

MECHANISM OF NOR'WESTERS OF BENGAL

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Any mechanism suggested to explain the occurrence of Nor'westers in Bengal during the summer months should satisfy the following important facts associated with them :—

- (i) Thunderstorms approach most frequently from west to northwest (hence they are called Nor'westers); the number of those approaching from other directions is small¹.
- (ii) The majority of Nor'westers occur between 1700 and 2100 hrs. IST.²
- (iii) Nor'westers usually occur later over southeast than over southwest Bengal.
- (iv) Nor'westers are usually more severe in southeast than in southwest Bengal.
- (v) In the majority of Nor'westers both the dry and wet bulb temperatures fall. In a few cases, although the W. B. may fall, the D. B. may not change or may even rise slightly².
- (vi) Nor'westers start simultaneously or at different times over different places. Time sequence for some thunderstorms occurring on the same day at different places is also noticed.

2. The explanation put forward by some Meteorologists³⁻⁵ that the Nor'westers are caused due to the over-running of warm and moist southerly air by relatively cool and dry westerly to northwesterly air does not satisfy the fact (ii) mentioned above; further the upper westerly to northwesterly air is not relatively potentially colder than the lower southerly air at the ground level, and hence it cannot descend unless it gets cooled due to evaporation of rain¹. The explanations advanced by S. N. Sen⁶ and by A. K. Das⁷ cannot also reconcile fact (ii).

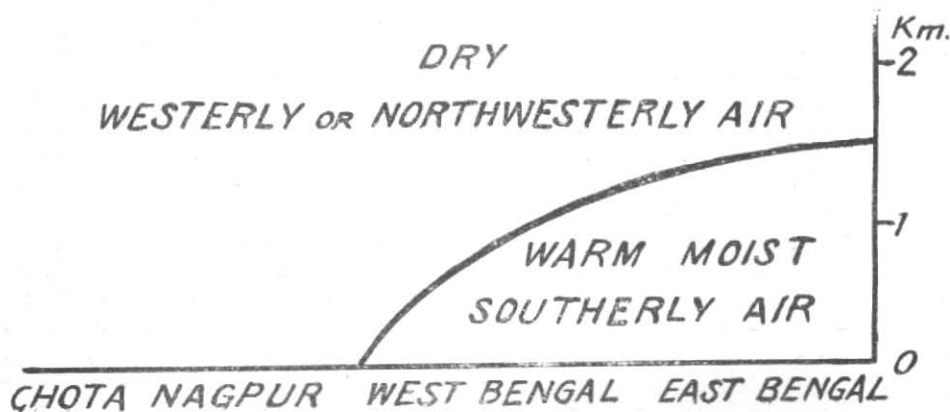


FIG. 1.

3. During the summer months there is normally moist southerly air in the lower levels over Bengal and dry westerly or northwesterly air in the upper levels. The depth of the moist current is greater in southeast than in southwest Bengal. Between the moist and dry air masses there is an isothermal region or an inversion. This distribution of air masses gives rise to latent instability conditions over Bengal in the summer months^{1, 8, 9}.

4. Desai and Mal¹ put forward the view that the important facts associated with Nor'westers become intelligible if one considers that insolation acts as a trigger for the release of the energy of latent instability and thus initiates the primary or parent thunderstorm.

According to Chatterjee and Sur⁸ some data obtained by them indicated that the flow of a colder mass of air from the neighbouring regions of a thunderstorm undercutting the originally existing mass of latently unstable air in lower Bengal could start a thunderstorm. They considered their data insufficient to investigate the other phenomena that could act as triggers for the release of energy of latent instability for outbreaks of thunderstorms in Bengal.

5. Desai amplified the mechanism of Nor'westers suggested by Desai and Mal¹ in February 1943 in a note supplied to the Bomber Command of the R. A. F.¹⁰ to make clear the time sequence shown by some Nor'westers. As stated in that note, the trigger is supplied by one, or more often a combination of the following :—

- (a) Insolation.
- (b) Outflow of air in different directions from a parent thunderstorm.
- (c) Eastward passage of the cold front of a western disturbance—generally in an occluded form.
- (d) Convergence of air due to Katabatic flow from the hills to the north and east.
- (e) Inflow of moist winds from the Bay into Bengal due to a disturbance or cyclonic storm.

6. Thunderstorms over Bengal have been classified as under by Desai :—

- (i) Those which occur with the passage of a cold front in connection with the western disturbances moving eastwards across northern India : In this case the Nor'westers occur along a line and one finds a time sequence as at the cold fronts of the middle latitudes. Nor'westers due to this mechanism can occur at any time of the day depending upon the time of the passage of the cold front.
- (ii) Those which occur in connection with cyclonic storms or depressions in the Bay of Bengal approaching the coast : These thunderstorms can approach a place from any direction and can occur at any time of the day.
- (iii) Those which occur in the morning (after midnight) : These occur in the regions adjoining Assam and near the hills in southeast Bengal when there is a flow of cold air from the hills. Cold air from these thunderstorms can start chains of fresh thunderstorms.
- (iv) Those which occur simultaneously over a large area and generally in the afternoon, late evening or early part of night : These are associated with either the approach of the western disturbances or with the accentuation of the east-west pressure gradient over Bengal. About 70 to 80% of the Nor'westers are of this type. The initial trigger for the release of the energy of latent instability and starting the primary or parent thunderstorm is insolation as suggested by Desai and Mal.¹ The descending air is generally from higher levels, *i.e.*, from regions where there are westerly to northwesterly winds ; being dry, it gets humidified and cooled due to evaporation of rain through which it passes and reaches the surface as cold air. Once a thunderstorm starts due to insolation acting as trigger, the cold air from the primary or parent thunderstorm can spread easily in the direction of the descending current, *i.e.*, generally from some northwesterly to some southeasterly direction, in the form of fingers spreading from the palm of the hand.

Secondary thunderstorms or Nor'westers can start at the tip of each such finger as the cold air moves forward; tertiary, quaternary etc., thunderstorms can also start

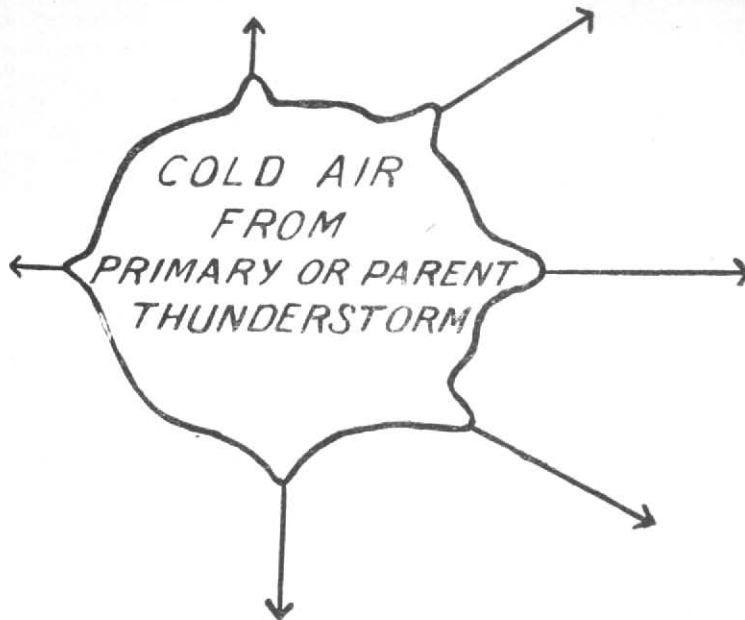


FIG. 2.

due to the same mechanism as cold air spreading from the secondary or a tertiary, etc., thunderstorms can act as trigger. Thus a number of thunderstorms can take place simultaneously, and there will be a time sequence in the thunderstorms started by any particular tip of cold air as in the case of a cold front; further thunderstorms will occur later in southeast than in southwest Bengal. If the cold air from the parent thunderstorm started by insolation acting as trigger spreads westwards, or northwards, no thunderstorms will ordinarily occur due to lack of sufficient latent instability conditions over those

regions. Nor' westers are generally more severe in southeast than in southwest Bengal as the moist current is deeper there, and hence more energy of latent instability can be realised to increase the violence of the storms.

Besides the above four types, one should also consider the thunderstorms which can start late in the night as a result of radiative cooling at the top of clouds, giving rise to sufficient instability and strong descending currents.

7. Results of the investigation on the Nor'westers of Bengal by the staff of the Upper Air Office, New Delhi, published in Technical Note, No. 10 referred to above, can be easily understood in the light of the mechanism of Nor'westers proposed by Desai and Mal¹ as amplified later by Desai.¹⁰

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