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TITLE: Changes to extreme wave climates of islands within the Western Tropical Pacific throughout the 21st century under RCP 4.5 and RCP 8.5, with implications for island vulnerability and sustainability

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ABSTRACT:

Waves are the dominant influence on coastal morphology and ecosystem structure of tropical Pacific islands. Wave heights, periods, and directions for the 21st century were projected using near-surface wind fields from four atmosphere?ocean coupled global climate models (GCM) under representative concentration pathways (RCP) 4.5 and 8.5. GCM-derived wind fields forced the global WAVEWATCH-III wave model to generate hourly time series of bulk wave parameters around 25 islands in the mid to western tropical Pacific Ocean for historical (1976?2005), mid-century, and end-century time periods for the December?February and June?August seasons. The December?February regional wave climate is dominated by strong winds and large swell from extratropical cyclones in the north Pacific while the June?August season brings smaller waves generated by the trade winds and swell from Southern Hemisphere extratropical storms. Extreme significant wave heights decreased (~ 10.0%) throughout the 21st century under both climate scenarios compared to historical wave conditions and the higher radiative forcing RCP 8.5 scenario displayed a greater and more widespread decrease in extreme significant wave heights compared to the lower forcing RCP 4.5 scenario. An exception was for the end-century June?August season. Offshore of islands in the central equatorial Pacific, extreme significant wave heights displayed the largest changes from historical values. The frequency of extreme events during December?February decreased under RCP 8.5, whereas the frequency increased under RCP 4.5. Mean wave directions rotated more than 30° clockwise at several locations during June?August, which could indicate a weakening of the trade winds' influence on extreme wave directions and increasing dominance of Southern Ocean swell. The results of this study underscore that December?February large wave events will become smaller and less frequent in most regions, reducing the likelihood and magnitude of wave-driven flooding at these island locations over the 21st century. However, relatively large increases in the mean of the top 5% of significant wave heights and large changes to the mean direction of these waves in the June?August season at several islands within 150?180° E will drive greater flooding and island morphological change along previously more stable shorelines. The reported results herein project large changes to tropical Pacific island wave climates that will be necessary for assessing island vulnerability under climate change in future studies.

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