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Extreme sea level changes long the east coast of India

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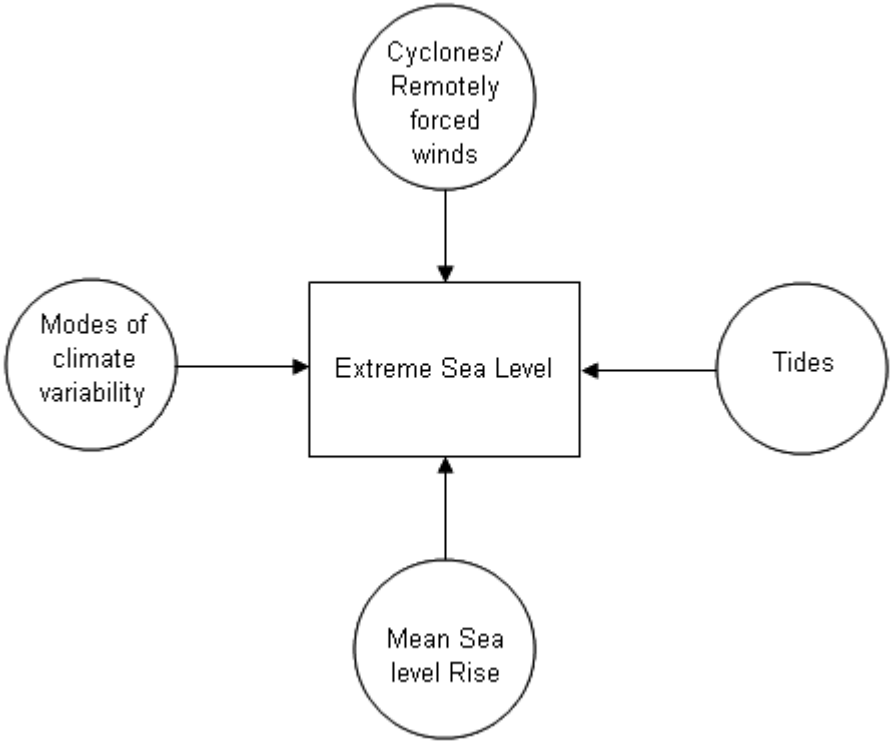
Relevance

- Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) by the IPCC (2012) to be released.

Introduction

- Extreme sea-level events at the coast occur mainly in the form of storm surges (apart from tsunamis)
- Impacts of extreme sea level at the coast are severe.
- There is a concern on the possible changes in frequency and intensities of extreme sea level events due to climate change.

Processes controlling an extreme sea level event

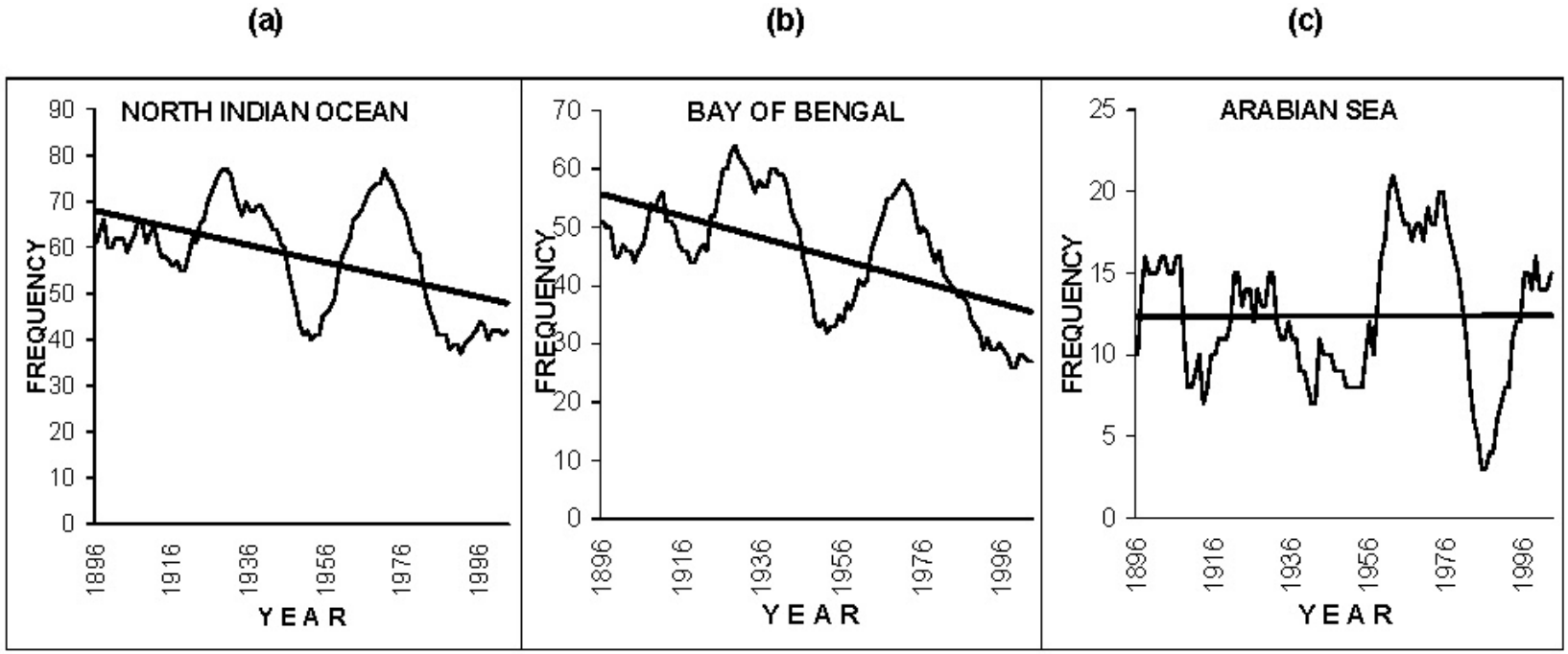


Observed changes in cyclones and uncertainties in their future projections

- Though there are no clear evidences of change in the frequency of tropical cyclones in many of the ocean basins, intense events are reported to be on the increase in many regions

- Projections of the changes in storminess (GCM or RCM) do involve large uncertainties.

Trends in the occurrence of cyclones in the past century (Niyas et al., 2009)

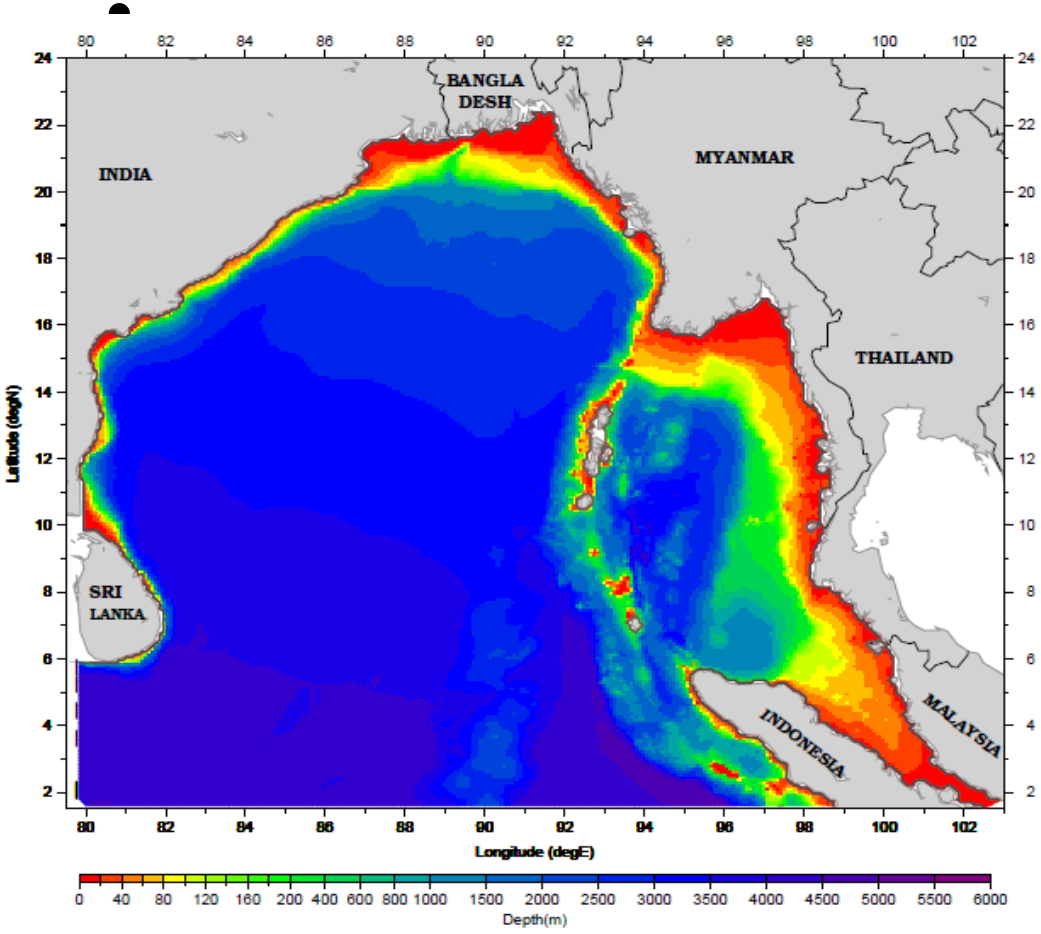


y = -0.1876x + 68.179
R^2 = 0.246

y = -0.1879x + 55.816
R^2 = 0.3263

y = 0.0003x + 12.363
R^2 = 0.000005

Storm surge model for the Bay of Bengal used in the present study



grid resolution of 5 minute, forced along the open boundary by tides from the global tidal model FES2004

- About 27-years (1973-2000) of all the LPS events that crossed the east coast are used to run the storm return surge model for individual events and compute the return levels.

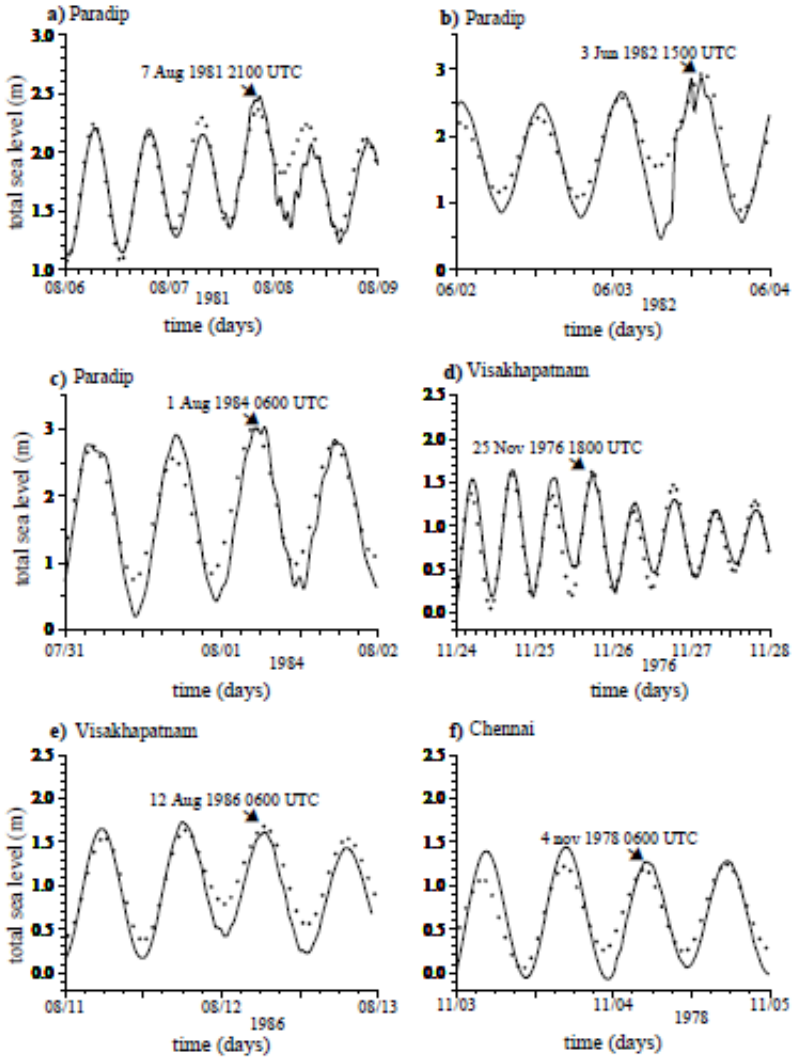
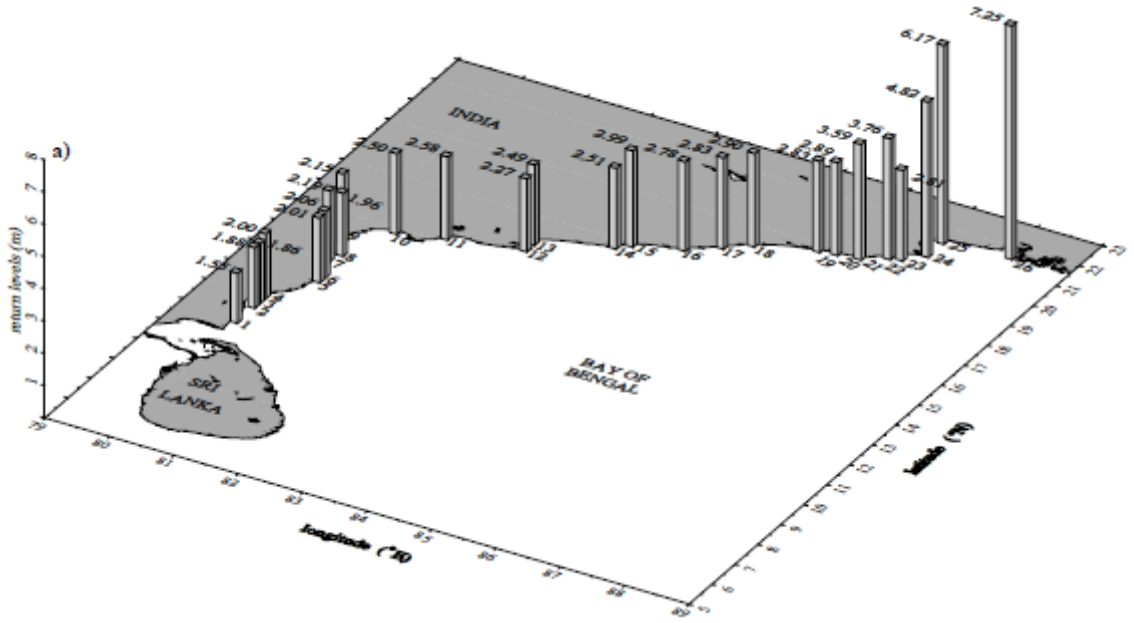


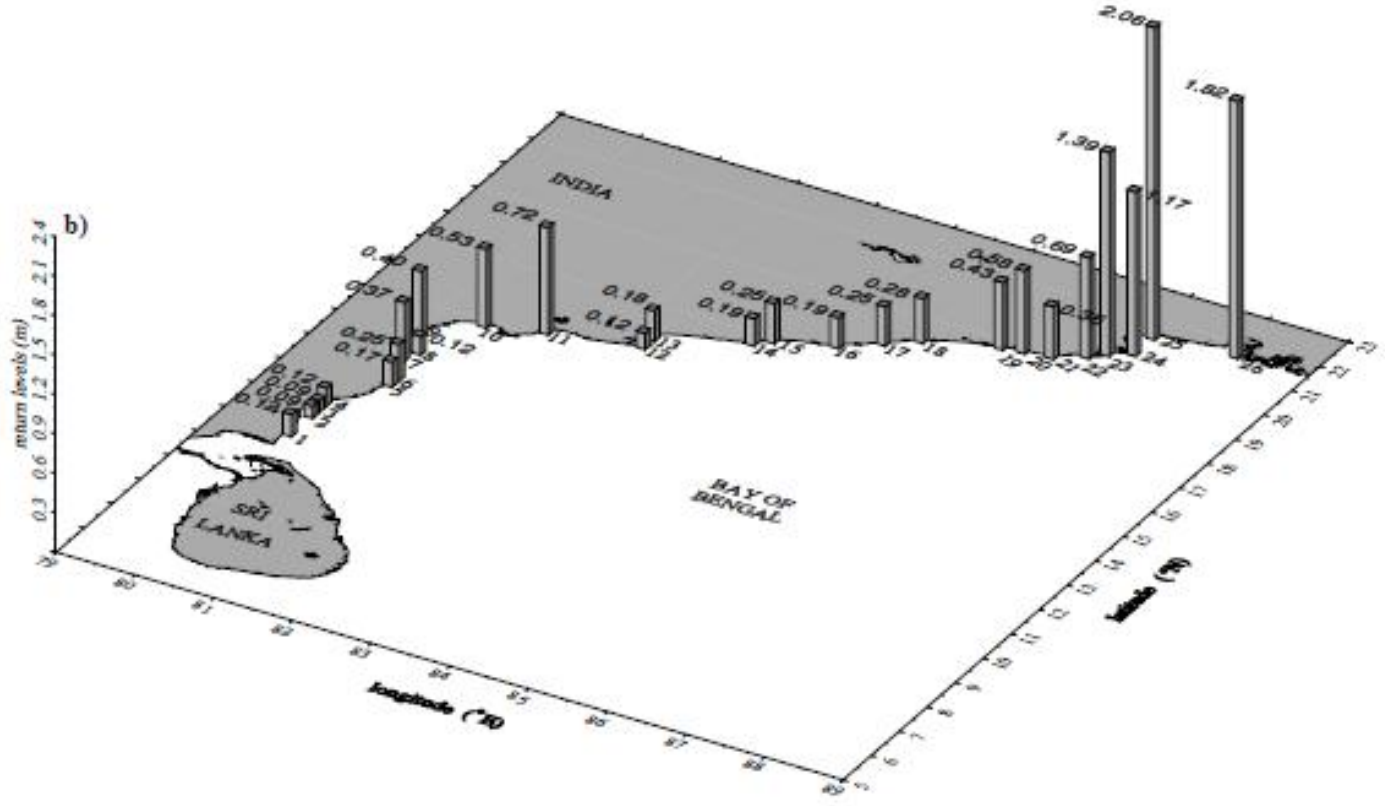
Figure 5.6 Comparison of the time series of simulated total sea level (continous line) and observed total sea level (dotted line) for 6 cyclone events, whose tracks are shown in Figure 5.5. The arrow points to the time at which the peak surge occurred at the mentioned station

50-year return levels of total sea level



- In : Sindhu and Unnikrishnan, Natural Hazards, in Press

50-year return levels of surges



Effect of mean sea level rise on storm surges

- Though there are uncertainties in the regional climate projections, various studies covering different regions over the globe have given evidences that both the 20th century observed changes in extreme sea level and 21st century projected changes are caused primarily by mean sea level rise.

Impact of climate change on extreme sea level along the east coast of India

- To assess future changes, combined effects of mean sea-level rise and changes in wind fields and pressure fields in a future climate scenario A2 are examined for the Bay of Bengal.

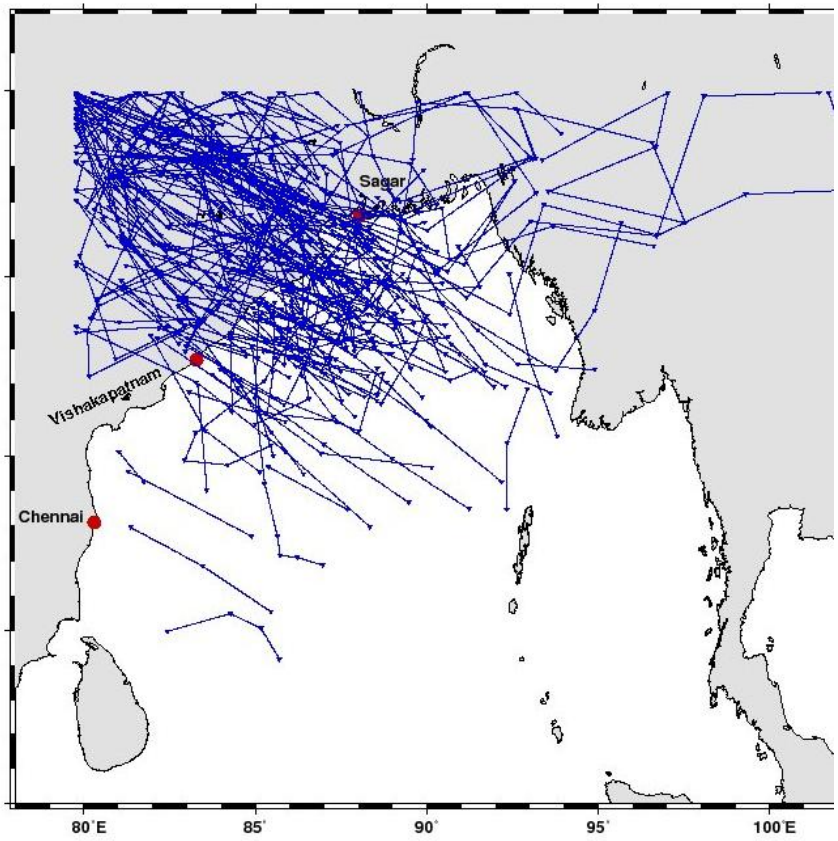
Regional climate model PRECIS

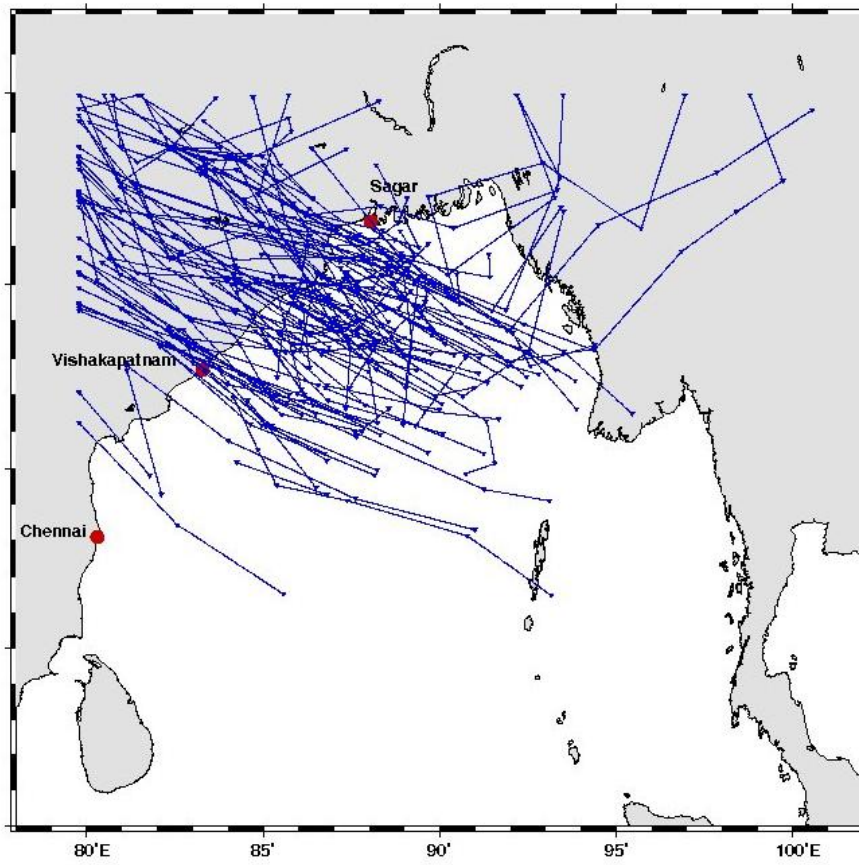
- Regional climate model simulations for the present scenario (1961-1990) and SRES A2 scenario (2071-2100) are analysed.

- A storm surge model is forced by winds and near-surface atmospheric wind fields from PRECIS

Composite track of cyclones (Regional climate model PRECIS) in the Bay of Bengal

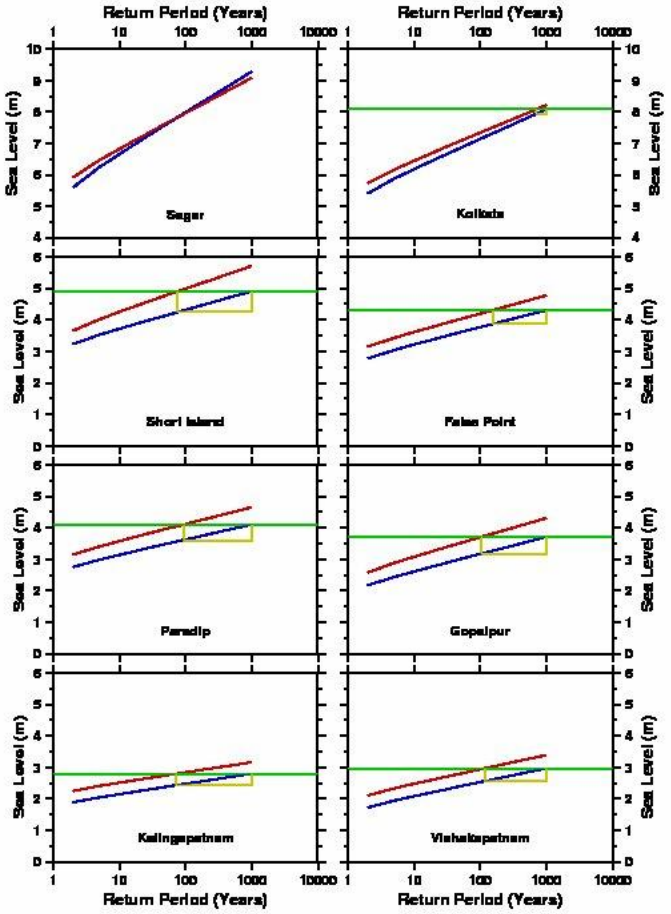
- baseline (1961-1990) A2 (2071-2100)





Changes in Return levels

- Storm surge
- model for the Bay
- of Bengal, forced
- by winds from PRECIS (baseline and A2 scenarios) and projected sea-level rise for the A2 scenario
- Blue (1961-1990)
- Red (2071-2100)



Changes in 100-year return levels for northern part of the east coast of India

- Forcing by winds and
- Surface atmospheric
- pressure fields from
- PRECIS and sea-level rise
- Added.
- Increase of 100-yr Return
- Levels by 5-20 % in the future
- A2 scenario

Station	100-yr return level (1961-1990) in m	100-yr return level (2071-2100) in m
Vishakhapatnam	2.53±0.08	2.94 ± 0.08
Paradip	3.63 ± 0.09	4.36 ± 0.11
Short Island	4.32 ± 0.11	4.99 ± 0.13
Sagar	7.98 ± 0.26	7.96 ± 0.20

Unnikrishnan et al. *Current Sci*., 2011

Conclusions

- Combined effects of changes in mean sea level and changes in storminess (regional climate model) provides estimates of changes in 100-year return levels along the east coast of India. By about 5 to 20 %.
- Return level estimates using storm surge model driven by RCM indicate higher flood risks associated with storm surges in future climate scenario

Impacts of extreme events and sea-level rise along the coastline

- Infrastructure development in the coastal sector (Kalpasar project in Narmada estuary, Sethusamudram project)