

## Sea Level Variation/change and Steric Contributions in the East China Sea

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### ABSTRACT

The sea level variation/change on different time scales in the East China Sea (ECS) is investigated based on the TOPEX/Poseidon (T/P) altimetric data from 1993 through 2003. The averaged rising rate of the sea level and the steric sea level in the ECS are 4.93 mm/yr and 3.18 mm/yr respectively, which suggests that the contribution of steric sea level rise can be 64.5%. The saline contribution to steric sea level is 40%. From 1950 through 2003, the steric sea level of the ECS rises at a rate of 0.50 mm/yr with a significant period of 18-year, and the saline contribution was close to 25%. EOF analysis of the altimeter data indicates a quasi-biennial sea level oscillation in the ECS, which is mainly affected by the fluctuation of the bimodality path of the Kuroshio and the discharge of the Yangtze River. Generally, the steric effect dominates the seasonal variability of the sea level, but in the interannual time scale, mean sea level change is closely associated with the dynamic influence of the Kuroshio and the runoff of the Yangtze River.

**KEY WORDS:** sea level variation, steric sea level, thermosteric, halosteric, the East China Sea

### INTRODUCTION

The sea level change is a consequence of two major effects in the oceans. One is the eustatic sea level change caused by the variation of the sea water mass which is associated with land ice melting and terrestrial water storage change, and the other is the steric sea level change due to the variation of the sea water density under the circumstance of quality conservation, which can be caused by both the changes of temperature and salinity.

Zuo et al. (1996) obtained the mean rate of sea level rise in the Pacific is 0.17cm/yr and the sea level of the coastal area in the Pacific Ocean is rising acceleratively as a whole. Leuliette et al. (2004) analyzed T/P and Jason satellite altimeter data of 1993-2003, and pointed out that the rate

of the global sea level rise was  $2.8 \pm 0.4$  mm/yr.

Chen et al. (1998, 2000) examined the thermosteric contribution to global mean sea level change using the climatological ocean temperature data of WOA94. Cabanes et al. (2001) analyzed the characteristics of the sea level change with Levitus (2000) data, and suggested that over the short 6-year period of 1993-1998, the rate of sea level rise measured by TOPEX/Poseidon satellite altimetry (of  $\sim 2.7$ mm/yr) was almost fully explained by the thermal expansion. Antonov et al. (2002) analyzed the thermosteric and halosteric sea level variation in the 0-3000 m during 1957-1994 and concludes that the rate of the sea level rise is 0.55 mm/yr and about 10% of this rate is due to a decrease of salinity. Antonov et al. (2005) implied that the thermal expansion of the 0-700 m layer of the World Ocean contributed 0.33 mm/yr to global sea level rise during 1955-2003. For the period of 1993-2003, the linear trend of thermosteric sea level is 1.23 mm/yr, whose contribution to the observed sea level accounts for 60% in the Pacific Ocean (Huang, et al., 1993), and less than 50% for the world ocean during this time (Shen et al., 2003). In the third IPCC report, it suggests according to the results of ocean general circulation models (OGCMs) that the most important contributor to the sea level rise is thermal expansion in the last 50 years, about 0.3-0.7 mm/yr (Church et al., 2001).

The East China Sea (ECS) has one of the broadest continental shelves in the world; under the influence of both the Kuroshio and the East Asia monsoon, the variability of sea level in this area is very complex. Yu et al. (2003) analyzed the effect of sea level variation on tidal characteristic values for the East China Sea. Wang et al. (1999) found that the maximal rise (4-7 mm/yr) appeared in the mouth of the Yangtze River along China coast using the data of 50 tide gauges from 1964 to 1996. So far, little work has been done on the sea level variation on different time scales and the thermal and saline contribution to the sea level rise and seasonal variation in the ECS. In this paper, the sea level