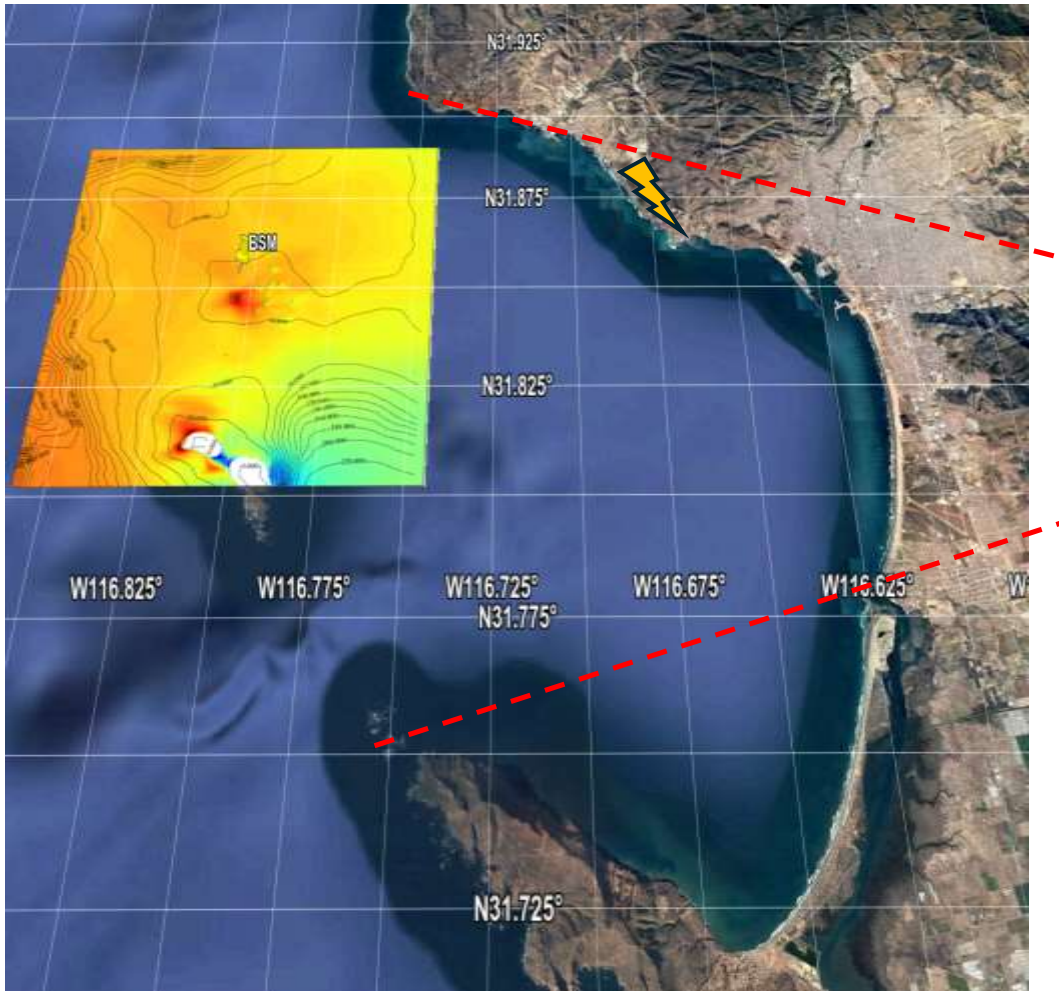
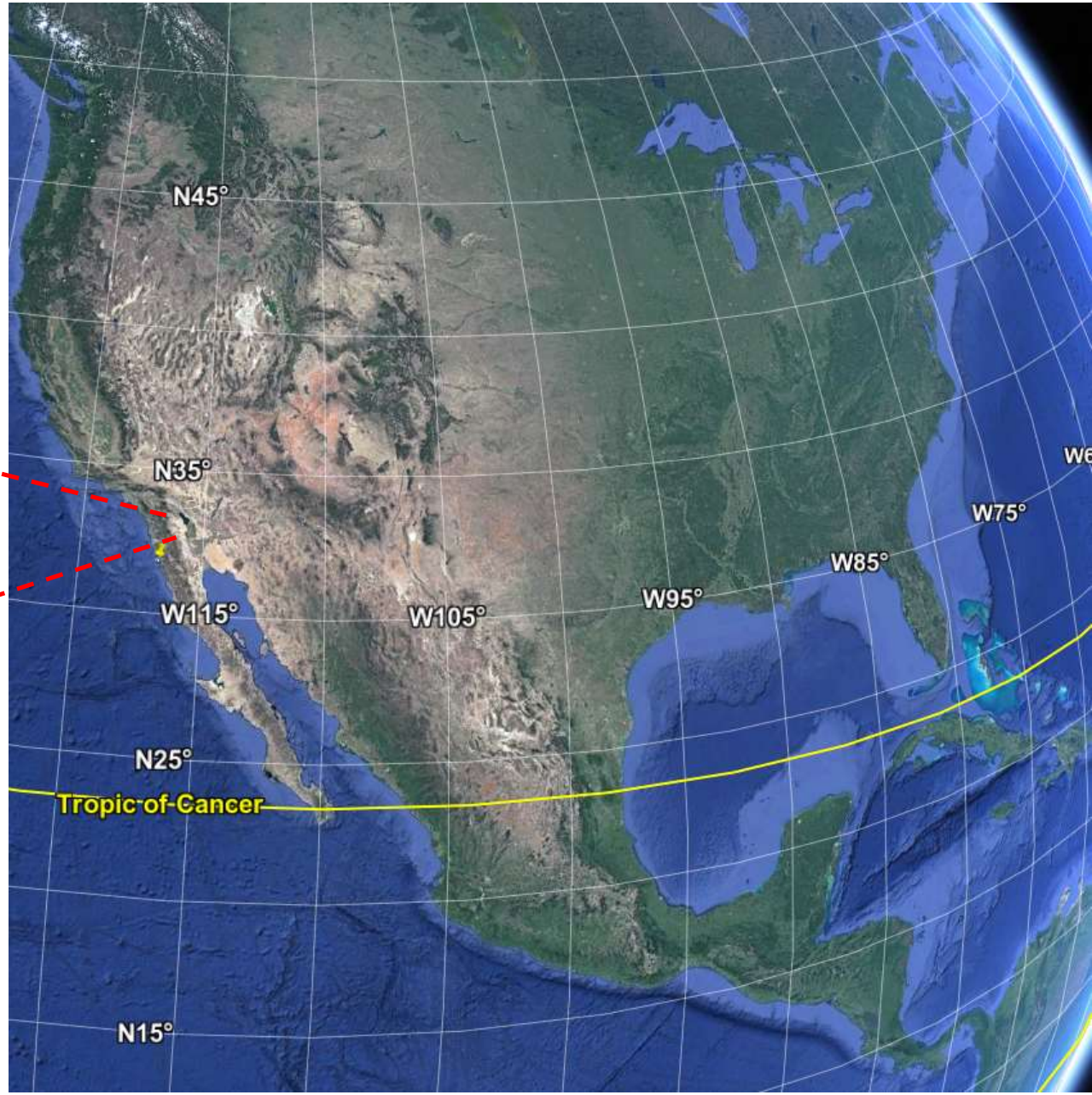
Optimization of a wave park using a spectral wave model and a binary genetic algorithm.

Santiago-Ojeda E. 1 , García-Nava H. 2 , and Gutiérrez-López E.3
1. FCM, Universidad Autónoma de Baja California 2. IIO, Universidad Autónoma de Baja California 3. FC, Universidad Autónoma de Baja California

PAMEC 2024, Barranquilla, Colombia.

Region





Position of electricity network

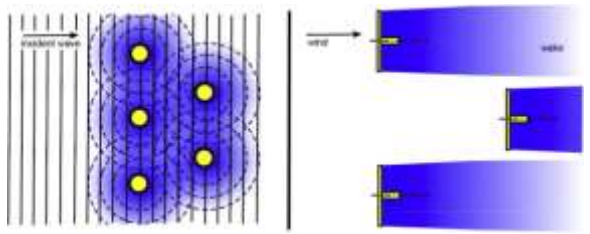
Objetive

- Evaluate the extractable power, through the analysis of different configurations and dimensions of wave energy converter device parks. Optimize the configurations and dimensions of a park

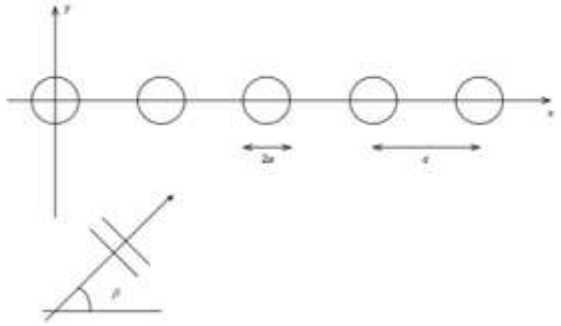
$$LCoE = \frac{\sum_{y=0}^{Y} PV\left(CapEx_y\right) + \sum_{y=0}^{Y} PV\left(OpEx_y\right) + \sum_{y=0}^{Y} PV\left(Dec_y\right)}{\sum_{y=0}^{Y} PV\left(AEP_y\right)}$$

Antecedents

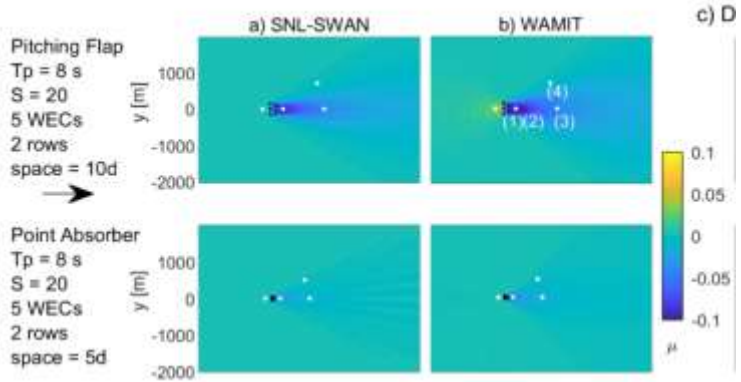
- Constructive and destructive interactions can impact the power generated by array.



(Babarit, 2013)



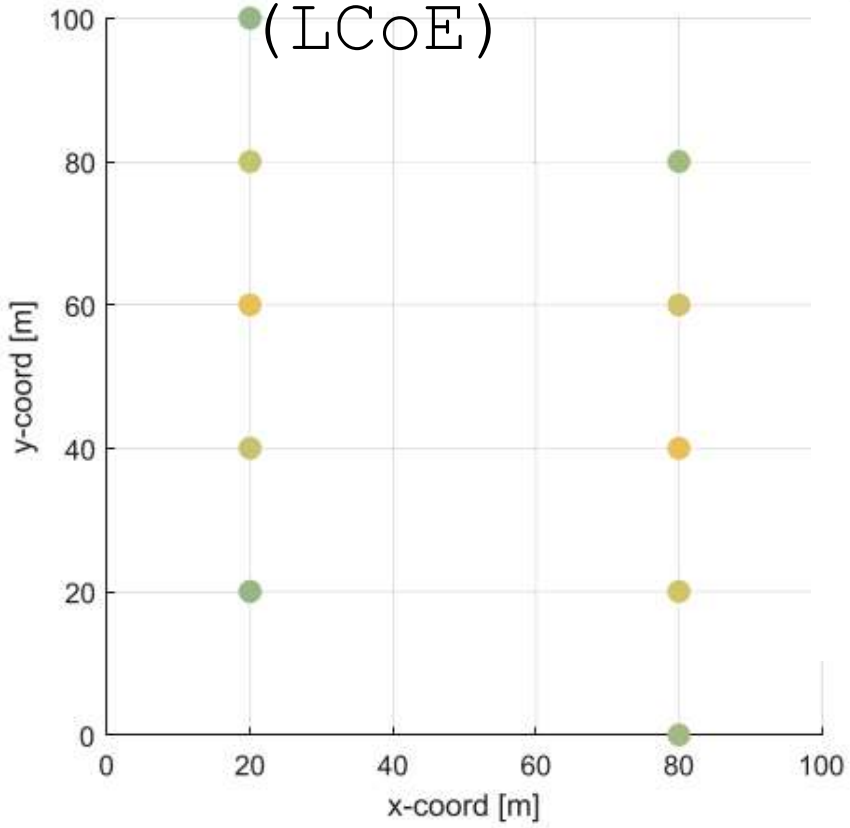
Fitzgerald and Thomas, 2016;



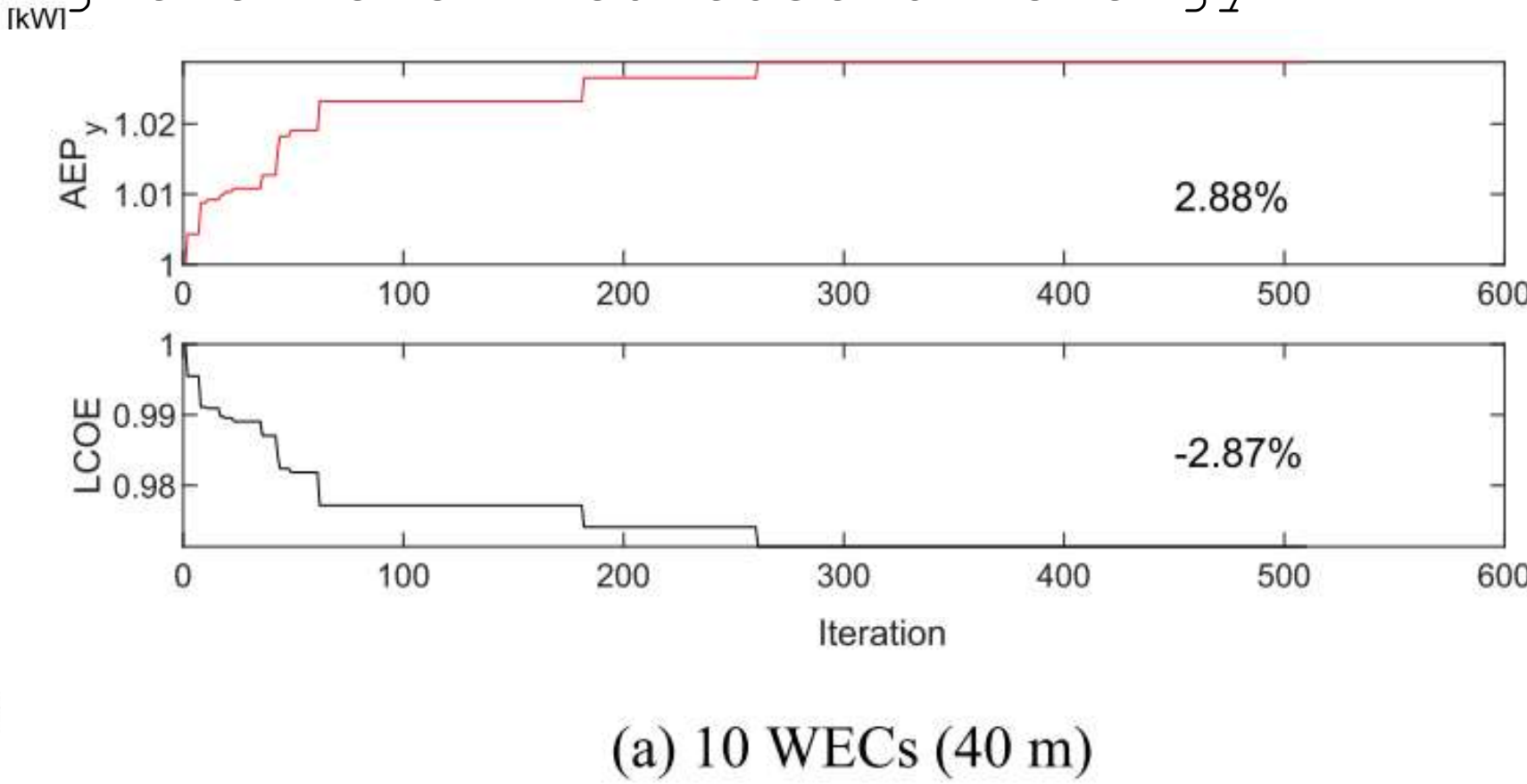
McNatt et al. (2020)

Optimization using LCoE

- For energy projects, cost is generally quantified using the levelized cost of energy (LCoE)



(a) 10 WECs (40 m)



(a) 10 WECs (40 m)

Giassi et al. (2020)

Methodology

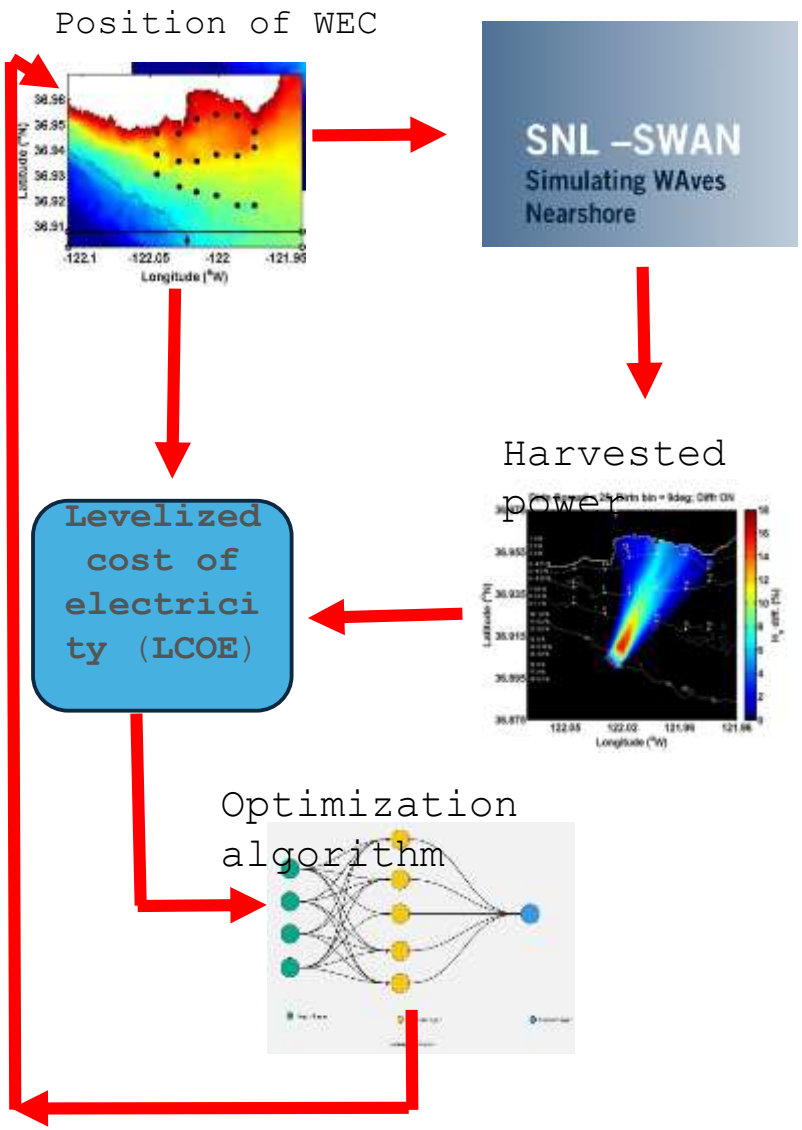
Definition of objective function and restriction.

1. First we choose the region, where we run the spectral model. Mesh size 0.1x0.1 degrees. with 256x256 cells.

2.Using position WEC in SNL-SWAN we obtain the power of the park .

3.With installation cost and maintain cost, we calculate the cost, The levelized cost of energy LCOE was used as the objective function.

4. Waves boundary conditions from Gorr-Pozzi et al. (2021) They simulated waves of the period from 2008 to 2018, with model SWAN.



What is a genetic algorithm?

It is a high-level search procedure that applies some rule or rules that are based on some source of knowledge in order to explore the search space efficiently.

Disadvantages are that it does not guarantee the global optimum, and its computational cost.

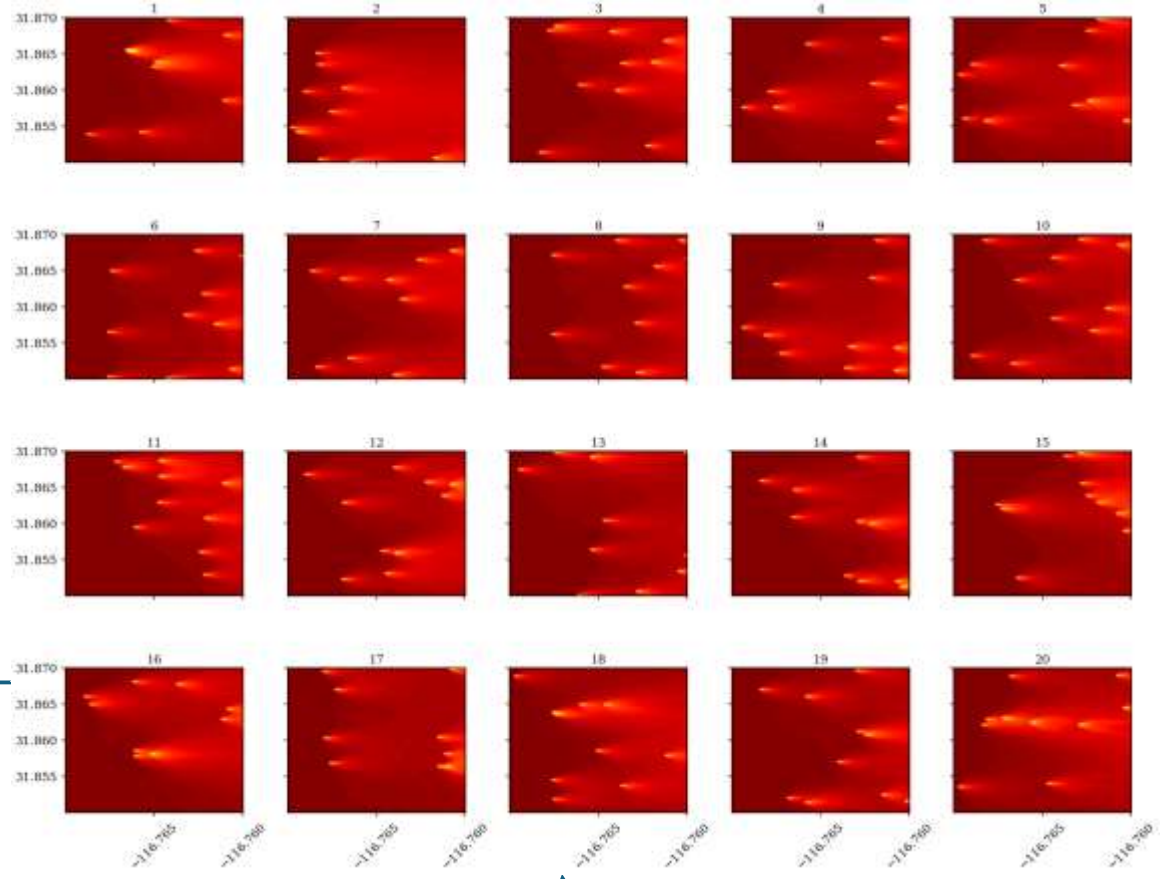
Its main advantages are that it is flexible and easy to use, and it is one of the latest frontiers of optimization.

Basic operation of a genetic algorithm

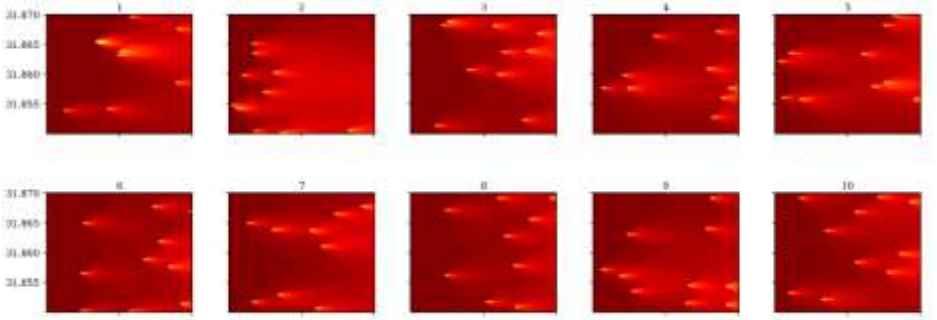
1. Randomly generate an initial population.
2. Calculate the fitness of each individual.
3. Select probabilistically based on fitness.
4. Apply genetic crossover and mutation operators to generate the following population.
5. Repeat steps 2 to 4 until a certain stop condition. Maximum number of iterations.

Genetic algorithm with SNL-SWAN

Initialisation

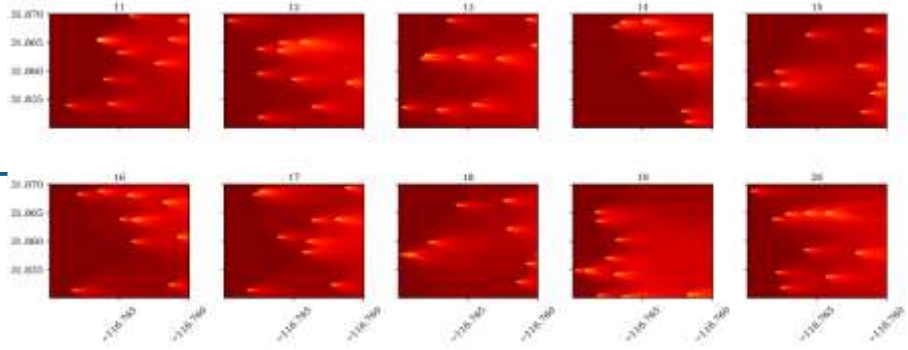


Parent selection



Recombination

Mutation

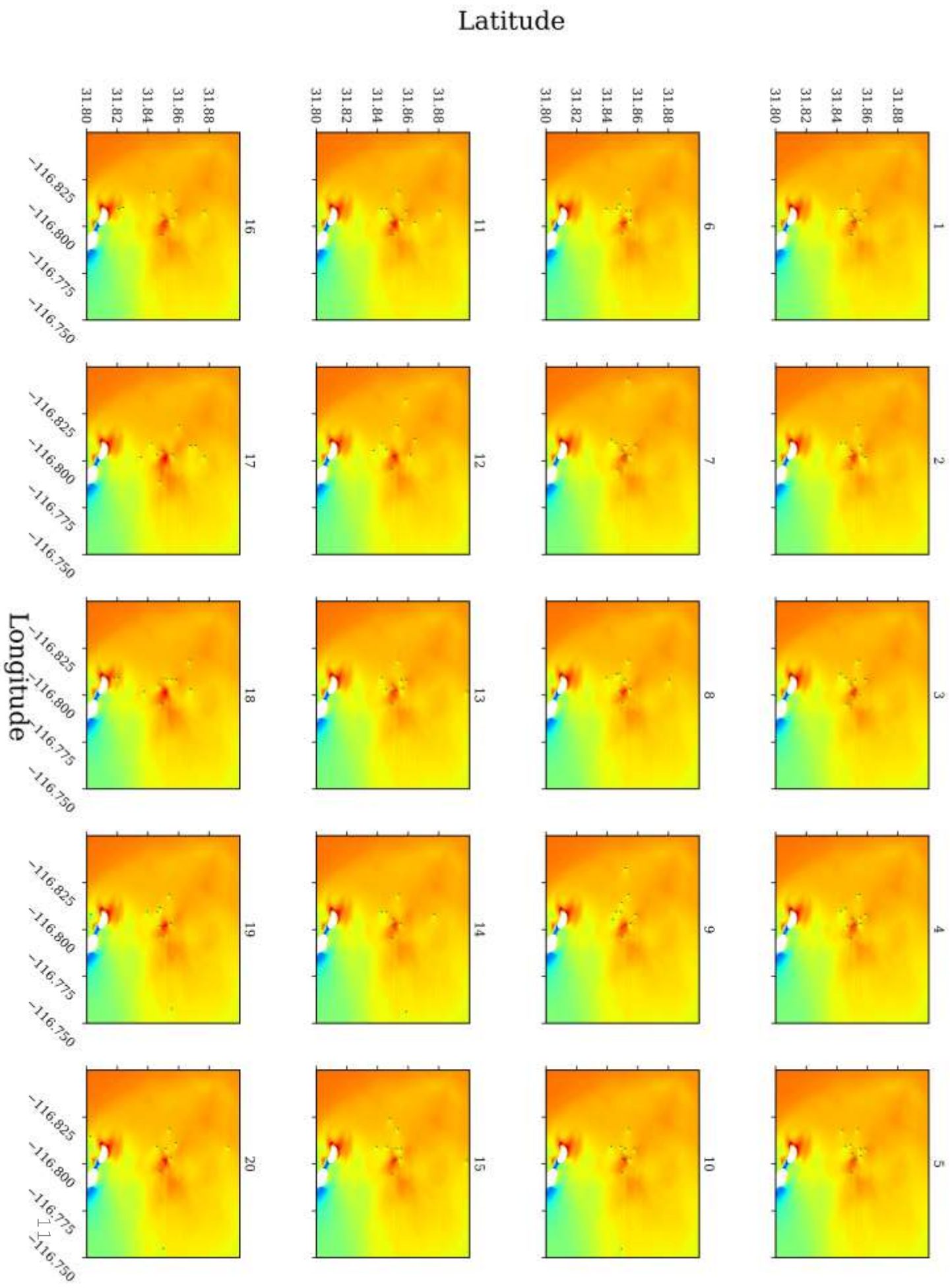


Survivor selection

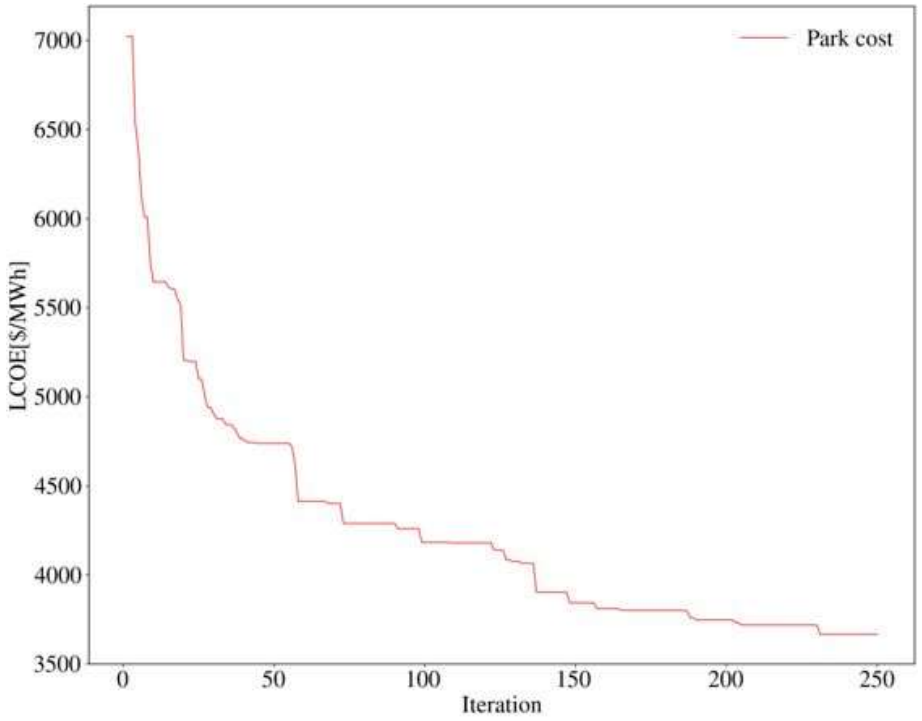
Termination

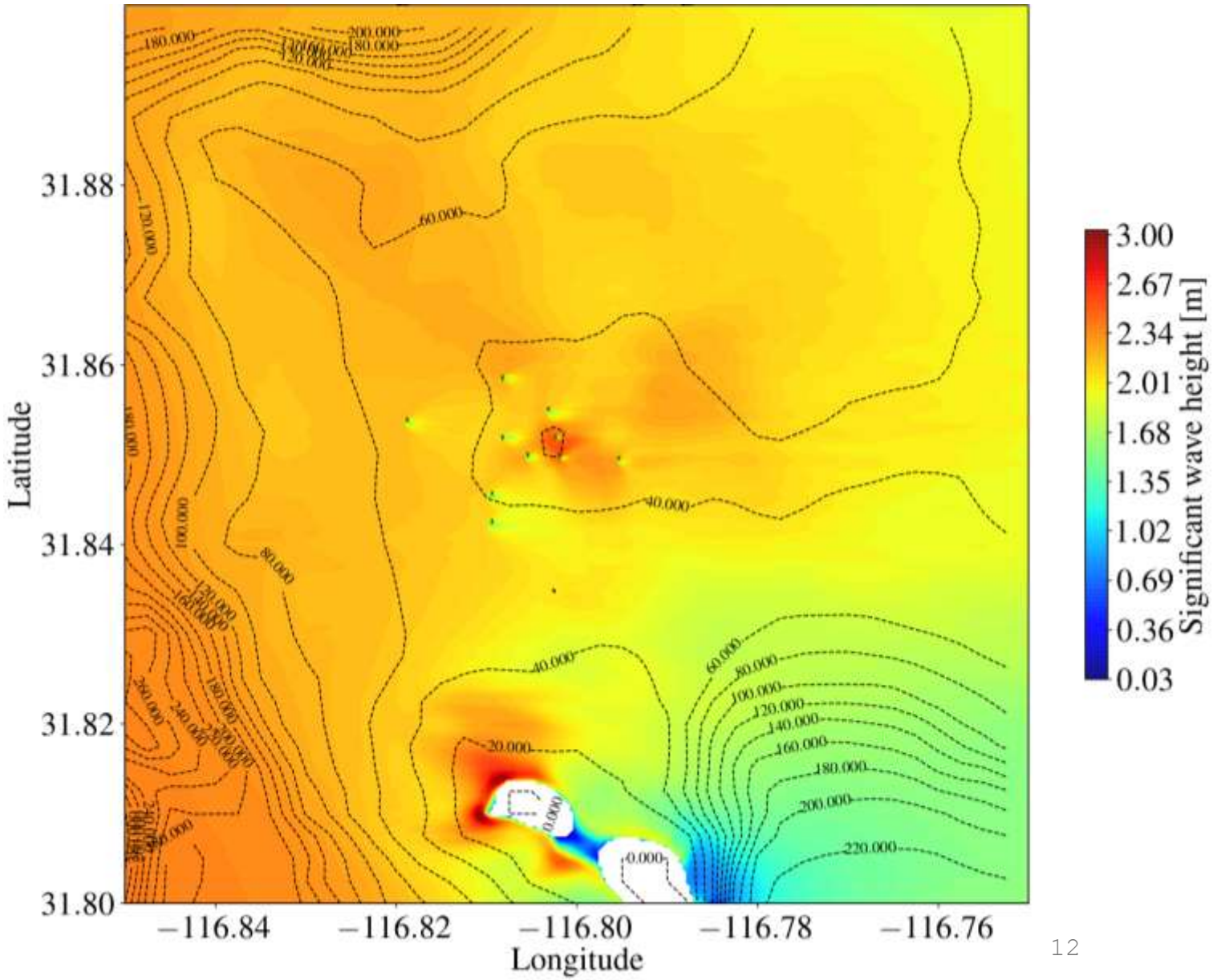
Preliminary results

The best sceneries found by GA



The highest rated scenario





Some issues until now

- Get prices for another devices
- Power matrix
- Lack of experiments in wave channels to validate
- We are optimized only LCoE but not maximized power production.

Thank you

This research is funded by a CONAHCYT scholarship

CONAHCYT

CONSEJO NACIONAL DE HUMANIDADES CIENCIAS Y TECNOLOGÍAS