Statistical Characteristics of sea surface height and sea surface temperature in the Western North Pacific

Byong-Jun HWANG, So-Hyun KIM, Hyo-Sang CHUNG

Remote Sensing research Laboratory,
Meteorological Research Institute(METRI), Seoul 156-720, Korea
Fax: +82-2-841-2787, E-mail: hbj@metri.re.kr

Abstract

SSH(Sea Surface Height) from TOPEX/Poseidon and SST data are analyzed to estimate characteristics of annual and inter-annual variations in the East Asian seas(110E - 180E, 20N - 50N) from November 1992 to May 1998. In EOF analysis of SSH and SST, 57% and 97% of the variance are represented by the first two modes. The first mode of SSH and SST shows strong annual variations expected for steric changes. The second mode of SSH shows a long-term variation, but that of SST shows 3 - 4month offset from annual variation. In the EOF analysis of the SSH and SST, 61% and 54% of the total variance are represented by the first three modes. The first mode represented a long-term variation, and the third mode reflected the bi-ennial variation. The first three mode were not strongly correlated with ENSO.

We further apply Canonical Correlation Analysis(CCA) to find the dominant correlation patterns with ENSO.

Key Words : SST, SSH, EOF, ENSO, SOI

1. INTRODUCTION

SSH(Sea Surface Height) by TOPEX/Poseidon, and optimal interpolated SST are used to estimate characteristics on the variations of SST and SSH in the western North Pacific from November 1993 to May 1998. Several Studies(Cheney 1982; Carnes et al. 1990) have found that sea surface height derived from altimeter and subsurface temperature are highly correlated. The correlation between SST and SSH is 0.6(Nerem et al. 1997). CPA(Coupled Pattern Analysis) between global SST and SSH presented annual cycle accounts for nearly all(95.3%) of the covariance. The spatial and temporal coefficients of the primary mode of a nonseasonal CPA are correlated with ENSO events.

Here we use EOF analysis for estimate annual and inter-annual variations in the western North Pacific. And we also use Canonical Correlation Analysis(CCA) to find out highly correlated mode with the equatorial region(170E-120W, 15N-15S). Before analysing the data we removed the tidal aliasing erros from SSH data, then EOF analysis is applied to the 67 months of SSH and SST data.

2. Data Processing

MSLA altimeter data have been generated for over 5.4 years, from October 1992 to May 1998, using AVISO GDR-M products for TOPEX/Poseidon(T/P), cycles 3 to 210. MSLA was corrected for instrumental errors, environmental perturbations, ocean wave influence, tide influence. CSR3.0 tidal model and ECMWF dry troposhperic and inverse barometer corrections are applied. MSLA are obtained using improved space/time objective analysis methods which takes into account long wave

errors(Le Traon et al., 1998). The maps have resolution of 0.25 degrees by 0.25 degrees. The MSLA data temporally low-passed at 140 days cutoff in order to remove tidal aliasing errors in shallow water(Park, 1995). Wang(1998) suggested that intermediate(~1500 km) and short scales (~800 km) containated with two dimensional phase propagation. So the SSH data spatially low-passed to remove the signal of low-frequency phase propagation

The optimum interpolation (OI) sea surface temperature (SST) is produced monthly on a one-degree grid. The analysis uses in situ and satellite SST's plus SST's simulated by sea-ice cover.

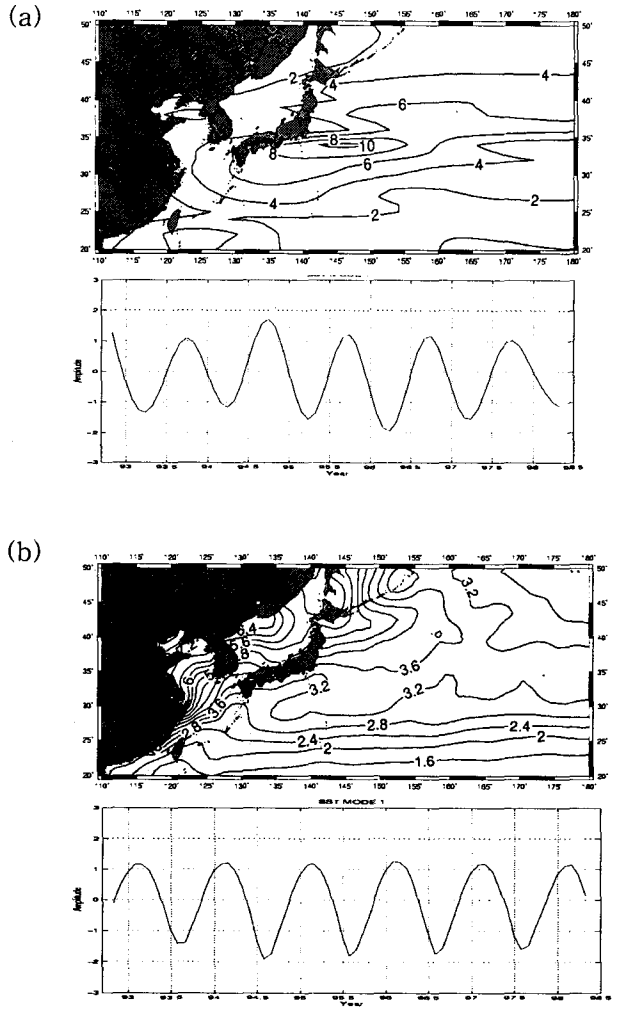


Fig. 1 Spatial pattern and time series of the first mode of SSH(a) and SST(b).

3. EOF analysis

EOF(Empirical orthogonal function) is used to decompose the time series of SSH and SST field into dominant modes of variability. The EOF decomposition into spatial modes and associated amplitude time series is computed using the singular value decomposition(SVD). Each of the spatial modes captures a fraction of the variance present in the original data.

Annual Mode

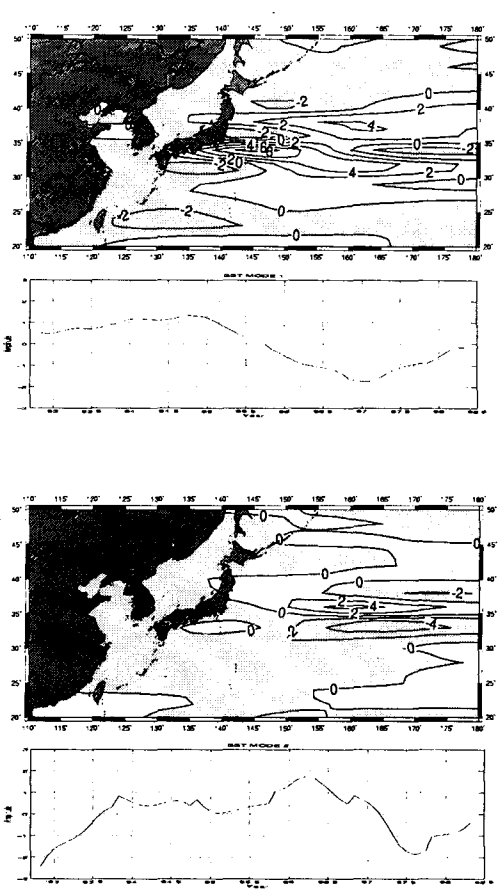


Fig. 2 Spatial and temporal pattern of the first (a) and second(b) mode of monthly anomaly of SSH

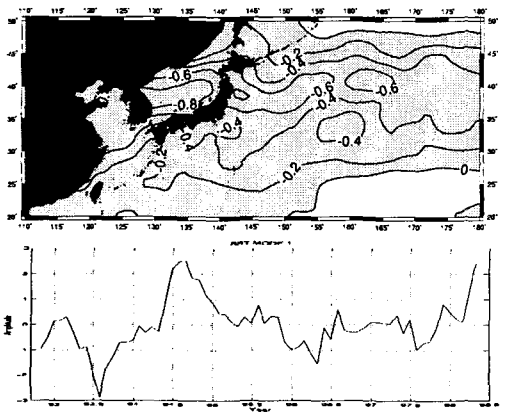
In the EOF analysis of the SSH, 75% of the variance of the original data is represented by the first two modes. 55% of the total variance is captured by the first mode, and 20% in the second mode. In case of SST, the first two mode shows 97% of the variance. 94% and 3% of the total variance of SST are captured by the first and second mode. The first mode of both have an annual period related to the steric signal. The spatial structure of the first mode of

SSH shows relatively strong variation in the region of Kuroshio extension, but in the case of SST in the northern part of Yellow Sea and East Sea(Fig. 1). The correlated annual variation of SSH and SST is dominant in the Kuroshio region. The second mode of SSH shows long-term variations, and that of SST offsets from annual mode by 3-4 months.

Inter-annual Mode

In the EOF analysis of the SSH, 49% of the variance of the original data is represented by the first two modes. 34% of the total variance is captured by the first mode, and 15% in the second mode. The EOF analysis of the SST shows 48% of the variance for first two modes. 32% of the total variance is captured by the first mode, and 16% in the second mode. The first two modes of SSH and SST are presented in Fig. 2 and Fig. 3. The first three modes of SSH and SST in inter-annual mode are compared with SOI. FFT of the time series of the first mode SSH and SST shows a peak at 5.5years and 3.6years, and two peaks for the second mode, and a peak at 2.1years for the third mode(Fig. 4). The first three mode didn't reflect ENSO signal in the western North Pacific.

(a)



(b)

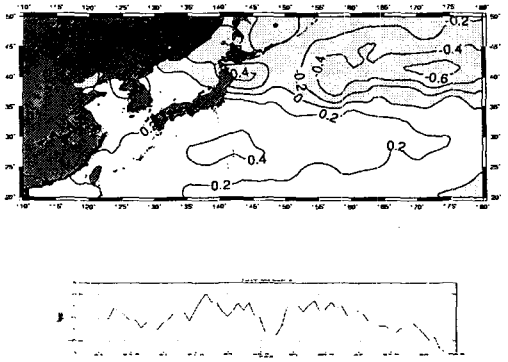


Fig. 3 Spatial and temporal pattern of the first (a) and second(b) mode of monthly anomaly of SSH

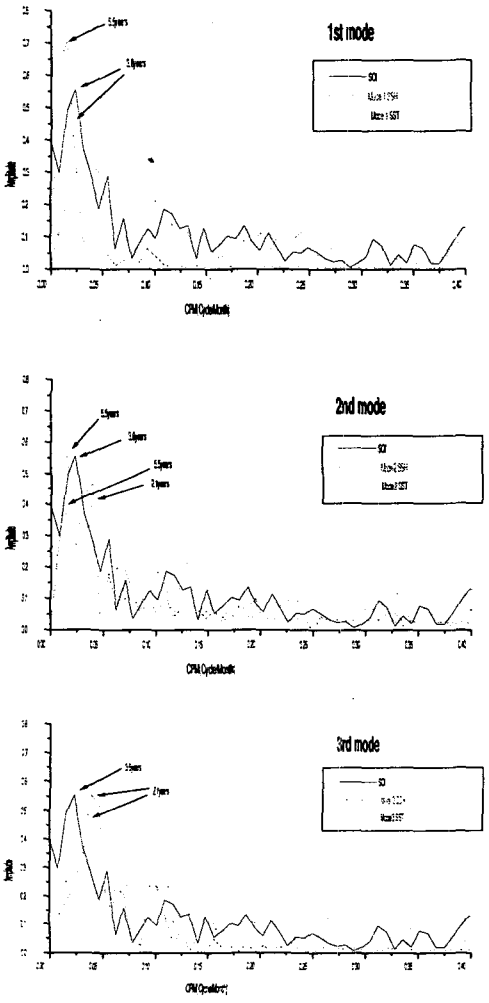


Fig. 4 Spectrums of time series amplitude of SSH and SST.

4. Results and Discussion

EOF analysis of SSH and SST data in the western North Pacific shows the first mode of SSH reflects a long-term change. And the second mode of SSH and SST have two peaks at 5.5years and 2.1years, and the third mode is dominated by bi-ennial variation. But the first three mode of SSH and SST did not represent a strong correlation with ENSO signal.

We will further apply the Canonical Correlation Analyse(CCA) to find the dominant correlation patterns with ENSO.

5. Acknowlegments

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