Preparing an XBeach Simulation

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March 5, 2024

Abstract

A step-by-step guide to preparing the bathymetry and wave boundary files needed prior to performing an XBeach simulations is discussed and outlined. Due to the limitations of the nonlinear shallow water equations (solved by XBeach), a larger domain solved using an wave-averaged approach (solved by SWAN) is performed in preparation of the XBeach domain, and boundary conditions. A series of necessary steps and use of relevant code is outlined in this document for the generation of such input files prior to performing an XBeach simulation.

1 Introduction

Wave data from wave buoys are generally available in deep waters. In addition, accurate prediction models are also available for such. But for nearshore regions, at shallower water depths, the data is much more scarce, and the more computationally expensive models are necessary. Due to the high variability or low accuracy of empirical sediment transport formulas, which are the basis of current sediment transport models, mainly due to its complicated nature. The wave conditions at the nearshore must be accurately estimated from deep-water locations. This can be performed using nearshore wave models like the Non hydrostatic version of XBeach, which is based on the nonlinear shallow water equations. Unlike, energy conservation based models, this type of model is wave-resolving and provides us wave per wave information of the nearshore hydrodynamics. Given the accuracy of these types of models, due to the assumption of weak dispersivity, the validity is limited to a certain depth. Thus, in order to obtain the wave conditions at the XBeach boundary, we calculate the propagation of waves using a wave-averaged model, based on the conservation of energy, SWAN, which is generally applicable to waves in intermediate to deep water. Generally, the use of a larger scale domain from deep water up to the XBeach boundary is used and simulated using an energy based approach (SWAN). Then wave conditions at the range of validity of the NLSWE's are obtained and input to the XBeach simulation. XBeach uses this information as its offshore wave boundary data, which it then uses to solve the NLSWE's up to the nearshore where sediment transports is of significant concern.

2 Methodology

The methodology is summarized as follows:

1. Generate SWAN domain. This extends from the deep water region atleast up to the offshore boundary of the XBeach domain. Although unnecessary, due to SWAN being computationally inexpensive, the grid is usually extended up to the shoreline as well.

2. Simulate waves in SWAN from offshore, wave gauge location to XBeach boundary. Note that this initial simulation is intended to determine the direction of the waves close to the potential XBeach boundary. A matlab code is provided to plot the (2d) wave propagation simulation results and easily select the XBeach domain and offshore boundary points to be perpendicular to the offshore waves, while including the site of interest close to the shoreline.

3. After selection of the XBeach domain and offshore boundary locations, we perform another SWAN simulation to obtain spectral information of the wave conditions at the selected boundary points. This spectral information is then used as input for the XBeach simulation together with the generated grid.