Sea Surface Temperature (SST) in South China Sea Retrieved from Chinese Satellite FY-3B VIRR Data

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Outline

- Introduction
- Method
- SST in SCS
- Discussion

Introduction

In the surface layer of the ocean, Sea Surface Temperature (SST) is the most important parameter, which is widely applied for studying water masses, air-sea interaction, marine ecosystem and environment, and other subjects.

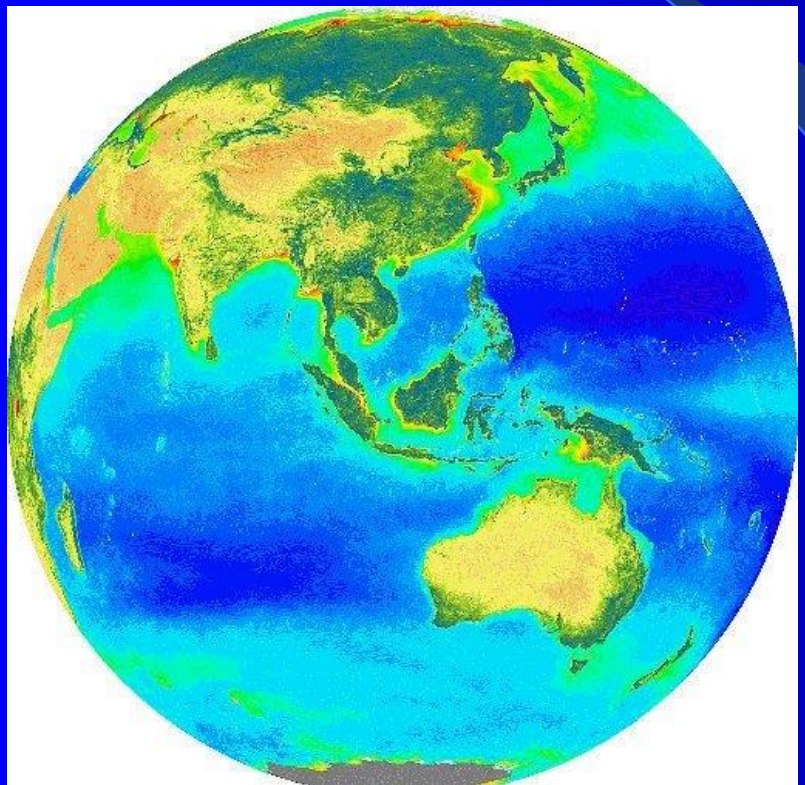
The satellite remote sensing technique has become the dominant approach for SST detection.

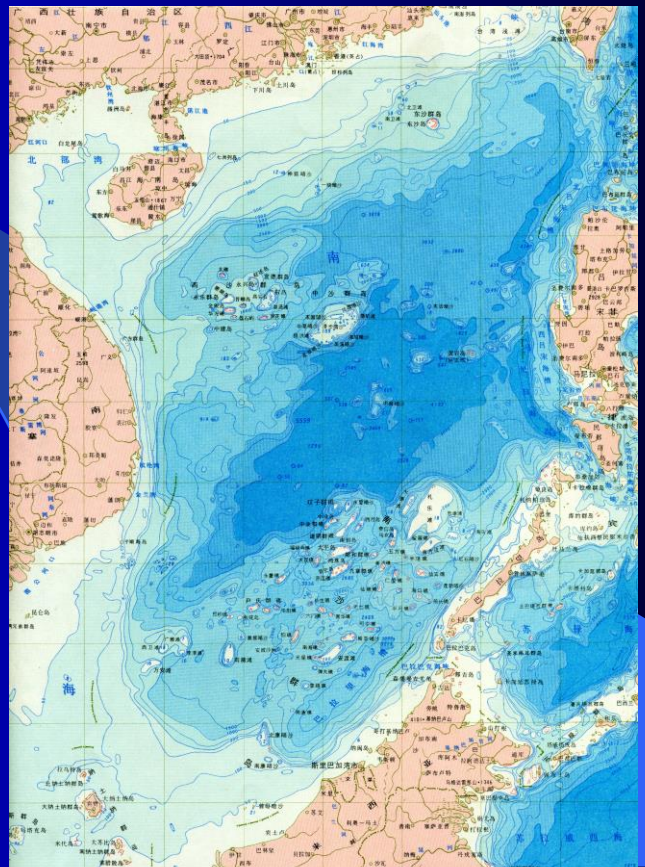
Introduction

In decades, a great many satellites with thermal infrared sensors have been launched and huge thermal infrared remote sensing data can be employed for detection of SST. And several Chinese Satellites with thermal sensors are available. FengYun-3 (FY-3) is the second generation polar-orbiting meteorological satellite series of China, and FY-3B is the second satellite of the generation, which was launched in 2010. The visible infrared radiometer (VIRR) is a main instrument aboard the FY-3B. VIRR has 10 bands, and the spectral ranges of the thermal infrared bands 4 and 5 are 10.3~11.3μm and 11.5~12.5μm, respectively, similar to NOAA/AVHRR.

Introduction

The South China Sea is a marginal sea that is part of the Pacific Ocean, It covers an area of around 3,500,000 square kilometres,located in 3~23N,103~118E. It is the main research area for the institute.





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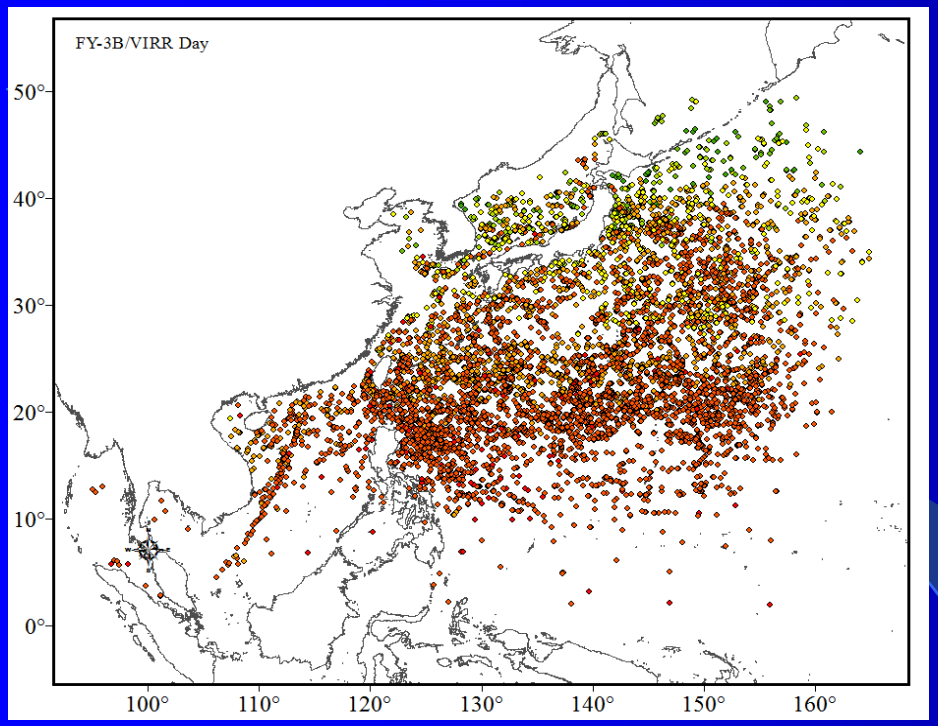
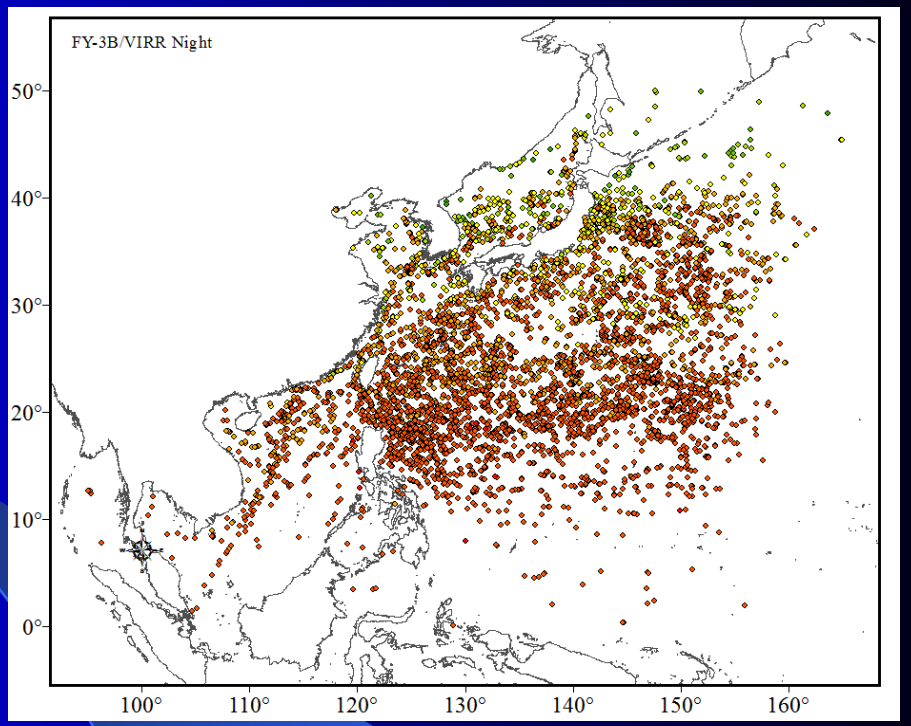
Method

- The simultaneously ship observation data and satellite data were collected from 2011 to 2012, Firstly, the cloud detection(He, Q.J.,2011) is executed for VIRR data and the cloud and land areas are marked. Secondly, the anomaly values are eliminated from ship observation data. Then the matchup dataset is generated according to the rule of closest time and location. and totally there are 20607 matchup samples in the dataset,11419 samples in daytime and 9188 samples in nighttime.





The distribution of matchup samples in 2011~2012

Method

Then the matchup dataset was used for development of the SST algorithm. and the non-linear SST (NLSST) algorithm (Walton,et al.1998) was selected:

$$SST = k_0 + k_1 \times T_{11} + k_2 \times T_{sfc} \times (T_{11} - T_{12}) + k_3 \times (T_{11} - T_{12}) \times (sec(\theta) - 1.0)$$

where the T_{11} and T_{12} is the brightness temperature of 11 and 12μm bands. θ is the sensor zenith in angular. k_0, k_1, k_2 and k_3 are coefficients regressed by matchup dataset. T_{sfc} is the first guessed SST value,here the daily optimum interpolation SST (OISST) is used as T_{sfc}

Method

Half of the samples in daytime and nighttime are respectively chosen by random function for acquirement of the coefficients of NLSST algorithm by building the multivariable linear regression model,

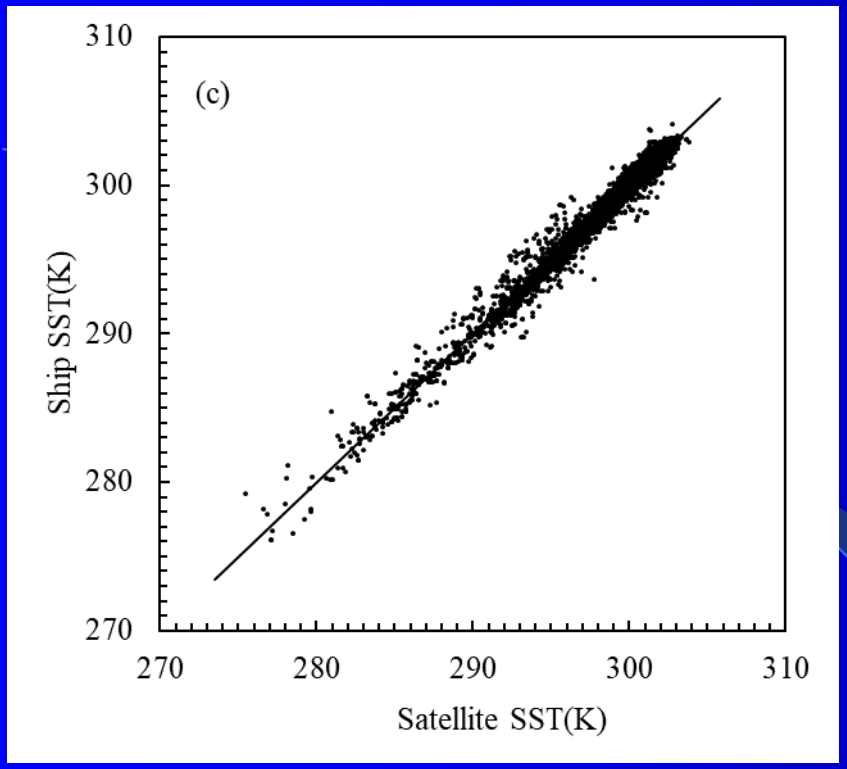
Regression coefficients of NLSST algorithm

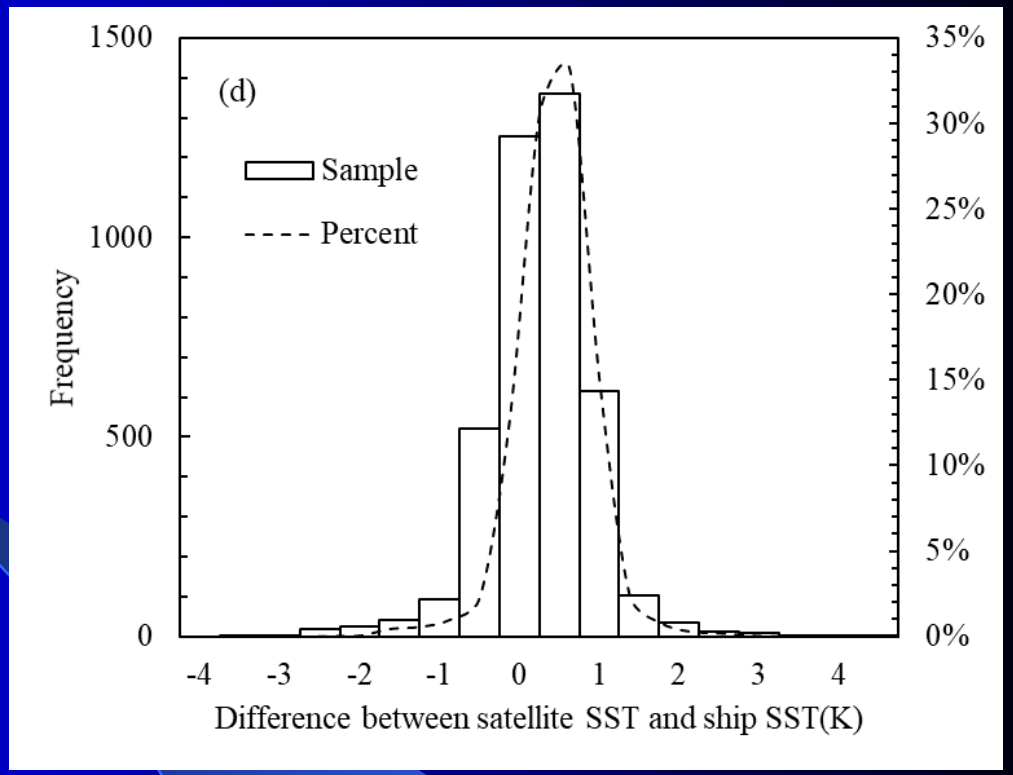
	k_0	k_1	k_2	k_3
Daytime	13.8235	0.9452	0.0098	0.7259
Nighttime	5.0800	0.9776	0.0078	0.6933

Method

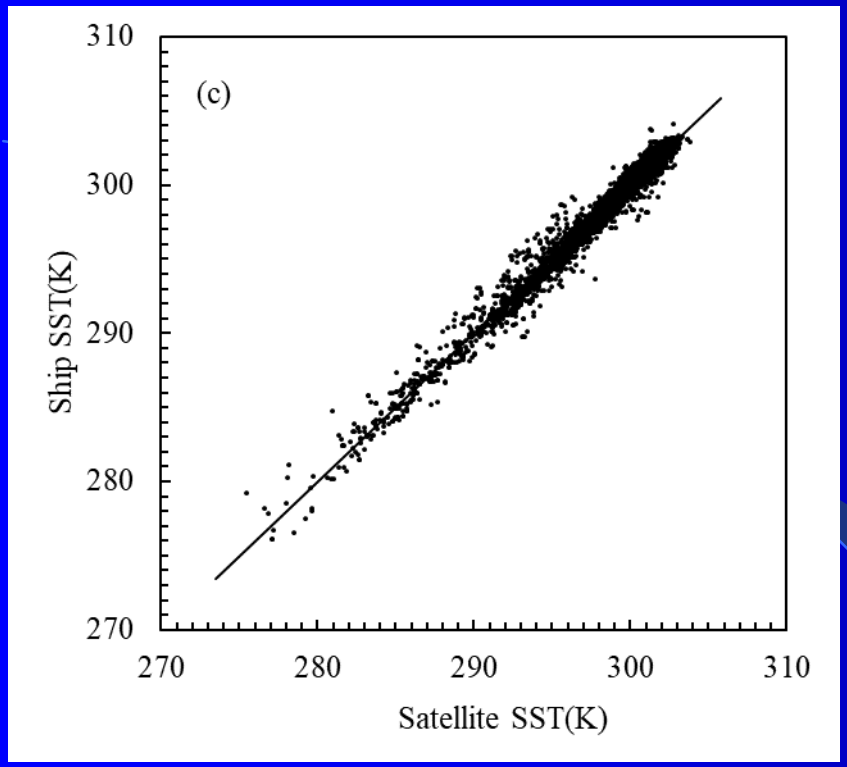
The left samples (5710 samples in daytime and 4094 samples in nighttime) are used for testing the accuracy of NLSST algorithm. The least absolute deviation method is applied to analyze the errors between the ship observation SST and retrieved SST.

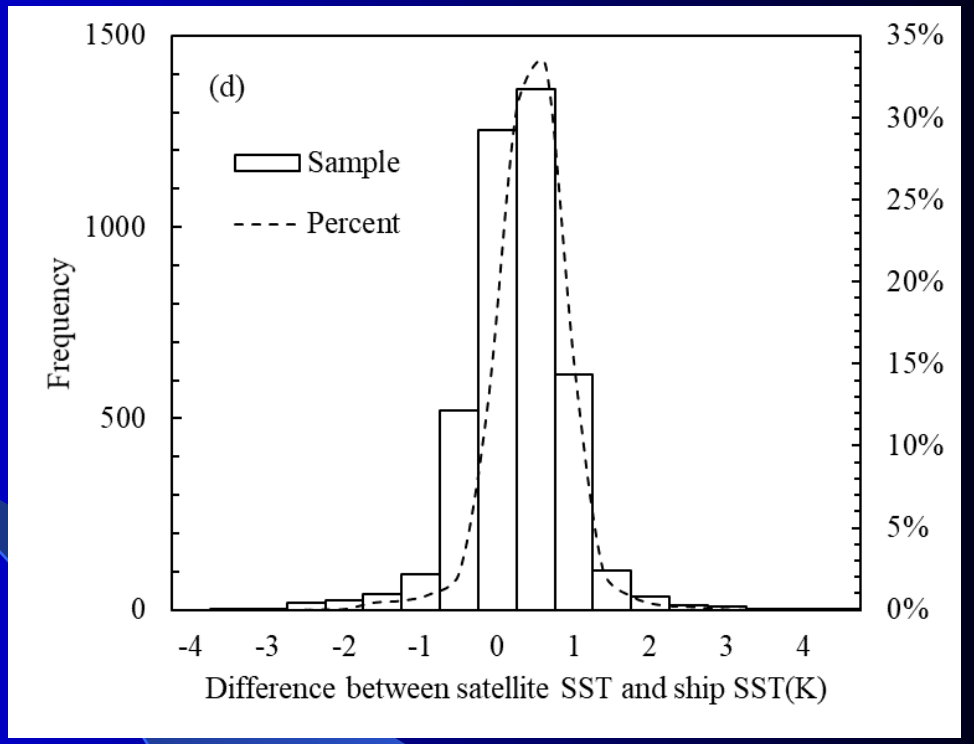
	Bias(K)	Standard deviation (K)	Absolute deviation (K)	Correlation coefficient
Daytime	0.006	0.688	0.503	0.990
Nighttime	0.018	0.659	0.471	0.989





The correlation plot and error distribution between satellite SST and ship SST at the daytime





The correlation plot and error distribution between satellite SST and ship SST at the nighttime

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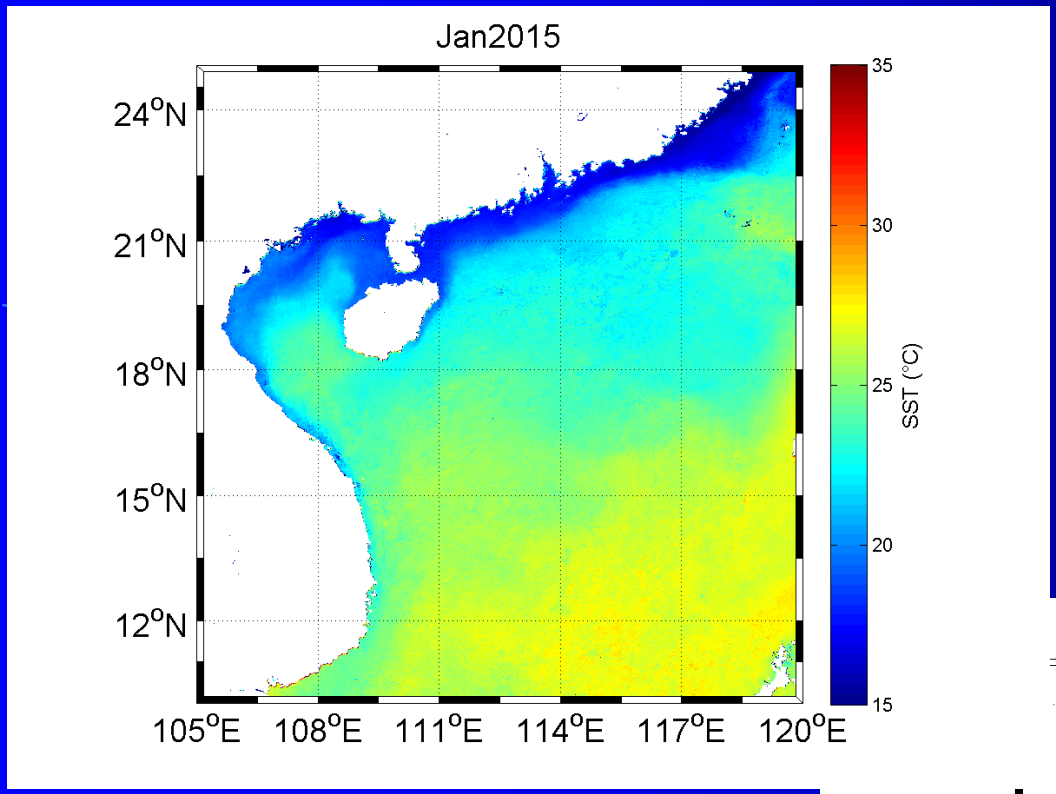
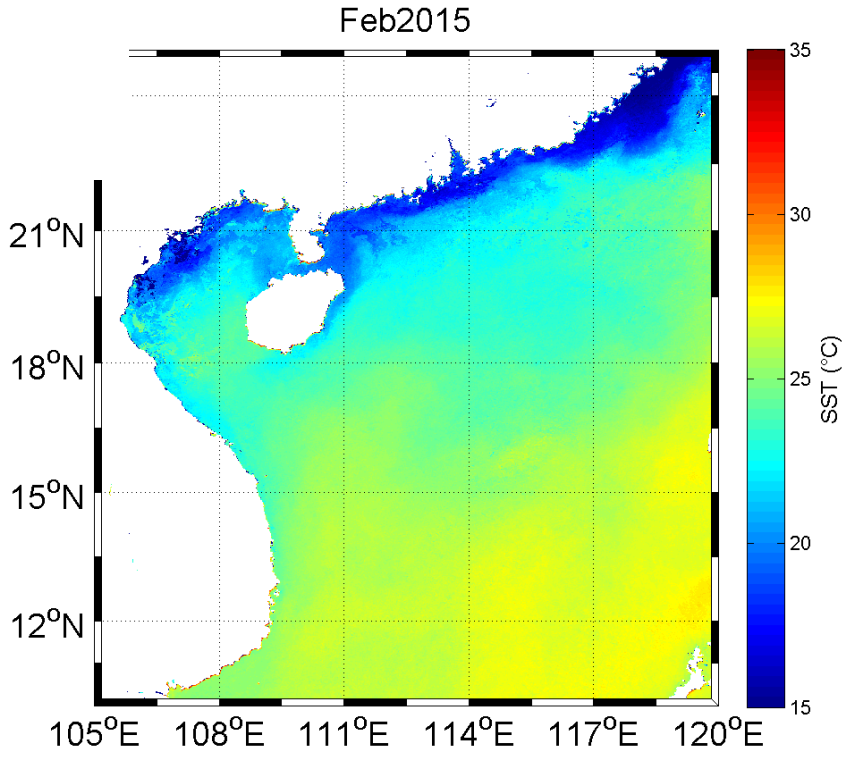
SST in SCS

- The NLSST algorithm is used to retrieve the SST products in SCS, then the monthly mean SST is calculated.


Jan2015
24°N
21°N
18°N
15°N
12°N
105°E
108°E
111°E
114°E
117°E
120°E
35
30
25
20
15
SST (°C)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18°N
15°N
12°N
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111°E
114°E
117°E
120°E
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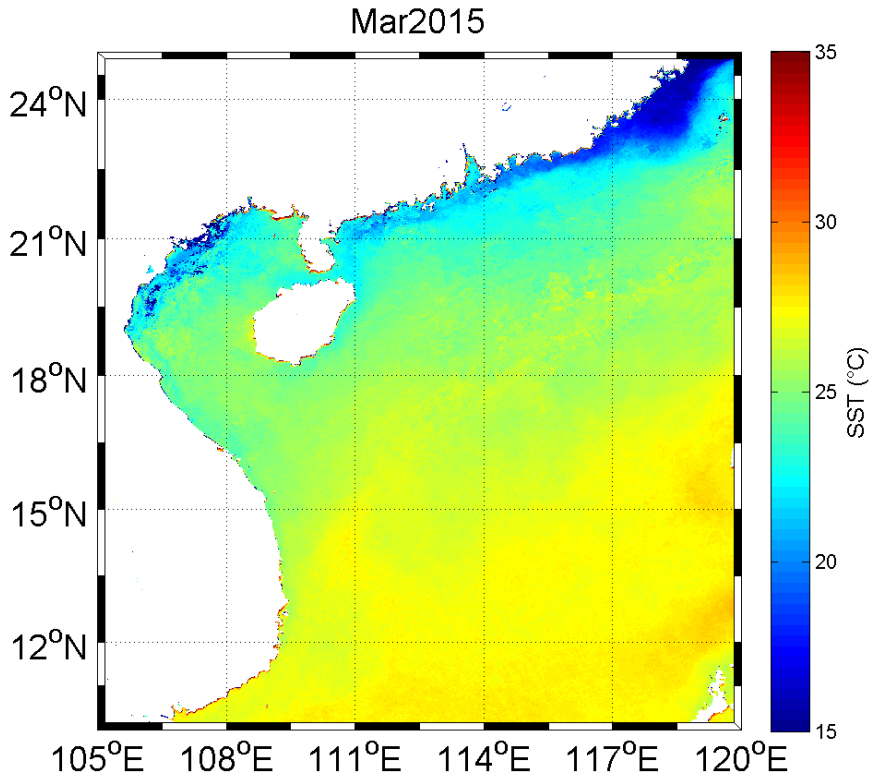
15
SST (°C)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24°N
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18°N
15°N
12°N
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108°E
111°E
114°E
117°E
120°E
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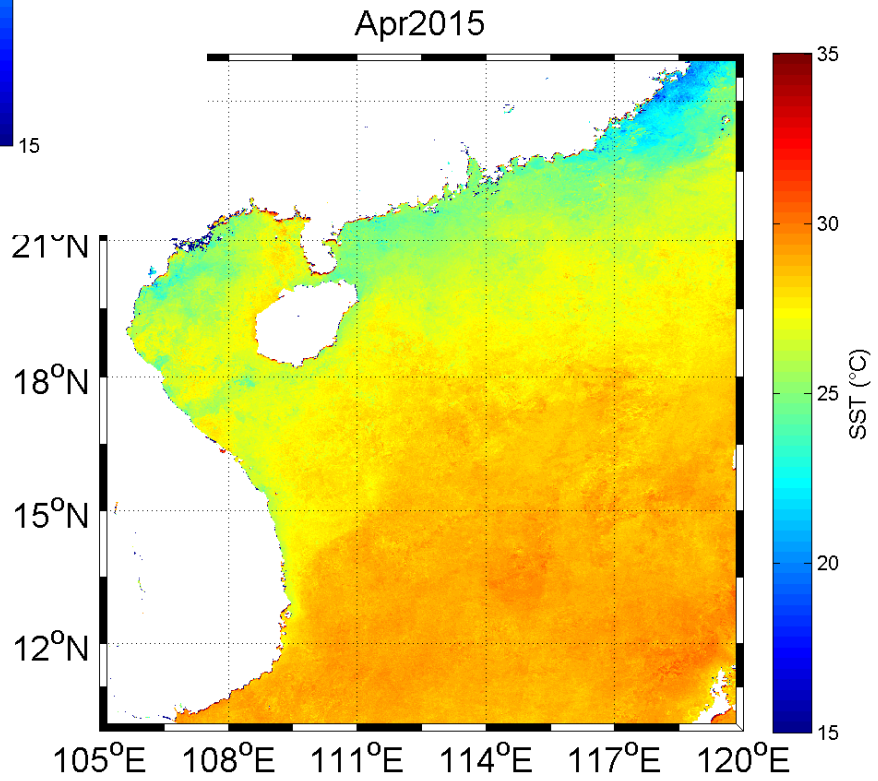
30
25
20
15
SST (°C)


Apr2015
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12°N
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111°E
114°E
117°E
120°E
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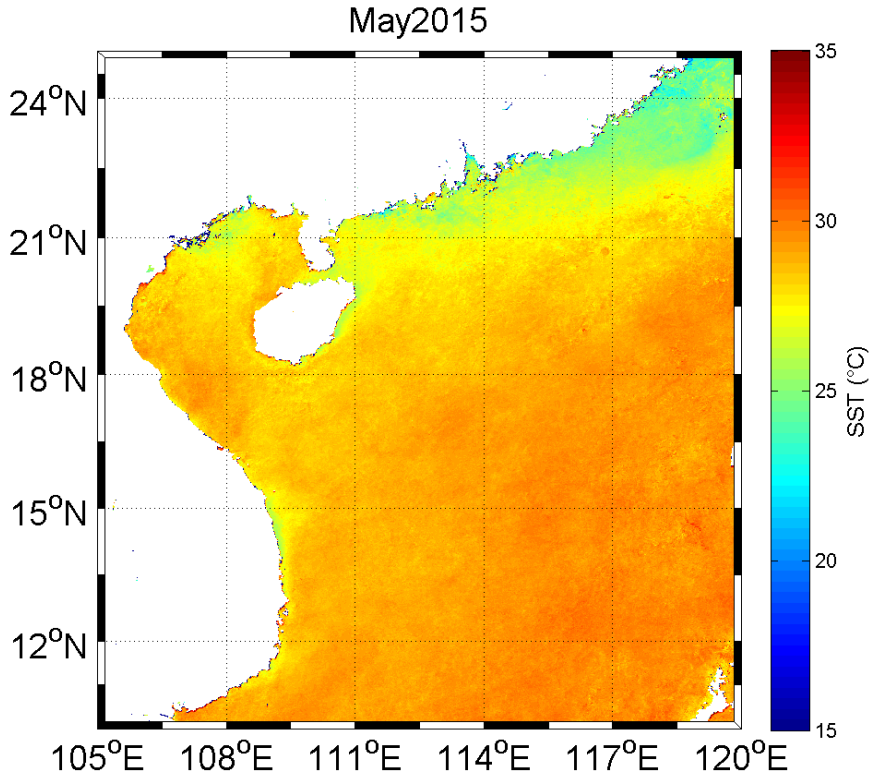
15
SST (°C)


May2015
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12°N
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114°E
117°E
120°E
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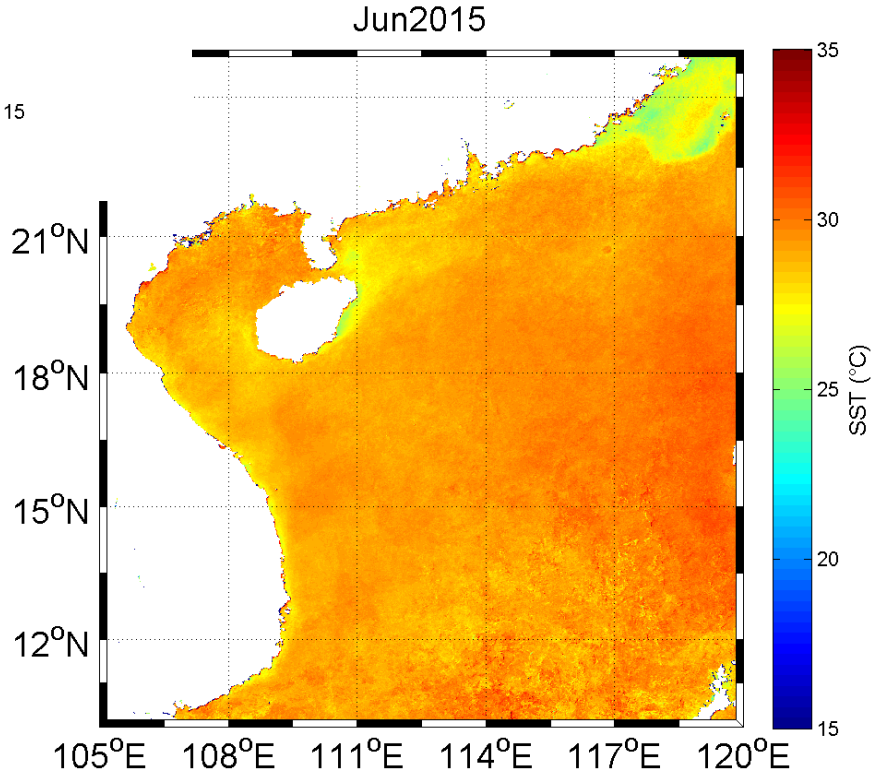
20
15
SST (°C)


Jun2015
21°N
18°N
15°N
12°N
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114°E
117°E
120°E
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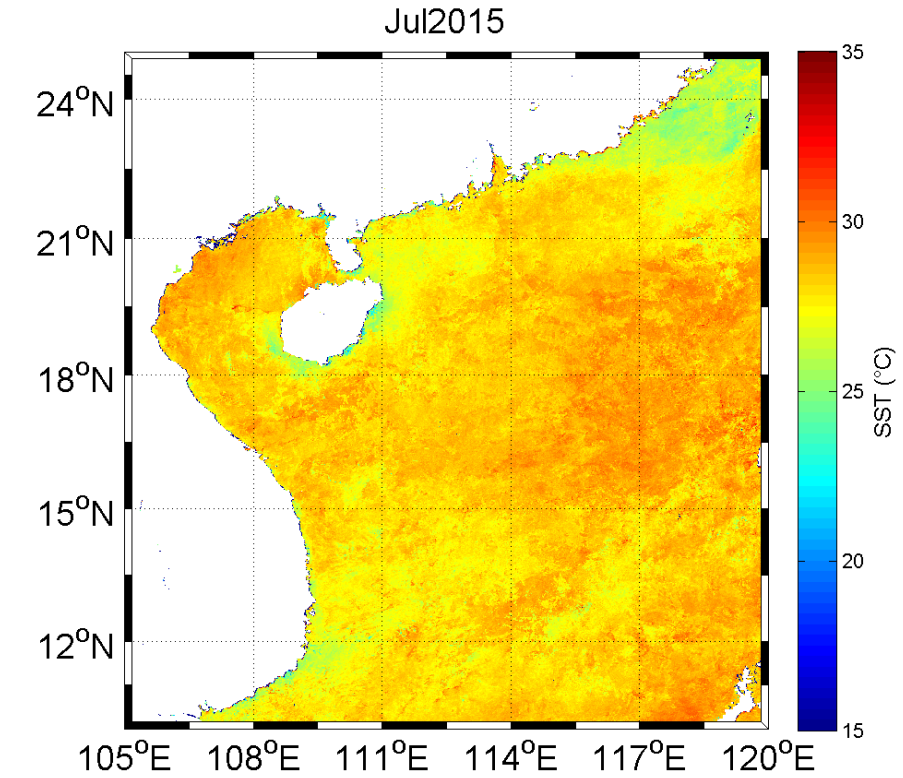
15
SST (°C)


Jul2015
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21°N
18°N
15°N
12°N
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108°E
111°E
114°E
117°E
120°E
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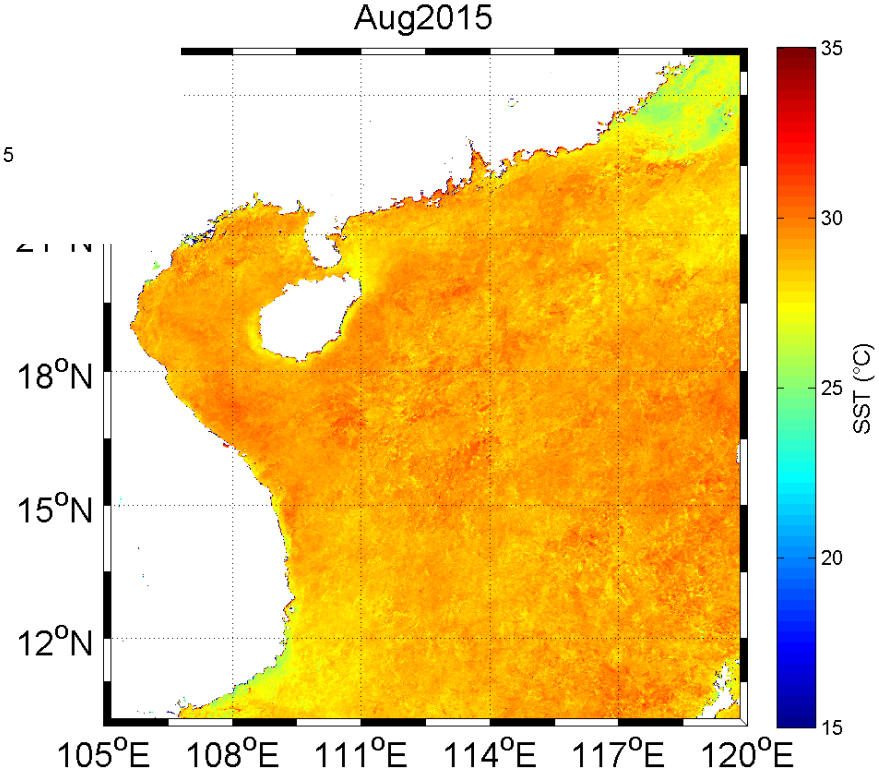
15
SST (°C)


Aug2015
18°N
15°N
12°N
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108°E
111°E
114°E
117°E
120°E
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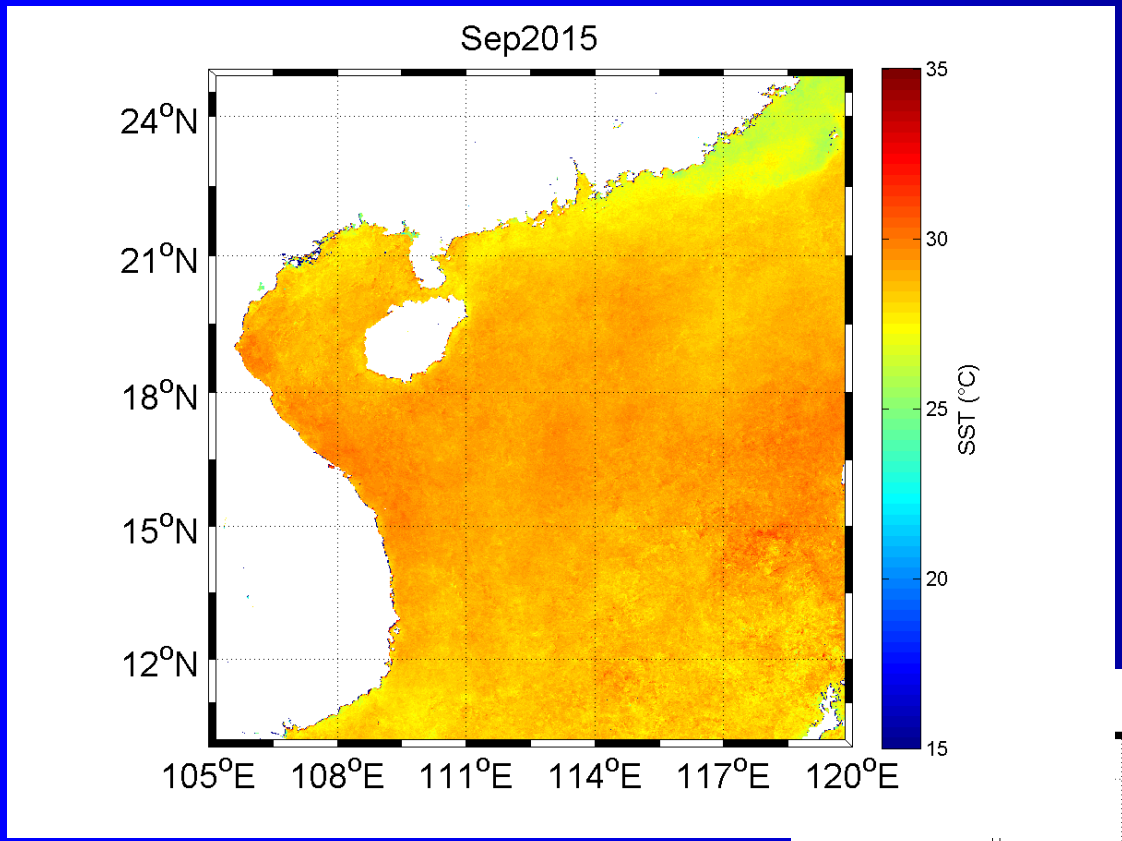
15
SST (°C)


Sep2015
24°N
21°N
18°N
15°N
12°N
105°E
108°E
111°E
114°E
117°E
120°E
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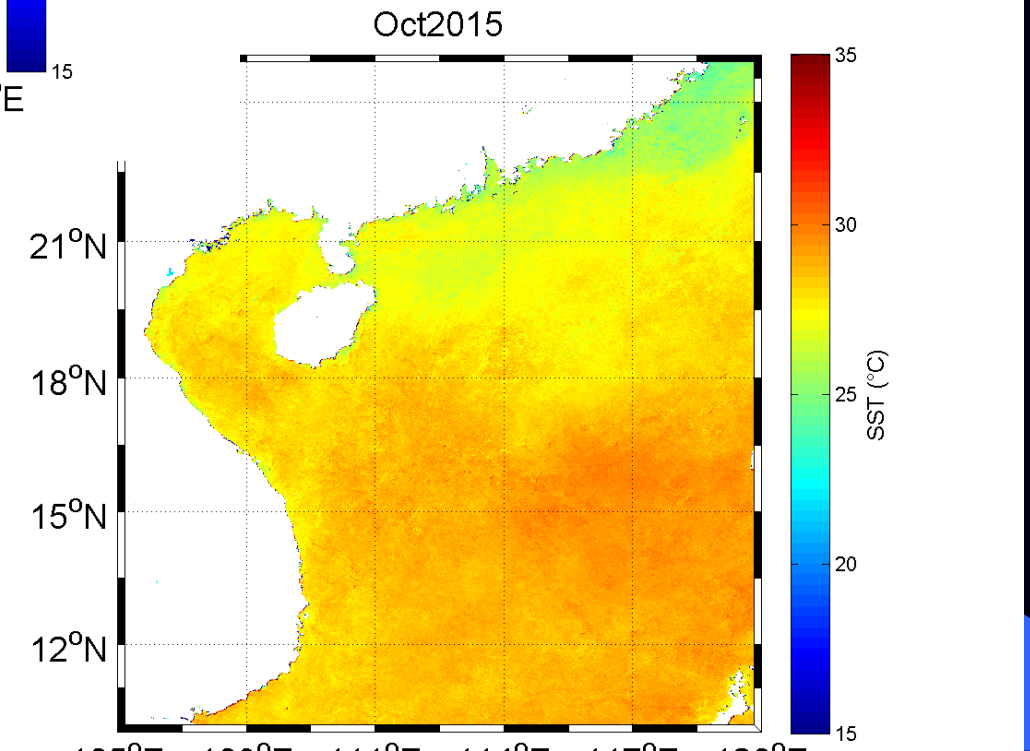
30
25
20
15
SST (°C)


Oct2015
21°N
18°N
15°N
12°N
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30
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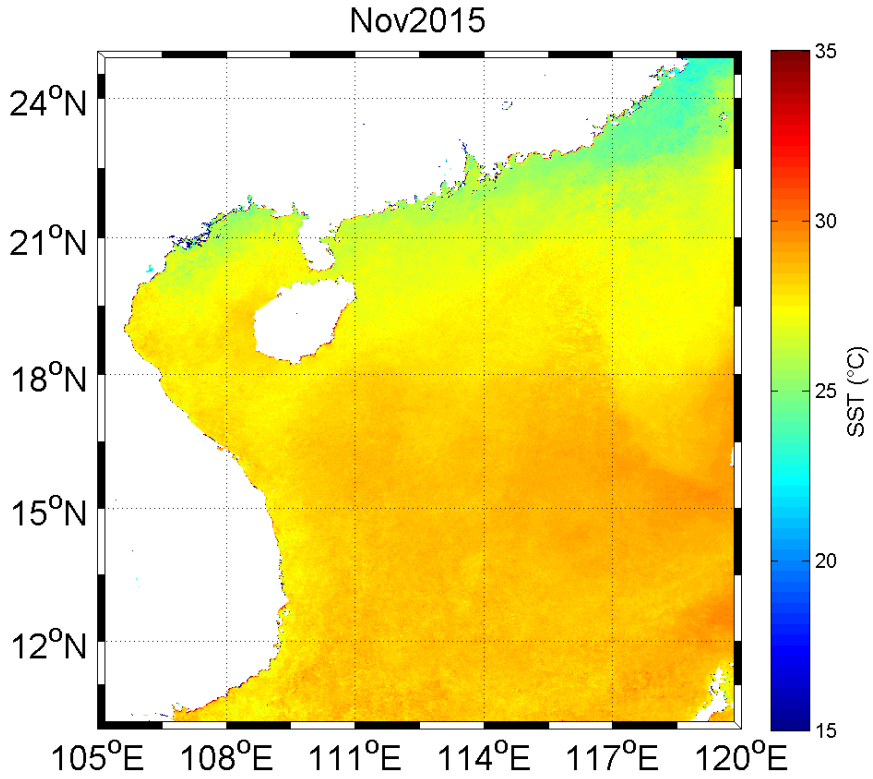
20
15
SST (°C)


Nov2015
24°N
21°N
18°N
15°N
12°N
105°E
108°E
111°E
114°E
117°E
120°E
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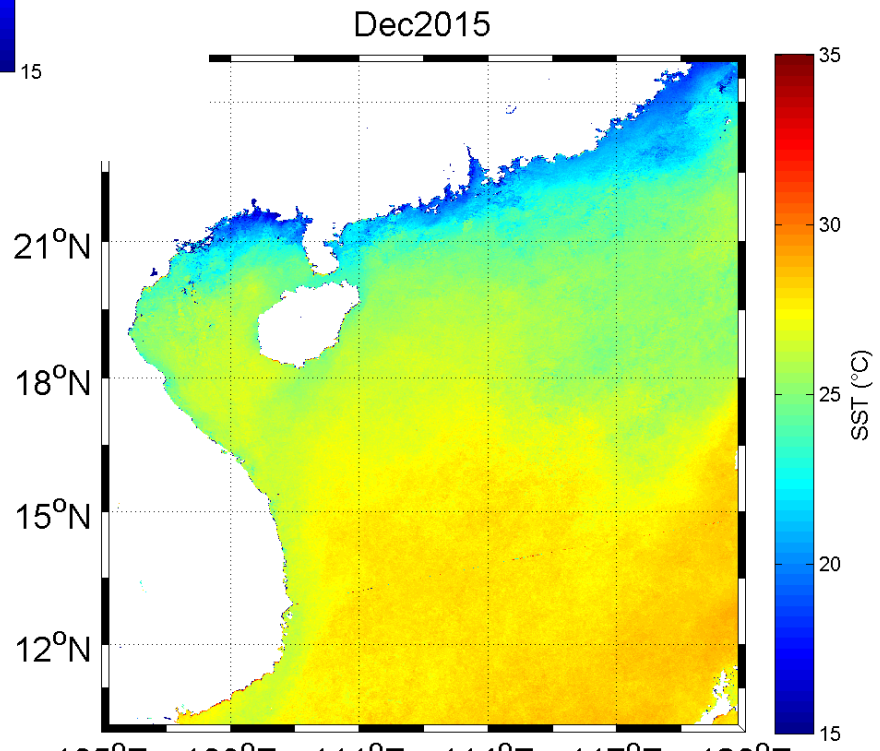
20
15
SST (°C)


Dec2015
21°N
18°N
15°N
12°N
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30
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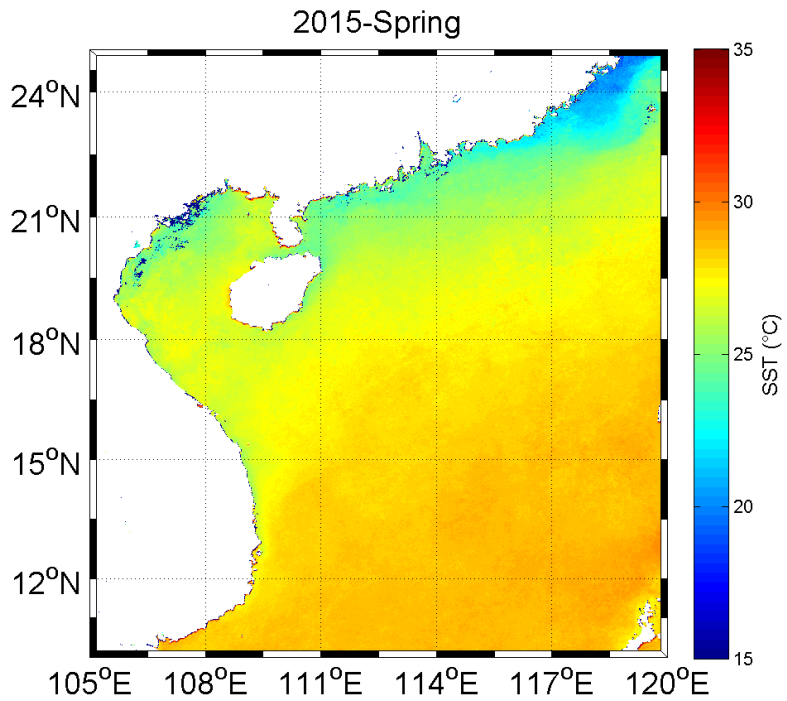
15
SST (°C)


2015-Spring
24°N
21°N
18°N
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12°N
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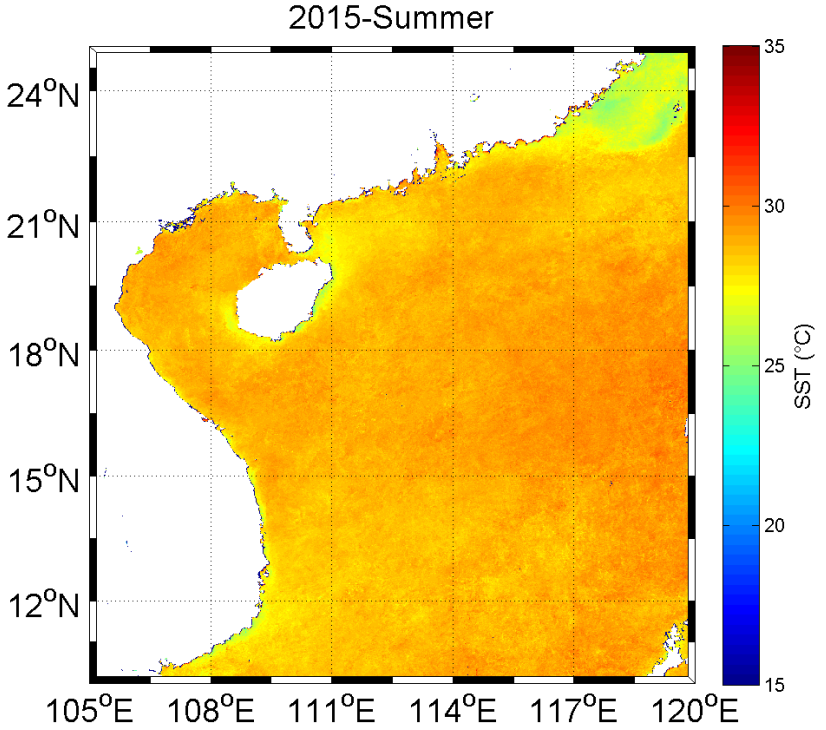
108°E
111°E
114°E
117°E
120°E
35
30
25
20
15
SST (°C)


2015-Summer
24°N
21°N
18°N
15°N
12°N
105°E
108°E
111°E
114°E
117°E
120°E
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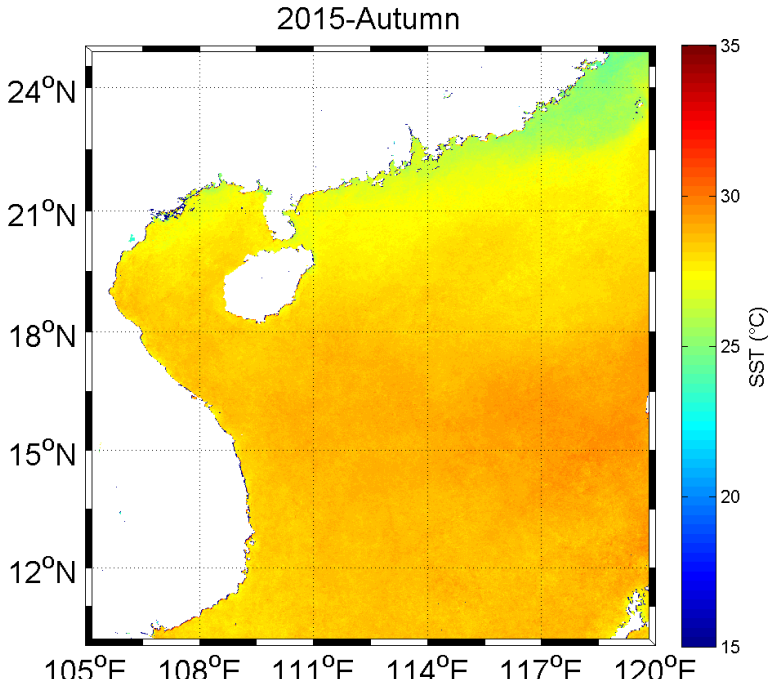
20
15
SST (°C)


2015-Autumn
24°N
21°N
18°N
15°N
12°N
105°E
108°E
111°E
114°E
117°E
120°E
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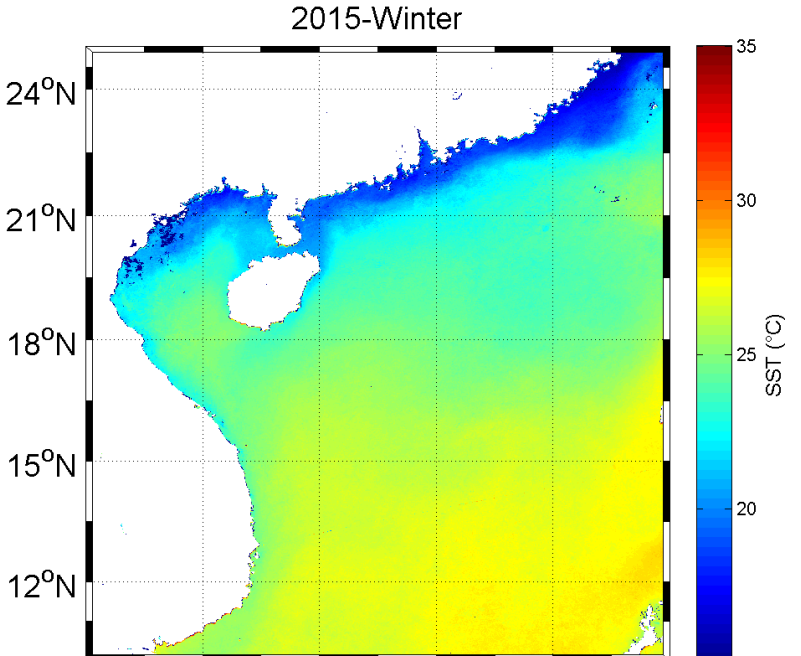
20
15
SST (°C)


2015-Winter
24°N
21°N
18°N
15°N
12°N
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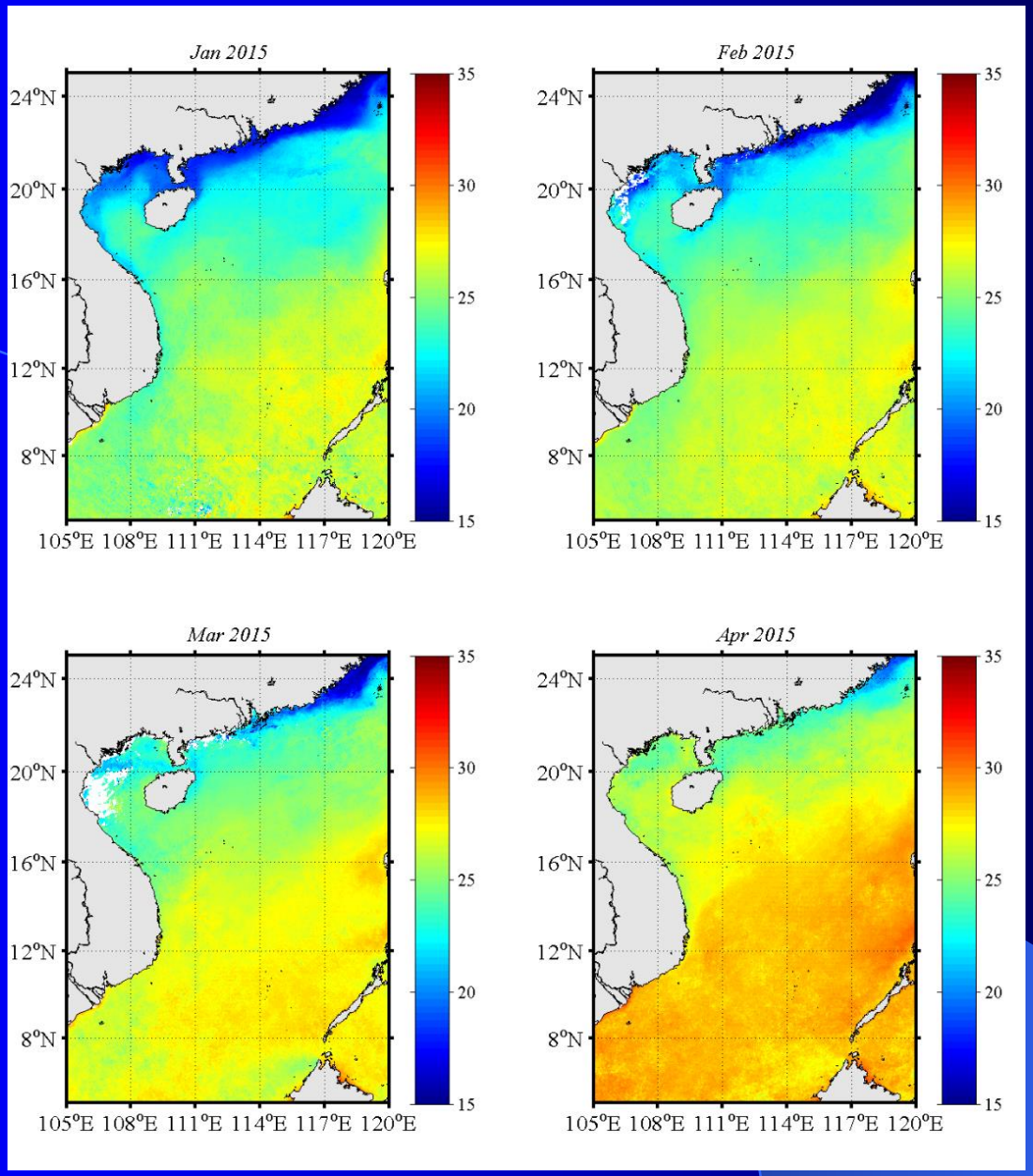
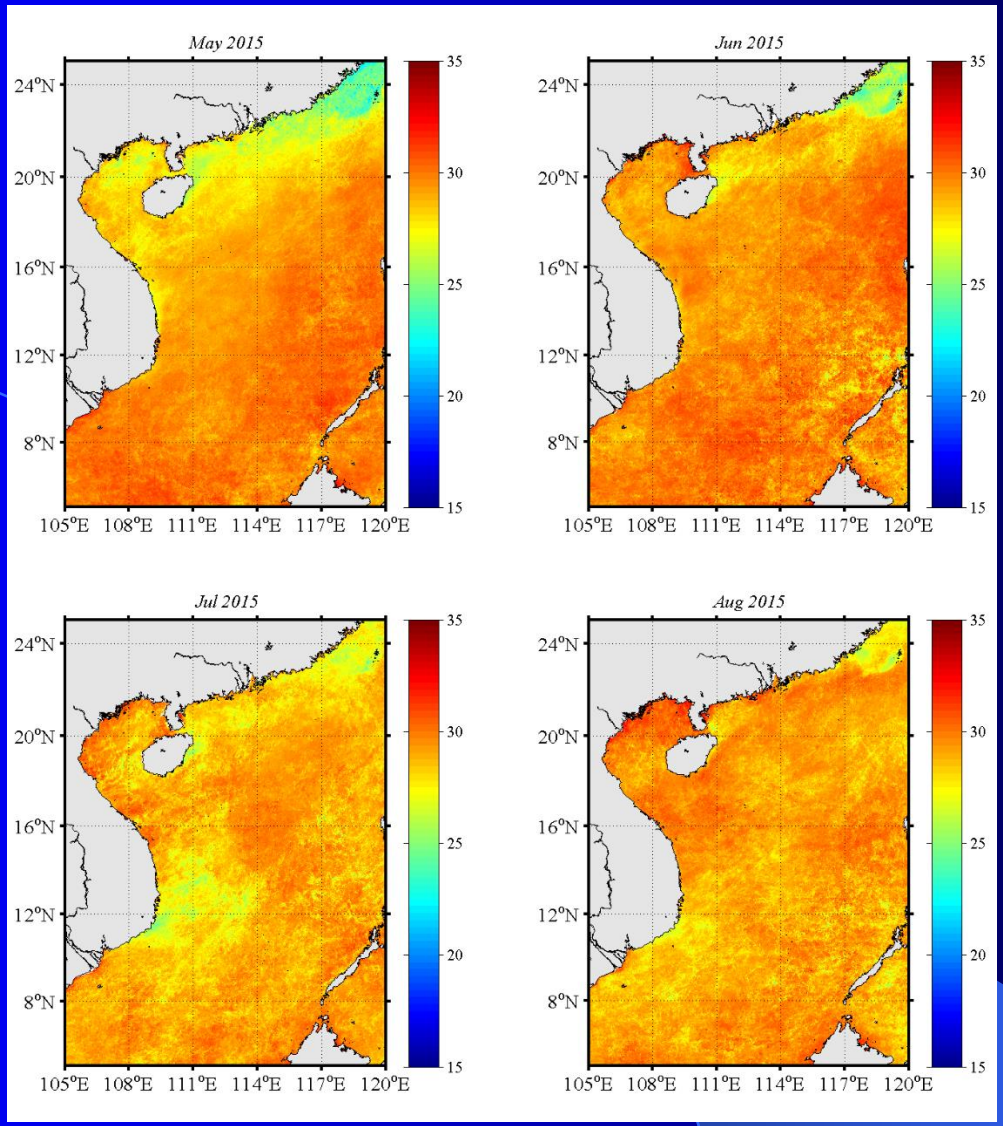
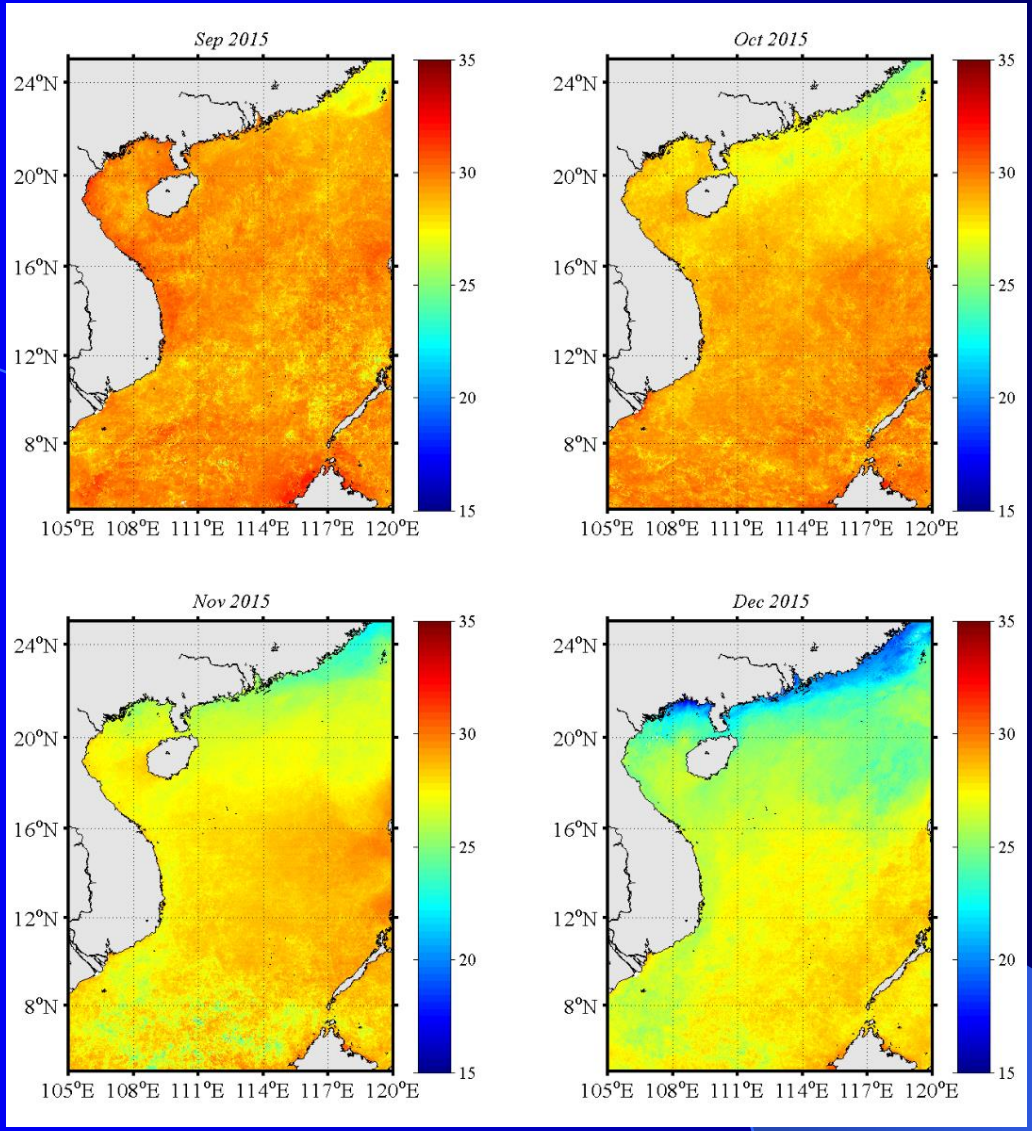
SST (°C)



MODIS-retrieved SST(Jan-Apr.2015).



MODIS-retrieved SST(May-Aug.2015)



MODIS-retrieved SST(Sep.-Dec.2015)

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Discussion

- The SCS distribution image maps of SST retrieved from FY-3B/VIRR have very similar pattern to the MODIS retrieved SST.
- The SCS distribution image maps of SST show that the higest monthly mean SST occurs in June, instead of in July. It mainly results from the stronger Monsoon and stronger vertical mixing in July.

Discussion

- The daily variation is not considered in the mean SST calculation. In the future, the daily variation should be considered for mean SST calculation according to the passing time of the satellite.

Acknowledgement

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感慨古今三叠情

THANK YOU!

遥望中外七彩景