Storm Surges Congress, Hamburg, Germany
13–17 September 2010
SSC2010-26

Storm surges on the coast of the State of Rio de Janeiro, Brazil

C. Neves
COPPE - Ocean Engineering Program, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil
(neves@peno.coppe.ufrj.br)

Due to the absence of extreme meteorological events in Brazil, not much attention has been called upon storm surges for the design of harbor structures, beach nourishment or drainage in coastal cities. Yet, discrepancies between tidal predictions and tidal measurements as large as 0.90 m are quite often reported on the Southern portion of Brazilian coast, mostly in last two decades. Such figure is significantly higher than the expected sea level rise predicted by IPCC for mean global sea level by year 2100. This fact should call the attention of city planners and environmental authorities for the urgent need of sea level monitoring along the coast of Brazil, taking into account the need for anticipating storm surges for operational procedures of various industrial plants, for design of coastal structures or simply for urbanization of coastal areas.

Numerical models based on POM have not succeeded in forecasting storm surges along Brazilian continental shelf, which may be attributed to the following reasons: lack of reliable wind data for the forcing mechanism, poor topographic description, overlooking of some physical relevant phenomenon, such as baroclinic effects. For this reason, a series of studies were concentrated along the coast of the State of Rio de Janeiro, in order to establish correlations between observed storm surges from tidal records, NCEP reanalysis data at selected grid points, and meteorological observations at land stations.

The data available consisted of one year of sea level, atmospheric pressure and wind velocity at hourly intervals, and NCEP/NCAR data every 6 hours. Three stations were considered, Piraquara, Rio de Janeiro and Macaé. For each location, 4 NCEP grid points were investigated, in order to determine which point showed better correlation with the data from the meteorological stations. At each grid point, wind stresses were computed. At Rio de Janeiro station, tidal records covered a time span of 18 years.

At first, a low pass filter was used in both meteorological and oceanographical data, in order to keep oscillations with periods longer than 60 hours. In time domain, the statistic of permanence of sea level was obtained, while in frequency domain, cross correlation studies were carried out between filtered sea level and pressure, and between filtered sea level and longshore and normal to shore components of wind stresses. Similar cross-spectral analysis was carried out with wind components at NCEP grid points and data from meteorological stations. Finally, long term data from Ilha Fiscal tidal station (Rio de Janeiro) was used to obtain the statistics of storm surges.

Coherent oscillations in meteorological NCEP data and sea level, at well defined periods ranging from 5 to 13 days, were found at all stations. Meteorological observations at coastal stations correlated poorly both with observed storm surges and with NCEP reanalysis data. The farther away the NCEP data, however, the better the spectral correlation with the storm surge, indicating the large scale nature of the phenomenon and suggesting that future observations of wind should be made offshore. In addition, the study motivates further investigation on whether the observed surges are a purely local phenomenon or result from long waves propagation.

The paper finally addresses possible engineering responses which should be considered by city planners, mainly at locations in the State of Rio de Janeiro.