Estimation of the air temperature over the sea using the satellite data

B. H. Kwon[1], G. M. Hong[2], Y. S. Kim[3]

[1]Dept. of Environmental Atmospheric Science, Pukyong National University, Busan, Korea

bhkwon@mail1.pknu.ac.kr

[2]Korea Global Atmosphere Watch Observatory, Meteorological Research Institute, Korea

[3]Dept. of Satellite Information Science, Pukyong National University, Busan, Korea

Abstract

Due to the temporal and spatial simultaneity and the high-frequency repetition, the data set retrieved from the satellite observation is considered to be the most desirable ones for the study of air-sea interaction. With rapidly developing sensor technology, satellite-retrieved data has experienced improvement in the accuracy and the number of parameters. Nevertheless, since it is still impossible to directly measure the heat fluxes between air and sea, the bulk method is an exclusive way for the evaluation of the heat fluxes at the sea surface. It was noted that the large deviation of air temperature in the winter season by the linear regression despite good correlation coefficients. We propose a new algorithm based on the Fourier series with which the SST and the air temperature. We found that the mean of air temperature is a function of the mean of SST with the monthly gradient of SST inferred from the latitudinal variation of SST and the spectral energy of air temperature is related linearly to that of SST. An algorithm to obtain the air temperature over the sea was completed with a proper analysis on the relation between of air temperature and of SST. This algorithm was examined by buoy data and therefore the air temperature over the sea can be retrieved based on just satellite data.

Key words: marine meteorology, air temperature, specific humidity, sensible heat flux, latent heat flux, bulk method

1. Introduction

Monitoring the global distribution of surface-layer air temperature is important not only for evaluation the strength of thermal coupling between ocean and atmosphere but also for monitoring the long-term global warming and impact of the change of SST on it. The effort to improve the accuracy of satellite-derived air temperature should be encouraged. In recent, due to the temporal and spatial simultaneity and the high-frequency repetition, the data set retrieved from the satellite observation is considered to be the most desirable ones for the study of air-sea interaction. With rapidly developing sensor technology, satellite-retrieved data has experienced improvement in the accuracy and the number of parameters. Nevertheless, since it is still impossible to directly measure the heat fluxes between air and sea, the bulk method is an exclusive way for the evaluation of the heat fluxes at the sea surface. In order to get the accurate fluxes using the bulk method, it is necessary to derive the relievable marine meteorological parameters such as SST, atmosphere

temperature, air pressure, wind speed and specific humidity. Accordingly, the accurate data retrieved from satellite observation will lead us to minimize the errors in the evaluation process of air-sea heat exchange.

2. Air Temperature

Through the regression analysis between SST and AT based on the buoy data (JMA), the relationship is expressed as $AT = 0.98 \cdot SST + 1.45$ with a regression coefficient r=0.98. Then, AT was obtained under substituting SST (=MCSST). Indirect method for the monthly mean of AT in this study was turned out to produce good estimation with r=0.98, BIAS +0.28 ℃ and RMSE 1.5 ℃. This may be explained that the atmospheric boundary near the sea surface has kept considerably homogeneous condition through the continuous heat exchange between air-sea. However, the comparison of daily mean temperatures shows a seasonal pattern in Fig. 1. To minimize the error caused by different regression equation for SST and AT in summer season ($AT = 1.01 \cdot SST - 0.66$) and in winter season ($AT = 1.27 \cdot SST - 9.61$).

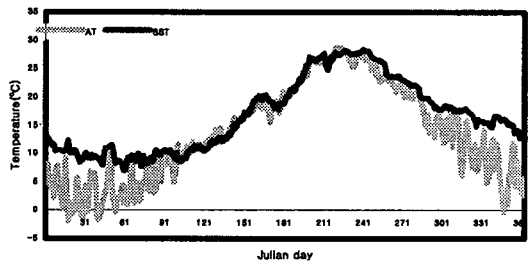

Fig. 1. Comparison of AT with SST from buoy data.

Based on the assumption that air temperature has closely relationship with sea surface temperature, we derive a corrected Fourier series equation from the correlation between sea surface temperature and air temperature using the buoy data. When the coefficients α, β and the power $\sqrt{A^2+B^2}$ are determined as functions of the SST for instances in Fig. 2, AT can be retrieved by only the time series of SST,

$$AT(t) = [\alpha \overline{SST(t)} + \beta] + \sqrt{A^2+B^2}\,\sin(\frac{2n\pi}{N}t + \gamma) \cdot$$

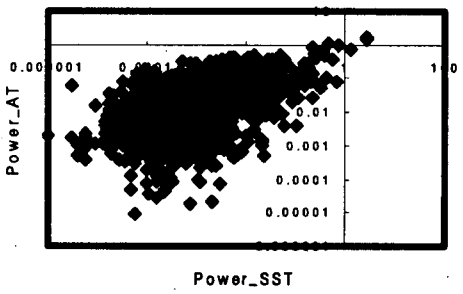

Fig. 2. Power of AT as a function of SST.

3. Summary

The seasonal bias in the regression between AT and SST was improved with the new method constructed by a function based on the Fourier series using only SST from satellite.

Acknowledgement

This research was performed for the project, technical development for Remote Sensing Meteorology, one of the Research and Development on Meteorology and Seismology funded by Korea Meteorological Administration (KMA).