Impact of ecosystem variability in the tropical Indian Ocean: A coupled 3-D bio-physical ocean general circulation model

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Abstract

This paper describes the results of a coupled 3-D bio-physical model, ocean general circulation model ROMS with an ecosystem model, which has been employed to study biogeochemical variability in the Indian Ocean. The ecosystem model consists of the nitrogen cycle model with parameterized sediment denitrification described by Fennel et al. (2006) and a model of carbonate chemistry following Zeebe and Wolf-Gladrow (2001). The comparison between observed satellite-derived ocean-color images and model simulated chlorophyll demonstrates that the model is successfully capturing the seasonal inter-regional contrasts in sea surface chlorophyll distribution. The model is adequately characterizing two distinct growth periods of phytoplankton, bloom, one in summer during the South West Monsoon (SWM), the other in winter during the North East Monsoon (NEM). The model is successfully producing a persistent occurrence of subsurface chlorophyll maximum in the Arabian Sea and in the Bay of Bengal and is validated with observations from Argo floats deployed in the southeastern Arabian Sea and in the northern Bay of Bengal during 2013. The sea surface bloom is caused by the entrainment not only of subsurface nutrients but also due to subsurface chlorophyll maximum. The model effectively simulates the characteristics of oxygen minimum zones (OMZs), which are intermediate-depth layers featuring low oxygen saturations, as observed in the Arabian Sea and in the Bay of Bengal. The existence of a subsurface oxygen maximum zones is attributed to the process of photosynthesis in subsurface chlorophyll maximum zone (Shulenberger and Reid, 1981; Riser and Johnson, 2008).

Keywords: Indian Ocean, Marine ecosystem modelling, Phytoplankton bloom, Subsurface chlorophyll maxima, Oxygen minimum zone.

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