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STUDY OF SOME METEOROLOGICAL ASPECTS OF NOVEMBER 1992 CYCLONE – A CASE STUDY

1. The intensity of the storm may be sensitive even in a small change in temperature of the ocean or land surface. The temperature decreases in the lower troposphere from surface to 500 hPa level in the region where the cyclone moves (Mahbub *et al.* 1997a). The change in the wind speed of the tropical cyclone moving over land is determined by the surface frictional elements (*e.g.*, grass, trees and buildings) and by hills and mountains. The role of energy fluxes is to govern the atmospheric circulation as well as the physical processes responsible for the formation and the movement of tropical cyclones (Palmen and Newton, 1969). Therefore, it is essential to study the role of tropospheric energy fluxes and temperature and their vertical distribution in prediction of formation and movement of tropical cyclones in respect of their intensity, track and landfall. The direction of movement of tropical cyclone is the direction of its energy flux (Mahbub *et al.* 1996). Mahbub *et al.* 1997b showed that the moist static energy decreases in the lower troposphere and increases in the upper troposphere in the region where the cyclone moves.

In the present study the meteorological parameters such as vertical variation of zonal and meridional wind speed and temperature in the surroundings of the Bay of Bengal have been investigated during the period of movement of November 1992 cyclone. We have also analysed vertical variation of meridional flux of moist static energy, zonal flux of moist static energy and vertical wind shear in the surroundings of the Bay of Bengal, using rawindsonde data at various pressure levels. Several stations such as Dhaka, Chittagong, Calcutta, Cuttack, Madras and Port Blair in the surroundings of the Bay of Bengal have been chosen to see the possible variation of these parameters.

2. We computed the meridional flux of moist static energy, zonal flux of moist static energy and vertical wind shear (Essenwanger, 1985) by using the following relations:

Meridional flux of moist static energy

$$= (C_p T + g Z + L q) \times (-V \cos\phi) \quad (1)$$

Zonal flux of moist static energy

$$= (C_p T + g Z + L q) \times (-V \sin\phi) \quad (2)$$

The Vertical wind shear $V_{w.shear}$

$$= U_{200} - U_{850} \quad (3)$$

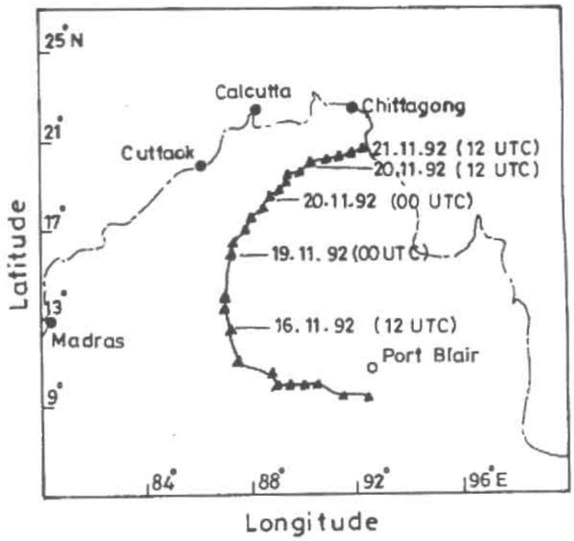


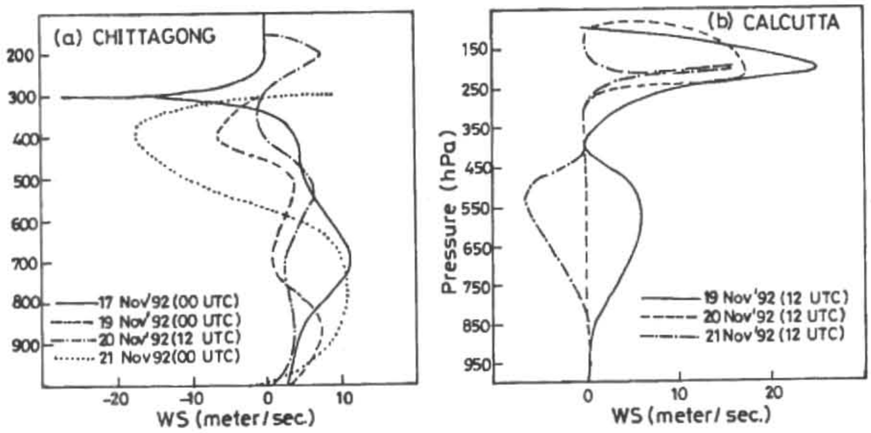
Fig. 1. Track of severe cyclonic storm with a core of hurricane wind of November 1992

Where,

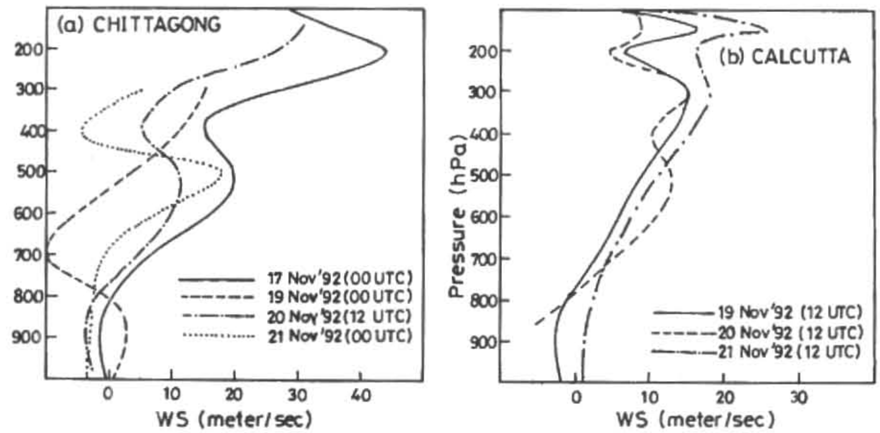
C_p	=	the specific heat of air at constant pressure
V	=	the wind speed
q	=	the specific humidity
$Cp\,T$	=	the specific enthalpy
$g\,Z$	=	the potential energy per unit mass
$L\,q$	=	the latent heat energy per unit mass
U_{200}	=	the zonal component of wind at 200 hPa
U_{850}	=	the zonal component of wind at 850 hPa
$V_{w.shear}$	=	the vertical wind shear

We use the value of specific heat at constant pressure $C_p = 1004\ J\ K^{-1}\ kg^{-1}$. The latent heat of evaporation and saturation vapour pressure over water at different temperature was used from Byres (1974). The upper air data were collected from the Storm Warning Centre (SWC) of Bangladesh Meteorological Department (BMD).

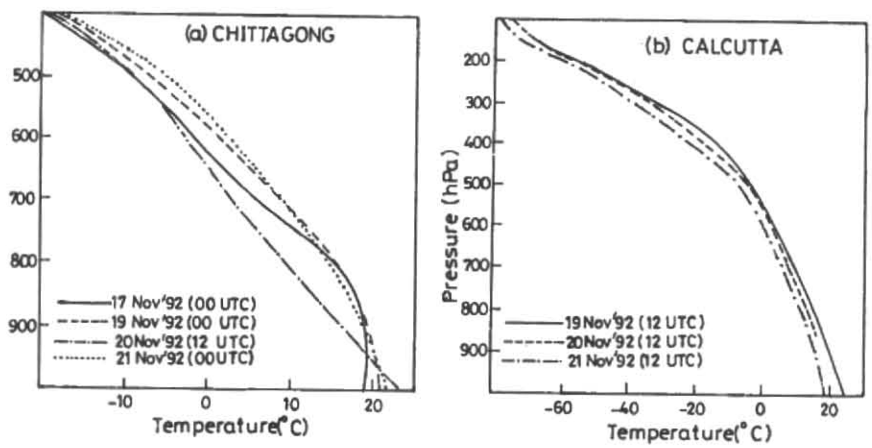
3. We have analysed in detail the vertical variation of meridional windspeed, zonal windspeed, temperature, meridional flux of moist static energy, zonal flux of moist static energy and vertical wind shear for the severe



Figs. 2(a&b). Meridional wind (meter/sec) over Chittagong and Calcutta



Figs. 3(a&b). Zonal wind (meter/sec) over Chittagong and Calcutta



Figs. 4(a&b). Temperature(°C) over Chittagong and Calcutta cyclonic storm with a core of hurricane winds of 1992. Day-to-day changes of these parameters have been discussed as the cyclone progress. The track of the cyclone is presented as in Fig. 1.

3.1. The meridional wind speed decreases at all levels on 18 with respect to that of 17, increases from surface to 800 hPa and 250 to 100 hPa level and decreases from 800 to 250 hPa on 20 with respect to that of 19 and decreases at all levels on 21 with respect to that of 20 November over Dhaka. The meridional wind speed increases [Fig. 2(a)] from the surface to 800 hPa and 300 to 100 hPa and decreases from 800 to 300 hPa over Chittagong on 19 with respect to that of 17 November. The meridional wind speed decreases from the surface to 750 hPa, increases from 750 to 100 hPa on 20 with respect to that of 19 and increases significantly from surface to 600 hPa and decreases significantly from 600 to 300 hPa level on 21 with respect to that of 20 over Chittagong. The meridional wind speed decreases gradually at all levels during 19-21 over Calcutta as the cyclone moves towards the landfall. The meridional wind speed increases at all levels on 18 with respect to that of 17 and decreases up to 300 hPa on 20 with respect to that of 19 over Cuttack. The meridional wind speed decreases gradually from surface to 300 hPa and has no regular trend from 300-100 hPa over Port Blair during 18-20.

3.2. The zonal wind speed increases at all levels on 18 with respect to that of 17 and decreases at all levels on 20 with respect to that of 18 and increases at all levels on 21 with respect to that of 20 over Dhaka. The zonal wind speed increases [Fig. 3(a)] from surface to 800 hPa and decreases from 800 to 100 hPa on 19 with respect to that of 17 and no regular increasing or decreasing pattern of zonal wind speed during 19-21 over Chittagong. Fig. 3(b) shows that the zonal wind speed increases gradually at all levels having some anomalies over Calcutta during 19-21 November. The zonal wind speed increases gradually from surface to 450 hPa and decreases from 450 to 100 hPa with little anomalies and decreases gradually during 17-20 over Cuttack and Port Blair respectively.

3.3. Little or no temperature variation is observed at all levels on 17 and 18 and increases significantly on 20 with respect to that of previous day and decreases at all levels on 21 with respect to that of 20 over Dhaka. The temperature increases [Fig. 4(a)] from surface to 350 hPa on 19 with respect to that of 17, decreases from surface to 400 hPa and constant above these levels on 20 with respect to that of 19 and increases again from surface to 300 hPa level on 21 with respect to that of 20 November over Chittagong. The temperature decreases gradually at all levels during 19-21 and 18 with respect to that of 17 over Calcutta [Fig. 4(b)] and Cuttack respectively. The temperature decreases at all levels on 21 with respect to that of any other days over Madras. The temperature increases slightly at all levels on 18 with respect to that of 17 and decreases at all levels having little anomalies on 19 with respect to that of 18 and decreases from surface to 500 hPa and increases from 500 to 100 hPa on 20 with respect to that of 19 over Port Blair.

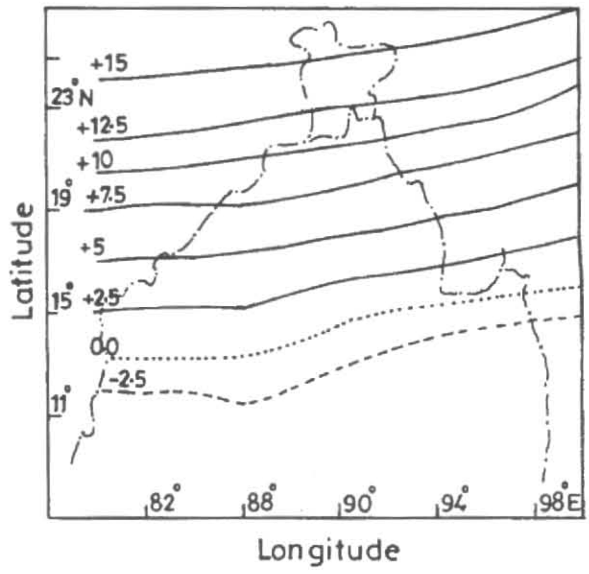
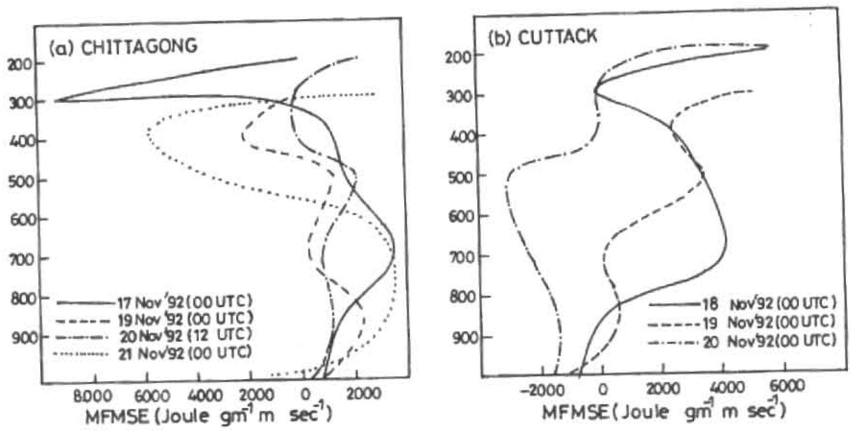
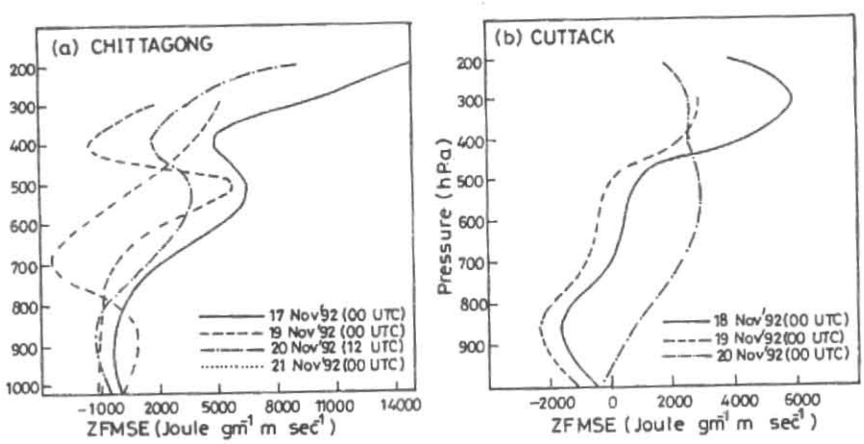


Fig. 5. Distribution of vertical wind shear on 20 November at 0000 UTC

3.4. The distributions of vertical wind shear (Fig. 5) over the Bay of Bengal and adjoining area at 0000 UTC on 20 have been studied and shows small vertical wind shear near the centre of the cyclone having magnitude ranging between 4 ms^{-1} and 6 ms^{-1}. These features are similar to those observed by Mandal *et al.* (1981) for a cyclone in the Arabian Sea and Mahbub *et al.* (1997a) for the Bay of Bengal cyclones.



Figs. 6(a&b). Meridional flux of moist static energy (Joule gm^{-1} m sec^{-1}) over Chittagong and Cuttack



Figs. 7(a&b). Zonal flux of moist static energy (Joule gm^{-1} m sec^{-1}) over Chittagong and Cuttack

3.5. The significant amount of southerly flux exists throughout the troposphere on 17 and small meridional flux exists during 18-21 from surface to 250 hPa and large southerly flux exists around 200 hPa on 20 and 21 over Dhaka. The large amount of southerly flux from surface to 320 hPa [Fig. 6(a)] and significant amount of northerly flux is found to exist from 320 to 200 hPa on 17 and slight southerly flux exists at all levels on 19 and 20 over Chittagong. The large amount of southerly flux exists from surface to 600 hPa and significant northerly flux exists from 600 to 325 hPa with sharp maxima at 400 hPa on 21 over Chittagong. The flux is southerly at all levels [Fig. 6(b)] on 18 and 19 and little amount of northerly flux exists near the surface on 19 and the flux is northerly from surface to 300 hPa and southerly from 300 to 200 hPa on 20 over Cuttack. The flux is southerly at all levels and decreases gradually during 18-20 over Port Blair.

3.6. The westerly (+ve) flux of moist static energy increases gradually at all levels except little anomalies on 17 and 18 and easterly (-ve) flux exists from surface to 700 hPa and westerly flux from 700 to 200 hPa on 20 and from surface to 200 hPa on 21 over Dhaka. The zonal flux decreases [Fig. 7(a] from 800 to 200 hPa having little anomalies during 17-21 except 19 over Chittagong. The large westerly flux exists from 800 to 200 hPa, small easterly flux exists from surface to 800 hPa on 20 and the maximum amount of westerly flux exists at 500 hPa and maximum amount of easterly flux at 400 hPa on 21 over Chittagong. The easterly flux increases from surface to 600 hPa [Fig. 7(b)] and the westerly flux decreases gradually from 600 to 200 hPa levels on 18 and 19 and the westerly flux exists from 950 to 200 hPa levels and little easterly flux exists around surface on 20 over Cuttack. The flux is westerly from 950 to 200 hPa levels and little amount of easterly flux exists around surface on 17 and the easterly flux increases gradually at all levels during 18-20 over Port Blair.

4. (*i*) The temperature increases from surface to 300 hPa on 19, decreases from surface to 400 hPa on 20 and again increases from surface to 300 hPa level on 21 November 1992 over Chittagong.

(*ii*) The northwesterly flux from surface to 400 hPa and southwesterly flux from 400-200 hPa on 20 over Cuttack may be deviated from the region towards northeast direction.

(*iii*) The significant northwesterly flux exists around 500 hPa and northeasterly around 400 hPa on 21 November over Chittagong. Due to this increase of temperature on 21 and north-westerly at 500 hPa level and northeasterly at 400 hPa level the cyclone may be deviated from the Chittagong coast and crossed the Myanmar coast as land depression.

(*iv*) The vertical wind shear is 4-6 ms^{-1} near the centre of the cyclone.

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