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THE NEW YORK CITY SNOWSTORM THAT NEVER WAS

Anthony Gigi WSFO New York City

INTRODUCTION

The Weather Service Office in New York City faced a difficult forecast for February 24, 1989. An Atlantic coastal storm threatened to give the New York City Metropolitan Area a significant snowfall. The significant snow never materialized. Surprisingly, it never snowed at all within the immediate New York City Area. This paper will investigate possible reasons for the absence of any snowfall.

SYNOPTIC OVERVIEW

A full longitudinal trough established itself over the eastern third of the United States the week of February 20th. A strong cold front passed through New York City the morning of the 22nd and stalled offshore. Meanwhile, short waves rotating around the base of the 500mb trough maintained a steady flow of weak storm systems over the Western Atlantic along the stalled front.

The last and most significant short wave reached the base of the trough on Thursday night the 23rd. A major coastal low was expected to develop east of the Carolinas Friday morning and move northeast. The 500mb flow became cut-off Friday morning as a storm system evolved east of Cape Hatteras.

The low tracked far enough to the south and east to avoid passing through the area favorable for significant snow ($>$ 6") in New York City (Spar, et al 1969). Figure 1 shows the path and central pressure of the low and the area through which lows generally pass when heavy snow occurs in New York City. Eastern Long Island and South Coastal New Jersey bore the brunt of the storm (Fig. 2) with up to 6 inches falling over Long Island and over one foot in South Coastal New Jersey.

Even though the storm moved outside the favorable area for heavy snow, one would have expected at least some light snow within New York City, but none occurred. Why? One possible reason was that all the upper air features were a little farther offshore than predicted. For example, the 850mb (Fig. 3A & 3B) thermal advection was concentrated in a relatively narrow band that just missed New York City as it moved northeastward.

A strong high pressure ridge extended from Quebec Province southwest to the Gulf Coast States Friday morning. A north, preferably northeast, flow is usually a necessary snow producing ingredient in the New York area with coastal lows since it establishes a warm air advection/overrunning pattern. However, on Friday the north flow was so dry it effectively evaporated the snow observed on radar falling over New York City. This left the New York City forecasters in a quandary on how much snow would actually fall. All day radar showed it was snowing over New York City, but none reached the ground. The surges of snow moving toward New York City from the south were challenged by the dry flow from the north. The dry air won the meteorological battle this day. The surface geostrophic wind had basically a land trajectory to New York City, while the trajectory for southern New Jersey had an oceanic fetch (Fig. 4). This trajectory established a moisture boundary with New York City on the dry side, contributing to the lack of snow.

NUMERICAL MODEL PERFORMANCE AND RESULTS OF HEAVY SNOW FORECAST TECHNIQUES (BASED ON THE 12Z/23RD DAY RUN & THE 00Z/24TH NIGHT RUN)

All the models were too strong with the upper air features. They were also too far north or northwest with their locations. The NGM, for example (Fig. 5), overforecast the 500mb low's strength by 130 meters Saturday morning (12Z Feb. 25th) and predicted the vorticity center too far north. Goetsch (1987) has compiled a checklist (Fig. 6) using long established techniques for forecasting heavy snow based on surface and upper level features. These heavy snow forecast techniques using both the Aviation and LFM model outputs suggested New York City was in an optimal area for heavy snow. The upper air NGM features suggested a heavy snow event for Long Island, but not for New York City.

Figure 7 shows the observed surface storm track and forecast tracks from the NGM, LFM and Aviation models. The most erroneous storm track and the one nearest the coast was from the NGM model. Although the NGM upper level features did not support heavy snow for New York City, the forecast track of the surface low was very favorable for heavy snow. It would have been unreasonable to forecast a light or insignificant snowfall for this area, especially when evidence from the other models was considered. Results from the winter of 1988-89 (Grumm and Siebers 1989) showed the NGM did exhibit a systematic bias of placing surface lows too far northwest, in this case closer to the coast, than actual storm tracks.

The NGM had drier QPF runs than the LFM throughout the event, keeping the LFM's wet wintertime bias reputation intact. The 00Z/24th LFM night run QPF forecast gave New York City in excess of one inch water equivalent. The LFM's systematic wet bias was probably exacerbated further by its use of only mandatory levels in the analysis and initialization of the model. The 00Z/24th upper air analysis from Albany was nearly saturated at 850mb and 700mb.

The LFM's inability (by design) to incorporate the drier air between 850mb and the surface at Albany was probably a contributing factor to the overestimated QPF forecast in New York City. This was the fifth precipitation event of the 1988-89 winter in which the LFM forecast excessive QPF amounts for the New York City area when no measurable precipitation occurred.

TROUBLE BREWING

The first sign that something was going wrong with the snow forecast came Thursday night. The cold dry air accompanying the north winds was underestimated by the models. A significant drop in the New York City dewpoint brought it below zero by Friday morning. The 00Z soundings on the 24th were already colder than optimal for a heavy snow event (Auer, 1987) which looks for 700mb temperatures between -5 and -8C, and 500mb temperatures of -22 and -25C. By 12Z on the 24th the 500mb temperature over New York City was down to -28C. Lest we all get meteorological cancer by living and dying by specific numbers, Southern New Jersey was also colder than the optimal snow range temperatures by 12z Friday (24th) morning and yet, over one foot of snow covered Southern Coastal New Jersey.

It is interesting to also note a snowstorm was in progress over Norfolk Virginia. One New York City Forecaster (once stationed in Norfolk) noted significant snowstorms ($>$6") do not follow in New York City when one is in progress at Norfolk ($>$4").

CONCLUSIONS

Why did it not snow at all in New York City? Apparently the combination of the slightly farther than expected eastward storm track with the strong and very dry flow from the north made this a non-precipitation event for New York City. Southern New Jersey was closer to the storm track and the surface flow had a more oceanic trajectory (Fig. 4) with higher moisture content than New York City. The cold dry air to the north acted like a brick wall to the northwestern advance of the snow shield.

Climatology shows New York City averages only one major snowfall ($>$6") a winter. Most, if not all, forecasters would have forecasted snow in New York City for February 24th. This event, like all snow events, was more complicated than it seemed. With any approaching coastal storm, one should look for reasons why it should and also why it should not snow before arriving at a forecast.

ACKNOWLEDGEMENTS

Many thanks to Stanley Wasserman who gave me the idea for the paper after I was upset when it didn't snow. Also many thanks to Stan, Gary Carter and Hugh Stone at SSD for their assistance and suggestions with this paper.

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Spar, Jerome, Zuckerberg, Fred and Friedman, Howard 1969: Aircraft Reconnaissance Of Winter Coastal Cyclones In the Northeastern United States, Bulletin of the American Meteorological Society, Vol. 50, No. 11 Nov. 1969, pp 857-865

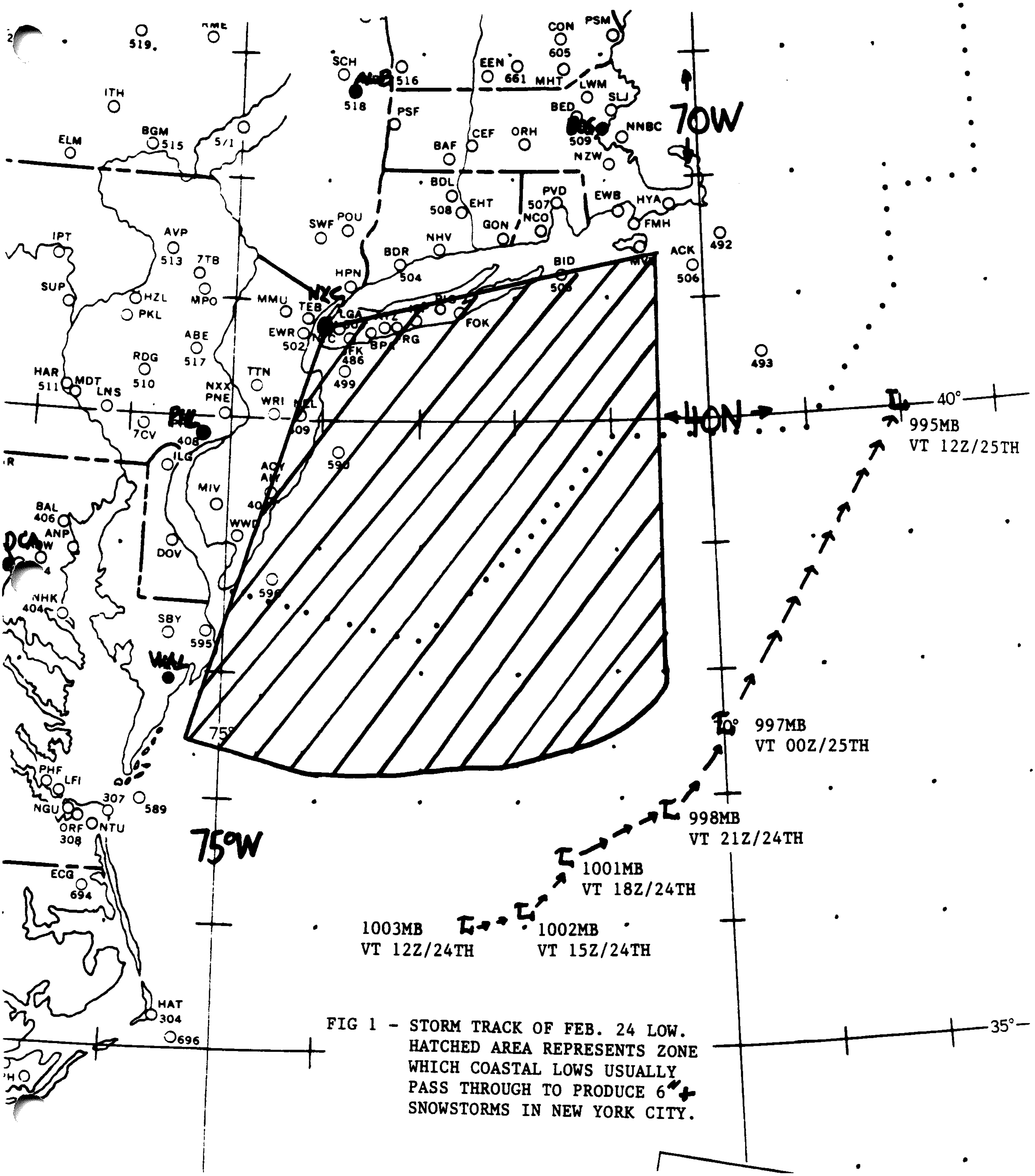

FIG 1 - STORM TRACK OF FEB. 24 LOW. HATCHED AREA REPRESENTS ZONE WHICH COASTAL LOWS USUALLY PASS THROUGH TO PRODUCE 6"+ SNOWSTORMS IN NEW YORK CITY.

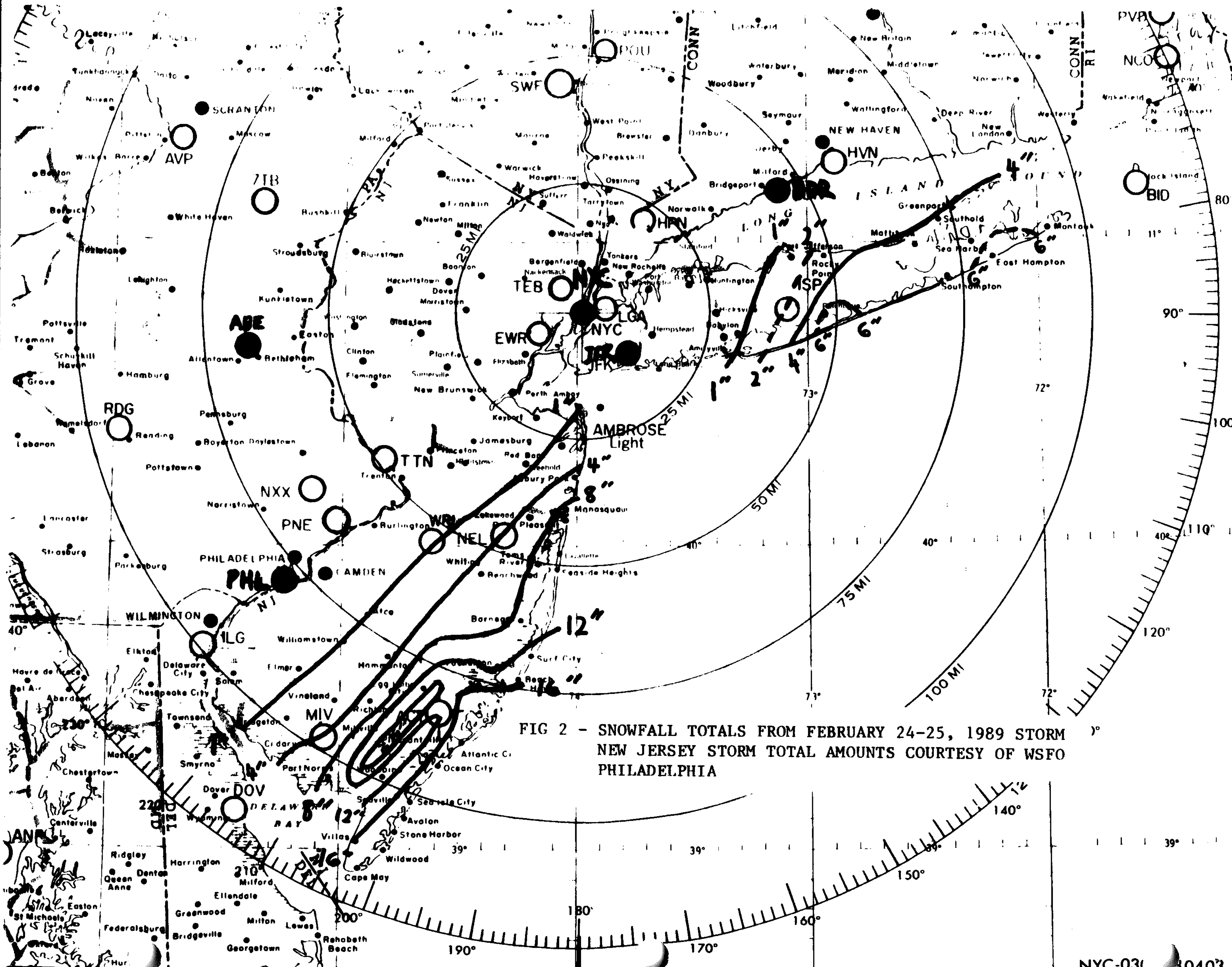

FIG 2 - SNOWFALL TOTALS FROM FEBRUARY 24-25, 1989 STORM
NEW JERSEY STORM TOTAL AMOUNTS COURTESY OF WSFO
PHILADELPHIA

NYC-03C 80403

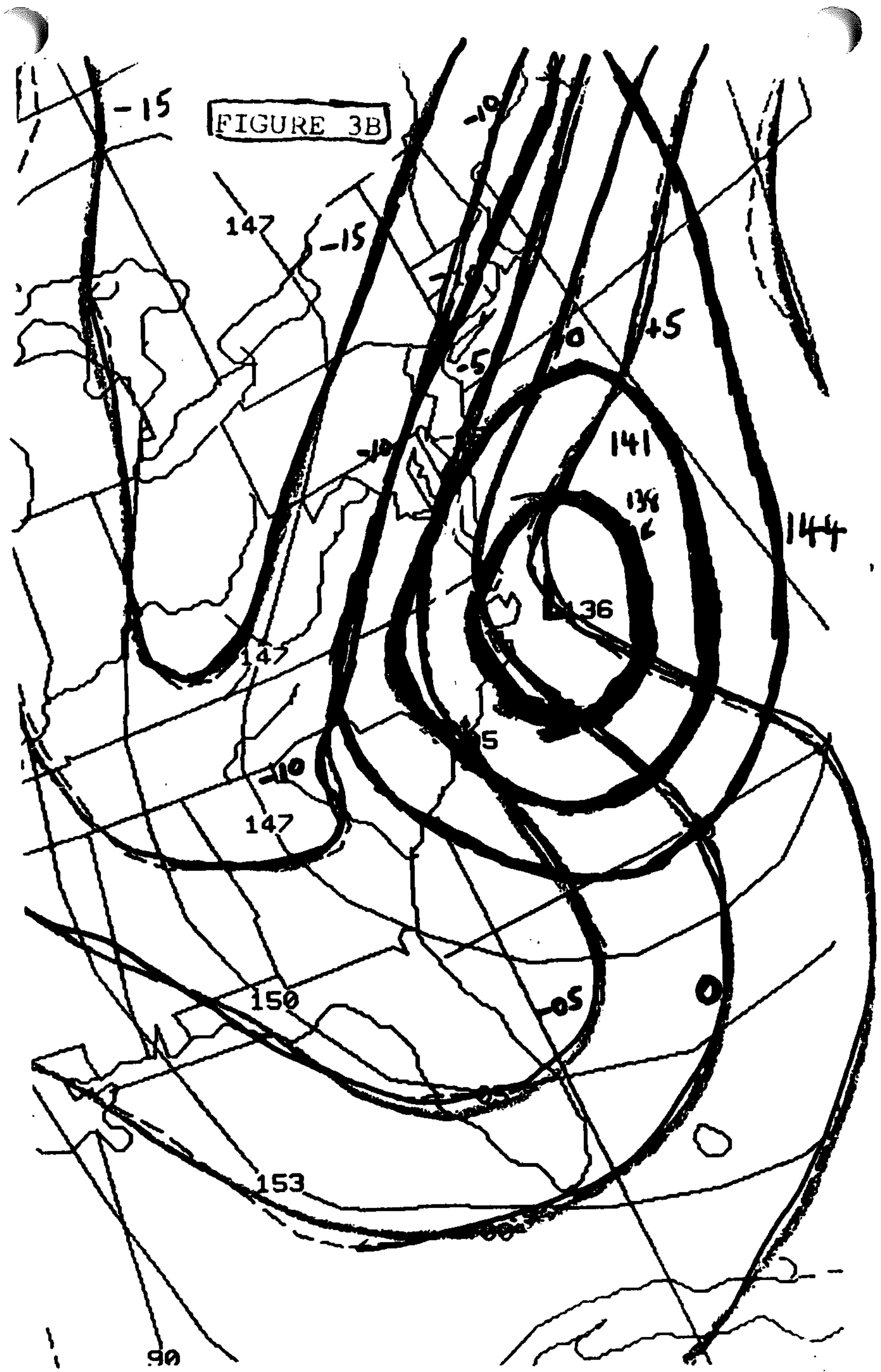

FIG 3A- NGM 24HR 850MB HEIGHTS & TEMPERATURE FORECASTS VALID 12Z ON 24TH
FIG 3B- NGM 850MB HEIGHTS & TEMPERATURE INITIALIZATION VALID 12Z ON 24TH

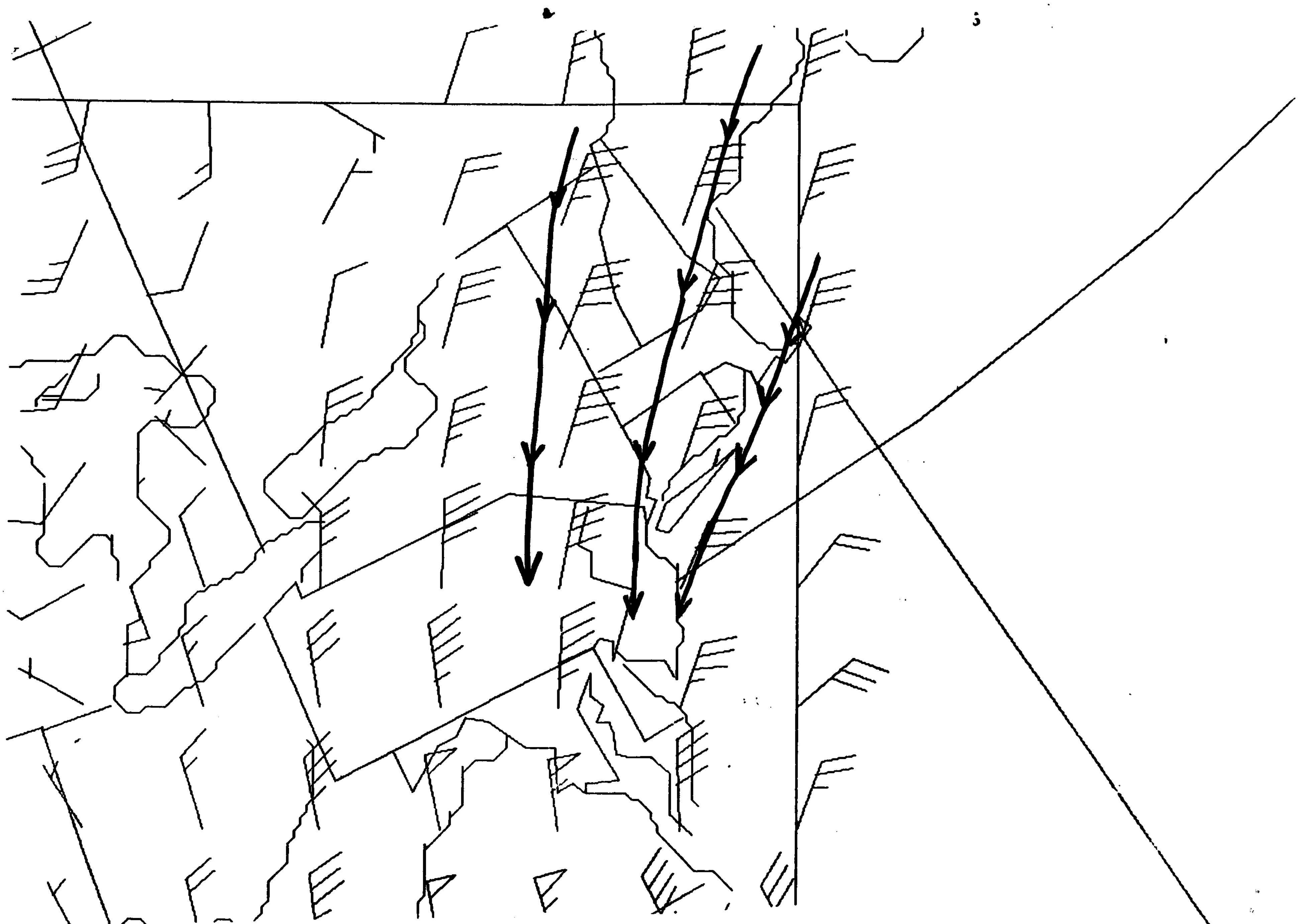

FIG 4 - SURFACE GEOSTROPHIC WIND (CHART 9AM) VALID 13Z ON FEB 24TH.

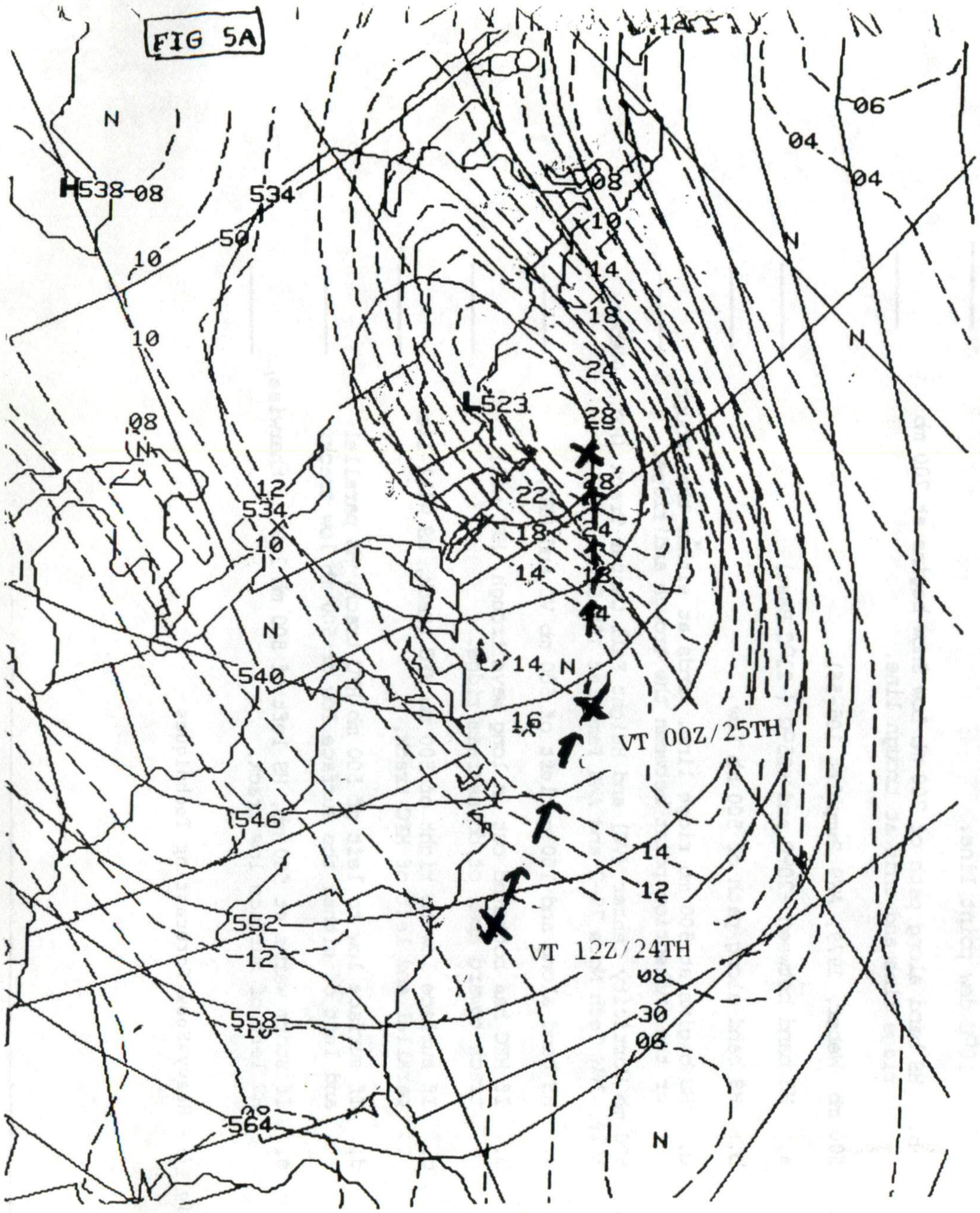

FIG 5A - NGM 36HR FCST 500MB HEIGHTS & VORTICITY VALID 12Z/FEB 25TH. 12HR & 24HR FCST POSITIONS OF VORTICITY (BASED ON 00Z/FEB. 24TH NGM RUN) ALSO SHOWN.

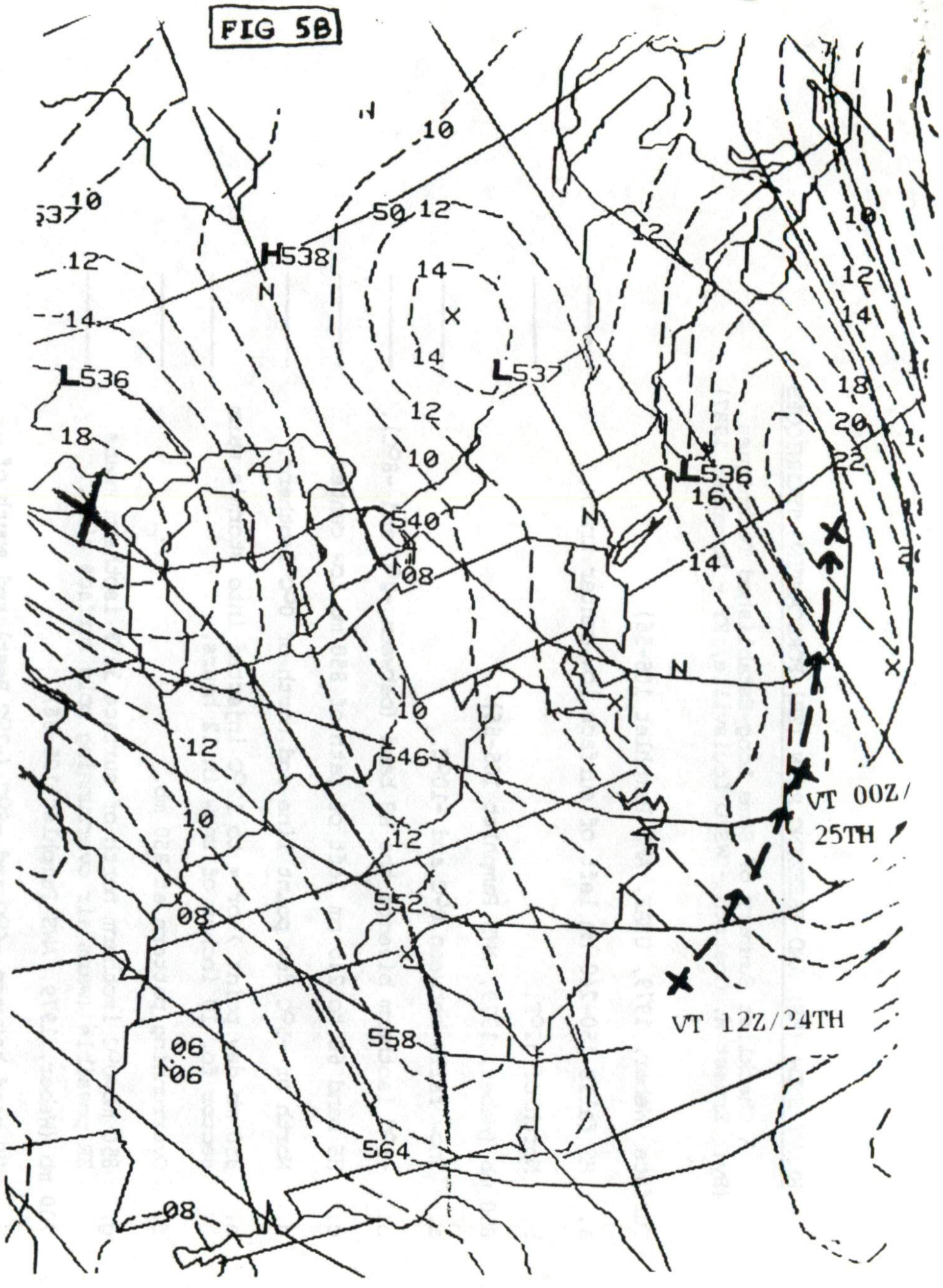

FIG 5B - NGM 500MB HEIGHTS & VORTICITY INITIALIZATION VALID 12Z/FEB 25TH. INTIALIZED LOCATIONS OF VORTICITY CENTER ALSO SHOWN FOR 12Z/24TH & 00Z/25TH.

HEAVY SNOW (HS) AND FREEZING RAIN (ZR) FORECASTING TECHNIQUES

A Checklist Summary of Some Long-Established Techniques
(By: Ernest H. Goetsch - WSFO Louisville, KY - November 1987)

1. Surface (Weber, 1979, USAF, AWS Pamphlet 105-56)

   a. HS falls 150-240 nm left of surface low center track. ______

   b. North of 32°F. ______

2. 850 mb (Weber, 1979, AWS Pamphlet 105-56)

   a. Snow falls between 0°C and -10°C. ______

   b. -5°C isotherm bisects the HS band (between -2°C and -8°C). ______

   c. HS band 60 to 240 nm left of path of 850 mb low center. ______

   d. North of -5°C dew point line and north of 0°C isotherm. ______

   e. 850 mb dew point > or = to 12°C injected into storm's warm sector for 10 inches of snow in 12 hours. ______

   f. Overrunning pattern at 850 mb. ______

   g. 850 mb 0°C isotherm north of surface 32°F isotherm means ZR possible (warm air overrunning cold surface air). ______

3. 700 mb (Weber, 1979, AWS Pamphlet 105-56)

   a. HS band between -6°C and -8°C (-7°C Best) and south of -10°C dew point line. ______

   b. HS band along path of 700 mb Low Snow begins at 700 mb ridge line and ends at trough line. ______

4. 500 mb (Weber, 1979, AWS Pamphlet 105-56)

   a. HS band between -20°C and -25°C (-23°C Best) ______

   b. HS band along path of 500 mb Low ______

   c. HS begins at 500 mb ridge line. Ends at either the trough or the inflection point between the trough and ridge. ______

5. 500 mb Vorticity Center (VC) and Height Fall Center Track (HFC) (Weber, 1979, 3WW Tech Note 79-2 and AWS Pamphlet 105-56)

   a. HS band along and 150 nm left of 500 mb VC and HFC. ______

   b. If HFC has bottomed out in long wave trough, HFC will track toward apex of downstream ridge. ______

   c. If surface low to right of 500 mb HFC track, HS will lie parallel and left of HFC track. ______

   d. If surface low to left of 500 mb HFC track, HS parallel and left of either the surface low or 500 mb low track. ______

   e. If storm warms at 500 mb, HS left of 500 mb low. Otherwise, HS left of surface low track. ______

Fig. 6 - Heavy Snow Forecasting Techniques

6. 200 mb (Cook, 1980)

a. 200 mb warm pocket coincides with 500 mb VC ______
(VC moves toward 200 mb cold pocket, with movement parallel to line connecting 200 mb warm and cold pockets) ______
(Coldest 200 mb temperature downstream from a warm pocket is area of HS in following 24 hours) ______

b. Snow index: Average snowfall (inches) for next 24 hours equal to 1/2 the maximum warm advection expected at 200 mb (Maximum advection of 840 nm in 24 hours). ______

7. 1000-500 mb Humidity

a. Greater than or equal to 80 percent for HS. ______

b. Greater than or equal to 65 percent for precipitation. ______

8. Thickness (AWS Pamphlet 105-56)

a. HS along 1000-500 mb thickness ridge, between 5310 m and 5370 m ______

b. Rain/Snow line and Thickness

Snow	if	1000-500 mb	<	5400 m		______
Snow	if	850-700 mb	<	1540 m to 1555 m		______
Snow	if	1000-850 mb	<	1295 m to 1300 m		______
Snow	if	1000-700 mb	<	2840 m		______
ZR	if	1000-850 mb	<	1300 m	and	______
		850-700 mb	>	1555 m	and	______
		surface temperature	<	32°F		______

9. Precipitable Water Index (PWI)

a. PWI x 10 == the approximate 12 hour HS accumulation ______

10. Magic Chart (7WG, 8WT) (Sangster and Jagler, 1985)
(7WG - Net Vertical Displacement in 12 hour period of parcel arriving at 700 mb, 8WT = 850 mb temperature progged for 24 hours).

a. HS area = 850 mb 0°C to -10°C and > or = to 80 mb ______

b. Moderate snow = 850 mb < 0°C and 60 to 80 mb ______

c. Light snow = 850 mb < 0°C and 20 to 60 mb ______

Discussion ______________________________

Fig. 6 - Heavy Snow Forecasting Techniques Continued

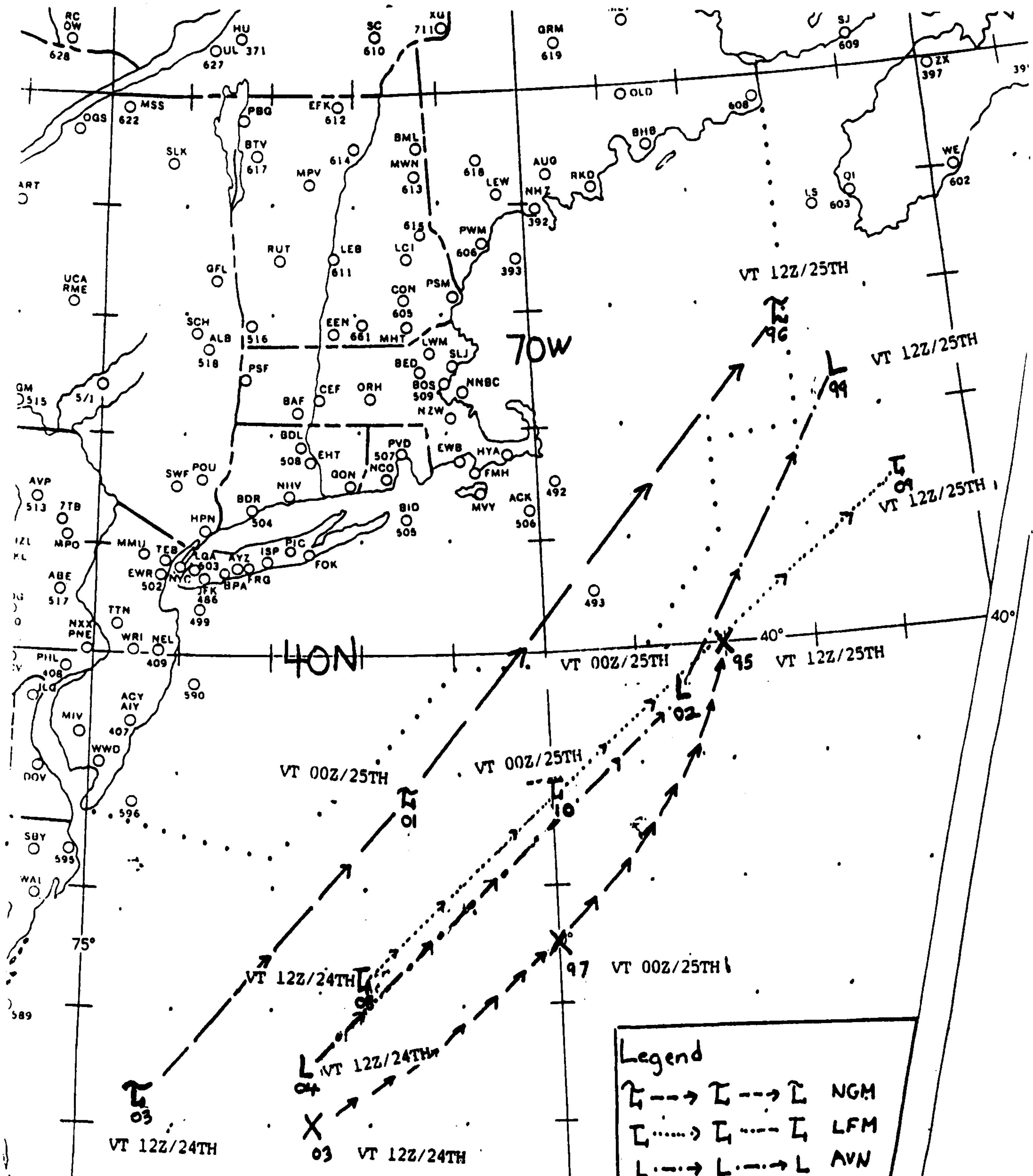

FIG 7 - MODEL COMPARISON OF FORECAST POSITIONS FOR COASTAL LOW WITH ACTUAL STORM TRACK. ALL FORECAST POSITIONS BASED ON 00Z RUN FEB 24TH.