OSMI ocean color products with updated cross-calibration coefficients

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Abstract: To date the KOMPSAT OSMI(Ocean Scanning Multi-spectral Imager) data have been widely used in natural disaster monitoring such as Typhoon, Asian Dust, Red Tide, and Forest Fire. Quantitative analyses related to the marine ecosystem have been delayed because they require good quality of data through Cal/Val activities.

To resolve such problem, KARI performed the OSMI cross-calibration study with SeaWiFS team. In this study, we will demonstrate the OSMI ocean color products with updated cross-calibration coefficients and compare them to the previous cross-calibration results.

Keywords: OSMI, SeaWiFS, cross-calibration.

1. Introduction

The developmental process of the multipurpose satellite KOMPSAT-1(launched December, 1999) has provided a significant opportunity to develop fundamental domestic technology and utilize satellite data. Though success of the project depends on the acquisition of new technologies and satellite image application, the lack of prior research and preparation has led to satellite data obtained from the project not being fully utilized. Unlike the EOC data, OSMI data from KOMPSAT-1 requires vast confirmation and has yet to be put into use for observational and commercial purposes.

Cooperation with global research agencies for the confirmation of OSMI data collection was necessary. The alliance with foreign agencies already familiar with sensors such as OSMI would not only confirm and certify data accuracy. The cooperation would also contribute to domestic research in collecting OSMI data from tropical regions by increasing the quality of domestic technology

The SeaWiFS team from NASA has launched the first coastal color zone scanner (CZCS) satellite in 1978 and has continued to carry out the SeaWiFS project. The team of scientists has been receiving support through the SIMBIOS project to inspect and certify coastal color zone scanner sensor data, and have already completed the verification of on board Japanese OCTS, German MOS, and French POLDER equipment. The application techniques for MOS is similar to the cross calibration for the OSMI on board the KOMPSAT-1, and would be sufficient for the OSMI sensor verification process.

SeaWiFS was launched on 1 August 1997 into a 705-km sun-synchronous polar orbit with a descending equatorial crossing time near local noon. The instrument is a scanning filter radiometer collecting data in eight spectral channels between 400 and 900 nm, with a surface resolution at nadir of approximately 1-km and a swath width of 2800 km. OSMI is a whisk-broom scanning Charge Coupled Device (CCD) with 96 detectors oriented along track and six programmable spectral channels in the visible and near infrared. The instrument has a ground resolution of approximately 1 km, with a swath width of 800 km. OSMI was launched on 21 December 1999 into a 685 km sun-synchronous polar orbit with an ascending equatorial crossing near 10:50 a.m. local time. Using the pre-launch calibration and standard atmospheric correction software developed for OSMI, it was found that the sensor was not able to retrieve reasonable ocean optical properties. To allow for meaningful comparisons between OSMI and SeaWiFS, it was necessary to first modify the standard SeaWiFS atmospheric correction software to accept and process the OSMI data, thereby ensuring consistent and proven algorithms. The normalized water-leaving radiance measurements of SeaWiFS were then used as truth data to enable a vicarious calibration of the 96 independent CCD elements of each OSMI spectral band.

2. Cross-calibration of OSMI with SeaWiFS

1) Cross-calibration Concept

Between October of 2000 and March of 2001, KARI provided the NASA SIMBIOS team with a total of 33 OSMI LevelIA and dark calibration data of the MOBY, Hawaii region. The NASA SIMBIOS team created an algorithm to cross-calibrate the OSMI data with the SeaWiFS, and the results were included to the OSMI Module of the MS112 software. KARI has received the MS112 software and has undergone inspection to verify the reliability of OSMI processing. The theory behind OSMI and SeaWiFS cross-calibration can be seen in the following radiation transfer equation of over ocean .

$$L't = Lr + L'a + L'ra + tLwc + TLg + tL'w \qquad (1)$$

TOA$(L't)$ radiation of OSMI is reproduced by SeaWiFS. Here, each $L'a$, $L'ra$, $tL'w$ is atmosphere and sea surface radiation of OSMI by geometric and atmospheric correction of SeaWiFS. $tLwc$ and TLg is radiation of OSMI by reflectance effect of sea surface.

As the Result, Vicarious gain can be calculated through compare with OSMI TOA$(L't)$ by Equation 1 and OSMI pre-launch calibration TOA (Lt).

$$\text{Vicarious Gain} = L't / Lt \qquad (2)$$

Figure 1 is displaying cross-calibration flow of OSMI with SeaWiFS.

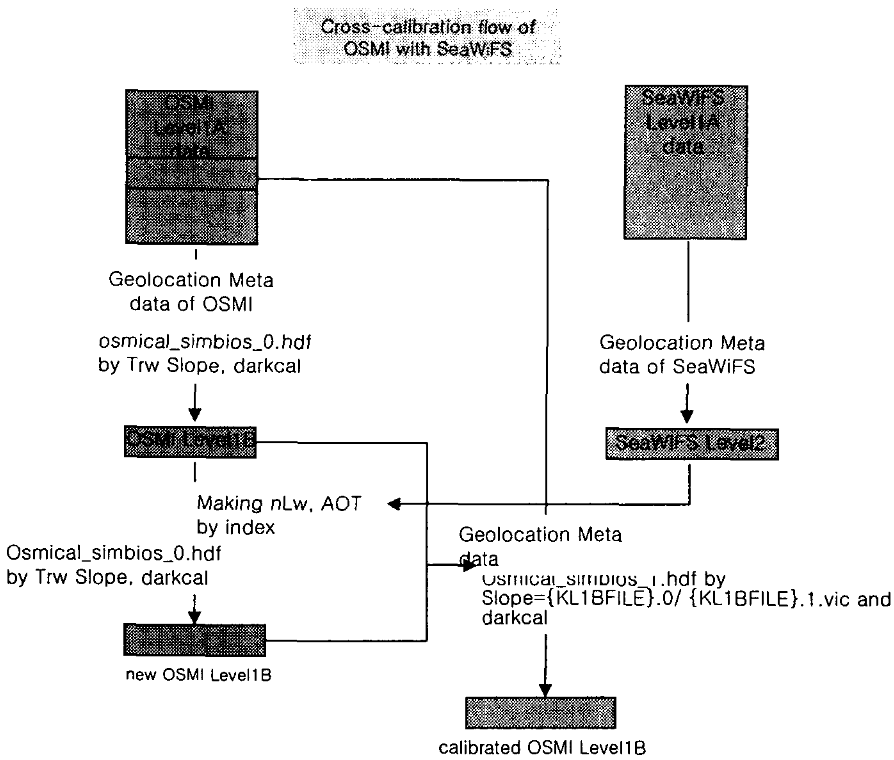

Fig. 1. Processing procedure of OSMI and SeaWiFS cross-calibration

2) Procedures of Cross-calibration

Procedures of Cross-calibration is as follows

Step1. Collect OSMI and SeaWiFS data from the same date (Use data from clear conditions to minimize error).

Step2. Process OSMI data from Level1A to Level1B. Apply pre-lauched radiometric calibration coefficient to find geolocation of sample area

- Input file: Calibration file of TRW, Dark calibration file

Step3. Adjust SeaWiFS to meet OSMI, and use SeaWiFS algorithm to calculate atmospheric and sea surface radiation.

- Input file: Geolocation file of OSMI and SeaWiFS, nLw and AOT used SeaWiFS algorithm

- Output file: *L'a, L'ra, tL'w*

L'a, L'ra : Atmospheric radiation of SeaWiFS adjusted to meet OSMI data
tL'w : Sea Surface radiation of SeaWiFS adjusted to meet OSMI data

Step4. Reproduce the TOA(*L't*) of OSMI using the aerosol and sea surface radiation retrived from step3.

Step5. Produce the TOA(*Lt*) for each band from Level1B resulting from OSMI measurements.

Step6. Produce calibrated coefficient from the comparative values of *L't* and *Lt*.

- Divide step5 output file(*L't*) of step4 output file(*Lt*)

Step7. Apply newly calculated radiation calibration coefficient to process Level1A to Level1B

3. Results and Discussion

1) Distributions of Cross-calibration Gain

Fig 2 is the vicarious calibration gains of the 96 independent CCD elements and each OSMI spectral band calculated finally.

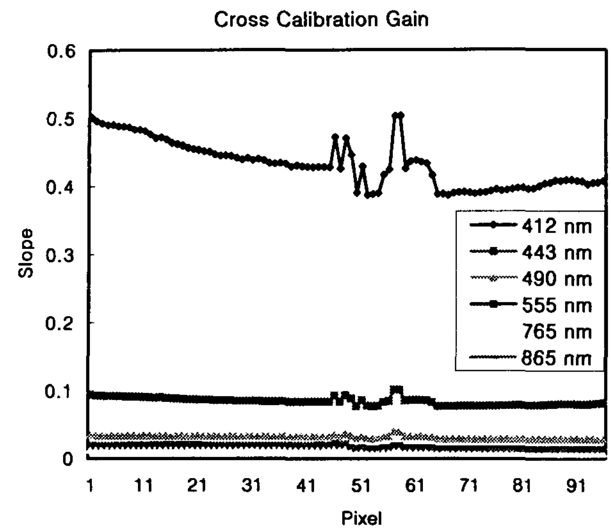

Fig. 2. Distributions of gain value in 96-piexels and 6-bands calculated from OSMI and SeaWiFS cross-calibration

2) Comparison of primary productions between OSMI and SeaWiFS in MOBY

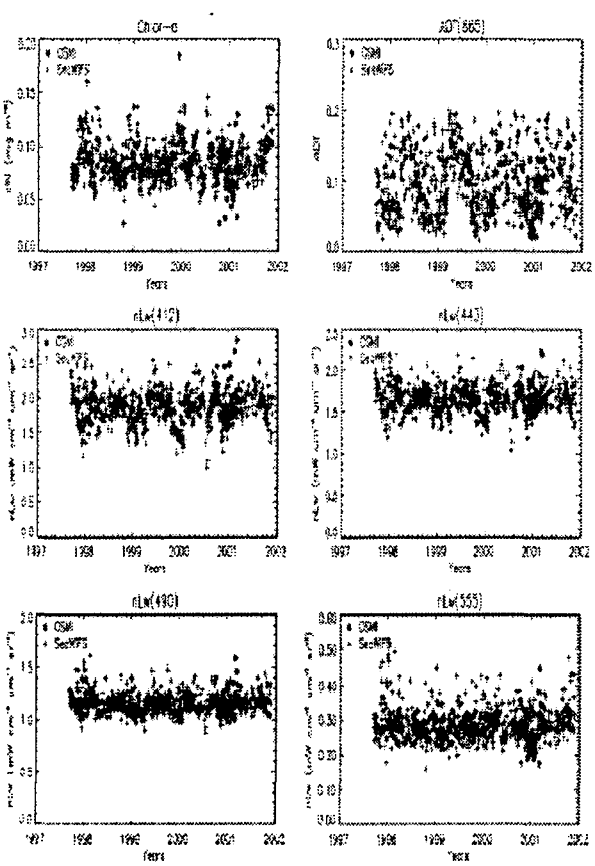

Fig. 3. Comparision of Level-2 products(chlorophyll-a concentration, AOT, nLw) between OSMI with SeaWiFS (from mid-2000 to 2001).

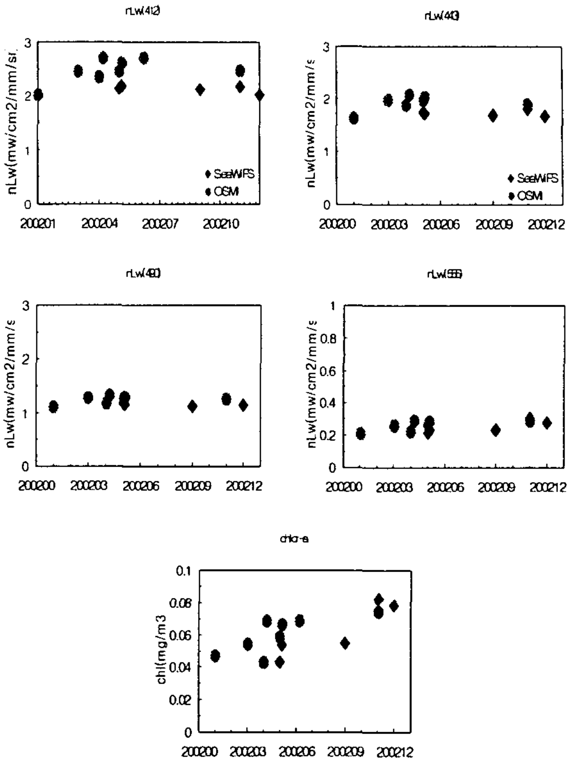

Fig. 4. Comparison of Level-2 products(chlorophyll-a concentration, AOT, nLw) between OSMI with SeaWiFS(2002) by update calibration.

In figure 3, the Level 2 productions(Chlorophyll-a concentration, AOT, nLw) of between OSMI and SeaWiFS data were compared. The OSMI Level2 data were collected from mid-2000 to 2001, and were compared to SeaWiFS data collected over the same period of time. Figure 4 is comparison of Level-2 products(chlorophyll-a concentration, AOT, nLw) between OSMI and SeaWiFS(2002) by update calibration. OSMI data is considerably similar with those of SeaWiFS.

3) The comparison of calibrated TOA of OSMI and from In-situ.

Figure 5 is the comparison between the results of calculating the TOA radiation (NW 37.594, East longitude 130.499) from KARI's cross-calibration calculation technique and field observations from Seoul National University to the NASA cross-calibrated OSMI TOA radiation in each spectral. The image shows no significant differences in the TOA radiation for each band. The calculation from the model being smaller than those from observations is due to cloudy conditions on the day of observation, while the model is designated to be used on clear skies[1].

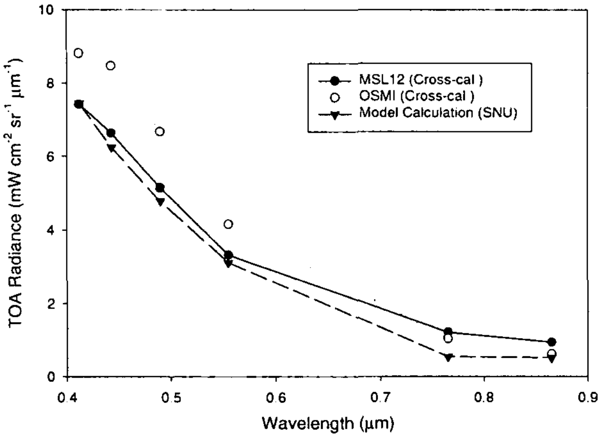

Fig. 5. The comparison between the results of calculating the TOA radiation (NW 37.594, East longitude 130.499) from KARI's cross-calibration calculation technique and field observations from Seoul National University to the NASA cross-calibrated OSMI TOA radiation in each spectral.

4) Figure 6 is distribution of Chlorophyll-a concentration Surrounding the Korean Peninsula (Applocation of NASA cross-calibration results).

Fig. 6. Distribution of Chlorophyll-a concentration Surrounding the Korean Peninsula

4. Conclusion

We updated cross-calibration coefficients of OSMI with SeaWiFS in this study and reproduced Level2 products of OSMI such as chlorophyll-a, AOT, nLw by updated cross-calibration coefficients. Results of this study can be summarized as follow.

- Updated cross-calibration coefficients had considerably reasonable value when compare OSMI with Level-2 data of SeaWiFS.
- The NASA cross-valibrated OSMI TOA radiation in each spectral is considerably similar in the results of calculating the TOA radiation from KARI's cross calibration calculation technique and field observations of SNU

References

[1] Kim, Y., Y. S. Kim, H. Lim, D. Lee, C. Kang, 1999: KOMPSAT data processing system: An overview and preliminary acceptance test results, *J. of the Korean Society of Remote Sensing*, 15(4), 357-365.

[2] Lee, D. H. and Y. Kim, 2000: Radiometric calibration of OSMI imagery using solar calibration, *J. of Astron. Space Sci.* 17(2), 295-308.

[3] Frink, M., 1996: LRC Calibration, *TRW IOC (KOMPSAT. 96.530.009).*

[4] Lee, P., 1998: LRC FM EIDP, Vol 1, 393.

[5] Yongseung Kim, Donghan Lee, Sungu Lee., 2002: Summary of the OSMI Radiometric Calibration Efforts, *NASA/TM-2002.*

[6] Yongseung Kim, Sungu Lee., 2003: Comparison of Ocean Color Products Between OSMI And SeaWiFS: Preliminary Results, *NASA/TM-2003.*