Development of New Generation Sea Surface Temperature

KAWAMURA Hiroshi
Center for Atmospheric and Oceanic Studies, Graduate School of Science, Tohoku University,

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ABSTRACT

In order to contribute to trial of the ocean weather forecasts, we have developed new generation sea surface temperature. It is clod free, high-spatial resolution daily SST product, which enables us to follow the movements of SST patterns relating to the oceanic variations. The product is produced through an objective analysis merging various infrared and microwave SST products.

1. INTRODUCTION

The GODAE project has sent "Prospectus for a••GODAE SST Project" to world SST researchers to encourage developments of high-resolution satellite-based sea surface temperature. It mentioned that "The need for an operational high-resolution SST product has been identified by several groups including the Global Ocean Data Assimilation Experiment (GODAE) and numerical weather prediction. This product would have a resolution near or better than 10 km, temporal resolution of 24 hours or less, and include proper account of skin temperature effects. It would be based on data from several different remote sensing instruments, appropriately calibrated against direct measurements, and be made available to the community in real-time. Models will be used to properly account for diurnal effects. Microwave and other data sources will be used to enhance coverage in areas where radiometer sampling is poor. The operational system (or systems) will be built to enable rapid access to all available data and to enable wide utility of the product. Such a product requires broad cooperation among scientists and relevant agencies. The attached paper provides an outline for a project to deliver such a product (http://www.bom.gov.au/bmrc/mrlr/nrs/oopc/godae/HiResSST/)."

2. DEVELOPMENT OF NEW GENERATION SEA SURFACE TEMPERATURE

We have generated a new SST product by merging AVHRR, GMS and TRMM SSTs, which are tuned against SSTs of the drifting buoys. Using the hourly GMS solar radiation and the surface winds from SeaWinds, SSMI and TRMM, diurnal effects are eliminated to adjust all SSTs acquired at different times in a day to the daily minimum SSTs at around 1m depth. Then, all SSTs are merged using an objective analysis for one year, October 1999 – September 2000. Processing flow of the new generation SST is shown in **Fig. 1**.

2.1. TREATMENT OF SST DUIRNAL VARIATION

Dealing with diurnal variation of SST properly is essentially important to produce high-quality daily SST products merging various SSTs observed at different times of a day. Even the SST products tuned against the drifting buoy SST have diurnal variations of about a few degree. We developed a regression equation to evaluate SST rise from the minimum in the morning due to solar heating. This method uses only satellite-derived marine meteorological data. Daily amplitudes of SST evaluated by our equation agree well with in situ ones with the RMS error of about 0.2 K and the bias of almost zero. We used this method to remove the SST rises due to solar heating from the satellite SSTs observed at various times of a day before merging them.

2.2. SST MERGING METHODOLOGY

After pre-processing of the individual satellite data, objective analysis was applied to merge the SST data from AVHRR, GMS S-VISSR, TRMM MI and VIRS. The 0.05° daily cloud-free SST products in three regions, i.e., the Kuroshio region, the Asia-Pacific Region and the Pacific, during one-year period of October 1999 to September 2000 were generated. The comparisons of the merged SSTs with Japan Meteorological Agency (JMA) buoy SSTs show that, with considerable error sources from individual satellite data and merging procedure, an accuracy of about 1.0K is achieved. The new product is called the new generation SST Version 1.0. The results demonstrate the practicality and advantages of merging SST measurements from various satellite sensors. **Fig.2** shows a time series of the new generation SSTs in the Kuroshio region.

2.3. ERROR ANALYSES

The Version 1.0 products are examined by comparing against moored buoy SSTs at 1m depth. Wavelet analysis of the merged and in situ SSTs shows that the former has amplitudes larger than those of the later, which is partly explained as an effect of aliasing due to the TRMM/TMI sampling in the merged products. The coherence between wavelet-decomposed merged and buoy SSTs has high values in autumn (cooling season) and low in spring (heating season). The phase differences between them are positive, which means that the wavelet components of merged SST delay from those of buoy SST. The reasons of delay are (1) the seasonal components of merged SSTs are strongly affected by a lack of infrared SSTs due to clouds in winter, and (2) small scale oceanic phenomena, which can not detected by the coarse-resolution microwave SSTs, influence the buoy SSTs.

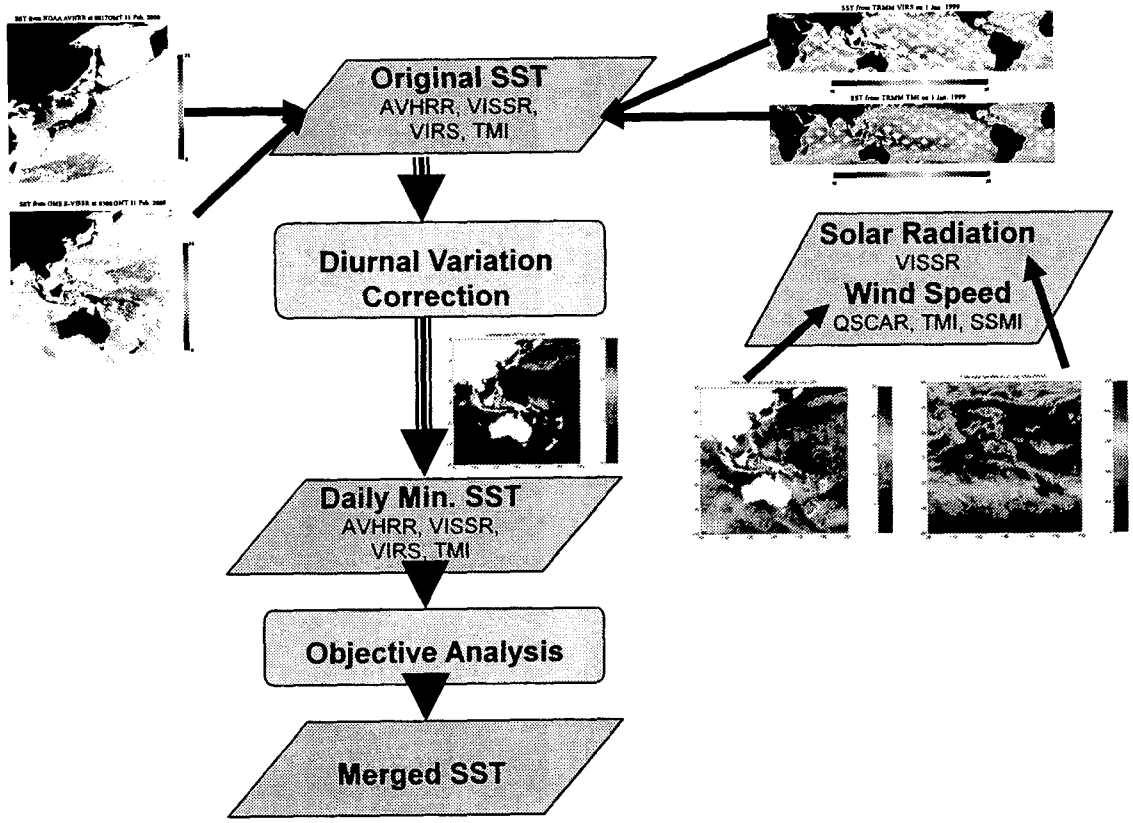
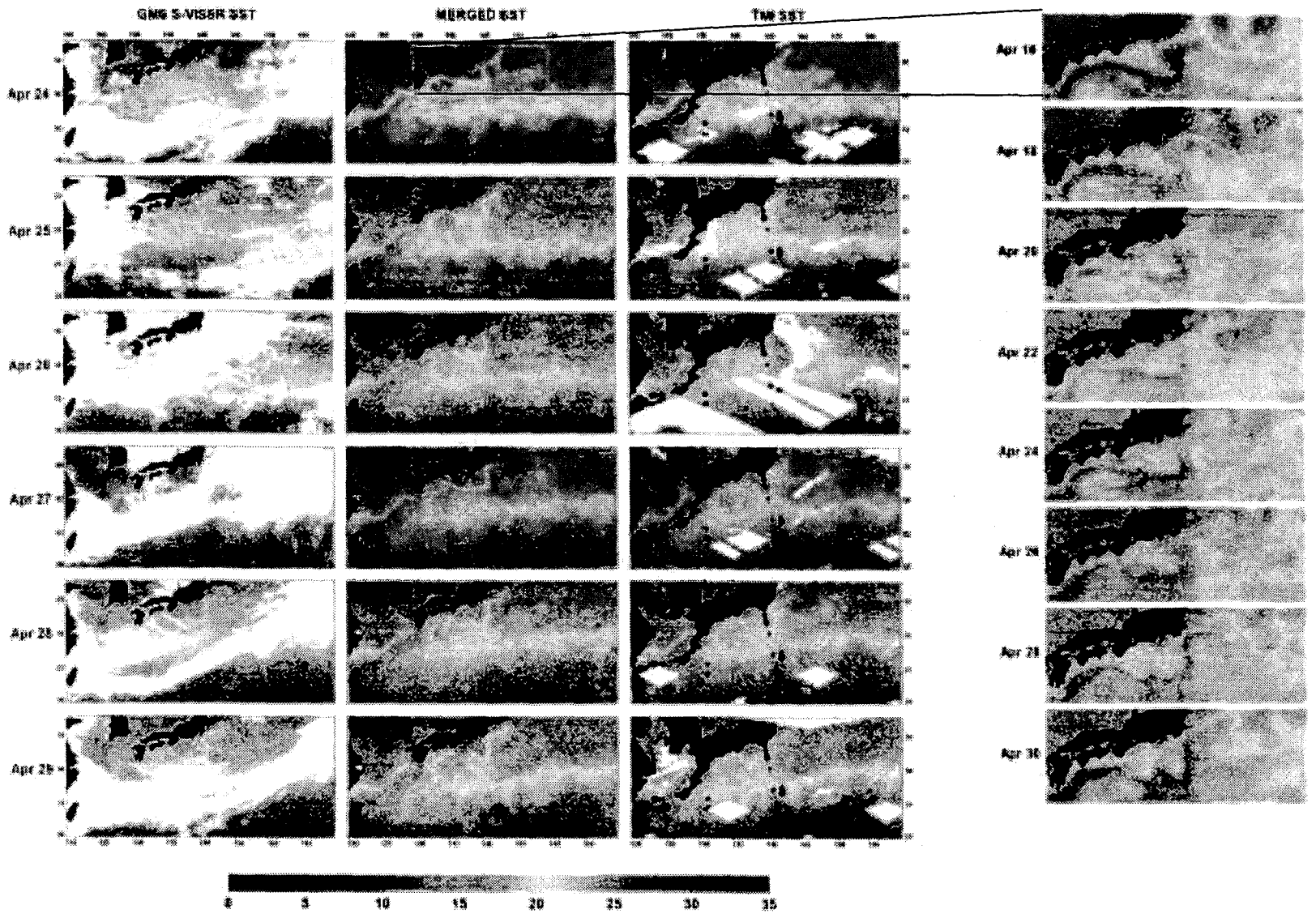


Fig. 1 Processing flow of the new generation sea surface temperature. The quality controlled satellite-derived SSTs are first processed[1),2),3) and 4)]. Hourly solar radiation at the sea surface is calculated[5), 6),and 7)] for the diurnal variation correction of SST[8), 9) and 10)]. The merging is done through the objective analyses[12), 13), 14) and 15)].

Fig.2 (Next Page)
A time series of the new generation sea surface temperature for April 24-29 2000. In the right panel, the daily GMS infrared SSTs (left), the new generation SST (middle) and the daily microwave SSTs (right) are indicated. The traditional infrared SSTs (left) are disturbed by frequent passages of cloud covers. The microwave SSTs (right) are cloud-free though their spatial resolution is coarse and SSTs near the lands are not detected. In contrast, the new generation SSTs have benefits of both satellite SSTs overcoming their weak points, i.e., cloud-free, high-spatial resolution, daily SSTs. The region south of Japanese Islands are extracted from the left panel and enlarged SST maps are indicated in the right panel, which demonstrates the movement of SST fronts corresponding to the Kuroshio currents.


GMS S-VISSR SST
MERGED SST
TMI SST
Apr 24
Apr 25
Apr 26
Apr 27
Apr 28
Apr 29
Apr 16
Apr 18
Apr 20
Apr 22
Apr 24
Apr 26
Apr 28
Apr 30
0
5
10
15
20
25
30
35

3. CONCLUDING REMARKS

The new generation SSTs have benefits of both the SSTs from infrared and microwave sensors. Well quality-controlled, daily, cloud-free SST products are necessary for the ocean weather forecasts. The version 1.0 product is open through the internet (http://www.ocean.caos.tohoku.ac.jp/~adeos/sst/).

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