Estimating Extreme Waves in the South Atlantic Ocean Using Regional Frequency Analysis and Wave Model Hindcast Data

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The focus of the present study is on the use of long-term wave model hindcast data for extreme wave analysis applications, however, with a different approach. First, wind fields from a new atmospheric model reanalysis generated at NOAA/NCEP are validated and calibrated, relative to surface buoy and Quikscat data. Calibration targets particularly wind fields associated with extratropical cyclones. For that purpose, a program was built to identify all cyclones taking the wind vorticity and local minima of surface pressure. In a subsequent step, model winds are filtered, the cyclonic disturbance is removed and QuikScat cyclone winds under a limited diameter are inserted on the filtered CFSR wind field. This procedure ensures that more realistic wind values are used as input to the wave model under strong wind fetches associated with extreme events.

In order to understand exactly the wind and wave conditions applied in the methodology described above, a preliminary study based on 72 extreme events with SWH from 4.1 to 7.6 meters measured in the south and southeastern Brazil by 9 buoys from 2002 to 2009 was performed. It is shown that the extreme events considered were generated by cyclones with cyclogenesis between 40º and 25º South, close to the north coast of Argentina, Uruguay and southern Brazil. Most of cyclones were generated 2 days before the maximum significant wave high by large fetches with Southwestern winds between 20 and 35 m/s. The maximum wave height registered had SWH equal to 7.61 meters and all events had also peak direction from southwest and peak periods between 9 and 17 seconds. A comparison of CFSR reanalysis with QuikScat data during these events show an underestimation of CFSR winds around 2 to 4 m/s at large fetches with moderate winds and differences around 5 m/s at small fetches in northern latitudes under strong winds up to 35 m/s.

Results so far suggest that it is possible to obtain a high resolution wave hindcast at the south and southeastern Brazil with high correlation with measurements and very low bias. Beyond the longer wave time series, the hindcast has the advantage of the spatial coverage. In a context of new oil exploration areas with a great expansion of activities near the Brazilian coast, an accurate hindcast makes possible to simply extract new grid points to apply statistical methods to estimate return levels. In this context, the current study will also include an improved approach for estimating extreme values of SWH: the Regional Frequency Analysis, which consists of using a neighboring time-series inside a statistical homogeneous area to decrease the variance of the estimator of a common quantile function. In this way the return values are calculated for a region, and not only at a single point. This new approach will allow to produce reliable return value fields with small confidence intervals, instead of fitting extreme distribution with low confidence at each new point of interest.