### Introduction

The sea level variation is associated with variation of motives in the ocean, atmospheric forcing, meteorological and hydrological forcing. In addition to short-term seasonal, inter-annual and inter-decadal changes, the sea levels also respond to changes in freshwater inflow, heat flux and other factors that are linked to climate change processes.

Tidal effects can be clearly noticed in a sea level record as a regular rise and fall of sea level and occurs virtually everywhere throughout the ocean. Wind stress and air pressure variations force sea level variations on time scales ranging from hours, to daily and seasonal scales. In the open seas, a change of sea pressure by 1 mb causes a cm change in sea level. Usually, sea level changes related to density (i.e., variation of atmosphere due to change of temperature and salinity) are seasonal and caused by seasonally changing evaporation, condensation and heat flux. Such variations are referred to as steric height variability (Tomczak and Godfrey, 1994). In addition, the El-Niño Southern Oscillation (ENSO) which occurs on a 2-5 cycle, causes climate changes around the world, which often have a large impact on the sea level.

### Description of study area

Sri Lanka is an island situated in the northern part of the Indian Ocean between 6°10’N and 9°30’N and 79°30’E and 81°30’E. It is separated by a shallow and narrow Palk Strait. Higher salinity Arabian Sea is located on its western side and the low salinity Bay of Bengal on its eastern side (Fig. 1). The continental shelf in Sri Lanka is narrow (2-5.2 km) and is shallower (30-90 m) than the average depth of the shelves (75-125 m). The shelf is narrowest around the southern part of the island of Sri Lanka, but broadens up to merge with the Indian continental shelf towards north and northeast. The outer edge of this shelf (continental slope) is comparatively steep falling to between 2000-4000 m (Fig. 2). A large number of submarine canyons appear both on the shelf and the slope.

### Time series analysis techniques

Methods of analyzing these data have consisted of harmonic analysis, spectral analysis (SA), and filtering. Harmonic analysis uses a least squares method to fit amplitudes and phases of known cosine functions (components) to a measured time series of sea level. Methods of spectral analysis used in this study was based on the application of a Fast Fourier Transform (FFT).

### Results

#### Tidal sea level variations

Daily sea level changes in the region are dominated by the semi-diurnal tides (mainly M2) account for most of the variations. The spring tidal range at inner Galle is about 2.4 m, the spring tidal range in Colombo Sri Lanka is only 0.6 m. M2, the main tidal constituent in Sri Lankan waters with amplitude of 0.10 - 0.18 m depending on site. A tide is mixed semi-diurnal and spring tidal range 20-25 m between 0.40 - 0.60 m. A smaller range appears in the northern region. The tidal phases on the east coast of Sri Lanka features different phases from the west coast with short phase lead against south coast (Fig 3 and Table 1).

The spectral analysis results of sea levels for both stations show that the energy of high frequency sea levels enhanced after the action of the tsunami. At Colombo, energy peaks of 20, 40 and 75 min were significantly enhanced after action of 26 Dec 2004 tsunami, which were present before the action of the tsunami (Fig 5a). After the 28 March 2005 event, only 75 min peak has enhanced (Fig 5b & 6b). Kirinda, energy peaks of 20, 40 and 75 min were enhanced after March 2005 tsunami (Fig. 5c & 6c). These results clearly indicate that the tsunami enhanced the energy of existing waves, particularly at high frequencies. These large amplitude oscillations are created when the frequency of the earthquake driven wave’s match the frequency at which the water is oscillating naturally.

### Seasonal sea level oscillations

Seasonal sea level variation at different locations in the Northern Indian Ocean region are Shown in Fig. 7a-b. In the inner Bay of Bengal at Hirno Point, the seasonal range of sea level variation is about 0.8 m. The seasonal range around Sri Lanka waters is about 0.2-0.3 m. The range decreases towards south, the seasonal range at Diego Garcia is less than 10 cm. The Fig. 8a shows that the sea level becomes maximum during August and minimum in January in Hirno Point, Bangladesh. But variation is almost opposite for Colombo (Fig. 7b), where maximum sea level occurs in December-January and the minimum in August-September. Approximately 50% of seasonal sea level range around Sri Lankan waters could be explained by steric height variations, assuming a well-mixed surface layer of 100 m and salinity variations of 2 ppm. Lowest salinities occur in November (Levitus, 1994). However, these figures chosen are rather arbitrary because coastal hydrography data are unavailable from the seas around Sri Lanka. The depth of the mixed layer is also not well known around Sri Lanka. On the other hand Patullo et al. (1955) found that the steric range in the inner bays of Bay of Bengal is 41 cm, though their calculations were also probably hampered due to insufficient data. They also meant that the steric effects in equatorial latitudes are largely thermal and relatively small. The rise due to wind set up and air pressure. Another, it is obvious that shifting winds and current systems off the coast (Schoet, 1994) could contribute to the seasonal variability as well. However, it is obvious that the very large and strongly seasonal input of freshwater to the inner Bay of Bengal directly influences the waters of Sri Lanka.

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### References