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Wave energy along the Chilean coast from wave modelling

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Located at the western border of South America, Chilean coasts are one of the most energetic in the world, receiving more than 50% of the wave energy estimated for South America. New sources of energy must be explored in order to answer to the growing energetic demand of the country, estimated to increase on at least 8000MW in 2020. In response to this context, the Ministry of Energy developed the Energetic Roadmap for the next few decades, stating that at least 70% of the electricity must come from renewable sources in 2050. The current study aims to help on the first steps towards wave energy characterisation at the Chilean coast, focused on the assessment of wave power along the coast, and in particular on the swell that arrives at the coasts of continental Chile and their generation zones that link Chilean coasts with remote areas of the Pacific Ocean.

From a 20-year global ocean wave model, an estimation of wave power in deep waters along the coast and swell generating areas were performed. Climatological analysis shows mean values of wave power ranging from 25 kW/m at northern Chile ($\sim$18°S) to 70 kW/m near the south ($\sim$54°S), and P90 reaches up to 200kW/m in the south of the country. Wave generating regions of major influence for Chilean waves are located mainly at South Pacific Ocean, with the South-eastern Pacific Ocean dominating the cold seasons for north and central Chile. Northern Chile also receives wave energy input from the North Pacific Ocean during Northern Hemisphere winter, arriving to central Chile with less energy, and being non significant at the South. Traveling time of the energy from the generating regions up to the Chilean coasts varies with latitude, being less in the southern regions than in the north, and also in summer than in winter. Also, meridional variations of the winter-summer difference are found, being higher for Chiloé region than for Iquique.

A high-resolution non-structured grid WAVEWATCHIII model was setup for Central Chile, comparing the effects of different wind forcing reanalysis, particularly CFSR and ERA-Interim, and physics parameterizations on numerical simulations of the nearshore wave energy fluxes near Valparaiso (33ºS). Our results show a difference of 3 kW/m in wave power estimations when using different wind reanalysis, and difference of less than 0.5 kW/m when adding the triad wave interactions term. Statistical indicators calculated using buoy and altimeter data for comparison favor the use of ERA-Interim winds and including triad wave interactions.

This model configuration was then applied to a high-resolution non-structured setup in the region offshore of Chiloé Island, southern Chile. It is estimated that the energy of only 10% of the energy offshore of Chiloe Island is of around 1800MW in July and 720MW in November, which are significant values compared to the 200MW that satisfy the energetic need of the entire island. Moreover, it is shown that the Pacific coast of Chiloé Island is one of the most suitable regions to harvest wave energy and deliver it to the electrical network, in terms of wave energy resource.