Radiometric Characteristics of Geostationary Ocean Color Imager (GOCI) for Land Applications

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Abstract: The GOCI imagery can be an effective alternative to monitor short-term changes over terrestrial environments. This study aimed to assess the radiometric characteristics of the GOCI multispectral imagery for land applications. As an initial approach, we compared GOCI at-sensor radiance with MODIS data obtained simultaneously. Dynamic range of GOCI radiance was larger than MODIS over land area. Further, the at-sensor radiance over various land surface targets were tested by vicarious calibration. Surface reflectance were directly measured in field using a portable spectrometer and indirectly derived from the atmospherically corrected MODIS product over relatively homogeneous sites of desert, tidal flat, bare soil, and fallow crop fields. The GOCI radiance values were then simulated by radiative transfer model (6S). In overall, simulated radiance were very similar to the actual radiance extracted from GOCI data. Normalized difference vegetation index (NDVI) calculated from the GOCI bands 5 and 8 shows very close relationship with MODIS NDVI. In this study, the GOCI imagery has shown appropriate radiometric quality to be used for various land applications. Further works are needed to derive surface reflectance over land area after atmospheric correction.

Key Words: GOCI, radiometric characteristics, land, COMS, NDVI, MODIS

1. Introduction

The Communication Ocean and Meteorological Satellite (COMS) has been successfully launched on June 27, 2010 and is having a geostationary orbit of 35,857 km altitude. The Geostationary Ocean Color Imager (GOCI) is one of two imaging sensors onboard the COMS and developed to provide continuous images at regional scale, which covers about 2,500 × 2,500 km² area centered at 130°E × 36°N (Fig. 1) (Cho et al., 2011). As the name implies, the GOCI has been mainly designed for ocean color monitoring with eight spectral bands, which are very similar to the SeaWiFS system. Although the main function of the GOCI is ocean color monitoring, it contains large land area of northeast Asia including the entire area of the Korean peninsula and Japan and the partial area of China, Mongolia, and Russia.

GOCI image has about 500 m spatial resolution and is providing eight hourly observations per day during daytime. Considering the very high temporal resolution, GOCI data have a great potential for detecting and monitoring several short-term changes such as crop phenology, forest fires, drought, and
heavy snow over lands. Although polar orbit sensors, such as AVHRR and MODIS, provide daily observation over any places on earth at about the same spatial resolution, frequent cloud cover often obscures land observations to detect short term changes (Cihlar et al., 2004). To use polar orbit images over land area, we often generate 8- to 16-day cloud free composite, which can only be used to detect any changes that occur in longer than the composition period.

After the initial calibrations and testing period, the Korea Ocean Research and Development Institute (KORDI) has provided GOCI data since April 2011. The KORDI supplies GOCI data in several different process levels, in which level 1B is radiometric calibrated and geometric corrected at-sensor radiance. GOCI level 2 products are mostly related to ocean information, such as atmospherically corrected water-leaving radiance, chlorophyll content, and total suspended sediment. Currently, there is no GOCI data product that is particularly designed for land applications. The objectives of this study are to compare the GOCI image with another similar satellite image and to analyze the radiometric characteristics of the GOCI level 1B data for land applications. If the GOCI data has comparable radiometric quality to other polar orbit satellite images like MODIS, which is widely used to derive several meaningful land related products, they can provide valuable information to monitor land surface parameters in short time period.

2. Dynamic range of GOCI radiance

In GOCI L1B image, each pixel has 32bit integer DN value and it can be directly converted to at-sensor radiance by applying the radiometric calibration coefficients provided by the KORDI. We have compared at-sensor radiance between GOCI and MODIS data obtained at the same time on April 5, 2011. Both MODIS Terra and Aqua data were geometrically registered to GOCI coverage and we extracted only the land area including the Korean peninsula and surrounding area after masking out the ocean part. Among the 36 spectral bands of MODIS, we initially selected only eight bands (MODIS band 8 ~ band 15) that are spectrally almost the same as the GOCI bands.

Fig. 2 compares at-sensor radiance between GOCI and MODIS. In overall, GOCI radiance value showed wider dynamic range and higher mean value than MODIS in all eight bands. Even through both data were obtained at the same time, viewing geometry and optical path length of geostationary GOCI and polar orbit MODIS were very different. Such differences might be one of the discrepancies between GOCI and MODIS. Wide dynamic range of GOCI can be beneficial to discriminate several land surface features having a little difference in reflected signal. The advantage of the GOCI’s wide dynamic range was also confirmed by visual interpretation between two images, in which GOCI image was better to show rather subtle tonal difference than MODIS image.

High radiance value and wide dynamic range