Color composite of SCANSAR and MODIS data for sea ice monitoring in the Sea of Okhotsk

Kohei Cho, Atsushi Komaki, Haruhisa Shimoda[(1)]

[(1)] Tokai University, 2-28-4, Tomigaya, Shibuya-ku, Tokyo 151-0063, Japan, E-mail:cho@yoyogi.ycc.u-tokai.ac.jp

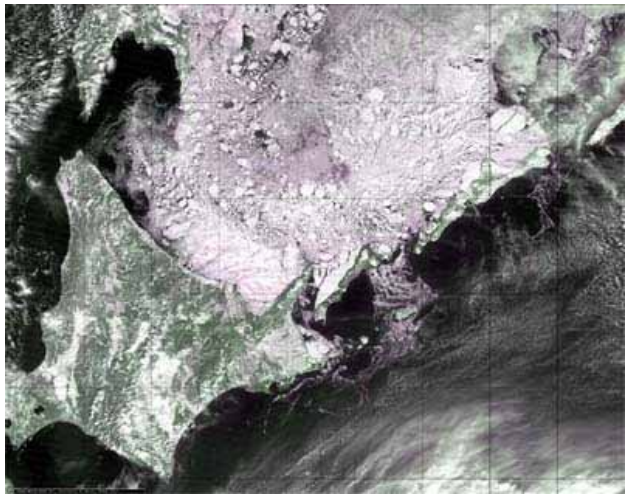
Abstract

Tokai University is providing MODIS images of the Sea of Okhotsk to the Ice Information Center of the Japan Coast Guard (JCG) on daily basis in winter seasons. The MODIS image is used by the JCG as one of the most fundamental data sources for making the Sea Ice Condition Charts which are provided from JCG to end users every day. In order to compensate the MODIS observation of the cloudy days, JAXA is occasionally providing PALSAR SCASAR mode images of ALOS satellite to JCG since December 2006. However, since the looks of the SCANSAR images are quite different from optical sensor images, it is not no so easy for the operators to use the SCANSAR images for making the Sea Ice Charts. In order to support the Sea Ice Chart production operators, ways to fuse the SCANSAR data with MODIS data were examined. The color composite of MODIS and SCANSAR data using HSI transformation was evaluated as an appropriate way of fusing both data for extracting sea ice information for making the charts. However, for the further study, multi-stage remote sensing is required.

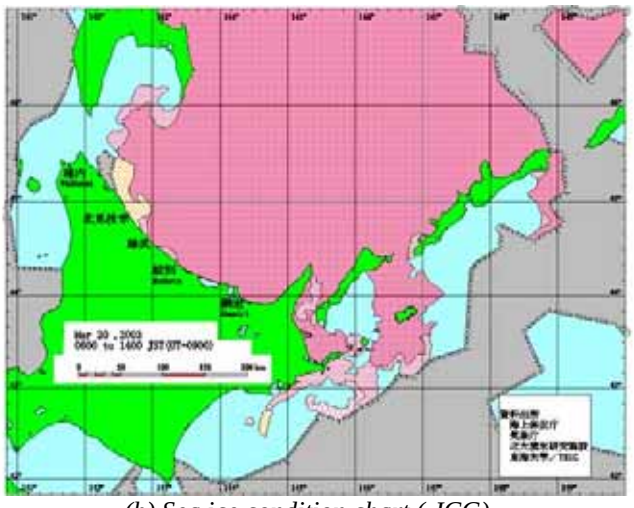
Keywords: PALSAR, ice concentration, thin sea ice

1. INTRODUCTION

The Ice Information Center of the Japan Coast Guard (JCG) makes Sea Ice Condition Charts[1] of the Sea of Okhotsk during the winter season which are provided to end users every day. Tokai University Space Information Center (TSIC) is receiving MODIS data from Terra and Aqua satellites, and is providing MODIS band1 and 2 composite images(band1:R,B, band2:G) of the Sea of Okhotsk on daily basis to JCG [2]. JCG is using the 250m resolution MODIS images as one of the most fundamental data sources for making the sea ice condition charts (see Figure 1) by visual interpretation. In the charts, sea ice concentrations are ranked in 10 steps and drew in different colors. However, the clouds over the Sea of Okhotsk are preventing the daily use of MODIS images for the sea ice condition chart production. In order to compensate the MODIS observation of the cloudy days, JAXA is occasionally providing PALSAR SCASAR mode images of ALOS satellite to JCG since December 2006. The SCANSAR mode enables us to acquire a 250 to 350km width observation of PARSAR images with a spatial resolution of 70 m. However, since the looks of SAR images are often so different from optical sensor images, it is not so easy for the operators to extract proper sea ice condition information from the PALSAR images. In order to support the sea ice condition chart production operator, the authors have fused MODIS data with SCANSAR data both of which were acquired within one hour difference. The result suggested the advantage of data fusion for sea ice monitoring in the Sea of Okhotsk.



(a) MODIS image received a Tokai University



(b) Sea ice condition chart (JCG)

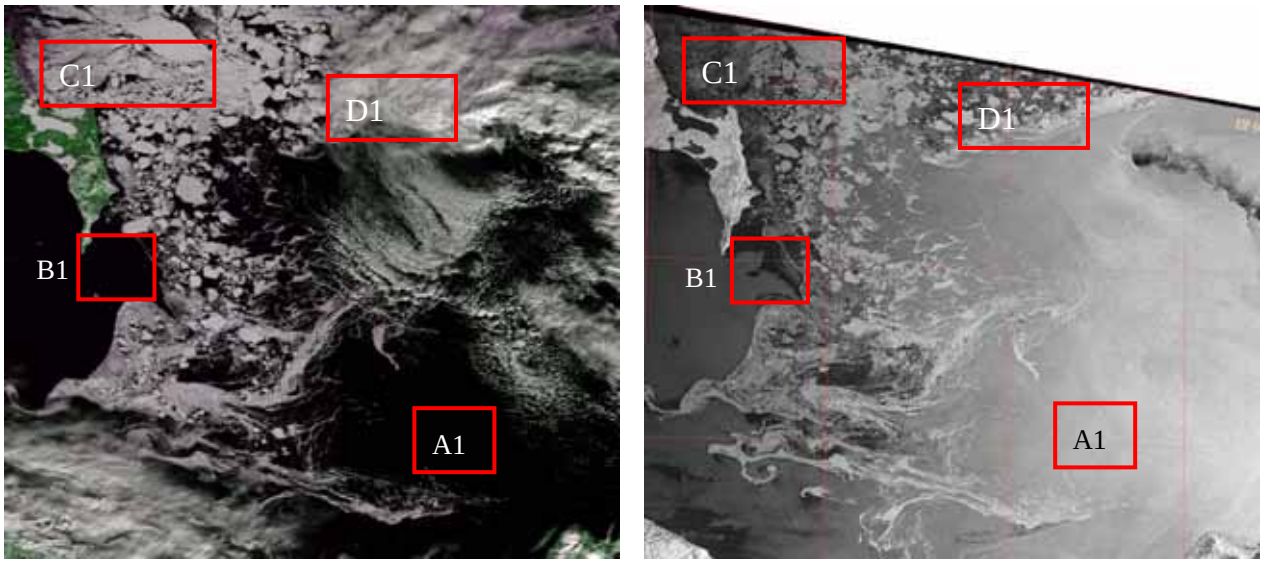
Figure 1. Sea ice condition chart production from a MODIS image and related information (Mar. 20, 2003)

2. TEST SITE AND USED DATA

The test site was selected within the area of the sea ice condition chart of JCG (see Figure 1(b)). ALOS/SCAN-SAR data and Aqua/MODIS data acquired on January 23 and February 9, 2007 were used for the analysis in this study (See Figure 2 and Figure 3). In MODIS band1(R,B) and band2(G) composite, the most of the sea ice area appears in light purple and most of the high clouds appears in white. The observation difference of the two sensor was about one hour.

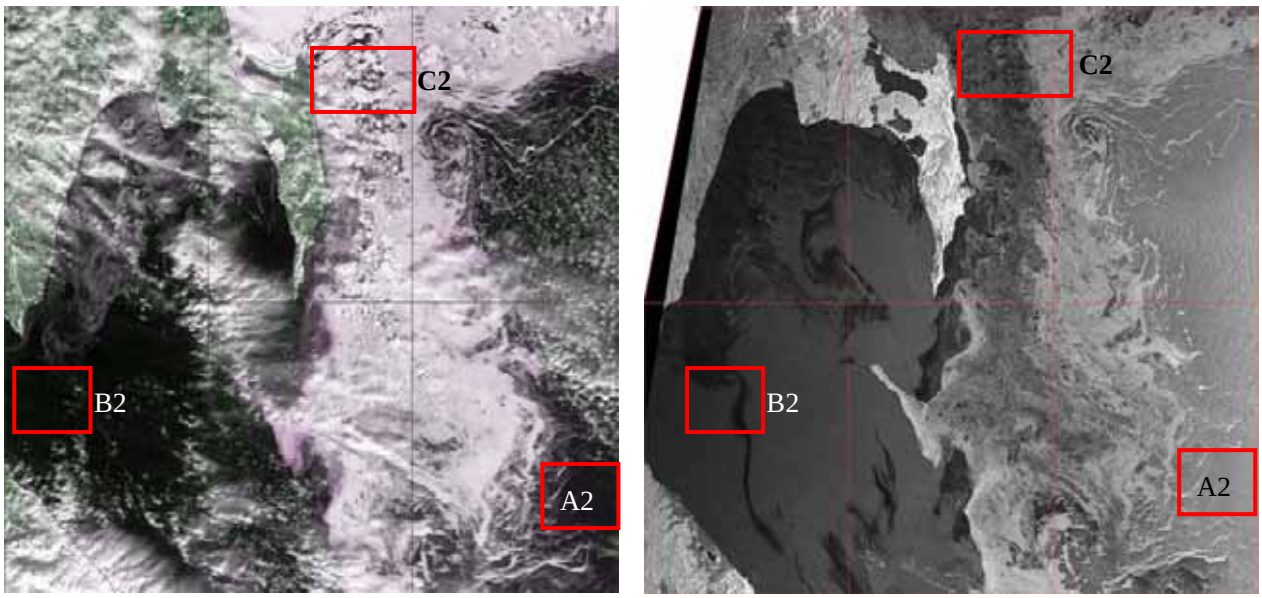
As you can see by comparing MODIS and PALSAR images observed on the same day, the sea ice distribution did not change much between one our interval observations. Of cause, it should be noted that the sea ice distributions in the both images were not completely the same. Also, in MODIS images of the both day, some areas were covered with clouds.

Table 1 shows the specification of the MODIS and SCANSAR data used in this study. Since JCG wants to use at least 250m resolution images, among the MODIS 36 channels, only the band 1 and 2 are used in this study.



(a) MODIS image (B,R: band 1, G: band 2) *(b) SCANSAR image*

Figure 2. MODIS and SCANSAR images comparison (January 23, 2007)



(a) MODIS image (B,R: band 1, G: band 2) *(b) SCANSAR image*

Figure 3. MODIS and SCANSAR images comparison (February 9, 2007)

Table 1. MODIS and SCANSAR Specifications

(a) MODIS

Band	Wave length	Resolution	Swath
Band 1	0.62 – 0.67 μm	250m	2330km
Band 2	0.84 – 0.88 μm		

＊Other channels are not used in this study.

(b) SCANSAR

Center Frequency	1270MHz (L-band)
Polarization	HH or VV
Incident angle	18～43°
Range Resolution	100m (multi look)
Swath	250～350km

In Figure 3, similar sea ice distribution can be observed in MODIS and SCANSAR images. Most of the sea ice areas are appearing bright in both images. The case is similar in Figure 4. However, if we see in details, difference of the two sensors could clearly be seen in those images as follows.

The area A1 and A2 shows that open water are appearing blight in SCANSAR images due to rather rough waves in low incident angle. On the other hand, as we can see in the area B1 and B2, the wavy open water are appearing in gray and the thin sea ice areas are appearing very dark in SCANSAR images. As for the area C1 and C2, in the MODIS images, all the sea ice looks bright. However, in the SCANSAR images, the left side of the sea ice area looks dark and the right side looks bright. D1 shows sea ice area covered with clouds. These differences of MODIS and SCANSAR images are suggesting the advantages and disadvantages of data fusion.

3. METHODOLOGY

There are various ways of fusing multi sensor data including principle component analysis, wavelet, and simple color composite [3][4][5]. However, there are several regulations in fusing the data in this study.

One is that the MODIS data and SCANSAR data which are to be fused are not observed on the same time. Under the calm weather, the sea ice distributions are quite stable between the observation of the two sensors, and it is possible to closely co-register the two images taken by the two sensors. However, more or less, the displacement of sea ice distribution between the two images remains. Another regulation is the way JCG use the satellite images for making the Sea Ice Condition Charts. The well trained operators are not willing to use classification result of satellite images and prefer to use satellite images for photo interpretation. Considering these limitations, the authors have decided to perform simple image composite method for fusing the data.

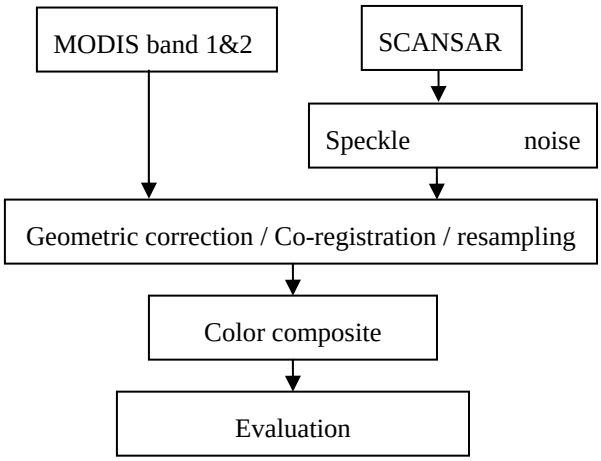


Figure 4. Flow of operation

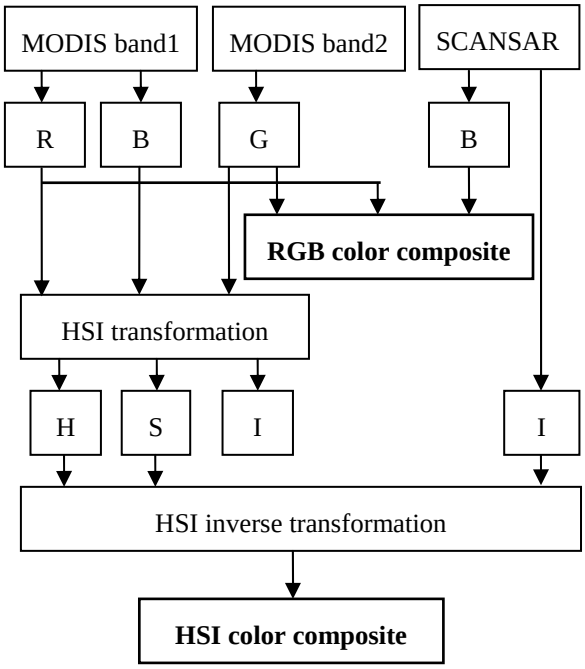
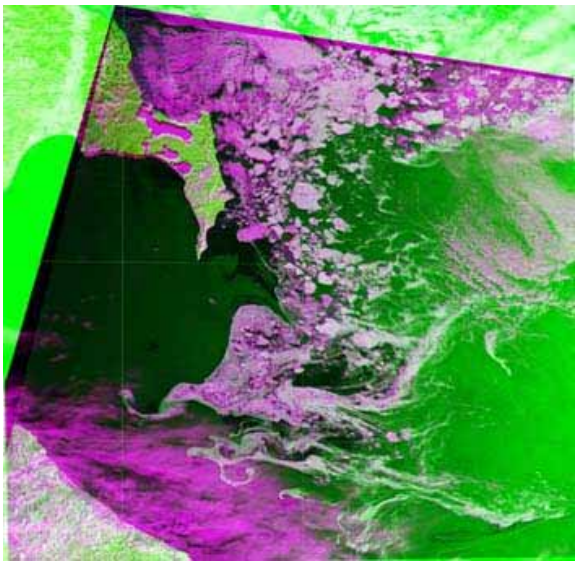


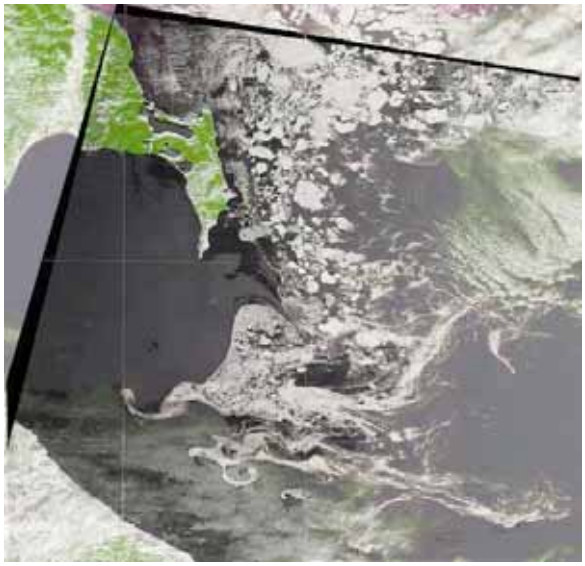
Figure 5. Flow of color composite

Figure 4 shows the flow of the operation, and Figure 5 shows the flow of color composite used in this study. After co-registration and resampling of MODIS band 1&2 and SCANSAR data acquired on the same day, the three data are fused by simple RGB color composite method and HSI transformation. Figure 6 shows one example of the six combination of RGB color composite of MODIS band 1&2 and SCANSAR.

Figure 7 shows the color composite using HSI transformation [6]. Here we call this as “HSI color composite”. In this composite, firstly we assign MODIS band1 to R&B, and MODIS band 2 to G. This color composite has been used for making sea ice condition charts as shown on Figure 1. Then, the composite image is transformed in to H,S,I components using HSI transformation. At this stage, we delete I component,



(R: MODISb2, G:SCANSAR, B: MODIDb1)
Figure 6. RGB color composite (January 23, 2007)



(RB: MODISb1, G:MODIDb2 + I:SCANSAR)

Figure 7. HSI color composite (January 23, 2007)

and add SCANSAR data as new I component. Finally, the H, S, I components are combined using HSI inverse transformation, and HSI color composite image was produced as shown on Figure 7.

5. DISCUSSION AND CONCLUSIONS

As shown on Figure 6, the simple color composite image of MODIS band 1&2 and SCANSAR data was reflecting the characteristics of both MODIS and SCANSAR data. Especially, assigning G(green) to SCANSAR seemed to be effective for enhancing the tone of the SCANSAR in the composite imagery. However, when MODIS band 1 or 2 is assigned to G(green), clouds were too much enhanced and the sea ice under the clouds were not clearly identified. Moreover, since the color appearance of the simple color composite images are so different from the original MODIS color image of Figure 2(a), it may not be so easy for operators to use them for making the sea ice condition charts.

On the other hand, the HSI color composite image of the three channels data as shown on Figure 7 retains the color combination of the original MODIS color image, and yet the characteristics of SCANSAR are well reflected in tone difference.

The HSI color composite suggested it's usefulness for making sea ice condition charts. However, for validation, the simultaneous observation of higher resolution satellite or aerial images and sea truth measurements are necessary [7]. The authors are planning to perform ALOS observation experiment in the Sea of Okhotsk in next February under the cooperation with JCG, JAXA and RESTEC.

Acknowledgement

This research is conducted under the agreement of JAXA Research Announcement titled 'Integration of AVNIR-2 and PALSAR data for classification of sea ice in the Sea of Okhotsk' (JAXA-PI 215).

References

[1]http://www1.kaiho.mlit.go.jp/KAN1/drift_ice/eng.html

[2] Cho K. et al, "Near real time MODIS image dissemination for sea ice monitoring" (Japanese), Proceedings of the 34th Conference of the Remote Sensing Society of Japan, pp.55-56, 2003.

[3] Le Moigne, J. et al, "Image Registration and Fusion Studies for the Integration of Multiple Remote Sensing Data," Proceedings of ICAPSSP 2006, Vol.5, pp.1189-1192, 2006.

[4] Partington, K. et al, "Data fusion for use of passive microwave data in operational sea-ice monitoring." Proceedings of IGARSS'99, Hamburg, Germany,1999.

[5] Worawattanamateekul J. et al, "Multisource data fusion results of fused optical and SAR data for Irigated rice areas identification," Map India 2000, 2000.

[6] Foley J. D. et al., "Fundamentals of Interactive Computer Graphics," Massachusetts; Addision-Wesley Publishing Company, pp.613-620, 1983.

[7] Cho K. et al., "Multi-stage remote sensing experiment for sea ice monitoring," Proceedings of the 19th International Symposium on Okhotsk Sea & Sea Ice, pp.63-66, 2004.