Environmental Circulations Associated with Tropical Cyclones Experiencing Fast, Slow and Looping Motion

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ABSTRACT

This study investigates the characteristic large scale flow patterns associated with fast, slow and looping tropical cyclone motion in the western Atlantic and the western North Pacific. Such storm motion is often difficult to forecast. Cyclones have been stratified by their speed - motion greater than 7.5 m/s (262 cases at 1200 individual time periods) or motion less than 2.5 m/s (201 cases at 914 individual time periods) and also into a looping track category (112 cases during 505 individual time periods). Data have been gathered for all storms meeting these criteria for the 21 year period of 1957-1977. In addition each class of cyclone motion has been further stratified by its position south of, near, or north of the subtropical ridge at 500 mb. Both individual case and composite analyses are performed. Climatological information on each motion class is also provided.

Significant differences in the climatology for these three classes of storm motion are observed. In lower latitudes, slow and looping cyclones occur with a higher percentage fequently (while fast cyclones occur with less percentage fequently) in the west Pacific than in the Atlantic. The reverse situation occurs at higher latitudes. However, the synoptic circulation characteristics around these three classes of cyclones are very much the same in both ocean basins. Individual case and composite data analyses indicate that cyclone motion is primarily related to the hemispheric westerly long waves and to the storm's position relative to the subtropical ridge. When a cyclone moves slowly or loops, there is typically a large amplitude 500 mb westerly wave trough to the northeast of the cyclone. This produces a near symmetrical tangential circulation around the slow and looping cyclones. The more poleward the cyclone is relative to the subtropical ridge, the further east the trough is relative to the looping tropical cyclone. When a cyclone moves fast, the long wave trough is to the west of the cyclone or the circulation is zonal. This causes fast-moving cyclones to have a large asymmetrical circulation. This asymmetry of the tangential wind with maximum wind speed to the right and minimum to the left of the storm direction is essential to tropical cyclone motion. It results from the addition of a vortex circulation and a basic translationl current.

The middle latitude long waves which influence cyclone motion are related to the hemispheric circulation. Harmonic analyses of the hemispheric 500 mb height fields show that stationary long waves with wave number five (wave length 70-75^{o} longitude) are most related to cyclone motion. Climatological differences of cyclone motion in the two oceans can be largely explained by the climatological flow pattern differences occurring in these two ocean basins.

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1. INTRODUCTION

This study was undertaken with the purpose of isolating and styding the special environmental flow situations associated with tropical cyclones which are experiencing a fast, slow, or looping motion. These types of cyclone motion are some of the most difficult to forecast. It may prove beneficial to study these special classes of cyclone motion by themselves and try to learn as much as possible of the physical processes responsible for such motion.

Of the many factors which affect tropical cyclone motion, the large scale circulation around a cyclone appears to be the most important. The 'steering flow' concept has long been used in operational forecasting of tropical storm motion. Riehl and Shafer (1944) were two of the first to point out the relationship between tropical cyclone motion and height changes in the polar westerlies. Dao (1965) noticed that a sudden modification in polar westerly long waves can cause significant changes in typhoon tracks. Burroughs and Brand (1972) indicated that westerly trough locations can greatly affect cyclone velocity after recurving. Chen and Ding (1979) have also discussed the many ways tropical cyclone motion can be affected by its surrounding circulation patterns. The horizontal scale of the surrounding flow patterns investigated in this study are larger than those typically used in storm-environment steering flow studies such as those of George and Gray (1976) and Chan and Gray (1982). This study discusses how the very large-scale synoptic-scale flow patterns (~ 1000 km) in which the tropical cyclone is embedded effects its current and subsequent motion.

In this research we use both individual case studies and compositing analyses to stratify storms undergoing these three special motion characteristics. Five hundred and seventy-five separate cyclone cases of motion are studied. Each case might extend for several days. In addition, all cyclones have been stratified by their latitude position relative to the subtropical ridge. Storms south of the subtropical ridge must be handled differently than storms located to the north or on the ridge.

Individual storms often do not have enough information around them to permit a meaningful and quantitative analysis. However, by compositing many similar cases together, one can often obtain the necessary information required for such an analysis. By subtracting the environmental conditions surrounding slow moving cyclones from those surrounding fast-moving cyclones, it is possible to isolate more quantitatively those factors most responsible for differences in cyclone movement.

The three classes of cyclones to be studied are each stratified by their latitudinal position north, on, or south of the subtropical ridge at 500 mb. Nine classes of cyclone motion are thus studied.

An attempt is made in this study to gain insight into the general problem of how the synoptic and planetary scale surrounding storm flow patterns act to influence the cyclone's motion. It appears that one reason why statistical forecast methods have not been as successful as anticipated is that the data have not been properly stratified according to the position of the cyclone relative to the subtropical ridge. A cyclone embedded in the trade winds and a cyclone embedded in the westerlies should not be treated the same way.

A companion paper to shortly follow this study (Xu and Gray, 1982) deals with with special questions of tropical cyclone recurvature and non-recurvature.

2. CLIMATOLOGY OF FAST, SLOW, AND LOOPING TROPICAL CYCLONE MOTION

2.1 Data Sources and Sample Selection

The Annual Typhoon Report issued by the Joint Typhoon Warning Center at Guam (for cyclones of the northwest Pacific) and the Best Tracks of the National Hurricane Center (for storms of the Atlantic) were used during the 21 year period 1957-1977 to select the three classes of tropical cyclone motion - fast, slow, and looping. All numbered or named tropical depressions, tropical storms, and typhoons (hurricanes) were examined.

Looping motions were manually selected from the cyclone best track charts. This data set consists of northwest Pacific cyclones which underwent a complete circular loop and west Atlantic cyclones which had a circular motion of at least three-quarters of a loop. If a cyclone undergoes two motion loops in one day it is counted only as one loop. The start and end time of looping are defined as the time at which the cyclone lost and regained a stable direction and speed. Looping period was defined as the period during which the cyclone was in a circular track. Looping diameters are defined as the mean values of the long and short axes of the track ellipses. Looping locations are taken to be the centers of the track circles. Table 1 and 2 present information on all the looping cyclones studied. Figure 1 shows some examples of erratic and looping motion in the west Atlantic and the northwest Pacific.

TABLE 1

Individual Cases of Western Pacific Looping Cyclones

Year	Cyclone Intensity[1]	Cyclone Name	Date/Time Start of Looping	Date/Time End of Looping	Period of Looping Days	Location of Looping Lat.	Location of Looping Long.	Diameter of Loop °Lat.	Looping Direction[2]
1957	S	Irma	10. 8.12	10.10.00	1.0	14.5	117.5	1	CC
1958	T	Marie	10.26.12	10.28.12	1.0	17.0	155.0	1	CC
1958	S	Pamela	11.30.12	12. 2.12	1.5	18.0	138.5	1	C
1960	T	Polly	7.22.00	7.25.00	3.0	23.5	127.0	0.5	CC
1960	T	Bess	8.22.12	8.23.12	2.0	35.5	154.0	2.5	C
1960	T	Della	8.21.12	8.25.12	2.5	22.0	137.0	1	CC
1961	S	Grace	7.21.00	7.23.00	1.5	22.5	127.5	1	CC
1961	T	Helen	7.30.00	7.31.12	1.0	28.0	129.5	0.5	CC
1961	T	Lorna	8.21.12	8.22.12	0.8	16.5	127.5	0.5	CC
1961	T	Clara	10.27.00	10.28.12	1.0	19.0	169.0	1	C
1962	T	Georgia	4.16.12	4.17.12	1.0	9.5	140.0	1	CC
1962	T	Kate	7.20.00	7.21.12	1.0	19.5	119.0	0.5	CC
1962	T	Sarah	8.16.00	8.18.12	2.5	23.5	125.0	1	CC
1962	T	Gilda	10.21.00	10.24.00	0.5	15.5	132.5	0.5	CC
1963	S	Lora	10.10.12	10.13.12	2.5	13.5	143.5	2	CC
1964	S	Tess	5.14.12	5.17.12	3.0	12.0	130.5	2	∞
1964	T	Kathy	8.17.00	8.21.12	5.0	26.0	129.0	5	CC
1964	T	Kate	11.13.00	11.15.00	3.0	9.5	112.5	2	CC
1964	S	Opal	12.14.12	12.15.12	0.8	15.0	120.5	1	CC
1965	T	Ivy	7.28.00	7.31.12	5.0	13.5	128.5	5	CC
1965	T	Jean	7.31.12	8. 1.00	0.5	17.5	130.5	0.5	CC
1965	S	Elaine	11. 9.12	11.11.00	0.8	17.0	112.5	1	CC
1966	S	Winnie	8.20.12	8.22.00	1.0	28.0	130.0	1	CC
1966	T	Alice	8.26.12	8.28.12	2.5	28.0	145.0	2	C
1966	D	T.D.20	9. 6.12	9. 9.00	2.5	30.5	152.0	2	C
1966	T	Elsie	9.11.12	9.13.12	2.0	18.5	118.0	1	C

[1] T = Typhoon, S = Tropical Storm, D = Depression [2] C = Clockwise, CC = Counterclockwise, ∞ = Irregular Looping

TABLE 1 (cont'd)

Year	Cyclone Intensity[1]	Cyclone Name	Date/Time Start of Looping	Date/Time End of Looping	Period of Looping Days	Location of Looping Lat.	Location of Looping Long.	Diameter of Loop °Lat.	Looping Direction[2]
1966	S	June	9.24.12	9.26.00	1.0	19.0	137.5	0.5	CC
1966	T	Kathy	10. 9.00	10.12.12	3.0	19.5	151.0	1	C
1967	T	Violet	4. 9.00	4.10.12	0.5	21.0	118.0	0.5	C
1967	S	Louise	8.16.12	8.18.12	2.0	19.0	142.0	1	∞
1967	T	Wanda	9.19.12	9.21.12	2.5	23.0	142.5	1	∞
1967	S	Amy	9.28.12	10. 1.12	3.5	20.5	158.5	2	C
1968	T	Jean	4.13.12	4.15.00	0.8	21.0	145.0	0.5	CC
1968	D	Mary	7.28.00	7.30.12	2.5	33.0	132.0	3	CC
1968	S	Nadine	7.21.12	7.23.00	1.5	18.0	126.5	1	CC
1968	S	Nadine	7.26.00	7.28.00	2.0	21.5	117.0	2	CC
1968	S	Polly	8. 6.00	8. 7.12	1.5	24.5	156.0	0.5	C
1968	S	Polly	8.14.00	8.15.12	1.5	27.5	124.0	1	CC
1968	S	Trix	8.23.12	8.27.00	3.0	24.0	129.5	2	CC
1968	T	Wendy	8.29.00	8.30.00	0.5	16.0	146.0	0.5	CC
1968	T	Wendy	9. 4.00	9. 5.00	0.5	21.0	123.5	1	CC
1968	T	Agnes	9. 4.00	9. 7.12	2.5	20.0	137.0	1	CC
1968	T	Bess	9. 1.12	9. 2.12	0.5	19.5	114.0	0.5	CC
1968	T	Gloria	10.22.00	10.23.00	0.8	26.0	133.0	0.5	CC
1968	D	Mamie	11.14.00	11.16.00	0.5	13.0	130.5	0.5	C
1969	T	Phillis	1.20.12	1.22.00	0.5	14.0	149.5	0.5	C
1969	D	T.D.11	9. 7.00	9. 9.00	2.0	19.0	119.0	1	CC
1969	D	T.D.12	9. 7.12	9. 9.00	1.5	13.0	112.0	1	CC
1969	T	Grace	9.30.00	10. 2.00	5.5	25.0	162.0	5	∞
1969	S	Lorna	11.26.00	11.27.00	1.0	14.0	131.5	0.5	C

[1] T = Typhoon, S = Tropical Storm, D = Depression [2] C = Clockwise, CC = Counterclockwise, ∞ = Irregular Looping

TABLE 1 (cont'd)

Year	Cyclone Intensity[1]	Cyclone Name	Date/Time Start of Looping	Date/Time End of Looping	Period of Looping Days	Location of Looping Lat.	Location of Looping Long.	Diameter of Loop °Lat.	Looping Direction[2]
1970	S	Nancy	2.20.00	2.21.00	0.5	8.5	147.5	0.5	CC
1970	T	Anita	8.17.12	8.18.12	0.5	21.0	139.0	0.5	CC
1970	S	Ellen	9. 5.12	9. 6.00	0.5	25.0	125.0	2	CC
1970	T	Hope	9.23.00	9.24.00	0.3	20.0	149.0	0.5	C
1970	S	Marge	11. 3.00	11. 6.00	1.5	15.0	115.5	0.5	CC
1971	S	Sarah	1. 9.12	1.10.12	0.5	11.0	136.5	0.5	CC
1971	D	Thelma	3.18.00	3.19.00	0.8	10.5	129.5	1	∞
1971	T	Elaine	10. 5.12	10. 7.12	0.3	16.5	115.5	0.5	CC
1971	T	Faye	10.10.12	10.12.12	3.0	14.5	120.5	3	CC
1971	T	Irma	11. 8.00	11. 9.12	0.3	8.0	141.5	0.5	CC
1972	D	Nina	6. 1.00	6. 2.00	1.5	9.0	143.5	1	CC
1972	T	Rita	7.11.12	7.13.00	1.0	18.0	132.5	0.5	CC
1972	T	Rita	7.21.00	7.25.00	4.0	27.0	126.5	3	CC
1972	T	Susan	7. 9.12	7.14.00	1.5	22.0	117.0	0.5	∞
1972	S	Grace	9.12.00	9.16.12	5.0	20.0	127.0	3	CC
1972	T	Ida	9.16.00	9.19.12	4.0	16.0	156.5	3	C
1972	S	Helen	9.17.12	9.19.12	1.5	42.5	139.0	2	CC
1972	S	Nancy	10.21.12	10.23.00	2.5	26.5	163.0	2	CC
1972	S	Violet	12.13.12	12.14.12	0.8	9.5	170.5	0.5	C
1973	T	Ellen	7.20.12	7.28.00	7.0	32.0	128.0	5	∞
1973	S	Iris	8.10.12	8.14.00	2.0	23.5	131.0	0.5	∞
1973	S	Nora	10. 2.12	10. 4.12	0.5	11.0	133.5	0.5	CC
1974	S	Mary	8.19.12	8.25.00	8.0	28.0	126.0	9	CC
1974	D	Polly	8.26.00	8.26.12	0.5	15.5	146.5	0.5	CC
1975	S	Lola	1.26.00	1.28.00	1.0	16.0	112.5	1	C
1975	D	Flossie	10.20.00	10.21.12	0.5	15.5	116.5	0.5	C
1975	S	Grace	10.24.00	10.30.00	6.0	18.0	129.0	2	∞
1975	S	June	11.16.00	11.18.00	1.0	6.5	142.5	0.5	C

[1] T = Typhoon, S = Tropical Storm, D = Depression [2] C = Clockwise, CC = Counterclockwise, ∞ = Irregular Looping

TABLE 1 (cont'd)

Year	Cyclone Intensity[1]	Cyclone Name	Date/Time Start of Looping	Date/Time End of Looping	Period of Looping Days	Location of Looping Lat.	Location of Looping Long.	Diameter of Loop °Lat.	Looping Direction[2]
1976	S	Marie	4. 3.00	4. 7.00	1.5	8.5	140.5	0.5	CC
1976	S	Olga	5.19.00	5.20.00	1.0	15.5	124.5	0.5	CC
1976	T	Pamela	5.14.12	5.18.00	3.5	7.5	152.0	3	CC
1977	S	Diana	9.16.12	9.21.00	1.0	17.0	116.0	1	CC
1977	S	Ivy	10.21.00	10.23.00	1.0	17.5	146.0	1	CC
1977	D	Jean	11. 2.00	11. 3.00	1.5	27.0	146.5	1	CC
1977	T	Mary	12.24.00	12.25.00	0.5	13.0	169.5	0.5	C

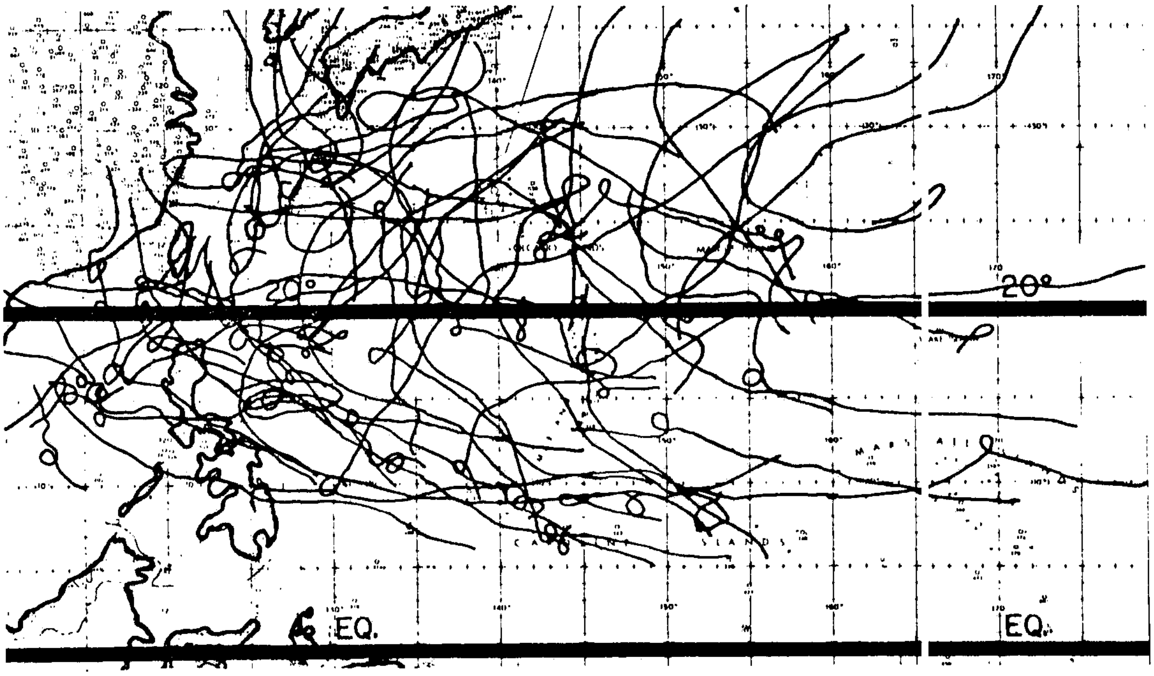
[1] T = Typhoon, S = Tropical Storm, D = Depression [2] C = Clockwise, CC = Counterclockwise, ∞ = Irregular Looping

TABLE 2

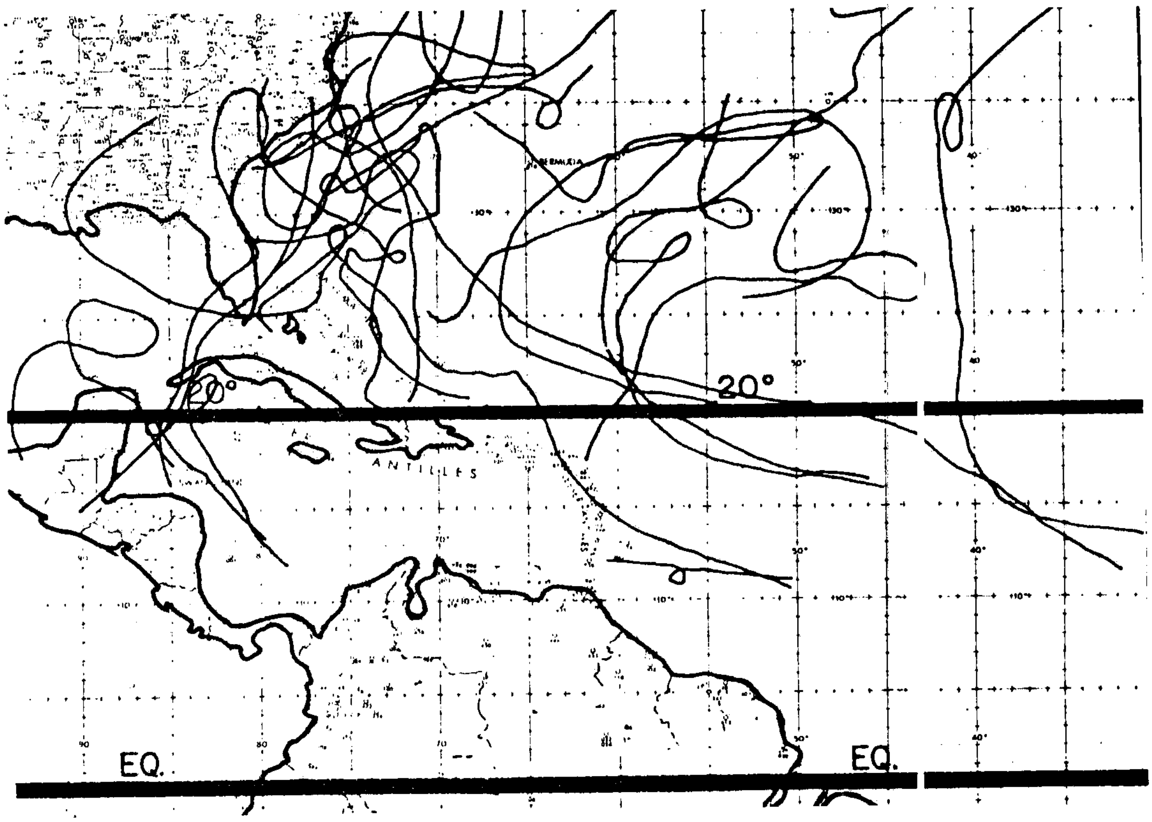
Individual Cases of Western Atlantic Looping Cyclones

Year	Cyclone Intensity[1]	Cyclone Name	Date/Time Start of Looping	Date/Time End of Looping	Period of Looping Days	Location of Looping Lat.	Location of Looping Long.	Diameter of Loop °Lat.	Looping Direction[2]
1957	S	Frieda	9.20.12	9.24.12	4.5	30.5	69.0	6.5	C
1959	H	Gracie	9.25.12	9.27.00	0.5	28.0	73.0	0.5	C
1960	D		6.24.12	6.26.00	1.0	28.5	98.5	1	CC
1960	D	Florence	9.22.00	9.22.12	1.0	22.5	83.5	1	CC
1961	S	Esther	9.21.12	9.25.12	4.5	38.5	68.0	6	C
1961	D	Jenny	11. 4.12	11. 7.12	1.5	27.0	45.0	3	CC
1962	S	Celia	9.18.12	9.20.12	2.5	30.0	53.0	3	C
1963	H	Flora	10. 5.00	10. 9.00	3.0	21.0	77.5	2	C
1963	H	Ginny	10.20.00	10.28.00	8.5	31.0	77.0	5	∞
1964	D	Isbell	10.11.12	10.12.12	1.5	19.0	86.0	0.5	CC
1965	H	Betsy	9. 4.12	9. 6.00	1.5	28.5	75.5	0.5	C
1965	H	Carol	9.23.12	9.28.12	3.5	33.5	41.5	1	C
1966	H	Inez	10. 3.12	10. 4.12	0.5	25.5	78.5	0.5	CC
1966	S	Lois	11. 4.12	11. 7.12	3.5	25.5	53.0	4.5	CC
1967	H	Doria	9.11.12	9.17.00	8.0	36.5	72.5	7.0	CC
1968	D	Abby	6. 8.12	6.11.12	3.5	34.0	80.5	3.5	C
1969	H	Inga	9.29.12	10.15.00	14.5	29.5	57.0	10.0	C
1969	S	Kara	10.12.00	10.15.00	4.5	33.0	73.0	2.5	∞
1969	H	Laurie	10.20.00	10.25.12	5.0	25.0	89.0	5	C
1971	H	Ginger	9.14.12	9.21.12	9.5	37.5	53.5	6.5	∞
1971	S	Laura	11.16.00	11.19.12	2.0	21.0	83.5	1.5	C
1972	H	Betty	8.29.12	9. 1.00	2.5	41.0	34.0	2.5	C
1972	H	Dawn	9. 7.12	9.11.00	3.5	35.0	72.0	4.0	CC
1973	S	Delia	9. 5.00	9. 6.00	1.0	28.5	95.5	1.0	CC
1974	H	Gertrude	9.30.00	10. 1.00	0.5	11.0	56.5	0.5	CC
1976	S	Belle	8. 6.12	8. 8.12	0.5	26.0	73.0	0.5	CC
1977	S	Clara	9. 9.00	9.11.00	2.0	33.5	63.0	1.5	C

[1] H = Hurricane, S = Tropical Storm, D = Depression [2] C = Clockwise, CC = Counterclockwise, ∞ = Irregular Looping



(a)



(b)

Fig. 1. Erratic and looping tropical cyclone tracks of the west Atlantic (diagram a) and the northwest Pacific (diagram b).

Fast and slow moving cyclones were selected by the following speed criterion. It was required that fast-moving cyclones continue moving faster than [illegible].5 m/s for at least three consecutive 12 hour time periods or more. Slow-moving cyclones were required to move at a speed of less than 2.5 m/s during a period no shorter than 36 hours. Because there are so many individual cases of slow and fast motion (examples were objectively selected by the computer), a listing of these cases will not be given.

2.2 Occurrences of Special Motion Categories

The occurence frequencies per year of these three types of cyclone motion during 1957-1977 in the west Pacific and west Atlantic are listed in Table 3. During this 21 year period in both oceans there were 262 fast motion cases, 201 slow motion cases, and 112 looping motion cases. The year to year variability is large. For example, in the west Pacific, the yearly mean looping events were 4, but in 1968 there were 13 looping cyclones while in 1959 there was none. A similar large variability exists in the Atlantic and also with the annual variability of slow and fast cyclones.

Comparing the three types of motion occurrences to the total tropical cyclone occurence, one finds that about one cyclone in seven experience a looping motion in both oceans while about one storm in two in the west Atlantic and one in four or five in the west Pacific undergoes a fast or slow motion. This suggests that both fast and slow motions occur more frequently in the west Atlantic than in the west Pacific. Figure 2 shows the speed distribution in both oceans. Cyclone mean speeds are almost the same in both oceans, but the variability of cyclone speed is somewhat larger in the Atlantic.

TABLE 3

Number of occurrences of fast, slow, and looping tropical cyclone motion events during 1957-1977 in the west Pacific (W.P.) and the west Atlantic (ATL.). Note that some storms can have more than one period of fast, slow, or looping motion.

Year	Fast Moving		Slow Moving		Looping		Total Tropical Cyclone Occurrences	
	W.P.	ATL.	W.P.	ATL.	W.P.	ATL.	W.P.	ATL.
1957	15	4	7	1	1	1	21	8
1958	6	8	3	2	2	0	22	10
1959	10	7	1	4	0	1	26	11
1960	9	4	9	0	3	2	27	7
1961	11	4	8	3	4	2	31	11
1962	14	2	13	3	4	1	30	5
1963	3	4	6	5	1	2	25	9
1964	13	8	5	7	4	1	40	12
1965	12	3	3	5	3	2	34	6
1966	11	6	8	5	6	2	30	11
1967	10	3	9	6	4	1	35	8
1968	5	5	13	3	13	1	27	8
1969	6	8	3	8	5	3	19	15
1970	2	1	4	3	5	0	24	10
1971	9	7	3	9	5	2	35	13
1972	6	2	9	1	9	2	30	7
1973	0	6	4	1	3	1	21	8
1974	4	4	4	2	2	1	32	11
1975	5	2	4	3	4	0	20	9
1976	9	6	10	2	3	1	25	10
1977	6	2	1	1	4	1	19	6
SUM	166	96	127	74	85	27	573	195
Yearly Mean	7.9	4.6	6.0	3.5	4.0	1.3	27.3	9.3

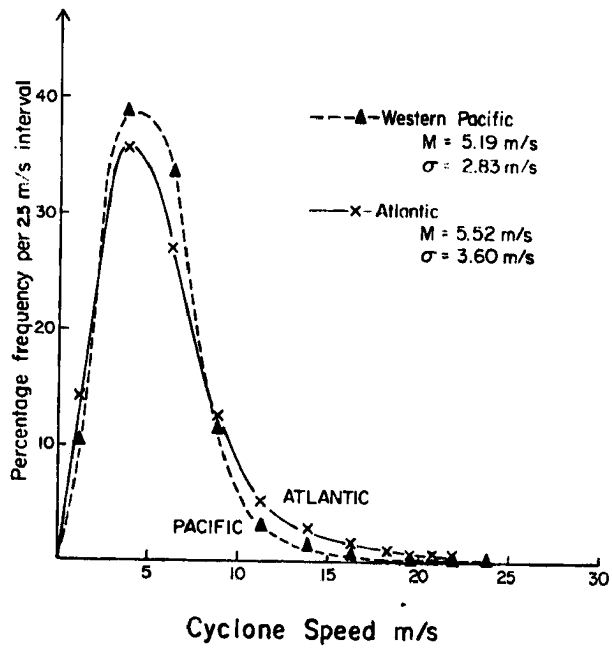


Fig. 2. Percentage frequency distribution of cyclone speed for western Pacific and Atlantic tropical cyclones. M = mean value, σ = standard deviation.

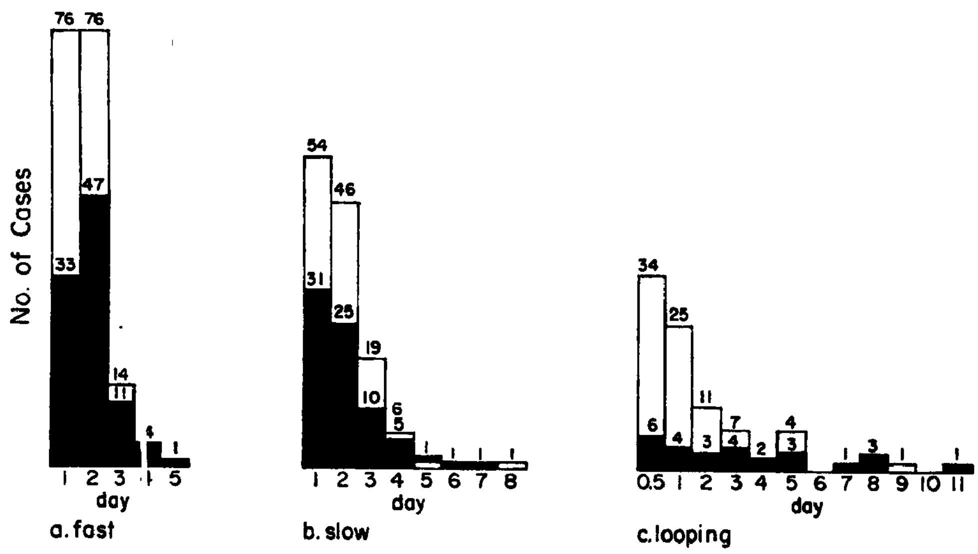


Fig. 3. Number of cases in each motion category as a function of duration (in days) for west Pacific (no shading) and west Atlantic (shaded).

2.3 Duration of Fast (> 7.5 m/s), Slow (< 2.5 m/s) and Looping Motion Events.

Figure 3 shows the distribution of the duration (in days) of these three types of cyclone motion. There is no significant difference in fast and slow periods between the two ocean basins. More than 90% of fast and slow cyclone motion periods are less than 3 days duration.

Looping periods can take anywhere from 1/2 to about 10 days. In the west Atlantic the mean looping period is 3.7 days while in the west Pacific it is about 2 days. The 85 percentile periods are 3 days in the Pacific and 5 days in the Atlantic. Thus, a looping motion typically takes longer to complete in the Atlantic than in the Pacific.

Figure 4 shows the distribution of looping diameter. In the Pacific the mean looping diameter is only about 1.4^{o} latitude. More than 85% of the west Pacific looping cyclones have looping diameters of less than 2^{o} latitude. In the Atlantic the mean and 85 percentile loops are 3.3^{o} and 7.0^{o} latitude respectively. Thus, looping motion is of significantly larger size and of longer duration in the Atlantic than in the Pacific.

Figure 5 shows the direction of looping. In the Pacific counterclockwise (CC) loops are more frequent than clockwise (C) loops by a ratio of 2 to 1, while in the Atlantic, clockwise and counterclockwise loops have a similar frequency. Thus, a higher percentage of clockwise loops occur in the Atlantic than in the Pacific.

2.4 Monthly Distribution of Events

Figure 6 shows the mean monthly distribution of the three motion classes during the 21 years in both ocean basins. Not much difference exists between these three classes of motion except in the early part of

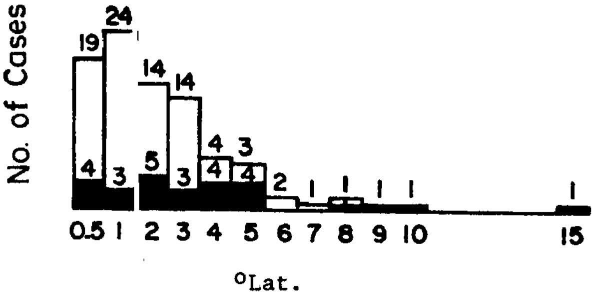


Fig. 4. Distribution of the frequency of looping diameter in °latitude for the west Pacific (no shading) and for the western Atlantic (shaded).

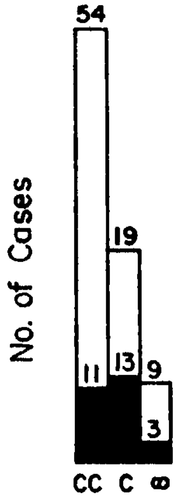


Fig. 5. Direction of looping, clockwise (C), counter-clockwise (CC), and both ways (∞). Unshaded column represents numbers for west Pacific, shaded numbers for west Atlantic.

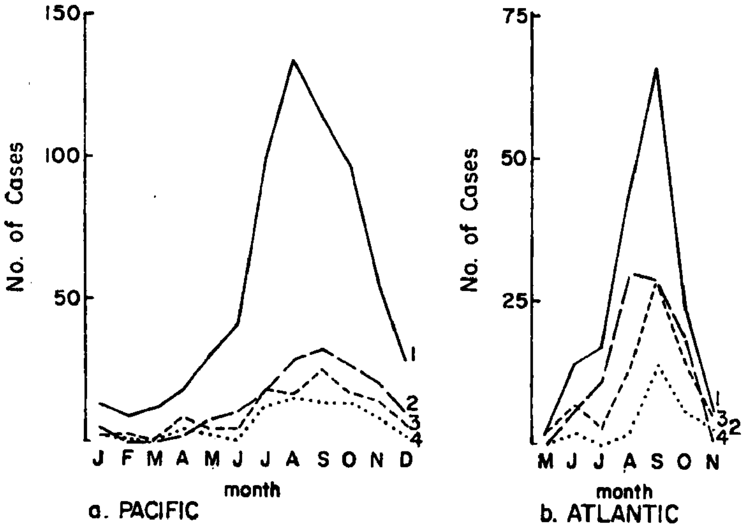


Fig. 6. 1957-1977 tropical cyclone occurrence by class and monthly frequency in Pacific (a) and Atlantic (b).

1. ———— tropical cyclone occurrence
2. — — — — — fast moving storms (>7.5 m/s)
3. ---------- slow moving storms (<2.5 m/s)
4. .... looping storms

the storm season when looping and slow motion is much less frequent in the Atlantic. Figures 7 and 8 show tropical cyclone tracks of July and November during the 90 years of 1886-1977 in the west Atlantic. In July most of the cyclones take on the usual straight or recurving track while in November a higher percentage of storms follow looping tracks.

2.5 Geographic Distribution

There are significant differences in the geographic distributions of these motion classes between the two ocean basins. In the Atlantic the distribution of fast storms (Fig. 9) has two maxima which represent the fast cyclones on the north and south sides of the subtropical ridge. In the Pacific (Fig. 10) only one maximum occurs. The Pacific fast motion maximum to the south of subtropical ridge does not appear separately. On the other hand, Atlantic slow and looping motion distributions (Figs. 11 and 13) have their maximum at higher latitudes than the Pacific systems (Figs. 12 and 14).

The geographic distributions of total tropical cyclone occurence (Figs. 15 and 16) are different between the two oceans, however. In the Atlantic more cyclones occur at higher latitudes than in the Pacific. It would be helpful to compare the geographic distributions of the ratio of these three types of motion occurrences to the total cyclone occurence.

Figures 17-22 show comparative results by ocean and motion categories. The percentage of fast moving cyclones (Figs. 17 and 18) are both high to the north of 30°N and both low between 20°N and 30°N in the two oceans. Significant difference between the two oceans appears to the south of 20°N where the ratios in the Pacific are still lower than 20 percent while nearly all cyclones at low latitude in the

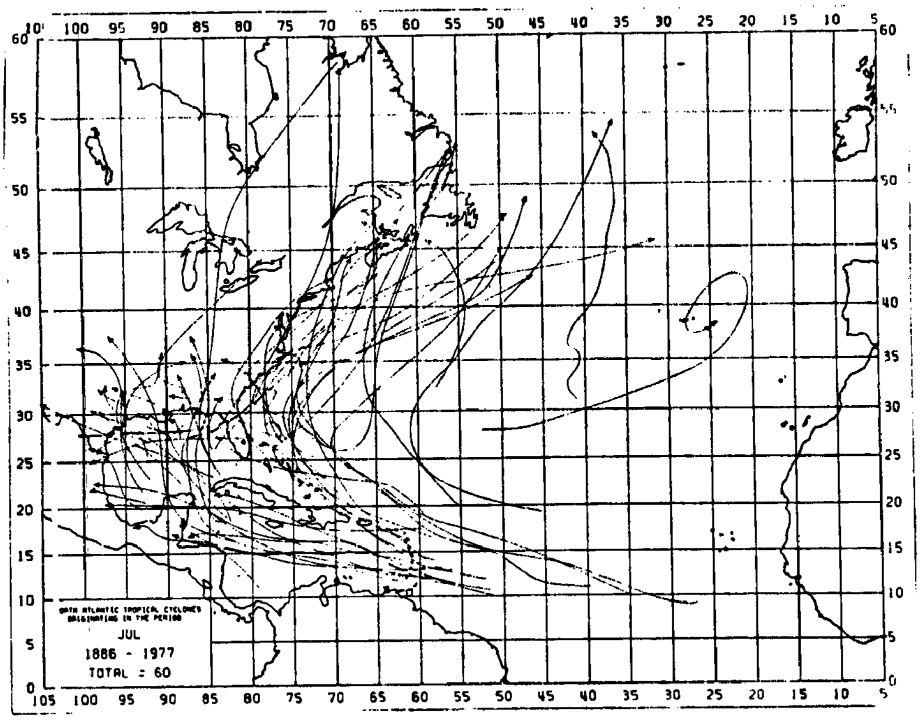


Fig. 7. 92 years (1886-1977) tropical cyclone tracks in July in the Atlantic (from Neumann et. al., 1978).

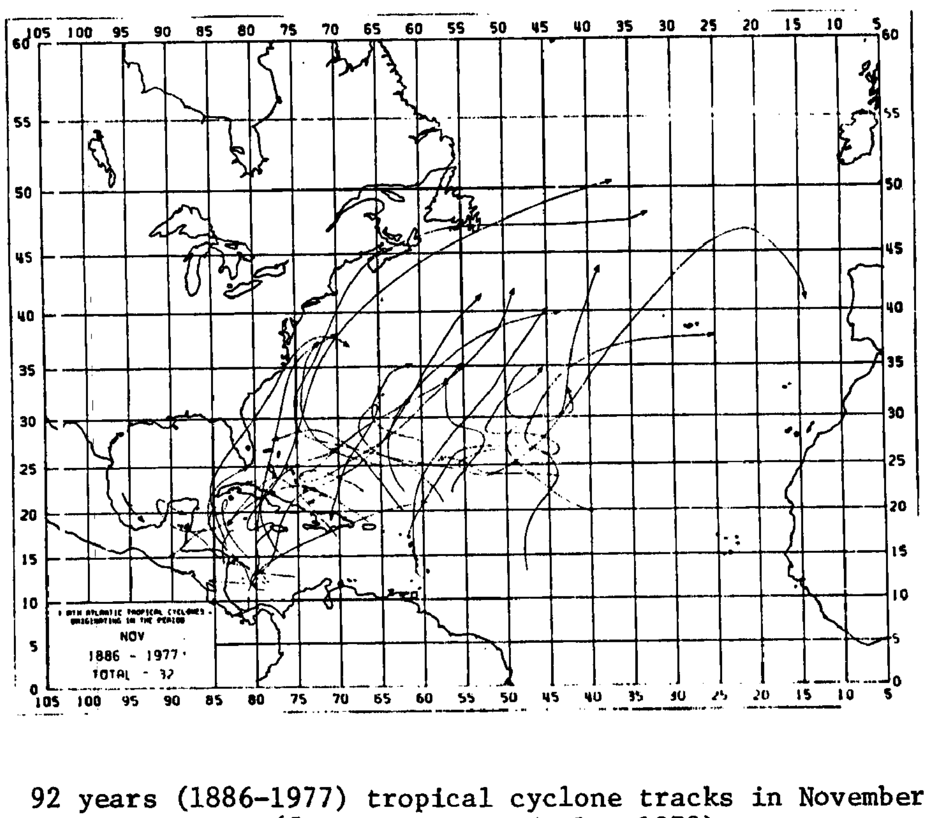


Fig. 8. 92 years (1886-1977) tropical cyclone tracks in November in the Atlantic. (from Neumann et. al., 1978).

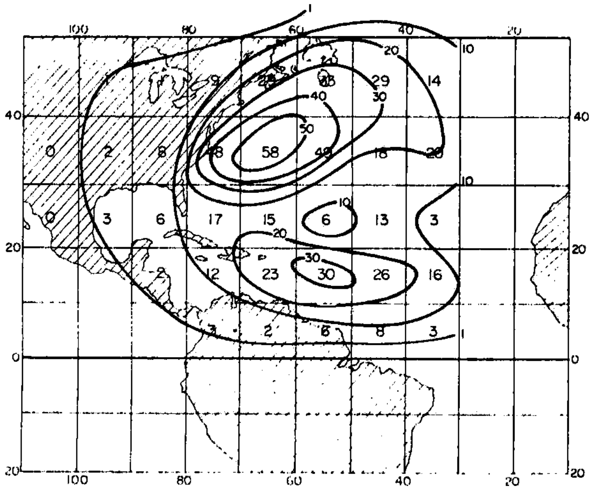


Fig. 9. Distribution of Atlantic <u>fast</u> moving storms per 10° Marsden square per 21 years.

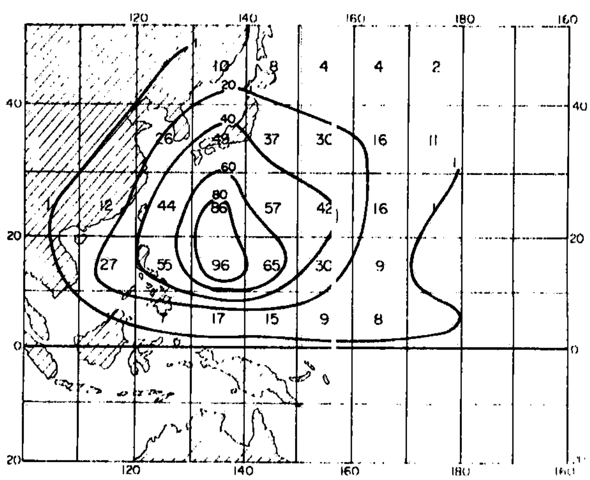


Fig. 10. Distribution of west Pacific <u>fast</u> moving storms per 10° Marsden square per 21 years.

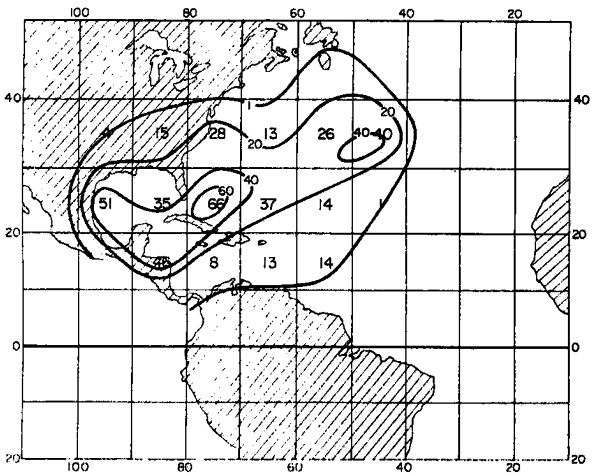


Fig. 11. Distribution of Atlantic <u>slow</u> moving tropical storms per 10° Marsden square per 21 years.

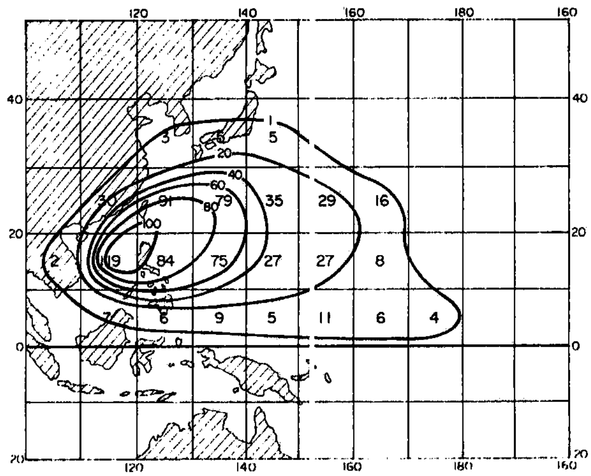


Fig. 12. Distribution of western Pacific <u>slow</u> moving storms per 10° Marsden square per 21 years.

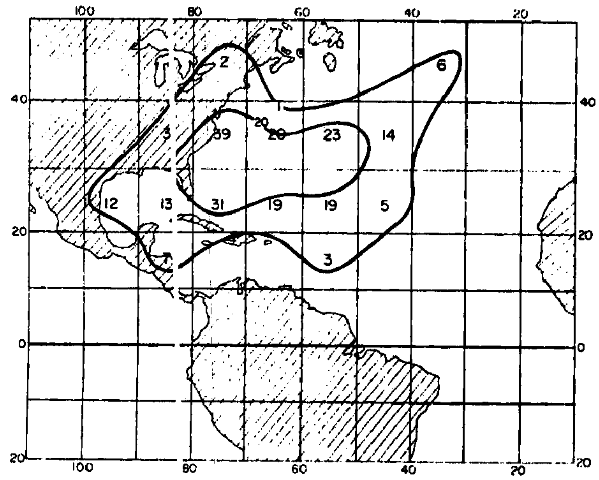


Fig. 13. Distribution of Atlantic looping storms per 10° Marsden square per 21 years.

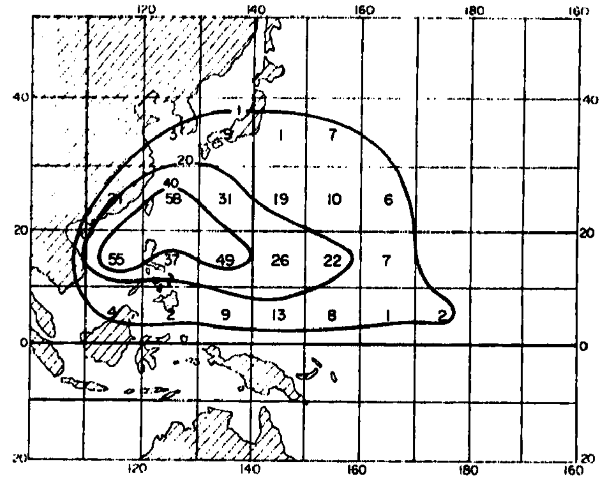


Fig. 14. Distribution of western Pacific looping storms per 10° Marsden square per 21 years.

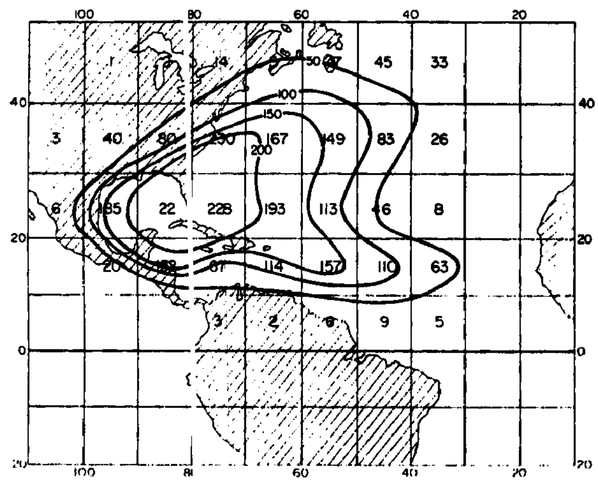


Fig. 15. Distribution of all Atlantic storms per 10° Marsden square per 21 years.

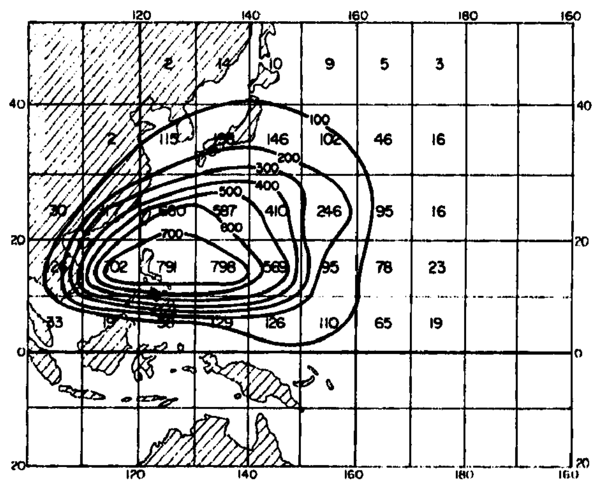


Fig. 16. Distribution of all western Pacific storms per 10° Marsden square per 21 years.

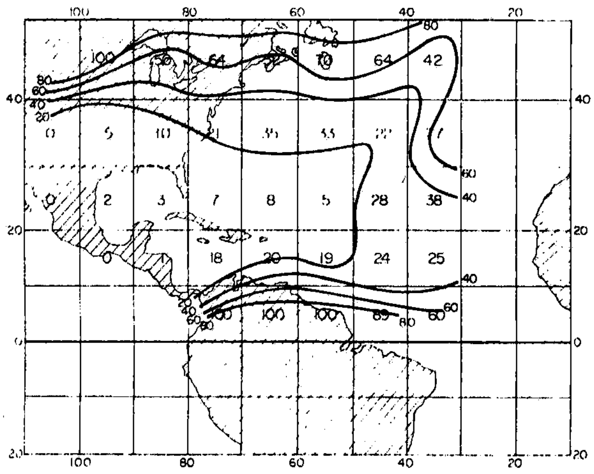


Fig. 17. Percentage of all Atlantic storms per 10° Marsden square which are fast moving (> 7.5 m/s).

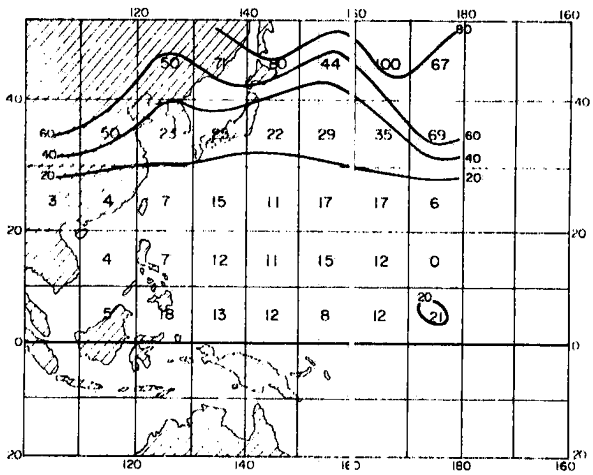


Fig. 18. Percentage of all Pacific storms per 10° Marsden square which are fast moving (> 7.5 m/s).

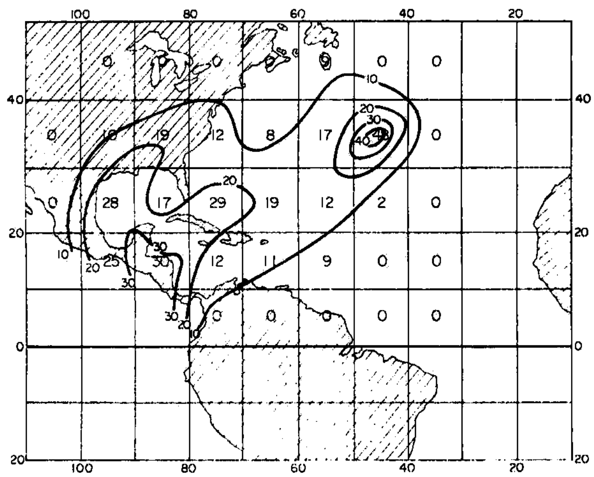


Fig. 19. Percentage of all Atlantic storms per 10° Marsden square which are slow moving (< 2.5 m/s).

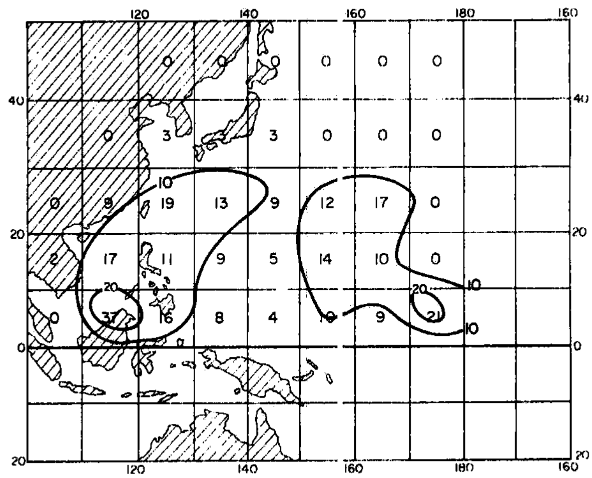


Fig. 20. Percentage of all Pacific storms per 10° Marsden square which are slow moving (< 2.5 m/s).

Atlantic move fast.

The percentage of slow storms in the western parts of the two oceans are similar. However, this difference is significant in the eastern parts of the two oceans. The maximum percentage of slow moving storms is at higher latitudes in the Atlantic (35°N) than in the Pacific (5-10°N) - see Figs. 19 and 20.

Difference is also apparent for the percentage of cyclones which undergo a looping motion. In the Atlantic, the highest percentage occurs to the north of 20°N, while in the Pacific the highest percentage of looping cyclones is south of 20°N (Figs. 21 and 22).

Figure 23 shows the ratios of the number of these three types of storm motion to the total occurrence of cyclones. South of 20°N, the percentage of fast moving cyclones is higher in the Atlantic than in the Pacific but the percentage of looping cyclones is much lower north of 20°N. The percentage of slow moving and looping cyclones in the Atlantic is nearly twice as great as in the Pacific but the percentage of fast moving storms in the two oceans are almost the same.

Why are there such differences in the cyclone motion climatologies between the two oceans? Most of these differences are believed to be due to the climatological environments in which the cyclones exist.

Before attempting to further explain these climatological motion differences, let us first compare the typical synoptic situations in which these three classes of cyclone motion exist.

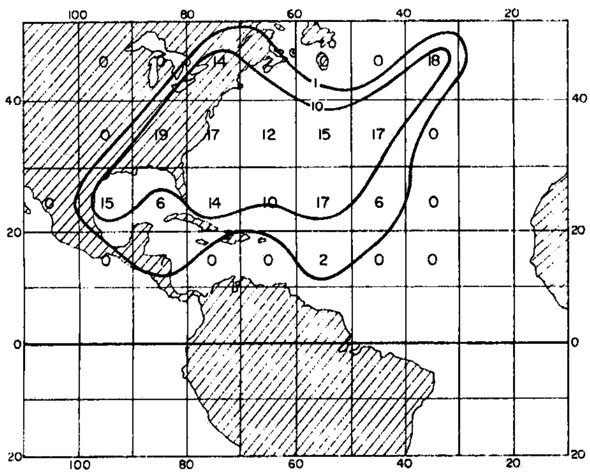


Fig. 21. Percentage of all Atlantic storms per 10° Marsden square which are undergoing a looping motion.

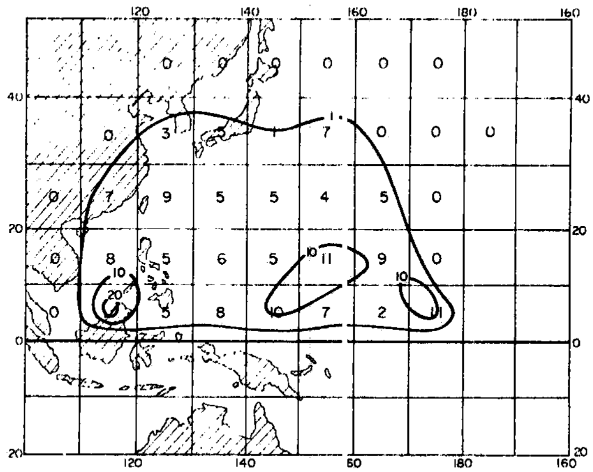
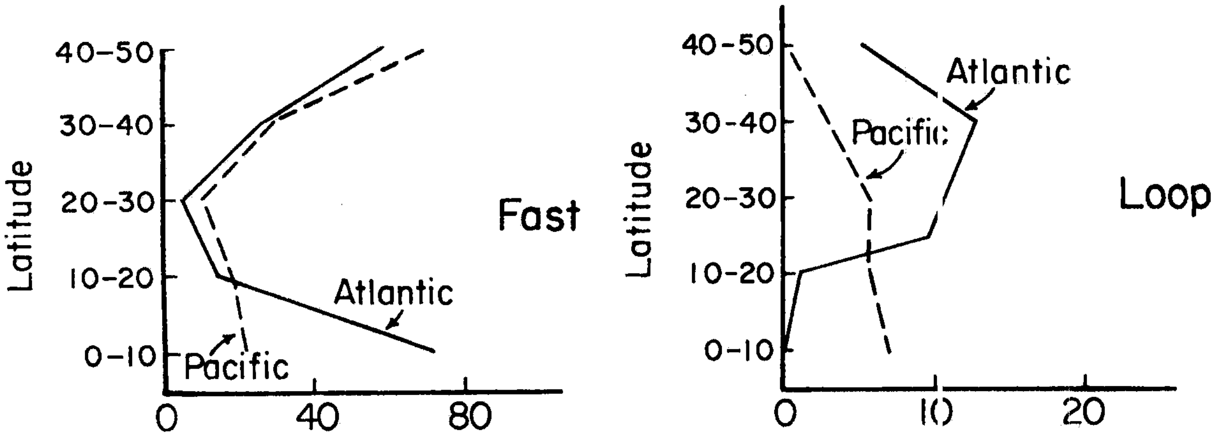


Fig. 22. Percentage of all Pacific storms per 10° Marsden square which are undergoing a looping motion.



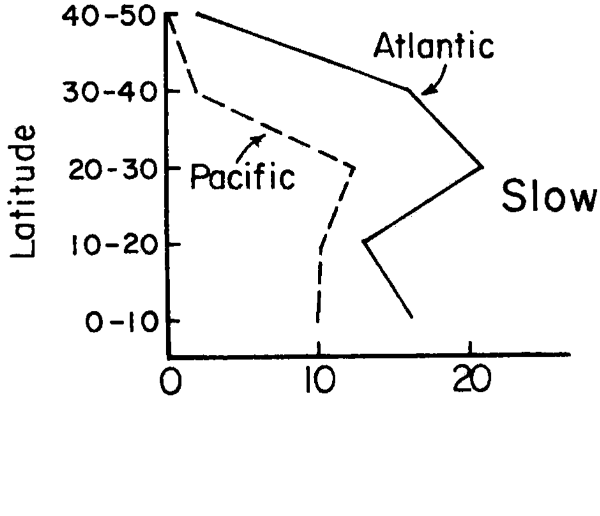


Fig. 23. Percentage of storms in the Atlantic and western North Pacific which are fast (> 7.5 m/s), slow (< 2.5 m/s) or looping vs. latitude.

3. SYNOPTIC CASE STUDIES OF LARGE SCALE SURROUNDING CIRCULATIONS ASSOCIATED WITH THESE THREE CYCLONE MOTION CLASSES

After studying many individual cases it was found that the types of large scale circulation patterns which occur with these three types of motion are related to the latitudinal position of the tropical cyclone relative to the subtropical ridge. Thus, in all the following analyses, storms will be stratified as to whether they are north, on, or south of the subtropical ridge at 500 mb.

3.1 Storms to the North of the 500 mb Subtropical Ridge

Figures 24 to 29 show six tropical cyclone tracks illustrating the three different motion classes. These storms are Gladys (October 1968), Heidi (October 1967), Inga (September 1969) in the Atlantic (Fig. 24) and Helen (September 1969), Ellen (July 1973), Bess (August 1960) in the Pacific (Fig. 25). The characteristics of the large scale circulation associated with each of these cyclones which were all located to the north of the subtropical ridge will be examined.

Fast Cases. Gladys and Helen began moving fast after they had moved to the north of the latitude position of the subtropical ridge. Figures 26 to 29 show the 500 mb and surface charts when the speed of these two cyclones first began to exceed 7.5 m/s. At 500 mb (Figs. 26 and 28), a strong westerly trough exists at a distance of about 15° longitude to the northwest of these two cyclones. Both cyclone systems were greatly influenced by the strong southwest air flow on the east sides of these troughs. Winds of magnitude 20 m/s at 500 mb are observed as close as 5° latitude from the center of these cyclones. In each of the two surface charts (Figs. 27 and 29), the surface subtropical ridge was split by a frontal trough which had a northeast-

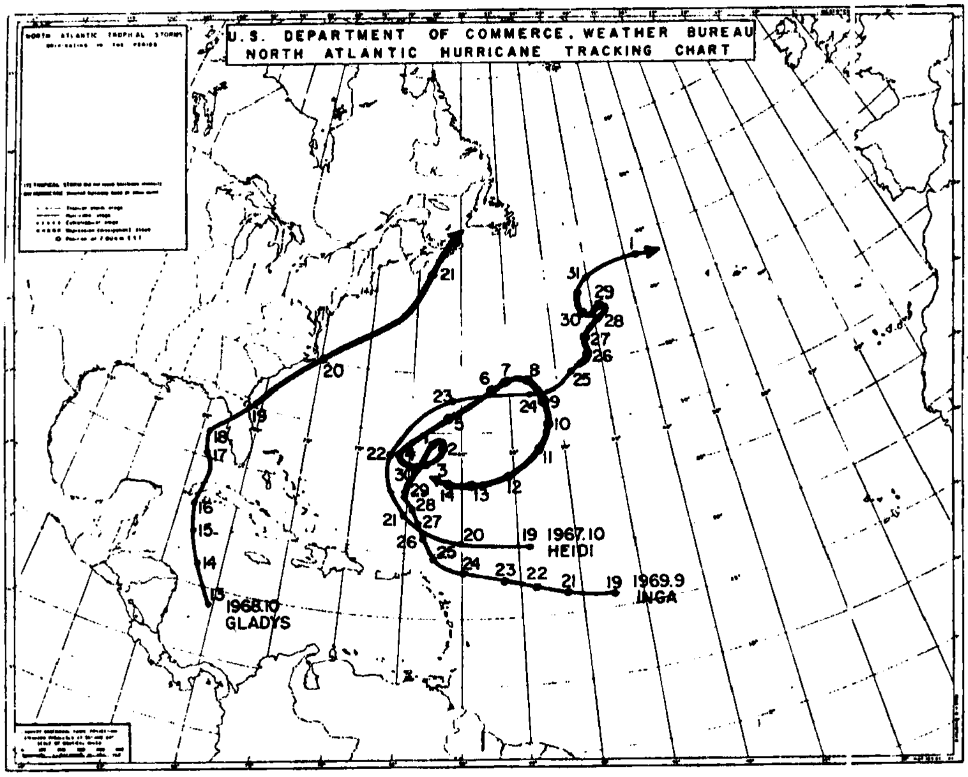


Fig. 24. Typical track examples of an Atlantic fast (Gladys), slow (Heidi), and looping motion (Inga) storm to the north of the subtropical ridge in the Atlantic.

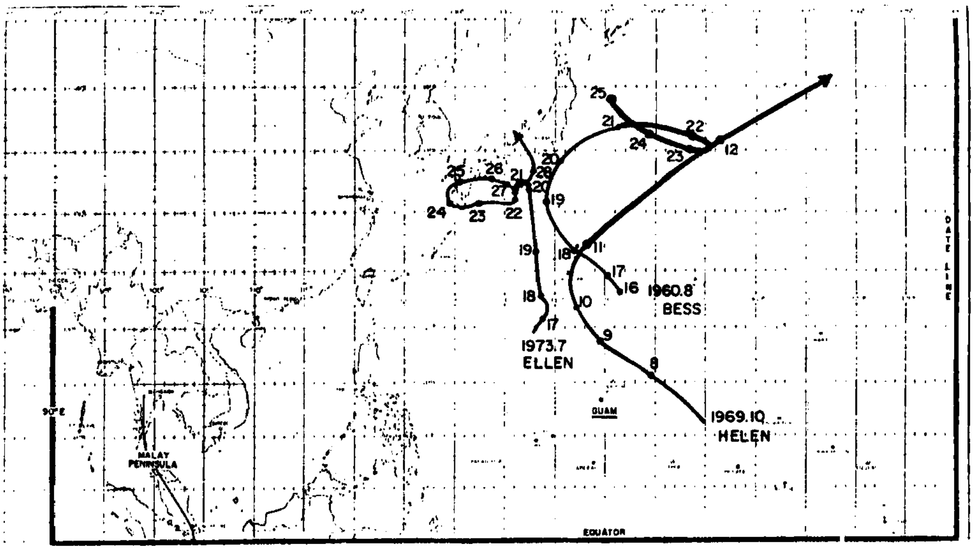


Fig. 25. Typical track examples of a Pacific fast (Helen), slow (Ellen), and looping motion (Bess) to the north of the subtropical ridge in the Pacific.

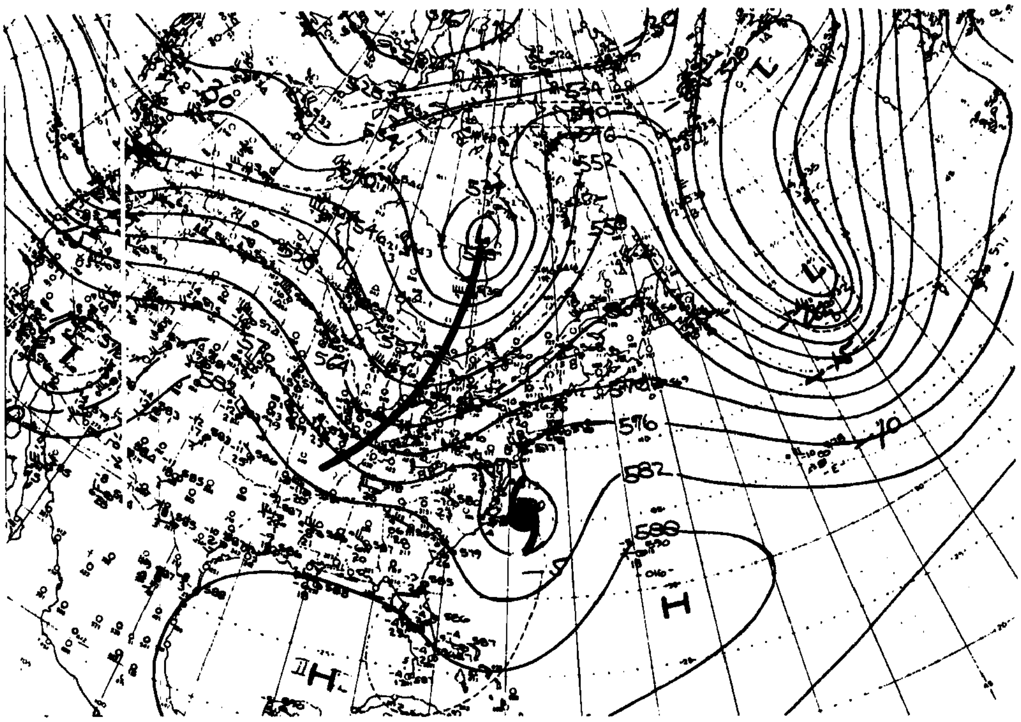


Fig. 26. 500 mb weather map for 20 Oct. 1968* of Hurricane Gladys which moved very rapidly. The main trough is to the northwest side of the hurricane.

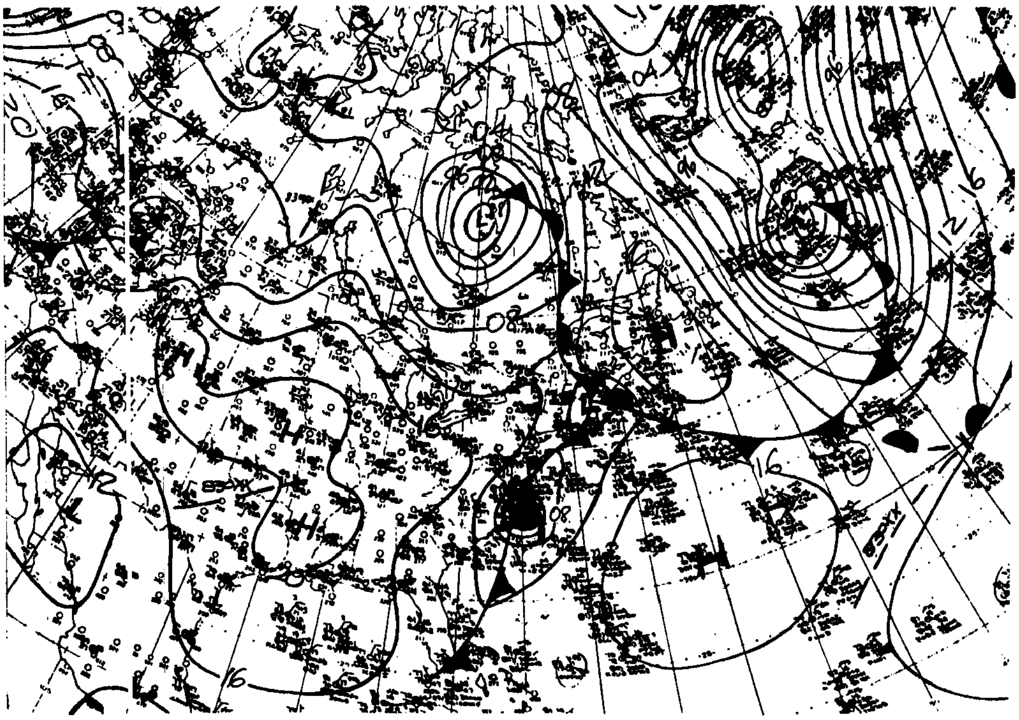


Fig. 27. Surface weather map for 20 Oct. 1968, for Hurricane Gladys which moved very rapidly. A surface trough with front extending towards the hurricane is round on the northeast side of the storm.

*All the weather maps shown in this paper are at 12Z except where noted otherwise.

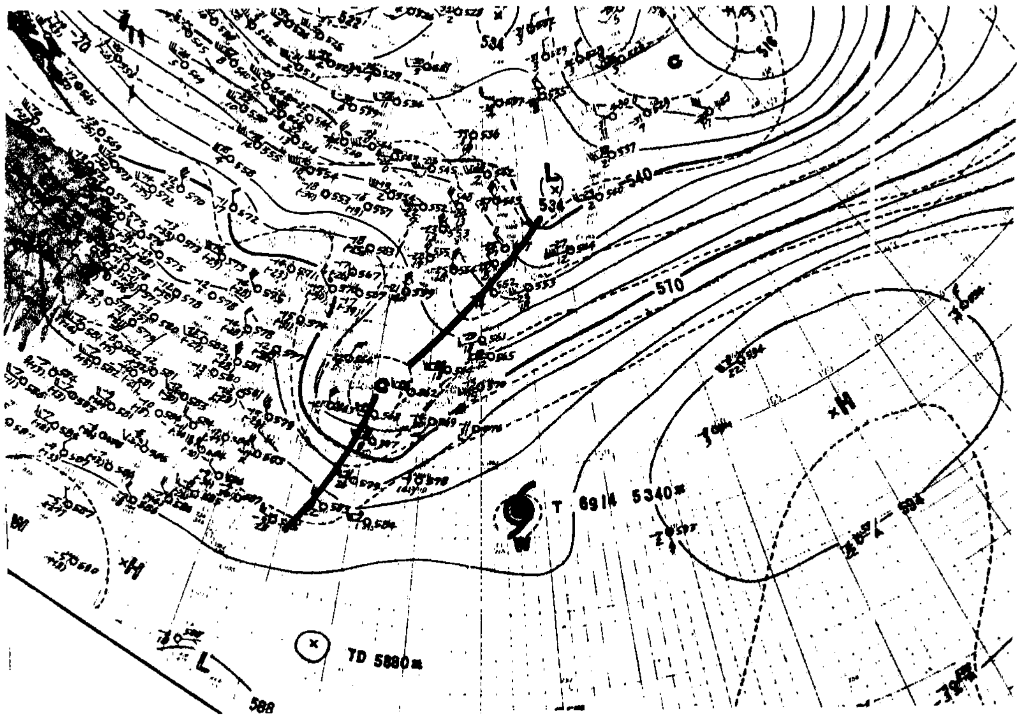


Fig. 28. 500 mb weather map for 11 Oct. 1969, of Typhoon Helen which moved very rapidly. A major trough is to the northwest side of the cyclone.

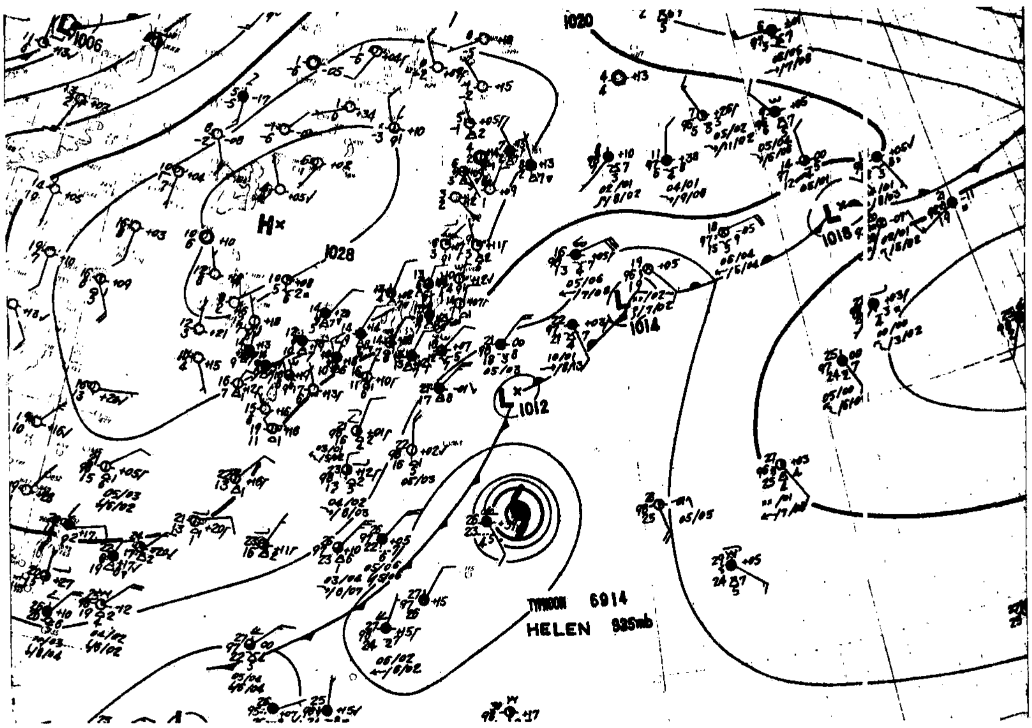


Fig. 29. Surface weather map for 11 Oct. 1969, of Typhoon Helen which moved very rapidly. A surface trough with associated front lies to the northeast of the hurricane.

southwest orientation and appeared to be connected to the cyclone. This caused the surface wind on the east side of the cyclone to be strong and from a southwesterly direction. The surface 'steering flow' was thus in the same direction as the winds at 500 mb. This leads to a deep layer steering flow towards the northeast. Storms which move fast have the same direction steering flows through a deep layer.

Slow Cases. Heidi and Ellen moved slowly for a period after they had moved across the subtropical ridge. Figures 30 to 33 show the 500 mb and surface charts when these two cyclones began moving slowly (with a speed < 2.5 m/s). At 500 mb (Figs. 30 and 32) a large amplitude westerly trough exists at 20-30° longitude to the northeast of these storms. Ridges were located about 5° to the west and north of the cyclone. This resulted in a relatively weak circulation around the cyclone. The 500 mb charts show that 20 m/s winds were located greater than 15° latitude away from the cyclone. On the surface (Fig. 31) a strong ridge exists to the north of Heidi, providing easterly steering flow at the surface. Such easterly steering opposses the 500 mb westerly steering flow. Ellen (Fig. 33) was embedded between two surface ridges. Two areas of maximum wind to the north and south of the cyclone resulted in a weak deep layer steering current.

Looping Cyclones. Inga and Bess took clockwise loops after they had moved across the latitude of the subtropical ridge. Figures 34 to 40 show the 500 mb and surface charts when these two cyclones were in a looping motion and were moving southward. Comparing Figs. 36, 37, 39 and 40 with Figs. 30 to 33, we can see that looping and slow motions have similar large scale circulation characteristics: low zonal index circulation, a westerly ridge at about the same longitude as the cyclone

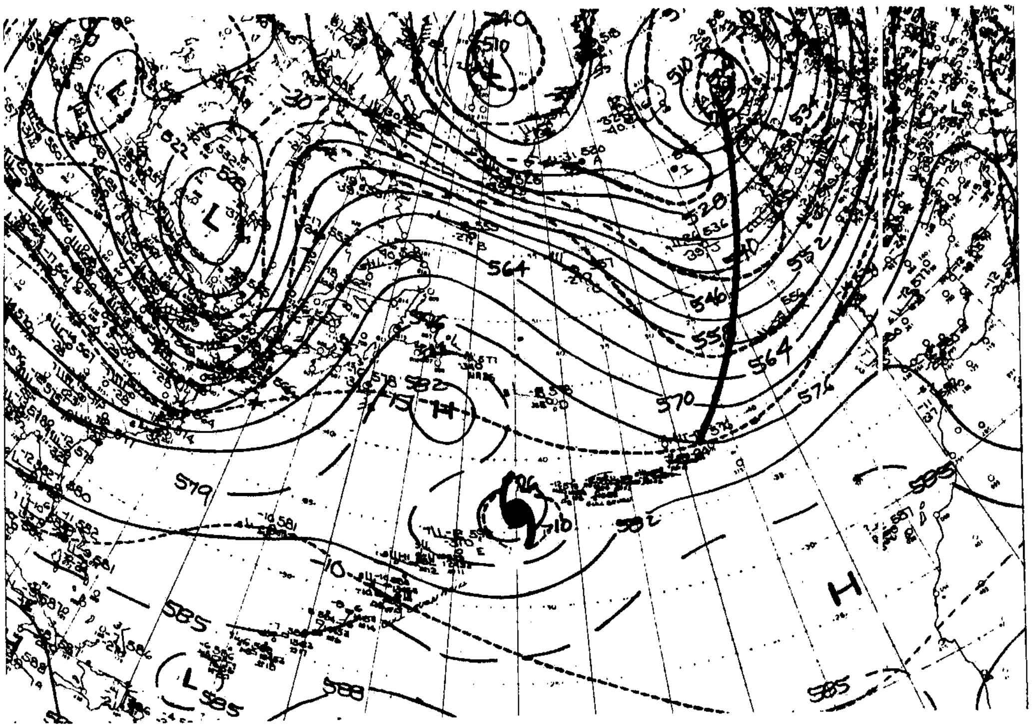


Fig. 30. 500 mb weather map for 26 Oct. 1967 of Hurricane Heidi which moved very slowly. The major trough is to the northeast side of the cyclone.

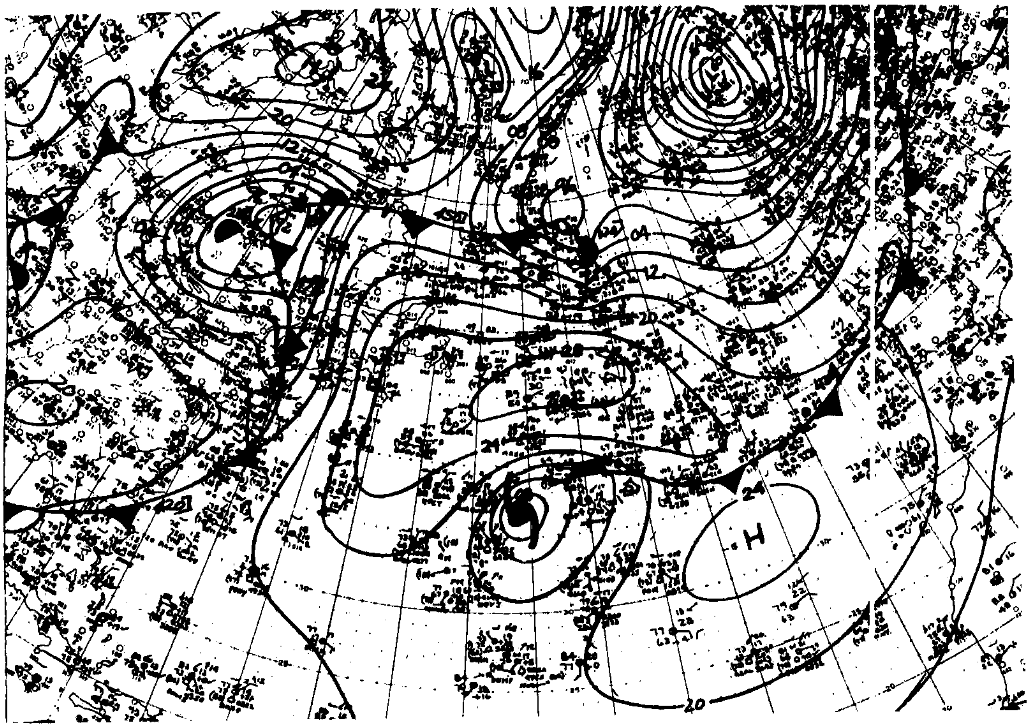


Fig. 31. Surface weather map for 26 Oct. 1967 of Hurricane Heidi which moved very slowly. There is a strong high pressure cell just to the north of the cyclone.

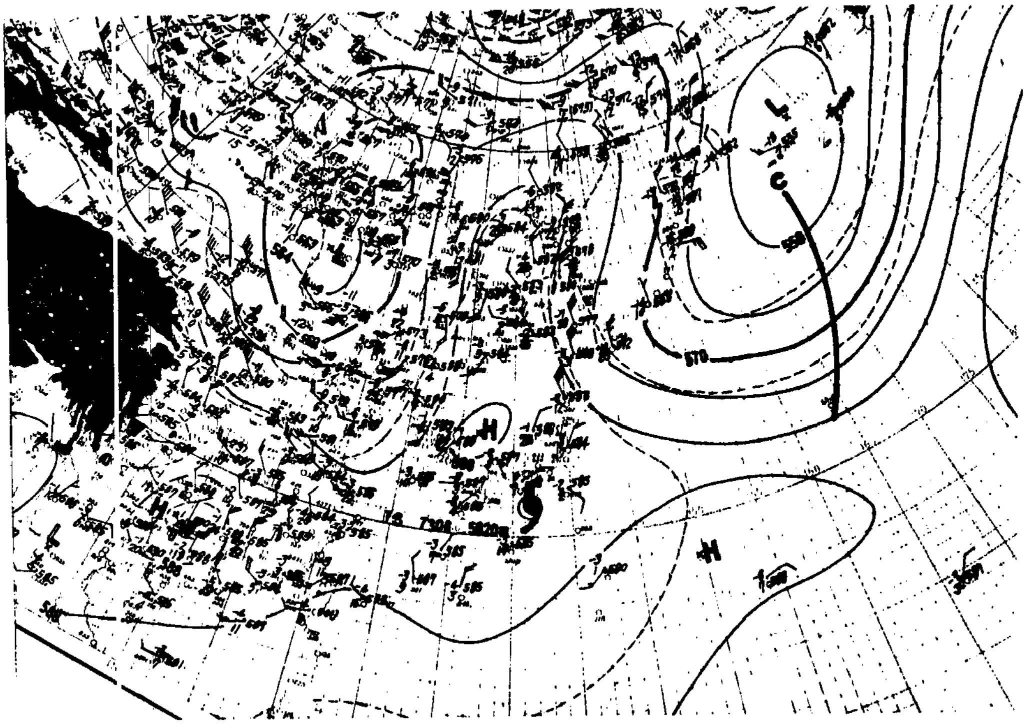


Fig. 32. 500 mb weather map for 21 July 1973 00Z of tropical storm Ellen which moved very slowly. Note that the major trough is to the northeast of the storm.

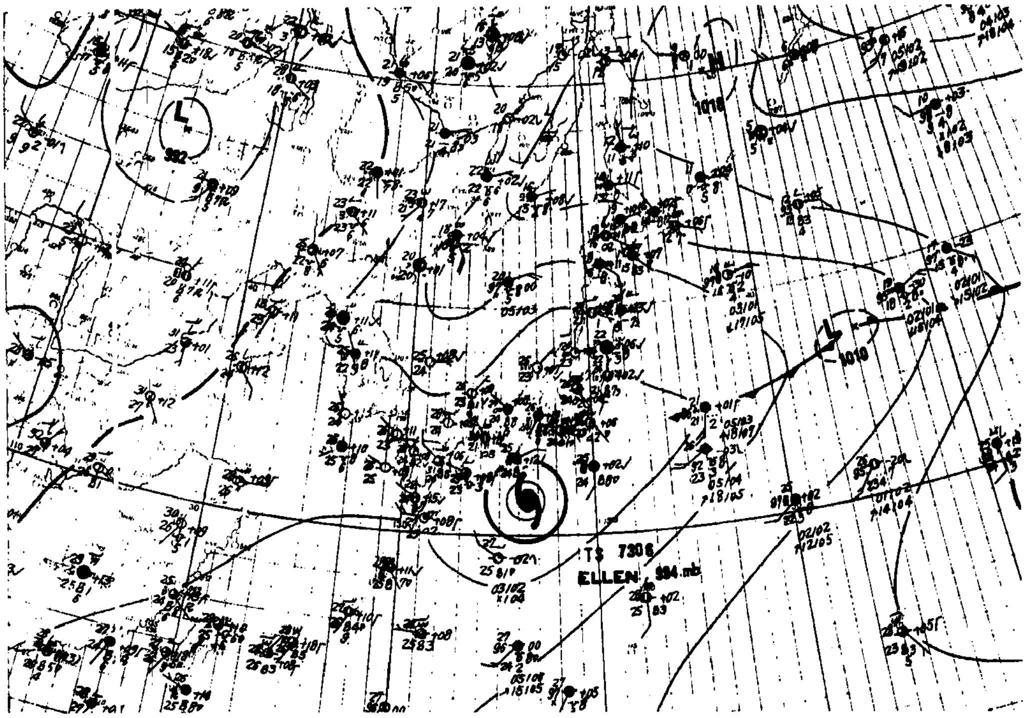


Fig. 33. Surface weather map for 21 July 1973 00Z of tropical storm Ellen which was moving very slowly. A weak surface high pressure ridge is located to the north.

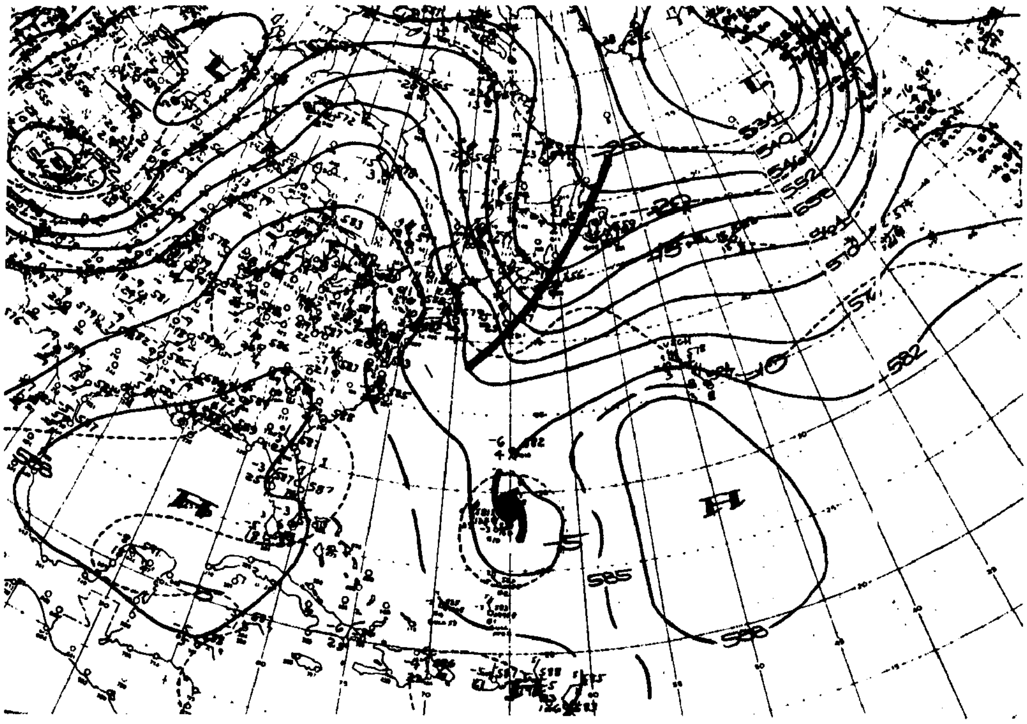


Fig. 34. 500 mb weather map of 4 Oct. 1969, of Hurricane Inga which was undergoing a looping motion.

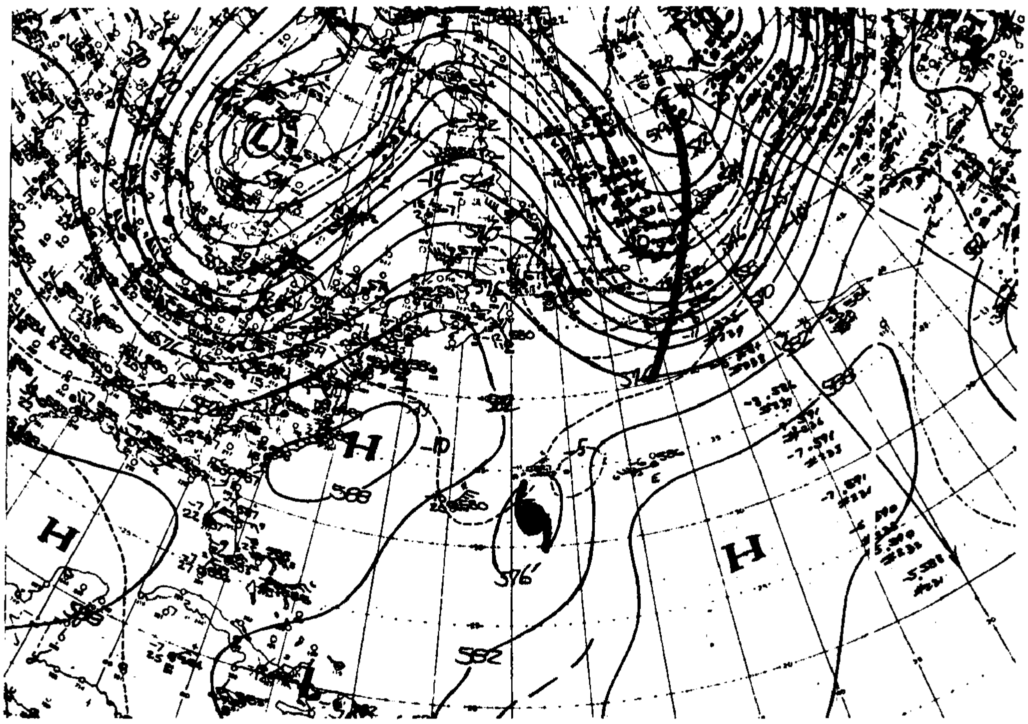


Fig. 35. 500 mb weather map of 7 Oct. 1969 of Hurricane Inga which was undergoing a looping motion.

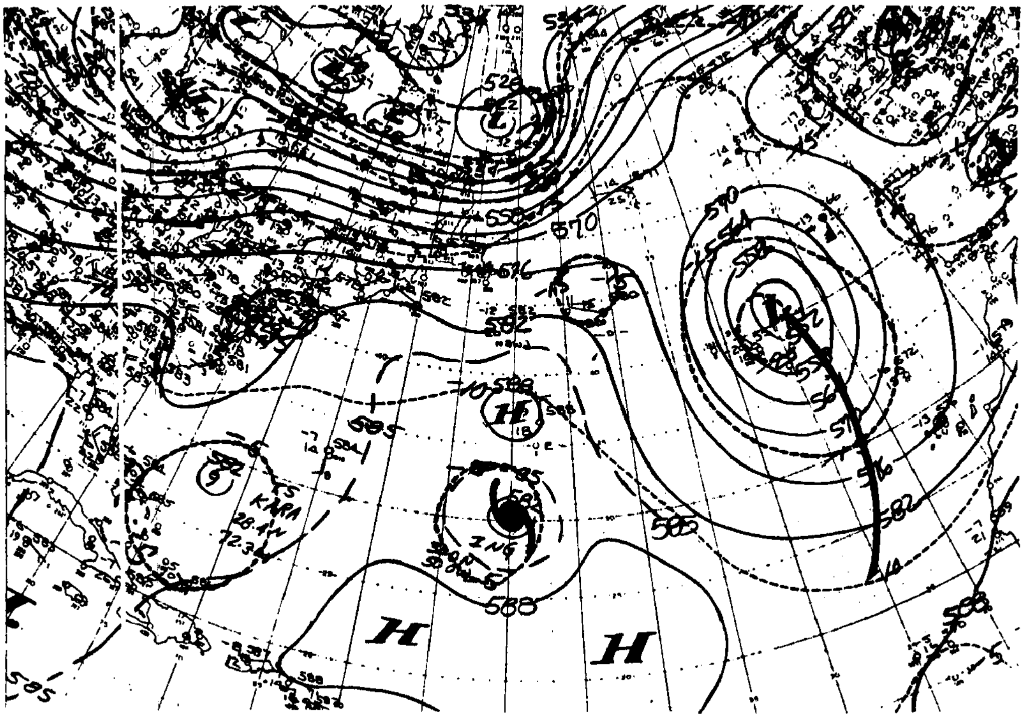


Fig. 36. 500 mb weather map of 10 Oct. 1969 of tropical storm Inga which was experiencing a looping motion. Figures 34-38 show how the northeast trough was developing when Inga took on a looping motion.

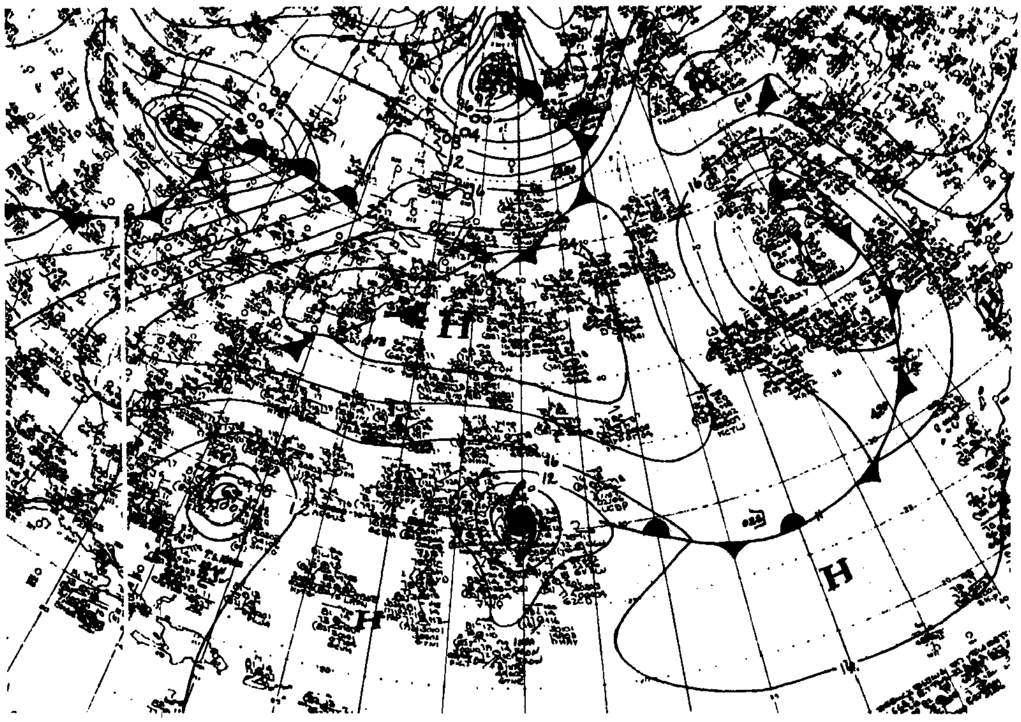


Fig. 37. Surface weather map of 10 Oct. 1969 showing tropical storm Inga which was experiencing a looping motion. Note the strong high pressure cell on the north side of the cyclone.

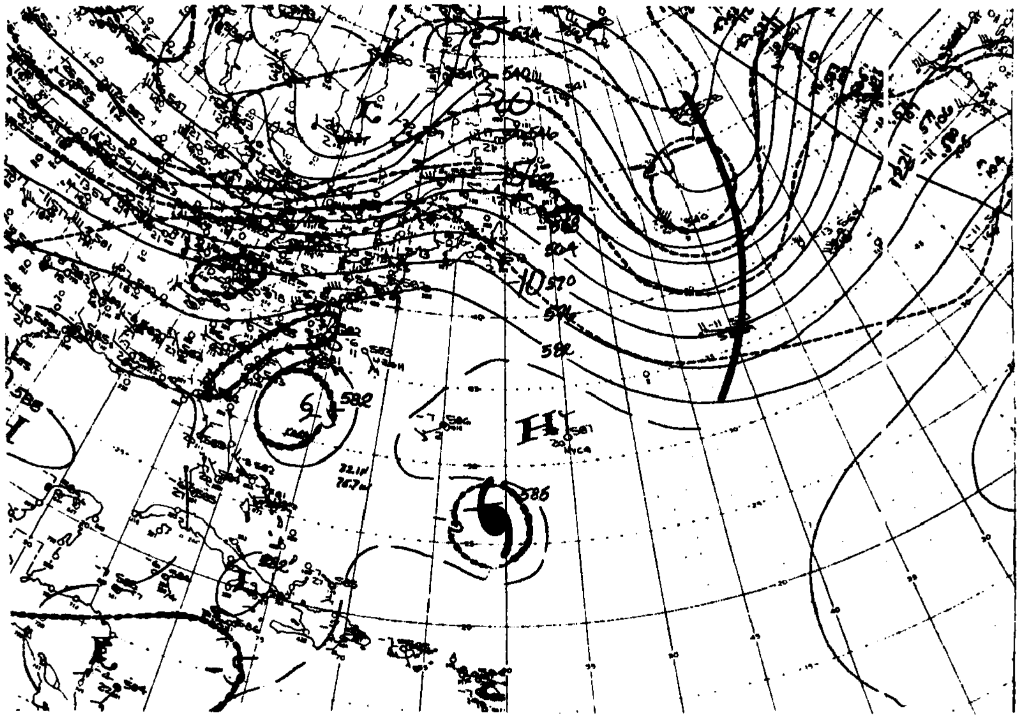


Fig. 38. 500 mb weather map of 14 Oct. 1969 of tropical depression Inga which had undergone a looping motion.

and a westerly trough 20-30^{o} longitude to the northeast of the cyclone. These circulation features result in a weak steering flow around the cyclone and with opposite steering directions at 500 mb and the surface.

Looping motion can be distinguished from slow motion by a deepening trough to the northeast of the storm. Figures 34 to 38 show how the east trough was developing when Inga took on a looping motion. It is the north wind behind a strong developing trough to the northeast of the cyclone which drives the cyclone southward and develops its looping motion. As the trough deepens a ridge becomes established to the north of the storm (Fig. 38) and the cyclone begins moving towards the west. Finally, another trough to the west of the cyclone catches up with the cyclone and steers it out of its loop. The ridge behind the trough then strengthens and draws the cyclone westward. From the 500 mb maps of 4,

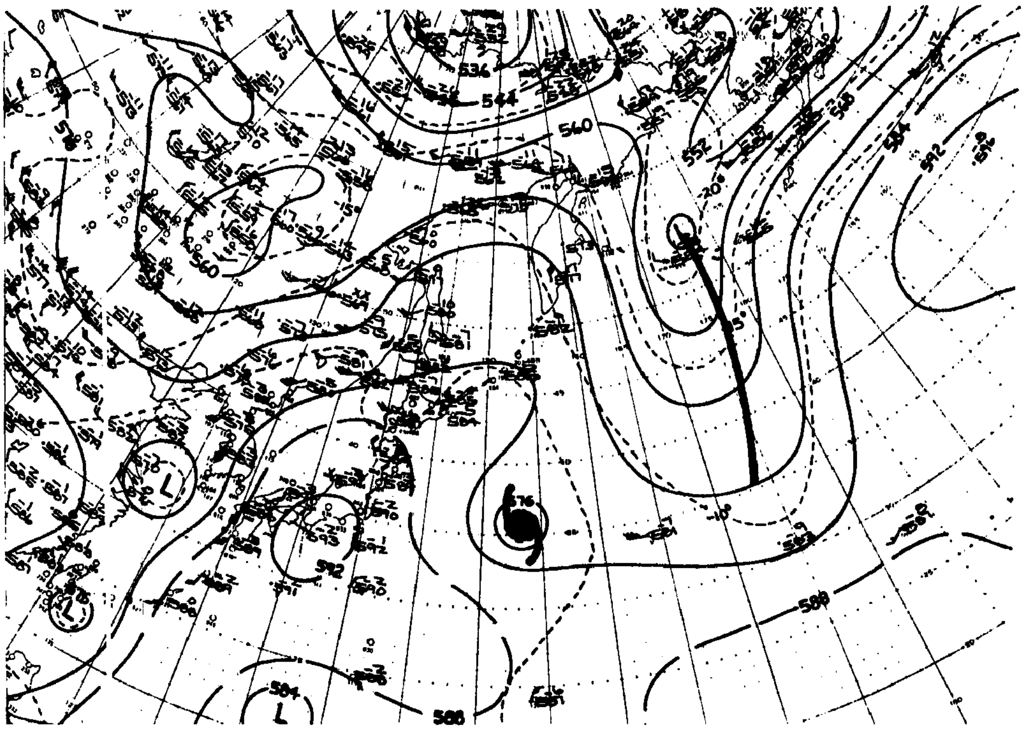


Fig. 39. 500 mb weather map of 22 Aug. 1960 00Z of Typhoon Bess which was undergoing a looping motion. A major trough is to the northeast of the typhoon.

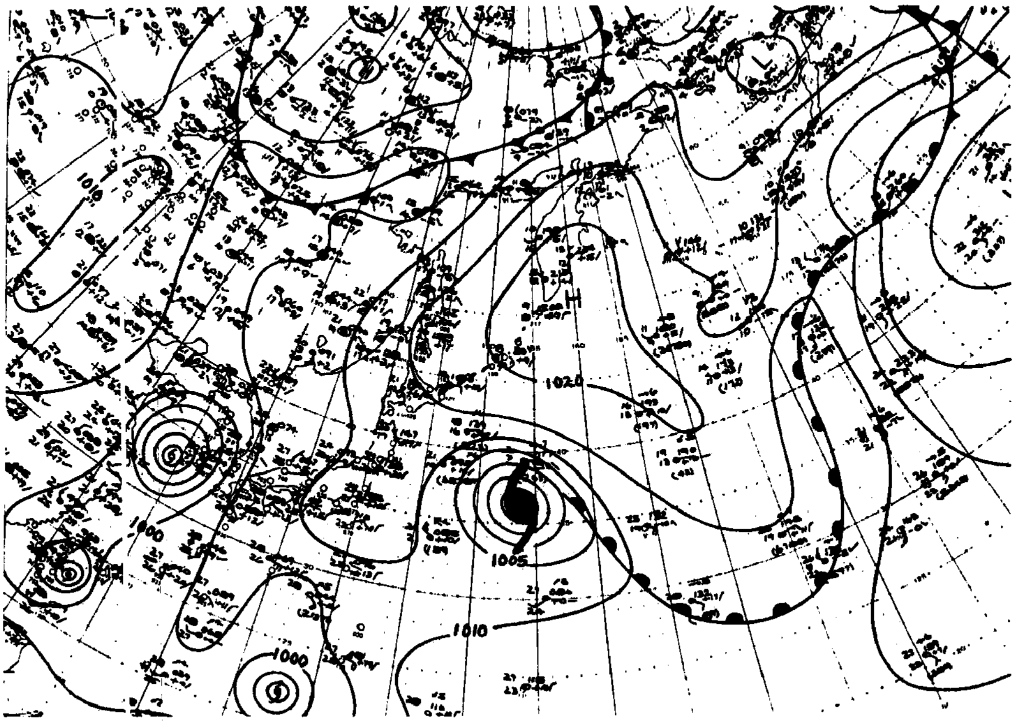


Fig. 40. Surface weather map of 22 Aug. 1960 00Z of Typhoon Bess which was undergoing a looping motion. A high pressure cell exists on the north side of the cyclone.

7, 10, 14 October, 1969 we can see the simultaneous occurrence of the developing trough to the east of the looping event.

3.2 Storms On or Near the Subtropical Ridge

Figures 41 and 42 show six other cyclone tracks for cyclones on or near the subtropical ridge which underwent fast, slow, or looping motion. These storms are Cleo (Aug., 1960), Gladys (Sept., 1964), Flora (Sept., 1963) in the Atlantic and Ida (Sept., 1966), Agnes (Sept., 1974) and Elaine (Nov., 1965) in the Pacific.

Fast Cases. Cleo and Ida went across the subtopical ridge with speeds greater than 7.5 m/s. Figures 43 to 46 show the 500 mb and surface charts when these two cyclones were near the subtropical ridge. In the two 500 mb charts (Figs. 43 and 44), a westerly trough penetrated deeply into the subtropics splitting the subtropical ridge. The westerlies at the bottom of the trough were in fact at a latitude 15^{o} further south than the subtropical ridge. These cyclones were located between a trough to the west and a subtropical ridge to the east. The steering current was therefore very strong from the south.

At the surface (Figs. 44 and 46) these cyclones were also located in a general southerly current. These cases illustrate how rapid a cyclone moves when the steering flows at the surface and 500 mb are from the same direction.

Slow and Looping Cases. Gladys and Agnes moved slowly (speeds < 2.5 m/s), while Flora and Cleo looped when they went across the latitude of the subtropical ridge. Figures 47 to 54 show the 500 mb and surface maps when these four cyclones moved across the latitude of the subtropical ridge. The common characteristics of their surrounding large scale circulation are: 1) at 500 mb there was a westerly trough at

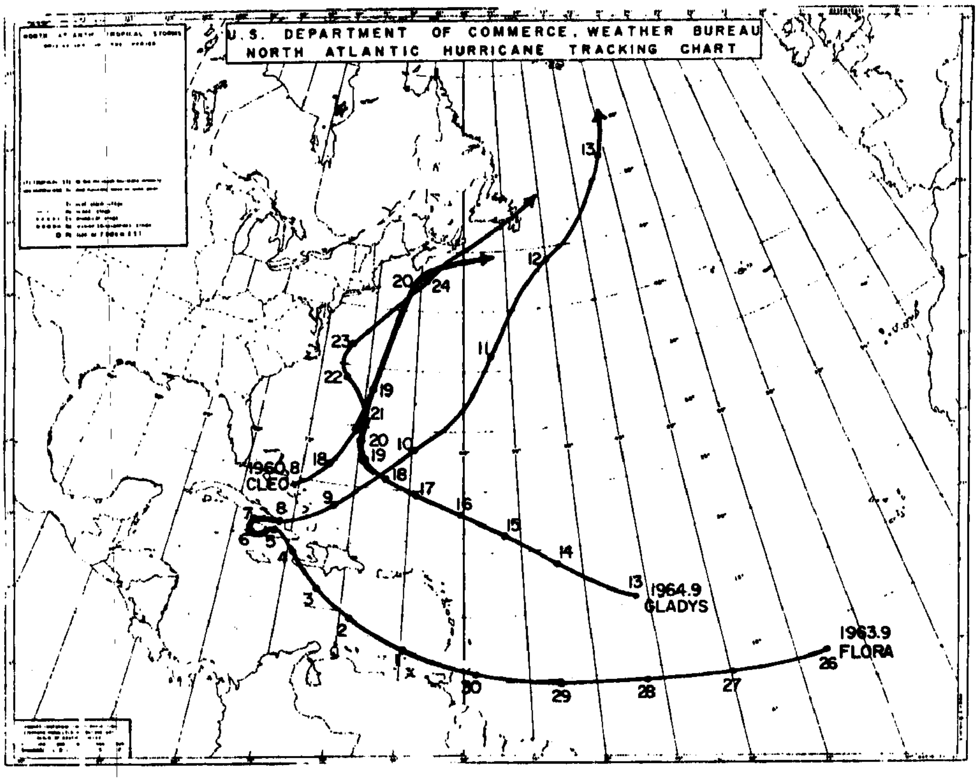


Fig. 41. Examples of an Atlantic fast (Cleo), slow (Gladys), and looping (Flora) motion storm located on or near the subtropical ridge.

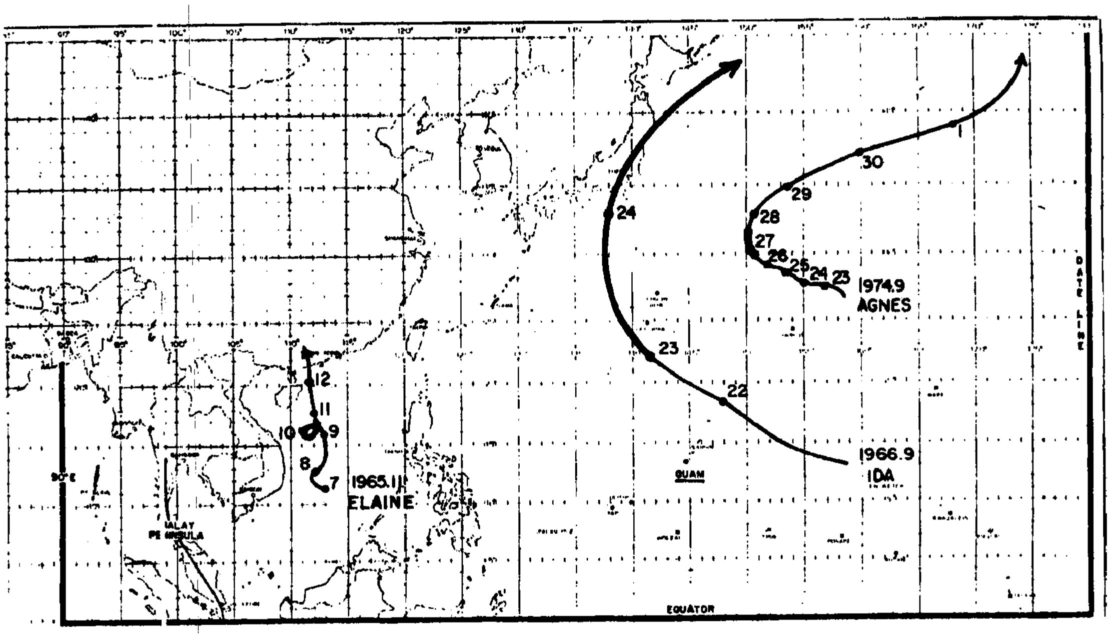


Fig. 42. Examples of a Pacific fast (Ida), slow (Agnes), and looping (Elaine) motion storm located on or near the subtropical ridge.

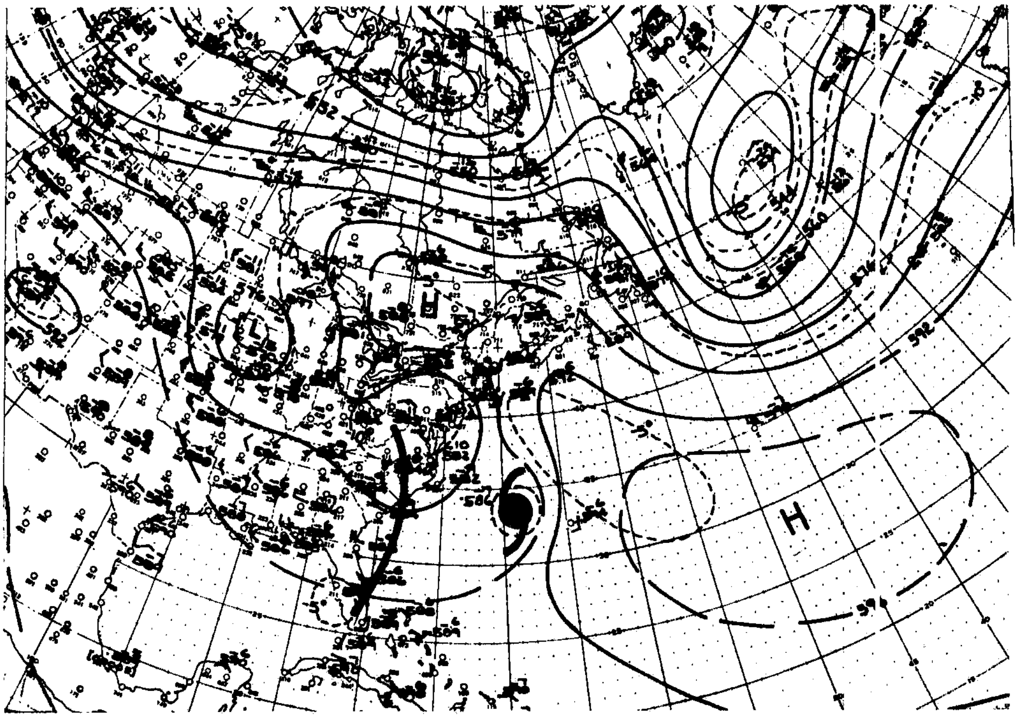


Fig. 43. 500 mb weather map of 19 Aug. 1969, 12Z of Hurricane Cleo which was moving very rapidly. The westerly trough penetrated deeply into the subtropics. Note that the hurricane is located between the subtropical high cell to the east and the westerly trough to the west.

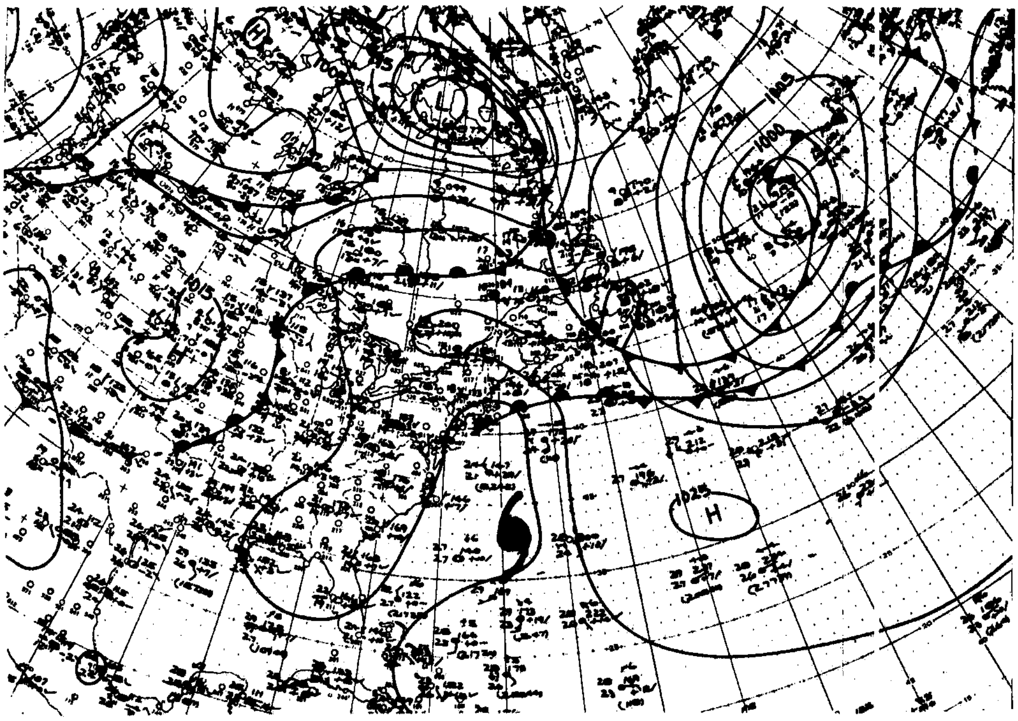


Fig. 44. Surface weather map of 19 Aug. 1960, 12Z of Hurricane Cleo which was moving rapidly. Like at 500 mb, the hurricane is also under the influence of southerly flow at the surface.

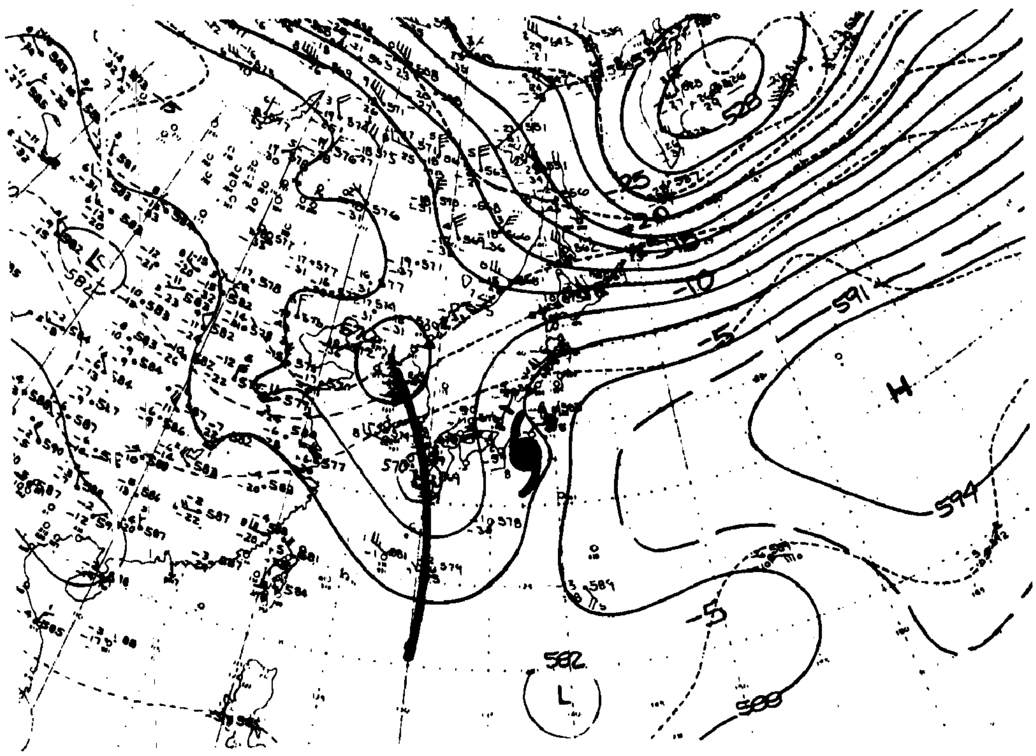


Fig. 45. 500 mb weather map of 24 Sept. 1966 of Typhoon Ida which was moving very rapidly. The westerly trough penetrates deeply into the tropics. The typhoon is between the subtropical high cell to the east and the westerly trough to the west.

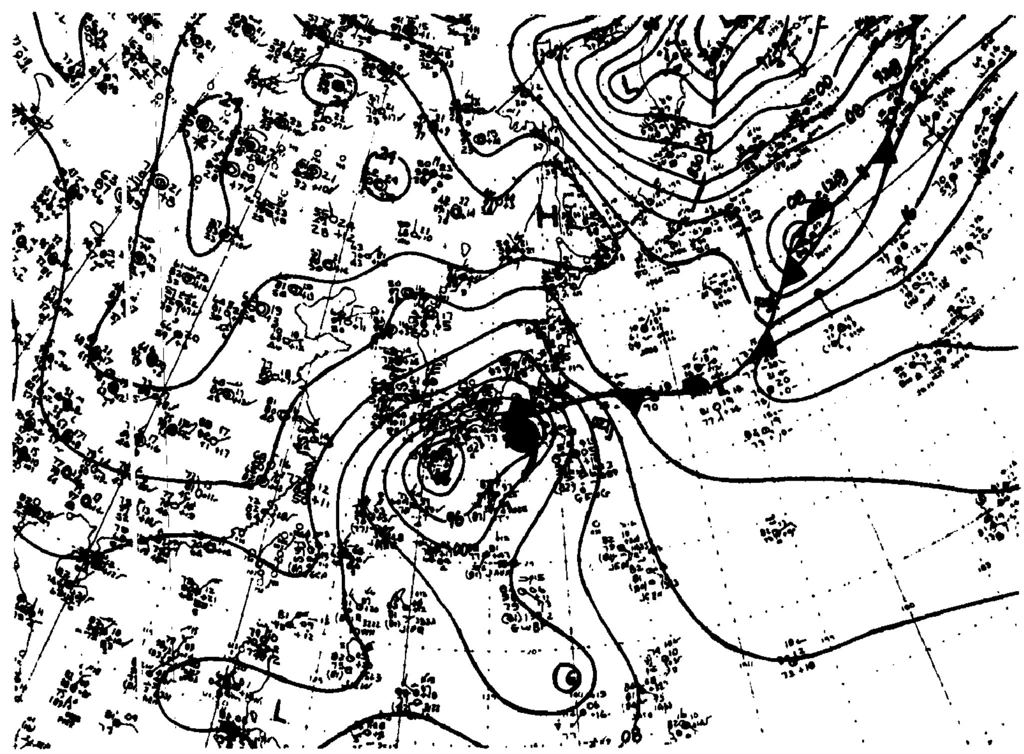


Fig. 46. Surface weather map of 24 Sept. 1966 of Typhoon Ida which was moving very rapidly. At the surface the typhoon also tends to be under the influence of a southerly current.

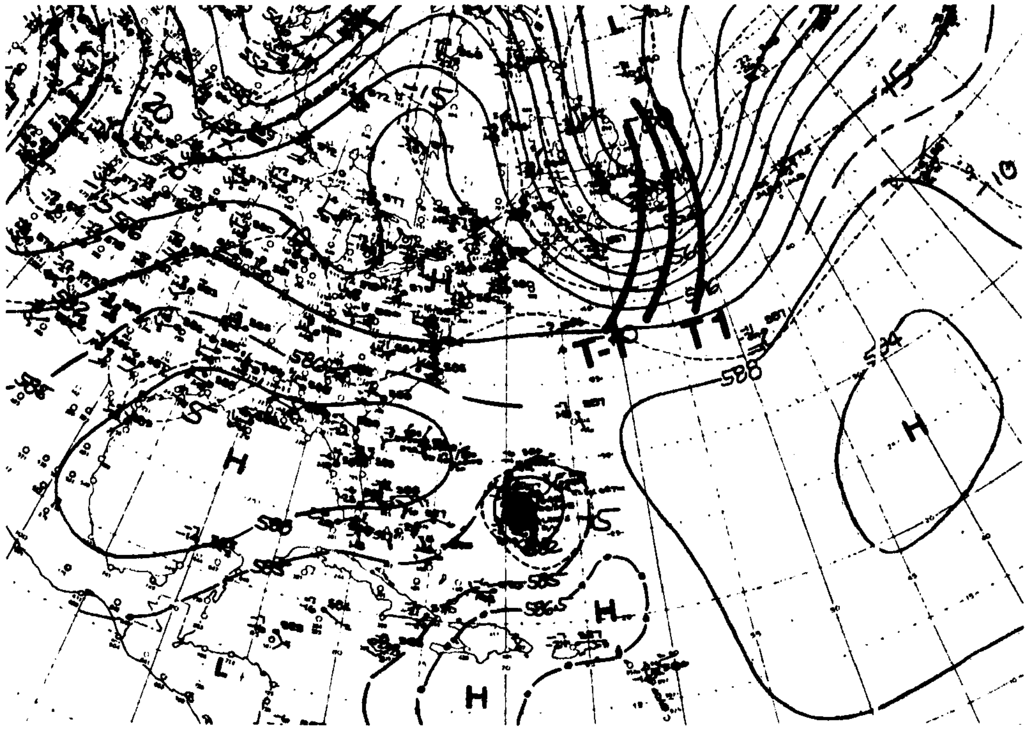


Fig. 47. 500 mb weather map of 19 Sept. 1964 of Hurricane Gladys which was moving very slowly. Trough locations one day before (T-1) and one day after (T+1) are also labeled. The main trough is on the northeast side of the hurricane and is moving very slowly.

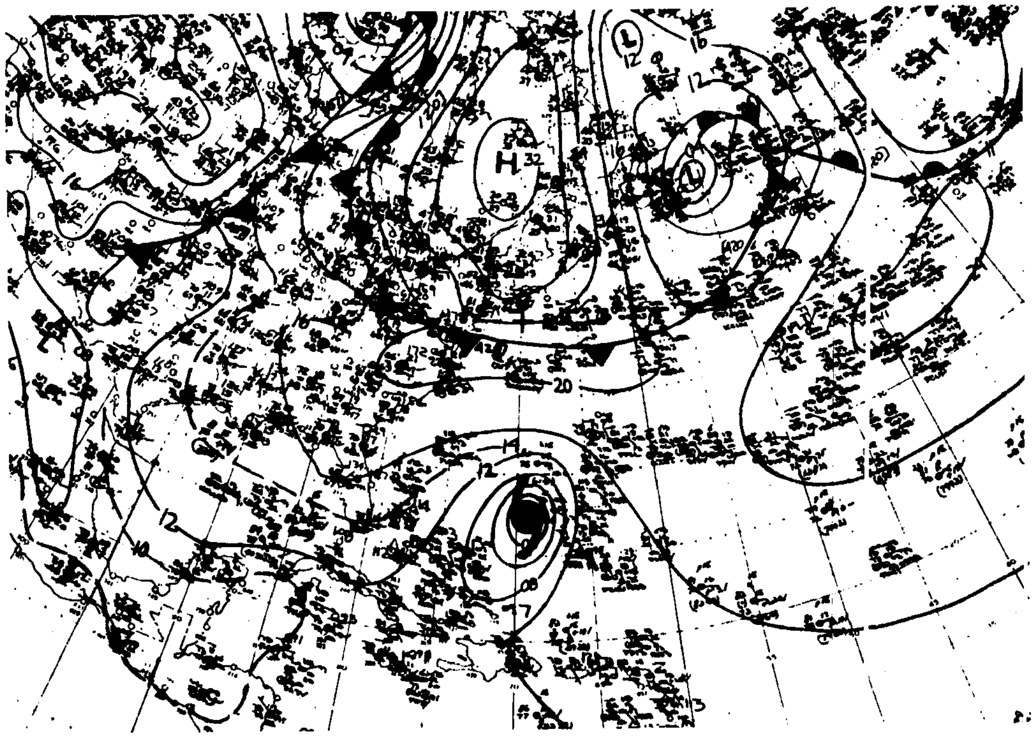


Fig. 48. Surface weather map of 19 Sept. 1964 of Hurricane Gladys which was moving very slowly. A high pressure band is to the north of the hurricane.

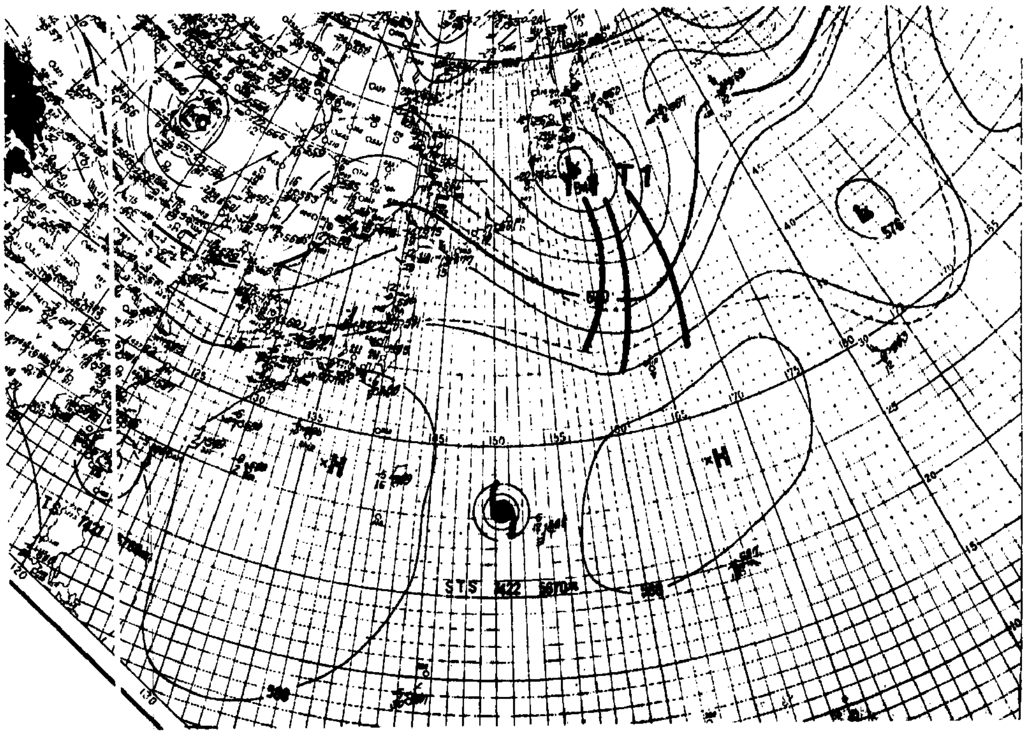


Fig. 49. 500 mb weather map of 27 Sept. 1974 of Typhoon Agnes which was moving very slowly. Trough locations one day before (T-1) and one day after (T+1) are also labeled. The main trough is to the northeast side of the typhoon and moving very slowly.

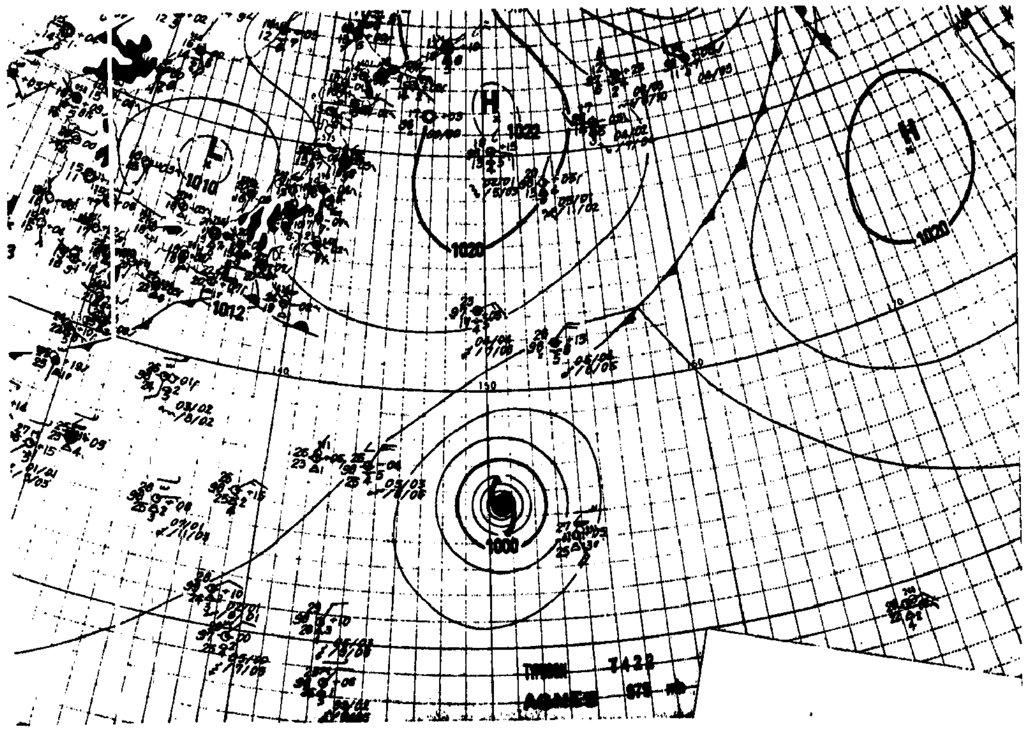


Fig. 50. Surface weather map of 27 Sept. 1974 of Typhoon Agnes which was moving very slowly. A high pressure ridge is located on the north of the typhoon.

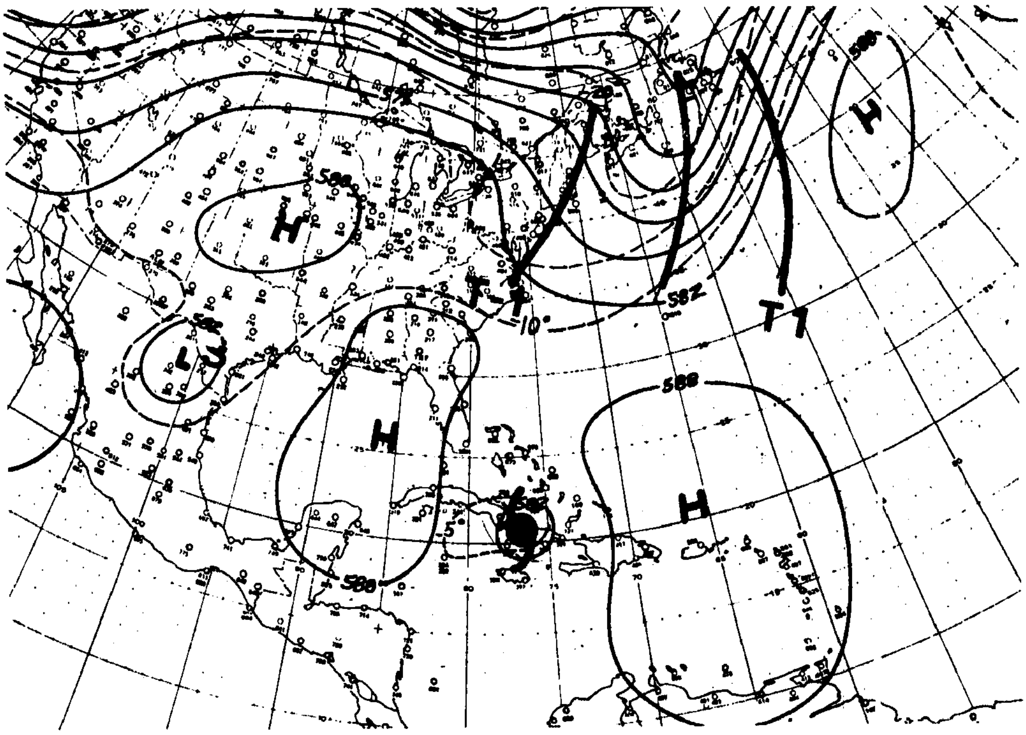


Fig. 51. 500 mb weather map of 5 Oct. 1963 of Hurricane Flora which was undergoing a looping motion. The trough locations one day before (T-1) and one day after (T+1) are shown. The main westerly trough is to the northeast of the hurricane and is moving rapidly.

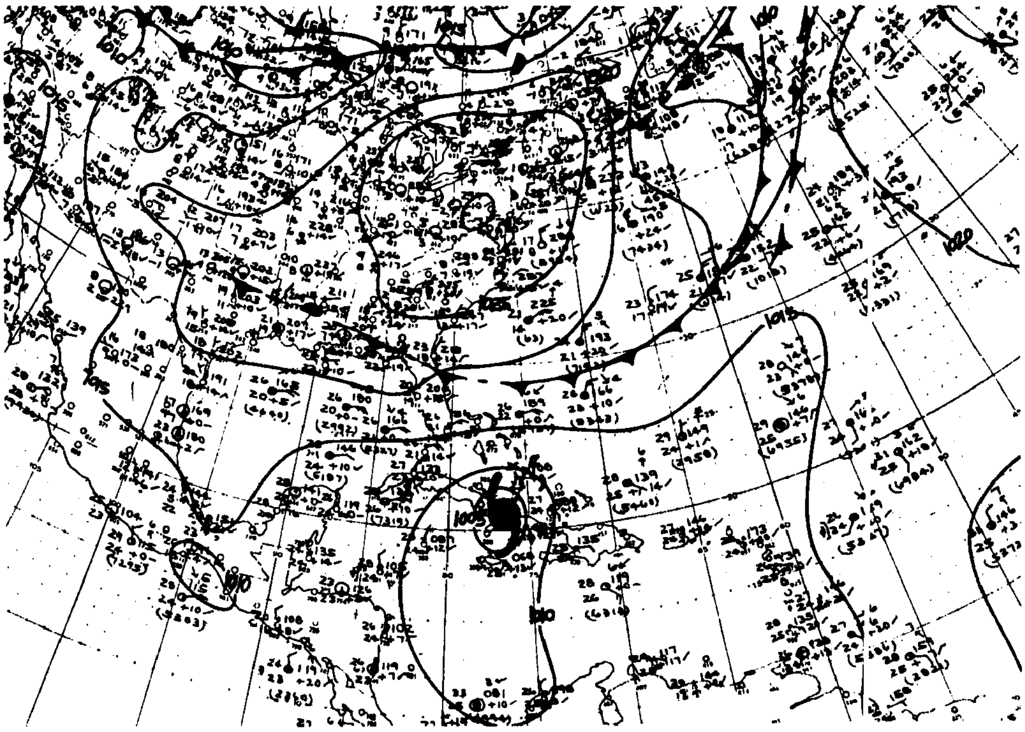


Fig. 52. Surface weather map of 5 Oct. 1963 of Hurricane Flora which was looping. A high pressure cell is located to the north of the hurricane.

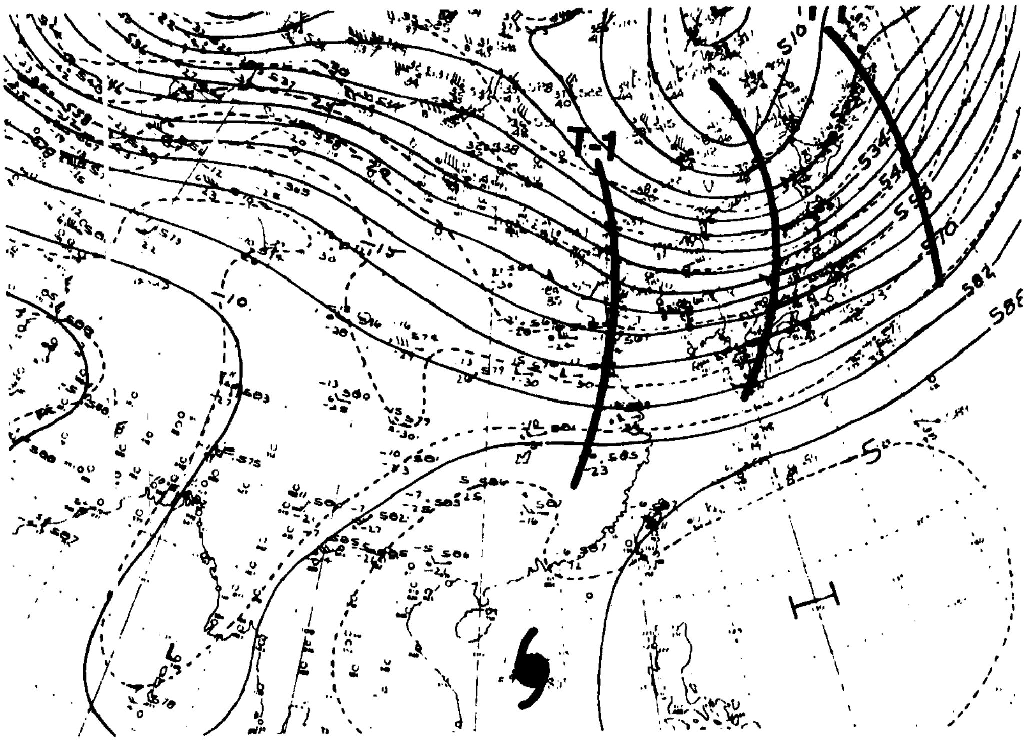


Fig. 53. 500 mb weather map of 10 Nov. 1965 of Tropical Storm Elaine, which was undergoing a looping motion. Trough locations one day before (T-1) and one day after (T+1) are labeled. The main trough is to the northeast of the depression and it is moving rapidly.

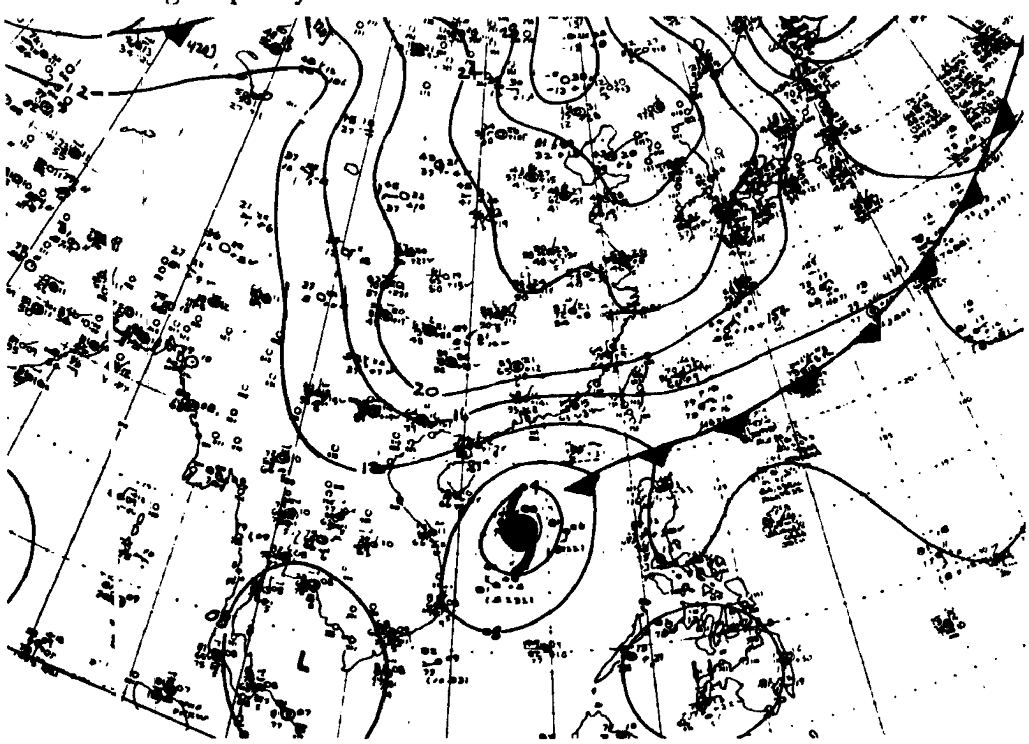


Fig. 54. Surface weather map of 10 Nov. 1965 of Tropical Storm Elaine which was undergoing a looping motion. A high pressure band is to the north of the storm.

10-20° northeast of the cyclone; a ridge was located at 10-20° on the northwest side; the cyclone was thus in a weak steering current, 2) at the surface the cyclone was to the south of a high pressure cell and its steering current was generally from the east.

The distinguishing feature between the slow and looping cases (as with the cyclones north of the subtropical ridge) is still in the trough to the northeast side of the cyclone. The two slow cyclones (Gladys and Agnes) are associated with troughs to the northeast which do not move (Figs. 47 and 49) while the two looping cyclones (Flora and Cleo) are associated with fast moving troughs (Figs. 51 and 53).

3.3 Storms to the South of the Subtropical Ridge

The tracks of the six cyclones to the south of the subtropical ridge are in Figs. 55 and 56. They are Cleo (Aug., 1964), Beulah (Sept., 1967), Delia (Sept., 1973) in the west Atlantic and Sally (Sept., 1964), Bess (Aug., 1957) and Faye (Oct., 1957) in the west Pacific.

When Cleo and Sally moved fast south of the subtropical ridge the 500 mb (Figs. 57 and 59) flow indicates a strong and zonal subtropical ridge to the north of the cyclone. Strong zonal air flow exists on both the north and south sides of the subtropical ridge. Cyclones are in a strong easterly current. At the surface (Figs. 58 and 60) there is also a zonal high pressure ridge to the north of the cyclone. Thus, surface and 500 mb steering currents are in the same direction.

When Beulah and Bess moved slowly and when Delia and Faye looped, the large scale circulations were similar. At 500 mb, cyclones were located near a neutral point. Westerly troughs were located to the north of the cyclones and subtropical highs to the east and west sides.

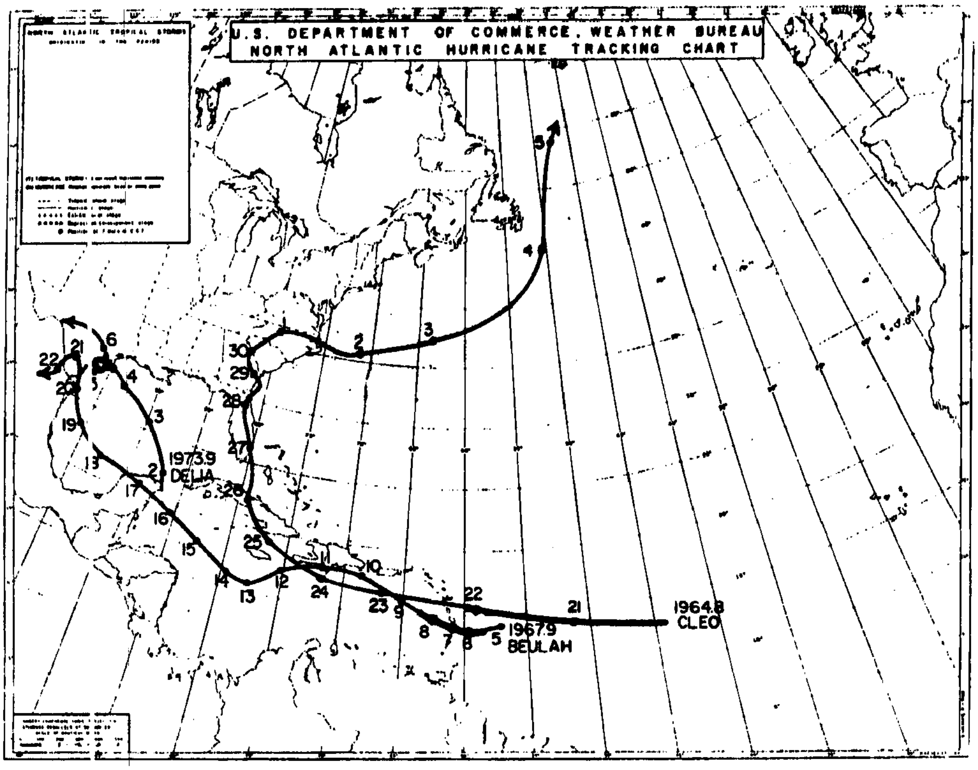


Fig. 55. Typical track examples of Atlantic fast (Cleo), show (Beulah), and looping (Delia) cyclone motion which occurred south of the subtropical ridge.

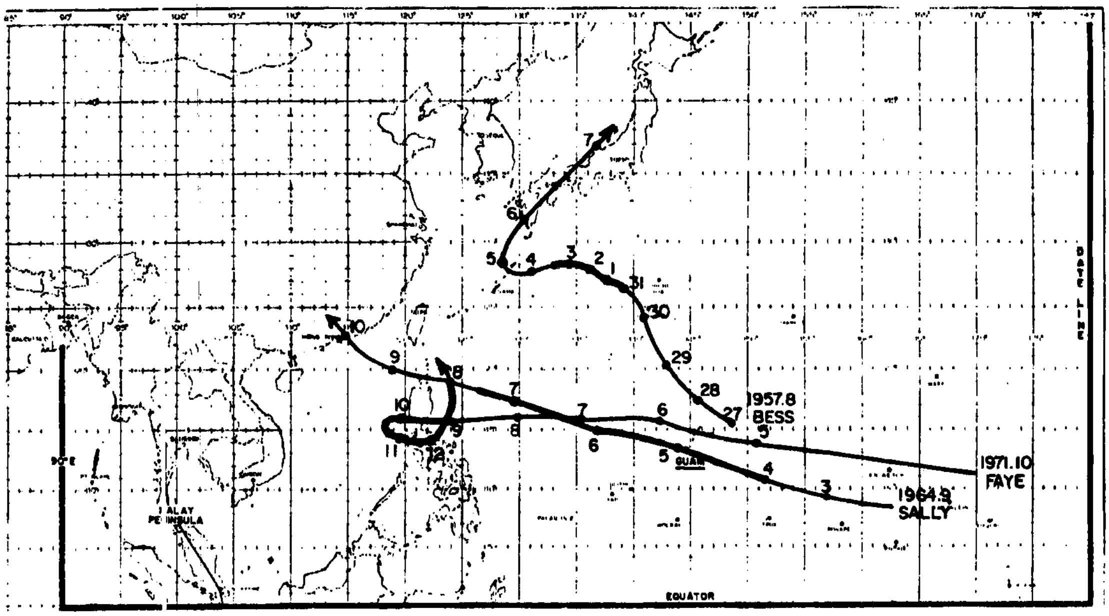


Fig. 56. Track examples of Pacific fast (Sally), slow (Bess), and looping (Faye) cyclone motion which occurred south of the subtropical ridge.

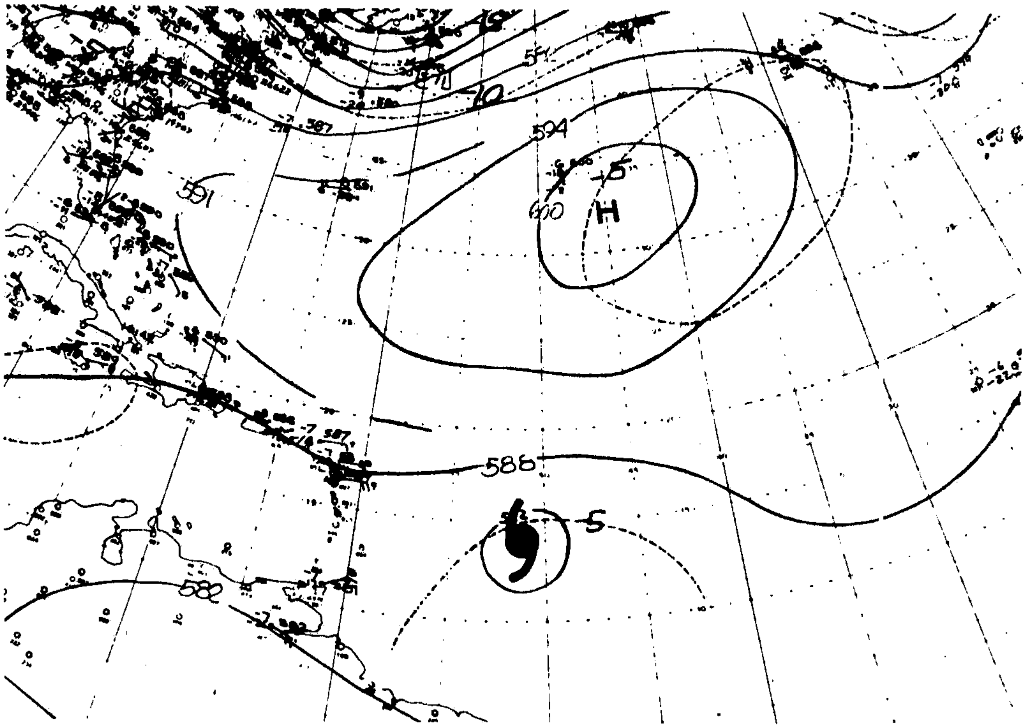


Fig. 57. 500 mb weather map of 21 Aug. 1964 of Hurricane Cleo which was moving rapidly to the south of the subtropical ridge. There are strong tradewinds and a strong subtropical ridge.

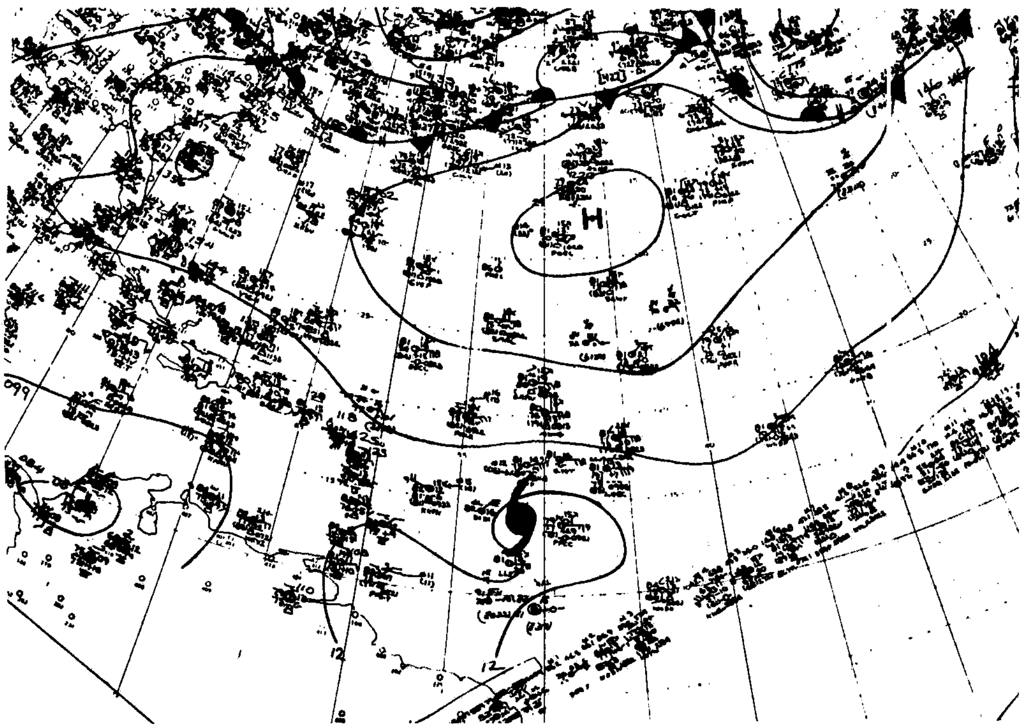


Fig. 58. Surface weather map of 21 Aug. 1964 of Hurricane Cleo which was moving rapidly to the west. Note the strong high pressure cell to the north of the hurricane.

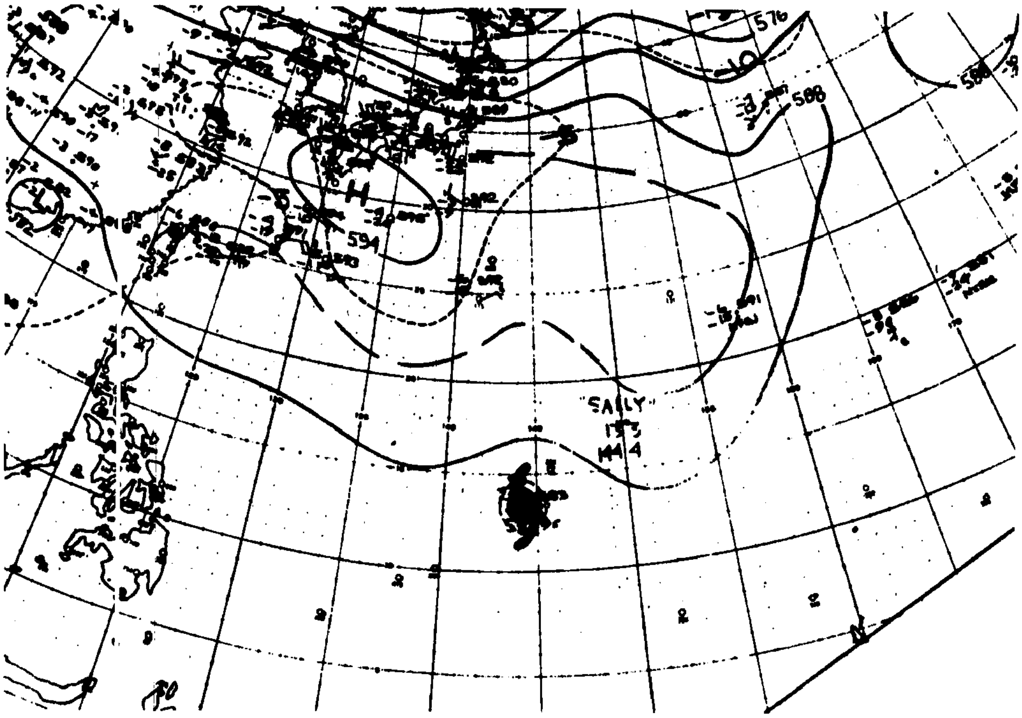


Fig. 59. 500 mb weather map of 5 Sept. 1964 of Typhoon Sally which was moving rapidly. There are moderately strong trade winds and a subtropical ridge on the poleward side of the storm.

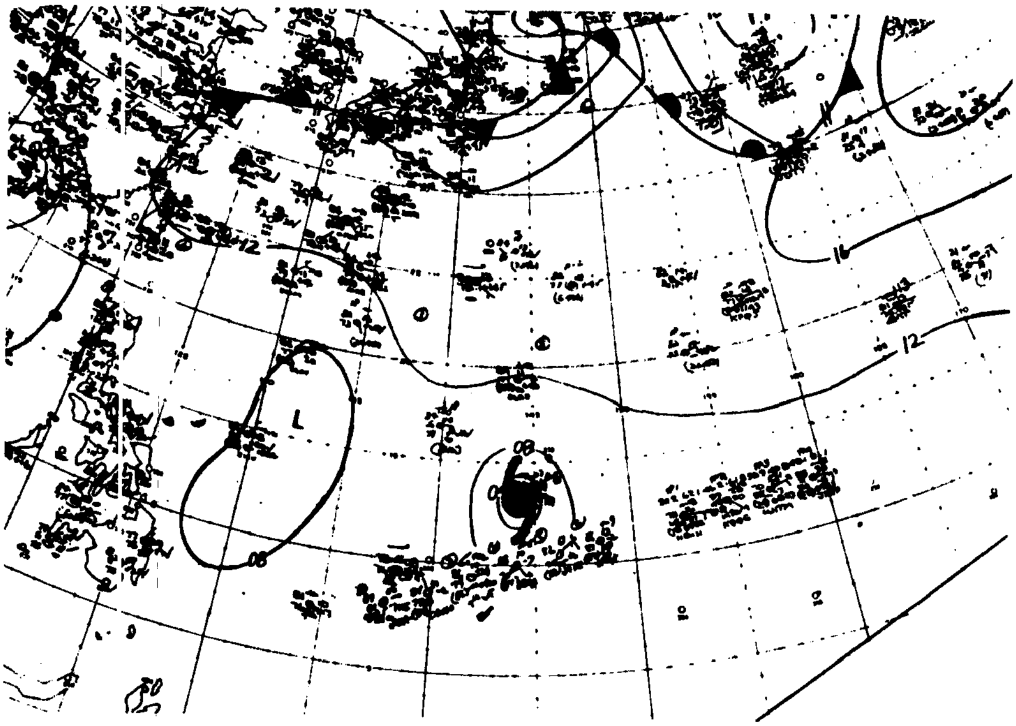


Fig. 60. Surface weather map of 5 Sept. 1964 of Typhoon Sally which was moving rapidly to the west. Note the high pressure cell to the north of the storm.

The net 500 mb circulation around the cyclone was quite weak (Figs. 61, 63, 65 and 67). The surface circulations (Figs. 62, 64, 66 and 68) were essentially the same as the 500 mb circulations.

The looping motions still distinguished themselves from the slow cases by the moving troughs to their northeast. In Figs. 61 to 67 troughs one day before (T-1) and one day after (T+1) map time are also labeled. From these maps we can see how the westerly troughs move in the looping cases but not in the slow cyclone motion cases.

3.4 Looping Motion Induced by Binary Cyclones

As Chen and Ding (1979) have previously noted, when two or more cyclones exist in close proximity (10-15^{o} or so) to one another, a mutual interaction can alter the motion of each cyclone. The different cyclone tracks are complex. A complete discussion is beyond the scope of this paper. In this paragraph, one typical example is listed to show how the interaction of cyclone pairs can make the west cyclone go through a looping motion. This is the typical situation when two cyclones interact with each other - the westerly cyclone will undergo the loop. This has been previously noted by Chen and Ding (1979). Brand (1970) has also discussed this type of cyclone motion.

Figure 69 shows the tracks of a pair of cyclones - Sarah and Wanda in September, 1967. On 18 September, Wanda was located west of Sarah. Comparing the 500 mb charts of 18 and 22 September we can see that the large scale flow patterns were very similar. So if there were no Sarah to the east, Wanda would have recurved on 18 September. But Sarah caught up with Wanda and recurved before Wanda. Wanda then looped prior to recurving on 21 September (Figs. 70 to 72).

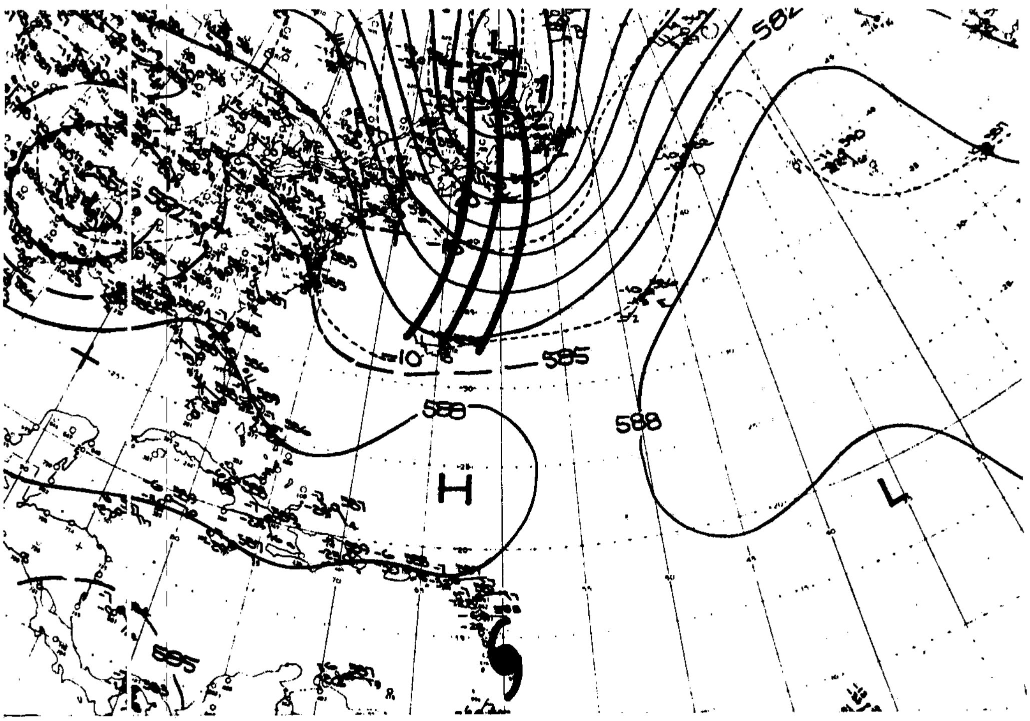


Fig. 61. 500 mb weather map of 7 Sept. 1967 of Tropical Storm Beulah which was moving very slowly. The trough locations one day before (T-1) and one day after this time period (T+1) are marked. The main westerly trough is to the north of the storm and it is moving slowly. The storm is near a neutral point in the flow field.

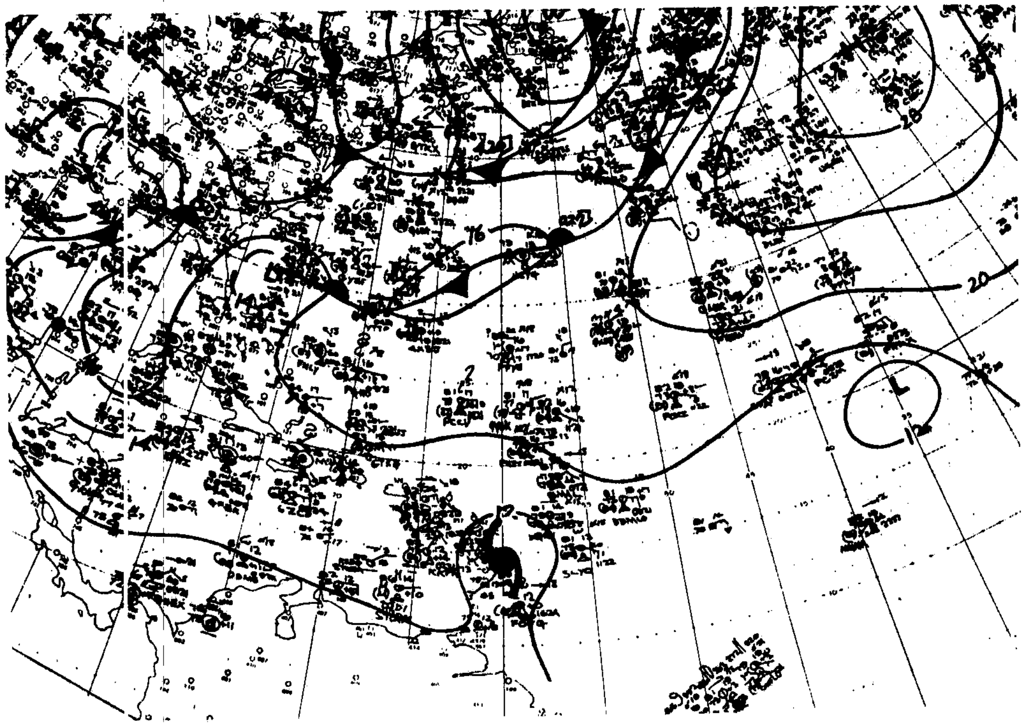


Fig. 62. Surface weather map of 7 Sept. 1967 of Tropical Storm Beulah which was moving very slowly. The surface ridge to the north of the storm is weak.

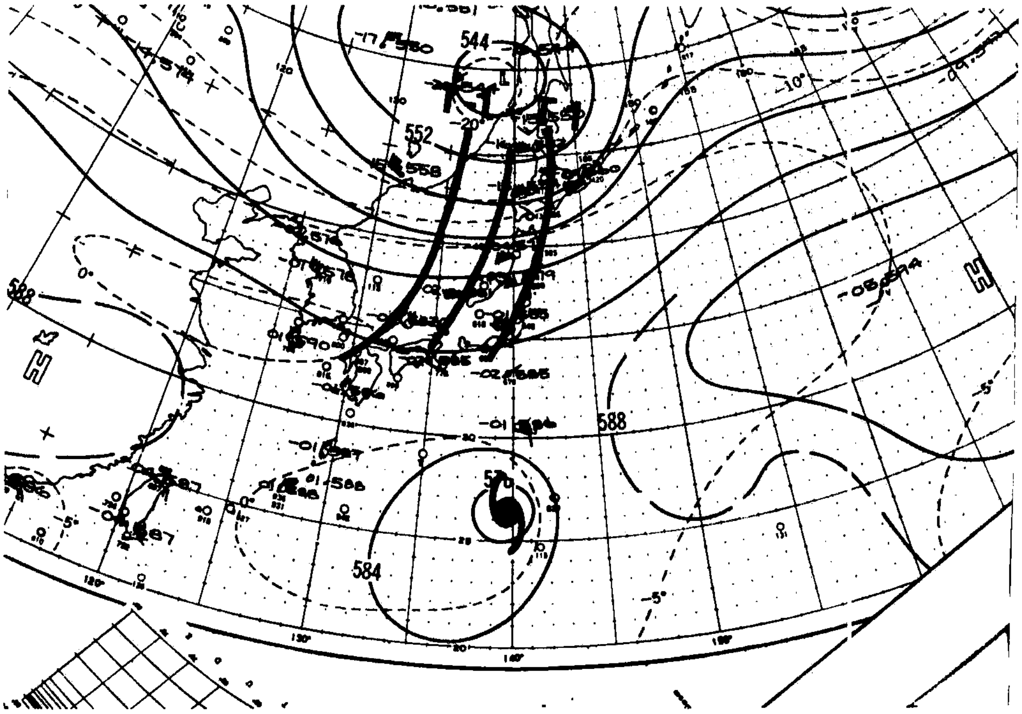


Fig. 63. 500 mb weather map of 31 Aug. 1957 of Typhoon Bess which was moving very slowly. The main trough was to the north of the typhoon and was moving very slowly. Typhoon was near to a neutral point. The trough position one day before (T-1) and one day after (T+1) the current time is marked.

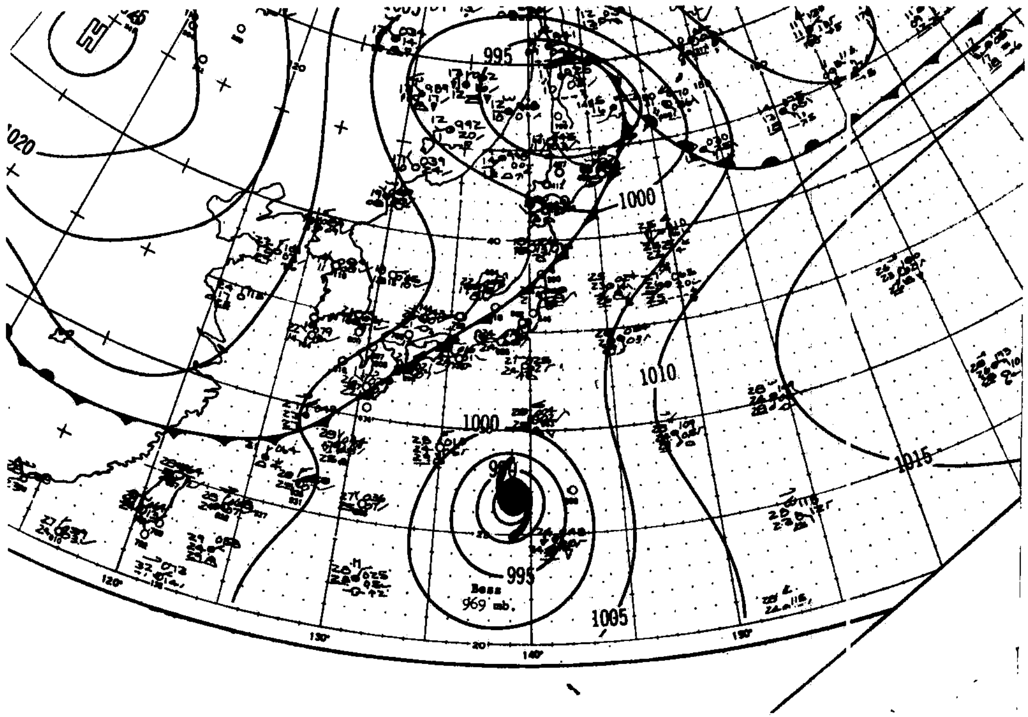


Fig. 64. Surface weather map of 31 Aug. 1957 of Typhoon Bess which was moving very slowly. The high pressure cell to the north of the typhoon has broken down. The typhoon is near a neutral point.

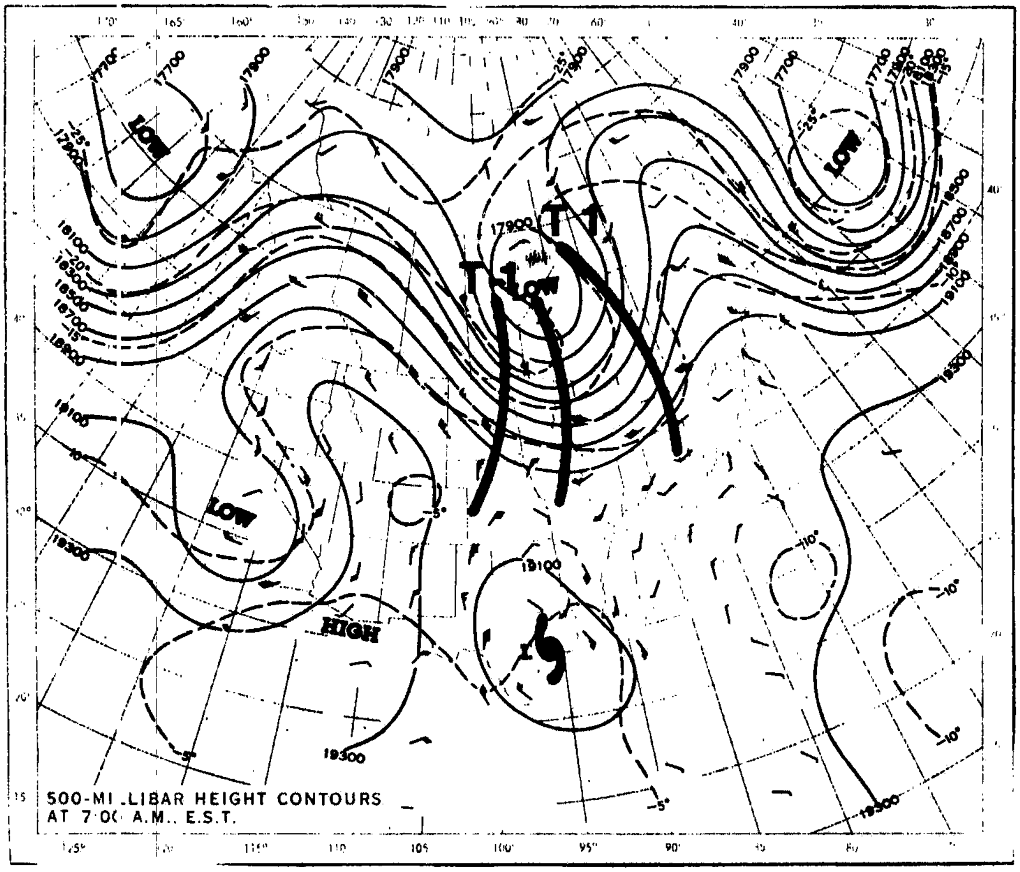


Fig. 65. 500 mb weather map of 00Z 4 Sept. 1973 of Tropical Storm Delia which was undergoing a looping motion. Main trough is to the north of the storm and moving rapidly. Storm was near a neutral point.

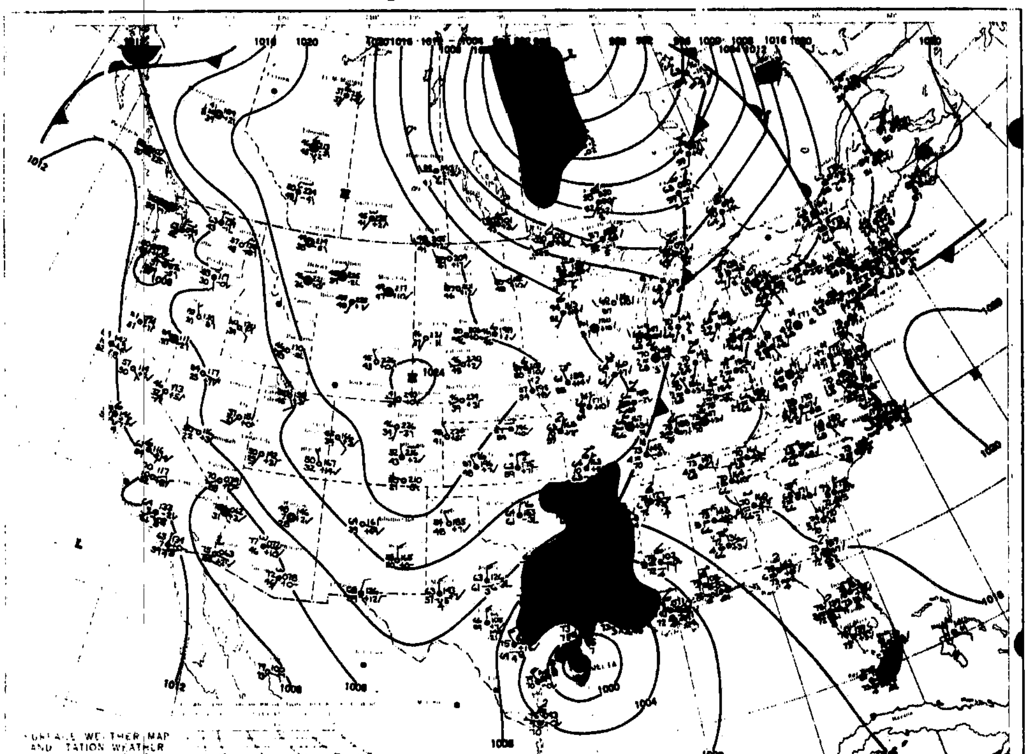


Fig. 66. Surface weather map of 4 Sept. 1973-00Z of Tropical Storm Delia which was undergoing a looping motion. The high pressure cell to the north of the storm is broken. Storm is near a neutral point.

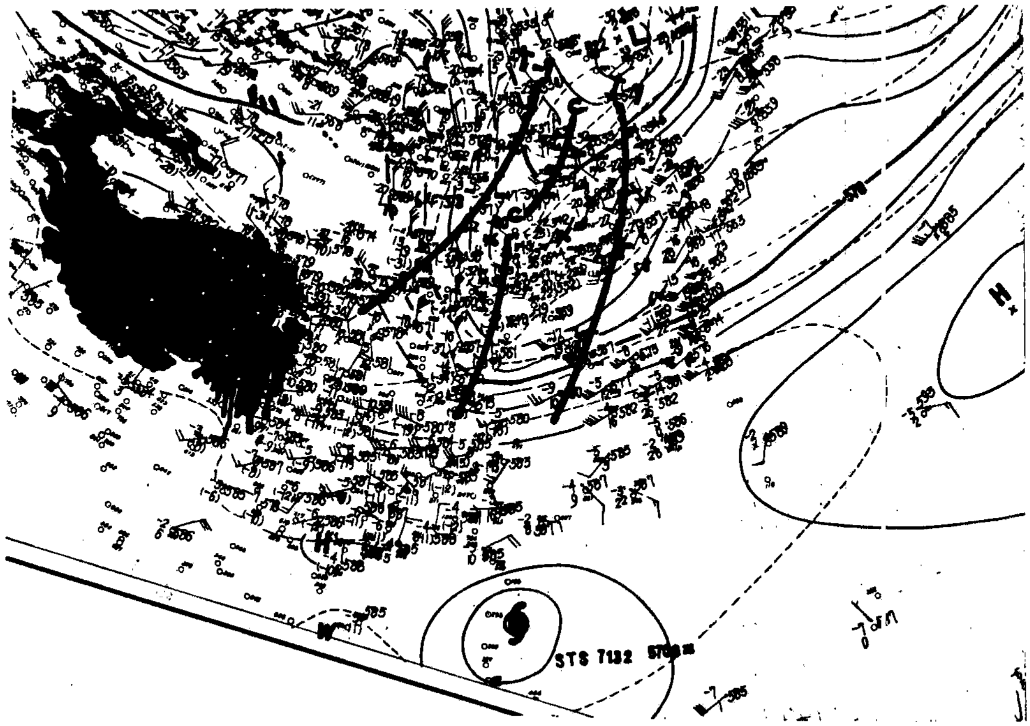


Fig. 67. 500 mb weather map of 10 Oct. 1971 of Tropical Storm Faye which was looping. The main trough is to the north of the storm and is moving rapidly to the east. The storm is near a neutral point.

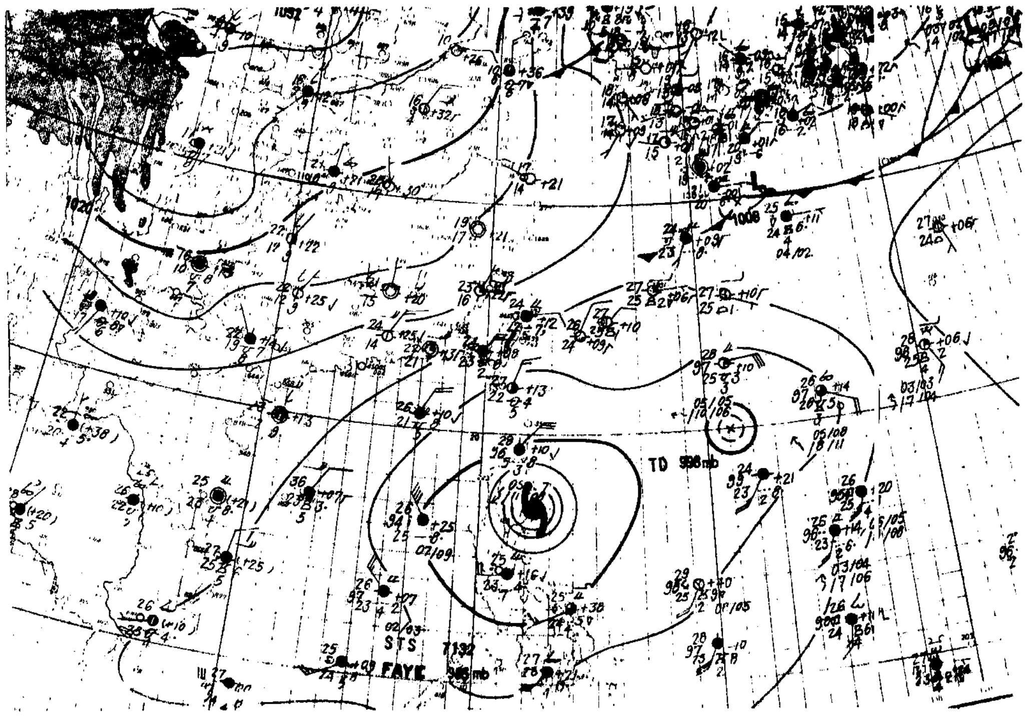


Fig. 68. Surface weather map of 10 Oct. 1971 of Tropical Storm Faye which was looping. The high pressure band to the north of the storm is broken. The storm is near a neutral point.

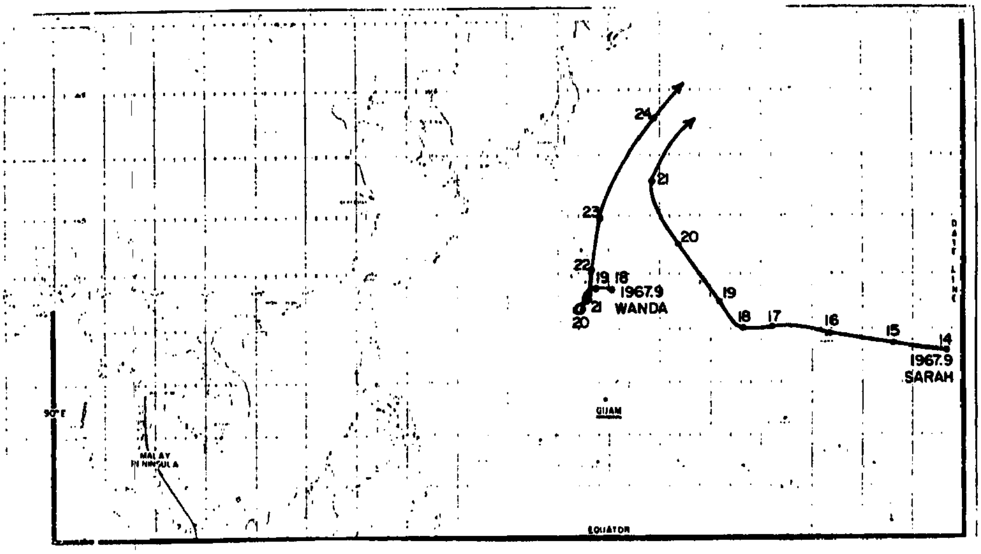


Fig. 69. The tracks of Hurricanes Sarah and Wanda during Sept. 1967. Before 19 Sept., Wanda was directly to the west of Sarah. Sarah was moving faster than Wanda. By 19 Sept. Sarah moved within 15° latitude of Wanda and each storm began affecting the others steering flow. Such steering flow changes caused Sarah to recurve and Wanda to take on a looping motion.

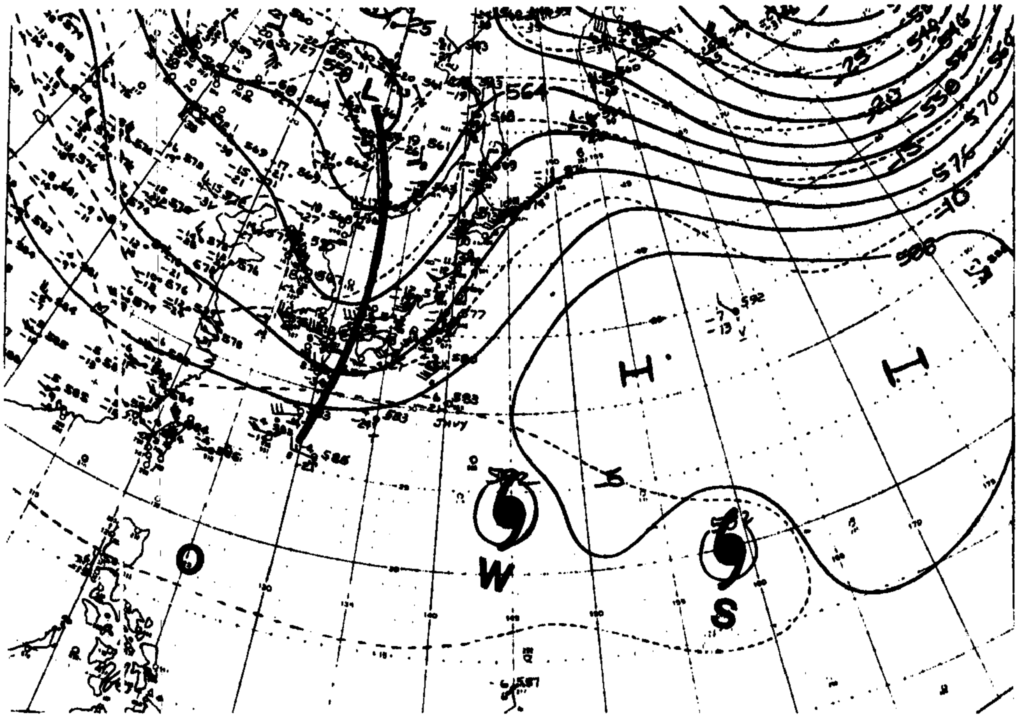


Fig. 70. 500 mb weather map of 18 Sept. 1967. Sarah was catching up with Wanda.

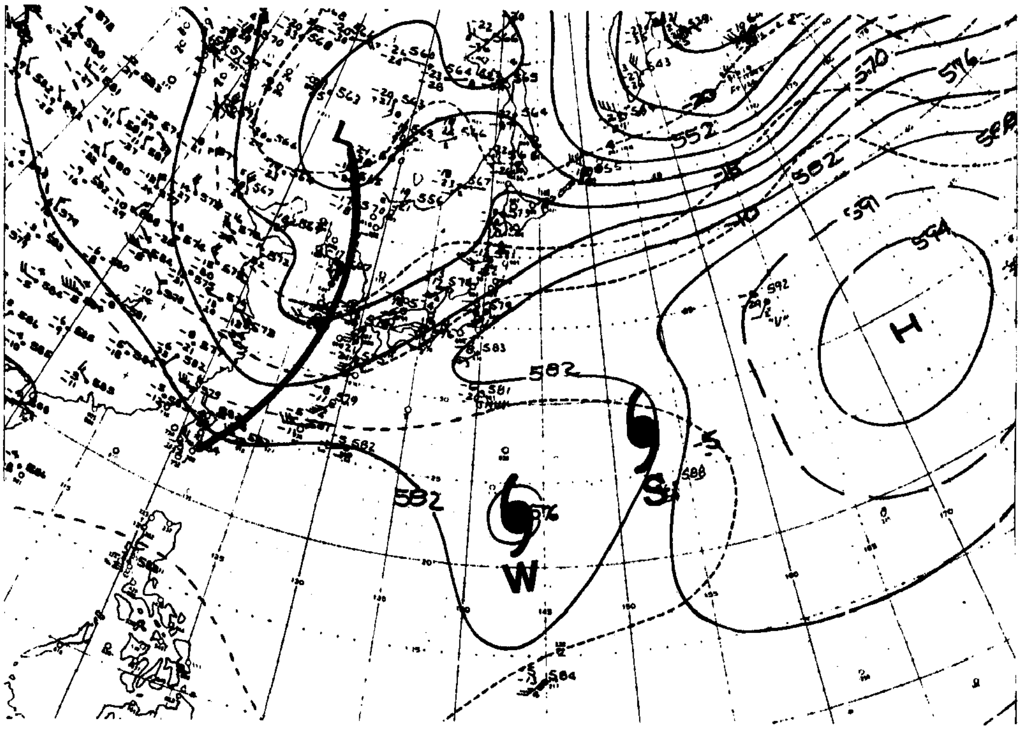


Fig. 71. 500 mb weather map of 20 Sept. 1967. Sarah has moved to the north and east side of Wanda. Sarah recurved rapidly and Wanda looped.

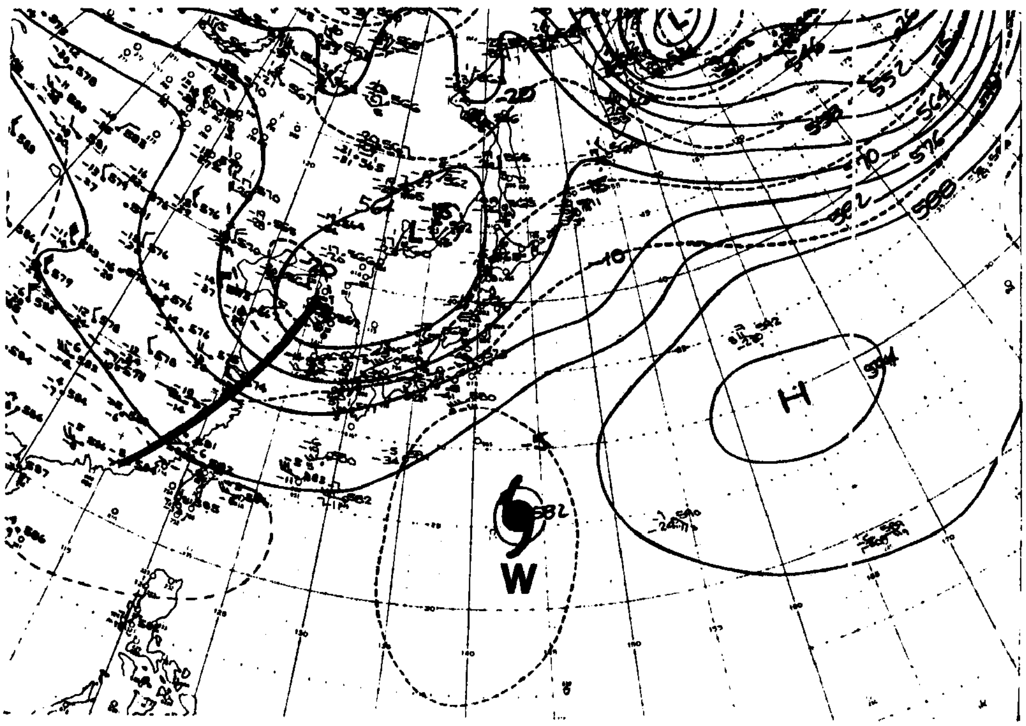


Fig. 72. 500 mb weather map of 22 Sept. 1967. After Sarah moved away, Wanda resumed a straight northward motion.

3.5 Summary

From the individual case studies it can be seen that these three types of tropical cyclone motion in both ocean basins are closely related to the large scale flow patterns around the cyclones. Storms undergoing different motion characteristics have different surrounding flow patterns. After compositing the daily 500 mb and surface weather maps of 575 cases (262 fast cases, 201 slow cases, 112 looping cases, and nothing that each case may extend for several days) in both oceans we find that the characteristics of the large-scale circulation described above are also typical for the average storm cases. Idealized examples of these flow cases will be discussed in the next section.

4. GENERAL SYNOPTIC MODELS FOR FAST, SLOW AND LOOPING STORM CASES

All the individual 500 mb and surface weather maps related to these three types of motion categories in both oceans (262 fast cases, 201 slow cases, 112 looping cases, each for several days) were studied. All cases occurred during the 21 years of 1957- 1977. The data used are: Daily Series Synoptic Weather Maps (January, 1957- April 1971), Daily Weather Maps (May 1971-December 1977) of the US NOAA Environmental Data Service and Daily Weather Maps (January 1961-December 1977) of the Japan Meteorological Agency. From these various case studies, typical synoptic-scale circulations associated with each of these three classes of cyclone motion can be generalized into various idealized models.

4.1 For Storms North of the Subtropical Ridge

Fast Motion. At 500 mb (Fig. 73) a westerly trough is located 10-20 longitude to the northwest side of the cyclone. A westerly ridge is located 10-20^{o} longitude on the northeast side of the cyclone. The storm is thus located in strong southwest airflow just to the east side of a westerly trough. A high speed air current is as close as 5^{o} latitude to the storm center. At the surface (Fig. 74) the poleward part of the cyclone is connected with a surface trough which extends northeastward. The surface steering flow has nearly the same direction as that of the 500 mb flow.

Slow and Looping Motions. At 500 mb (Fig. 75) a westerly trough is located 20-30^{o} to the northeast side of the cyclone. In looping cases, this trough to the northeast is developing and moving. A westerly ridge is located at about the same longitude as the cyclone. The overall surrounding circulation is weak. High speed airflow is at least 15^{o}

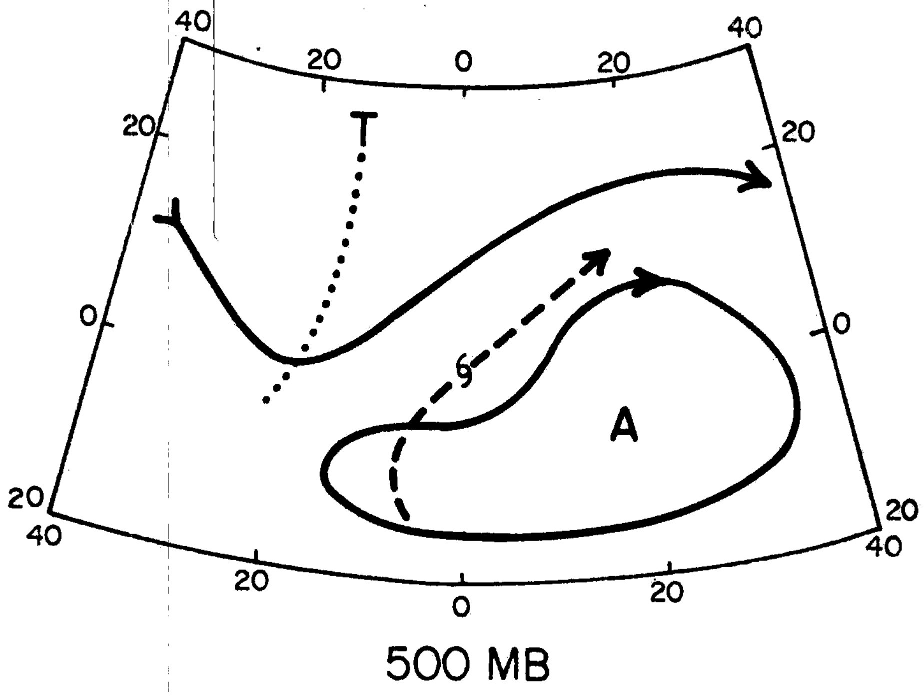


Fig. 73. Typical conditions for <u>fast</u> cyclone motion to the north of the subtropical ridge. A westerly trough is located 10-20^{o} on the northwest side of the cyclone.

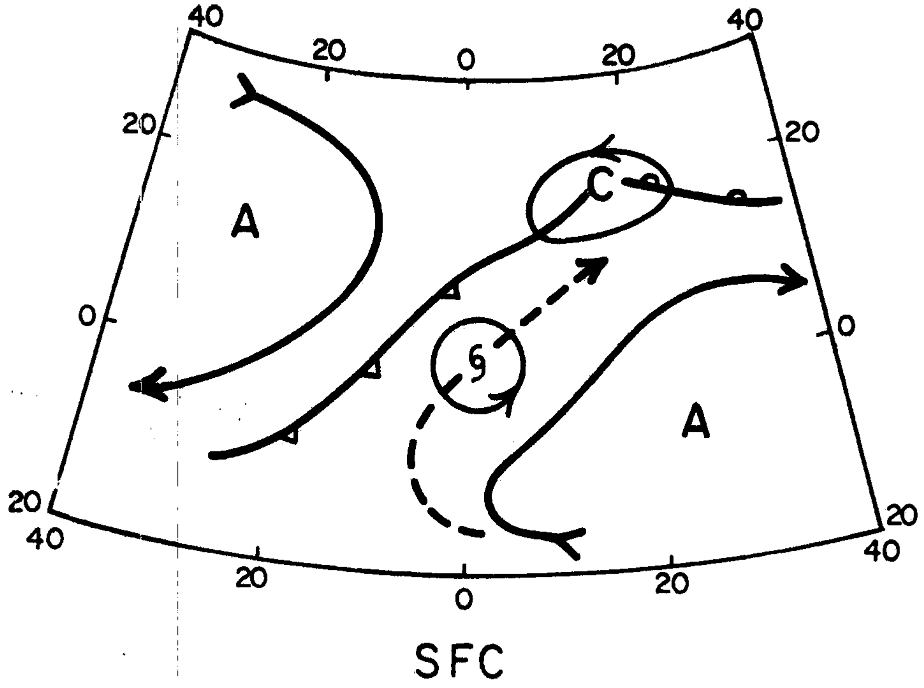


Fig. 74. Typical surface conditions associated with Fig. 73. The tropical cyclone is connected with a frontal trough which extends to the northeast.

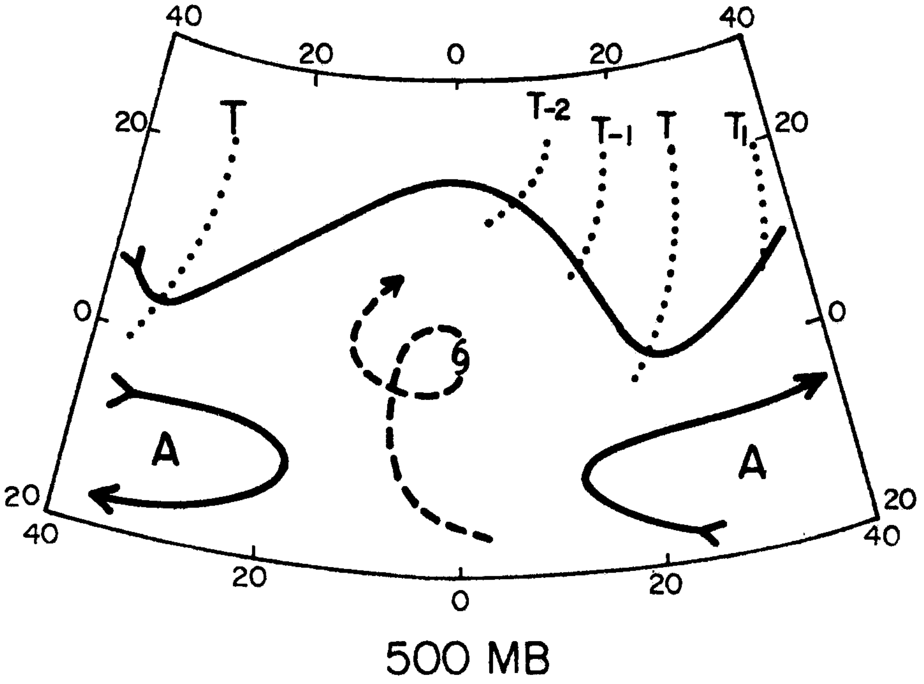


Fig. 75. Typical flow pattern for slow moving and looping tropical cyclones north of the subtropical ridge. The westerly trough is in 20-30° longitude to the east and north of the cyclone. In looping cases, this trough is deepening.

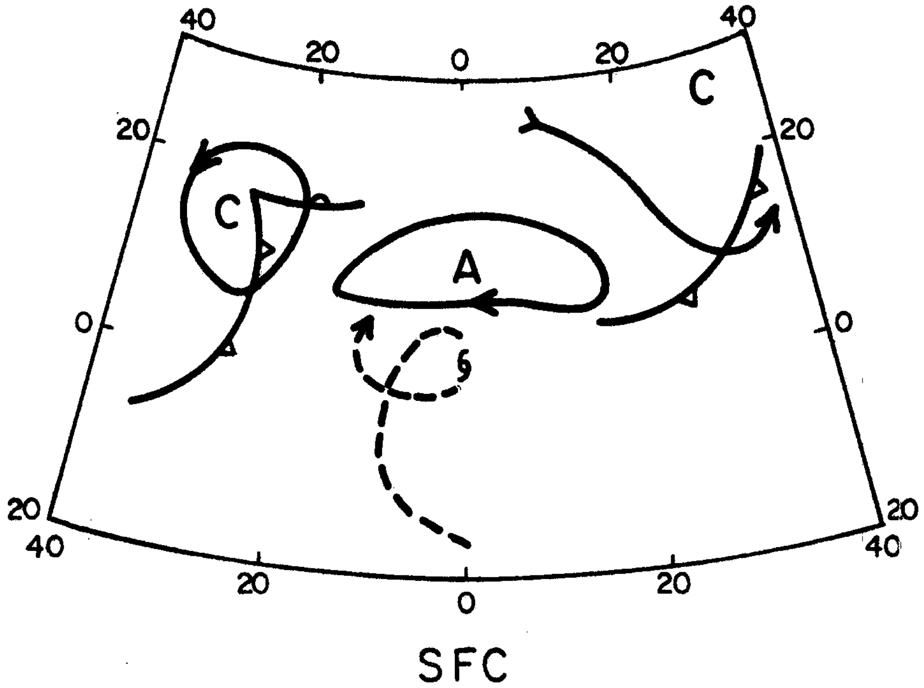


Fig. 76. Typical surface conditions with Fig. 75. A surface high pressure cell is located to the north of the cyclone.

latitude away from the cyclone. At the surface (Fig. 76) a high pressure exists to the north of the cyclone. Surface steering flow is generally easterly and in an opposite direction to the 500 mb flow.

4.2 For Storms Near the Subtropical Ridge

Fast Motion. At 500 mb (Fig. 77) a westerly trough digs deeply into the subtropics to the west and a subtropical high cell is located to the east. The steering current is strongly from the south. At the surface (Fig. 78) an anticyclone associated with the subtropical ridge is to the east and a cyclonic circulation to the west. The surface steering current is in the same direction as the 500 mb flow and is moderately strong from the southwest.

Slow and Looping Motion. At 500 mb (Fig. 79) a westerly trough is located 10–20° to the northeast side of the cyclone. In the looping situations a fast-moving shortwave is present at this location. A westerly ridge is located 10–20° on the poleward side of the cyclone. This results in a weak steering flow around the cyclone. At the surface (Fig. 80) there is a ridge to the north of the cyclone. Surface steering is generally from the east and opposite to that at the middle levels.

4.3 For Storms to the South of the Subtropical Ridge.

Fast Motion. At 500 mb (Fig. 81), there is zonal westerly flow at midlatitudes and a subtropical ridge which causes stronger than normal trade winds at the surface (Fig. 82). There is also a ridge to the north of the cyclone. The cyclone is in a strong easterly steering flow at both 500 mb and at the surface.

Slow and Looping Motions. At both 500 mb and the surface (Figs. 83 and 84) the tropical cyclone is near a neutral point. A westerly trough

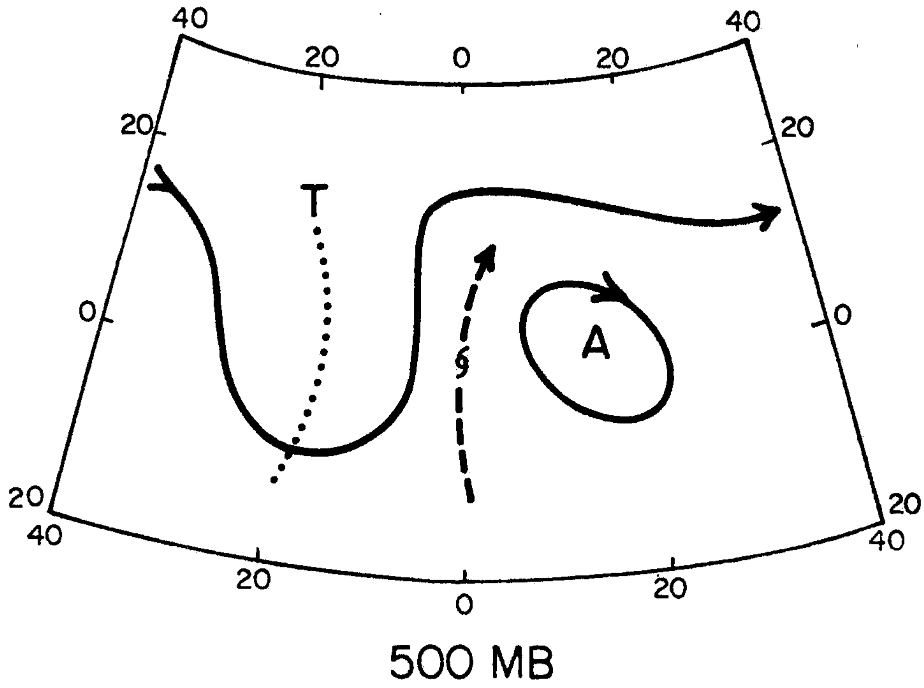


Fig. 77. Typical flow pattern for <u>fast</u> moving tropical cyclones near the subtropical ridge. A westerly trough extending deep into the subtropics in 10-20° longitude to the west of cyclones.

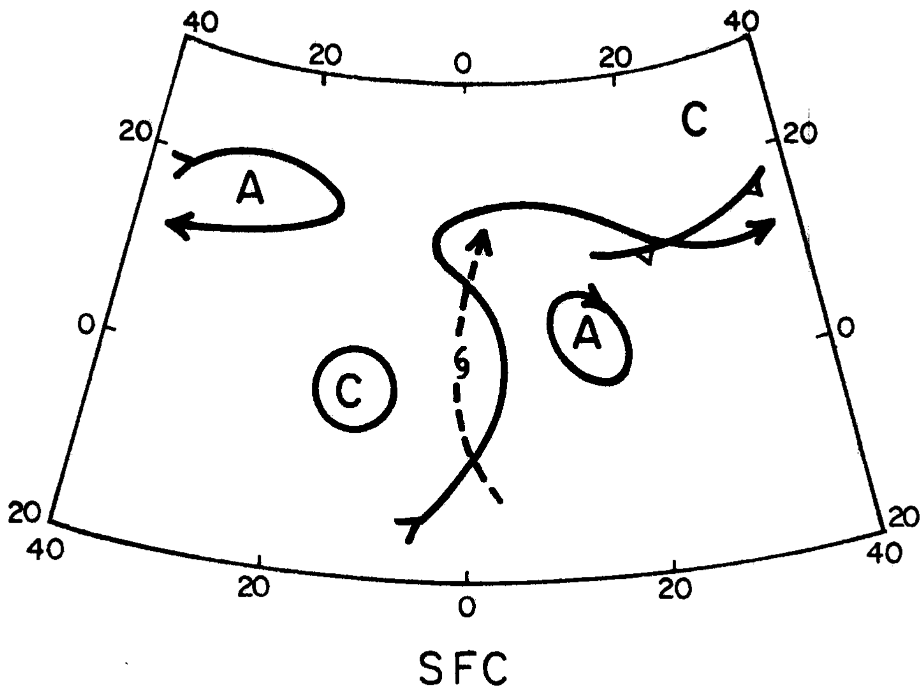


Fig. 78. Typical surface conditions associated with Fig. 77. A surface high pressure is to the east of the cyclone.

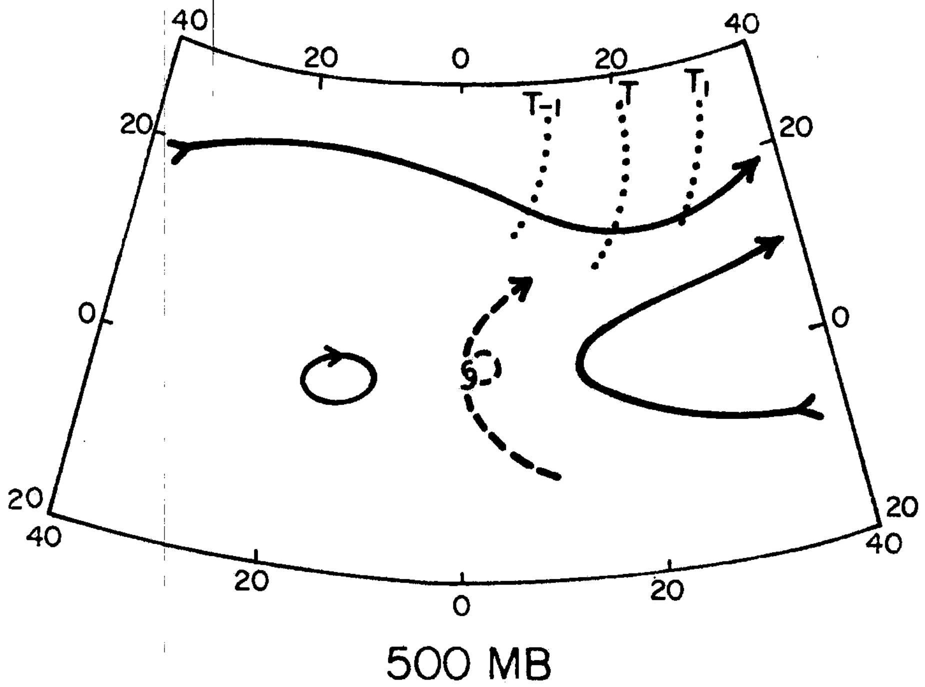


Fig. 79. Typical flow pattern for slow moving and looping tropical cyclones near the subtropical ridge. A westerly trough is located 10-20° to the northeast of the cyclone. In looping cases, this is a rapidly moving short wave trough.

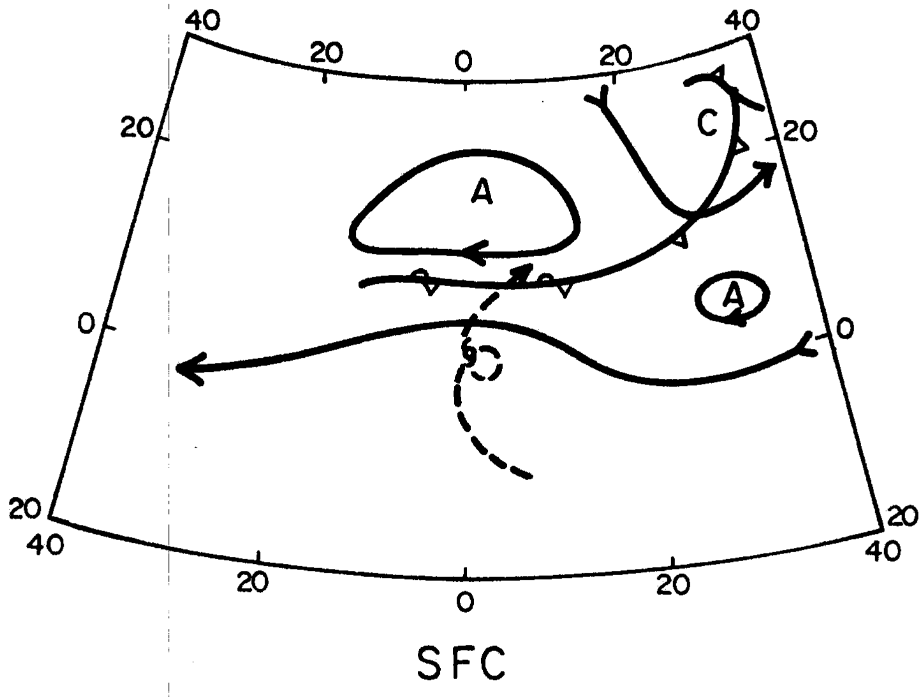


Fig. 80. Typical surface conditions associated with Fig. 79. A surface high pressure is to the north of the cyclone.

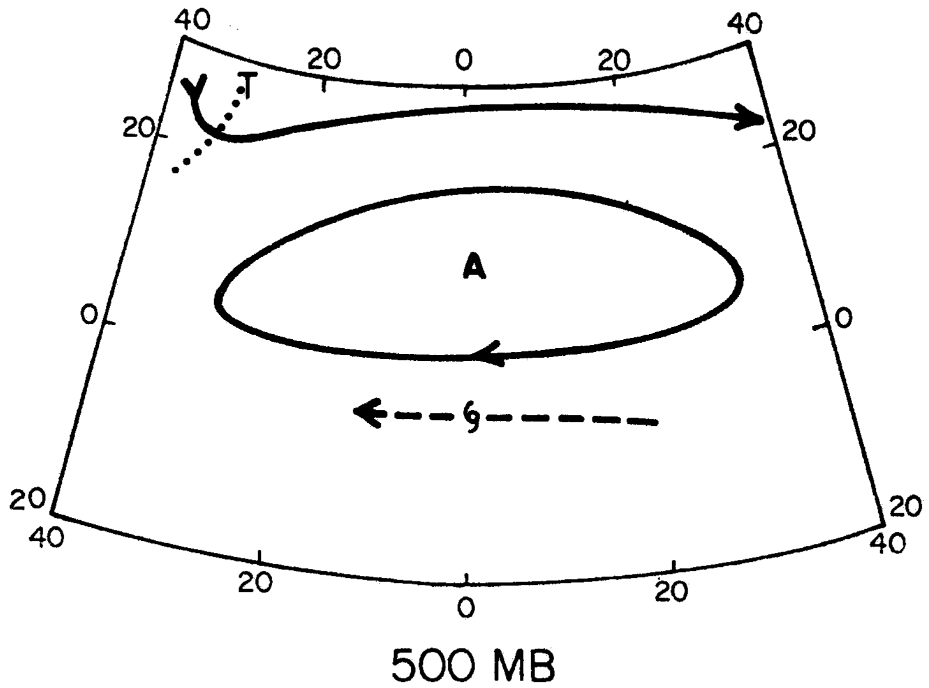


Fig. 81. Typical flow pattern for fast moving tropical cyclones south of the subtropical ridge. There are zonal easterly winds and a strong subtropical ridge to the north side.

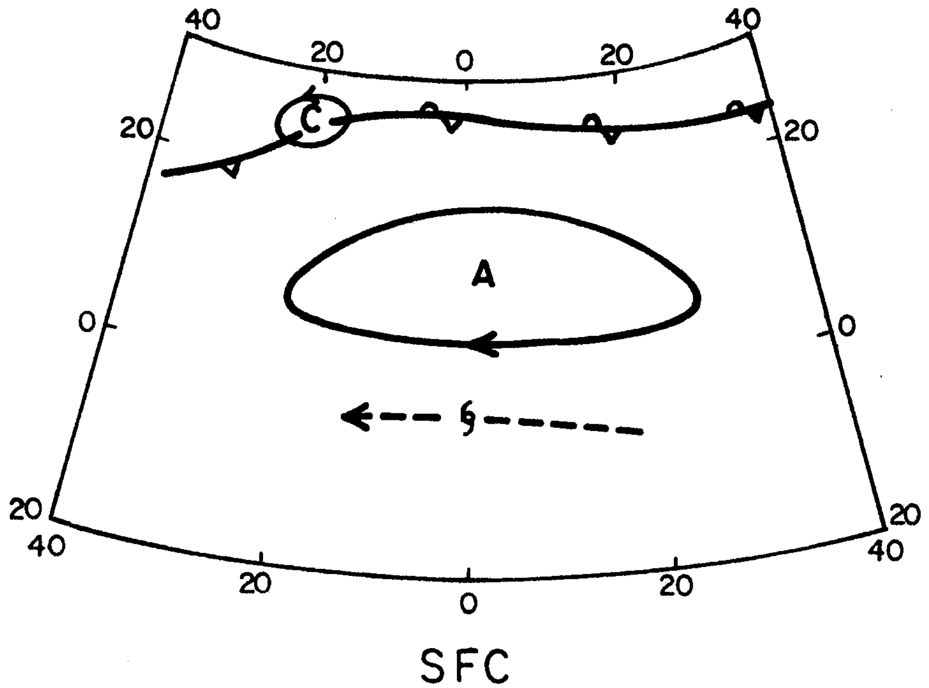


Fig. 82. Typical surface conditions associated with Fig. 81. Strong surface ridge is also to the north of the cyclone. Steering flow is the same at both levels.

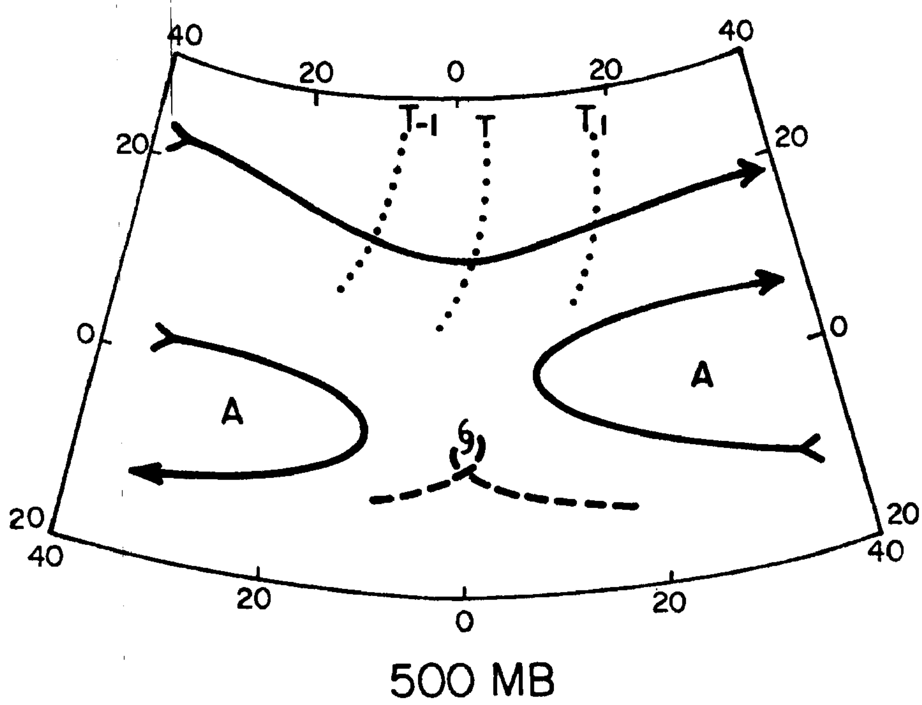


Fig. 83. Typical flow pattern for slow moving and looping tropical cyclones south of the subtropical ridge. A westerly trough is located at about the same longitude to the north. The cyclone is near the neutral point in the flow field. In looping cases there is a short wave trough moving rapidly by the cyclone to the north.

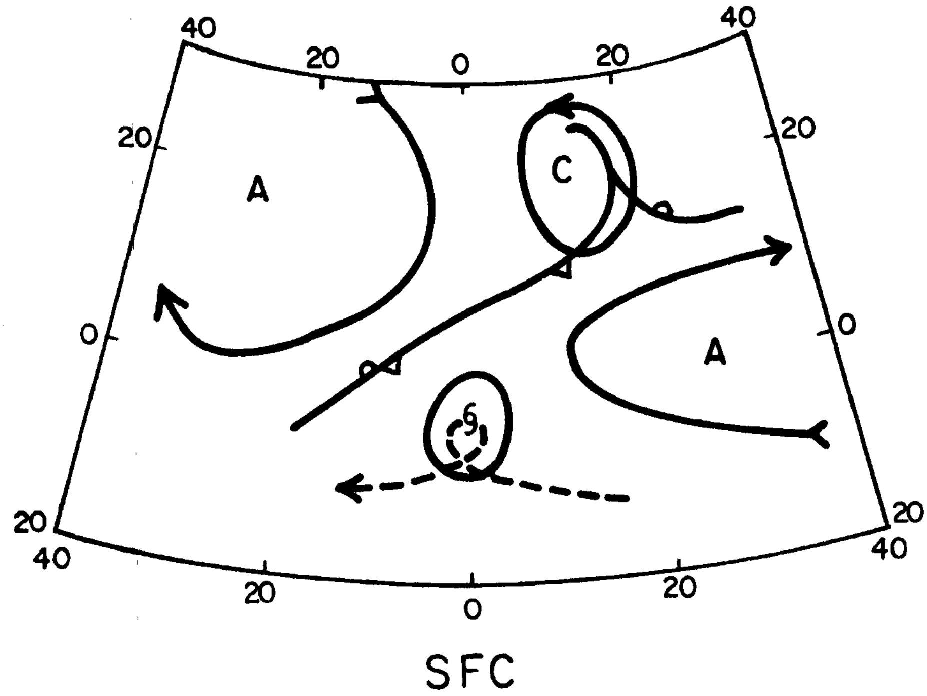


Fig. 84. Typical surface map associated with Fig. 83. The surface cyclone is also located near a neutral point in the flow field.

exists relatively far to the north. Two high pressure cells exist to the east and west of the cyclone. In looping cases, the westerly trough moves quickly .

From the schematic maps shown above we can see that westerly waves have a major influence on tropical cyclone motion, and that the relative reinforcement of the surrounding steering current between middle and low levels greatly affects the cyclone speed. Fast motion requires that the surface and middle level steering be in the same direction.

In the next section, composited height maps and derived geostrophic wind fields are presented to give a more quantitative verification of these synoptic models.

5. COMPOSITE ANALYSES OF THE THREE CLASSES OF CYCLONE MOTION

5.1 Data Sources and Composite Methods

Daily 00Z and 12Z 500 mb height and surface pressure grid point data during 1957-1977 were extracted from the National Center of Atmospheric Science (NCAR), Boulder,Colorado global data tapes. This information was used to make large-scale composite analysis of each of the nine motion classes which are all stratified by their position relative to the subtropical ridge at 500 mb.

Because high case counts are desirable for a representative composite analysis, all the data related to the 575 cases were used. Each case was divided into 5 periods: two days before the event (-2), one day before the event (-1), during the event (0), the last day of the event (1), and one day after the event (2). Every time period includes two 12 hour intervals except the 'during event' period which can include more time intervals. A few 0 or during events lasted as long as 8-10 days.

As before, each case was stratified by its latitude position relative to the 500 mb Subtropical (S.) Ridge (R.). For fast motions, determination of the position relative to the S.R. was simply based on the direction of the cyclone. Cyclones moving in a direction towards 30°-50° are considered north of the S.R., cyclones moving in a direction 340°-20° are near the S.R., and cyclones moving 250°-290° are considered south of the S.R. For slow and looping motions, the stratification is based on the cyclone's position relative to the 500 mb subtropical ridge and the cyclone's track as related to which side of the recurving point it is on.

After stratification, each case is put into one of 90 specific storm situations (two ocean basins, three types of motion, three locations relative to the subtropical ridge, and five time periods associated with the event).

A 5° latitude and longitude geographic grid is used for compositing. The domain is -10° to $+35^{\circ}$ latitude and $\pm 50^{\circ}$ longitude relative to the storm center. From the 500 mb height and surface pressure field geostrophic winds were calculated and composited in each of the 90 individual case situations.

All the composite maps for these examples which have more than ten cases are shown in the Appendix. From these composite maps, we can see the major and persistent features which describe these various classes of cyclone motion. The statistics of these composites will now be discussed.

5.2 Differences in Westerly Trough Locations Associated With These Motion Classes.

Figure 85 gives the 500 mb composite westerly trough locations (longitude relative to cyclone center) between 10°–30° latitude to the north of the cyclones by time period and event. Information is given from two days before the event occurs until 1 day after the event. The fast motion events have different distributions of westerly trough positions than the slow and looping motion events. Irrespective of the cyclone's location relative to the subtropical ridge, slow and looping motions are always associated with a trough to the northeast of the cyclone. Fast moving cyclones are always associated with a trough to the west side. The more poleward the cyclone is relative to the subtropical ridge, the further eastward the westerly trough is relative to the slow and looping cyclones. This figure shows that there is a

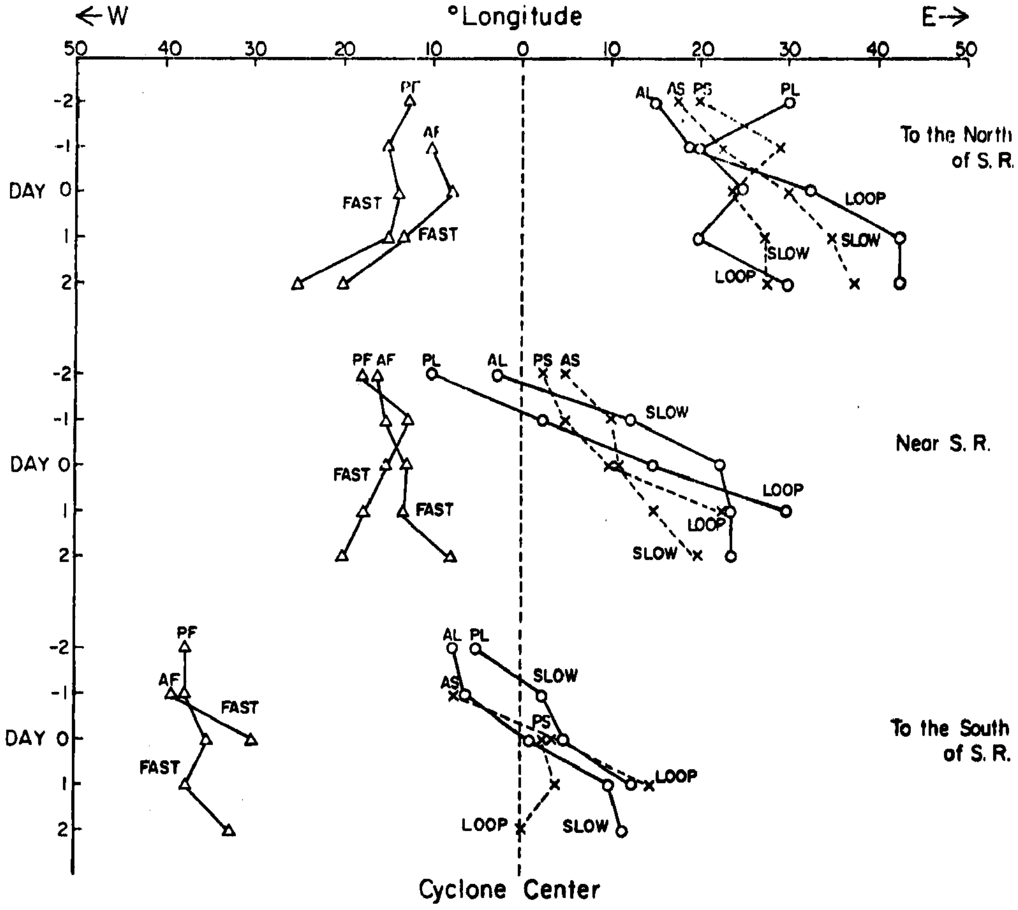


Fig. 85. 500 mb composite westerly trough locations between 10-30° latitude to the north of the cyclone at the time of the event.

AF denotes Atlantic Fast Motion

PF denotes Pacific Fast Motion

AS denotes Atlantic Slow Motion

PS denotes Pacific Slow Motion

AL denotes Atlantic Looping Motion

PL denotes Pacific Looping Motion

difference in the longitude positions of the westerly troughs of about 30^{o} between the fast moving cyclones and the slow and looping cyclones. These differences in westerly wave locations should result in composite height differences. Figures 86-89 show 500 mb height differences of fast minus slow, and fast minus looping motion for both Atlantic and Pacific cases. These four maps show definite positive and negative height differences to the northeast and northwest sides of these different cyclone motion classes to the north of, near, and to the south of the subtropical ridge. In diagram (a) of these figures (north of S.R.), the pair of positive and negative centers are more to the east than in diagram c (south o S.R.). This verifies that the troughs which cause cyclones to move slowly or loop are more to the east when cyclones are to the north of S.R. and more to the west when cyclones are to the south of S.R.

5.3 Flow Pattern Modification and Looping Motion to the North of Subtropical Ridge

In the last section we saw that the difference maps of fast minus slow and fast minus looping 'during events' indicate similar distribution in the two ocean basins. Similar difference maps for the periods of one and two days before the beginning of these events were also made. Except for the looping motion storms to the north of the subtropical ridge, most of the difference maps one day and two days before events look very similar to the periods during the event. Figure 90 shows an example of the 500 mb height difference maps of fast minus slow and fast minus looping motion two days before events in the west Atlantic. The difference of fast minus slow events still retains a pattern similar to that during the event (Figs. 86a and 90a). By contrast, the difference of fast minus looping events shows appreciable

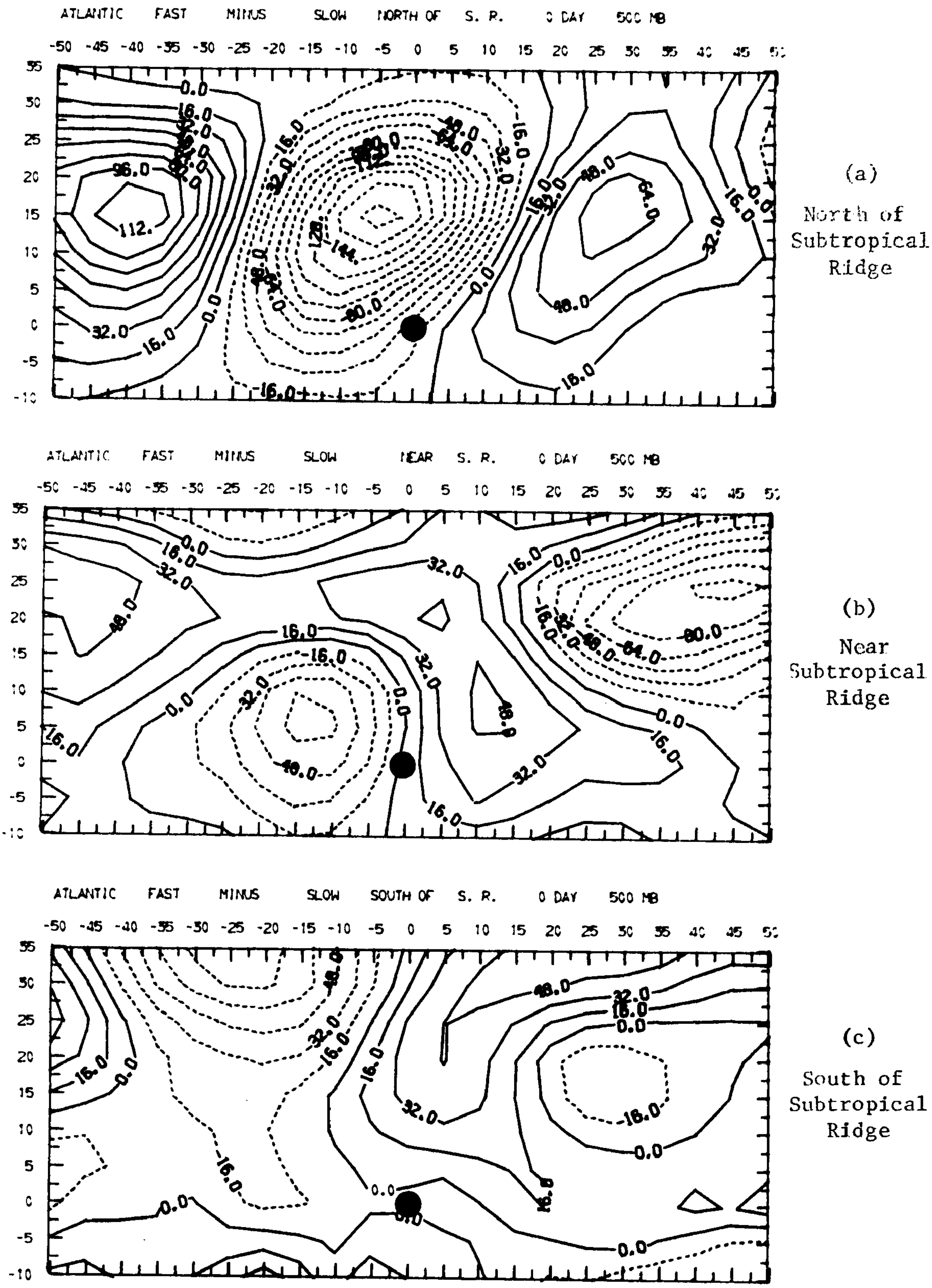
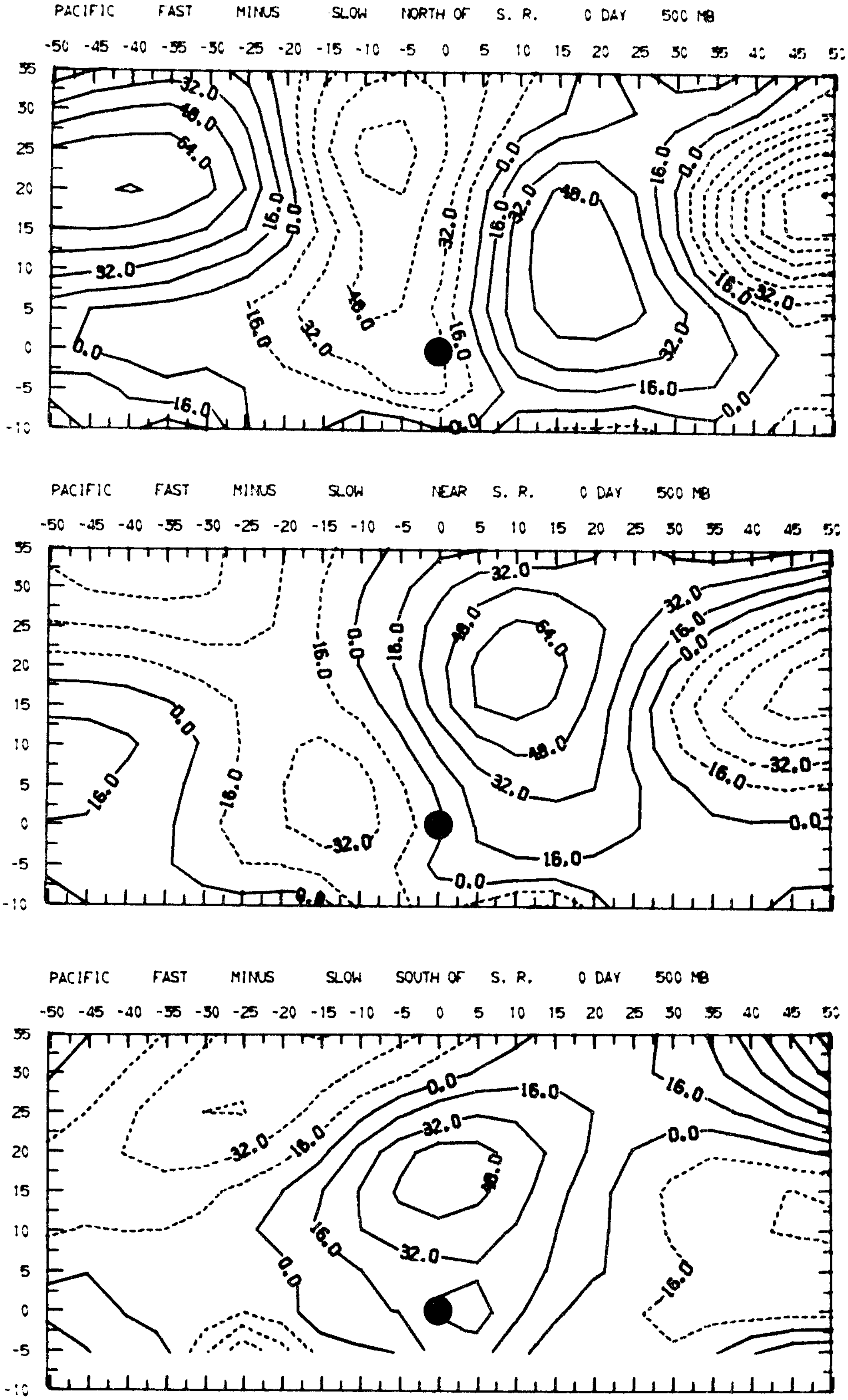


Fig. 86. 500 mb composite height differences in meters of fast minus slow cyclones in the Atlantic. The large dot (●) marks the position of the cyclone.



(a) North of Subtropical Ridge

(b) Near Subtropical Ridge

(c) South of Subtropical Ridge

Fig. 87. 500 mb composite height differences in meters of fast minus slow cyclones in the Pacific. The large dot (●) marks the position of the cyclone.

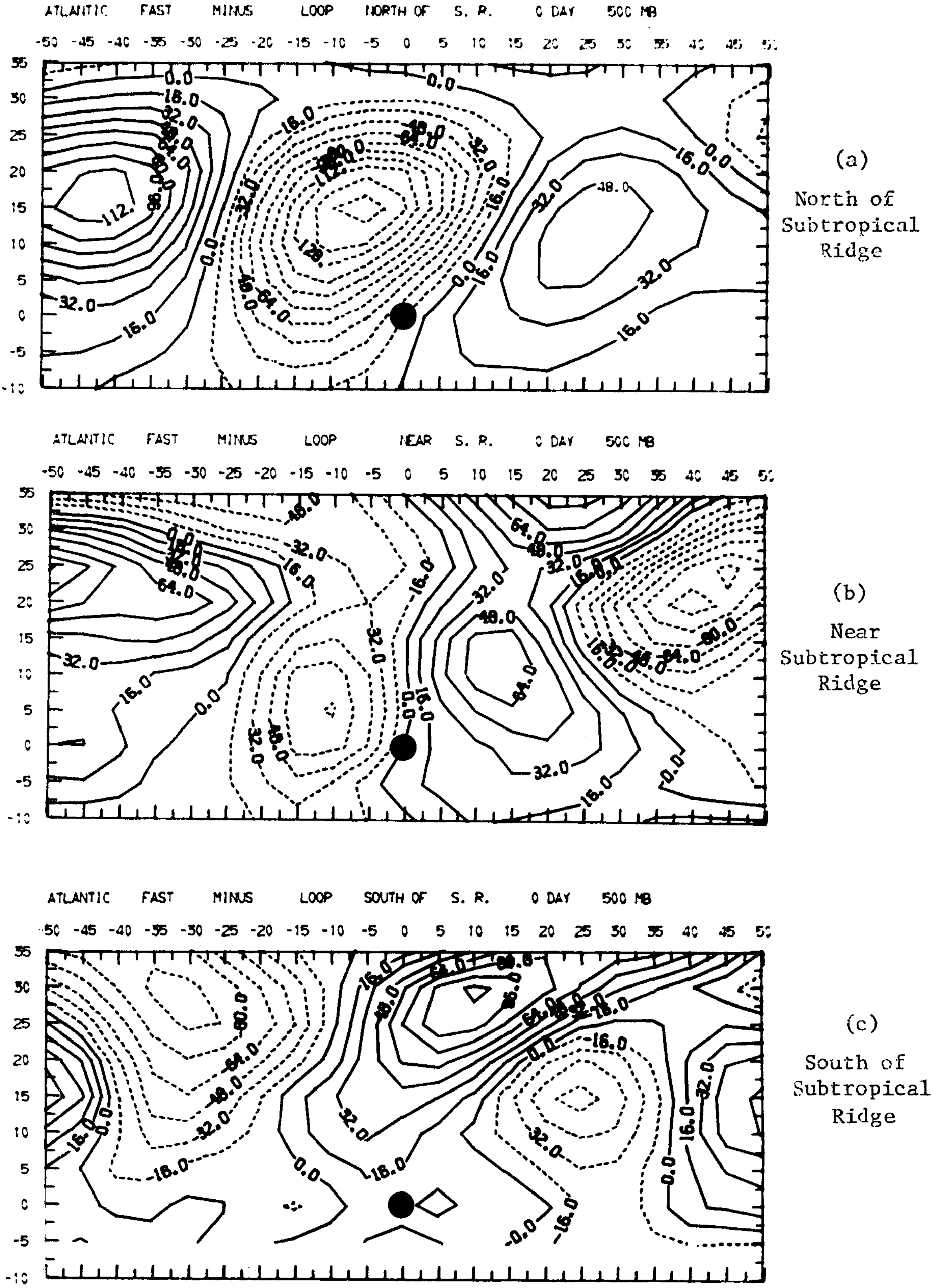
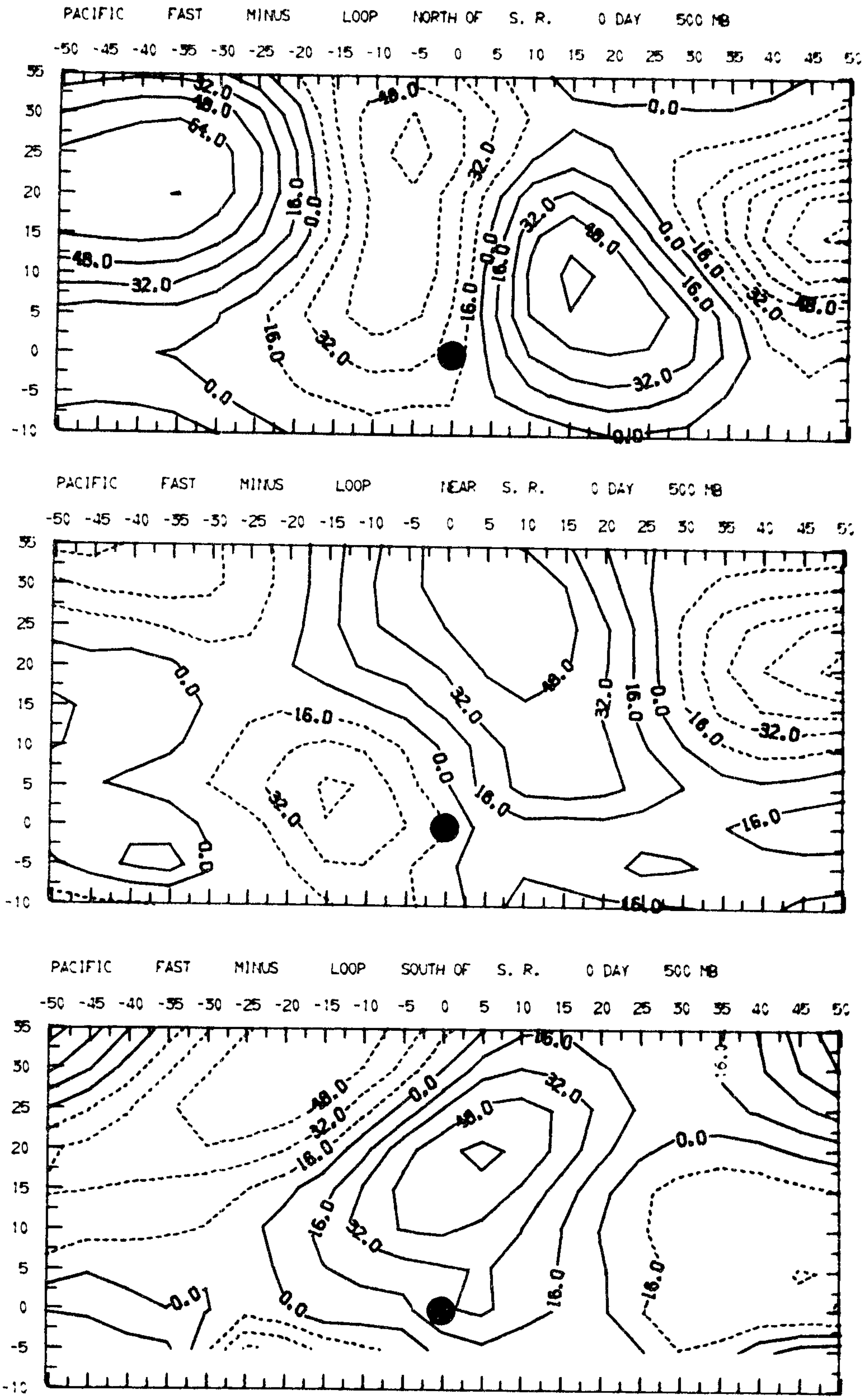


Fig. 68. 500 mb composite height differences of fast minus looping cyclones in the Atlantic. The large (●) marks the position of the cyclone.

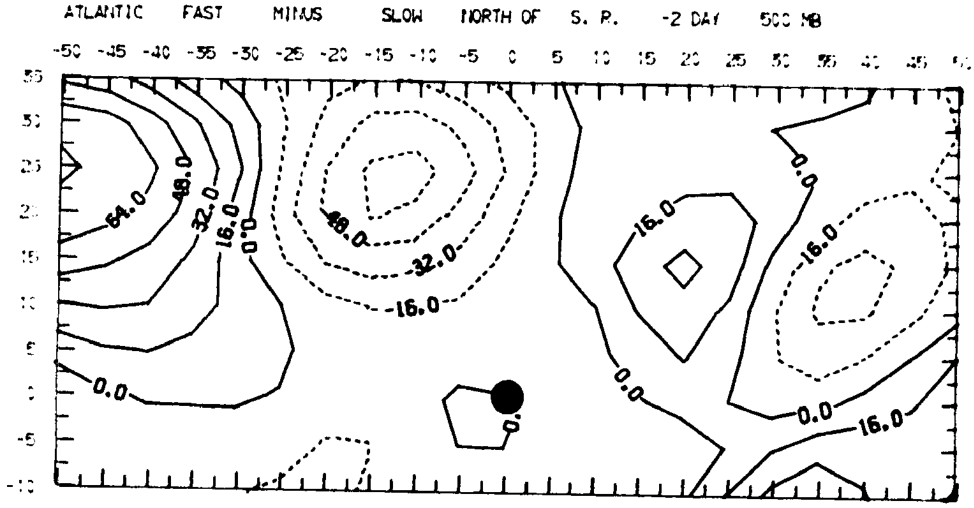


(a) North of Subtropical Ridge

(b) Near Subtropical Ridge

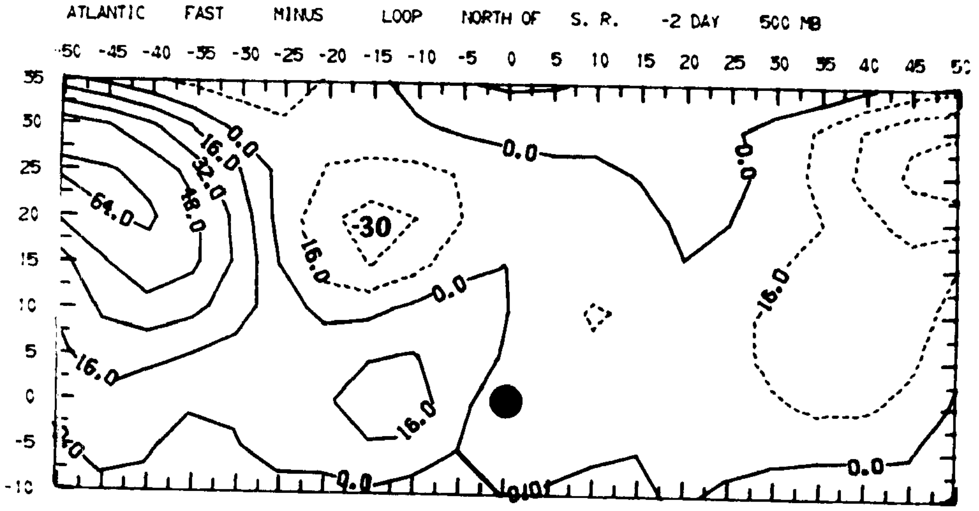
(c) South of Subtropical Ridge

Fig. 89. 500 mb composite height differences of fast minus loop in Pacific. The large dot (●) marks the position of the cyclone.



North of Subtropical Ridge

a) fast minus slow cyclones



South of Subtropical Ridge

b) fast minus looping cyclones

Fig. 90. 500 mb height difference of fast minus slow (a) and fast minus loop (b) two days before the event for Atlantic storms located to the north of the subtropical ridge. The large dot (●) marks the position of the cyclone.

change (Figs. 90b and Fig. 88a) from two days before until the event. The flow pattern of slow motion did not change very much while the looping motion pattern changed. Flow pattern modification is thus important for looping motion cases to the north of the subtropical ridge.

5.4 Differences in Wind Speed in the Surrounding Circulation Associated With the Three Motion Classes

Figure 91 shows the distance from the tropical cyclone to the nearest 10 m/s isotach (not the cyclone circulation itself) in the 500 mb composite maps of the three motion classes in the two ocean basins. This figure shows the influence of the surrounding 500 mb wind to the cyclone speed. At 2 and 1 days before the event (except in the Pacific north of the S.R.) there is little difference in the distances between the cyclone and the 10 m/s isotach among the three motion classes. All storm centers to 10 m/s isotach distances are greater than 10^{o} latitude. Major differences between fast motion and the other two types of motion only appear during the events. When a cyclone to the north of the S.R. starts moving fast, the surrounding westerly high speed airflow rapidly approaches the cyclone center. In situations where the cyclone is near or south of the S.R. a new high speed airflow often separated from the main westerly belt is observed to form near the cyclone.

During the periods in which cyclones move slow or loop, surrounding cyclone 500 mb high speed air currents are far away from the cyclone. When high speed air currents are far away from the cyclone it moves slowly or takes on a looping motion. As soon as high speed air currents approach the cyclone it accelerates. Thus, the surrounding airflow exert quite an influence on cyclone motion.

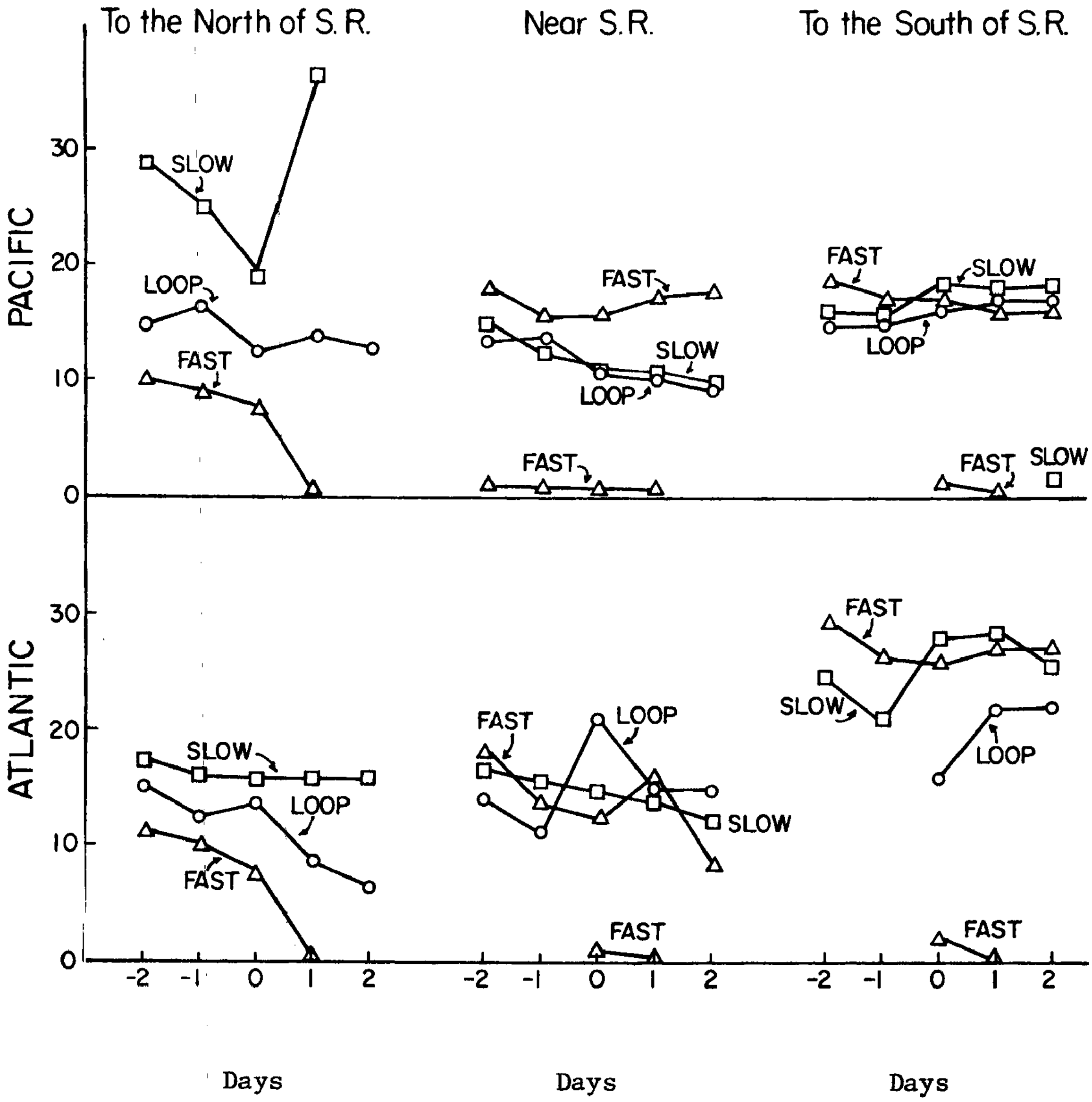


Fig. 9.1. The distances (in degrees latitude) from the tropical cyclone center to the nearest 10 m/s isotach (not tropical cyclone circulation itself) at 500 mb composite maps of the three types of motion in the two ocean basins relative to the days before (-), during (0), or after the motion event.

The analysis in section 5.2 shows that the location of the westerly trough is very closely related to cyclone movement. The function of the westerly trough, in fact, is to specify the degree to which the high speed air currents approach the cyclone. With a westerly trough to the west the cyclone becomes entrapped in the high speed currents. With a large amplitude westerly trough to the east of or near the longitude of the cyclone, the high speed westerly current is kept away from the cyclone.

From the analysis shown above we can see that the surrounding circulation has a very important influence on cyclone motion. In the next section we shall try to explain how the surrounding airflow acts to cause cyclone motion.

6. WIND ASYMMETRY ACROSS FAST AND SLOW MOVING STORMS

Our analysis shows how closely related the storm's environmental circulations and its movement are. But how does the cyclone's surrounding circulation physically affect its motion? In order to understand this question better we have made additional composites of rawinsonde data around fast- and slow-moving cyclones to compare their differences.

Rawinsonde composites have thus been performed in the west Atlantic where a 21 year data sample is available. The data distribution and composite philosophy have been discussed in many of the earlier reports of our research group such as Williams and Gray (1973), Frank (1977a, 1977b) and Gray et al. (1982).

All the fast and slow motion cases during the 21 year period of 1957-1977 we studied before were used to make rawinsonde composites. These stratifications are similar to the height composites except that rawinsonde data were used in place of grided height values. This gives us the detailed vertical resolution which is not possible from just the 500 mb and surface data. Compositing was performed only during the periods the storms were moving fast or slow for six situations (two classes of motions (fast, slow) at three different locations (to the north, near, and to the south of the subtropical ridge). Two coordinate systems were used in the composites. They are: 1) the geographic cyclindrical coordinate system and 2) the cyclone oriented cylindrical coordinate system. In the former, the grid is always oriented to point towards north, while in the latter, or cyclone system, the grid is oriented along the direction of cyclone motion. In this latter system the cyclone speed has been vectorially subtracted from all the winds so that wind components are given relative to the cyclone center. Figure 92 shows this grid orientation.

6.1 Tangential Wind Asymmetry in Geographic Coordinates

Figures 93 through 98 show these tangential wind distributions of the six cyclone movement cases in geographic coordinates. For each composite, the vertical mean tangential winds for four layers are given. These are: a) the 300-100 mb layer, b) the 1000-350 mb layer, c) the 700-350 mb layer, and d) the 1000-800 mb layer average wind. Cyclone direction and speed are labeled with an arrow.

For the layer (1000-350 mb) for which the storm cyclonic circulation of the vortex extends, fast moving cyclones (Figs. 93, 95, 97) are always associated with large tangential wind asymmetry irrespective of their position relative to the subtropical ridge. That is, the maximum tangential wind is always on the right side. Slow moving cyclones (Figs. 94, 96 and 98) have much less tangential wind asymmetry. This is a natural consequence of the storm vortex being superimposed upon a large-scale steering current.

Figure 99 shows the mean tangential winds of the three octants on the right-hand-side and the three left side octants in the 1000-350 mb layer at various radii. Figure 92 shows these octants. Figure 100 shows the subtraction of the left quadrant tangential winds from those in the right quadrant, or the right vs. left quadrant asymmetry of the cyclone. From these charts one can see that for fast moving cyclones, the right side tangential winds are always stronger than the left side ones. The maximum difference is 12 m/s near 4^{o} latitude radius. For slow moving cyclones, these right vs. left quadrant differences are

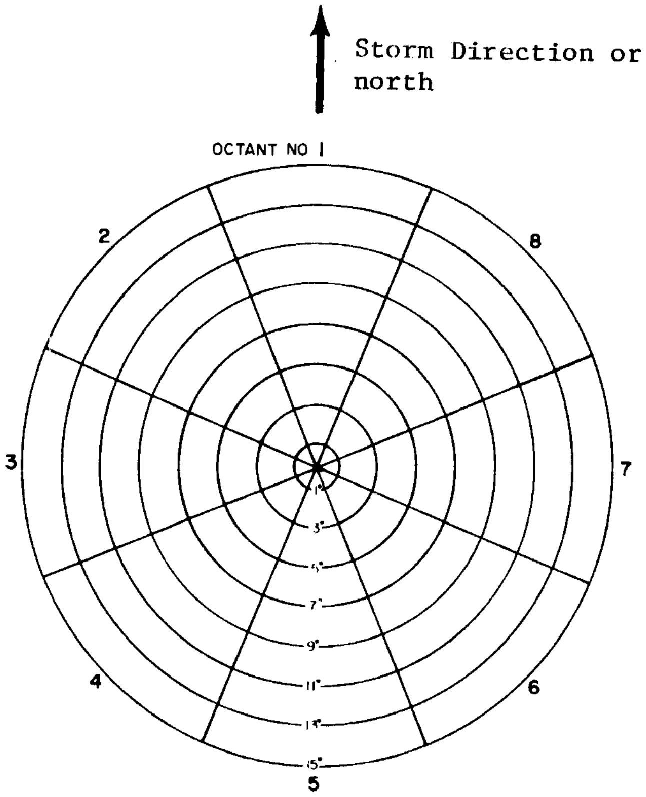


Fig. 92. Rawinsonde compositing grid in geographic or storm coordinates. Arrow points to the north or in the direction of storm motion. In the storm coordinate system the right side of the storm octants is given by 6, 7 and 8. The left of the storm is given by octants 2, 3, and 4.

typically less than 3 m/s. Figures 99 and 100 show that fast-moving cyclones have very asymmetric tangential wind distribution while slow moving cyclones do not.

At the outflow level (300–100 mb) (Figs. 93a, 94a, 95a, 96a, 97a, and 98a) these differences in right vs. left quadrant tangential wind between fast and slow moving cyclones are not nearly as apparent as at lower levels. It appears that the middle and lower troposphere levels are much more important for cyclone motion than are upper troposphere levels as some meteorologists during the 1950's use to hypothesize (E. Jordan, 1952; Miller, 1958).

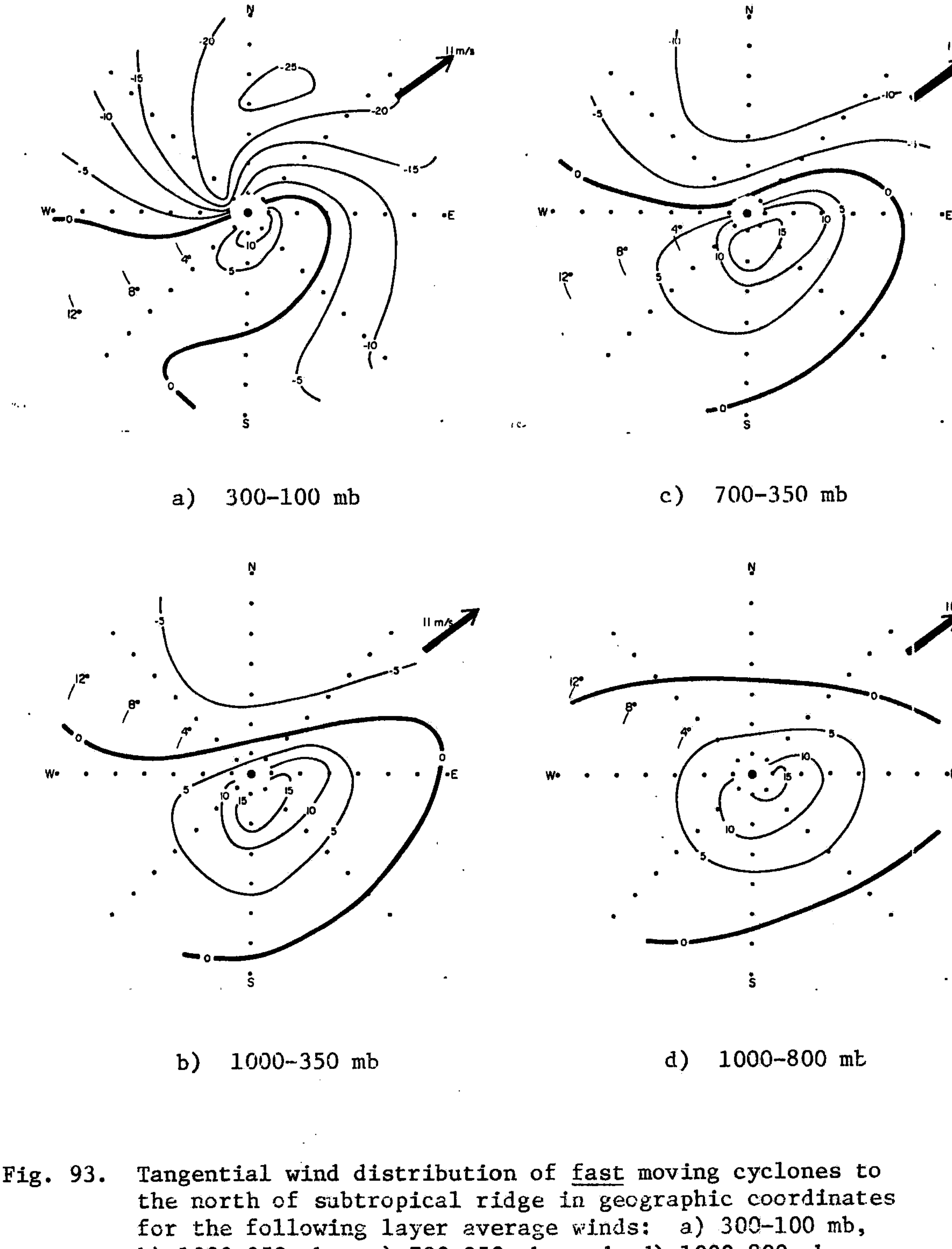


Fig. 93. Tangential wind distribution of <u>fast</u> moving cyclones to the north of subtropical ridge in geographic coordinates for the following layer average winds: a) 300-100 mb, b) 1000-350 mb, c) 700-350 mb, and d) 1000-800 mb. Arrows indicate the average cyclone direction and speed in m/s.

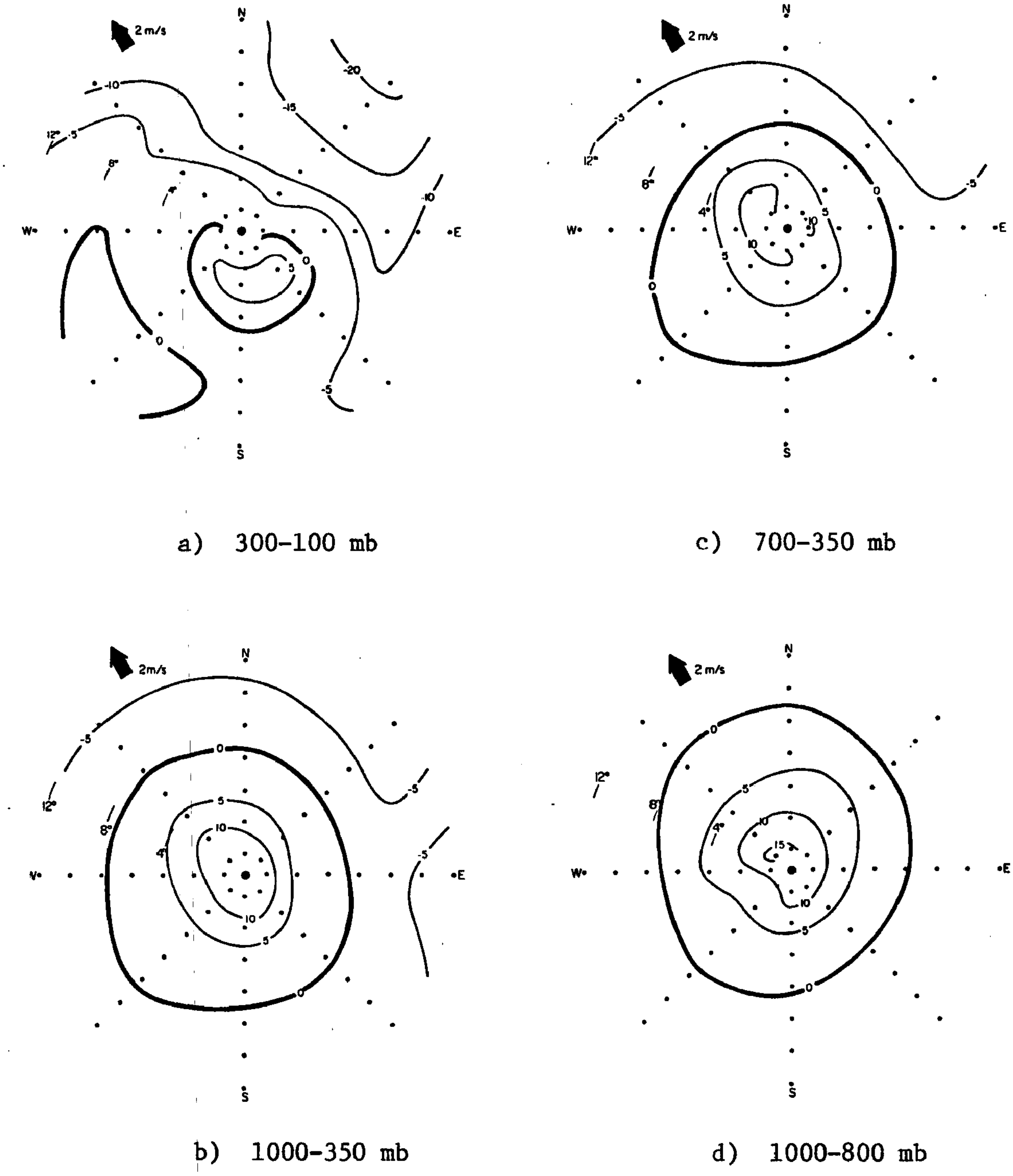
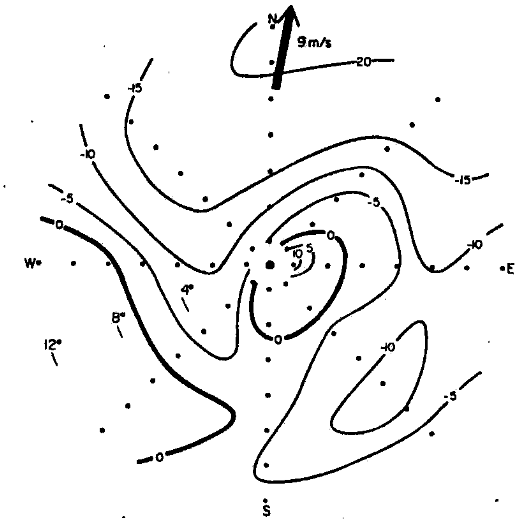
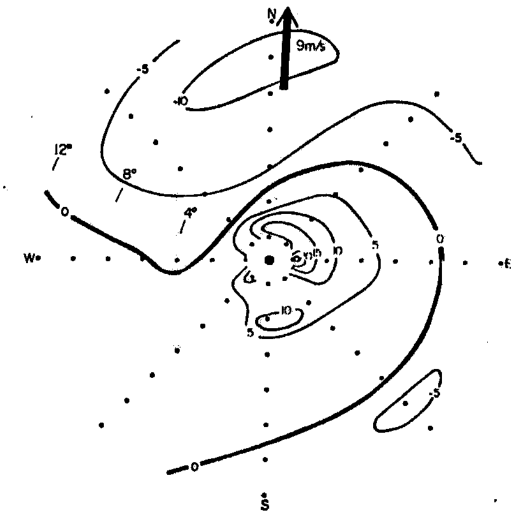


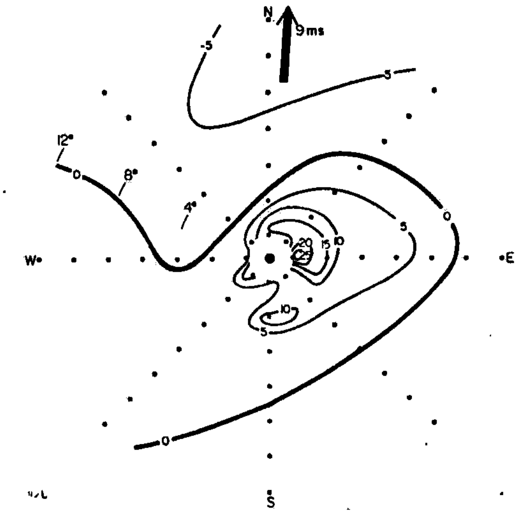
Fig. 94. Same as Figs. 93(a-d) but for <u>slow</u> moving cyclones to the north of subtropical ridge. An arrow indicates cyclone direction and speed in m/s.



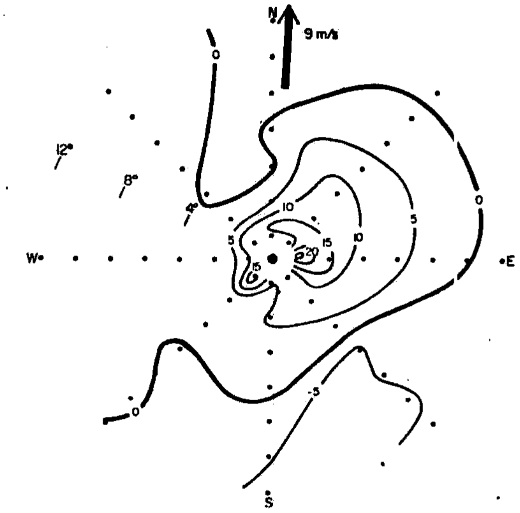
a) 300–100 mb



c) 700–350 mb

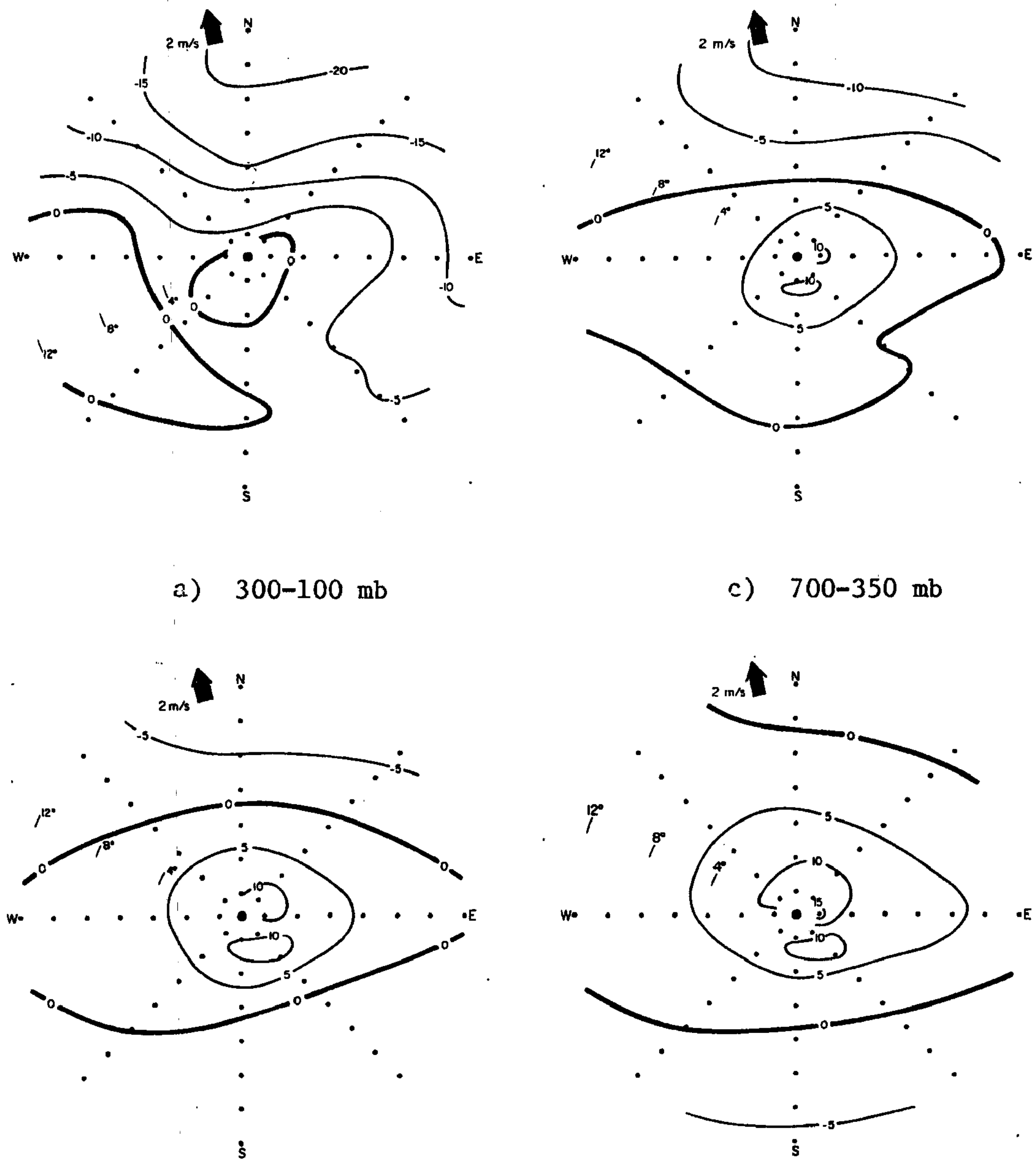


b) 1000–350 mb



c) 1000–800 mb

Fig. 95. Same as Figs. 93(a-d) but for <u>fast</u> moving cyclones near subtropical ridge. An arrow indicates cyclone direction and speed in m/s.



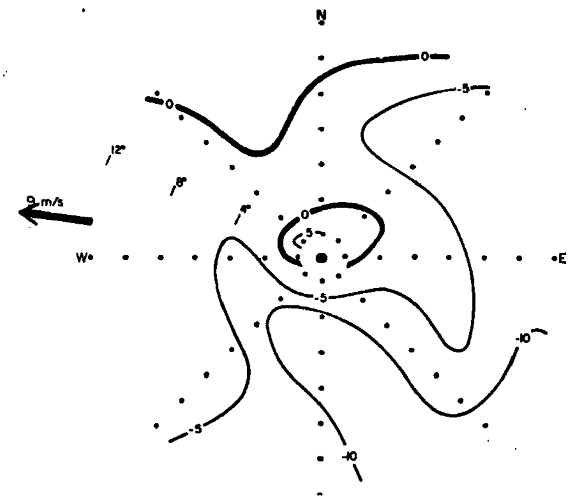
a) 300-100 mb

c) 700-350 mb

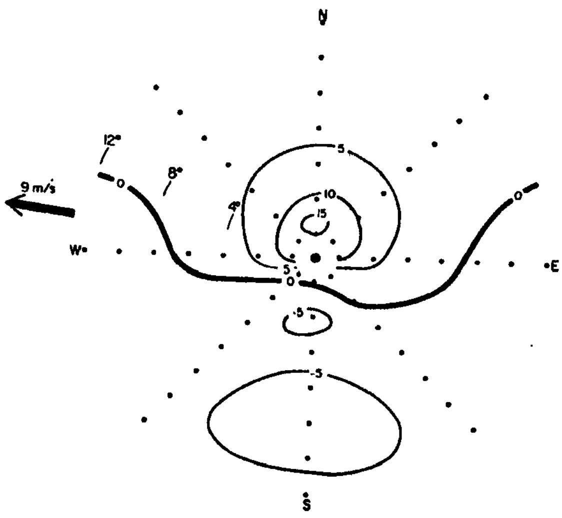
b) 1000-350 mb

d) 1000-800 mb

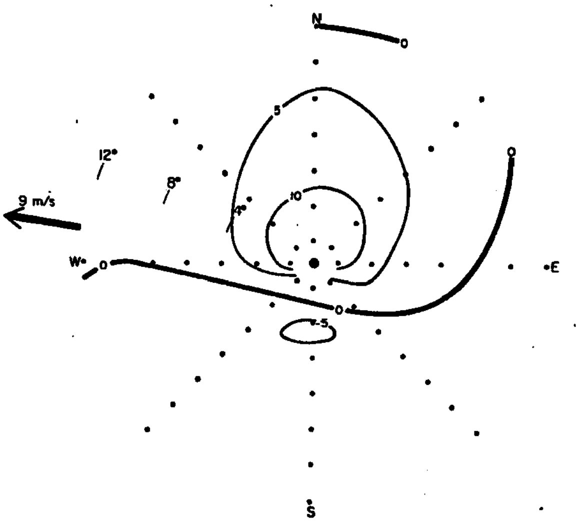
Fig. 96. Same as Figs. 95(a-d) but for slow moving cyclones near subtropical ridge. An arrow indicates the cyclone direction and speed in m/s.



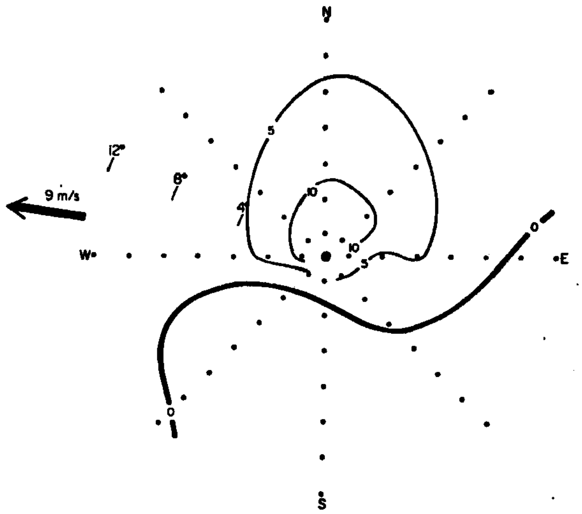
a) 300-100 mb



c) 700-350 mb



b) 1000-350 mb



d) 1000-800 mb

Fig. 97. Same as Figs. 93(a-d) but for a <u>fast</u> moving cyclone to the south of subtropical ridge. Arrows indicate the cyclone direction and speed in m/s.

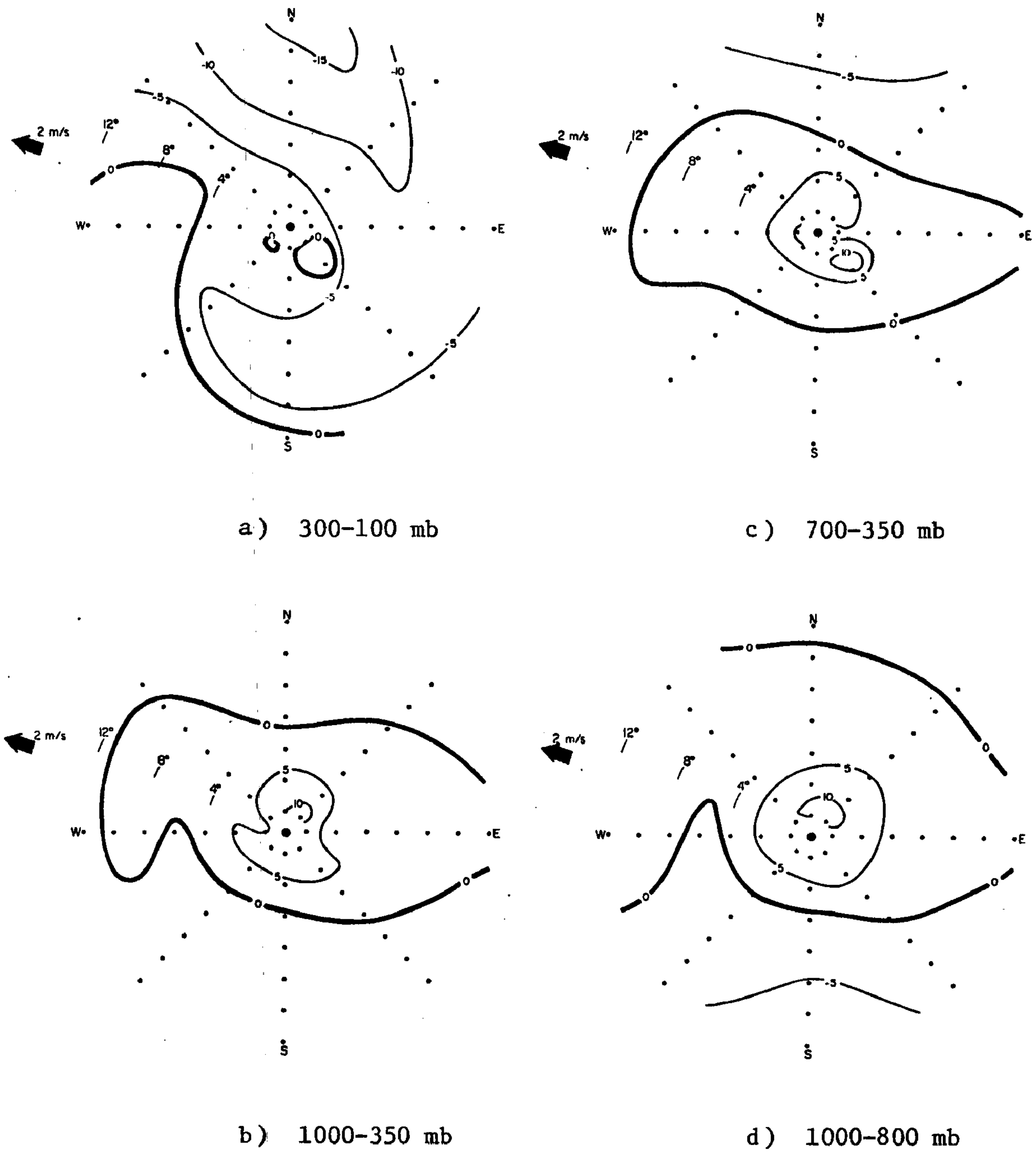
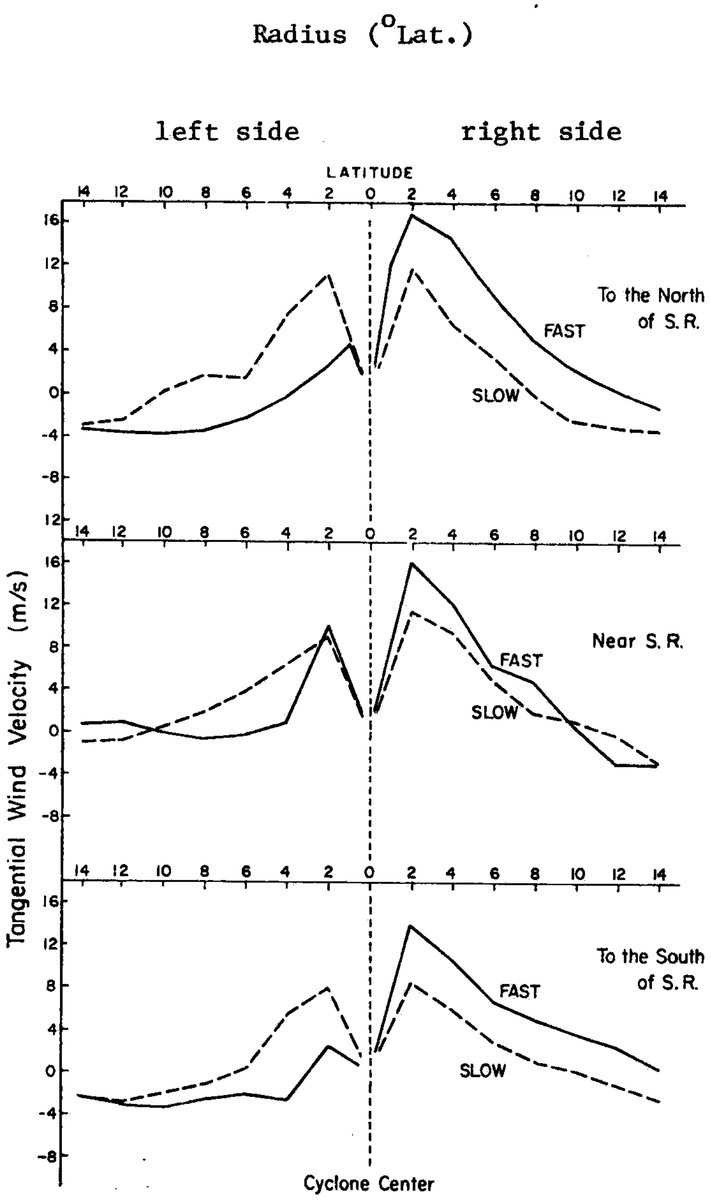


Fig. 98. Same as Figs. 97(a-d) but for the slow moving cyclone to the south of subtropical ridge. Arrows indicate the cyclone direction and speed in m/s.



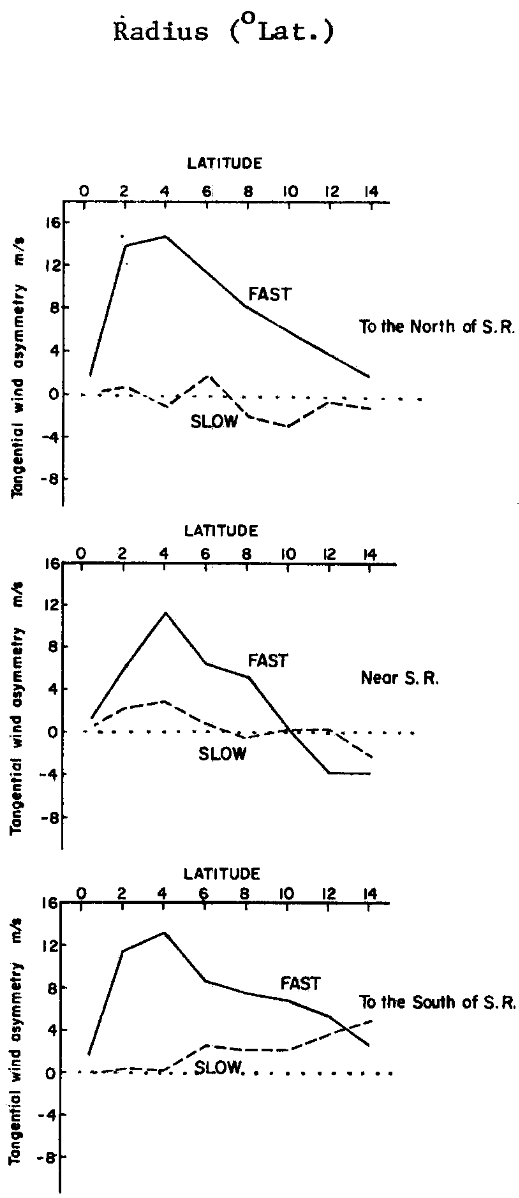


Fig. 99. Mean tangential wind distribution of the three right octants and three left octants in 1000-300 mb layer versus radius in storm coordinates. a) to the north of S.R. b) near S.R. c) to the south of S.F.

Fig. 100. Right minus left quadrant tangential wind difference in storm motion coordinates.

6.2 Vertical Variablity of Tangential Wind Asymmetry

Comparing layer (c)-(700-350 mb) and layer (d)-(1000-800 mb) there are large differences existing in the vertical variability of tangential wind asymmetry between fast and slow motion. (See Figs. 93c to 98c and 93d to 98d.) Regardless of the cyclone's direction of motion, a large left to right tangential wind asymmetry is present around the fast-moving cyclones. Also, it should be observed that the maximum winds at each layer is on the same side of the cyclone. By contrast, when cyclones move slowly, not only are the tangential winds more symmetrical, but the maximum and minimum winds are often found at different sides at different levels within the cyclone. Often two wind maxima are present on different sides of the storm.

Figure 101 shows the tangential wind distribution around the cyclone at 3-7^{o} latitude radius at 500 mb and 950 mb. One can see that for the fast-moving cyclones the maximum tangential wind at 500 mb and 950 mb is on the same side. Slow moving cyclones do not show this same type of wind asymmetry. In addition the maximum wind at different levels is often not on the same side of the cyclone. Fast-moving cyclones are not only asymmetric in tangential wind distribution but also the maximum winds at all levels is on the same side of the cyclone. Slow-moving cyclones have not only a more symmetric wind structure; but they also typically have maximum wind in different quadrants at different levels. The right vs. left quadrant wind asymmetry is due to the stronger steering current which the fast storm is embedded in. When one adds a vortex motion to this steering current, a large right vs. left quadrant asymmetry naturally results.

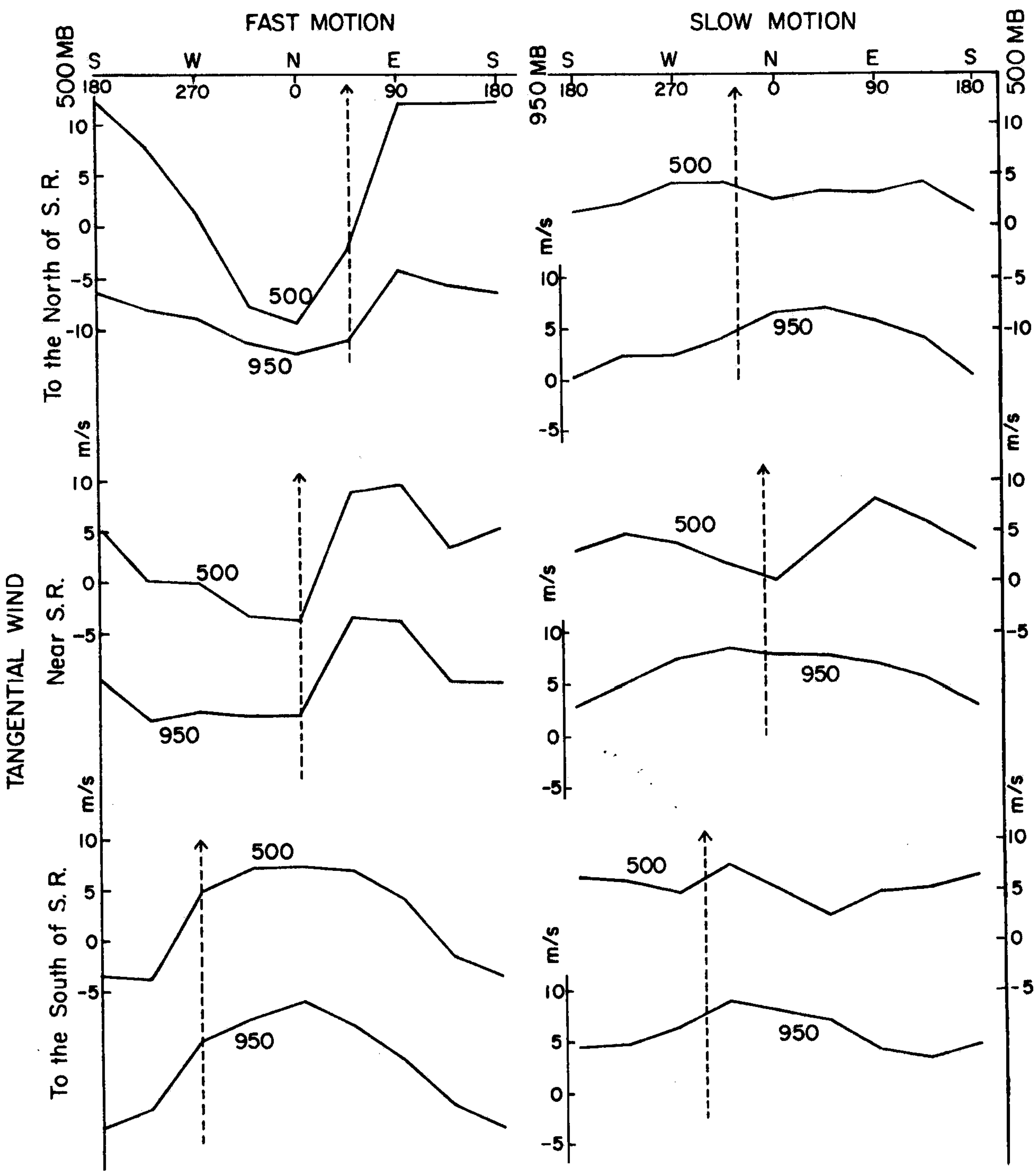


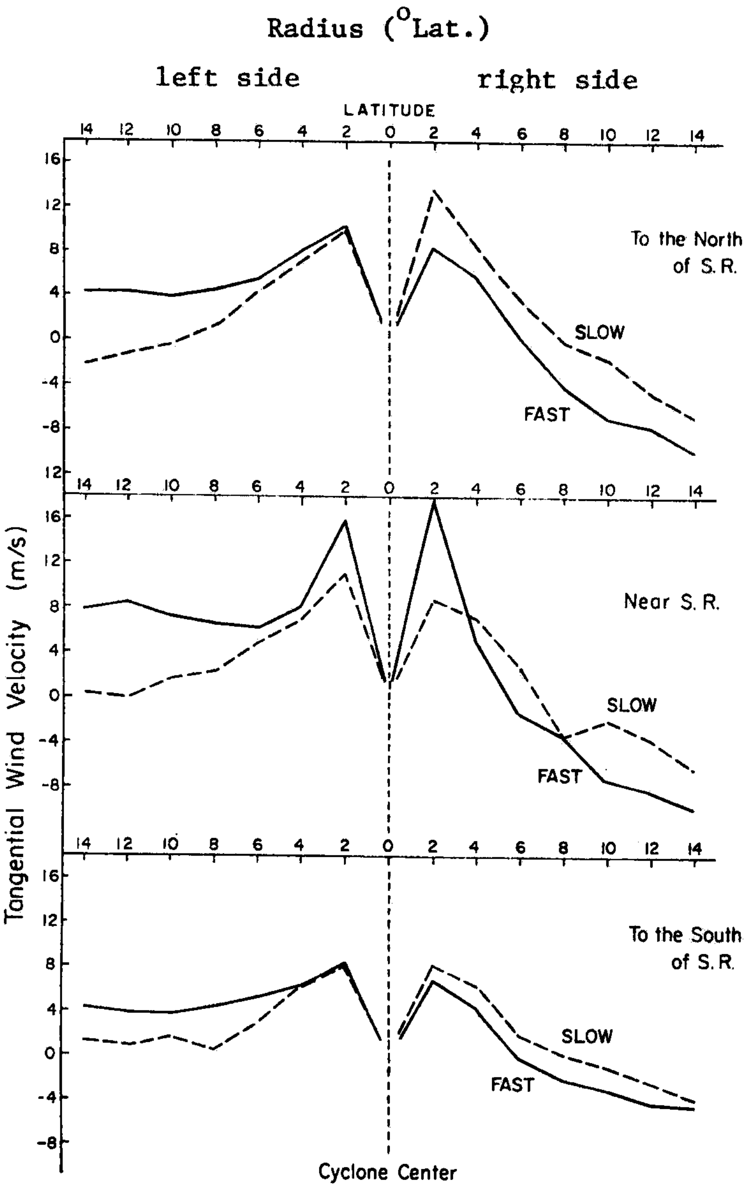
Fig. 101. Average tangential wind distributions in a cylindrical circle around (South (S), West (W), etc.) fast (left) and slow (right) cyclones in a 3-7° latitude belt at 500 mb and 950 mb. Arrows represent mean cyclone direction.

6.3 Asymmetry in Cyclone Coordinates

Figures 102 and 103 portray similar maps as Figs. 99 and 100 but are in cyclone coordinate where the cyclone motion has been subtracted from all of the winds and the coordinate system is oriented in the direction to which the cyclone is moving. When this is done note that the right vs. left quadrant asymmetry no longer exists and that the asymmetry even reverses itself at radii larger than 4°. Both fast and slow cyclones have tangential wind asymmetry with maximum winds to the left in the coordinate system relative to the moving storm center. And as we expected this 'so called' asymmetry is more apparent in fast motion than in slow motion.

The asymmetry differences between these two coordinate systems imply that tropical cyclones move faster than their surrounding steering flow. The precise physical processes of tropical cyclone motion from a variety of points-of-view are currently being investigated by J. C. L. Chan (1982) and G. Holland (1982) of our project and more detailed reports on this subject will be forthcoming.

This right vs. left side tangential wind asymmetry is essential for cyclone motion and is caused by the surrounding storm steering current. Cyclones can move rapidly only when the storm asymmetries coincide at different levels. When cyclones lose their surrounding steering current they quickly develop a symmetric wind structure. This symmetric wind structure does not have strong preferred areas for positive vorticity advection. In this case, the storm motion is dictated solely by the earth's vorticity advection which (as discussed by Holland, 1982) causes storms to drift slowly westward.



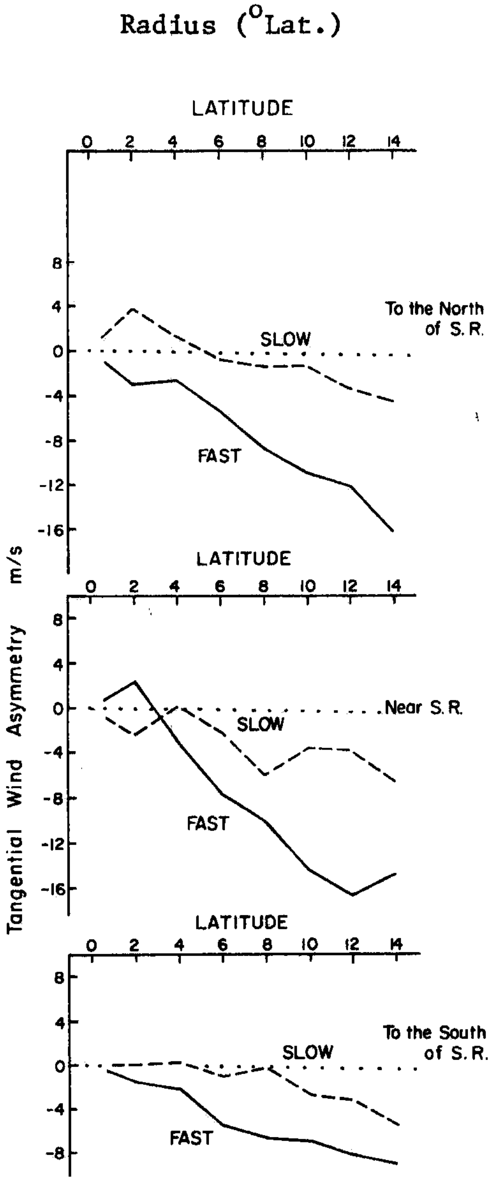


Fig. 102. Same As Fig. 99 but for cyclone coordinate with the cyclone motion subtracted from all of the winds.

Fig. 103. Same as Fig. 100 but for cyclone coordinate where the cyclone motion has been subtracted from all of the winds.

Thus, tropical cyclones are not isolated from their environment. A cyclone embedded in a uniform surrounding environmental flow pattern will always have a asymmetric circulation. A cyclone in a static surrounding airflow will be symmetric. The action of the middle latitude trough to the northeast of slow or looping motion situations is to create a static environmental flow background. This produces a symmetric wind structure about the looping storm.

Because tropical cyclone motion is so closely related to middle latitude westerly trough distributions, it is important to examine how cyclone motion is related to hemispheric flow patterns.

7. HEMISPHERIC LONG WAVE TROUGH-RIDGE DISTRIBUTIONS ASSOCIATED WITH THE THREE CLASSES OF CYCLONE MOTION

Figures 104 and 105 show the positions of hemispheric 500 mb westerly wave troughs relative to the cyclone center position for looping cyclones to the north and south of the subtropical ridge in both oceans. These charts show that the westerly waves which affect cyclone motion are a part of a special hemispheric circulation. The long waves with wave number 5 (stationary wave pattern) seem to have preferred longitudinal locations relative to the position of looping cyclones. A more quantitative examination of these westerly wave patterns seem in order.

7.1 Data and Analysis Method

To examine the relationship between tropical cyclone motion and hemispheric westerly wave distributions harmonic analyses was performed for these three classes of motion events. Analysis was made in 10-30° latitude bands to the north of the cyclone centers around the globe with the daily 00Z and 12Z 500 mb height grid point data of 1957- 1977.

The 500 mb height field can be decomposed into Fourier components as follows:

$$H_{500}(x) = A_o + \sum_{m=1}^{10} A_m \cos m\,[x-(Q_m-\pi)], \qquad (1)$$

where

m = wave number

A_m = amplitude of wavenumber m (m=0, 1, 2,...,10)

Q_m = phase angle of the trough with wave number m

The degree of meridional flow and trough phase angle distribution for wave number 1-10 were calculated. Degree of meridional flow is

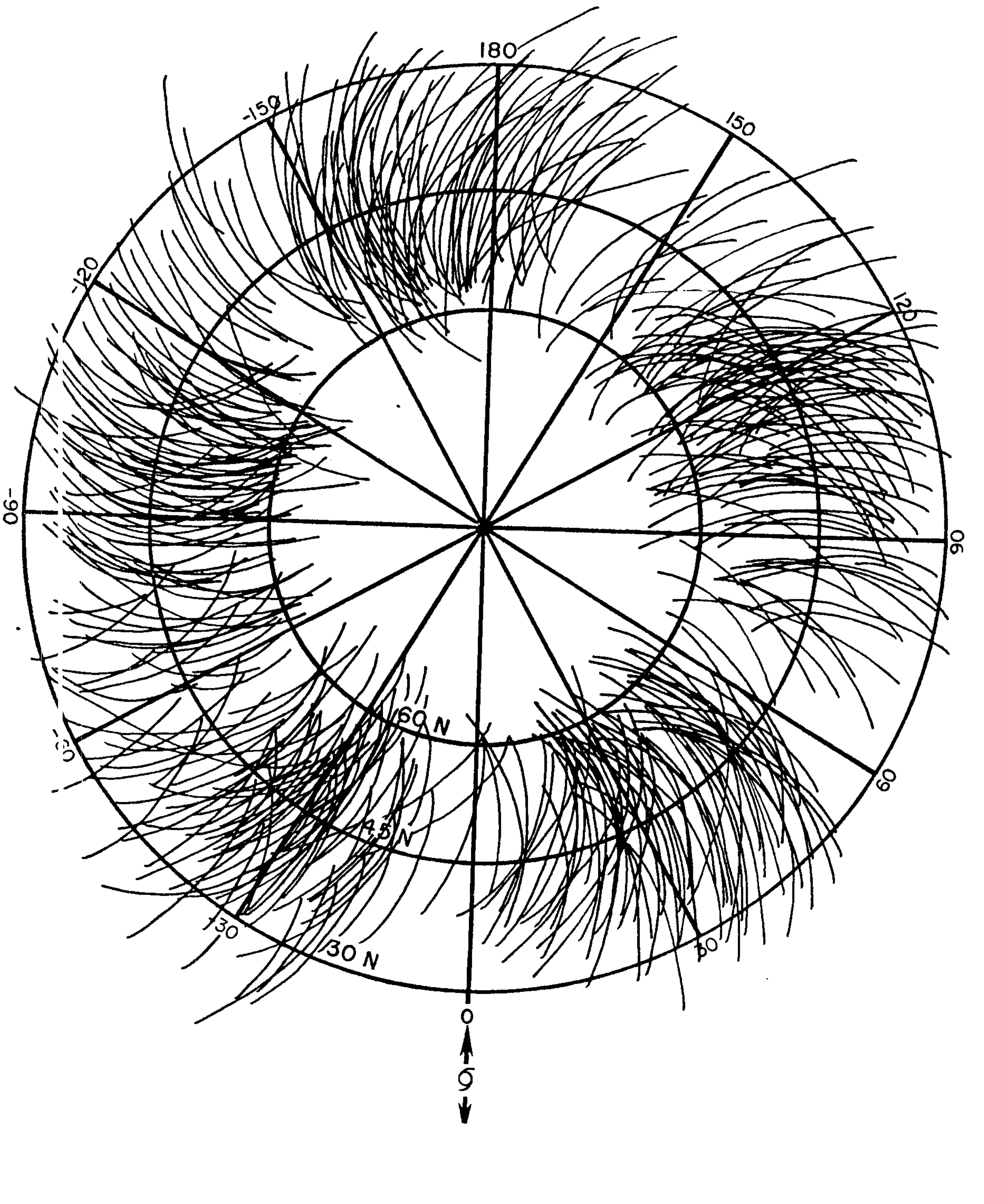


Fig. 104. Positions of 500 mb westerly wind troughs (solid curved lines) about the Northern Hemisphere relative to the position of looping cyclones to the north of the subtropical ridge. The symbol ϭ denotes the longitude of the looping cyclone. Concentric circles denote latitude.

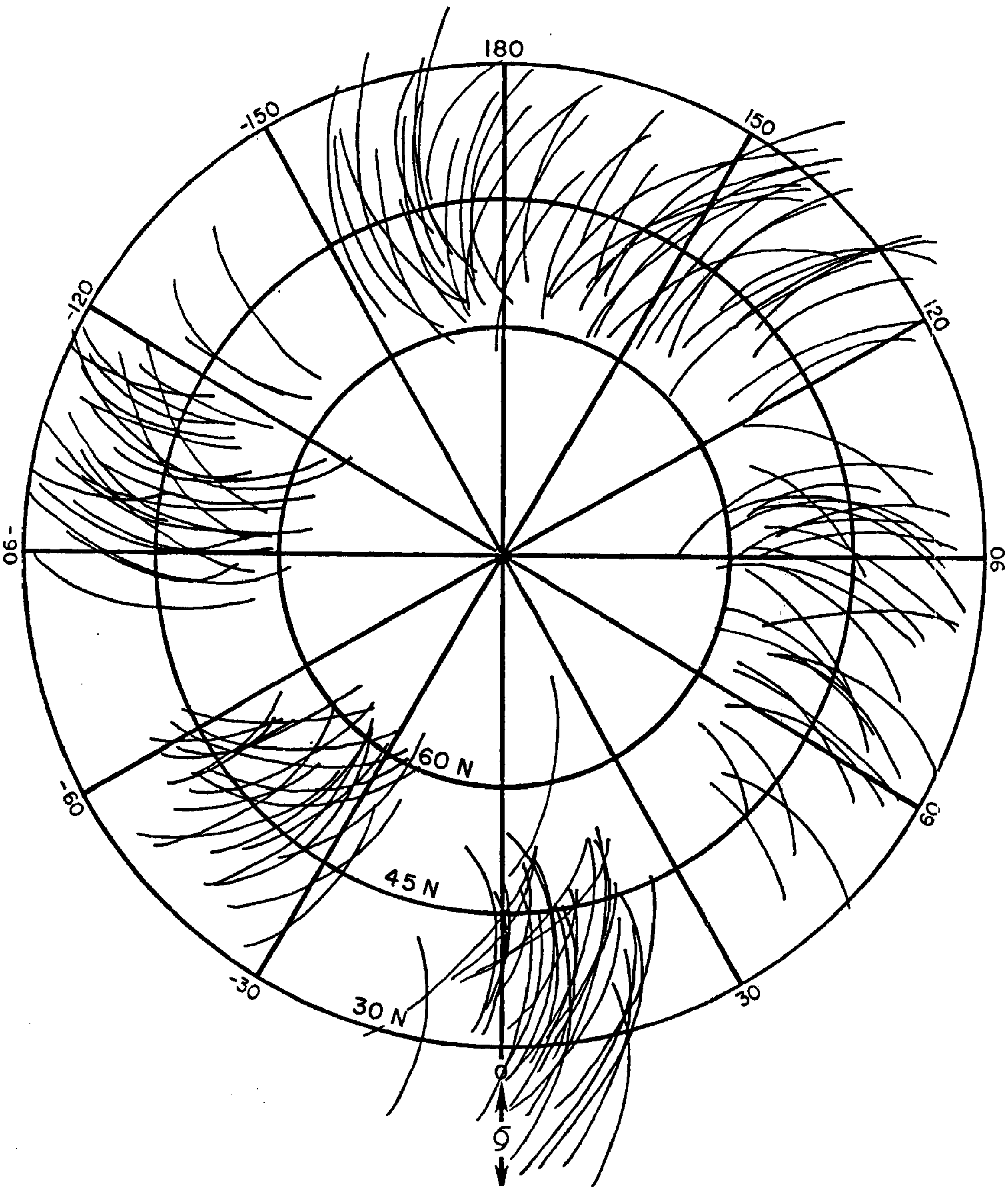


Fig. 105. Same as Fig. 104 but for looping tropical cyclones to the south of the subtropical ridge.

defined as

$$M_m = m\, A_m \tag{2}$$

Trougł phase angle frequency for every 5^o longitude interval is

$$F_m = \frac{N - \frac{N}{360/5m}}{n} \times 100\% \tag{3}$$

m is the total number of cases

n is the trough number per 5 degree longitude intervals.

F_m is positive when there are more troughs in the longitude interval. It is negative when there are fewer troughs (or more ridges) in this interval.

Harmonic analyses were performed for the two oceans separately. Once again very similar results were observed in both ocean basins. We will thus show the total of both oceans rather than portraying each ocean separately.

7.2 Degree of Meridional Flow for Harmonic Waves of Wavenumber 1-10

Figure 106 shows the degree of meridional flow for harmonic waves with m = 1, 2, 3,......10 for our three motion clases. From Fig. 106 we can see two main differences:

1) To the south of the subtropical ridge, the fast moving cyclones have a smaller degree of meridional wind component than the slow and looping motion cases for all the harmonic waves from wave number 3 to 8. This means that to the south of the subtropical ridge (bottom diagram of Fig. 106) fast storm motion is associated with more zonal air flow than the other two classes of cyclone motion.

2) Near the subtropical ridge, short waves with wave numbers 7-9 have greater meridional flow in looping motion than in slow motion. This verifies the observational results obtained in the individual case studies that moving shortwaves are important for looping motion near or to the south of the subtropical ridge.

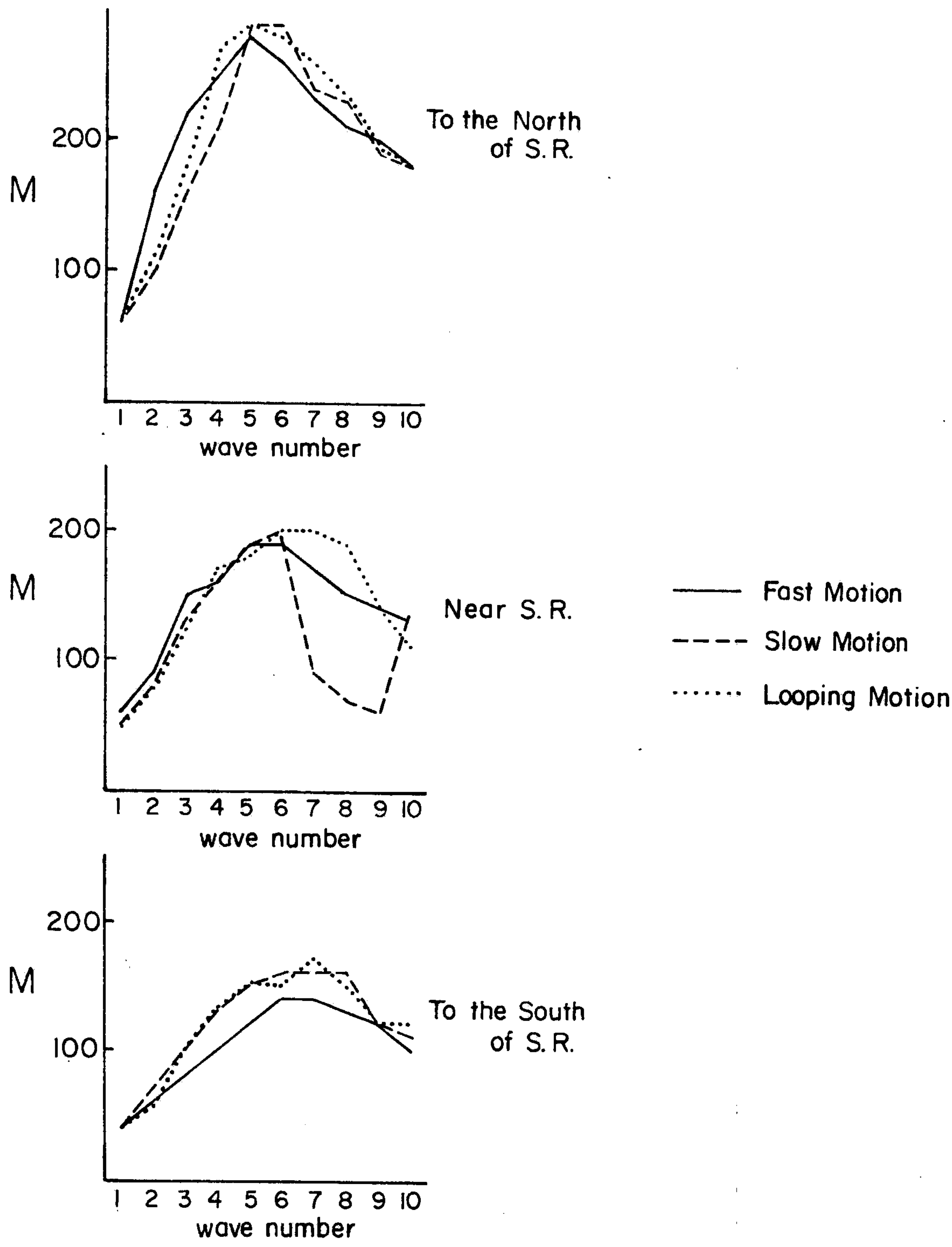


Fig. 106. Degree of meridional flow (M) of harmonic waves 1-10 for the three motion classes and position locations relative to the subtropical ridge.

7.3 Phase Angle of Wave Number 1-2

Figures 107 to 109 show wave trough location distribution of the three types of motion for wave numbers 1-2. In these figures there is no apparent difference in trough distribution of wave number 1-2 among the three motion classes. When cyclones are near or to the north of subtropical ridges, they are all near the wave ridge, while for cyclones south of the subtropical ridge, they are all near the wave trough. So, the ultra long wave lengths of wave number 1 and 2 appear not to be important in tropical cyclone motion.

7.4 Phase of Long Wave

Figure 110 is similar to Figs. 107 to 109 but is for wave number 5 which represents wavelengths of 70-75^{o} longitude. The wave-trough distributions associated with this wave number are much more distinguishable for these three motion classes. To the north of subtropical ridge, when cyclones moves fast, the wavenumber five wave troughs are typically oriented to the west of the cyclone; when cyclones move slowly or loop, wave trough is to the east of the cyclone. To the south of subtropical ridge, when cyclones moves fast, the wave number five ridges tend to be distributed near the longitude where the cyclone exists; when cyclones move slowly, however, the wavenumber five troughs will typically be located near the longitude of the cyclone.

This harmonic analysis verifies that the flow patterns which affect cyclone motion are hemispherically-related and mainly caused by the stationary long wave. Stationary long waves are persistent; they also have the largest meridional component in the midlatitudes (Figs. 104 and 105). Different long wave patterns can bring about a different cyclone motion response. A rapid modification of the long wave patterns can

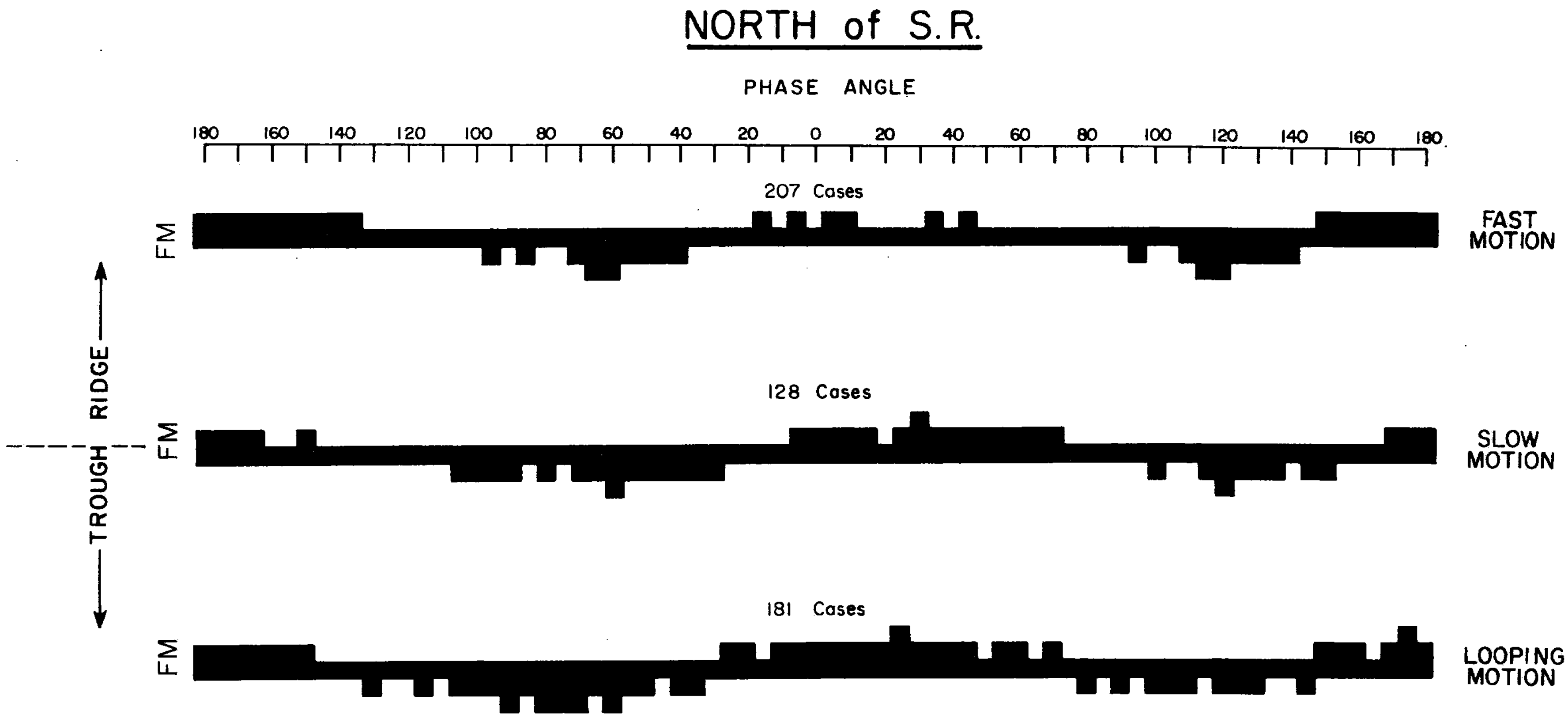


Fig. 107. Wave trough distribution relative to the position of the cyclone (phase angle 0) for the three classes of cyclone motion for wave numbers 1-2 to the north of the subtropical ridge. The number of cases in each analysis is shown with that case.

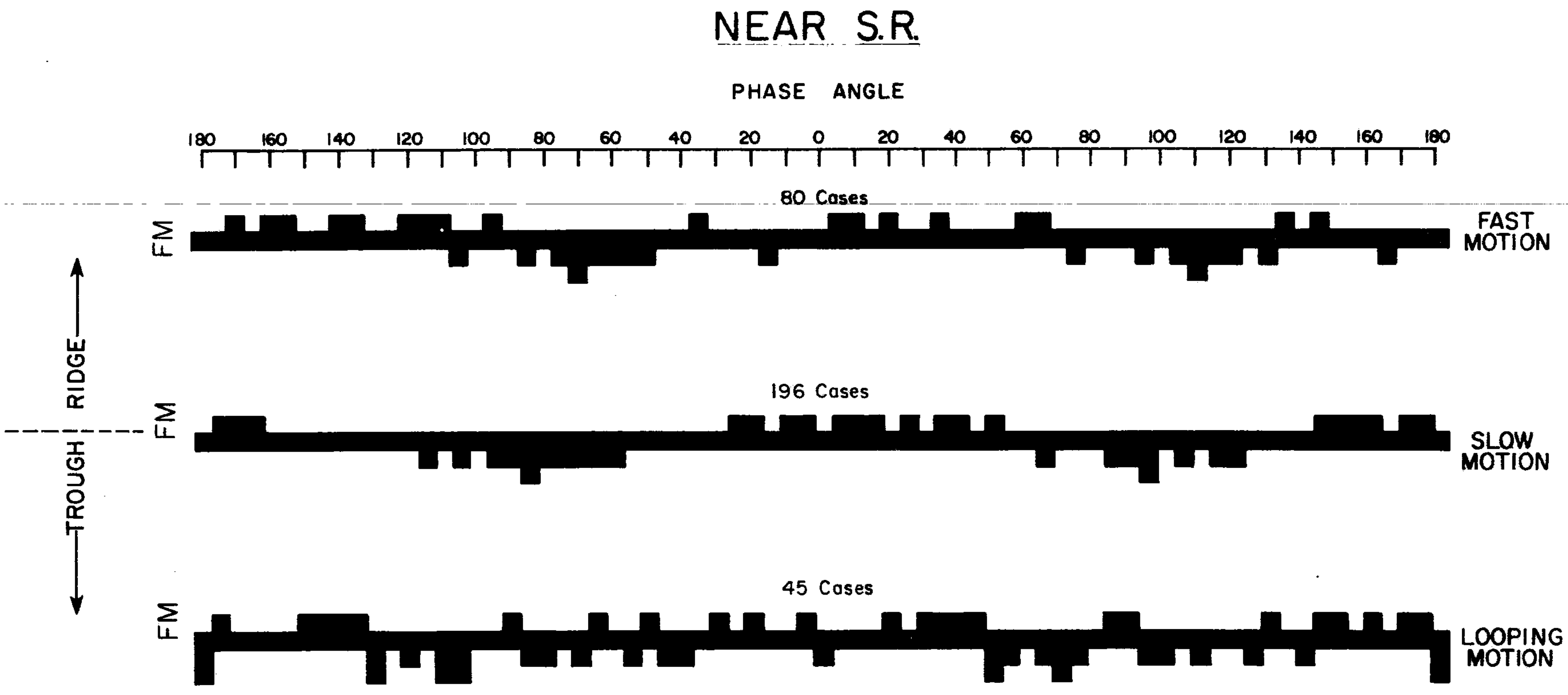


Fig. 108. Same as Fig. 107 but for cyclones near the subtropical ridge.

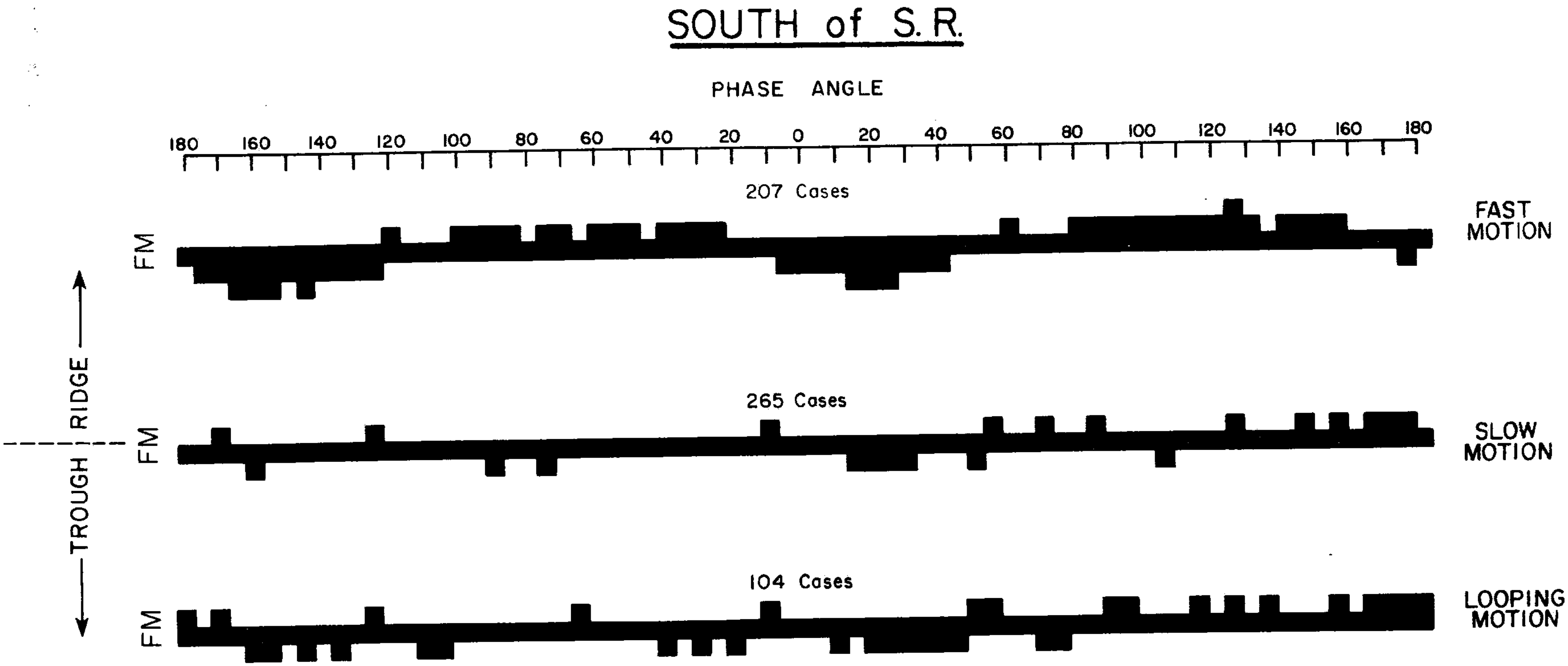


Fig. 109 Same as Fig. 107 but for cyclones to the south of the subtropical ridge.

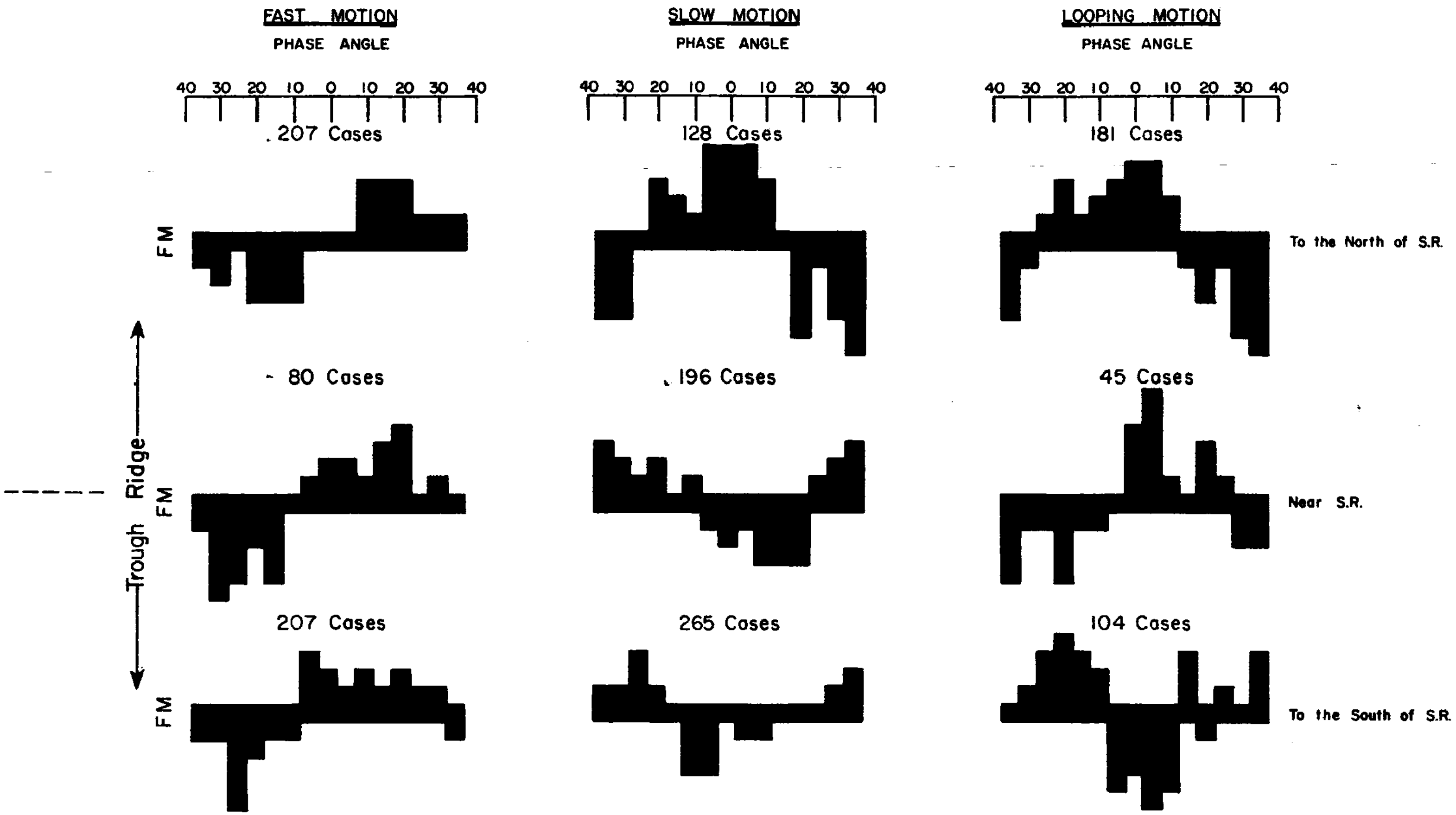


Fig. 110. Wave trough distribution relative to the position of the cyclone (phase angle 0) for the three classes of cyclone motion and location relative to the S.R. for wave number 5.

cause cyclones to take on quite different track characteristics. It is thus important for the forecaster to check the hemispheric long wave patterns before he makes a forecast. The establishment of new troughs 35^{o} longitude to the east or west of a cyclone position should be carefully monitored.

Figure 111 shows the hemispheric 500 mb chart which was present when Hurricane Inga (1969) was undergoing a looping motion. This is a typical example of a wave number five flow pattern.

7.5 Short Wave and Looping Motions Near and to the South of Subtropical Ridge

Figure 112 shows a similar analysis as Fig. 110 but for wave number 7-8. When cyclones looped near or to the south of subtropical ridge, there were short waves concentrated in a narrow area near the cyclone's longitude. This did not occur for the other two types of motion or for the looping motion to the north of subtropical ridge. This helps verify the point being made with the individual case studies. The distinguishing feature of looping motion and slow moving cyclones near or to the south of subtropical ridge is a short-wave trough going across the cyclone's longitude to the north.

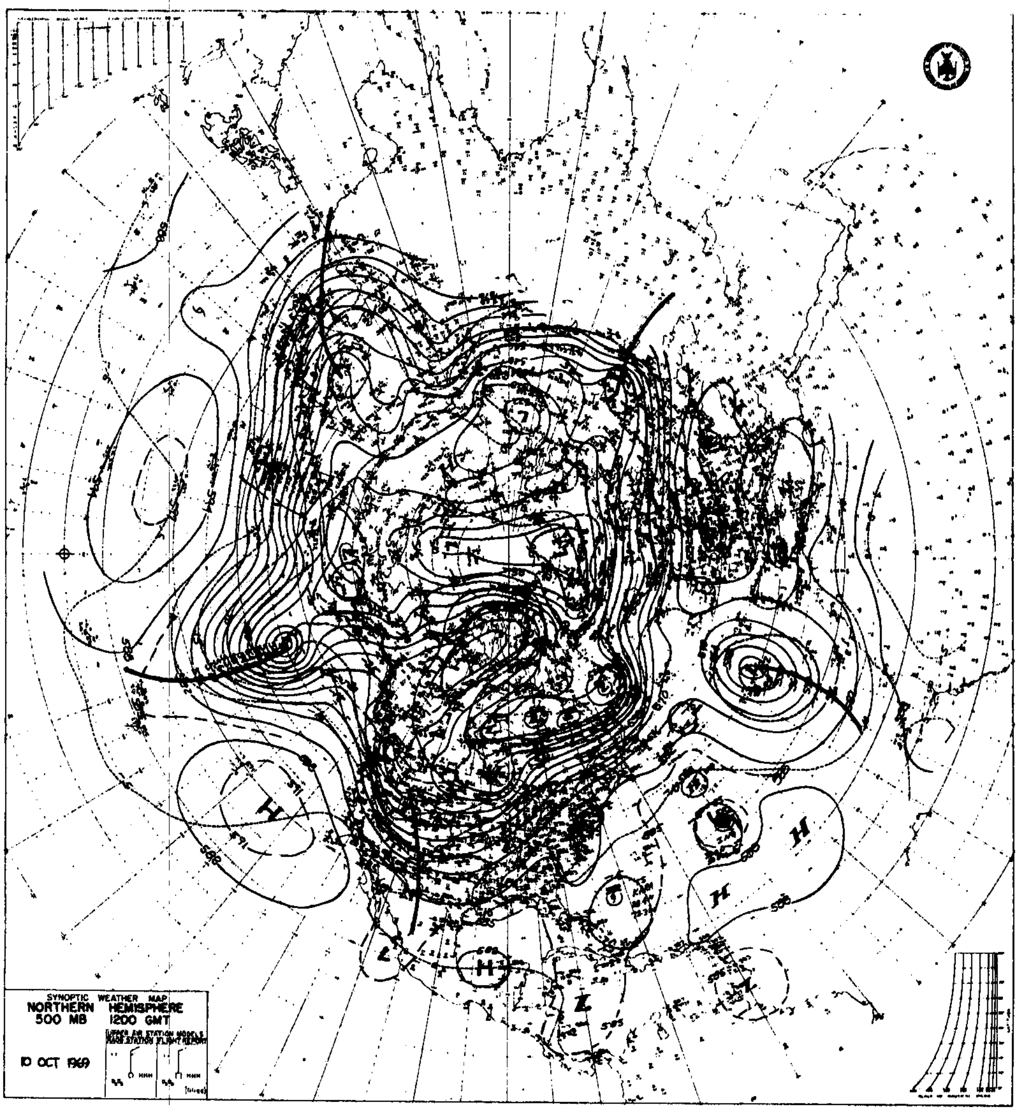


Fig. 111. Hemispheric 500 mb chart of 1 Oct. 1969. This is typical of a wave number 5 flow pattern when a tropical cyclone takes on a looping motion. Troughs are indicated by the solid line.

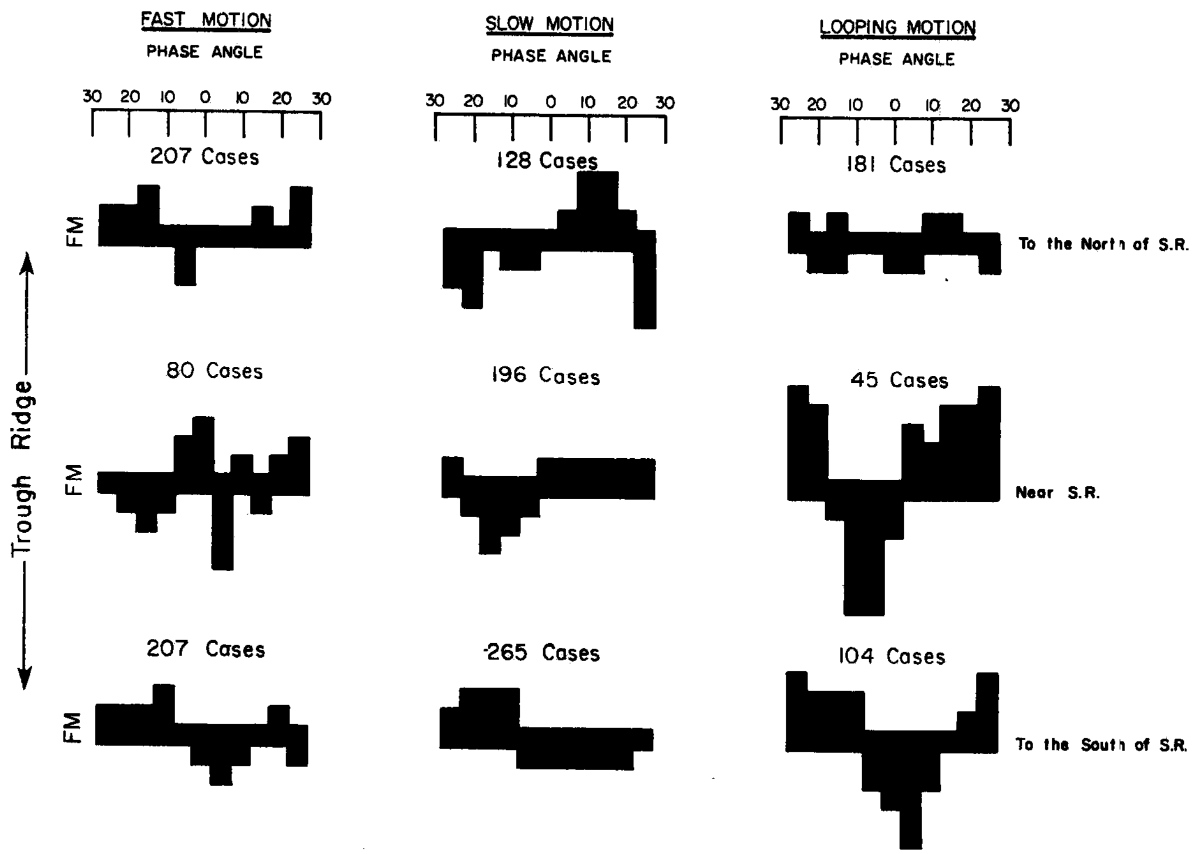


Fig. 112. Same as Fig. 110 but for wave number 7-8.

8. RELATIONSHIPS BETWEEN LARGE SCALE MEAN CIRCULATION AND TROPICAL CYCLONE MOTION CLIMATOLOGY

We have tried to show that although tropical cyclone motion climatologies of these three types of cyclone motion are different between the two ocean basins, the synoptic-scale circulations around the cyclones are much the same. But what causes these climatological differences?

In our climatological analyses in Chapter 2, we noticed several differences between the two ocean basins in regards to cyclone motion climatology. These climatological differences in cyclone movement are largely related to the difference in geographical wind regime present in the two ocean basins. For example, in the Pacific, the mean looping time period and diameter are 2 days and 1.4 degrees latitude, only 23% of looping events occur in a clockwise direction. The same figures for looping motion to the north of subtropical ridge in the Pacific are 3.1 days, 2.5 degrees latitude and 59% clockwise direction. This means that looping motions to the north of subtropical ridge have a longer period, have a larger diameter, and are more clockwise in direction. Because a higher percentage of cyclones in the Atlantic loop to the north of the subtropical ridge than in the Pacific, the mean looping time period, diameter and clockwise direction ratio are consequently different than in the Pacific. To understand these looping motion differences between ocean basins, we have only to understand the large-scale climatological flow regime differences between these two ocean basins.

Figures 113 and 114 show the mean gradient level wind for July. In the west Pacific, there is a westerly monsoon current extending upward through a deep layer, while in the west Atlantic monsoon westerly winds

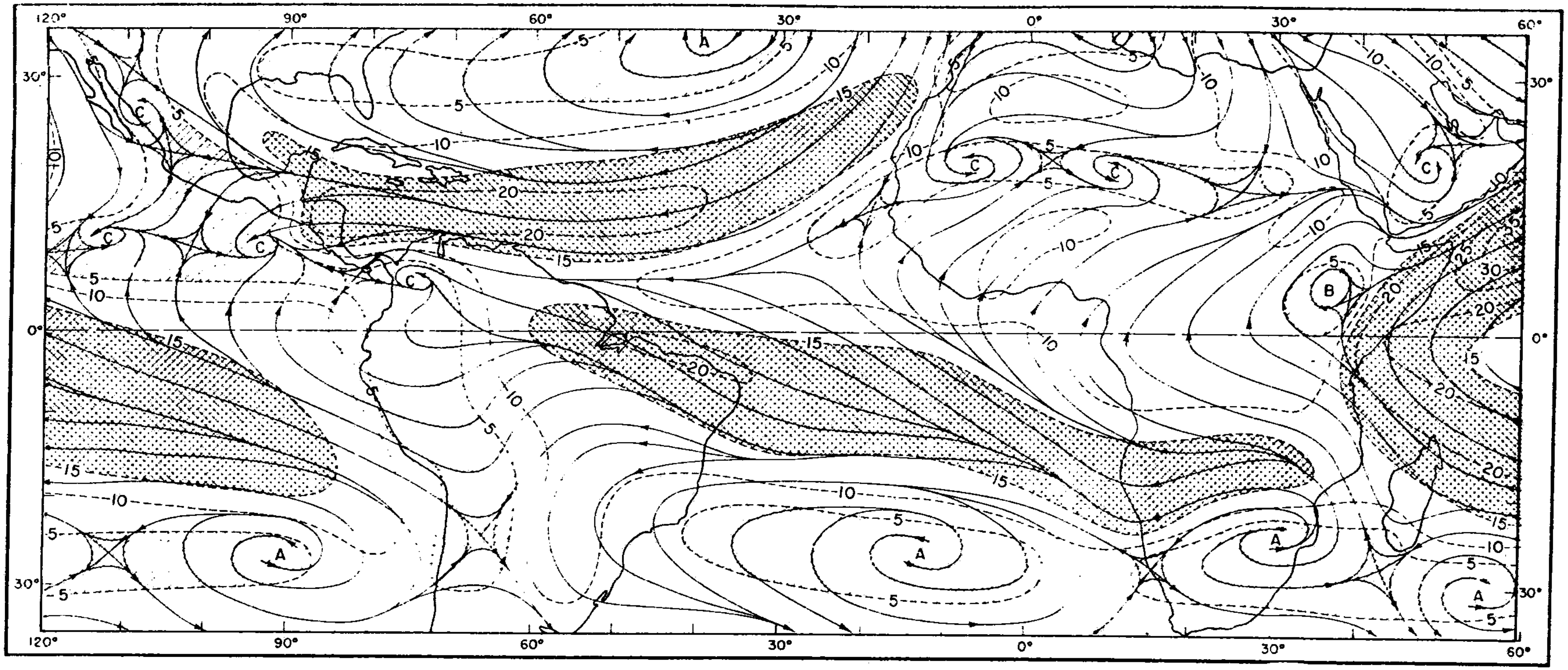


Fig. 113. Resultant gradient-level wind for July (from Atkinson, 1971). In the western Atlantic there is no lower tropospheric monsoon trough. The steering current at low latitudes is strongly from the last.

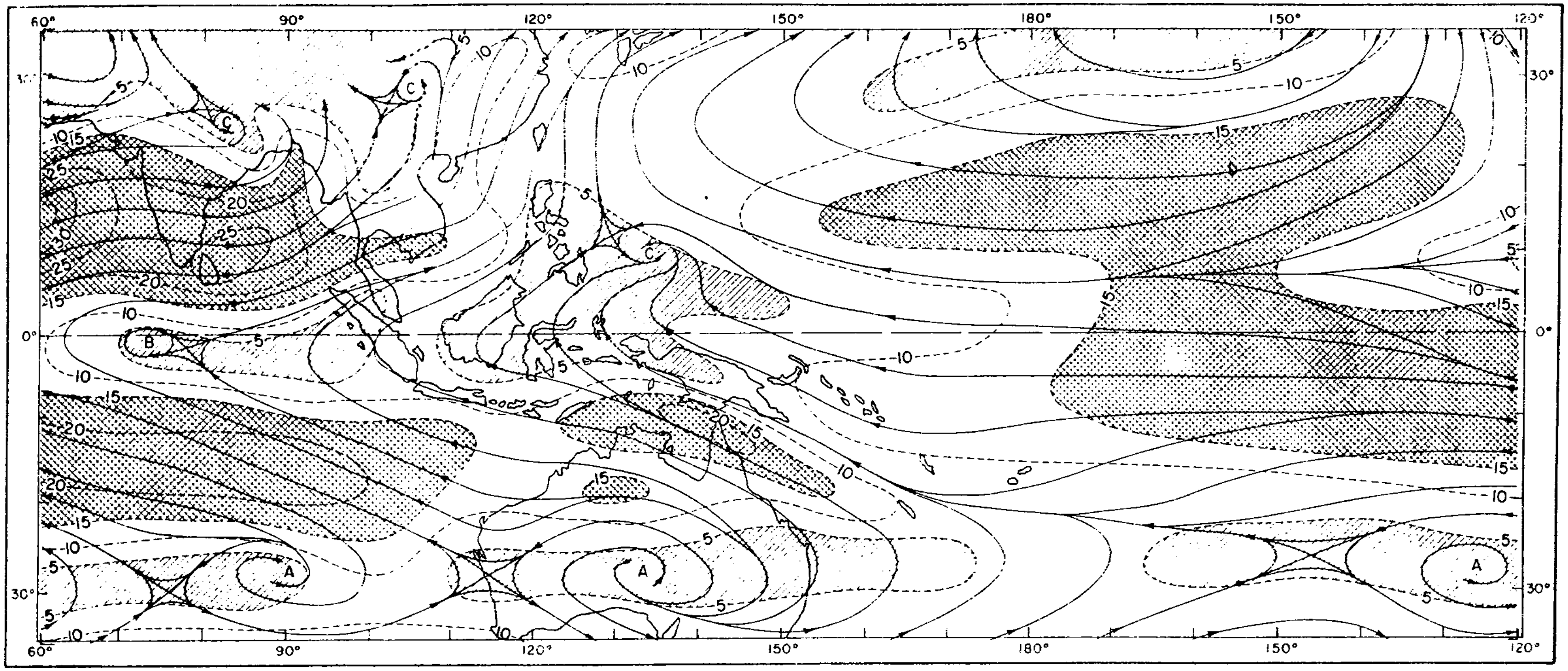


Fig. 114. Resultant gradient-level wind for July (from Atkinson, 1971). In the west Pacific there is a lower troposphere monsoon trough which causes the steering current to be much weaker from the east than at a comparable latitude in the west Atlantic.

are not present. Easterly trade winds dominate the tropical western Atlantic. This causes low latitude Atlantic cyclones to move faster to the west than their counterparts in the Pacific. More cyclones move slow or loop at low latitudes in the Pacific than in the Atlantic.

It is well known that the midlatitude westerly trough near the east Asian coast is the strongest and most stable in the world and that blocking situations are more frequent in the Atlantic than in the Pacific. As a result, fewer cyclones move slow or loop in the Pacific than in the Atlantic.

Differences in the tropical cyclone motion climatology between the two oceans are thus mainly a result of differences in the mean large-scale circulations between the two ocean basins.

9. SUMMARY DISCUSSION

It is hoped that this paper has offered a helpful synthesis of the usual environmental conditions associated with these three classes of tropical cyclone motion which are often very difficult to predict. It is hoped that the composite 500 mb and surface maps contained in the Appendix of this report may be able to be used as an aid to the operational forecaster.

This paper has stressed the importance of stratifying tropical cyclone motion with respect to the latitude position of the cyclone relative to the subtropical ridge. Cyclones south of the subtropical ridge must be handled quite differently from those located to the north of the S.R.

The characteristics of the synoptic circulation around cyclones undergoing these three types of motion are very much the same in both oceans. Slow and looping cyclones are associated with westerly troughs to their northeast sides. Fast motion cyclones are associated with westerly troughs to their northwest sides.

The large-scale flow affects storm motion by establishing an asymmetry in the tangential wind distribution. It was observed that fast moving cyclones have maximum winds on the same side of the cyclone through a deep layer, while slow moving cyclones have maximum winds on different sides of the cyclone at different levels. Such large or small horizontal wind asymmetry is to be expected if a symmetric storm vortex were to be superimposed upon a strong or a weaker surrounding steering current.

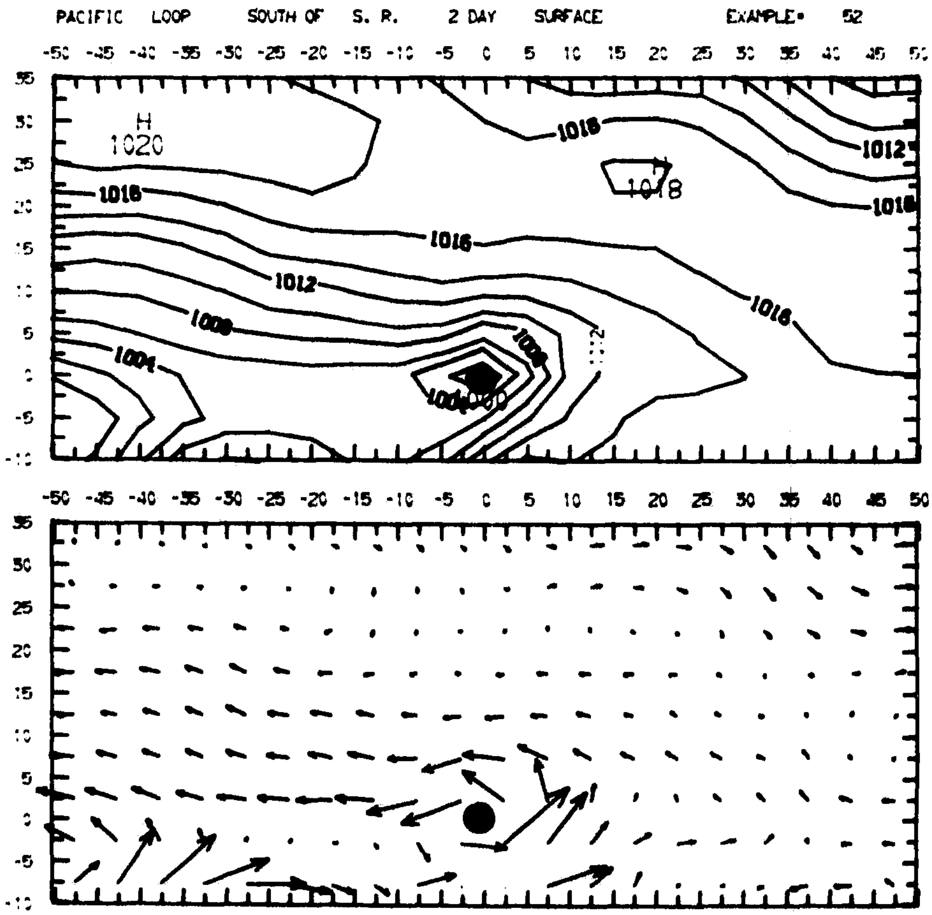
The large-scale flow which affects cyclone motion are often well related to the hemispheric long wave patterns. Stationary long wave number five is the most important for cyclone motion.

Climatological differences in cyclone motion between the Atlantic and the Pacific are primarily a result of differences in mean circulation which are present in these two ocean basins.

A companion paper to this study (Xu and Gray, 1982b) using similar methodology will deal with the question of tropical cyclone recurvature vs. non-recurvature.

The appendix of this paper gives composite height-pressure fields and geostrophic wind conditions at 500 mb and the surface associated with each of these 9 cyclone motion classes for 5 different time periods before, during and after these motion events. Statistical tests as to the significance of these flow field patterns is also given. It is hoped that these composite flow fields may be of some benefit to the operational forecaster.

PAC. LOOP 2
S.



Sfc.

PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE= 52

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	2	1									1	2	3	3	3	PASS	PASS	PASS
30	1	3	3	3	3	2	2	1										2	3	3	3	PASS	PASS	PASS
25							1											1	2	2	2	PASS	PASS	PASS
20		1	1											1								PASS	PASS	
15	3	3	3	3	2						1					1	2	2	1	2	2	PASS	PASS	PASS
10	3	3	3	3	3	2	2								1	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	2	1		1	3	3		1	2	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	2	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	2	3	2	2	1			1	1	1	1		1	1	2	2	3	2	2	1	1	PASS	PASS	PASS
-10																								

REFERENCES

Brand, S., 1970: Interaction of binary tropical cyclones of the western north Pacific Ocean. J. Appl. Meteor., 9, 433-442.

Burroughs, L. D. and S. Brand, 1973: Speed of tropical storm and typhoons after recurvature in the western Pacific Ocean. J. Appl. Meteor., 12, 452-458.

Chan, J. C. L., 1982: On the physical processes responsible for tropical cyclone motion. Forthcoming Atmos. Sci. Paper, Colo. State Univ., Ft. Collins, CO.

Chan, J. C. L. and W. M. Gray, 1982: Tropical cyclone movement and surrounding flow relationships. To appear in Mon. Wea. Rev.

Chen, L. S. and Y. H. Ding, 1979: An introduction to western Pacific typhoons. Science Press of Beijing, China (in Chinese).

Dao, S. Y., 1965: Several types of tropical cyclone track which affect China coastal area. Research report about subtropical weather systems which affect China in summer season. Science Press.

Dunn, G. E. and B. I. Miller, 1964: Atlantic hurricanes. Louisiana State Univ. Press, 377 pp.

Frank, W. M., 1977a: The structure and energetics of the tropical cyclone, I: Storm structure. Mon. Wea. Rev., 105, 1119-1135.

Frank, W. M., 1977b: The structure and energetics of the tropical cyclone, II: Dynamics and energetics. Mon. Wea. Rev., 105, 1136-1150.

George, J. E. and W. M. Gray, 1976: Tropical cyclone motion and surrounding parameter relationships. J. Appl. Meteor., 15, 1252-1264.

Gray, W. M., 1981: Recent advances in tropical cyclone research from rawinsonde composite analysis. WMO Programme on Research in Tropical Meteorology, World Meteorological Organization, Geneve, Switzerland, 407 pp.

Holland, G. J., 1982: Tropical cyclone motion: Environmental interaction plus a beta effect. Atmos. Sci. Paper No. 348, Colo. State Univ., Ft. Collins, CO, 47 pp. (Also submitted to J. Atmos. Sci.)

Jordan, E. S., 1952: An observational study of the upper wind circulation around tropical storms. J. Meteor., 9, 340-346.

REFERENCES (cont'd)

Miller, B. I., 1958: The use of mean layer winds as a hurricane steering mechanism. Nat'l Hurricane Res. Proj. Rept., No. 18, 24 pp. (Available from Natinal Hurricane Research Lab., Coral Gables, FL.)

Riehl, H. and R. J. Shafer, 1944: The recurvature of tropical storms. J. Meteor., 1, 42-54.

Williams, K. T. and W. M. Gray, 1973: Statistical analysis of satellite-observed trade wind cloud clusters in the western North Pacific. Tellus, 25, 313-336.

Xu, J. and W. M. Gray, 1982: Environmental circulation associated with tropical cyclone recurvature vs. non-recurvature. Forthcoming Atmos. Sci. Paper, Colo. State Univ., Ft. Collins, CO.

APPENDIX

LARGE SCALE CIRCULATION COMPOSITE MAPS FOR ALL NINE MOTION CLASSES

This appendix shows 500 mb and surface composite maps when tropical cyclones in the two oceans take on fast, slow or looping cyclone motion. They contain geostrophic winds as well as height gradients on a constant pressure surface. This information is presented to give quantitative information to the tropical cyclone forecaster so that he may be able to better evaluate his current map situation for similar motion characteristics.

Each cyclone motion event was divided into 5 time periods labeled by -2, -1, 0, 1, 2 as shown in schematic form in Fig. 115. In Fig. 115 point A is the starting time of the event (as defined Chapter 2) and point B is the ending of the event. Time period -2 and -1 are 2 days and 1 day before start time (or before A) respectively. Time period 2 is 1 day after end time (i.e.-after B). Time period 1 is a combination of time period B and 12 hours before B. Time period 0 can involve a time period as long as 1 to more than 10 days. It is the time period from A to 24 hours before B.

In the Atlantic to the north of the subtropical ridge, the 0 period of looping events lasts longer. These events were subdivided into three subperiods by cyclone direction to show the details of the changes in the large scale flow pattern. These three subperiods were the time periods when the cyclone moved towards the south (direction between 95-210^{o}), west (direction between 215-330^{o}) and north (direction between 335-90^{o}).

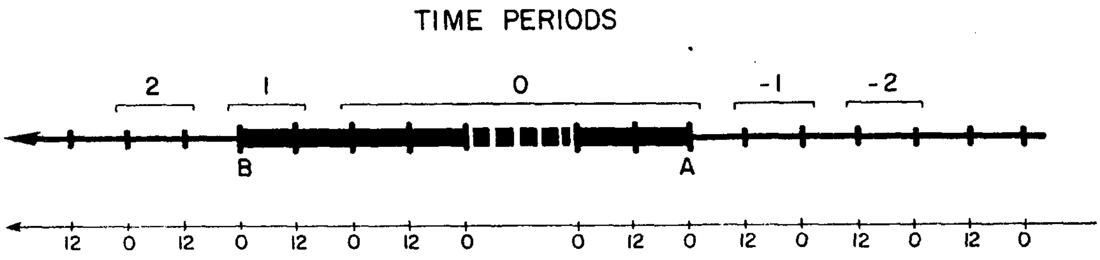


Fig. 115. Definition of time periods before (minus), during (0), and after (+) the specific motion events. Point A is the beginning of the motion event, point B is the end of the event.

-2 time period means the average of two 12-hour time periods approximately two days before the motion event commenced.

-1 time period means the average of two 12-hour time periods 12 and 24 hours before the motion event commenced.

0 time period means the time period of the motion event except the last two time periods. This time period can last from 1 to 10 days.

+1 time period is the last two 12-hour periods of the motion event -- or time period B plus the time period 12 hours before period B.

+2 time period is the average of the two 12 hour time periods immediately after the event or period B.

The areal scope of the composites is a rectangular area 50^{o} longitude to the west and east, 10^{o} south, and 35^{o} north latitude of the cyclone. The grid length is 5 degrees latitude or longitude.

The units of the composites are 10 geopotential meters at 500 mb and millibars at the surface. The geostrophic winds are expressed by vector arrows with 1 grid length (5^{o} latitude on the maps) represent 30 m/s at 500 mb and 15 m/s at the surface.

Statistical tests were performed for each height-pressure composite map. The tropical cyclones in one composition may be located at different latitudes. The latitudinal difference of 500 mb height causes a large standard deviation of composite 500 mb height fields. In the previous analysis it has been shown that the essential factors which affect cyclone motion are the longitudinal location of the westerly trough relative to the cyclone. The height departure from the latitudinal mean height which represents the ridge and trough locations on that latitude is much more responsible for cyclone motion than the height field by itself. Statistical tests were performed on these height departure fields.

Let $H_{i,j,k}$ be the height (pressure) value. Subscript i denotes east-west direction, j south-north direction, k the case number. The total number of cases in a composite is n. Let $\bar{\ }$ and ′ represent mean and departure values for a specific latitude belt denoted [ ] as the average from different examples.

Then,

$$[H_{ij}] = \frac{1}{n} \sum_{k=1}^{n} H_{ijk}$$

is the height (pressure) composite shown in this appendix.

$$\overline{H}_{jk} = \frac{1}{21} \sum_{i=1}^{21} H_{ijk}$$

$$H'_{ijk} = H_{ijk} - \overline{H}_{jk}$$

are the latitudinal mean value and the height departure from this latitudinal mean value for individual motion classes.

The mean values and standard deviations (S') of H'_{ijk}, are as follows:

$$[H'_{ij}] = \frac{1}{n} \sum_{k=1}^{n} H'_{ijk}$$

$$S'_{ij} = \sqrt{\frac{1}{n-1} \sum_{k=1}^{n} (H'_{ijk} - [H'_{ij}])}$$

Two kinds of significant tests were performed on H'_{ijk}.

[TEST 1]

If $[H'i,j]$ is not equal to zero then we gain confidence in the composite height-pressure values at the individual grid points. If this height value test is passed, then we know that the height composite value in this grid point is significantly different from the latitudinal mean.

In order to do this we construct a function

$$t_{ij} = \frac{\sqrt{n}\,[H'_{ij}]}{S'_{ij}}$$

where $t_{i,j}$ represents the T-distribution with (n-1) degrees of freedom, then

$$t_{\alpha} = \int_{-td}^{td} t(n-1)d\gamma = 1-\alpha$$

Here α is the significant level

$$\text{when } |t_{ij}| \geq t\alpha, \quad [H'_{ij}] \neq 0$$
$$\text{when } |t_{ij}| < t\alpha, \quad [H'_{ij}] = 0$$

The left table in each page labeled Test 1 shows these test results. For instance, when the value of 3 (or 2,1) was printed, the composite height (pressure at the surface) was significantly different from the latitudinal mean at the significant level 0.001 (or 0.01, 0.05). When the test failed to pass, nothing was printed at that grid point.

[TEST 2]

For specific latitudes, we simultaneously test the 500 mb height (or surface pressure) difference between ridge and trough. This test gives us confidence in the ridge-trough height differences. If this test is passed, then the 500 mb height (or surface pressure) value at the ridge is significantly higher than the one at the trough.

Let i_1 be the ridge point and i_2 the trough point. Construct another function

$$t_j = \frac{[H'_{i_1j}] - [H'_{i_2j}]}{\sqrt{\frac{2}{n}} \cdot \sqrt{\frac{(n-1)\ S'_{i_1j}{}^2 + (n-1)S'_{i_2j}{}^2}{2n-2}}}$$

Again represent the t_j-distribution with degrees of freedom (2n-2). The test then becomes

$$\text{when } |tj| \geq t\alpha, \quad [H'_{i_1j}] \neq [H'_{i_2j}]$$
$$\text{when } |tj| < t\alpha, \quad [H'_{i_1j}] = [H'_{i_2j}]$$

The right hand table of each page labeled Test 2 shows these latter test results. When 'Pass' was printed, the 500 mb ridge height (or surface pressure) is significantly different from the trough height (pressure). When the test fails, nothing was printed.

Table A of the Appendix gives a list of these composite maps.

For better storm track assessment, forecasters may find it helpful to refer to these nine classes of cyclone motion categories in each of two ocean basins. It is too difficult in an operational environment to find appropriate cases from the thousands of daily historical weather maps. The unexperienced forecaster will generally not have the background to recognize the essential height pattern differences from the typical operational flow pattern. For example, when a trough is deepening to the northeast of the storm, a forecaster may not realize that this may cause a looping motion. These composite maps give forecasters a brief library of the historical weather maps. Although they are smoothed compared to the daily maps, these 154 maps express the long wave flow patterns very well.

Basic Rules. Before making a cyclone track forecast, decide which side of the subtropical ridge the cyclone is located. Compare the real time map and the numerical prediction (if available) to these composite maps. At 500 mb, take note of the long wave positions, their likely future alteration, and the distance the jet stream is from the cyclone. At the surface, note if the steering flow is in the same direction as the 500 mb flow and if the surface ridge is to the north of the cyclone and is breaking down. Find the most similar composite map of these many cases. The cyclone will likely follow the type of motion indicated. Then use other methods to help verify or reject your assessment.

THE FOLLOWING 308 COMPOSITE MAPS AND 154 MULTIPLE STATISTICAL TESTS OF 500 MB HEIGHT FIELDS (IN METERS) AND SURFACE (SFC) PRESSURE FIELDS (IN MILLIBARS) ARE PRESENTED FOR THE WESTERN ATLANTIC (A OR ATL.) AND NORTHWEST PACIFIC (P OR PAC.) FOR FAST, SLOW AND LOOPING TROPICAL STORMS TO THE NORTH (N), ON (ON), OR TO THE SOUTH (S) OF THE SUBTROPICAL RIDGE AT 500 MB. TABLE A OUTLINES ALL OF THESE COMPOSITE MAP STRATIFICATIONS BY APPENDIX PAGE NUMBER AND GIVES THE NUMBER OF EXAMPLES IN EACH CASE. THE HEAVY DOT (●) SHOWS THE CYCLONE CENTER POSITION.

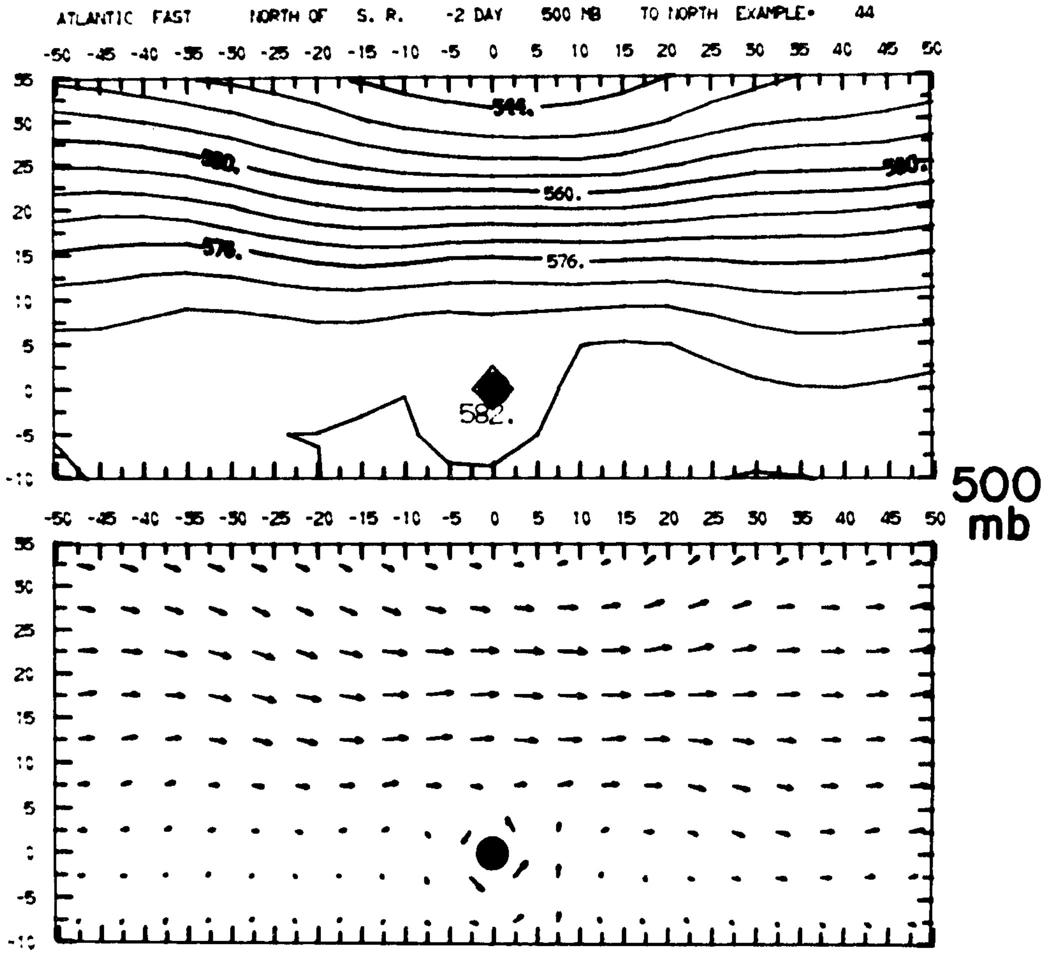
ARROW LENGTHS OF 5^{o} LATITUDE DISTANCE REPRESENT 30 m/s AT 500 MB AND 15 m/s AT THE SURFACE>

TABLE A

Summary of composite maps in the Appendix.

Relative Position to the S.R.	Days	Fast Motion						Slow Motion						Looping Motion							
		500 mb			Surface			500 mb			Surface			500 mb				Surface			
		Ocean	Page	Example	Ocean	Page	Example	Ocean	Page	Example	Ocean	Page	Example	Ocean	Page	Example	Dir.	Ocean	Page	Example	Dir.
To the North of S.R.	-2	A P	1 2	44 78	A P	3 4	42 71	A	17	34	A	18	32	A	31	28		A	32	27	
	-1	A P	5 6	49 81	A P	7 8	46 74	A	19	37	A	20	36	A P	33 34	29 14		A P	35 36	27 14	
		A	9	83	A	11	81	A	21	107	A	23	103	A P	37 38	136 45		A P	39 40	128 42	
	0	P	10	124	P	12	113	P	22	21	P	24	15	A A A	41 43 45	46 49 37		A A A	42 44 46	45 46 41	
	1	A P	13 14	42 104	A P	15 16	41 100	A P	25 26	44 12	A P	27 28	43 10	A A P	47 49 50	14 19 20		A A P	48 51 52	14 18 20	
	2							A	29	39	A	30	37	A A P	53 55 56	20 11 18		A A P	54 57 58	17 11 15	
Near S.R.	-2	A P	59 60	18 41	A P	61 62	17 37	A P	73 74	29 40	A P	75 76	27 39	P	93	19		P	94	19	
	-1	A P	63 64	20 49	A P	65 66	20 45	A P	77 78	33 51	A P	79 80	30 48	A P	95 96	17 20		A P	97 98	13 21	
	0	A P	67 68	27 53	A P	69 70	26 45	A P	81 82	95 100	A P	83 84	88 90	A P	99 100	12 33		A P	101 102	8 33	
	1	P	71	20	P	72	20	A P	85 86	50 67	A P	87 88	45 63	P	103	30		P	104	30	
	2							A P	89 90	49 47	A P	91 92	45 42	P	105	25		P	106	24	
To the South of S.R.	-2	P	107	22	P	108	21	A P	123 124	19 46	A P	125 126	20 45	P	143	28		P	144	27	
	-1	P	109	42	P	110	38	A P	127 128	26 60	A P	129 130	26 57	P	145	42		P	146	41	
	0	A P	111 112	71 156	A P	113 114	62 124	A P	131 132	83 182	A P	133 134	84 153	A P	147 148	5 99		A P	149 150	4 91	
	1	A P	115 116	32 86	A P	117 118	29 81	A P	135 136	43 97	A P	137 138	43 92	P	151	62		P	152	58	
	2	A P	119 120	25 65	A P	121 122	23 66	A P	139 140	33 76	A P	141 142	34 71	P	153	59		P	154	52	

ATL. FAST N. -2

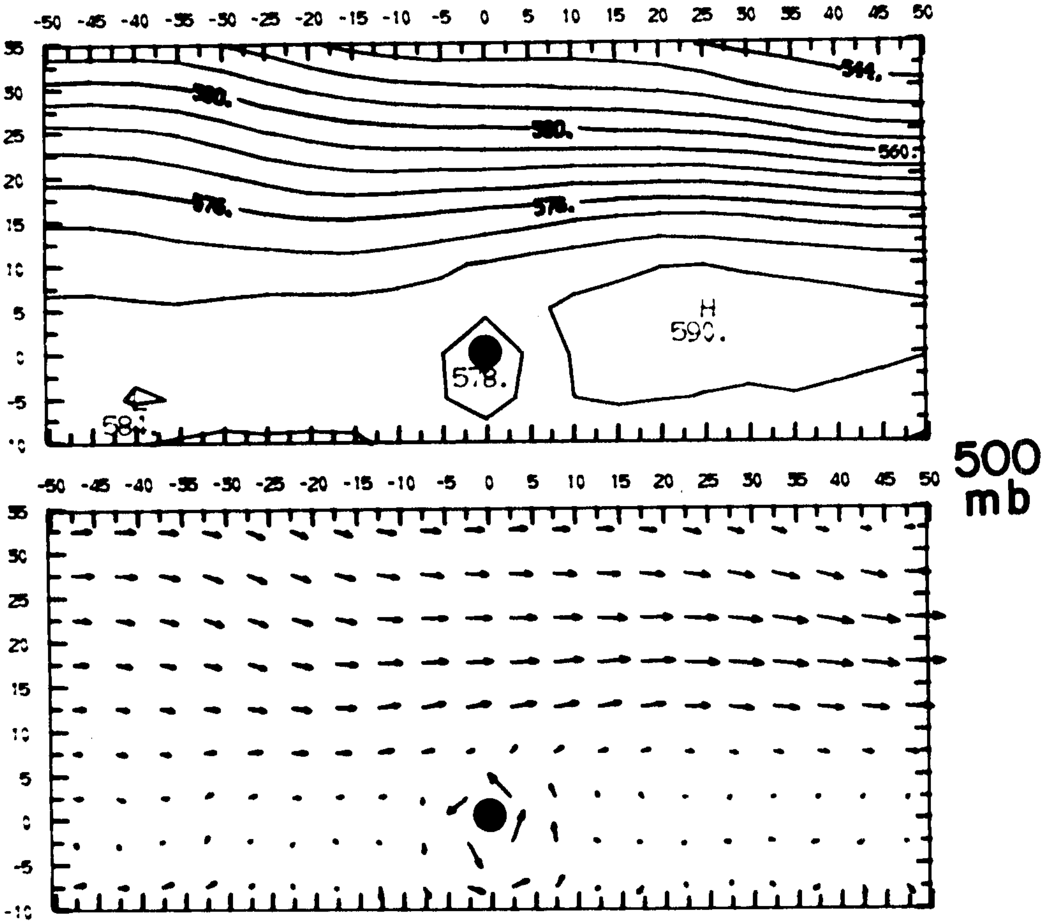


ATLANTIC FAST NORTH OF SUBTROPICAL RIDGE -2 DAY 500 MB TO NORTH EXAMPLE= 44

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1	1						1	2	3	3	2	1								PASS	PASS	PASS
30	3	3	3	2	1				1	2	2	3	3	2								PASS	PASS	PASS
25	3	3	3	3	1				1	1	1	1	2	1								PASS	PASS	PASS
20	2	3	3	3																		PASS	PASS	PASS
15		1	2	2																		PASS	PASS	
10																						PASS		
5													1	2	2							PASS	PASS	
0	1	1								2	3	1	2	3	3	2						PASS	PASS	PASS
-5	2	3	3	2	2	1	1	1	1	2	2		2	3	2	2	3	3	2	1	1	PASS	PASS	PASS
-10		1	2	2	2	2	3	2	2	2						2	3	3	3	1		PASS	PASS	PASS

PAC. FAST -2
N.

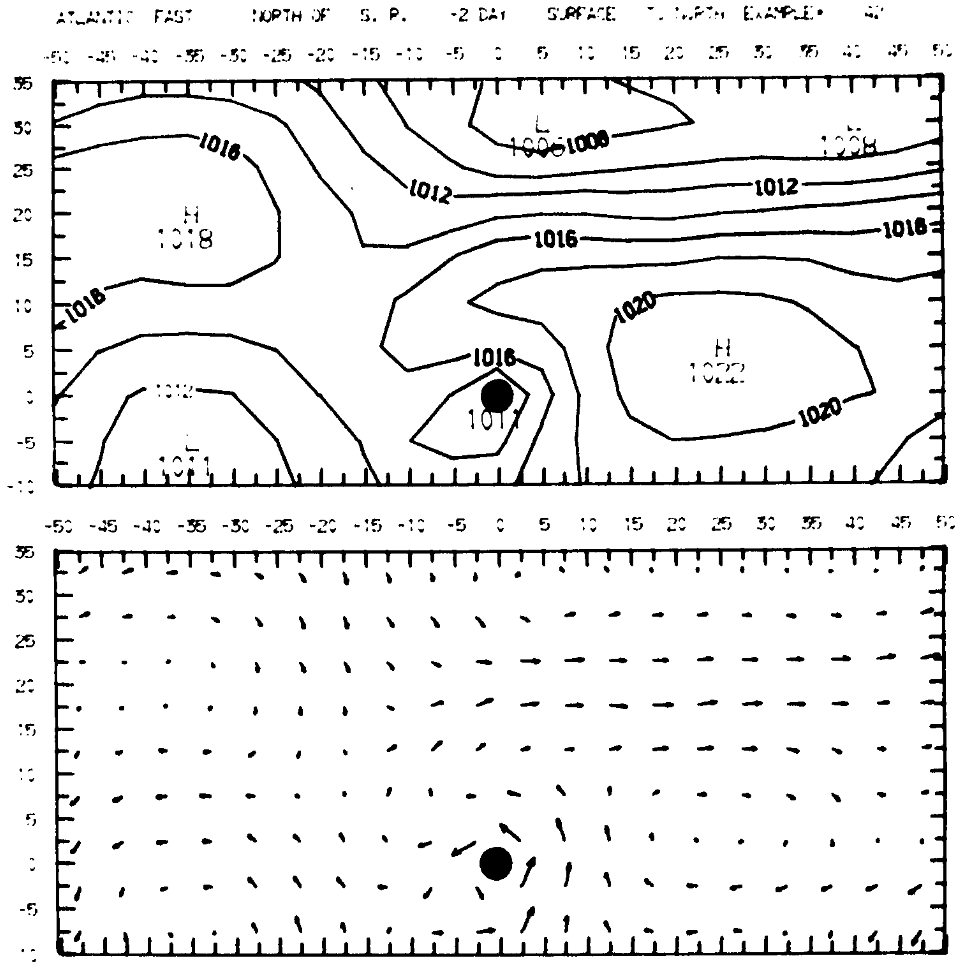
PACIFIC FAST NORTH OF S. R. -2 DAY 500 MB TO NORTH EXAMPLE= 78



PACIFIC FAST NORTH OF SUBTROPICAL RIDGE -2 DAY 500 MB TO NORTH EXAMPLE= 78

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
35	3	3	3	3	3	3										2	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	1								1	2	3	3	3	3	3	PASS	PASS	PASS
25	3	3	3	3	3	3									1	2	3	3	3	3	3	PASS	PASS	PASS
20	3	3	3	3	3														2	3	3	PASS	PASS	PASS
15					1	3	3	3	3	1				3	3	3	1					PASS	PASS	PASS
10	3	3	3	3	3	3	3	3	3	1		1	3	3	3	3	3	3	3	1	1	PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	2	3	3	3	2					3	3	2	3	3	3	3	3	3	3	3	2	PASS	PASS	PASS
-5			1	1						1	3		3	3	1	1	1	1				PASS	PASS	PASS
-10																								

ATL. FAST N. -2

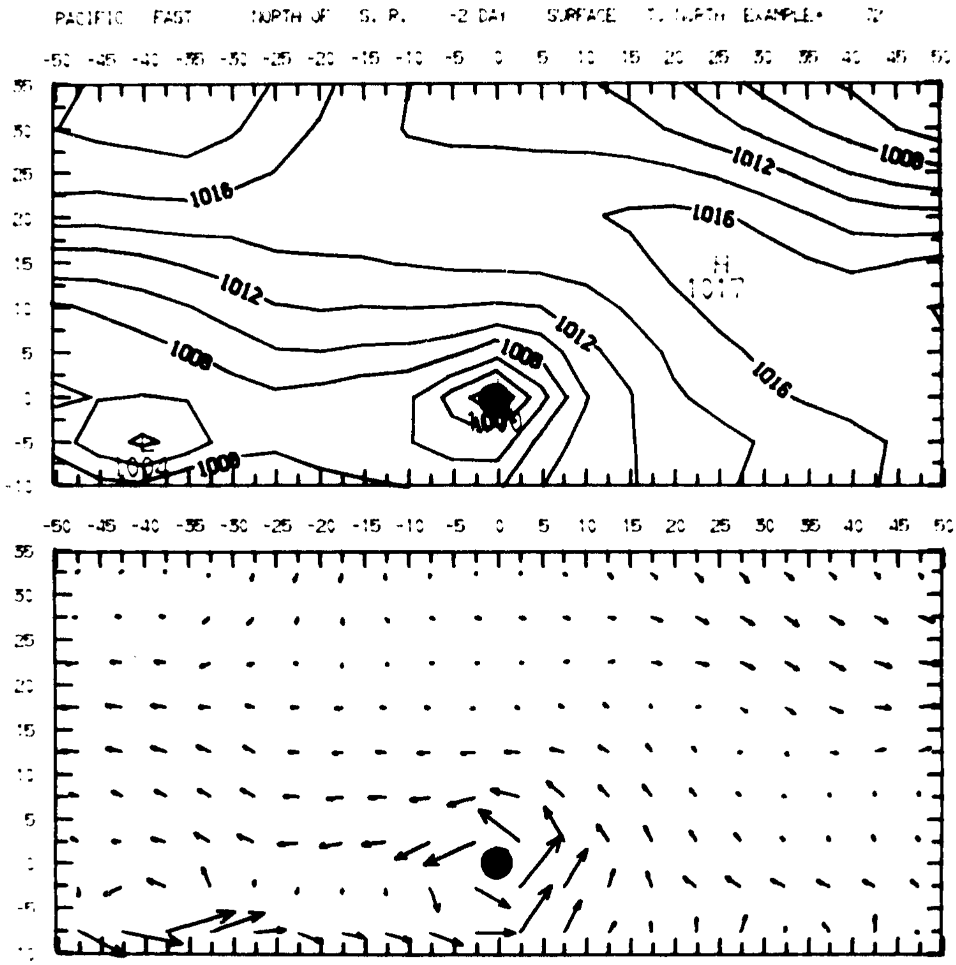


Sfc.

ATLANTIC FAST NORTH OF SUBTROPICAL RIDGE -2 DAY SURFACE TO NORTH EXAMPLE= 42

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35			1	2	2	2																PASS	PASS	
30	1	2	3	3	3	3	2				1	2	2	1	1							PASS	PASS	PASS
25	2	3	3	3	3	2					1	2	2	1	1							PASS	PASS	PASS
20	1	1	1	2	2				1													PASS	PASS	PASS
15							1	2	1													PASS	PASS	
10		1	2	2	3	3	3	3				1	1	2	3	3	3	1				PASS	PASS	PASS
5	2	3	3	3	3	3	3	2			1		2	3	3	3	3	3	2	1	2	PASS	PASS	PASS
0	2	3	3	3	3	3	3	1	1	3	3	1	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	1	PASS	PASS	PASS
-10	3	3	3	3	3	3	3	2	1			3	3	3	3	3	3	3	3	1		PASS	PASS	PASS

PAC. FAST N. -2

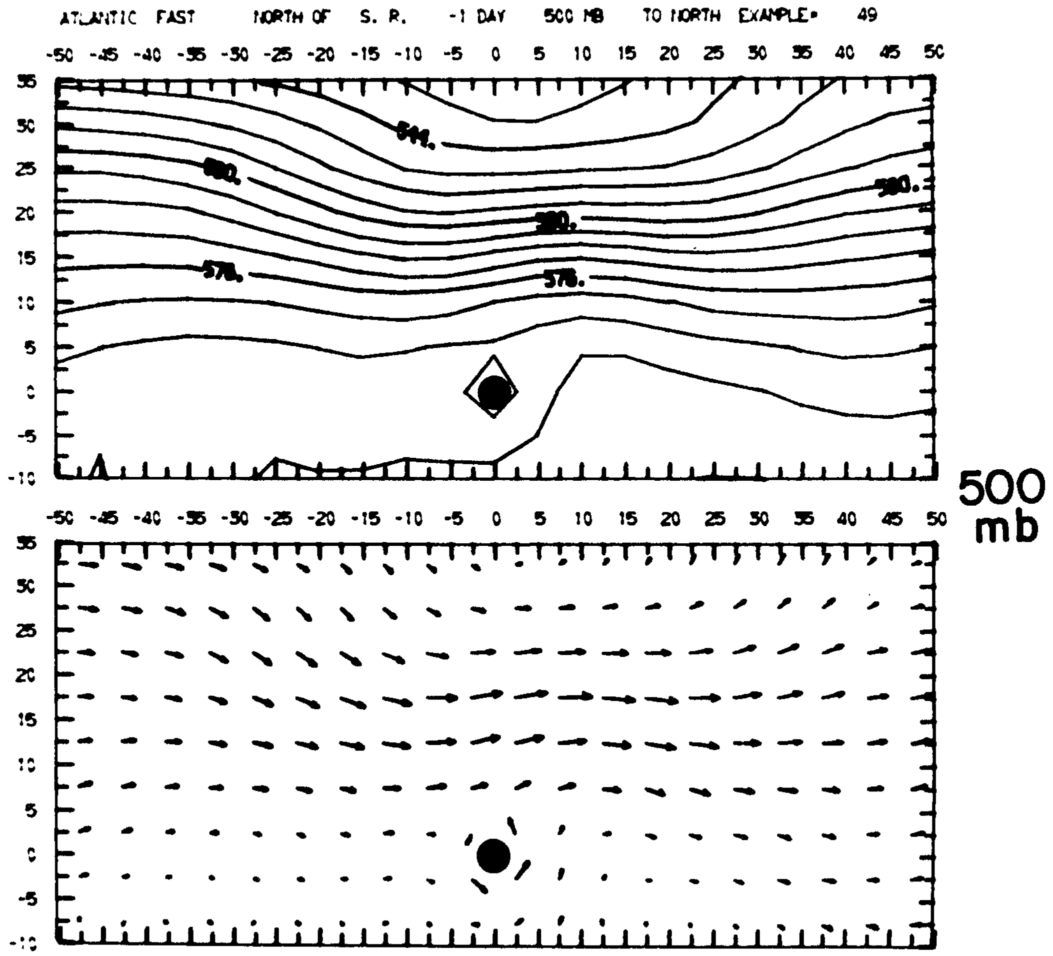


Sfc.

PACIFIC FAST NORTH OF SUBTROPICAL RIDGE -2 DAY SURFACE TO NORTH EXAMPLE• 72

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	3	2							1	2	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	2									1	3	3	3	3	3	PASS	PASS	PASS
25	3	2	3	3	2	1												3	3	3	3	PASS	PASS	PASS
20														1	1	1			1	1	1	PASS	PASS	
15	3	3	3	3	1									1	3	3	3	2		1	2	PASS	PASS	PASS
10	3	3	3	3	3	1		1	1	2	2	1		2	3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3.	3	3	2	3	3	3	3	3		2	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	2	2	2	3	3	3	3		2	3	3	3	3	3	3	3	PASS	PASS	PASS
-5		1	2	2	2	2	1	1	1	1	2			2	2	3	3	3	3	3	3	PASS	PASS	PASS
-10																				1		PASS	PASS	

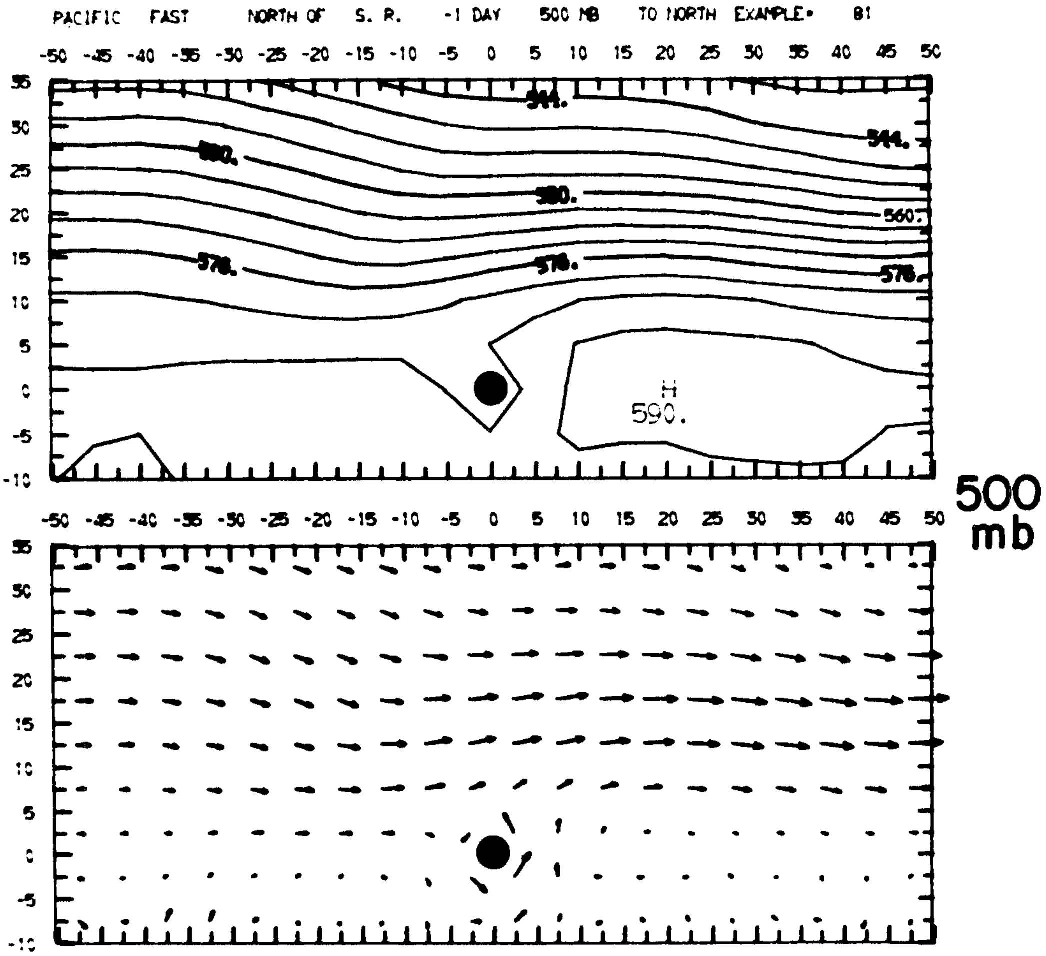
ATL. FAST -1
N.



ATLANTIC FAST NORTH OF SUBTROPICAL RIDGE -1 DAY 500 MB TO NORTH EXAMPLE= 49

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1								1	2	3	3	3	3					2	2	2	PASS	PASS	PASS
30	3	3	3	2	1				2	3	3	3	3	3	3	1			1	1	1	PASS	PASS	PASS
25	3	3	3	3	3			2	3	3	3	3	3	3	3	2					1	PASS	PASS	PASS
20	3	3	3	3	3			2	3	3	2	2	2	2	2	1						PASS	PASS	PASS
15	1	2	3	3	1				2	1												PASS	PASS	PASS
10												1	1									PASS	PASS	
5								1				2	3	3	1							PASS	PASS	PASS
0								1	1	3	3		3	3	3	2	1					PASS	PASS	PASS
-5	1					1	1	2	2	3	3		2	3	3	3	2	1				PASS	PASS	PASS
-10	2	2	2	3	3	2	3	3	3	1				2	3	3	3	3	3	1		PASS	PASS	PASS

PAC. FAST -1
N.



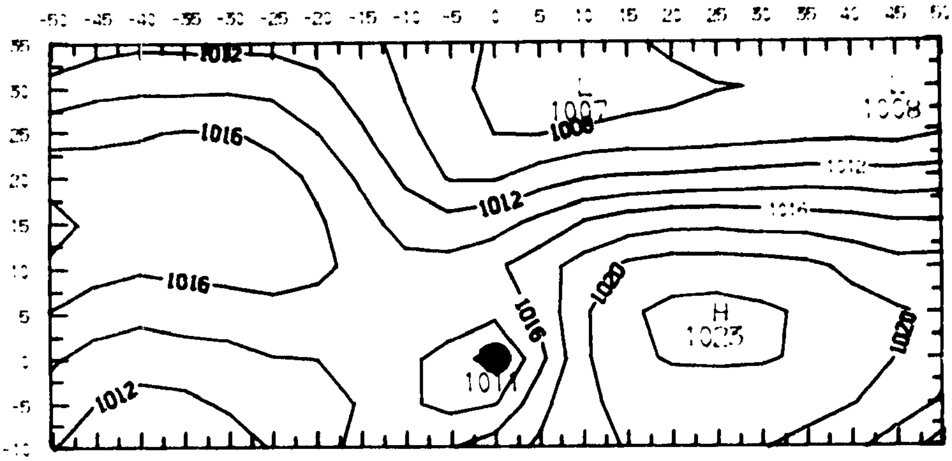
PACIFIC FAST NORTH OF SUBTROPICAL RIDGE -1 DAY 500 MB TO NORTH EXAMPLE= 81

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	5	1				1	1		1	1	2	5	5	5	5	5	PASS	PASS	PASS
30	5	5	5	5	5	5	5								1	5	5	5	5	5	5	PASS	PASS	PASS
25	5	5	5	5	5	5	5								1	2	5	5	5	5	5	PASS	PASS	PASS
20	5	5	5	5	5	5			1	1	1						1	2	5	5	5	PASS	PASS	PASS
15	5	5	5	5			2	5	5	5			1	2	2	1			1	1		PASS	PASS	PASS
10				1	5	5	5	5	5	5		1	5	5	5	5	5	1				PASS	PASS	PASS
5	5	5	5	5	5	5	5	5	5	5	5		5	5	5	5	5	5	5	2	1	PASS	PASS	PASS
0	5	5	5	5	5	5	5	2	5	5	5	2	5	5	5	5	5	5	5	5	5	PASS	PASS	PASS
-5	2	5	5	2	1					2	2		5	2	2	5	5	5	2			PASS	PASS	PASS
-10																								

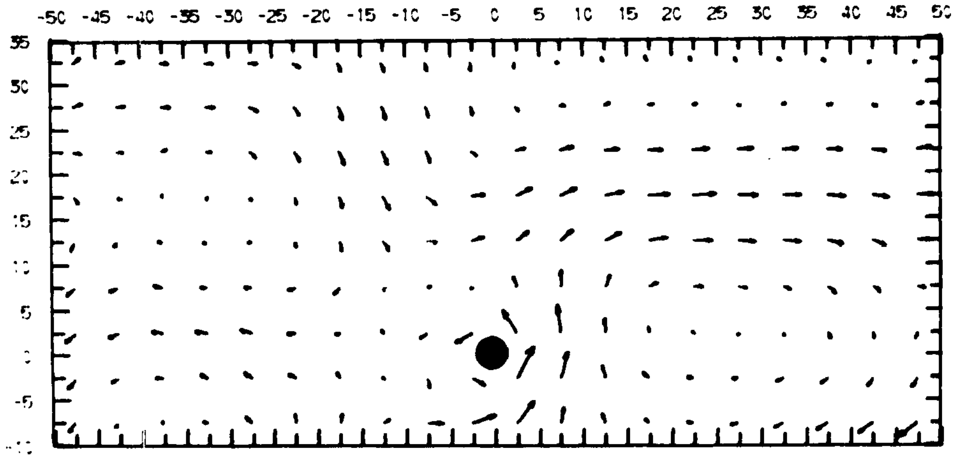
ATL. FAST -1

N.

ATLANTIC FAST NORTH OF S. R. -1 DAY SURFACE TO NORTH EXAMPLE= 46



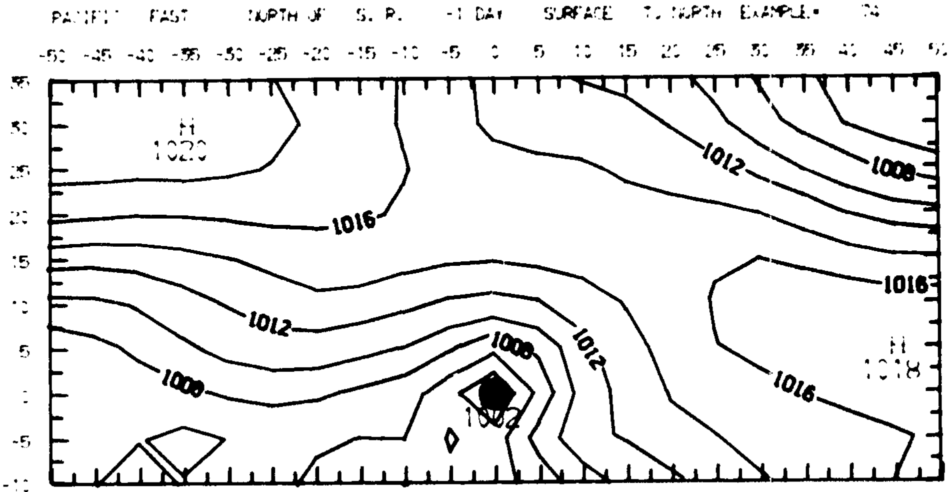
Sfc.



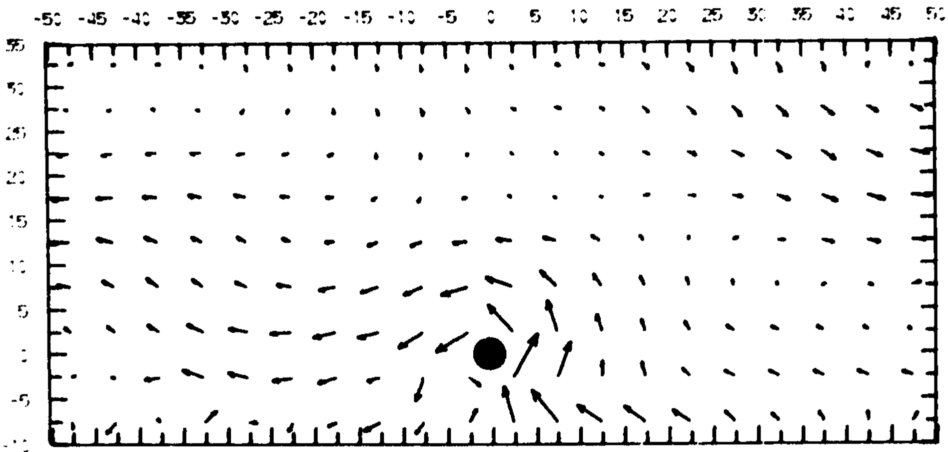
ATLANTIC FAST NORTH OF SUBTROPICAL RIDGE -1 DAY SURFACE TO NORTH EXAMPLE= 46

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35			1									1	1	1								PASS	PASS	
30	1	2	3	3	3	3	2					1	2	3	2							PASS	PASS	PASS
25	2	3	3	3	3	3	2			1	1	2	2	2	2	1	1					PASS	PASS	PASS
20	2	1	1	3	3	3	1		1	3	2	1										PASS	PASS	PASS
15									2	3	2											PASS	PASS	PASS
10				1	1			2	3	3	2			3	3	3	3	2				PASS	PASS	PASS
5	1	2	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	2	1	PASS	PASS	PASS
0	2	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2	PASS	PASS	PASS
-5	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2	PASS	PASS	PASS
-10	3	3	3	3	3	3	3	3	1		1	3	3	3	3	3	3	3	3			PASS	PASS	PASS

PAC. FAST N. -1



Sfc.

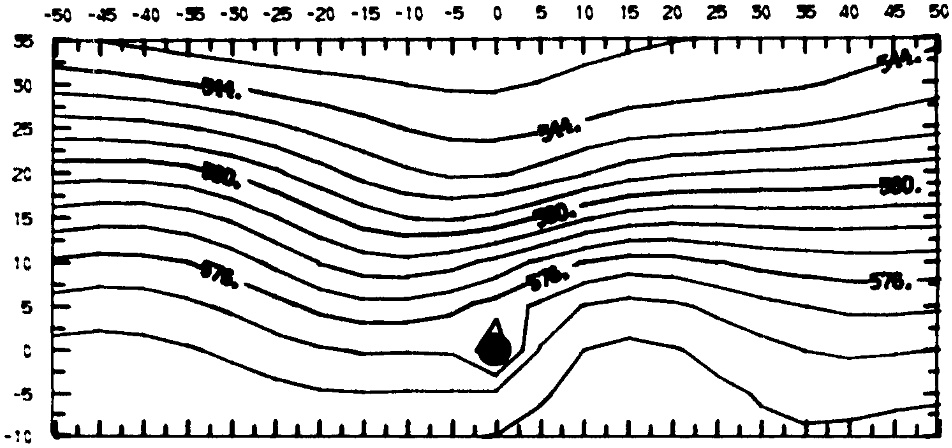


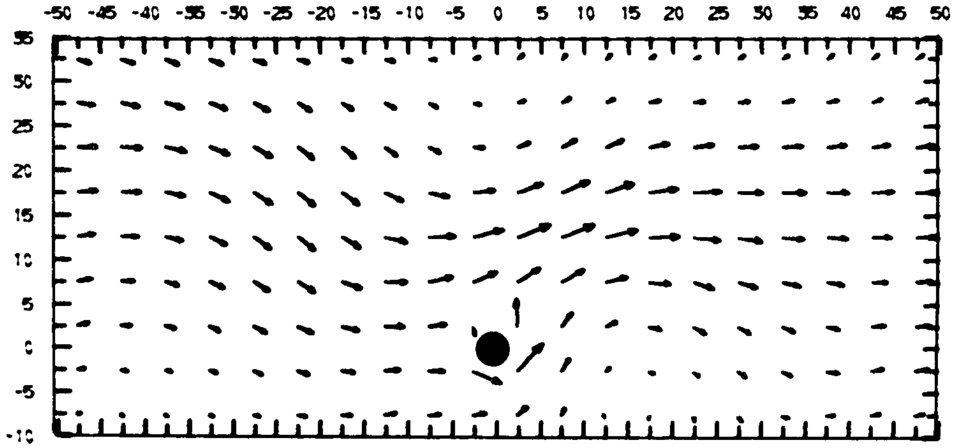
PACIFIC FAST NORTH OF SUBTROPICAL RIDGE -1 DAY SURFACE TO NORTH EXAMPLE= 14

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	3	3	3	1				1	2	2	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	3	3	2						1	2	3	3	3	3	3	PASS	PASS	PASS
25	3	3	3	3	3	3	3	2	1							1	2	3	3	3	3	PASS	PASS	PASS
20	1					1	1	1											2	2	3	PASS	PASS	PASS
15	1	2	1													1						PASS	PASS	
10	3	3	3	2	1					3	3	3			3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	1			2	3	3	3	3		2	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	2	1	2	3	3	3	3	3	3	3	3		1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10							1	2	1	1						1	1	1	1	2	2	PASS	PASS	PASS

ATL. FAST O N.

ATLANTIC FAST NORTH OF S. R. 0 DAY 500 MB TO NORTH EXAMPLE= 85



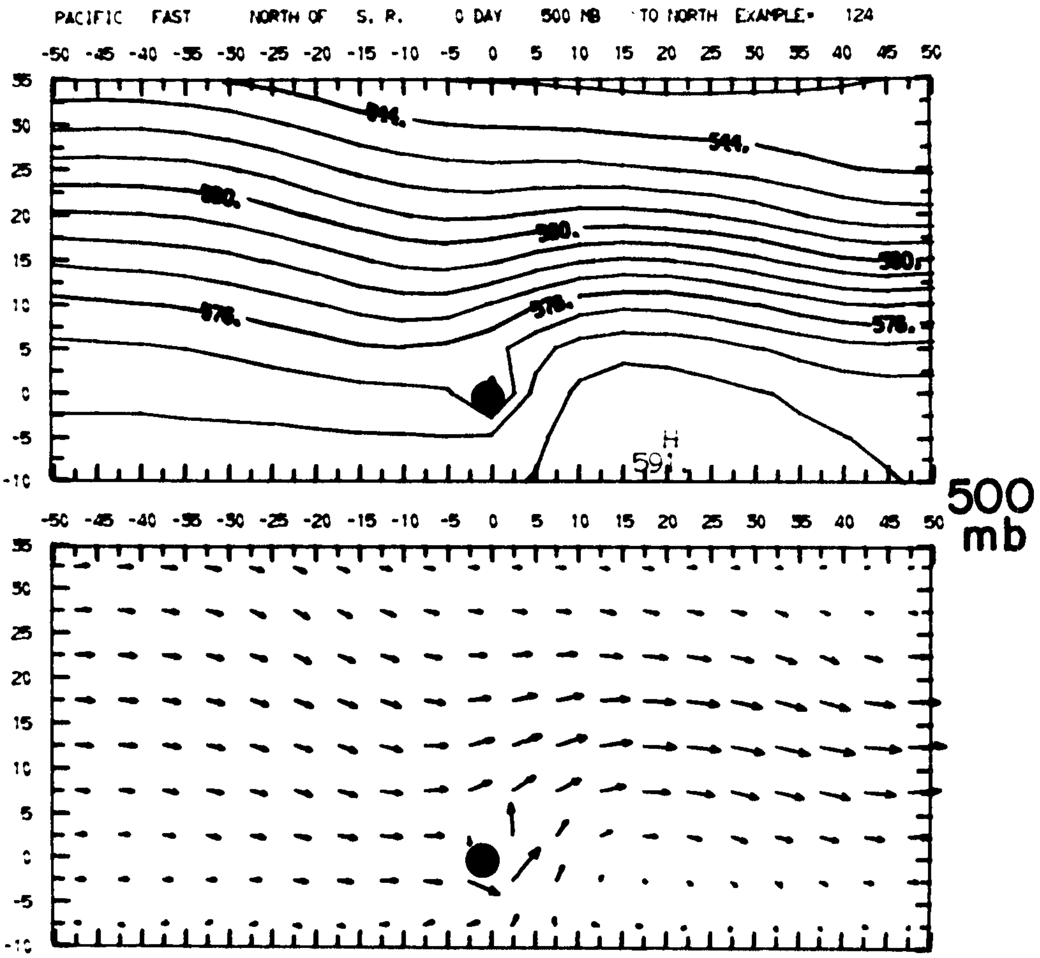


500 mb

ATLANTIC FAST NORTH OF SUBTROPICAL RIDGE 0 DAY 500 MB TO NORTH EXAMPLE= 85

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35					1	2	2	2	2	2	1						1	1	2	3	3	PASS	PASS	PASS
30	2	1	1					1	2	2	2	2								1	1	PASS	PASS	PASS
25	3	3	3	3	2			2	3	3	3	3	2	1								PASS	PASS	PASS
20	3	3	3	3	3			3	3	3	3	3	3								1	PASS	PASS	PASS
15	3	3	3	3	3		2	3	3	3	3	3			1	1						PASS	PASS	PASS
10	3	3	3	3		1	3	3	3	3	3		3	3	3	3						PASS	PASS	PASS
5	1	3	3			3	3	3	3	3	3		3	3	3	3	1					PASS	PASS	PASS
0	1	2	1			3	3	3	3	3	3		3	3	3	3	1					PASS	PASS	PASS
-5					2	3	3	3	3	3	3		3	3	3	3						PASS	PASC	PASS
-10			2	3	3	3	3	3	3	2		3	3	3	3	1				1	1	PASS	PASS	PASS

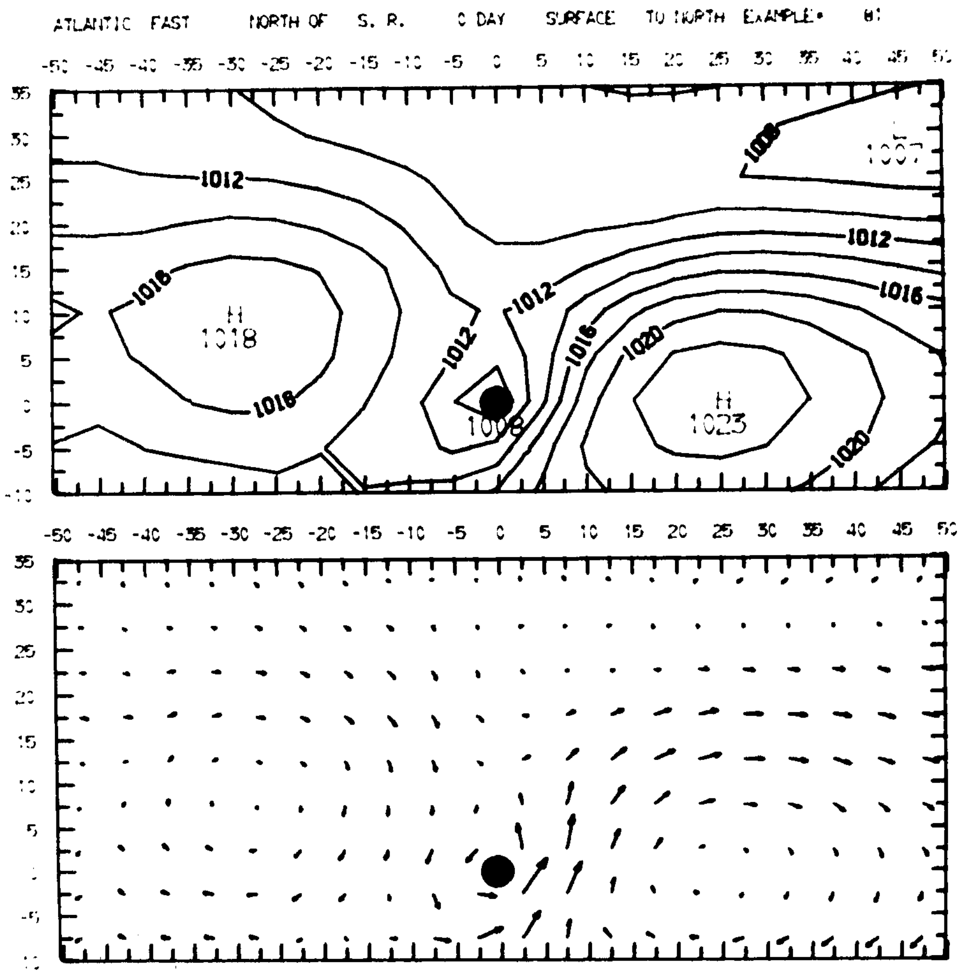
PAC. FAST O
N.



PACIFIC FAST NORTH OF SUBTROPICAL RIDGE 0 DAY 500 MB TO NORTH EXAMPLE= 124

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	2	1						1	1	2	2	2	1	1				PASS	PASS	PASS
30	3	3	3	3	3	3	2					1	1	2	3	3	3	3	3	3	3	PASS	PASS	PASS
25	3	3	3	3	3	3	3							1	2	3	3	3	3	3	3	PASS	PASS	PASS
20	3	3	3	3	3	3	2			1	1						3	3	3	3	3	PASS	PASS	PASS
15	3	3	3	3	3	2		1	3	3	3		2	3	3			3	3	3	3	PASS	PASS	PASS
10	3	3	3	1		1	3	3	3	3	3	1	3	3	3	3	2		2	3	2	PASS	PASS	PASS
5				2	3	3	3	3	3	3	3	3	3	3	3	3	3	3				PASS	PASS	PASS
0	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	2	2	PASS	PASS	PASS
-5	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	2	1	PASS	PASS	PASS
-10	3	3	3	3	2	2	2	2	1			1	3	3	3	3	3	2				PASS	PASS	PASS

ATL. FAST O
N.

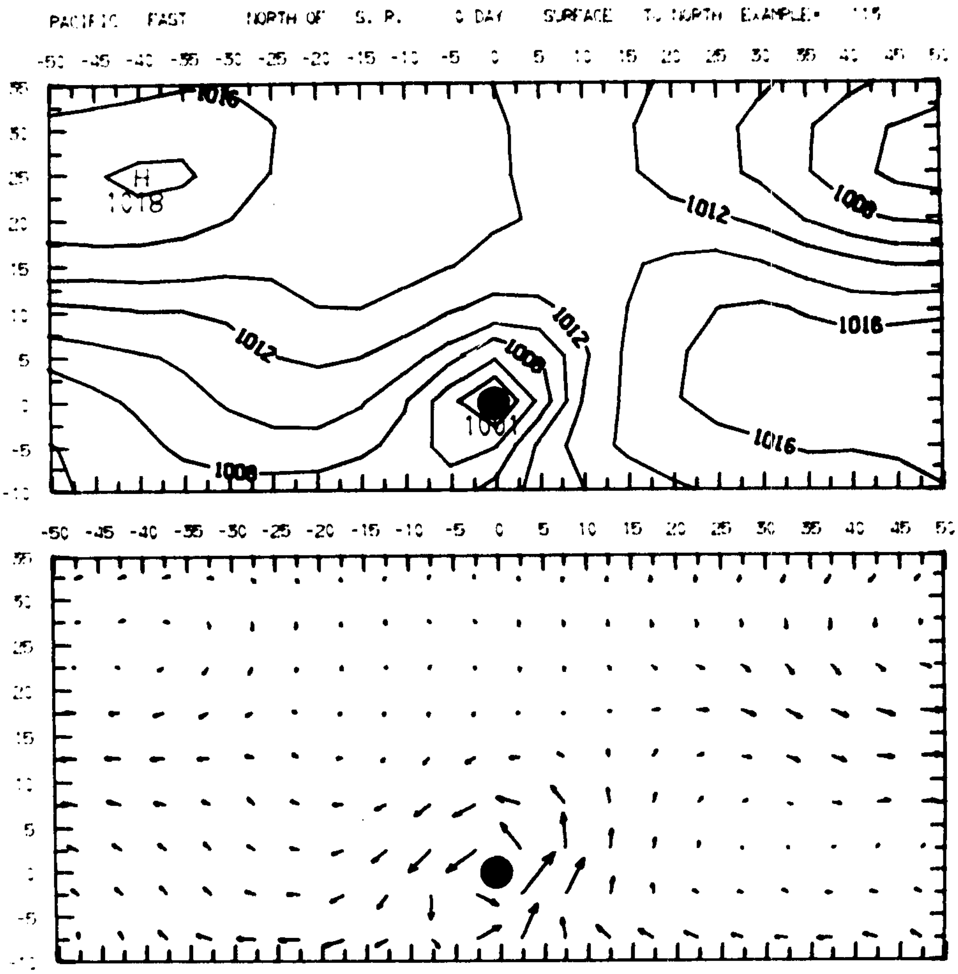


Sfc.

ATLANTIC FAST NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE TO NORTH EXAMPLE: 81

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1	1																		1	PASS	PASS	
30	1	2	2	2	1													1	1	1	1	PASS	PASS	PASS
25	2	2	2	2	2	3	2									1	1	1	1	1	1	PASS	PASS	PASS
20	1	1	1	2	3	3	2				2	2	1	1								PASS	PASS	PASS
15				2	3	3	2			3	3	3	2									PASS	PASS	PASS
10					1				3	3	3	3	2		3	3	3	3				PASS	PASS	PASS
5	1	1						3	3	3	3	3		3	3	3	3	3	3	1		PASS	PASS	PASS
0	2	3	3	1		1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	PASS	PASS	PASS
-5	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3		PASS	PASS	PASS
-10	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	1		PASS	PASS	PASS

PAC. FAST O N.

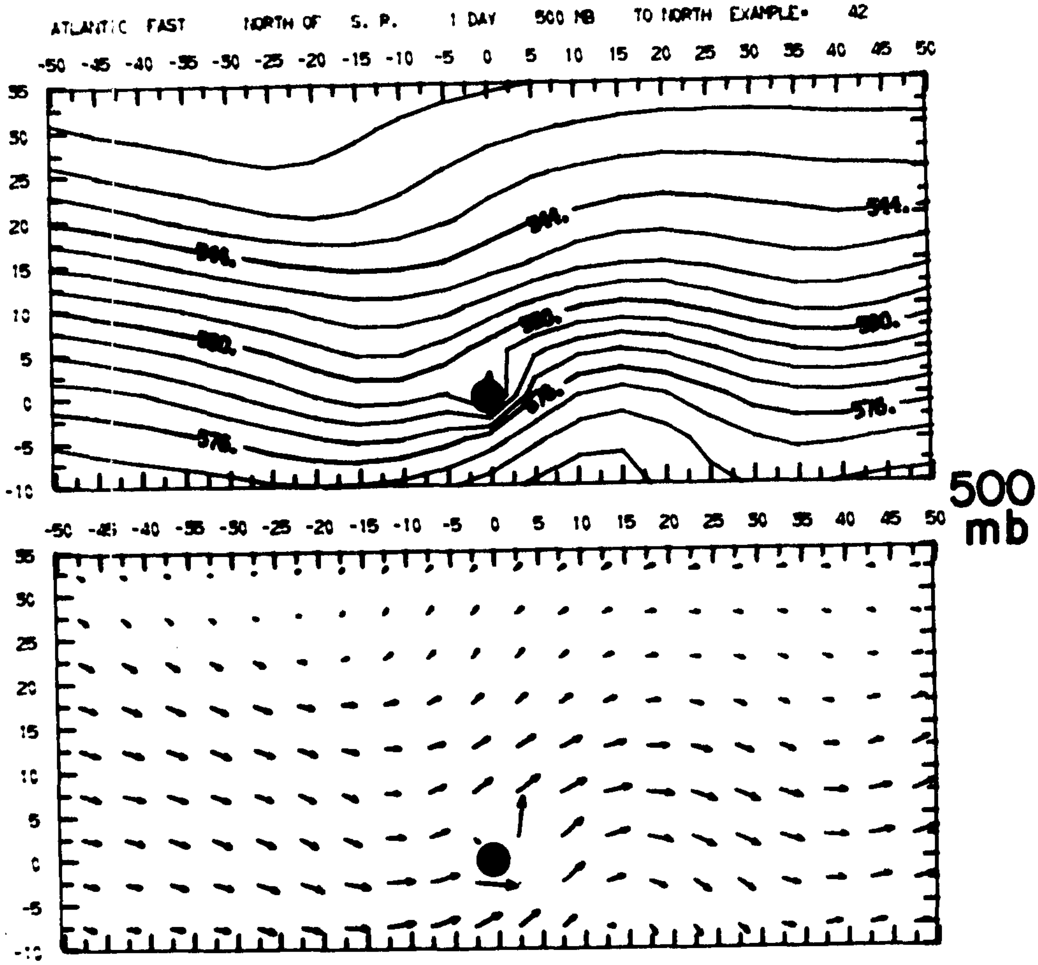


Sfc.

PACIFIC FAST NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE TO NORTH EXAMPLE= 113

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1	2	3	3	3	2	2	2	1	1					1	2	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	2	1	1	1	1					2	3	3	3	3	3	PASS	PASS	PASS
25	3	3	3	3	3	3	2	2	2	2	1				1	2	3	3	3	3	3	PASS	PASS	PASS
20	3	3	3	3	2	1	1	2	1								1	3	3	3	3	PASS	PASS	PASS
15																				1	1	PASS	PASS	
10	3	2	1	1	1					2	3	3			3	3	3	3	1	1	1	PASS	PASS	PASS
5	3	3	3	3	1				3	3	3	3	1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	1			3	3	3	3	3	1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10	3	3	3	3	3	3	3	3	3	3	2		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS

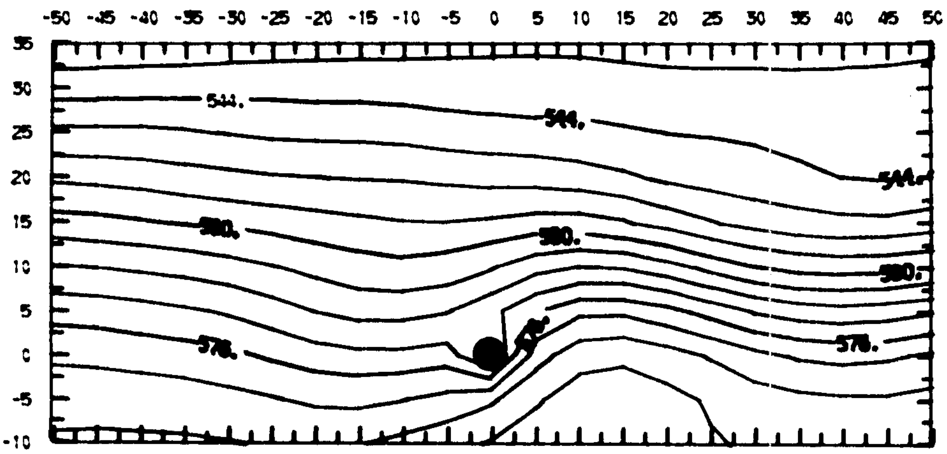
ATL. FAST 1
N.



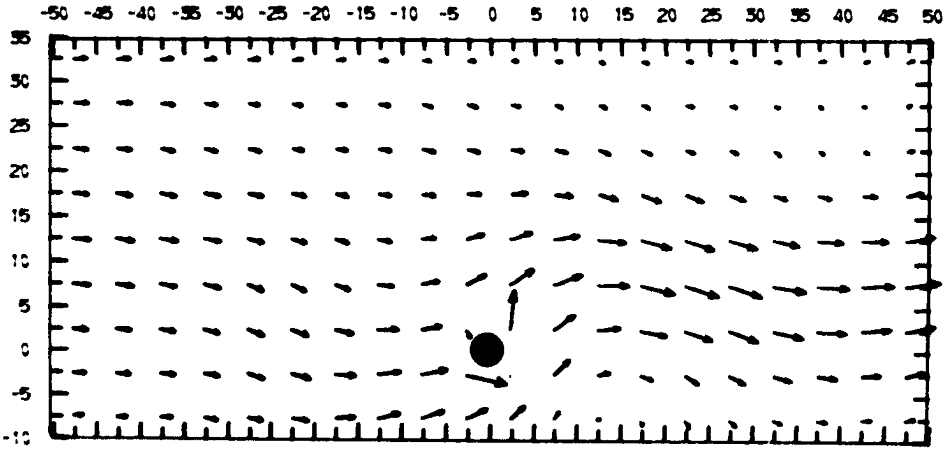
ATLANTIC FAST NORTH OF SUBTROPICAL RIDGE 1 DAY 500 MB TO NORTH EXAMPLE= 42

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35			1	1	2	2	2	1						1	1	2	1	1				PASS	PASS	PASS
30			2	2	3	3	3	2					1	2	3	3	3	2	1	1		PASS	PASS	PASS
25			1	2	3	3	3	3	2				2	3	3	3	3	3	2	1		PASS	PASS	PASS
20					3	3	3	3	3	1			1	2	3	3	3	1				PASS	PASS	PASS
15	1					2	2	2	3	2				1	2	1						PASS	PASS	PASS
10	2	1					2	2	3	3			2	3	2							PASS	PASS	PASS
5	2	1				2	3	3	3	3		2	3	3	3	2						PASS	PASS	PASS
0	1				1	3	3	3	3	3	1	2	3	3	3	2						PASS	PASS	PASS
-5					2	3	3	3	3	3		3	3	3	3	2						PASS	PASS	PASS
-10			1	2	3	3	3	3	2		2	3	3	3	2							PASS	PASS	PASS

PAC. FAST N. 1



500 mb

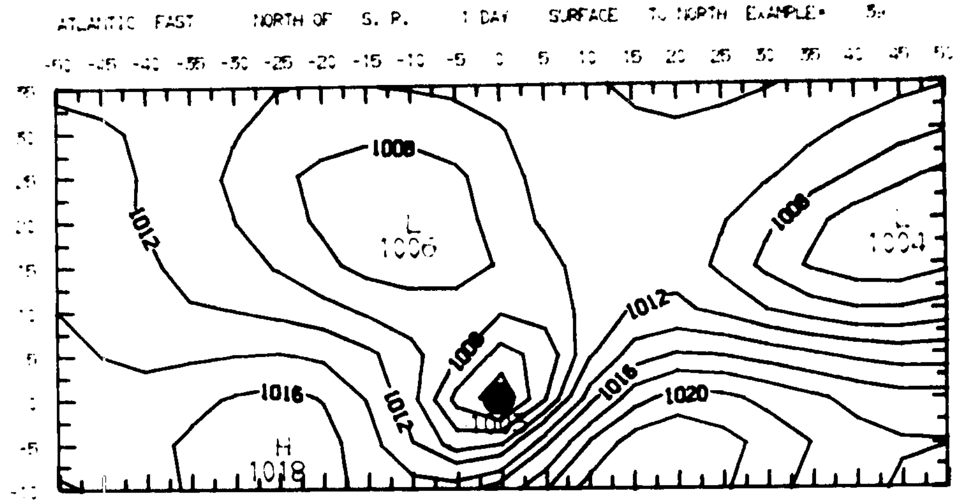


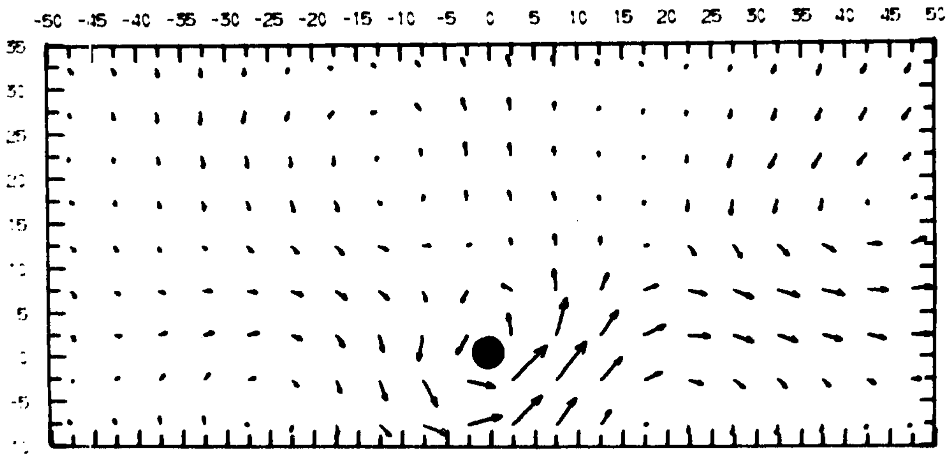
PACIFIC FAST NORTH OF SUBTROPICAL RIDGE 1 DAY 500 MB TO NORTH EXAMPLE= 104

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35																						PASS		
30																								
25	2	2	2	2	2	1	1									1	1	2	5	5	2	PASS	PASS	PASS
20	5	5	5	5	5	2	2	2	1						1	2	5	5	5	5	5	PASS	PASS	PASS
15	5	5	5	5	5	2	1					1	2			2	5	5	5	5	5	PASS	PASS	PASS
10	5	5	5	5	2			2	5	2		5	5	5	1		5	5	5	5	2	PASS	PASS	PASS
5	5	5	2			5	5	5	5	5	1	5	5	5	5	5		2	2	1		PASS	PASS	PASS
0				5	5	5	5	5	5	5	5	5	5	5	5	5	5				1	PASS	PASS	PASS
-5	5	5	5	5	5	5	5	5	5	5		5	5	5	5	5	5	1			2	PASS	PASS	PASS
-10	5	5	5	5	5	5	5	5	5		5	5	5	5	5	5						PASS	PASS	PASS

ATL. FAST 1
N.



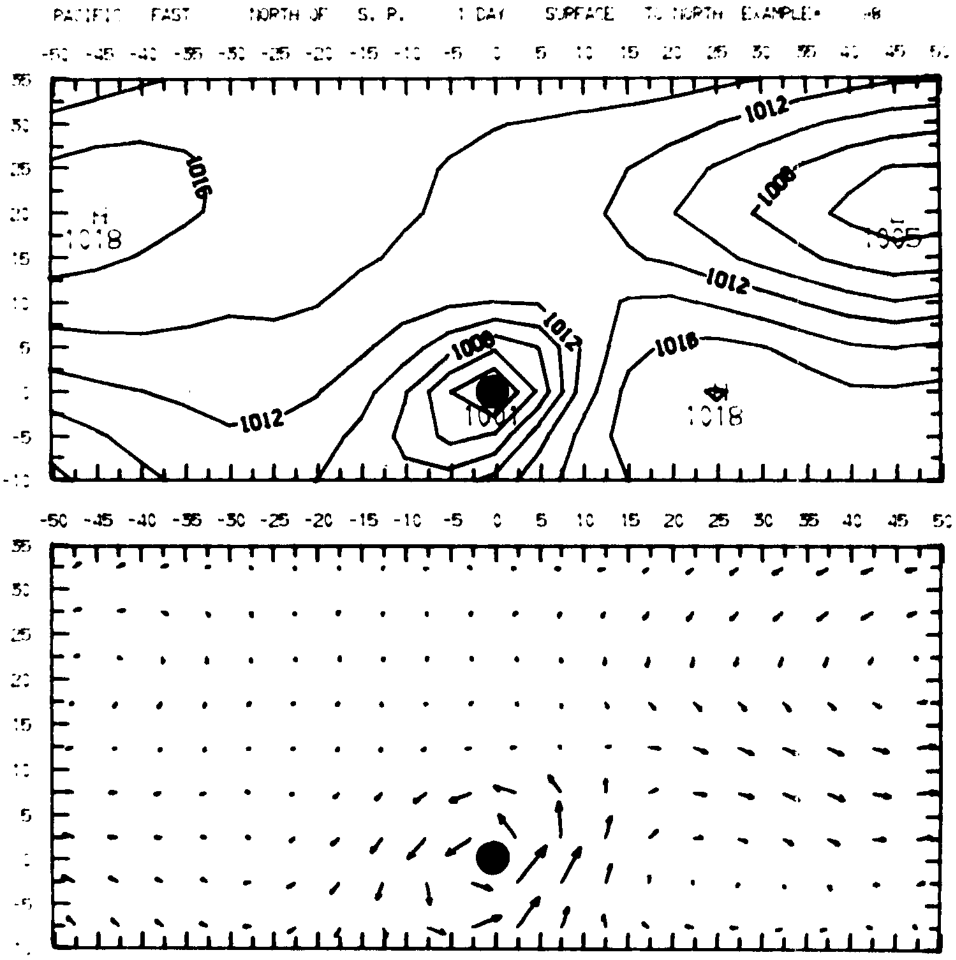


Sfc.

ATLANTIC FAST NORTH OF SUBTROPICAL RIDGE 1 DAY SURFACE TO NORTH EXAMPLE= 39

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35															1	1						PASS	PASS	
30	1	1					1	1	1	1			1	1	1	1					1	PASS	PASS	
25	2	3	2				2	2	2	1			2	3	2	1				1	2	PASS	PASS	PASS
20	1	2	2	2				1	1				1	2	2				2	2	2	PASS	PASS	PASS
15	2	1	1	1	1									2	1			1	2	2	1	PASS	PASS	PASS
10	2	1																				PASS	PASS	
5									1	3	3	3		2	3	2						PASS	PASS	PASS
0						1			3	3	3	3		3	3	3	3	2	1			PASS	PASS	PASS
-5	1	1	1					2	3	3	3		3	3	3	3	3	2				PASS	PASS	PASS
-10	3	3	3	2			1	3	3	3		2	3	3	3	3	2					PASS	PASS	PASS

PAC. FAST N. 1



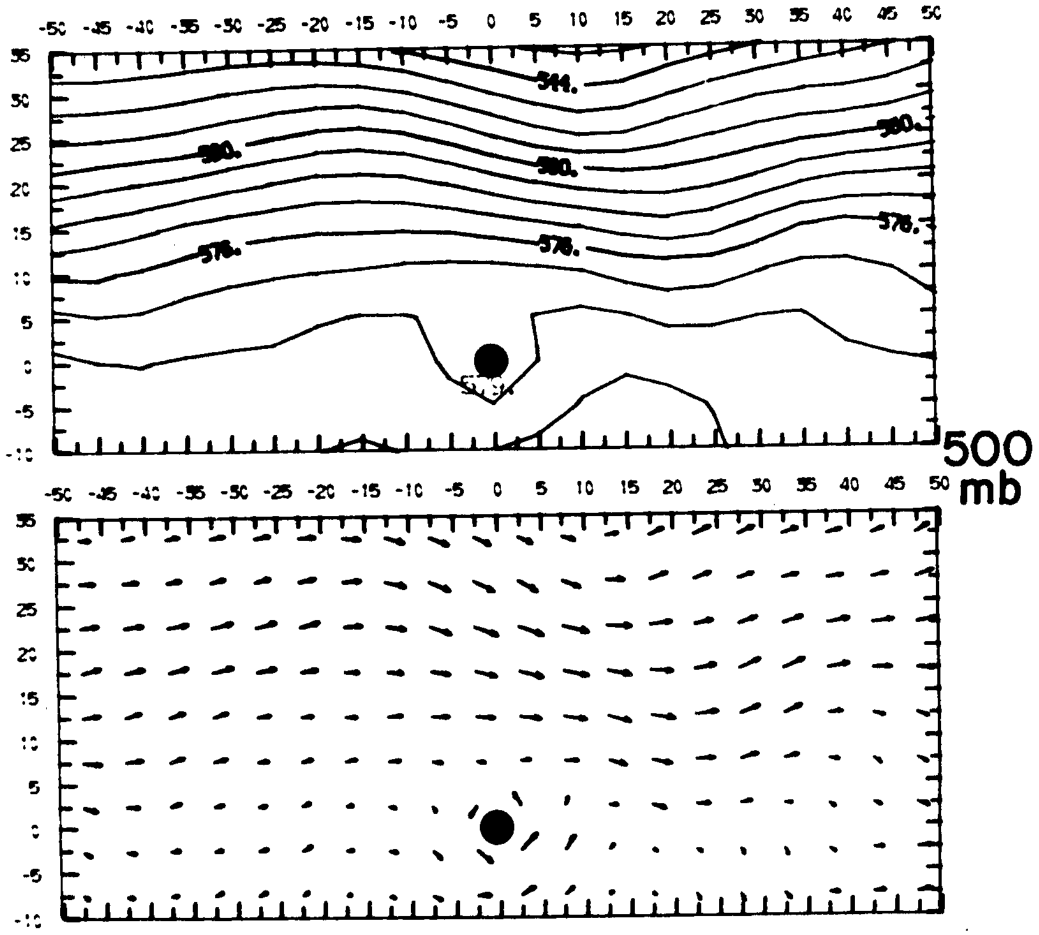
Sfc.

PACIFIC FAST NORTH OF SUBTROPICAL RIDGE 1 DAY SURFACE TO NORTH EXAMPLE• 98

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1										1	1	1	1					1	1	1	PASS	PASS	
30		1	2	2	2	2	2	1	1	1							2	3	3	3	3	PASS	PASS	PASS
25	3	3	3	3	3	3	3	3	2	1	1				1	3	3	3	3	3	3	PASS	PASS	PASS
20	3	3	3	3	3	3	3	3	3	2	1				2	3	3	3	3	3	3	PASS	PASS	PASS
15	3	3	3	3	2	2	2	2	1	1						1	2	3	3	3	3	PASS	PASS	PASS
10	1	1	1	1															1	1	1	PASS	PASS	PASS
5									3	3	3	3		3	3	3	3	2				PASS	PASS	PASS
0	1							3	3	3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	1		1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS

ATL. SLOW -2 N.

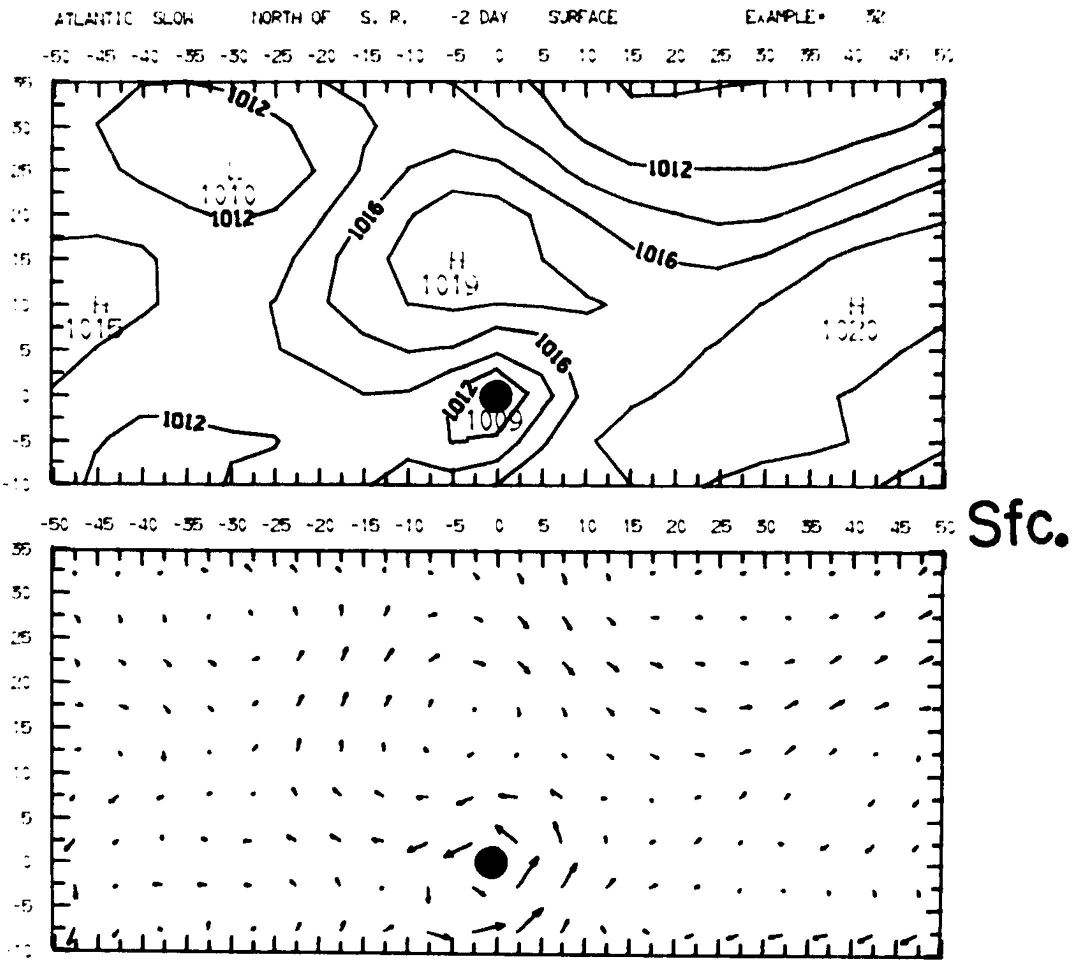
ATLANTIC SLOW NORTH OF S. R. -2 DAY 500 MB EXAMPLE= 54



ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE -2 DAY 500 MB EXAMPLE= 54

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35											2	5	5	2							1	PASS	PASS	PASS
30						1	1	1				5	5	5	1						1	PASS	PASS	PASS
25							1	1				2	5	5	1						2	PASS	PASS	PASS
20	2	1						1					2	2	1					1	1	PASS	PASS	PASS
15	2	1												1	2	1			1	1		PASS	PASS	PASS
10	1	1	1																			PASS	PASS	
5		1	1									1	2									PASS	PASS	PASS
0										2	5	1	5	2			1					PASS	PASS	PASS
-5										1	2		5	5	2				1			PASS	PASS	PASS
-10		1	1									2	5	5	2							PASS	PASS	PASS

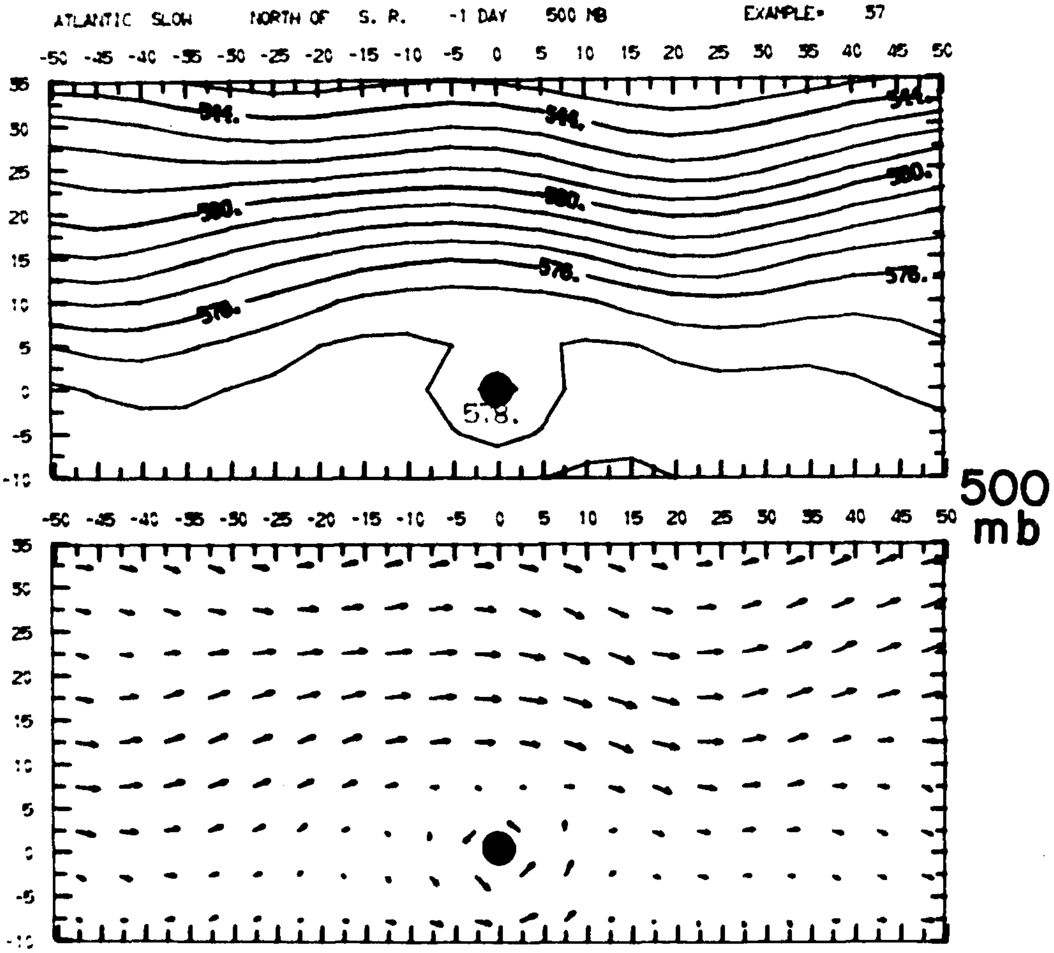
ATL. SLOW -2
N.



ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE -2 DAY SURFACE EXAMPLE• 32

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35							1	1	1					1	1							PASS	PASS	
30									1	1												PASS		
25				1	2	1			1	1												PASS	PASS	PASS
20			1	2	3	1			1	2	2										1	PASS	PASS	PASS
15			1	3	3	2			1	2	1								1	2	1	PASS	PASS	PASS
10			1	3	3	2												1	2	2		PASS	PASS	PASS
5		1	3	3	1	1					2			1	2	2	3	3	3	1		PASS	PASS	PASS
0		2	2	2	2	1	1			3	3	3	3	3	3	3	3	3	3	1		PASS	PASS	PASS
-5		2	3	3	3	2	1	1	2	3	3		3	3	3	3	3	3	2	1		PASS	PASS	PASS
-10		2	2	2	2	1						2	3	3	3	3	2					PASS	PASS	PASS

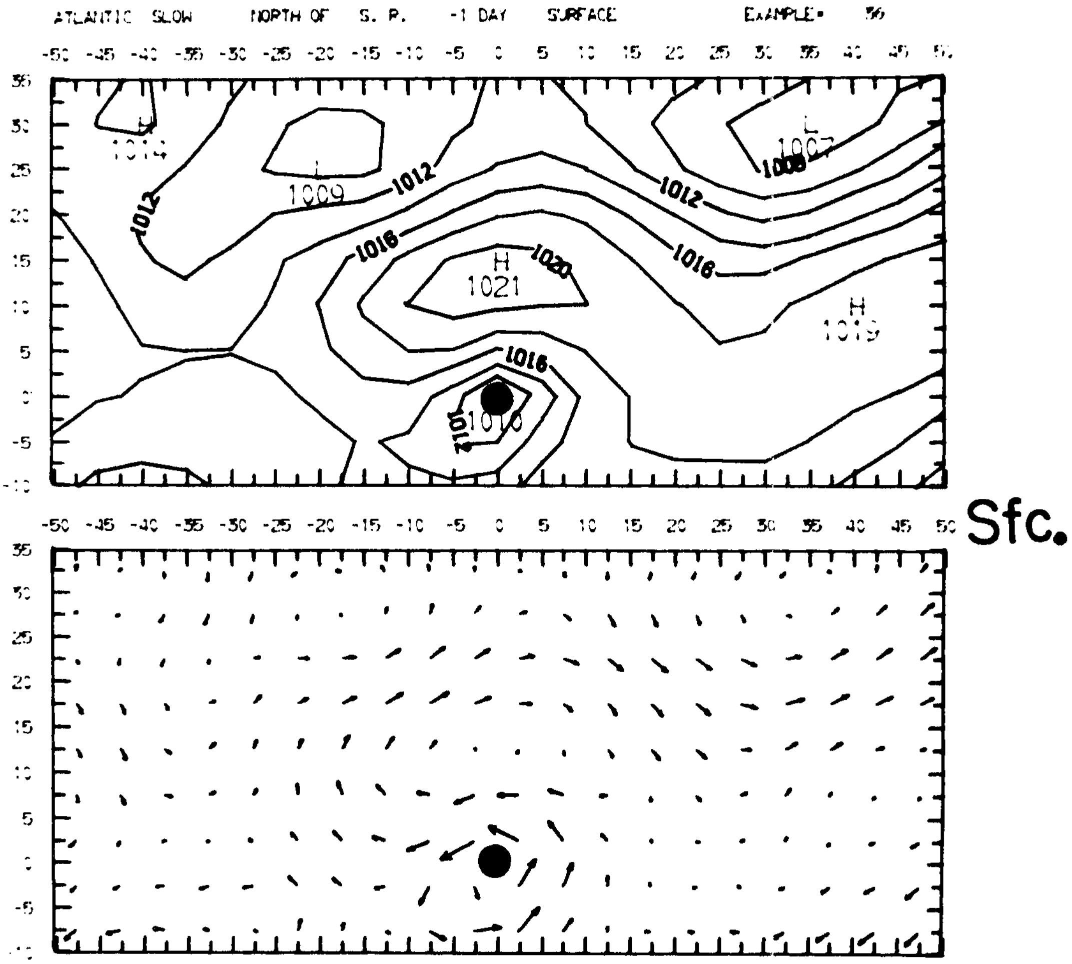
ATL. SLOW N. -1



ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 57

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1														1							PASS	PASS	
30	1	1												1	2	1					1	PASS	PASS	PASS
25															2	2					2	PASS	PASS	PASS
20	1	2	2																	1	2	PASS	PASS	PASS
15	3	3	3	1				1	2	2	2	1								1	1	PASS	PASS	PASS
10	3	3	3	2	1			2	3	3	3	3	1									PASS	PASS	PASS
5	1	2	2	1			1	2	2	1			2	2							1	PASS	PASS	PASS
0							1	2		2	3	2		2							1	PASS	PASS	PASS
-5										2	3	1		1	2							PASS	PASS	PASS
-10													3	2								PASS	PASS	

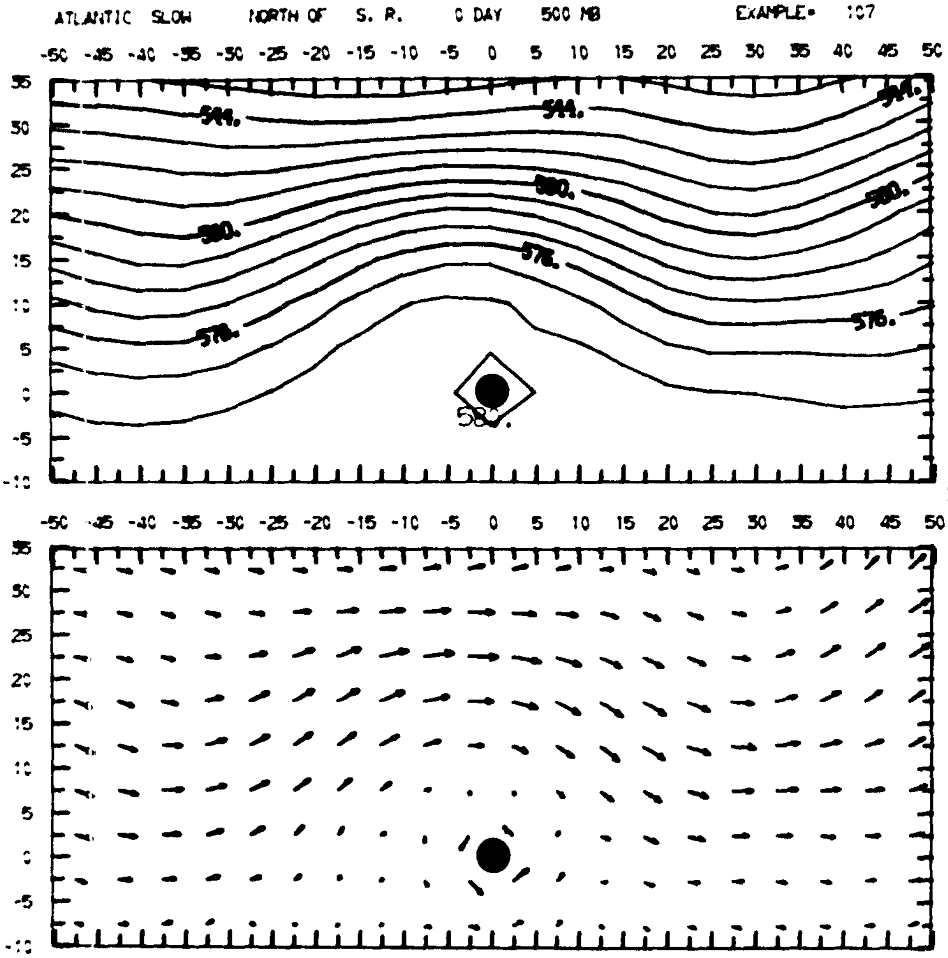
ATL. SLOW N. -1



ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 36

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
											TEST 1											EST 2		
35		1	2	1														1	1	1		PASS	PASS	
30		1	2	1													1	1				PASS	PASS	PASS
25											1	1										PASS	PASS	
20			1	2	2					1	2	3	2									PASS	PASS	PASS
15		1	3	3	3	2			1	3	3	3	2									PASS	PASS	PASS
10		1	3	3	3	3			3	3	3	3	2									PASS	PASS	PASS
5		1	2	2	2	2								1	1	1		1	1	1	1	PASS	PASS	PASS
0			1	1	1	1				3	3	3		3	3	3	3	3	3	2		PASS	PASS	PASS
-5		1	2	2	3	2	1		2	3	3		3	3	3	3	3	3	3			PASS	PASS	PASS
10	1	2	3	3	3	1						3	3	3	3	3	3	1				PASS	PASS	PASS

ATL. SLOW O N.



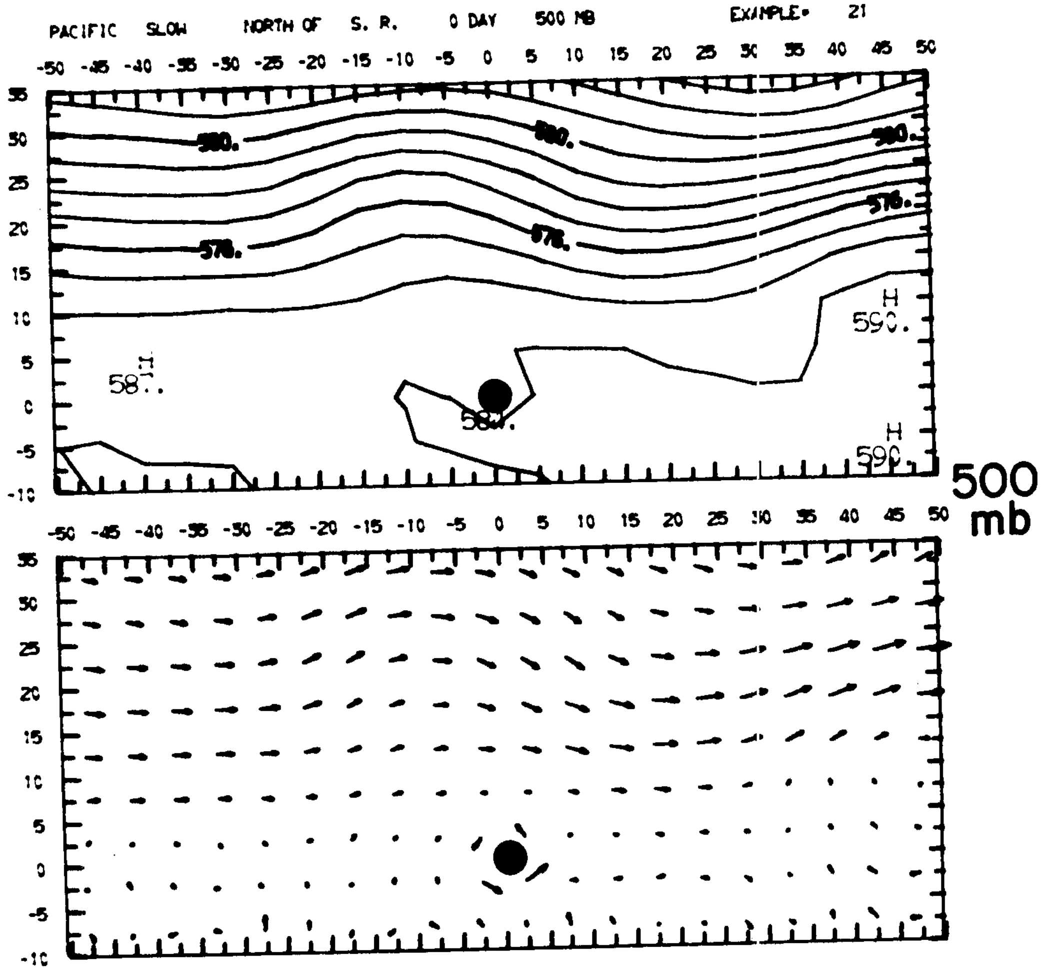
500 mb

ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 107

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35							1	1	1	1										1	5	PASS	PASS	PASS
30	1															1	2	1		1	5	PASS	PASS	PASS
25									2	5	5	2			1	5	5	5			5	PASS	PASS	PASS
20		2	5	5	5	1		5	5	5	5	5	2		2	5	5	5			5	PASS	PASS	PASS
15	1	5	5	5	5	1		5	5	5	5	5	5		2	5	5	5	2			PASS	PASS	PASS
10	2	5	5	5	5	1	2	5	5	5	5	5	5	1	1	5	5	5	2	2		PASS	PASS	PASS
5	2	5	5	5	5		5	5	5	5	5	5	5	5		2	1	1	2	5	1	PASS	PASS	PASS
0	1	5	5	5	1		5	5	5	1	5		5	5					1	1		PASS	PASS	PASS
-5	2	5	5	1			1	5	5		2		5	5	1							PASS	PASS	PASS
-10												2	2	1								PASS	PASS	

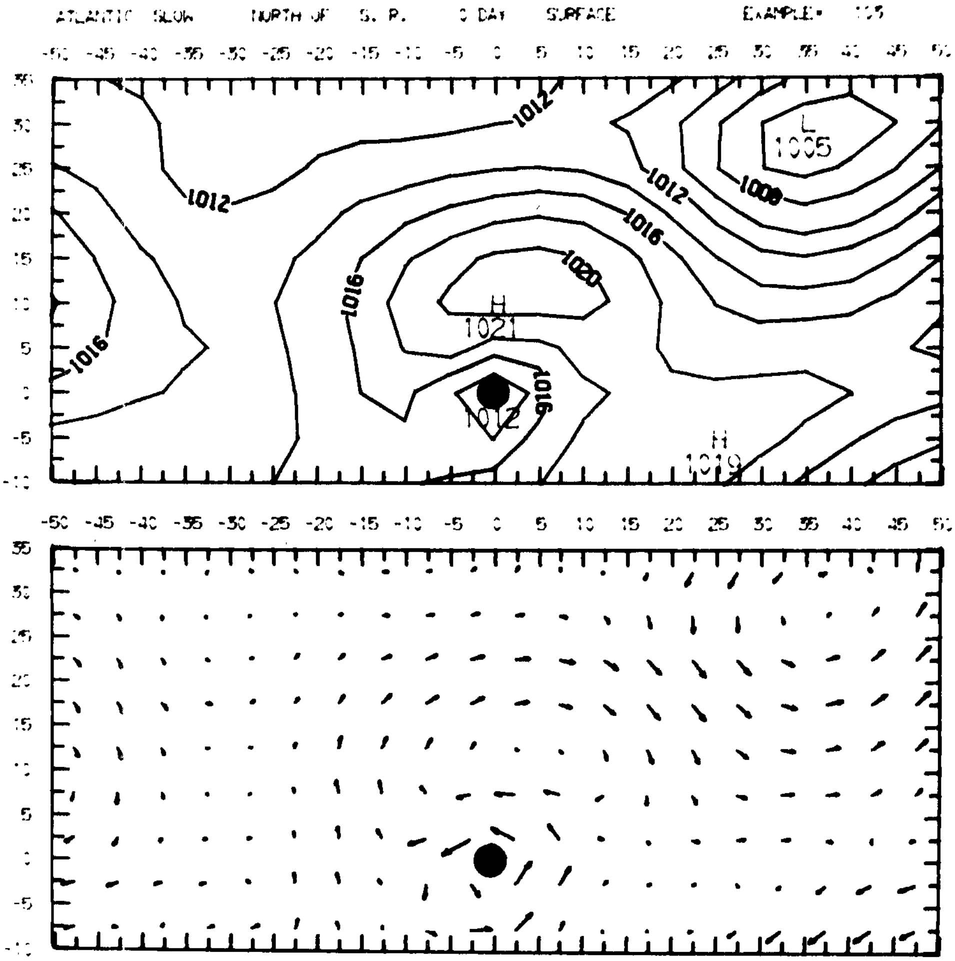
PAC. SLOW O
N.



PACIFIC SLOW NORTH OF SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 21

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1															1	2	1				PASS	PASS	
30								2	2	1						2	3	2				PASS	PASS	PASS
25								3	3	3	1			1	1	2	2					PASS	PASS	PASS
20								1	2	3	1			1	1	1				2	3	PASS	PASS	PASS
15			1	1						1				1	2	1			2	3	3	PASS	PASS	PASS
10		1	2	3	2	1												1	3	3	3	PASS	PASS	PASS
5																				1		PASS		
0	2				1								1	1						1		PASS	PASS	
-5	2	3	1		1	2		1					3	1	2	2			1			PASS	PASS	PASS
-10														1		1						PASS		

ATL. SLOW O N.

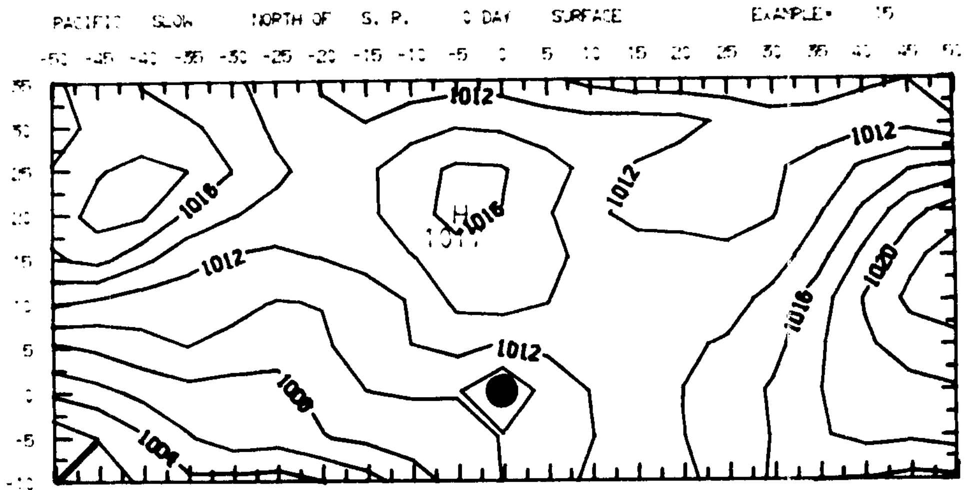


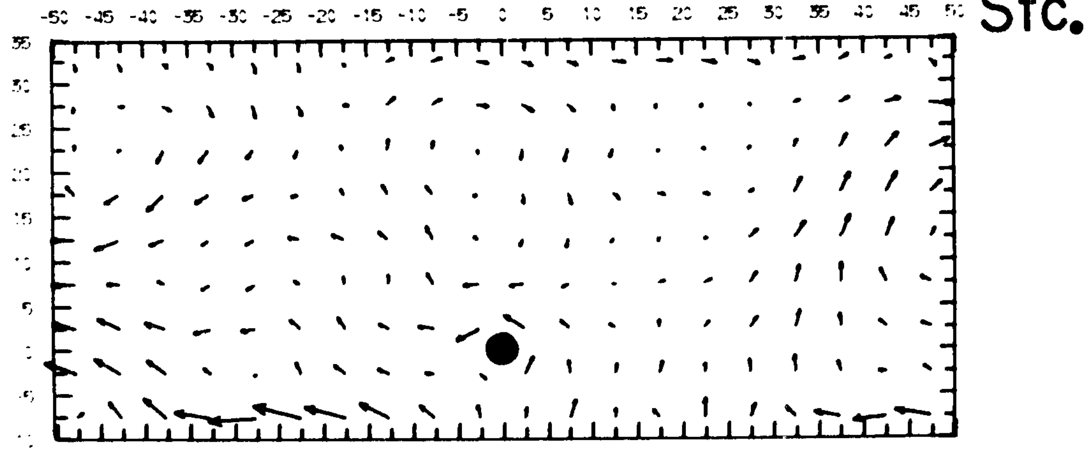
Sfc.

ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 103

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	2	2	1								1	3	3	2		1	3	3	3	3	PASS	PASS	PASS
30	2	2	2	1						1	2	3	3	2		2	3	3	3	3	2	PASS	PASS	PASS
25	3	2						1	2	3	3	3	3	1		3	3	3	3	3		PASS	PASS	PASS
20	2			1	1				2	3	3	3	3	3		2	3	3	3	2		PASS	PASS	PASS
15			1	3	3	3	1		3	3	3	3	3	3		2	3	3	3	1		PASS	PASS	PASS
10			3	3	3	3	3		3	3	3	3	3	3		1	2	2	1			PASS	PASS	PASS
5			3	3	3	3	3		2	3			3	3	1					1	2	PASS	PASS	PASS
0		1	3	3	3	3	3			3	3	3	3	3	3	3	3	3	3	2		PASS	PASS	PASS
-5	3	3	3	3	3	3	1			3	3	3	3	3	3	3	3	3			2	PASS	PASS	PASS
-10	3	3	3	3	3	2				2	3	3	3	3	3	3	3			3	3	PASS	PASS	PASS

PAC. SLOW O N.

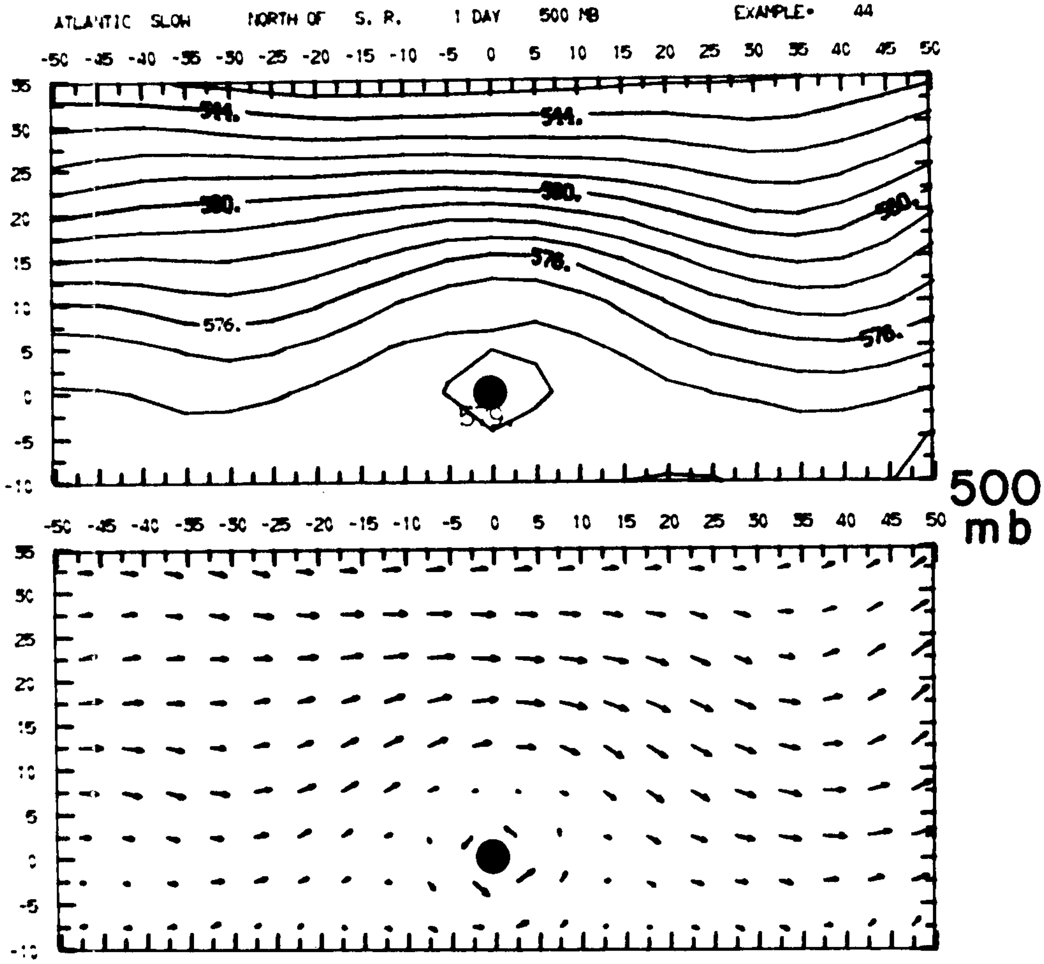




PACIFIC SLOW NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 15

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	2	3	2	1									1							PASS	PASS	PASS
30	1	1		1																		PASS		
25			1	1													1					PASS	PASS	
20		1	1				1						1			1	1			2	2	PASS	PASS	PASS
15				2	2	3	2	1								2			3	3	3	PASS	PASS	PASS
10		1	2	2	3	3	3	2										2	3	3	3	PASS	PASS	PASS
5	3	3	2	2	3	2	3	2			2						2	3	3	3	3	PASS	PASS	PASS
0	3	2	2	3	3	3	2	2	3	3	3				2	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	1	1	1												1	1	1	1	1	2	PASS	PASS	PASS
-10		1	2					1			1	2				1				1	2	PASS	PASS	

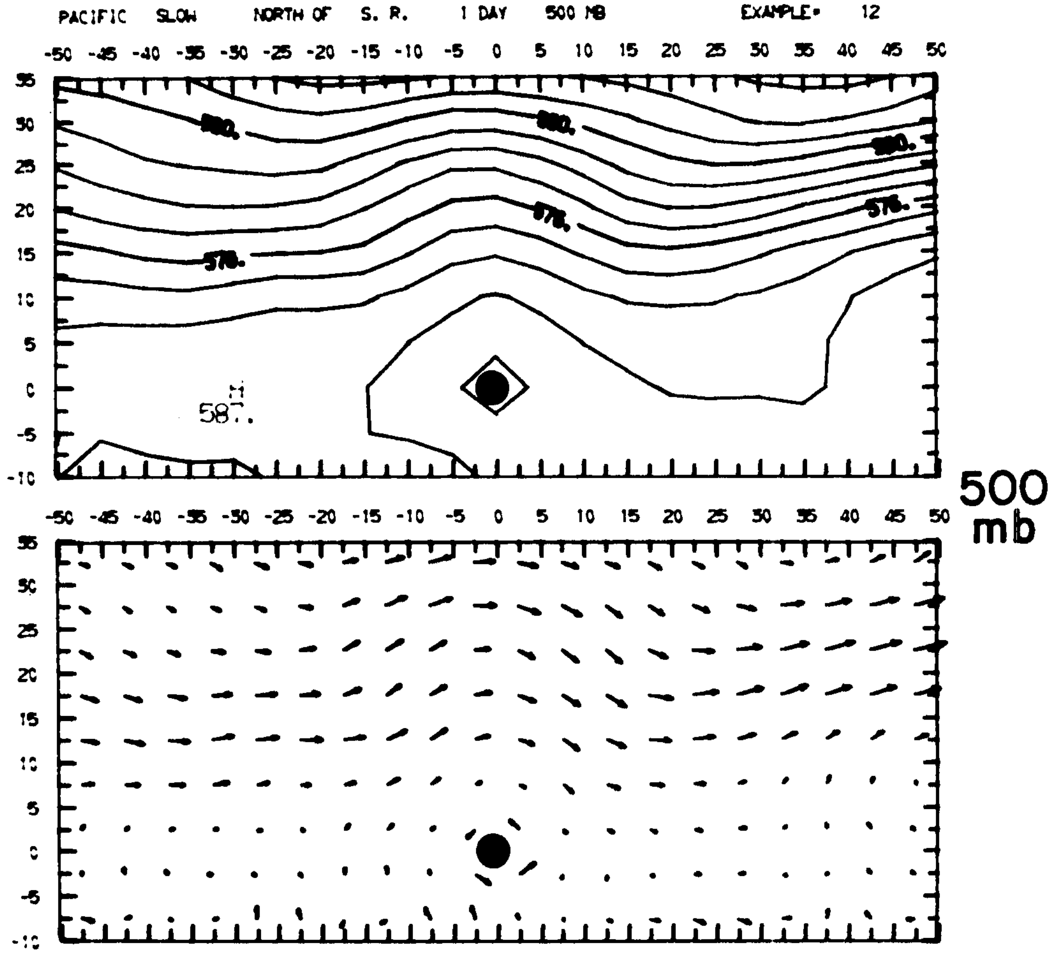
ATL. SLOW N. 1



ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 44

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35																					1	PASS		
30																					1	PASS		
25																	2	1				PASS	PASS	
20								1	2	5	2	1				1	5	5	2			PASS	PASS	PASS
15									5	5	5	5	5			1	5	5	5	1		PASS	PASS	PASS
10					1	1			5	5	5	5	5	1		1	5	5	5	5		PASS	PASS	PASS
5					1			1	5	5	5	5	5	2		2	5	5	5	5		PASS	PASS	PASS
0								5	2		5		2	5				1	1			PASS	PASS	PASS
-5		2	1					2			2			2							5	PASS	PASS	PASS
-10		1													1	1					1	PASS	PASS	

PAC. SLOW 1
N.

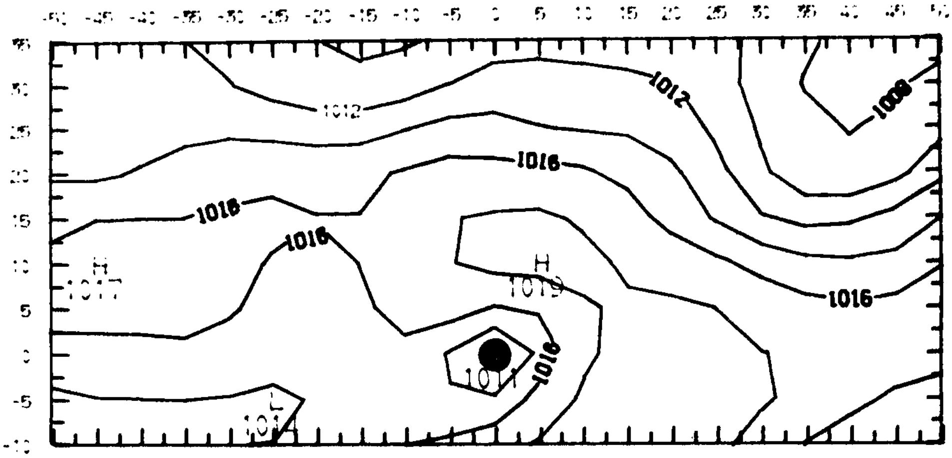


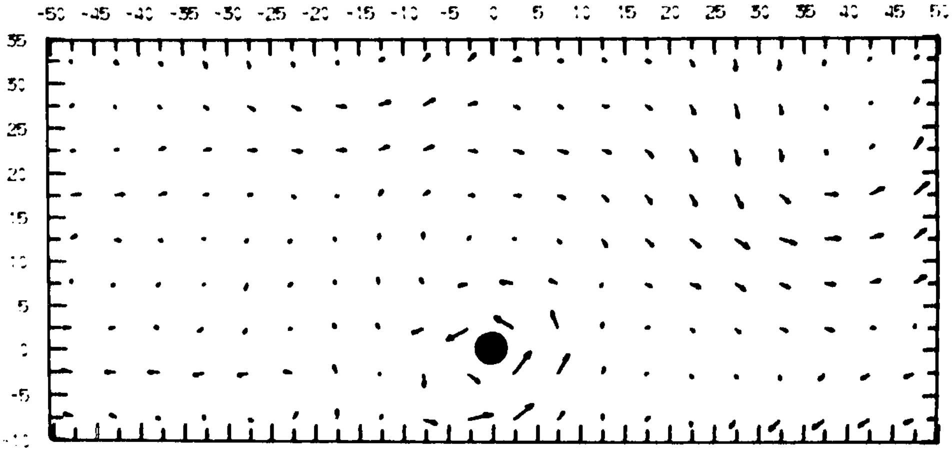
PACIFIC SLOW NORTH OF SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 12

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	3	2	1																		PASS	PASS	
30	1	1	1							1	1						1	1				PASS	PASS	PASS
25									1	3	3	1										PASS	PASS	
20									1	3	3	1								1	3	PASS	PASS	PASS
15	1	1	1	2	2	2	1			3	3				1				1	2	3	PASS	PASS	PASS
10	1	1	2	3	3	1				2	1								1	3	3	PASS	PASS	PASS
5	1			1	1	1	2			1										1	1	PASS	PASS	
0	2	1				1	1		2													PASS	PASS	
-5	3	3	2	1	1	2				2	3	2	1	1	1	1	1	1				PASS	PASS	PASS
-10																		1				PASS		

ATL. SLOW N. 1

ATLANTIC SLOW NORTH OF S. R. 1 DAY SURFACE EXAMPLE• 43



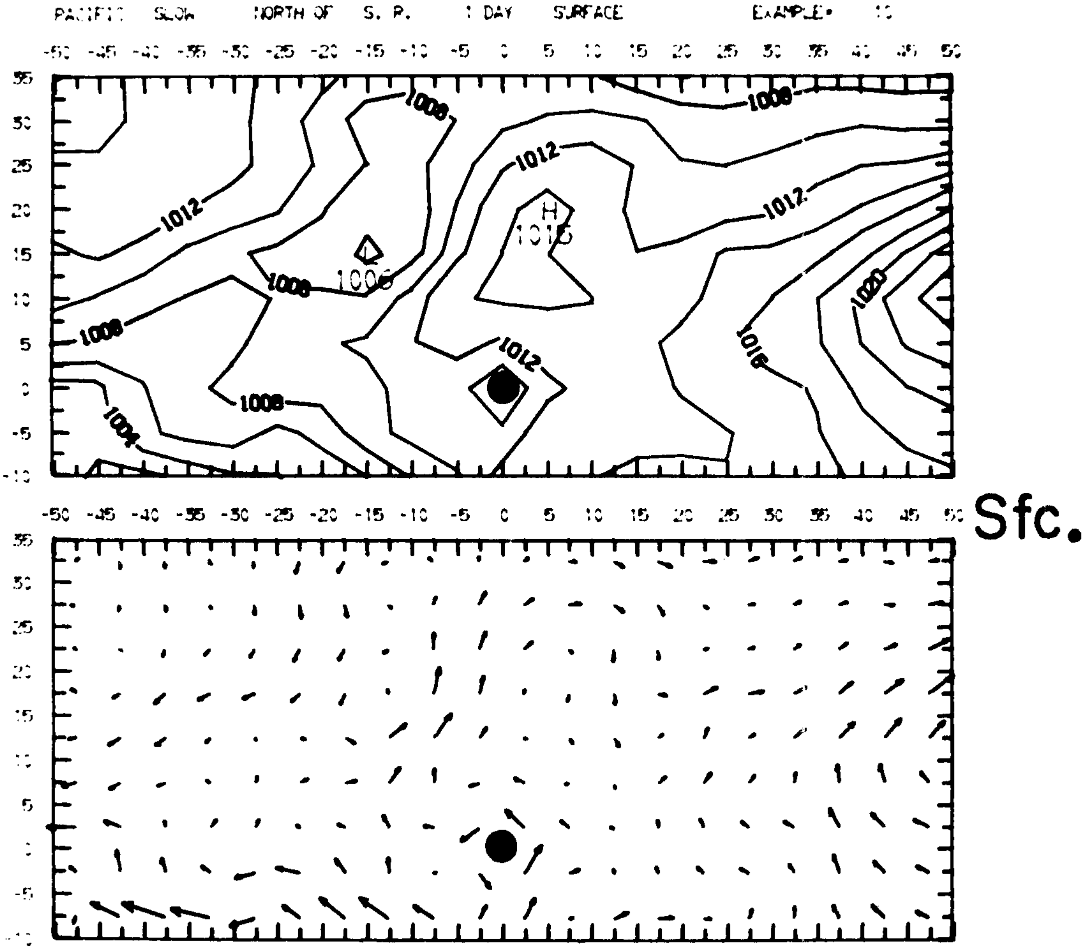


Sfc.

ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE• 43

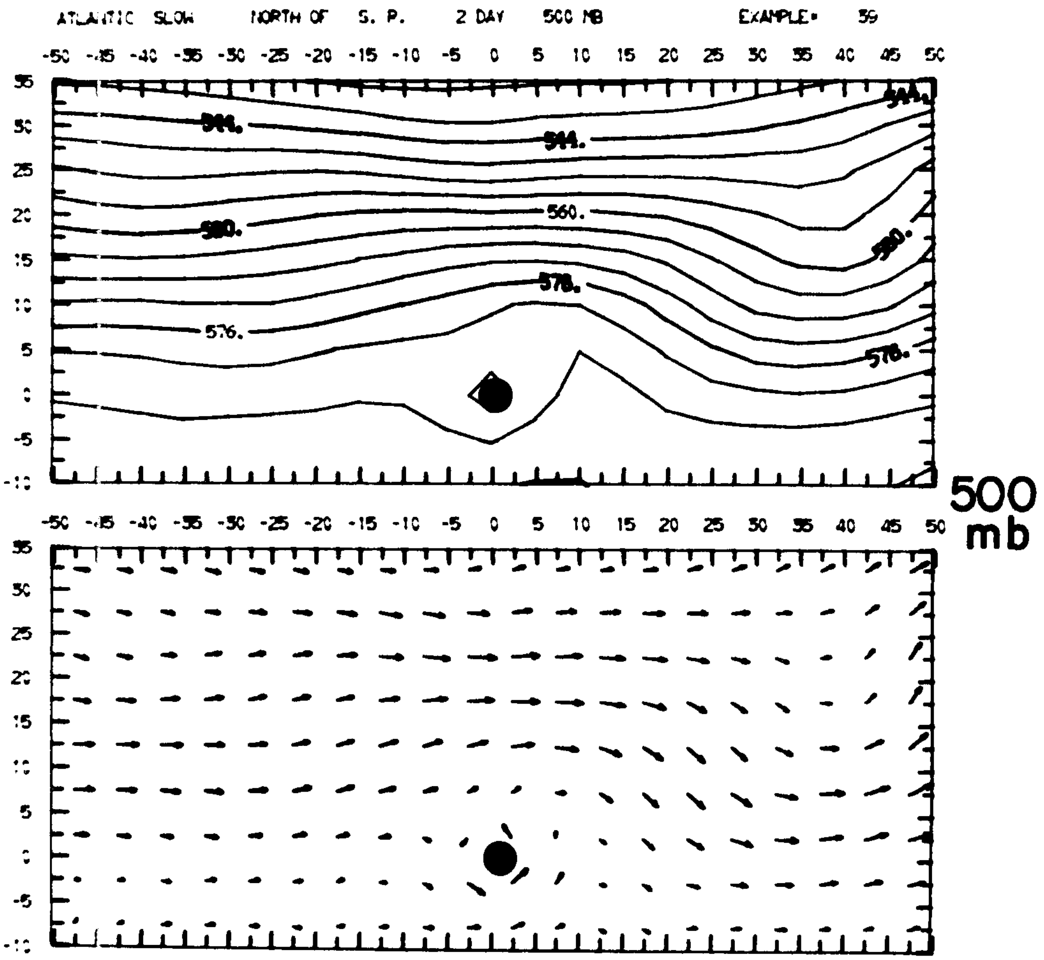
	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1																	1	1	1	PASS	PASS	PASS
30												1						2	2	2	1	PASS	PASS	PASS
25										1	1						2	3	3	3	1	PASS	PASS	PASS
20									1	2	2	2	1				3	3	3	3	1	PASS	PASS	PASS
15									1	2	2	2	2			1	3	2	2	1		PASS	PASS	PASS
10											2	3	2									PASS	PASS	
5													1	1	1							PASS	PASS	
0										3	3	3		3	3	3	2	1				PASS	PASS	PASS
-5	1	1	3	2	2	2				3	2	1	3	3	3	3	3	1				PASS	PASS	PASS
-10	2	2	3	3	1						2	3	3	3	3	3	1					PASS	PASS	PASS

PAC. SLOW N. 1



PACIFIC SLOW NORTH OF SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE= 10																							
	TEST 1																				TEST 2		
																					SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35			1	1	2	2																PASS		
30					1																	PASS		
25								1	1													PASS		
20							2	3	2												2	PASS	PASS	PASS
15				2	2	2	2	2	3								1	1	2	3	3	PASS	PASS	PASS
10			1	3	3	2	2	2	3								2	3	3	3	3	PASS	PASS	PASS
5		1	2	3	3	2	2	3	1							3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	2	2	2	1		1			1				2	3	2	3	3	3	3	PASS	PASS	PASS
-5	3	2	1	1	2											3	2	2	2	2	2	PASS	PASS	PASS
-10	2	1	1	2	1	1		1										1	1	1	1	PASS	PASS	

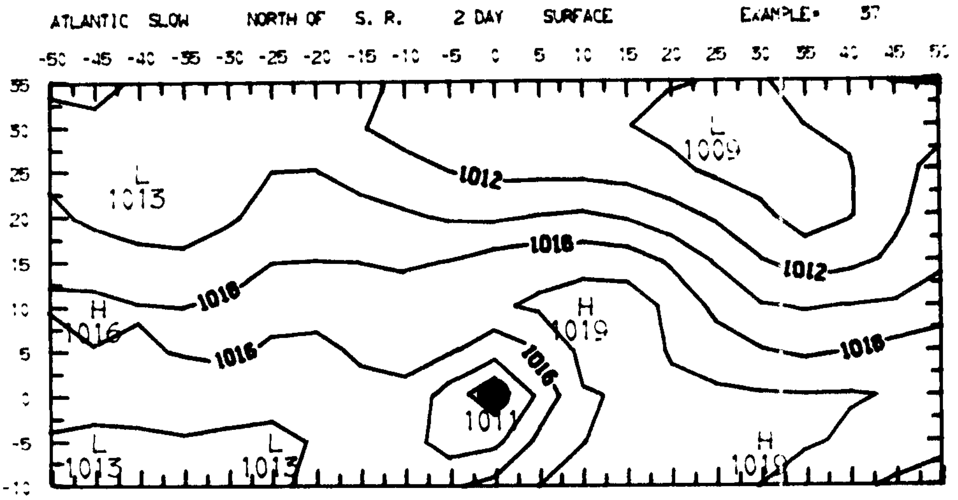
ATL. SLOW 2
N.

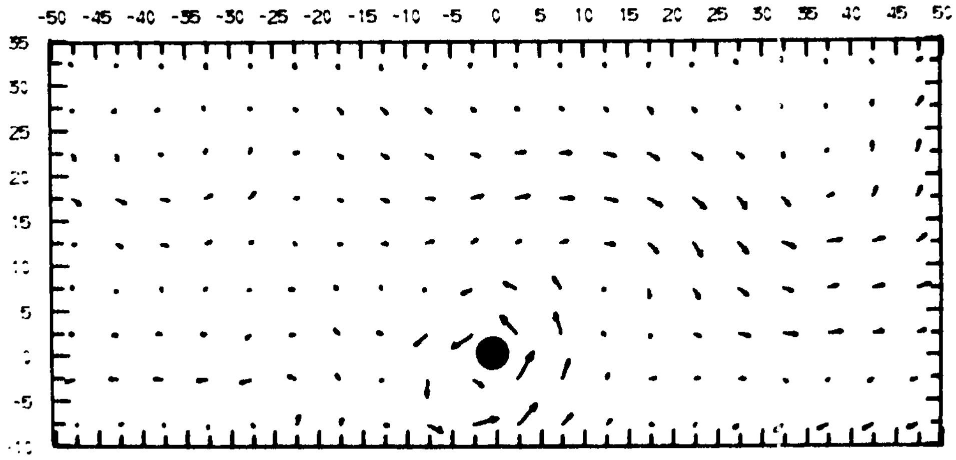


ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE 2 DAY 500 MB EXAMPLE= 59

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35									1											1	2	PASS	PASS	PASS
30									1	1	1									2	5	PASS	PASS	PASS
25																					5	PASS	PASS	PASS
20										1								1	1			PASS	PASS	
15									1	5	5	5	5	1			2	5	5	2		PASS	PASS	PASS
10									1	5	5	5	5	5			5	5	5	5		PASS	PASS	PASS
5									1	1	5	5	5	2		1	5	5	5	2		PASS	PASS	PASS
0											2		5	2			1	1	1			PASS	PASS	PASS
-5											2		2								1	PASS	PASS	
-10	1	2										1	1									PASS	PASS	

ATL. SLOW N. 2





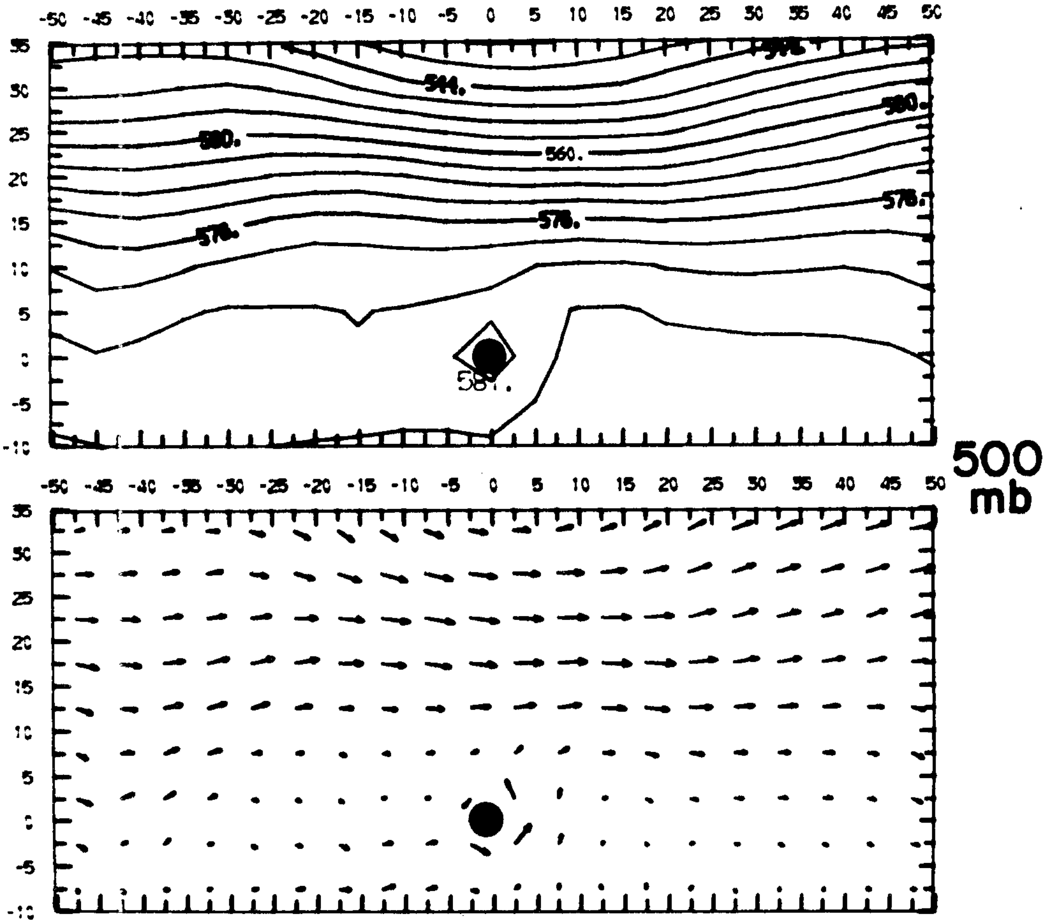
Sfc.

ATLANTIC SLOW NORTH OF SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE= 37

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1	1																			PASS		
30																1						PASS	PASS	
25																	1	1				PASS	PASS	
20																	1	2	1			PASS	PASS	PASS
15												1	1				2	2	2			PASS	PASS	PASS
10												1	2	3				1				PASS	PASS	PASS
5											2		3	3								PASS	PASS	PASS
0										3	3	2	3	2	2	1	1	1	2	1	1	PASS	PASS	PASS
-5	1	2	3	2	2	2	1			3	3		3	3	3	3	3	2	1			PASS	PASS	PASS
-10	2	2	3	3	2	2						3	3	3	3	3	2					PASS	PASS	PASS

ATL. LOOP N. -2

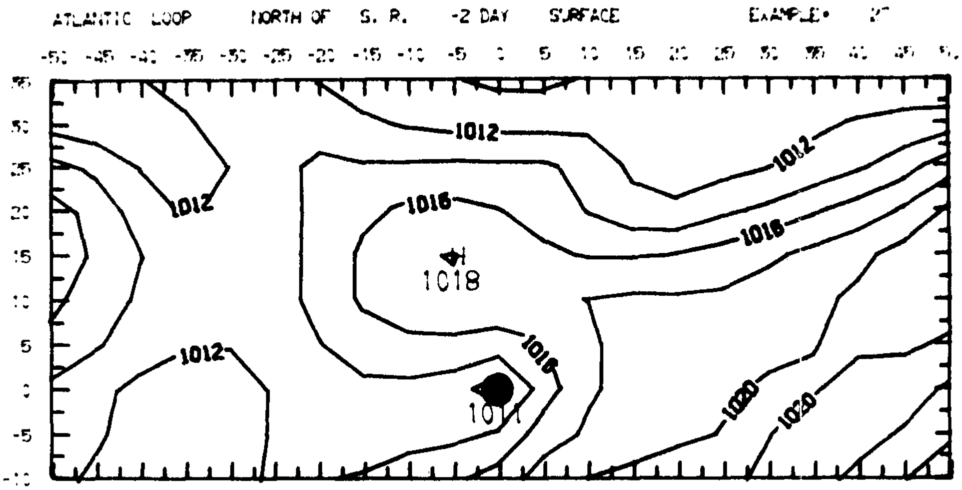
ATLANTIC LOOP NORTH OF S. R. -2 DAY 500 MB EXAMPLE= 28



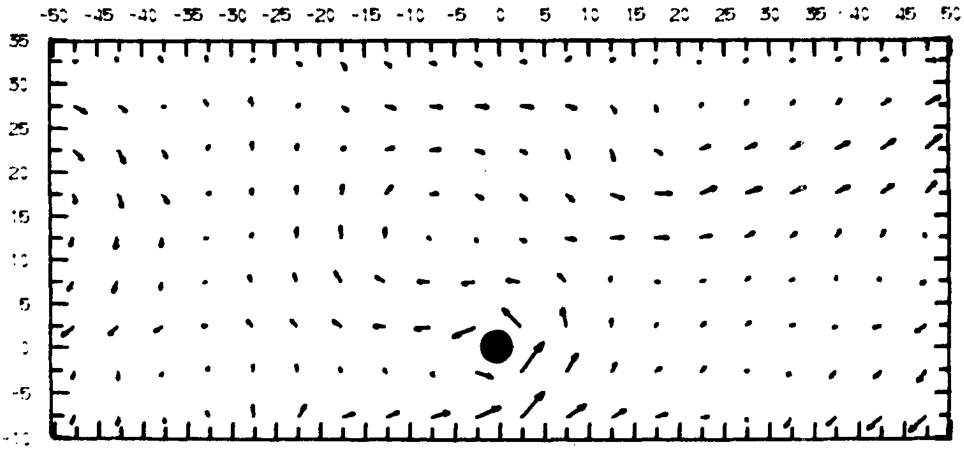
ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE -2 DAY 500 MB EXAMPLE= 28

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1	1	1	1				1	2	2	2	2	1								PASS	PASS	PASS
30					1					1	2	5	5	2						2	2	PASS	PASS	PASS
25												2	5	1						2	5	PASS	PASS	PASS
20																				2	5	PASS	PASS	PASS
15																				1		PASS	PASS	
10		1	1										1	1								PASS	PASS	
5		1	1					1				1	5	5	2	2	1	1	1			PASS	PASS	PASS
0		1	1				2	5	5	2	5		5	5	2	5	2	1	1	2	1	PASS	PASS	PASS
-5		1	2			1	1	5	5	2	1		5	5	5	5	2	1	1	1	1	PASS	PASS	PASS
-10					1										1	1						PASS	PASS	

ATL. LOOP N. -2



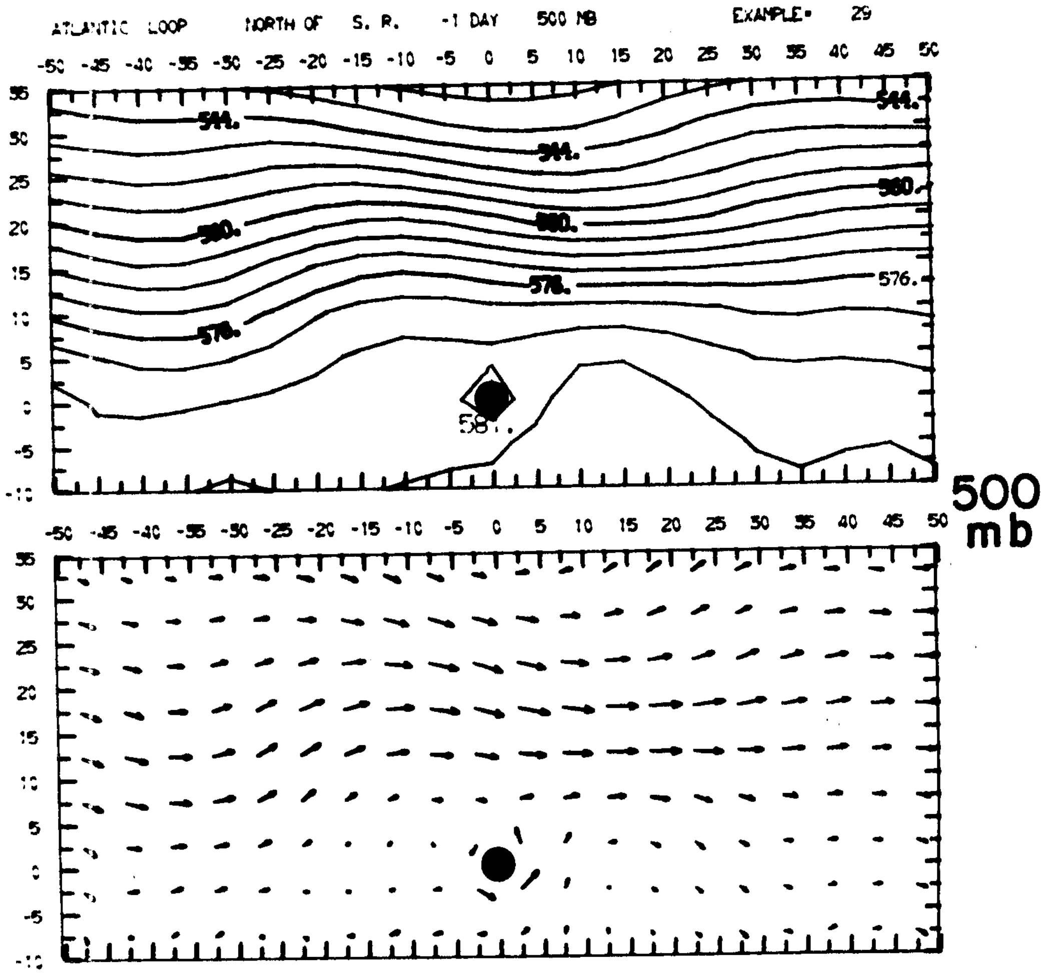
Sfc.



ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE -2 DAY SURFACE EXAMPLE= 27

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35																								
30																								
25															1						1	PASS	PASS	
20				2	2									1	1					1	3	PASS	PASS	PASS
15			1	3	3	2	1		1	1									1	3	3	PASS	PASS	PASS
10			2	3	3	3	1										1	2	3	3	3	PASS	PASS	PASS
5		1	3	3	3	3	2	1			3		1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0		2	3	3	3	3	2	2	3	3	3		3	3	3	3	3	3	3	3	1	PASS	PASS	PASS
-5	2	3	3	3	3	3	2	2	3	2	1	2	3	3	3	3	3	3	3	1		PASS	PASS	PASS
-10	2	2	2	2	1	1	1	1				2	3	3	3	3	3	1				PASS	PASS	PASS

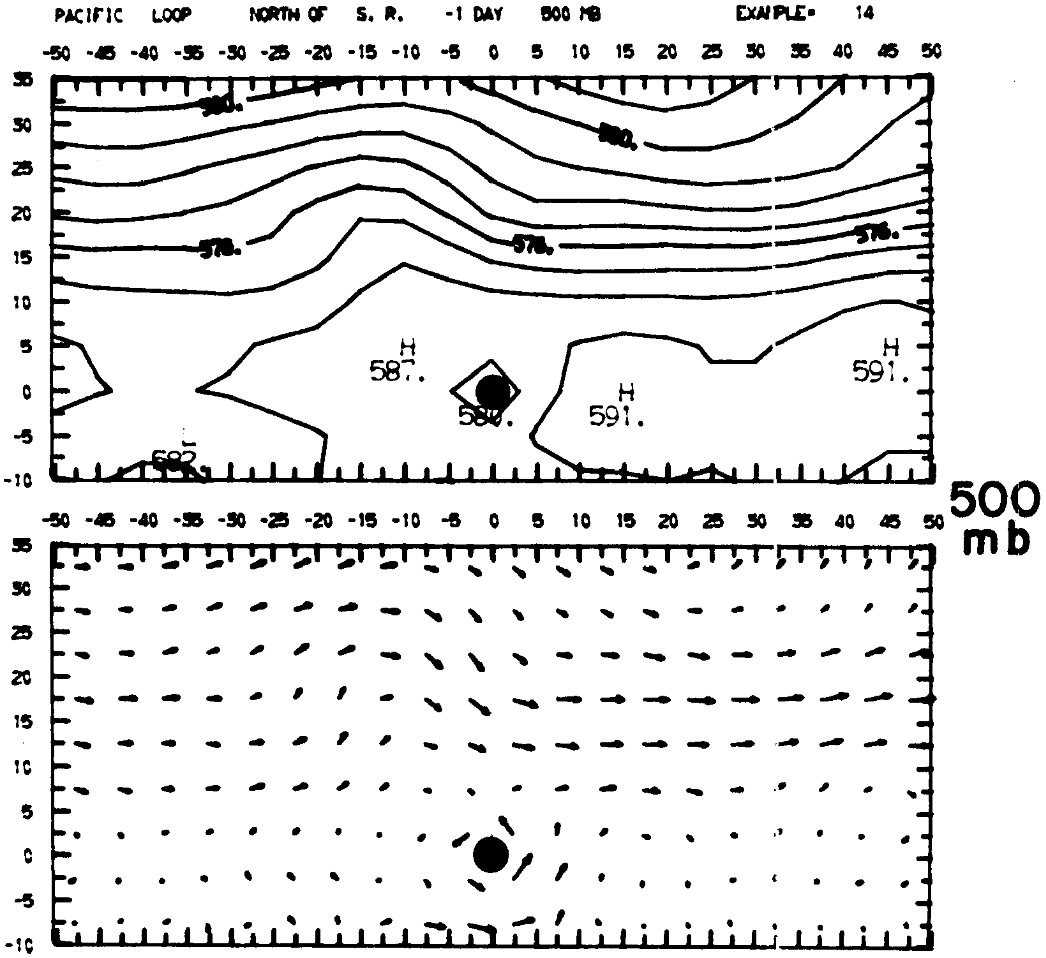
ATL. LOOP N. -1



ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 29

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1								1	2	2	2	1									PASS	PASS	PASS
30										1	2	2	2									PASS		
25												2	2	1								PASS	PASS	
20													1	1							1	PASS	PASS	
15		1	2	2	1			1	2	1												PASS	PASS	PASS
10		2	3	3	2			2	3	2			1	2	1							PASS	PASS	PASS
5		2	3	2	1				2	1		2	3	3	3							PASS	PASS	PASS
0		1	1	1									3	3	3							PASS	PASS	PASS
-5		2	2				1	1				2	3	3	3							PASS	PASS	PASS
-10		3	2										1	3	2							PASS	PASS	PASS

PAC. LOOP -1
N.

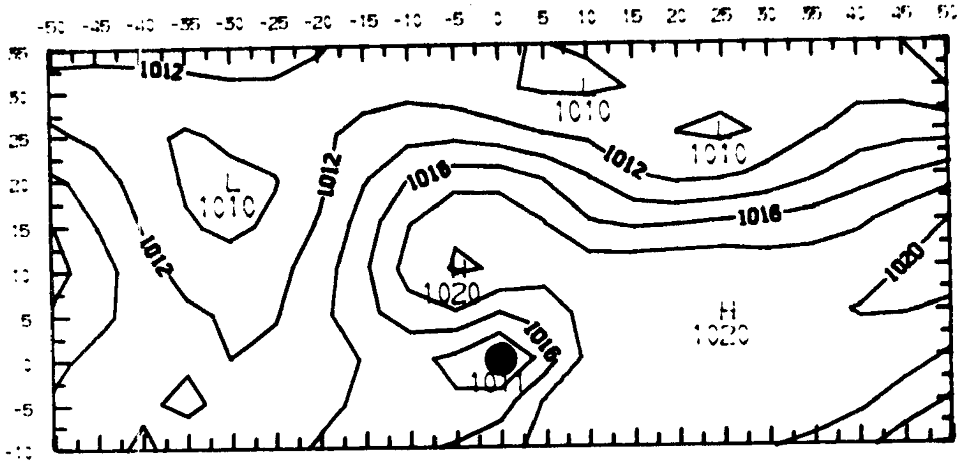


PACIFIC LOOP NORTH OF SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 14

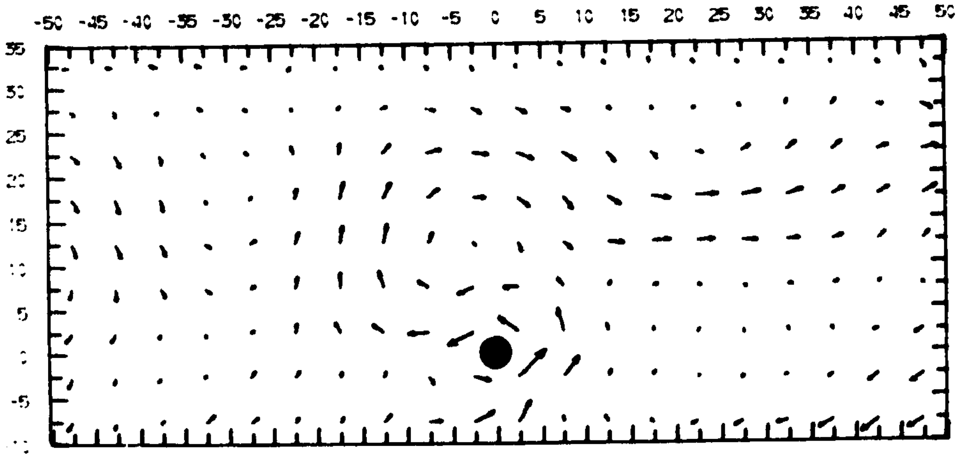
	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35															1						1	PASS	PASS	
30							1	1	1	1					1							PASS	PASS	
25							2	3	3													PASS	PASS	
20							2	3	3													PASS	PASS	
15		1						2	2													PASS	PASS	
10	1	2	2	2	2	2	1		1										1	2	1	PASS	PASS	PASS
5	1	2	2	2	2								1	2	1			1	2	1		PASS	PASS	PASS
0		2	2	2	1					1	1		3	3	2			2	2	1		PASS	PASS	PASS
-5	1	3	2	1	:	2				1			3	2	2	2	2	2	3	3	1	PASS	PASS	PASS
-10																			1					

ATL. LOOP N. -1

ATLANTIC LOOP NORTH OF S. R. -1 DAY SURFACE EXAMPLE= 27



Sfc.

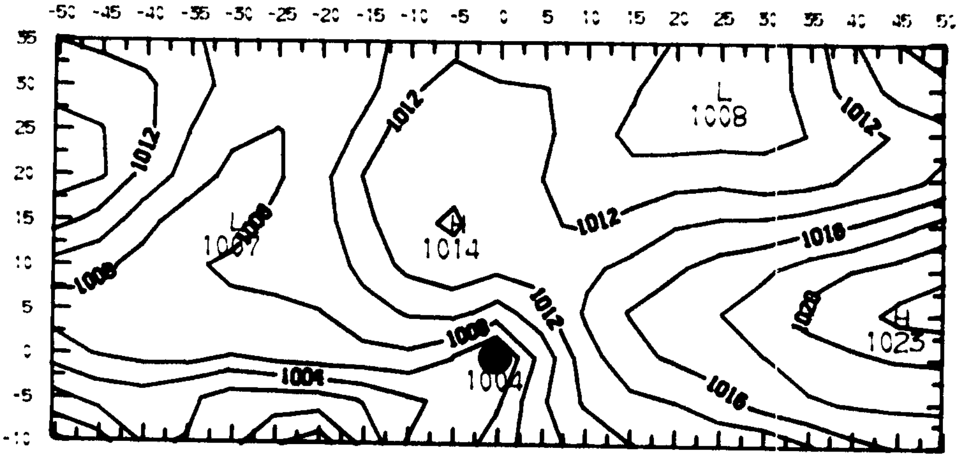


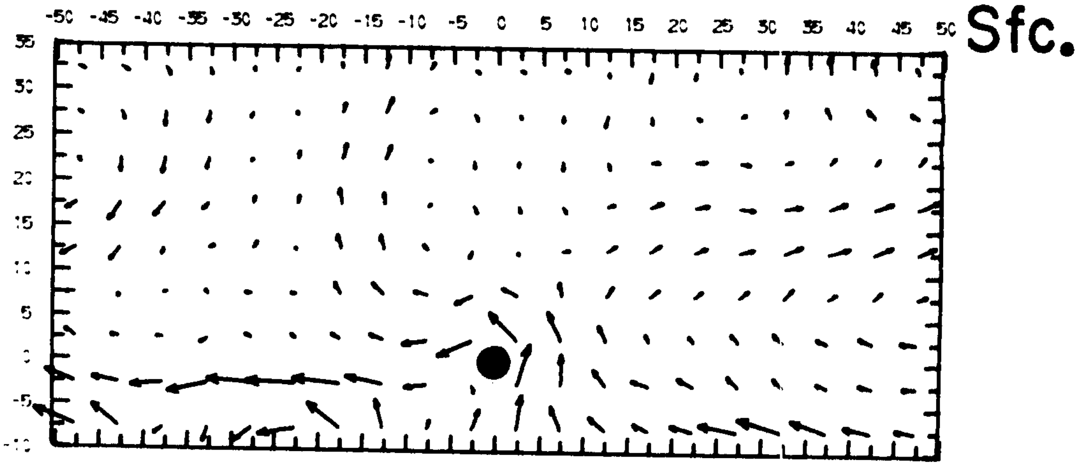
ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 27

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35																								
30																								
25																					1	PASS	PASS	PASS
20				2	2	2			1	2	2													
15			2	3	3	3	2		1	3	3	2								1	3	PASS	PASS	PASS
10			3	3	3	3	3		1	3	3	2	2	3	3	2	1	1	1	3	3	PASS	PASS	PASS
5		1	3	3	3	3	3						3	3	3	3	3	3	3	3	2	PASS	PASS	PASS
0		2	3	3	3	3	2	2	1	3	3		3	3	3	3	3	3	3	3	1	PASS	PASS	PASS
-5	2	3	3	3	3	3	2	2	1	2		3	3	3	3	3	3	3	2			PASS	PASS	PASS
-10	2	3	3	3	2	2	1				1	3	3	3	3	3	2					PASS	PASS	PASS

PAC. LOOP N. -1

PACIFIC LOOP NORTH OF S. R. -1 DAY SURFACE EXAMPLE= 14



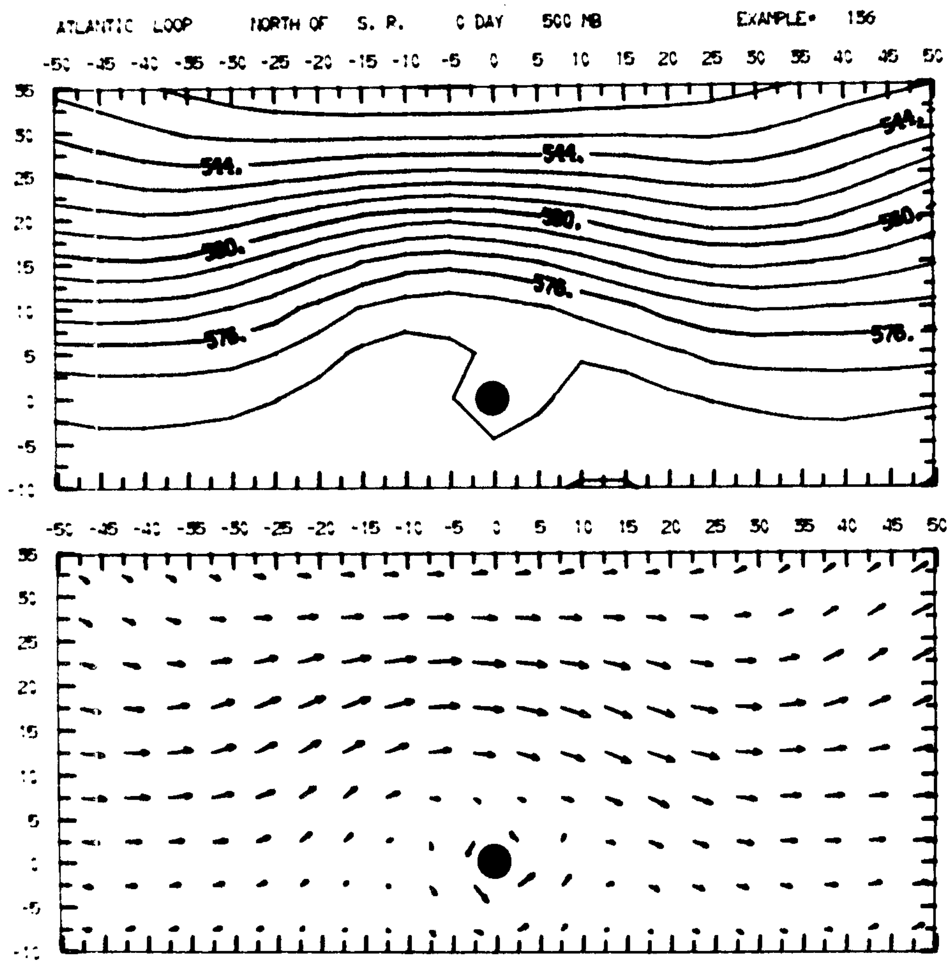


PACIFIC LOOP NORTH OF SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 14

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35							1														2	PASS	PASS	PASS
30							1	1							1						1	PASS	PASS	
25						1	1		1													PASS		
20					2	2	1		1													PASS	PASS	
15			1	3	3	2	1											1	1	2	2	PASS	PASS	PASS
10		1	3	3	3	3	2	1								2	3	3	3	3	3	PASS	PASS	PASS
5	1	1	3	3	3	3	3	2	2	1	1			1	2	3	3	3	3	3	3	PASS	PASS	PASS
0	2	2	2	2	2	2	2	2	2	2	2	1		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	2	2	3	2	2	3	3	3	2	2	1		1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10								1							1	1	1		1	1		PASS		

ATL. LOOP 0 N.

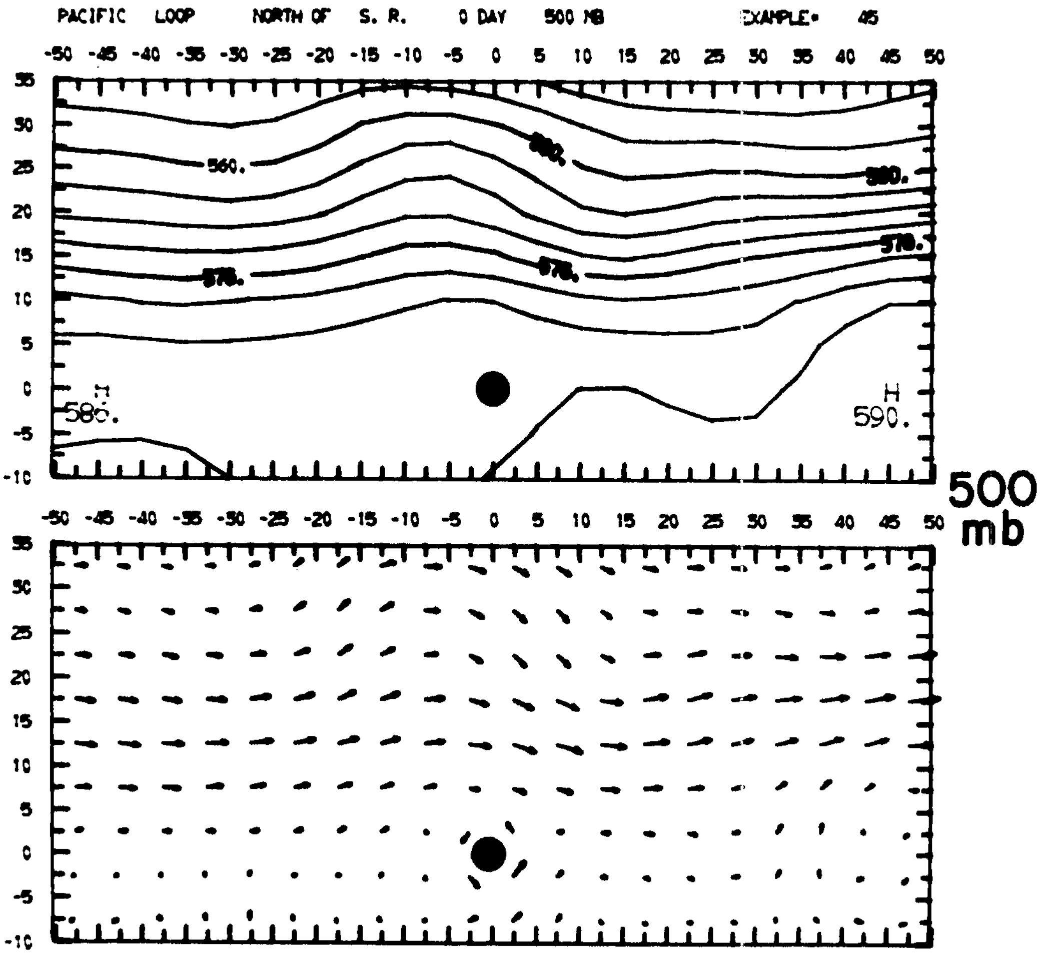


500 mb

ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 156

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	1				2	2	5	5	5	5	2	1					2	5	5	PASS	PASS	PASS
30	5	1						1	1	1	1	1							1	5	5	PASS	PASS	PASS
25				1												1	1			2	5	PASS	PASS	PASS
20	2	5	5	5	1			5	5	5	5	5			1	2	5	1			5	PASS	PASS	PASS
15	5	5	5	5	5		2	5	5	5	5	5	5		1	5	5	2	1			PASS	PASS	PASS
10	5	5	5	5	5		5	5	5	5	5	5	5	2		5	5	5	5	2	2	PASS	PASS	PASS
5	5	5	5	5	5		5	5	5	5	5	5	5	5		2	5	5	5	5	5	PASS	PASS	PASS
0		5	5	2	1		5	5	5	1	5		5	5	1			2	5	2	1	PASS	PASS	PASS
-5	5	5	5	1			2	5	5		5		5	5	2			1			1	PASS	PASS	PASS
-10	1	2					1						2	1				1	1		2	PASS	PASS	PASS

PAC. LOOP O
N.

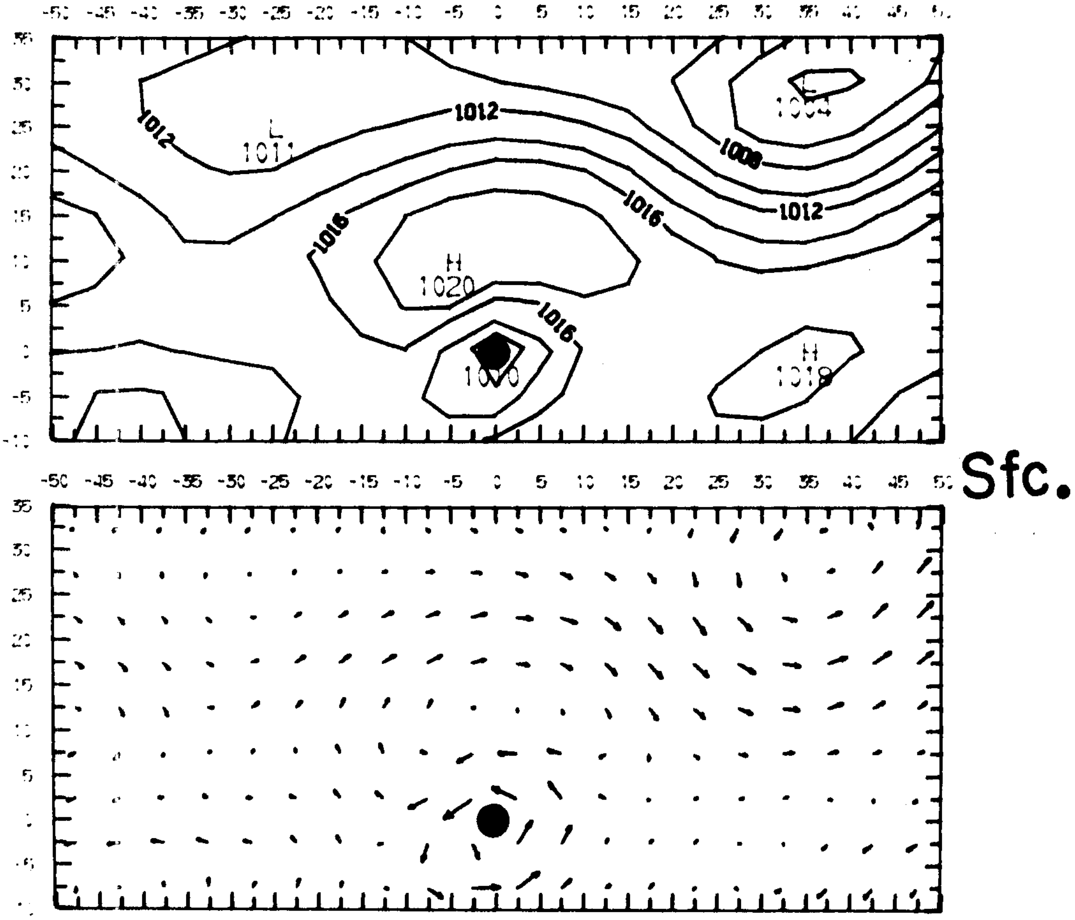


PACIFIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 45

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35								2	2	1					1	2	1					PASS	PASS	PASS
30								3	3	3	2						1	1	1			PASS	PASS	PASS
25								2	3	3	3			1	1							PASS	PASS	PASS
20									2	3	1		1	2	1						1	PASS	PASS	PASS
15		1	2	2	2	1			1	1			2	3	2				1	3	3	PASS	PASS	PASS
10	2	2	3	3	3	3	1			1	1		1	2	1				3	3	3	PASS	PASS	PASS
5	2	1	2	3	3	2													3	3	3	PASS	PASS	PASS
0	3	2	2	2	3	2	1						1	1				1	3	3	1	PASS	PASS	PASS
-5	3	3	3	3	3	2							3	3	2	2	2	3	3	2		PASS	PASS	PASS
-10	3	3	3	3	3	3	1	1			1	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS

ATL. LOOP O N.

ATLANTIC LOOP NORTH OF S. R. 0 DAY SURFACE EXAMPLE= 128

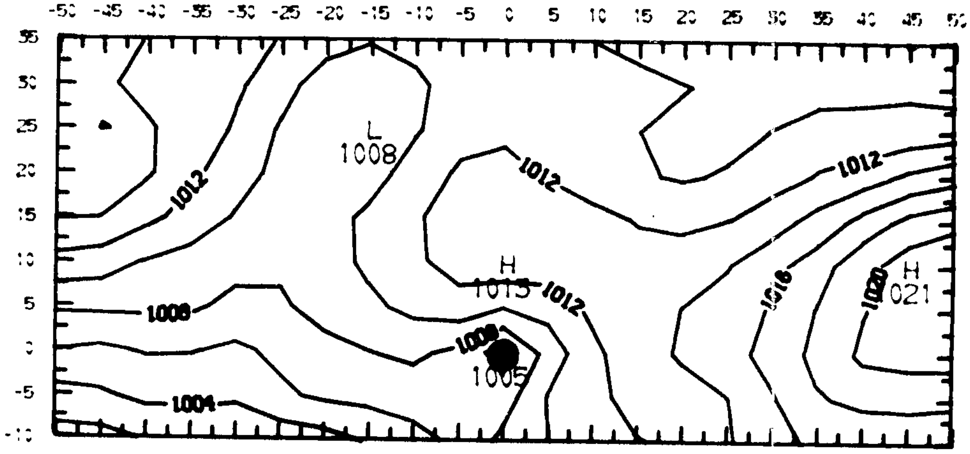


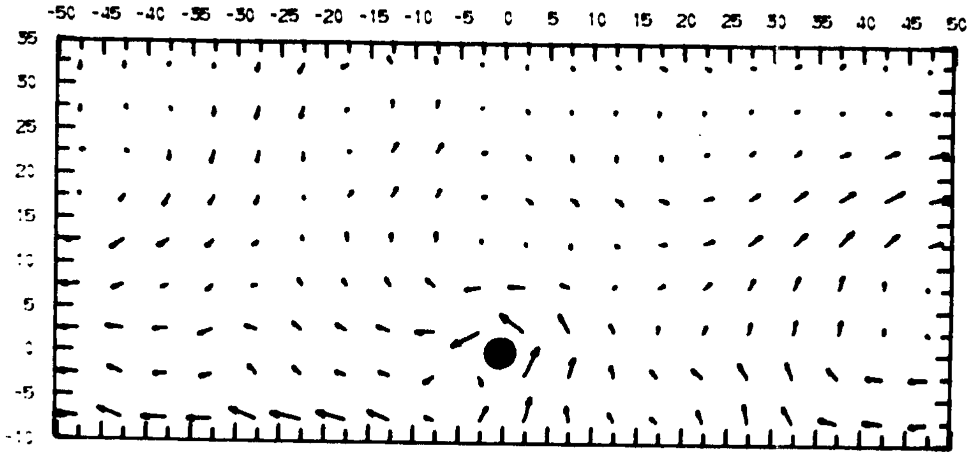
ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 128

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	2	1					1	1				3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	2	1	1	1	1	1						3	3	3	3	3	1	PASS	PASS	PASS
25	3	3	2						1	3	3	3	2			3	3	3	3	2		PASS	PASS	PASS
20	2								2	3	3	3	3	1		3	3	3	3			PASS	PASS	PASS
15				3	3	2			3	3	3	3	3	2		3	3	3	2			PASS	PASS	PASS
10			2	2	3	3			3	3	3	3	3	2		1	2	2				PASS	PASS	PASS
5		1	3	3	3	2	1		3	3	1		1	2				1	1	2	2	PASS	PASS	PASS
0	2	3	3	3	3	3	1		1	3	3	3	1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	3	3				3	3		3	3	3	3	3	3	3	2		PASS	PASS	PASS
-10	3	3	3	3	3	3					2	3	3	3	3	3	3	3				PASS	PASS	PASS

PAC. LOOP N. O

PACIFIC LOOP NORTH OF S. R. 0 DAY SURFACE EXAMPLE= 37





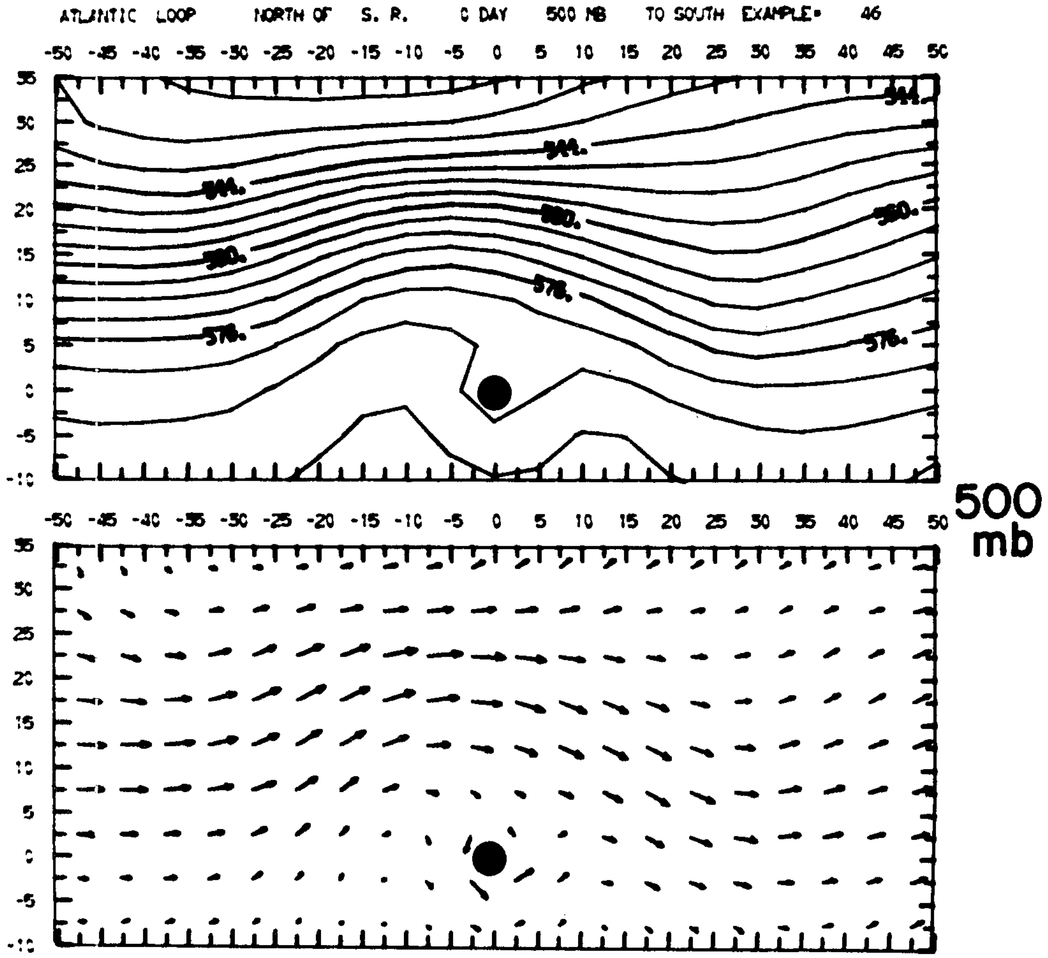
Sfc.

PACIFIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 37

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	3	2	2	2	1										1	2	1					PASS	PASS	PASS
30	3	2	2	2	1		1	2	1													PASS	PASS	PASS
25	2	2	3	2			2	2														PASS	PASS	PASS
20	1	3	3			2	3	3												2	3	PASS	PASS	PASS
15				2	3	3	3	3										2	3	3	3	PASS	PASS	PASS
10		2	3	3	3	3	3	3	2								3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	3	2	3	2			1	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	3	3	3	3	3	3	2		1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10	3	3	3	3	3	3	3	3	3	2		1	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS

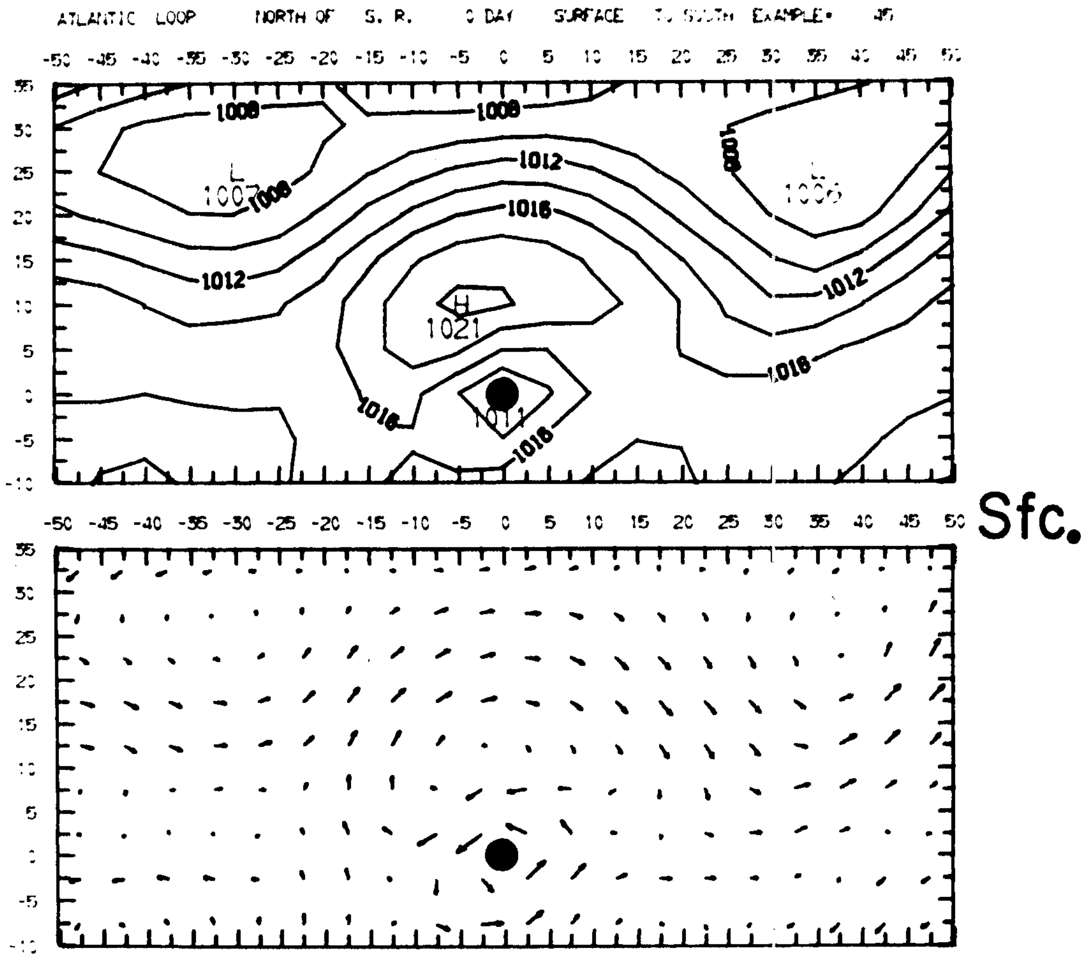
ATL. LOOP O N.



ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY 500 MB TO SOUTH EXAMPLE= 46

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35				2	2	2	3	3	3	3	3	1				1	2	3	3	3	3	PASS	PASS	PASS
30		1	2	3	2	2	2	1	1	1						1	1	2	3	3	3	PASS	PASS	PASS
25	1	3	3	3	2	1												1	2	2	3	PASS	PASS	PASS
20	2	3	3	3	3	1			3	3	3	1								1	2	PASS	PASS	PASS
15	3	3	3	3	2			3	3	3	3	3	1			1	1					PASS	PASS	PASS
10	3	3	3	3	1		2	3	3	3	3	3	2		1	2	2	2	1			PASS	PASS	PASS
5	2	2	2	1			3	3	3	3	3	2	3		1	3	3	3	2	2		PASS	PASS	PASS
0			1				3	3	3	2			3	2		1	2	3	3	2		PASS	PASS	PASS
-5	2	2	2	1			2	3	3	2			3	3			1	2	1			PASS	PASS	PASS
-10	2	3	1				1	2	2	1		1	2	2				1			2	PASS	PASS	PASS

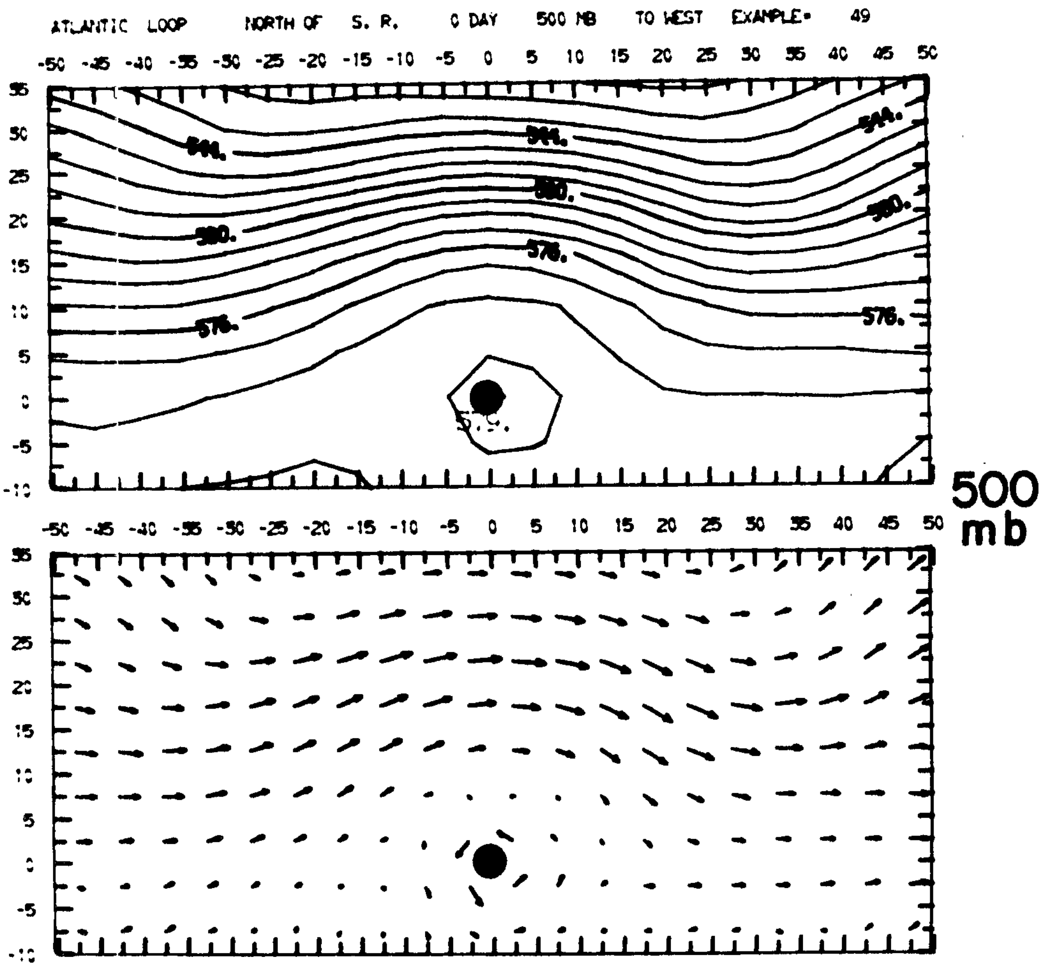
ATL. LOOP O N.



' LANTIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE TO SOUTH EXAMPLE• 45

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	1							1	1											PASS	PASS	PASS
30																								
25				1	1				1	2	3	3	2									PASS	PASS	PASS
20			1	2	1	1			2	3	3	3	3	1			1	2	1			PASS	PASS	PASS
15				2	1	1			3	3	3	3	3	1		1	3	3	1			PASS	PASS	PASS
10			1	2	1	1			3	3	3	3	2	1		1	2	2				PASS	PASS	PASS
5			1	1				1	3	3												PASS	PASS	PASS
0			1			1			1	1	3	1		2		1	1	2	2	1		PASS	PASS	PASS
-5	3	3	3	3	3	2					1	1	3	3	3	3	3	3	1			PASS	PASS	PASS
-10	3	3	3	3	3	2				1	2	3	3	3	3	3	3				1	PASS	PASS	PASS

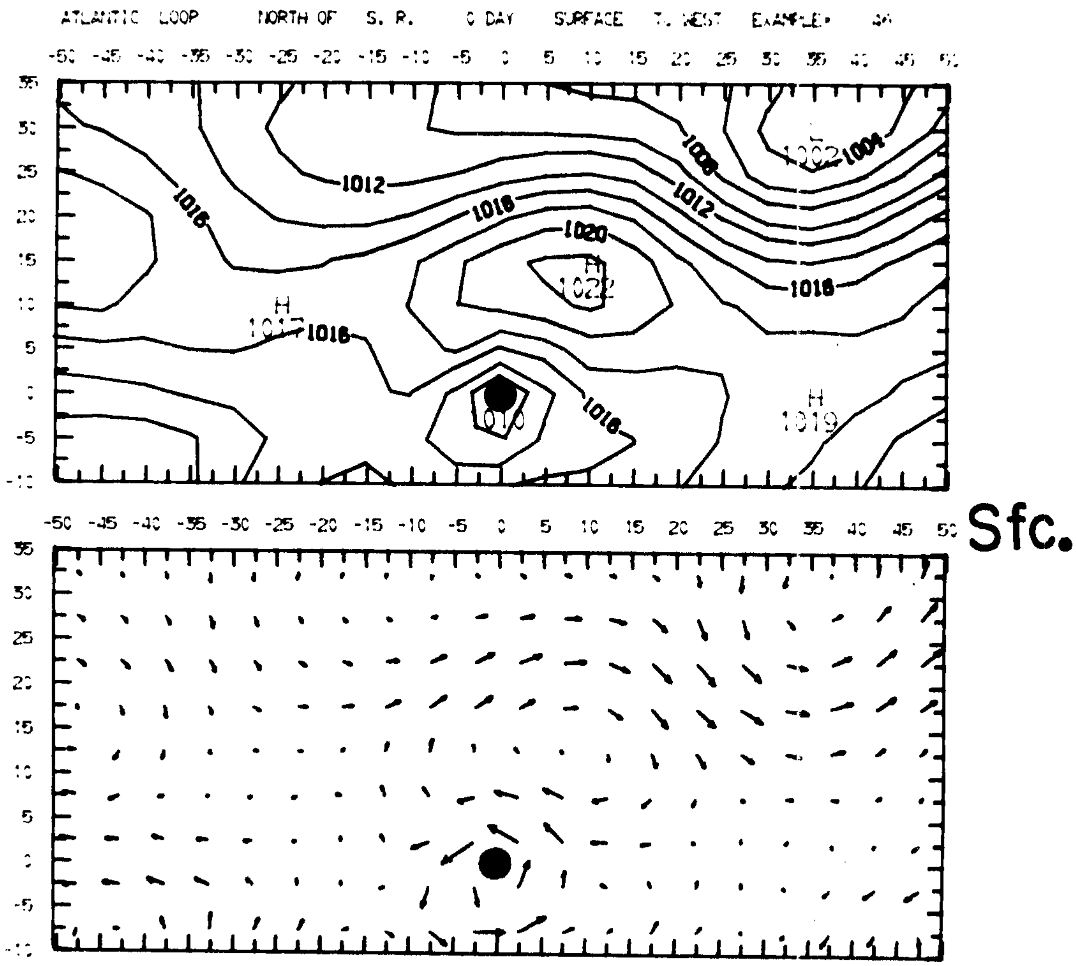
ATL. LOOP O N.



ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY 500 MB TO WEST EXAMPLE= 49

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	2								1	1	2	2	2	2	1				2	PASS	PASS	PASS
30	3	3	1												2	2	1				3	PASS	PASS	PASS
25	1									1	1	1				2	2	1			2	PASS	PASS	PASS
20				1					3	3	3	3	2			2	3	2				PASS	PASS	PASS
15	1	2	3	3	2			1	3	3	3	3	3	1		1	2	2	1			PASS	PASS	PASS
10	2	3	3	3	3			3	3	3	3	3	3	3			2	2	2	2	2	PASS	PASS	PASS
5	2	3	3	2	1			3	3	3	3	3	3	2			1	2	2	2	2	PASS	PASS	PASS
0		2				1	3	3	3		3	2										PASS	PASS	PASS
-5	2	2				2	3	3	2		3	3								2	3	PASS	PASS	PASS
-10						1	3					1									3	PASS	PASS	PASS

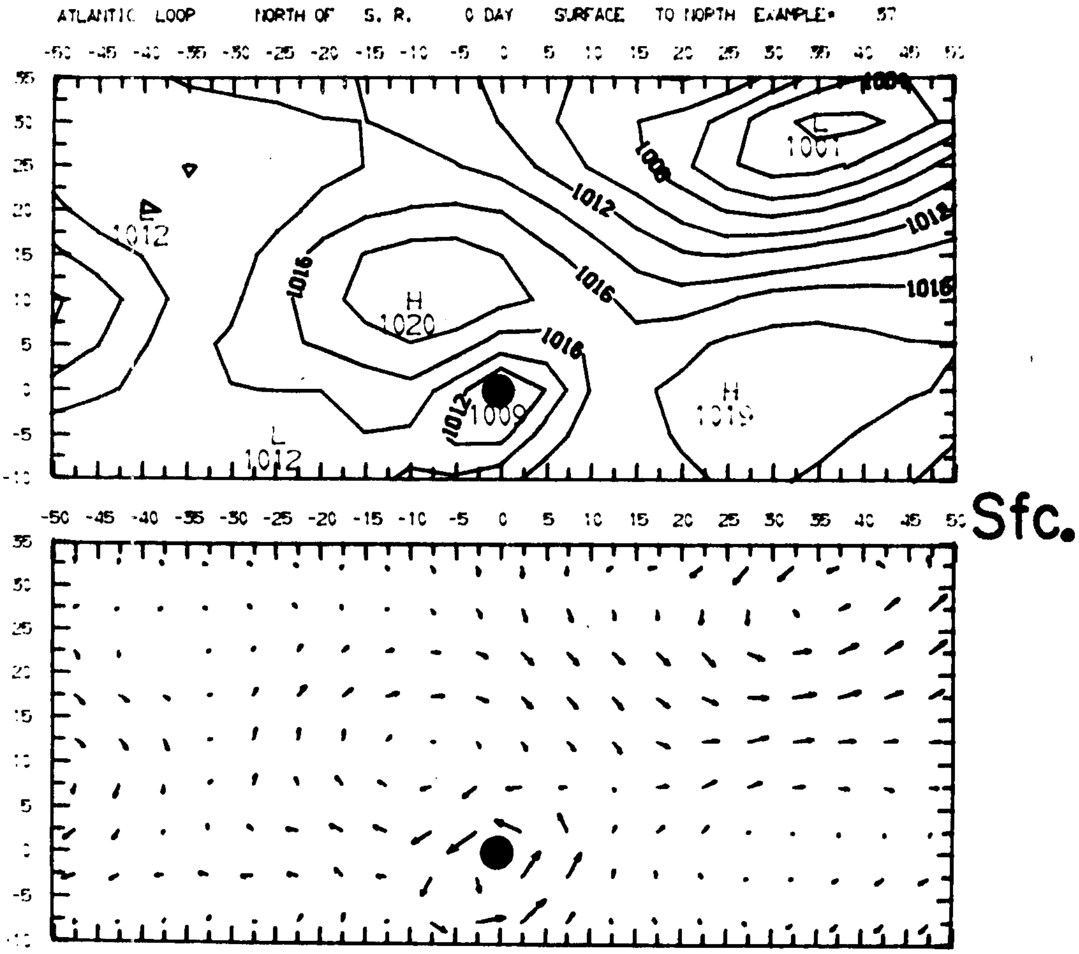
ATL. LOOP O N.



ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE TO WEST EXAMPLE= 46

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	1										1	3	3	3	3	1	PASS	PASS	PASS
30	3	3	3	3	2											2	3	3	3	2		PASS	PASS	PASS
25	3	3	3	2									1			3	3	3	3	[illegible]		PASS	PASS	PASS
20	3	2	2								2	3	3	2		2	3	3	2			PASS	PASS	PASS
15					1	2	1			1	3	3	3	3			3	3	2			PASS	PASS	PASS
10				1	2	1	2	2		2	3	3	3	3	1							PASS	PASS	PASS
5						2	3	1		1	1		3	3	1			1				PASS	PASS	PASS
0	3	2	2	1	1	1				3	3	3		1	2	3	3	3	3	[illegible]	1	PASS	PASS	PASS
-5	3	3	3	3	3		1	2		3	3			1	3	3	3	3	3			PASS	PASS	PASS
-10	3	3	3	3	2			1							3	3	3	1				PASS	PASS	PASS

ATL. LOOP N. 0

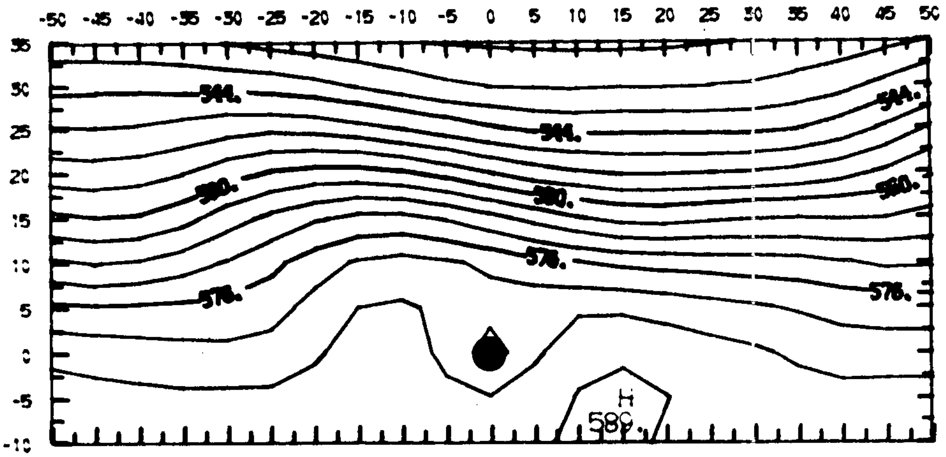


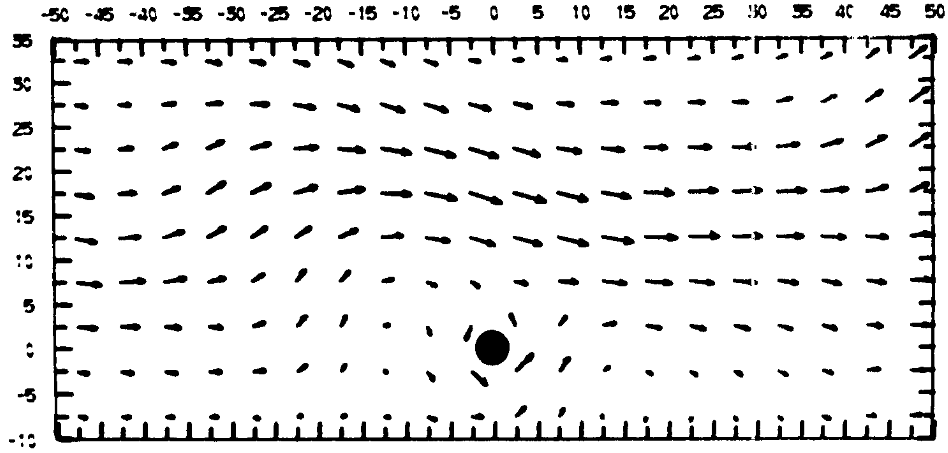
ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE TO NORTH EXAMPLE= 37

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	2	3	3	2	2	1	1								2	3	3	3	3	PASS	PASS	PASS
30	1	3	3	3	3	3	3	2	2	2	1				1	2	3	3	3	2	1	PASS	PASS	PASS
25	1	1	1	1	1	2	2	2	2	2	1				2	2	2	2	2			PASS	PASS	PASS
20							1	2	2	2	2	1			1	2	2	1				PASS	PASS	PASS
15								3	3	3	3				1	1	1					PASS	PASS	PASS
10				2	2			1	3	3	1											PASS	PASS	PASS
5			2	3	2						1	1				2	2	2	1	1	1	PASS	PASS	PASS
0			2	2	1	1	1			3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	2	2	3	3	3	3	2		2	3	3		3	3	3	3	3	3	3	2	1	PASS	PASS	PASS
-10	1	3	3	3	3	2	1					2	2	2	3	3	3	2	1			PASS	PASS	PASS

ATL. LOOP N. 0

ATLANTIC LOOP NORTH OF S. R. 0 DAY 500 MB TO NORTH EXAMPLE= 41



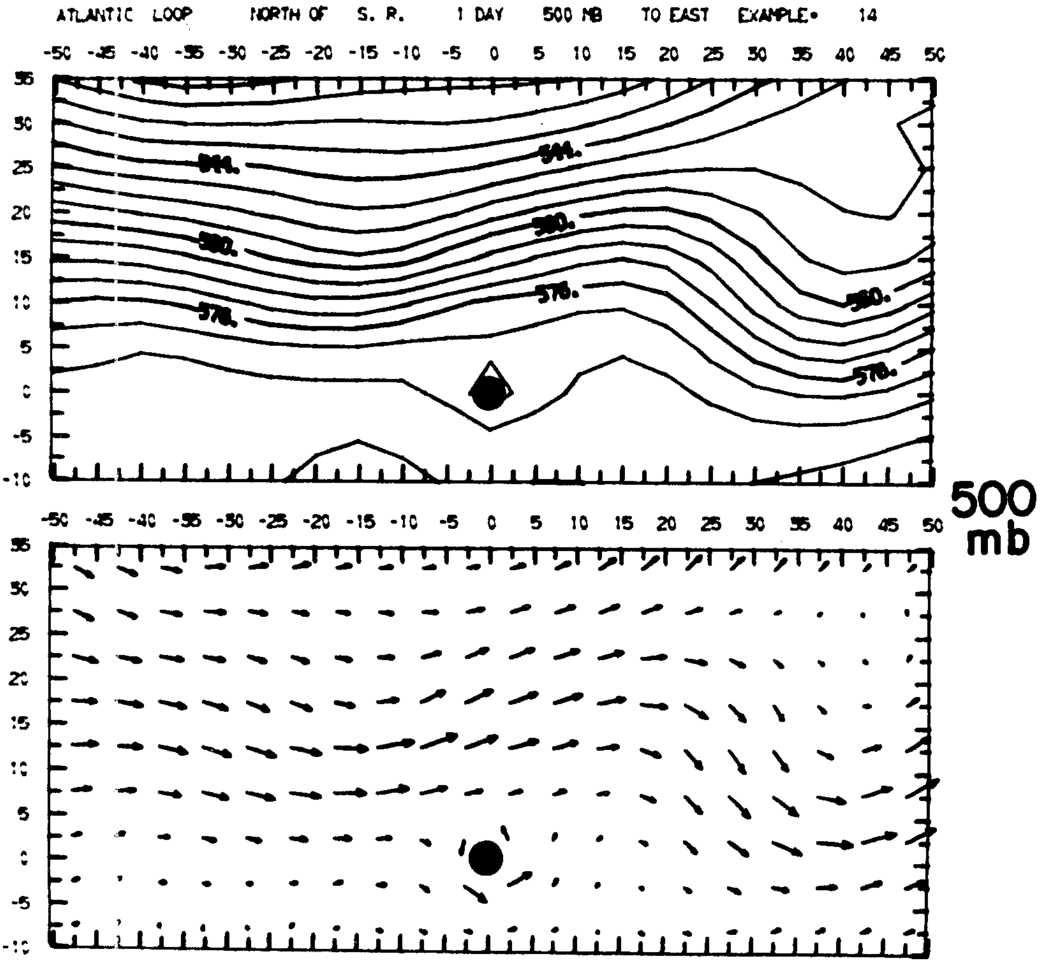


500 mb

ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 0 DAY SURFACE TO NORTH EXAMPLE= 57

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	2	5	5	2	2	1									1	2	5	5	2	PASS	PASS	PASS
30		2	5	5	2	2	2	2	2	2	1					2	2	5	2	2	1	PASS	PASS	PASS
25	1	1	1		1	1	2	2	2	2	1				1	2	2	2	2	1		PASS	PASS	PASS
20							2	2	2	2	5	1			1	2	2	1				PASS	PASS	PASS
15							1	5	5	5	2				1	2	1					PASS	PASS	PASS
10				2	2			2	5	5	1											PASS	PASS	PASS
5			2	5	2											1	2	1	1		1	PASS	PASS	PASS
0			2	2	1	1	1			5	5	5		5	5	5	5	5	5	5	5	PASS	PASS	PASS
-5		1	2	5	5	5	2	1	2	5	5		5	5	5	5	5	5	5	5	2	PASS	PASS	PASS
-10	1	5	5	5	5	2	1					2	2	2	5	5	5	2	1			PASS	PASS	PASS

ATL. LOOP 1
N.

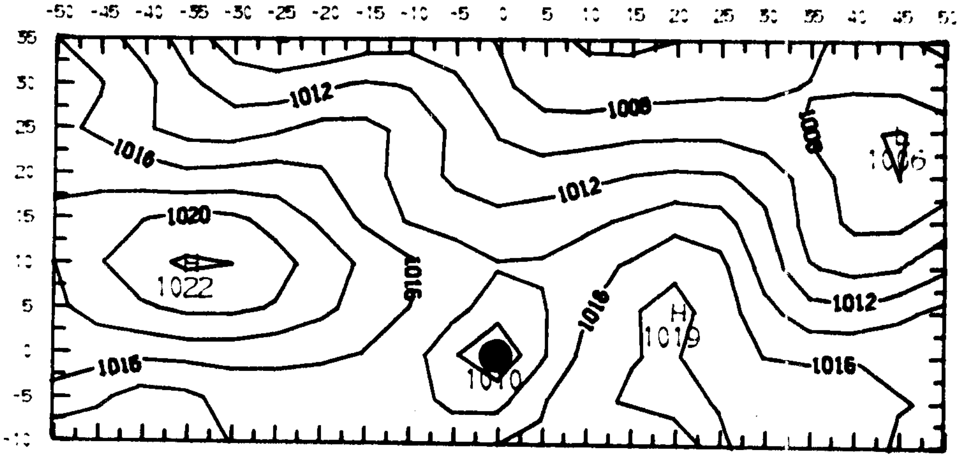


ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 1 DAY 500 MB TO EAST EXAMPLE= 14

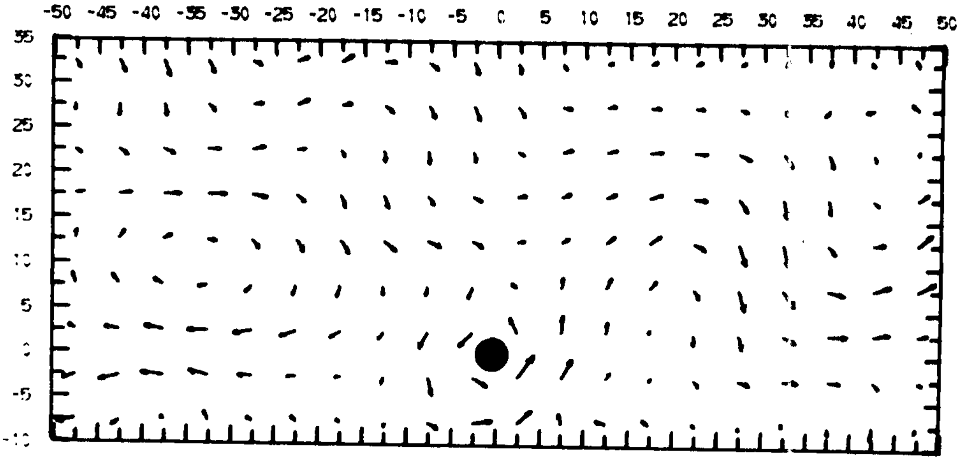
	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35			1	1	2	2	1	1	1	1	1						1	2	2	3	3	PASS	PASS	PASS
30										1								1	1	2	2	PASS	PASS	PASS
25																						PASS		
20							1	1						2	2							PASS	PASS	PASS
15	1	1					1	1				1	3	3	2			1	2	1		PASS	PASS	PASS
10	1	2	2								1	1	2	3	2		1	2	3	2	1	PASS	PASS	PASS
5		1	2	1									1	1	1		2	3	3	2	1	PASS	PASS	PASS
0			1	1					1								2	2	2	1		PASS	PASS	PASS
-5											1											PASS	PASS	
-10																					1	PASS	PASS	

ATL. LOOP N. 1

ATLANTIC LOOP NORTH OF S. R. 1 DAY SURFACE TO EAST EXAMPLE= 14



Sfc.

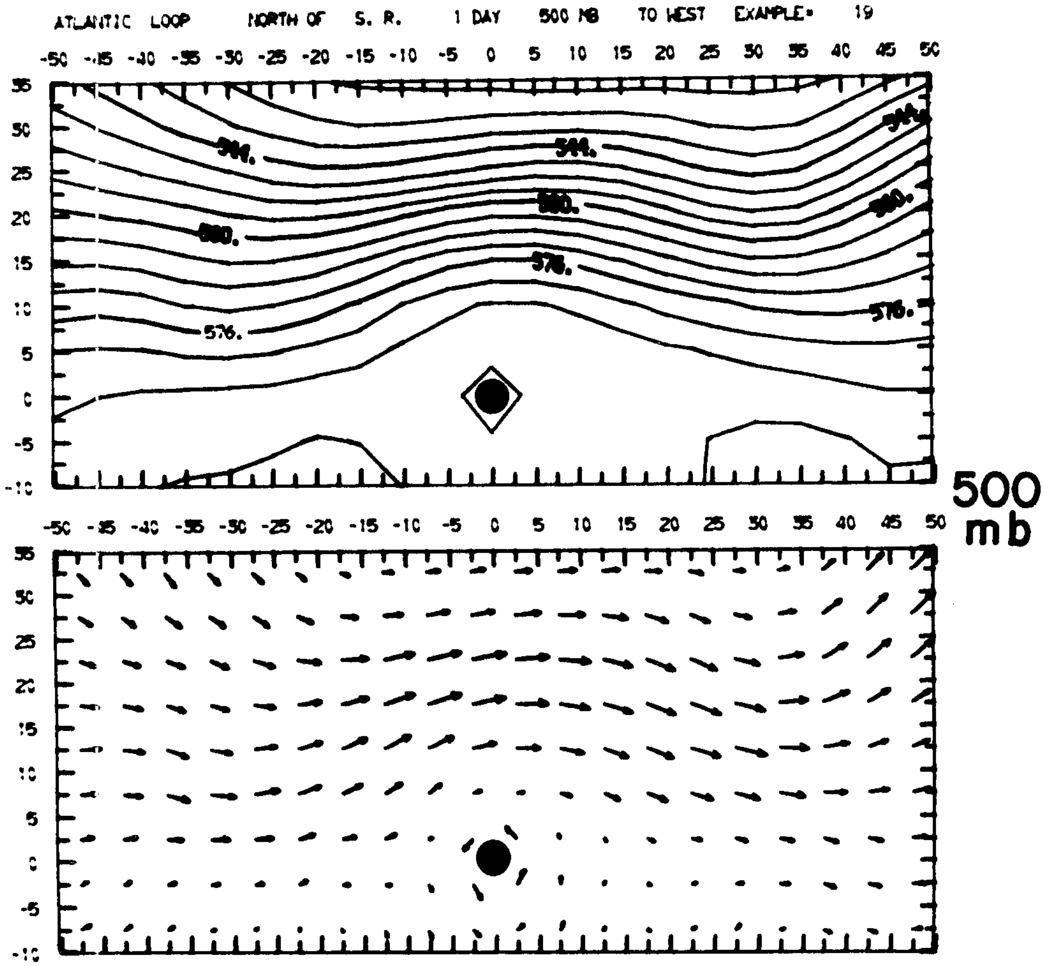


ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 1 DAY SURFACE TO EAST EXAMPLE= 14

TEST 1 / TEST 2 (SIGNIFICANT LEVEL)

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	1																			PASS	PASS	PASS
30	2	2	1																			PASS	PASS	
25	1	1						1														PASS	PASS	
20	1																		1	1	1	PASS	PASS	
15		1	1	1	1													2	2	2	1	PASS	PASS	PASS
10		1	1	2	1							1						3	3	2	1	PASS	PASS	PASS
5			1	1	1						3	3						1	2			PASS	PASS	PASS
0										2	3	2		1	2							PASS	PASS	PASS
-5			3	2						2	3		2	1	2	2	2	2				PASS	PASS	PASS
-10		1	2	2											2	2	1	1				PASS	PASS	

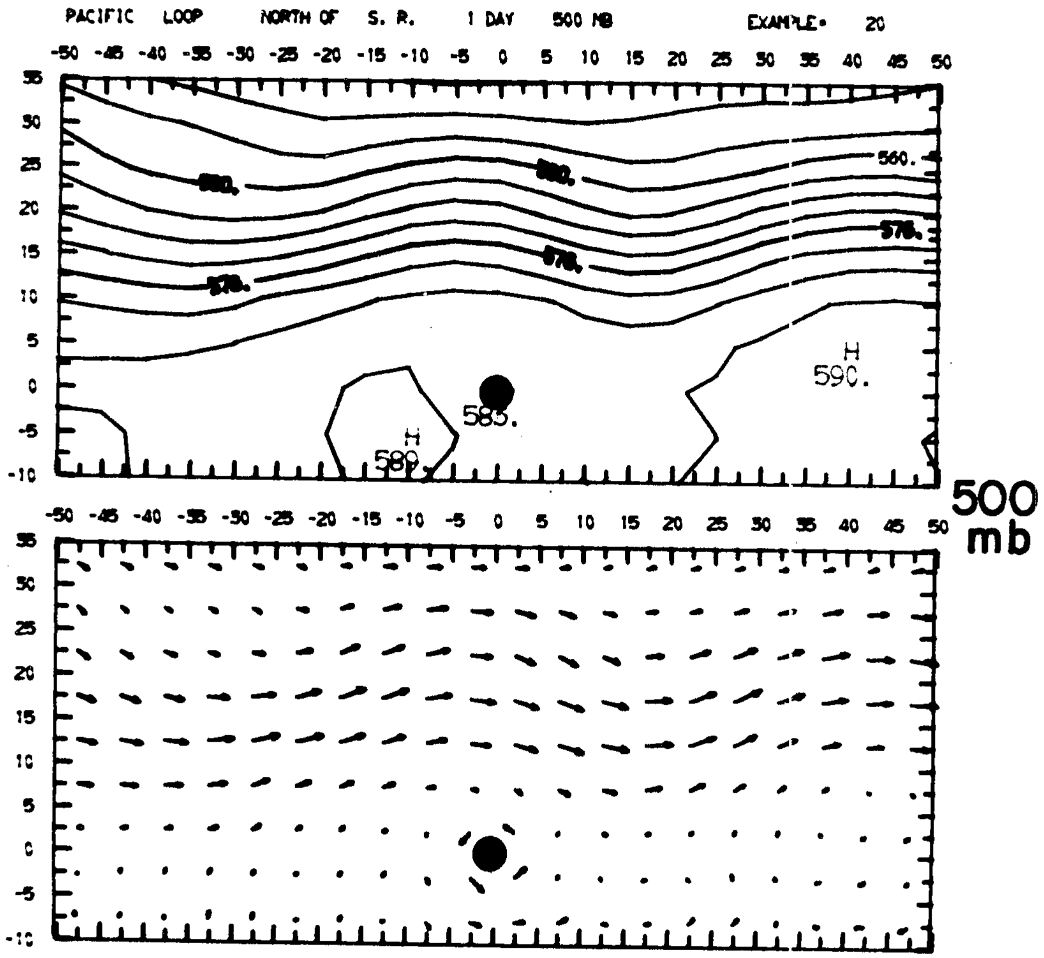
ATL. LOOP 1
N.



ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 1 DAY 500 MB TO WEST EXAMPLE= 19

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	2									1	1									PASS	PASS	PASS
30	3	3	1																		3	PASS	PASS	PASS
25	1															1	1				2	PASS	PASS	PASS
20											1	2					1					PASS	PASS	
15					1	1				2	3	3	1									PASS	PASS	PASS
10			1	2	2	1				3	3	3	2	1								PASS	PASS	PASS
5	1	1	2	1	1					3	3	3	3	2								PASS	PASS	PASS
0	1												1	1								PASS	PASS	
-5	1									1	3	1										PASS	PASS	
-10	1									2	3	2										PASS	PASS	PASS

PAC. LOOP N. 1

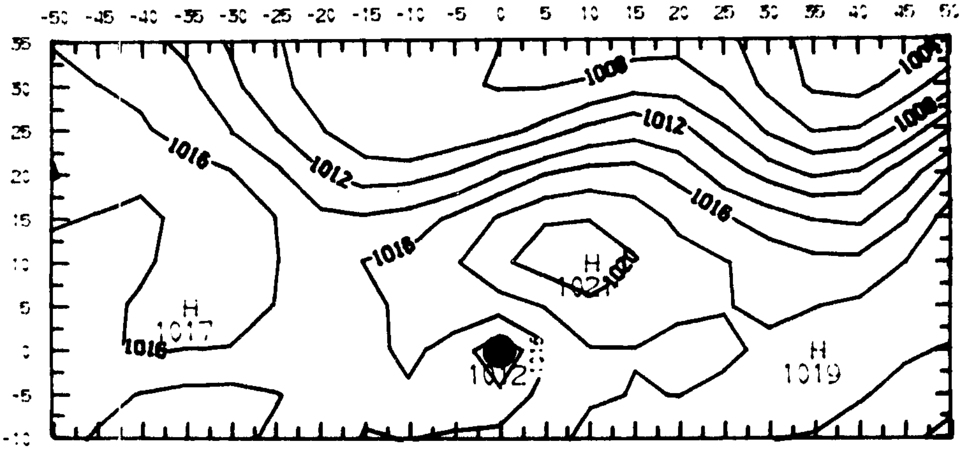


PACIFIC LOOP NORTH OF SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 20

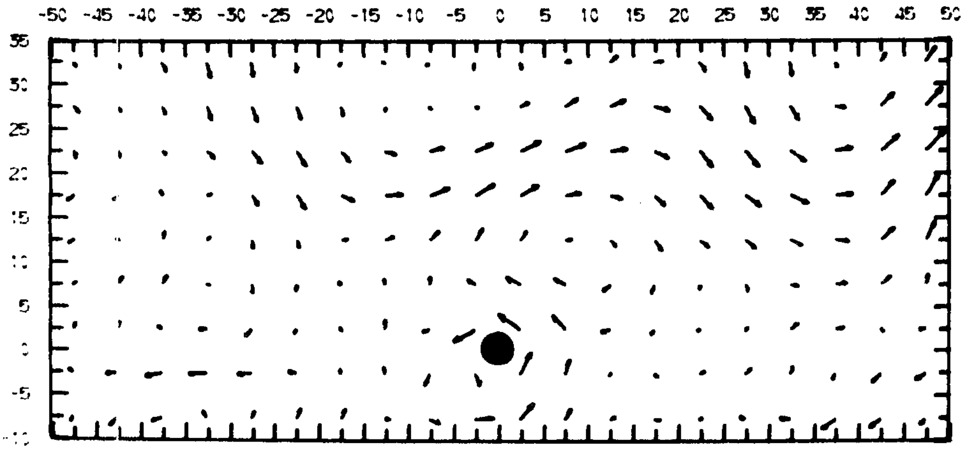
	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	1																				PASS	PASS	
30	2	1																				PASS	PASS	
25																						PASS		
20			1	2	2	2	1			2	1			1				1	1	2	2	PASS	PASS	PASS
15	1	2	2	3	3	3	2		1	2	1			1	1			2	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	2											2	3	3	3	3	PASS	PASS	PASS
5	3	2	2	2	2	1											2	3	3	2		PASS	PASS	PASS
0	2	2	1	1												1	2	2	1			PASS	PASS	PASS
-5	3	[illegible]	3	1				1	1								2	2				PASS	PASS	PASS
-10	2	2	1	1				1								2	2	2	2	1		PASS	PASS	PASS

ATL. LOOP 1
N.

ATLANTIC LOOP NORTH OF S. R. 1 DAY SURFACE TO WEST EXAMPLE= 18



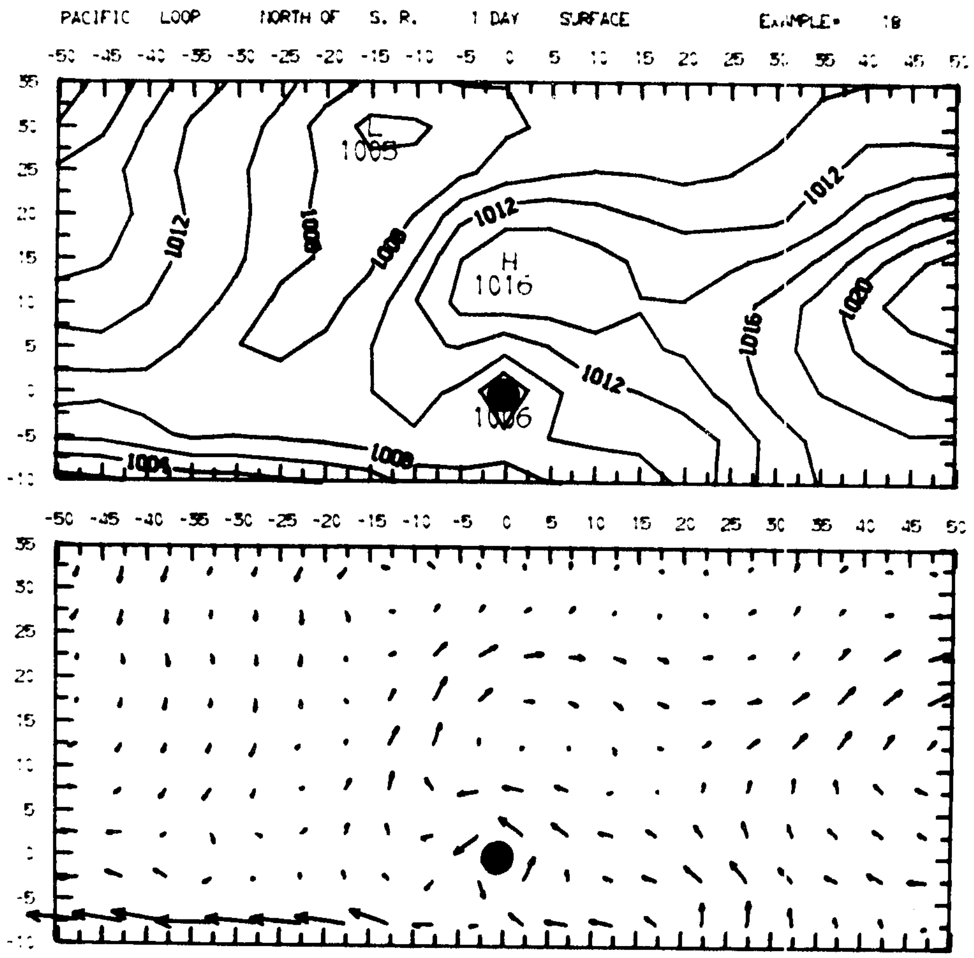
Sfc.



ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 1 DAY SURFACE TO WEST EXAMPLE= 18

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	2														1	2	1		PASS	PASS	PASS
30	3	3	3	3	2												2	2	2	1		PASS	PASS	PASS
25	2	2	2	2													1	1	1			PASS	PASS	PASS
20																						PASS		
15												2	1									PASS		
10											1	3	2								1	PASS	PASS	
5							1						2								1	PASS	PASS	
0	1									1	2							1	1			PASS	PASS	PASS
-5				1	1	1				1			2	2	2	1	1	1				PASS	PASS	PASS
-10		1	2	3	1								2	2	2							PASS	PASS	PASS

PAC. LOOP N. 1

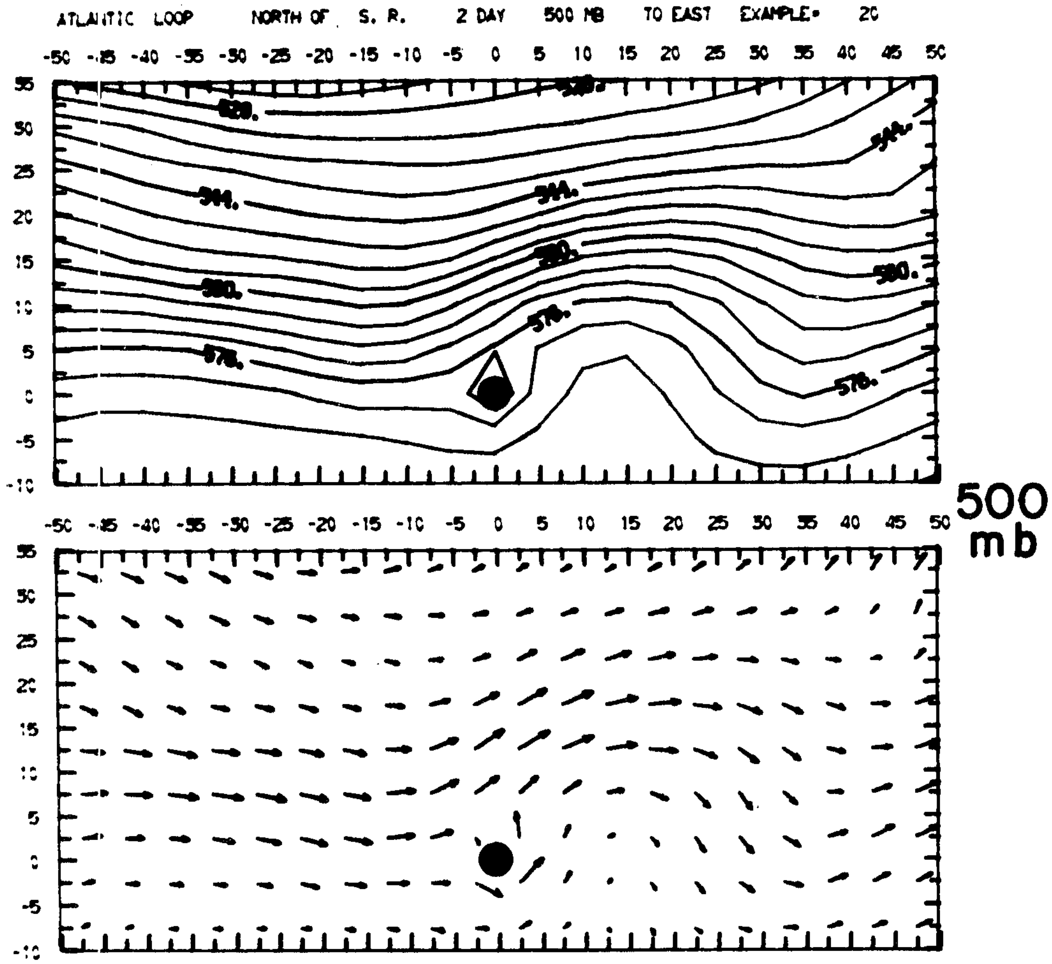


Sfc.

PACIFIC LOOP NORTH OF SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE= 18

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	1																		PASS	PASS	PASS
30	3	3	2					1	1	1												PASS	PASS	PASS
25	2	2	1				1	1	1	1											1	PASS	PASS	PASS
20						2	3	3	2										1	3	3	PASS	PASS	PASS
15				2	2	3	3	3	3										3	3	3	PASS	PASS	PASS
10				3	3	3	3	3	3								1	3	3	3	3	PASS	PASS	PASS
5			1	3	3	3	3	3	2		2					2	2	3	3	3	3	PASS	PASS	PASS
0		1	1	2	2	2	2	2	1	1	2	1				2	3	3	3	3	3	PASS	PASS	PASS
-5	2	2	2	1	1	1	1	1			1					1	2	2	2	2	2	PASS	PASS	PASS
-10	2	3	2	1	1	1	1									2	3	2	2	2	2	PASS	PASS	PASS

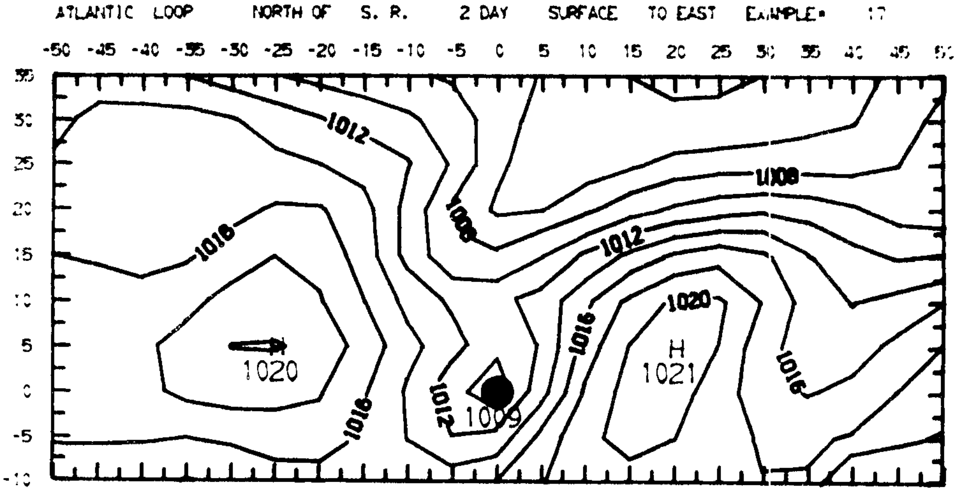
ATL. LOOP 2
N.

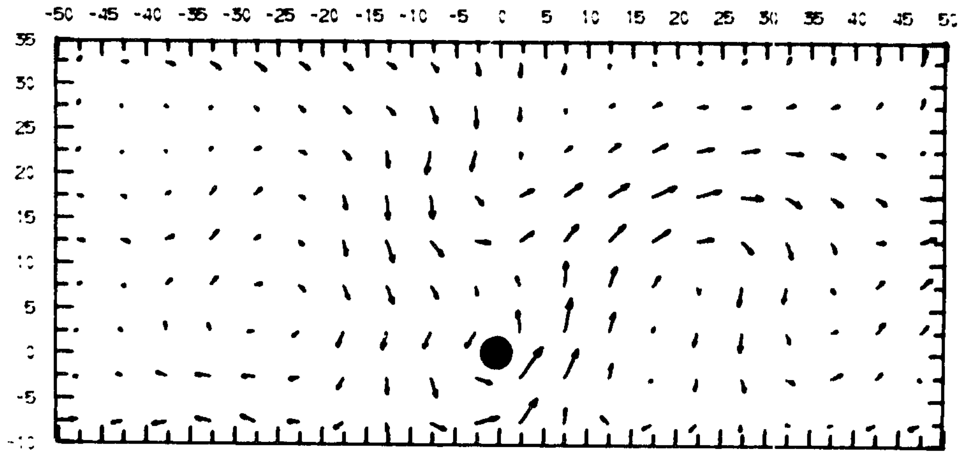


ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 2 DAY 500 MB TO EAST EXAMPLE= 20

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35					2	3	3	3	3	1							1	2	3	3	3	PASS	PASS	PASS
30						1	2	2	2	2	1								1	2	3	PASS	PASS	PASS
25								1	1	1	1										1	PASS	PASS	PASS
20								1	2	1				1	1	1						PASS	PASS	PASS
15						1	2	2	2	1			3	3	3	3						PASS	PASS	PASS
10						2	2	3	3	1		3	3	3	3	2						PASS	PASS	PASS
5							2	2	2			3	3	3	3				1			PASS	PASS	PASS
0								1	1	1			3	2				1	1			PASS	PASS	PASS
-5																		1				PASS	PASS	
-10				1													1	1			1	PASS	PASS	

ATL. LOOP 2
N.



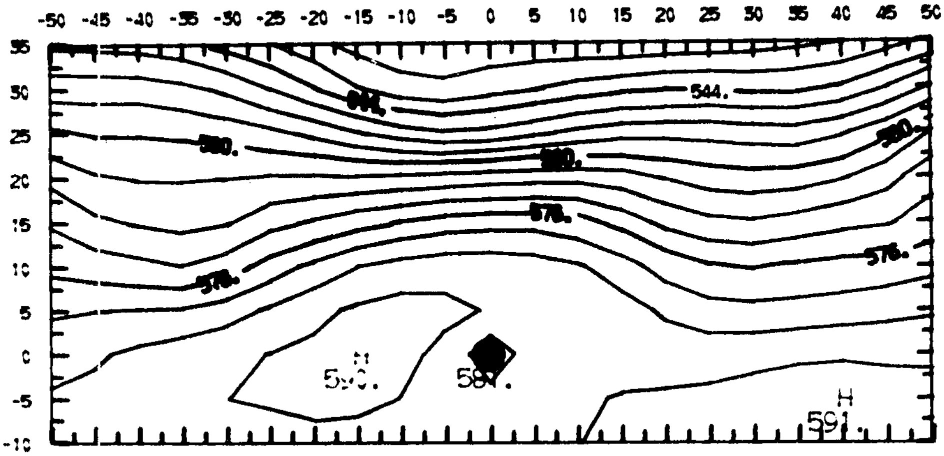


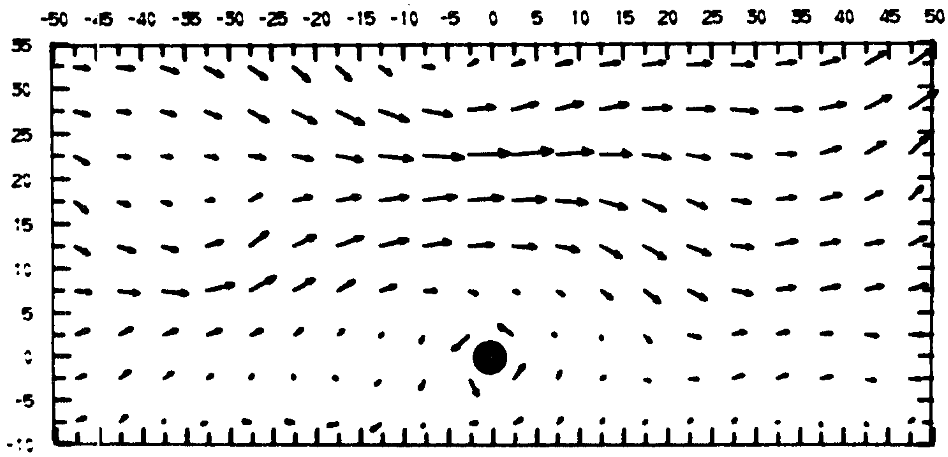
ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 2 DAY SURFACE TO EAST EXAMPLE= 17

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	2	1	1								1	2	2	2	2	1				PASS	PASS	PASS
30	2	3	3	2	2	1	1					1	2	2	2	2	2	1				PASS	PASS	PASS
25	3	2	2	1	1	1	1	1			1	3	3	1	1	1						PASS	PASS	PASS
20	1				1	2	2			1	3	2	1									PASS	PASS	PASS
15						1	1			2	2	1				1						PASS	PASS	PASS
10									1	2	2	1		1	2	2						PASS	PASS	PASS
5						1	1		1	3	3	3		2	3	1						PASS	PASS	PASS
0									2	3	3	2		3	3							PASS	PASS	PASS
-5									3	3	3		2	3	2	1						PASS	PASS	PASS
-10			2	3	2			1	1				2	3	3	1	1	1				PASS	PASS	PASS

ATL. LOOP N. 2

ATLANTIC LOOP NORTH OF S. R. 2 DAY 500 MB TO WEST EXAMPLE= 11



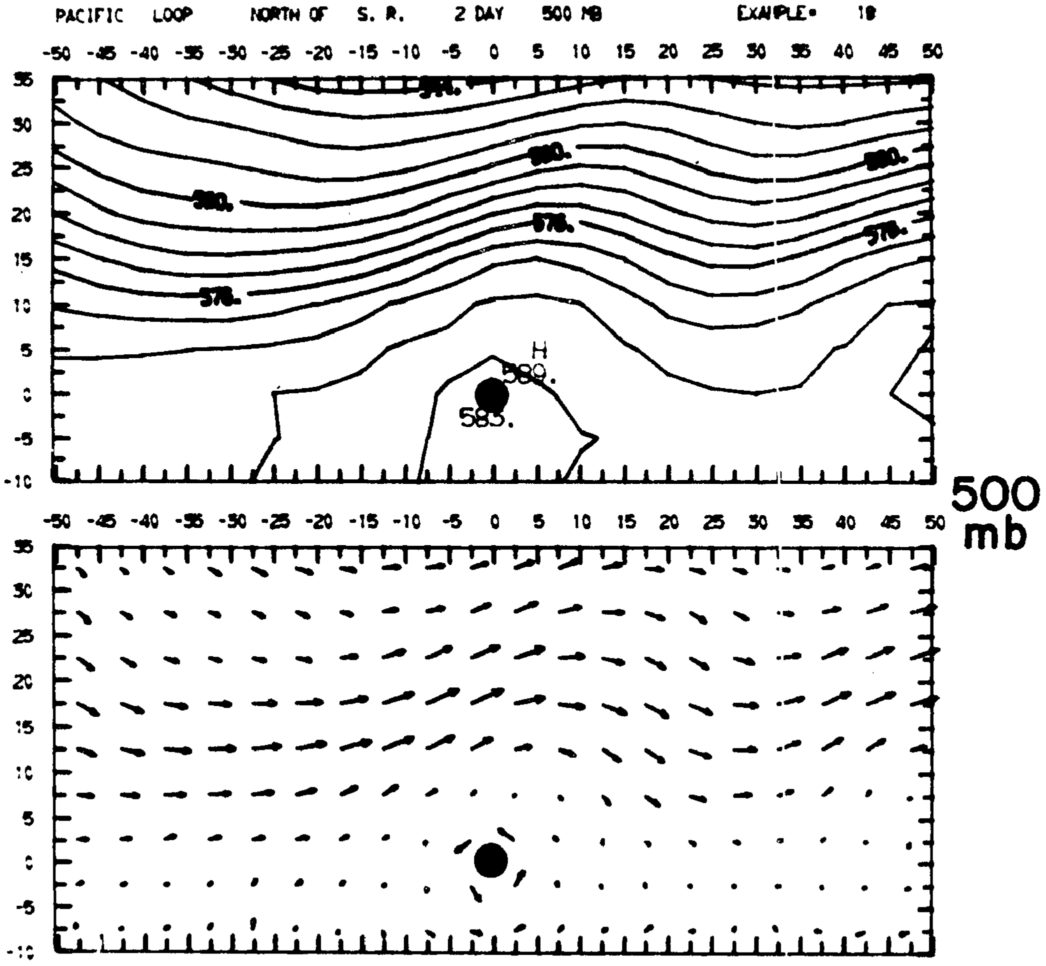


500 mb

ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 2 DAY 500 MB TO WEST EXAMPLE= 11

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	1																			PASS	PASS	
30	1	1	1																			PASS	PASS	
25																					1	PASS	PASS	
20																								
15				1					1	3	2	1										PASS	PASS	PASS
10			2	2	1			1	3	3	3	3	2			1						PASS	PASS	PASS
5	1	1	2	1			1	2	3	3	3	3	2	1		1						PASS	PASS	PASS
0	2	1					1	2	3													PASS	PASS	PASS
-5	2	1								1	2										2	PASS	PASS	
-10	1			1	2				2	1						1	1	2	2	3	2	PASS	PASS	PASS

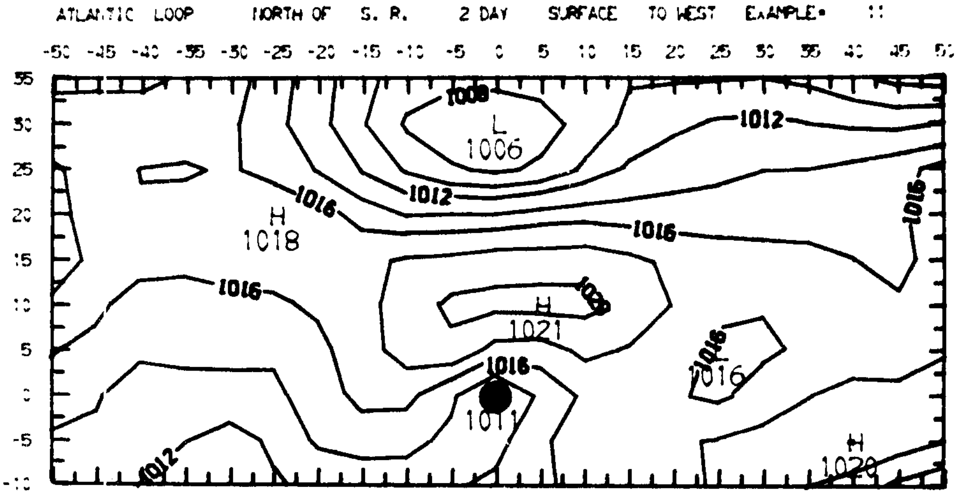
PAC. LOOP N. 2

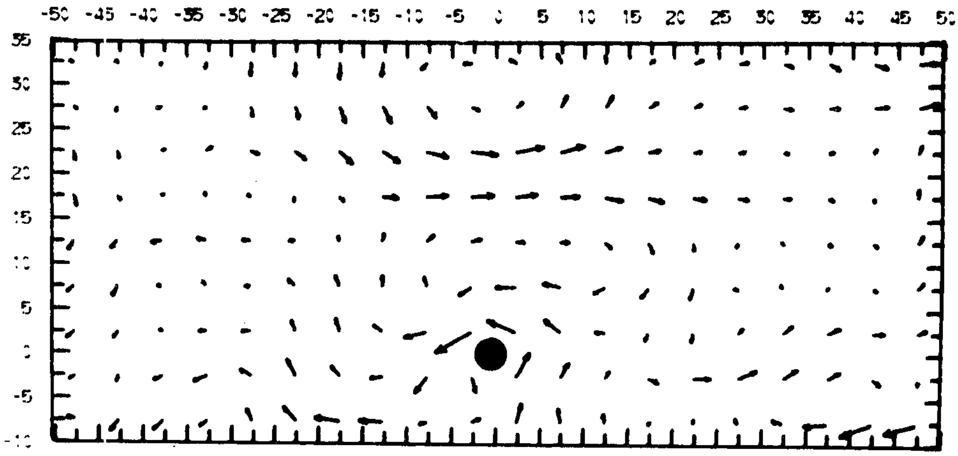


PACIFIC LOOP NORTH OF SUBTROPICAL RIDGE 2 DAY 500 MB EXAMPLE= 18

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	1																				PASS	PASS	
30	1																					PASS		
25							1	1														PASS	PASS	
20			1	1	2	2	3	3	1		3	3	2	1						1	2	PASS	PASS	PASS
15		3	3	3	3	3	3	2		2	3	3	3	2					1	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	2			2	3	3	3	1					1	3	3	PASS	PASS	PASS
5	3	3	3	3	3	2			1	2	2	3	3	1					1			PASS	PASS	PASS
0	2	1	2					1	1		1											PASS	PASS	PASS
-5	2	1	1	1													1					PASS	PASS	
-10							2								1		1	1	1			PASS	PASS	

ATL. LOOP N. 2



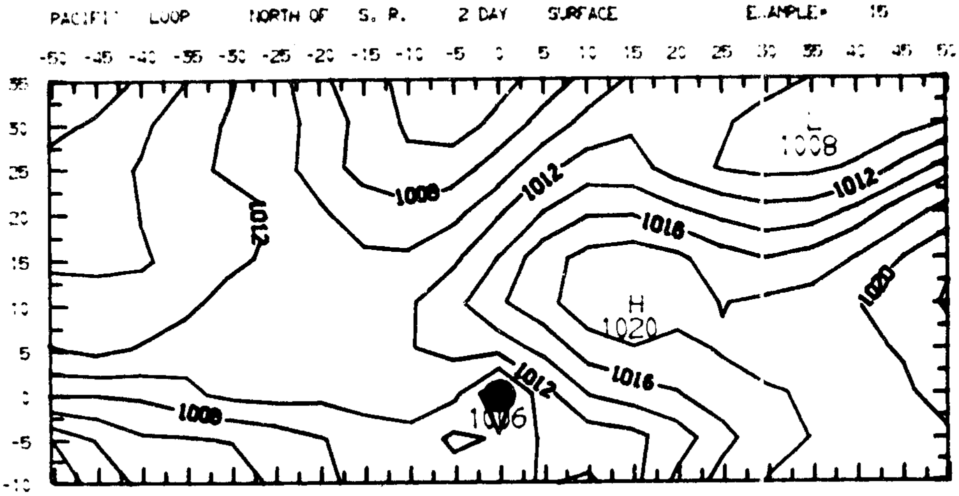


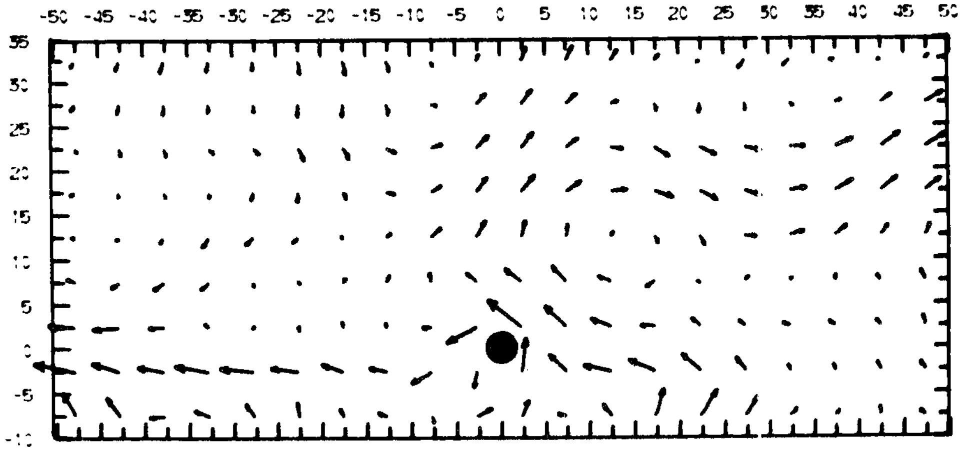
ATLANTIC LOOP NORTH OF SUBTROPICAL RIDGE 2 DAY SURFACE TO WEST EXAMPLE= 11

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	1	1	1	1	1																	PASS	PASS	
30										1	1											PASS	PASS	
25											1											PASS		
20																								
15																								
10										2	2	2	2									PASS	PASS	
5									1	2			1									PASS	PASS	
0									1		1	1								1	1	PASS	PASS	
-5		2	1	1	1	1			1	2	2		1	2	3	1	1	2	2	1		PASS	PASS	PASS
-10			2	2	2	1		1	1	1			1	1	2	2	1	1	1			PASS	PASS	PASS

PAC. LOOP 2
N.



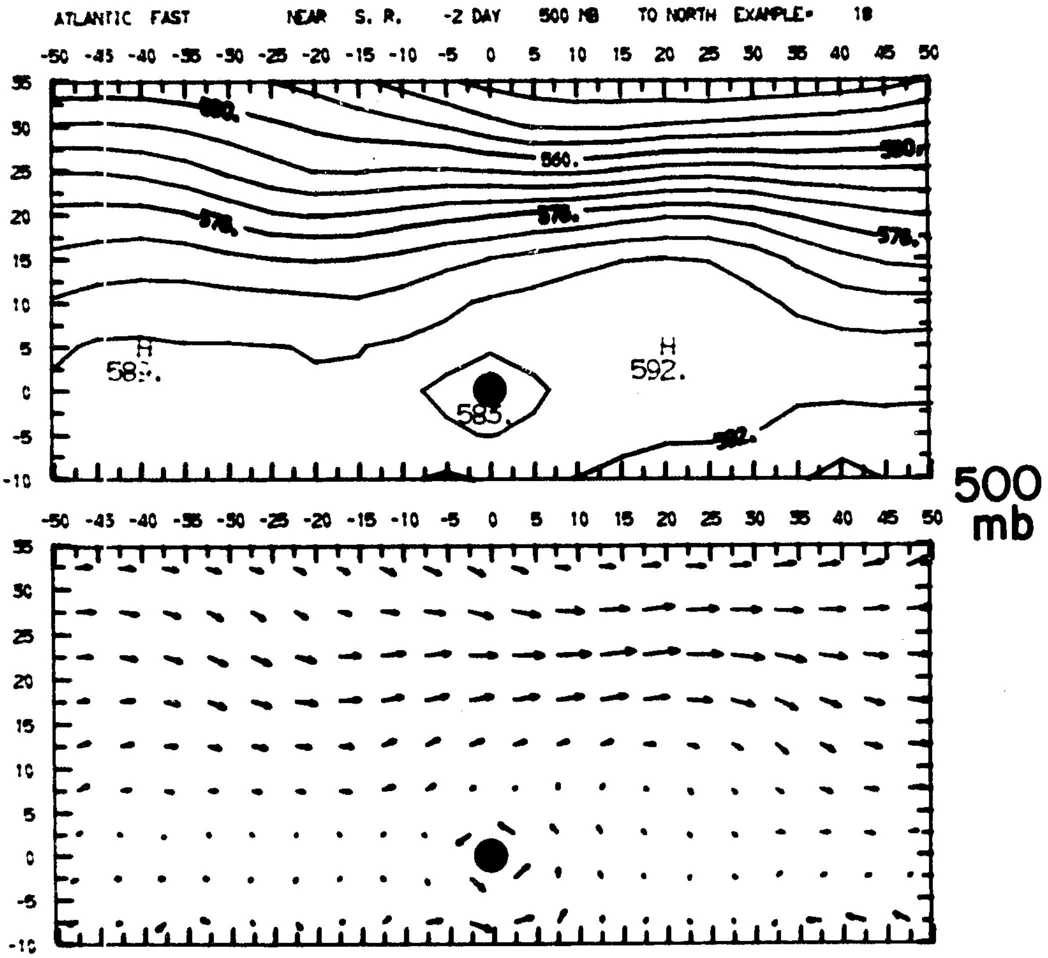


Sfc.

PACIFIC LOOP NORTH OF SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE= 15

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	2	2	1					1	1	1	1										PASS	PASS	PASS
30	1	1	1					1	2	1												PASS	PASS	PASS
25								2	3	1											1	PASS	PASS	
20							2	3	3	3											3	PASS	PASS	PASS
15					2	3	3	3	3	3			2	2	1					2	3	PASS	PASS	PASS
10				1	3	3	3	3	3	2		1	3	3	1		1	1		2	3	PASS	PASS	PASS
5			1	2	3	3	3	3	3	3	3		2	2	2	3	2	1	[illegible]	2	3	PASS	PASS	PASS
0	1	1	2	1			1	1	2	2	3			1	2	3	1	1		2	2	PASS	PASS	PASS
-5	3	2	1	1	1	1	1			1					1	2	1	1	[illegible]	2	2	PASS	PASS	PASS
-10	2	1	1	2	1	2	2								1	2	1	1	[illegible]	3	2	PASS	PASS	PASS

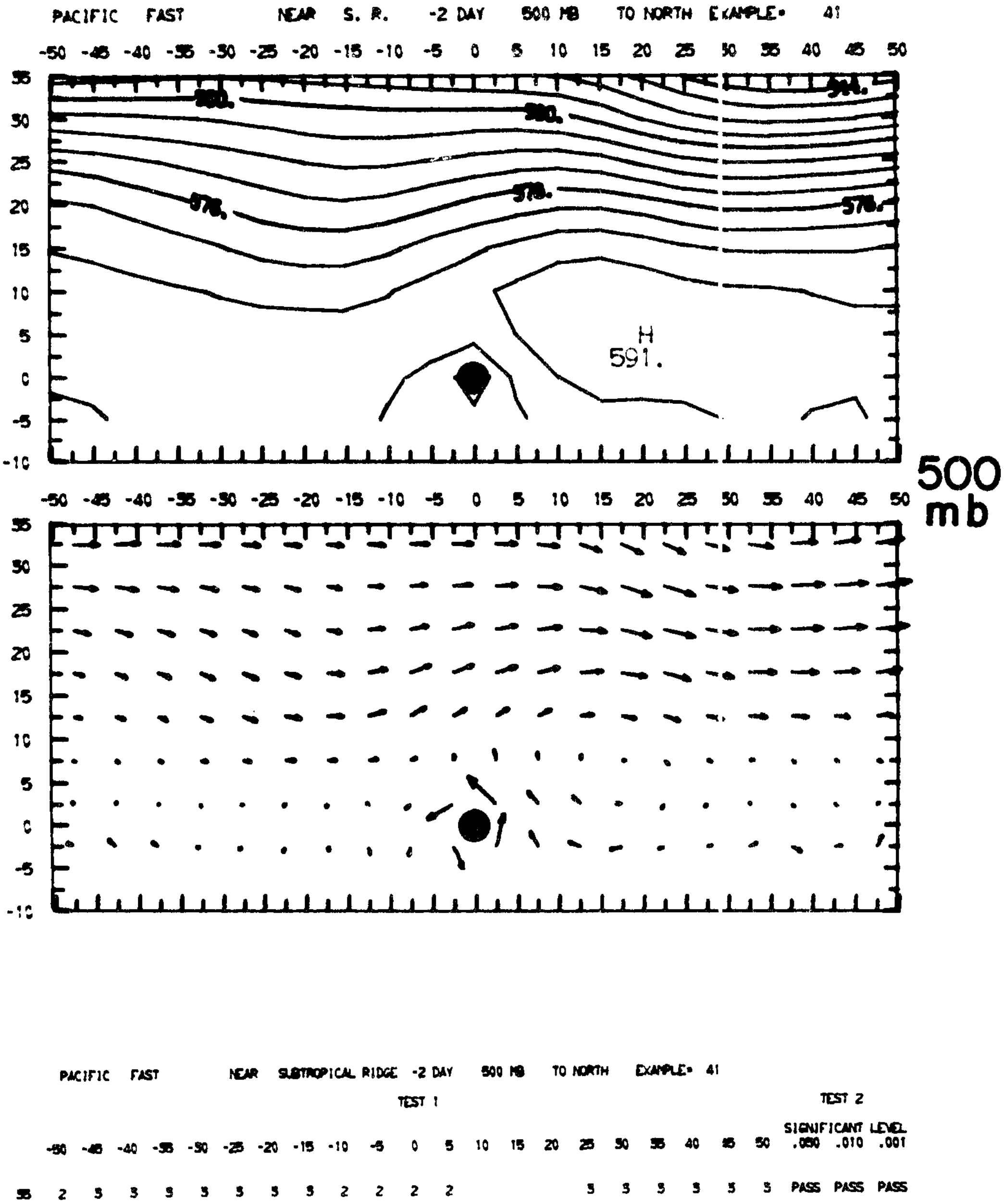
ATL. FAST -2
Near



ATLANTIC FAST NEAR SUBTROPICAL RIDGE -2 DAY 500 MB TO NORTH EXAMPLE= 18

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	?	2	2	1	1						1	1	1	1	1	1	1	1			PASS	PASS	PASS
30	3	3	3	2																		PASS	PASS	PASS
25	2	3	3	1																		PASS	PASS	
20								1							1	1						PASS	PASS	
15							1	2					1	2	3	3	2			1	1	PASS	PASS	PASS
10							1	2					2	3	3	2						PASS	PASS	PASS
5							2	1					1	3	3	1						PASS	PASS	PASS
0				1		1	2	1		3	3	3		3	3	1		1	1	1	1	PASS	PASS	PASS
-5	1	3	3	3	3	2	1		1	3	2	2			1	1	2	3	3	2	2	PASS	PASS	PASS
-10																								

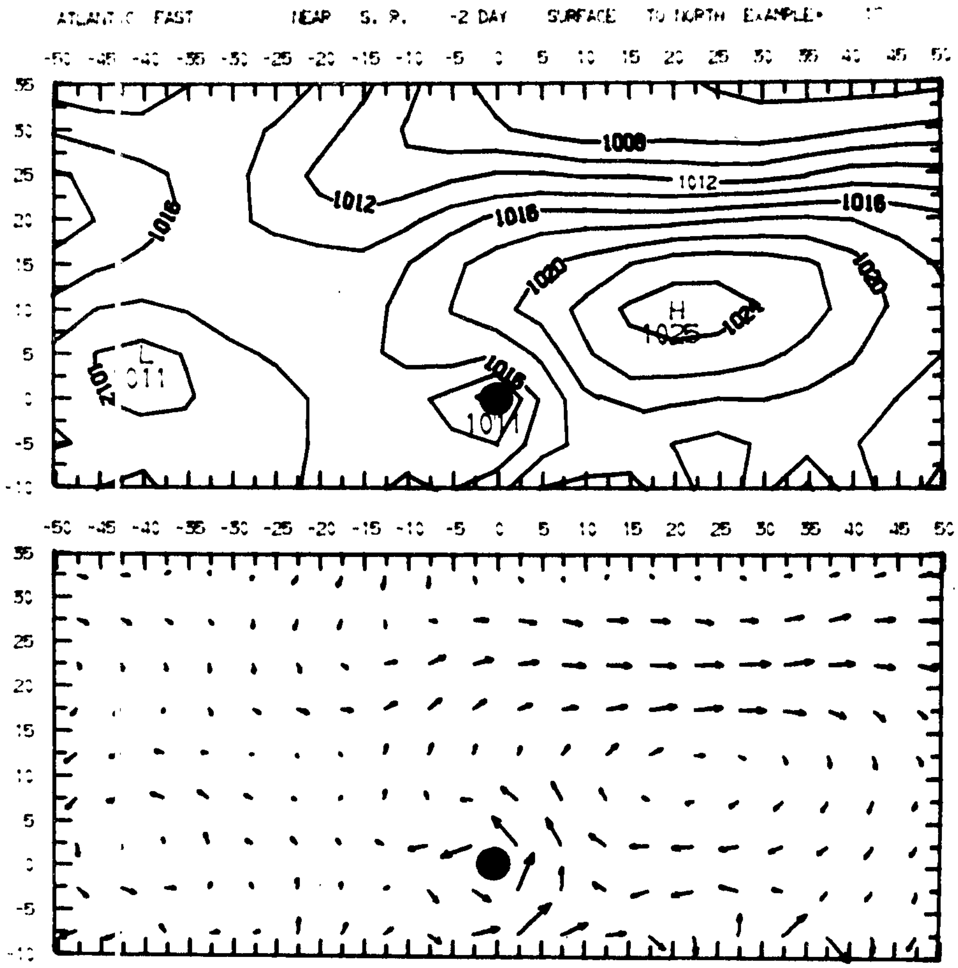
PAC. FAST -2
Near



PACIFIC FAST NEAR SUBTROPICAL RIDGE -2 DAY 500 MB TO NORTH EXAMPLE= 41

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	3	3	3	3	3	3	3	2	2	2	2				3	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	2	1	1	1	1	1			1	3	3	3	3	3	3	PASS	PASS	PASS
25	3	3	3	2	1								1			2	2	2	2	1		PASS	PASS	PASS
20	3	3	1			3	3	3	3				2	2								PASS	PASS	PASS
15				1	3	3	3	3	3	1		2	3	3	3	1						PASS	PASS	PASS
10	1	2	3	3	3	3	3	3	3	1		3	3	3	3	3	2	2				PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	3	3	2		3	3	3	3	3	3	1		1	PASS	PASS	PASS
0	1	1				1	2	2	1	3	3	1	2	3	3	2	2	2			1	PASS	PASS	PASS
-5											1						2				1	PASS	PASS	
-10																								

ATL. FAST -2
Near



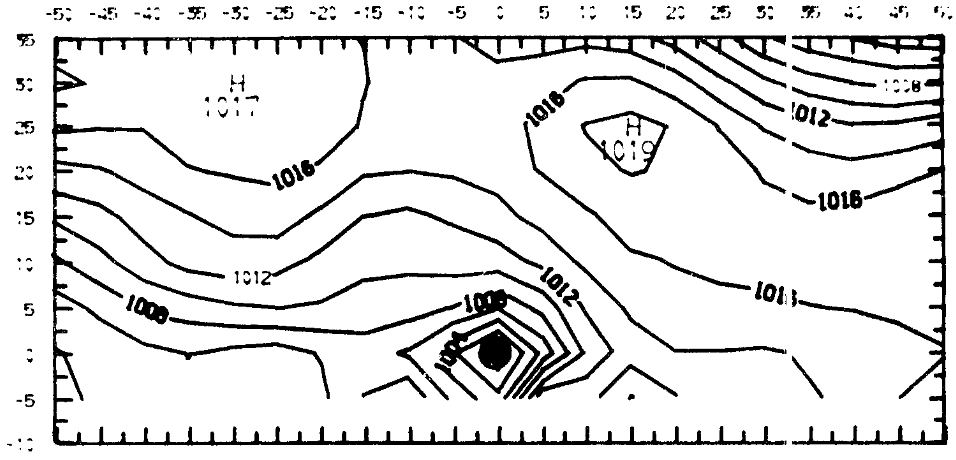
Sfc.

ATLANTI FAST NEAR SUBTROPICAL RIDGE -2 DAY SURFACE TO NORTH EXAMPLE= 17

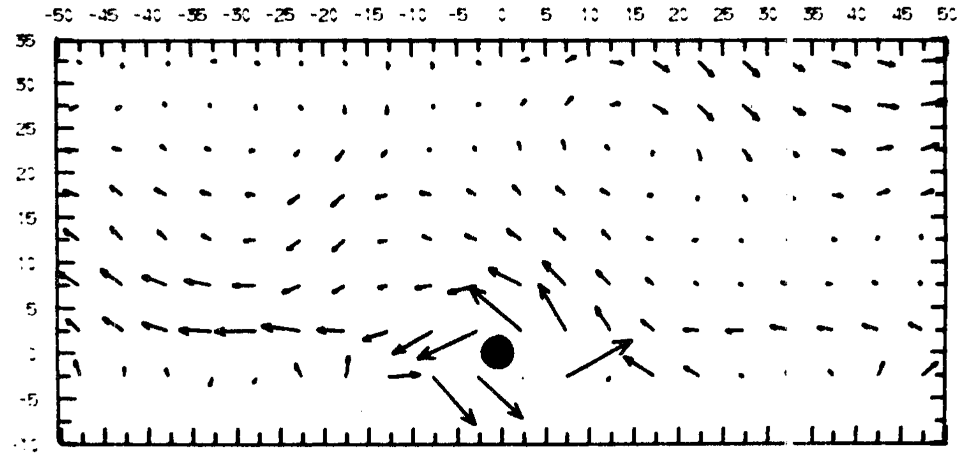
	-50	45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
35	1			1	2	2	1								1	1	1	1	1			PASS	PASS	PASS
30	2	1	1	1	2	1							1	1								PASS	PASS	PASS
25	2	1	1																			PASS	PASS	
20						2	2	2	1													PASS	PASS	
15			1	1	3	3	3	3	2			1	2	3	3	3	3	3				PASS	PASS	PASS
10	2	3	3	3	3	3	3	3	1			2	3	3	3	3	3	3	1			PASS	PASS	PASS
5	3	3	3	3	3	3	3	3					3	3	3	3	3	3	2			PASS	PASS	PASS
0	1	3	3	3	2	2	2	1	1	3	3		3	3	3	3	3	3	1			PASS	PASS	PASS
-5		1	2	3	2	1	1						3	3	1		2	1				PASS	PASS	PASS
-10																								

PAC. FAST -2
Near

PACIFIC FAST NEAR S. R. -2 DAY SURFACE TO NORTH EXAMPLE= 37



Sfc.



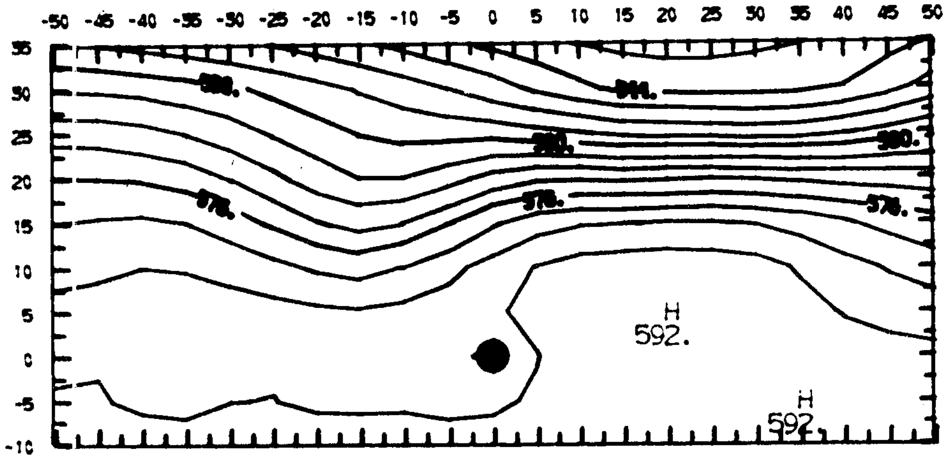
PACIFIC FAST NEAR SUBTROPICAL RIDGE -2 DAY SURFACE TO NORTH EXAMPLE= 37

TEST 1 / TEST 2 (SIGNIFICANT LEVEL)

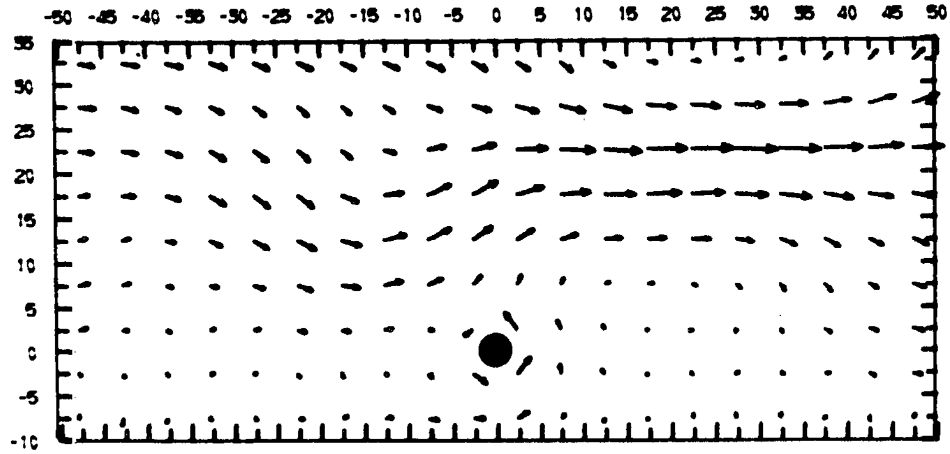
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	3	3	2	3	3	3	3	3	1						1	3	3	3	3	3	PASS	PASS	PASS
30	2	2	1	1	2	2	2	1					1	2			1	3	3	3	3	PASS	PASS	PASS
25													2	3	1			1	1	1		PASS	PASS	PASS
20	1							1	1				2	3	2							PASS	PASS	PASS
15	3	2						2	3	2			1	3	3	2	2	1	1	2	2	PASS	PASS	PASS
10	3	3	1				1	3	3	3	3		2	3	3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	1	1		1	1	1	3	3	3	2		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	1	1	1	1	2	2			3	3	3	2	2	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5																								
-10																								

ATL. FAST -1
Near

ATLANTIC FAST NEAR S. R. -1 DAY 500 MB TO NORTH EXAMPLE= 20



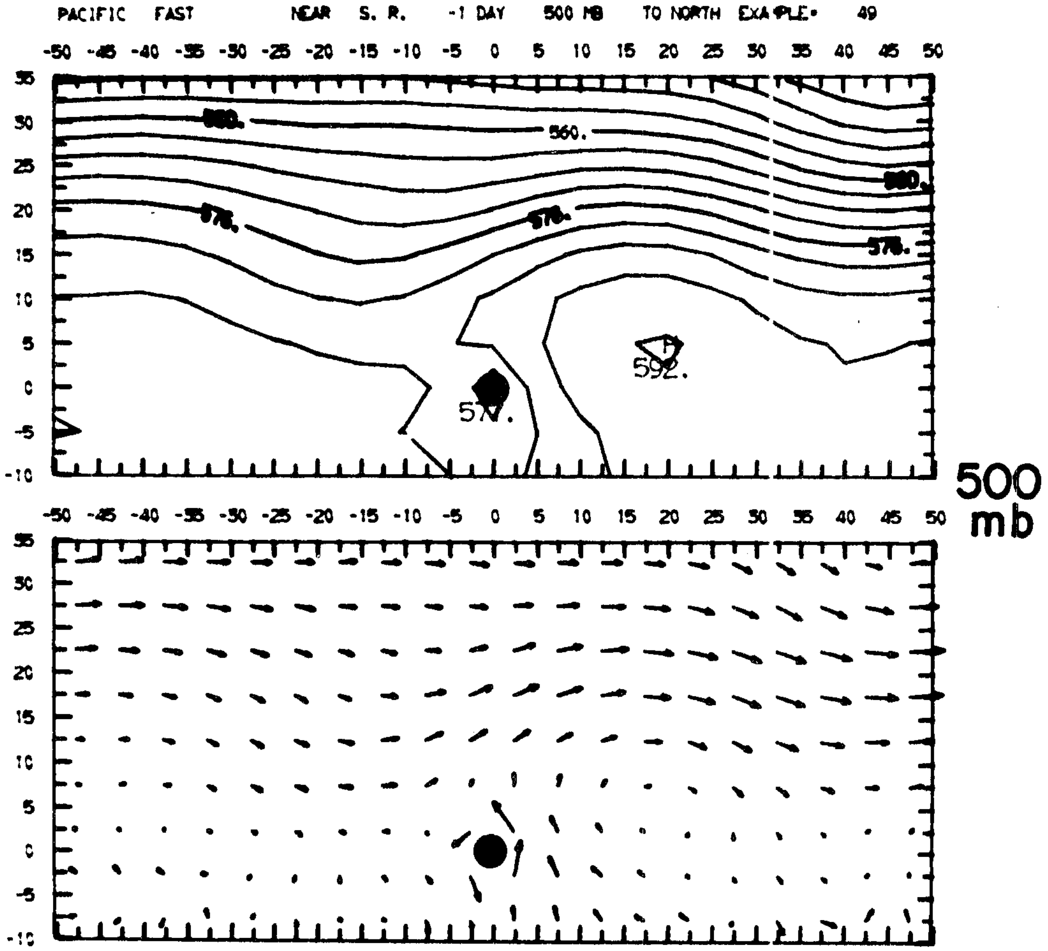
500 mb



ATLANTIC FAST NEAR SUBTROPICAL RIDGE -1 DAY 500 MB TO NORTH EXAMPLE= 20

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	2						1	5	5	5	5	5	2	1			PASS	PASS	PASS
30	5	5	5	5	5	2	1					2	5	5	5	5	5	5	2	2		PASS	PASS	PASS
25	5	5	5	5	2	1							1	1	1	1	1	1	1			PASS	PASS	PASS
20	1	2	5	2			2	5	2	1												PASS	PASS	PASS
15						2	5	5	5	2		2	5	2	2	5	5	2				PASS	PASS	PASS
10						1	5	5	5	1		2	5	5	5	5	5	2				PASS	PASS	PASS
5							2	5	5	1			5	5	5	5	5					PASS	PASS	PASS
0				1	1		1	5	2	5	2		2	5	5	5	2	1				PASS	PASS	PASS
-5			1	2	5	2	2	2	2	5	2		1	2	1	2	2	2	2	2	2	PASS	PASS	PASS
-10				1	1					1								2				PASS	PASS	

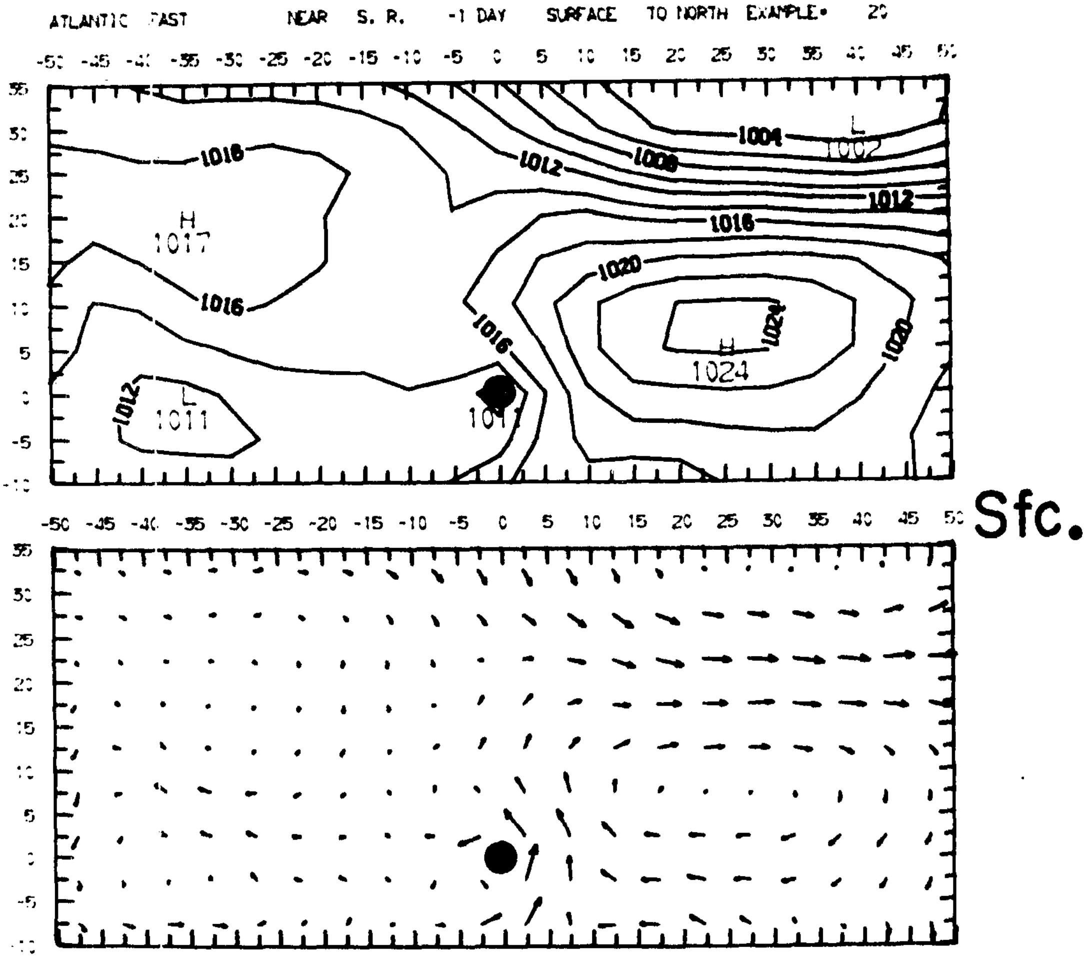
PAC. FAST -1
Near



PACIFIC FAST NEAR SUBTROPICAL RIDGE -1 DAY 500 MB TO NORTH EXAMPLE= 49

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35			1	2	2	2	2	2	2	1							1	3	3	3	3	PASS	PASS	PASS
30	1	2	3	3	3	3	2	2	1	1							2	3	3	3	3	PASS	PASS	PASS
25	2	3	3	3	3	2							1	1	1		1	3	3	3	3	PASS	PASS	PASS
20	3	3	3	3	1		1	2	3	2			3	3	3	1		2	3	3	2	PASS	PASS	PASS
15	1	2	1			3	3	3	3	3		2	3	3	3	3						PASS	PASS	PASS
10				2	3	3	3	3	3	3		3	3	3	3	3	3					PASS	PASS	PASS
5	3	3	2	1	3	3	3	3	3	3	3		3	3	3	3	3	1			3	PASS	PASS	PASS
0	3	3	2			1	2	3	3	3	3	2	3	3	3	3	3	2		2	3	PASS	PASS	PASS
-5	2	1					1	3	2	3	2	1		3	3	3	3	2		1	2	PASS	PASS	PASS
-10																								

ATL. FAST Near -1

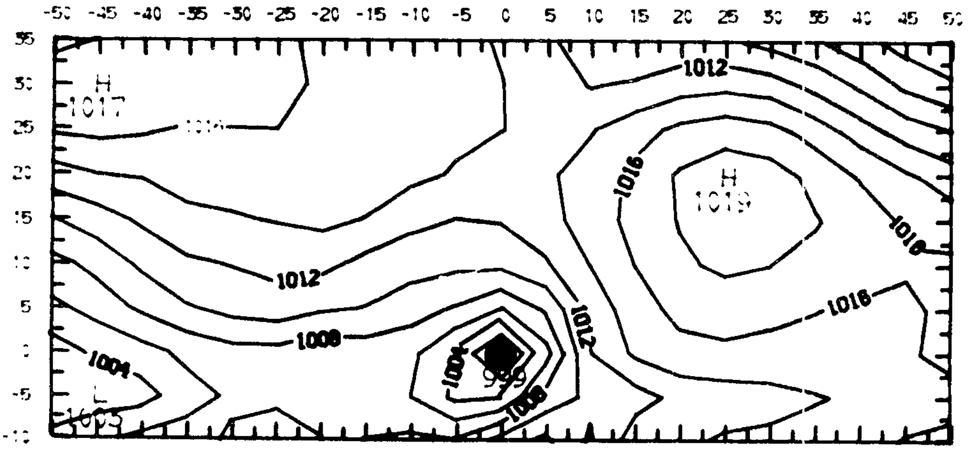


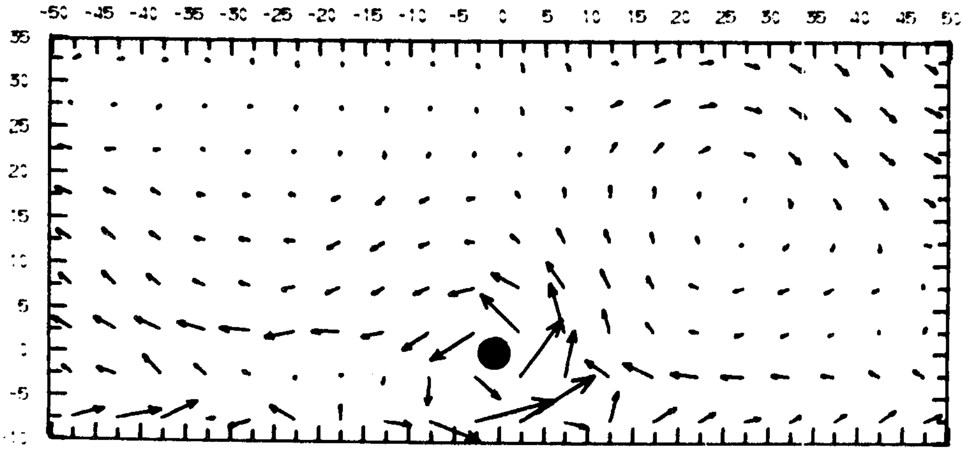
ATLANTIC FAST NEAR SUBTROPICAL RIDGE -1 DAY SURFACE TO NORTH EXAMPLE= 20

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	2	2	2	3	3	3	1					1	2	2	2	2	2	2	1	PASS	PASS	PASS
30	2	2	2	2	3	3	3	3	2					1	2	3	3	3	3	3	2	PASS	PASS	PASS
25	2	1	1	1	2	2	2	2							1	2	2	2	3	3	2	PASS	PASS	PASS
20																								
15								1	3	2			1	2	3	3	2	1				PASS	PASS	PASS
10	2	3	2	1	1	2	3	3	3	2	1		3	3	3	3	3	3	2			PASS	PASS	PASS
5	2	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3			PASS	PASS	PASS
0	2	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	2		PASS	PASS	PASS
-5	1	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	2		PASS	PASS	PASS
-10		1	1	1	1	2	1	1	2	2			1			1	2	2	1			PASS	PASS	PASS

PAC. FAST -1
Near

PACIFIC FAST NEAR S. R. -1 DAY SURFACE TO NORTH EXAMPLE= 45



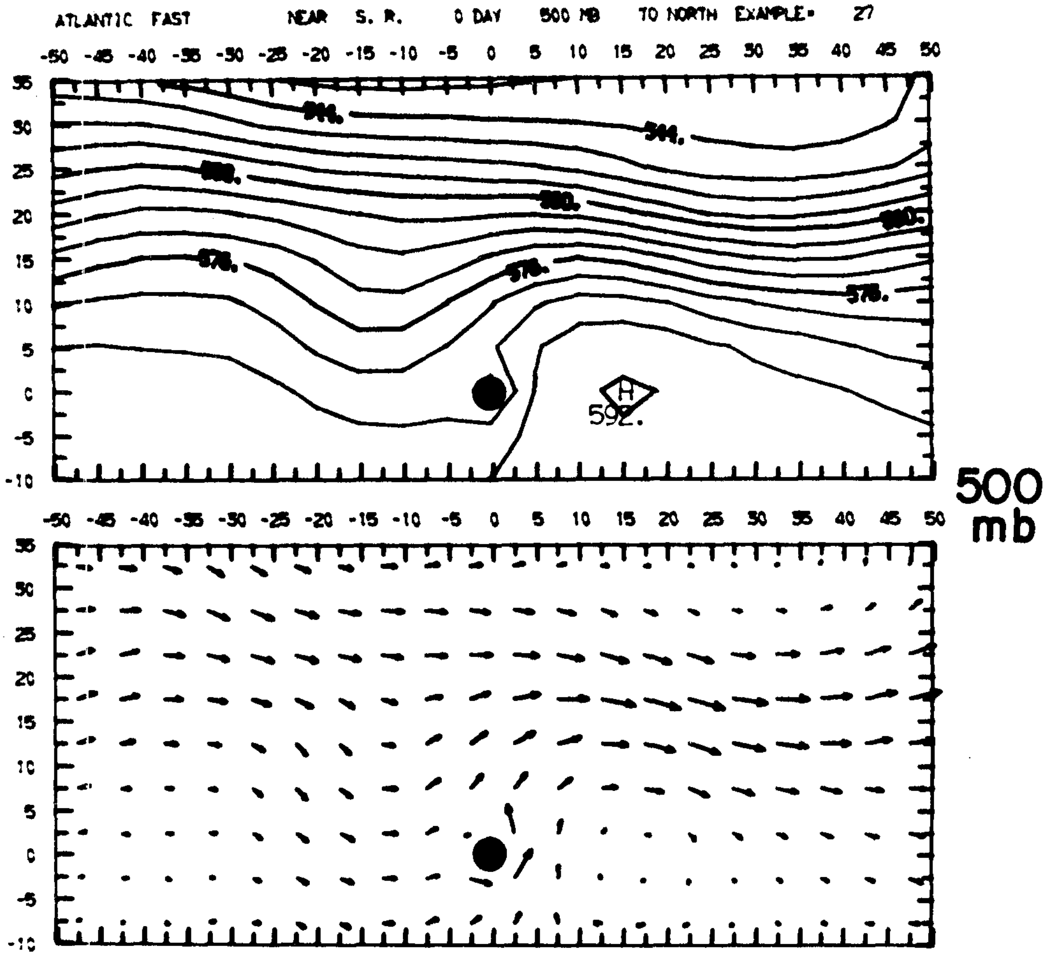


Sfc.

PACIFIC FAST NEAR SUBTROPICAL RIDGE -1 DAY SURFACE TO NORTH EXAMPLE= 45

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1	1	1	2	2	2	2	2	2				1	1	1	2	2	2	3	3	PASS	PASS	PASS
30	2	2	2	1	1	1													1	2	3	PASS	PASS	PASS
25																1				1	2	PASS	PASS	PASS
20	1									1	2	1			3	3	3	1				PASS	PASS	PASS
15	3	3	1						2	3	3			2	3	3	3	3	2			PASS	PASS	PASS
10	3	3	3	1				2	3	3	3	1		3	3	3	3	3	3	2	2	PASS	PASS	PASS
5	3	3	3	1				1	3	3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	2	1	2	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	2	1	1			2	2	2		1	1	2	3	3	3	3	3	3	PASS	PASS	PASS
-10																								

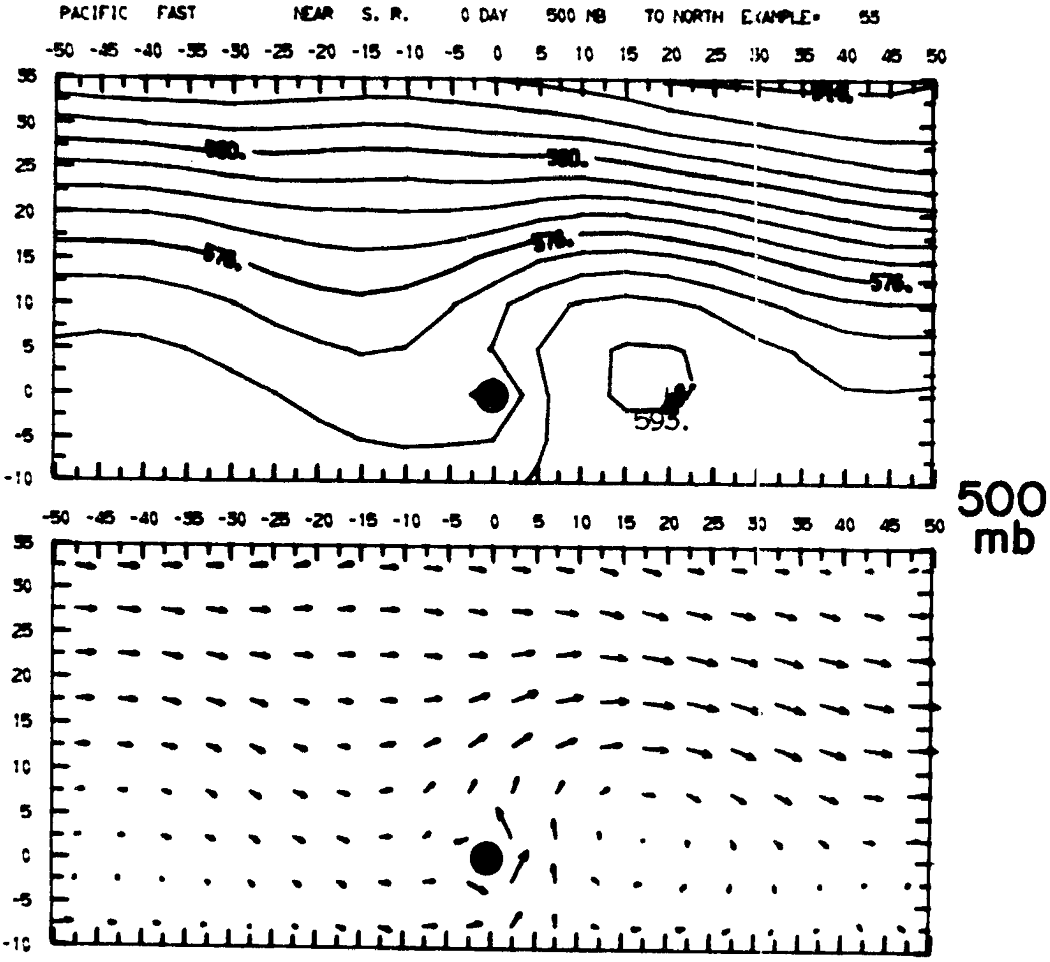
ATL. FAST O
Near



ATLANTIC FAST NEAR SUBTROPICAL RIDGE 0 DAY 500 MB TO NORTH EXAMPLE= 27

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	1																				PASS	PASS	
30	5	5	5	2										1	1	1	1	1				PASS	PASS	PASS
25	2	5	5	5	5	2								2	5	5	5	5	2	2		PASS	PASS	PASS
20		2	5	5	5	5	1								2	5	5	5	5	2		PASS	PASS	PASS
15		1	5	5	5							1	5	2			1	2	2			PASS	PASS	PASS
10							2	5	5	2		5	5	5	5							PASS	PASS	PASS
5						1	5	5	5	5		5	5	5	5	5	1					PASS	PASS	PASS
0						1	2	5	5	5	2	1	5	5	5	5	2	2				PASS	PASS	PASS
-5				1	2	2	2	2	5	5	2	1	5	5	5	5	2	2	1			PASS	PASS	PASS
-10			1	1	1	1	2	2	5	2		1	5	1			1	1	2	2	1	PASS	PASS	PASS

PAC. FAST O
Near

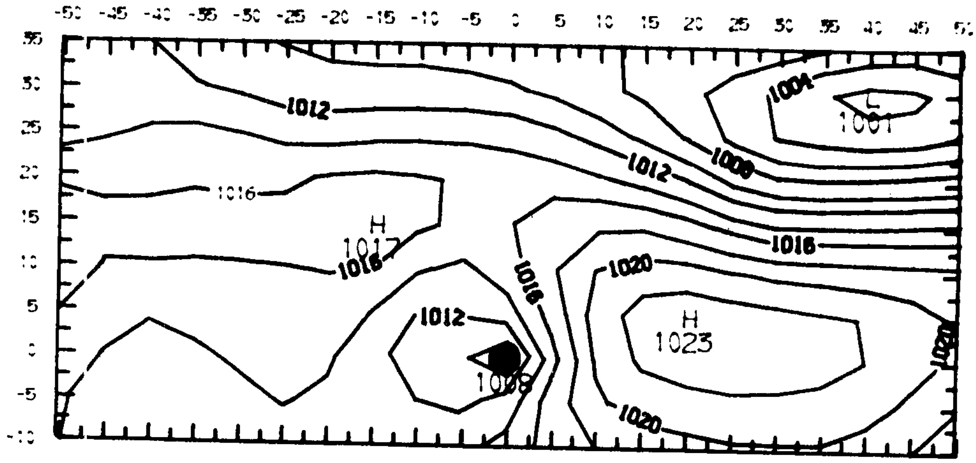


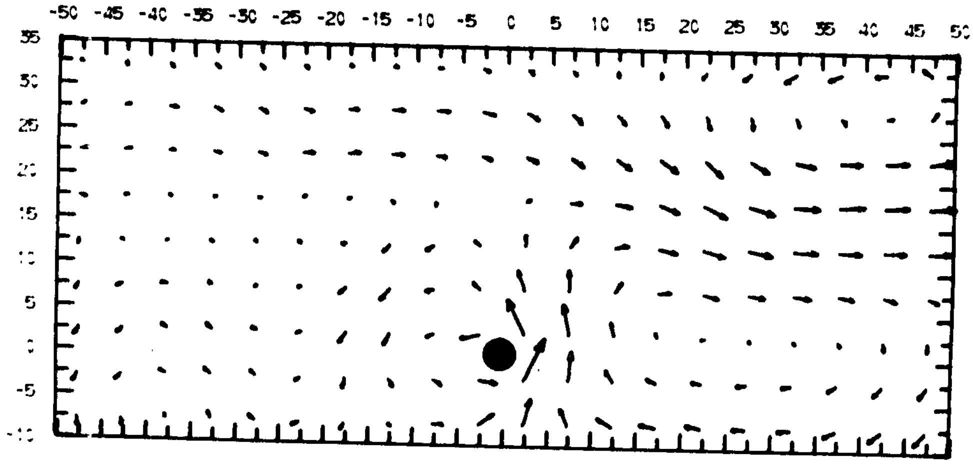
PACIFIC FAST NEAR SUBTROPICAL RIDGE 0 DAY 500 MB TO NORTH EXAMPLE= 55

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35							1	2	1						2	3	3	2	1	1		PASS	PASS	
30	2	2	1	1	1	1	1	2	2	1					1	3	3	3	3	3	3	PASS	PASS	PASS
25	2	2	2	2	1			1	1	1						1	2	3	3	3	3	PASS	PASS	PASS
20	2	2	2	1								1	3	3	1			2	3	3	3	PASS	PASS	PASS
15		1	1			2	3	3	3	1		3	3	3	3	3			2	3	3	PASS	PASS	PASS
10				1	3	3	3	3	3	3		3	3	3	3	3	3			1	1	PASS	PASS	PASS
5	2	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2				PASS	PASS	PASS
0	3	2	1	2	3	3	3	3	3	3	3		3	3	3	3	3	3	1	2	3	PASS	PASS	PASS
-5	3	3	1		3	3	3	3	3	3	3		3	3	3	3	3	2	1	2	3	PASS	PASS	PASS
-10	3	2	2	1			1	2	2	1			3	3	1		1	2	2	2	1	PASS	PASS	PASS

ATL. FAST O
Near

ATLANTIC FAST NEAR S. R. 0 DAY SURFACE TO NORTH EXAMPLE= 26



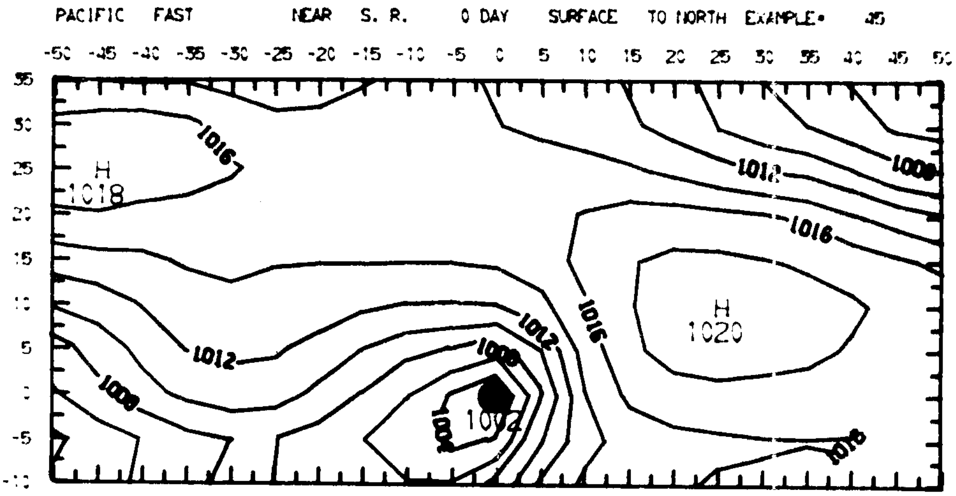


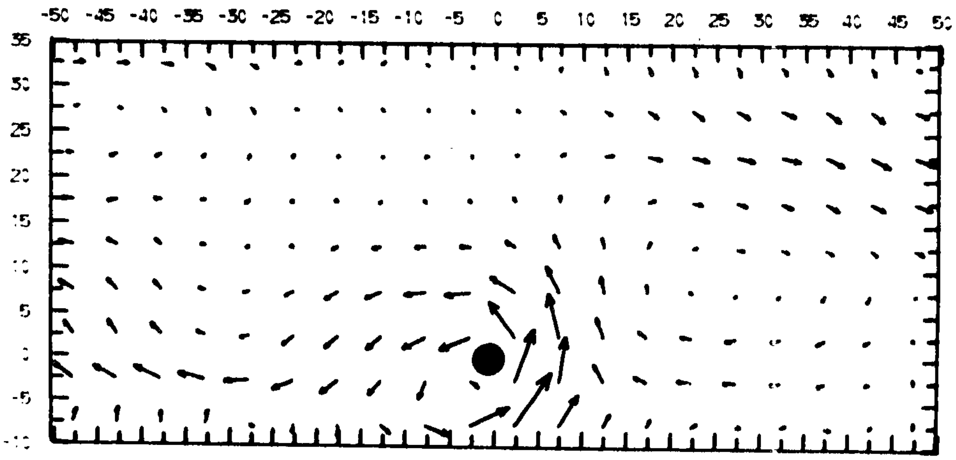
Sfc.

ATLANTIC FAST NEAR SUBTROPICAL RIDGE 0 DAY SURFACE TO NORTH EXAMPLE= 26

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	1															1	1	2	1	PASS	PASS	PASS
30	2	2	2	2	1											1	2	3	3	3	3	PASS	PASS	PASS
25	1	2	2	2	2	1	1	2	2	2	2					2	3	3	3	3	3	PASS	PASS	PASS
20						1	2	2	1	1						1	2	2	2	2	2	PASS	PASS	PASS
15																								
10									2	3	2		3	3	3	1						PASS	PASS	PASS
5		1	2	1	1	1	1	3	3	3	3	1	3	3	3	3	3	3	3	3	1	PASS	PASS	PASS
0		3	3	3	2	2	3	3	3	3	3	1	3	3	3	3	3	3	3	3	2	PASS	PASS	PASS
-5	1	3	3	3	2	3	3	3	3	3	3		3	3	3	3	3	3	3	3	1	PASS	PASS	PASS
-10	1	3	3	3	2	3	3	3	3	2			3	3	3	3	3	3	3	2		PASS	PASS	PASS

PAC. FAST O
Near





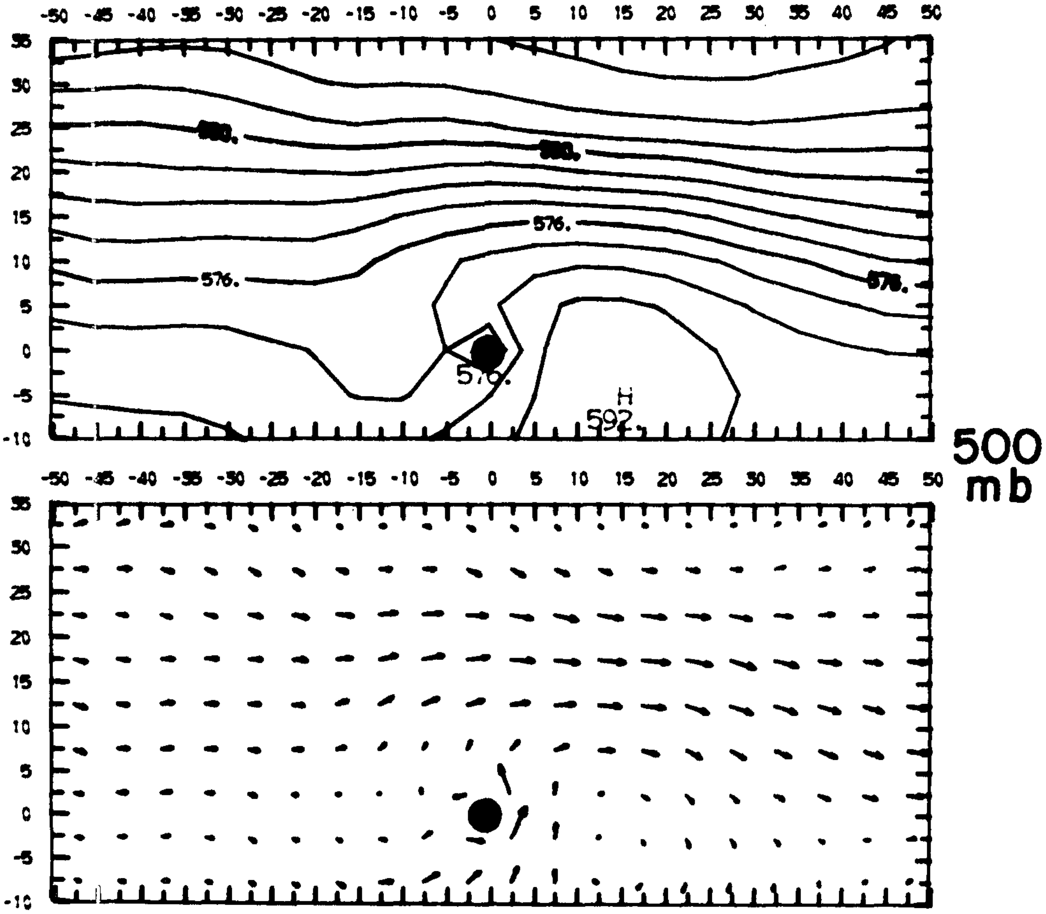
Sfc.

PACIFIC FAST NEAR SUBTROPICAL RIDGE 0 DAY SURFACE TO NORTH EXAMPLE= 43

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	1	1				1	2	2	1	1				1	3	3	3	3	3	PASS	PASS	PASS
30	2	2	3	2	1				1	1						2	2	3	3	3	3	PASS	PASS	PASS
25	2	2	2	1															1	2	3	PASS	PASS	PASS
20																					1	PASS	PASS	
15	1	1												2	2	2	1					PASS	PASS	PASS
10	3	3	2				1	2	3	3	3	1		3	3	3	3	3	3	2	1	PASS	PASS	PASS
5	3	3	2				2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	1				2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	1	1	2	3	3	3	3	3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10	3	2	1	1		1	2	2	2	2	1		3	3	3	3	3	3	3	3	2	PASS	PASS	PASS

PAC. FAST 1
Near

PACIFIC FAST NEAR S. R. 1 DAY 500 MB TO NORTH EXAMPLE= 20

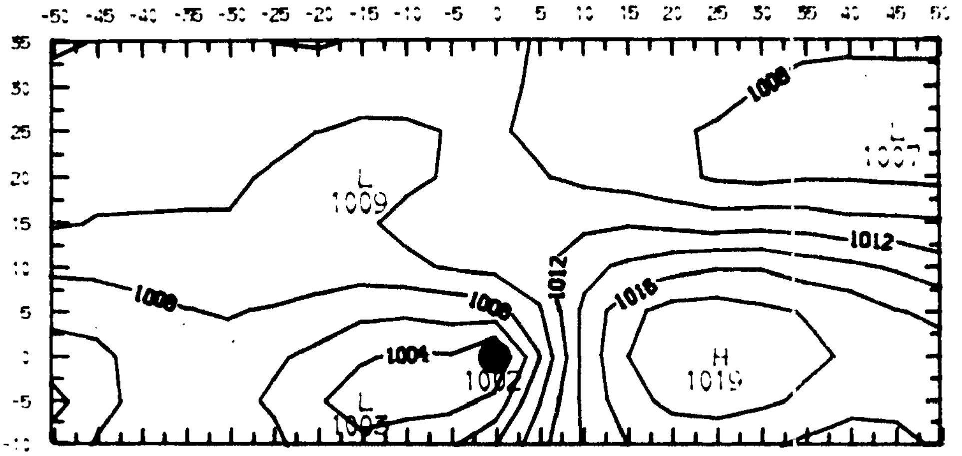


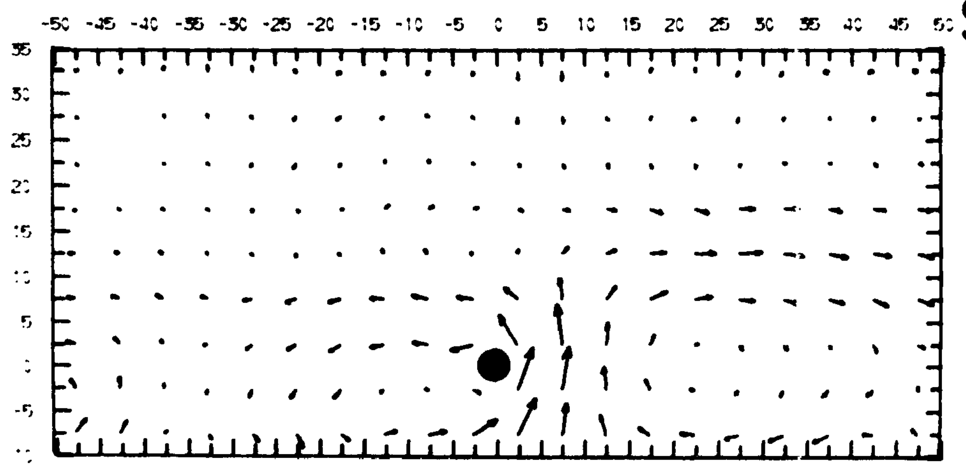
PACIFIC FAST NEAR SUBTROPICAL RIDGE 1 DAY 500 MB TO NORTH EXAMPLE= 20

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35				1																		PASS		
30	1	2	2	2	1									1	1							PASS	PASS	PASS
25	1	1	2	1	1										1	1	1	1				PASS	PASS	PASS
20																		1	1	1	1	PASS	PASS	
15										1	2	2	2	1					1	2	2	PASS	PASS	PASS
10		1	2	2	2	1					2	2	3	3	2	1				1	2	PASS	PASS	PASS
5	1	1	2	2	2	3	2	1	1			3	3	3	3	2						PASS	PASS	PASS
0			1	1	2	3	3	3	3	3		3	3	3	3	3	1					PASS	PASS	PASS
-5				1	2	3	3	3	3	3		3	3	3	3	3						PASS	PASS	PASS
-10				2	3	3	3	3	3			2	3	3	3	2						PASS	PASS	PASS

PAC. FAST 1
Near

PACIFIC FAST NEAR S. R. 1 DAY SURFACE TO NORTH EXAMPLE= 20



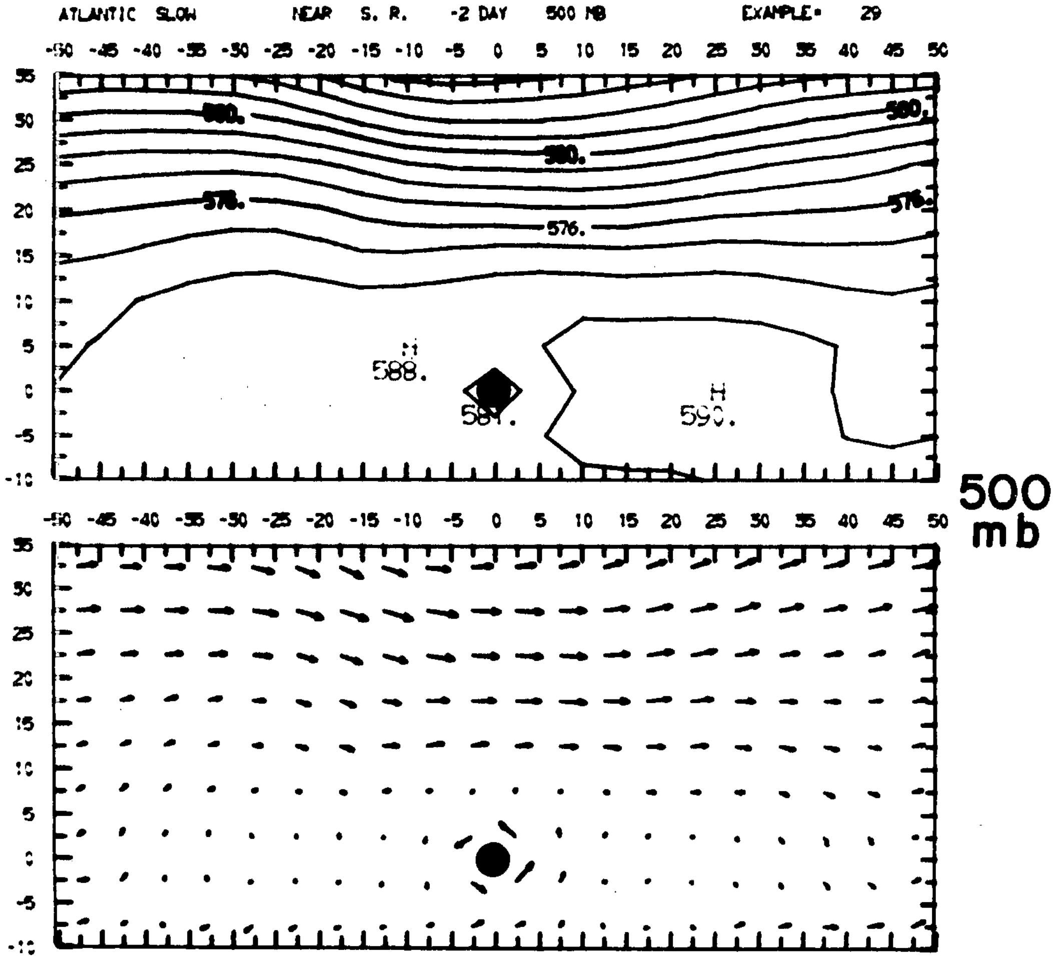


Sfc.

PACIFIC FAST NEAR SUBTROPICAL RIDGE 1 DAY SURFACE TO NORTH EXAMPLE= 20

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35																						PASS		
30																								
25																								
20																								
15																								
10	1	1	1	1			1	2	1				1	2	3	3	2	1				PASS	PASS	PASS
5	3	3	2	1	1	2	3	3	3	3	3	1	2	3	3	3	3	3	3	2	1	PASS	PASS	PASS
0	3	2	1	1	2	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	2	1	1	2	3	3	3	3	3	3		3	3	3	3	3	3	2	2	3	PASS	PASS	PASS
-10	3	2	1	2	2	2	3	3	3	3	2		3	3	3	3	3	2	1	2	3	PASS	PASS	PASS

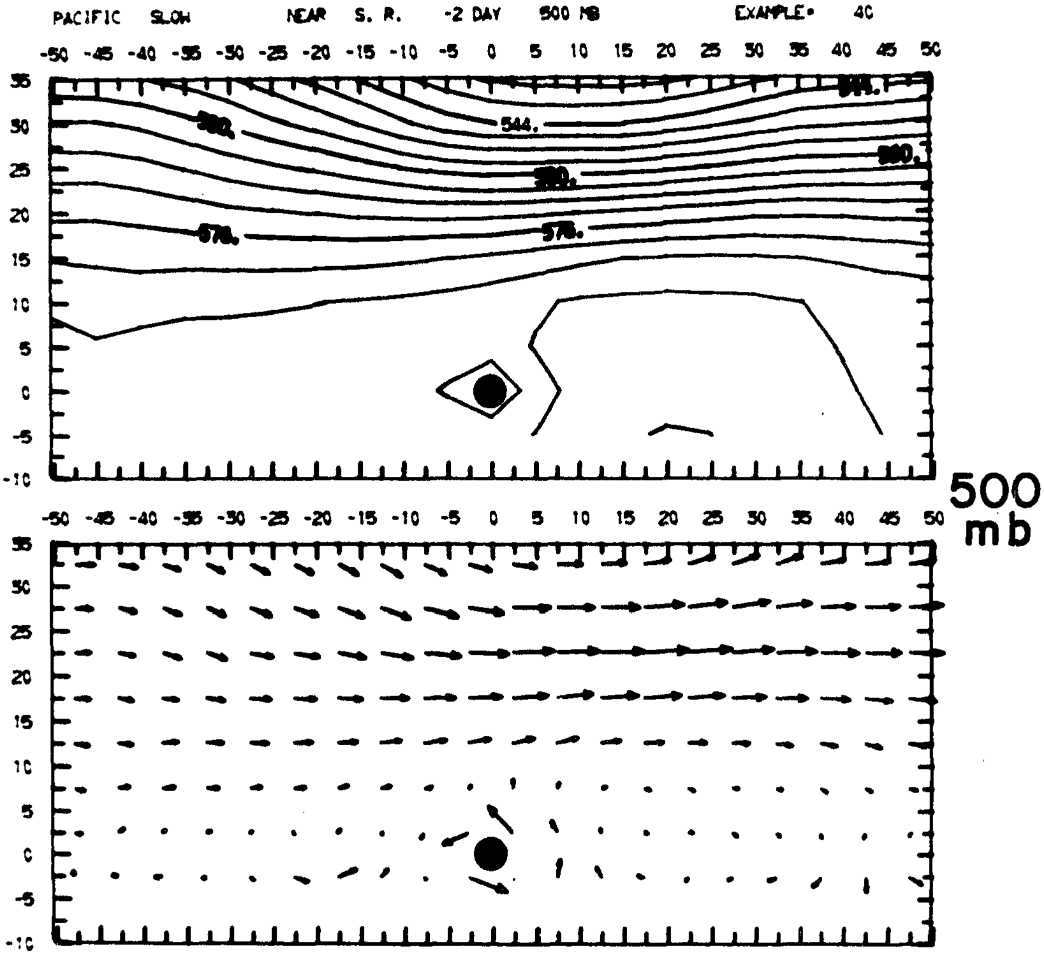
ATL. SLOW -2
Near



ATLANTIC SLOW NEAR SUBTROPICAL RIDGE -2 DAY 500 MB EXAMPLE= 29

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	2	2	2	1			1	3	3	3	3	2								1	PASS	PASS	PASS
30		1	1	1	1				1	2	3	3	3	2						1	2	PASS	PASS	PASS
25			1	1	1						1	2	2	2							1	PASS	PASS	PASS
20																						PASS		
15																						PASS		
10	3	2	1									1	1	1	1							PASS	PASS	PASS
5	3	2	2										2	3	2	1	1					PASS	PASS	PASS
0	1									2	3	2	2	2	2	2	2	1				PASS	PASS	PASS
-5		1	1							2	2		2	1	2	3	3	2				PASS	PASS	PASS
-10					1				1								1	1	1	1	2	PASS	PASS	

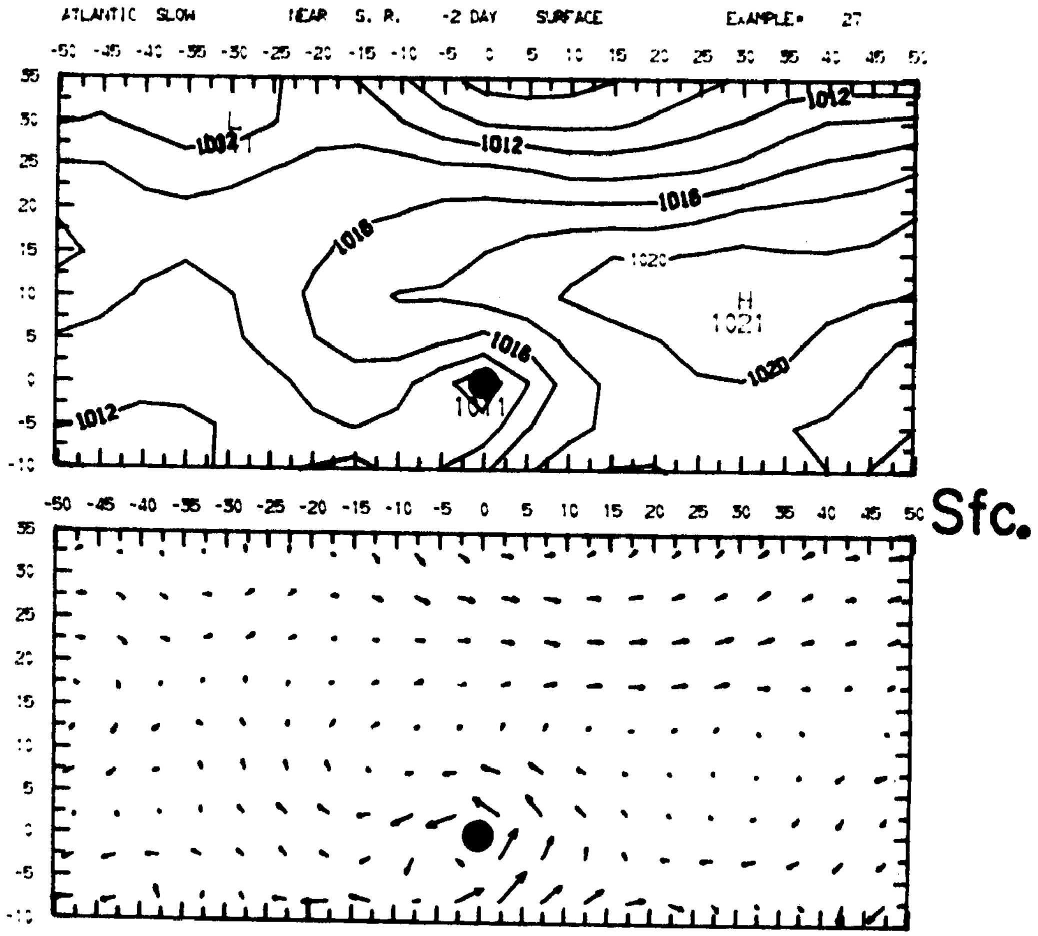
PAC. SLOW -2
Near



PACIFIC SLOW NEAR SUBTROPICAL RIDGE -2 DAY 500 MB EXAMPLE= 40

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	TEST 2 SIGNIFICANT LEVEL .050	.010	.001
	TEST 1																							
35	5	3	5	5	5	5	2		1	5	5	5	5	5	5	5	2					PASS	PASS	PASS
30	5	5	5	5	5	5	1		2	5	5	5	5	5	5	5						PASS	PASS	PASS
25	5	5	5	5	2				1	5	5	5	5	2	1							PASS	PASS	PASS
20	2	1						1	1	2	1											PASS	PASS	PASS
15	1	2	5	5	5	5	5	5	2				2	5	5	5	2	2	1			PASS	PASS	PASS
10	2	5	5	5	5	5	5	2	1			5	5	5	5	5	5	5	1			PASS	PASS	PASS
5	1	2	2	2	2	5	1			1		5	5	5	5	5	5	2				PASS	PASS	PASS
0	2	5	2	1		1			2	5	5		2	5	5	5	5	5	1			PASS	PASS	PASS
-5																								
-10																								

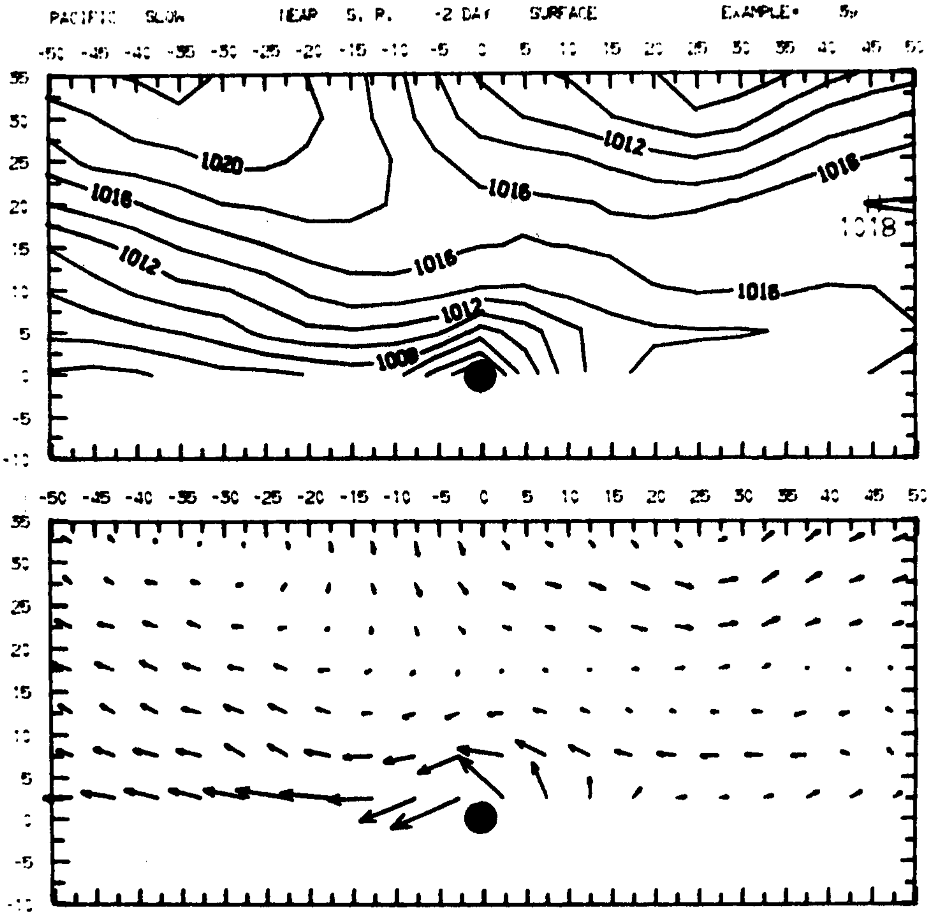
ATL. SLOW -2
Near



ATLANTIC SLOW NEAR SUBTROPICAL RIDGE -2 DAY SURFACE EXAMPLE= 27

	TEST 1																					TEST 2		
	-50	-45	-40	-5	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35											2	2	2	1								PASS	PASS	PASS
30												1	1	2							1	PASS	PASS	
25																					1	PASS	PASS	
20			2	2	1												1	1		1	2	PASS	PASS	PASS
15		2	3	3	3	2	1						1	2	2	2	2	2	1	1	2	PASS	PASS	PASS
10	2	3	3	3	3	2	1					1	3	3	3	2	3	3	3	2	1	PASS	PASS	PASS
5	3	3	3	3	3	1					2		3	3	3	3	3	3	3	1		PASS	PASS	PASS
0	1	2	2	2	2	1				3	3	3	2	3	3	3	3	3	3	1		PASS	PASS	PASS
-5	1	2	2	2	2	1			2	3	2		3	3	3	3	3	2	2	1		PASS	PASS	PASS
-10	1	1	1	1	2							2	2	3	2	1						PASS	PASS	PASS

PAC. SLOW -2
Near

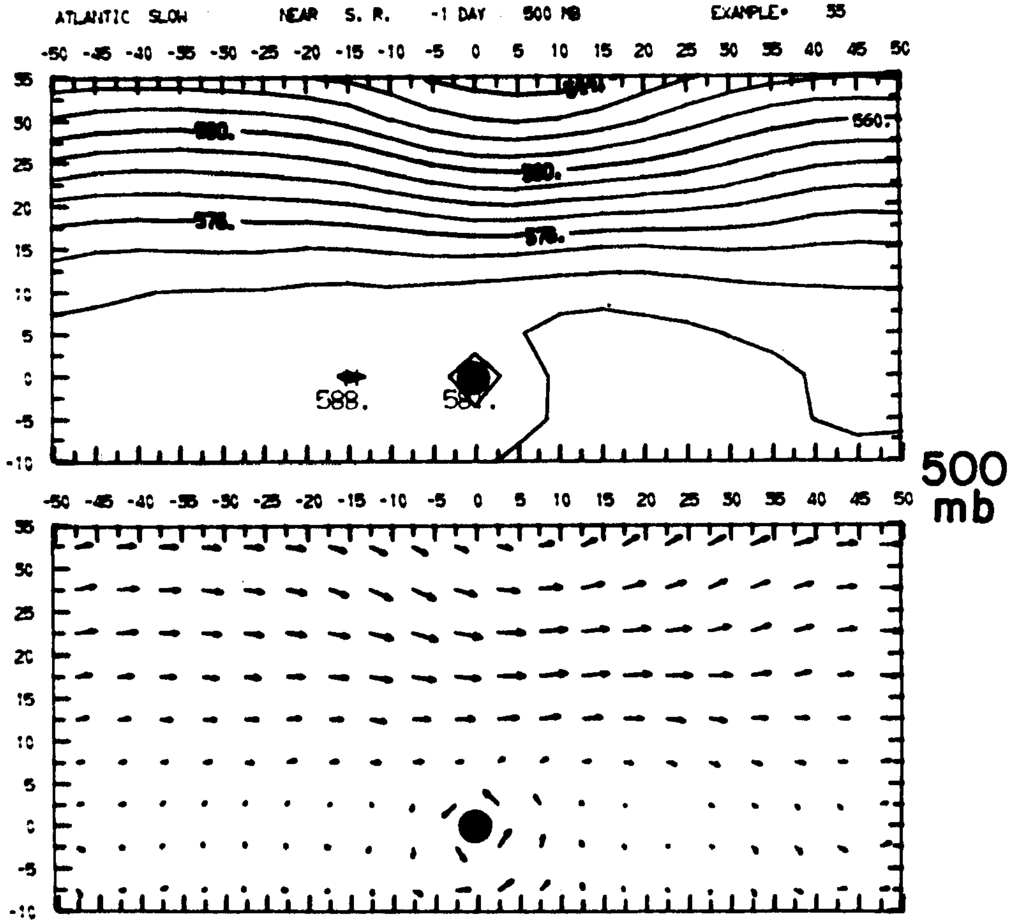


Sfc.

PACIFIC SLOW NEAR SUBTROPICAL RIDGE -2 DAY SURFACE EXAMPLE= 39

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	3	3	2			2	3	3	3	3	3	2	1			PASS	PASS	PASS
30	2	3	3	3	3	3	3	3	2			1	2	3	3	3	3	1				PASS	PASS	PASS
25				1	2	2	2	2	1					1	2	2	2					PASS	PASS	PASS
20	2	1					1	1														PASS	PASS	PASS
15	3	3	3	2					1								1	1	1			PASS	PASS	PASS
10	3	3	3	3	3			1	2					2	3	3	3	3	1	1	2	PASS	PASS	PASS
5	3	3	3	3	2						3	2		2	2	2	2	2	3	3	3	PASS	PASS	PASS
0	3	3	2	2	1	1	1	3	3	2	3			2	3	3	3	3	3	3	3	PASS	PASS	PASS
-5																								
-10																								

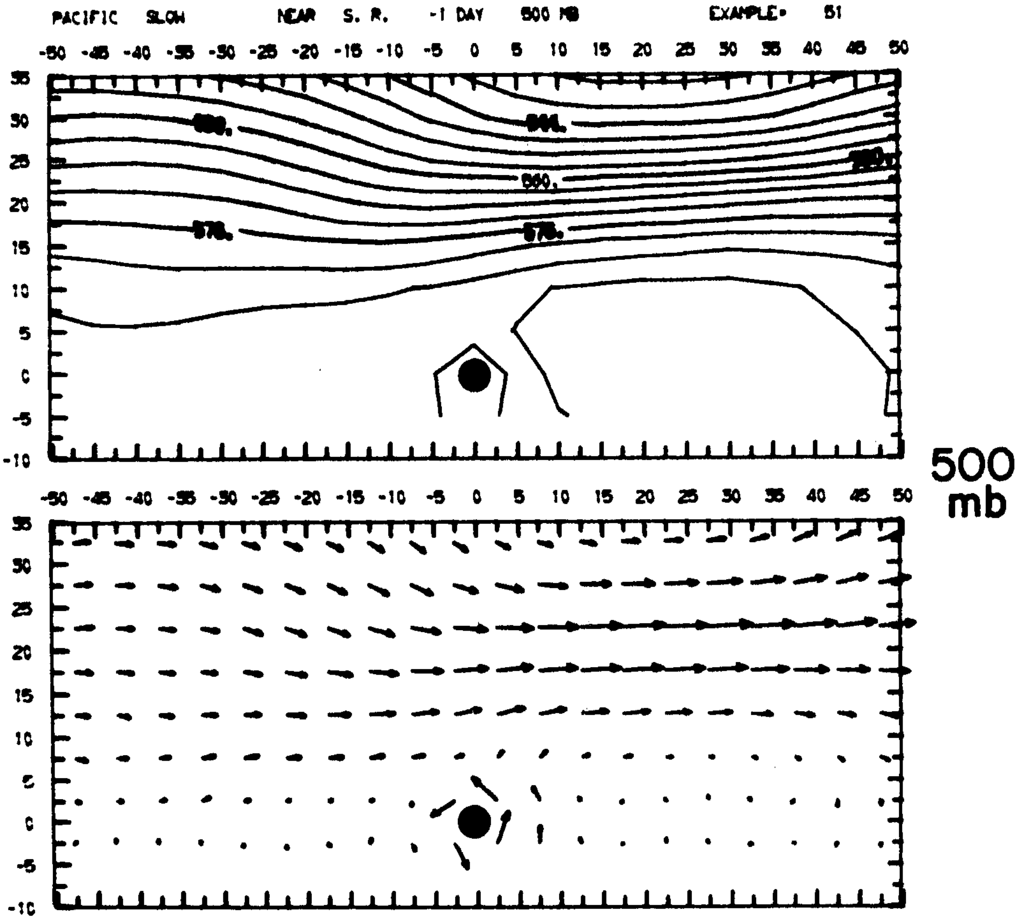
ATL. SLOW -1 Near



ATLANTIC SLOW NEAR SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 35

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	1	1						2	2	3	3	3					2	2	1	PASS	PASS	PASS
30			1	1	1				1	2	2	3	3	3	1			1	2	1	1	PASS	PASS	PASS
25			1	1						1	1	1	2	2	1							PASS	PASS	
20																						PASS		
15																								
10	1	1											1	3	2							PASS	PASS	PASS
5	2	1	2	1									3	3	3	2						PASS	PASS	PASS
0	1									2	3	2	2	3	3	3	2	1				PASS	PASS	PASS
-5		1	2	2	1					1	2			1	1	2	2	1				PASS	PASS	PASS
-10		2	2	1		1	2	2							1	1	1	1				PASS	PASS	

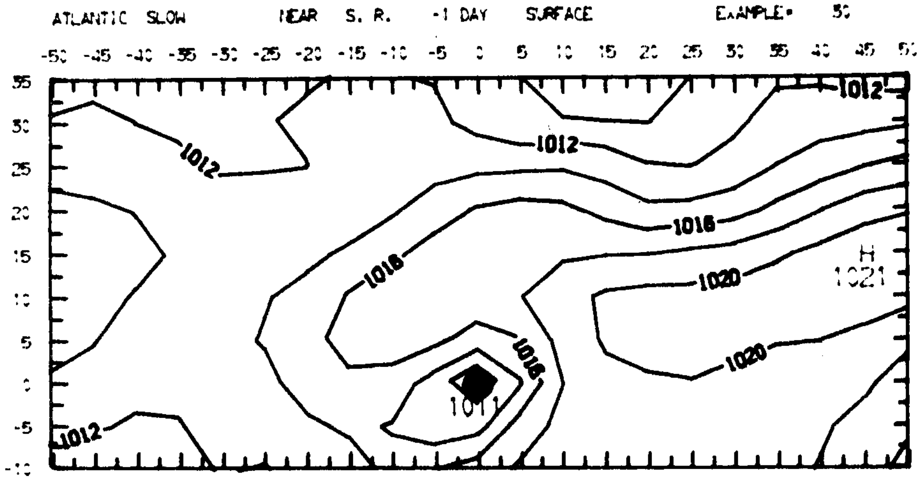
PAC. SLOW -1
Near

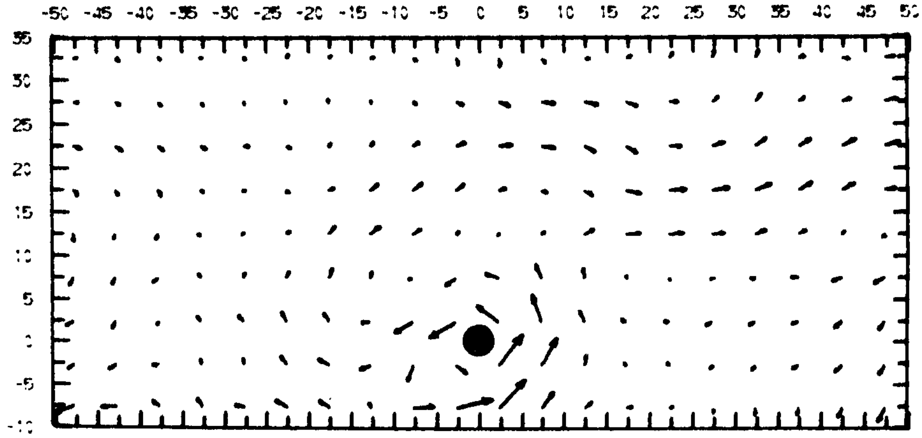


PACIFIC SLOW NEAR SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 51

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	5	5	2			2	5	5	5	5	5	5	5	5	1		PASS	PASS	PASS
30	5	5	5	5	5	5	5	2		1	5	5	5	5	5	5	5	5	5			PASS	PASS	PASS
25	5	5	5	5	5	5	2			5	5	5	5	5	5	5	2	1				PASS	PASS	PASS
20	5	5	5	5	2			2	5	5	5	5	2	1						1	1	PASS	PASS	PASS
15			2	2	5	5	5	5	5	5	1			5	5	5	5	5	2	2		PASS	PASS	PASS
10	5	5	5	5	5	5	5	5	5			5	5	5	5	5	5	5	2	1		PASS	PASS	PASS
5	5	5	5	5	5	5	1	1	1	1		1	5	5	5	5	5	5	2			PASS	PASS	PASS
0	5	5	5	2	1	1			1	5	5		5	5	2	2	5	5	5	1		PASS	PASS	PASS
-5	2	2	1							1	1			2	2	2	2	2	2	1		PASS	PASS	PASS
-10																								

ATL. SLOW -1
Near



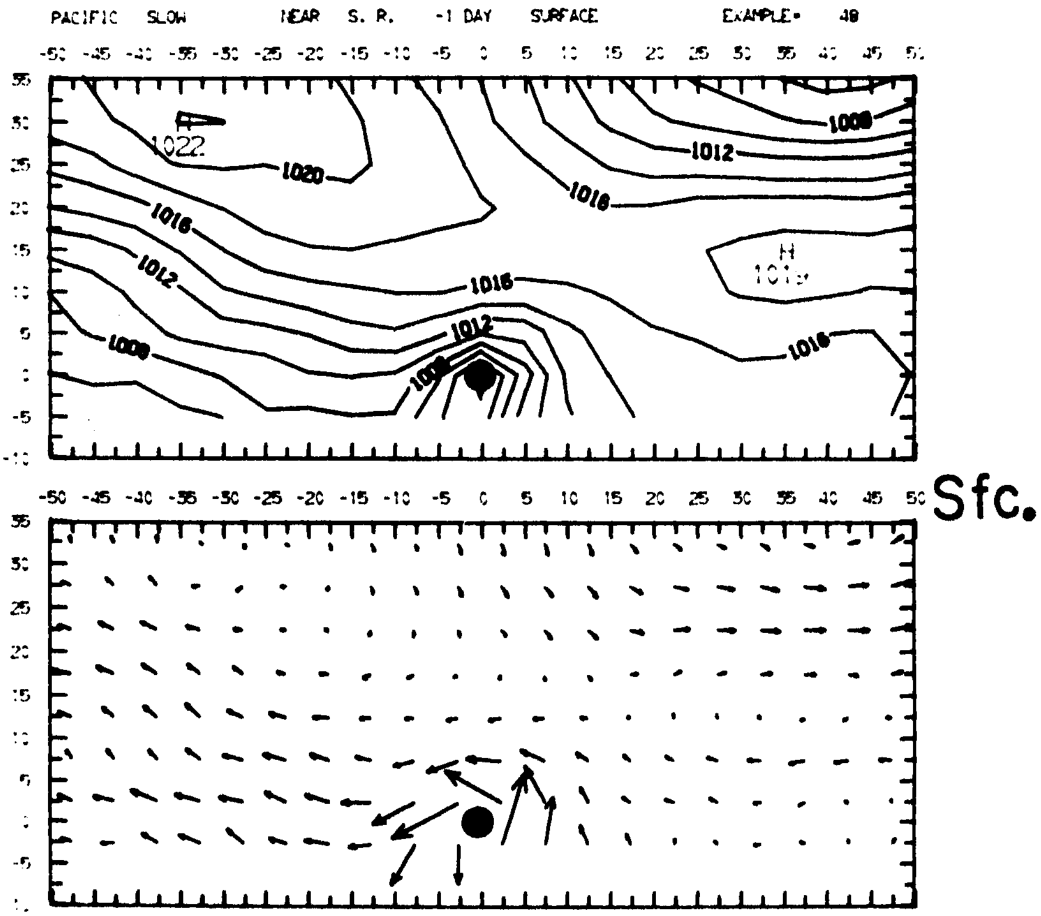


Sfc.

ATLANTIC SLOW NEAR SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 30

	TEST 1																					TEST 2		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35														1								PASS		
30															1									
25																						PASS		
20					1		1												1	2	2	PASS	PASS	PASS
15		1	2	3	3	3	3	1								1	1	3	3	3	3	PASS	PASS	PASS
10		3	3	3	3	3	3	1					1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
5	1	3	3	3	3	3	1				3	1	2	3	3	3	3	3	3	2		PASS	PASS	PASS
0	1	2	3	3	3	2				3	3	3	3	3	3	3	3	3	3	2		PASS	PASS	PASS
-5	1	2	3	3	3	3	1	2	3	3	3	2	3	3	3	3	3	3	2	1		PASS	PASS	PASS
-10	2	2	3	3	3	2	2	1	1			1	2	3	3	3	3	2	2			PASS	PASS	PASS

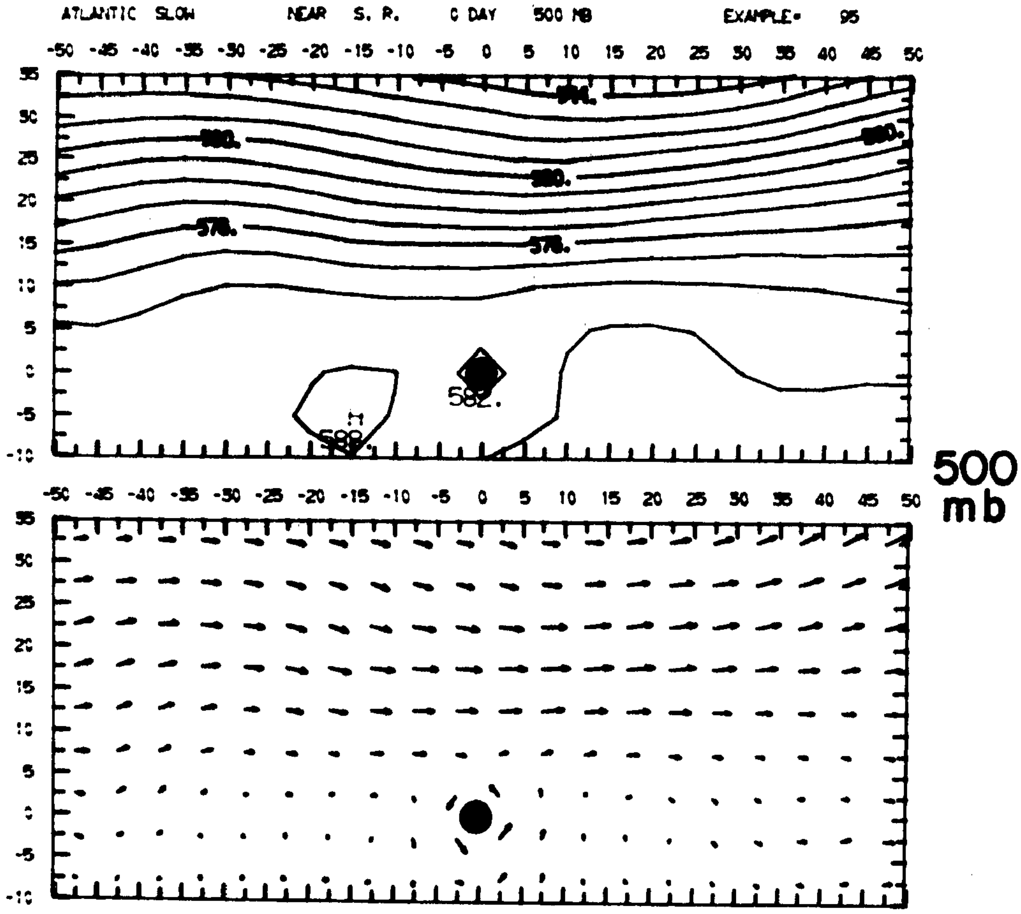
PAC. SLOW -1
Near



PACIFIC SLOW NEAR SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 48

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	3	3	3	2			1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
30	2	3	3	3	3	3	3	3	3	3			1	2	3	3	3	3	3	3	2	PASS	PASS	PASS
25			1	3	2	2	2	3	3	2				1	2	2	2	2	2	1		PASS	PASS	PASS
20	3	2	1				1	2	2	1												PASS	PASS	PASS
15	3	3	3	3				1									1	2	2	2	1	PASS	PASS	PASS
10	3	3	3	3	1					1				1	2	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	2			1		3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	2					3	3	2	2	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	2	2	2	1	2	1		2	2	3	2		1	2	3	3	3	3	3	3	3	PASS	PASS	PASS
-10																								

ATL. SLOW 0
Near

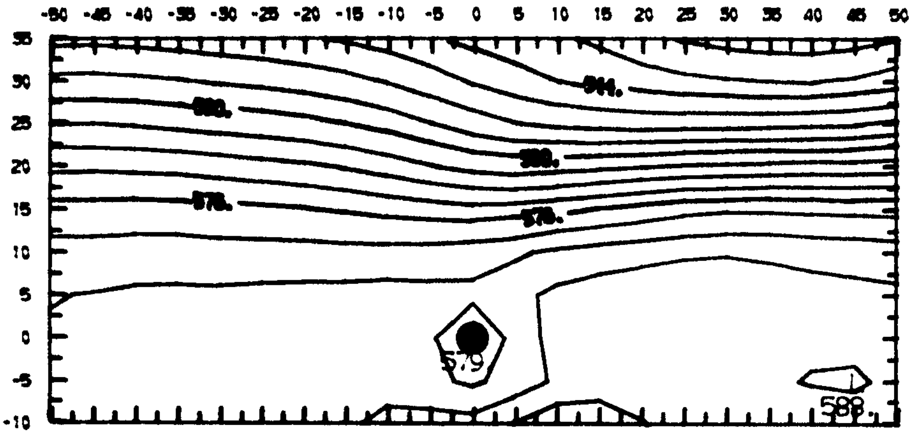


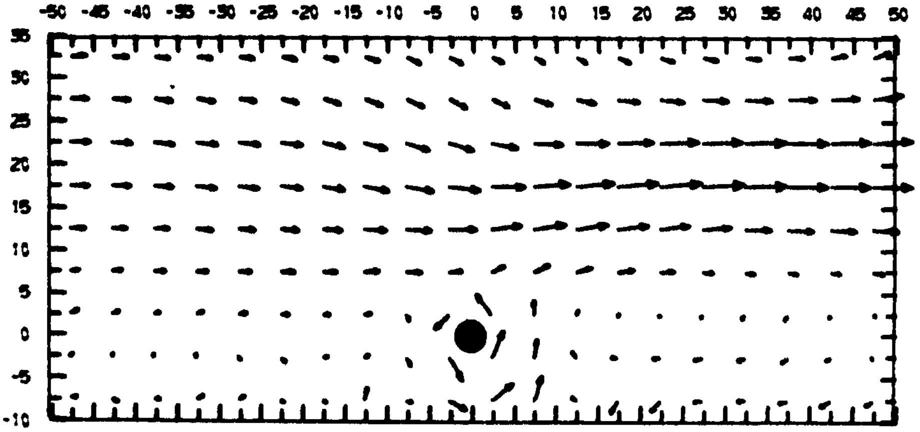
ATLANTIC SLOW NEAR SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 95

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	2				1	2	5	5	5	5	5	5			2	5	PASS	PASS	PASS
30		2	5	5	5	2				1	5	5	5	5	5	2	1			5	5	PASS	PASS	PASS
25			2	5	2	1				2	5	5	5	2	1				2	5	5	PASS	PASS	PASS
20			1	5	5	1			1	5	5	5	2	1				1	2	5	5	PASS	PASS	PASS
15	2	1			2	2			1	1	1	1						1	1		1	PASS	PASS	PASS
10	5	5	5										1	2	2	1						PASS	PASS	PASS
5	5	5	5								2		5	5	5	5					1	PASS	PASS	PASS
0	2	5	2					1	1	5	5	5	5	5	5	5						PASS	PASS	PASS
-5		1	5	2	1					5	5	5		1	5	5	2			1	2	PASS	PASS	PASS
-10	5	5	5	5	5	5	2	1	1						1	5	5	2	1	1	2	PASS	PASS	PASS

PAC. SLOW 0
Near

PACIFIC SLOW NEAR S. R. 0 DAY 500 MB EXAMPLE= 100





500 mb

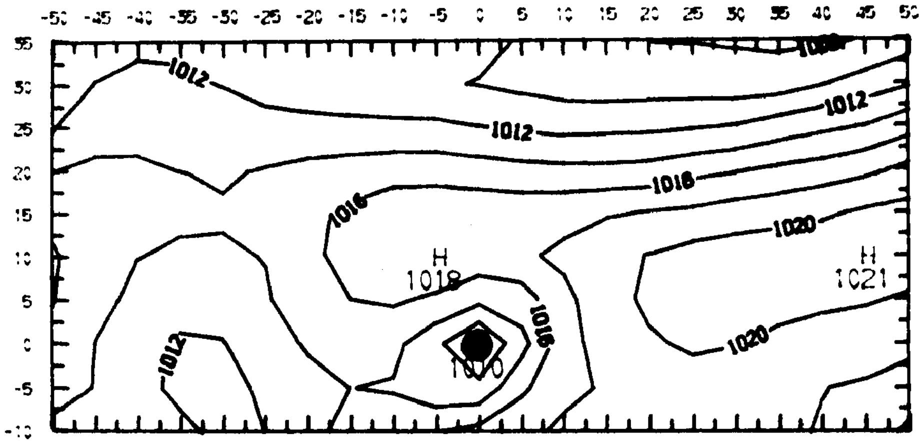
PACIFIC SLOW NEAR SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 100

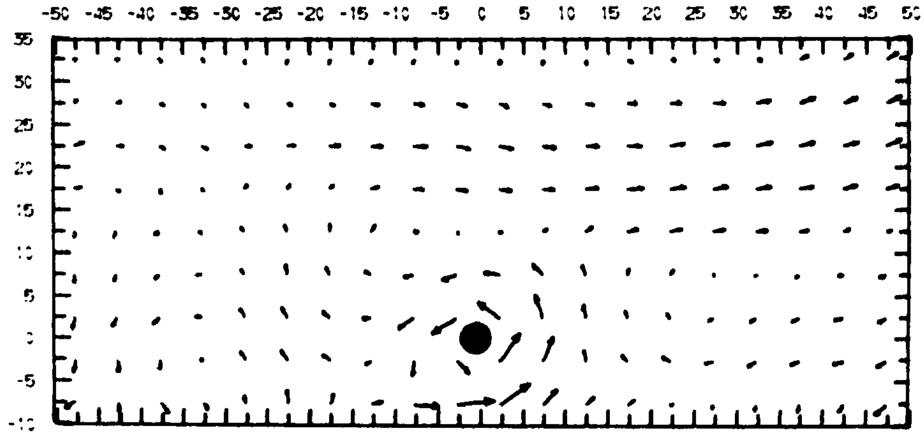
TEST 1 / TEST 2 (SIGNIFICANT LEVEL)

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	5	5	5	5	1			1	5	5	5	5	5	5	5	5	PASS	PASS	PASS
30	5	5	5	5	5	5	5	5	5			2	5	5	5	5	5	5	5	5	5	PASS	PASS	PASS
25	5	5	5	5	5	5	5	5	2		2	5	5	5	5	5	5	5	5	5	2	PASS	PASS	PASS
20	5	5	5	5	5	5	5			5	5	5	5	5	5	2						PASS	PASS	PASS
15							1	5	5	5	5	5	5			5	5	5	5	5	5	PASS	PASS	PASS
10	5	5	5	5	5	5	5	5	5	5	5		2	5	5	5	5	5	5	5	5	PASS	PASS	PASS
5	5	5	5	5	5	5	5	5	5	5	5		5	5	5	5	5	5	5	5	5	PASS	PASS	PASS
0	5	5	5	5	2				1	5	5	5	5	5	5	5	5	5	1	1	2	PASS	PASS	PASS
-5	5	5	5	1					1	5	5	2	2	5	5	5	5	2			2	PASS	PASS	PASS
-10	2		1									2										PASS		

ATL. SLOW O
Near

ATLANTIC SLOW NEAR S. R. 0 DAY SURFACE EXAMPLE= 88



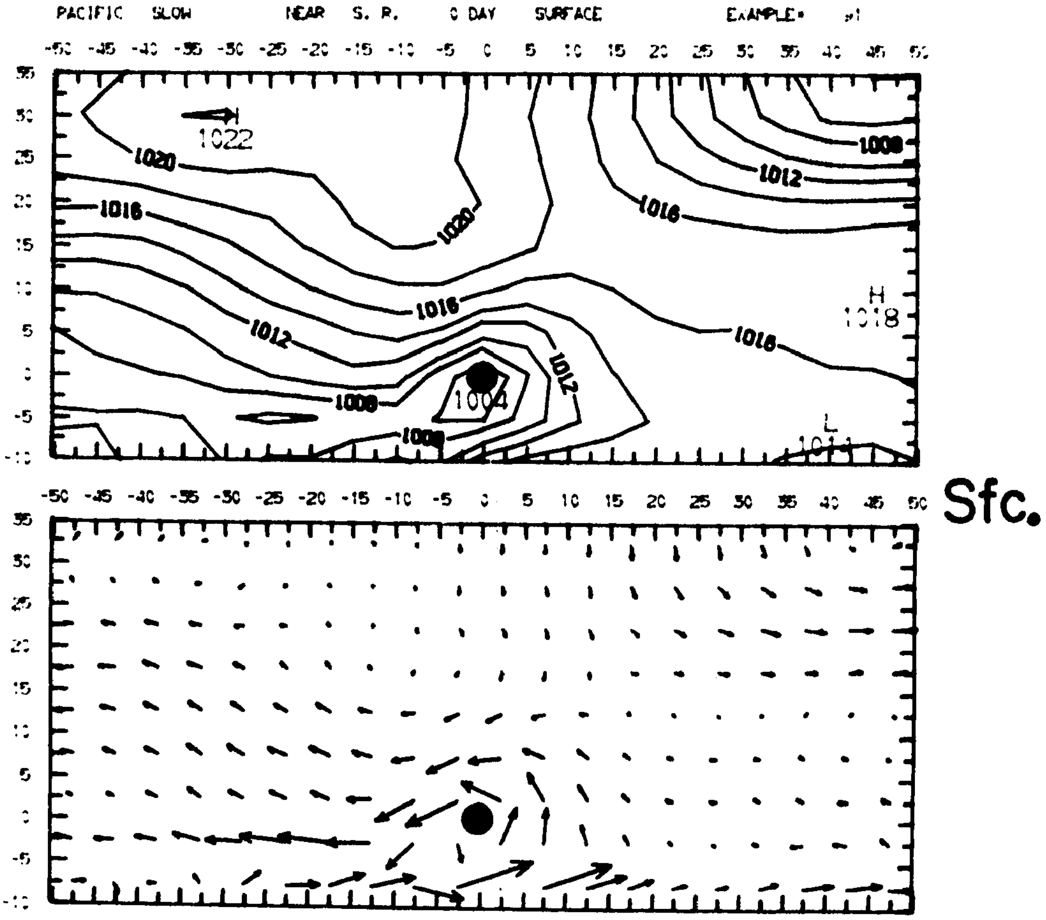


Sfc.

ATLANTIC SLOW NEAR SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 88

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	2	2	2	2	2	1							1	2	2	1	2	2	1		PASS	PASS	PASS
30		1	2	2	1																	PASS	PASS	
25																				1	2	PASS	PASS	PASS
20				1	1														1	2	3	PASS	PASS	PASS
15	1	2	3	3	3	3	2									1	2	2	3	3	3	PASS	PASS	PASS
10	2	3	3	3	3	3	3							3	3	3	3	3	3	3	3	PASS	PASS	PASS
5	1	3	3	3	3	3	3	1	1	3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0		3	3	3	3	3	2	1	3	3	3	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5		3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10	2	3	3	3	3	3	3	1				2	3	3	3	3	3	3	1			PASS	PASS	PASS

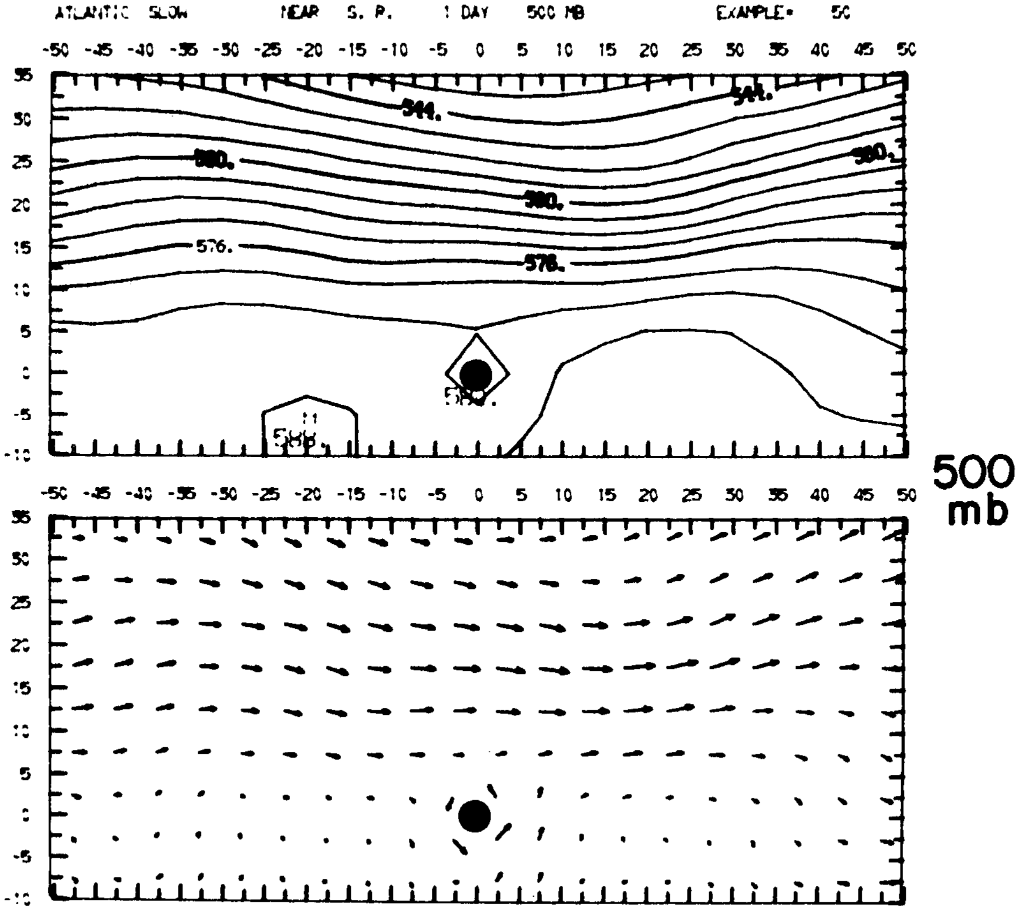
PAC. SLOW O
Near



PACIFIC SLOW NEAR SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE• 91

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	3	3	3	3	3	3	3	3	3	3	3	2		3	3	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	3	3	3	3	3	3			3	3	3	3	3	3	3	PASS	PASS	PASS
25	2	3	3	3	3	3	3	3	3	3	3	2			3	3	3	3	3	3	3	PASS	PASS	PASS
20						1	2	3	3	3	3	1			1	2	3	2	2	2	1	PASS	PASS	PASS
15	3	3	3	3	3		1	3	3	3	3	1										PASS	PASS	PASS
10	3	3	3	3	3			3	3	3	2				2	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	2			2		3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3					3	3	3		3	[illegible]	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	3	3	2	2	3	3	3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10																								

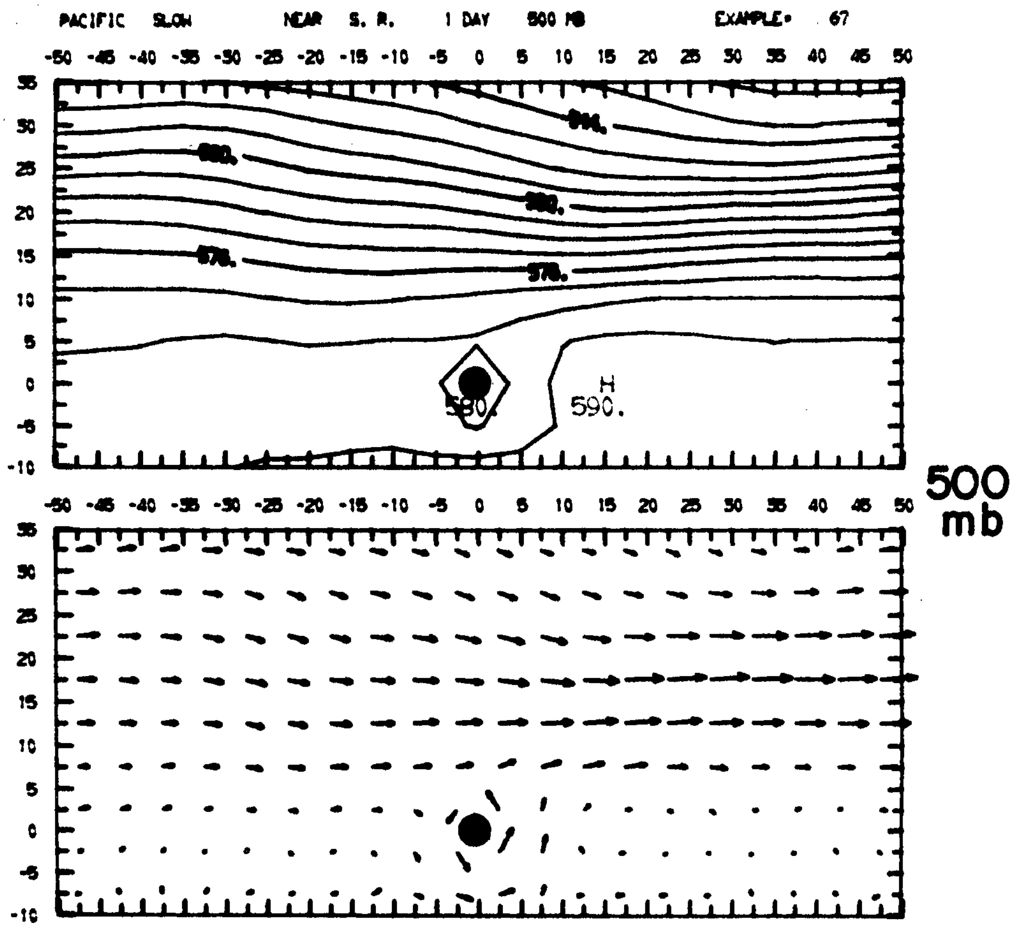
ATL. SLOW 1
Near



ATLANTIC SLOW NEAR SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 50

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	2	1				2	5	5	5	5	5	1						2	PASS	PASS	PASS
30	2	5	5	2	1					2	5	5	5	5	2					1	2	PASS	PASS	PASS
25		?	5	5	2	1					2	5	5	5	5	1			1	5	5	PASS	PASS	PASS
20			2	5	5	2					1	5	5	5	5	1			5	5	2	PASS	PASS	PASS
15				1	1							1	2	2				2	5	1		PASS	PASS	PASS
10																	1	1				PASS		
5		1								1	5			2	5	5	5	1		1	2	PASS	PASS	PASS
0										5	5	5	5	5	5	5	5	1				PASS	PASS	PASS
-5		1	2	1						5	5	1	5	5	5	5	2					PASS	PASS	PASS
-10	1	2	2	1					1	5	2		1	2	1	1	1					PASS	PASS	PASS

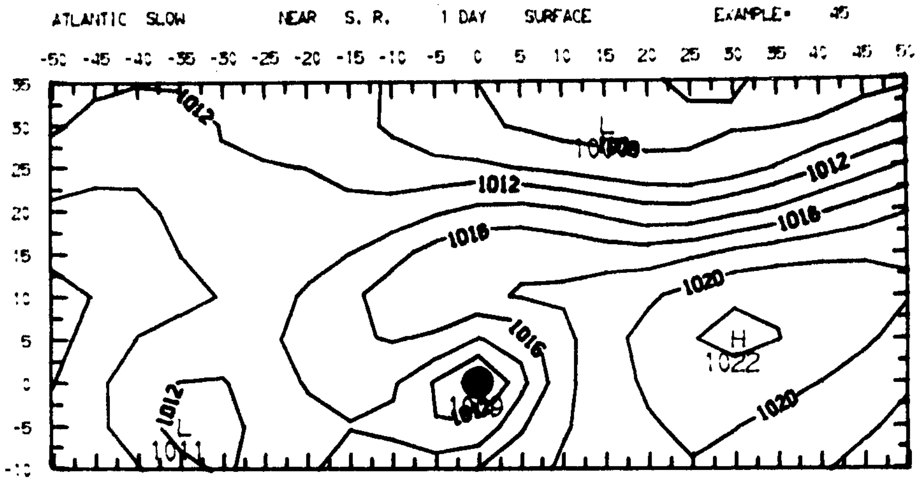
PAC. SLOW 1
Near

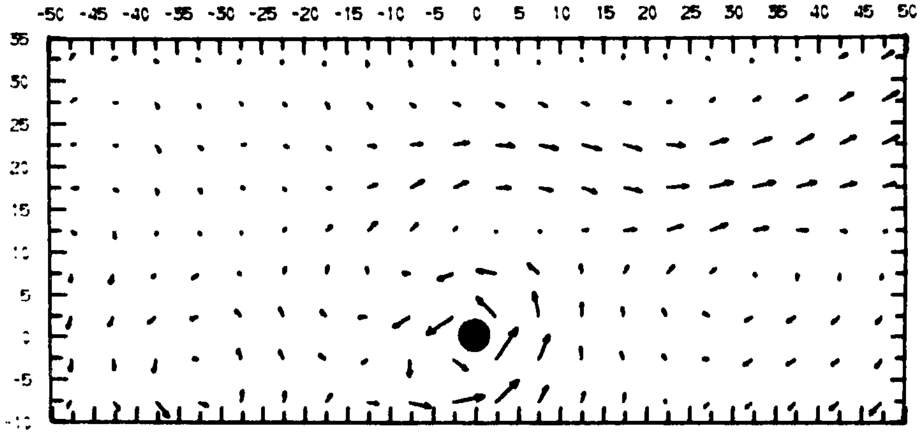


PACIFIC SLOW NEAR SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 67

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	2	2	2					1	2	3	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	3	3	2				1	2	3	3	3	3	3	3	3	PASS	PASS	PASS
25	3	3	3	3	3	3	3	2	1			1	3	3	3	3	3	3	3	2	2	PASS	PASS	PASS
20	3	3	3	3	3	2	1					2	3	3	3	3	2	1				PASS	PASS	PASS
15	3	2	2	2	1				1	1	1	2	3	2	1							PASS	PASS	PASS
10	1	1	1		2	3	3	3	3	3	1			2	3	3	3	2	2	2	2	PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	2	1	1	1	2	1	1	3	3	3	3	3	3	3	3	2	2	3	3	PASS	PASS	PASS
-5	3	3	2							3	3		2	3	3	3	3	1	1	3	3	PASS	PASS	PASS
-10	1	1						1				1										PASS		

ATL. SLOW Near 1



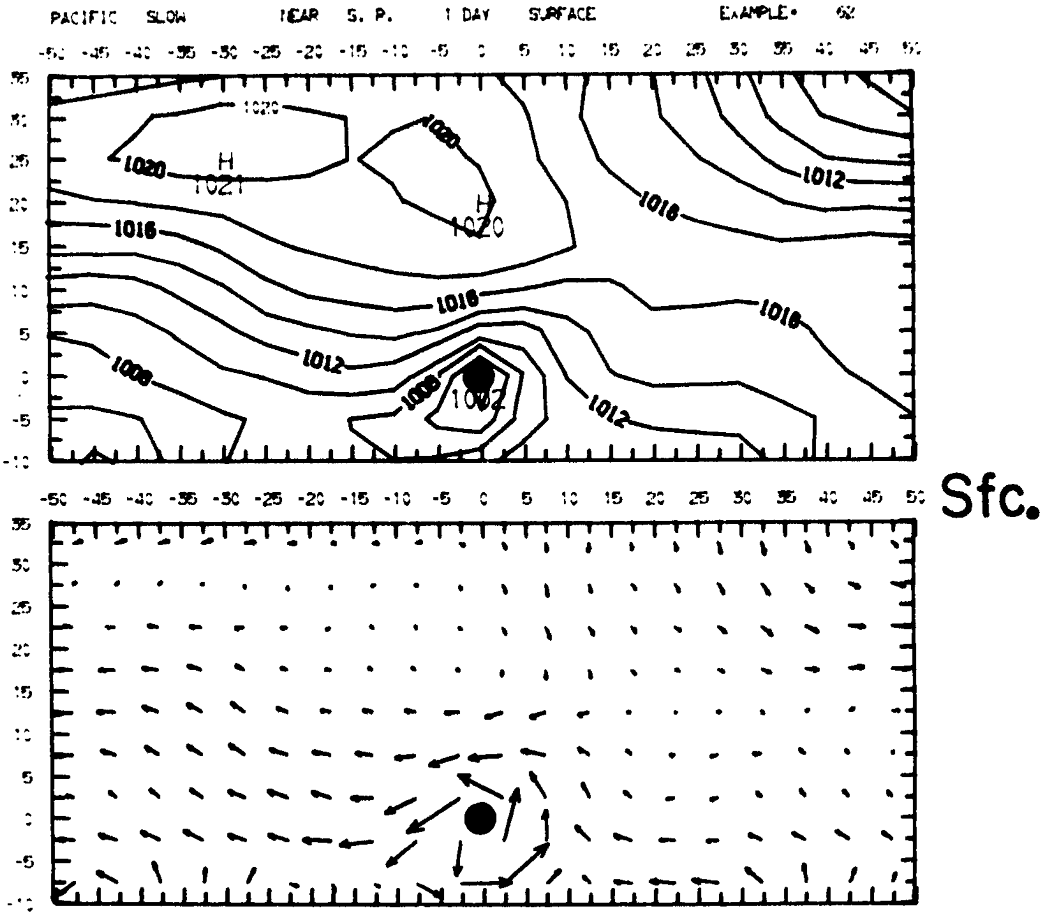


Sfc.

ATLANTIC SLOW NEAR SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE= 45

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	1	2	2	2	1						1	1								PASS	PASS	
30		1	2	2	2	1							1	1	1	1						PASS	PASS	PASS
25		1	1											1	2	2					2	PASS	PASS	PASS
20															1					2	3	PASS	PASS	PASS
15			1	2	3	3	3	2									1	2	3	3	3	PASS	PASS	PASS
10		2	3	3	3	3	3	2						2	3	3	3	3	3	3	2	PASS	PASS	PASS
5		2	3	3	3	3	3	2	1	3	3	3		3	3	3	3	3	3	3	2	PASS	PASS	PASS
0		2	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5		2	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	1	PASS	PASS	PASS
-10		1	3	2	2	3	2	1	1				3	3	3	3	3	3	1			PASS	PASS	PASS

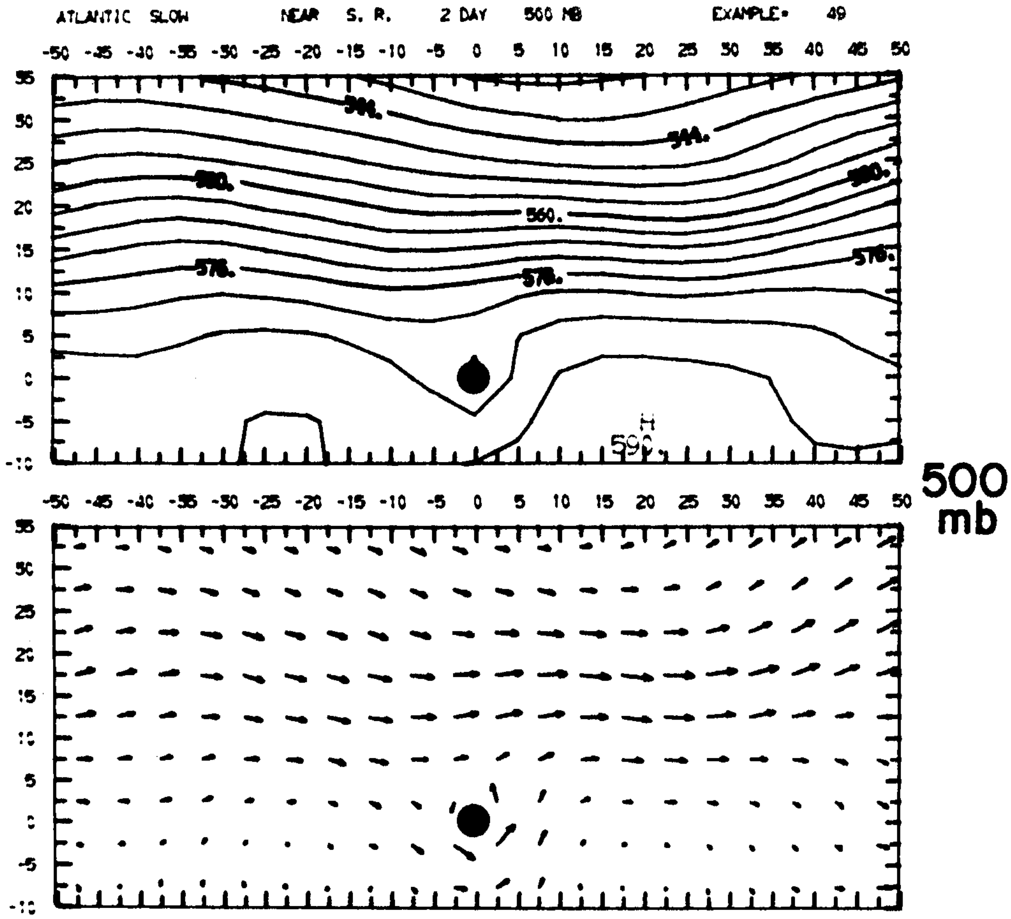
PAC. SLOW 1
Near



PACIFIC SLOW NEAR SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE= 62

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35			1	1	2	2	2	3	3	3	3	3	2			1	3	3	3	3	3	PASS	PASS	PASS
30	2	2	3	3	3	3	3	3	3	3	3	2			1	2	3	3	3	3	3	PASS	PASS	PASS
25	2	3	3	3	3	3	2	2	3	3	3	2			1	2	3	3	3	3	3	PASS	PASS	PASS
20						1	1	2	3	3	3	3					2	3	3	2	2	PASS	PASS	PASS
15	3	3	3	2				2	2	3	3	3	1									PASS	PASS	PASS
10	3	3	3	3	2			1	2	3	2									1	2	PASS	PASS	PASS
5	3	3	3	3	3				1		3	3		3	3	3	2	2	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3					3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	1			1	2	3	3			3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10		1							1													PASS	PASS	

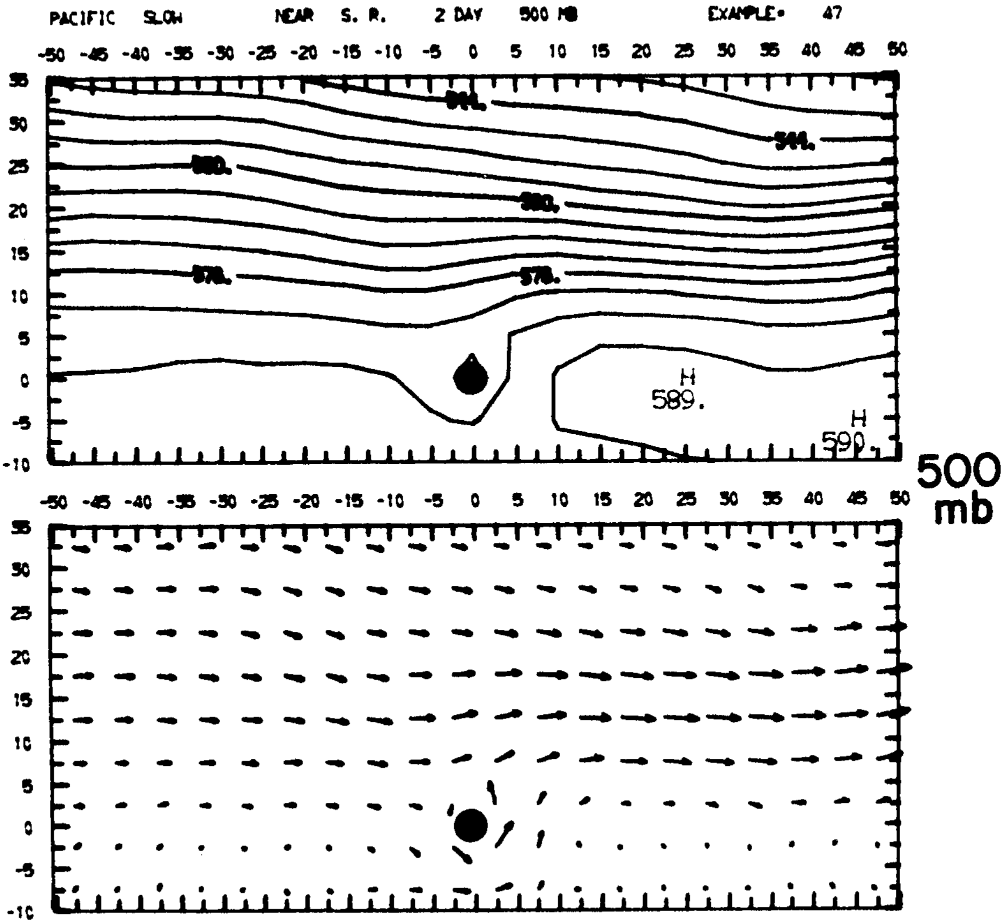
ATL. SLOW 2
Near



ATLANTIC SLOW NEAR SUBTROPICAL RIDGE 2 DAY 500 MB EXAMPLE= 49

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	2	1				1	5	5	5	5	5	2						PASS	PASS	PASS
30	2	5	5	5	1					1	2	5	5	5	5	5	1			1	2	PASS	PASS	PASS
25	1	2	5	5	2						1	2	5	5	5	5	2			1	5	PASS	PASS	PASS
20		1	5	5	5					1	1	1	1	2	5	5	2			5	5	PASS	PASS	PASS
15				2	1				1	1					1	1			1	5	5	PASS	PASS	PASS
10									2	1				1					1			PASS	PASS	PASS
5									2	5	5		5	5	5	5	2	1			1	PASS	PASS	PASS
0									2	5	5	5	5	5	5	5	5	2			1	PASS	PASS	PASS
-5		2	2	1						5	5		5	5	5	5	2					PASS	PASS	PASS
-10		5	5	5						1		1	5	5	2	1						PASS	PASS	PASS

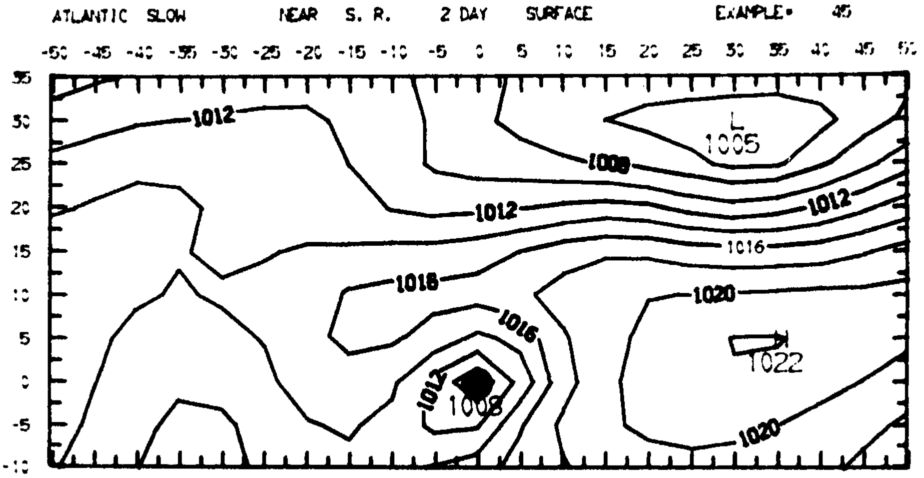
PAC. SLOW 2
Near

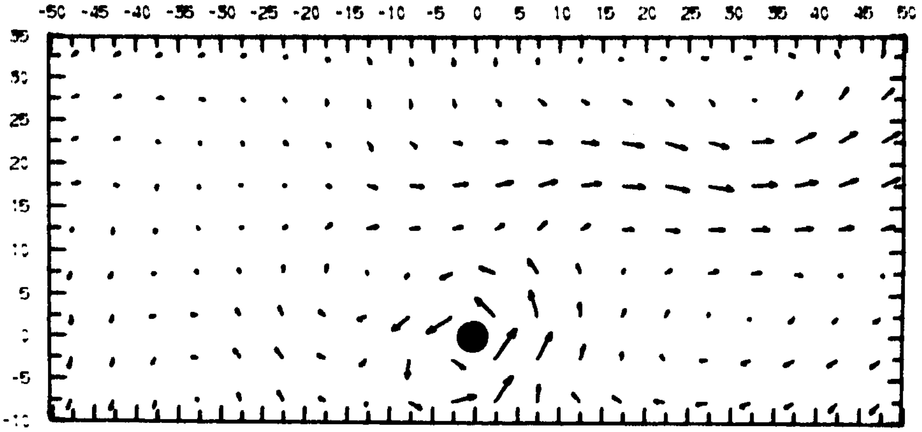


PACIFIC SLOW NEAR SUBTROPICAL RIDGE 2 DAY 500 MB EXAMPLE= 47

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	1	1	1	1	1											1	2	2	5	5	PASS	PASS	PASS
30	5	2	2	5	5	5	1									2	5	5	5	5	5	PASS	PASS	PASS
25	5	5	5	5	5	5	2	1							1	5	5	5	5	5	2	PASS	PASS	PASS
20	5	5	5	5	5	5	1								1	5	5	5	2	1		PASS	PASS	PASS
15	2	2	2	2	1											1	2	1				PASS	PASS	PASS
10								1	5	5			2	2	2							PASS	PASS	PASS
5	5	5	5	2	5	5	5	5	5	5	5		5	5	5	5	5	1		2	5	PASS	PASS	PASS
0	5	5	5	2	2	5	2	2	5	5	5	2	5	5	5	5	5	5	2	5	5	PASS	PASS	PASS
-5	5	2	1	2	2	2	1	2	5	5	5		1	2	5	5	5	5	5	5	5	PASS	PASS	PASS
-10	2	1						1												1	1	PASS	PASS	PASS

ATL. SLOW 2
Near





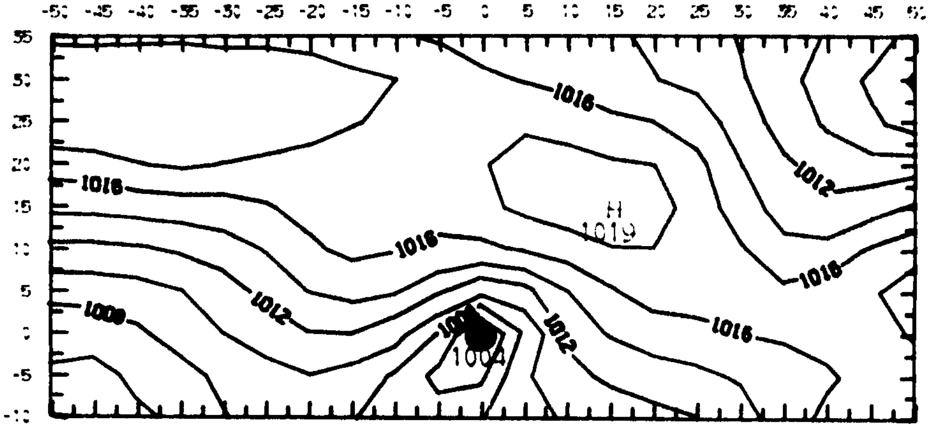
Sfc.

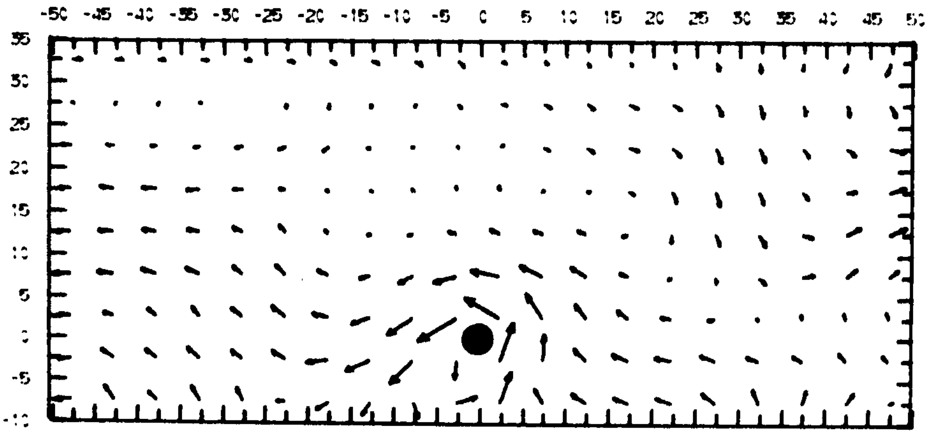
ATLANTIC SLOW NEAR SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE= 45

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35						1	1	2	1													PASS	PASS	
30		1	1	2	2	2	3	3	1					1	1	2	2	2	2			PASS	PASS	PASS
25	1	2	2	2	2	2	2	1							1	3	3	2				PASS	PASS	PASS
20																	1				1	PASS	PASS	
15					1	1								1	1	1				1	2	PASS	PASS	PASS
10	1	3	3	3	3	3	3	1						2	3	3	3	3	3	3	3	PASS	PASS	PASS
5	2	3	3	3	3	3	3			3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0		3	3	3	3	3	2	1	3	3	3	3	1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5		3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10	1	3	3	3	3	3	3	3	3	3		2	3	3	3	3	3	3	3	2		PASS	PASS	PASS

PAC. SLOW Near 2

PACIFIC SLOW NEAR S. R. 2 DAY SURFACE EXAMPLE• 42



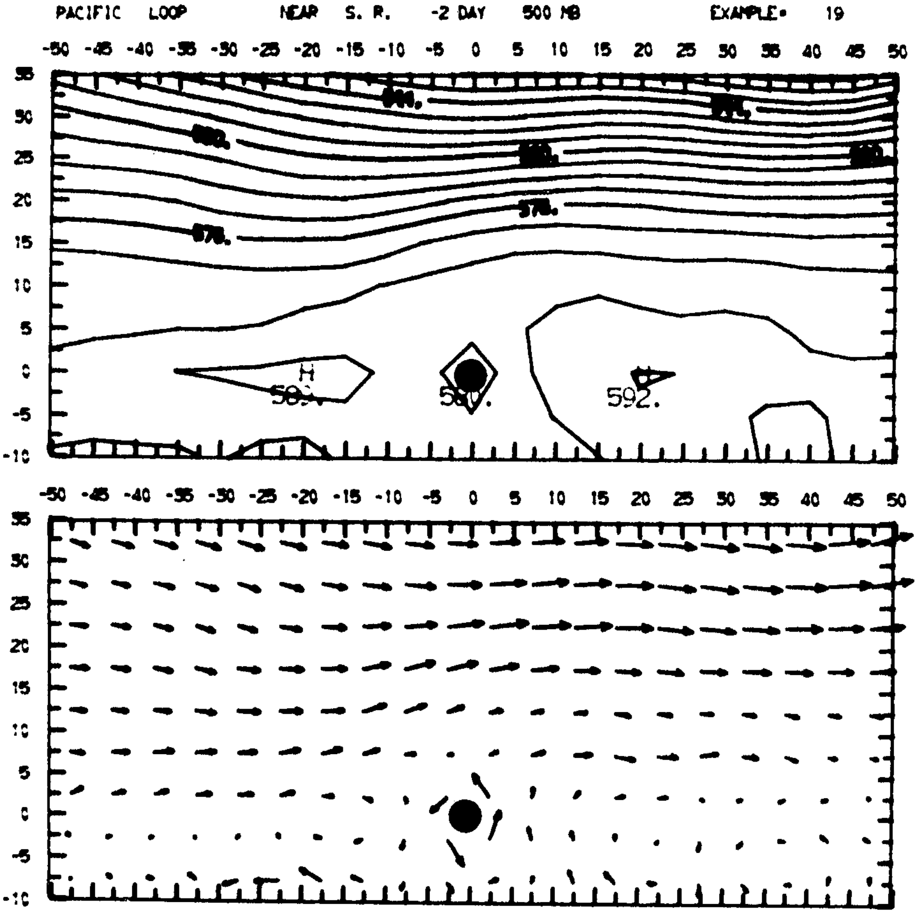


Sfc.

PACIFIC SLOW NEAR SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE• 42

	TEST 1																					TEST 2		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	1	1	1	1	1	1	1										1	2	3	3	3	PASS	PASS	PASS
30	3	3	2	2	2	2	2	2	2	1							1	3	3	3	3	PASS	PASS	PASS
25	2	2	2	2	2	2	1	1				1					1	3	3	3	3	PASS	PASS	PASS
20			1	1							1	3	2				1	3	3	3	2	PASS	PASS	PASS
15		1										3	3	3	3			2	3	1		PASS	PASS	PASS
10	3	3	3	3	2							1	3	3	3	2					1	PASS	PASS	PASS
5	3	3	3	3	3						3	3		3	3	3	3	2	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3					3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	2				3	3	3			1	2	3	3	3	3	3	3	PASS	PASS	PASS
-10	3	2	2	2					2	[illegible]							1	3	3	3	3	PASS	PASS	PASS

PAC. LOOP -2
Near

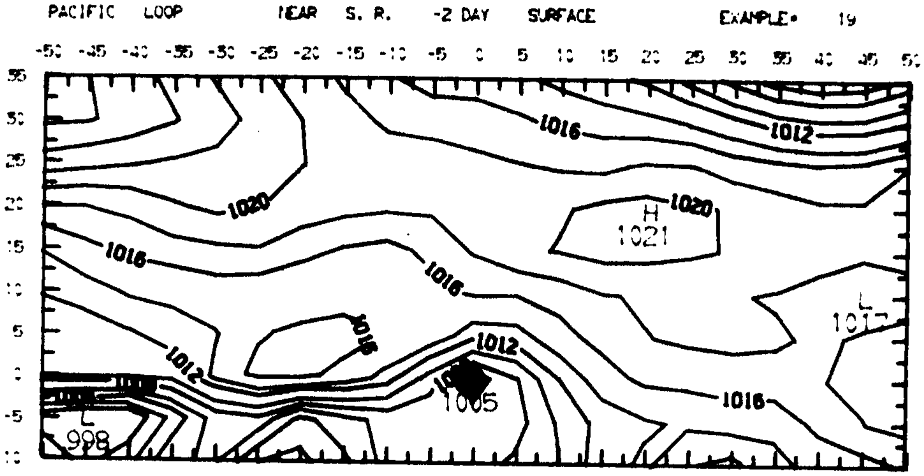


500 mb

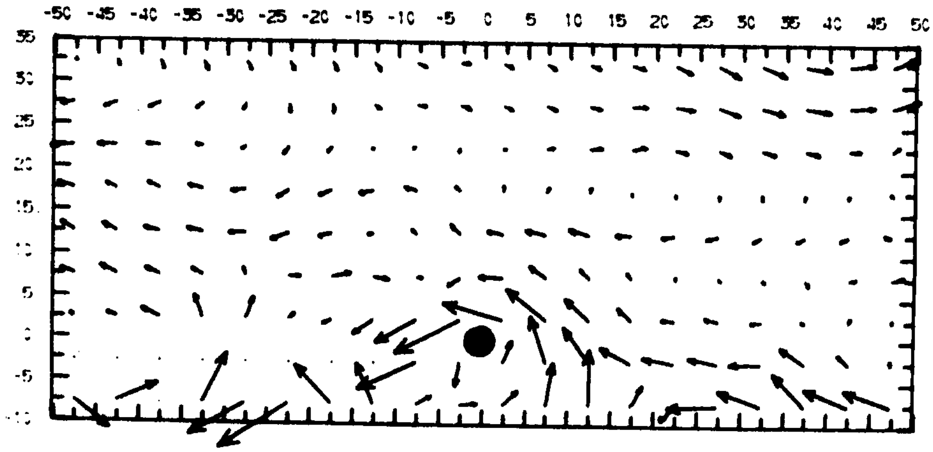
PACIFIC LOOP NEAR SUBTROPICAL RIDGE -2 DAY 500 MB EXAMPLE= 19

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	2	1									1	2	2	3	3	2		PASS	PASS	PASS
30	3	3	3	3	2													1	2	1		PASS	PASS	PASS
25	3	3	3	2																		PASS	PASS	PASS
20						1	1	1	1				1	1								PASS	PASS	PASS
15				1	3	3	2	2				1	2	2	1							PASS	PASS	PASS
10			1	2	3	3	2	1				1	2	3	1							PASS	PASS	PASS
5	1	1	1	3	2	1							1	2	3	2	1					PASS	PASS	PASS
0	1		1							2	3	1		2	2	2	1					PASS	PASS	PASS
-5											2			2	1							PASS	PASS	PASS
-10																								

PAC. LOOP -2
Near



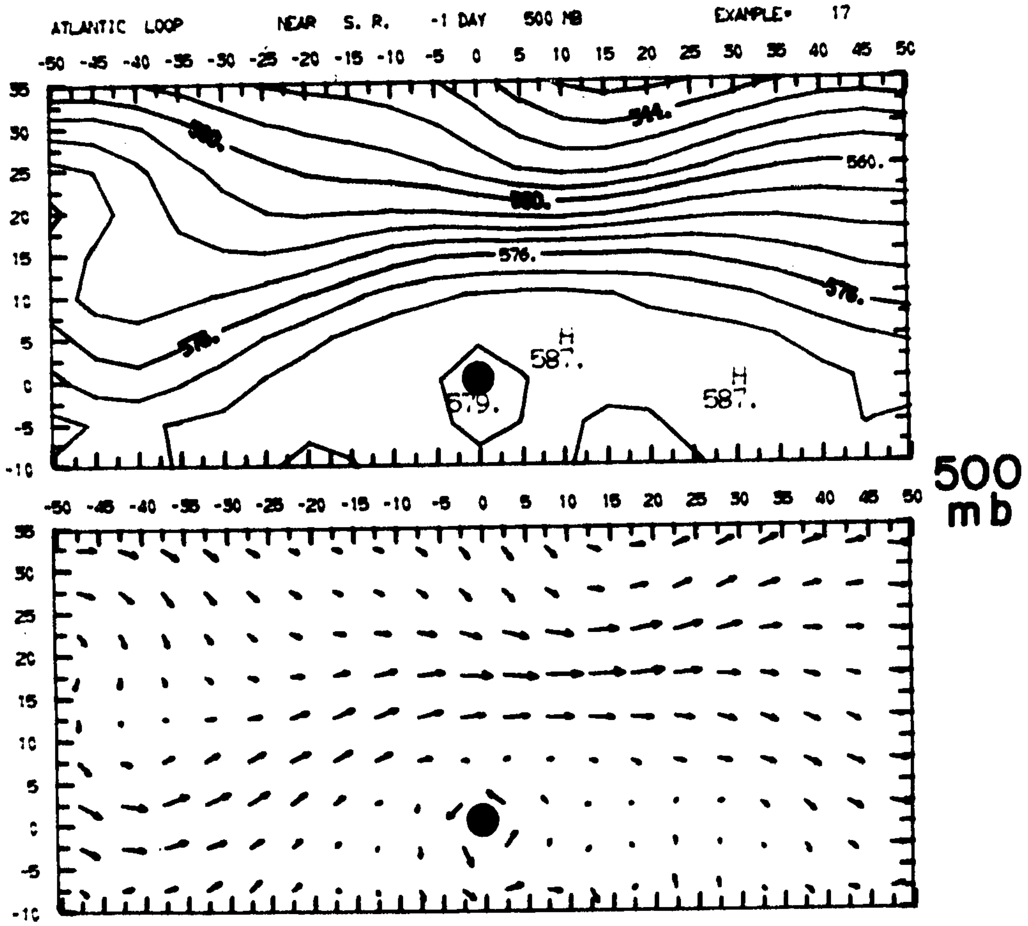
Sfc.



PACIFIC LOOP NEAR SUBTROPICAL RIDGE -2 DAY SURFACE EXAMPLE= 19

	TEST 1																					TEST 2	
																						SIGNIFICANT LEVEL	
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	2	2	1								1	3	2	3	3	3	3	PASS	PASS	PASS
30	3	3	3	2	1	1										1	2	2	2	2	2	PASS	PASS	PASS
25	2																		1			PASS	PASS	PASS
20																								
15	2												1	2	2	2						PASS	PASS	PASS
10	1	1												2	2	2	1					PASS	PASS	PASS
5	1										1				1	1						PASS	PASS	
0						1				3	3	2	1	1	1	1			1			PASS	PASS	PASS
-5	1	1				2			1			2			1				1	3	2	PASS	PASS	PASS
-10																								

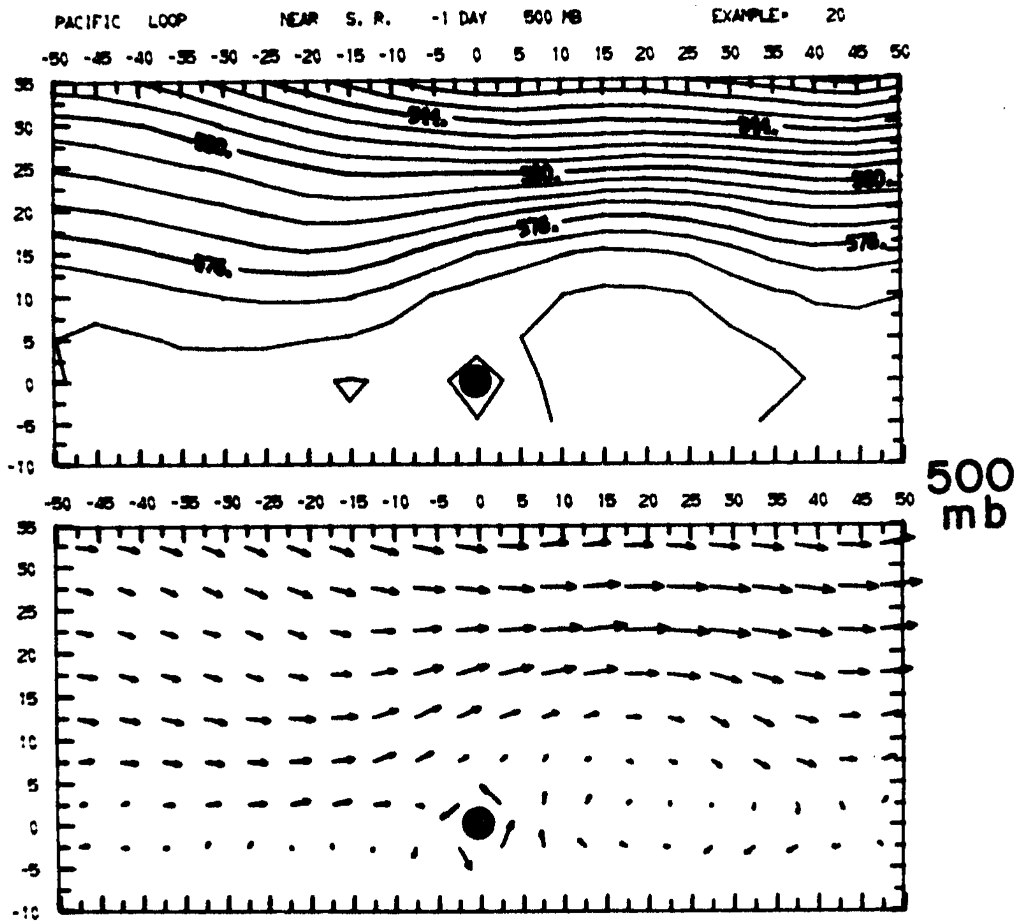
ATL. LOOP Near -1



PACIFIC LOOP NEAR SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 20

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	2	1			1	1	1			1	2	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	2						1			1	2	2	2	2	2	1	PASS	PASS	PASS
25	3	3	3	3	2																	PASS	PASS	PASS
20							1	2	1					2	2	1						PASS	PASS	PASS
15				1	3	3	3	3	2			2	3	3	3	3						PASS	PASS	PASS
10				2	3	3	3	3	1			2	3	3	3	3	1					PASS	PASS	PASS
5	1		1	2	2	3	2					1	3	3	3	2						PASS	PASS	PASS
0	1	1	2	2							1		3	3	1	1	1	1				PASS	PASS	
-5											2	2			2	1						PASS	PASS	PASS
-10																								

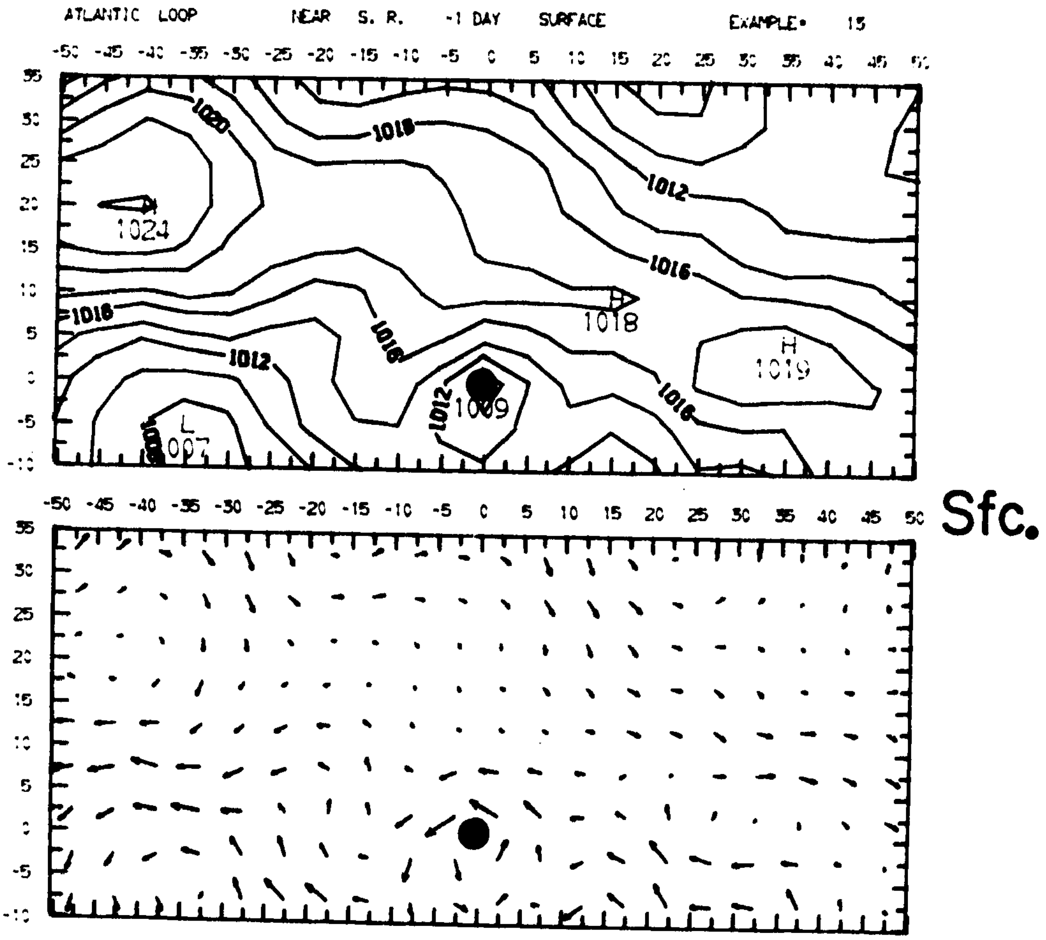
PAC. LOOP -1
Near



ATLANTIC LOOP NEAR SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 17

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	3	2	2	1							2	3	3	3	2						PASS	PASS	PASS
30	2	2	3	2	1						1	2	3	3	3	1						PASS	PASS	PASS
25	2	2	2	1						1	1	2	2	3	2							PASS	PASS	PASS
20	2	2																				PASS	PASS	PASS
15				1	:	2	1															PASS	PASS	
10	2	3	3	3	3	3	2		1	1	2	2	2	2	1	1						PASS	PASS	PASS
5	2	2	3	3	3	2		2	2	2	2	3	3	2	1	1	1					PASS	PASS	PASS
0	1	2	2	1	1		2	2	2		2		1			1	3	2				PASS	PASS	PASS
-5						1	1	1			2				1		2	1				PASS	PASS	PASS
-10	2	3	1			3	2	2	2					2	2	2						PASS	PASS	PASS

ATL. LOOP -1
Near

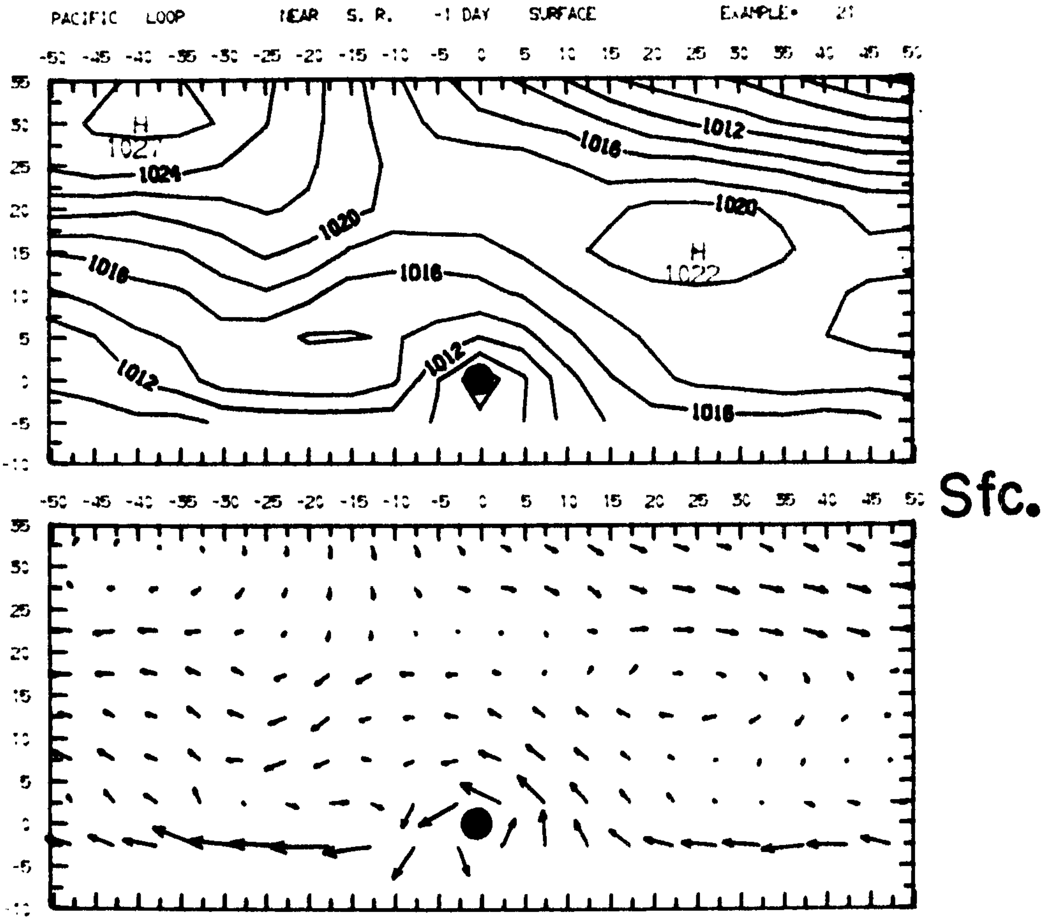


ATLANTIC LOOP NEAR SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 13

TEST 1 / TEST 2 SIGNIFICANT LEVEL

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	2	2	1									3	3	2						PASS	PASS	PASS
30		1	2	2	1									2	2	2	1					PASS	PASS	PASS
25		1	1	1	1									1	2	2	1					PASS		
20	1	1	1																			PASS		
15	1	1																				PASS		
10																								
5			1														1	2				PASS	PASS	PASS
0		1	1	1	1						3	1				2	3	3	3	3	3	PASS	PASS	PASS
-5		2	2	2	2					1	2					3	3	1	2	3	3	PASS	PASS	PASS
-10					1	2	2									1			3	3	3	PASS	PASS	PASS

PAC. LOOP -1
Near

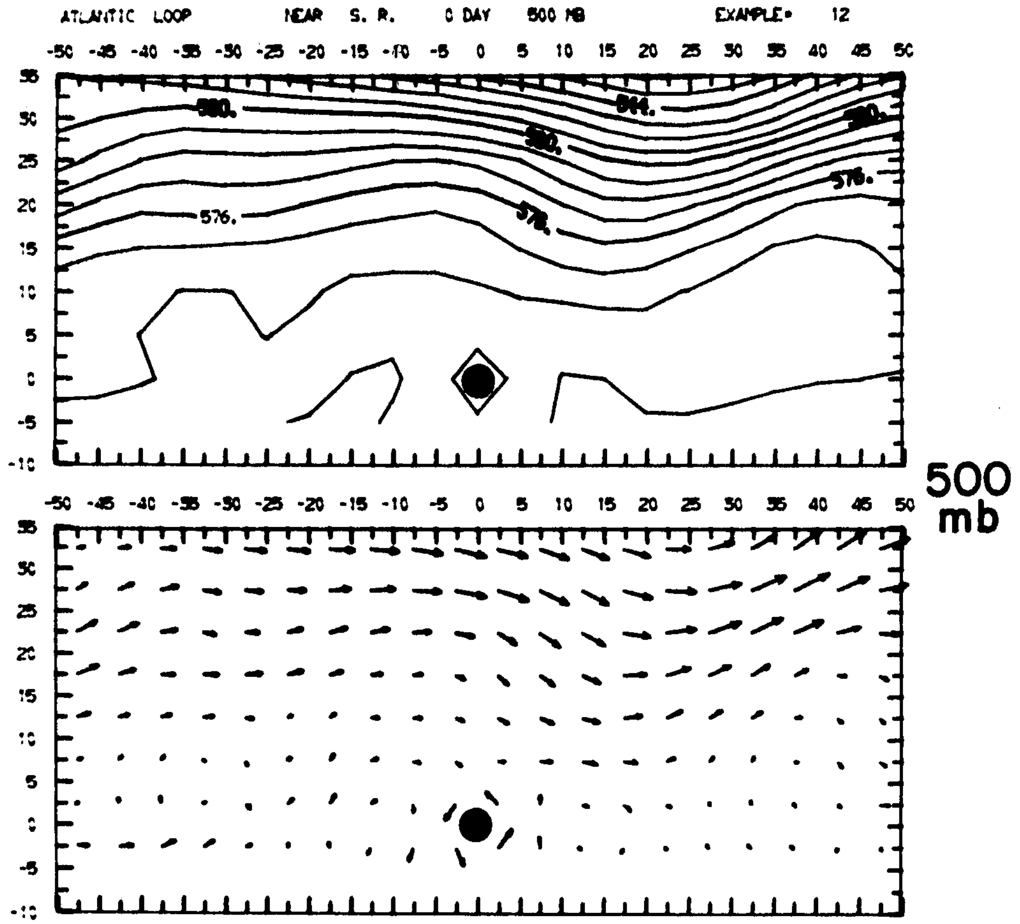


PACIFIC LOOP NEAR SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE• 21

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	3	3	3	3	3	3	3	2	1					1	2	3	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	2	1						1	1	1	2	3	3	3	3	PASS	PASS	PASS
25	2	2	2	2	2	1											1	1	2	2	2	PASS	PASS	PASS
20																						PASS		
15	2	1													1	2	1					PASS	PASS	PASS
10	2	1												1	2	2	2	2				PASS	PASS	PASS
5	2	1								1	2			1	3	3	3	3	[illegible]			PASS	PASS	PASS
0										2	2	1	1		1	2	1	1				PASS	PASS	PASS
-5										1	2	2												
-10																								

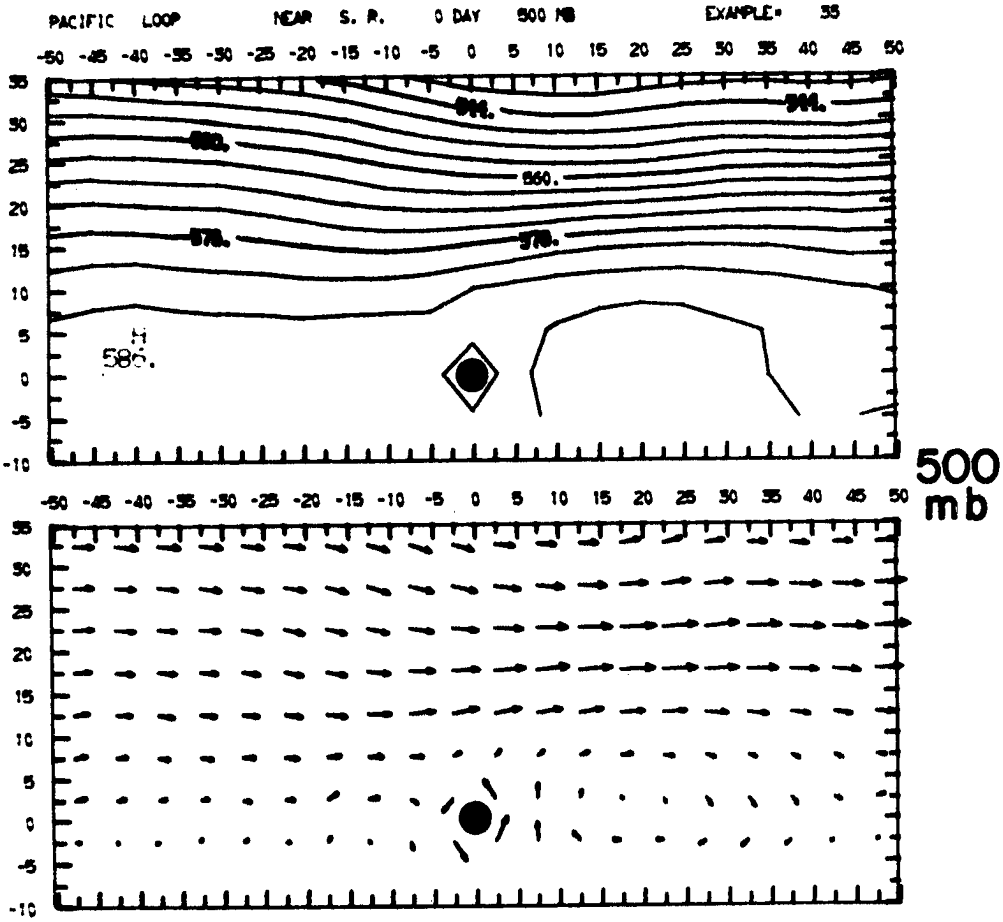
ATL. LOOP 0
Near



ATLANTIC LOOP NEAR SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 12

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1	1	1	1							2	2	2	2	2	2					PASS	PASS	PASS
30				1	1								2	2	2	2	1				1	PASS	PASS	PASS
25									2	3	2			1	1	1					1	PASS	PASS	
20									2	3	1			1	1				1	1	1	PASS	PASS	PASS
15										1			1	2	1				1			PASS	PASS	
10																	1	2				PASS	PASS	
5	2					2	1		1				1					1	1			PASS	PASS	PASS
0	3	2				1		3	3		2		3	3							1	PASS	PASS	PASS
-5											1						1	1				PASS	PASS	
-10																								

PAC. LOOP O
Near

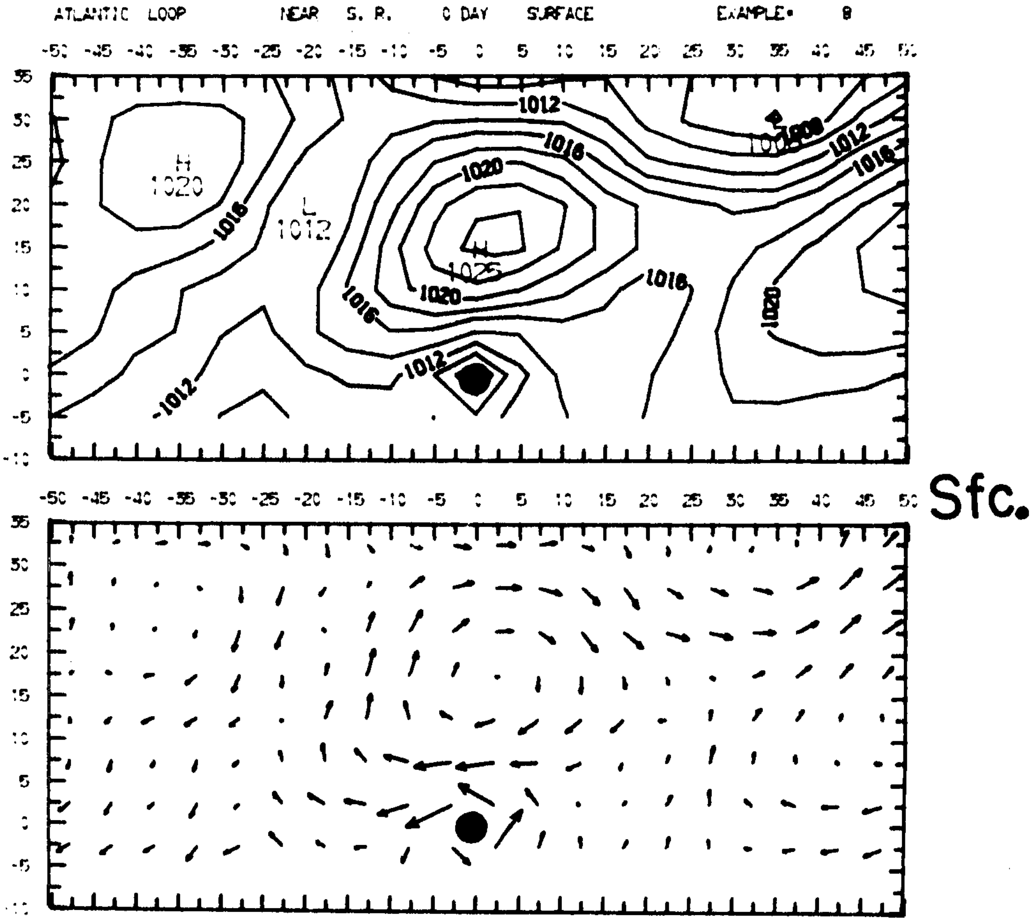


PACIFIC LOOP NEAR SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 35

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	TEST 2 SIGNIFICANT LEVEL .050	.010	.001
35	3	3	2	2	2	1	1				2	2	3	2	2							PASS	PASS	PASS
30	3	3	3	3	3	2	2				1	2	3	3	2	1	1	1				PASS	PASS	PASS
25	3	3	3	3	3	3	1				2	3	3	3	3	2						PASS	PASS	PASS
20	3	3	3	3	2				1	2	2	2	1									PASS	PASS	PASS
15								1	2	3	2					1	1	1				PASS	PASS	PASS
10	1			1	2	3	3	2	2	1		1	2	2	3	3	3	2				PASS	PASS	PASS
5				1	2	2	1			2	1		2	3	3	3	3					PASS	PASS	PASS
0	1	2	2	1		1				1	2		3	3	3	3	2					PASS	PASS	PASS
-5		1	1	1							1			1	2	3	2					PASS	PASS	PASS
-10																								

TEST 1 (columns -50 to 50)

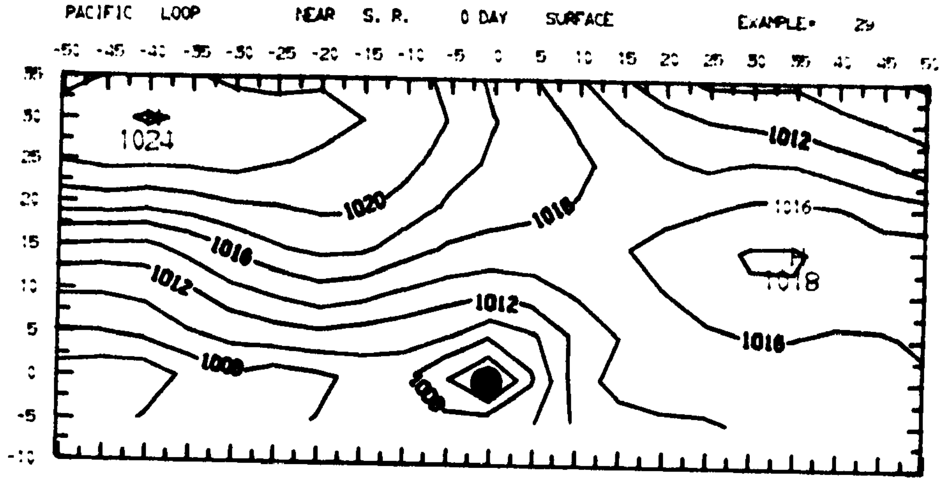
ATL. LOOP O
Near

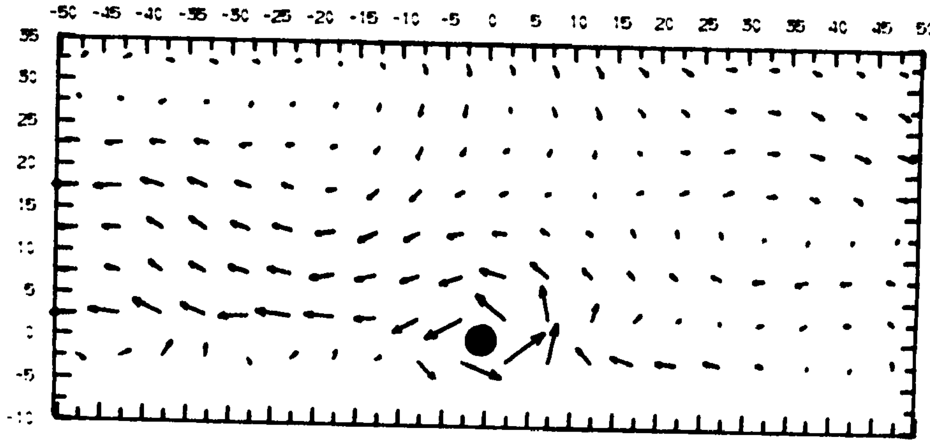


ATLANTIC LOOP NEAR SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 8

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	1	1	2	1																PASS		
30			2	3	2	1													1			PASS	PASS	
25				1														1	1			PASS		
20											1	1										PASS	PASS	
15							1			2	3	2									1	PASS	PASS	PASS
10					2	1				3	1									1	2	PASS	PASS	PASS
5				1	1	1											1	2	3	3	3	PASS	PASS	PASS
0						1	1			2	2				1	2	2	3	3	3	2	PASS	PASS	PASS
-5				1	1	1	1							1	2	2	3	[illegible]	1			PASS	PASS	PASS
-10																								

PAC. LOOP 0
Near





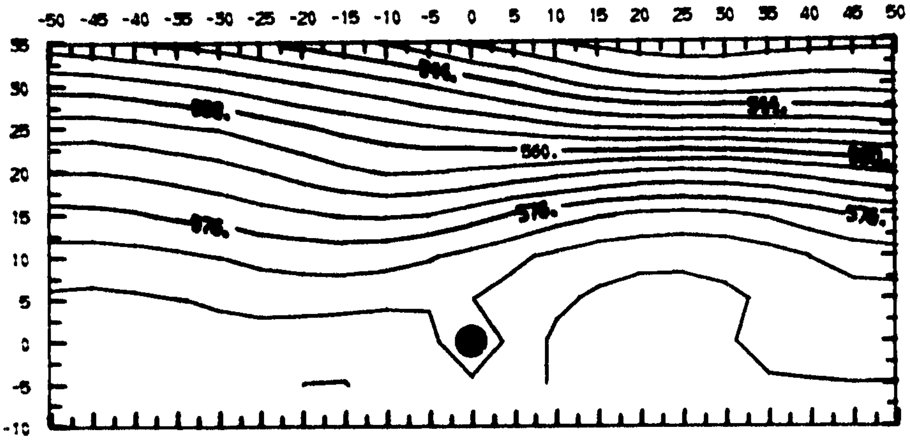
Sfc.

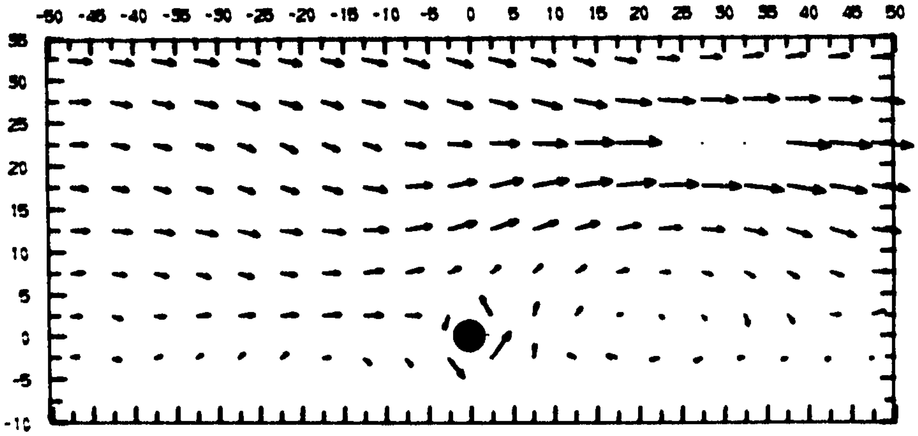
PACIFIC LOOP NEAR SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 29

	TEST 1																					TEST 2		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	1	2	3	3	3	3	3	3	2	1			1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	3	2	2					2	3	3	3	3	3	3	3	PASS	PASS	PASS
25	3	3	3	3	3	3	3	2	1					1	2	3	2	1	2	2	3	PASS	PASS	PASS
20	1	1			1	2	2	2	1					1	1							PASS	PASS	
15	3	3	2				2	2										1				PASS	PASS	PASS
10	3	3	3	2							1				1	2	3	3	3	3	2	PASS	PASS	PASS
5	3	3	3	2						2	3	3		1	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	2	1		1	1		2	3	3	1	1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5										2	1													
-10																								

PAC. LOOP 1
Near

PACIFIC LOOP NEAR S. R. 1 DAY 500 MB EXAMPLE= 50





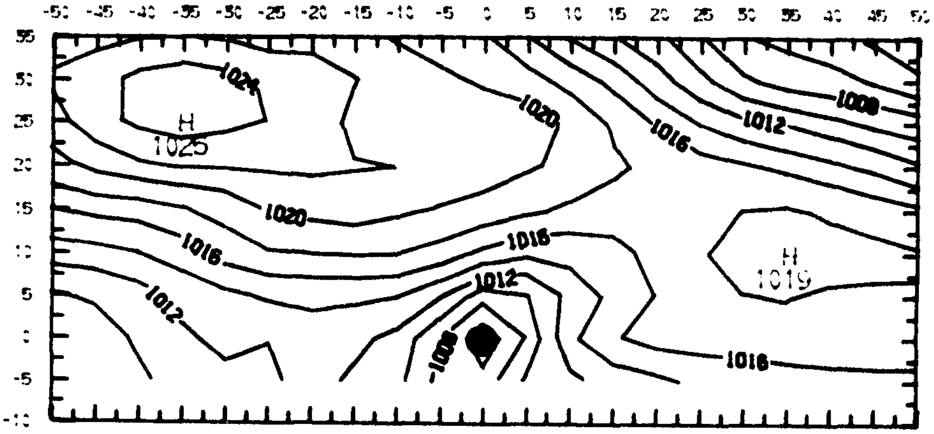
500 mb

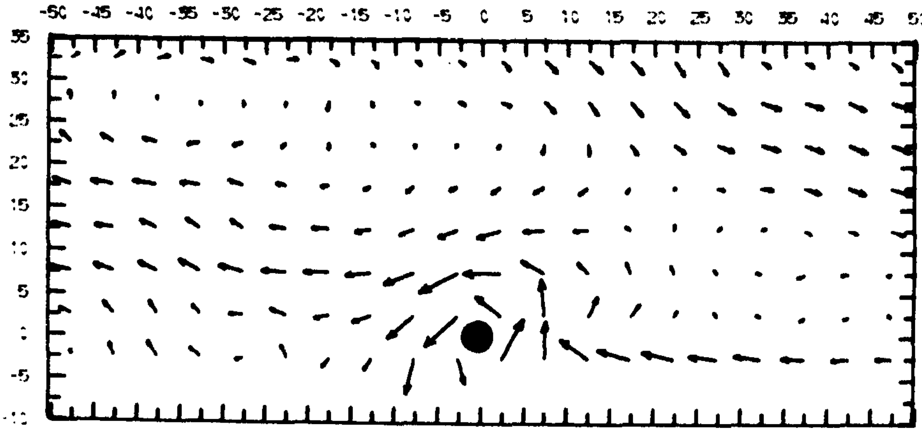
PACIFIC LOOP NEAR SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 50

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	5	2	1				1	2	5	5	5	5	5	2	2	1	PASS	PASS	PASS
30	5	5	5	5	5	5	2	2	1				1	5	5	5	5	5	2	2	2	PASS	PASS	PASS
25	5	5	5	5	5	5	2							2	5	5	5	2	2	1	2	PASS	PASS	PASS
20	5	5	5	2	2			1	2	2	1										1	PASS	PASS	PASS
15						2	2	5	5	5	1		1	5	5	5	5	2				PASS	PASS	PASS
10					2	5	5	5	5	5			5	5	5	5	5	5				PASS	PASS	PASS
5				1	2	5	5	5	5	2			2	5	5	5	5	1				PASS	PASS	PASS
0			1	1									5	5	5	2	1					PASS	PASS	PASS
-5		1	1				1	1														PASS		
-10																								

PAC. LOOP 1
Near

PACIFIC LOOP NEAR S. R. 1 DAY SURFACE EXAMPLE= 30





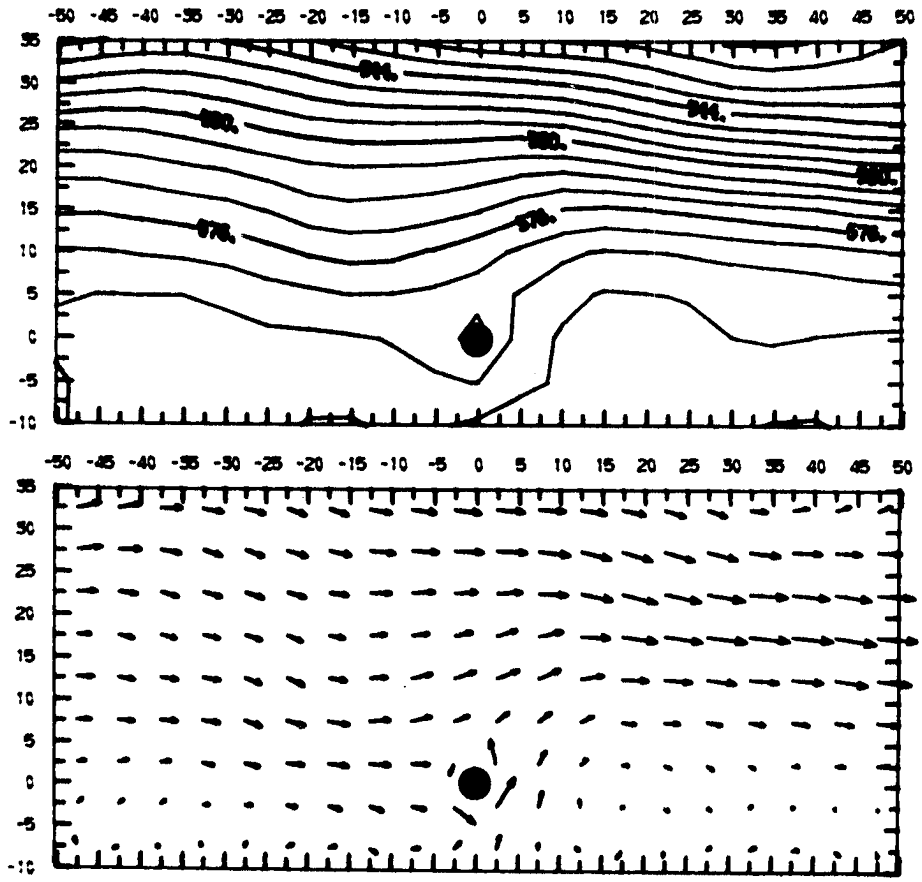
Sfc.

PACIFIC LOOP NEAR SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE= 30

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	2	3	3	3	3	3	2	2	1			1	2	3	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	3	3	2	2	1				2	3	3	3	3	3	3	PASS	PASS	PASS
25	1	3	3	3	3	3	2	1	2	2	2	2			1	3	3	3	3	3	3	PASS	PASS	PASS
20			1	2	2	2	2	2	2	1						1	2	2	2	2	3	PASS	PASS	PASS
15	1					1	2	1	1													PASS	PASS	PASS
10	3	3	2									2	1			1	2	2	1	1		PASS	PASS	PASS
5	3	3	2							2	3	3			2	3	3	3	3	3	3	PASS	PASS	PASS
0	3	2							2	3	3	2		1	3	3	3	3	2	2	2	PASS	PASS	PASS
-5	1									2	1					1	1	1	1	1	1	PASS	PASS	
-10																								

PAC. LOOP 2
Near

PACIFIC LOOP NEAR S. R. 2 DAY 500 MB EXAMPLE= 25



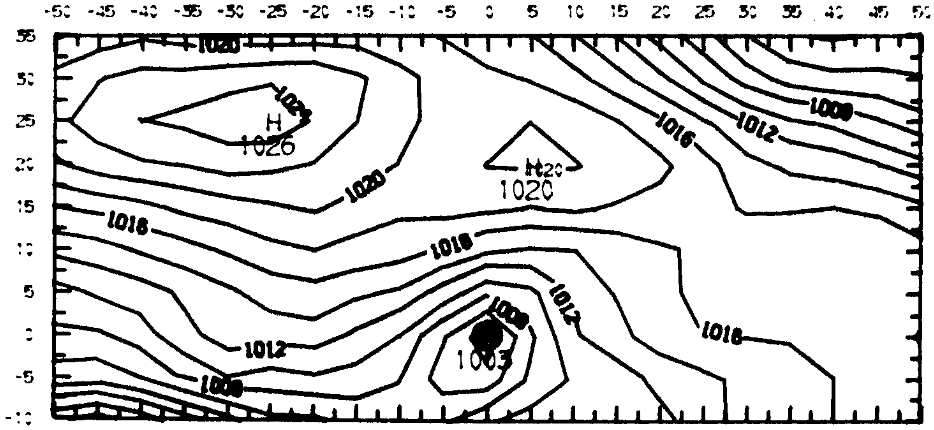
500 mb

PACIFIC LOOP NEAR SUBTROPICAL RIDGE 2 DAY 500 MB EXAMPLE= 25

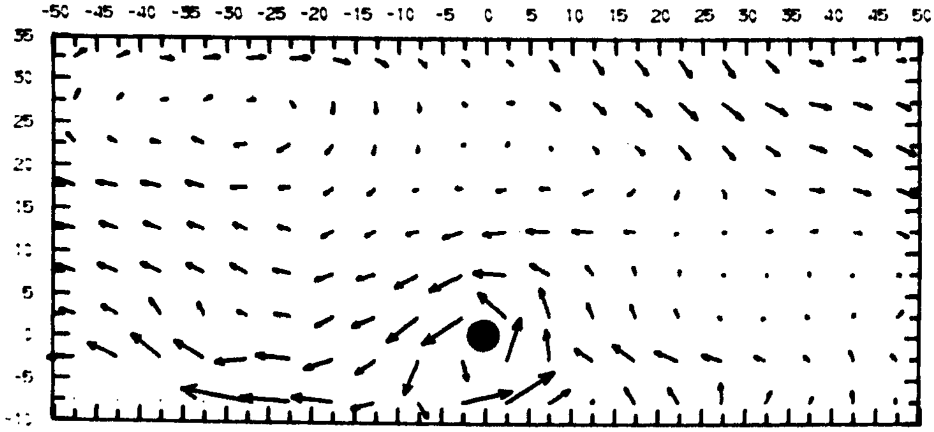
	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	2	2	2	2	1						1	1	1	2	2	2	2			PASS	PASS	PASS
30	2	3	3	3	3	2	1								1	2	3	3	3	2	1	PASS	PASS	PASS
25	3	3	3	3	3	2										2	3	3	2	2	2	PASS	PASS	PASS
20	3	3	3	2	1													1	1	1	2	PASS	PASS	PASS
15							2	2	2	1			1	2	2							PASS	PASS	PASS
10						2	3	3	3	3	1		3	3	3	2	1	1				PASS	PASS	PASS
5						3	3	3	2	3	3		3	3	3	2	1	1	1			PASS	PASS	PASS
0	1	1	1			1	1	1	1	2	2		3	3	3	1					1	PASS	PASS	PASS
-5	1	1	1						1	1				1	1							PASS	PASS	PASS
-10																								

PAC. LOOP 2
Near

PACIFIC LOOP NEAR S. R. 2 DAY SURFACE EXAMPLE= 24



Sfc.

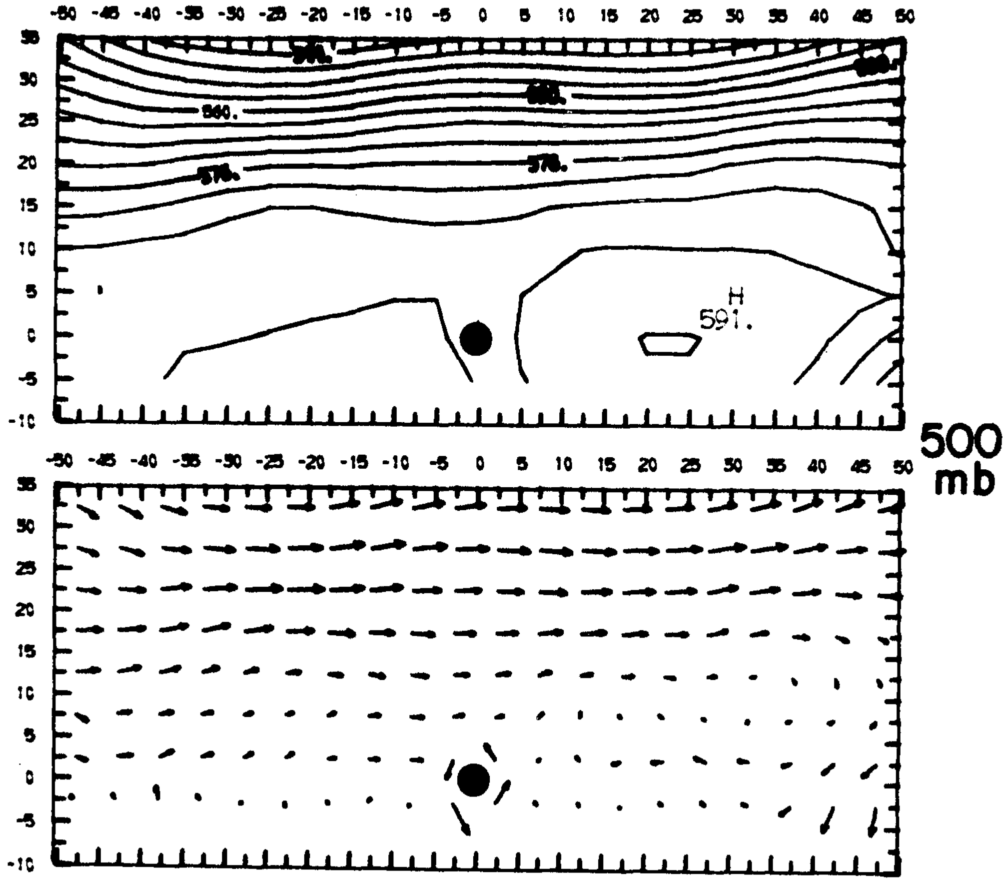


PACIFIC LOOP NEAR SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE= 24

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		2	2	2	3	2	2	3	3	2	1				1	3	3	3	3	3	3	PASS	PASS	PASS
30	1	3	3	3	3	3	3	3	2	1					2	3	3	3	3	3	3	PASS	PASS	PASS
25	1	2	2	3	3	3	3	2	1							2	3	3	3	3	3	PASS	PASS	PASS
20			1	2	3	2	2	1									2	2	2	2	2	PASS	PASS	PASS
15						1	2															PASS		
10	2	1					1															PASS	PASS	PASS
5	3	2	1							1	3	2			1	3	3	3	3	2	2	PASS	PASS	PASS
0	3	3	1						1	3	3	1			2	3	3	3	3	3	3	PASS	PASS	PASS
-5	1	1								3	1					2	2	2	2	2	2	PASS	PASS	PASS
-10			1	1				1										1		1		PASS	PASS	

PAC. FAST S. -2

PACIFIC FAST SOUTH OF S. R. -2 DAY 500 MB TO WEST EXAMPLE= 22

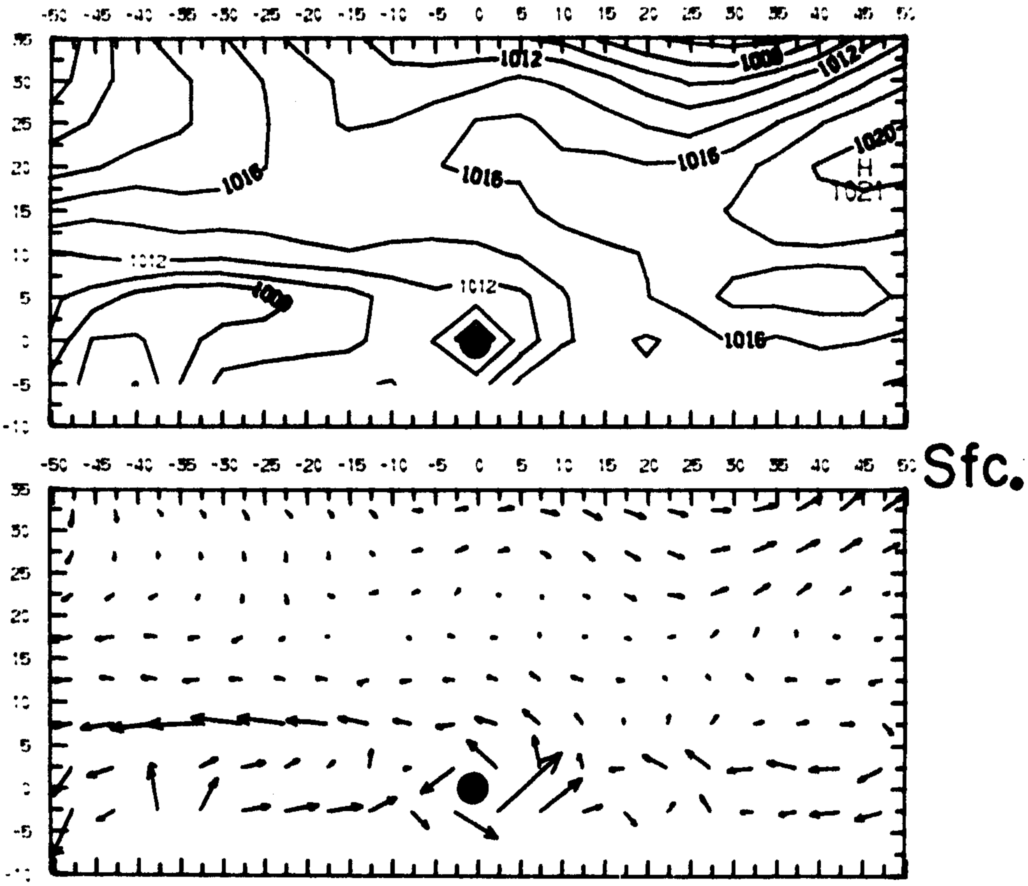


PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE -2 DAY 500 MB TO WEST EXAMPLE= 22

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2					1	2	2												1	2	PASS	PASS	PASS
30					2	2	2	1											1	2	2	PASS	PASS	PASS
25		1	2	3	3	2	1											2	3	3	3	PASS	PASS	PASS
20	3	3	3	3	2												1	3	2	1	1	PASS	PASS	PASS
15	3	2	2	1										1				1				PASS	PASS	PASS
10	1	1											1	1								PASS		
5		2	1			1									1	3	2	1				PASS	PASS	PASS
0		1	1						1	1	1	1							1					
-5																1	1	1				PASS		
-10																								

PAC. FAST -2
S.

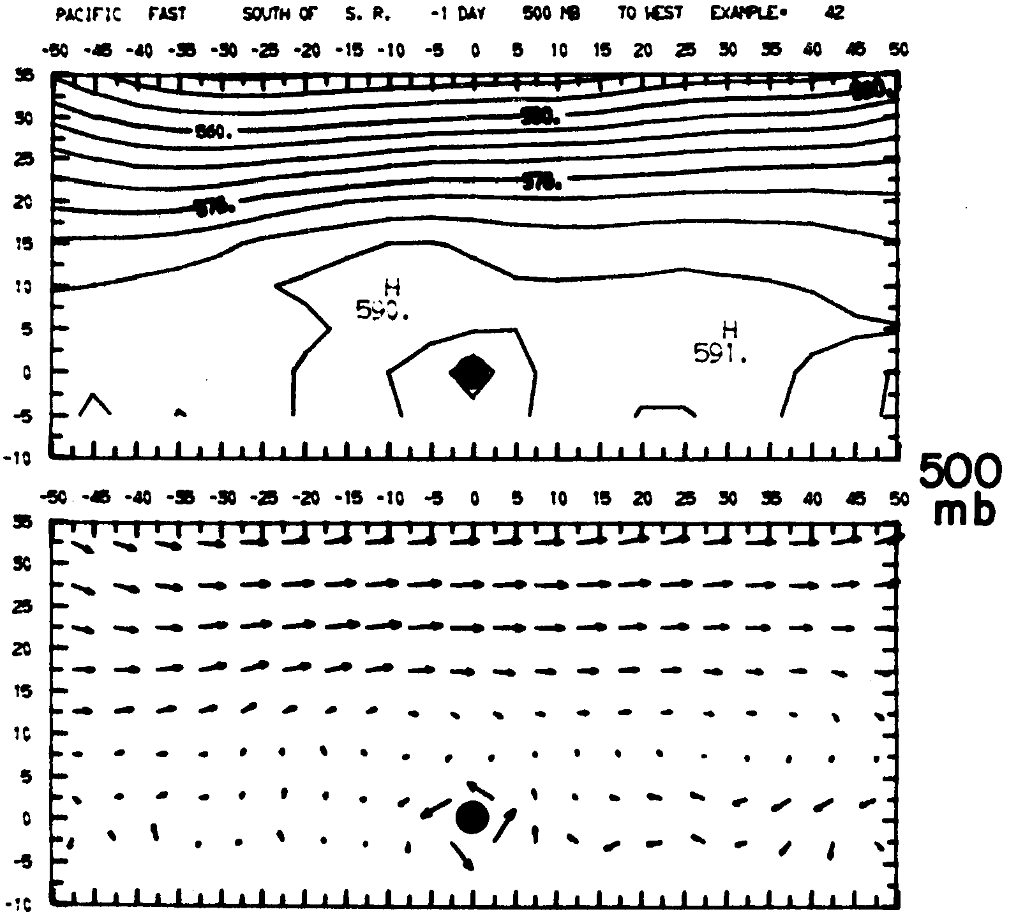
PACIFIC FAST SOUTH OF S. R. -2 DAY SURFACE TO WEST EXAMPLE= 21



PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE -2 DAY SURFACE TO WEST EXAMPLE= 21

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	TEST 2 SIGNIFICANT LEVEL .050	.010	.001
											TEST 1													
35	3	3	2	1	1										1	2	2	2				PASS	PASS	PASS
30	3	2	1													1	2					PASS	PASS	PASS
25	1							1	1						1	2				1	1	PASS	PASS	
20							1	1											1	1	1	PASS	PASS	PASS
15						1												1	2	1		PASS	PASS	
10	1										1					1	2	2	2	1		PASS	PASS	PASS
5			1	1	1	1	3				1			2	2	2	3	3	3	3	1	PASS	PASS	PASS
0		2	2							1							1	1	1			PASS	PASS	PASS
-5	1												1									PASS	PASS	
-10																								

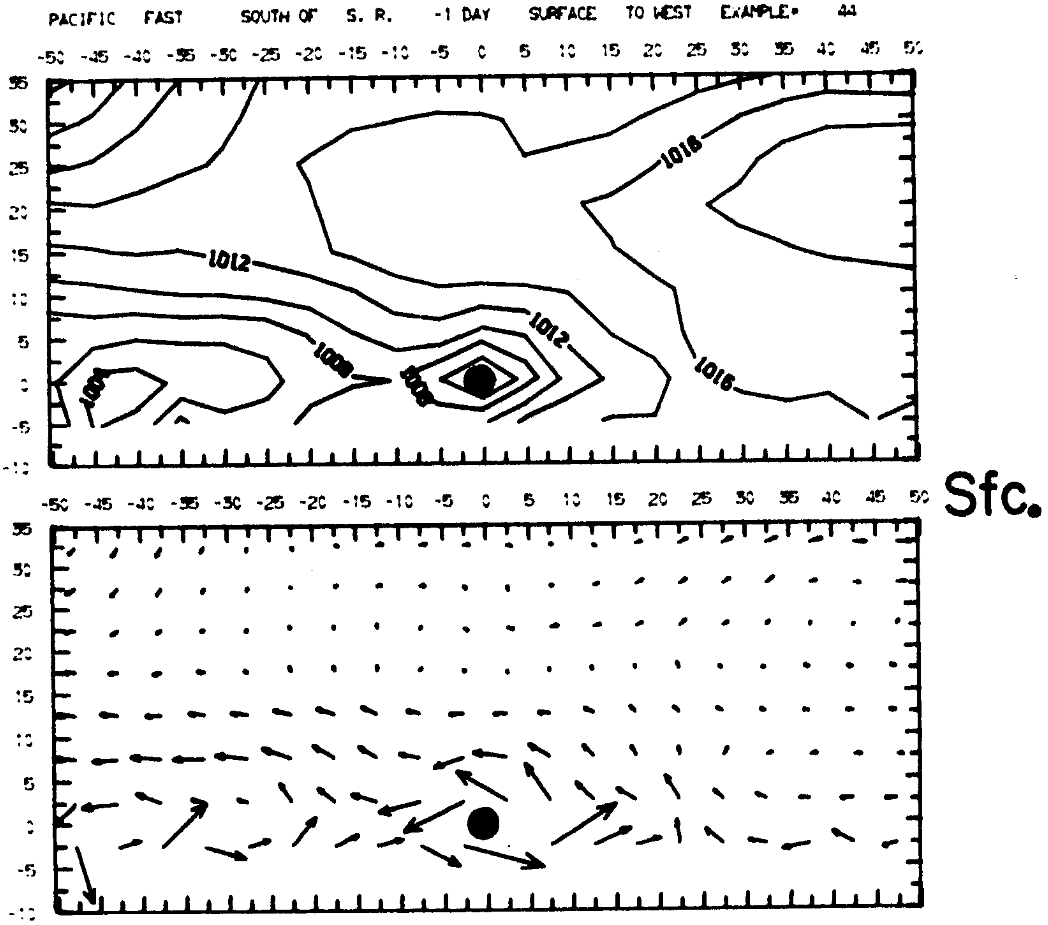
PAC. FAST S. -1



PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE -1 DAY 500 MB TO WEST EXAMPLE= 42

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2			1	2	1	1	1	1											1	2	PASS	PASS	PASS
30			1	2	2	2	2	1	1								1	2	2	3	3	PASS	PASS	PASS
25		3	3	3	3	3	3	1								1	1	2	2	3	3	PASS	PASS	PASS
20	3	3	3	3	3	2				1	1				1	2	1	1	1			PASS	PASS	PASS
15	3	3	3	3	2			3	3	3	3	1			1	1						PASS	PASS	PASS
10	3	3	2	1			1	3	3	3	3	1									1	PASS	PASS	PASS
5	3	2	2	1	1	1			1					2	1	2	3	2				PASS	PASS	PASS
0													3			1	2	1						
-5														5										
-10																								

PAC. FAST -1
S.

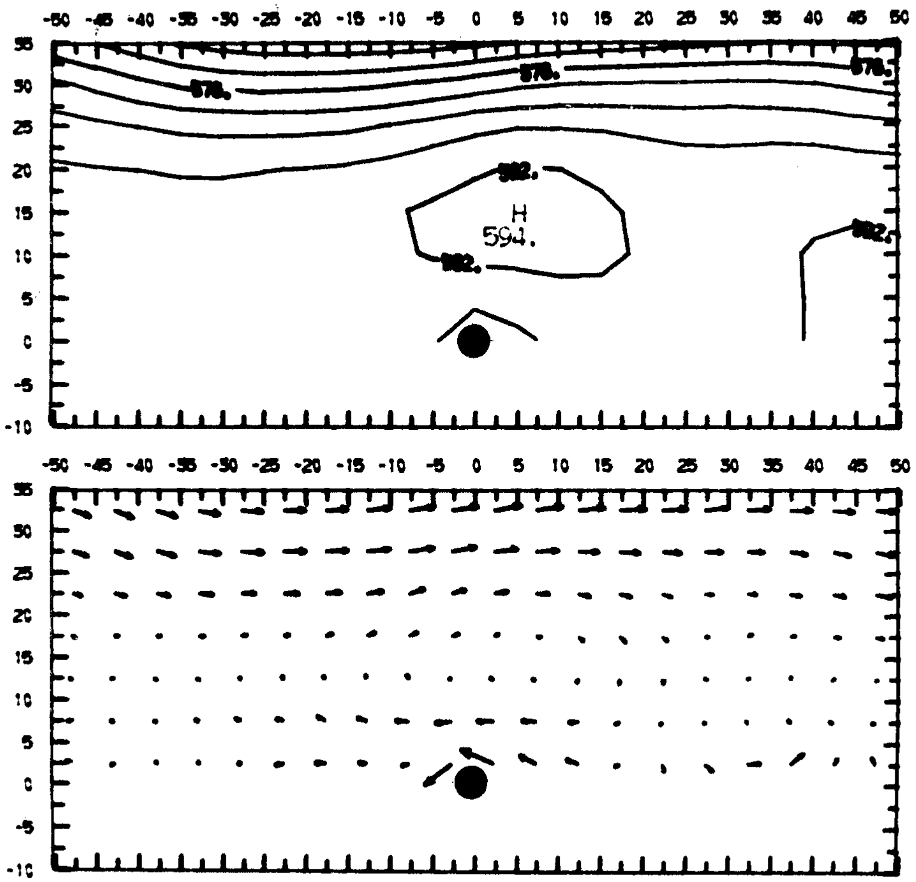


PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE -1 DAY SURFACE TO WEST EXAMPLE= 44

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	1																			PASS	PASS	PASS
30	2																		1			PASS	PASS	
25					1	1											1	2	2	2	2	PASS	PASS	PASS
20	1	1	1	2	2	2	1	1								3	3	2	2	2	3	PASS	PASS	PASS
15	2	3	2	3	2	2	1								1	3	3	3	3	3	3	PASS	PASS	PASS
10	3	3	2	3	3	3	3	2						1	3	3	3	3	3	3	3	PASS	PASS	PASS
5	1	2	3	3	3	3	3	2			2	1		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0		2	2	3	1					1	2			2		3	2	2	1	2	2	PASS	PASS	PASS
-5													1									PASS		
-10																								

ATL. FAST O
S.

ATLANTIC FAST SOUTH OF S. R. 0 DAY 500 MB TO WEST EXAMPLE= 71



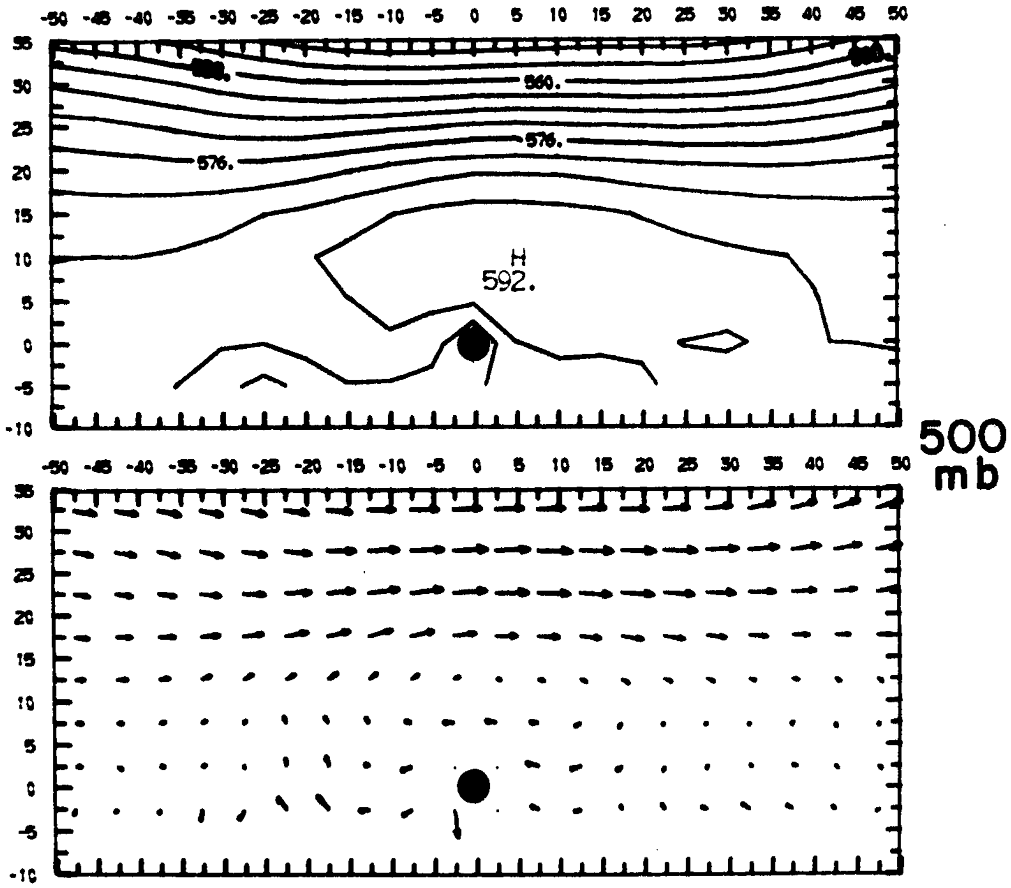
500 mb

ATLANTIC FAST SOUTH OF SUBTROPICAL RIDGE 0 DAY 500 MB TO WEST EXAMPLE= 71

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5			2	5	5	2	2	2	1							1	2	2	1	PASS	PASS	PASS
30	5			2	5	5	5	5	2	1			1	1	1	1	2	2	2			PASS	PASS	PASS
25			2	5	5	5	5	2			2	5	5	5	2	1	1					PASS	PASS	PASS
20	1	2	5	5	5	5	5	1		2	5	5	5	5								PASS	PASS	PASS
15	5	5	5	5	5	5	5		1	5	5	5	5	5			1		1	1		PASS	PASS	PASS
10	5	5	5	5	5	5	5		1	5	5	5	5	5	1				5	5	5	PASS	PASS	PASS
5	5	5	5	5	5	5								2	2	2	1	1	5	5	5	PASS	PASS	PASS
0																			2			PASS		
-5																								
-10																								

PAC. FAST O
S.

PACIFIC FAST SOUTH OF S. R. 0 DAY 500 MB TO WEST EXAMPLE= 136

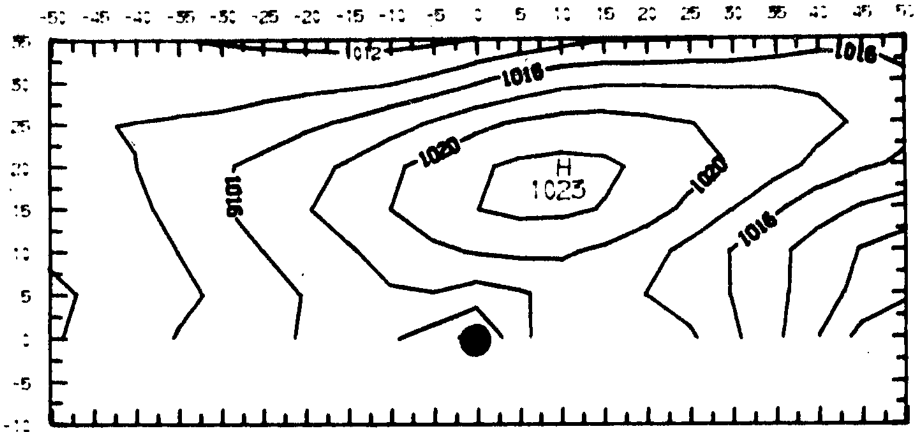


PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE 0 DAY 500 MB TO WEST EXAMPLE= 136

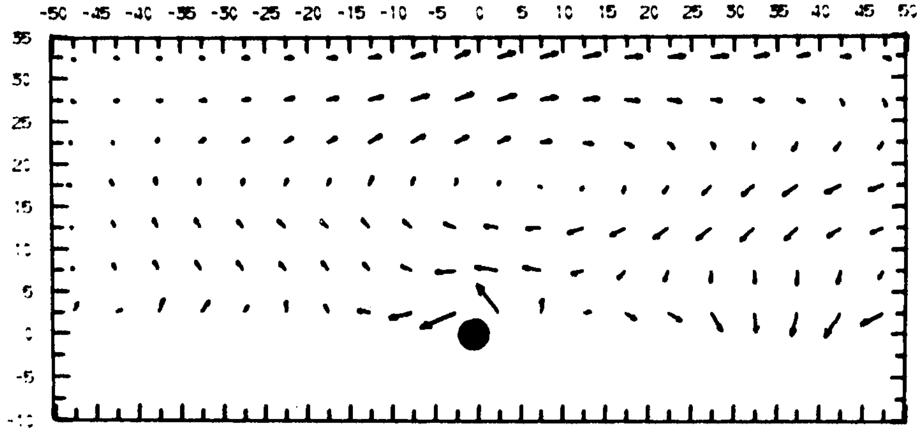
	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5			1	5	5	5	5	5	2	2	2	1				2	5	PASS	PASS	PASS
30	5	5	5	2		1	5	5	5	5	2	2	1	1	2	1				5	5	PASS	PASS	PASS
25	5	2			5	5	5	5	2											5	5	PASS	PASS	PASS
20	5	5	5	5	5	5	5	1	1	5	5	5	5	5	2						1	PASS	PASS	PASS
15	5	5	5	5	5	5	2	1	5	5	5	5	5	5	5	2					1	PASS	PASS	PASS
10	5	5	5	5	5	5		5	5	5	5	5	5	5	5	5	1			2	5	PASS	PASS	PASS
5	5	5	5	5	5	5	2		5	5	2	5	5	5	5	5	1	1				PASS	PASS	PASS
0			1	2	1	1							2	1								PASS	PASS	
-5					1	2	1											1	1	1		PASS	PASS	PASS
-10																								

ATL. FAST O
S.

ATLANTIC FAST SOUTH OF S. R. 0 DAY SURFACE TO WEST EXAMPLE= 62



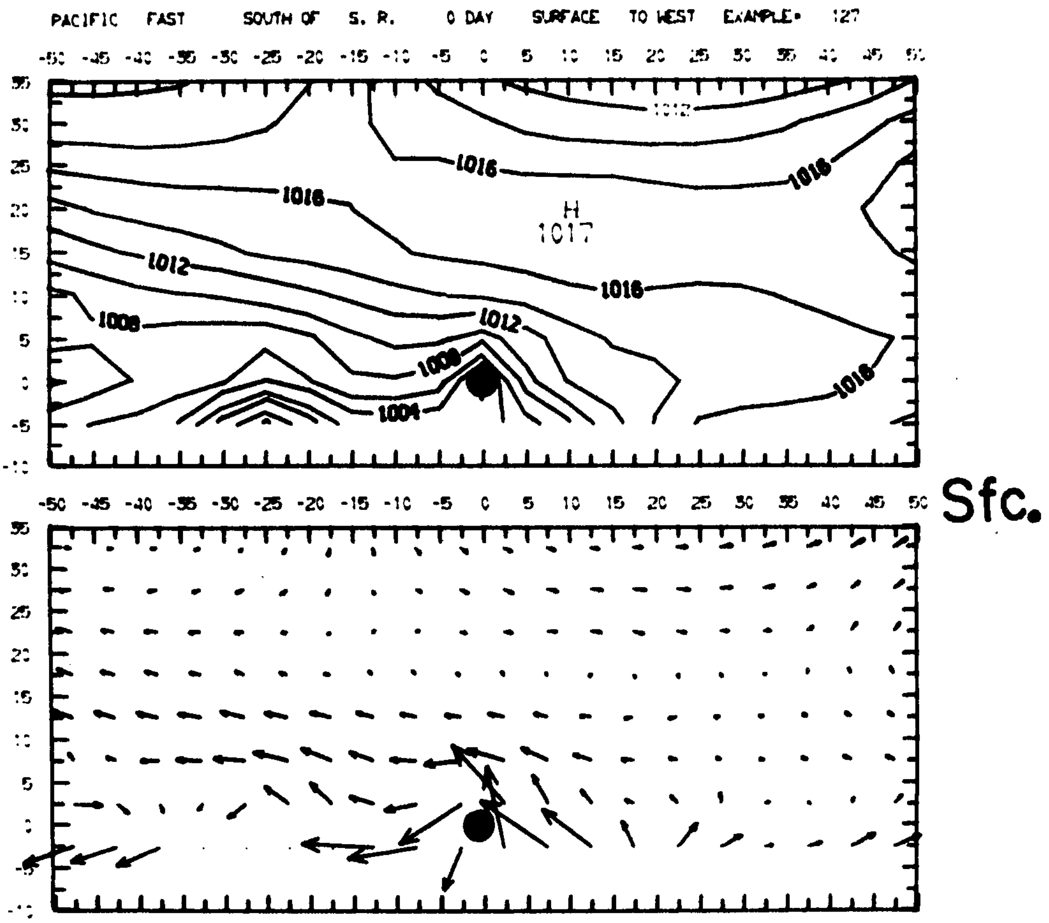
Sfc.



ATLANTIC FAST SOUTH OF SUBTROPICAL RIDGE 0 DAY SURFACE TO WEST EXAMPLE= 62

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35							1	1	1									1	2	3	3	PASS	PASS	PASS
30	2	3	3	3	3	3	2	2	1			1	2	3	3	3	3	3	3	2		PASS	PASS	PASS
25	3	3	3	3	3	3	2	1			3	3	3	3	3	3	3	2	1			PASS	PASS	PASS
20	3	3	3	3	3	3	1		2	3	3	3	3	3	3	3	2			2	3	PASS	PASS	PASS
15	3	3	3	2	3			3	3	3	3	3	3	3	3	3			3	3	3	PASS	PASS	PASS
10	3	3	3	3	2		2	3	3	3	3	3	3	3	3	2		2	3	3	3	PASS	PASS	PASS
5	3	3	3	2	1			3	3	3	3	3	3	3	3	2			2	3	3	PASS	PASS	PASS
0	2											1	1	1	2	1					1	PASS	PASS	PASS
-5																								
-10																								

PAC. FAST O S.

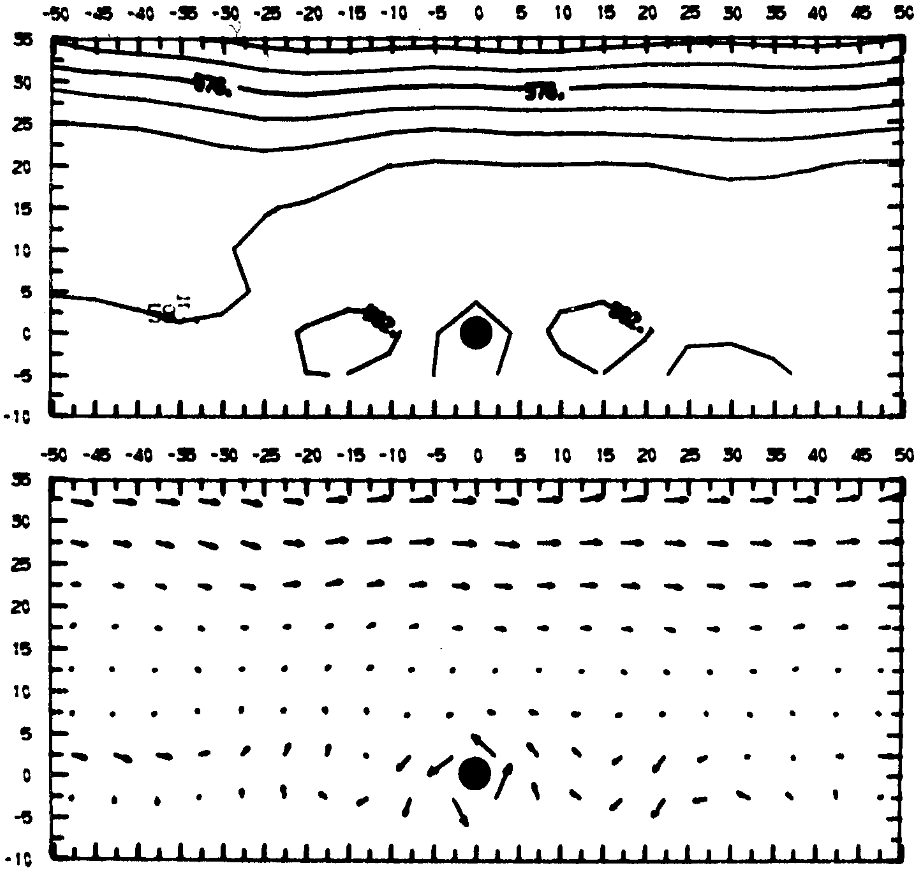


PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE 0 DAY SURFACE TO WEST EXAMPLE= 127

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	3	2			3	3	3	3	3	3	3	3	2	1		PASS	PASS	PASS
30	3	3	3	3	3	3	2				1	2	3	3	3	3	2	1				PASS	PASS	PASS
25																					2	PASS	PASS	PASS
20	3	3	2	2	1	1						2	2	1						2	3	PASS	PASS	PASS
15	3	3	3	3	3	3	1			2	3	3	3	3	3	3	2	2	2	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	3	1		1	2	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	1	1	3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0				1	2	2	1	1	3	3	3			2	1	1	2	2	1	2	2	PASS	PASS	PASS
-5				1	1		1	1	2	2				1	1	1	1	1	2	2	1	PASS	PASS	
-10																								

ATL. FAST 1
S.

ATLANTIC FAST SOUTH OF S. R. 1 DAY 500 MB TO WEST EXAMPLE= 52



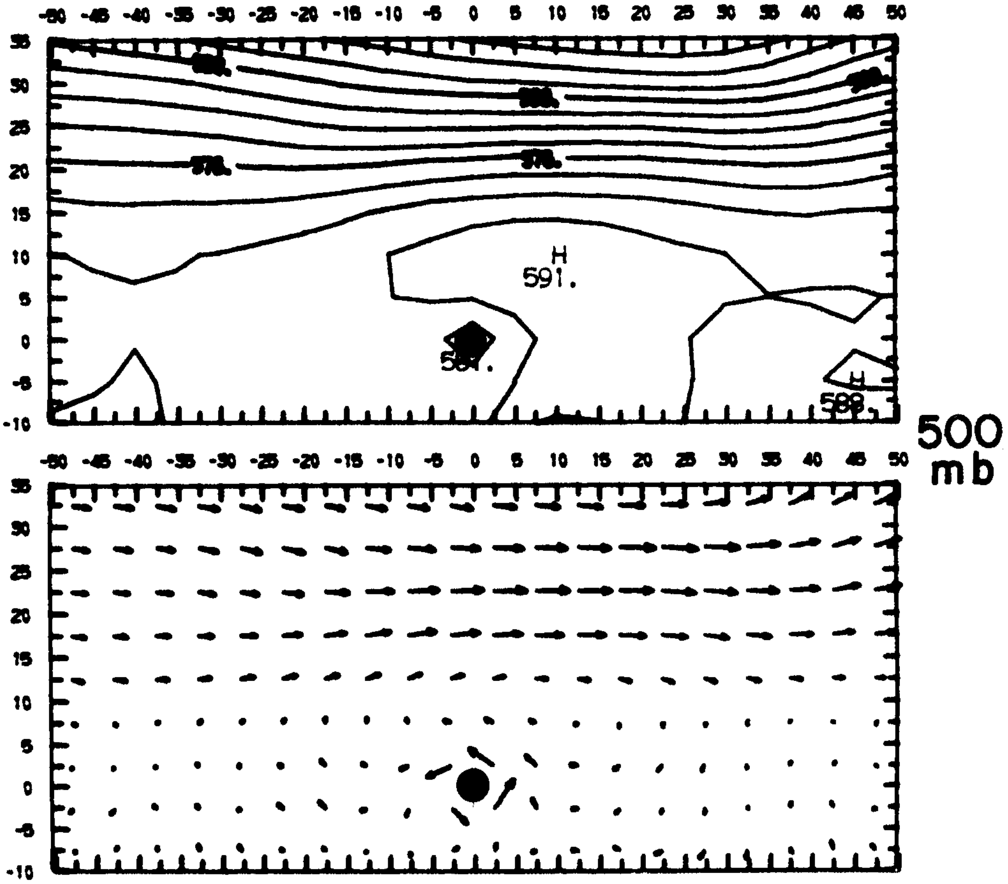
500 mb

ATLANTIC FAST SOUTH OF SUBTROPICAL RIDGE 1 DAY 500 MB TO WEST EXAMPLE= 52

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1																					PASS		
30	1																					PASS	PASS	
25																								
20						1																PASS		
15	2	2	1	2	2	3	2				1	1	1	1	1					1	1	PASS	PASS	PASS
10	3	3	3	3	3	3	3		1	1	1	2	3	2	1	1	1	2	2	1	1	PASS	PASS	PASS
5	3	3	3	3	3	3							2			2	3	3	3	2	1	PASS	PASS	PASS
0	1					1		1											1			PASS		
-5					1				1															
-10																								

PAC. FAST 1
S.

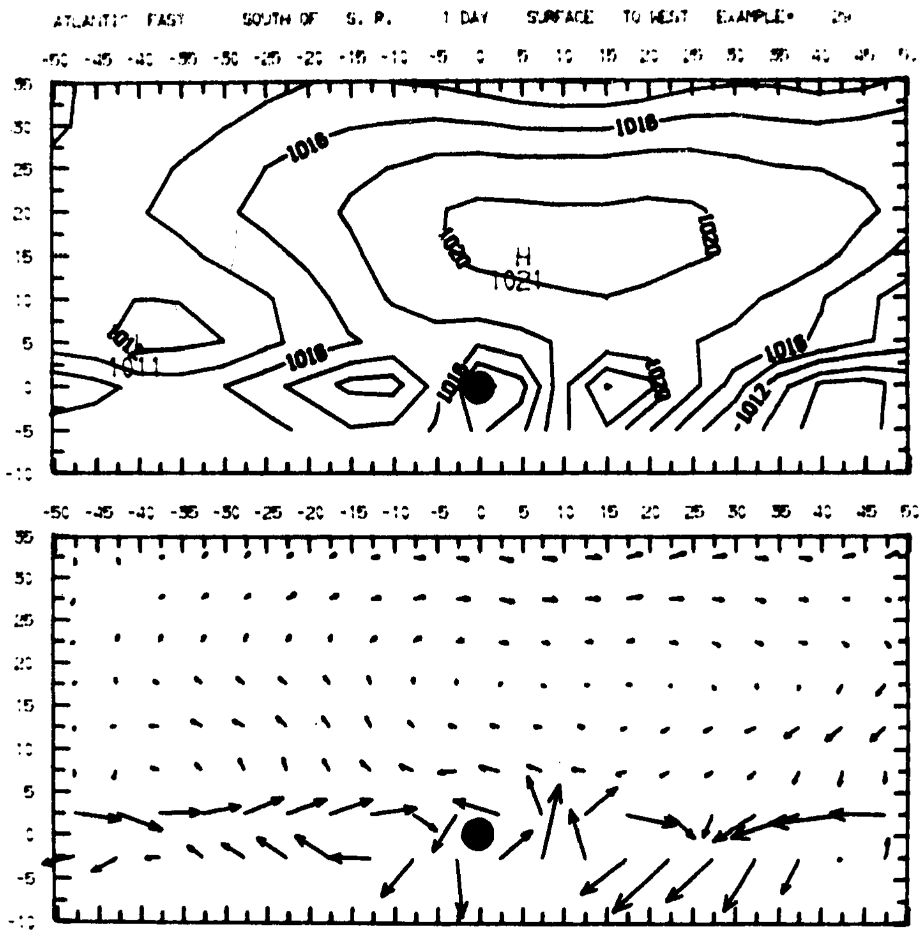
PACIFIC FAST SOUTH OF S. R. 1 DAY 500 MB TO WEST EXAMPLE= 86



PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE 1 DAY 500 MB TO WEST EXAMPLE= 86

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	2	1			1	5	5	5	5	5	5	5	2			1	PASS	PASS	PASS
30	5	5	5	5	5	5	1			1	2	5	5	5	5	5	5	5			2	PASS	PASS	PASS
25	5	5	5	5	5	1		1	1	1	1	1	1	1	1	1	2	1			2	PASS	PASS	PASS
20					2	2	2	2				1	2	2	1						1	PASS	PASS	PASS
15	5	5	5	5	5	5	5	1		5	5	5	5	5	5	2						PASS	PASS	PASS
10	5	5	5	5	5	5	5		2	5	5	5	5	5	5	5	1					PASS	PASS	PASS
5	5	5	5	5	5	5	2		1	2	2	5	5	5	5	5						PASS	PASS	PASS
0	2	2	2	2	5	2	1				2		5	5	5	1				1	2	PASS	PASS	PASS
-5		1	2	1	5								2	2	2							PASS	PASS	PASS
-10		1										2										PASS	PASS	

ATL. FAST 1
S.

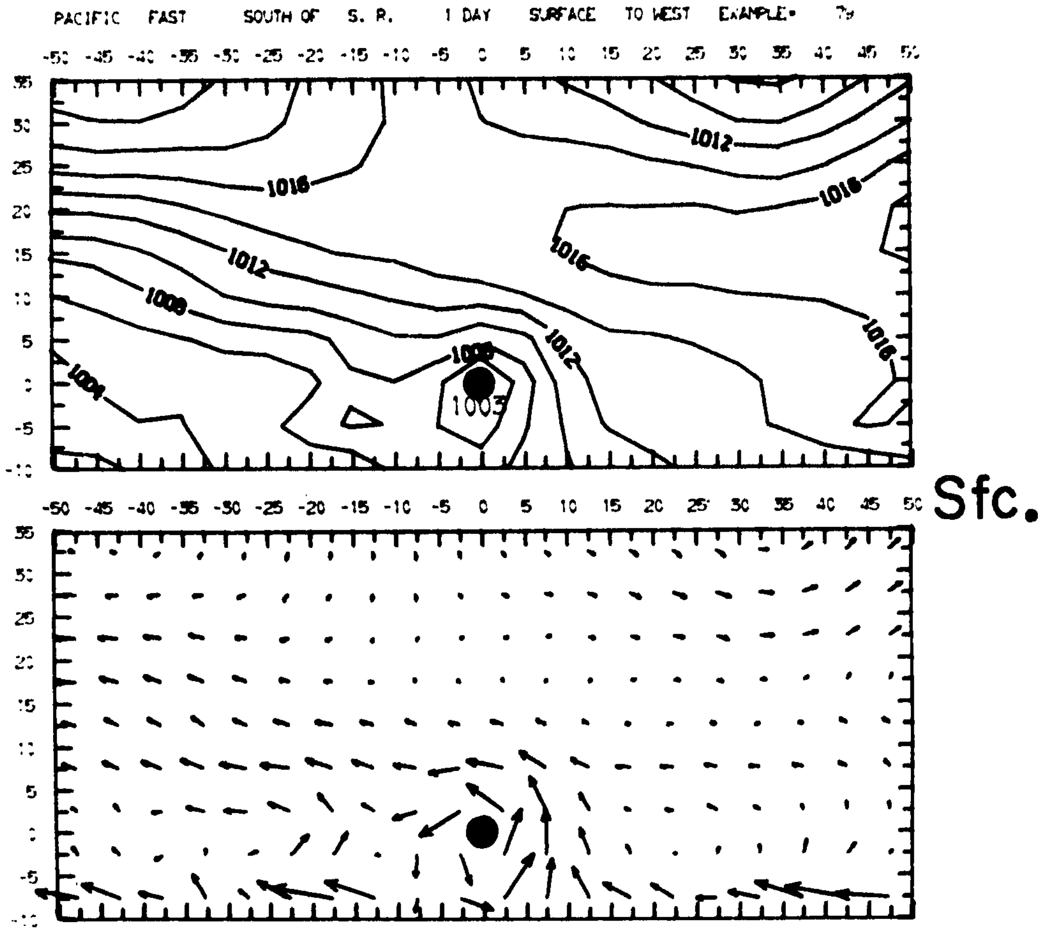


Sfc.

ATLANTIC FAST SOUTH OF SUBTROPICAL RIDGE 1 DAY SURFACE TO WEST EXAMPLE= 29

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	.																							
30		1	2	2	1																	PASS	PASS	
25	3	3	3	3	2					1	1	1	1	1	2	1						PASS	PASS	PASS
20	3	3	3	3	2	1				2	3	3	3	3	3	2	1					PASS	PASS	PASS
15	3	3	3	3	3	3			2	3	3	3	3	3	3	3	3	2			1	PASS	PASS	PASS
10	3	3	3	3	3	3	1		3	3	3	3	3	3	3	3	3				2	PASS	PASS	PASS
5	2	3	3	3	3	2			1	3	1	2	3	3	3	3	3	1				PASS	PASS	PASS
0															1	1			1			PASS		
-5										2					1			1	1			PASS		
-10																								

PAC. FAST 1
S.

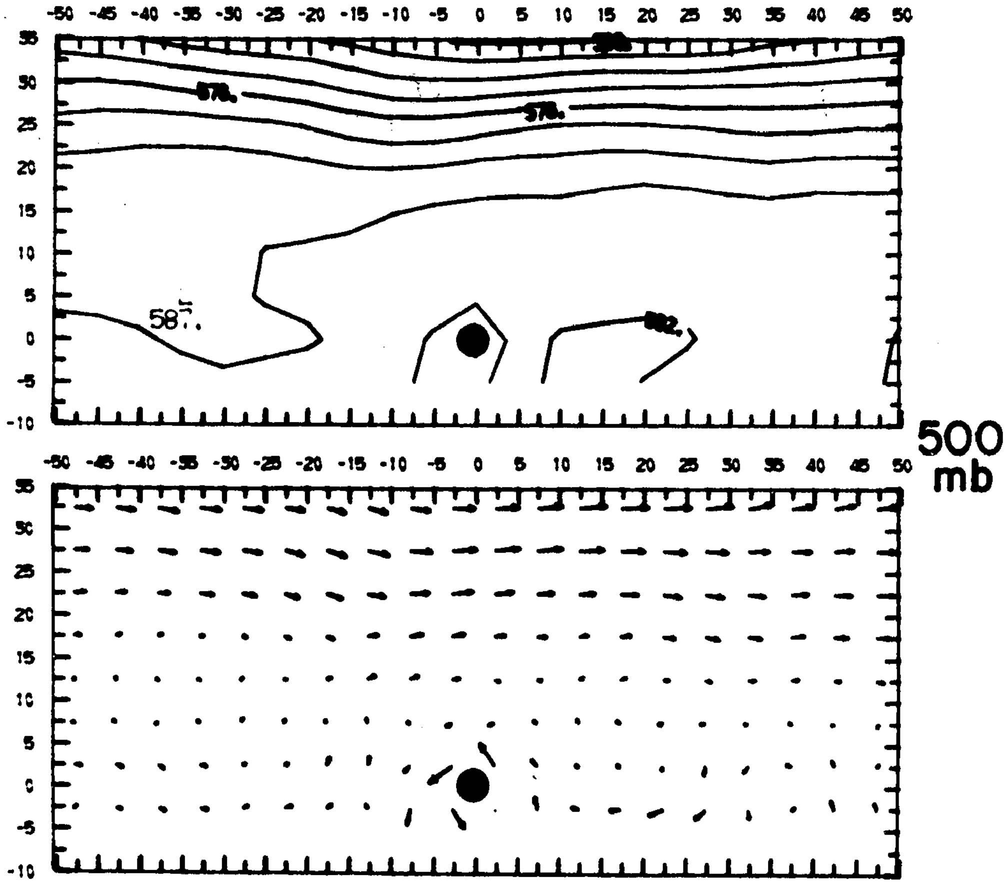


PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE 1 DAY SURFACE TO WEST EXAMPLE= 79

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	3	2	1			1	3	3	3	3	3	3	3	2	1	PASS	PASS	PASS
30	3	3	3	3	3	3	2	1				1	1	2	3	3	3	3	3	1		PASS	PASS	PASS
25					1	1										1	2	2				PASS	PASS	PASS
20	3	3	3	2																1	2	PASS	PASS	PASS
15	3	3	3	3	3	2					1	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	3	2				3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	1		3	1	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	3	3	2		2	3	1	2	3	3	2	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	2	2	3	1	1			1	2			2	3	2	2	2	3	3	3	PASS	PASS	PASS
-10	1			1	1		1															PASS	PASS	

ATL. FAST 2
S.

ATLANTIC FAST SOUTH OF S. R. 2 DAY 500 MB TO WEST EXAMPLE= 25

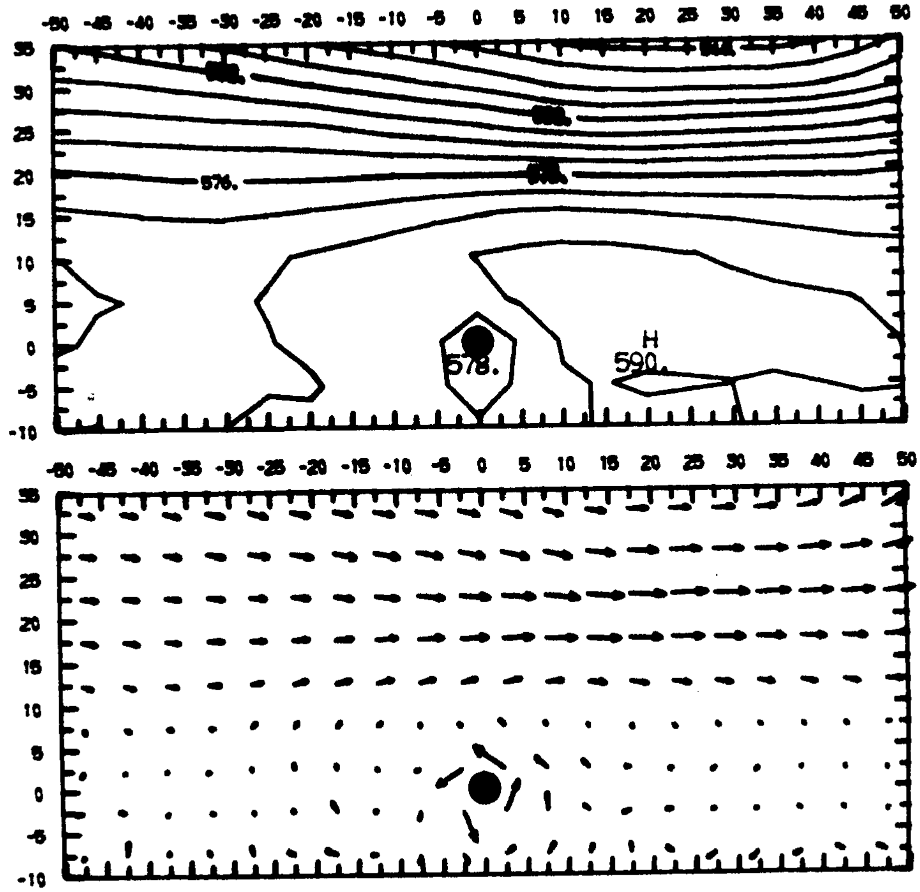


ATLANTIC FAST SOUTH OF SUBTROPICAL RIDGE 2 DAY 500 MB TO WEST EXAMPLE= 25

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	1								1											PASS	PASS	PASS
30	1	2	1						1	1												PASS	PASS	PASS
25		1							1													PASS	PASS	
20								1	1													PASS		
15							1	1							1	1	1					PASS	PASS	
10	5	5	5	5	5	2	2			1					2	5	5	5	5	5	2	PASS	PASS	PASS
5	5	5	5	5	5	2								1	2	2	5	5	5	5	5	PASS	PASS	PASS
0					1	2	1													1	1	PASS		
-5											1		2									PASS		
-10																								

PAC. FAST 2
S.

PACIFIC FAST SOUTH OF S. R. 2 DAY 500 MB TO WEST EXAMPLE= 65

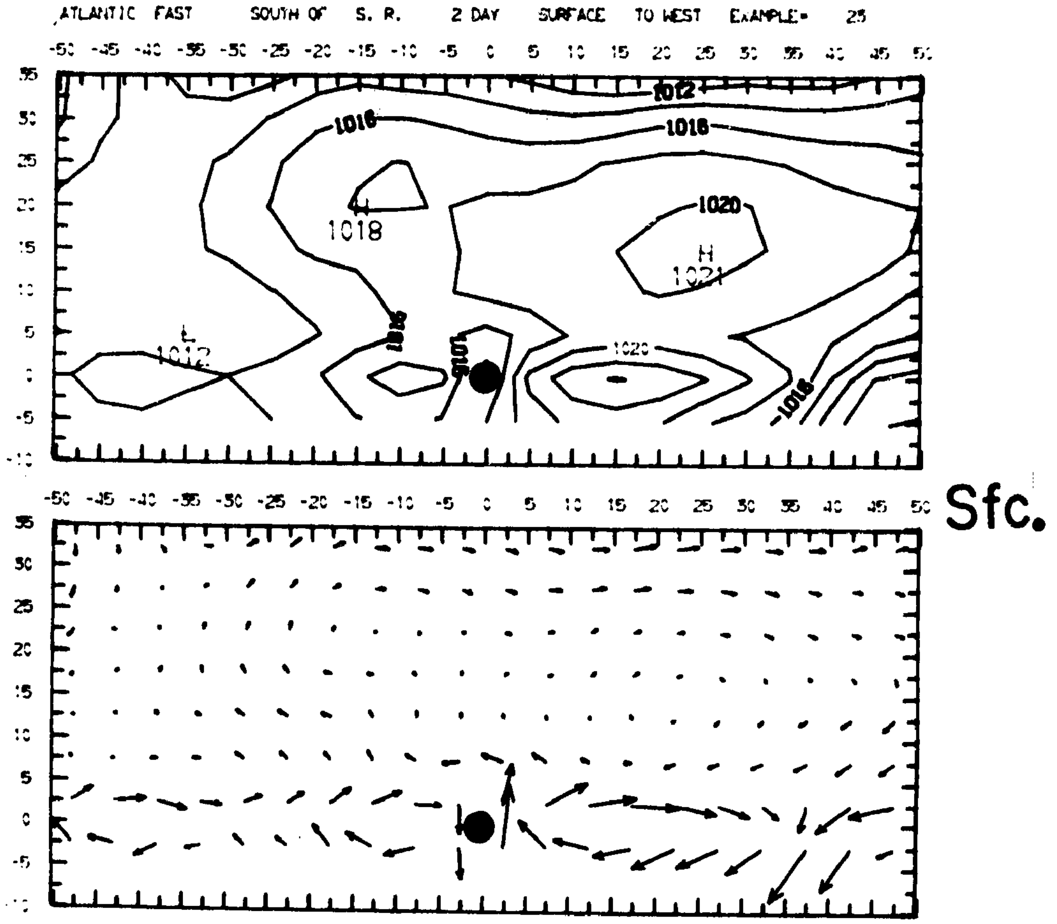


500 mb

PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE 2 DAY 500 MB TO WEST EXAMPLE= 65

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	5	5	1			1	5	5	5	5	5	5	5	5	1		PASS	PASS	PASS
30	5	5	5	5	5	5	5	2				5	5	5	5	5	5	5	5	2		PASS	PASS	PASS
25	5	5	5	5	5	5	5	5				2	5	5	5	5	5	5	2	1		PASS	PASS	PASS
20	1																					PASS	PASS	
15		2	5	5	5	5	5	1		2	5	5	5	5	5	5	1					PASS	PASS	PASS
10	5	5	5	5	5	5	5	1		5	5	5	5	5	5	5	5					PASS	PASS	PASS
5	5	5	5	5	5	5	5					5	5	5	5	5	5	2	1		1	PASS	PASS	PASS
0	2	2	2	5	5	5	1			1	5	2	5	5	5	5	5	5	5	5	1	PASS	PASS	PASS
-5	1	1				1					5			1	1		1	1	1	2	2	PASS	PASS	PASS
-10	2	1											1			5	1					PASS	PASS	

ATL. FAST S. 2

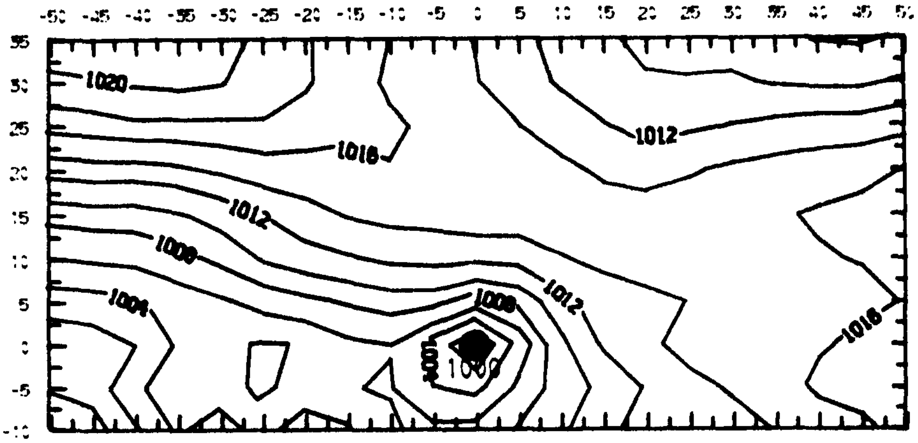


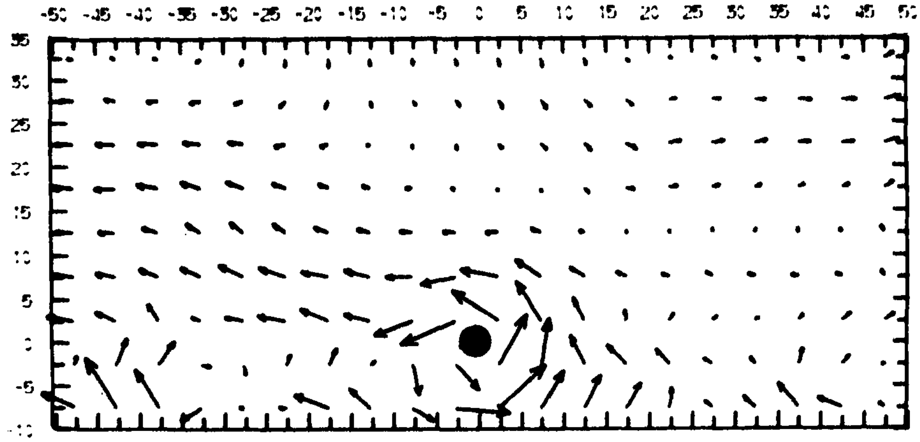
ATLANTIC FAST SOUTH OF SUBTROPICAL RIDGE 2 DAY SURFACE TO WEST EXAMPLE= 23

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	1																				PASS	PASS	PASS
30				2	1																	PASS		
25		2	3	3	2				1						2	2	1					PASS	PASS	PASS
20	3	3	3	3	3									2	3	3	3	1				PASS	PASS	PASS
15	3	3	3	3	3	2						2	2	3	3	3	3	1	1			PASS	PASS	PASS
10	3	3	3	3	3	3	1			1	3	3	3	3	3	3	3	2				PASS	PASS	PASS
5	3	3	3	3	3	3	1			1		1	3	3	3	3	3	2				PASS	PASS	PASS
0					2	1						1	1	1	2	1					1	PASS	PASS	PASS
-5						2	2						1		1	1				1	1	PASS	PASS	
-10																								

PAC. FAST 2 S.

PACIFIC FAST SOUTH OF S. R. 2 DAY SURFACE TO WEST EXAMPLE= 67





Sfc.

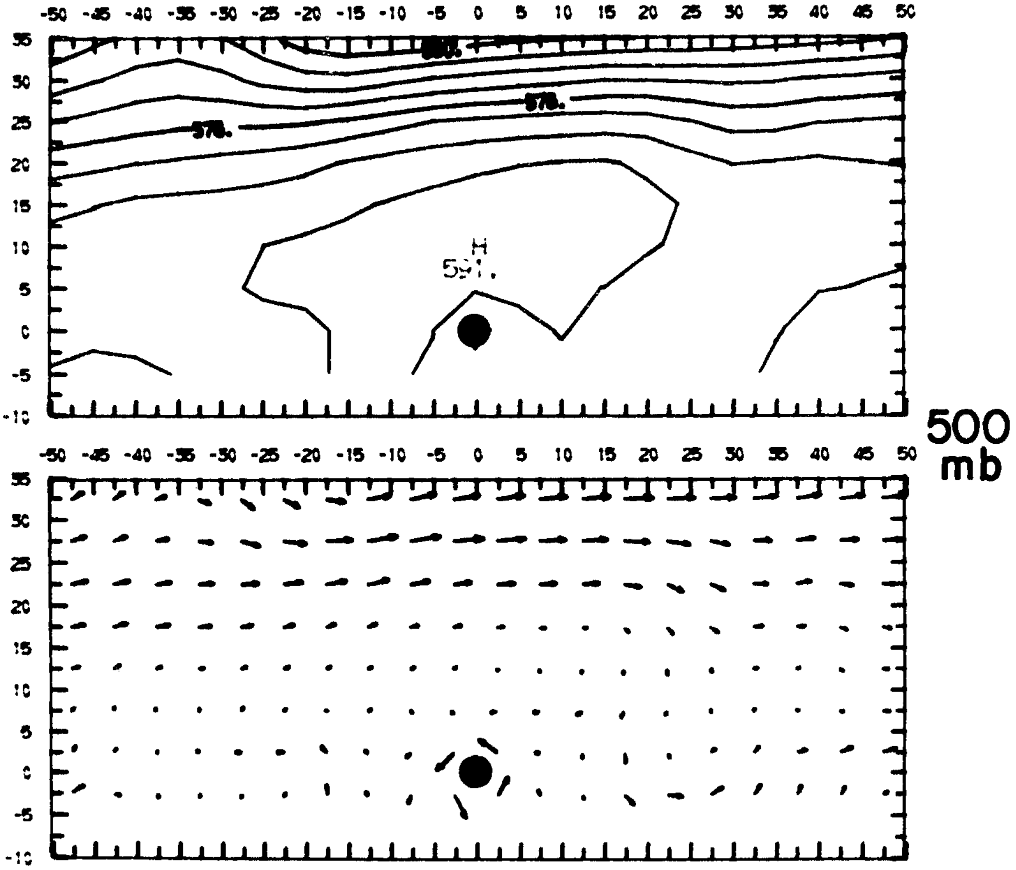
PACIFIC FAST SOUTH OF SUBTROPICAL RIDGE 2 DAY SURFACE TO WEST EXAMPLE= 67

TEST 1 | TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	3	3	3	3	3	3	3	3	2			1	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	3	3	1			1	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
25	1	2	2	2	2	3	2	1	1				1	2	3	2	2	1	1			PASS	PASS	PASS
20	2	1	1						1	1												PASS	PASS	
15	3	3	3	3	3	2				1	3	2	2	1	1		2	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	1			1	1	2	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	3	2	1	2	3	2	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	2	2	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	2	1	2	3	3	3	2	3	2		1	2	3	3	3	3	3	3	3	PASS	PASS	PASS
-10	1	1			2			1		2			2		2		1	1	1	1	1	PASS	PASS	

ATL. SLOW -2 S.

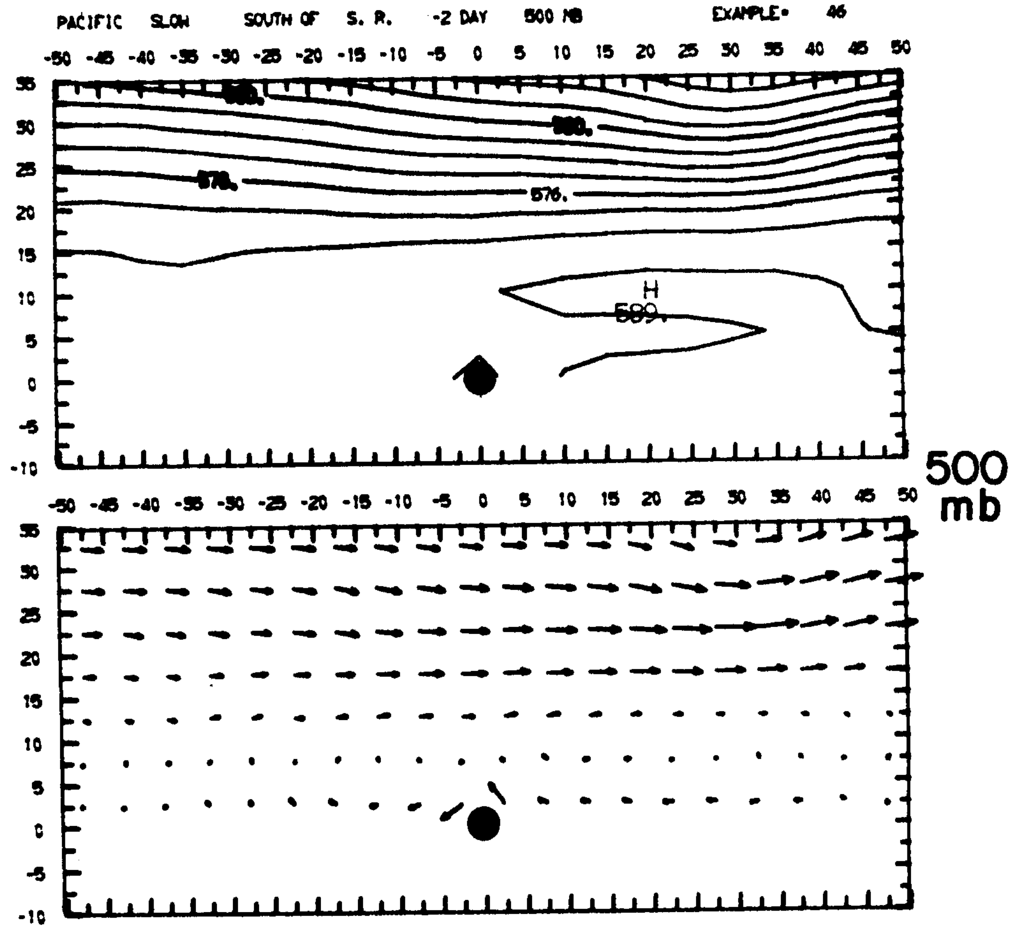
ATLANTIC SLOW SOUTH OF S. R. -2 DAY 500 MB EXAMPLE= 19



ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE -2 DAY 500 MB EXAMPLE= 19

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
35			1	1																		PASS	PASS	
30																					1	PASS	PASS	
25	2	2	1			1	1					1	2	3	2							PASS	PASS	PASS
20	3	3	2	2	2	1				1	2	3	3	3	3							PASS	PASS	PASS
15	2	1		1						2	3	3	3	3	2							PASS	PASS	PASS
10	2	1							1	3	3	3	2	2								PASS	PASS	PASS
5	3	1					1	1	2	2												PASS	PASS	PASS
0	2																1					PASS	PASS	
-5		1														1						PASS		
-10																								

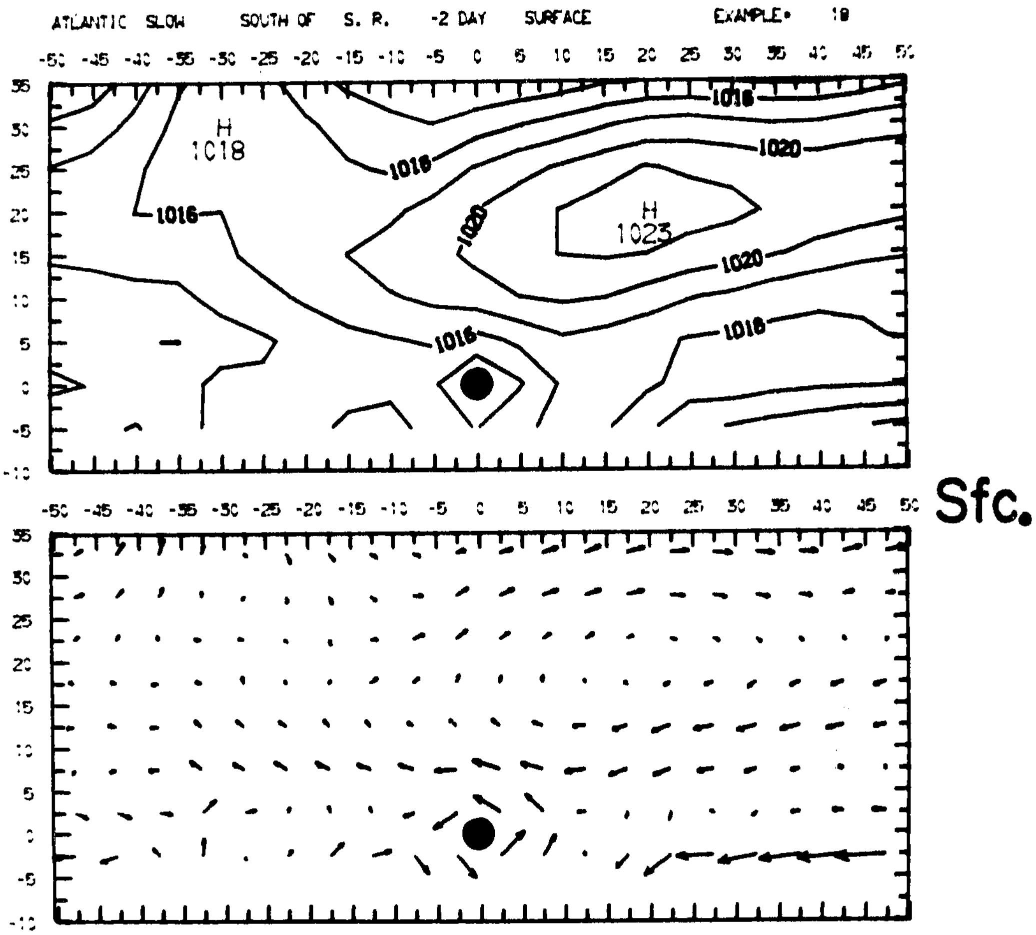
PAC. SLOW -2
S.



PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE -2 DAY 500 MB EXAMPLE= 46

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	2	2	1						1	5	5	5	5	5	2	1	PASS	PASS	PASS
30	5	5	5	5	5	5	2						1	2	5	5	5	5	1			PASS	PASS	PASS
25	5	5	5	5	5	2							1	2	5	5	5	1			1	PASS	PASS	PASS
20		1									1									2	5	PASS	PASS	PASS
15	1	1	5	5	5	2	2	1						1	2	2	1	1	2	2		PASS	PASS	PASS
10	5	5	5	5	5	5	2					1	2	5	5	1	1	2	1			PASS	PASS	PASS
5	2	1																	1	1		PASS	PASS	PASS
0	2	1	1	1	1											2			1	5	1	PASS		
-5																								
-10																								

ATL. SLOW -2
S.

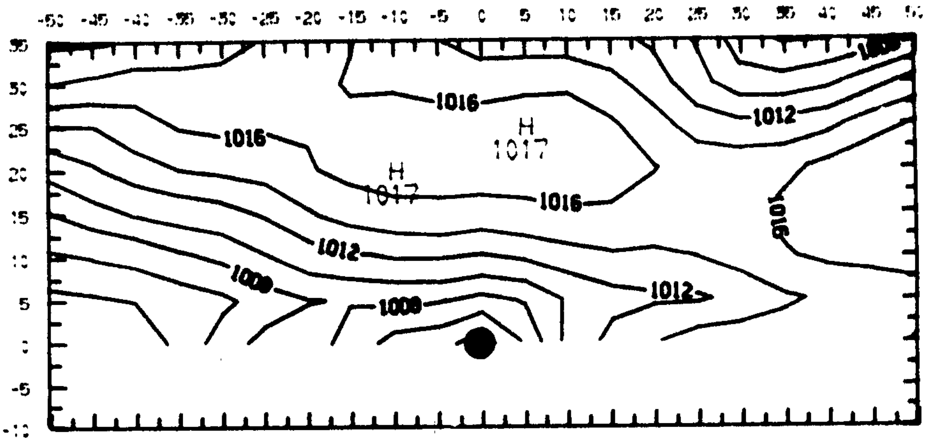


• ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE -2 DAY SURFACE EXAMPLE• 18

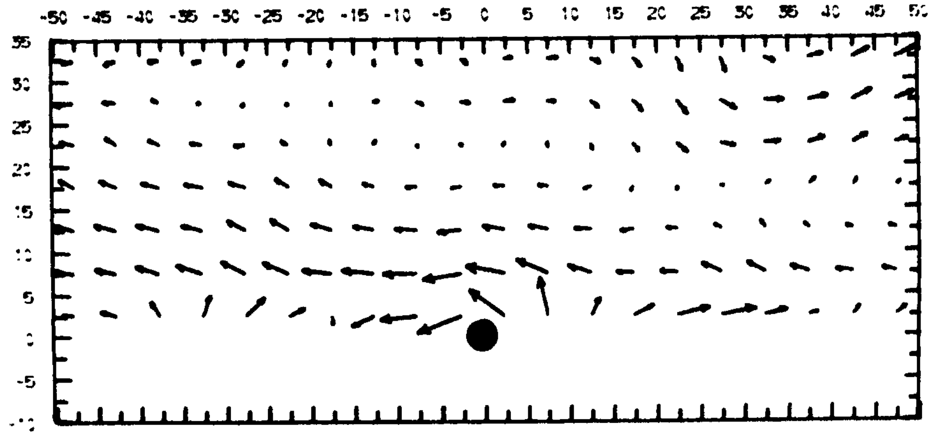
	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35																						PASS	PASS	
30	1																					PASS	PASS	
25	1	1							1					2	3	3	1					PASS	PASS	PASS
20	2	2	1	1	2	1	1	2				1	2	3	3	3	2	1	1			PASS	PASS	PASS
15	3	3	3	2	2						1	3	3	3	3	3	2					PASS	PASS	PASS
10	3	3	3	3	1					1	3	3	3	3	3	2						PASS	PASS	PASS
5	1	2	2	2	1					1		1	3	3	1							PASS	PASS	PASS
0															1									
-5													1	1		1	1		1	1		PASS		
-10																								

PAC. SLOW -2
S.

PACIFIC SLOW SOUTH OF S. R. -2 DAY SURFACE EXAMPLE= 45



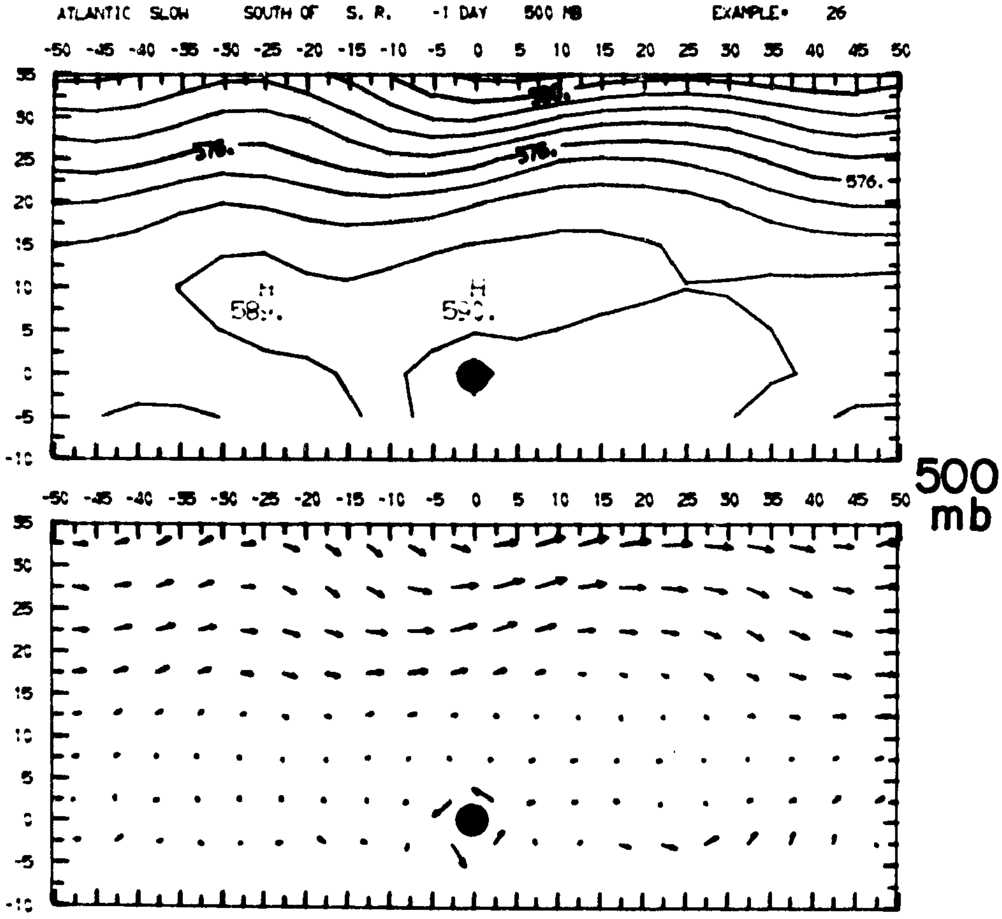
Sfc.



PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE -2 DAY SURFACE EXAMPLE= 45

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	2	1	1							1	2	3	3	2	2	1	PASS	PASS	PASS
30	2	1		1	1											2	3	2	1			PASS	PASS	PASS
25										1	1	2	1				1					PASS	PASS	
20	3	3	2						1	2	2	2	2									PASS	PASS	PASS
15	3	3	3	3	3	2				2	1	2	3	2	1			2	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3							2	2	1	1	2	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	2	1				1			2	1	1	2	3	3	3	3	PASS	PASS	PASS
0	2	3	1	1				1	1			2		1	1	2	2	2	3	3	3	PASS	PASS	PASS
-5																								
-10																								

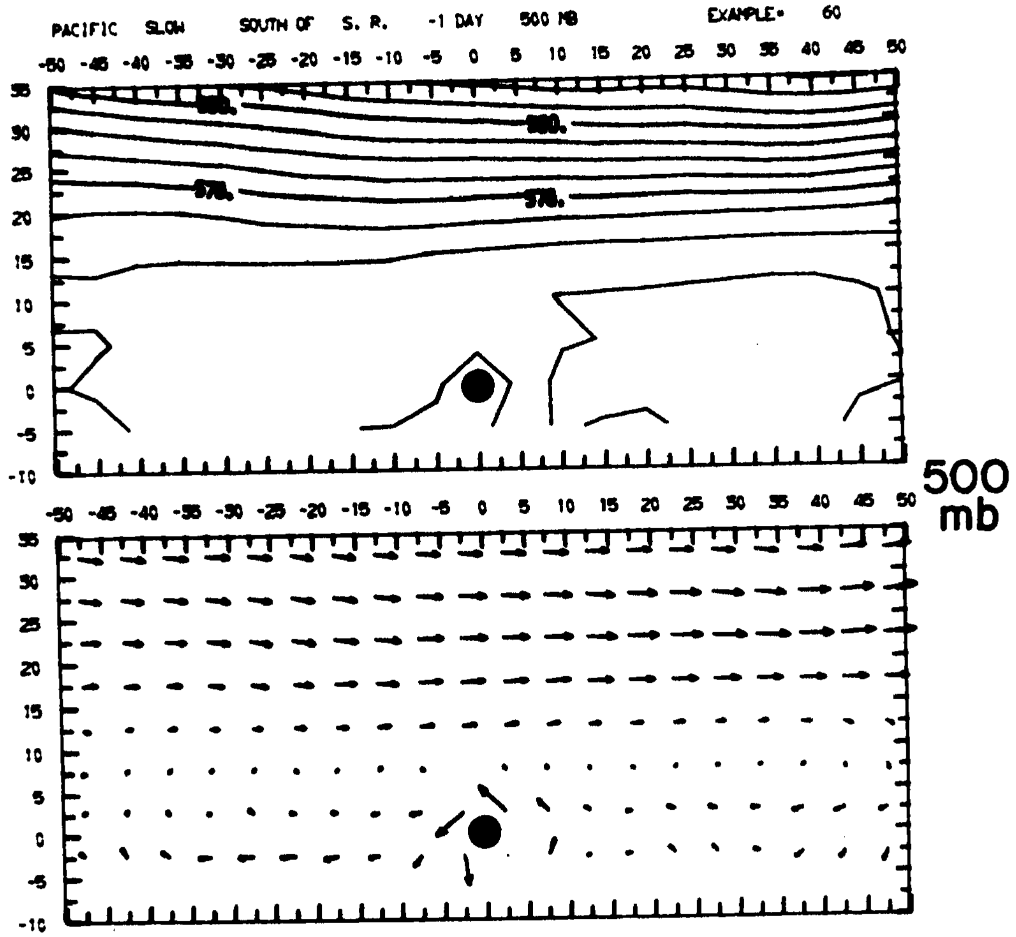
ATL. SLOW -1
S.



ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 26

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35				2	3	3	2				1	2	1									PASS	PASS	PASS
30					2	2					1											PASS	PASS	
25													2	3	3	2						PASS	PASS	PASS
20												2	3	3	3	3				1	1	PASS	PASS	PASS
15	1	1									1	1	2	1								PASS	PASS	PASS
10	3	3	1							1	1											PASS	PASS	PASS
5	1	1														1					2	PASS	PASS	PASS
0																					1	PASS	PASS	
-5						2													1	1		PASS		
-10																								

PAC. SLOW -1
S.

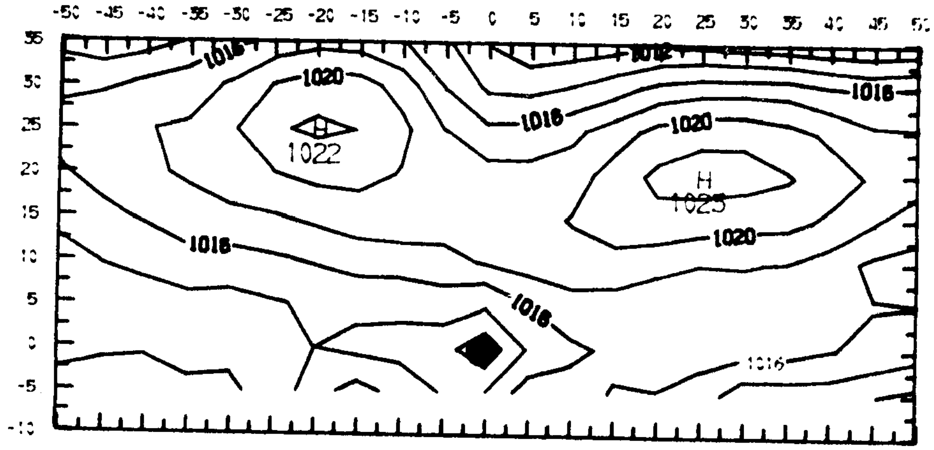


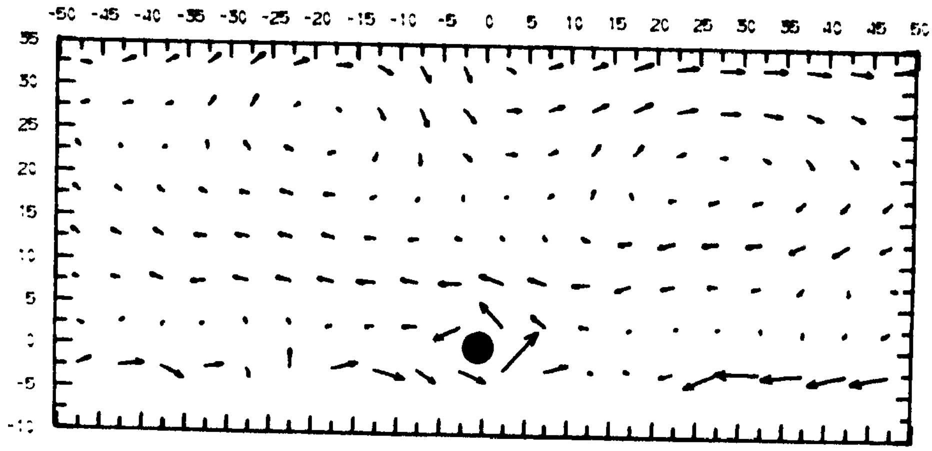
PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 60

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	2	2	2							1	1	1		1	2	5	2	1	PASS	PASS	PASS
30	5	5	5	5	5	2							1	2	1	1	2	2	2	2		PASS	PASS	PASS
25	5	5	5	5	2									1	1	1	1	1	1			PASS	PASS	PASS
20		1	1	1					1	1												PASS	PASS	PASS
15	2	1	1	1	2	2	5	2	2					1	1	1	1	2	2	2	1	PASS	PASS	PASS
10	5	5	5	5	5	5	5	5	1				5	5	5	5	5	5	5	3		PASS	PASS	PASS
5	5	5	5	5	1								2	5	5	2	2	2	3	2		PASS	PASS	PASS
0	2	2											1	2	5	2	1	1	1			PASS	PASS	
-5																								
-10																								

ATL. SLOW S. -1

ATLANTIC SLOW SOUTH OF S. R. -1 DAY SURFACE EXAMPLE= 24





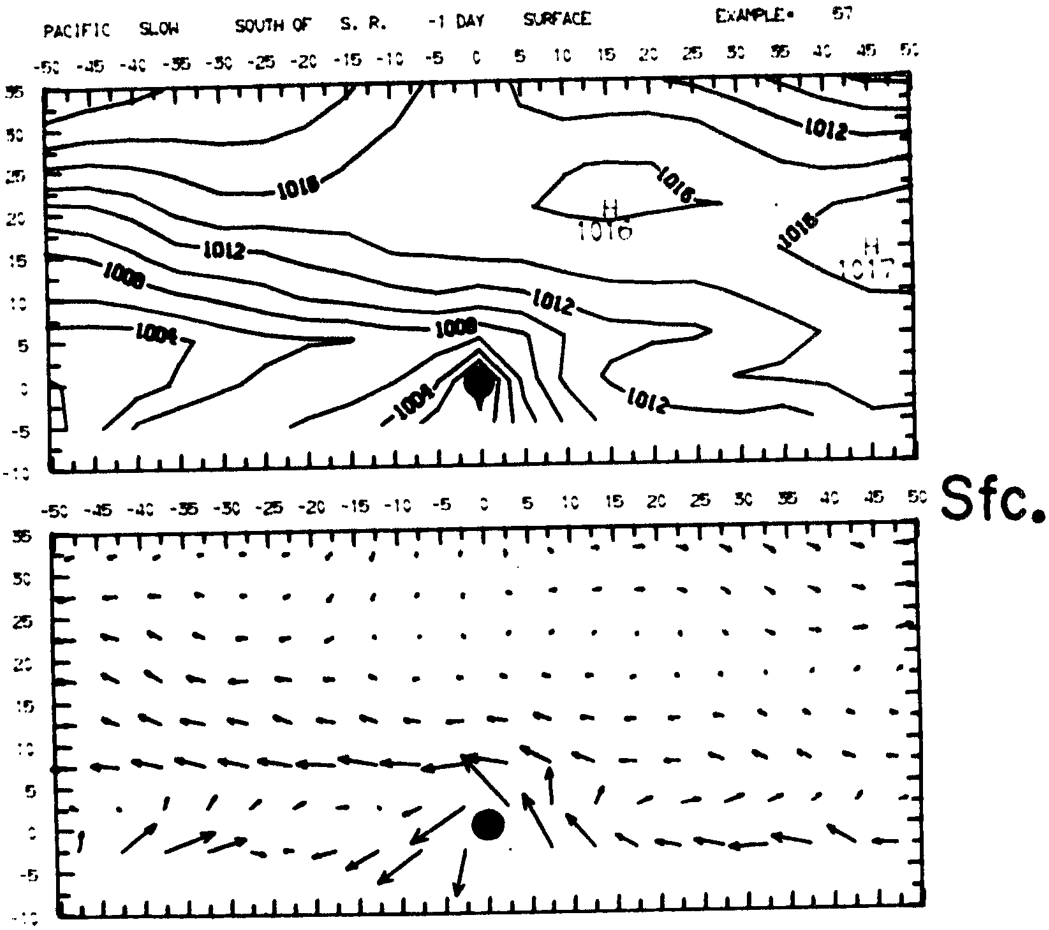
Sfc.

ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 24

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35						1	1	2	1													PASS	PASS	
30							2	2				1										PASS	PASS	PASS
25	1						2	2			1	1			1	2	3	1				PASS	PASS	PASS
20	2	3	1												3	3	3	2				PASS	PASS	PASS
15	3	3	2										1	3	3	3	3	1				PASS	PASS	PASS
10	3	2	2	1	1						1	3	3	3	3	2	3					PASS	PASS	PASS
5	1	1	1	1	1	1							3	2	2	2	3	1				PASS	PASS	PASS
0											1			1	2	2	1	1				PASS	PASS	PASS
-5			1										1		1						1	PASS	PASS	
-10																								

PAC. SLOW -1
S.

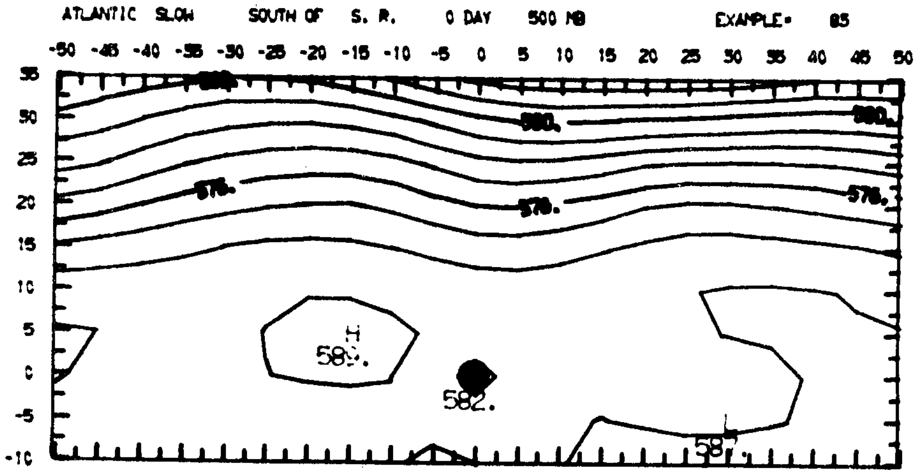


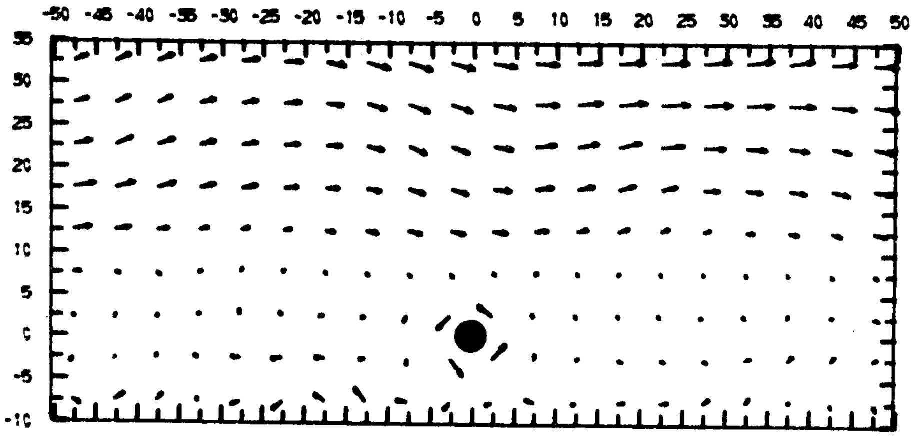
PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 57

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	3	3	3	3	3	3	3	3					3	3	3	3	3	3	3	2	2	PASS	PASS	PASS
30	2	2	2	2	2	2	2										1	1	1	1	1	PASS	PASS	PASS
25																						PASS		
20	3	3	3										1	2	1						1	PASS	PASS	PASS
15	3	3	3	3	2	2						1	2	3	3	3	2	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	1						3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	3	2	1	1	1		2	3	3	2	3	3	3	3	3	PASS	PASS	PASS
0	2	2	2	1					1					2	2	2	2	2	2	2	2	PASS	PASS	PASS
-5																								
-10																								

ATL. SLOW S. 0



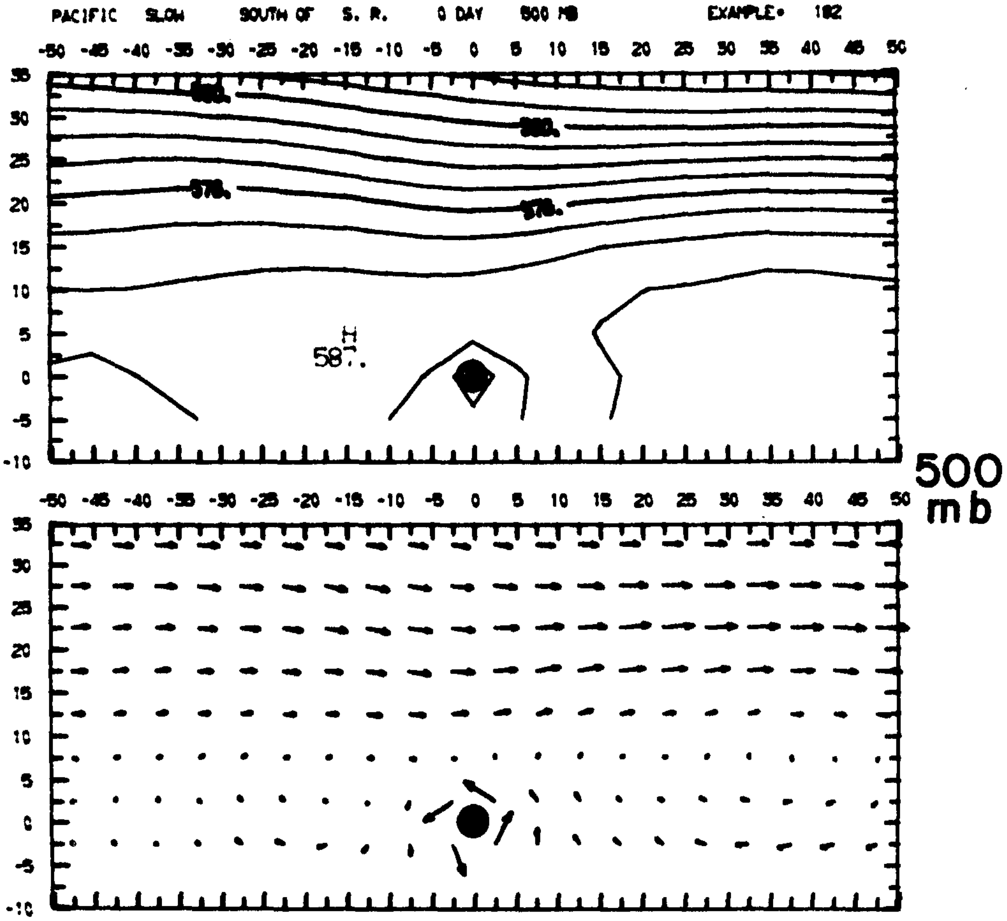


500 mb

ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 85

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	3	3	3	3	3	3	3			1	2	3	3	3	3	2	1				PASS	PASS	PASS
30				1	3	3	3	3	2			1	2	2	1							PASS	PASS	PASS
25	3	3				2	3	3	1			1										PASS	PASS	PASS
20	3	3	2			1	2	3			1	1			1	3	3	2				PASS	PASS	PASS
15	3	3	2			1	1				1	1				3	3	3	1			PASS	PASS	PASS
10	1		1	1							1	2				1	3	3	1			PASS	PASS	PASS
5				2			2	2	1		1											PASS	PASS	PASS
0							1	2	1	2	3	3							1	3	2	PASS	PASS	PASS
-5							1				3	1							2	3	3	PASS	PASS	PASS
-10																					1	PASS	PASS	

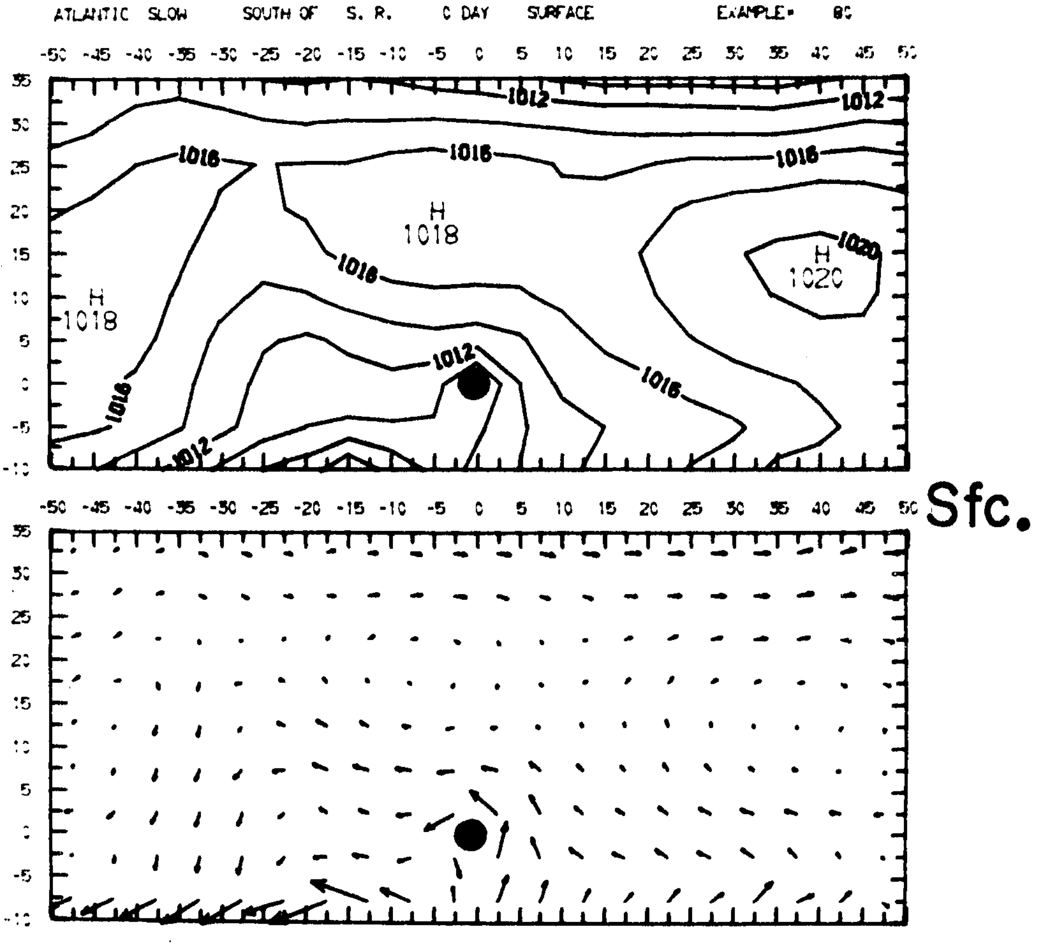
PAC. SLOW O
S.



PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 182

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	5	5	5	5	5	5	5	2				1	5	5	5	5	5	5	5	5	5	PASS	PASS	PASS
30	5	5	5	5	5	5	5	2			1	2	5	5	5	5	5	5	5	5	5	PASS	PASS	PASS
25	5	5	5	5	5	5	5			2	5	5	5	5	5	1						PASS	PASS	PASS
20				2	2	1			5	5	5	5	5			1	5	5	5	2	1	PASS	PASS	PASS
15	5	5	5	5	5	5	5	5	5	5	5	5		1	5	5	5	5	5	5	5	PASS	PASS	PASS
10	5	5	5	5	5	5	5	5	5	5	5		1	5	5	5	5	5	5	5	5	PASS	PASS	PASS
5	5	5	5	5	5	5	2			5	5	5		5	5	5	5	5	5	5	5	PASS	PASS	PASS
0	5	5	5	5	5	5				5	5	5		5	5	5	5	5	5	5	5	PASS	PASS	PASS
-5	1	2	2	5	5	2	2	2	2	5	5	5		2	5	5	5	5	5	5	2	PASS	PASS	PASS
-10																								

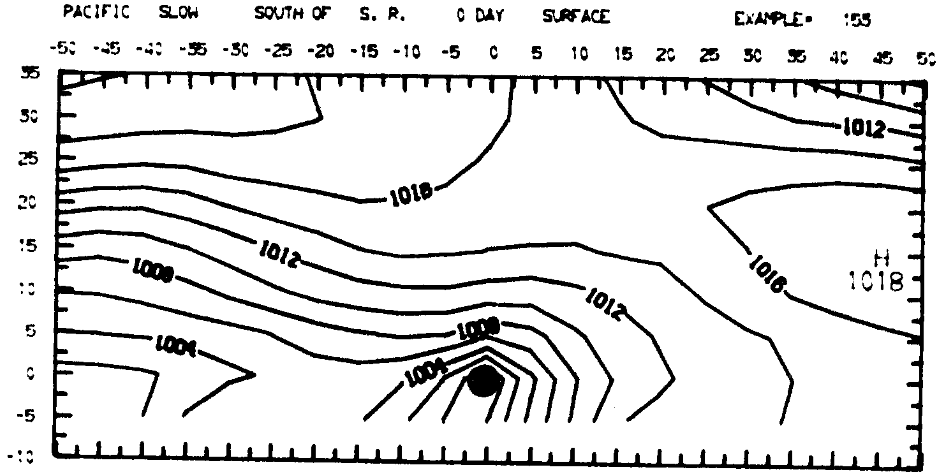
ATL. SLOW O S.

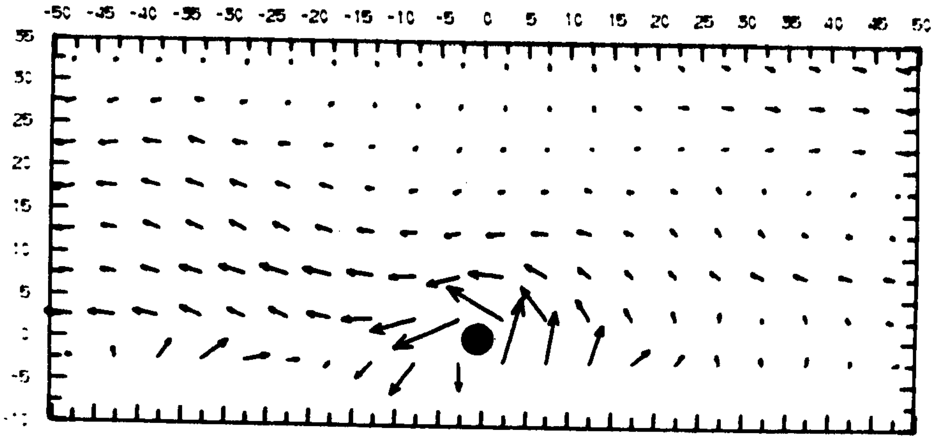


ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 80

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	2	3	3	1									1	1	1						PASS	PASS	PASS
30				1																		PASS		
25	1																					PASS	PASS	
20	1				1	2	1						1				2	3	3	2		PASS	PASS	PASS
15				2	3	3	3	1				2	2			2	3	3	3	3	2	PASS	PASS	PASS
10				2	3	3	3	3	3	3	3	3	1		1	3	3	3	3	3	3	PASS	PASS	PASS
5	1	2			3	3	3	3	3	3	3	3			2	3	3	3	3	3	3	PASS	PASS	PASS
0	2	3	1		2	3	3	3	3	3	3	3		1	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3		2	3	3	3	3	3	3	3			2	3	3	3	3	3	3	PASS	PASS	PASS
-10																								

PAC. SLOW O
S.





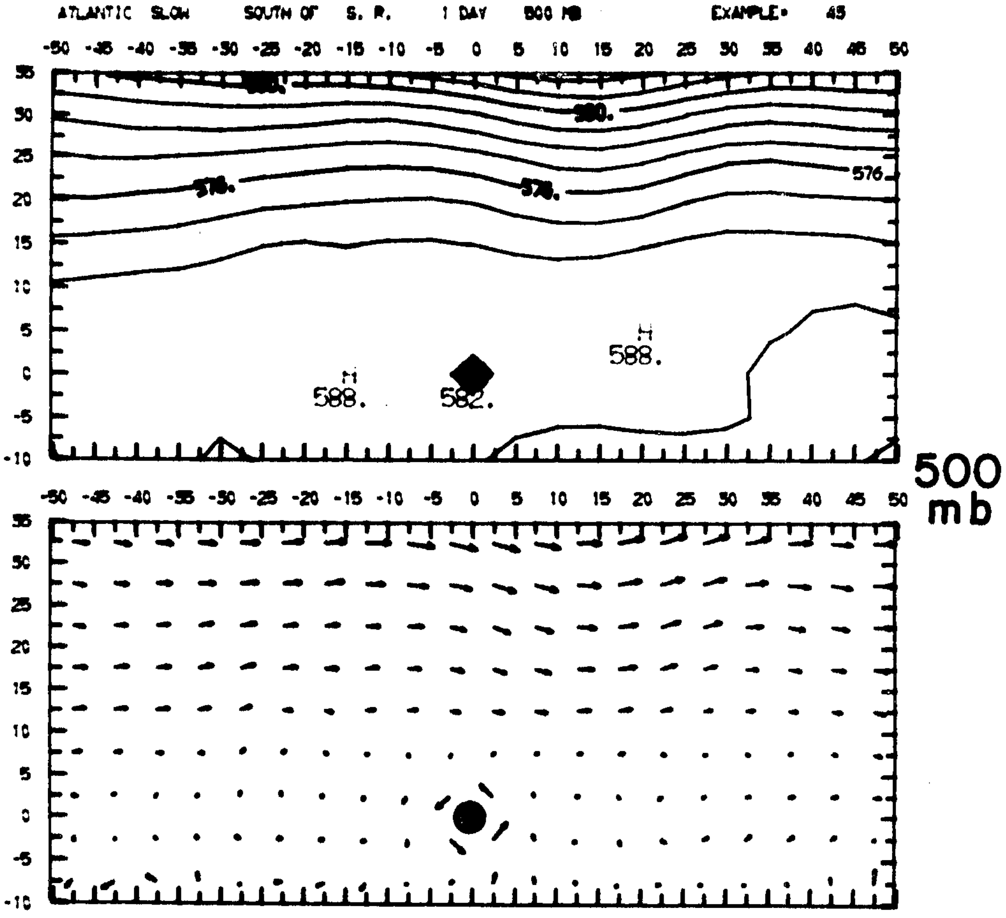
Sfc.

PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 153

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	3	3	3	3	3	3	3	3	3	2	1			3	3	3	3	3	3	3	3	PASS	PASS	PASS
30	3	3	3	3	3	3	3	3	2	1			1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
25					1	1	2	2	1				1	1	1							PASS	PASS	
20	3	3	3	3	1												2	3	3	3	2	PASS	PASS	PASS
15	3	3	3	3	3	3			1						1	3	3	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	1					1		1	3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	1	2	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-10																								

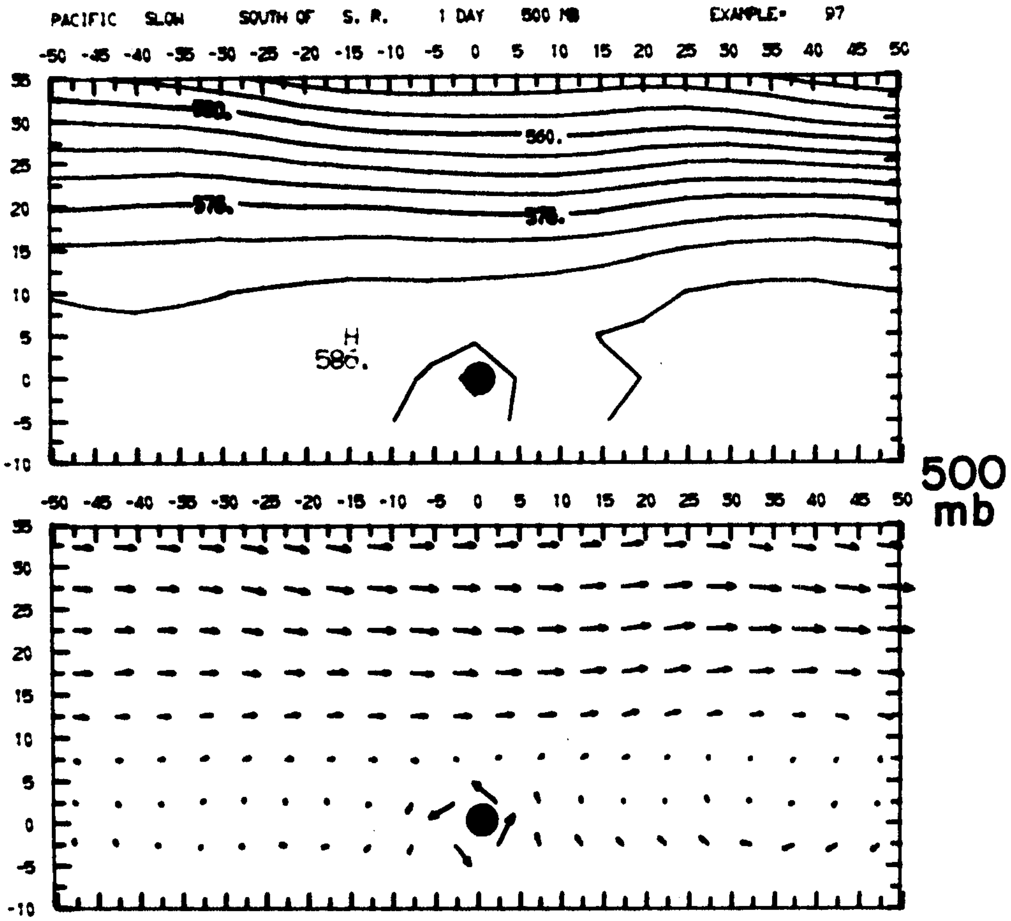
ATL. SLOW S. 1



ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 45

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	1	1								1	2	2	2	1						PASS	PASS	PASS
30													1	1	1							PASS	PASS	
25														1								PASS	PASS	
20		1	1														1	2				PASS	PASS	PASS
15	1	2	2														1	1				PASS	PASS	PASS
10	2	2	1																1	1		PASS	PASS	PASS
5																					1	PASS	PASS	
0								1		2	3	1							2	3	2	PASS	PASS	PASS
-5			1	1	1					1	1							1	2	1	1	PASS	PASS	PASS
-10																								

PAC. SLOW 1
S.

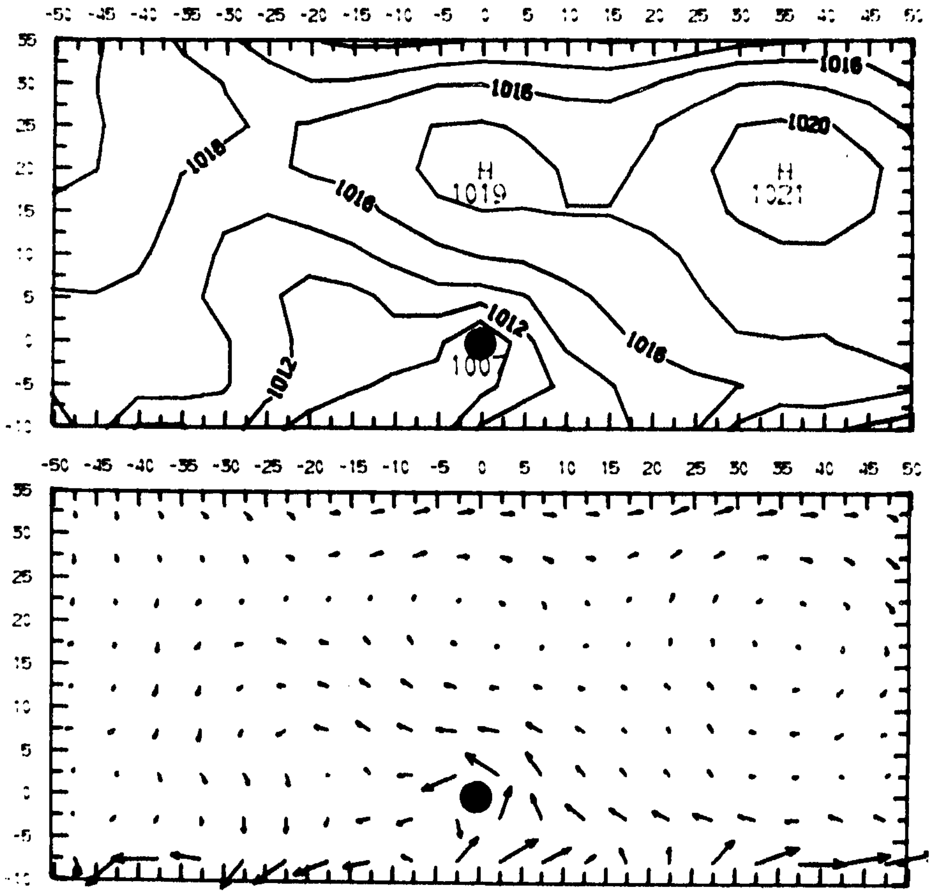


PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 97

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	2													1	2	3	3	PASS	PASS	PASS
30	3	3	3	3	3	2													2	3	3	PASS	PASS	PASS
25	3	3	3	3	3	1					1	1	2	1								PASS	PASS	PASS
20											1	2	2				2	2	3	2		PASS	PASS	PASS
15	3	3	3	3	3	3	2			1	1	1				3	3	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	3	2	2	2	1				3	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	2				3	3	1		3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	2	2	3	3	3	1			1	3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	1	1							1	2	3	1				2	2	2	1	2		PASS	PASS	PASS
-10																								

ATL. SLOW S. 1

ATLANTIC SLOW SOUTH OF S. R. 1 DAY SURFACE EXAMPLE= 59



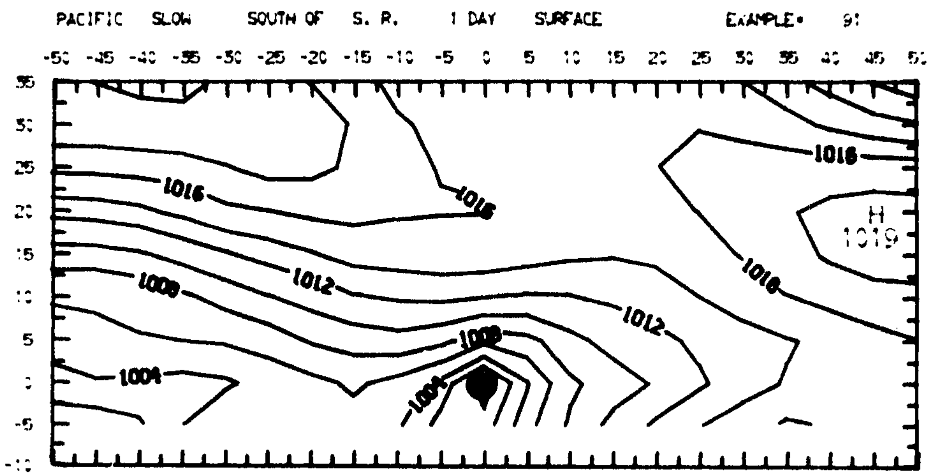
Sfc.

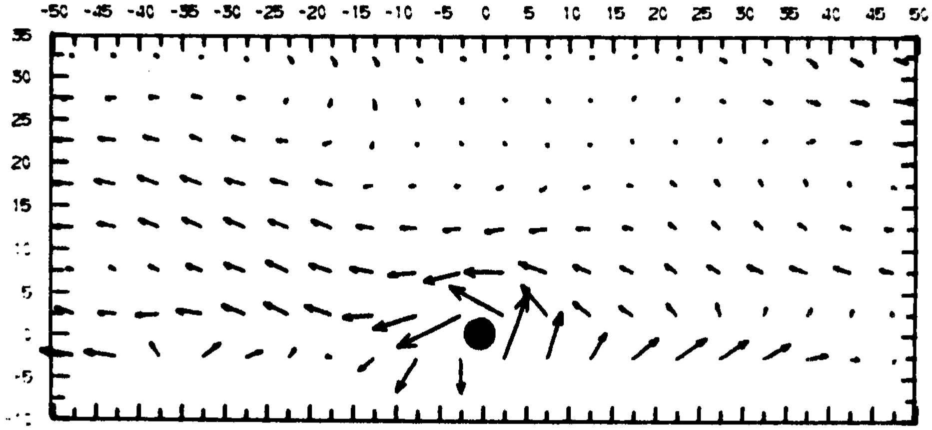
ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE= 39

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	3	3	2	1				1	1	1												PASS	PASS	PASS
30	3							1														PASS	PASS	PASS
25					1	1	1											1	1			PASS	PASS	
20				1	2	2	1	1									1	2	2	2		PASS	PASS	PASS
15				1	3	3	3	2								1	2	3	3	2		PASS	PASS	PASS
10				1	3	3	3	3	3	1						1	3	3	3	2	1	PASS	PASS	PASS
5					2	3	3	3	3	3	3	2		1	2	3	3	3	3	3	2	PASS	PASS	PASS
0						2	3	3	3	3	3	3			2	3	3	3	2	2	2	PASS	PASS	PASS
-5		1				2	1	1	2	3	3	1			1	3	2	2	1	1	1	PASS	PASS	PASS
-10																								

PAC. SLOW 1
S.





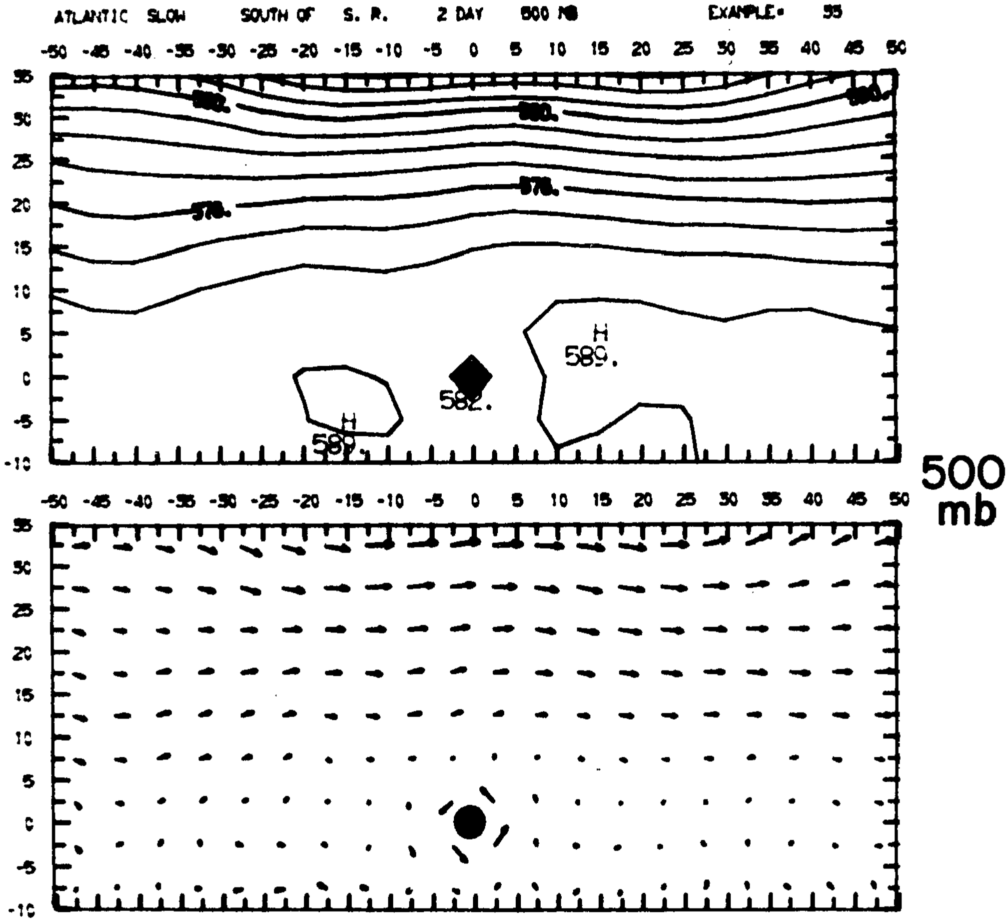
Sfc.

PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE= 91

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	3	3	3	3	3	3	2										1	2	3	3	3	PASS	PASS	PASS
30	2	2	2	2	3	3	2						1	1					1	2	2	PASS	PASS	PASS
25						1	1						1	1								PASS	PASS	
20	3	3	3	1														2	3	3	2	PASS	PASS	PASS
15	3	3	3	3	3	2				1	1						3	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	2								1	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	3			2	3	3		2	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	3	2	1	3	3	3	3		2	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	2	2	2	1				1	2	2	2	1		2	3	3	3	3	3	3	3	PASS	PASS	PASS
-10																								

ATL. SLOW 2
S.

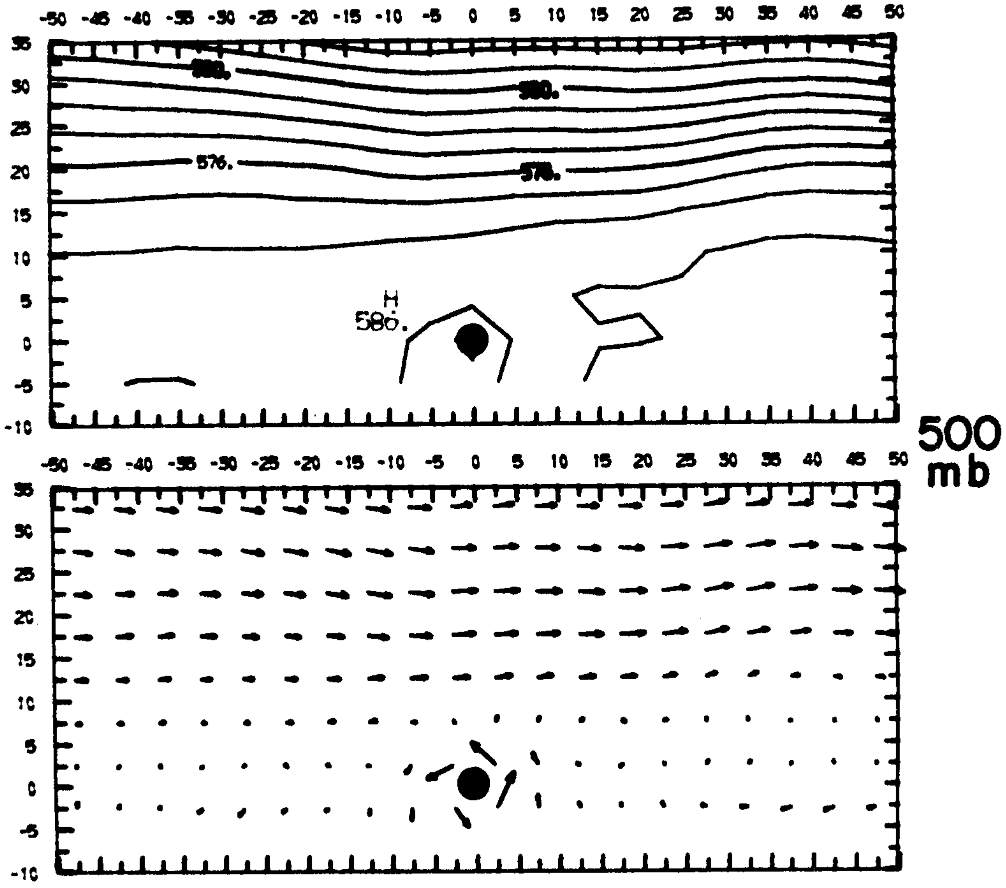


ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE 2 DAY 500 MB EXAMPLE= 55

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	2	2				1	1	1					1	2					1	PASS	PASS	PASS
30	1	1																				PASS	PASS	
25																								
20											1											PASS		
15	1	2	2	1							1	1	1									PASS	PASS	PASS
10	2	3	3	2								1	2	1	1	1	1	1				PASS	PASS	PASS
5	1	2	3	1									2	2	2	1	1	1	2			PASS	PASS	PASS
0		1	2	2						1	3	2	1		1		1	3	3	3	2	PASS	PASS	PASS
-5	1	2	2	1							1							3	3	2	1	PASS	PASS	PASS
-10	1	1	1			1	1											1	1	2	1	PASS	PASS	PASS

PAC. SLOW 2
S.

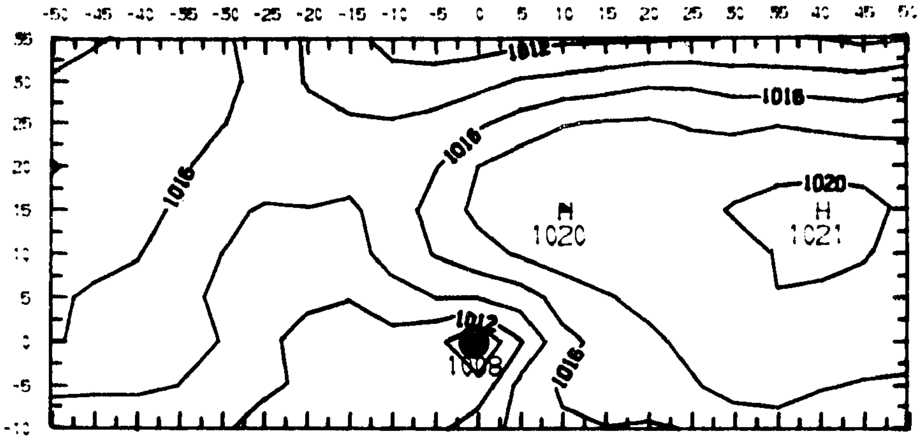
PACIFIC SLOW SOUTH OF S. R. 2 DAY 500 MB EXAMPLE= 76



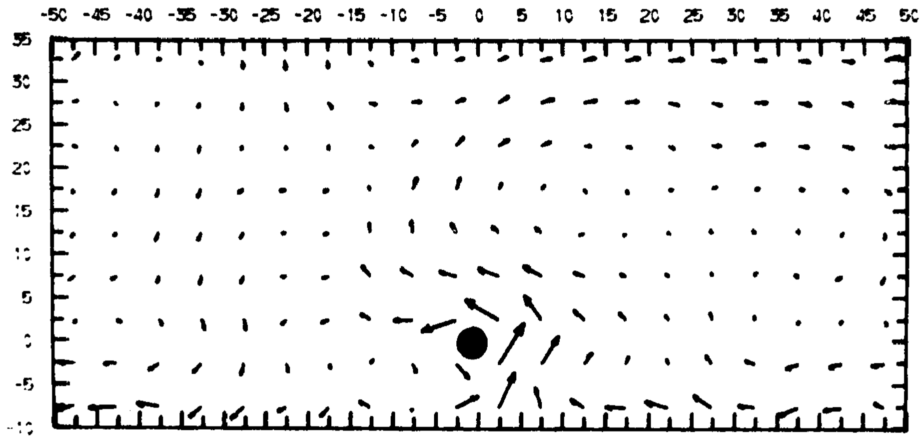
PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE 2 DAY 500 MB EXAMPLE= 76

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	1				1	1												PASS	PASS	PASS
30	3	3	3	3	2				1	2	1											PASS	PASS	PASS
25	3	2	2	2	1				2	3	2	1	1	1	1							PASS	PASS	PASS
20								1	3	3	2	1					1	3	3	3	2	PASS	PASS	PASS
15	3	3	3	2	2	2	3	3	3	2							3	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	3	3	1				1	1		2	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	2	2	1	3	3		1	2	2	3	3	3	3	3	3	PASS	PASS	PASS
0	3	1	2	1		1	1		2	3	3	3	3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5									1	1	2	1		1	3	3	3	3	1			PASS	PASS	PASS
-10																								

ATL. SLOW S. 2



Sfc.

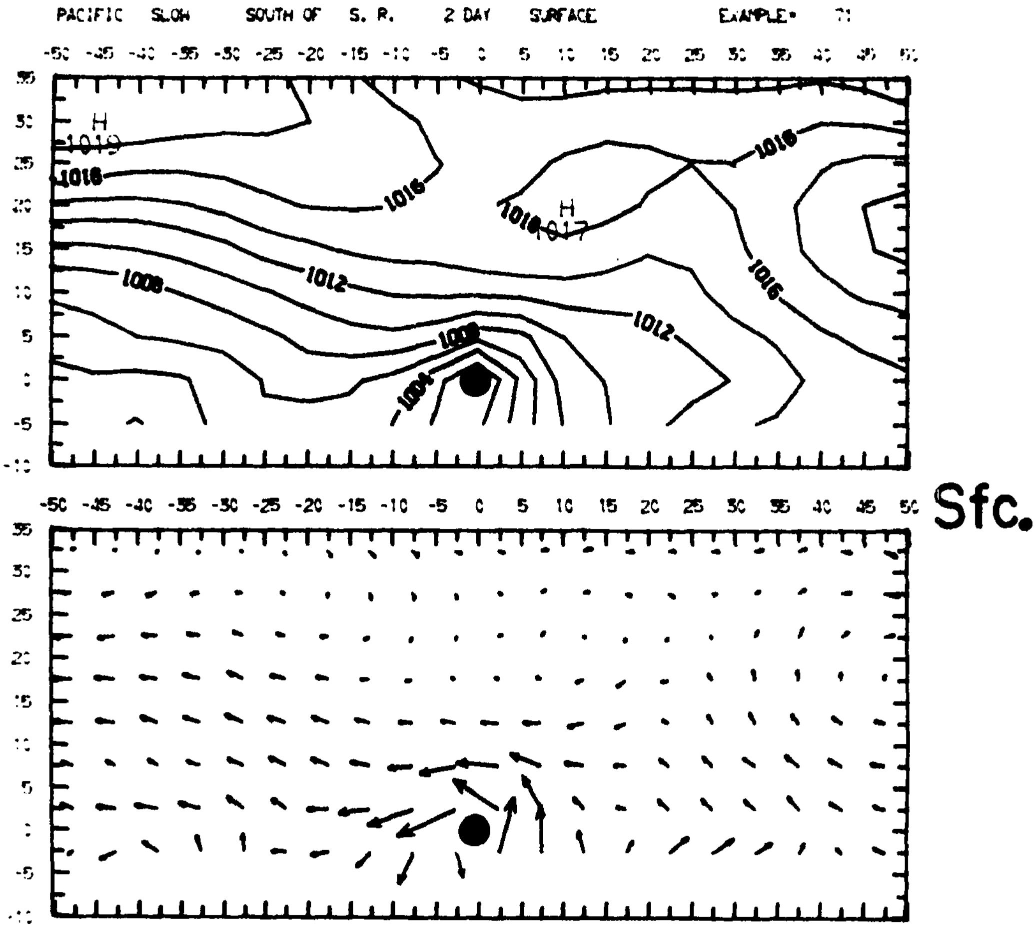


ATLANTIC SLOW SOUTH OF SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE= 33

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35		1	2	2	1																	PASS	PASS	PASS
30			1						1	1												PASS	PASS	
25							1	1	2	1												PASS	PASS	
20					2	2	2	2	3	1			1	2	1			1	1			PASS	PASS	PASS
15				1	3	3	3	3	3			2	3	2	1	1	2	2	3	2	1	PASS	PASS	PASS
10				2	3	3	3	3	3	1		2	3	3	2	2	3	3	3	3	1	PASS	PASS	PASS
5				1	3	3	3	3	3	2	3	1		3	3	3	3	3	3	3	1	PASS	PASS	PASS
0					1	3	3	3	3	3	3	3		1	3	3	3	3	3	3	2	PASS	PASS	PASS
-5					2	2	1	1	1	2	2			1	2	3	3	2	1			PASS	PASS	PASS
-10			1	1		1	1									1	1	1				PASS	PASS	

PAC. SLOW 2

S.

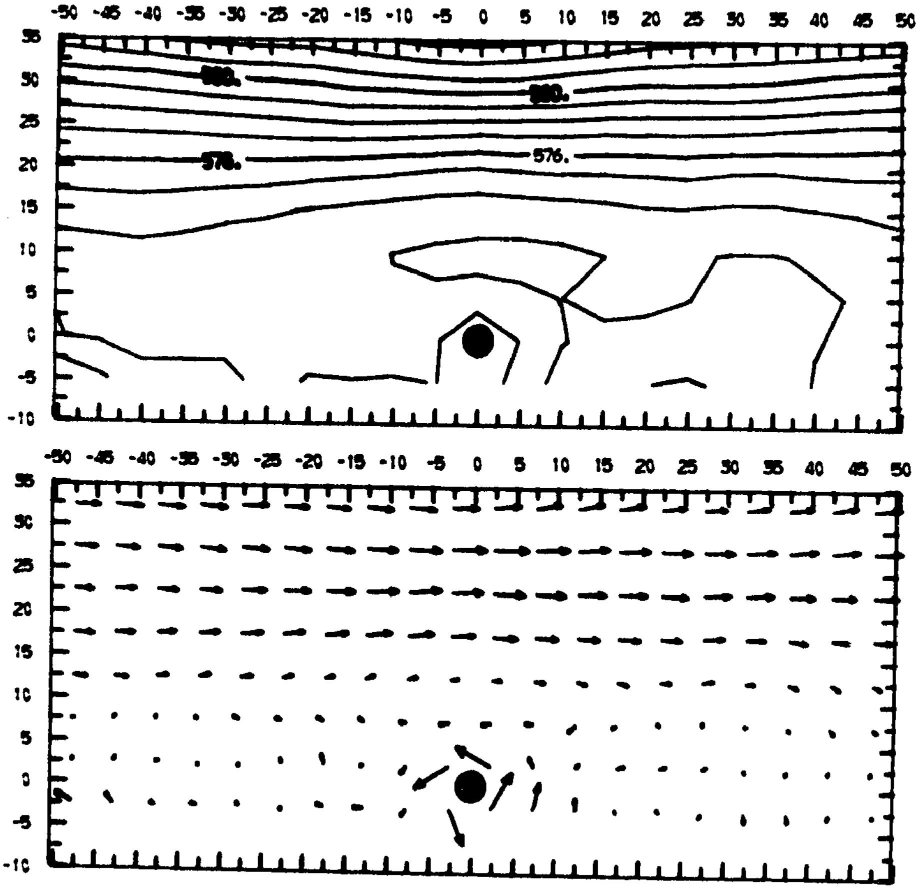


PACIFIC SLOW SOUTH OF SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE= 71

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	3	3	3	3	3	2				1	1	2	2	1	1					1	PASS	PASS	PASS
30	2	2	3	2	2	1					1	1										PASS	PASS	PASS
25																						PASS		
20	3	3	3	2	1														3	3	3	PASS	PASS	PASS
15	3	3	3	3	3	2						1	1					3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	2									1	3	3	3	3	3	PASS	FASS	PASS
5	3	3	3	3	3	3	2			1	3	3		1	2	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	2		2	3	3	3	3		3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	1	1	1	2			1	1	3	3	2			1	3	3	2	3	3	3	3	PASS	PASS	PASS
-10																								

PAC. LOOP S. -2

PACIFIC LOOP SOUTH OF S. R. -2 DAY 500 MB EXAMPLE= 28



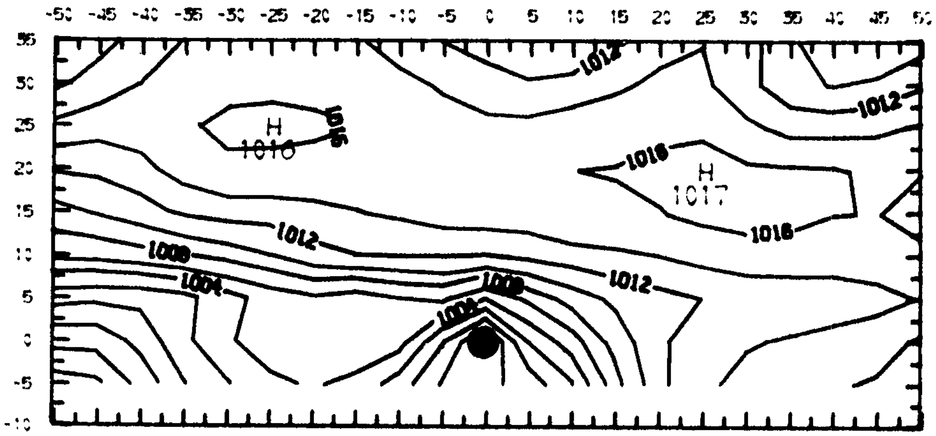
500 mb

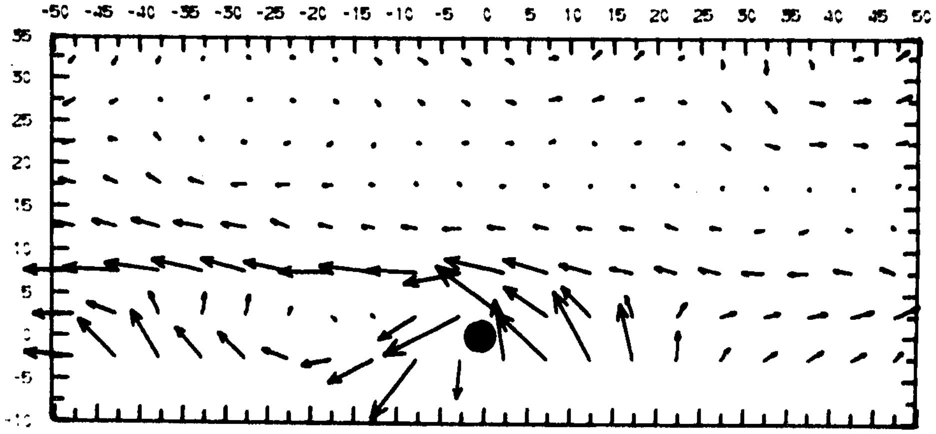
PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE -2 DAY 500 MB EXAMPLE= 28

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1									1	2	1	1									PASS	PASS	
30	1	1							1	2	1	1									1	PASS	PASS	PASS
25								1														PASS		
20		1	1	1	1																	PASS		
15	1	2	2	2	1					2	2	1	1									PASS	PASS	PASS
10		1	2	2	1					1	2	3	2								1	PASS	PASS	PASS
5	2	2	1	1	1	1							1				1	1				PASS	PASS	PASS
0					1	2	1											1	1			PASS		
-5			1		1									1	2	3	1					PASS		
-10																								

PAC. LOOP S. -2

PACIFIC LOOP SOUTH OF S. R. -2 DAY SURFACE EXAMPLE= 26



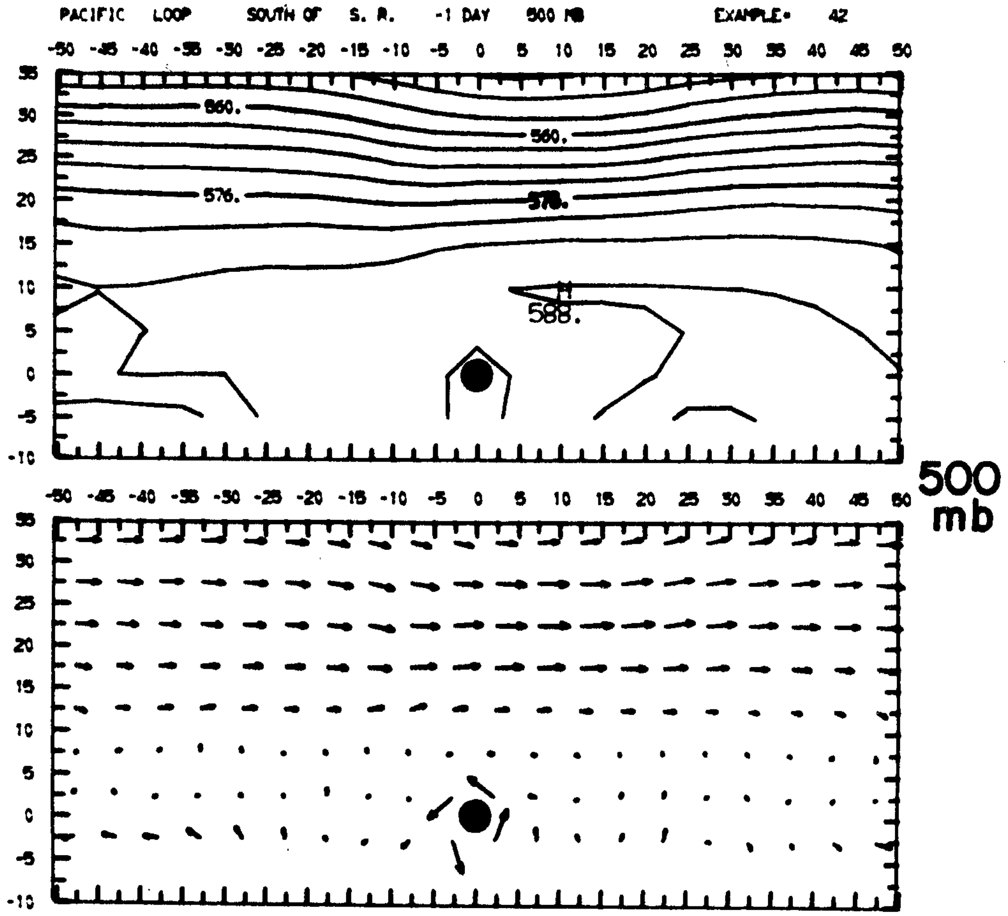


Sfc.

PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE -2 DAY SURFACE EXAMPLE= 26

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	1									1	2							1		PASS	PASS	PASS
30	2	1																	1			PASS	PASS	
25																								
20	1	2	1																			PASS	PASS	
15	3	3	3	1									1	1	1	2	1	1				PASS	PASS	PASS
10	3	3	3	3	2	1						2	1	1	1	2	3	2	1	1	1	PASS	PASS	PASS
5	3	2	2	2	2			1			1			2	3	3	3	3	2	2	3	PASS	PASS	PASS
0	1	1	1	1										1			1	1	1	1	1	PASS	PASS	PASS
-5	1	1	1						1	1	1			1		1	1				1	PASS	PASS	
-10																								

PAC. LOOP S. -1

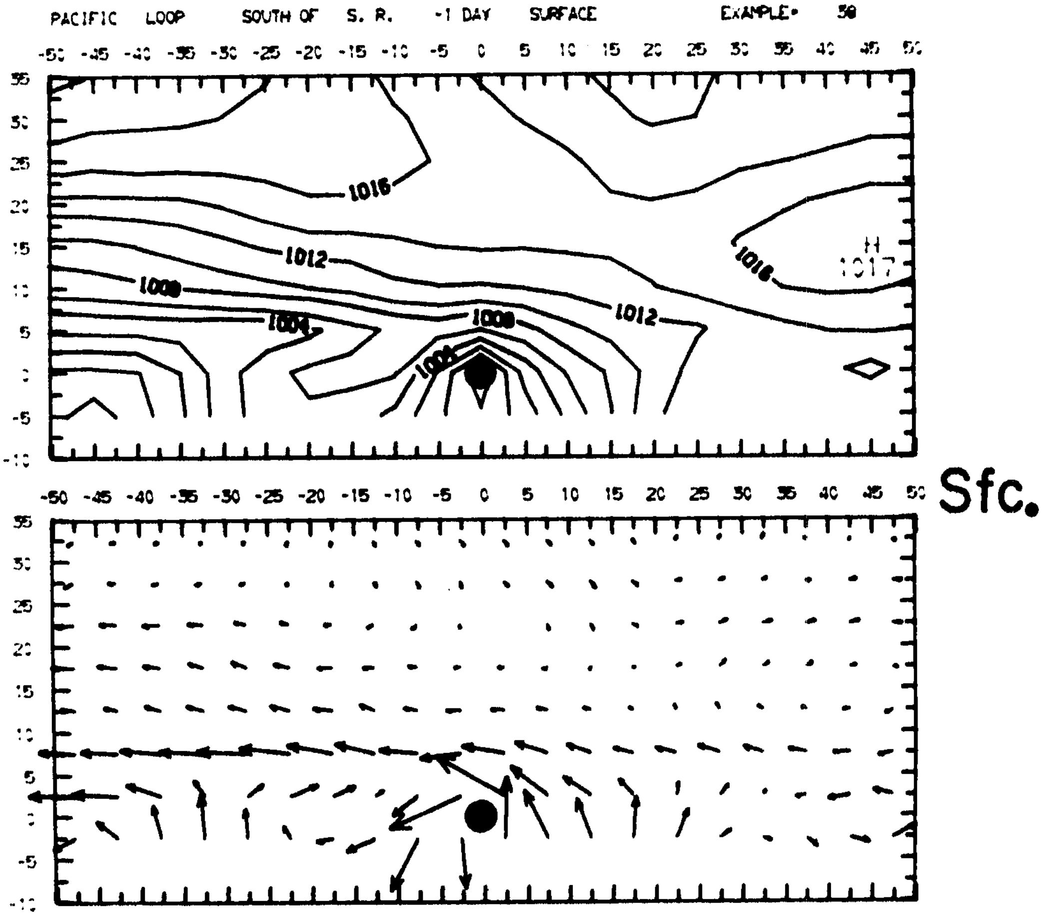


PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE -1 DAY 500 MB EXAMPLE= 42

TEST 1 / TEST 2

	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35											1	2	2	1								PASS		
30	1	1			1					1	2	3	3	2	1							PASS	PASS	PASS
25									1	1	1	2	1	1						1		PASS	PASS	
20									1	1							1	1				PASS	PASS	
15	1	3	3	2	2	1	1								1	1	1					PASS	PASS	PASS
10	3	3	3	3	2	1	2	1			2	2	3	3	3	2	1					PASS	PASS	PASS
5	3	3	3	3	3		1								1	1	3	3	3	1		PASS	PASS	PASS
0				1	2	1											1	1		1		PASS	PASS	
-5																								
-10																								

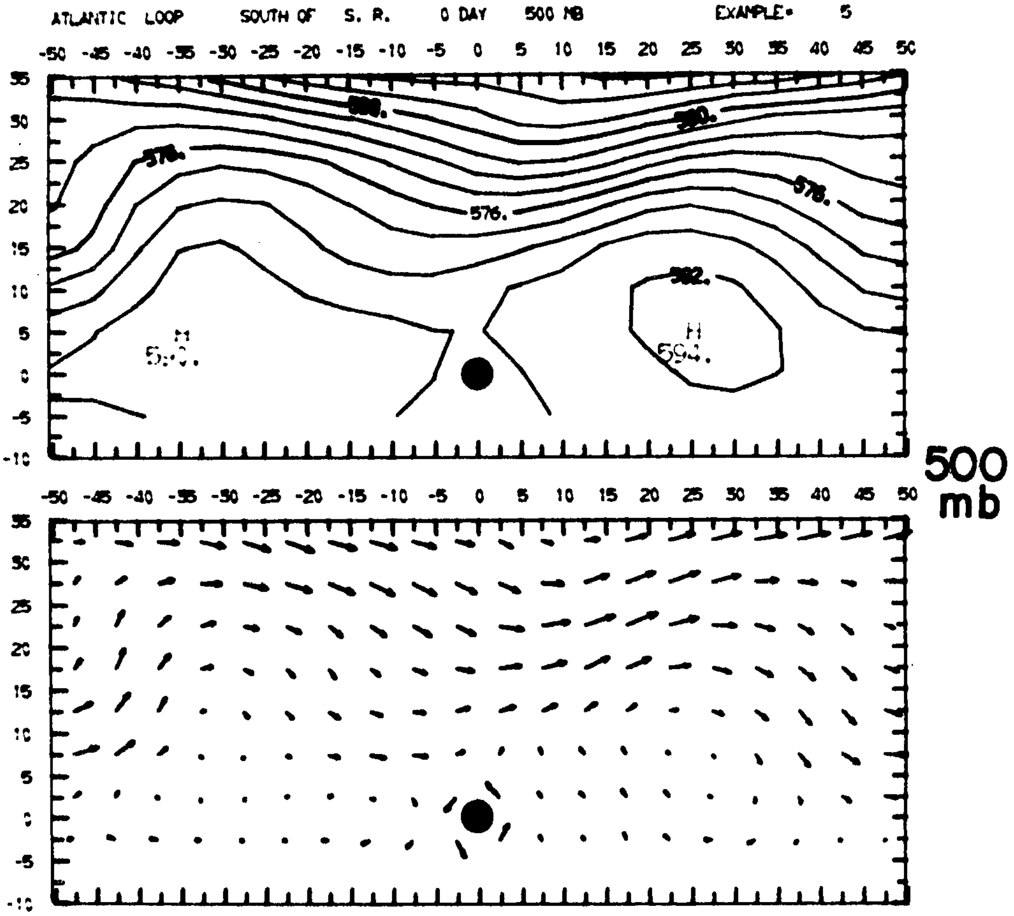
PAC. LOOP -1
S.



PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE -1 DAY SURFACE EXAMPLE= 38

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2	2	2	2	1								2	3	3	2						PASS	PASS	PASS
30	2	2	2	2	1								1	2	2	1						PASS	PASS	PASS
25														1	1							PASS	PASS	
20			1																			PASS		
15	3	3	3	3	2											1	2	2	3	2	1	PASS	PASS	PASS
10	3	3	3	3	3	2	2	1					1	3	3	3	3	3	3	3	2	PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	1		3		3	3	3	3	3	3	3	3	3	PASS	PASS	PASS
0	2	1	2	2											1	1	2	3	1		1	PASS	PASS	PASS
-5		1	1	1							1	2				1	1	1	1			PASS	PASS	
-10																								

ATL. LOOP 0
S.

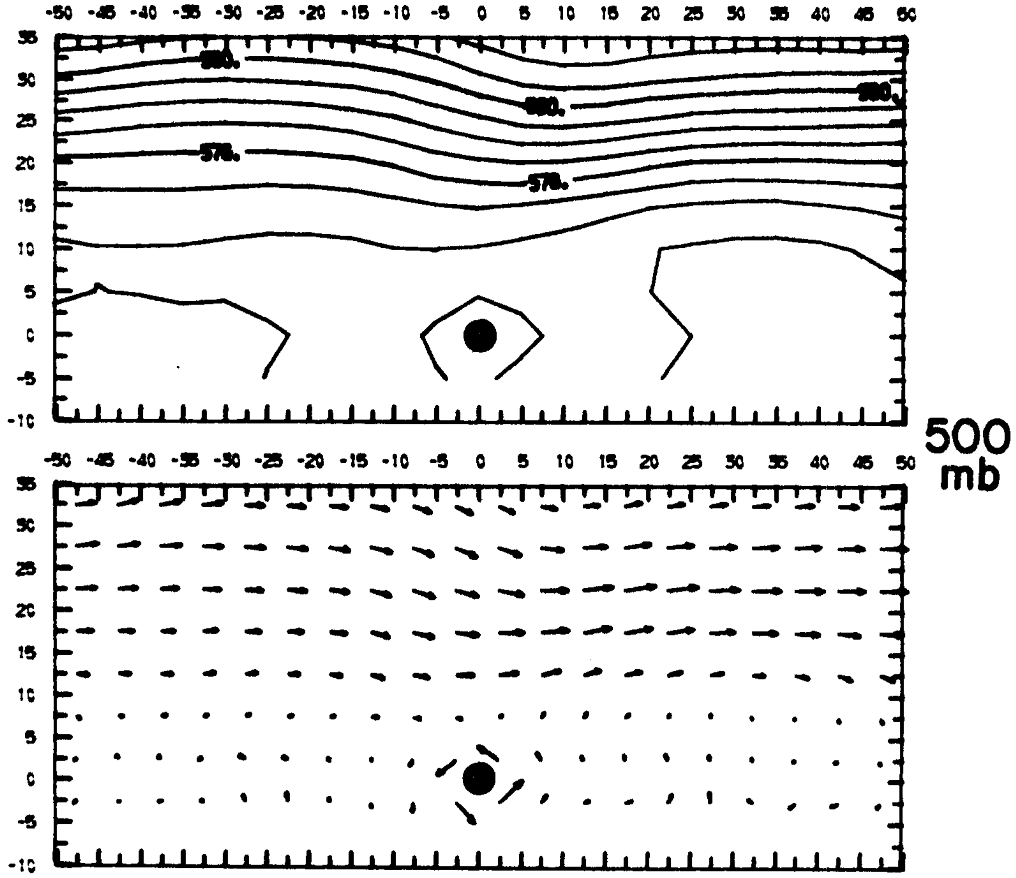


ATLANTIC LOOP SOUTH OF SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 5

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35																						PASS		
30																						PASS		
25			1	1																		PASS		
20												1										PASS	PASS	
15	1			2	2					1											1	PASS	PASS	
10										2							1	1		1	1	PASS	PASS	
5	2									1	2					2	2	1				PASS	PASS	PASS
0		1								2	1	1					2					PASS	PASS	PASS
-5	1																1	1	1			PASS	PASS	
-10																								

PAC. LOOP 0
S.

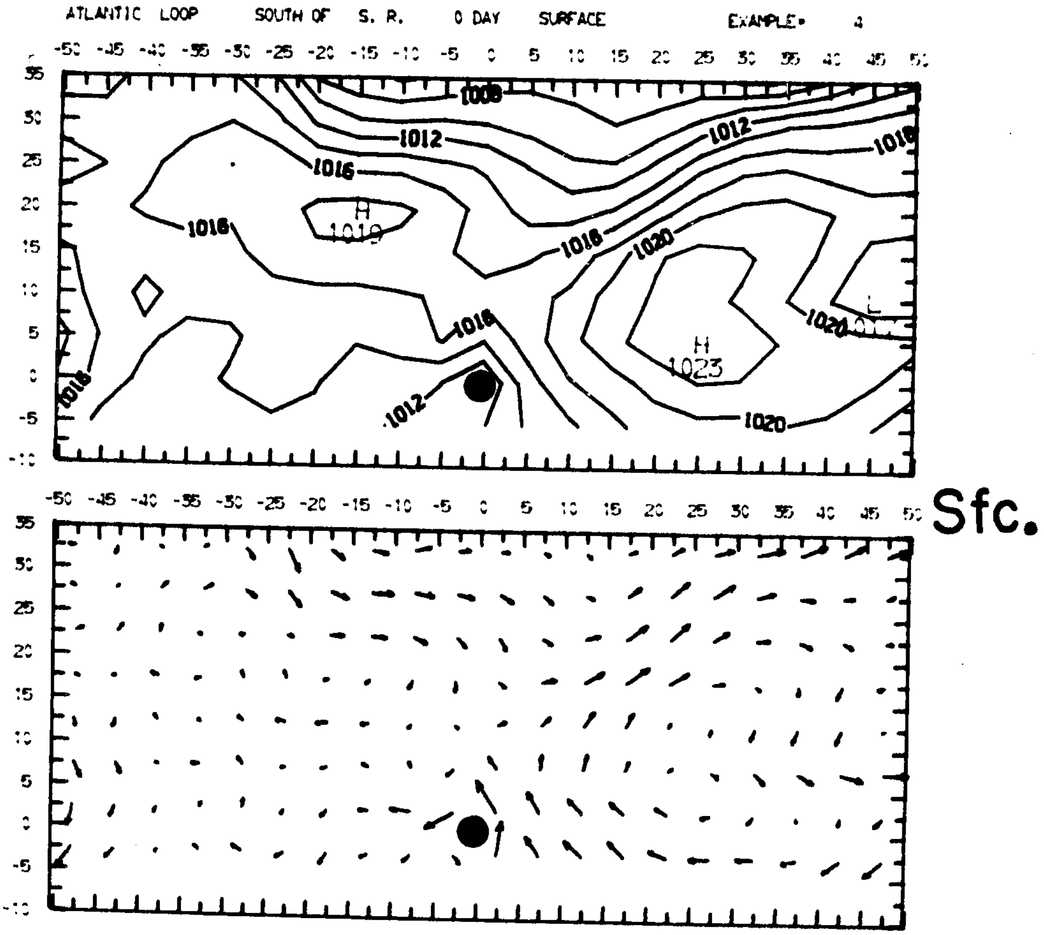
PACIFIC LOOP SOUTH OF S. R. 0 DAY 500 MB EXAMPLE= 99



PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE 0 DAY 500 MB EXAMPLE= 99

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35			2	3	3	3	3	3	2			2	3	3	3	2	1					PASS	PASS	PASS
30	1	2	3	3	3	3	3	3	2		1	3	3	3	3	3	1					PASS	PASS	PASS
25	2	3	3	3	3	3	3	3			3	3	3	3	3	1						PASS	PASS	PASS
20		1	2	2	3	3	2			3	3	3	3	3								PASS	PASS	PASS
15			1	2					2	3	3	3	1		3	3	3	3	3			PASS	PASS	PASS
10	3	3	3	3	3	2	2	3	3	3	3	2		3	3	3	3	3	3	2		PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	2	3	3	3		2	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	3	2			3	3	3			2	3	3	3	3	3	3	PASS	PASS	PASS
-5	3	3	3	3	3	2				3	3	2		2	2	3	3	3	3	3	3	PASS	PASS	PASS
-10																								

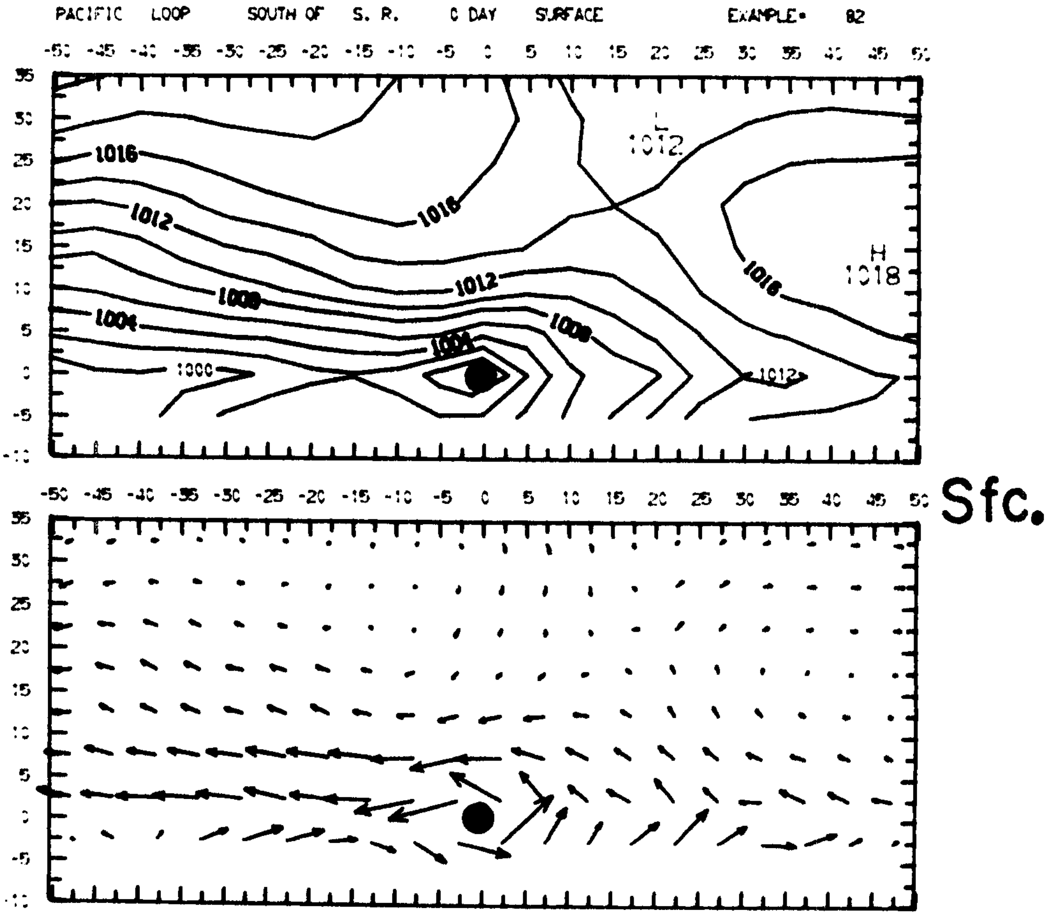
ATL. LOOP O
S.



ATLANTIC LOOP SOUTH OF SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 4

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35																								
30			1	1																				
25																								
20																								
15																	1					PASS		
10															1	1	1					PASS		
5																						PASS		
0										1						1	1	2	1			PASS		
-5															1	2	3	2				PASS		
-10															1	2	2	1				PASS		

PAC. LOOP S. O

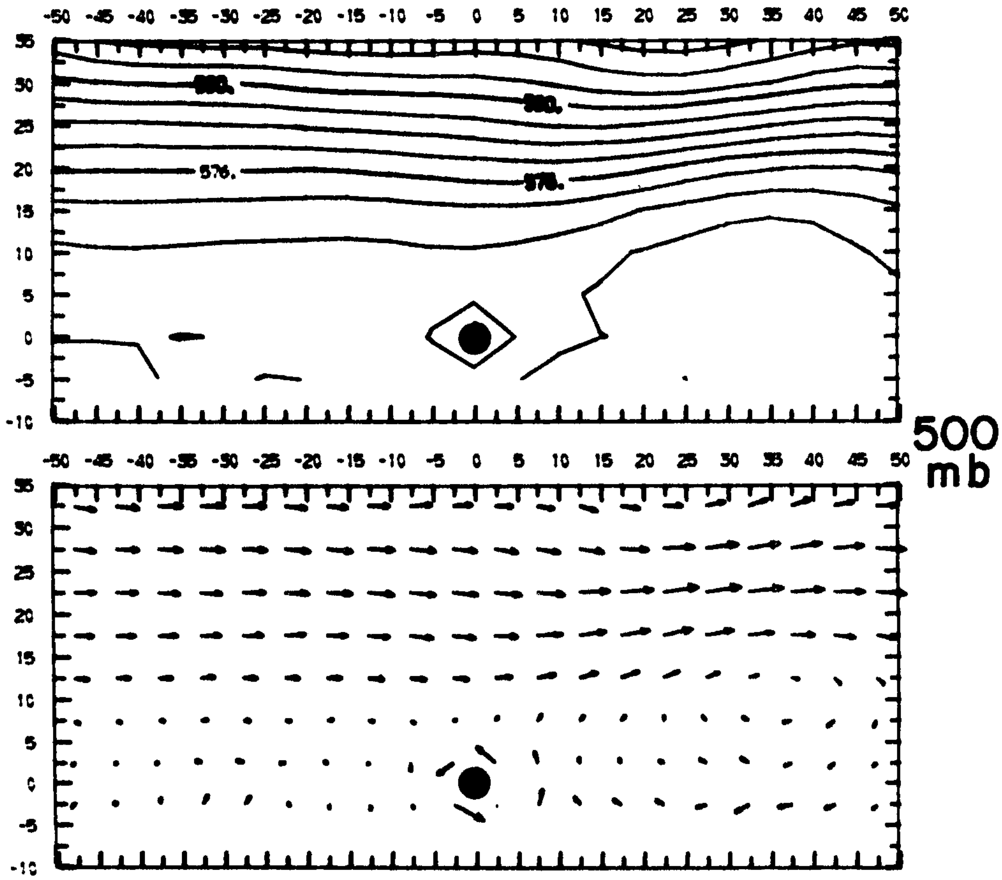


PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE 0 DAY SURFACE EXAMPLE= 82

	TEST 1																					TEST 2		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	SIGNIFICANT LEVEL .050	.010	.001
35	3	3	3	3	3	3	3	3	2	1			2	3	3	3	3	2	1	1	1	PASS	PASS	PASS
30	2	1		1	2	2	2	2	1	1			2	3	3	3	1					PASS	PASS	PASS
25						1	2	1	1	2			1	2	2							PASS	PASS	PASS
20	3	3	3	2				1	2	1								2	2	2	1	PASS	PASS	PASS
15	3	3	3	3	3	2			2	1						1	3	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	2						2	2		1	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	3	3	2	3	3	3		1	3	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	3	3	3	3	3	3	2		2	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	1	2	2	3	2			2	2	1					2	3	3	3	2	2	3	PASS	PASS	PASS
-10																								

PAC. LOOP 1
S.

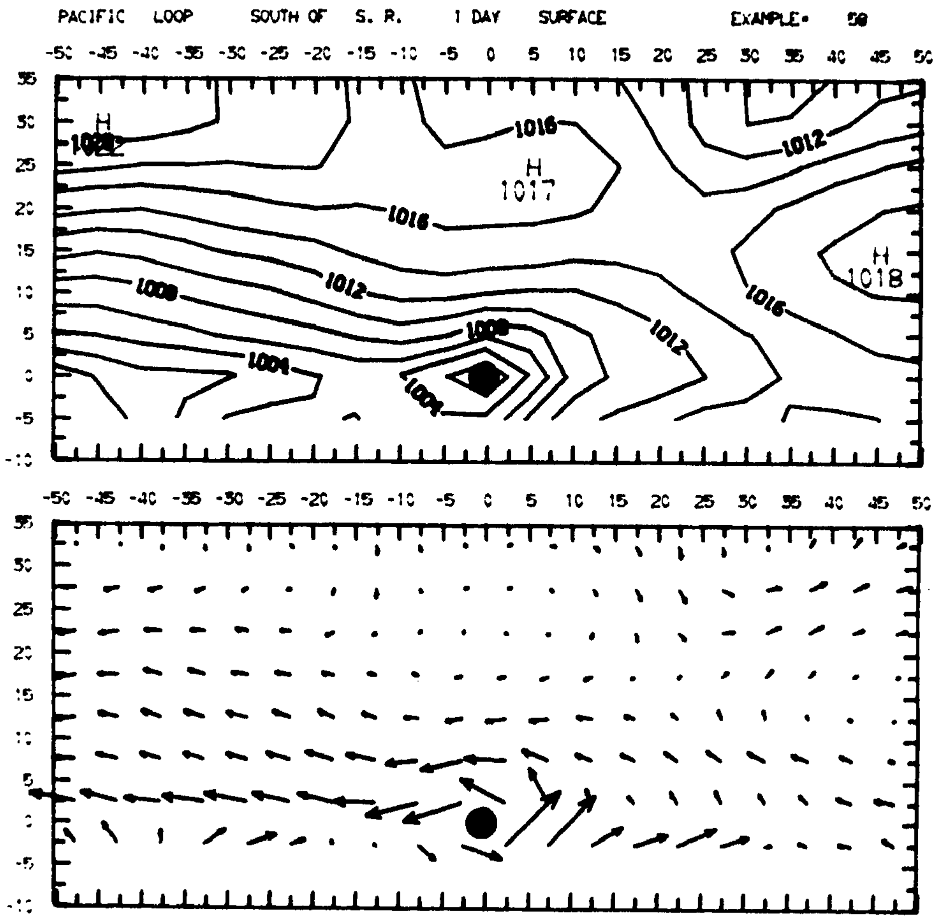
PACIFIC LOOP SOUTH OF S. R. 1 DAY 500 MB EXAMPLE= 62



PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE 1 DAY 500 MB EXAMPLE= 62

	TEST 1																					TEST 2		
																						SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	2														2	2	1					PASS	PASS	PASS
30	2	1	1	1										2	3	3	1					PASS	PASS	PASS
25											1	1	2	2	2				1	2	1	PASS	PASS	PASS
20										2	2	3	2	1			2	3	3	3	2	PASS	PASS	PASS
15	3	3	3	3	3	2	1	1	1	2	3	3	1			3	3	3	3	2		PASS	PASS	PASS
10	2	3	3	3	2	2	2	1	1	2	3	3			3	3	3	3	3	1		PASS	PASS	PASS
5	2	3	3	3	3	3	3	2	2	3	3	1		2	3	3	3	3	3	3	2	PASS	PASS	PASS
0	2	2	2	2	2	2				2	3	2	1	1	1	1	2	3	3	3	2	PASS	PASS	PASS
-5	2	2	2	1							1					1	1					PASS	PASS	PASS
-10																								

PAC. LOOP 1
S.

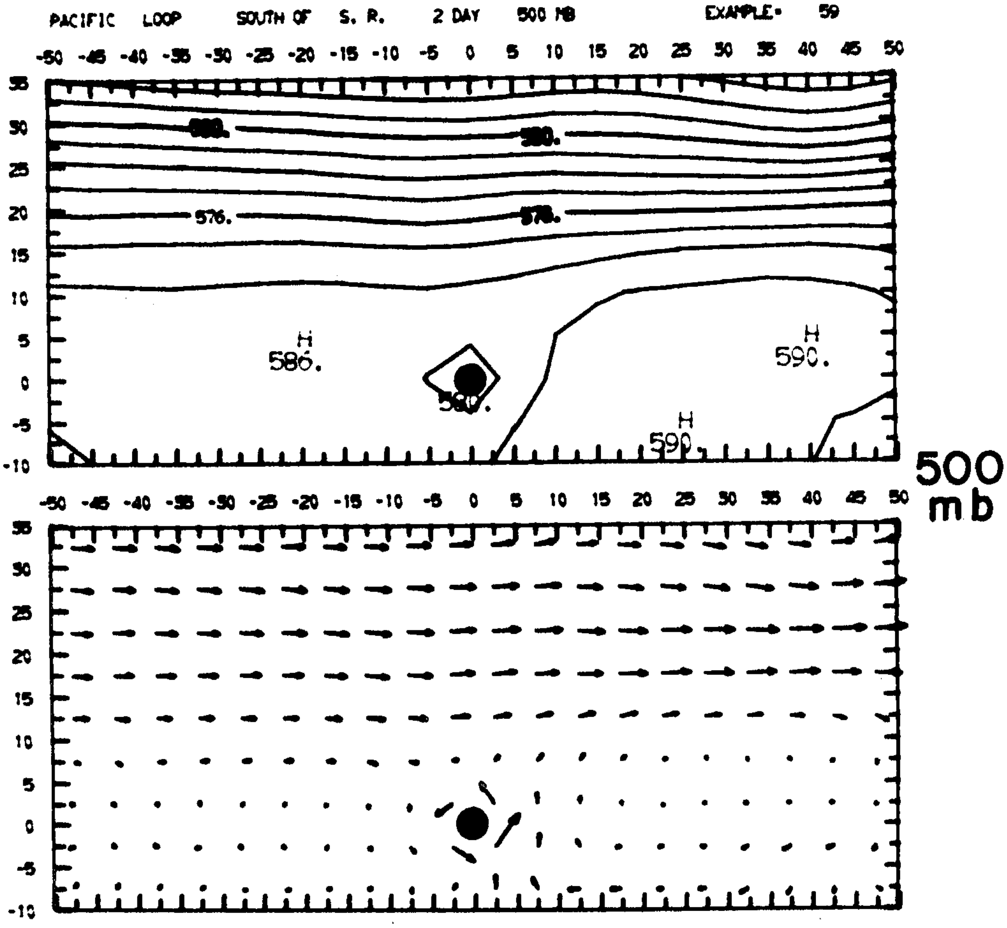


Sfc.

PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE 1 DAY SURFACE EXAMPLE- 58

	TEST 1																					TEST 2	
																					SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	2	2	1							1	3	3	3	3	2	1	PASS	PASS	PASS
30	3	3	3	3	3	2	2	1							2	3	3	3	2	1		PASS	PASS	PASS
25	1					1	1								1	3	3	1				PASS	PASS	PASS
20			1																	1	1	PASS	PASS	PASS
15	3	3	3	3	3	1											1	3	3	3	3	PASS	PASS	PASS
10	3	3	3	3	3	3	1									2	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	2	3	3	2		1	3	3		1	2	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	3	3	3	2	2	3	3	3	2	3	3	2	3	3	3	3	3	3	PASS	PASS	PASS
-5	1	2	2	1				2					1	2	2	3	2	2	1	1	1	PASS	PASS	PASS
-10																								

PAC. LOOP 2
S.

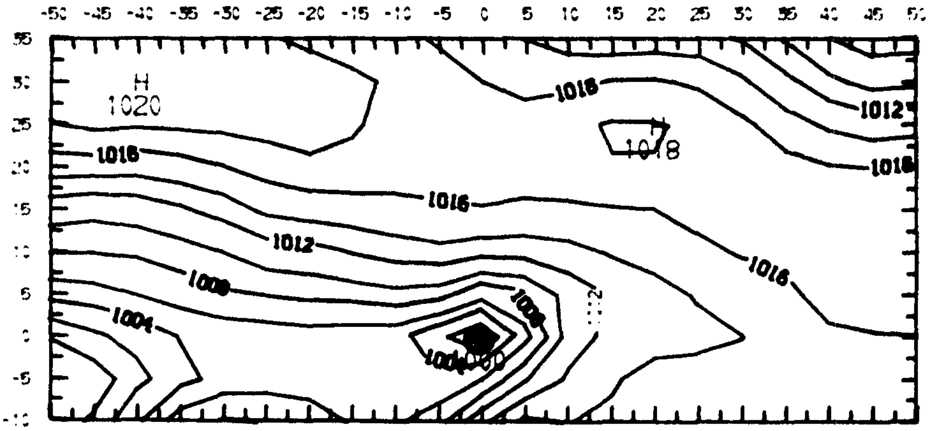


PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE 2 DAY 500 MB EXAMPLE= 59

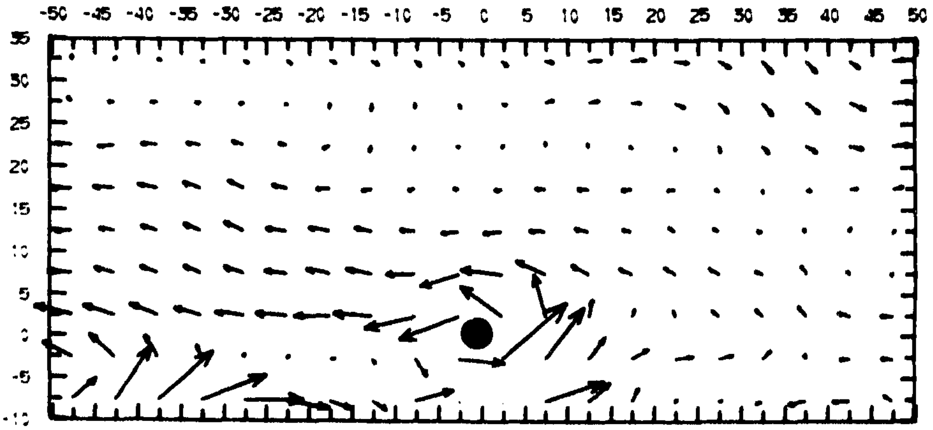
	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	1	1																1	1			PASS	PASS	
30	2	2	2	1														1	1			PASS	PASS	PASS
25	2	1	1															1				PASS	PASS	PASS
20										1														
15	1	2	2	2	1			1	2	1	1					1	2	3	3	2		PASS	PASS	PASS
10	2	2	3	3	3	2	2	2	2	2	1	1			2	2	3	3	3	2		PASS	PASS	PASS
5	2	2	3	3	2	2	1	1	2	3	3	2		1	2	2	3	3	3	3	3	PASS	PASS	PASS
0	2	3	2	2	1					3	3		1	2	2	2	2	1	1	2	1	PASS	PASS	PASS
-5	2	2	1	1					1	2	1		1	1	2	2	2	1				PASS	PASS	PASS
-10																								

PAC. LOOP 2
S.

PACIFIC LOOP SOUTH OF S. R. 2 DAY SURFACE EXAMPLE= 52



Sfc.



PACIFIC LOOP SOUTH OF SUBTROPICAL RIDGE 2 DAY SURFACE EXAMPLE= 52

	TEST 1																					TEST 2 SIGNIFICANT LEVEL		
	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	.050	.010	.001
35	3	3	3	3	3	3	2	1									1	2	3	3	3	PASS	PASS	PASS
30	1	3	3	3	3	2	2	1										2	3	3	3	PASS	PASS	PASS
25							1											1	2	2	2	PASS	PASS	PASS
20		1	1											1								PASS	PASS	
15	3	3	3	3	2						1					1	2	2	1	2	2	PASS	PASS	PASS
10	3	3	3	3	3	2	2								1	3	3	3	3	3	3	PASS	PASS	PASS
5	3	3	3	3	3	3	2	1		1	3	3		1	2	3	3	3	3	3	3	PASS	PASS	PASS
0	3	3	3	2	3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3	3	PASS	PASS	PASS
-5	2	3	2	2	1			1	1	1	1		1	1	2	2	3	2	2	1	1	PASS	PASS	PASS
-10																								

W. M. GRAY'S FEDERALLY SUPPORTED RESEARCH PROJECT REPORTS SINCE 1967

CSU Dept. of Atmos. Sci. Report No.	Report Title, Author, Date, Agency Support
104	The Mutual Variation of Wind, Shear and Baroclinicity in the Cumulus Convective Atmosphere of the Hurricane (69 pp.). W. M. Gray. February 1967. NSF Support.
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Unnumbered	Monthly Climatological Wind Fields Associated with Tropical Storm Genesis in the West Indies (34 pp.). J. W. Sartor. December 1968. NSF Support.
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---	A Climatology of Tropical Cyclones and Disturbances of the Western Pacific with a Suggested Theory for Their Genesis/Maintenance. W. M. Gray. NAVWEARSCHFAC Tech. Paper No. 19-70 (225 pp.). November 1970. (Available from US Navy, Monterey, CA). US Navy Support.
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348	Tropical Cyclone Motion: Environmental Interaction Plus A Beta Effect. Greg. J. Holland. May 1982. ONR Support.
---	Tropical Cyclone and Related Meteorological Data Sets Available at CSU and Their Utilization. W. M. Gray, E. Buzzell, G. Burton, G. Holland and Other Project Personnel. February 1982. NSF, ONR, NOAA, NEPRF Support.

Author: Jianmin Xu and William M. Gray

ENVIRONMENTAL CIRCULATIONS ASSOCIATED
WITH TROPICAL CYCLONES EXPERIENCING
FAST, SLOW AND LOOPING MOTION

Colorado State University
Department of Atmospheric Science

Subject Headings
Tropical cyclones
Cyclone motion

National Science Foundation
Grant No. ATM-7923591

NOAA
Grant No.NA79RAD00002

This study investigates the characteristic large scale flow patterns associated with fast, slow and looping tropical cyclone motion in the western Atlantic and the western north Pacific. Such storm motion is often difficult to forecast. Cyclones have been stratified by their speed - motion greater than 7.5 m/s (262 cases at 1200 individual time periods) or motion less than 2.5 m/s (201 cases at 914 individual time periods) and also into a looping track category (112 cases during 505 individual time periods). Data have been gathered for all storms meeting these criteria for the 21 year period of 1957-1977. In addition each class of cyclone motion has been further stratified by its position south of, near, or north of the subtropical ridge at 500 mb. Both individual case and composite analyses are performed. Climatological information on each motion class is also provided.

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