DEVELOPMENT OF A GMS MCSST CD-ROM FOR COMPUTER ASSISTED TEACHING

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ABSTRACT

The authors have developed a GMS MCSST CD-ROM. The CD-ROM consists of GMS thermal channel images, MCSST(multi-channel sea surface temperature) images, animations and some documents which gives introduction to remote sensing and the dataset. The MCSST images were derived from the VISSR sensor onboard the Geo-stationary Meteorological Satellite GMS-5. The users can learn about GMS VISSR sensor, SST estimation, ocean current etc. from the documents. The simple user interface allows users to easily see and compare each image. In order to reduce the cloud cover of the MCSST image, one have to compose multi-temporal GMS data. As number of days to compose increases, more clouds would be rejected. However, on the other hand, increase of the days to compose does reduce the time resolution of the dataset. The authors have produced one, three, five and seven days composite images and the animations which are all stored in this CD-ROM. By looking at each image as well as the animation, users can understand the advantage and effect of multi-temporal composite of GMS data for SST pattern observation. In spite of the existence of cloud effects, many interesting SST pattern can be seen in the animation which were difficult to observe in the previous MCSST data sets of NOAA.

1 INTRODUCTION

Table 1. Specification of GMS/VISSR and NOAA/AVHRR

satellite	GMS-5	NOAA
sensor	VISSR	AVHRR
wavelength (micro meter)	VIS : 0.55□0.9	0.58□0.68
		0.725□1.10
	IR3 : 6.5□7.0	3.55□3.93
	IR1 : 10.5□11.5	10.3□11.3
	IR2 : 11.5□12.5	11.5□12.5
IFOV	1km(Visible) 5km(IR)	1km
Observation period	1 hour	12 hours

The Japanese Geo-stationary Meteorological Satellite GMS-5 was launched in 1995. The major improvement of the VISSR sensor onboard GMS-5 was the split of the thermal infrared channel into two channels. Due to this improvement, it has become possible to apply the Multi-channel Sea Surface Temperature (MCSST) method to the VISSR data for estimating the sea surface temperature (SST) like NOAA/AVHRR. Thus, the authors have been working on the development and validation of the GMS MCSST dataset for the passed few years. The spacial resolution of the VISSR IR channels is 5km which is much lower than 1km of the AVHRR IR channels. However, the temporal resolution of VISSR is one hour which is much higher than 12 hours of the AVHRR(see Table 1). Usually, at least one week of AVHRR □data are combined to make one cloudless MCSST image. The temporal advantage of the GMS observation suggests that the GMS MCSST dataset may cover some of the applications which may not be covered by NOAA MCSST dataset. In this study, the authors have developed the GMS MCSST CD-ROM to promote and verify the use of GMS MCSST dataset.

2 DEVELOPMENT OF GMS MCSST DATASET

2.1 SST Estimation

According to the MCSST method(McClain et al, 1985), the following equation was used to calculate MCSST from GMS VISSR infrared channels.

$$MCSST = a \times IR1 + b \times (IR1 - IR2) + c \quad (1)$$

a,b,c: constant
IR1, IR2: VISSR IR channels

The constant a,b, and c were calculated by applying regression analysis to the VISSR IR data and the buoy measured SST provided from JMA. The calculated results were a = 1.1161, b = 0.9004, c = 1.8114. The co-relation coefficient between the GMS MCSST and the buoy based SST was 0.9620.

2.2 Specification of GMS MCSST Dataset

The authors are developing the GMS MCSST dataset around Japan. The specifications of the dataset are shown on Table 2, and the geographic area of the dataset is shown on Figure 1. In order to reject the clouds, multi temporal images were composed using maximum value composite method.

Table 2. GMS MCSST dataset specification

calibration method	MCSST method
temperature resolution	0.2 □
calculated SST range	0.0 □ 34.0 □
geographic area	120E - 180E 20N - 50N
pixel size	5.0km
image size	1076 pixels × 673 lines
composite method	maximum value composite

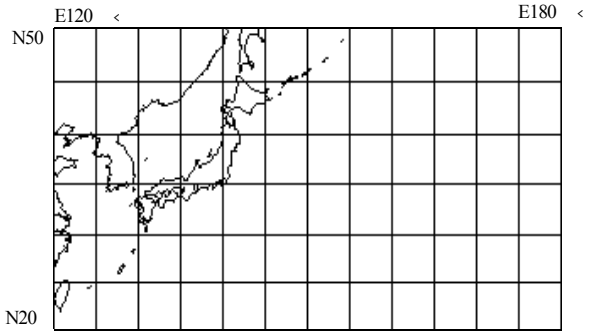


Figure 1. Geographic coverage of the MCSST dataset

The concept of the maximum value composite method is shown on Figure 2. For example, if we are to combine four MCSST images, each pixel value of the all four images are compared and the maximum value is selected for the pixel value of the composite image. Since the brightness temperature of the cloud covered pixels or cloud affected pixels are lower than SST, the maximum value composite method is quite effective for selecting less cloud affected pixels from each MCSST image.

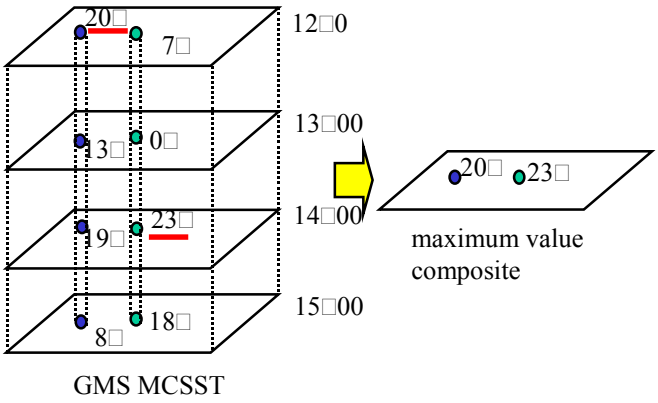
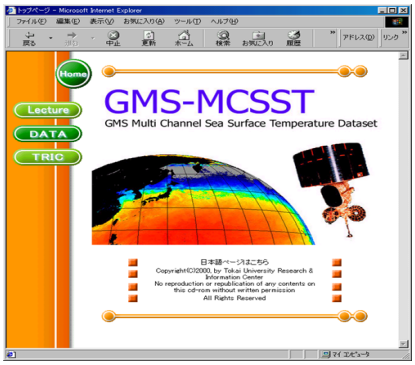


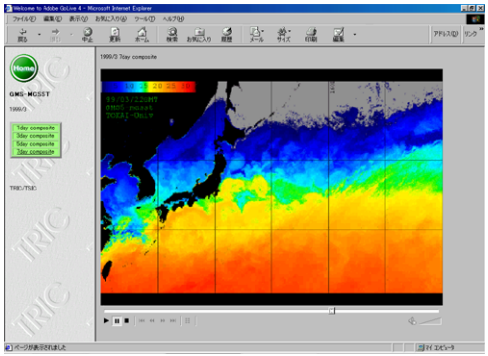
Figure 2. concept of the maximum value composite method

3 CONTENTS OF THE CD-ROM

The CD-ROM consists of GMS images and some documents. The GMS images consists of thermal infrared channel images and MCSST images. The thermal infrared images are of the globe(sub-sampled) and of around Japan (full resolution) . The time period of which is from March 1st to 31st ,1999, and the time interval of the thermal infrared channel images is one hour. As for the MCSST images, the area is around Japan and the composite days are one, three, five and seven. The animations of the MCSST images are also recorded in the CD-ROM. The user can easily see those images as well as the documents with browsing software such as the Internet Explorer of Micro Soft (see Figure 3). The documents introduce the dataset, technical word, concept of remote sensing, SST etc. The contents of the CD-ROM are listed on Table 3.



(a) Home page



(b) Animation display

Figure 3. Screen image of the GMS MCSST CD-ROM operation

Table 3. Image contents of the GMS MCSST CD-ROM.

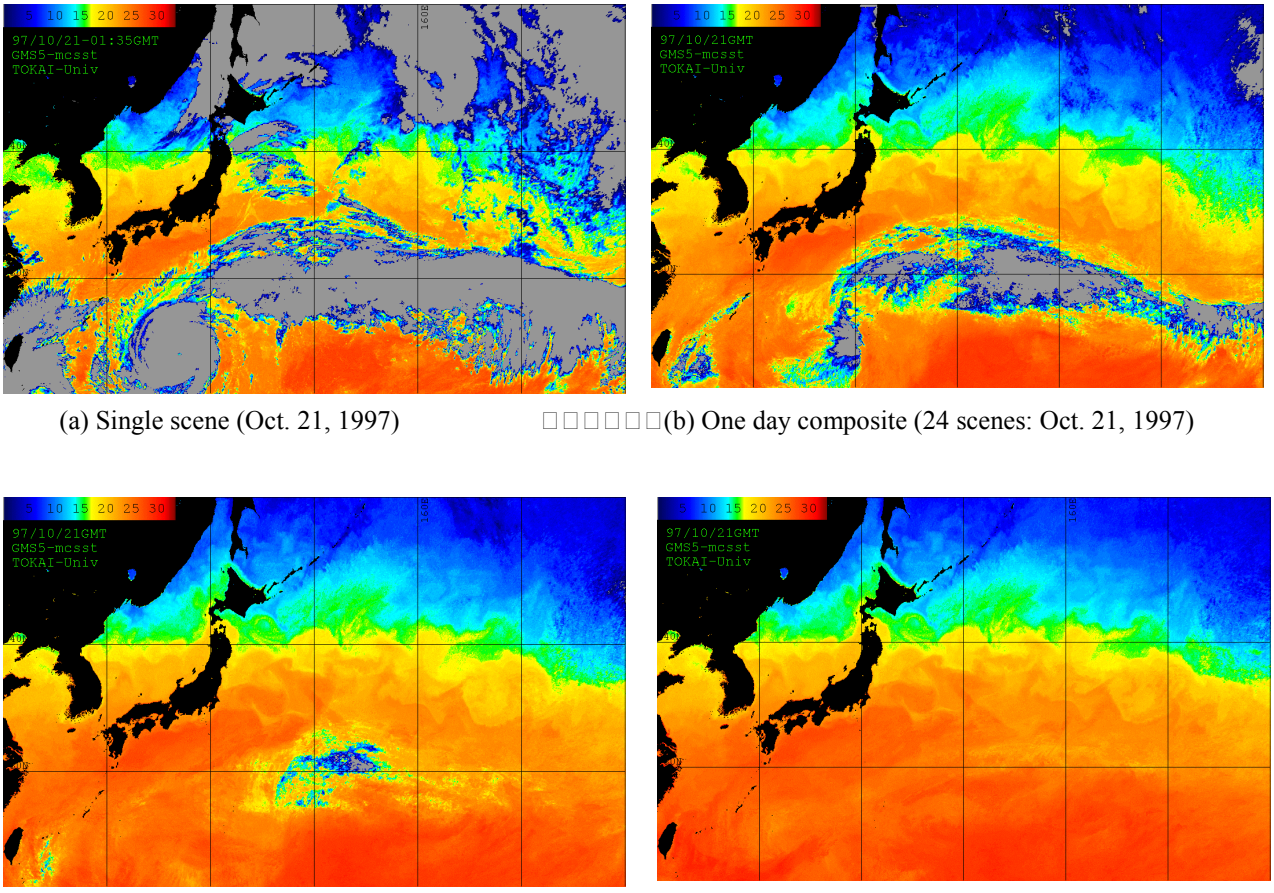
ata name	area	resolution	image size	format	time interval
thermal infrared channel image	globe	26km	480 x 480	jpeg	1 hour
thermal infrared channel image	Japan	5km	1076 x 673	jpeg	1 hour
thermal infrared channel image browse	Japan	27km	200 x 125	jpeg	1 hour
MCSST image	Japan	5km	1076 x 673	GIF	1, 3, 5, 7 days composite
MCSST image browse	Japan	27km	200 x 125	GIF	1, 3, 5, 7 days composite
MCSST image animation	Japan	27km	200 x 125	avi, mov	1, 3, 5, 7 days composite

4 DATASET EVALUATION

4.1 SST Pattern Observation

By increasing the number of the days to compose, the effects of the clouds can be reduced. In other words, more SST pattern will appear on the composite images. However, on the other hand, increase of the days to compose does reduce the time resolution of the dataset. In order to evaluate the suitable number of days to compose, GMS MCSST dataset with one, three, five and seven days composite were stored in the CD-ROM. Figure 4 shows how the cloud covered area are reduced with the increase of the days to compose. In this case, most of the clouds were rejected with five days composite. This kind of MCSST image can hardly be produced with five days composite of NOAA/AVHRR. The composed images strongly suggest the use of GMS MCSST dataset for monitoring the temporal changes of SST.

On the other hand, when we look into the details, even in the five or seven days composite images, some atmospheric patterns can still be observed. Since the calculated MCSST of those areas are not so low, they look like real SST pattern. The authors estimate that the existence of very thin clouds is reducing the MCSST of those areas.



(a) Single scene (Oct. 21, 1997) (b) One day composite (24 scenes: Oct. 21, 1997)

(c) Three days composite (72 scenes: Oct. 20 - 22, 1997) (d) Five days composite (120 scenes: Oct. 19 - 23, 1997)

Figure 4. Effect of cloud rejection in GMS/MCSST dataset with the increase of the number of the days to compose

4.2 Multi-temporal Information

The time series of cloudless GMS MCSST images are quite useful for understanding the SST pattern changes of the ocean. Figure 5 shows an example of the dynamic SST pattern changes observed with the GMS MCSST dataset. The user of the CD-ROM can see the GMS MCSST animation for multi-temporal analysis of the ocean phenomena, and also for evaluating the effect of multi-temporal composite. Since each composite image was produced daily, the user can see the dynamic movement of clouds and SST patterns in the animation. The animation of one or three days composite does show the dynamic movement of cloud. But, on the other hand, since many clouds are still remaining in the composite images, the animations of those images are not effective for reading the SST pattern changes. The dynamic SST pattern changes can clearly be seen in the animation of five and seven days composite images. These animations are useful for the beginners to understand the dynamic movement of the ocean.

As described in the previous section, even though the cloud effect can be minimized in the seven days composite, in some areas, atmospheric effect does remains in the SST patterns of the composite image. These effects are sometimes difficult to recognize in a single composite image. However, when looking at the animations, it is much easier for the users to distinguish the cloud affected false SST change patterns from the real SST change patterns.

5 CONCLUSIONS

A GMS MCSST CD-ROM was produced. Most of the major cloud covered areas could be removed by five days composite of GMS data. This strongly suggests the advantage of GMS MCSST against the NOAA MCSST. Especially, the animation of GMS MCSST dataset were useful for monitoring the dynamic SST pattern changes as well as the atmospheric effects which may caused by thin clouds. The authors are planning to distribute this GMS MCSST CD-ROM to the scientists for the further evaluation of the dataset.

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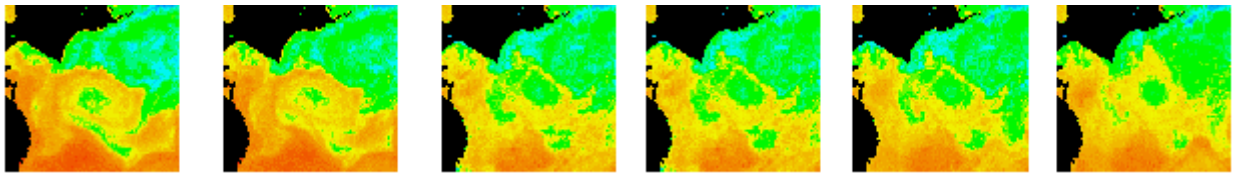

Figure 5. The SST pattern changes observed in the time series of the GMS MCSST five days composite images.