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Using deep learning methods to create translators between biogeochemical models, improving regional ocean model global integration

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Abstract: The marine ecosystem is driven by a complex set of processes spanning a wide range of temporal and spatial scales. Processes-based modelling is one of the key elements in our understanding of the marine biogeochemical status of the ocean and the prediction of its future. With the increasing complexity and specific application of biogeochemical (BGC) models, comes the difficulty to cross over between the variety of models and being able to leverage from one model simulation to another. Most BGC models have a different size class arrangement for plankton species meaning it is challenging to initialize/nest a BGC model using another one. Regional applications of a biogeochemical model usually use climatology or statistical relationship to initialise and set ocean boundary conditions for the BGC tracers. By setting the offshore boundary far enough from the area of interest the errors due to the poorly constrained boundary usually dissipate before impacting the model result in the region of interest. Improving interoperability across different BGC models could alleviate this problem and allow for the complete integration of regional models within global models. Here we show that machine learning algorithms (generative adversarial network (GAN)) can be used to create a translator between different BGC models. The neural network learns the specifics of the complex BGC regional model from variables common across all BGC models (total chlorophyll, nitrate, temperature, salinity). The GAN can then be used to regenerate the specific variables of the regional model from the global model. We applied this translator to the eReefs biogeochemical model and performed a set of twin experiments to quantify the errors and behaviour of the model when using the translator.

Keywords: *Marine ecosystem, biogeochemical models, interoperability, machine learning, eReefs*