Forecasting global-scale marine species distributions: Combining Marine Ecosystem Models and Bayesian additive regression trees

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Marine Ecosystem Models (MEMs) have been developed to analyse the past and future dynamics of the oceans. One of such efforts is EcoOcean, a complex, mechanistic and spatio-temporal explicit MEM of the global oceans based on a trophodynamic core. EcoOcean can be informed with the species native ranges and suitable habitats. For key environmental variables, species' functional responses and time-varying maps delivered by Earth System Models (ESMs) are needed. The different sources of uncertainty in these inputs may influence the validity and accuracy of EcoOcean results. For this reason, our study explores the use of global SDMs to reduce the uncertainty associated with these inputs. A promising new alternative to traditional SDMs classification tree methods is the Bayesian Additive Regression Trees (BART). BART is a non-parametric Bayesian regression approach based on a sum-of-trees model. Our hypothesis is that BART can be a powerful approach to inform global-scale Marine Ecosystem Models (MEMs). In this study, we compare the projected results of EcoOcean when incorporating the outputs of BART as inputs and compare them with runs without informing the global model. Specifically, we perform a study on the combination of BART and EcoOcean targeting several species of marine mammals and top predators (marine turtles, tunas, sharks, etc.). All functional groups include species distributed very differently in the marine environment, some being highly commercial and other being non-commercial, and show a global distribution as a functional group.

Keywords: BART, EcoOcean, ensemble, global scale, and climate change.