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Use of Mesoscale Data in Determining the Location of Surface Fronts

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The Surface Analysis Branch (SAB) at NMC generates the familiar NMCGPH90F graphic for AFOS users throughout the country. This product contains the estimated locations of surface frontal positions over North America. Additional mesoscale analysis of surface data is normally conducted at many NWS offices. This may be especially true in the West, where NMC frontal positions are mislocated at times due to complex mountainous terrain, local wind influences and limited surface data. The case shown in this paper demonstrates not only the importance of examining all of the data available carefully, but also underscores the value of a mesoscale observation network in improving critical short-range forecasts.

During the day of April 30, 1988, a synoptic-scale trough moved east into the Western Region out of the Gulf of Alaska. The associated cold front was moving rapidly through the northern portion of the region. The front was slowing down and appeared to be weakening with time in the southern half of the region. At 1200 UTC and 1500 UTC (figure 1), SAB correctly analyzed a surface cold front extending from Salt Lake City in northern Utah to just south of Ely (in eastern Nevada). However, the NMC analysis mistakenly showed the cold front extending from just south of Ely to near Yuma (in southwestern Arizona), as will be seen in the following discussion.

Surface data at 1600 UTC (table 1) indicated that strong southwest winds were present at Las Vegas (LAS), Nellis AFB (LSV, near Las Vegas), and Desert Rock (DRA, about 40 miles NW of Las Vegas). Winds in the vicinity of Tonopah (TPH, about 100 miles northwest of Las Vegas) were from the west gusting to 26 knots. Surface winds were becoming stronger with time at all locations and surface temperatures were following the normal diurnal trend in southern Nevada. Sea level pressures were also falling rapidly in both southern Nevada and southern Utah (figure 2). The available surface data at 1600 UTC suggested that a strong front was located to the northwest of the Nevada Test Site (NTS, about 60 miles northwest of Las Vegas). Satellite imagery showed no discernible clouds along the front until later in the day.

By 1900 UTC, it was becoming more obvious that the southern portion of the cold front on the NMCGPH90F graphic was incorrectly analyzed. Surface data from a highly dense mesoscale network located on and near the NTS showed gusty southwesterly winds to 25 knots through the NTS, but 27 knots out of the northwest at TPH (figure 3)[1]. Winds ahead of the front, and within the NTS, were gusting to 40 knots from the southwest (table 2). At 2300 UTC, the NTS network indicated a significant wind shift was occurring at the northwest end of the NTS (figure 4). By 0000 UTC on May 1, 1988, DRA surface winds had gusted to 50 knots (table 3). By 0122 UTC, DRA reported an 80° wind shift (from 220° to 300°). In the first hour after the front passed, the temperature dropped 7°F, the surface pressure rose 3 mb, the dew point rose 18°F and the sky cover went from high scattered to a mid-level broken ceiling.

Interpolation between the 2300 UTC and 0000 UTC mesonet data (figures 4, 5) indicated that the front was moving at 25 to 30 knots in a southerly direction. At this rate, the cold front would arrive in Las Vegas in approximately 4 hours. LAS indicated a wind shift at 0548 UTC.

The cold front that went through Las Vegas that afternoon had the strongest official winds recorded in Las Vegas in over 4 years. Between 2300 UTC and 0200 UTC, winds were sustained at 40 knots with gusts up to 60 knots. Forecasters from WSFO Reno and the Las Vegas office of the Weather Service Nuclear Support Office issued strong wind advisories and high wind warnings well in advance of the strong winds. These advisories and warnings were issued as a result of concerted efforts to ascertain the actual location and the strength of the surface frontal system.

NMC cannot be expected to produce the same quality frontal analysis over the western states as is done over the eastern states, due to reasons previously mentioned in this paper. Consequently, forecasters in the West must focus upon local sources of data which aid in the analysis of frontal positions, and try not to rely strictly upon NMC guidance for the frontal locations. Western forecasters also have considerably more insight into local data tendencies throughout their area of concern than do those at the national offices. Therefore, the western forecaster must take the time to analyze fronts and other significant synoptic features to ensure accuracy.

In the end, the local forecaster is responsible for the products that are issued. In this case, had the forecaster not examined the data carefully, the severity of the winds would not have been reflected in the forecast products. This case also underscores the value of mesoscale observation networks in improving critical short-range forecasts.

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1 WSNSO transmits the NTS mesonet data on AFOS to the Western Region every hour on the half hour under AFOS product name DOEOSODOE.

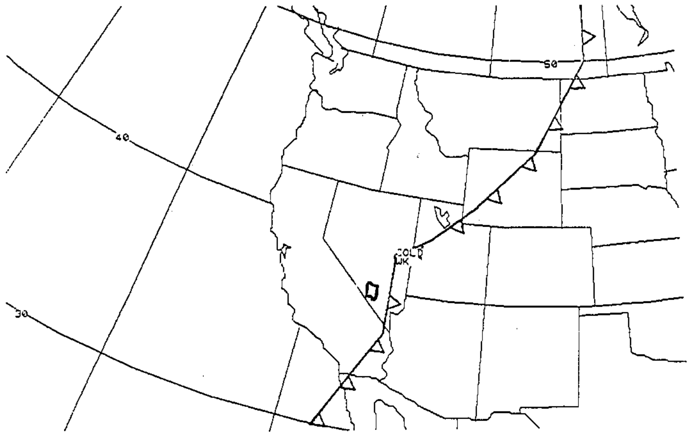

Figure 1. NMC-analyzed surface fronts, 1500 UTC, 30 April 1988. The Nevada Test Site(NTS) in this figure and in Figure 2 is outlined in southern Nevada.

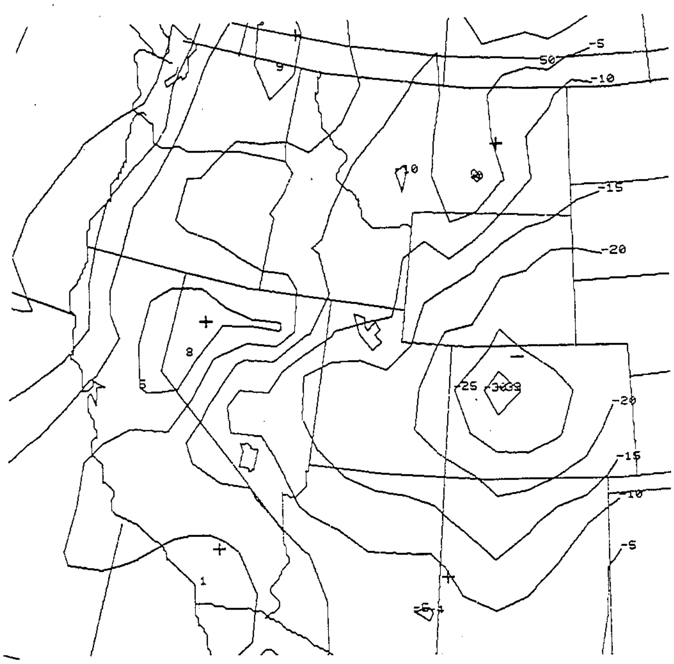

Figure 2. 3-hourly surface pressure tendency, 1500 UTC, 30 April 1988.

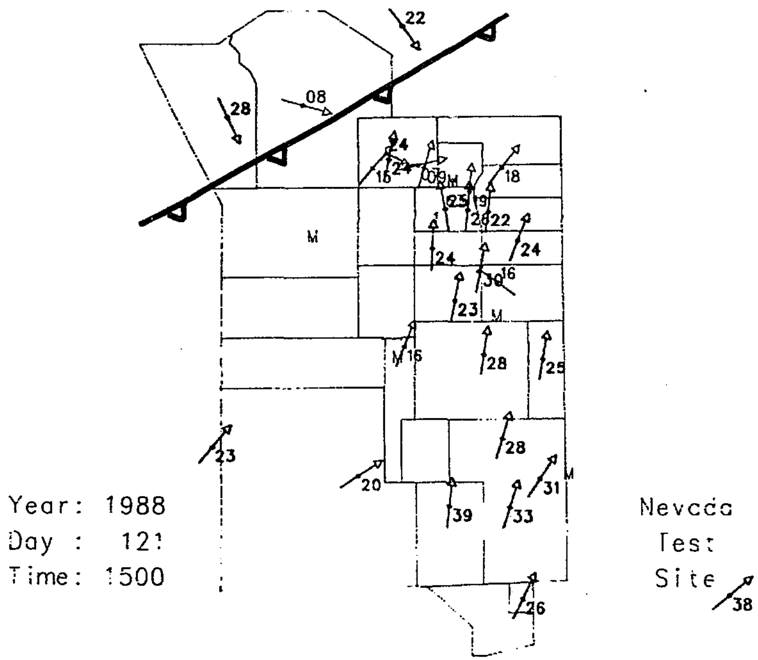

Figure 4. As in Figure 3, but for 2300 UTC, 30 April 1988.

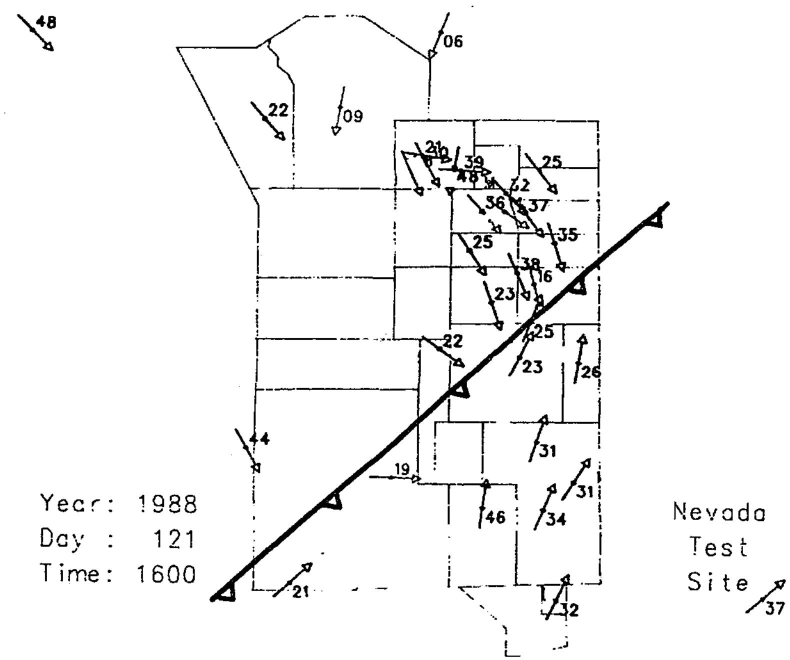

Figure 5. As in Figure 3, but for 0000 UTC, 1 May 1988.

TABLE #1

APRIL 30, 1988 -- 16 UTC Surface data

TPH SA 1551 230 SCT 250 -BKN 50 082/51/13/2818G26/989
DRA SA 1550 E220 OVC 20 083/61/37/2421/985
LAS SA 1548 160 SCT E220 OVC 35 077/68/35/2023G31/981
LSV SA 1555 200 SCT E250 BKN 40 064/69/36/2014/980

TABLE #2

APRIL 30, 1988 -- 20 UTC SURFACE DATA

TPH SA 1951 80 SCT E90 BKN 50 036/55/15/2912/975/ VIRGA N-S
DRA SA 1950 220 -SCT 20 039/68/34/1928G41/973/ PK WND 1841/50
LAS SA 1951 150 SCT 220-BKN 35 051/74/31/2127G34/973/ FEW CU W-NW ACSL OCNL BD
ALQDS PK WND 2239/39
LSV SA 1955 150 SCT 250-BKN 40 025/76/35/2118G25/969/ACSL SW PK WND 2030/15

TABLE #3

APRIL 30, 1988 -- 00 UTC SURFACE DATA

TPH SA MISSING
DRA SA 2358 220 SCT 10 010/63/6/2035G44/963/BD W-N VSBY LWR NW PK WND 2050/03
517 1072 72 / RADAT 20091
LAS SA 2348 250 SCT 10 017/72/18/2243G58/963/BD ALQDS PK WND 2158/38/727 1008
78
LSV SA 2355 -X 150 SCT 250 SCT 15 002/73/17/2030G40/960/ BD 1 ACSL E
PK WND 1944/16 / 529 1041

TABLE #4

APPARENT FROPA TIMES (from surface data)

TPH ...... 04/30 1845 UTC
DRA ...... 05/01 0122 UTC
LAS ...... 05/01 0548 UTC
LSV ...... 05/01 0325 UTC

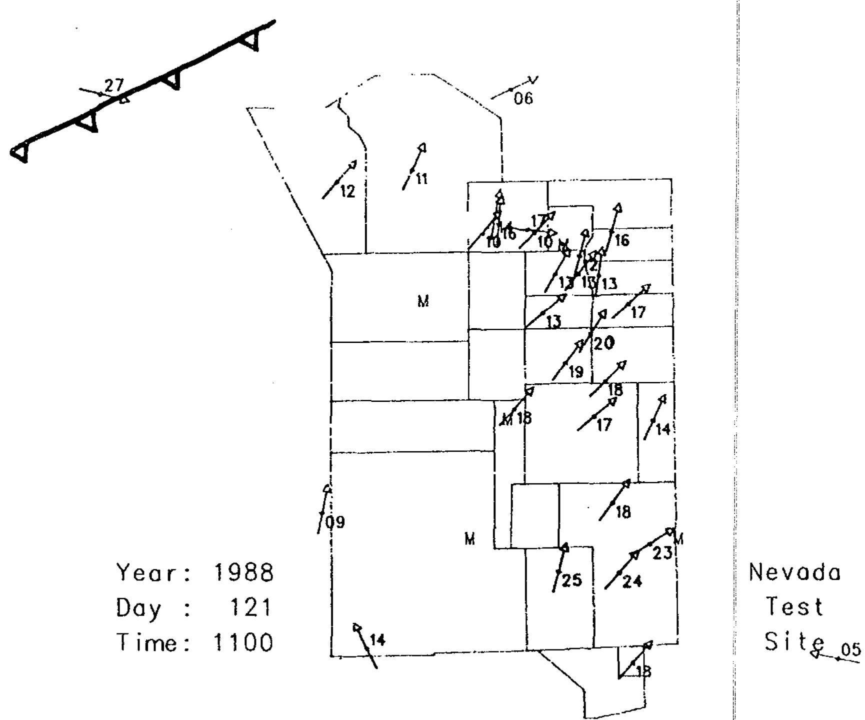

Figure 3. Surface meso-network plot around the NTS, 1900 UTC, 30 April 1988. Wind speeds in kts. Note: Location of TPH (upper left observation) is not drawn to scale. It is, in reality, about 5 times as far from the NTS as shown.