Deep-Sea Research II 100 (2014) 27–37

Contents lists available at ScienceDirect

Deep-Sea Research II

journal homepage: www.elsevier.com/locate/dsr2

Surface drifter trajectories highlight flow pathways in the Mozambique Channel

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ARTICLE INFO

Available online 15 November 2013

Keywords:
Mozambique Channel
Surface circulation
Mesoscale eddies
Surface drifters
Frontal flow

ABSTRACT

The pattern of surface circulation in the Mozambique Channel was elucidated from the trajectories of 82 satellite-tracked drifters over the period 2000–2010 and complementary satellite-derived altimetry. Overall, the trajectories indicated that anticyclonic activity was mostly observed on the western side of the Channel, with cyclonic activity being more prevalent in the east. A lack of eddy activity was noted in the southeast corner of the Channel (i.e. SW of Madagascar). Drifter behaviour illustrated that surface water from the Comoros Basin, entrained into anticyclonic eddies during formation, can be retained and isolated for months whilst being transported southwards through the Channel. During a tropical cyclone weather event, a drifter was observed to switch between counter-rotating eddies indicating that horizontal mixing of the Ekman layer does occur. The drifters also illustrated and emphasised the flow field and transport between eddies (i.e. the interstitial flow) in the Mozambique Channel. Despite the dominance of southward propagating anticyclones, drifters were able to move north and south through the Channel in the frontal flow field between eddies within periods of 51–207 days. Cross-channel transport in both directions between the Madagascan and Mozambique shelf regions was similarly observed, with time spans of 19–30 days. Surprisingly, drifters from the southern limb of the East Madagascar Current were transported westward across the channel to the Mozambique shelf. This transport was similarly facilitated by the frontal flow field between eddies. It is hypothesised that the frontal zones between eddies and interstitial waters play an important role in distributing biota in the Mozambique Channel.

1. Introduction

The concept of the Mozambique Current as a well-defined and continuous western boundary current has been under investigation for some time and progress has been largely dependent on advances in measurement technologies. Early work using only shipdrift observations presented by Sætre (1985) had suggested a non-continuous current off the coast of Mozambique. These data showed a general anticyclonic circulation in the channel with three areas of higher than average current speed and directional stability along the Mozambique coast: (1) north of the channel narrows; (2) along the Inhambane shelf; and (3) south of Delagoa Bight. Sætre (1985) also found seasonal differences, with the strongest currents during the northeast monsoon season from November to April.

The first hydrographic observations by Sætre and da Silva (1984) showed the existence of large anticyclonic gyres separated by smaller cyclonic eddies in the northern (Comoros Basin), central and southern parts of the Mozambique Channel, but no persistent current along the Mozambican shelf. Donguy and Piton (1991) also observed a large anticyclonic gyre in the Comoros Basin and strong but variable southward flow across the narrow part of the Channel. The work of both Sætre and da Silva (1984) and Donguy and Piton (1991) showed a highly variable circulation in the Mozambique Channel. More recent hydrographic observations by de Ruijter et al. (2002) confirmed the absence of a persistent current along the Mozambique shelf and instead they observed a succession of anticyclonic mesoscale eddies that propagated poleward along the western boundary of the Mozambique Channel.

Recent moored current meter measurements by Ridderinkhof and de Ruijter (2003) across the narrowest part of the Channel (Fig. 1A) indicated large spatial and temporal variability in the current field and the dominance of strong current events during

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http://dx.doi.org/10.1016/j.dsr2.2013.10.014

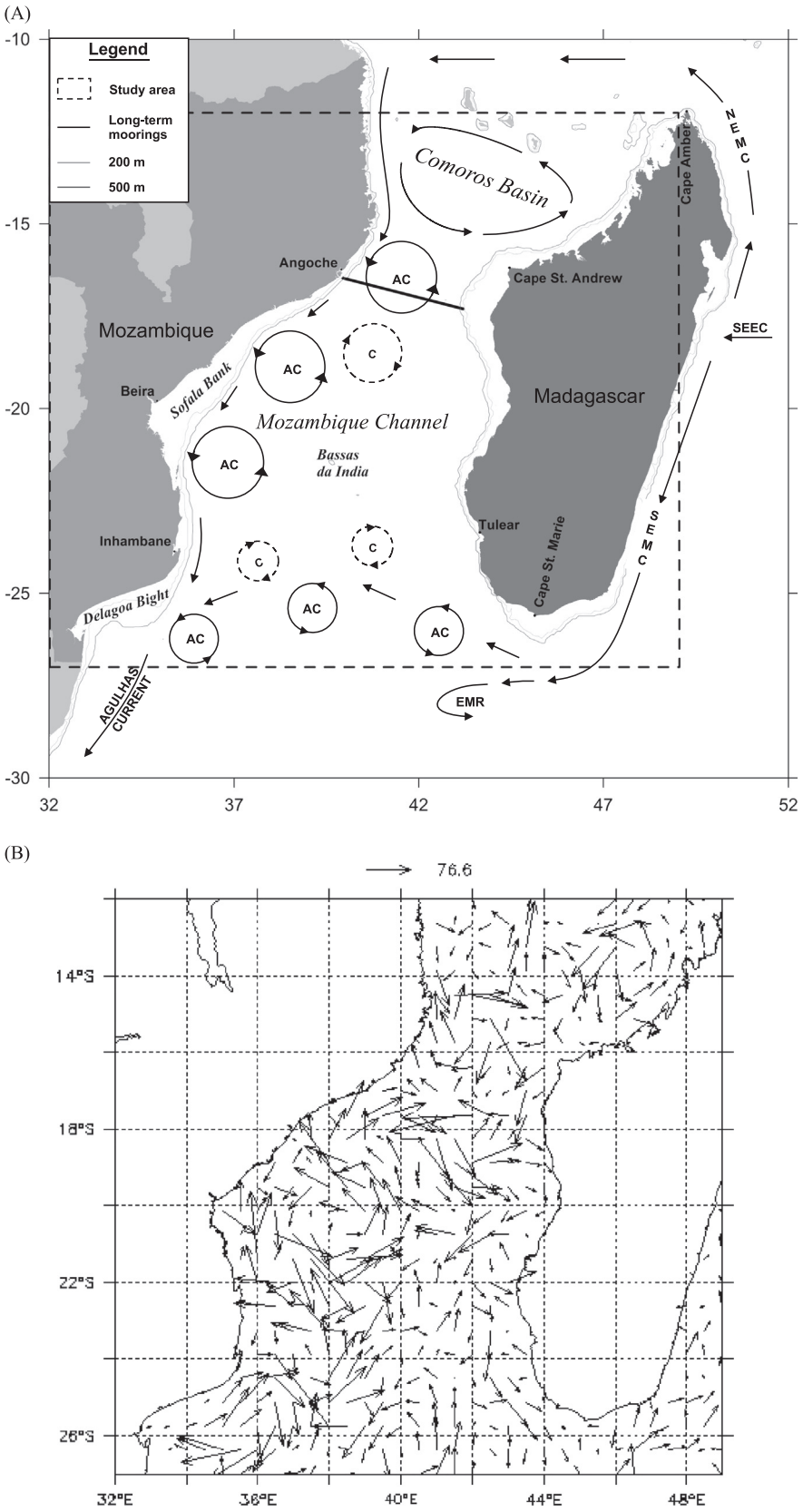

Fig. 1. (A) Dominant circulation features associated with the Mozambique Channel and (B) altimeter-derived geostrophic flow vectors (cm s^{-1}). Anticyclonic eddies (AC); Cyclonic eddies (C); Southeast Equatorial Current (SEEC); Northeast and Southeast Madagascar Currents (NEMC, SEMC); East Madagascar Retroflection (EMR).

which anticyclonic eddies were formed. These authors found no seasonality in the current regime, nor the formation of anticyclones in the channel narrows, and they estimated a net mean southward volume transport of 14 Sv through the channel over a period of one year, with substantial variations of between 20 Sv north and 60 Sv south. Updated calculations from the same