WAVE HINDCAST IN THE PACIFIC OF CENTRAL AMERICA BY USING UNSTRUCTURED MESH

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PACIFIC COAST IN CENTRAL AMERICA

Highly touristic activities, fishing and trade shipping coexist along the Pacific coast of Central America, the last one dominated by the Panama Canal. Then, an accurate spatio-temporal characterization of wave climate is of utmost importance and relevance.

Notwithstanding, the existence of various wave models over the Pacific Ocean, such models offer information under spatial resolution of 0.2° at most and three hourly temporal resolution.

WAVEWATCHIII PERFORMANCE

Several WavewatchIII ® (WW3 Group, 2019) parametrizations have been adapted to the Central American Pacific coast, obtaining results which differ from each other. The herein proposed model configuration considers a non-structured mesh whose resolution in the far open ocean ranges from 180 km to approximately 1 km along the shoreline of Central America. The higher resolution region lies within the 76.6° and 92.7° West longitude, and from 4° South latitude up to 16° North latitude, covering the coastline of Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, and Ecuador, as shown on the right in figure 1.

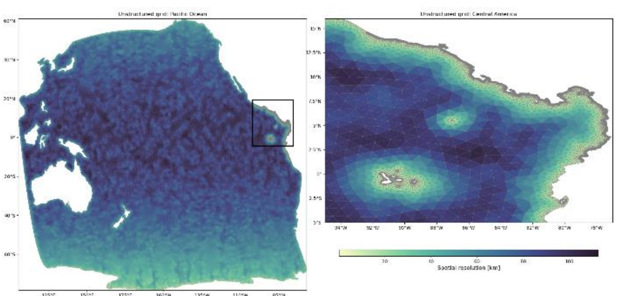

Figure 1 – Unstructured grid for (A): Pacific Ocean, (B) Zoom into the Central American region

Among the main factors contributing to the reduction of errors in the estimations by the spectral wave model used are accuracy of forcing fields, the realism of modelled parametrizations and the selection of integration of the Wave Action Equation (Alday, et. al., 2021). This study adopts those criteria and also offers relevance to unstructured computational resolution and the use of field recorded wave data from several months.

This modelling was forced by ERA-5 Reanalysis wind data (Herbasch, et. Al., 2018), this was determined after several comparisons of different wind data. The model was calibrated through a meticulous test series, focusing on the parameters of wind-wave generation, wave energy dissipation, wave interactions, spatial propagation schemes, dissipation due to obstructions in the wave spatial propagation (Mentaschi, et. al., 2015, Mentaschi, et. al., 2019), and computational timestep. In the stage of the model calibration measured wave data from ADCP located on Cocos Island (87.05545° West longitude, 5.5047833° North latitude) and in the vicinity of the Nicoya Peninsula in Costa Rica (85.126383° West longitude, 9.556867° North latitude) were used as reference information. Specifically, the spectral parameters of the zero-order moment wave height (H_{m0}) and the peak period (T_p) have been calibrated. The first step in the calibration process consisted of performing a linear regression by ranges defined by the cumulative distribution values of each variable to be fitted. The ranges of the variable have been established as partitions defined by the k-fold unsupervised learning method. Secondly, a multiple linear regression was applied in function of the predominant wave direction, following the methodology proposed by Albuquerque, et. al. (2018). The goodness of fit after calibrating the H_{m0} for the Nicoya Peninsula node is exemplified by one Taylor Diagram in figure 2, as well as the correlation coefficient map for the optimized configuration set over the region of study in figure 3.

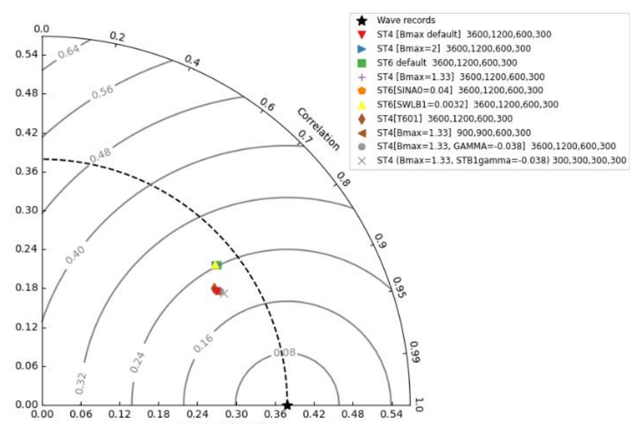

Figure 2 – Taylor diagram for several run tests carried out in Nicoya peninsula node

Once the different sets of model configurations have been evaluated, it is observed that in general the parameters of the ST4 source term package fit best in this study. The satellite data comparison excepts the regions outside 50 km from the coast, this to avoid satellite record disturbances produced by the land. However, lower correlation coefficients appeared towards the vicinity of the coastal regions even for the considered best set of configurations. Thus, it was decided to perform a comparison with a near ADCP located in the Pacific coast of Costa Rica, also considering information from the CFSRv2 (Saha, et al., 2010) reanalysis model.

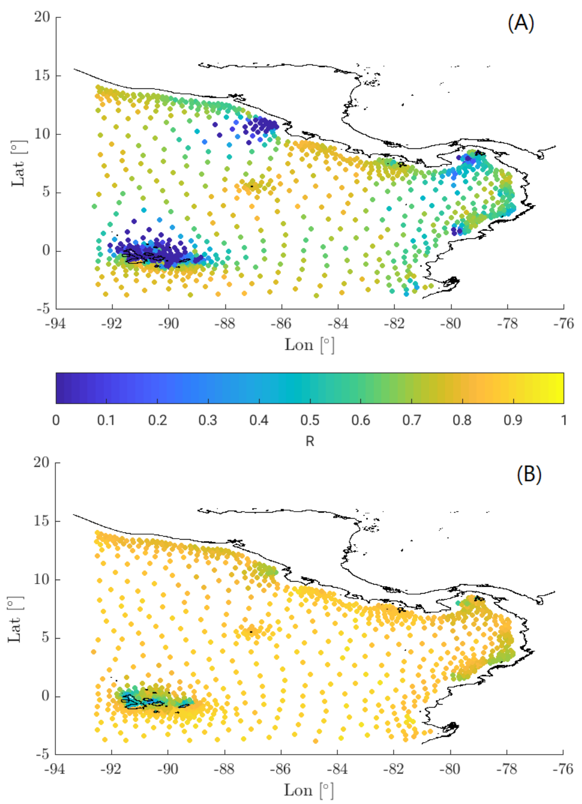

Figure 3 - Correlation coefficient maps for H_{m0}, (A): Previous calibration process, (B): Calibrated variable. Calibration based on satellite data

The H_{m0} and T_p timeseries are presented in figure 4, during 2014, one of the most energetic years in this region. The result of H_{m0} in this graph reveals that the modeling based on both wind input data follows the time pattern of the variables. Thus, it became evident that there is a better fit with the CFSRv2 wind input for the extreme events. Regarding the peak periods, it is observed that the modeled wave based on ERA-5 fits better to the ADCP records during the analyzed period. Therefore, either one or the other wind input database can be considered for engineering purposes, depending on whether the coastal study is for extreme events and coastal works design, or for intermediate conditions focused on docking operations and mid- and long-term trends.

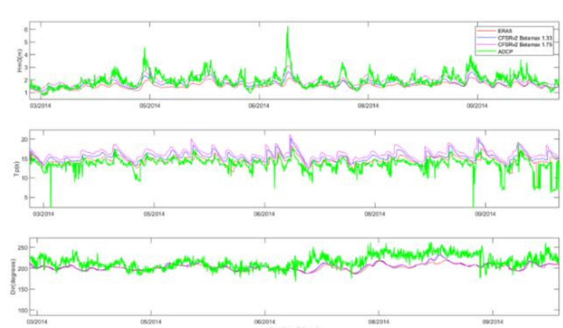

Figure 4 - Wind input assessment held at the ADCP location: 85.126383° West longitude, 9.556867° North latitude, during 2014.

Notice this model does not consider current input data, however, this discard has been compensated with the adjustment in the wind-wave generation terms, essentially with the parameter whose nomenclature is 'Betamax' under the ST4 configuration scheme in the model.

The future pathway of this study consists of generating an enhanced operational wave model for the Central American Pacific region, and subsequently to carry out wave forecasting.

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