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Predicting massive floating macroalgal blooms in the regional sea

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Increasingly severe and massive floating macroalgal blooms pose significant challenges to the prediction and management of coastal and ocean environment. This study introduces the Floating Macroalgal Growth and Drift Model (FMGDM), a physical-ecological model that tracks, replicates, and extinguishes Lagrangian particles to dynamically simulate the growth and drift pattern of floating macroalgae. The model updates the position, velocity, quantity, and represented biomass of these particles synchronously within its tracking and ecological modules. The macroalgal ecodynamic processes are driven by the oceanic physical-biochemical environments of hydrodynamics, temperature, nutrients, and atmospheric conditions. With the support of the hydrodynamic model and biological macroalgae data, FMGDM can serve as a model tool to forecast floating macroalgal blooms. We developed a forecasting system for large-scale floating macroalgal blooms, which integrates the FMGDM with the Finite-Volume Community Ocean Model (FVCOM). This system is capable of predicting the physical-biogeochemical environment and macroalgal ecodynamic processes in the regional ocean. Biological parameters for this model were specifically derived from culture experiments of *Ulva prolifera*, a phytoplankton species causing the largest worldwide bloom of green tide in the Yellow Sea, China. With real-time multi-resource satellite data, the system successfully applied to predict green tide events in the Yellow Sea for 2021-2023. The prediction accuracy of coverage can reach 67.0%, and the minimum error of green tide center of mass is 7.39 nautical miles for total coverage of 52.01 km^2 and prediction duration of 7 days. Supported by regional marine data and macroalgal physiological characteristics, this system can be expanded to other similar floating macroalgal blooms.