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The Naval Seafloor Evolution Architecture: a platform for forecasting dynamic seafloor roughness

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Model predictions of waves, currents, and sediment transport, as well as the acoustic response of the seafloor depend on reliable estimates of seafloor roughness due to both sediment properties and bedform geometry. To predict the spatial and temporal dynamics of seafloor roughness under changing wave conditions, we have developed a modular modeling framework, the Naval Seafloor Evolution Architecture (NSEA). NSEA requires hydrodynamic forcing as input, which can either be directly observed or output from a hydrodynamic model. A nonequilibrium spectral ripple model is driven with this forcing to estimate the power spectrum of the seafloor elevation. Stochastic realizations of seafloor roughness consistent with this power spectrum are generated, which can be used as input to acoustic models to predict the acoustic response of the seafloor. Running ensembles forward through the model allows uncertainty in the hydrodynamic forcing, the sediment properties, and the parameters of the spectral ripple model and acoustic model to be propagated to the model outputs. Bayesian inference can also be applied to solve the inverse problem of estimating the seafloor spectrum and model parameters from observations. We illustrate the features of this model architecture by applying it to estimate seafloor roughness during a field experiment off the coast of Panama City, Florida, USA. We show how NSEA, working in both forward and inverse mode, can use available hydrodynamic models and observations as well as side-scan sonar imagery of the seafloor to estimate changing seafloor roughness with quantified uncertainty.