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An integrated framework that combines machine learning and numerical models to improve wave-condition forecasts

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Abstract

This study investigates near-shore circulation and wave characteristics applied to a case-study site in Monterey Bay, California. We integrate physics-based models to resolve wave conditions together with a machine-learning algorithm that combines forecasts from multiple, independent models into a single "best-estimate" prediction of the true state. The Simulating WAves Nearshore (SWAN) physics-based model is used to compute wind-augmented waves. Ensembles are developed based on multiple simulations perturbing data input to the model. A learning-aggregation technique uses historical observations and model forecasts to calculate a weight for each ensemble member. We compare the weighted ensemble predictions with measured data to evaluate performance against present state-of-the-art. Finally, we discuss how this framework that integrates data-driven and physics-based approaches can outperform either technique in isolation.

1. Introduction

Physics-based numerical models are defined by: (1) the physical formulation, (2) numerical discretization, and (3) input data driving the simulations. Typically, all three involve some degree of uncertainty. Wave modeling

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