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CURRENT STATUS OF OPERATIONAL WIND PRODUCT IN JMA/MSC

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Abstract

The Japan Meteorological Agency (JMA) has started operation of Himawari-8 Atmospheric Motion Vectors (AMVs) from July 7th 2015. AMV computed from Himawari-8 has been disseminated to NWP centers via Global Telecommunication System (GTS) in BUFR format every 60 minutes. The observing function of Advanced Himawari Imager (AHI) is significantly enhanced from those of MTSAT-2; multispectral capacity (16 bands), high spatial resolution (0.5 – 1.0 km for visible and 1 – 2 km for infrared), fast imaging (within 10 minutes for full disk), and rapid scanning with flexible area selection and scheduling. These upgrades of imager enabled to retrieve more AMVs with more accuracy than before. And the agency plans to launch Himawari-9 as a backup for Himawari-8 in November 2016. The backup operation planed to be started in summer season of 2017. JMA/MSC has a plan to start operation of Himawari-8 rapid scan AMVs for monitoring, nowcasting and short-range NWP systems in 2016.

1. REPLACEMENT FROM MTSAT TO HIMAWARI

JMA/MSC replaced operational geostationary meteorological satellite from MTSAT-2 to Himawari-8 at 7th July 2015. AMV derivation software and its characteristics were also changed with the replacement. MTSAT-2 AMVs were disseminated to users via GTS by 24th March 2016 for NWP users. Launch of Himawari-9, which will be utilized as a backup satellite for Himawari-8, is planned on November 2016. The backup operation by Himawari-9 will be started in 2017 Q1. AMV derivation method for Himawari-9 will be same as for Himawari-8. But very small difference originated from difference between sensor response functions of Himawari-8 and -9 maybe seen. Format of Himawari-9 will be also same as Himawari-8 except satellite ID and central frequencies of bands.

2. SPECIFICATION OF OPERATIONAL HIMAWARI-8 AMV

Himawari-8 AMVs are currently being disseminated hourly as same as MTSAT AMV. One IR (10.4um), three WV (6.2, 6.9 and 7.3um) and one VIS (0.6um) are available for users. Distance between neighbouring grid points for AMV computation is 17 pixels (34km at nadir). Target box sizes used for pattern matching computation are 7x7 and 31x31 pixels. 10 minutes separated three consecutive images are being used as an input. This setting is determined for data assimilation to global NWP.

And JMA/MSC is producing spatially fine AMVs for meso-scale NWP. Most settings are same as above, but spatial resolution is set as 10 pixels (20km at nadir). The meso-scale AMV are computed around Japan area only.

JMA/MSC is planning to increase spatial resolution and dissemination frequency from hourly to half-hourly. However, line speed and capability of GTS are not enough to send all of AMV data. Effective Thinning method or alternative way to transmit is required for high-resolution AMV.

3. AMV CHARACTERISTIC CHANGES WITH REPLACEMENT TO HIMAWARI-8

- **Spatial distribution**

Himawari-8 is the third generation geostationary meteorological satellite. Observable data is significantly increased in meaning of spectral, spatial and temporal resolution. For effectively using the data, JMA/MSC changed completely AMV derivation algorithm for target selection, tracking, height estimation and quality control. Those Changes enabled to retrieve more winds than before (Fig 1). Increase of spatial coverage by low level winds is significant.

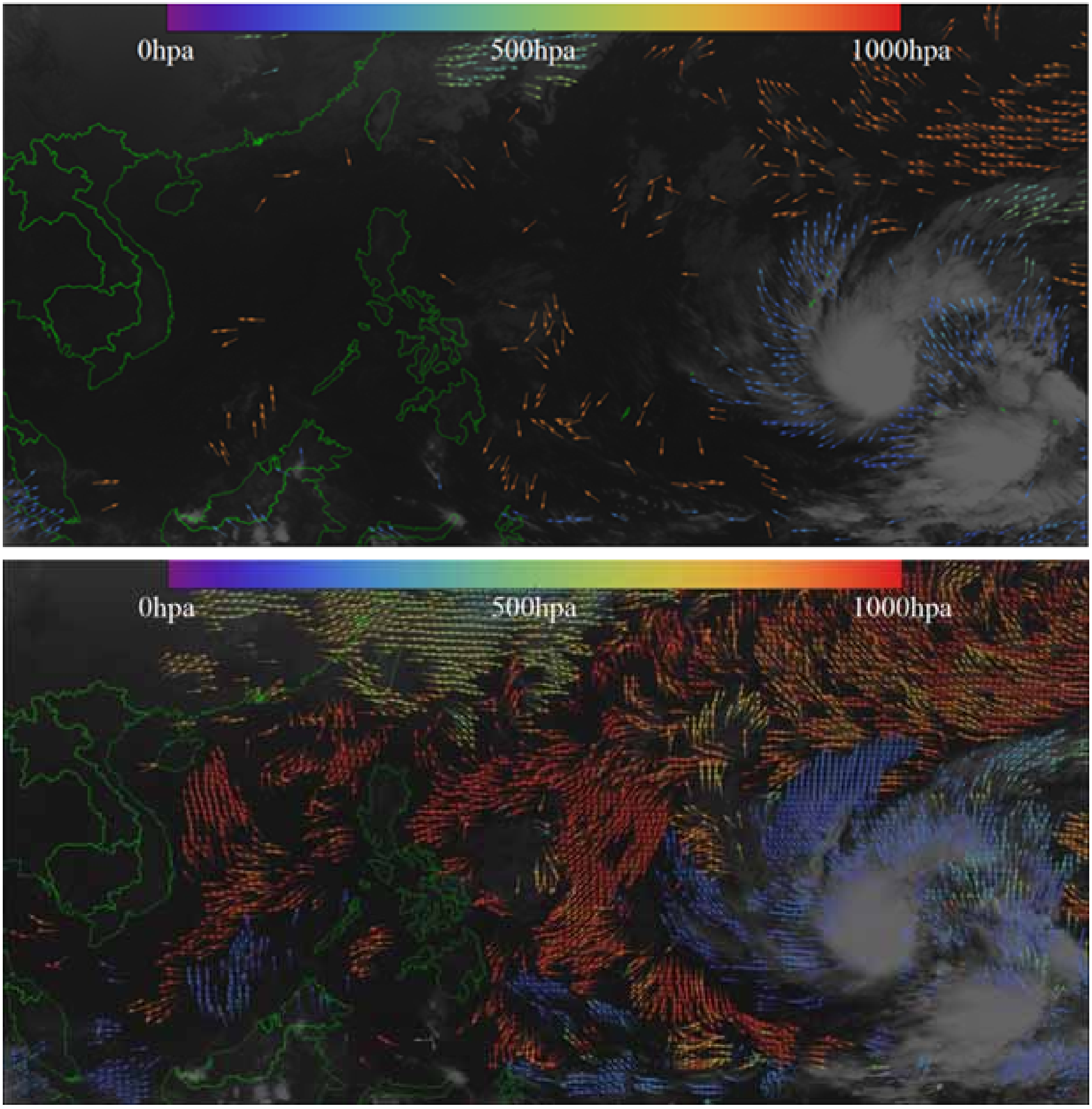

Fig1 : Comparison of MTSAT AMVs (QI>80) derived from heritage software (top) and new software for Himawari-8 AMV(bottom) for 00UTC 02 March 2014. Coverage of low-level winds are significantly improved by algorithm upgrade. Collor of wind vectors corresponds to estimated height.

- **Height estimation**

New height assignment method using multiple bands simultaneously improves accuracy of estimated heights. Fig 2 shows difference between estimated cloud heights from MTSAT and Himawari-8 IR AMVs. Data coverage and estimated height are significantly changed with replacement from MTSAT-2 to Himawari-8.

- **Sonde statistics**

Table 1 and 2 shows IR AMV vs sonde statistics for MTSAT and Himawari AMV. All of statistical elements show that there is no significant (over 0.5m/s) quality debasement in Himawari AMV in comparison with MTSAT winds. Most of statistical elements are improved in summer and winter seasons, especially for negative wind speed BIAS in winter season. Table 3 and 4 shows same but for WV AMVs. As for summer, change of quality is almost neutral but most of elements on multiple levels and over areas were improved in winter season.

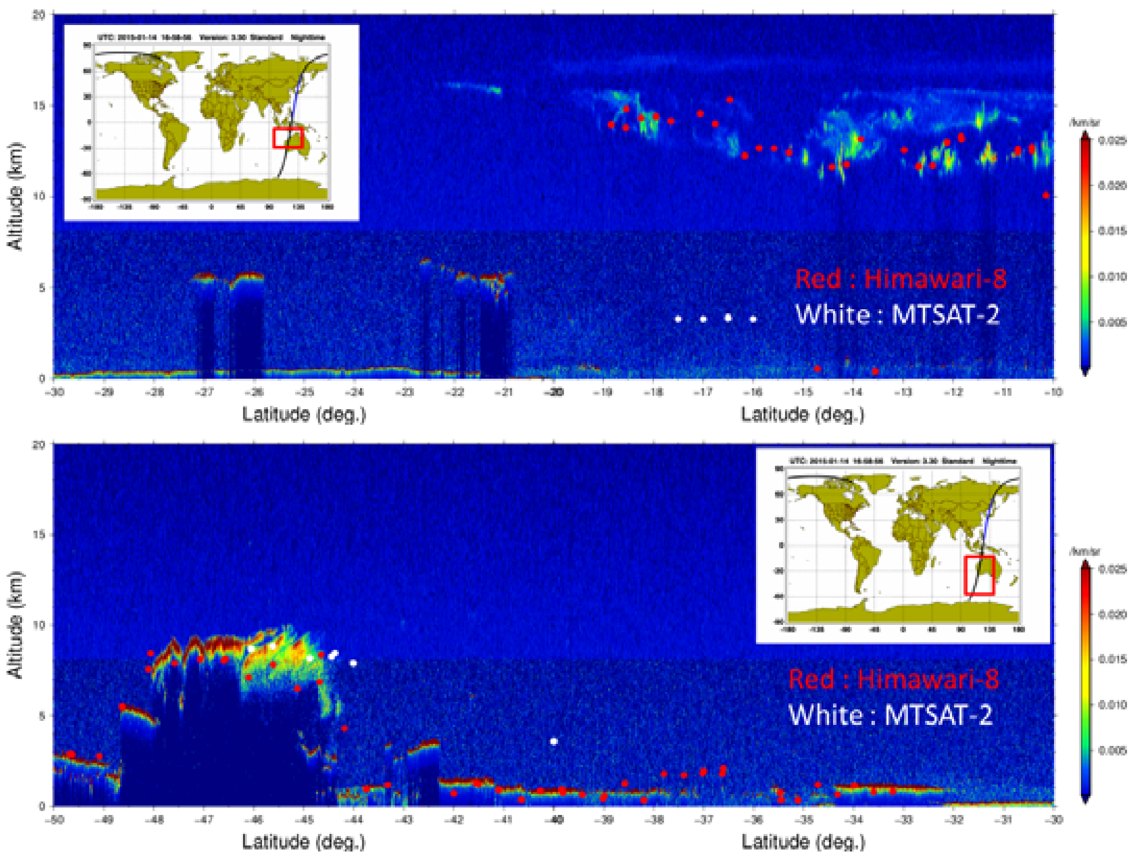

Fig2 : Comparison of estimated cloud height from Himawari-8 AMV and MTSAT-AMV background images are Calipso 523 nm total backscatter for 17UTC 14 January 2015. Height of very thin cirrus was difficult to estimate accurately by MTSAT AMV derivation scheme but most of winds are assigned to appropriate level in Himawari-8 AMV(top). And height estimation of Himawari-8 AMV for dense clouds is considered to be more accurate than MTSAT-AMV.

Period : August 1 – August 31 2015 (QI > 0.85)

Himawari-8 AMV using Himawari-8 imagery and new algorithm

HIGH-LEVEL (-400hPa)	ALL	NH	TROP	SH
MVD	4.88	5.25	4.52	5.25
RMSVD	5.82	6.20	5.40	6.50
BIAS	−0.1	0.04	−0.23	−0.16
SPD	19.07	22.08	15.93	29.89

MED-LEVEL (400-700hPa)	ALL	NH	TROP	SH
MVD	3.97	4.05	3.42	4.81
RMSVD	4.67	4.75	4.00	5.59
BIAS	−0.12	0.03	−0.28	−0.28
SPD	12.28	12.23	8.94	19.24

LOW-LEVEL (700hpa -)	ALL	NH	TROP	SH
MVD	3.22	2.99	3.21	3.44
RMSVD	3.86	3.71	3.8	4.08
BIAS	0.54	0.04	0.84	0.45
SPD	8.85	8.26	8.23	10.55

MTSAT-2 AMV using MTSAT-2 imagery and heritage algorithm

HIGH-LEVEL (-400hPa)	ALL	NH	TROP	SH
MVD	5.11	5.71	4.4	5.68
RMSVD	6.17	6.84	5.26	6.99
BIAS	−0.66	−0.87	−0.36	−1.83
SPD	18.07	21.55	13.56	27.11

MED-LEVEL (400-700hPa)	ALL	NH	TROP	SH
MVD	4.96	4.81	4.11	5.76
RMSVD	6.05	5.66	4.91	7.21
BIAS	−0.35	0.07	−0.39	−0.99
SPD	16.52	14.3	11.87	23.04

LOW-LEVEL (700hpa -)	ALL	NH	TROP	SH
MVD	3.32	3.04	3.27	3.62
RMSVD	3.95	3.86	3.88	4.17
BIAS	0.26	−0.43	0.52	0.23
SPD	8.12	7.44	8.05	8.78

Table 1 : montyhly sonde statistics of Himawari-8 (left) and MTSAT (right) IR AMVs for August 2015. MVD, RMSVD, BIAS and SPD corresponds to motion vector difference, root mean square vector difference, wind speed bias (AMV-sonde) and average wind spead respectively. Unit for this table is in m/s. Red (Blue) color represents improvement (debasement) to MVD, RMSVD and BIAS (at least over 0.5m/s). Green means no significant change (less than 0.5m/s) in statistics.

Period : December 1 – December 31 2015 (QI > 0.85)

Himawari-8 AMV using Himawari-8 imagery and new algorithm

HIGH-LEVEL (-400hPa)	ALL	NH	TROP	SH
MVD	4.77	5.73	4.10	5.08
RMSVD	5.72	6.75	4.87	6.07
BIAS	−0.32	−0.38	−0.34	0.04
SPD	24.2	40.49	12.96	27.57

MED-LEVEL (400-700hPa)	ALL	NH	TROP	SH
MVD	4.58	4.74	3.72	4.32
RMSVD	5.48	5.65	4.55	5.05
BIAS	−0.19	−0.24	−0.18	0.52
SPD	19.69	21.78	8.56	15.37

LOW-LEVEL (700hpa -)	ALL	NH	TROP	SH
MVD	3.39	3.57	3.01	3.60
RMSVD	4.06	4.28	3.60	4.19
BIAS	0.22	−0.14	0.84	0.38
SPD	9.90	10.46	9.09	9.12

MTSAT-2 AMV using MTSAT-2 imagery and heritage algorithm

HIGH-LEVEL (-400hPa)	ALL	NH	TROP	SH
MVD	4.90	6.56	3.78	5.71
RMSVD	5.99	7.80	4.42	6.77
BIAS	−0.74	−1.4	−0.47	−0.28
SPD	18.8	33.32	9.43	23.93

MED-LEVEL (400-700hPa)	ALL	NH	TROP	SH
MVD	5.79	5.94	5.67	4.78
RMSVD	7.03	7.21	6.99	5.56
BIAS	−1.76	−1.79	−2.6	−1.21
SPD	21.45	22.32	11.97	18.5

LOW-LEVEL (700hpa -)	ALL	NH	TROP	SH
MVD	3.62	4.04	2.95	3.88
RMSVD	4.25	4.69	3.48	4.41
BIAS	−0.13	−0.57	0.39	0.02
SPD	9.55	10.49	8.66	8.76

Table 2 : same as Table 1 but for winter season. Negative wind speed BIAS in high and middle level is significantly decreased

Period : August 1 – August 31 2015 (QI > 0.85)

Himawari-8 AMV using Himawari-8 imagery and new algorithm

HIGH-LEVEL (-400hPa)	ALL	NH	TROP	SH
MVD	5.07	5.51	4.71	5.41
RMSVD	6.07	6.55	5.64	6.71
BIAS	0.4	0.72	0.16	0.16
SPD	20.27	23.52	17.43	32.37

MTSAT-2 AMV using MTSAT-2 imagery and heritage algorithm

HIGH-LEVEL (-400hPa)	ALL	NH	TROP	SH
MVD	5.45	5.90	4.89	5.80
RMSVD	6.53	7.00	5.90	6.99
BIAS	0.79	0.7	0.91	0.39
SPD	19.81	23.41	15.12	28.79

Table 3 : Same as Table 1 but for WV (6.2um) AMV. Significant change is not seen in most of elements over all areas and levels.

Period : December 1 – December 31 2015 (QI > 0.85)

Himawari-8 AMV using Himawari-8 imagery and new algorithm

HIGH-LEVEL (-400hPa)	ALL	NH	TROP	SH
MVD	4.81	5.8	4.2	5.29
RMSVD	5.76	6.83	4.98	6.36
BIAS	0.17	0.26	0.03	0.8
SPD	24.82	42.48	14.47	29.39

MTSAT-2 AMV using MTSAT-2 imagery and heritage algorithm

HIGH-LEVEL (-400hPa)	ALL	NH	TROP	SH
MVD	5.39	7.11	3.93	5.85
RMSVD	6.68	8.53	4.68	6.96
BIAS	0.99	1.19	0.66	1.68
SPD	23.96	40.22	10.69	26.63

Table 4 : Same as other table but for WV winds in winter season. Wind speed BIAS is mitigated for all areas but change of MVD and RMSVD over tropical region is neutral.

4. FUTURE UPGRADE PLAN FOR JMA AMV

JMA/MSC plans to increase kinds of operational wind products using not only full disk imagery but also rapid scan target observation imagery. Fig 3 shows current and future operational AMVs in JMA/MSC. Higher spatial density winds than current operational will be produced for JMA global NWP models. This high resolution winds are difficult to disseminate to abroad due to line speed problem of GTS at this present. The agency is looking for how to send big data. And production of rapid scan AMVs will be started in 2016. Fig 4 is comparison of visible AMVs derived from 10 minutes and 2.5 minutes. Rapid scan winds from 2.5 minutes separated images are considered to be able to retrieve very small scale phenomena such as orographic wind. And spatial coverage over stratus area is also improved over area which localized feature is less than other areas. This is considered that higher temporal and spatial resolution is generally helpful for increasing spatial coverage of AMVs. JMA /MSC have a plan to use rapid scan AMVs for early warning information of typhoon.

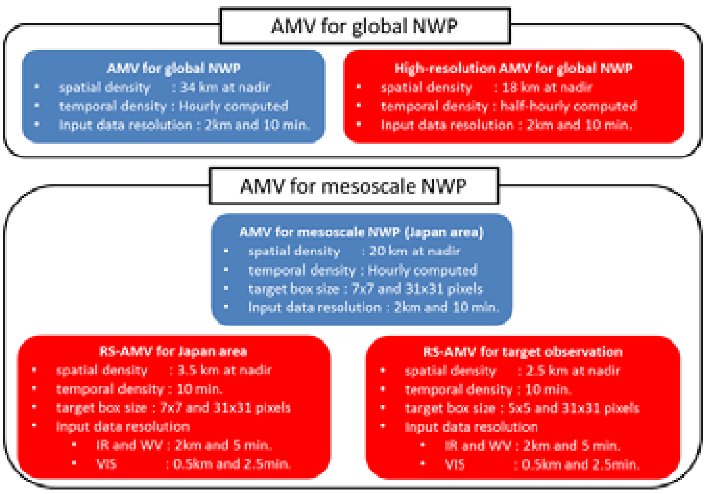

Fig3 : current and future satellite wind products in JMA/MSC. Blue is current operational products and red is planned to start in 2016.

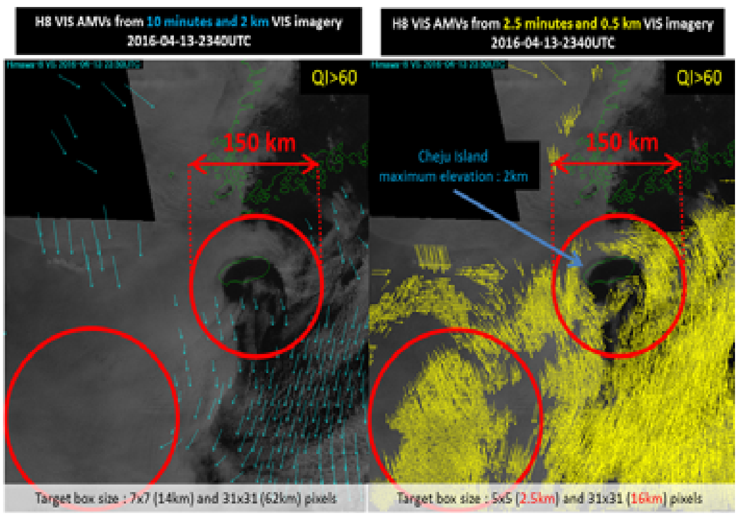

Fig4 : Comparison of VIS AMVs from normal resolution (10minutes and 2km : left) and high resolution (2.5 minutes and 0.5km : right). Retrieved winds are considerably different. Orographic winds going around Cheju island is observed in rapid scan winds.

5. SUMMARY

The Japan Meteorological Agency (JMA) has started operation of Himawari-8 AMVs from July 7th 2015. Characteristics of the Himawari-8 AMV are significantly changed by replacement of imager and introduction of new derivation algorithm. The changes to quality are considered to be neutral or positive changes in radio sonde statistics. Spatial coverage by AMVs is clearly improved compared with MTSAT AMV. The Agency plans to produce high resolution AMV products for global and meso-scale NWP. Rapid scan AMV derived from high temporal (2.5 min.) and spatial resolution (0.5km) imagery are thought to be able to retrieve smaller scale winds than case using normal resolution imagery. The rapid scan AMVs will be used for not only NWP but also early warning alert for Typhoon.

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