COMPARISON OF ATMOSPHERIC CORRECTION ALGORITHMS FOR DERIVING SEA SURFACE TEMPERATURE AROUND THE KOREAN SEA AREA USING NOAA/AVHRR DATA

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ABSTRACT To retrieve Sea Surface Temperature(SST) from NOAA-AVHRR imagery the spilt window atmospheric correction algorithm is generally used. Recently, there have been various new algorithms developed to process these data, namely the variable-coefficient split-window, the R54 transmittance-ratio method, fixed-coefficient nonlinear algorithm, dynamic water vapour (DWV) correction method, Dynamic Water Vapour and Temperature algorithm (DWVT). We used MCSST (Multi-Channel Sea surface temperature) and NLSST(Non linear sea surface temperature) algorithms in this study. The study area is around the Korea sea area (Yellow Sea). We compared and analyzed with various methods by applying each Ocean in-situ data and satellite data. The primary aim of study is to verify and optimize algorithms. Finally, this study proposes an optimized algorithm for SST retrieval.

KEY WORDS: Sea Surface Temperature(SST), Split-window algorithms(MCSST)

1. INTRODUCTION

Sea surface height due to global warming is an important parameter for monitoring the Earth's environment changes. The estimation of SST from satellite measurements, satellite data analysis and verification, satellite data correction have been studied since 1970s. Eugenio et al. (2005) suggested the regional optimization of atmospheric correction algorithm. Kumar et al. (2002) studied the atmospheric correction algorithms using in situ temperature. Pichel et al. (2001) validated such algorithms in the coastal sea and lake using NOAA/AVHRR data.

Sea surface temperature (SST) were derived from The Advanced Very High Resolution Radiometer (AVHRR/2, AVHRR/3) sensors onboard the NOAA-12,NOAA-16, NOAA-17, NOAA-18 satellites. NOAA12(AVHRR/2) has five bands, i.e., channel (0.58-0.68μm), channel2 (0.725-1.10μm), channel3 (3.55-3.93μm) channel4 (10.30-11.30μm) channel5 (11.5-12.5μm), and NOAA-16,17,18(AVHRR/3) has five similar bands and one additional band 3A(1.58-1.64μm). The AVHRR satellite has the spatial resolution of 1.1km *1.1km at nadir. The AVHRR provides regional information on vegetation condition and sea surface temperature.

In this paper, we focus on optimizing algorithms based on the analysis and comparison of sea surface temperature from satellite and Jung sun situ data (NFRDI) in yellow sea. The split window method uses channel 4 and 5 brightness temperature to calculate SST. We used MCSST (Multi-Channel Sea surface temperature) and NLSST (Non linear sea surface temperature) algorithms in this study.

2. MEHHOD

2.1 Study area

The study area is the Yellow Sea that semi-closed sea surrounded by the Korea peninsula in the east and the Chinese continent in the west, connected with the Bohai Bay in the northwest and the East China Sea in the south. The Yellow Sea is covered by an area of 4.87×105 km2 , with the depth of 44m and 1.94×104 km3 of water. The bottom topography of the Yellow Sea is narrow and elongated in a north-south direction, with isobaths mostly running in the same direction (KORDI). Jung-sun situ data of point in Yellow sea is the study area(Fig. 2)

2.2 Satellite data

Korea Ocean Satellite Center (KOSC) in KORDI receives data from NOAA satellites. NOAA Level 2 SST data for the period of 2005-2006 are used in this study.

Free cloud images were selected and matched up in-situ data were collected .

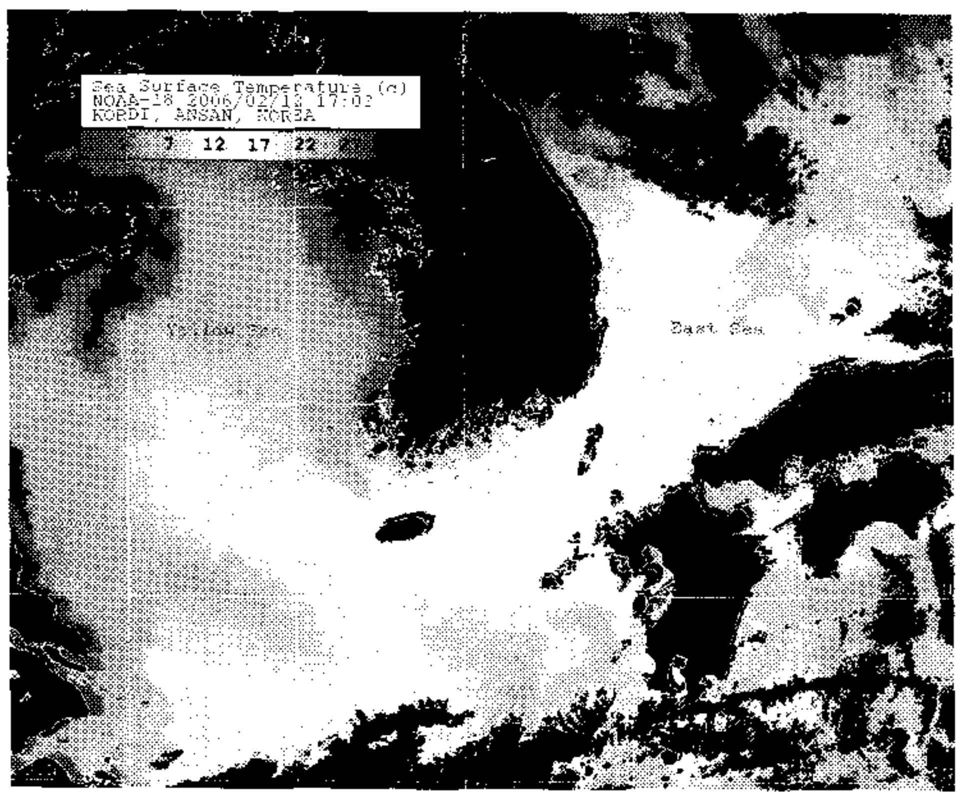

Figure 1. Study area in the Yellow sea (Sea Surface Temperature image on 2 February, 2006). We used SST image from the Korea Ocean Satellite Center (KORDI-KOSC).

2.3 In situ data

In situ data were collected from 1 January 2006 to 31 December in the Yellow sea. We used Jung sun situ data obtained from the Korea National Fisheries Research Development Institute(NFRDI).

In situ data for standard depths 0m (skin temp) depth were used. Figure 2 shows the location of the sample stations in this study area map.

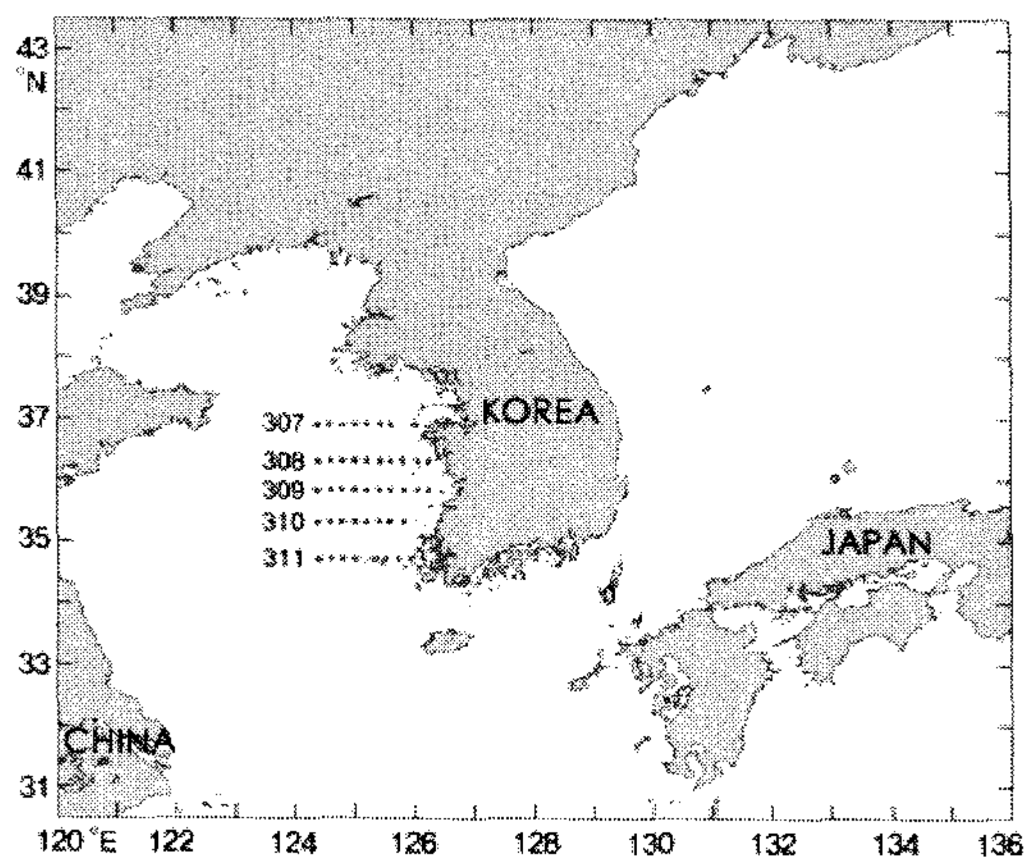

Figure 2. Map of the yellow sea area is supported form NFRDI homepage, The circle markers are in situ-data observation locations.

2.4 Data method

Walton developed the non-linear sea surface temperature estimation algorithm and CPSST (cross product sea surface temperature) method, which reduce errors for dataset containing random noise.

Split window (mc) :

$$SST = A*T4 + B*(T4-T5) + C*(T4-T5)*(SEC(sza)-1) + D*(SEC(sza)-1)+E \quad (1)$$

Mc algorithm computes SST using channels 4 and 5 as below. SEC (sza) is the satellite zenith angle θ.

Nonlinear split window (nlmc) :

$$SST = A*T4 + B*MC*(T4-T5) + C*(T4-T5)*(SEC(sza)-1) + D*(SEC(sza)-1) + E \quad (2)$$

2.5 Data processing flow chart

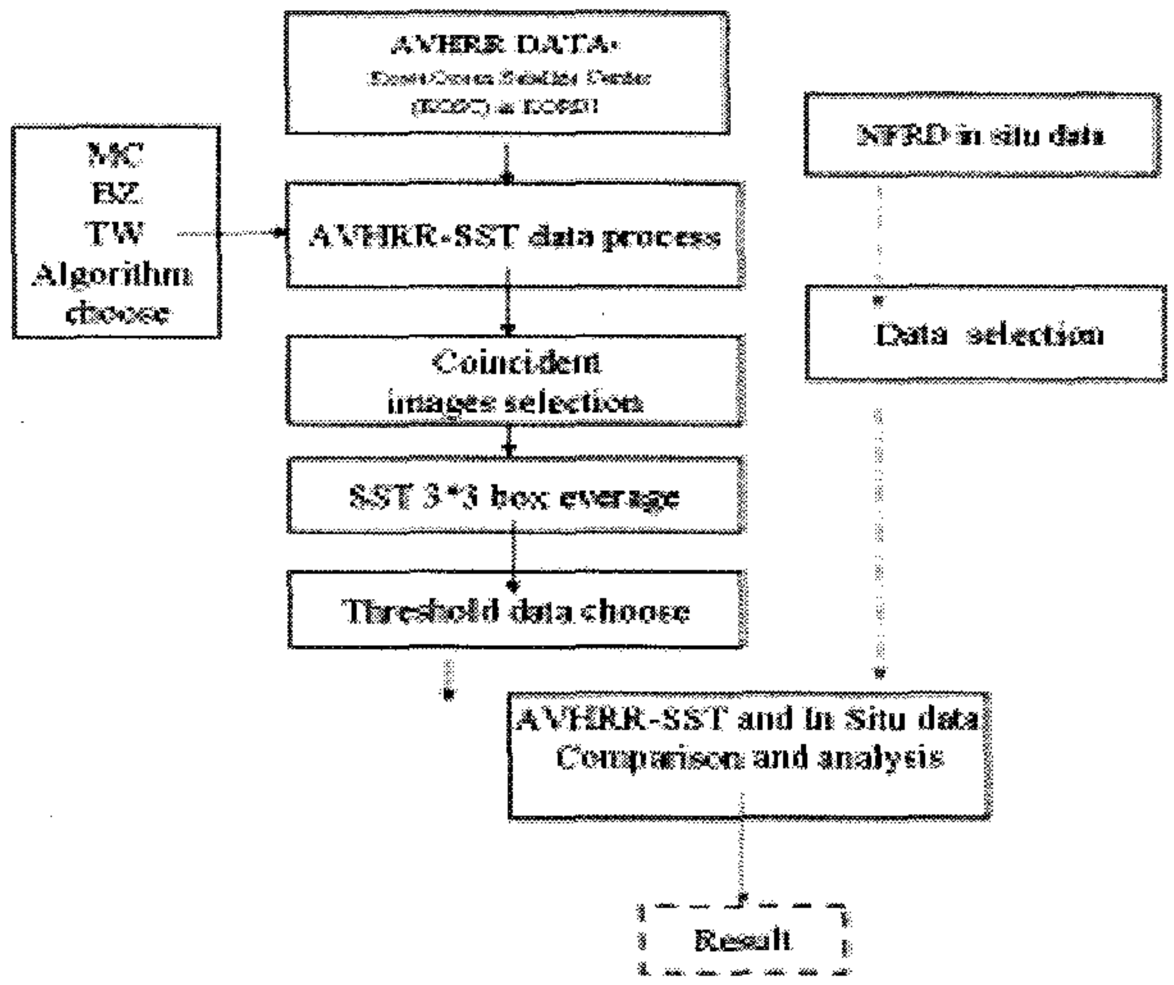

Table 1. Fixed constant coefficients used in the MCSST linear method.

Satel.	Time	A	B	C	D	E(K)
n18	Day	1.02453	2.10044	0.784059	0.00000	0.0
n18	Night	1.00841	2.23459	0.736946	0.00000	0.0
n17	Day	0.992818	2.49916	0.915103	0.000	0.00
n17	Night	1.01015	2.58150	1.00054	0.000	0.00
n16	Day	0.999317	2.301950	0.628966	0.000	0.00
n16	Night	0.995050	2.536550	0.753291	0.000	0.00
n12	Day	0.963563	2.579211	0.242598	0.0	10.144
n12	Night	0.967077	2.384376	0.480788	0.0	9.210

Table 2. Fixed constant coefficient used in nonlinear MCSST algorithm.

Satel	Time	A	B	C	D	E(C)
n-18	D	0.934004	0.0724457	0.748044	0.00000	1.81519
n-18	N	0.939146	0.0750661	0.728430	0.00000	1.46473
n-17	D	0.936047	0.0838670	0.920848	0.000000	1.73023805
n-17	N	0.938875	0.0864265	0.979108	0.000000	1.43070625
n-16	D	0.914471	0.077612	0.668532	0.000000	1.671754
n-16	N	0.898887	0.083933	0.755283	0.000000	1.524984
n-12	D	0.876992	0.083132	0.349877	0.0	2.87336
n-12	N	0.888706	0.081646	0.576136	0.0	2.52104

Table 3. List of sample station location used in the analysis.

Sample station	Sample number	Bottom depth (m)	Latitude (N)	Longitude (E)	Survey date
307	19	0	36.565	124-126	11 February 2006 14 April 2006 12 October 2006
308	7	0	36.198	124-126	12 February 2006 15 April 2006 13 October 2006
309	15	0	35.513	124-126	18 February 2006 22 April 2006 14 October 2006
310	2	0	35.201	124-126	19 February 2006 23 April 2006 15 October 2006
311	3	0	34.403	124-126	20 February 2006 24 April 2006 16 October 2006
312	0	0	34.055	124-126	21 February 2006 25 April 2006 17 October 2006
313	4	0	33.244	124-126	13 February 2006 17 April 2006 14 October 2006
314	5	0	33.00	124-126	12 February 2006 15 April 2006 14 October 2006

3 RESULT

Our analysis showed that the split-window algorithm yields residual error below 0.5°C. This error is caused by the differences in the data match up dataset; in situ data were from the 5-10m layer (bulk temperature) and satellite-SST were from the top layer of the ocean(skin temperature). For yellow sea, MCSST retrieval algorithm displayed standard deviation 0.39°C and R is 0.99 for NOAA-12 14,15,16,17,18 data. In the future study, we hope to improve the accuracy of SST with more number of match up dataset of in situ and satellite data.

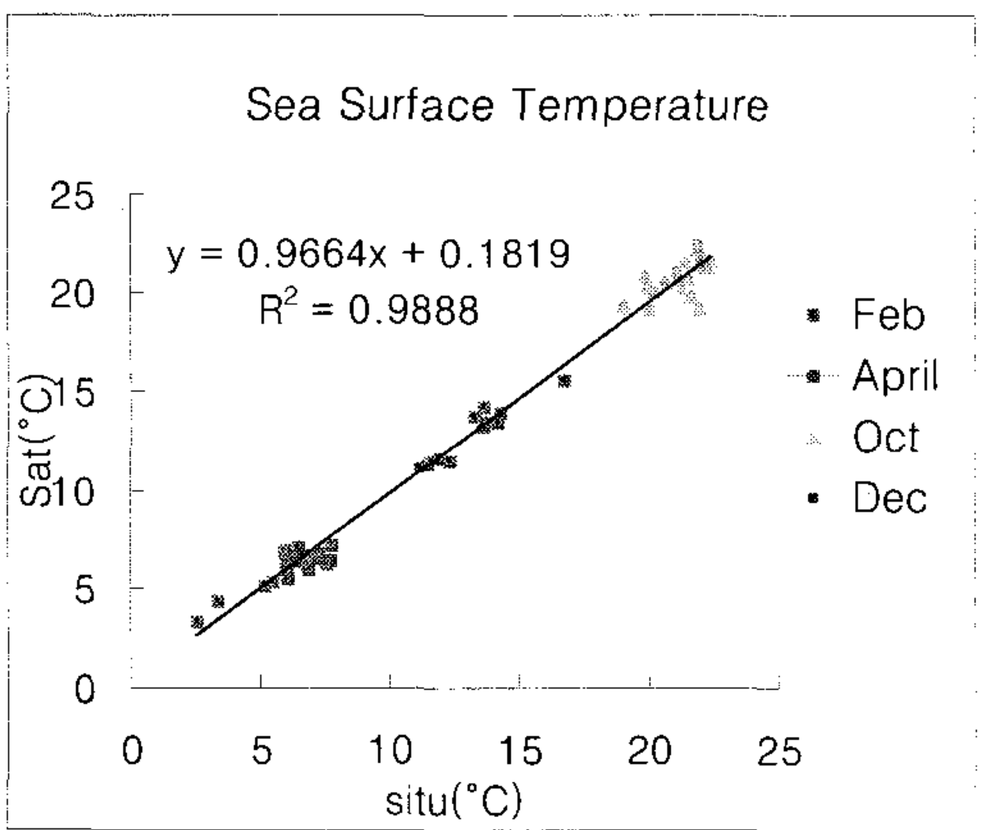

Figure 4. comparison between the proposed MCSST algorithm and Jung Sun situ SST data.

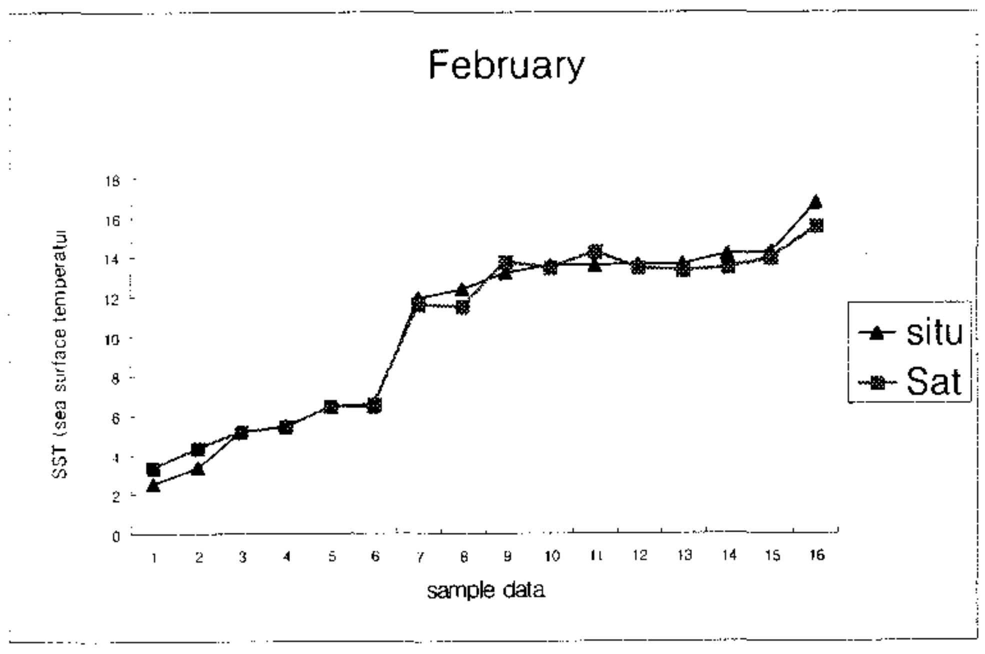

Figure 5. Comparison between the proposed MCSST algorithm and Jung Sun situ SST for February 2006.

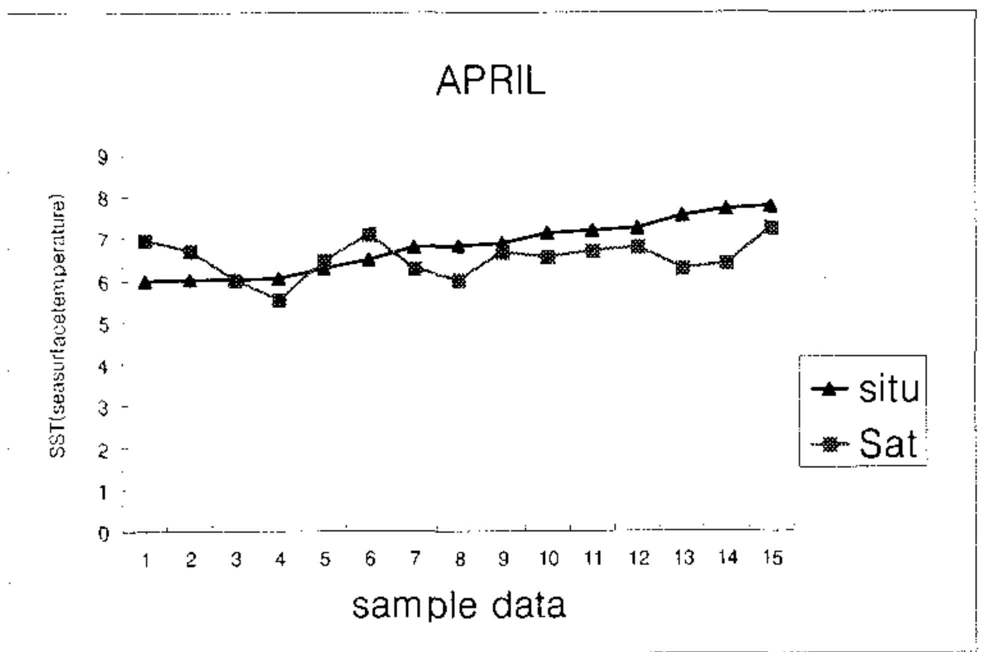

Figure 6. Comparison between the proposed MCSST algorithm and Jung Sun situ SST for April 2006.

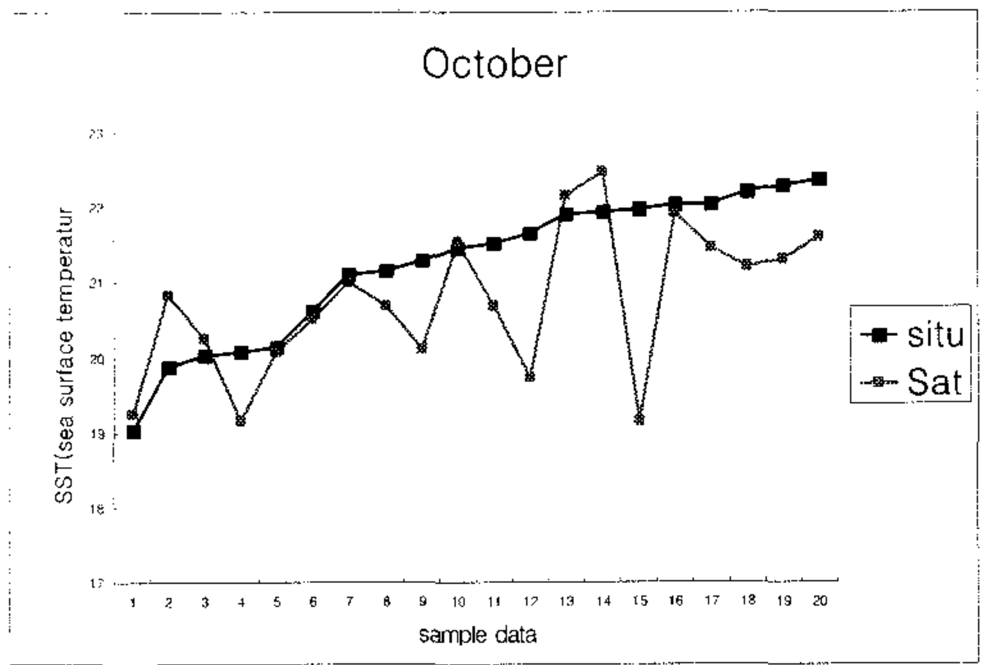

Figure 7. Comparison between the proposed MCSST algorithm and Jung Sun situ SST for October 2006.

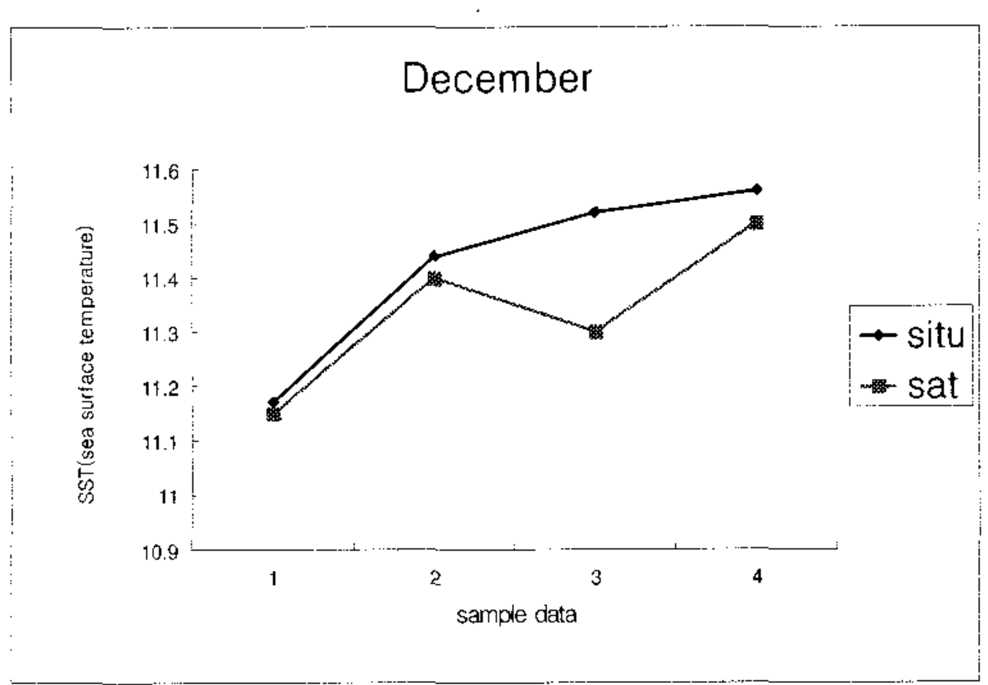

Figure 8. Comparison between the proposed MCSST algorithm and Jung Sun situ SST for December 2006.

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