Object-Based Evaluation of Marine Heatwave Predictions

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The ocean has absorbed 90% of recent warming associated with anthropogenic climate change; as a result, extreme ocean heat events known as marine heatwaves (MHWs) are becoming more frequent and more intense. Accurate and understandable MHW forecasts are needed to allow local decision makers and industries to respond to and plan for these events. Recent work demonstrates skillful prediction of MHWs at each gridpoint in the ocean. Here, we illustrate and evaluate a method of detecting and predicting spatially connected MHW objects. To demonstrate the predictive capabilities of object-based MHW forecasting we apply Ocetrac, a MHW tracking tool, to the Seasonal-to-Multiyear Large Ensemble (SMYLE) Experiment, a set of initialized hindcasts using the Community Earth System Model that contains 20-member ensembles of 24-month simulations initialized quarterly from 1970 to 2019. After detecting MHWs at each gridpoint and time step, we use Ocetrac's morphological image processing to connect events spatially.

To evaluate the predictive skill of object-based MHW forecasting, we apply the Method for Object-based Diagnostic Evaluation (MODE) to MHW events identified by Ocetrac in all SMYLE initializations from 1989 to 2018. We quantify the accuracy of predicted MHW attributes such as area, location, and intensity, and assess metrics of predictive skill such as the Maximum of Median Interest and the Gilbert Skill Score. We also use case studies to demonstrate visualizations and evaluate the skill of notable MHW events. This work illustrates the capacity to forecast connected MHW events and to quantify the uncertainty in those forecasts. Accurate MHW forecasts will provide essential information to fisheries managers and conservationists to help stakeholders prepare for future MHWs.