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THE SWELL TRACK REACHING THE CONTINENTAL SHELF OF MARANHÃO

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Abstract:

The swell track exploits the dispersive nature of ocean waves to trace their source and travel time, and provides a robust framework for identifying distant storm origins. Building on this approach, we applied the algorithm proposed by Cagigal et al. (2021), which leverages the dispersion characteristics of ocean waves to precisely determine the source and travel time of each distinct event, to be applied on the ERA5 reanalysis data. This approach is possible for isolated swell trains because the frequency peak and the time of arrival exhibit a linear relationship. Therefore, to compute the distance of origin, we need only calculate the slope of the linear regression from the time-series of the peak frequency. From this, to better determine the dominant wave regime in the continental shelf of Maranhão (CSMA), we analyze the ratio between the wind-sea's significant wave height and the swell's significant wave height. Utilizing the methodology outlined above, we have conducted an analysis of the specific occurrences related to the swell system over intermediate water depths of 200 m, situated at the point located offshore the CSMA (0.5°S and 44°W), covering the period from 1991 to 2020. The output algorithm indicates that the predominant swells in the North Atlantic Ocean originate from both tropical storms (August-October) and extratropical storm (December-January) seasons associated with the the boreal autumn and winter periods, respectively, resulting in the generation of swells from the north (height of 3.27 m in winter) and north/northeast (height of 2.38 m in autumn) quadrants. North Atlantic tropical storms, such as hurricanes, typically originate within the latitudes of 5° to 20°, where the interaction between warm air and warm seawater leads to atmospheric instability. The favorable atmospheric conditions for hurricanes depend on the exchange of heat energy flux between oceanic humidity and temperature with the atmosphere. Extratropical storms in the North Atlantic, such as cyclones, typically occur between 30° and 60° latitude, are driven by strong horizontal temperature gradients between warm and cold air masses, which generate baroclinic instability. In addition, it is possible to identify a secondary region responsible for swell generation associated with the intensification of trade winds occurring in the Equatorial zone in boreal summer (June-September) when the warming enhancing the meridional temperature and pressure gradient, generating shift northward of trade winds and the increase waves reach a height of 2.07 m. According to our results, swells generated by tropical storms typically take approximately 3.5-4.5 days to travel the distance until the CSMA. In contrast, extratropical storms arising from middle and high latitudes generally need an average of 6-7 days to reach the CSMA. In the equatorial zone, the arrival of swells at the CSMA averages between 3.5 and 7 days. This work summarizes findings previously published in Regional Studies in Marine Science (2024), adapted for the context of this event.

Keywords: Swell track; Continental Shelf of Maranhão; North Atlantic Ocean storms; ERA5