Observational Aspects of the Low-level Cross-equatorial Jet Stream of the Western Indian Ocean

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Summary – Studies of all available upper wind data up to 3 km over eastern Africa and the western Indian Ocean reveal a major low-level air current circulating at about 1.5 km in the western periphery of the monsoon regime. The current originates in the southern hemisphere and penetrates progressively further north in spring until it reaches its maximum development in July. The major current is composed of systems of low-level jet streams which can be located on a daily basis, always in the same geographical areas, with speeds reaching 25–50 ms\(^{-1}\) at heights of only 1–1.5 km. Because the current is topographically-locked over eastern Africa the massive flow of air from one hemisphere to the other can be monitored and some relationships with the rainfall of parts of western India can be deduced.

This paper is only a brief review of the observational and analytical studies which have been carried out and reference should be made to original papers for details of the structure and development of the current.

Key words: Jet stream: Cross equatorial.

1. Introduction

During the months of the northern summer a zone of strong southwesterly surface winds extends from the northern part of the east coast of Somalia towards India. These strong surface winds, sometimes known as the Somali Jet, have been known for centuries. The Somali Jet, however, is only one manifestation of a much larger scale phenomenon – a major current which lies in the lowest 3 km of the atmosphere and extends from the small islands east of Madagascar across the flat arid lands of eastern Kenya, Ethiopia and Somalia, over the Arabian Sea and thence across India.

2. The major current

Upper wind observations by pilot balloon methods from ships at the Kenya coast and over the western Arabian Sea in the years 1925–36 revealed winds at
1–2 km of about 20–25 ms\(^{-1}\) from the south and southwest respectively on occasions during the months of the northern summer (METEOROLOGICAL OFFICE, 1940), and Catalina aircraft patrolling the sea area south and east of Socotra in the years 1942–44 measured southwesterly winds of up to 35 ms\(^{-1}\) at 500 m above the sea surface. Also, records from the pilot balloon station at Ras Asir (formerly Cape Guardafui) for the summer months revealed the existence of wind speeds up to 50 ms\(^{-1}\) in the years 1930–33 (ROME, 1932–35).

In 1964 winds of 25 ms\(^{-1}\) near Socotra were reported by BUNKER (1965) and low-level jet streams were identified over peninsular India by JOSEPH and RAMAN (1966), whilst at about the same time southerly winds of 25–50 ms\(^{-1}\) blowing across equatorial Kenya were being studied by FINDLATER (1966, 1967). This study was extended by using all available pilot balloon, radar and aircraft wind data to demonstrate that all these strong wind reports during the northern summer were due to the existence of a major low-level air current which covered much of the western Indian Ocean and parts of eastern Africa, linking major synoptic systems of the two hemispheres. The major current reaches its maximum development in July and its general form and some detailed features have been described by FINDLATER (1969a).

It has been calculated that this current, circulating in the western periphery of the monsoon regime, could account for about half of the total cross-equatorial transport of air in the lower troposphere in July, (FINDLATER, 1969b).

Monthly-averaged sets of wind data from many past and present upper wind stations over eastern Africa and the western Indian Ocean have allowed analyses of the mean monthly airflow at several levels to be made, in order to gain some insight into the areal and vertical extent of the phenomenon and its development from month to month.

Although the current is a feeble feature of the southern hemisphere during the northern winter it expands and strengthens progressively to develop into the dominant feature of the low-level flow of the western Indian Ocean by July. The form of the current at 1 km in July is shown in Fig. 1 and this diagram also represents quite accurately the mean flow in June and August. Many features of interest are apparent, notably the generally light flow over the oceanic equator and the core of strong flow over the north and south Indian Ocean and over eastern Africa. The core leaves the African continent near 9°N on the Somali coast over the area of marked upwelling of cool water.

For other details of the flow in each month and at different levels reference should be made to the original analyses of FINDLATER (1971a). These analyses have been based on the densest possible network of upper wind stations and are more detailed than other representations of low-level flow in the area. For example, the atlas of RAMAGE and RAMAN (1972) uses data from only a small proportion of the upper wind stations over eastern Africa and thus does not accurately depict the flow over and near eastern Africa.

During the months of May to October the core of the current is locked to the