MSc internship (4-6 months)

Tropical cyclone induced waves: characterization, and contribution to mean wave climatology and extreme wave climate

Introduction

Tropical cyclone (TC)-induced coastal flooding is the most devastating coastal disaster, accounting for more than 90 % of the loss of life and property due to natural disasters in low-lying coastal areas (Pielke *et al*. 2008). It arises from a combination of storm surge (i.e. anomalously high sea level due to onshore water transport ahead of the storm and inverse barometric effect), and energetic waves induced setup (i.e. mean sea-level elevation due to the presence of breaking waves). Storm surge modelling is a key element of coastal early warning systems, but models have not yet demonstrated their full ability to adequately reproduce patterns of coastal flooding (Krien *et al*. 2016, 2017), in particular due to the complex waves contribution (which is generally omitted). A few studies showed that a significant part of total flooding can be attributed to waves (e.g. Flather 1994, Krien *et al*. 2017). Indeed, TC-generated waves in deep water considerably evolve in shallow water before reaching the coast. This transformation includes transfer of energy towards low frequency energy (i.e. infragravity waves) that can be responsible for most of the run-up at the shoreline (Aucan and Ardhuin 2013, Beetham *et al.* 2017). Finally, exposure to coastal flooding is expected to increase over coming decades due to climate change, global sea-level rise, and coastal population density increase (Karim and Mimura 2008). To develop effective mitigation and adaptation strategies for reducing the impacts of coastal flooding and increasing coastal resilience, it is hence essential to better understand the mechanisms of coastal flooding induced by extratropical storms and tropical cyclones under present climate conditions and future climate scenarios (Allen *et al.*, 2014).

Objectives

Previous studies of the wave field induced by a given storm are based on specific case-studies (e.g. Fan et al. 2009, Sirisha et al. 2015, Chen and Curcic 2016). The relationship existing between the TC characteristics and its wave response is still poorly described. The first objective of the present study is thus to describe and analyse the wave response as a function of TC parameters over the last 30 years, and in all cyclonic basins.

The second objective is to assess the contribution of TC-induced waves to the wave climatology. Indeed, extreme waves in coastal areas can be generated by TCs but also by swells generated by other events as extratropical storms. The respective contributions of these two phenomena to extreme waves statistics need to be quantified.

Proposed work

The work will consist of analysing simulations performed with Wavewatch III wave model (WWIII) at a global scale for the last 30 years, and comparing the simulated wave fields to observations (buoy and satellite measurements). This will allow to assess the dependency of wave amplitude, and spatial asymmetries to TC characteristics (e.g., intensity, size, speed) and their related physical mechanisms.

A set of simulations is available with different atmospheric forcings, including or not tropical cyclones. By analysing the difference between these simulations (with and without TC

forcing), the contribution of TCs to the wave climatology will be assessed in the different ocean basins.
All simulations and data will be provided, as well as a toolbox to compare observations and simulations.
The candidate will perform the analyses and scientific interpretation.

Work conditions
The candidate will be hosted at Ifremer, in the Laboratory of Physical and Spatial Oceanography (UMR LOPS), within the Satellite and Air-Sea Interaction (SIAM) team, and will interact with collaborators from the Institute of Research and Development (IRD).
Supervisor: Swen JULLIEN (Ifremer, LOPS)
Co-supervisor: Christophe Menkes (IRD, Entropie)
Gratification: ~600eur/month

Application
The candidate should have a scientific background in physical oceanography and/or meteorology, computing skills (Python or equivalent, Unix system), and oral and written communication skills.
CV and cover letter should be sent to swen.jullien@ifremer.fr

References
Allen, M., et al., 2014. IPCC fifth assessment synthesis report - Climate Change 2014 synthesis report. Intergovernmental Panel on Climate Change (IPCC)
Aucan, J., and Ardhuin, F., 2013. Infragravity waves in the deep ocean: An upward revision. Geo. Res. Let.
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Pielke Jr RA et al., 2008. Normalized hurricane damage in the United States: 1900–2005. Nat. Hazards Rev.
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