Retrieval of satellite cloud drift winds with GMS-5 and inter comparison with radiosonde data over the Korea

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ABSTRACT

Conventional methods for measuring winds provide wind velocity observations over limited areas and time period. The use of satellite imagery for measuring wind velocity overcomes some of these limitations by providing wide area and near continuous coverage. And its accurate depiction is essential for operational weather forecasting and for initialization of NWP models. GMS-5 provides full disk images at hourly intervals. At four times each day - 0500, 1100, 1700, 2300 hours UTC-a series of three images is received, separated by thirty minutes, centered at the four times. The current wind system generates winds from sets of 3 infrared(IR) images, separated by an hour, four times a day. It also produces visible(VIS) and water vapor(WV) image-based winds from half-hourly imagery four times a day. The derivation of wind from satellite imagery involves the identification of suitable cloud targets, tracking the targets on sequential images, associating a pressure height with the derived wind vector, and quality control. The aim of this research is to incorporate imagery from other available spectral channels and examine the error characteristics of winds derived from these images.

1. Introduction

Conventional methods for measuring winds provide wind velocity observations over limited areas and time period. The use of satellite imagery for measuring wind velocity overcomes some of these limitations by providing wide area and near continuous coverage. And its accurate depiction is essential for operational weather forecasting and for initialization of NWP models.

GMS-5 observations provide an opportunity to continually monitor the data-sparse regions of the west and east sea of Korea. In this regard, hourly infrared, visible and water vapor imagery-based winds have been generated locally at the METRI (Meteorological Research Institute) to augument the real time data base available to the operational regional forecast system within its stringent cutoff time. Table 1 shows the GMS-5 image channels and their characteristics.

Table 1. GMS-5 Channels

Channel ID	Wavelength Range	Resolution
VIS	0.5㎛ ~ 1.0㎛	1.25km
IR1	10.2㎛ ~ 11.4㎛	5km
IR2	10.9㎛ ~ 12.2㎛	5km
IR3	6.7㎛ ~ 7.2㎛	5km

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2. The Wind System

Hourly and half-hourly (four times a day), GMS S-VISSR infrared (IR), water vapor (WV) and visible (VIS) images are received. Targets are selected and tracked automatically using a model forecast to initiate the search for the selected targets on subsequent images. A lag correlation technique is used to estimate the vector displacement. Altitude assignment is similar to that in Le Marshall *et al.* (1994, 1998b) with refinements to allow for the changes in spectral response functions and calibration for the new GMS-5 VISSR. As a result, the winds reflect the benefit of dynamic calibration and use of the split window channels (IR1, IR2) for water vapor correction and height assignment (Le Marshall, 1998a).

In recent times, the distribution of winds over the Korean region is derived. Fig. 1 provides an example of infrared image at 0500 UTC on 10 August 1999. We can see the low pressure near the Japan and front in China. Using 30 minutes time interval images including visible, infrared and high resolution visible we produced three kinds of wind and more detail winds with wind heights (hPa) and speeds (kts) around the Korea. The stars (*) indicate the positions of features (tracers) used for tracking. Fig. 2 shows more detailed infrared and 6.7 m water vapor wind vectors are plotted over East Asia for the same time. High-speed winds are monitored over the front areas and depict low-pressure wind system below the Japan. The complementary nature of the clear-air water vapor motion vectors and cloud-motion vectors is evident, with the clear air vectors providing middle-level wind information in areas devoid of cloud compared to infrared winds.

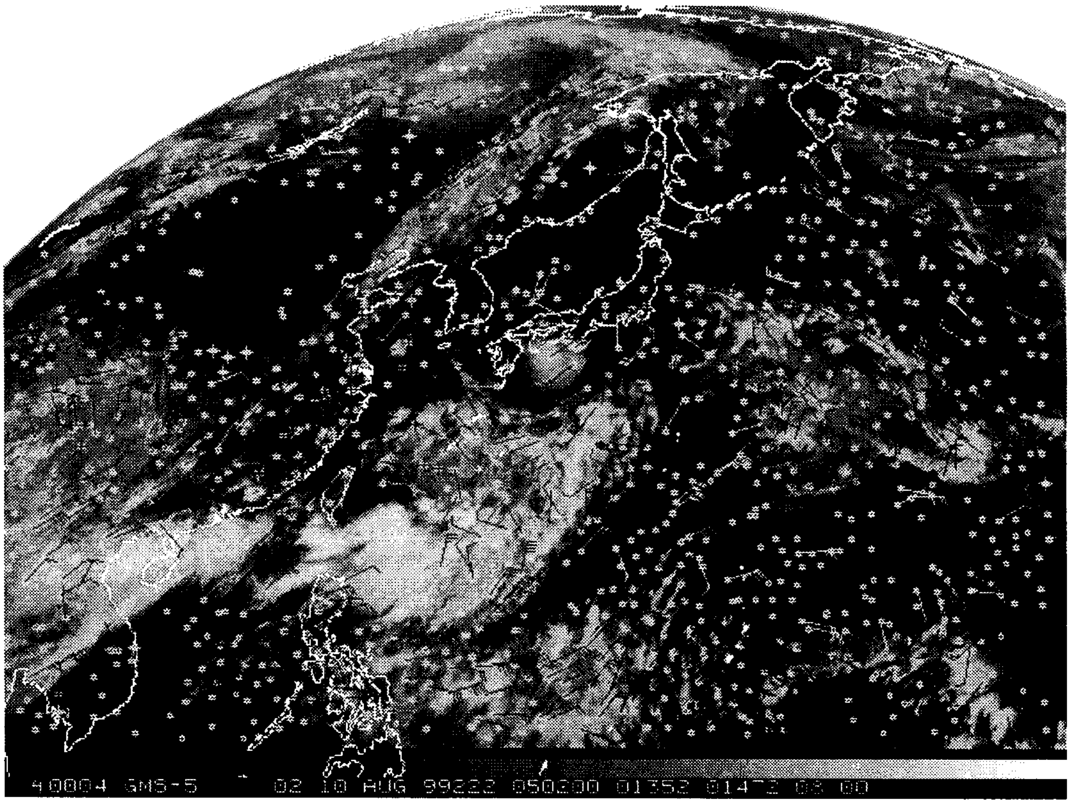

Fig. 1 Infrared cloud drift winds generated from GMS-5 images around 0500 UTC on 10 August 1999. Stars(*) denote tracers available for tracking.

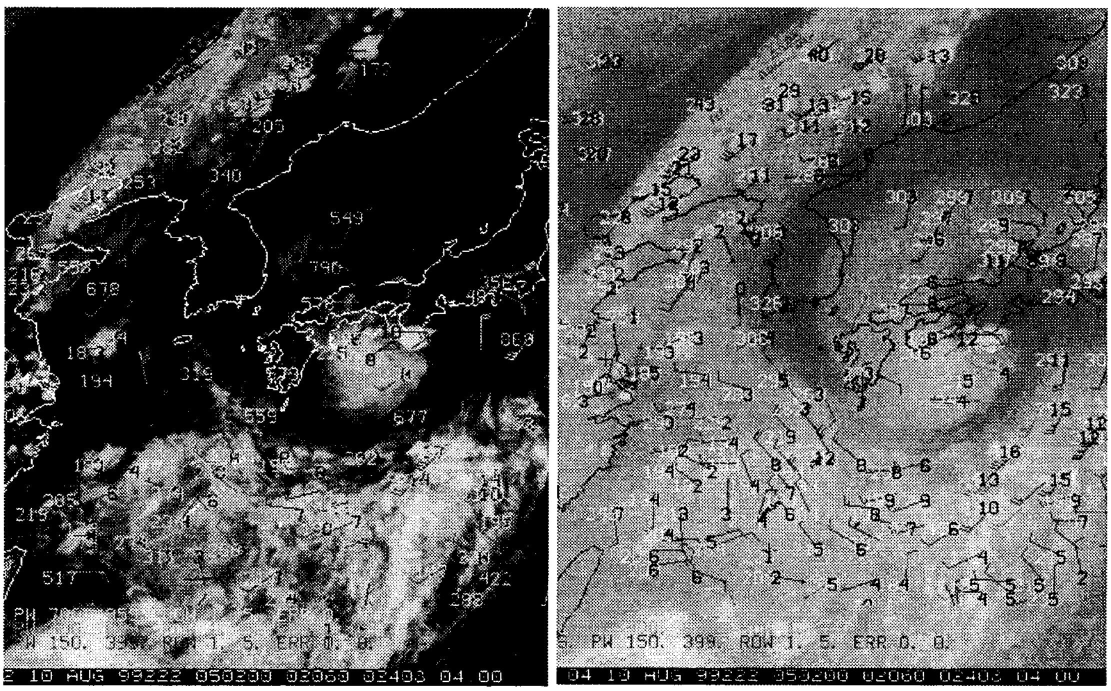

Fig. 2 The same as Fig. 1 except for more detail infrared and water vapor drift winds.

3. The Results

CGMS (Committee of Geostationary Meteorological Satellite) Working Group Ⅲ (WG Ⅲ) started with a discussion of an appropriate reporting format for the comparison of Cloud Vectors (CMV) with radiosonde data (Menzel, 1996) The goal of the reporting is to assist in achieving international production of like quality motion vectors. WG Ⅲ suggested reporting MMVD, RMSVD, BIAS, SPD, NCMV, and NC for low (>700 hPa), middle (700 to 400 hPa) and high (<400 hPa) for all winds as well as those segmented by latitude bands in the northern extratropics (north of 20N), tropics (20N to 20S), and southern extratropics (south of 20S). Collocation with radiosondes should be within 150 km and 3 hours. The statistics calculated from comparisons with collocated radiosondes are included in Table 2. We can see that MMVD for IR1 are 3.9, 5.4 and 6.9 for high, middle and low-levels, respectively. And for WV, the values are 6.2 and 5.7 for middle and high-level, respectively for test run time from 14 to 24 February 2000. Compared to CGMS Report, these results show reasonable values.

Table 2 Mean magnitude of vector difference (m/s), RMS vector difference (m/s), speed bias (m/s) and mean speed of vectors (m/s) between cloud and water vapor drift winds and NH radiosonde within 150 km and 3 hours from cloud motion winds (Test data, 14 ~24 Feb., 2000).

Wind Level		**IR1**	**WV**
HIGH LEVEL (100~399 hPa)	**MMVD**	**6.9**	**5.7**
	RMSVD	**8.0**	**6.7**
	BIAS	**-1.7**	**-1.6**
	SPD	**26**	**24**
MIDDLE LEVEL (400~699 hPa)	**MMVD**	**5.4**	**6.2**
	RMSVD	**6.3**	**7.3**
	BIAS	**-2.1**	**-2.9**
	SPD	**12**	**14**
LOW LEVEL (700~999 hPa)	**MMVD**	**3.9**	
	RMSVD	**4.6**	
	BIAS	**-2.4**	
	SPD	**5**	

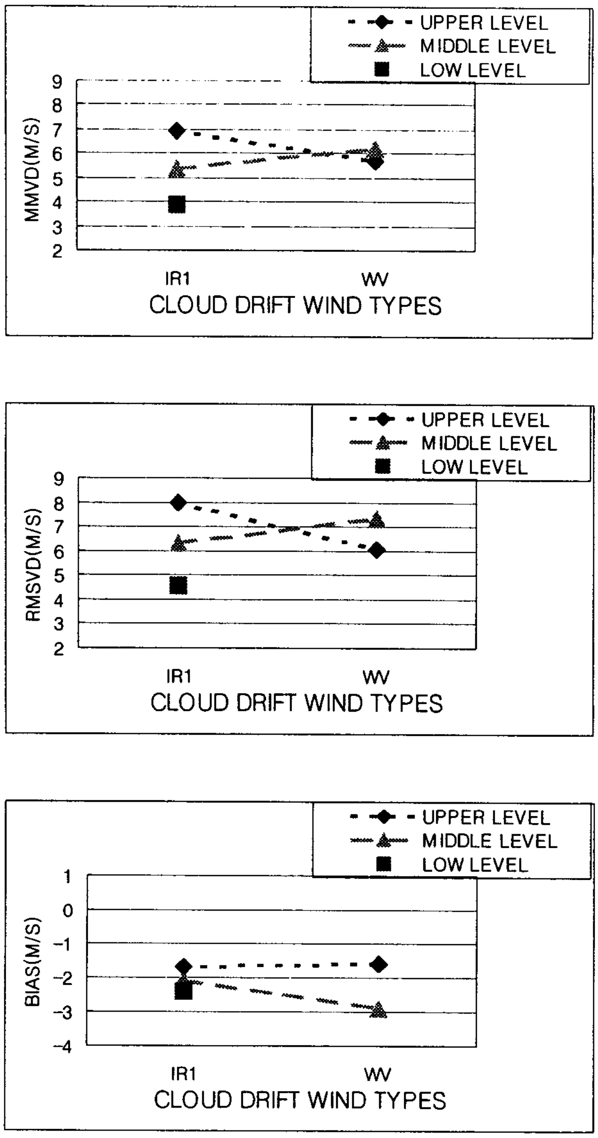

Fig. 3 Radiosonde verification statistics(MMVD, RMSVD, BIAS) for GMS-5 cloud wind vector selected channel IR1 and WV from 14 to 24 Feb., 2000 over the Korea(Test run).

4. Summary

It has been shown that GMS-5 VIS, IR, WV sequential imagery can be used to produce cloud and water vapor wind vectors on hourly basis in addition to usual 6-hourly winds from half-hourly image triplets. We will continue to improve the quality of cloud and water vapor winds. It can be used for application to regional analysis and prediction. It also used for their utility in typhoon track forecasting and intensity.

5. References

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