Characterizing uncertainty in ensemble models of oil spill fate and transport.

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Abstract

Modeling oil spill fate and transport requires inputs of physical forcing (typically from circulation models), which rarely come with metrics of uncertainty. Uncertainty in winds and currents from these models can vary due to data assimilation (or lack thereof), numerical mixing differences across model architectures, errors in forcing, and biases that arise when parameterizing physical processes that are not resolved by the model grid. In order to gain the most benefit from frontier advancements in oil spill fate and transport predictions, we need to develop metrics of uncertainty in order to better qualify our results and train AI algorithms. In this study, we explore the use of Dynamical Systems Tools to characterize the uncertainty of impacts from a World War II sunken vessel, Coast Trader. We compare predictions of upwelling, downwelling, and transition seasons (Spring and Fall) using a combination of both Canadian and U.S. response circulation models, represented in two cases: (1) HRDPS (winds) with CIOPS-W (surface ocean currents), and (2) ERA-5 (winds) with WCOFS (surface ocean currents). We show seasonal variations in fate and transport for these two case studies using a one hundred member Monte Carlo simulation in each season. Although wind forcing plays a significant role in oil spill fate and transport, we can explain differences in results based on evaluations of surface ocean currents. In addition, drifter observations are compared with ensemble statistics of likelihood to evaluate predictive skill. In addition to the scientific results, this project demonstrates the strength of international collaborations in supporting recovery operations and responding to threats from oil and chemical spills.