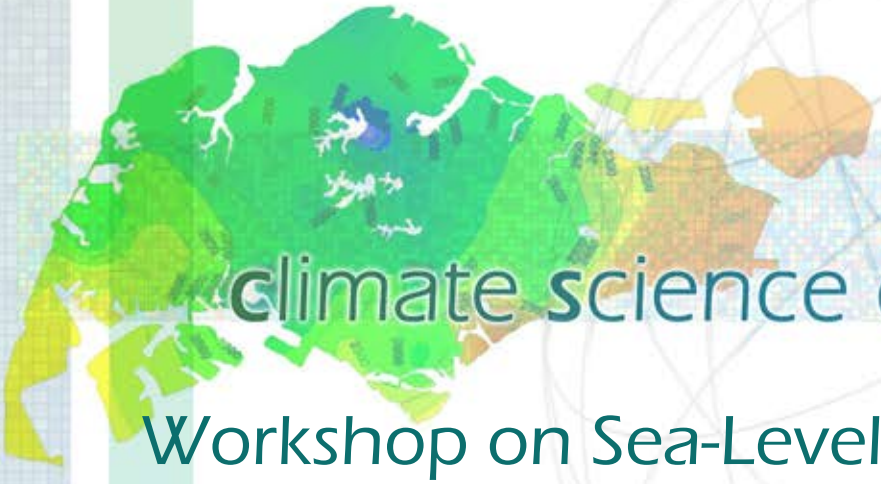

climate science experts network

# Workshop on Sea-Level Rise and Extremes
## 5 Mar 2014


Meeting organisers:

Dr Chris Gordon, Centre for Climate Research Singapore

Dr Pavel Tkalich, Tropical Marine Science Institute, NUS



Ministry of the Environment and Water Resources

Meteorological Service Singapore
Centre for Climate Research Singapore

NUS National University of Singapore

TMSI Tropical Marine Science Institute
National University of Singapore

# ABSTRACTS OF PRESENTATIONS

## 1. Storm surges at Sunda Shelf, the past and 21st century projections

*Dr Pavel Tkalich, Dr Quang-Hung Luu, Tropical Marine Science Institute,*
*National University of Singapore*

***Abstract***

The presentation will begin with a brief overview of the ocean modelling work at TMSI. This will be followed by a presentation on the scientific investigation of storm surges at the Sunda shelf.

The South China Sea (SCS) is the unique semi-enclosed basin that lies under the main southwest-northeast pathway of the seasonal monsoons. Its large-scale sea level dynamics is dominated by the northeast (NE) monsoon (November–February) and southwest (SW) monsoon (June–August). Strong sea level surges during NE monsoon, if coinciding with spring tide, usually lead to coastal floods in the Sunda Shelf region and Singapore Strait (SS) in particular. Using tide gauge records, satellite altimetry and reanalyzed wind in the region, we revealed that the wind over central part of SCS is arguably the most important factor determining the observed variability of Sea Level Anomalies (SLAs) at hourly to monthly scales.

Climatological SLAs in SS are found to be positive, and of the order of 30 cm during NE monsoon, but negative, and of the order of 20 cm during SW monsoon. The largest anomalies are associated with intensified winds during NE monsoon, with historical highs exceeding 50 cm. At the hourly and daily timescales, SLA magnitude is correlated with the NE wind speed over central part of SCS with an average time lag of 36–42 h.

The talk is discussing the past trend and 21st century projections of storm surges in the domain of interest.

## 2. Sea Level Rise and Coastal impacts Research in the Centre for Australian Weather and Climate Research

*Dr Kathleen McInnes, CSIRO Marine and Atmospheric Research, Australia*

***Abstract***

Extreme sea levels caused by severe storms pose a major threat to low-lying coastlines. Climate variability and change can alter the impacts of these events due to both changes in mean sea level and changes in weather and circulation patterns. This talk will describe some recent and ongoing studies into extreme sea levels and their future changes in Australia and the Pacific. Firstly, the results of a recent study aimed at better understanding the current and future risk of extreme sea levels in Fiji and Western Samoa in the South Pacific will be described. In this study, stochastic tropical cyclone and hydrodynamic models were used to estimate the extreme sea levels arising from storm surge and astronomical tides for late 20$^{th}$ century conditions and also under projected changes in tropical cyclones and sea level. The contribution of wind waves to extreme sea levels is also particularly important, especially for many Pacific islands that are surrounded by steep coastal margins. Yet to account for waves requires data that is often not available and high resolution modelling that is often not feasible for many coastal locations in this region. A hydrodynamic downscaling study to incorporate wave breaking effects is described for Apia to illustrate the role of waves on extreme sea level events and the importance of high resolution data to understand the impacts of such events. A second area of research examines how projected changes to weather systems affect extreme sea levels around the coastline of Australia. Hydrodynamic model simulations forced by 4 CMIP5 climate models have been undertaken for baseline and future climate conditions and results will be presented and discussed.

## 3. Sea level rise and variability around the Peninsular Malaysia

*Dr Pavel Tkalich, Dr Quang-Hung Luu, Tropical Marine Science Institute,*
*National University of Singapore*

***Abstract***

Peninsular Malaysia is bounded from the west by Malacca Strait and the Andaman Sea, both connected to the Indian Ocean, and from the east by South China Sea being largest marginal sea in the Pacific Basin. As a result, sea level along Peninsular Malaysia coast is assumed to be governed by various regional phenomena associated with the adjacent parts of the Indian and Pacific Oceans. At annual scale, sea level anomalies (SLAs) are generated by the Asian monsoon; interannual sea level variability is determined by the El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD); whilst long term sea level trend is coordinated by the global climate change. The aim of our talk is to quantify the relative impacts of these multi-scale phenomena on sea level variability around the Peninsular Malaysia using long-term tide gauge record and satellite altimetry. A robust method is developed to reconstruct the gappy sea level data based on its governing physics. This helps in deriving relative and pure sea level rise rates for Malacca Strait, eastern Peninsular Malaysia and Singapore Strait. Our results further suggest the existence of a narrow topographic constriction off Singapore which separates different modes of annual and interannual sea level variability along coastline of Peninsular Malaysia.

## 4. Sea level research at Met Office Hadley Centre: current work and future plans

*Dr Matt Palmer, Met Office Hadley Centre, UK*

***Abstract***

In this talk, I will give an overview of the sea level research work done at the Met Office Hadley Centre: a world leading centre for climate change research. The talk will include a brief summary of the IPCC AR5 Chapter on Sea Level and how the science has moved on since the previous IPCC assessment. Current work and future plans for sea level research will be put in the wider global context and I will highlight some of the key science questions that we will tackle in the coming years.

## 5. Sea level science at the National Oceanography Centre: Current work and future projects

*Dr Lucy Bricheno, National Oceanography Centre, Liverpool, UK*

***Abstract***

The National Oceanography Centre (NOC) is a national research organisation wholly owned by the Natural Environment Research Council; it delivers integrated marine science and technology from the coast to the deep ocean. At NOC Liverpool, the focus is coastal oceanography and sea-level science.

The Sea Level and Ocean Climate (SLOC) group studies the past, present and future changes of sea level and land level. NOC Liverpool also hosts the Permanent Service for Mean Sea Level (PSMSL), which is responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges. In the Shelf and Coastal Impacts subgroup of Marine Systems Modelling (MSM), we are concerned with how climate change and direct human drivers impact coastal and shelf seas. This includes modelling freshwater inputs, hydrodynamic circulation, surface waves, tides and storm surges. NOC Liverpool develops and maintains tide-surge models used for forecasting storm surges on the coasts of England and Wales for the Environment Agency. Results from The National Tidal and Sea Level Facility (NTSLF) are transmitted to the Environment Agency and used for coastal flood warning in England and Wales.

I will talk about the work done in these well-established groups, as well as outline relevant current and future projects. One of particular interest is the United Kingdom Environmental Prediction (UKEP): a collaboration with the UK Met Office and the Centre for Ecology and Hydrology (CEH). UKEP is developing the first coupled high resolution probabilistic atmosphere-marine-land surface-composition-ecosystem prediction system for the UK at 1km scale. An overarching aim of the project is to improve ocean forecasting, storm surge, wave forecasting and marine state.

## 6. Climate Projections for Regional Seas

*Dr Jonathan Tinker, Met Office Hadley Centre, UK*

***Abstract***

The marginal shelf seas are the part of the ocean that humans interact with. Most of our fisheries, oil and gas, and shipping are dependent on shelf seas. Shelf seas face many anthropogenic pressures including pollution, over-fishing and mineral extraction; climate change is impacting an already stressed system. In order to monitor, manage and mitigate these impacts, it is important to quantify the likely future impacts.

I have developed a set of climate projections for the North West European (NWE) shelf seas focusing on physical variables such as temperature, salinity, circulation and water column structure. I will present the state-of-the-art modelling system and experimental design that allow quantification of aspects of future climate uncertainty. The talk will include the projected changes over the century, before touching on the temporal evolution of the NWE shelf seas, the emergence of the climate signal, and the possibility of near-future projections.

Throughout this work, I have worked closely with the users from the UK's marine community, and will outline a few examples of collaborations that have developed from this work.