Accepted Manuscript

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PII: S0924-7963(17)30526-2
DOI: doi:10.1016/j.jmarsys.2018.05.001
Reference: MARSYS 3079

To appear in: *Journal of Marine Systems*

Received date: 26 December 2017
Revised date: 23 April 2018
Accepted date: 2 May 2018

Please cite this article as: Bernardino S. Malauene, Coleen L. Moloney, Christophe Lett, Michael J. Roberts, Fransic Marsac, Pierrick Penven , Impact of offshore eddies on shelf circulation and river plumes of the Sofala Bank, Mozambique Channel. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Marsys(2017), doi:10.1016/j.jmarsys.2018.05.001

Impact of offshore eddies on shelf circulation and river plumes of the Sofala Bank, Mozambique Channel

Bernardino S. Malauene[a,b,*], Coleen L. Moloney[b], Christophe Lett[c], Michael .J. Roberts[d,e], Fransic Marsac[f,g], Pierrick Penven[h]

[a]Instituto Nacional de Investigação Pesqueira, Av. Mao Tse Tung 309, Maputo, Mozambique
[b]Department of Biological Sciences and Marine Research Institute, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa
[c]Sorbonne Universités, UPMC Université Paris 06, IRD, Unité de Modélisation Mathématique et Informatique des Systèmes Complexes (UMMISCO), F-93143, Bondy, France
[d]Ocean Science and Marine Food Security, Nelson Mandela University, Port Elizabeth, South Africa
[e]National Oceanography Centre, European Way, Southampton, UK
[f] ICEMASA, Department of Oceanography, University of Cape Town, South Africa and
[g]IRD, UMR 248 Marbec, Avenue Jean Monnet, 34203 Sete Cedex, France
[h]Universités Brest, CNRS, IRD, Ifremer, Laboratoire d'Océanographie Physique et Spatiale, IUEM, Brest, France

*Corresponding author at: Instituto Nacional de Investigacao Pesqueira, Av. Mao Tse Tung 309, Maputo, Mozambique.
Email address: dinomalawene@yahoo.com.br (Bernardino S. Malauene)

Abstract

A high-resolution, two-way nested Regional Ocean Modeling System, forced with monthly climatologies, has been set up for the Sofala Bank and adjacent deeper ocean of the Mozambique Channel to investigate the role of offshore mesoscale eddies on the shelf circulation, hydrographic structures and river plumes. The model is shown in comparison with available observations and published studies. Most known oceanographic features are reproduced by our model. We applied Self-Organizing Maps and showed that offshore passing eddies, depending on their strength and proximity to the shelf, modulate the shelf circulation and river plume direction and spread. The presence of a strong cyclonic eddy close to the shelf induces northward surface shelf currents. In contrast, the presence of a strong anticyclonic eddy close to the shelf induces a strong southward current over most of the shelf, except off Beira. Our analyses confirm that the plume of the Zambezi River is bi-directional. The southward-directed plume patterns, opposite to the dominant northwards, occur in response to nearby offshore anticyclonic eddies (26% of occurrence). This behavior could have an influence on water dispersal, shelf ecosystems and important fisheries. Therefore, offshore mesoscale eddies should be taken into account when studying the ocean dynamics of the Sofala Bank.

Keywords:
Mesoscale eddies, Shelf processes, River plume, ROMS, SOMs

1 Introduction

The Mozambique Channel, a semi-enclosed region between Madagascar and Mozambique off the African mainland (Fig. 1), is unique on a global scale because of the absence of a permanent continuous western boundary current like the Kuroshio, East Australia, Gulf Stream, Brazil or Agulhas Currents. Although currents off Pemba in northern Mozambique can show characteristics of a western boundary current (Ullgren et at., 2016) the circulation in the Mozambique Channel is dominated by trains of intermittent, passing mesoscale eddies (Biastoch and Krauss, 1999; de Ruijter et al., 2002; Lutjeharms, 2006; Sætre and da Silva,1984; Schouten et al., 2003). Most of these eddies are a result of instabilities of the flow at the northernmost tip of Madagascar and around the narrows of the Channel at ~16°S (Backeberg and Reason, 2016; Halo et al., 2014). Although some of these eddies are cyclones,