

WAVE CHARACTERISTICS FROM SPARSE DATA WITH IMPLICATIONS TO DERIVE COASTAL BATHYMETRY FROM REMOTE SENSING

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CONTEXT

Estimating bathymetry through remotely-sensed waves from optical imagery, lidar and radar, is a current major challenge of coastal science and engineering. Dense, abundant and regular dataset are generally required to capture wave characteristics. This seems to be the main limitation preventing the use of satellite remote sensing and other short observation bursts with space or time constraints (Almar et al., 2020). While traditional approaches privilege either space or time sampling, a great advantage can be found in the use of both.

DATA AND METHODS

Synthetic dataset is generated using the Croco (Coastal and Regional Ocean Community) model (Marchesiello et al., 2022), in its tridimensional and non-hydrostatic phase-revolving version. Free surface synthetic data from typical nearshore simulations over 500m x 500m with a 1 m resolution over 1 min and 1s output resolution is done. Simulations with monochromatic and JONSWAP wave forcing were considered.

Data are extracted within spatio-temporal slices - that is the actual resolution of the method to derive wave kinematics. Over these slices, hundreds to thousands random points are selected typically (Figure 1).

Two approaches are introduced and tested against modeled wave fields, using optimization and a very fast matrix transformation.

The optimization process identifies a minimum point of a cost function, which quantifies the least squares error between a linearly dispersed wave and the actual data, across various variables. These variables here include wave direction, period, and wavelength, and there is also the possibility of assessing an underlying current. Similarly, the matrix-based approach is an optimal data reduction transformation to find the absolute minimum.

RESULTS

We explore here how best to handle irregular and spatially and temporally limited data of ocean surface elevation - or a proxy such any signal intensity - in order to derive wave characteristics.

The results of constrained optimization appear to be more robust whereas the unconstrained solver leads to unstable results where the estimated variables vary significantly. Furthermore, the estimate show to be sensitive to the resolution of the dataset, despite the randomly selected points. Hence, due to computational considerations, the matrix-based approach appears to hold promise.

Advantages and disadvantages over conventional

methodologies such as Satellites to Shores (S2Shores, Bergsma et al., 2019), with spectral or correlation approaches (Almar et al., 2021), are discussed, with implications for bathymetry retrieval.

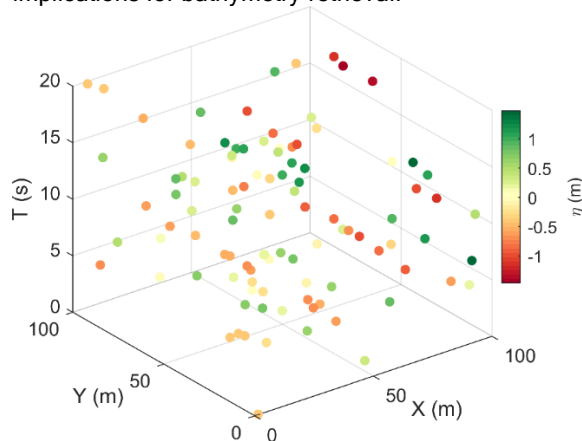


Figure 1 - Illustration of sparse and limited surface elevation wave data within a 3-dimension space-time slice.

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