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Evolution of physical and biological characteristics of mesoscale eddy in north-central Red Sea

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Eddies appear to be important to both the physical and biogeochemical dynamics of the Red Sea. Numerical simulations of physical dynamics and remote sensing studies of chlorophyll concentration and sea surface height in the Red Sea indicate their importance to the upper portions of the sea (Raitsos et al., 2013; Yao et al., 2014; Zhan et al., 2014). Despite their apparent importance, process studies of these eddies have been lacking. In March 2013 we began an extended observational study of the north-central Red Sea (NCRS) where anticyclonic eddies have been observed. The study began with a ship-based characterization of the eddy and was followed by a three-month observational time series using an autonomous glider equipped with a CTD, oxygen sensor, and optical sensors for chlorophyll, CDOM and optical backscatter. The ship-based study captured an initial snapshot of an anticyclonic eddy and it's associated biological and bio-optical distributions. Initially, chlorophyll distributions tended to mirror the density distribution, with deeper isopycnals and chlorophyll maximum depth in the anticyclonic eddy center. The anticyclone eddy in March had an along basin diameter of 150 km, penetrated vertically less than 150 m and elevated near surface chlorophyll concentrations appeared along its outer boundary. The shallowing of the pycnocline of the outer boundaries of the anticyclone eddy on March may elevate nutrients into the lower euphotic zone, contributing to phytoplankton productivity and biomass within the eddy. This eddy contains most of the kinetic energy of the region with the maximum velocities up to 30 - 35 cm/s. The eddy appeared to interact with the coastal reefs where exchange particulate and dissolved matter may occur. The autonomous glider provided the spring-to-summer progression of the system with increasing stratification, shallowing of the subsurface chlorophyll maximum, and fluctuations in the position and intensity of the eddy. Our glider effort showed the development of a cyclonic structure north of the anticyclonic feature and nearer to Yanbu, 23 °N. In oligotrophic regions, like NCRS the deep chlorophyll maximum (DMC) can represent a significant proportion of the depth-integrated productivity. The mesoscale eddy field can further influence the biological response intensification and it played an important role in the primary production. Both types of eddies can transport deeper nutrient-rich waters into the upper ocean, enhancing the primary productivity.