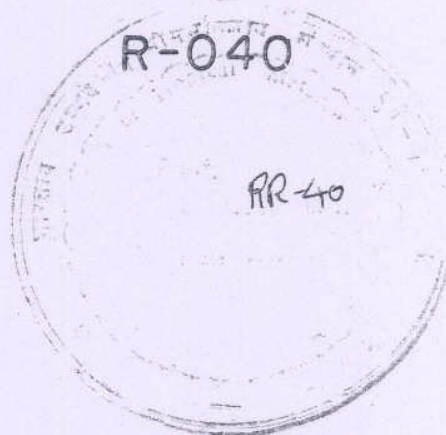


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A note on the preliminary results of
integration of a five level P.E. model
with westerly wind and low orography

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by

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ABSTRACT

Numerical experiment is conducted with idealized westerly wind, $u = 10$ mps, at all levels of the model atmosphere and the elliptic orography as an obstacle to flow with maximum height of 400 meters at the centre of the domain of integration. The integration is performed for 4 days of model time. The forecast results are presented and discussed.

1. Introduction

A five level P.E. model is being developed for Indian region. The simplified version of the model was used by Singh and Saha (1976) and the computational stability of the finite difference schemes was tested. Since then the efforts are being made to incorporate various physical processes in the model.

The typical terrain shape of India and the surrounding region has important dynamic effects on the evolution of the atmospheric flow. The response of orography of this

region on atmospheric flow has been investigated by Das and Bedi (1976, 1978). They have adopted the sigma coordinate system for the model equations. The computational procedure is described by Das and Bedi (1978).

The numerical experiment using the primitive equation model has also been performed for simulation of the orographic effects by Bavadekar and Khaladkar (1983). The model equations are expressed in pressure coordinate system. The evolution of the westerly flow with typical terrain shape of India, Burma and Tibetan massif with a maximum height of one km has also been investigated by Bavadekar and Khaladkar (1983 a). The lee-troughs due to Western Ghats and Burma mountains have been found in both numerical as well as analytical solutions using three level P.E. model and the linear steady state vorticity equation respectively.

In the present note an attempt has been made to test the model performance with five level P.E. model which gives increased resolution in the vertical. The forcing due to low elliptic orography with maximum height of 400 meters is introduced at the bottom layer of the model. The experiment is conducted with idealized westerly wind, $u = 10$ mps, at all the levels of the model.

2. The description of the model

The model consists of following equations :

- i) u and v momentum equations in flux form.

- ii) The equation of continuity.
- iii) Hydrostatic approximation.
- vi) Thermal equation and
- v) Surface pressure tendency equation.

The equations are given by Bavadekar and Khaladkar (1983).

The frictional and diffusion terms are not considered in the present experiment.

The Coriolos parameter f is given by

$$f = f_0 + \beta y \dots (1)$$

where $f_0 = 0.7292 \times 10^{-4} \text{ sec}^{-1}$ at 30°N and
 $\beta = 1.982 \times 10^{-11} \text{ m}^{-1} \text{ sec}^{-1}$ corresponding to
 30°N . The domain of integration and the vertical structure of the model are given in Fig. 1 and Fig.2 respectively.

The finite difference schemes are similar to that given by Okamura (1975, 1976). The initial values are given in Table 1. The orographic heights and the corresponding surface pressure values are given in Table 2. The grid length used is 5° latitude/longitude and Matsuno's time integration scheme is used for integration with time-step of 12 minutes. The integration is performed for 4 days of model time.

3. Results of integration

The results of the forecast fields are presented for few typical levels. The forecast wind fields are shown in figures 3 to 5 for 200, 600 and 950 mb levels. The wind field is not affected much as the forcing is weak due to low orography. The northerly component of the wind is developed when the flow is crossing over the orographic barrier as seen from the figures for 600 and 950 mb levels.

The vertical p-velocity is shown for the levels 300, 700 mb and surface in figures 6 to 8. The vertical velocity is upward on the windward side and downward on the leeward side of the orographic barrier. The temperature departures are shown in figures 9 and 10 for 300 and 700 mb levels respectively. The cooling and warming shown in the diagrams are appropriate in view of the vertical velocity development in these regions.

The results obtained with five level P.E. model are thus more or less similar to that reported earlier by using three level P.E. model (Bavadekar and Khaladkar 1983). The experiment within the framework of five level vertical structure also indicates that the computer program with its logical and computational operations is satisfactorily working for simulation of the effects of low orography. Further development regarding incorporation of the high orographic barriers in the model is being continued.

Acknowledgements

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Table 1 : The initial values for the model

Latitude deg. N	Heights of isobaric levels in meters					Temperature in °A					Sea level pressure in mb Psea.
	Z ₁	Z ₂	Z ₃	Z ₄	Z ₅	T ₁	T ₂	T ₃	T ₄	T ₅	
50	11565	6981	4007	1753	380	234.8	253.8	269.3	280.3	300.0	992.3
45	11620	7036	4062	1808	435	"	"	"	"	300.4	998.3
40	11670	7086	4112	1858	485	"	"	"	"	300.8	1003.7
35	11715	7131	4157	1903	530	"	"	"	"	301.0	1008.6
30	11755	7171	4197	1943	570	"	"	"	"	301.2	1013.0
25	11789	7205	4231	1977	604	"	"	"	"	301.3	1016.8
20	11819	7235	4261	2007	634	"	"	"	"	301.4	1020.0
15	11843	7259	4285	2031	658	"	"	"	"	301.5	1022.7
10	11863	7279	4305	2051	678	"	"	"	"	301.5	1024.9

Table 2

Table 2 : Orographic heights and corresponding surface pressure values

250	300	350	300	250
(980.7)	(975.1)	(969.6)	(975.1)	(980.7)

250	300	350	400 ⁺	350	300	250
(985.1)	(979.5)	974.0)	(968.5)	(974.0)	(979.5)	(985.1)

250	300	350	300	250
(989.0)	(983.4)	977.8)	(983.4)	(989.0)

Note : Bracketed figures are surface pressure values in mb.

+ : The centre of the domain with maximum height of orography (400 m).

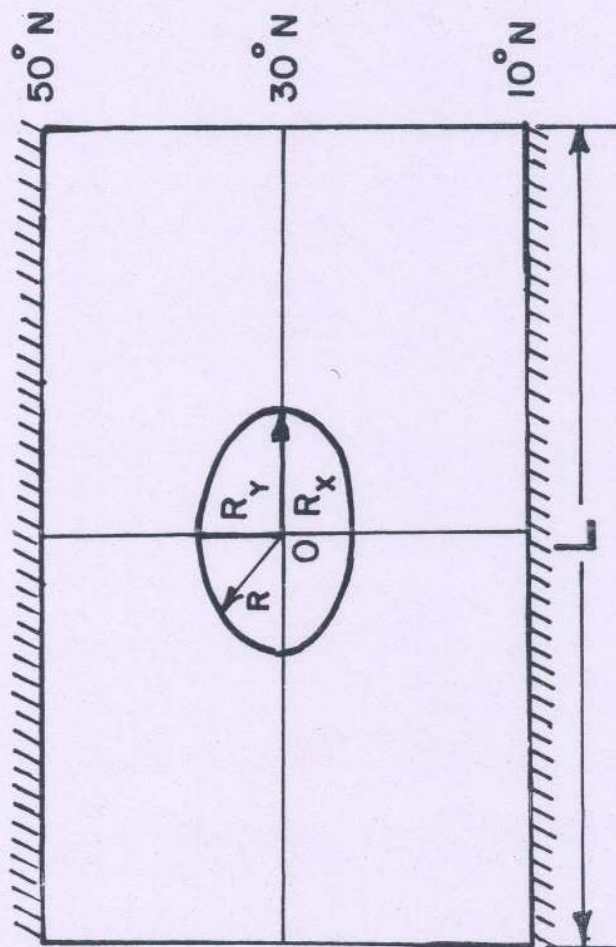


FIG.1: THE DOMAIN OF LIMITED AREA P.E. MODEL

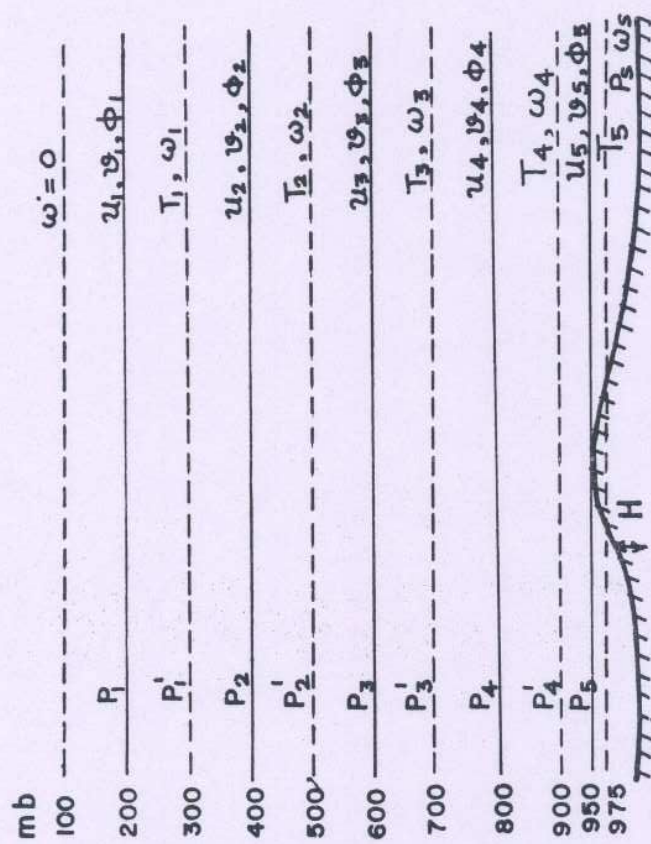


FIG.2 : THE VERTICAL STRUCTURE OF THE FIVE LEVEL
P. E. MODEL.

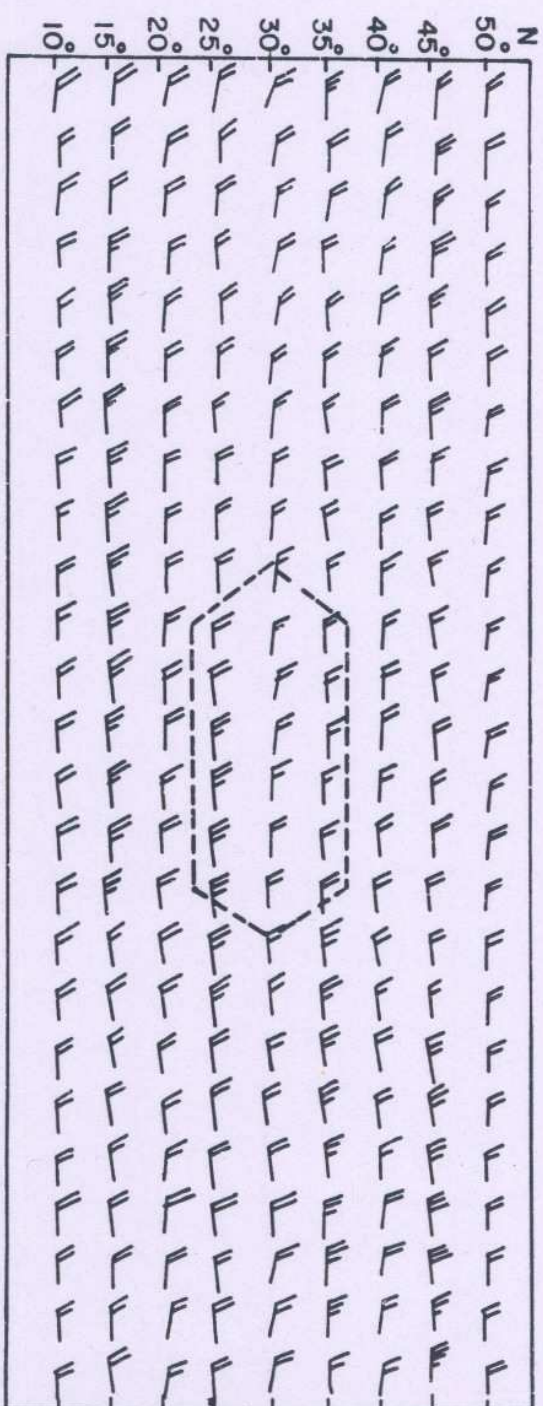


FIG. 3: THE FORECAST WIND FIELD AT 200mb LEVEL. FORECAST : 96HRS.

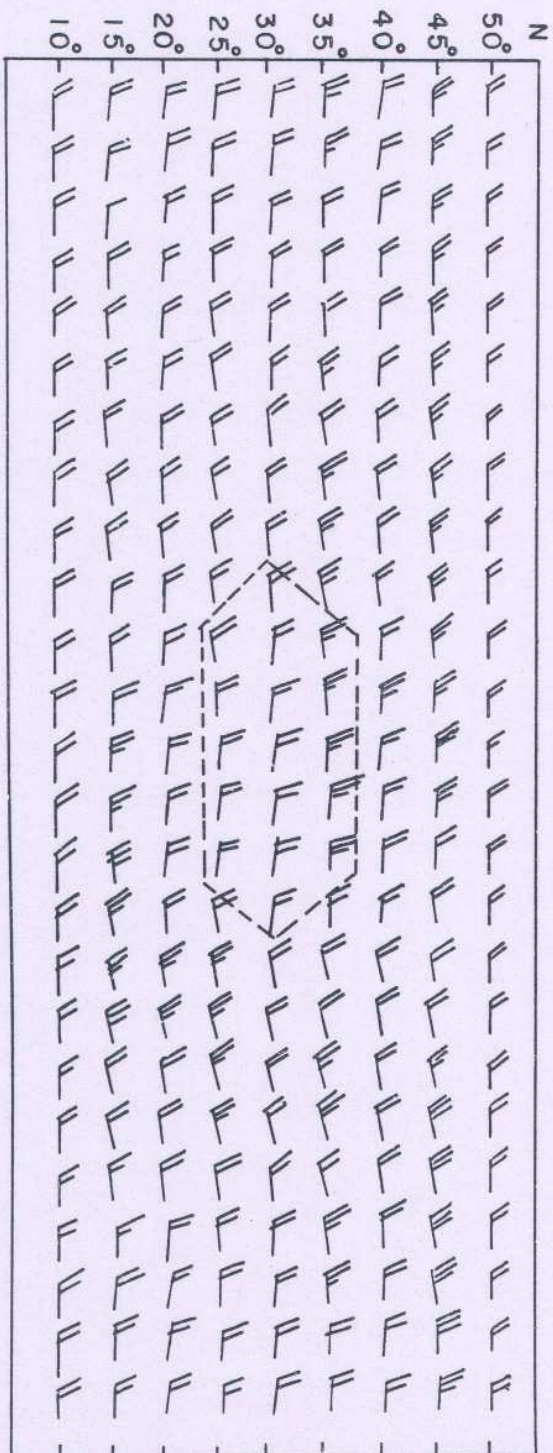


FIG.4 : FORECAST WIND FIELD AT 600 mb LEVEL. FORECAST : 96 HRS.

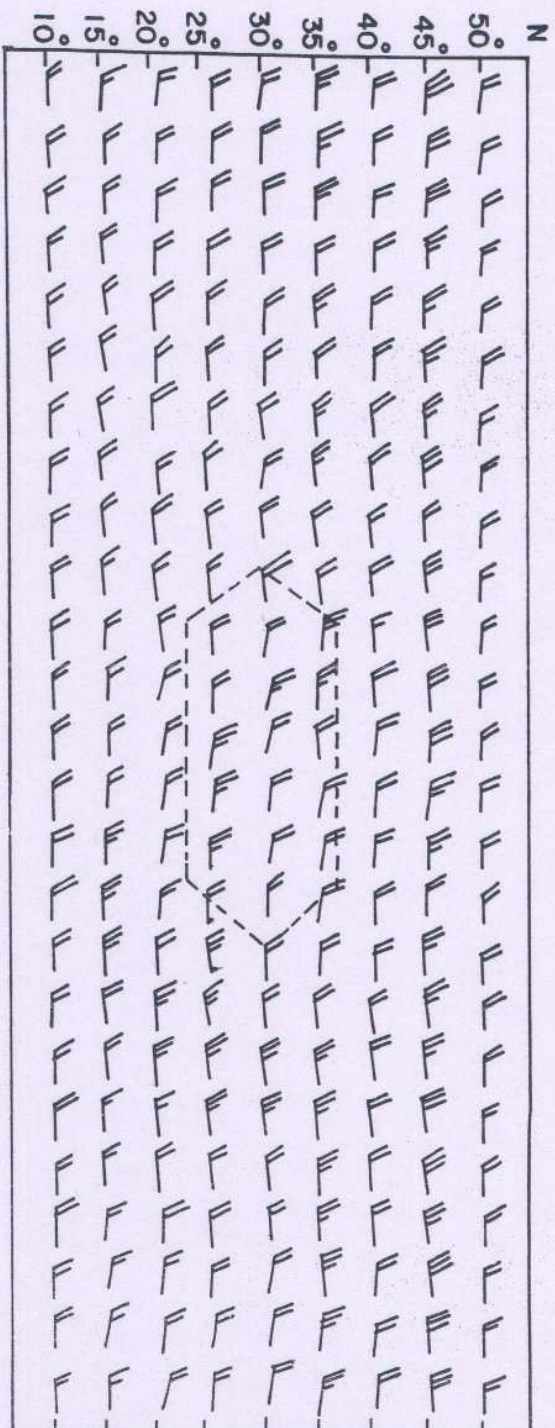


FIG.5: THE FORECAST WIND FIELD AT 950mb LEVEL, FORECAST : 96 HRS.

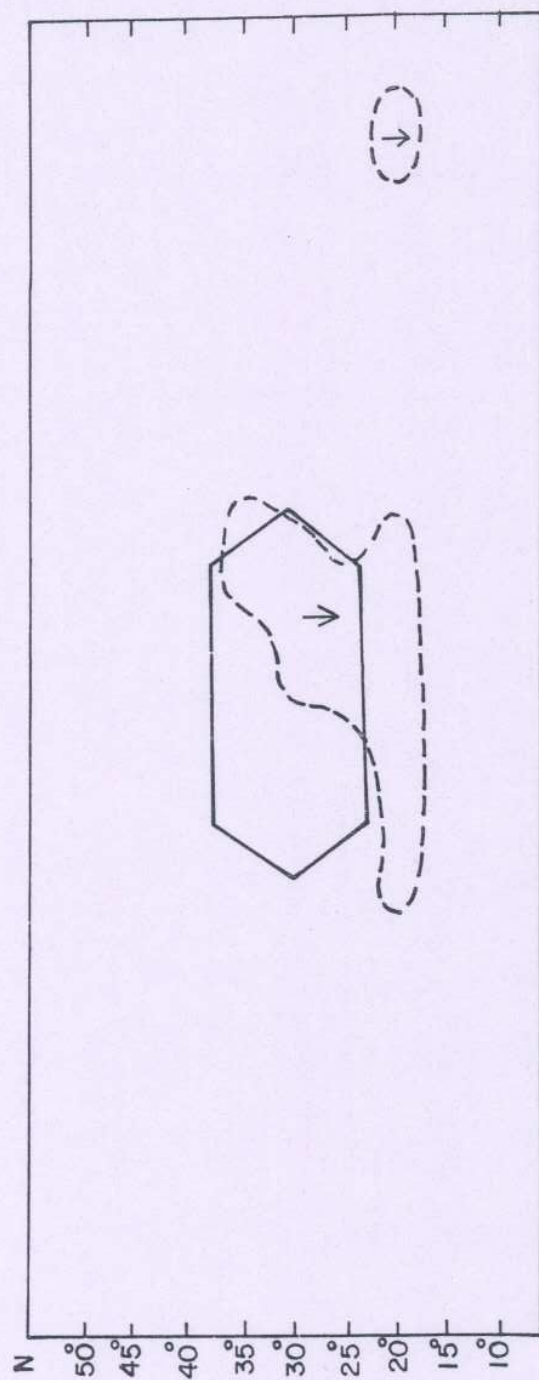


FIG.6: THE VERTICAL p-VELOCITY AT 300 mb LEVEL. UNIT : 10^{-3} mb sec $^{-1}$
 CONTOUR SPACING IS AT 0.3 UNIT INTERVAL

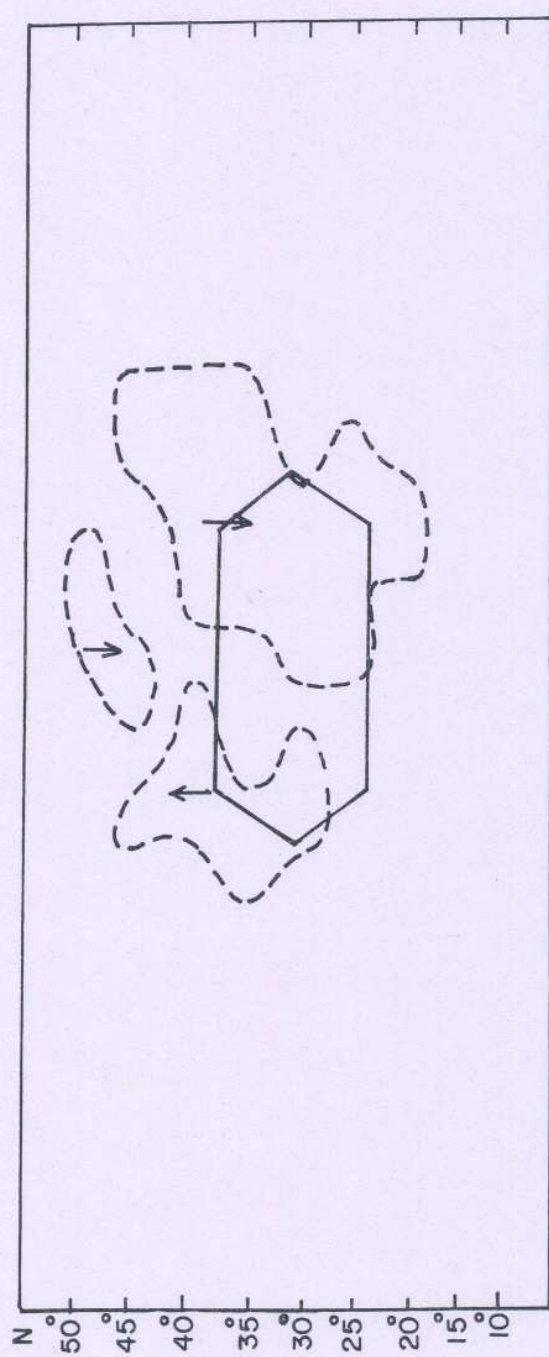


FIG. 7: THE VERTICAL p -VELOCITY AT 700mb LEVEL. UNIT : $10^{-3} \text{mb sec}^{-1}$
CONTOUR SPACING IS AT 0.3 UNIT INTERVAL.

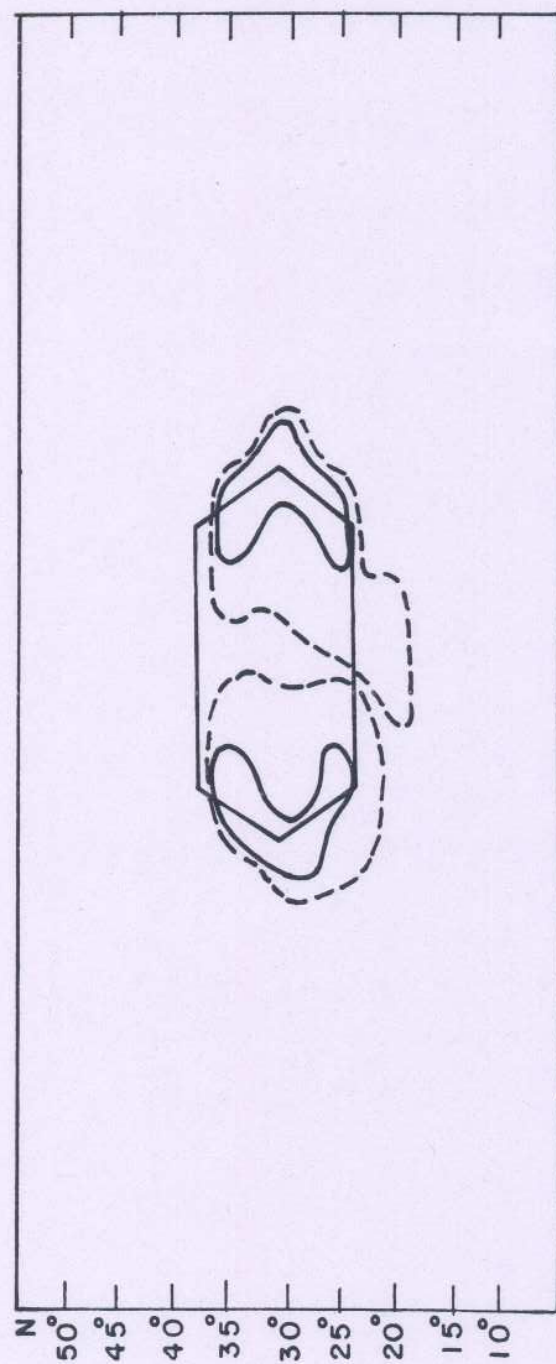


FIG.8: VERTICAL p -VELOCITY AT THE SURFACE UNIT: $10^{-3} \text{ mb sec}^{-1}$
CONTOUR SPACING IS AT 0.3 UNIT INTERVAL

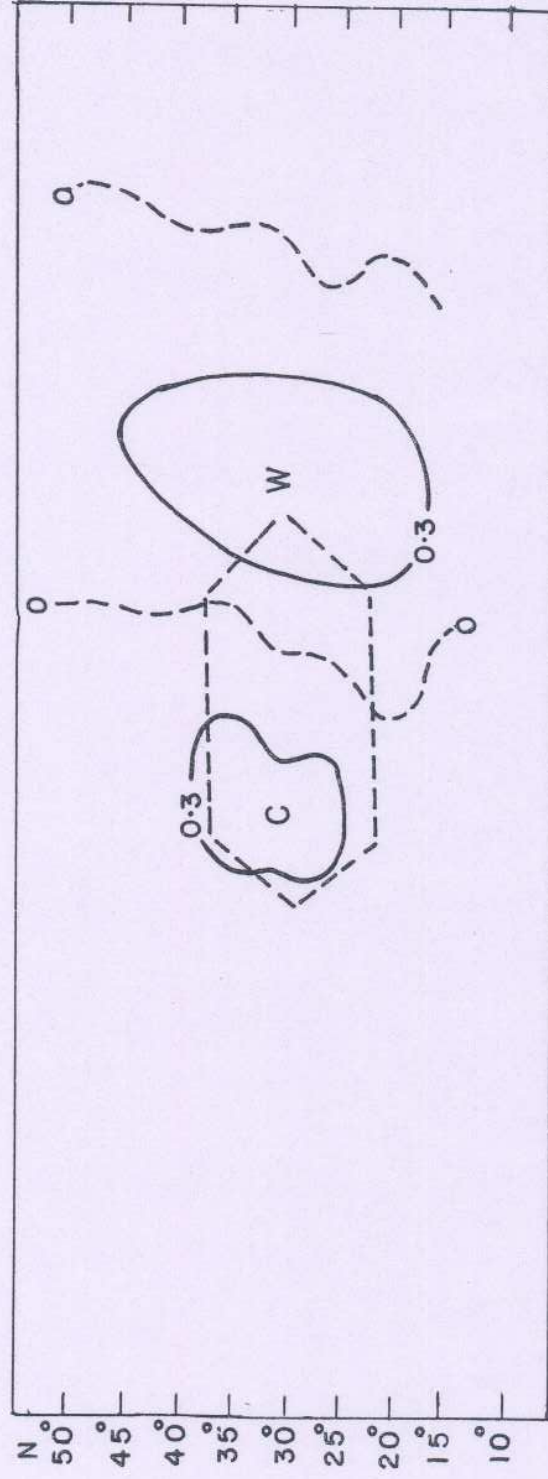


FIG. 9: THE TEMPERATURE DEPARTURE $\Delta T = T_{96} - T_0$ (IN DEG. CENT)
LEVEL : 700 mb .

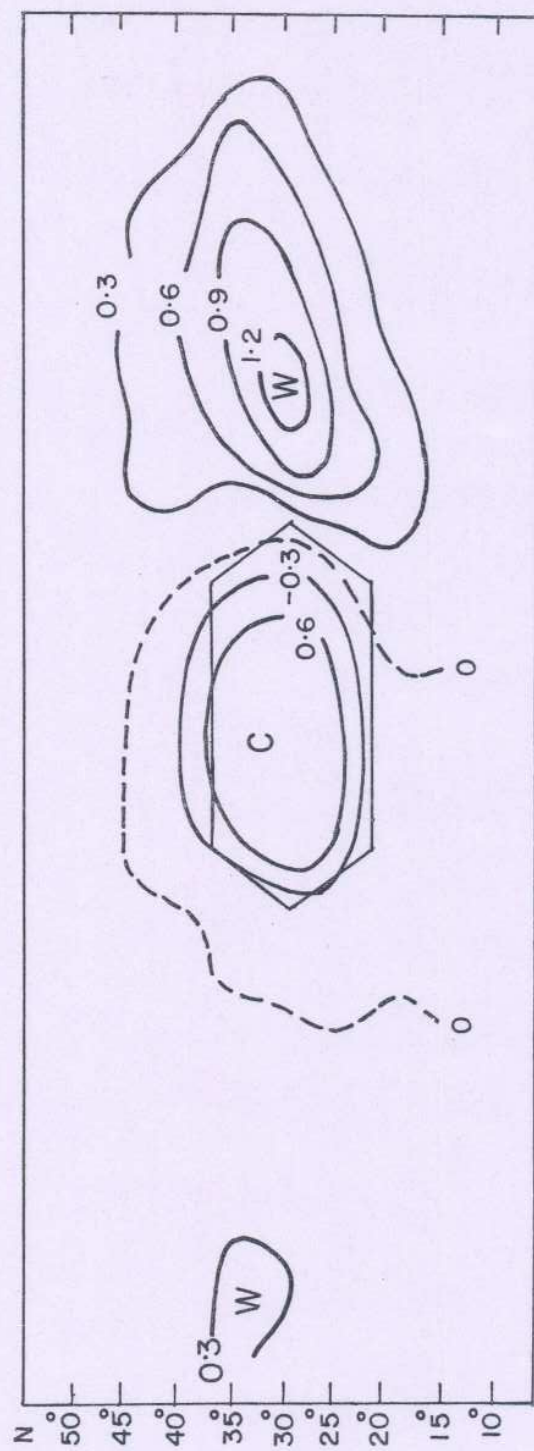


FIG. 10: THE TEMPERATURE DEPARTURE $\Delta T = T_{96} - T_0$ (IN DEG. CENT),
LEVEL : 700mb.