Applied Math Seminar scheduled on Wednesday, April 24, 2019, 2:30-3:30pm, CR5209

Speaker: Prof. Scott James (Baylor University)

Title: Deep Learning Surrogate Models to Forecast Ocean-wave Conditions

Abstract:

The coastal ocean represents a complex modeling challenge, intimately connected as it is to both the deep ocean and the atmosphere. The temporal evolution of oceanic processes (surface waves, flow fields, etc.) are characterized by highly nonlinear behavior; further, these processes are highly sensitive to external forces (e.g., changes in wind speeds) and other factors (e.g., local bathymetry and topography). By supervised training of machine learning models on many thousands of iterations of a physics-based wave model, accurate representations of significant wave heights and period can be used to predict ocean conditions. A model of Monterey Bay was forced by measured wave conditions, ocean-current nowcasts, and reported winds. These input data along with model outputs of spatially variable wave heights and characteristic period were aggregated into supervised learning training and test data sets, which were supplied to machine learning models. These machine learning models replicated wave heights with a root-mean-squared error of 9 cm and correctly identify over 90% of the characteristic periods for the test-data sets. Impressively, transforming model inputs to outputs through matrix operations requires only a fraction (~1/5,000th) of the computation time compared to forecasting with the physics-based model.

About the speaker:

Scott James received his BS and MS in Mechanical Engineering from UC San Diego with emphases in computational fluid dynamics. In 2001, he graduated from UC Irvine with a doctorate in Engineering emphasizing solution of environmental flow and transport problems. Shortly thereafter, he joined Sandia National Laboratories to work on the Waste Isolation Pilot Plant, the only operating transuranic nuclear waste repository in the world, the Yucca Mountain Project for high-level nuclear waste storage, and on a wide variety of water-resources and renewable energy problems. From 2012 to 2014, consulting for E^{x}ponent Incorporated, he focused on identifying the environmental impacts of marine renewable energy projects, modeling and optimizing algae growth for biofuel production, and simulating enhanced oil recovery techniques. Since joining the Departments of Geosciences and Mechanical Engineering at Baylor University, in addition to working on various environmental fluid dynamics projects, Scott conducts research at the intersection of water and energy with recent interests in deep learning applications.