The generation of cloud drift winds and inter comparison with radiosonde data

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Abstract

Wind velocity is one of the primary variables for describing atmospheric state from GMS-5. And its accurate depiction is essential for operational weather forecasting and for initialization of NWP(Numerical Weather Prediction) models. 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. Multi spectral imagery from GMS-5 was used for this purpose and applied to Korean region with together BoM(Bureau of Meteorology). The derivation of wind velocity estimates from low and high resolution visible, split window infrared, and water vapor images, resulted in improvements in the amount and quality of wind data available for forecasting.

1. Introduction

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 show 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

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 IR images, separated by an hour, four times a day. It also produces VIS and WV image-based winds from half-hourly imagery four times a day. A summery of winds produced is given in Table 2.

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(Le Marshall, 1994)

Table 2. Cloud drift wind types generated in the METRI.

Wind type	Freq.	Tim(UTC)	Wind triplet (ΔT)
IR, WV, VIS	6 hr.	05, 11, 17, 23	30 min.
IR, WV, VIS	1 hr.	00, 01, ...23	1 hour

IR: Infrared WV: Water Vapor Vis: Visible

2. The Winds

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, 1998b).

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 MVD, 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). Some definitions follow for clarification.

The mean vector difference (MVD) is given by,

$$(MVD) = \frac{1}{N}\sum_{i=1}^{N}(VD)_i$$

where the vector difference $(VD)_i$ between and individual CMV report (i) and the collocated rawinsonde (r) report used for verification is,

$$(VD)_i = \sqrt{(U_i - U_r)^2 + (V_i - V_r)^2}$$

The root-mean-square vector difference (RMSVD) traditionally reported is the square root of the sum of the squares of the mean vector difference and the standard deviation about the mean vector difference,

$$(\mathrm{SVD}) = \sqrt{(\mathrm{MVD})^2 + (\mathrm{SD})^2}$$

where the standard deviation (SD) about the mean vector difference is,

$$(SD) = \sqrt{\frac{1}{N}\sum_{i=1}^{N}((VD_i - (MVD))^2}$$

The speed bias (BIAS) is given by

$$(BIAS)_i = \frac{1}{N}\sum_{i=1}^{N}(\sqrt{U_i^2 + V_i^2} - \sqrt{U_r^2 + V_r^2})$$

The number of wind vectors produced is given by NCMV and the number of collocations found with raobs is indicated by NC. Collocation with radiosondes should be within 150 km. The statistics calculated from comparisons with collocated radiosondes does not included in this paper.

3. The Results

In recent times, the distribution of winds over the korea region is derived. Fig. 1 provides an example of infrared image at 23 UTC on 9 August 1999. We can see the low pressure near the Japan and front in China. Using 30 minute time interval images including visible, infrared and high resolution visible we produced three kinds of wind and more detail winds with wind heights and speeds around the Korea.

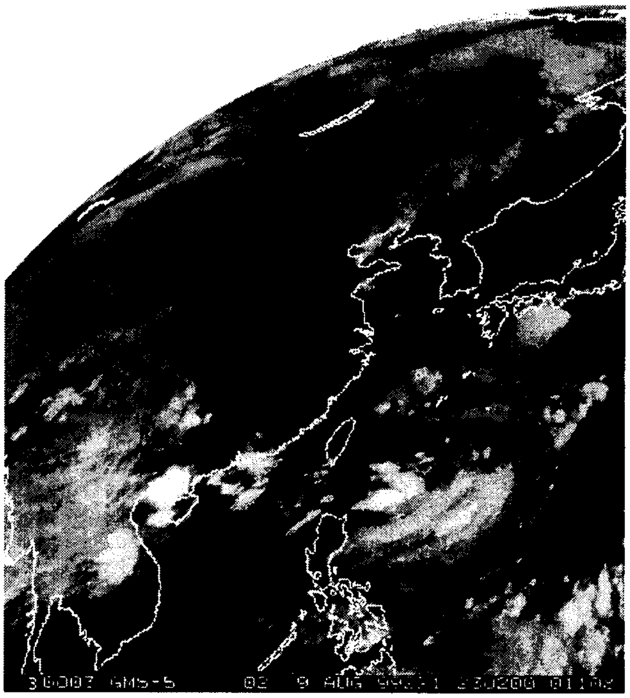

Fig. 1. A infrared image at 23 UTC on 9 August 1999.

Fig. 2 shows infrared wind vectors are plotted over East Asia for the same time. The stars(*) indicate the positions of features(tracers) used for tracking. High wind speeds are monitor over the front areas and depict low pressure wind system below the Japan.

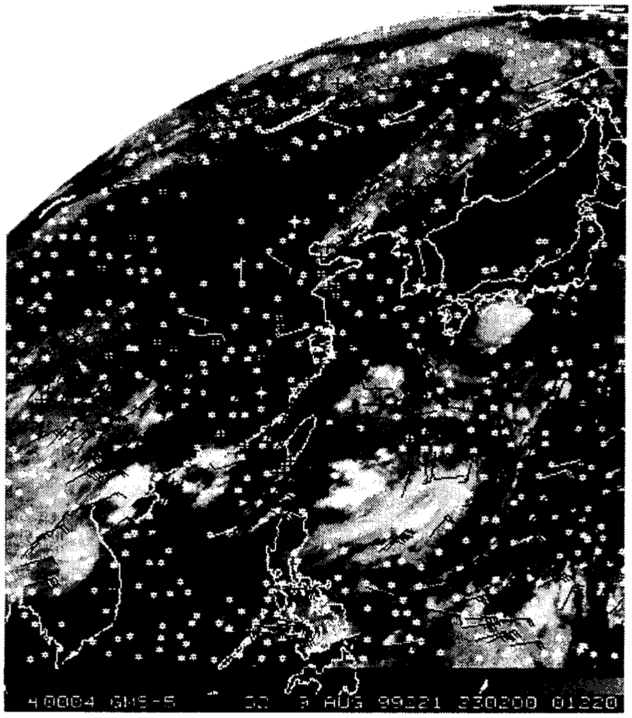

Fig. 2. A infrared winds at 23 UTC on 9 August 1999.

Fig. 3 shows visible wind vector for same time. Wind products are not so good because of the much dark areas. Fig. 4 provides a 6.7㎛ water vapor winds for 2300 UTC on 9 August 1999. 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 Fig. 2.

Fig. 3. The same as Fig. 2 but for visible winds

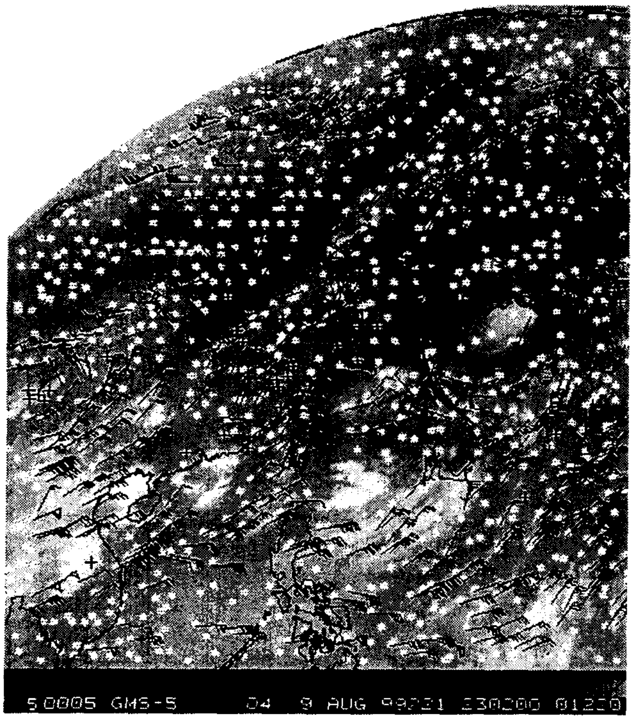

Fig. 4. The same as Fig. 2 but for water vapor winds

In Fig. 5, we can see the more detail wind information. It represents wind height levels (hPa) and speed(m/sec) each wind. Also yellow wind is low level (>700 hPa), blue color winds represent middle level winds (700 to 400 hPa), and red winds are correspond high level winds (150 to 400 hPa).

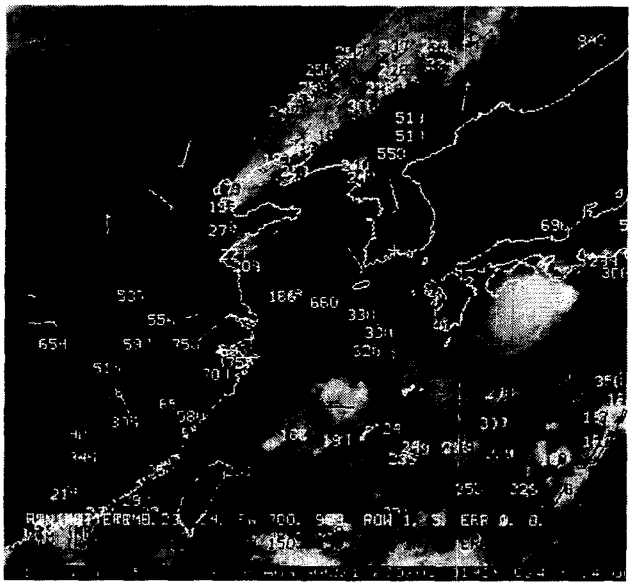

Fig. 5. The same as Fig. 2 but for wind height(hPa) and wind speed.

From Fig. 6 to Fig. 8, we can see more exact information.

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.

Fig. 6. The same as Fig. 3 but for wind height(hPa) and wind speed.

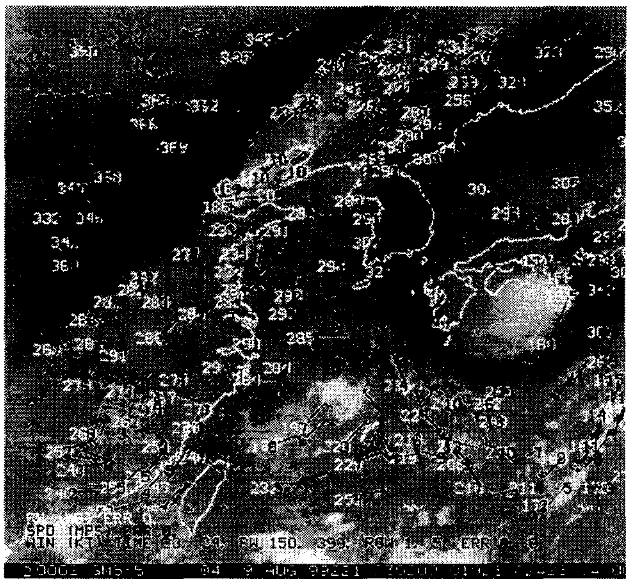

Fig. 7. The same as Fig. 4 but for wind height(hPa) and wind speed.

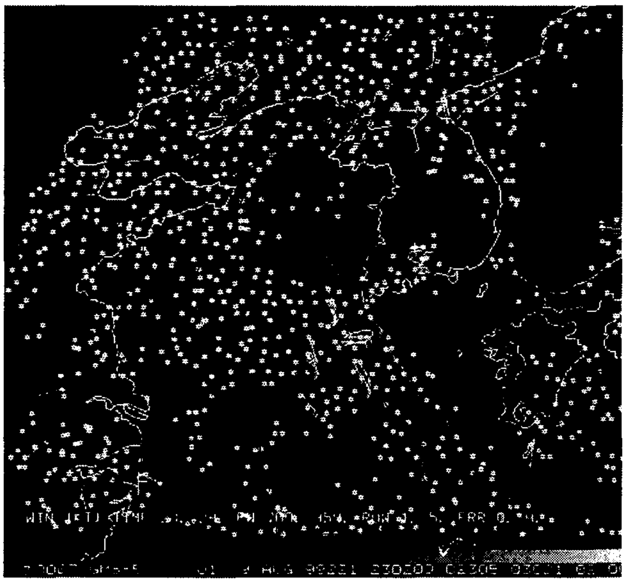

Fig. 8. The same as Fig. 2 but for all winds.

5. References

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