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Title: Use of unstructured meshes for wave height and particles horizontal displacement analysis in central zone Veracruz, Mexico.

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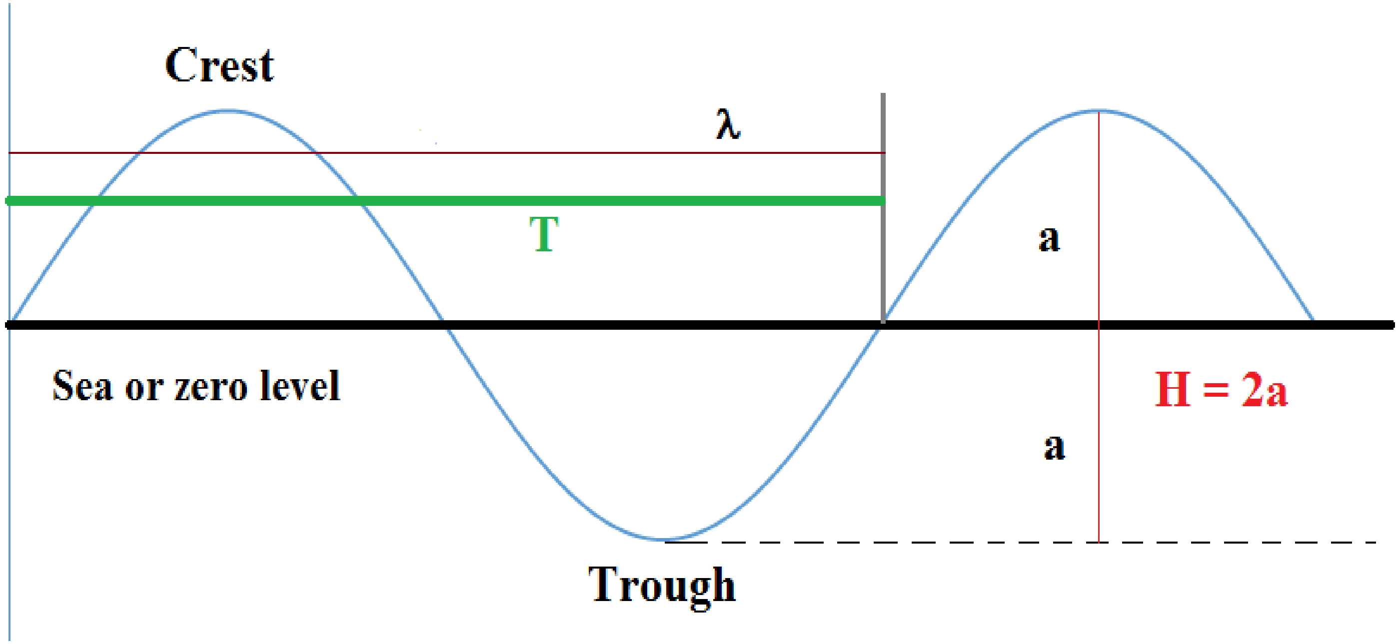
Introduction

The objective research is the calculation of free-floating particle displacement trajectory using the Simulating Waves Nearshore (SWAN) software having as base unstructured meshes to get the diagram of the study area. Third-party tools and data were used, such as bathymetry, wave and tide data from the Global Ensemble Forecast System-Wave (GEFS-Wave) and data processing using SWAN.

The modelling software and some local developments were used to generate valid Delaunay diagrams for the central zone of the Veracruz state, Mexico. For the configuration of the experiments, we worked with physics variables of the modelling software until achieving one that resembled the real conditions of the area; once the similarity was achieved, it was possible to run the experiments to obtain the wave height and frequency and replace the values in the horizontal displacement equation until obtaining the spaghetti diagrams that indicate the possible paths of the particles.

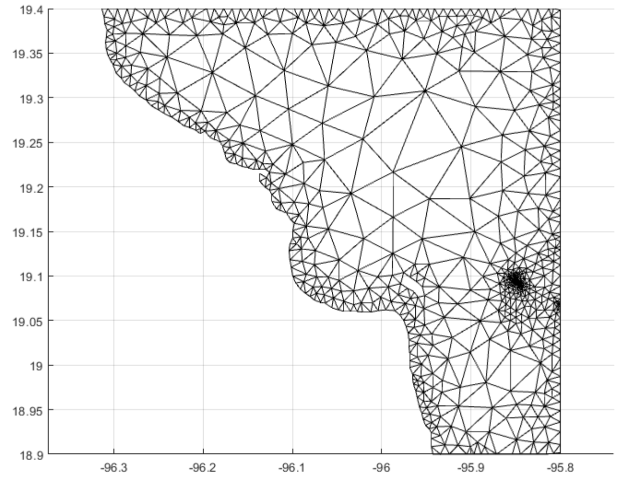
Methodology

A wave is considered to be the sinusoidal variation in elevation of the sea surface and can be defined as a height, **H**, which is the vertical distance from the crest to the trough of the wave in feet or meters, with wavelength, **λ**, which is the distance in feet or meters between two similar points on the wave and the wave period, **T**, which is the time in seconds or minutes it takes for the wave to repeat itself.



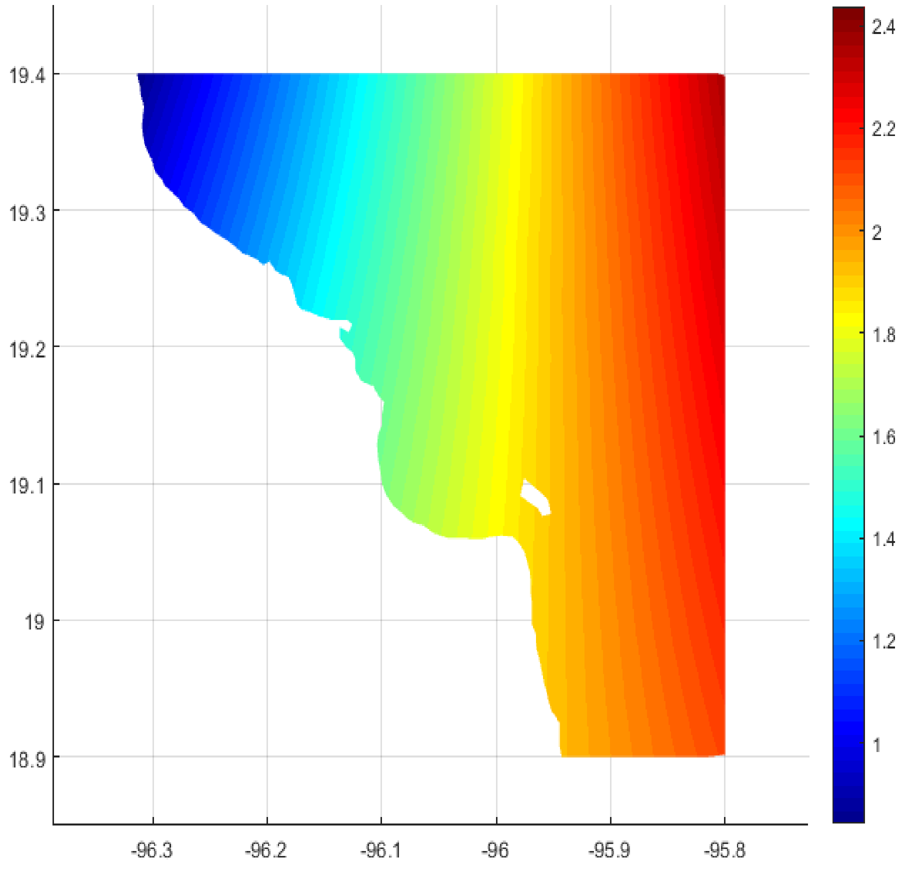
Although the experiment seeks to obtain the waves total height on the beach, the effect that the lunar cycles have on the tide must be considered; This is because the simulation software performs the calculations for the waves height caused by the wind and does not contemplate a dynamic generation of the tide with the lunar cycles, so it must be entered manually. There are some oceanographic models from which the initial tidal data is taken. For this experiment we will use the data set of the GEFS-Wave, which is an assemble of the GFS and WW3 models administrated by NOAA; This model has the peculiarity that 1) the data is verified and 2) it takes the 6 hours of the last forecast generated in order to obtain continuity of the forecasts and discard the 00 or start time.

By definition the forecasts wave heights are the "Significant Wave Height"; this is the average wave height (trough to crest) of the highest 1/3 of the forecast waves. So working only with the output from the model misses the general rule: the largest individual wave one can find will be a little less than twice the significant wave height. It does not mean that all waves encountered will be within the forecasted significant wave height; some will be less and some will be more because the measurement uses the Rayleigh statistical distribution model. Consequently, the results produced by the SWAN model for the variables Hsig (significant wave height) and Hswell (significant swell height) will be used to calculate the seas variable



Some of the problems reported were the interpretation of the data produced by the SWAN simulator as well as the way in which it needs the input data to make the calculations on the wave's height considering the tide and the wind waves. One of the errors that appeared in the diagrams was the effect of wave tidal continuity.

```
CGRID UNSTRUCTURED CIRCLE 36 0.0521 1.0 31
Resolution in sigma-space: df/f =  0.1000

READ UNSTRUCTURED TRIANGLE 'veracruz'

The unstructured grid contains solely triangles generated by Triangle

Number of vertices          =    1715

Number of cells             =    3196
   Number of internal cells =    2970
   Number of boundary cells =     226

Number of faces             =    4909
   Number of internal faces =    4679
   Number of boundary faces =     230

The minimum gridsize =     0.00001
The maximum gridsize =     0.06978


INPGRID BOTTOM -96.40 18.9 0 143 119 0.004166 0.004166

$>INPGRID BOTTOM UNSTRUCTURED

READINP BOTTOM -1 'veracruz.bot' 2 6
**  Heading lines file veracruz.bot **
-> ncols        144
-> nrows        120
-> xllcorner    -96.400000000000
-> yllcorner    18.900000000000
-> cellsize     0.004166666667
-> NODATA_value -32767
```



Results

- Once the data were obtained, it was possible to substitute the values in the horizontal particle displacement equation and perform the analysis on free-floating bodies, such as some types of algae, as well as floating debris (garbage). The accumulated data allowed us to construct spaghetti-type diagrams that allow us to make an approximate calculation of the movement of objects on the ocean surface. An accumulation of data is mentioned since a spaghetti diagram reflects the possible change in the path of a body, and this change cannot be reflected only in time t; a sequence of t, t+1, t+2… t+n is required to indicate the expected change.

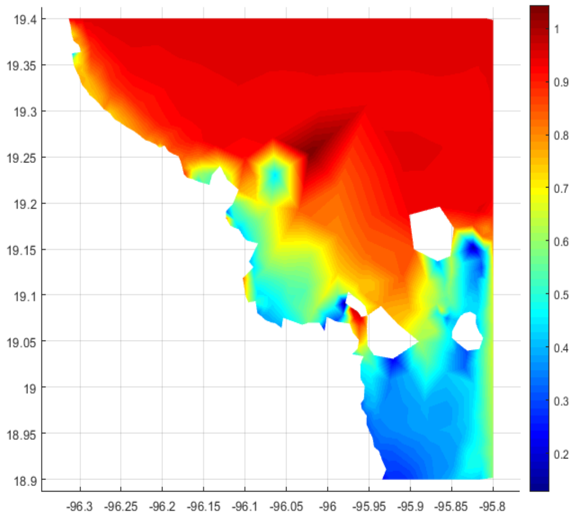


Table: Results01, SWAN version:41.31AB				
date	Hsig	Hswel	seas	buoy
01/10	1.5893	0.1976	1.6015	2.089
01/11	1.9837	0.2467	1.9989	2.108
01/12	1.6832	0.2093	1.6961	1.967
01/13	2.1233	0.2640	2.1396	2.472
01/14	2.4428	0.3038	2.4616	2.278
02/20	0.73153	0.09126	0.7372	0.8367
02/21	0.32296	0.04014	0.3254	0.4921
02/22	0.66603	0.07802	0.6705	0.6252
02/23	0.13386	0.01923	0.1352	0.1593

Conclusions

- The results showed a high percentage of acceptance with respect to the values recorded by the tide gauges and buoys, showing a variation within 20%. The particles horizontal displacement showed great consistency with the movement of floating objects that were in the area, but it was not possible to validate them mainly due to the lack of information from the authorities; although laboratory results with satellite images indicated a good correlation.
- Just as the software considers variables for the experiment physics, it would also be advisable to have several data sources that could be introduced into the experiment, thus not only having data from SEMAR and NOAA. Likewise, for further research, the use of non-hydrostatic, free-surface, rotational flow and transport phenomena in coastal waters models is suggested; such as SWASH, XB and ADCIR, among others.

Conclusions …

- The experiment showed consistency with the available data and scales; It would be advisable to have more sensitive bathymetry data and a smaller area (less than 100 km^2) if the objective was to analyze the waves height and their approach or invasion of beach or inland areas.

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