STUDY OF THE MAIN FEATURES OF THE SOMALI CURRENT ALONG THE COAST OF EAST AFRICA

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ABSTRACT

The low-level cross Equatorial Jet (EALLJ) overlies a narrow current of fast moving water, which also reverses its direction between summer and winter seasons. This is known as the Somali Current.

The Somali current is a remarkable response of the seasonally reversing circulation in the northern part of the western Indian Ocean. It flows northwards in summer, but reverses direction in winter. The Somali current is closely linked with strong coastal upwelling near 9^{o}N. This creates a narrow strip of low sea surface temperatures off Somali coast where the temperature may be as low as 15^{o}C.

This study attempts to establish the main characteristic features of the Somali current observed throughout the year over the northwest Indian Ocean. To achieve this objective we first establish the monthly mean wind flow patterns, and compute the curl and divergence of the mean wind stress.

Then, numerically evaluate the streamfunction using a simple steady-state barotropic model which is derived from a simplified vorticity equation. Finally, we evaluate the intensity of upwelling from the divergent part of the oceanic circulation by developing a simple model from a simplified divergence equation.

The wind data taken near the coast of East Africa by commercial ships for a period of five years were used in the study. This wind observation was on daily basis and located along the ship routes.

The monthly mean features of the Somali current are presented and discussed under the four well-known seasons over our region of interest: the winter monsoon season (December-February), the pre-summer monsoon season (March-April), the summer monsoon season (May-September) and the pre-winter monsoon (October-November).

During winter, the northeasterly flow along the East African coast is evident, with increasing anticyclonic curvature south of the equator. The air current intensifies and reaches maximum intensity in January.

Negative vorticity is found to the right and positive vorticity to the left of the mean speed maximum in the northeasterly flow. The northeasterly flow is a diffluent one with maximum divergence of order of about $1.0 \times 10^{-5} s^{-1}$. Our simple barotropic model clearly reproduced the winter Somali Current, which attained its peak in January. A zone of downwelling is observed to occur off the coast of Somalia and upwelling south of the equator during winter season.

Pre-summer monsoon is a transition period from the winter season to summer monsoon season. The transition between winter and summer is gradual. It is not an abrupt and sudden reversal in the mean wind direction. This season is characterised by the retreat of the winter monsoon and the establishment of the summer monsoon current in April. Small zones of convergence are observed along the coast of East Africa and also in the equatorial region by April, depicting a well-defined convergence zone (ITCZ) between northerly and southerly air current. During the period, the ocean circulation is weak. However, the winter Somali Current is seen to prevail still in March, but it is replaced by summer Somali Current in April, which is well defined along the coast between 4°S and 8°N. By April, upwelling off the coast of East Africa is evident in the northern hemisphere.

In summer, strong cross equatorial flow originating from the south (in the vicinity of Malagasy) in form of southeasterly-southwesterly flow, intensifies progressively and reaches maximum intensity in July (~ 14 m/s). The summer monsoon flow is, like the winter monsoon flow, highly diffluent north of the equator, and is characterised by positive vorticity to the left and negative vorticity to the right of the mean speed maximum. The summer Somali Current is well - defined along the coast in summer. The current intensifies as from May and reaches its peak in July, when speeds in excess of 3.0 m/s have been computed. Our model reproduces the southern gyre found in the equatorial region (between 5°S and 5°N approximately). But, it doesn't reproduce the northern gyre ('great whirl'), which is believed to exist during the season between $5^{O}N$ and $12^{O}N$ (near Socotra). It is thought to be caused by the westward propagation of baroclinic modes towards the coast. Therefore, the absence of this northern (anticyclonic) gyre, in our model results, we feel, provides an indirect evidence suggesting the propagation of the baroclinic modes. The zone of upwelling in the northern hemisphere is observed to intensify progressively as from May and reaches its peak in July. However,a zone of downwelling is also observed to occur off the south coast (southern hemisphere) throughout the season.

The pre-winter monsoon season, like the pre-summer monsoon, is gradual. The transition between the summer and winter season takes place in November. Confluence is observed along the coast in November due to the onshore flow and diffluence elsewhere in the interior of the ocean. By November, the winter Somali Current is clearly evident along the coast, but is weak. Upwelling observed during the summer season is replaced by downwelling in the northern hemisphere during the pre-winter season.