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MESO-ETA MODEL SUCCESSFULLY PREDICTS A CATALINA EDDY OFF THE SOUTHERN CALIFORNIA COAST

Wilfred Pi and Dave Reynolds - NWSFO Monterey, CA

Introduction

Preliminary evaluation of the new 29-km resolution Meso-Eta model has demonstrated its ability to forecast the onset of a Catalina eddy circulation off the southern California coast. This is potentially a major breakthrough in National Weather Service forecasting operations as none of the other forecast models used by NMC such as the Nested Grid Model or the Aviation Model has had the resolution to be able to forecast such a mesoscale feature. The Catalina eddy forms off the southern California coast near Santa Catalina Island, and its circulation extends from Point Conception to San Diego. Catalina eddies occur several times during each spring and summer season.

The effects of the Catalina eddy on the weather over southern California are very significant. Stratus clouds can deepen as much as 1000 to 2000 feet and extend inland to the coastal hills, burning off late in the day or not at all. Air traffic is greatly affected, maximum temperatures drop as much as 7-8°C from the previous day, and the severity of pollution is reduced. On the morning of May 30, 1995, an eddy circulation center formed in the Santa Barbara Channel, expanded, and moved southward. The purpose of this Technical Attachment is to compare the time, location, and size of an eddy circulation predicted by the Meso-Eta model to what actually occurred. The 0300 UTC Meso-Eta model run of May 30, 1995 will be examined.

Mechanisms of Eddy Development

Recent studies by Ulrickson et al., (1995) and Mass and Albright (1989) show that eddy circulations develop as a result of strong northerly winds over California near the surface which can be caused by a tight pressure gradient, usually a result of a short-wave trough passing through the Pacific Northwest. Northerly winds blowing across land are blocked by the 3000 foot east-west traversing Santa Ynez Mountains just north of the Point Conception - Santa Barbara coast (see Fig. 1). These winds are either deflected eastward or forced over the mountain range creating light downslope winds over the Point Conception - Santa Barbara coastline. These warmer, downslope winds create lower pressures in the Santa Barbara region and its immediate coastal waters than in areas further south. As a result, southerly winds develop. The southerly winds are deflected westward by the Santa Ynez Mountains where they converge with the unblocked northerly winds west of Point Conception. Thus, a cyclonic circulation forms in the general area south of the Point Conception - Santa Barbara coastline. Stratus clouds are advected north along the coast. The damming effect of the Santa Ynez Mountains causes a deepening of the stratus clouds. Mass and Albright (1989) have shown that northerly winds of 25-30 knots over the open ocean are sufficient for eddy formation.

Case Study

Figure 2a displays the initial analysis from the Meso-Eta 0300 UTC run of the 1000 mb temperature and wind fields. It shows a zone of moderately strong northerly winds of 25-30 knots west of the central California coastline southward over the open ocean. Lighter northerly winds of 15 knots or less can be seen over the land mass extending out over the Santa Barbara Channel. Figures 2a-f are a time series of the model run every three hours. In the 6-hour forecast valid at 0900 UTC (Fig. 2c), the 1000 mb wind shows that the eddy circulation is beginning to form with its center just south of the Channel Islands. Southeasterly winds are developing offshore south of the Santa Barbara coast. By the 9-hour forecast valid 1200 UTC (Fig. 2d), the 1000 mb winds show southeast winds extending further north to the coastline. Note the position of the 22°C isotherm over and south of the Point Conception - Santa Barbara coastline during the initial stages of the Meso-Eta run in Figs. 2a-c. The air temperature in this area is warmer than the surrounding ocean areas. This results in lower pressures in the area, and southerly winds develop. Figure 2g shows the Meso-Eta's 10 meter wind and sea-level pressure analysis valid at 0600 UTC. A surface low is centered in the aforementioned area.

Data from six offshore buoys at 2-hourly intervals were available to compare to the Meso-Eta wind analysis (Figs. 3a-f). The name and location of the buoys are listed in Table 1. Unfortunately, at times the buoys fail to transmit data. Starting at 0600 UTC (Fig. 3a), all buoys have west to northwest winds, a typical climatological wind condition (Mass and Albright, 1989); data from buoy 46025 is missing. The Santa Barbara surface observation has light east-northeast winds. By 0800 UTC (Fig. 3b), the winds at buoy 46025 (hereafter, buoys are referred to by the last two digits) are southerly, while winds are southwesterly at buoy 53, light and variable at buoy 45, and northwest at buoys 23, 54, and 11. It is apparent that an eddy is forming in the vicinity of the Santa Barbara Channel. This small-scale eddy circulation has been previously documented by Kessler and Douglas (1991). By 1000 UTC (Fig. 3c), the winds at buoy 53 are southeasterly, while winds are northerly at buoy 54, still northwest at buoy 23, and light and variable at buoy 45. A significant change occurs by 1200 UTC (Fig. 3d) as winds at buoys 53 and 54 have switched to easterly, while winds at buoy 23 are northeast, and light and variable at buoy 45. After 1400 UTC (Fig. 3e), easterly winds have overrun the entire Santa Barbara Channel. The 1600 UTC (Fig. 3f) winds at San Nicholas Island are southerly. This indicates that the eddy is affecting a larger area, and that the center of the eddy has moved farther south.

Conclusion and Recommendations

An eddy circulation began forming over the Santa Barbara Channel between 0600 and 0800 UTC on May 30, 1995. The Meso-Eta model's 0000 UTC run on May 30, 1995 forecast the development of an eddy circulation between 0600 and 0900 UTC. At this time, the center of the eddy is further south and on a larger scale in the Meso-Eta model than what actually verified. The Meso-Eta model does not have the resolution to forecast a midchannel eddy which has an average diameter of only 40 km during its initial stages (Kessler and Douglas, 1991). This discrepancy appears to have little effect on land stations, although that must be investigated further. With time, between 1200 and 1600 UTC, the eddy expands and its center moves south of the Channel Islands, becoming more in line with the Meso-Eta's positioning. The Meso-Eta model forecast of wind speed and direction agreed well with actual conditions throughout the time series. The temperature structure on the model run was consistent with the mechanisms that cause an eddy circulation to form. Overall, the performance and result of the Meso-Eta model is encouraging. Research will continue to determine if the Meso-Eta model can consistently forecast these features.

References

Kessler, R.C., and S.G. Douglas, 1991: A Numerical Study of Mesoscale Eddy Development over the Santa Barbara Channel. *J. Applied Meteor.*, **30**, 633-651

Mass, Clifford F., and Mark D. Albright, 1989: Origin of the Catalina Eddy. *Mon. Wea. Rev.*, **117**, 2406-2436

Ulrickson, B.L., J. Steven Hoffmaster, Jeremy Robinson, and Daniel Vimont, 1995: A Numerical Study of the Catalina Eddy. *Mon. Wea. Rev.*, **123**, 1364-1373

Acknowledgements

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Table 1

Buoy number	Coordinates	Location
46011	34.9N 120.9W	26 nm NNW of Pt. Conception
46054	34.3N 120.4W	8 nm S of Pt. Conception
46023	34.3N 120.7W	11 nm W of Pt. Conception
46053	34.2N 119.8W	13 nm SSW Santa Barbara
46045	33.8N 118.4W	8 nm SW Los Angeles
46025	33.7N 119.1W	38 nm W Los Angeles

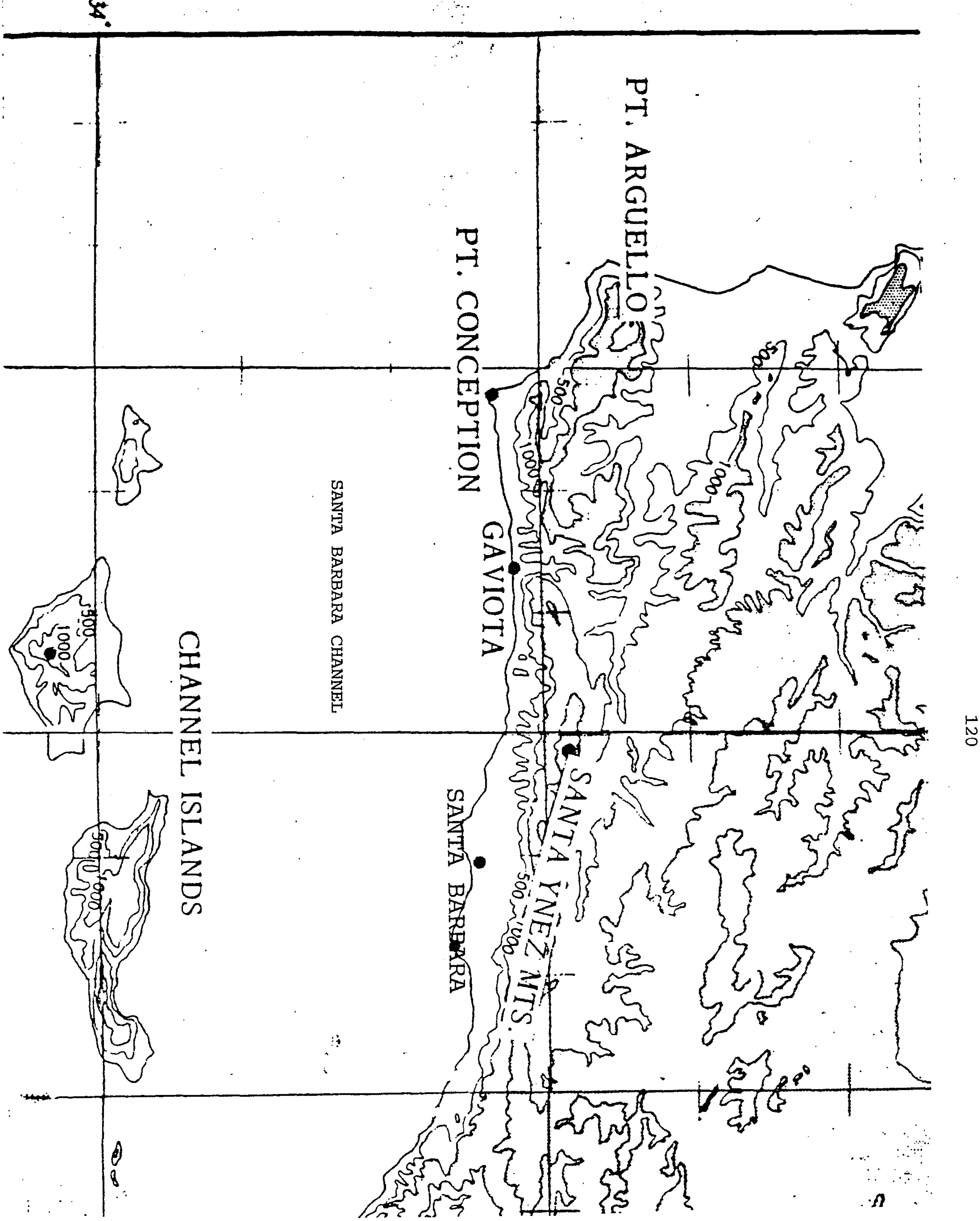

Figure 1 - Geography of the Point Conception - Santa Barbara area

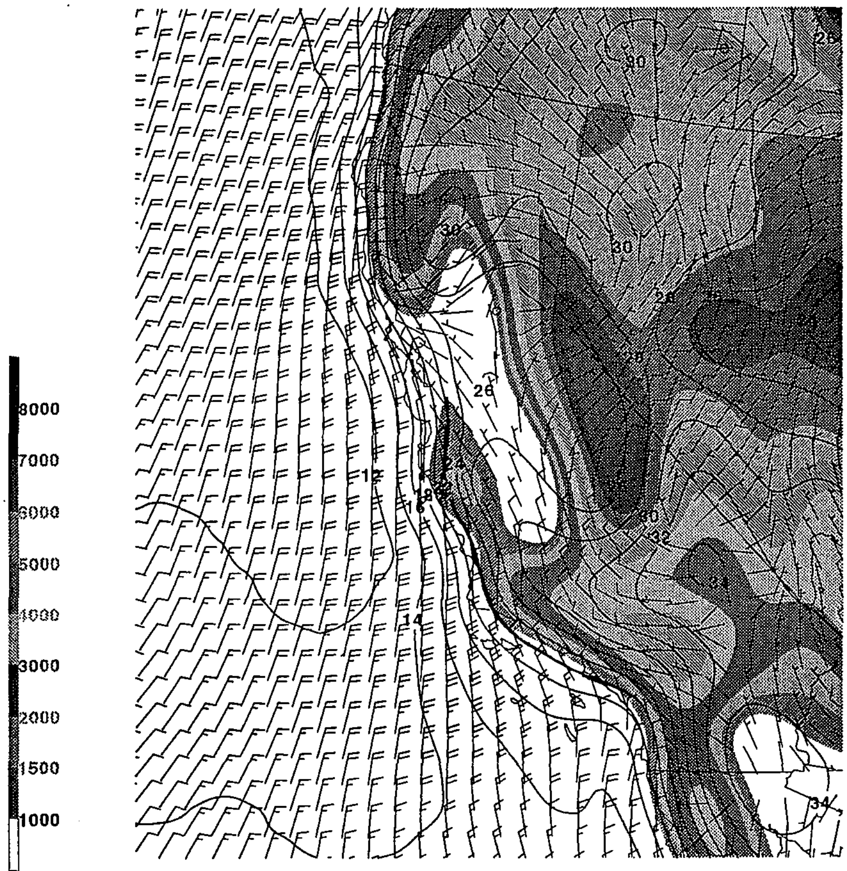

Fig. 2a

950530/0300V000 MESOETA 1000 WINDS AND TEMPERATURE

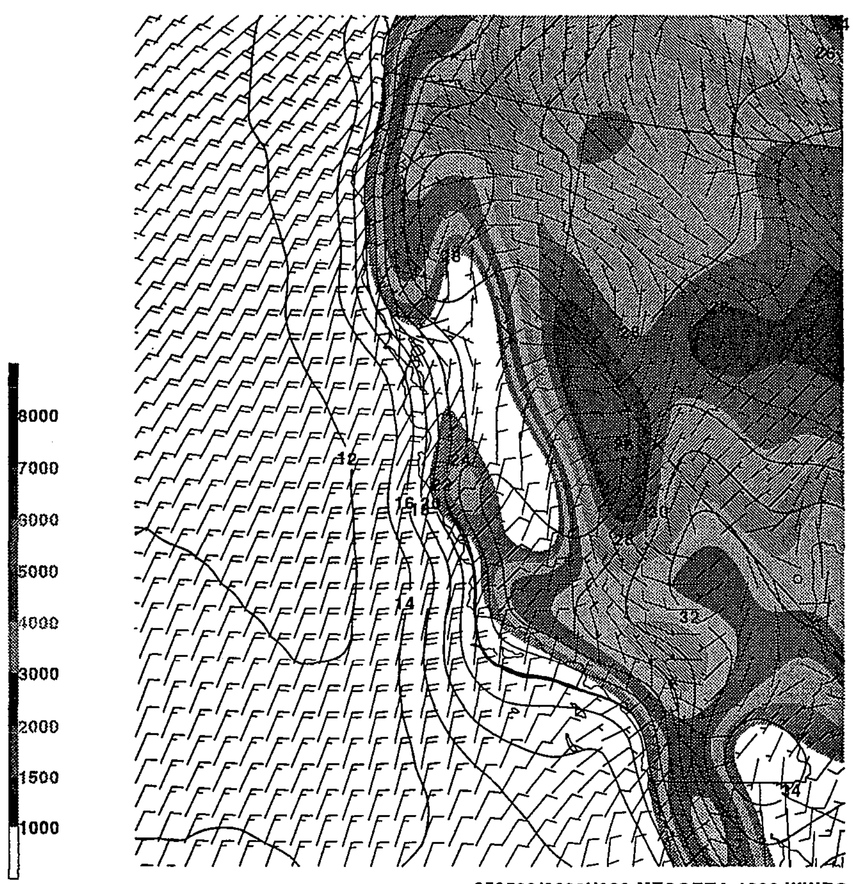

Fig. 2b

950530/0600V003 MESOETA 1000 WINDS AND TEMPERATURE

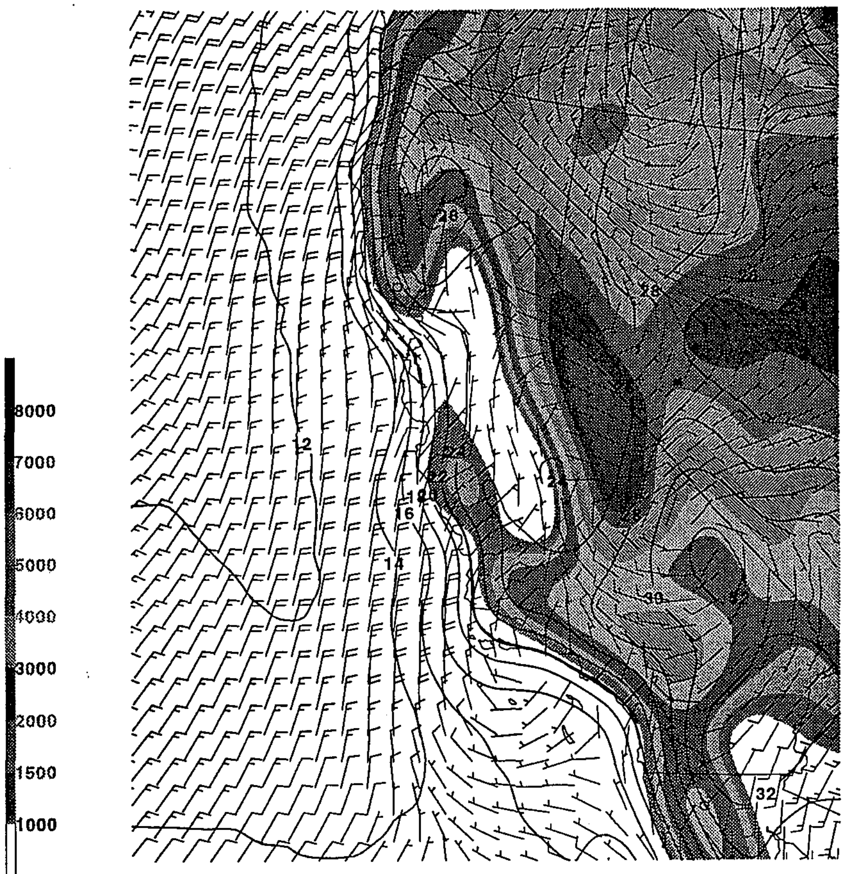

Fig. 2c

950530/0900V006 MESOETA 1000 WINDS AND TEMPERATURE

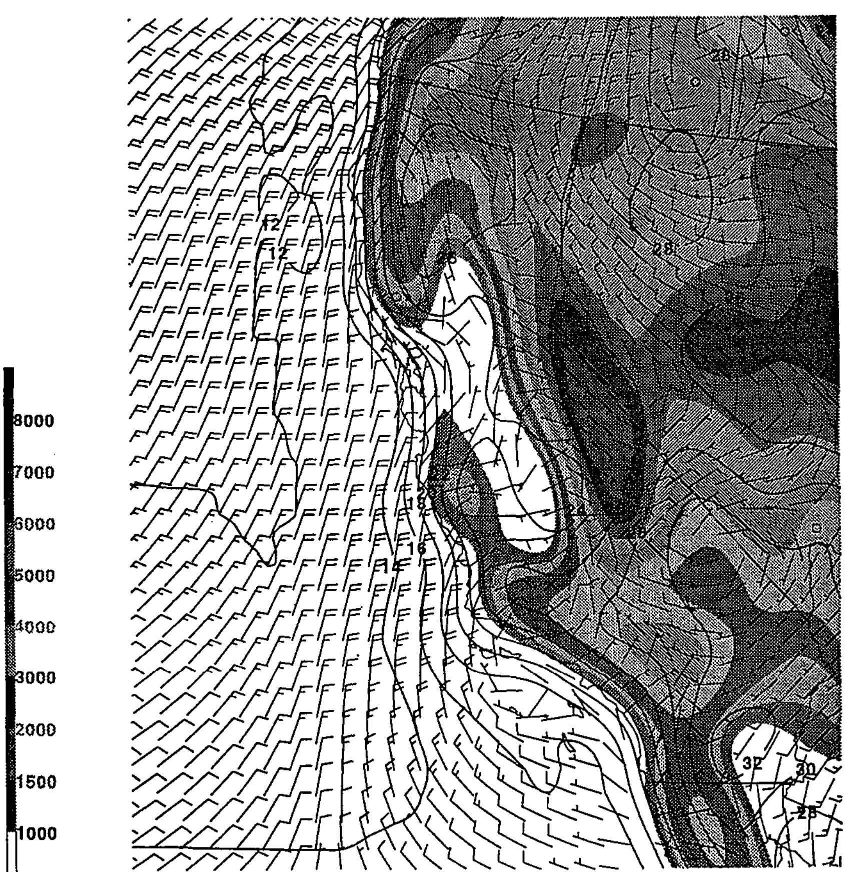

Fig. 2d

950530/1200V009 MESOETA 1000 WINDS AND TEMPERATURE

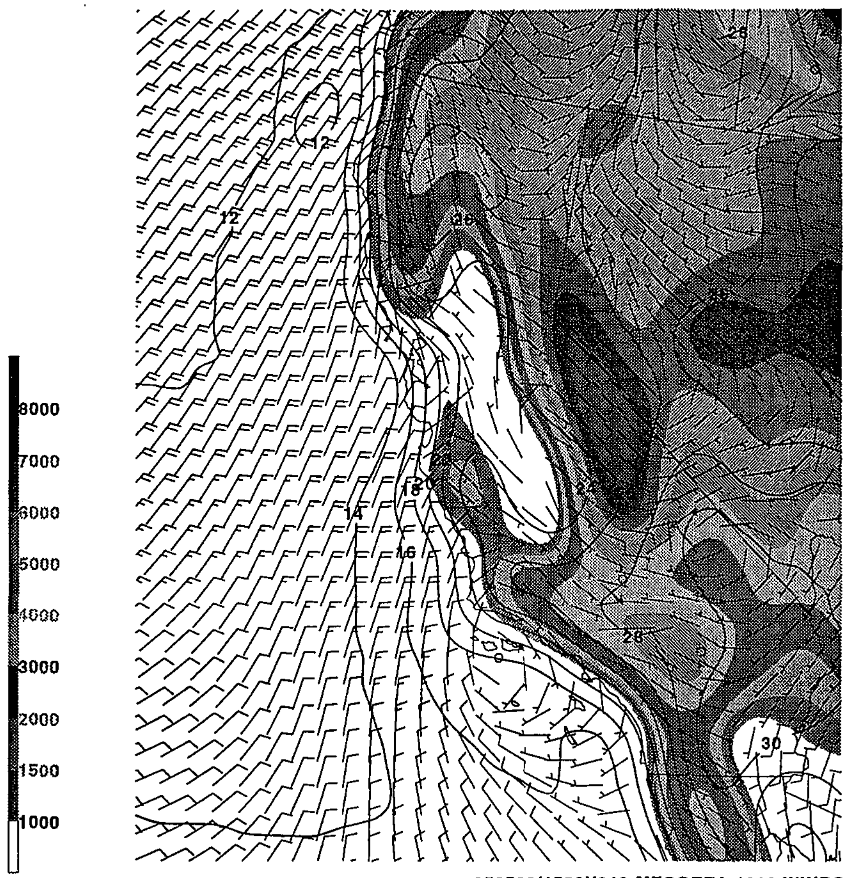

Fig. 2e

950530/1500V012 MESOETA 1000 WINDS AND TEMPERATURE

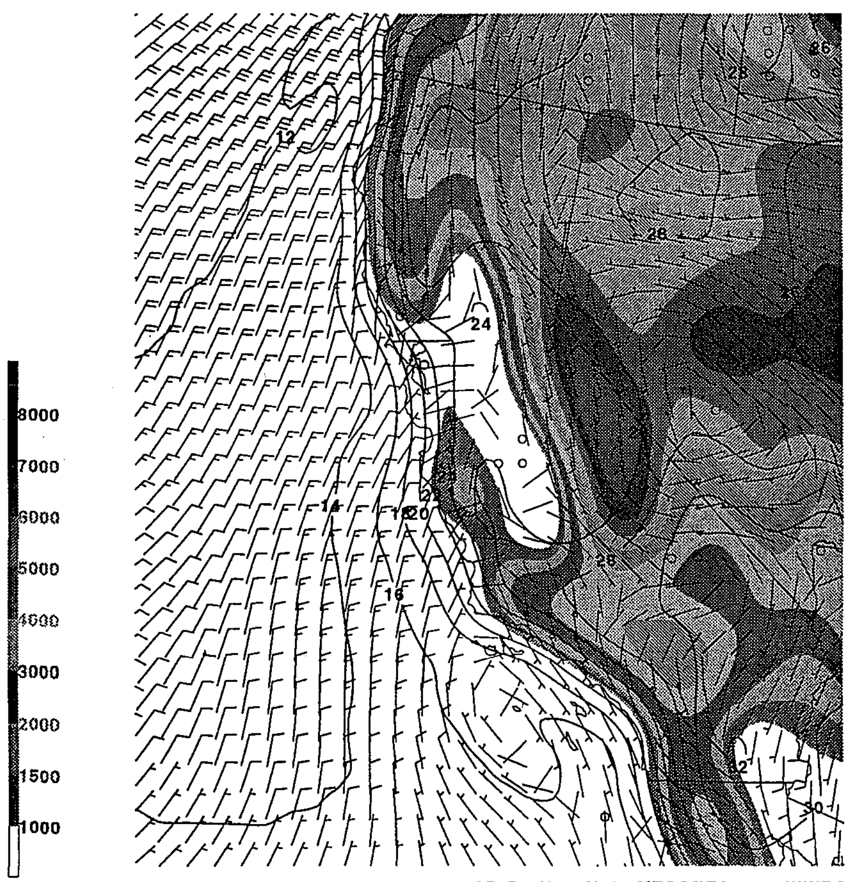

Fig. 2f

950530/1800V015 MESOETA 1000 WINDS AND TEMPERATURE

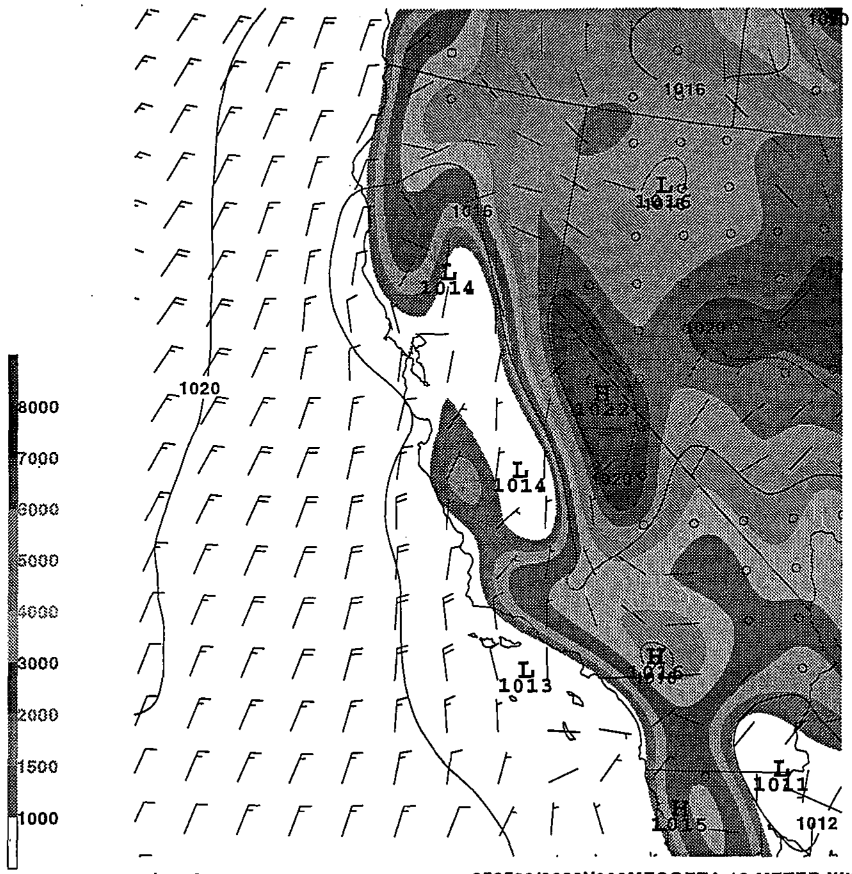

Fig. 2g 950530/0600V003MESOETA 10 METER WIND & MSLP

WIND ANALYSIS FOR 30MAY95 0600Z

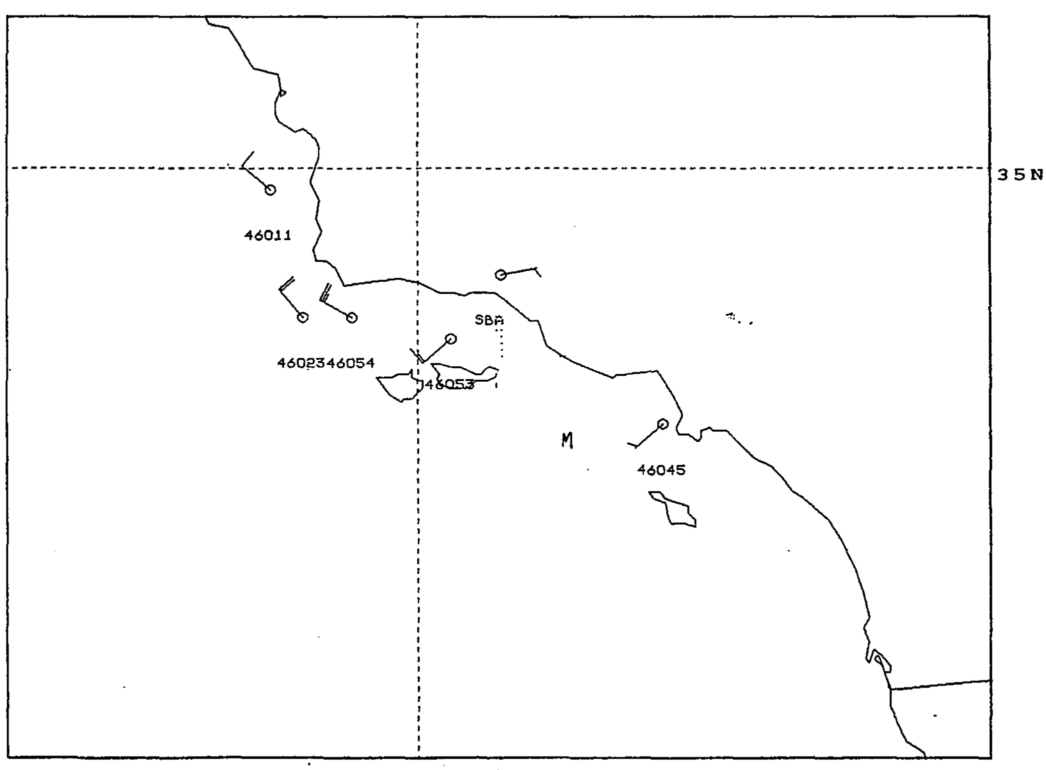

Fig. 3a

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WIND ANALYSIS FOR 30MAY95 0800Z

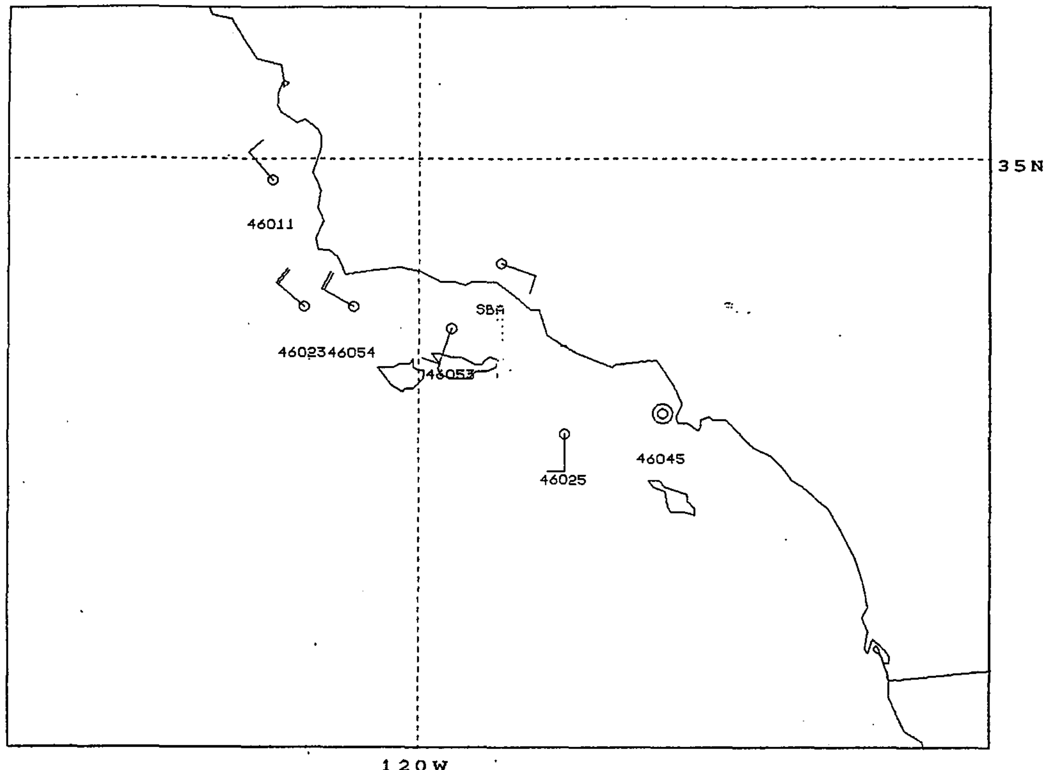

Fig. 3b

U. S. NAVY / NOAA

WIND ANALYSIS FOR 30MAY95 1000Z

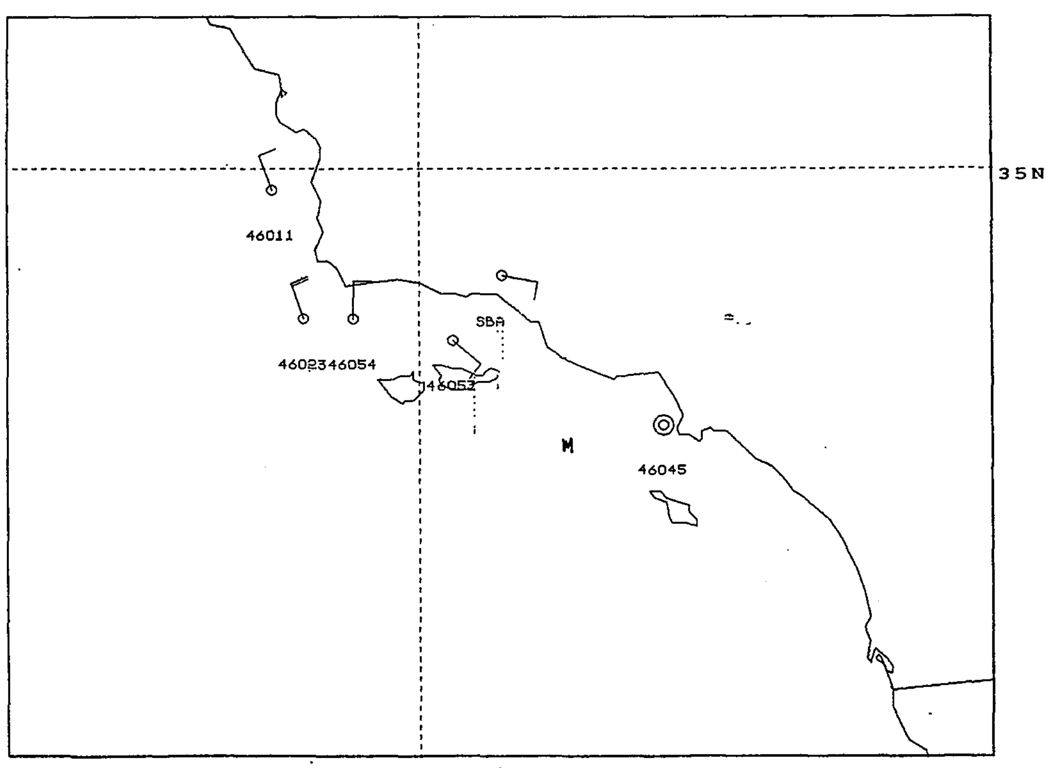

Fig. 3c

U. S. NAVY / NOAA

WIND ANALYSIS FOR 30MAY95 1200Z

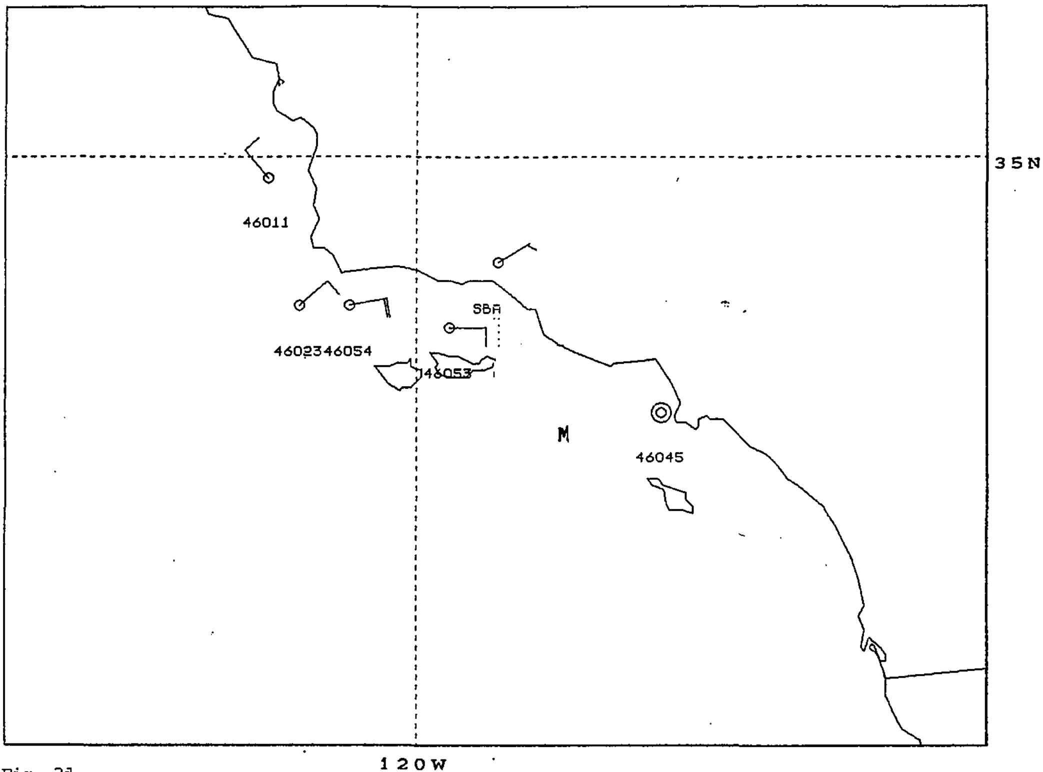

Fig. 3d

U. S. NAVY / NOAA

WIND ANALYSIS FOR 30MAY95 1400Z

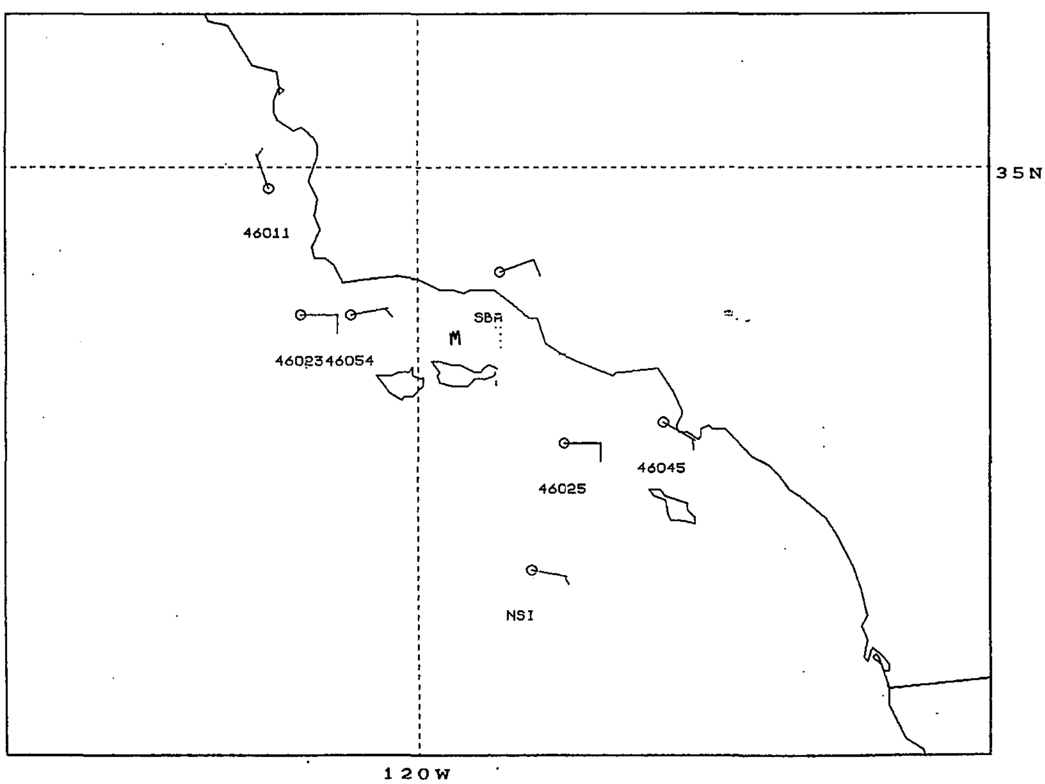

Fig. 3e

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WIND ANALYSIS FOR 30MAY95 1600Z

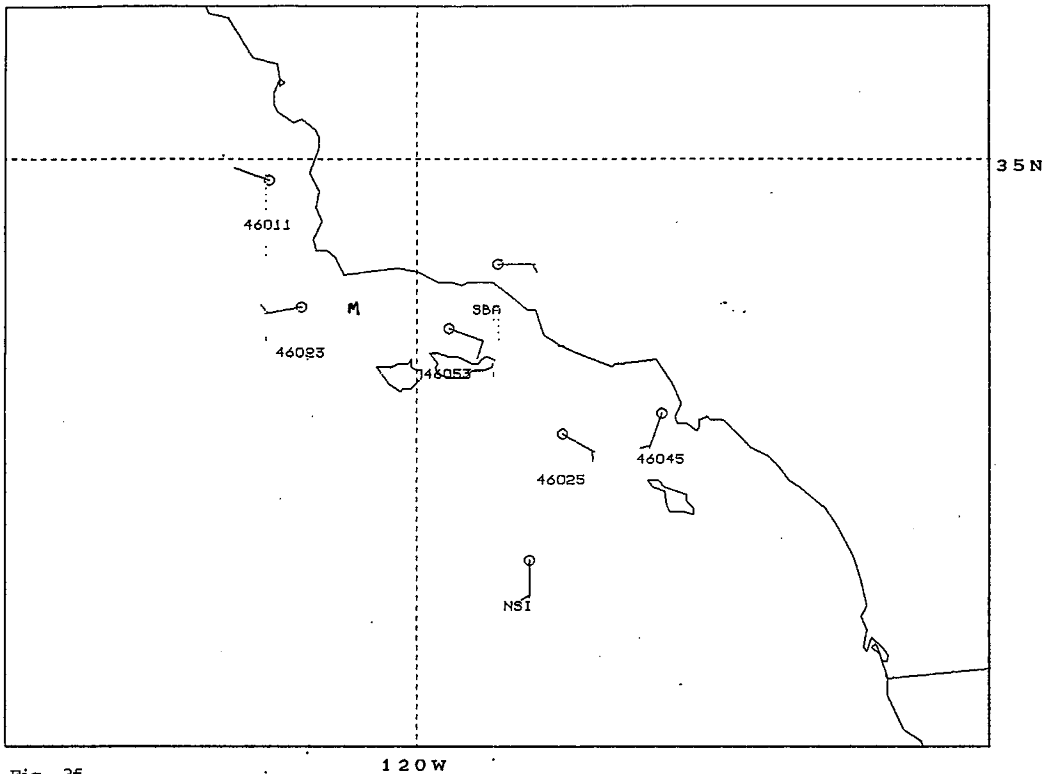

Fig. 3f

U. S. NAVY / NOAA