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Coupling across individuals, populations and human systems in marine ecosystem models

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Understanding and projecting responses of marine ecosystems to changing climate conditions and direct human impacts, such as fisheries, requires integrated ecosystem analyses at scales previously unexplored. This lecture will use examples from existing marine ecosystem models that illustrate coupling of physical and biological processes at a range of scales and discuss limitations inherent in particular model structures. The ecological and modeling challenges in predicting the responses of marine ecosystems to change will be discussed within the context of three focus areas. The first focus area is development of fundamental understanding of the factors that determine the structure and function of the food webs at multiple scales. Ecological research is often centered on key species or localized systems, a tendency which is reflected in existing food web and ecosystem models. To build on this, a systematic analysis of regional food web structure and function is required. The second focus area is development of a range of mechanistic models that vary in their resolution of ecological processes, and consider links across physical scales, biogeochemical cycles and feedbacks. The third focus area is development of methodologies for scenario testing across a range of trophic levels of the effects of past and future changes, which will facilitate consideration of the underlying complexity of interactions and the associated uncertainty. Modeling approaches that are developed within a scale-based framework that emphasizes both physical and ecological aspects will be discussed. The lecture will end with a discussion of coupling of marine ecosystem models to human system models.