ESTIMATION OF THE WAVE POWER POTENTIAL IN COASTAL REGIONS OF FLORIDA

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RENEWABLE ENERGY RESOURCES

The state of Florida has an abundance of renewable energy resources. Florida sees sun in an average 60% of its available daylight hours [1], and has 8,436 miles of coastline [2], and thus solar and wave energy are two promising alternatives to more conventional energy sources. The Electric Power Research Institute estimates the wave power potential along the Gulf of Mexico coast and East coast of the United States as 60 TWh/year and 160 TWh/year, respectively [3]. One TWh/year can power approximately 93,850 US homes annually, and thus it is likely that ocean wave energy has the potential to greatly contribute to the overall energy supply. This can be acheived by harnessing and converting wave energy into electricity using wave energy conversion devices. However, the feasibility of wave energy conversion must be assessed before such technologies can be employed. As a first step, the amount of available wave power in regions where devices may be deployed should be estimated. In this study, we assess the wave power potential of Florida's nearshore coastal regions.

CALCULATION OF WAVE POWER

There are two general formulae used to calculate wave power. The first formula computes wave power using density (ρ), gravitational acceleration (g), number of frequency bins (N), spectral wave density (S_i), frequency (f), wave number (k), and water depth (d) as inputs:

$$Eqn\ (1) \quad P = \frac{\rho g^2}{4\pi}\sum_{i=1}^{N}\frac{S_i}{f}\left[\left(1+\frac{2k_f d}{\sinh(2k_f d)}\right)\tanh(k_f d)\right]\Delta f$$

The second formula is based on a deep water assumption, and computes wave power using only standard wave parameters, namely significant wave height (H_s) and energy period (T_e) as inputs:

$$Eqn\ (2) \qquad P = 0.49 * T_e * H_s^2$$

Equation (2) is often used in place of equation (1), though it is unclear how much uncertainty this simplification introduces to the wave power estimation. Here, we assess this uncertainty by estimating the wave power using both formulae, and then comparing the estimates to each other. We compute all estimates using data from National Data Buoy Center (NDBC).

WAVE MODELING

Spectral wave density data is generally sparse. For example, in Florida only five of the nearby NDBC buoys contain this information. The paucity of spectral density data largely motivates the use of a numerical wave model. Here, we use the operational wave forecasting system model, WAVEWATCH III. This model uses bathymetry, wind, sea surface temperature, and ocean boundary conditions, to estimate spectral density data at specified locations.

WAVE POWER ANALYSIS

The wave power potentional in the coastal regions of Florida are thoroughly investigated. Locations with the largest and most steady power potential are identified through a comparative assessment of the coastal regions studied. Spatial and temporal distribution of the wave power potential is also investigated.

CLIMATE CHANGE IMPACTS

Effects of climate change on wave power potential, e.g. sea level rise and changes in storm climatology, are also explored in this study. It has been shown that large mean sea levels cause extreme wave heights and increase the frequency of extreme wave climates [4]. Furthermore, we anticipate that expected increases in wind strength, wind duration, and wave heights for everyday conditions will amplify wave power potential in the coming decades, and assess that here. We also consider the impact of extreme events, which are generally expected to occur more frequently at greater intensities, in order to estimate changes in wave power potential over the next century.

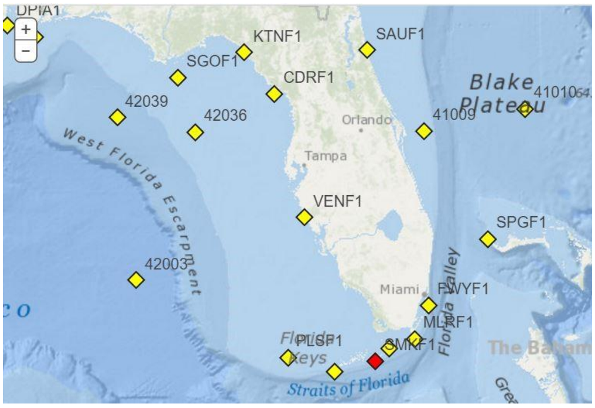

Figure 1 – Study Area and current National Data Buoy Center (NDBC) buoy locations

KEYWORDS

Wave power potential; Wave energy converter; Renewable energy; Wave Modeling, WAVEWATCH III

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