Proceedings for the 14th International Winds Workshop,
23-27 April 2018, Jeju City, South Korea

REPROCESSING OF ATMOSPHERIC MOTION VECTORS FOR JRA-3Q AT JMA/MSC

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Abstract

Climate-related operation requires quantitative evaluation of long-term atmospheric conditions in climate predictions such as seasonal forecasting and global warming, as well as in the analysis of extreme weather events and climate change. However, the characteristics of long-term atmospheric data vary by period, and the results of related analysis are likely to be inaccurate. Accordingly, reanalysis with a high-quality homogeneous dataset covering a long period is necessary. Against this background, the Japan Meteorological Agency (JMA) has conducted the Japanese 25-year Reanalysis (JRA-25) and the Japanese 55-year Reanalysis (JRA-55), and also plans a project known as the Japanese 75-year Reanalysis (JRA-3Q).

JMA's Meteorological Satellite Center (MSC) is currently reprocessing Atmospheric Motion Vectors (AMVs) from past satellite images using the latest Himawari-8 AMV derivation algorithm to accommodate the JRA-3Q project. The reprocessing is limited to data from GMS-5 (1995 - 2003), GOES-9 (2003 - 2005), MTSAT-1R (2005 - 2010) and MTSAT-2 (2010 - 2015), as the algorithm requires water vapor channel information.

To evaluate AMVs with the latest algorithm in contrast to the operational algorithm, reprocessed AMVs were compared against the first guess of a numerical weather prediction model. The results indicated that AMV errors with the latest algorithm were smaller, thereby highlighting its capacity for the derivation of high-quality homogenized AMVs.

INTRODUCTION

Climate-related operations involve prediction and analysis of extreme weather events and climate change, and therefore require a high-quality homogeneous dataset covering a long period for quantitative evaluation of long-term atmospheric conditions. As the characteristics of operational analysis datasets vary significantly over time due to technological development of numerical weather prediction models, data assimilation systems and observation technology, reanalysis is necessary to produce high-quality homogeneous data.

Reanalysis projects involve consistent use of the most up-to-date systems and observation data possible and reprocessing of meteorological satellite data using the latest algorithm. This paper details the reprocessing of AMVs for JRA-3Q based on the latest algorithm (Shimoji 2017).

AMV REPROCESSING FOR JRA-3Q

The Japanese Reanalysis (JRA) initiative was launched to produce high-quality homogeneous climate data covering a long period. To date, JMA has produced the JRA-25 and JRA-55 reanalysis datasets. The JRA-25 project covering the period from 1979 to 2004 was jointly conducted by JMA and the Central Research Institute of Electric Power Industry (CRIEPI), with reprocessing of AMVs from GMS-3 to GMS-5 for the period from 1987 to 2003 (Onogi *et al.* 2007). JRA-55 was conducted by JMA for the period from 1958 onward (Kobayashi *et al.* 2015), with reprocessing of AMVs using the operational derivation algorithm for all past satellites from GMS-1 to MTSAT-1R (Oyama 2010). The forthcoming JRA-3Q reanalysis project (with "3Q" representing three quarters of a century) involves JMA's reprocessing of AMVs using the latest derivation algorithm for Himawari-8 data. The target satellites are MTSAT-2 (2010 - 2015), MTSAT-1R (2005 - 2010), GOES-9 (2003 - 2005) and GMS-5 (1995 - 2003). Water vapor images are necessary for the

Himawari-8 AMV algorithm, and data from these satellites include the necessary water vapor channel information (Figure 1).

As shown in Figure 1, reprocessing of AMVs for the MTSAT series (2005 - 2015) is complete, and the reprocessed AMVs have been validated. A significant difference is observed between the reprocessed AMVs and Japanese Global Spectral Model (GSM) data. Reprocessing for GMS-5 data is in progress.

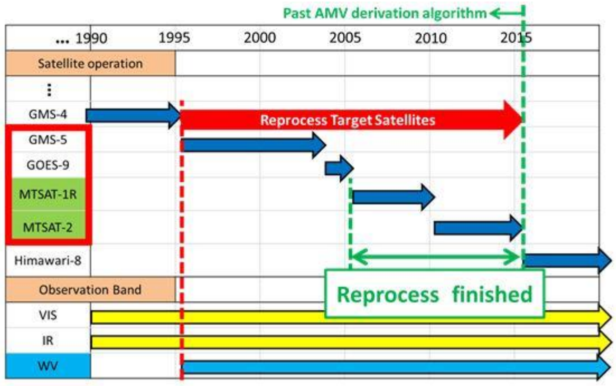

Figure 1: Current status of reprocessing for JRA-3Q

IMPROVEMENT BASED ON THE LATEST AMV DERIVATION ALGORITHM

Comparison between the latest AMVs and operational AMVs for 00:00 UTC on 1st January 2013 with MTSAT-2 IR AMVs and data involving forecast QI thresholds over 85. The main differences between these algorithms highlight the two points noted below (Shimoji 2017).

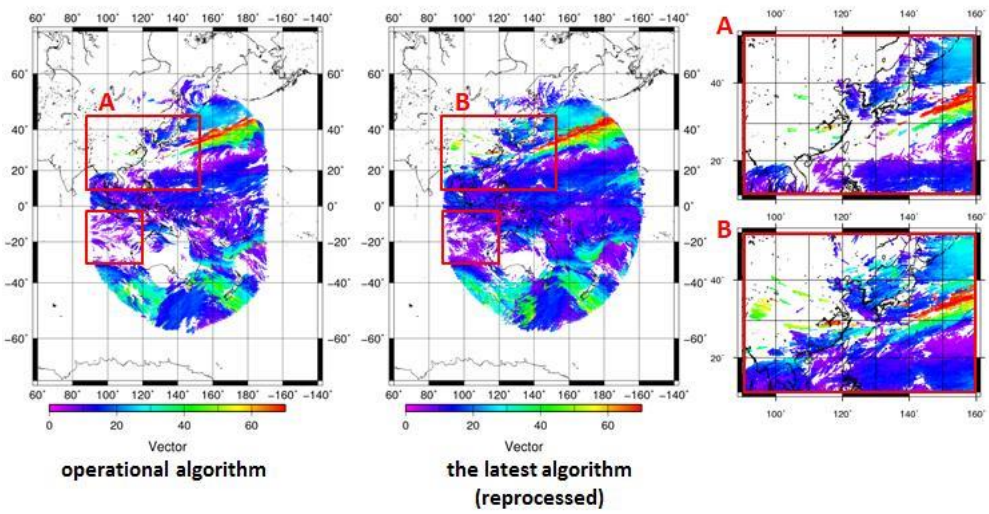

***Figure 2*: Coverage using the latest algorithm (A) and the operational algorithm (B)**

1. Using averages of correlation surfaces for noise reduction eliminated correlated AMV errors in the tracking process. The Himawari-8 algorithm is based on a cross-correlation method, as per the MTSAT algorithm. However, the Himawari-8 algorithm involves the use of multiple cross-correlation surfaces, while the MTSAT algorithm uses only a single surface.
2. The height assignment method involves the use of maximum likelihood data, and the MTSAT algorithm involves the use of H_2O-IRW intercept data or the IR/WV TBB method.

Figure 2 shows notable improvement in reprocessed AMVs. Coverage is enhanced using the latest algorithm, especially in the areas marked A and B, due to expansion of the derivation area and the improved targeting algorithm.

Figure 3 shows O-B statistics maps indicating wind speed bias, RMSVD and mean speed. The satellite images are from MTSAT-2, the band is IR, and the derivation term is from 1st January to 31st December 2013. Negative wind speed bias and large RMSVD values tend to be derived in high wind speed areas with operational AMVs (Shimoji 2014). However, the wind speed bias for reprocessed AMVs tends to be positive, and O-B statistics are spatially uniform for first-guess values (Figure 3 and Table 1).

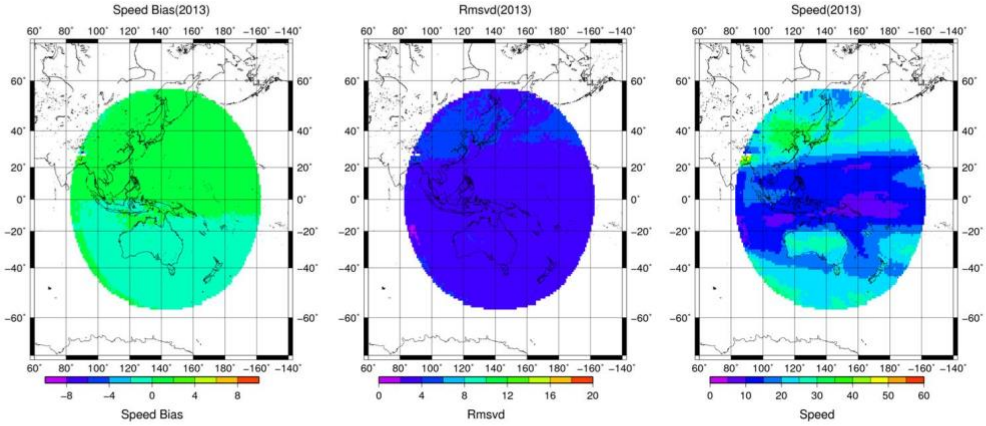

Figure 3: Verification of statistical value map (IR)
Speed bias (left), RMSVD (center) and mean speed (right)

Table 1: Speed bias, RMSVD and mean speed in individual areas

	Speed Bias				Rmsvd				Speed			
	ALL	NH	TROP	SH	ALL	NH	TROP	SH	ALL	NH	TROP	SH
Upper	0.36	1.20	0.56	-0.75	3.82	4.39	3.30	3.97	23.89	29.37	14.97	31.05
Middle	0.54	1.03	0.51	0.11	3.34	3.81	0.51	3.65	16.27	19.93	9.08	22.66
Low	0.29	0.75	0.37	-0.18	2.24	2.48	2.07	2.26	10.39	11.52	8.25	12.3

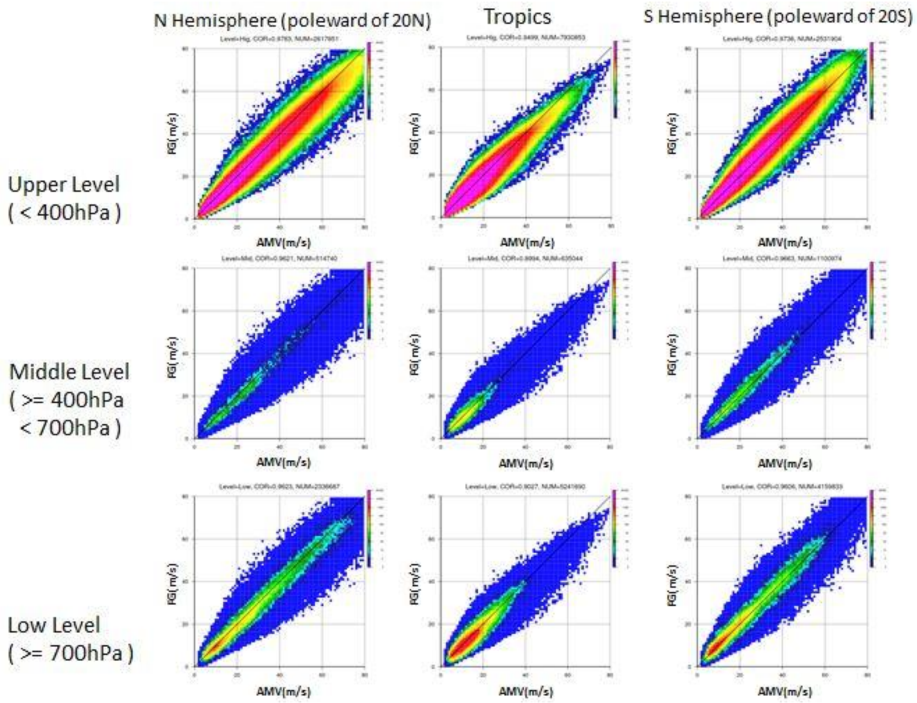

Figure 4: Wind speed correlations

High wind-speed correlations were also observed between derived AMVs and first-guess values (FG winds; Figure 4).

REPROCESSING PLANS

The JRA-3Q team plans reanalysis to use reprocessed AMV data from the end of March 2019 onward, to be followed by data verification. We are planning further reprocessing for as-yet unprocessed satellite images. The resulting data will be provided to other institutions.

Information on the JRA-3Q reprocessed AMVs will be provided on the current web page for the JRA-55 project and related AMVs (https://www.data.jma.go.jp/mscweb/en/product/reprocess/).

SUMMARY

JMA plans to use reprocessed AMV data based on the latest algorithm for the forthcoming JRA-3Q reanalysis project. The algorithm requires water vapor images for height assignment, and AMVs are reprocessed for MTSAT-1R, -2, GOES-9 and GMS-5, which have water vapor channels. Validation between the latest and operational AMVs indicated improved O-B statistics. JMA plans to provide the reprocessed data internationally.

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