Circulation over India and neighbourhood during the Southwest Monsoon season

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ABSTRACT. A survey has been made of circulation over India and neighbourhood as represented by streamlines analysis by different authors for July and of the theories put forward by different workers about the southwest monsoon taking into consideration the IOE observations over the Arabian Sea and facts of weather, climatology and orographical features of the country. It is shown that the claims of the exponents of streamlines analysis regarding its utility in day-to-day forecasting have to be treated with considerable reserve as the same does not give adequate importance to topographical features which play a vital role in the (a) production of rainfall besides convergence and upglide action, (b) modification of the properties of the air masses involved and (c) deflection of the air streams which contributes significantly in making the Indian southwest monsoon a self-sustaining system in the lower levels of the atmosphere. The significant layers would appear to be from the surface up to about 500 mb, the position of the partition at 9 and 12 km between the middle latitudes westerlies and the easterlies to their south remains about the same in the July “mean” and in ‘active” and “break” monsoon conditions.

1. Introduction

India is essentially an agricultural country and its prosperity depends upon rains. Most of this rain falls during the southwest monsoon season. Failure of rains in any particular part of the country affects not only production of food but also of electricity from the various hydro-electric projects which enables to run many industries. As a result of the importance of rains during the southwest monsoon season, numerous workers both Indian and foreign have given attention to study the circulation patterns over India and neighbourhood with a view to understand the mechanism of the monsoon, particularly forecasting rainfall and weather for shipping and aviation.

2. Some facts of weather and climatology during the southwest monsoon season and the role of topography of the subcontinent

It has hitherto been considered that the rainfall over India during the southwest monsoon season June to September, is caused by the arrival over the country of the deflected southeast trades from the southern hemisphere and that the orographic features of the country, i.e., the Western Ghats, the Eastern Ghats, the mountains on the Burma coast, the Assam hills, the Himalayas and the mountains in the northwest frontier of the subcontinent, play an important role in the distribution and intensity of rainfall (Simpson 1921).

Banerji (1930, 1931) has considered the effect of topography on the configuration of isobars and the stream flow. The heat low over West Pakistan during the monsoon season would be further west if the mountains in the northwest and the Himalayas were not there; the trough of low over the Gangetic valley would not come into existence if the Western Ghats, the Burma and Assam mountains and the Himalayas were not there.

On the basis of data of upper air collected over India and the neighbouring countries, the monsoon current was generally considered to be 4 to 5 km deep (India met. Dep. 1943, 1945).

Petterssen (1953) has considered the dynamics of the Indian southwest monsoon. He has stated that while perturbations on the monsoon are quite important from the point of view of its vagaries from year-to-year with reference to rainfall, one has to consider the creation of vorticity by thermal processes and its balancing by frictional dissipation and export particularly downwind to the Bay of Bengal, for realising the steady state of the monsoon; the resulting large scale cyclonic system will create and maintain an area of low pressure in the lower levels over the Indian subcontinent. India is to the south of the westerly jet stream and the vorticity decreases with elevation, but the jet is not a part of the monsoon itself. Further, the mechanical influence of the orographic features of the subcontinent have to be given due weight, as frictional force will act against the motion.

The bulk of the import of air into India during the southwest monsoon season is across the Western Ghats with ascending motion on the western slope and descending motion on the eastern slope; a small portion enters direct into the Bay, south of about Lat. 8°N. Allowing the modifying influence of friction on vorticity, the net result will be a ridge of anticyclonic vorticity over the Ghats with a gradual change to a maximum of cyclonic relative vorticity further to the east and also to the north of the northern shoulder of the Ghats. The Arakan hills to some extent (some of the