LONG-TERM CHANGE IN GLOBAL SWELL DOMINANCE BASED ON 6 DECADES OF RE-ANALYSIS DATA

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ABSTRACT
We discuss the impact of changing climate on swell domination, globally using 6 decades of wave simulation and show how the share of swells in significant wave height varies spatially during various decades. Such outcomes will help us develop a learning pattern to detect future changes in swell-dominated areas.

INTRODUCTION

Surface ocean waves are in general a combination of seas (locally generated waves) and swells. Understanding swell domination in the ocean is crucial for safety during recreational activities, coastal erosion control, and marine operations. Swell can create hazardous conditions for boats, surfers, and swimmers, and can contribute to shoreline erosion. Hence, it is important to develop an understanding of swell climate in a specific region for any future planning. Moreover, the changing climate and climatic fluctuations can affect the swell-dominated areas. In this study, we discuss the change in swell-dominated areas on a global scale. To detect the long-term changes in swell patterns, we used 6 decades of modelled wave climate using JRA-55 re-analysis wind field to discuss the decadal and multi-decadal variations.

METHODOLOGY

We used the JRA-55 re-analysis wind dataset (KOBAYASHI et al., 2015), with a spatial resolution of 60 km and a temporal resolution of 6 hours, to force the SWAN (Simulating WAves Nearshore) Cycle III version 41.31 (The SWAN Team, 2019) numerical wave model for the entire globe between 1958 and 2019. The bottom conditions were provided from the General Bathymetric Chart of the Oceans (GEBCO: https://www.gebco.net/) (spatial resolution: 30 arc-seconds). The computational grid covering the entire globe (0° E-360° E in longitude and 90° S-90° N in latitude) was employed with a spatial resolution of 1° and computational time steps of 30 minutes. The output grid was also considered with the spatial and temporal resolutions of 1° and 6 hours, respectively. The wave model was calibrated by tuning the whitecapping coefficient to minimize errors in comparison with the measurement, i.e., in-situ and satellite data. The validated model was then used to generate the wave climate including significant wave height (combined sea and swell waves) (H_s) and swell wave height (H_{swell}), for six decades (1958-2019), and the results were used in inter and intra-annual assessment of variation in wave climate.

RESULTS & DISCUSSION

Based on the simulated wave climate for the period of 6 decades, the ratio of H_{swell} to H_s was calculated for each time step and the average values of the ratio were calculated for various multi-decadal scales. Figure 1 shows the ratio of H_{swell} to H_s for three 20-yearly periods, i.e., 1960-1979, 1980-1999 and 2000-2019. According to this figure, the regions with higher swell dominance ratios have varied across different time scales, with the most recent period displaying higher dominance in certain areas. The study also conducted a decadal-scale analysis to quantify these changes and identify regions that are more vulnerable to fluctuations in wave climate in terms of swell dominance. Further details of these findings will be discussed in the full paper.

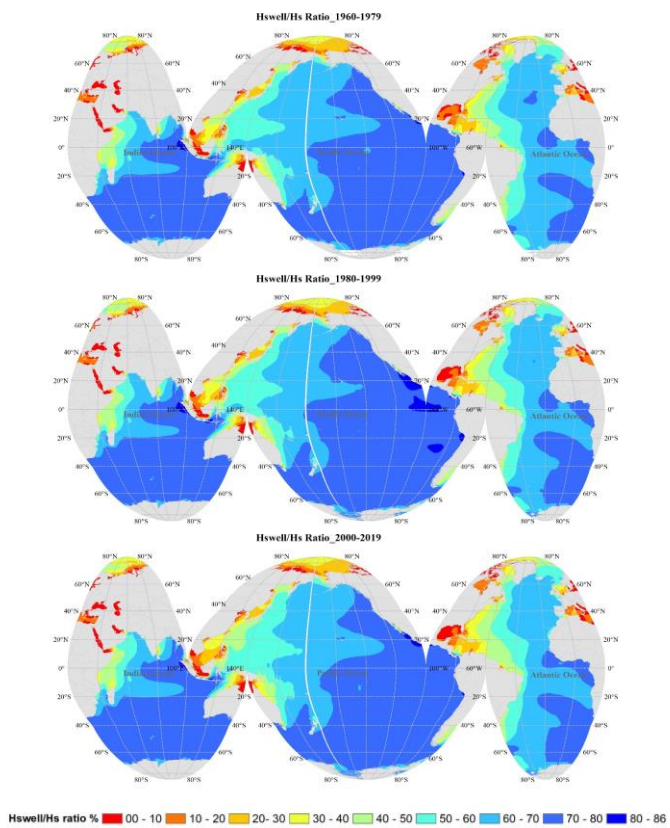

Figure 1 Spatial distribution of swell-dominated areas in multi-decadal scales

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