Geophysical Research Abstracts
Vol. 17, EGU2015-9940, 2015
EGU General Assembly 2015

Impact of eddies on surface chlorophyll in the South Indian Ocean

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A unique feature of the subtropical South Indian Ocean is the existence of anticyclonic eddies that have higher chlorophyll concentrations than cyclonic eddies. Off Western Australia, this anomalous behavior is related to the seeding of anticyclonic eddies with shelf water enriched in phytoplankton biomass and nutrients. Further off-shore, two mechanisms have been suggested to explain the eddy/chlorophyll relationship: (i) eddies originating from the Australian coast maintain their chlorophyll anomaly while propagating westward; and (ii) eddy-induced Ekman upwelling (downwelling) enhances (dampens) nutrient supply in anticyclonic (cyclonic) eddies. Here we describe the relationship between eddies and surface chlorophyll within the South Indian Ocean, and discuss possible mechanisms to explain the anomalous behavior in light of new analyses performed using satellite chlorophyll data. We show that anticyclonic eddies exhibit higher surface chlorophyll concentration than cyclonic eddies across the entire South Indian Ocean basin (from 20 to 28°S), particularly in winter. Using Self Organizing Maps we analyze the chlorophyll patterns within anticyclonic eddies and cyclonic eddies and highlight their complexity. Our analysis suggests that multiple mechanisms may underlie the observed eddy/chlorophyll relationship. Based on Argo float data, we postulate the relationship may be partly related to seasonal adjustment of the mixed layer depth within eddies. Deeper mixing in anticyclonic eddies is expected to enhance nutrient supply to the mixed layer, while shallower mixing in cyclonic eddies is expected to reduce it. This could explain why the observed winter surface chlorophyll bloom is stronger in anticyclonic eddies than in cyclonic eddies.