

Why little Rain over the west and north Arabian Sea and over and around the West Pakistan heat low during the Southwest Monsoon Season ?

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ABSTRACT. Ramage's views and model to explain little rain over the west and north Arabian Sea and over and around the West Pakistan heat low have been examined and it is shown that they cannot be accepted. The hitherto prevalent viewpoint about the same is able to explain observations during the HIOE period with a slight modification as suggested by Desai, if one takes into consideration facts of weather, climatology and topography of the Indian subcontinent.

1. Existing Ideas

Since the establishment of the India Meteorological Department, it has been noticed that in spite of the presence of the heat low over upper Sind and the southwest Punjab during the southwest monsoon season, little rain falls over and near that area. Why does the moist monsoon air not flow into this region of lowest pressure and rise there, giving heavy rain? After the kite ascents' upper air data became available over northwest India, Simpson (1921) dealt with this important question in his famous paper and came to the following conclusions.

The lowest pressure is between Multan and Jacobabad desert region well within the angle between Himalayas and the northwest frontier and Baluchistan hills, and therefore, the air can flow into it only from east and south; this flow is, however, small for the gradients are slight and the main air stream which crosses the Sind coast subdivides and goes in towards the central parts of the country across Rajasthan. Still this small amount of moist air flow into the heat low would be enough for ascensional movement of moist air to cause rain. But (a) the high temperatures and (b) the direction of upper air currents there, do not allow rain to occur. The upper air over northwest India above 2500 ft blows from between west and north off the high hills of Baluchistan and the northwest frontier and it is warm and dry, humidity being very low. Air near ground has high humidity as it crosses Sind coast, but it warms up considerably as it passes inland from Karachi to Jacobabad which has about 5°C higher mean temperature than the former and its humidity decreases; the air over the heat low would have to rise about 3000 feet, before condensation can take place, but before it reaches that height, it has encountered the upper warmer and drier westerly to northwesterly current with which it mixes and in consequence no cloud is formed over the region of low pressure to give rain.

Actual temperatures over land area are not directly responsible for ascensional currents which cause rain during the southwest monsoon over the Indian subcontinent; it is the peculiar distribution of mountain ranges which forces the moist air from west to southwest to ascend and give rain (effect of Western Ghats and the Burma coast mountains) and also deflect it northwestwards to the East Punjab (effect of the Burma coast and Assam mountains and the Himalayas) through Bengal, Bihar and Uttar Pradesh to the north of the axis of the trough of low pressure over the Gangetic plain which (*i.e.*, the axis of the trough) slopes equatorwards with height as a result of which rain falls to the south of the trough axis at the surface (Desai 1953, 1965a, 1965b). Actually over the region where rain falls, temperatures are low and where rain is prevented temperatures are abnormally high; during break in the rains, temperatures rise. Thus the trough over the Gangetic plain would not appear to be essentially a consequence of the temperatures but of the topographical features of the country (Petterssen 1953), although the low over the West Pakistan is due wholly to high temperatures.

Hitherto the view of the Indian meteorologists about scanty rainfall during the southwest monsoon over and around the heat low is based on Simpson's ideas. The inversion over Karachi about 3000 feet above the surface as revealed by the aeroplane ascents and later by the radiosonde ascents there, is due to differences in the thermal properties of the lower cool moist monsoon (deflected trades) and upper warmer drier continental (from Baluchistan and northwest frontier side) air masses.

2. Ramage's viewpoint

Ramage (1965, 1966) while discussing the absence of rain over the west Arabian Sea on the basis of HIOE observations according to which the height of the base of inversion over there is about 1.0 to 1.5

km, has suggested that the inversion is due to subsidence. He has stated that computation of the divergence of the mean resultant winds at standard levels over the eastern portion of the heat low (Indo-Pakistan border area) reveals net ascent below 700 mb and net descent above, the former associated with the heat low circulation and the latter with convergent easterlies on the periphery of the monsoon depressions.

He has also proposed a model for vertical circulation extending southwest from the West Pakistan heat low based on his concept that the inversion is due to subsidence. The model is considered to explain limitations of the supply of moisture as to make appreciably heavy monsoon rains over western India unlikely without significant incursions of deeply moist air from the Bay of Bengal across the Peninsula.

3. Remarks regarding Ramage's viewpoint

Discussing IIOE results over the Arabian Sea, Desai (1965a) has shown that absence of rain, over the west and north Arabian Sea, is due to the fact that ordinarily there are no factors over the area capable of breaking up the inversion which is due to different air masses as in the case of the West Pakistan heat low area except that the upper warmer drier air is from northeast Africa and Arabia side instead of from Baluchistan and northwest frontier. There is ordinarily no anti-cyclone or any other conditions over the area between 900 and 800-mb levels which can cause subsidence giving rise to an inversion. Convergence will be able to break up the inversion and cause clouds and rain if depressions or storms affect the area.

Absence of rain over the area of the heat low over West Pakistan is due to the causes mentioned by Simpson (1921). Further, there are no hills or mountains across the path of the moist current over Saurashtra-Kutch-Sind coast unlike the west coast where there are the Western Ghats. Depressions from the Arabian Sea or Bay of Bengal moving towards the area will cause clouds and rain.

The lower 5000 feet deep moist layer acts as a vast reservoir of moisture. The surface layer frequently shows nearly dry-adiabatic lapse rate. As the monsoon current flows east to northeastwards towards the Western Ghats, it is forced to rise and there is development of cloudiness and rain as well as lifting and weakening of the inversion. The presence of drier unstable layer with lapse rate close to dry-adiabatic above the moist current, further helps rapid growth of *Cu* and *Cb* clouds having large vertical extent and release of more moisture upwards for condensation and precipitation. This mechanism leads to the presence of a more or less homogeneous moist air mass about 5.0 km deep over the Peninsula, while there is only about 1.5 km deep monsoon current over the Arabian Sea to the west of about Long. 68° E. The causes of appreciable heavy rains in western India and over the west coast of the Peninsula have been discussed at length by Desai [1946, 1951, 1965a, 1965 b and papers under publication (1), (2) and (3)].

In view of what has been stated above the model proposed by Ramage for the Arabian Sea monsoon cannot be accepted just like his model for the Bay of Bengal monsoon (Rao and Desai 1965).

REFERENCES

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| Desai, B. N. | 1946 | <i>J. Gujarat Res. Soc.</i> , 8 , 1, pp. 2-10. |
| | 1951 | <i>Mem. India met. Dep.</i> , 28 , Pt. 5, pp. 217-228. |
| | 1953 | <i>Bombay geogr. Mag.</i> , 1 , pp. 44-51. |
| | 1965a | Mechanism of the southwest monsoon rainfall in the light of the results of the IIOE during 1963 and 1964—Summary of a talk before Met. Officers at Bombay, 3 Sep., circulated. |
| | 1965b | <i>Curr. Sci.</i> , 34 , 23, pp. 657-659. |
| Papers submitted for publication in <i>Indian J. Met. Geophys.</i> | — | (1) Circulation over India and neighbourhood during the southwest monsoon season. |
| | — | (2) Troughs on either side of the equator, vortices embedded in them and relation between transport of moisture across the equator and rainfall on the west coast of India. |
| | — | (3) A critical examination of streamlines charts and conclusions of Dixit and Jones on (a) active and (b) weak monsoon conditions presented in their report issued from the International Meteorological Centre at Bombay during April 1965. |
| Desai, B. N. and Koteswaram, P. | 1951 | <i>Indian J. Met. Geophys.</i> , 2 , 4, pp. 250-265. |
| Petersen, S. | 1953 | <i>Proc. Indian Acad. Sci.</i> , 37A , pp. 229-232. |
| Ramage, C. S. | 1965 | Proc. of Symp. on Met. Results of the IIOE, 22-26 July—The summer atmospheric circulation over the western Arabian Sea. |
| | 1966 | <i>J. Atmos. Sci.</i> , 23 , pp. 144-150. |
| Rao, Y. P. and Desai, B. N. | 1965 | <i>Indian J. Met. Geophys.</i> , 16 , 3, pp. 479-481. |
| Simpson, G. C. | 1921 | <i>Quart. J.R. met. Soc.</i> , 47 , pp. 152-172. |