

ENSEMBLE WAVE CLIMATE PROJECTIONS BASED ON CMIP5 MODELS

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INTRODUCTION

A warming climate has the potential to not only raise sea level but also exacerbate coastal hazards due to changes in storm frequency and intensity. Along open coasts where wave energy is often the dominant process dictating shoreline positions, changes in mean and extreme wave conditions are likely to alter long-term geomorphic evolution patterns.

A growing number of studies have considered how the global wave climate may respond to climate change using Global Climate Models (GCMs) under multiple climate forcing scenarios. These studies have been carried out independently, using different methods to estimate future wave conditions. Within each individual study, only a limited number of GCM simulations were investigated due to limited study scope, resources, and/or availability of suitable data. Therefore, individual studies are unable to fully quantify uncertainty of projected changes in wave climate.

The Coordinated Ocean Wave Climate Project (COWCLIP) is to provide infrastructure to support a systematic, community-based framework that allows for validation and inter-comparison of wave projections, and to make these freely accessible to the scientific community supported by WMO. Here, the primary aims are to 1) present quantitative evaluations of projected global scale wave conditions (Morim et al., 2019) and 2) to present the framework and preliminary results of regional wave modeling that will provide projections of nearshore wave conditions for use in long-term geomorphic change analyzes.

METHODOLOGY

Phase 2 of COWCLIP is a designed experiment with contributions from various researchers. Phase 2 commenced in late 2013 and will summarize an ensemble of CMIP5 wave projections for different climate scenarios, including regional projections. Mean and extreme wave statistics are being computed along coasts at spatial scales of 100s kms.

Given the increasing evidence for historical changes in wave conditions, we were interested in how projected future changes in atmospheric circulation would alter the characteristics of wind-waves around the world. As part of the Coordinated Ocean Wave Climate Project (www.cowclip.org), 146 projections from 22 groups, using a range of different statistical and dynamical wave models, used outputs from several climate models, under different future climate scenarios, to determine how waves might change in the future.

RESULTS

While we identified some differences between different studies, we found that if the 2 degC Paris agreement

target is kept, signals of wave climate change are unlikely to exceed the magnitude of natural climate variability. However, under a business as usual future climate scenario (RCP8.5) we found agreement in the projected future changes in wave heights, lengths and/or directions along 50% of the World's coasts (see Fig.1). These changes varied by region, with regional differences in increase/decrease in wave height and length of up to 10 and 5% respectively, and rotation of wave direction of up to 17 degrees.

Less than 5% of the global coastline is at risk of future increasing wave heights. These regions being the southern coasts of Australia, and segments of the Pacific coast of South and Central America. The future decreasing wave heights lead also risk to change coastal system. However, the implications of future changes in wave conditions on coastal stability vary at localized scales. Regions where wave heights remain unchanged, but wave lengths or periods show projected increase will experience increased forces exerted on the coast or associated infrastructure. One way this might be felt is via waves running further up a beach, increasing wave driven flooding. Similarly, waves travelling from a slightly altered direction in projected climate scenarios (suggested to occur over 20% of global coasts) can alter longshore transport of sediment along a coast. Such changes can upset the balanced budget of available sediment with implications for shoreline position.

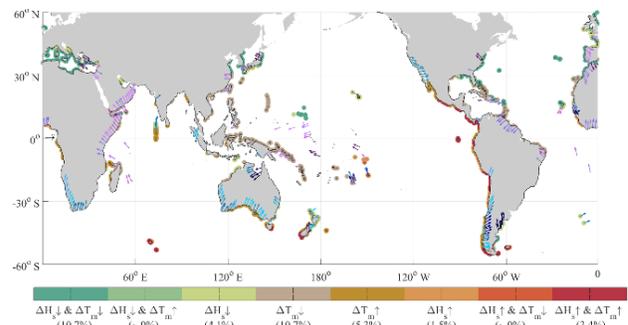


Fig. 1 - Projected robust changes in offshore significant wave height (H_s), period (T_m) and direction (θ_m) by 2080-2100 (under RCP8.5) in the proximity of the world's coastlines.

REFERENCES

Morim et al. (2019): Robustness and uncertainties in global multivariate windwave climate projections, Nature Climate Change, 10.1038/s41558-019-0542-5