Modelling marine connectivity in the Great Barrier Reef with SLIM

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High-resolution ocean circulation models are required to simulate the complex and multi-scale currents that drive physical connectivity between marine ecosystems. However, standard coastal ocean models rarely achieve a spatial resolution of less than 1km over the >100km spatial scale of dispersion processes. Here we use the high-resolution unstructured-mesh coastal ocean model SLIM that locally achieves a spatial resolution of 100m over the scale of the entire Great Barrier Reef (GBR). Using such a high-resolution model allows us to simulate the classical cascade from large-scale to small-scales, but also a feedback from the small-scale to the large-scale. By coupling SLIM with a biophysical model of larval dispersal we can track the position of virtual larvae or propagules released into the simulated domain. Connectivity matrices are then generated from the positions of the particles at the start and at the end of the simulations. Useful information can be extracted from these large matrices by using graph theory tools such as community detection, page rank and influence rank algorithms. These methods are illustrated for different applications including connectivity between submerged and near-sea-surface coral reefs and crown-of-thorns starfish outbreaks. Our study suggests that combining a high-resolution multi-scale ocean model with novel graph theory algorithms is a powerful tool for studying physical connectivity between marine ecosystems and informing management decisions.

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