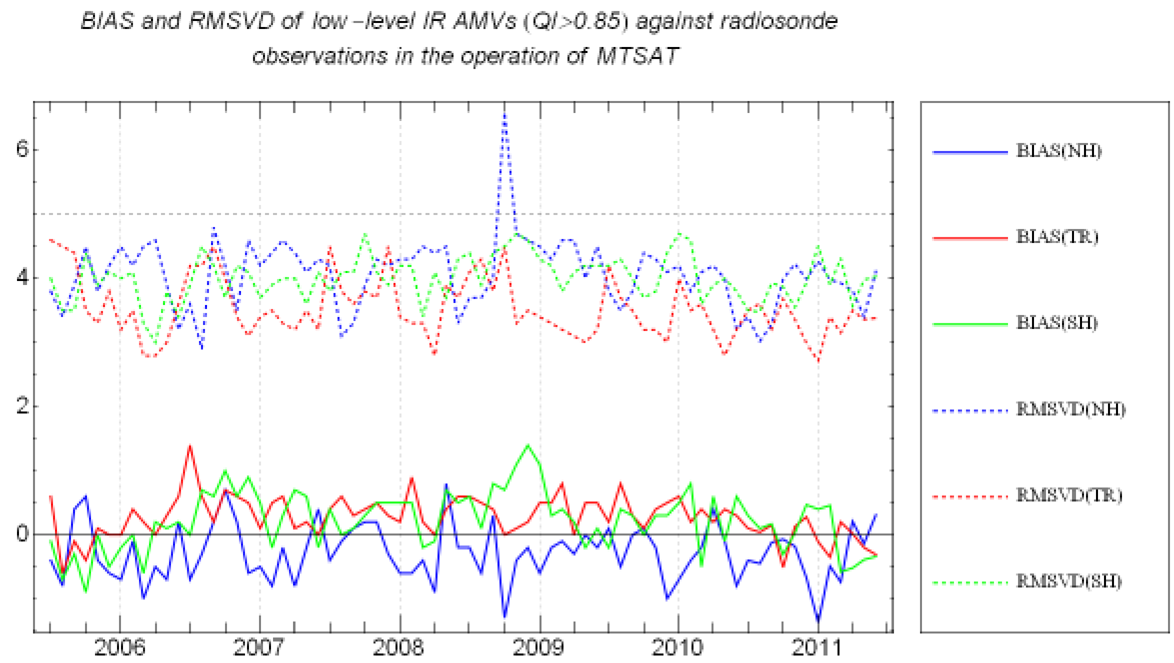
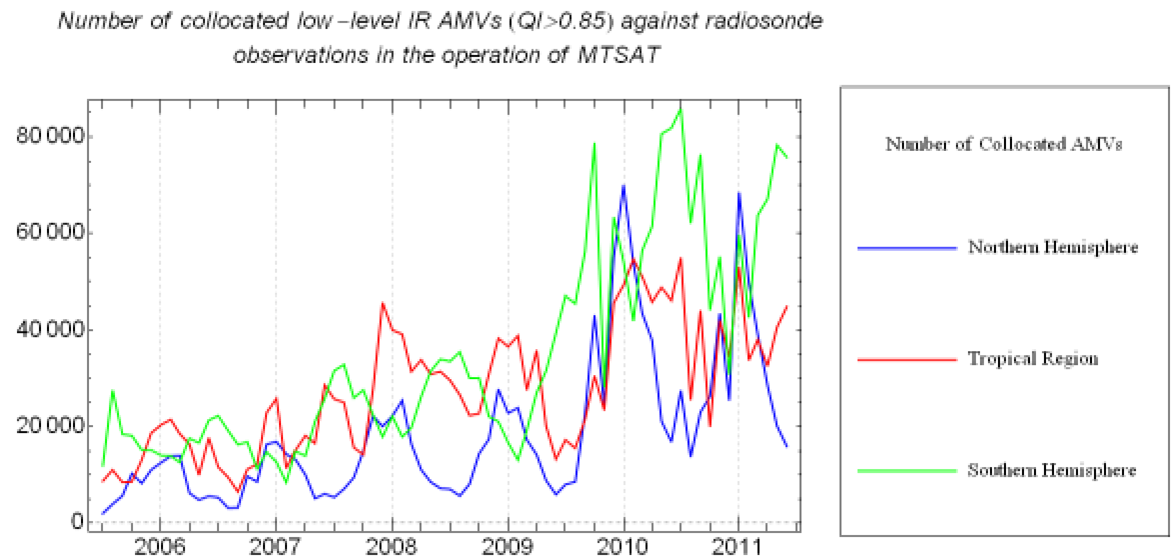


Figure 4



- WV AMVs over cloudy areas

Figures 5 and 6 are similar to those above, but for high-level WV AMVs. With respect to AMV quality change, the magnitude of the fast BIAS of WV high-level AMVs is slightly larger than that seen before the upgrades of 2009. However, these upgrades reduced periodic fluctuations of BIAS, especially in the winter season over the Northern Hemisphere.

Figure 5

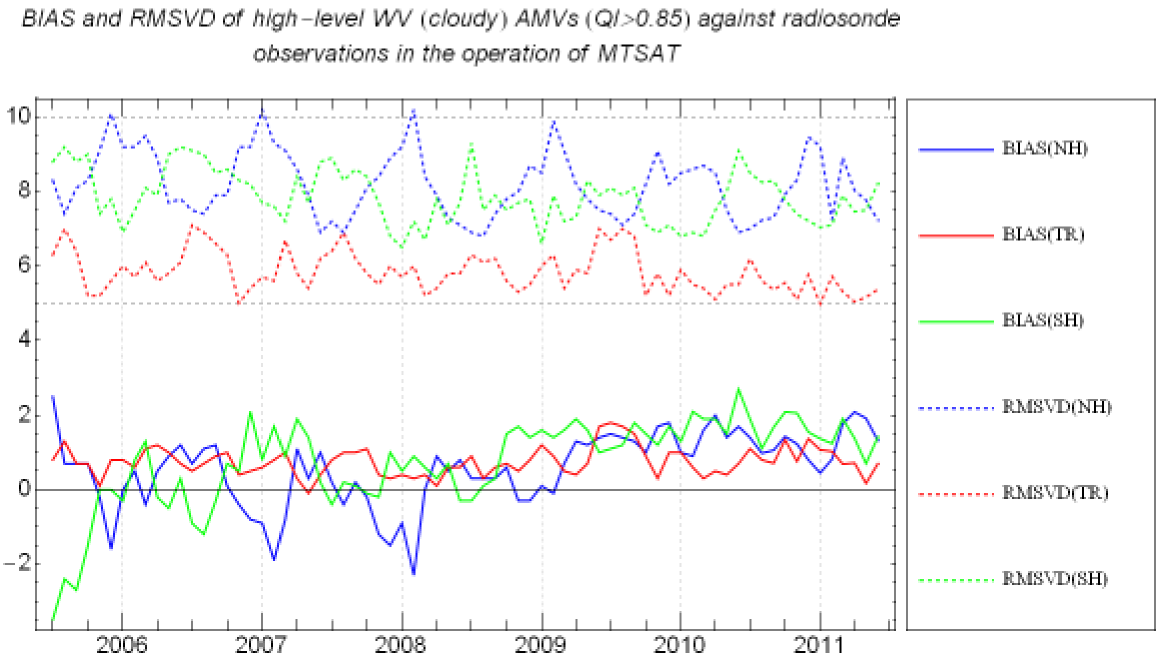
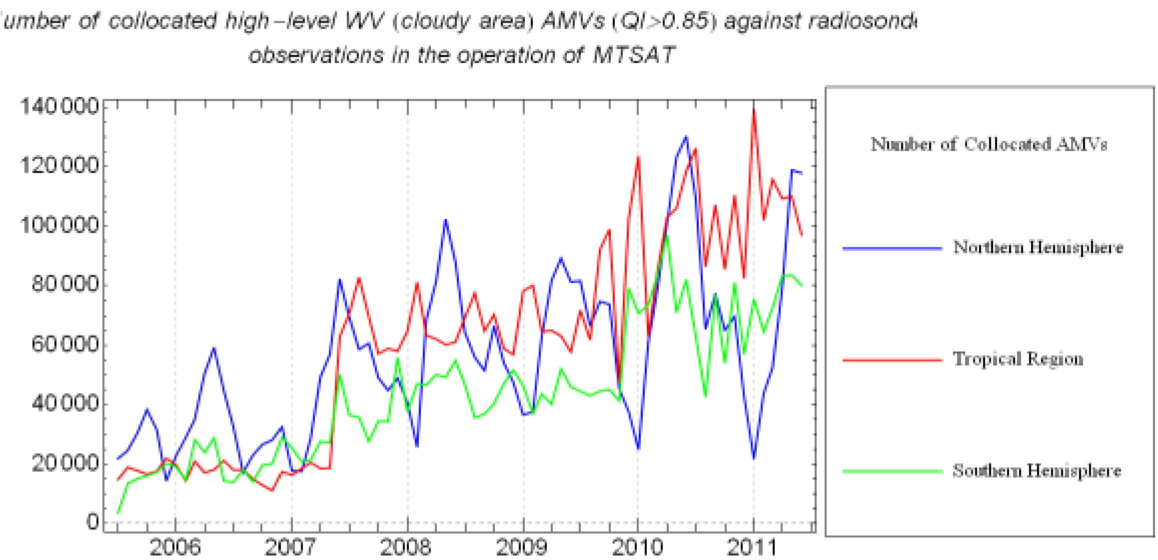


Figure 6



4 RESPONSES TO CGMS RECOMMENDATIONS

This section describes JMA's responses to CGMS recommendations.

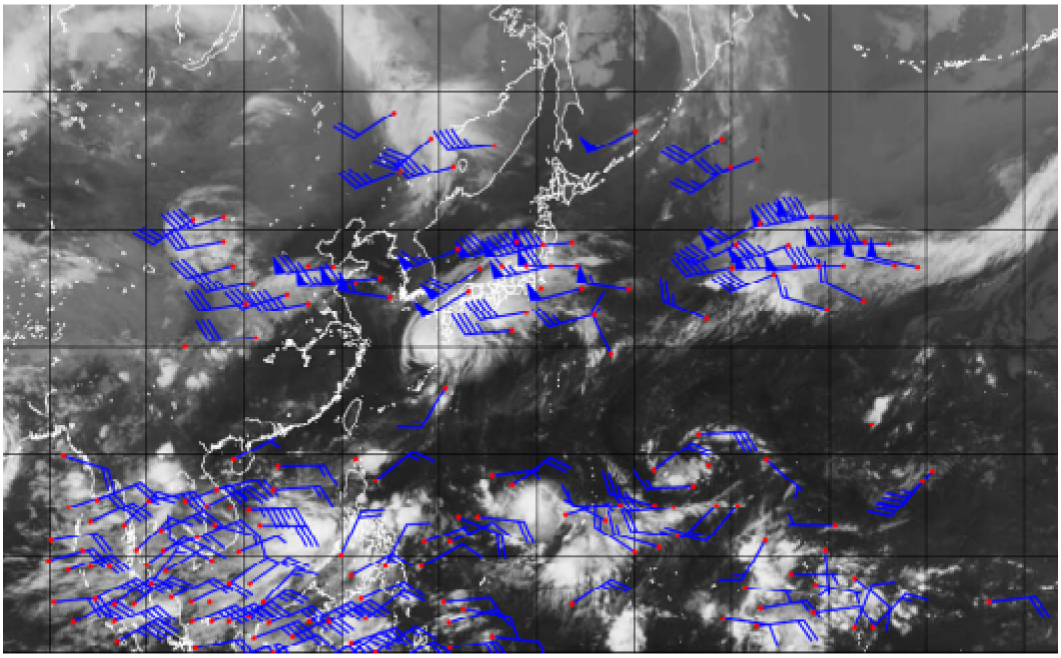
4.1 RESPONSE TO RECOMMENDATION 38.14

Recommendation 38.14: JMA is invited to report on the use of high-resolution AMVs derived for the T-PARC experiment.

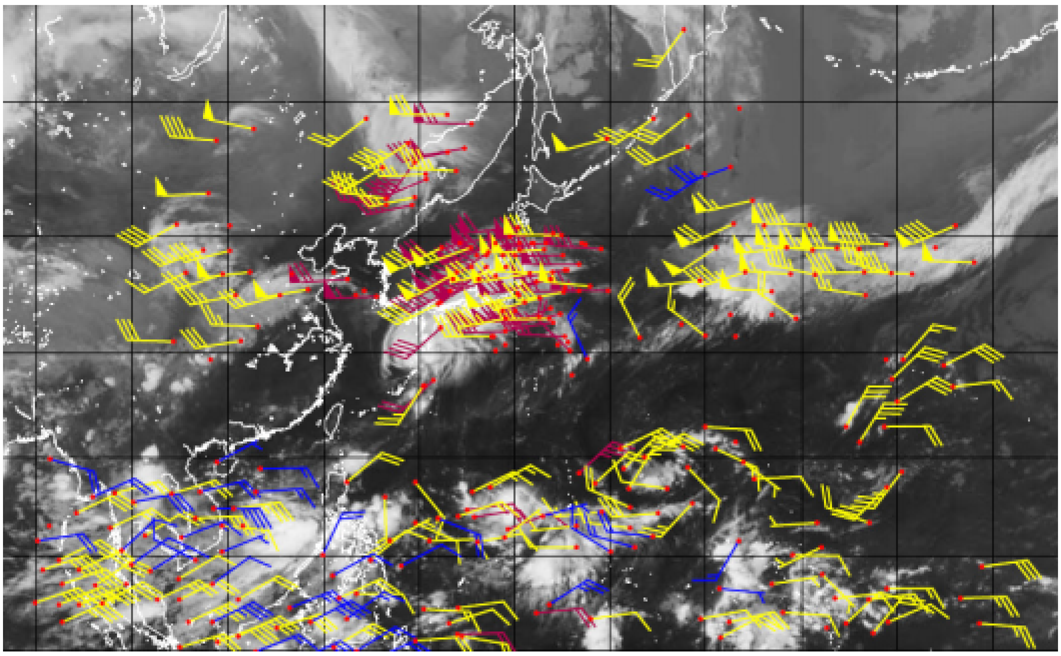
JMA conducted a special observation experiment as part of T-PARC in the summer of 2008. In this experiment, the effectiveness of a next-generation forecast technology called the Interactive Forecast System was examined in relation to the track forecasts of three typhoons. JMA/MSC conducted rapid-scan operation using MTSAT-2's Rapid Scan function and derived MTSAT-2 Rapid Scan AMVs for the T-PARC experiment during the periods of 10 – 13 September, 17 – 18 September, and 27 – 28 September, 2008. Observing-system experiments (OSEs) targeting Typhoon Sinlaku and a tropical depression with MTSAT-2 Rapid Scan AMV data confined to a 100-km area were performed using JMA's operational global and meso-scale models (GSM and MSM). Other experimental T-PARC observation data and typhoon bogus values were not used in the OSEs to allow evaluation of the impact of MTSAT-2 Rapid Scan AMV data alone.

Figure 7 shows examples of MTSAT-1R IR imagery and distribution of normal and Rapid Scan MTSAT AMV wind barbs after QC at 300 hPa. MTSAT-2 Rapid Scan operation increases the efficiency of wind vectors for NWP. Rapid Scan AMVs were derived from MTSAT-2 imagery every four or seven minutes.

The results of the OSEs showed that the bias and root mean square error of wind against radiosonde observations in the GSM and MSM were reduced. MTSAT-2 Rapid Scan AMVs also improved analysis fields and forecasting in these models. Figure 8 shows the extent of forecast improvement with regard to RMSE for one- to three-day forecasts in the GSM, and illustrates that MTSAT-2 Rapid Scan AMVs have a positive impact on NWP. However, Sinlaku track errors were debased in comparison to CNTL at a late forecast time as shown in Figures 9 and 10. It is necessary to investigate the cause of the deterioration in timing for atmospheric flow. As a whole, MTSAT-2-RS AMVs contributed to an improvement of analysis fields and forecasting in the case studies. Additional experimentation on the utilization of Rapid Scan AMVs is needed.



(a)



(b)

Figure 7: MTSAT-1R IR imagery at 1718 UTC and distribution of MTSAT AMV wind barbs after QC at 300 hPa from 1717 UTC to 1719 UTC ((a) CNTL, (b) TEST). The red, yellow and blue barbs are based on MTSAT-2-RSAMVs_4MIN or MTSAT-2-RSAMVs_7MIN, MTSAT-2-RS-

AMVs_15MIN, and MTSAT-1R AMVs, respectively. The wind barb unit is knots. Wind half-barbs represent 5 knots, and full barbs are 10 knots. Wind flags are 50 knots.

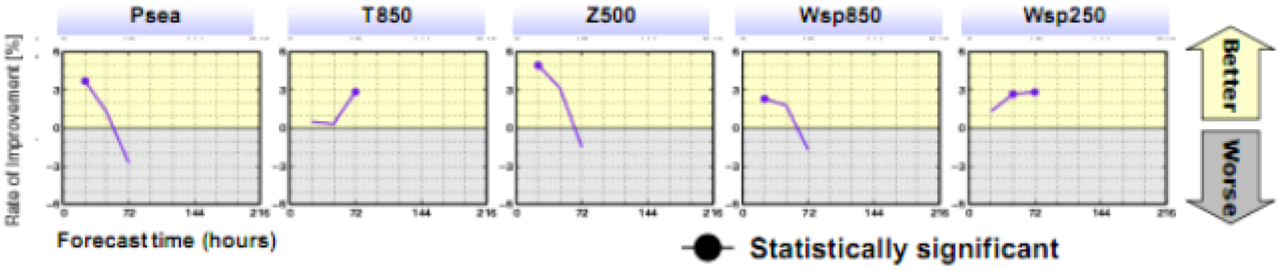


Figure 8: Extent of forecast improvement with regard to RMSE for one- to three-day GSM forecasts from 18 UTC on 10 September, 2008, to 06 UTC on 13 September, 2008. Psea shows surface pressure, T850 shows 850-hPa temperatures, Z500 shows 500-hPa geopotential heights, Wsp850 shows 850-hPa wind speeds, and Wsp250 shows 250-hPa wind speeds. Positive values indicate better scores.

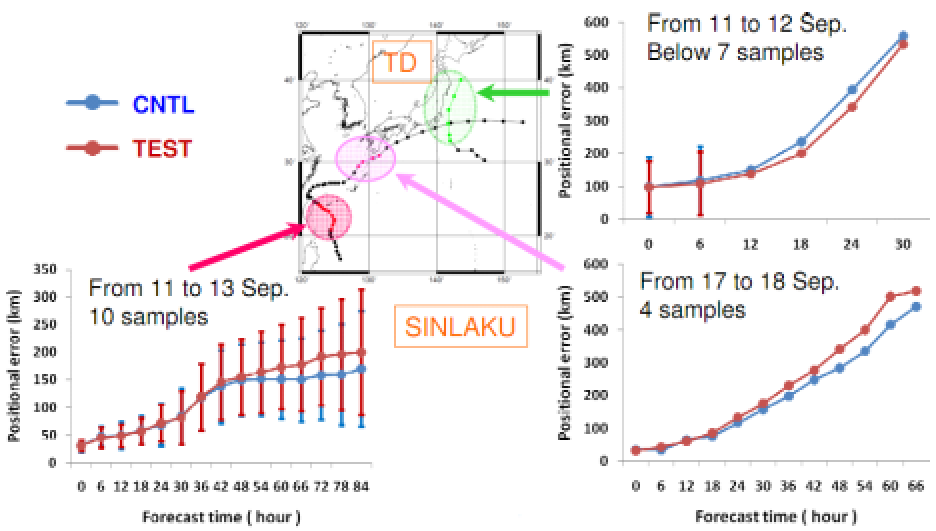


Figure 9: Positional errors for Typhoon Sinlaku and a TD for the three sections in the GSM. The red line is for TEST, in which MTSAT-2-RS AMVs were assimilated. The blue line is for CNTL, in which MTSAT-2-RS AMVs were not assimilated. Error bars represent a 95% confidence interval. The red, pink and green coloring represents areas and/or periods of MTSAT-2 Rapid Scan observation for T-PARC and MTSAT-2-RS AMV derivation and assimilation.

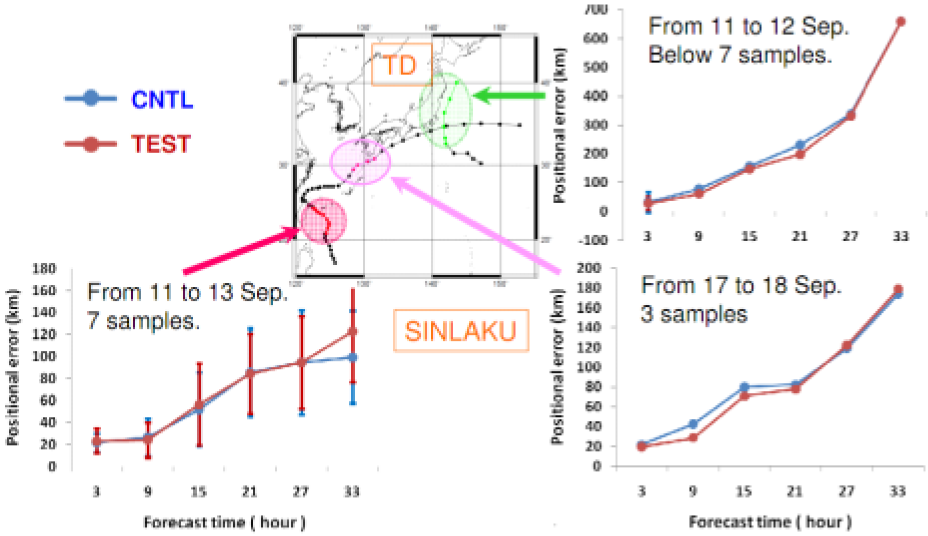


Figure 10: Positional errors for Typhoon Sinlaku and a TD for the three sections in the MSM. The other details are as per those in Figure 10.

4.2 RESPONSE TO RECOMMENDATION 38.15

Recommendation 38.15: CGMS operators are invited to express their interest in the portable AMV software package from the EUMETSAT 'Nowcasting SAF' for testing and internal comparisons.

As part of efforts to improve JMA's AMVs, JMA/MSC plans to examine the efficiency of the Nowcasting SAF portable AMV software package. This is expected to provide important information for algorithm investigation and for the development of AMV procedures to be applied in observations by Himawari-8.

5 ACTIVITIES FOR AMV DEVELOPMENT

This section describes recent JMA activities for AMV development.

5.1 AMV COMPUTATION USING RAPID-SCAN IMAGES

JMA/MSC currently conducts rapid-scan observations around the islands of Japan in summer at five-minute intervals using MTSAT-1R. The Agency is conducting an experiment to assimilate Rapid Scan AMVs into its NWP system and to investigate estimation of wind speeds around typhoons. In order to obtain real data for use in improving and/or developing AMVs and other products, JMA/MSC implements both 4-km resolution HRIT and 2-km HRIT imagery observation every five minutes. The new algorithms and/or procedures developed are expected to be applicable to observations by Himawari-8.

5.2 IMPROVEMENT OF HEIGHT ASSIGNMENT FOR LOW-LEVEL AMVs

JMA is currently developing a height assignment procedure for low-level AMVs. New low-level AMVs derived using this method have no 850-hPa upper limit, which is an issue with the current method. Validation and NWP experimentation for these AMVs are now under way.

5.3 AMV REPROCESSING FOR JRA-55

JMA has completed reprocessing of AMVs from GMS-series, GOES-9 and MTSAT-1R images using the newest operational algorithms. Target box sizes of 16, 24 and 32 pixels were adopted in the reprocessing. The dataset was provided for JMA's future long-term reanalysis project (JRA-55) and for Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM).