

## THE POSSIBILITY OF GCOM-C1/ SGLI FOR CLIMATE CHANGE IMPACTS ANALYSING

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**KEYWORDS:** SGLI, GCOM-C, Global Change, Vegetation Index, Biomass

### ABSTRACT:

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) concluded that many collective observations gave a aspect of a global warming and other changes in the climate system. It is very important to understand this process accurately, and to construct the model by whom an environmental change is accurately forecast. Future earth observation using satellite data should monitor global climate change, and should contribute to social benefits. Especially, human activities has given the big impacts to earth environment. This is a very complex affair, and nature itself also impacts the clouds, namely the seasonal variations. JAXA (former NASDA) has the plan of the Global Change Observation Mission (GCOM) for monitoring of global environmental change. SGLI (Second Generation GLI) onboard GCOM-C 1 (Climate) satellite, which is one of this mission, is an optical sensor from Near-UV to TIR. SGLI can provide the various high accuracy products of aerosol, cloud information, various biophysical parameters (Biomass, Land Cover, Albedo, NPP, Water Stressed Vegetation, LST, etc.), coastal information (CDOM, SS, PAR, CHL, SST, etc.), and cryospheric information (Albedo, Snow/Ice Cover, NDII, Sea ice type, Snow Grain Size, NDSI, Snow Surface Temperature, etc.). This paper shows the introduction of the unique aspects and characteristics of the next generation satellite sensor, SGLI/GCOM-C, and shows the preliminary research for this sensor.

## 1. INTRODUCTION

For the environment analysis, continuous global observation is necessary. Satellite remote sensing is very useful for this purpose and can provide the spatial and temporal monitoring of global environment. JAXA has made a new plan of Global Change Observation Mission (GCOM) for monitoring of global environmental change and understanding the mechanism of global environmental change, including global warming. Data obtained from GCOM are necessary for the monitoring of global climate change and the improvement of climate model, and it should bring useful contribution to social benefits.

GCOM is a follow-on satellite observation mission incorporating the technology and results of GLI (Global Imager) and AMSR (Advanced Microwave Scanning Radiometer) on ADEOS-II. The GCOM mission will consist of two series of medium-sized satellites: GCOM-C (Climate) and GCOM-W (Water). GCOM-C satellite will carry the instrument of SGLI (Second Generation GLI), which is the advanced version of GLI. On the other hand, GCOM-W satellite will carry the AMSR follow-on instrument such as scatterometer like SeaWinds onboard ADEOS-II. Three consecutive generations of satellite with one year overlap will be operated in over 13 years observing period. GCOM is designed to establish a long-term observation for monitoring global environment changes, improving knowledge of climate system, developing climate forecast models, and distributing the environmental data.

### 1.1 GCOM-C/SGLI

SGLI, optical sensors observe the reflected solar radiation and/or the infrared radiation from the surface of the earth including land, ocean, and cloud using multiple channels for measuring the biological contents (chlorophyll, photosynthetically active radiation, and vegetation index), temperature, snow, and ice cover, and cloud distribution. These data are useful for understanding the global circulation of carbon, estimating radiation budget, monitoring environmental changes, and also our comprehension of primary marine production.

SGLI has 19 spectral channels from near ultraviolet to thermal infrared. In particular, SGLI has some unique channels, which have been used rarely in previous: 380 nm channel for aerosol detection over land, 763 nm for oxygen absorption, and 1,380 nm for cirrus cloud detection. 11 channels from Near-UV to SWIR have a resolution of 250 m at the nadir and 2 channels in the MTIR have a resolution of 500 m, which cover a large portion of the earth's surface with various spatial scales. Various geophysical parameters consisting of atmospheric, oceanic, land, and cryospheric parameters, are retrieved from radiance data from SGLI. These parameters are used for evaluating ocean and land biomass and primary production on a global scale, for generating global fields of clouds, water vapor, and aerosol parameters, and for monitoring snow/ice properties around bi-polar regions, and so on (Refer to Table1).

**2. SIMULATION RESULTS OF SGLI LAND PRODUCT FROM EXISTING DATA**

In this chapter, some original SGLI Land products are discussed. These products are estimated by using new and unique channels of GCOM-C/SGLI sensor, and are expected as useful SGLI Land products for understanding and improvement of climate change.

**2.1 Change detection of vegetation biomass**

SGLI can observe surfaces of the earth on slant in RED-NIR region. This function improves the detection efficiency of vegetation biomass. Conventional biomass estimation method using existing vegetation couldn't reflect the 3D (three-dimensional) structure of vegetation canopy. Fig. 2 demonstrates the advantage of multi-angle observation applied to the detection of biomass change for NOAA/AVHRR data. Fig. 2 shows the change of vegetation biomass obtained from multi-angle observation of RED and NIR during 1995 to 1999 in China. In Fig. 1, enclosed regions by white circle show large differences between 1995 and 1999. In these regions, vegetation cover changes strongly.

In the case of Fig. 1, NOAA/AVHRR data obtained from different path were used. For the SGLI, different angle observation is available with along track. It means that SGLI can observe different angle reflectance in almost same atmospheric condition.

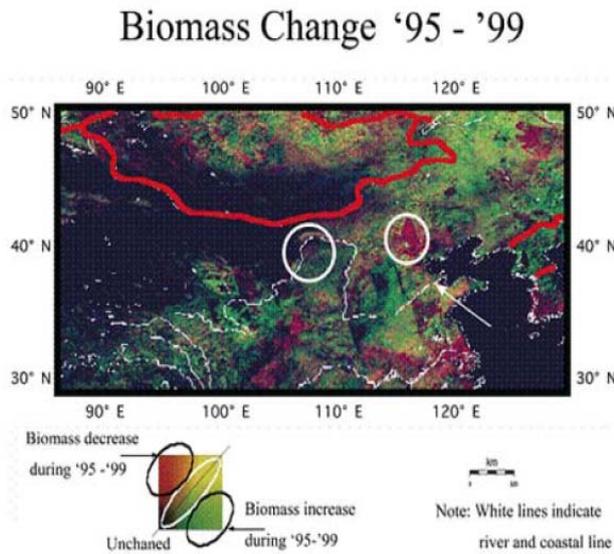


Figure 1. Biomass change detection using multi-angle observation data.

**2.2 Shadow Index (SI)**

The influence of shadow is inevitable to satellite data. In vegetation areas, the ratio of visible shadow space varies widely with tree type, plant growth, season, and so on, because the structure and roughness of vegetation are different each other. Then, taking into account the influence of shadow effect, new vegetation index is developed. This index is named shadow index (SI). The results are shown in Fig. 2. As seen from Fig. 2, SI expresses the difference of

vegetation coverage and type, such as closed and open, or evergreen and deciduous broadleaf. Thus, it is expected that SI is useful for vegetation analysis of land-cover classification, vegetation-type classification, and vegetation biomass estimation, and so on.

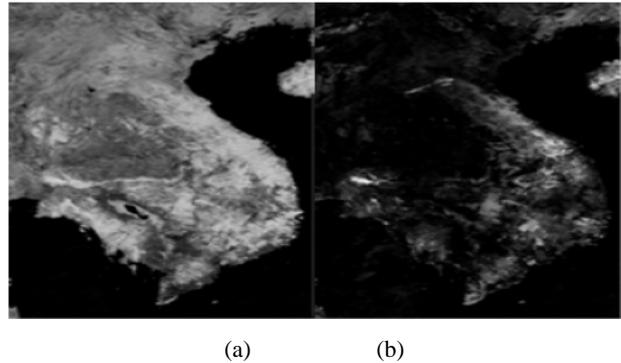


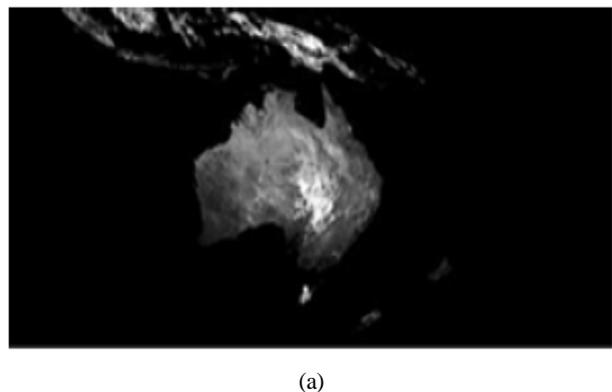
Figure 2. The images of ADEOS-II/GLI 250 m data around Indochina Peninsula on 2003/4/7-2003/4/22. The data shown are (a) NDVI image and (b) shadow index (SI) image in gray scale. Shadow index is estimated by utilizing the normalization method.

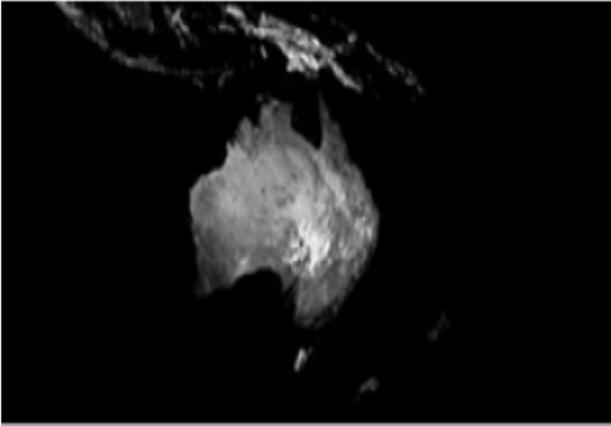
**2.3 Water Stress Trend (WST)**

Water is indispensable for animals and plants. The shortage of water is serious for many forms of life, but waterless area is spreading out by the impact of global warming. By monitoring plant growth, it is possible to grasp the water stress state of land, and we developed a new vegetation index, named Water Stress Trend (WST). Water is hard both to warm up and to cool down. This means that temperature variation of vegetation depends on the quantity of water stress. Based on this water characteristic, WST is estimated using the quantity of temperature change.

Recently, the drought damage of Australia becomes serious problem. Fig. 3 shows the WST results in two periods. Water stress was little in 2005, but big in 2006. As seen from Fig. 3, though WST in 2005 (Fig. 4 (a)) is small in the whole area, many big areas of WST are there in 2006 ((Fig. 3 (b)).

Therefore, WST which estimated from the accumulation of difference in radiant temperature is useful to detect waterless area.



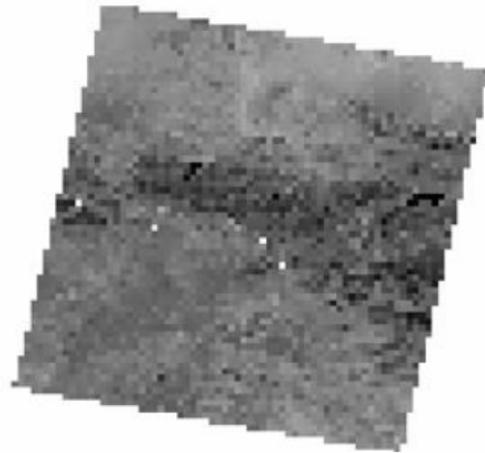


(b)

Figure 3. The Images are Accumulation of Difference of Radiant Temperature for Area Around Australia. Accumulation of Difference of Radiant Temperature was Calculated Using Day and Night Data. Data are (a) 2005/8/12-2005/8/20 and (b) 2006/8/12-2006/8/20as Observed By Terra/MODIS

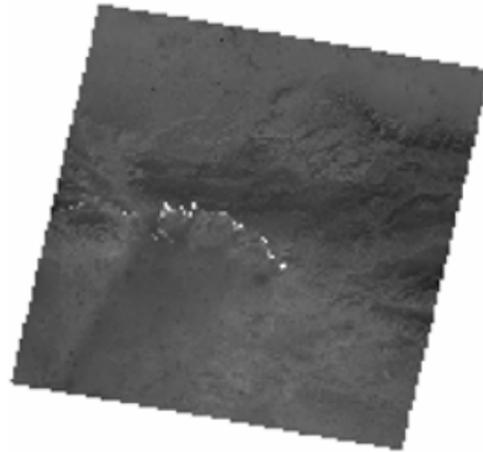
#### 2.4 Fire Detection Index (FDI)

SGLI does not have 4  $\mu\text{m}$  channel which plays a significant role to the forest fire detection for MODIS and upcoming VIIRS data processing, however, SGLI will has finer spatial resolution channels such as 250 m for 1,600 nm and 500 m for 10.8  $\mu\text{m}$ . To detect the forest fire from SGLI data, the thresholding technique will be available for 10.8  $\mu\text{m}$ , 2,200 nm, 1,600 nm channels. Fig. 4 shows the simulated images of forest fire for ASTER band 4 (1,600 nm) and 13 (10.8  $\mu\text{m}$ ) by averaging into 250 m, 500 m and 1,000 m of spatial resolution over San Bernardino, CA on 26 Oct. 2003. This result shows that spatial resolution improvement makes the SGLI forest fire detection ability comparable with that of MODIS and VIIRS

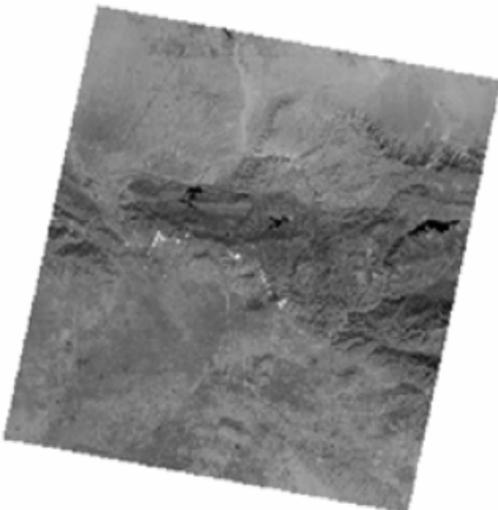


(b)

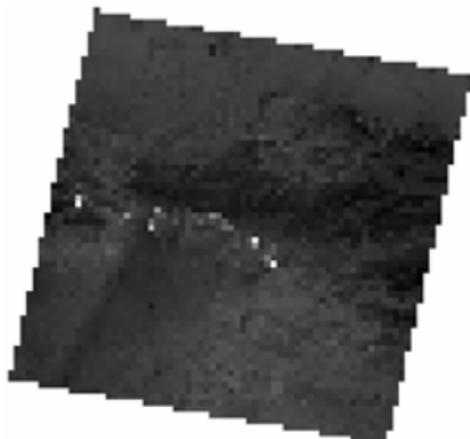
Figure 4. (a) ASTER band 4 (resolution 250m), (b) ASTER band 4 (resolution 1000m)



(c)



(a)



(d)

Figure 4. (c) ASTER band 13 (resolution 500m), (d) ASTER band 13 (resolution 1000m)

### 3. SUMMARY

