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"A Tropical Cyclone in the Mediterranean? A NCEP MRF & a LAM Forecast of a Rare Event"

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A tropical cyclone in the Mediterranean? A NCEP MRF and a LAM forecast of a rare event.

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Short outline of the seminar.

Between the 7th and the 15th of October 1996 two anomalous Mediterranean cyclones, displaying surprising "tropical" features, developed in the Mediterranean Sea. Until now, the baroclinic theory has been regarded as the only possible explanation for all the Mediterranean cyclones. Particularly, the interaction of a large scale baroclinic wave with an orographic obstacle like the Alps, has been considered the cause of most of the Mediterranean cyclones (Buzzi and Tibaldi, 1978; Speranza et al., 1985).

However, there are some rare cyclonic events which cannot be described within the frame of the baroclinic theory, because of their smaller scale (100-200 km instead of 1000-2000 km), their extreme intensity and because they occur in an almost completely barotropic atmosphere. Some of those events, like the one that developed in the Mediterranean between the 7th and the 10th of October 1996, present also a "hurricane-like" structure, with a perfectly recognizable eye and a warm core. The satellite image provides a surprising picture which has nothing to do with the satellite images of baroclinic systems usually seen in the Mediterranean (Fig. 1).

Furthermore, the NCEP analyses of October 8th at 00 Z display, although limited by the poor resolution (1 degree) a cyclone with no baroclinicity very close to the west of Sardinia (Italy). The alignment between the cutoffs at all levels with the minimum of sea level pressure (Fig.2a, Fig. 2b), the warm anomaly at 500 hPa perfectly centered over the corresponding minimum of sea level pressure (and nested into a larger scale mid-tropospheric cold anomaly) and the satellite image, which displays a clear and perfectly recognizable eye, suggest a cyclonic feature very different from normal Mediterranean cyclones. The cyclone cannot either be regarded as a "Polar Low" (Emanuel, 1989) because such systems, although frequently observed in the Mediterranean, occur only during massive outbreaks of arctic air over the Mediterranean, mostly between January and March, whereas the cyclone we are describing here occurred with surface temperatures much above 20 C.

The cross-sections in the meridional and zonal directions of the wind speed show

a well defined "eye-wall" structure (Fig. 3a, Fig. 3b) with low velocities. The wind speeds around the "eye-wall" are stronger of a factor of 3 than the speeds normally involved with the baroclinic orographically-induced Mediterranean cyclones.

A possible explanation of the system is attempted, showing that the Mediterranean Sea, in spite of the high values of the Coriolis parameter, allows in this part of the year, a sort of small-scale air-sea interaction with a positive feedback, similar to the one described by Emanuel (1986, 1988) made possible by the particular shape of Mediterranean coast, that forces downwelling and increases SSTs when a cyclone is tracking in a certain way. Furthermore, the relatively high SST in fall, the particular position of the jets inducing a strong horizontal shear in the upper troposphere, and the lack of any baroclinic event in the same time frame, with very small vertical shears, are possible concurrent mechanisms for such kinds of events. Latent heat release by intense cumulus convection (Charney and Eliassen, 1964; Kuo, 1965) will be the contributing source of energy as in more usual tropical storms.

The performance of the so called DALAM (Data Assimilation Limited Area Model) in use at the Ufficio Centrale di Ecologia Agraria (UCEA), Rome, Italy, is evaluated. The model, derived from Mesinger's original UB/NMC model, has a 30 km resolution and its domain covers most of western and central Mediterranean. It will be shown that the model captured quite correctly the anomalous dynamics, by reproducing a cyclone with almost no baroclinicity, very small scale, strong winds and heavy precipitations.

However, the performance of the NCEP medium range forecast model (mrf) is certainly better from the track perspective.

In fact, for some reason which is still under study, the initial conditions given to DALAM, directly provided from the ECMWF, although having higher resolution, were much more smoothed than the NCEP analyses for all the three days of Oct 7th, 8th and 9th. This is probably due to a filter in the ECWMF data which treated the cyclone like an "error" because too steep with respect of the usual Mediterranean cyclones. For this reason, this is a surprising case in which a mrf like the NCEP mrf outperformed a LAM in predicting the track of a rare but very dangerous feature. Some islands in the Tyrrhenian Sea (Aeolian) have been invested by 30 meters per second winds during the night between the 8th and the 9th, and this was not predicted by the local weather service.

The warm core and the track of the system is correctly captured by the mrf, together with the temporary drop of energy due to the crossing of Sardinia, when the system apparently loses its structure and its eye. But shortly after leaving land, the cyclone goes back again to its anomalous appearance, display-

ing a "tropical" structure and tracking southeastward.

Our conclusion is that the study of Mediterranean cyclones has been affected by a "mid-latitude" bias, from both perspectives of theoretical understanding and operational forecast approach. It seems clear to the authors that some of the most impressive floods occurred in the last years (i.e., Nov 94, 55 casualties in Piedmont) and June 96, with 500 mm of rains dumped in 12 hours over the Versilia (Tuscany) cannot be explained within the frame of the baroclinic theory. A comparison of the NCEP and DALAM performances in those circumstances also reveal a serious difference in the initial conditions between NCEP and ECMWF, what causes the mrf to develop a tropical-like feature unlike the DALAM model.
However, the extreme proximity of the Mediterranean to the Atlantic baroclinic storm-track and the much higher occurrence of purely baroclinic events in the Mediterranean, does not allow to recognize easily some "tropical-like" features, that can frequently be nested into larger scale baroclinic systems.

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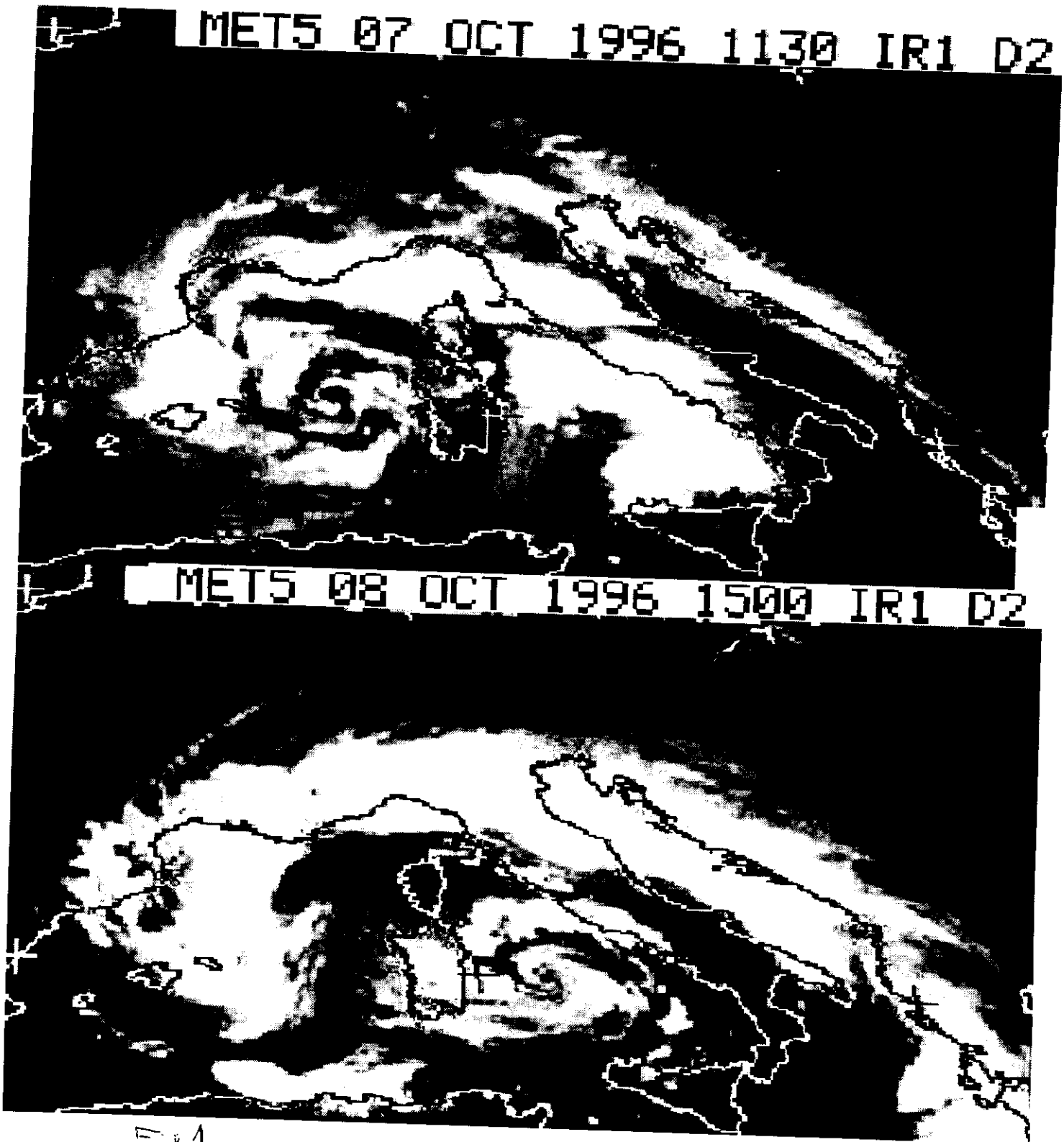
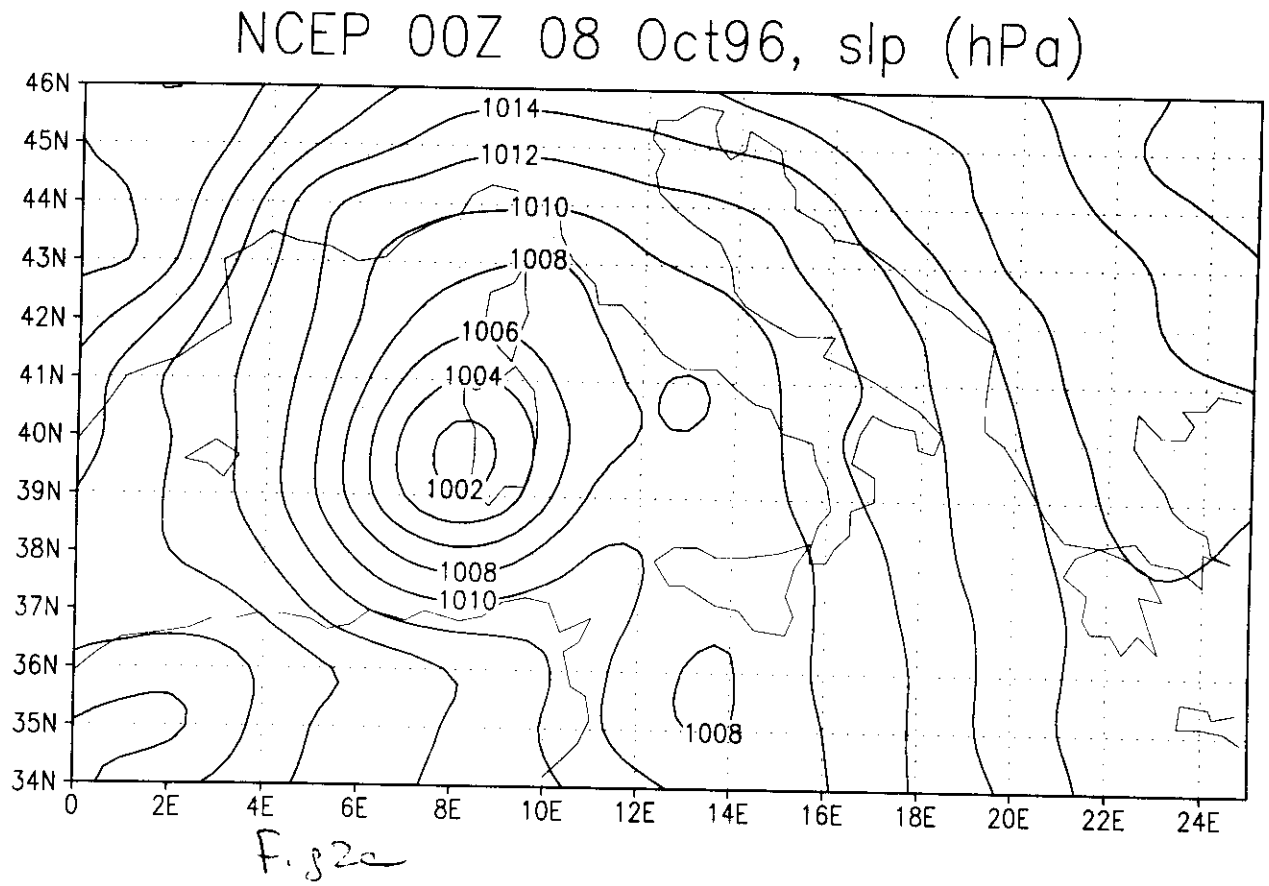


Fig 1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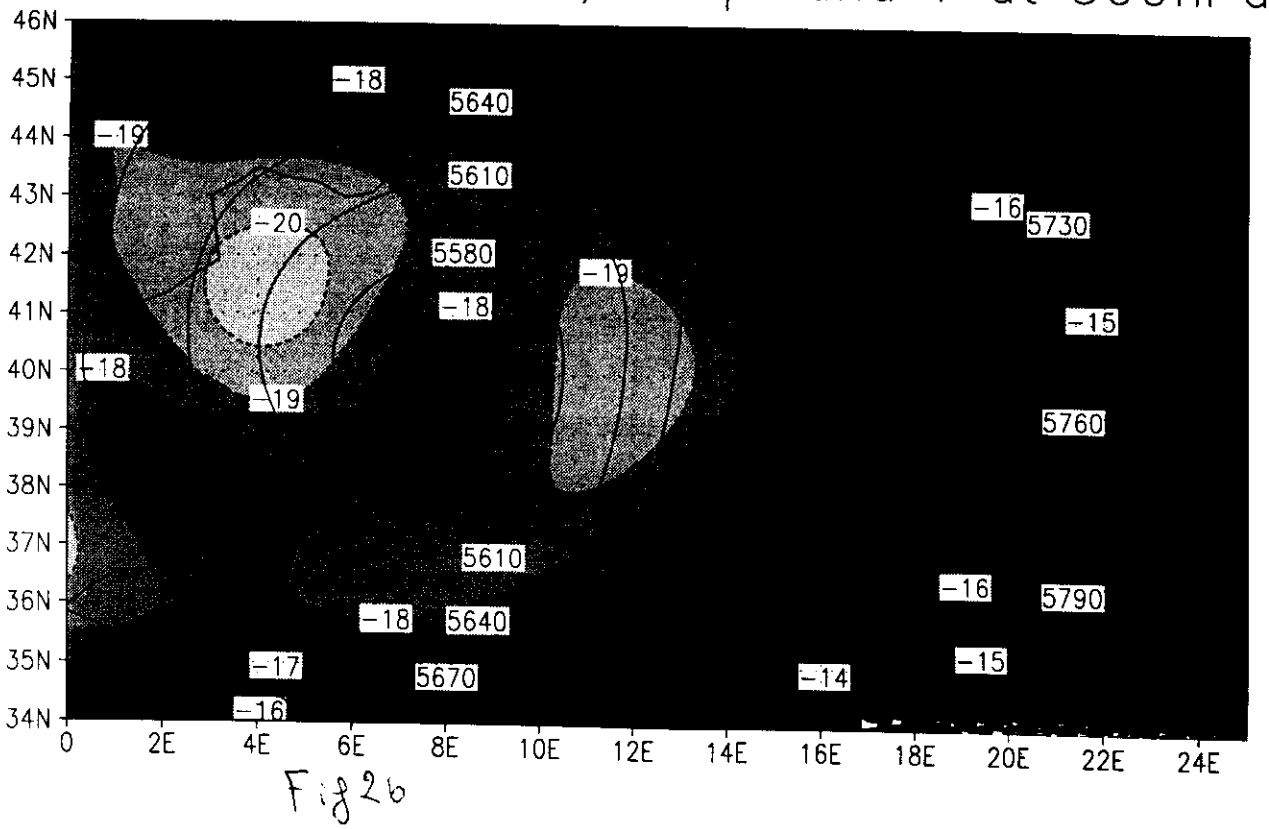
46N
45N
44N
43N
42N
41N
40N
39N
38N
37N
36N
35N
34N
0
2E
4E
6E
8E
10E
12E
14E
16E
18E
20E
22E
24E
1014
1012
1010
1008
1006
1004
1002
1008
1010
1008

Fig 2a


NCEP 00Z 08 Oct96, Geop. and T at 500hPa
46N
45N
44N
43N
42N
41N
40N
39N
38N
37N
36N
35N
34N
0
2E
4E
6E
8E
10E
12E
14E
16E
18E
20E
22E
24E
-18
5640
-19
5610
-20
5580
-19
-18
-18
-19
5610
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5760
-16
5790
-18
5640
-17
5670
-14
-15
-16

Fig 2b

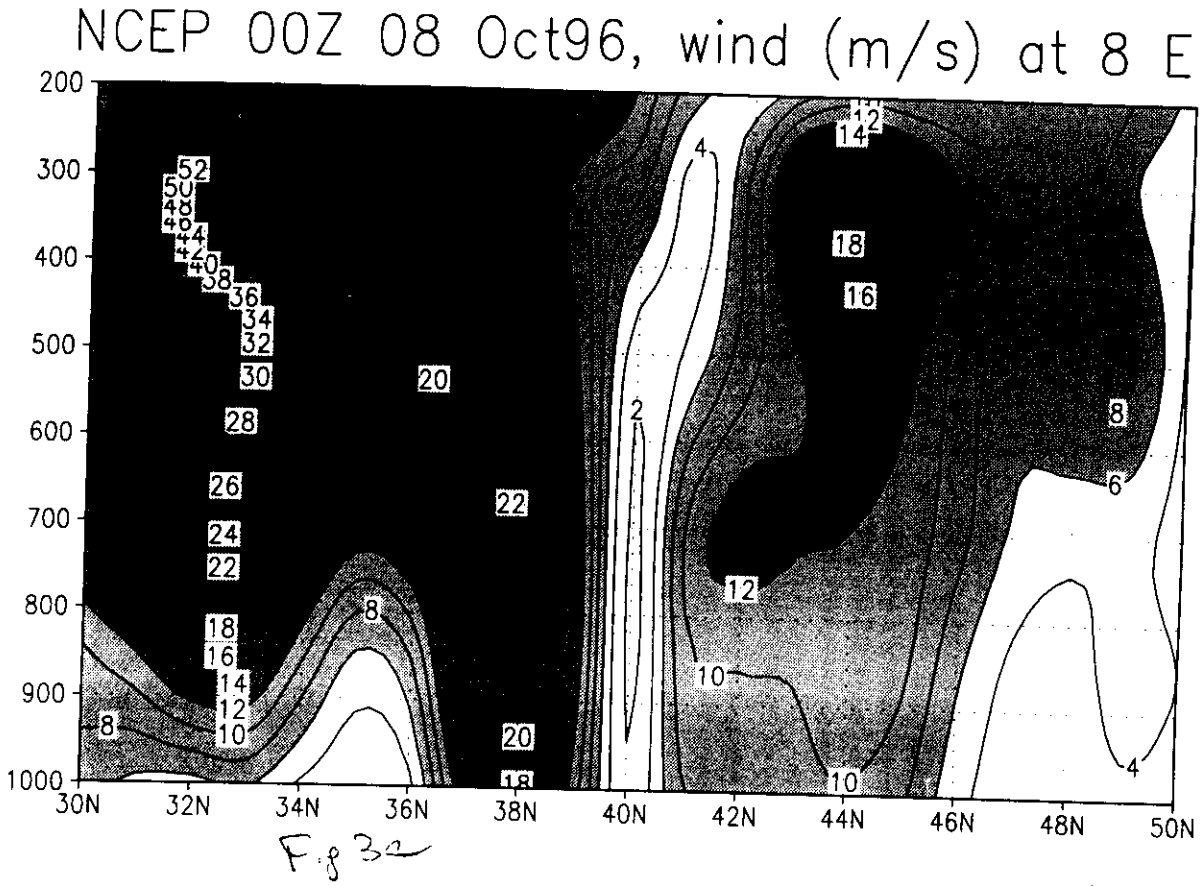
NCEP 00Z 08 Oct96, wind (m/s) at 8 E
200
300
400
500
600
700
800
900
1000
30N
32N
34N
36N
38N
40N
42N
44N
46N
48N
50N

Fig 3a

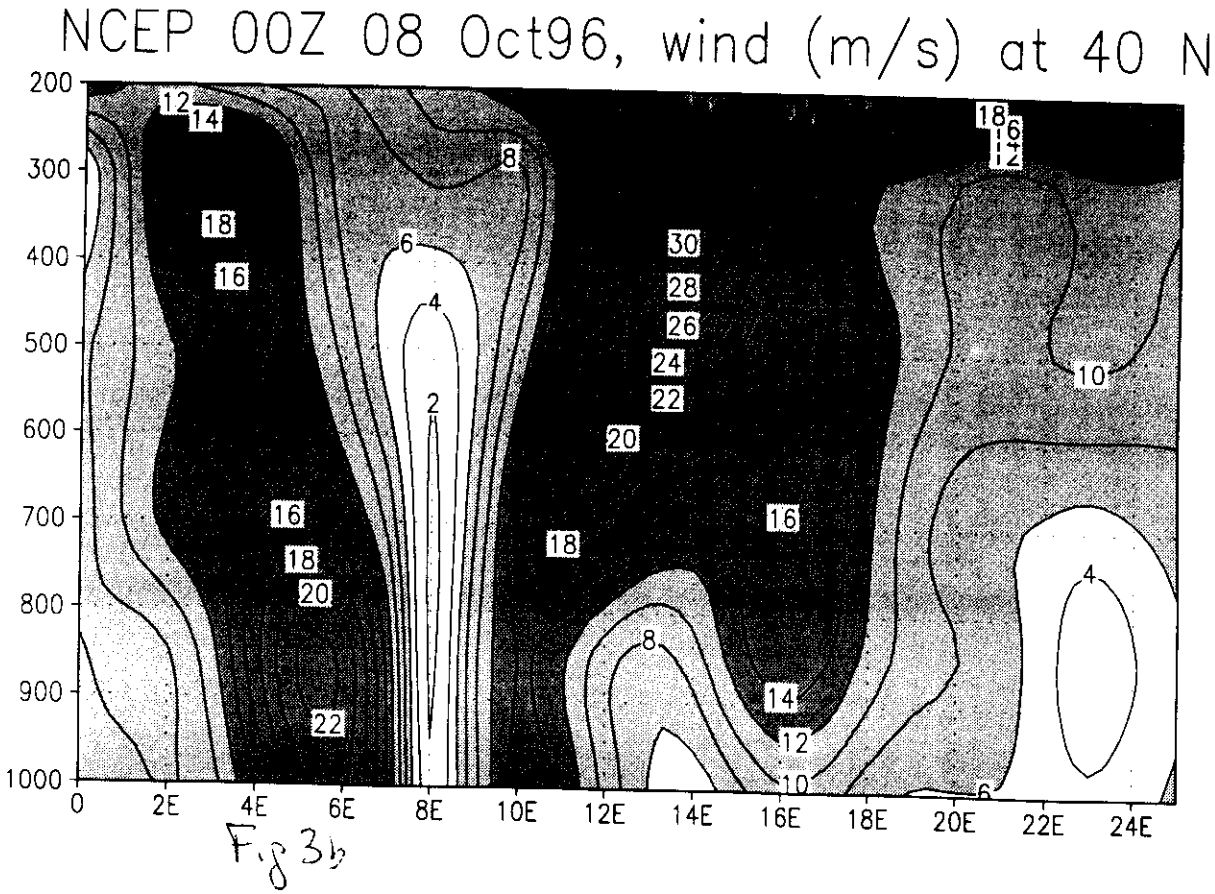
NCEP 00Z 08 Oct96, wind (m/s) at 40 N
200
300
400
500
600
700
800
900
1000
0
2E
4E
6E
8E
10E
12E
14E
16E
18E
20E
22E
24E

Fig 3b