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Prepared by JMA
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SEA-ICE MOTION VECTOR PRODUCT FROM MSC/JMA

In response to CGMS Recommendation 36.07

This paper reports on the sea-ice motion vector product generated by MSC/JMA in relation to Action 36.20 and Recommendation 36.07 from CGMS-36.

The sea-ice motion vector product is generated using data from MTSAT-1R/JAMI, and sea-ice drift velocity is calculated. JMA/MSC has been providing this product since March 2009 and utilizing it for sea-ice monitoring.

SEA-ICE MOTION VECTOR PRODUCT FROM MSC/JMA

1. INTRODUCTION

This paper reports on a sea-ice motion vector product generated at the Meteorological Satellite Center of the Japan Meteorological Agency (MSC/JMA) since March 2009. The product is created using visible-channel data from MTSAT-1R's Japanese Advanced Meteorological Imager (JAMI).

2. SEA-ICE MOTION VECTOR PRODUCT

The Sea of Okhotsk to the north of Japan is covered by sea ice during the winter, and is known as one of the southernmost seasonal sea-ice zones in the Northern Hemisphere (Figure 1). Sea ice in this area extends widely in winter, affecting maritime transportation and fishery activities and making information on sea ice important for such users. In winter, JMA operationally provides sea-ice concentration charts derived mainly from MTSAT-1R imagery. In order to provide information on sea-ice drift, MSC/JMA has developed a sea-ice motion vector product generated using MTSAT-1R/JAMI imagery.

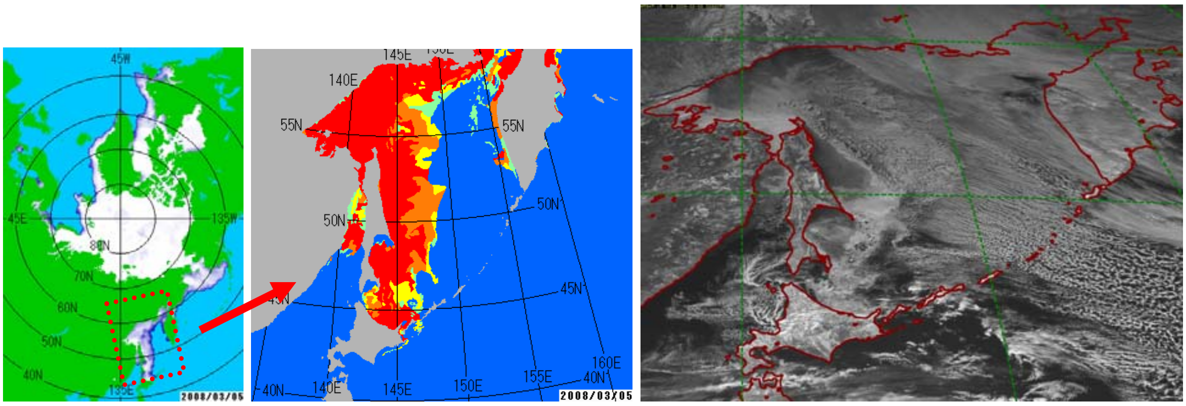

Figure 1 Examples of sea-ice extent for the Northern Hemisphere (left) and the Sea of Okhotsk (center), and an MTSAT-1R/JAMI HRIT visible channel image (right)

MTSAT-1R is stationed at 140 degrees east, and observes the Northern Hemisphere at intervals of around 30 minutes. Sea-ice edges extend to a latitude of 45 degrees north in the Sea of Okhotsk. Accordingly, continuous geostationary satellite monitoring of sea-ice cover is possible. The ground resolution of MTSAT-1R/JAMI visible channel imagery around the south of the Sea of Okhotsk is 1.5 to 2.0 km, which is sufficient to enable observation of the small-scale features of sea-ice motion in marginal ice zones.

In this product, sea-ice motion is derived by tracking ice floes and leads (fractures or passageways through sea ice) in two images acquired during the daytime. Tracking is performed using pattern matching (maximum cross-correlation method) . In this method, the image segment to be tracked is extracted from the first image, which is known as the template. Then, the search area is extracted from the second image, and image patterns similar to those in the template are searched for using cross-correlation coefficients. Table 2 shows the parameters used for this pattern matching, which are appropriately selected to enable measurement of small-scale sea-ice drift features in the region.

Table 2 Parameters used for pattern matching

Template size	8 x 8 pixels	Pixel size south of the Sea of Okhotsk: approx. 1.7 km
Search-area size	32 x 32 pixels	
Interval between images	4 hours	

Pattern matching is performed for the entire image, including regions of cloud and open water, and vectors tracking sea-ice motion are then extracted. Figure 2 shows an example of sea-ice motion vector extraction. The derived motion vectors are not uniform except over sea-ice regions (Figure 2 (a)). The uniformity of vector distribution is evaluated using the two statistical values [1] of vector entropy and uniformity in direction (Figure 2 (b)). Based on empirical thresholds for the two statistical values, sea-ice motion vectors are extracted (Figure 2 (c)).

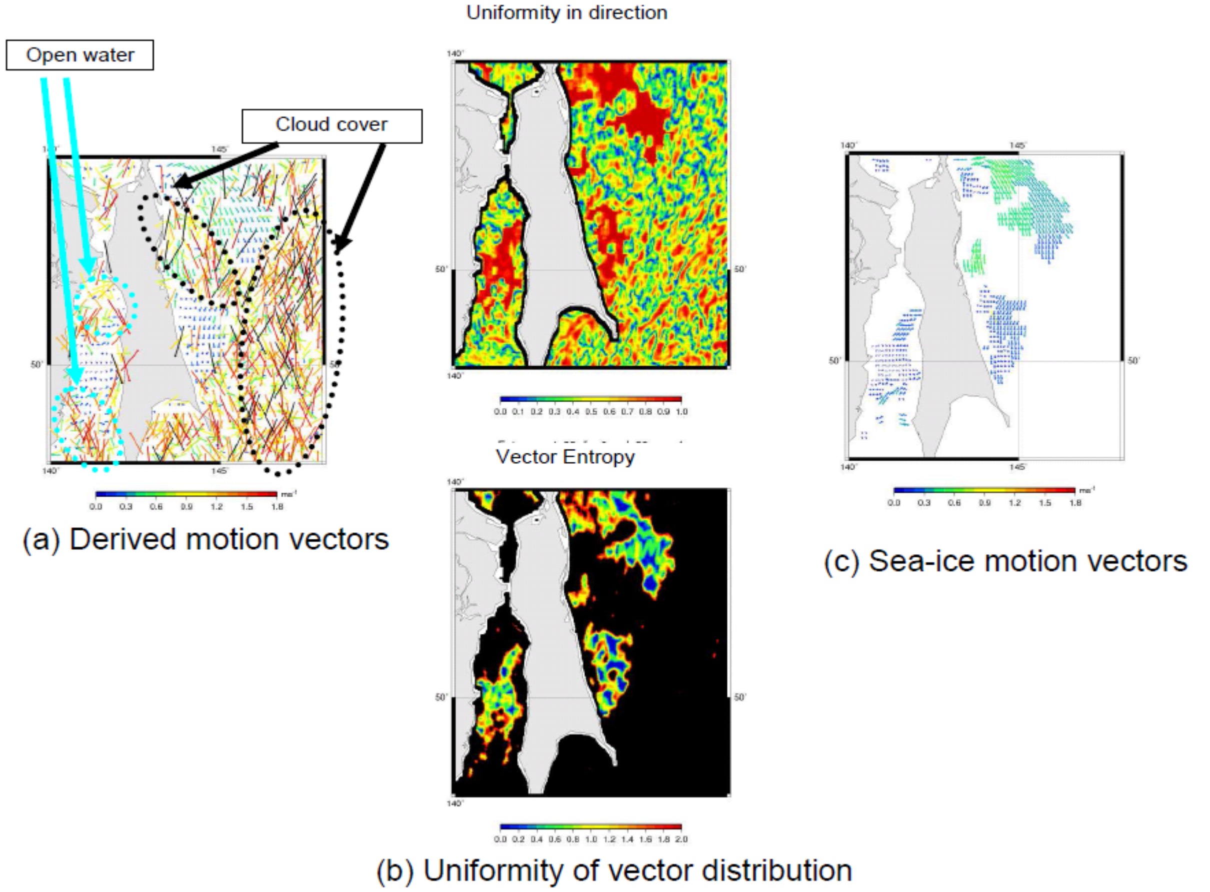

Figure 2 An example of erroneous vector removal
(a) Motion vectors derived by pattern matching (b) Uniformity of vector distribution (c) Extracted sea-ice motion vectors

Figure 3 shows an example of the sea-ice motion vector product.

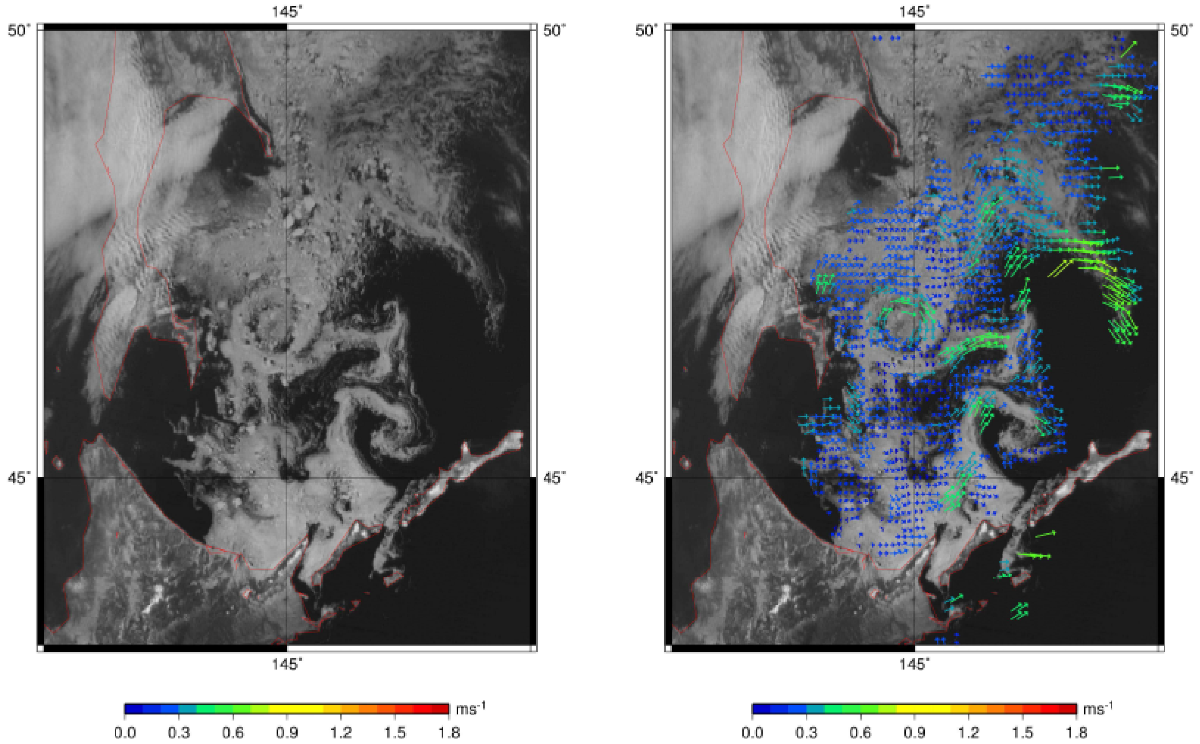

Figure 3 An example of the sea-ice motion vector product showing vectors generated from VIS images at 01 UTC and 05 UTC on 13 March 2008. Visible channel imagery is shown on the left, and the same image with vectors overlaid is shown on the right. Small-scale sea-ice motion features (such as meandering and eddies) that are typical in marginal ice zones are depicted.

This product had been under validation since January 2007 and entered operation in March 2009.

3. FUTURE PLANS

At present, the sea-ice motion vector product is utilized by JMA. The Agency plans to add information about sea-ice drift to the existing sea-ice concentration chart.

4. REFERENCE

[1] Matsumoto T. and T. Imai, 2008: Methodology of Extracting Sea Ice Motion Vectors from Geostationary Meteorological Satellite Data. Meteorological Satellite Center Technical Note, No. 50.