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Spatial distribution of sea level trend and annual range in the China Seas from 50 long term tidal gauge station data

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ABSTRACT

The seasonal sea level variability and the long term trend of the sea level in the China Seas is investigated based on the monthly mean sea level data at 48 long term tide stations. Results show the average rising rate of all the stations is 2.3mm/a. The rising rate of the sea level in the north area is a little larger than the south area, and large rising rate appears on the island or at the big river mouth. The annual range of the sea level along the coast of China seas shows larger values in the north than in the south. The months when the highest or lowest sea levels occur in the south area lag the north area. River runoff can influence the annual range of the nearby sea level prominently. Monsoon, sea surface air pressure and SST are three important factors that cause the sea level variation along the coast of the China seas.

KEY WORDS: Sea level variation; sea level trend; China seas

INTRODUCTION

Over the past 20th century, the global mean sea level has risen about 10-25cm with a most likely value of 18cm (Gornitz,1995; Warrick et al., 1996), corresponding to a rate of about 2mm/a. The thermal expansion of the upper ocean and the melting of mountain glaciers associated with global mean surface temperature rising are the most important contributors. For the low-lying coastal areas, a small rising rate of the sea level may cause profound economic and social burden, as sea level rise will significantly aggravate the disaster of storms and marine erosions. And for the coastal areas, it is not the absolute but relative sea level that is concerned most.

In recent years, more and more research reveals a rising sea level along the coast of China seas on the background of the global mean sea level rise (Tian et al., 1993, 1998; Zuo et al., 1996). A coarse estimation of the rise rate of the relative sea level along the coast of China seas in the last century is 2.2mm/a with a trend of acceleration. For the coastal cities, ground subsidence caused by the over mining of the groundwater and construction of large buildings will accelerate the rise of the local relative sea level and the forthcoming disaster of aggravated storm surge and flood will severely affect the economy and life of the citizens of the nation.

The variation of relative sea level along the China coast are affected mainly by thermal expansion, wind stress and air pressure. The annual range of the mean sea level in the north area is larger than the south area with the largest value occurs in the Bohai Sea and the months when the extreme sea level happens in the north area precedes the south area (Zuo et al., 1994).

From 1993-2003, the averaged rising rate of the sea level and the steric sea level in the East China Sea is 4.93 mm/yr and 3.18 mm/yr respectively, which suggests that the contribution of steric sea level rise can be 64.5% and the long term sea level rise in the East China Sea is mainly due to steric effect. The maximal sea level rise occurs east and north of the Taiwan Island, while the largest steric sea level rise appears in the region of the Tsushima Current and the Kuroshio (Yan et al., 2007).

In this paper, 48 tide stations in the China seas are selected to analyze the seasonal and long term sea level variability. The second part discusses the data and the method used in the research and the third part gives out the result of the sea level variability and several causes are discussed and the fourth part is the main conclusion of the research.

DATA AND METHOD

The monthly mean sea level data of 48 tide stations along the coast of China seas are used in this paper, among which 38 are along the coast of China, 6 on the coast of Korea and 3 on the coast of Japan (Fig.1). The monthly mean sea level data of the stations of China are supplied by the National Marine Data & Information Service and the data of the Korea are supplied by the Permanent Service for Mean Sea Level (http://www.pol.ac.uk/psmsl/) and the data of Japan are downloaded from the website of University of Hawaii Sea Level Center (http://ilikai.soest.hawaii.edu/uhslc/rqds.html). Both the location of the tide stations and time period of the data are shown in Table 1.

The stochastic dynamical method (Tian et al., 1993) is used to obtain the linear trend of monthly mean sea level in which this monthly mean sea level Y(t) is decomposed into four parts,

$$Y(t) = T(t) + P(t) + X(t) + \alpha(t) \tag{1}$$