Sea Level Variation of the North Pacific Ocean during the 1997-98 El Niño Event

Yanfang Li
College of Physical and Environmental Oceanography, Ocean University of China, Qingdao, China

Meixiang Chen and Juncheng Zuo
Key Laboratory of Coastal Disaster and Defense, Ministry of Education, Hohai University, Nanjing, China

ABSTRACT

Using POP model to simulate the sea level variation in the North Pacific during the 1997-98 El Niño event, and estimate different contributions of wind and heat flux to sea level. The results show that during the 1997-98 El Niño, in the North Pacific Ocean the negative sea level anomaly appears in the high latitude and western equatorial Pacific Ocean, while the positive sea level anomaly appears in the eastern equatorial Pacific Ocean, the sea level anomaly in the interior of the mid-latitude shows a phase shift. Experiments show that wind dominates on the response of sea level to the 97-98 El Niño event, The sea level variation during 97-98 El Niño caused by wind is about 80% and the residual is caused by heat flux and SSS.

KEY WORDS: El Niño; wind stress; SST; SSS; sea level; North Pacific; heat flux; numerical simulation.

INTRODUCTION

As the impact of human activities on the earth system is growing rapidly, sea level rise has become one of the greatest global environmental problems. Because sea level rises, most of the sedimentary coast is confronted with serious erosion, and coastal people have to deal with the ensuing coastal management. The most vulnerable regions are the low arenaceous or slimy coasts, where a small amount of sea level rise can submerge large tracts of land and intensify seawater erosion (Zuo, 2007).

During the El Niño event, affected by circulation and SST, sea level changes intensively, especially in the dramatic occurrence of El Niño event. During the winter of 1997–98, abnormally high sea levels significantly contributed to hundreds of millions of dollars in flood and storm damage in the San Francisco Bay region (USGS, 1999). The 1997-98 El Niño was characterized by exceptionally strong high-frequency wind variability during the onset phase. Numerical models, which succeeded in predicting the onset of the 1997-98 El Niño, were unable to forecast its intensity (Barnston, 1999; Landsea and Knaff, 2000). The North Pacific (NP) is considered to be one of the most dynamically important regions of the world ocean. Expanded interest in studies of its circulation is due to the extremely powerful El Niño event of 1997–1998(Wang, 2004). The intent of this work is to hindcast the sea level variation throughout the North Pacific basin for 1997 and early 1998, and thereby analyze the contributions of anomalous atmospheric conditions, discuss the response of sea level to El Niño event.

MODEL AND DATA

Levitus (2005)

Levitus (2005) temperature and salinity datum are climatological mean 3-D temperature and salinity fields, provided by National Oceanographic Data Center Ocean Climate Laboratory, which are based on nearly 7 million local temperature profiles observations, improved on WOD01. The monthly mean fields include 24 standard layers extending from the surface to 1500 m depth, with a 0.25*0.25 grid, covering range \(-85.89\,^\circ\text{S} - 85.179\,^\circ\text{N}\). These mean fields include 19 layers extending from the surface to 1000m depth, and are derived from over 4.4 million historical in situ temperature profiles collected from various instrument groups, including XBT, MBT, CDT and traditional bottle measurements. In this paper we use it as the climate monthly mean temperature and salinity forcing conditions for the control experiment.

Hellerman wind climatology

Hellerman wind climatology (1983) wind stress is the monthly average climate wind stress data, which is based on the global ocean observations from 1870 to 1976 with resolution \(2\,^\circ\times2\,^\circ\), and its range covers \(180^\circ\,W - 180^\circ\,E, 90^\circ\,S - 90^\circ\,N\), downloaded on Colombia University web. We use it as the climate wind stress forcing and as a standard to correct other wind stress data.

(Ishii dada)

Ishii temperature and salinity datum are provided by Japanese weather bureau, the Ishii (2005) data set consists of monthly \(1^\circ\times1^\circ\) gridded