MESON TRACKS ON PLATES EXPOSED ON THE NILGIRIS

THIS note gives the results of measurements on cosmic ray tracks obtained on photographic plates, which were exposed in the open on the Niligiris in South India during Nov.-Dec. 1947. A set of Ilford nuclear research, type B 1,100 μ thickness emulsion plates, contained in a paraffin-covered cardboard box was exposed for six weeks at Ootacamund (altitude 7,300 feet) and a similar set contained in a thin wall aluminium case was exposed, during the same period, at Aruvankadu (altitude 6,700 feet). A Zeiss microscope fitted with a 44 X objective and a 10 X micrometer scale eyepiece, was used for the measurements of the tracks on the plates. The average number of meson tracks as identified by their characteristic low grain density, large angle of scattering and thick grain density towards end of range, are found to be 0·52 and 0·47 per sq. cm., on the plates exposed at Ootacamund and Aruvankadu, respectively. The track lengths are found to vary from 100 to 800μ, with the majority of them around 150μ. The lower limit for the number of mesons that arrive per day per c.c., therefore, at the altitnde 7000 feet and geomagnetic latitude 2·8° will be 0.7. Of the 32 tracks examined, only two, whose lengths are 570μ and 590μ, seem to correspond to the μ-decay meson observed in the photographs of Lattes and co-workers.[1]

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1. C. M. G. Lattes, *et al.*, *Nature.*, 1947, **160**, 485.

ROLE OF THREE AIR MASSES IN TROPICAL CYCLONIC STORMS

A CYCLONIC storm is strictly "tropical" when three air masses Em, Tr and Tc or Tcm enter into its formative structure and when it has a westward tendency of motion.[1] The properties of air masses have been described elsewhere.[2] There is considerable divergence regarding the need and the role of the air masses: whether the release of latent heat of moisture or whether the waves set up at the interface of two necessary air streams as in the extratropical latitudes give rise to a tropical cyclonic storm. In the lower latitudes, the component of earth's angular velocity is small. An approach to the problem should tackle both the production or release of energy and the cyclonic vorticity. I have pointed out earlier that Em, the equatorial maritime air, acts as the thermodynamic 'source', that Tc or Tcm, the tropical continental air or the tropical continental maritime air, acts as a 'sink' and that Tr, the far eastern transitional or mixed air, is required to delay the cycle of operations till sufficient cyclonic vorticity is developed.[3] In the tropics, cyclonic vorticity and release of energy are two distinct entities and may not necessarily co-exist.[4] A closed low pressure area is characterised by a vertical structure with an almost dry adiabatic lapse-rate over several kilometres and over a short height with even super-adiabatic lapse-rate. The situation is such that it is favourable for maintenance of convection.

It has been known for a long time, though it has had to be re-stressed at intervals, that the southerly air, which has its origin in the 'S. E. Trades' in the southern hemisphere, was a necessary concomitant of the weather over a large part of the Indian area during and near about the northern summer. As the theory of cyclonic storms is to be the same everywhere in the tropics, it is sufficient to deal with conditions in the north Indian Ocean. For the release of energy of monsoon depressions and tropical cyclonic storms, Em is needed. An examination of the vertical structure of temperature and humidity of Em shows that it can easily release energy. Em has to be the 'source' for the release of energy.

For the major period that tropical cyclonic storms or monsoon depressions form in the Indian area Tr is hotter and in the lower layers mostly more moist than Em. Both the dry and wet bulb potential temperatures of Tr are greater than that for Em. This warm or hot easterly air has not been found to behave analogous to the air of the 'warm sector' of an extra-tropical depression by Deppermann[5] and others. The precipitation occurs from lower heights than 12,000 ft. There is also a marked temperature inversion in the 'Trades' between 1·5 and 2·0 km. Hence Tr cannot be considered as a 'source' and certainly not as a 'sink' of a tropical cyclonic storm.

The continental air is dry, often very dry. For depressions that form in the Bay of Bengal, the movement of Tc can easily be followed by the temperature waves from beyond the N. W. frontier of India (geographical).[6] Here the potential wet bulb temperature of the air is considerably below that of either Tr or Em. This air has some sea travel, for depressions that form in the east Bay of Bengal or east Arabian Sea. But this sea travel of Tc is much smaller than that for Tr. Hence Tc or Tcm can play the role of 'sink'.

In the temperate latitudes, the westerly winds are to the equatorial side of the easterlies. This juxtaposition gives rise to a 'natural' cyclonic vorticity. In the tropics, in the non-monsoon months, and during breaks of the monsoon, the strength of the westerlies generally decreases on approaching the equator. In the monsoon months, Tc has a westerly component and Em has a westerly and occasionally an easterly component. In the absence of an easterly Tr north of Em; the natural vorticity, in the tropics, that one can expect is anticyclonic. To overcome the latter and induce a cyclonic vorticity, one or both of the following should happen: the westerly component of Em should be increased and the westerly strength of Tc should be decreased, so that the westerly component of the wind may decrease with increase of latitude. With the passage of a monsoon 'pulse' or Em across the equator from the southern hemisphere to

the Bay of Bengal; the winds at Mannar, Trincomalee, Trichinopoly and often at Colombo reach gale force below 2 km. The corresponding wind force before the passage of Em would be light to moderate. The second condition is satisfied if an easterly stream due to Tr is superposed on the field of Tc. If there be a sufficient supply of Tr, the juxtaposition would show a cyclonic vorticity in the neld. If at the interface of Em and Tr, unstable perturbations are set up, the conditions would lead to the formation of a tropical cyclonic storm. The fact that there is considerable difference in the properties of Em and Tr need not complicate the issue except to demarcate the streams. The release of energy must be due to Em and Tc or Tcm. It is difficult to assess which two streams of the three must first come into play. In the description of tropical cyclonic storms[2] all the instances that occurred over two years have been taken into account, and an examination was made of cyclonic storms for a period of nearly ten years. The facts were consistent with the assumption of the air masses above.

It has been argued as a serious objection to the above picture that, in the formative stage, there was no easterly component of wind to the north or northeast of the centre of the tropical cyclonic storm. Dr. Sverre Petterssen showed, in his talk on Feb. 11th, 1948, at the Poona Meteorological Office, that if a cyclonic vorticity is induced due to the shear at the partition of Em and Tr in the north tropics, the resulting depression would form to the southeast of the area enclosed earlier by the two streams. It appears necessary to look for the easterlies in the formative stage of a tropical cyclonic storm much further north than the subsequent centre of the storm. In other words, a tropical cyclonic storm forms to the southeast of the triangular area formed by the three streams Em, Tr and Tc or Tcm and not inside it. This clears up a number of small but essential difficulties.

It is often noticed that a small low pressure area travels westwards across Assam and north Bengal showing the passage of a residual of a China Sea typhoon. But the resulting monsoon depression forms often in the north angle of the Bay of Bengal and gives an apparent southward travel to the residual of the typhoon. The incursion of Tr is shown by the westward passage of shallow low pressure areas.[4] The low pressure area over Assam and north Bengal may not necessarily be due to the actual westward passage of the China Sea typhoon but may just indicate the incursion of Tr. The formation of the monsoon depression much further south of Tr becomes understandable from last para.

The passage of Em across the equator is discontinuous and occurs only at intervals. As Em moves north to form a tropical cyclonic storm, it does not form a continuation of the S.E. Trades on the other side of the equator. Between Em and the equator the mixed air Tr and Tc can and does flow. This allows the passage of northern Tr to the south to form the Em of the southern tropical cyclonic storm that often forms in a more easterly longitude. The invasion of Tr, south of the tropical cyclonic storm and the equator, also allows the infeed of Tr to a secondary tropical cyclonic storm in the same hemisphere forming in a more westerly longitude. The secondary tropical cyclonic storm must form to the south of Tr. The secondary tropical cyclonic storm in the same hemisphere and in a more westerly longitude, would be therefore much further south than what one would have expected from only elementary considerations. This fact is amply borne out by the tropical cyclonic storms that form in the Bay of Bengal which can be considered as secondaries of China Sea typhoons. Due to paucity of observations, it may happen that the primary and secondary tropical cyclonic storms get mixed up and the tropical cyclonic storm is given a large southerly direction and movement.

Poona 5, S. L. MALURKAR.
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1. Malurkar, *Curr. Sci.*, 1947, **16**, 277. 2. *Ibid.*, 1947, 174 and "Recent Advances in Tropical Meteorology", *Ind. Sci. Congress Symposium*, Jan. 1948. 3. Malurkar., *Curr. Sci.*, 1947, **16**, 14. 4. Malurkar, *Proc. Ind. Acad. Sci.* (Bangalore), 1947, **25**, 297. 5. Deppermann, "Are there warm sectors in Philippine Typhoon" Weather Bureau, Manila, 1936. 6. Malurkar, *Forecasting Weather In or Near India*, 1945, **43**, 90. 7. *Ibid.*, 63.

A NOTE ON THE PETROLOGY OF THE CORUNDUM AND CHROMITE-BEARING ROCKS OF THE SITHAMPUNDI-RAMADEVAM AREA, NAMAKKAL TALUK, SALEM DISTRICT, MADRAS

DURING the re-examination of the Sithampundi corundum belt, a hitherto unrecorded occurrence of chromite ore was located. The results of a preliminary examination of the rocks of this area are outlined below :—

Anorthite-hornblende gneisses form an arc shaped belt, with a southerly convexity, and run for a length of nearly fifteen miles, from Pattalur in the west to Kottakkalpalaiyam in the east. The general trend of these gneisses is W.N.W. in the west gradually veering to E.N.E. towards the eastern end and maintaining an uniform southerly dip. The chromite-bearing amphibolites and the associated pyroxenites and pyroxene-garnet rocks occur interbanded along the foliation planes of the anorthite-hornblende gneiss. Several bands of chromite-bearing amphibolites of varying thickness traverse practically the whole of the anorthite gneiss belt.

The anorthite-hornblende gneiss is an even grained pale coloured rock, essentially made up of basic feldspars and greenish black amphiboles, the latter arranged with their longer axis parallel to the general direction of foliation. Textural, as well as mineralogical variants of the main type are met with, some varieties being salic, wherein the development of minerals like chondrodite, zoisite, scapolite and garnet is marked. The corundum for which these rocks are quarried occurs sparsely distri-