ANALYSIS OF A SEVERE THUNDERSTORM
USING THE WEATHER EVENT SIMULATOR (WES)

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Introduction

On 10 September 2002 a severe thunderstorm developed in the mountains of extreme southwestern California near CZZ (FIG. 1), about 35 miles east of San Diego Lindbergh Field (SAN). Using the Weather Event Simulator (WES) to examine this case, it appears that the key players in the development of the severe thunderstorm were the combination of a quasi-stationary deformation zone, the rugged mountainous terrain of San Diego County, and diurnal heating. A simulation for this event was created using the WES. It has proven to be an extremely valuable training tool at WFO San Diego. In this TA-LITE we will give a brief overview of the case along with some of the graphics used in the simulation.

Synoptic and Mesoscale Features

Using data from the WES simulation, the 1200 UTC 10 September 2002 MesoEta 500 mb Heights and Vorticity showed an upper level high over the central California coastal waters, extending northeast into the northern Great Basin (FIG. 2a). The upper level high was forcing split flow over the eastern Pacific, off the California coast. In the southern branch a weak upper level cutoff low was off the coast just southwest of San Diego, California (SAN). Further west an upper level trough was approaching the coast. This trough was the "kicker" for the cutoff low, and the cutoff low can be seen tracking northeast during the day. The center of the low moved northeast to a position over northern Baja California by 0000 UTC 11 September 2002, as seen on the 0000 UTC 11 September 2002 MesoEta 500 mb Heights and Vorticity (FIG. 2b).

The position of the upper level low and the associated deformation zone can easily be seen in the 915 UTC water vapor imagery (FIG. 3a). The deformation zone extends from a point about 200 miles southwest of SAN, northeast through SAN into the desert areas, and continuing northeast into Utah. (The location of SAN is indicated by the "x"). The vertical motion along the deformation zone was strong enough to spark early morning convection (FIG. 3b) at 1430 UTC over the deserts, and set the stage for a deformation zone event during the afternoon (FIG. 3c) at 2000 UTC. As for the vertical structure, the 1200 UTC 10 September 2002 NKX sounding (FIG. 4) showed a large mid-level lapse rate along with some instability (Showalter Index of about -1).

The KNKX WSR-88D [located near Miramar (NKX)] showed the progression of the storm system as it moved south along the mountains, which is coincident with the deformation zone. The event unfolded as 3 strong cells developed on this mesoscale convective system (MCS) in San Diego County, and a 4th very strong cell developing as the MCS moved over northern Baja California. The Vertically Integrated Liquid (VIL) can be seen for the 3 major cells in figures 5a, 5b, and 5c. The VIL, echo top, and composite reflectivity for the largest cell that developed in San Diego County is shown in figures 6a-c. Tables 1-3 show the VIL, echo top, and VIL density values for the 3 strong cells.

TIME (UTC)	VIL (kg/m^2)	ECHO TOPS (kft)	VIL DENSITY RANGE (kg/m^3)
10/1747	28	25-30	3.06-3.67
10/1753	35	30-35	3.28-3.83

Table 1. Data for the first strong cell (located about 35 miles northeast of SAN) for 10 September 2002. The first line displays values for the time when the top of the VIL density range surpasses 3.50, and the second line is the peak in VIL density for this cell.

TIME (UTC)	VIL (kg/m^2)	ECHO TOPS (kft)	VIL DENSITY RANGE (kg/m^3)
10/1758	39	30-35	3.65-4.26
10/1808	43	30-35	4.03-4.70

Table 2. Data for the 2nd strong cell (located about 35 miles east-northeast of SAN) for 10 September 2002. The first line contains the values for the time when the top of the VIL density range surpasses 3.50, and the second line is the peak in VIL density for this cell.

TIME (UTC)	VIL (kg/m2)	ECHO TOPS (kft)	VIL DENSITY RANGE (kg/m3)
10/1833	42	35-40	3.44-3.94
10/1838	48	35-40	3.94-4.50

Table 3. Data for the 3rd strong cell (located about 35 miles east of SAN) for 10 September 2002. The first line contains the values for the time when the top of the VIL density range surpasses 3.50, and the second line is the peak in VIL density for this cell.

Based on the KNKX WSR-88D echo top graphic and the Vertically Integrated Liquid (VIL) graphic from the WES, the upper end of the VIL density range for the first cell was barely above the severe thunderstorm threshold of 3.5 (Amburn and Wolf, 1996). In cells 2 and 3 the upper end of the VIL density range was above the "near 100 percent probability threshold for severe hail" value of 4.5 (Small et al., 1998), indicating a high probability of large hail.

Verification

The first spotter report indicated small hail in the Alpine area (east-northeast of SAN) at about 1807 UTC 10 September 2002, piling up on the ground about 1 inch deep. Very little additional information was received until the next day when verification of the events of 10 September 2002 were obtained (since it is sometimes very difficult to get reports from these remote areas of the county). The severe thunderstorm warning issued at 1841 UTC 10 September 2002 verified, as hail of up to 1 inch in diameter fell at about 1900 UTC 10 September 2002. The large hail fell about 8 miles west of Campo, California (CZZ). Heavy rain and some flooding was also reported. The infamous "pink pixel" (65 dBZ echo) also showed up on the 1838 UTC 10 September 2002 KNKX WSR-88D composite reflectivity product (FIG. 6c). This feature has proven to be an effective severe weather indicator in the past, as it is almost always associated with either large hail, damaging winds, flash flooding, or some combination of the above in southern California.

Discussion and Conclusion

The utility of the WES has been clearly illustrated in this TA-LITE. This "deformation zone severe weather event" is now a part of our training regimen on the WES, and should jog the memory of the forecaster when a similar situation arises. This shows that the Weather Event Simulator is an excellent way to help forecasters develop situational awareness prior to the occurrence of similar events, as well as gain experience in working such an event. Another goal of this simulation is to deliver more applicable training to an individual forecaster. While seeing the events unfold on the WES, the forecaster can make decisions based on the forecasters's current knowledge base. The trainer will be better able to spot areas of weakness in the individual, and address the training needs of that individual (which are likely to be different than those of other members of the forecast staff). This in itself will increase training efficiency, since forecasters will receive less training in areas where little is needed, and more in the targeted areas where it is needed.

Acknowledgments

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References

Amburn, S. A., and P. L. Wolf, 1996: VIL Density as a Hail Indicator. Wea. Forecasting, 12, 473-478

Small, I. J., D. V. Atkin, and T. E Evans III, 1988: Severe Hail Detection Using VIL Density and its Application in the Western States. Western Region Technical Attachment No. 98-37, 8 pp.
http://www.wrh.noaa.gov/wrh/98TAs/9837/index.html

Figure 3a

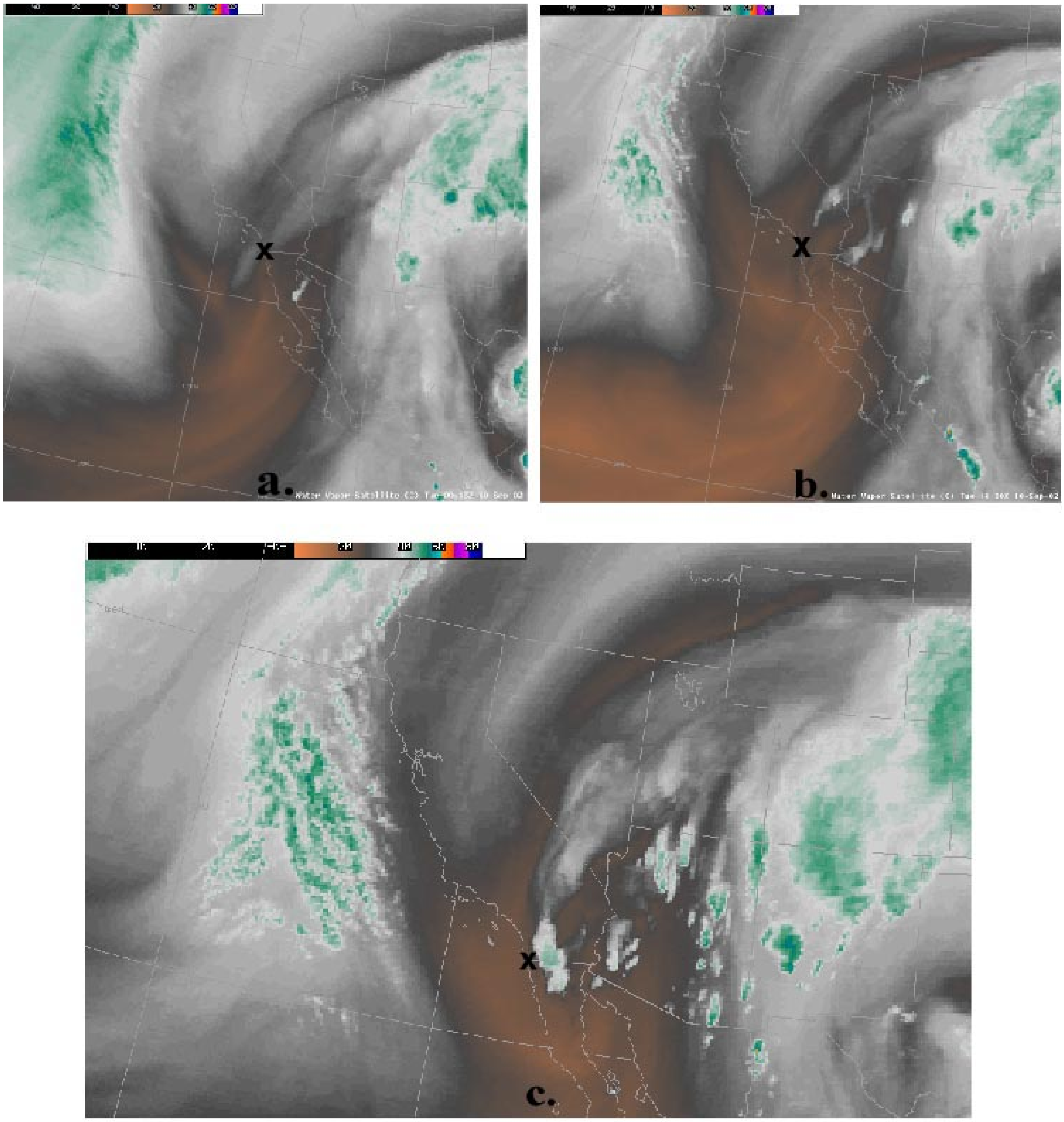

Fig. 3. The evolution of the deformation zone and severe thunderstorm near San Diego Lindbergh Field (SAN). The "x" is San Diego Lindbergh Field. (a) The 0915 UTC 10 September 2002 water vapor imagery. (b) The 1430 UTC 10 September 2002 water vapor imagery. (c) The 2000 UTC 10 September 2002 water vapor imagery.

Figure 3b

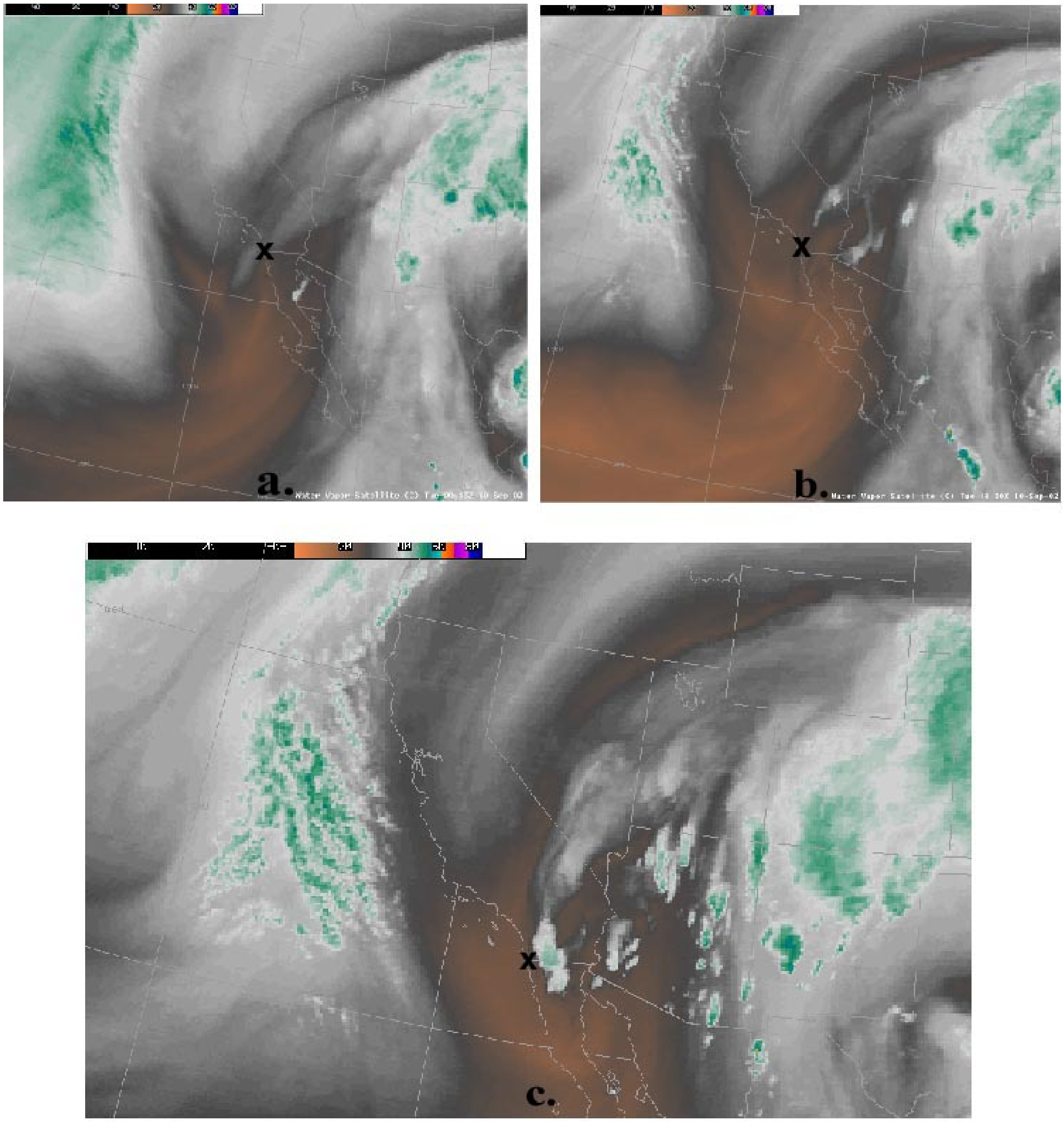

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Figure 3c

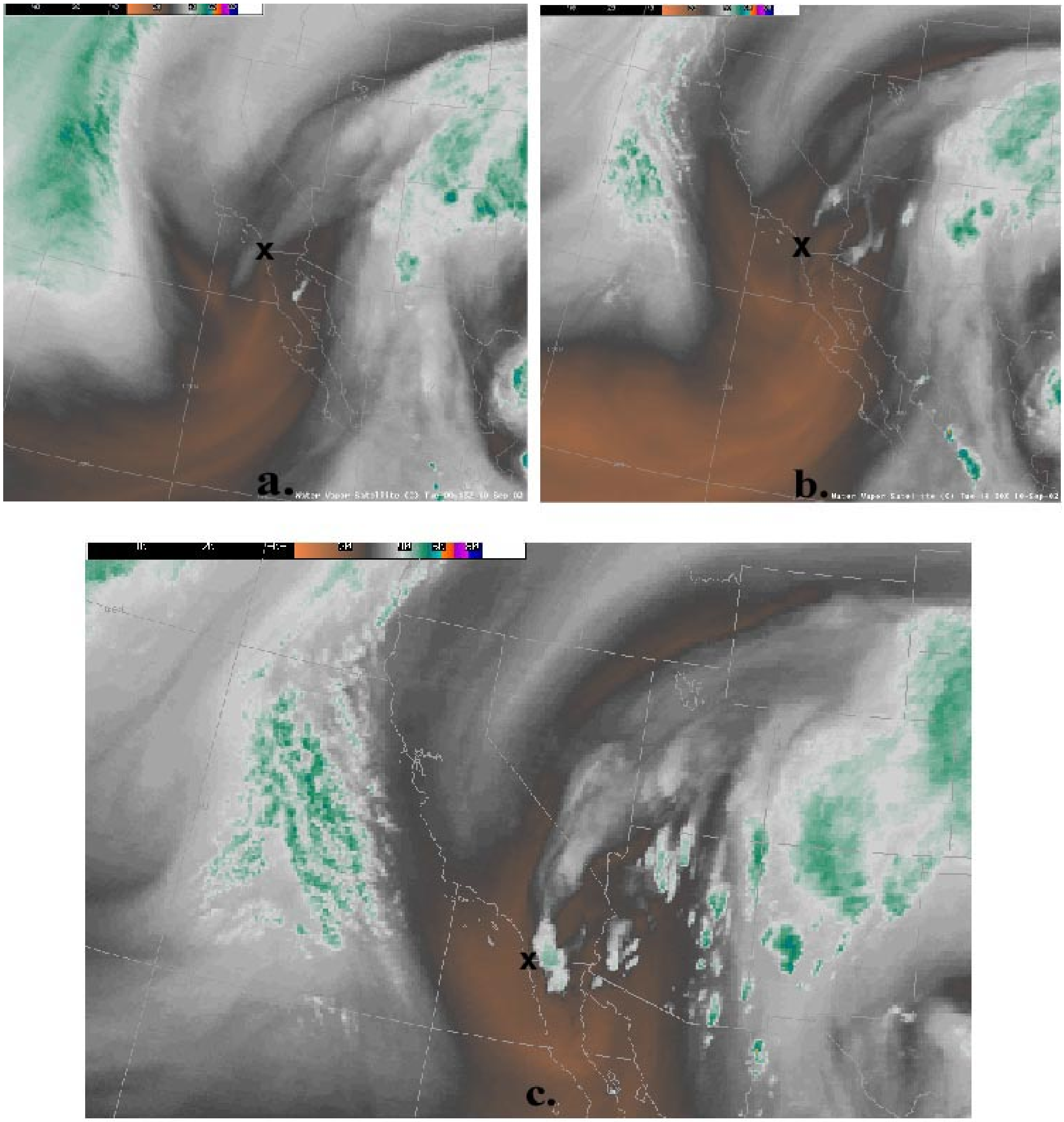

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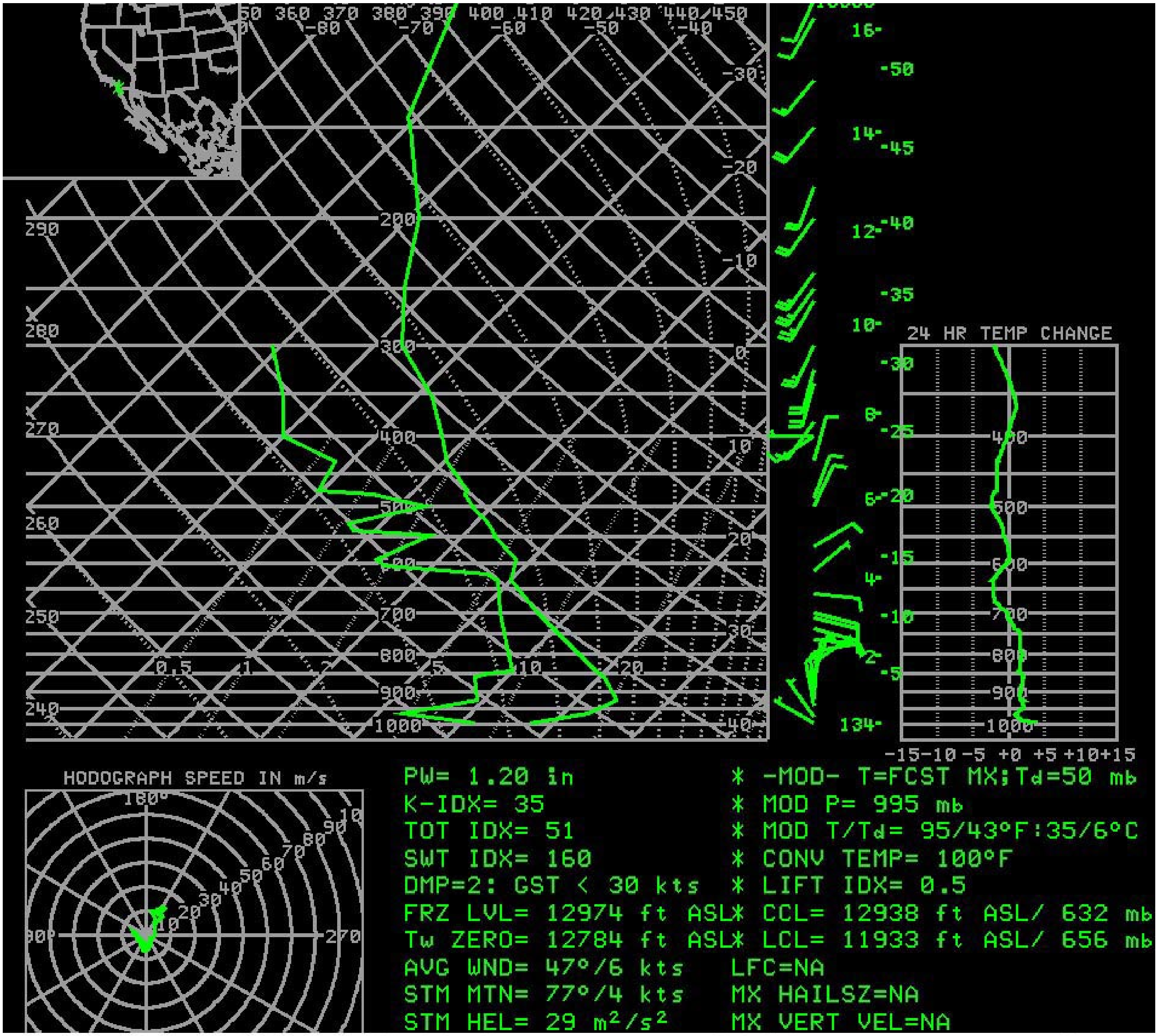
Figure 4



```
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K-IDX= 35                 * MOD P= 995 mb
TOT IDX= 51               * MOD T/Td= 95/43°F:35/6°C
SWT IDX= 160              * CONV TEMP= 100°F
DMP=2: GST < 30 kts       * LIFT IDX= 0.5
FRZ LVL= 12974 ft ASL* CCL= 12938 ft ASL/ 632 mb
Tw ZERO= 12784 ft ASL* LCL= 11933 ft ASL/ 656 mb
AVG WND= 47°/6 kts        LFC=NA
STM MTN= 77°/4 kts        MX HAILSZ=NA
STM HEL= 29 m²/s²         MX VERT VEL=NA
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Fig. 4. 1200 UTC 10 September 2002 NKX sounding

Figure 5a, 5b, and 5c

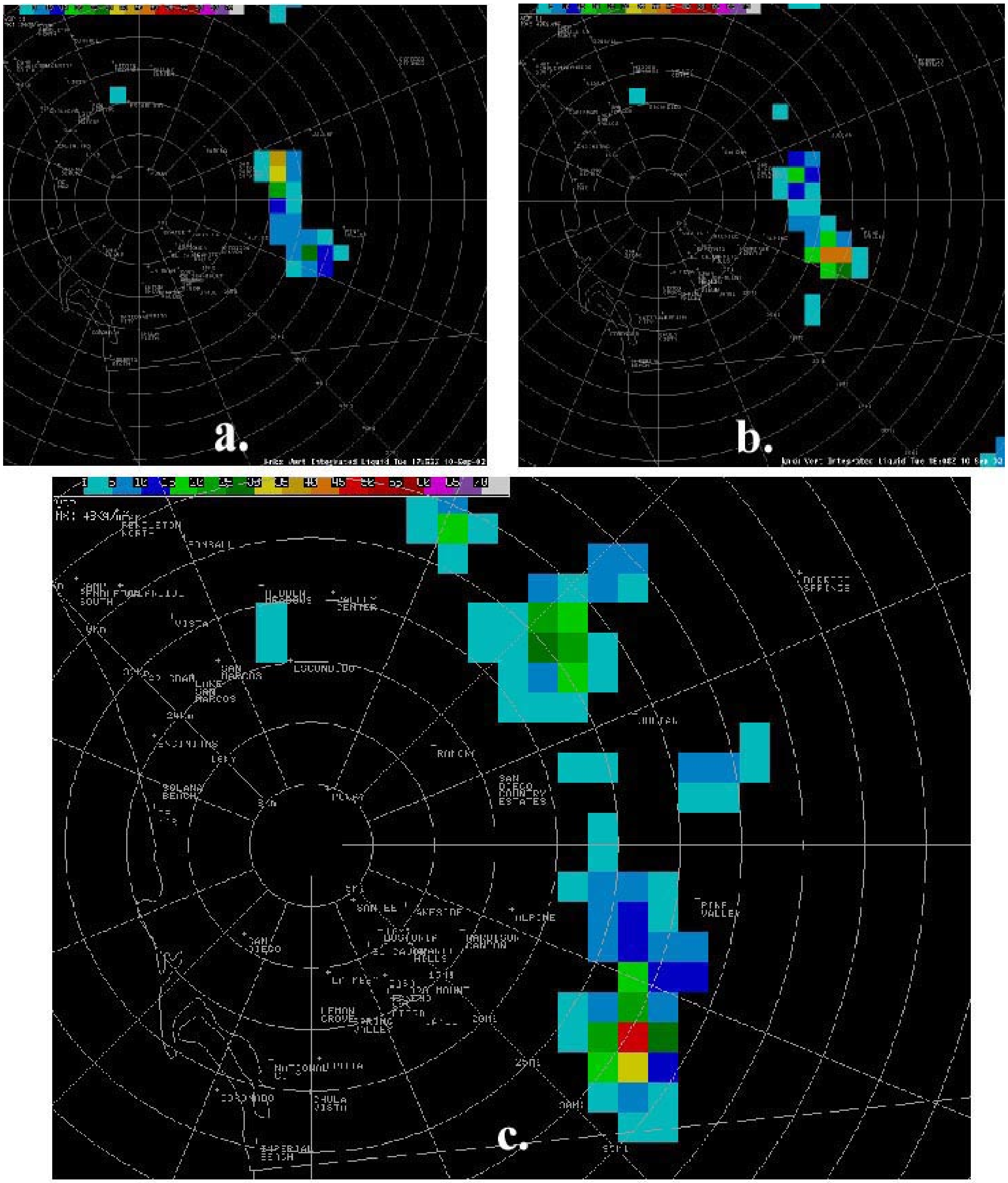

Fig. 5. KNKX WSR-88D VIL for the 3 large cells in San Diego County on 10 September 2002 at (a) 1753 UTC (b) 1808 UTC and (c) 1838 UTC.

Figure 6a, 6b, and 6c

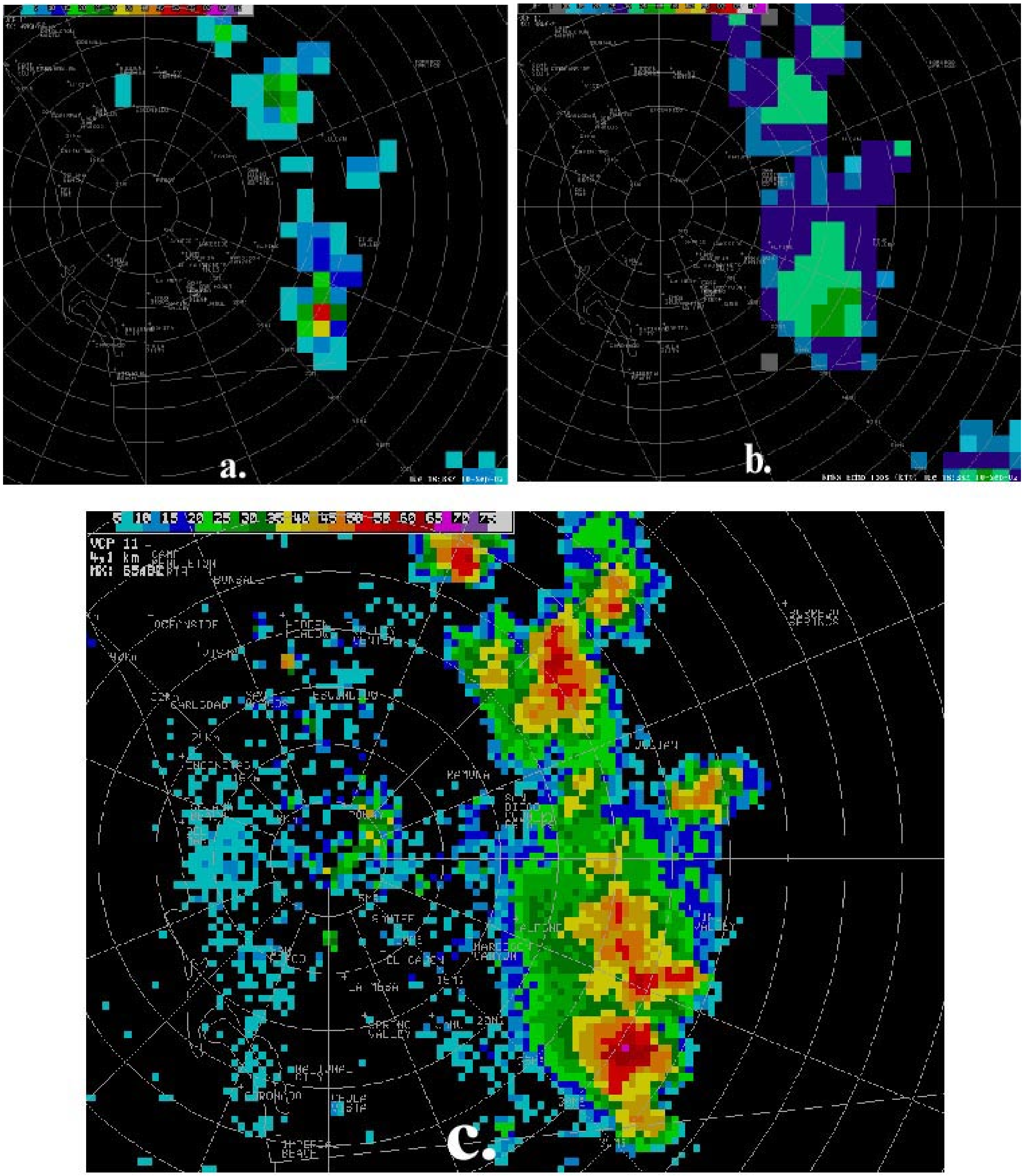

Fig. 6. KNKX WSR-88D imagery of the 3rd cell at 1838 UTC 10 September 2002 showing (a) VIL (b) Echo Top and (c) Composite Reflectivity