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Confronting complexity: modelling marine ecosystems and their response to climate change

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Biogeochemical modelling of the world's oceans has for many years involved using so-called nutrient-phytoplankton-zooplankton-detritus (NPZD) models in which primary producers and their consumers are represented each by a single state variable. Many recent models are however dividing the plankton into different functional types (PFTs) such as diatoms, coccolithophorids and nitrogen fixers, based on the realisation that particular system feedbacks, e.g. those associated with climate change, are related to individual groups. Incorporating extra complexity beyond NPZD is however fraught with difficulties: poorly understood ecology, aggregating species into meaningful functional groups, sensitivity to the parameterisations in question, and lack of data and adequate validation techniques. Whereas the continued articulation of detail in marine ecosystem models is undoubtedly the way forward, this must be tempered by a healthy dose of scepticism regarding model outcomes. Objective methods of validation and model intercomparison are central to future progress. In this context, I argue that NPZD models do a relatively good job at predicting bulk properties such as total chlorophyll and primary production, and that validation of complex models must therefore focus on model-data intercomparison for the PFTs themselves. Future approaches should focus on building up complexity gradually, where possible focusing on key organisms rather than necessarily a multitude of interacting plankton groups.