WES Case Study of a Strong Convective Outbreak over Western Nevada on August 4th, 2003

Brian Brong, WFO Reno, NV

Introduction

Several synoptic and mesoscale factors combined to generate a strong convective outbreak over western Nevada on August 4th, 2003. The thunderstorms produced severe wind gusts, heavy rain and small hail. Interstate 80 was closed due a mud slide along the Washoe-Storey county line in Nevada. The KRGX radar indicated a tornado approximately 17 miles west of Pyramid Lake, but due to the remote location no conformation was obtained. This paper will examine the synoptic and mesoscale patterns that produced this significant event by western Nevada standards.

Synoptic and Mesoscale Overview

An upper level low and associated jet streak (Figure 1) were off the California coast at 12Z August 4th, 2003. The low reached the coast while a jet streak moved into the central Sierra Nevada mountains that afternoon (Figure 2). The upper low combined with the diffluent left exit region of the jet to produce deep layer shear and large scale ascent above a moist unstable environment at the time of peak afternoon heating. The 12Z KREV sounding (Figure 3) showed this deep layer shear with the veering wind profile below 500 mb and a 0-3km storm relative helicity value of 172 m2/s2.

The 12Z KREV sounding on the 4th (Figure 3) also indicated an unstable environment was in place over western Nevada with an unusually high CAPE value of 1479 J/kg and a lifted index of -4.1. Sufficient moisture was in place with a PW value of 0.78 inches and high surface dew points in the low to mid 50s (Figure 4). The high surface dew points were a result of several days of subtropical moisture advection on the west side of an upper level anticyclone over Arizona and New Mexico. Figure 4 shows the LAPS mean sea level pressure analysis and surface observations from 16Z. The analysis indicates a thermal trough over the Sierra Nevada, which will shift east and serve as the surface focusing mechanism for convective initiation.

This environment was capable of producing isolated supercells with a threat of large hail and damaging winds. The wind and hail threat was echoed by SPC, which placed western Nevada under a slight risk of severe thunderstorms and issued two mesoscale discussions to highlight the event. Heavy rain was also a big concern due to the high surface dew points and precipitable water values with the approaching upper low. A small threat of tornadoes also existed due to the combination of moderate storm relative helicity and strong buoyancy from the 12Z sounding.

Event Discussion

By 21Z, strong surface heating shifted the position of the thermal trough (Figure 5) to the east, from Bishop, CA (KBIH) northward to Lovelock, NV (KLOL). This also shifted the winds over the Sierra Nevada around Lake Tahoe from southeast to the west and southwest. Gusty south winds at KBIH and Tonopah, NV (KTPH) were providing additional inflow to western Nevada. The resulting area of surface convergence initiated convection to the east of Lake Tahoe over Douglas and Lyon counties (Figure 6). These storms intensified rapidly between 22Z and 23Z as the large scale ascent associated with the upper low moved over western Nevada. One cell just east of Reno (KRNO, Figure 7) evolved into a supercell and split over Storey County (Figures 8 and 9). As this cell crossed Interstate 80, heavy rainfall produced a mud and rock slide that closed the highway. The left mover passed over the Palomino Valley and continued to produce heavy rain and wind gusts between 50 and 60 mph. Figure 9 also shows another strong cell developing to the south of Virginia City which followed the path of the supercell. Heavy rain and small hail was reported from Virginia City to the Palomino Valley, with as much as one inch of rain in fifteen minutes.

A thunderstorm developed on the northwest side of Pyramid Lake and produced outflow just after 00Z August 5th. The outflow interacted with the westerly winds off the Sierra Nevada, resulting in a surface boundary 20 miles west of Pyramid Lake (Figure 10, 0.5 velocity, and Figure 11, 0.5 reflectivity). At 01Z August 5th, a thunderstorm developed south of this boundary and tracked northward. This thunderstorm interacted with the surface boundary and produced a very strong rotational signature at 0123Z (Figure 12). The surface boundary likely enhanced the low level shear and was the last piece of the puzzle for tornadic development. Unfortunately due to the remote location, no verification was obtained to prove that a tornado was produced from this rotational signature.

Figure 1

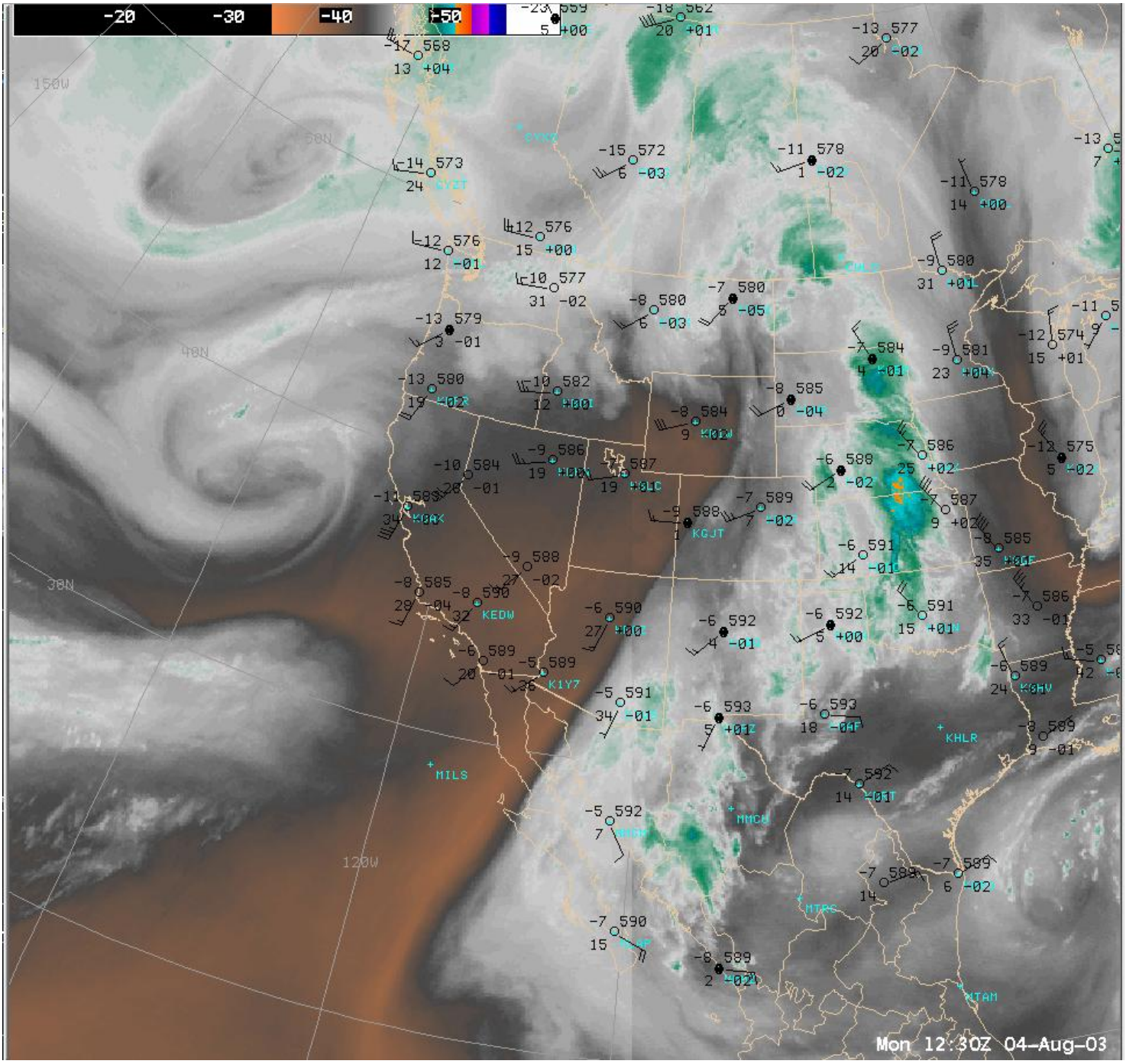

-20
-30
-40
-50
150W
50N
40N
30N
120W
KGJT
KEDW
KHLR
MILS
Mon 12:30Z 04-Aug-03

Figure 2

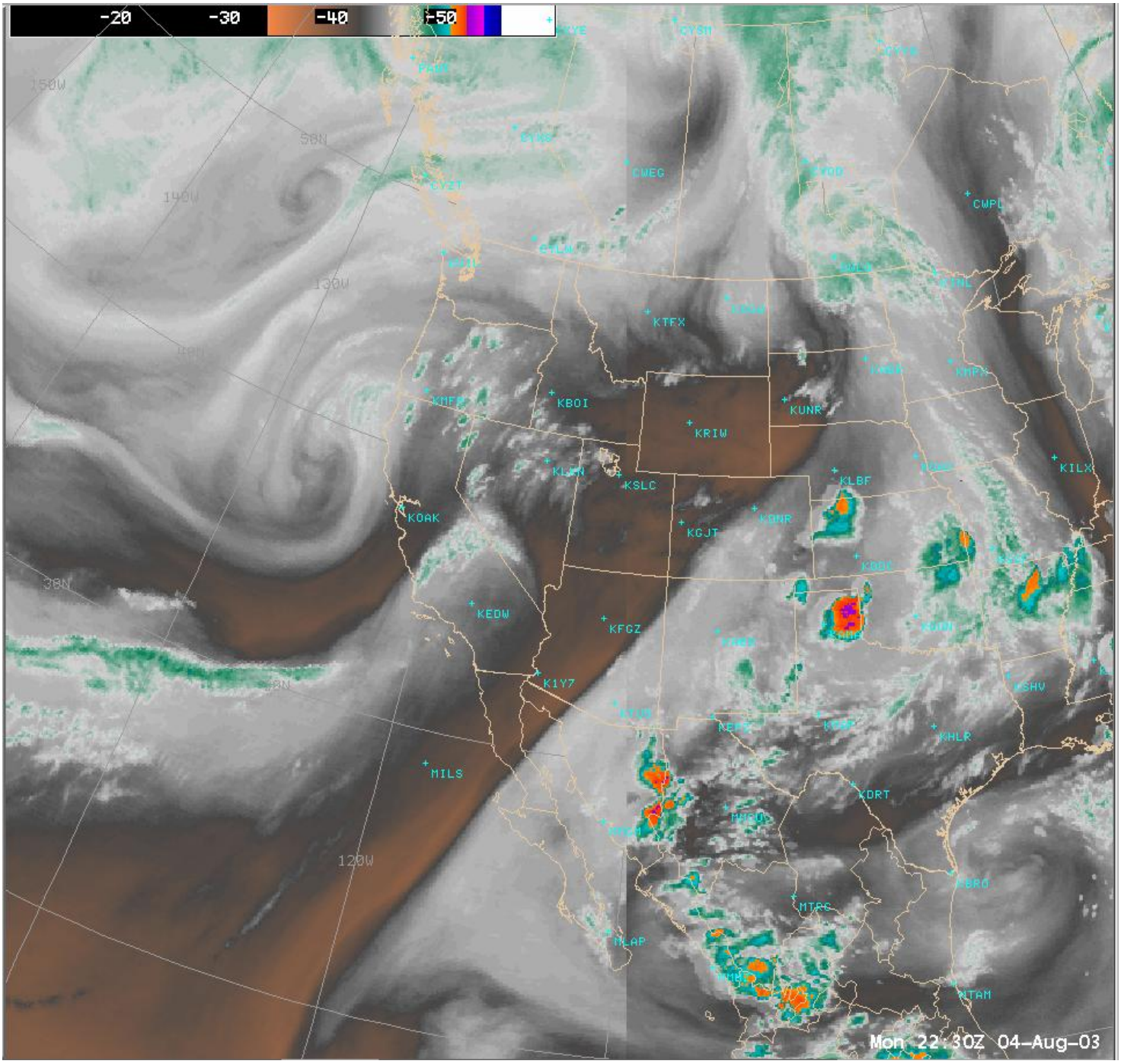

-20
-30
-40
-50
CYSN
CYVP
CWEG
CYOD
CWPL
CYZT
CYLW
KTFX
KMFR
KBOI
KUNR
KRIW
KLWN
KSLC
KLBF
KOAK
KGJT
KEDW
KFGZ
K1Y7
KSHV
KHLR
MILS
KDRT
MTPG
MLAP
KTAM
Mon 22:30Z 04-Aug-03

Figure 3

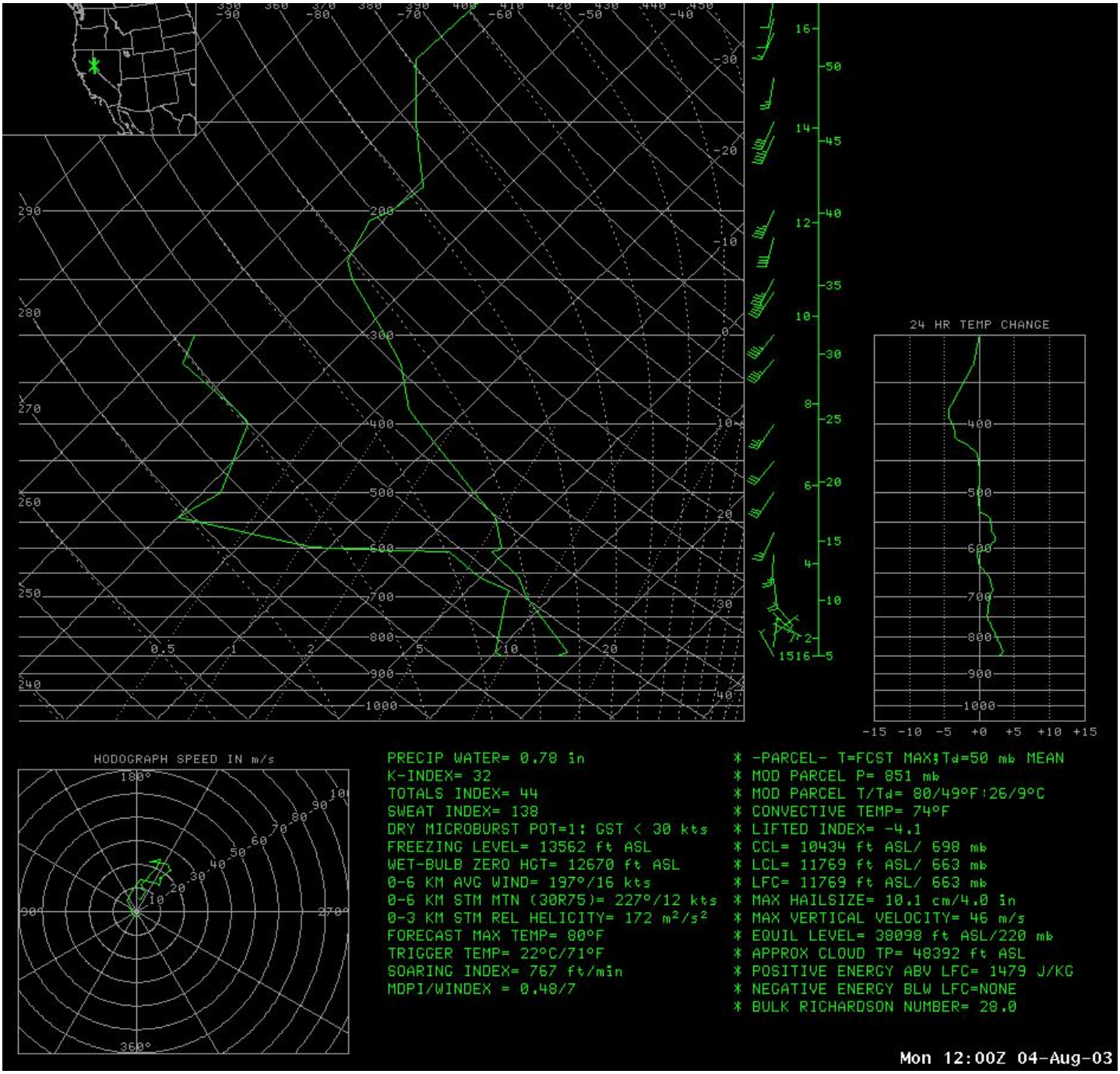

24 HR TEMP CHANGE
HODOGRAPH SPEED IN m/s
PRECIP WATER= 0.78 in
K-INDEX= 32
TOTALS INDEX= 44
SWEAT INDEX= 138
DRY MICROBURST POT=1: GST < 30 kts
FREEZING LEVEL= 13562 ft ASL
WET-BULB ZERO HGT= 12670 ft ASL
0-6 KM AVG WIND= 197°/16 kts
0-6 KM STM MTN (30R75)= 227°/12 kts
0-3 KM STM REL HELICITY= 172 m²/s²
FORECAST MAX TEMP= 80°F
TRIGGER TEMP= 22°C/71°F
SOARING INDEX= 767 ft/min
MDPI/WINDEX = 0.48/7
* -PARCEL- T=FCST MAX;Td=50 mb MEAN
* MOD PARCEL P= 851 mb
* MOD PARCEL T/Td= 80/49°F:26/9°C
* CONVECTIVE TEMP= 74°F
* LIFTED INDEX= -4.1
* CCL= 10434 ft ASL/ 698 mb
* LCL= 11769 ft ASL/ 663 mb
* LFC= 11769 ft ASL/ 663 mb
* MAX HAILSIZE= 10.1 cm/4.0 in
* MAX VERTICAL VELOCITY= 46 m/s
* EQUIL LEVEL= 38098 ft ASL/220 mb
* APPROX CLOUD TP= 48392 ft ASL
* POSITIVE ENERGY ABV LFC= 1479 J/KG
* NEGATIVE ENERGY BLW LFC=NONE
* BULK RICHARDSON NUMBER= 28.0
Mon 12:00Z 04-Aug-03

Figure 4

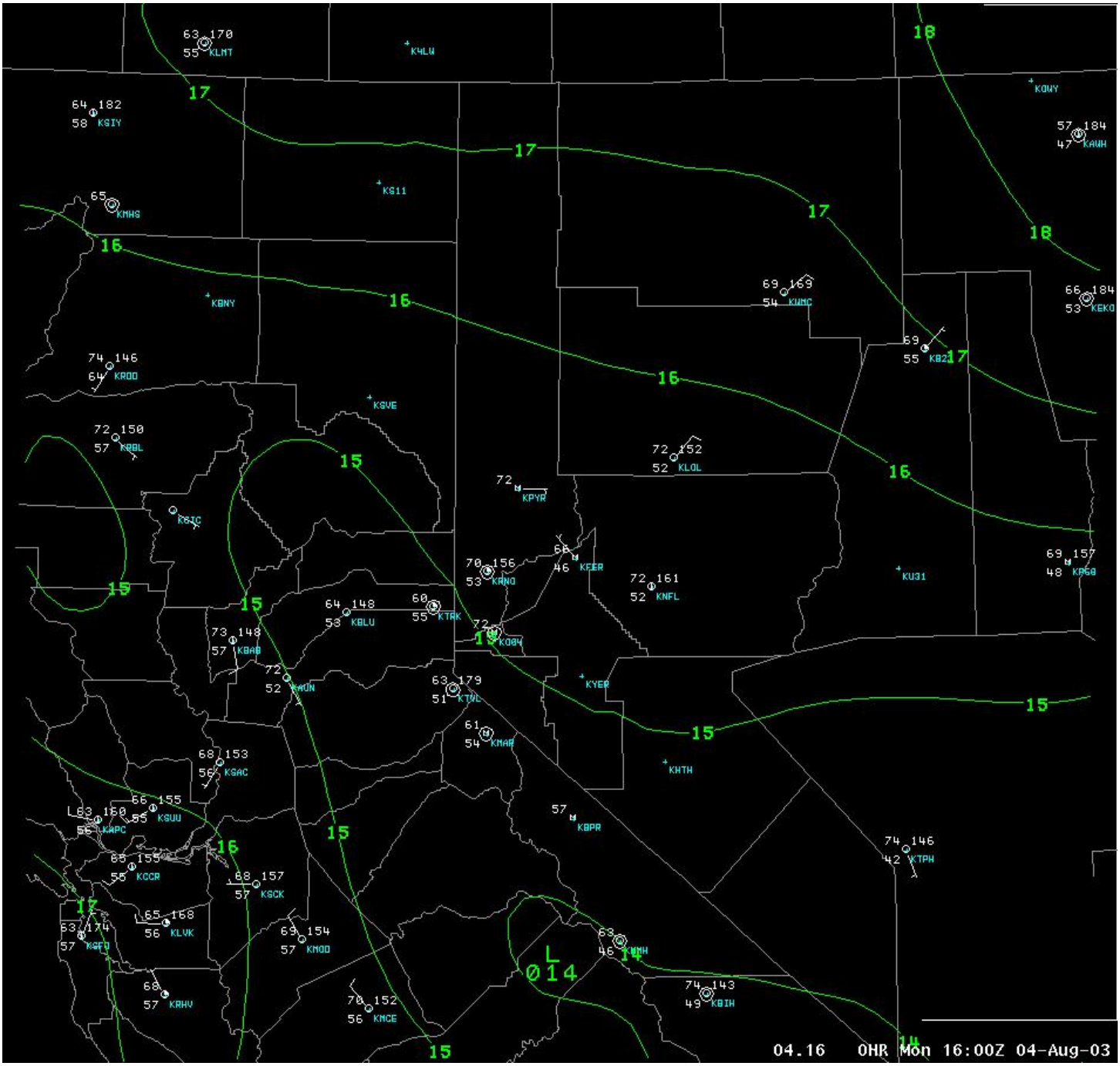


Figure 5

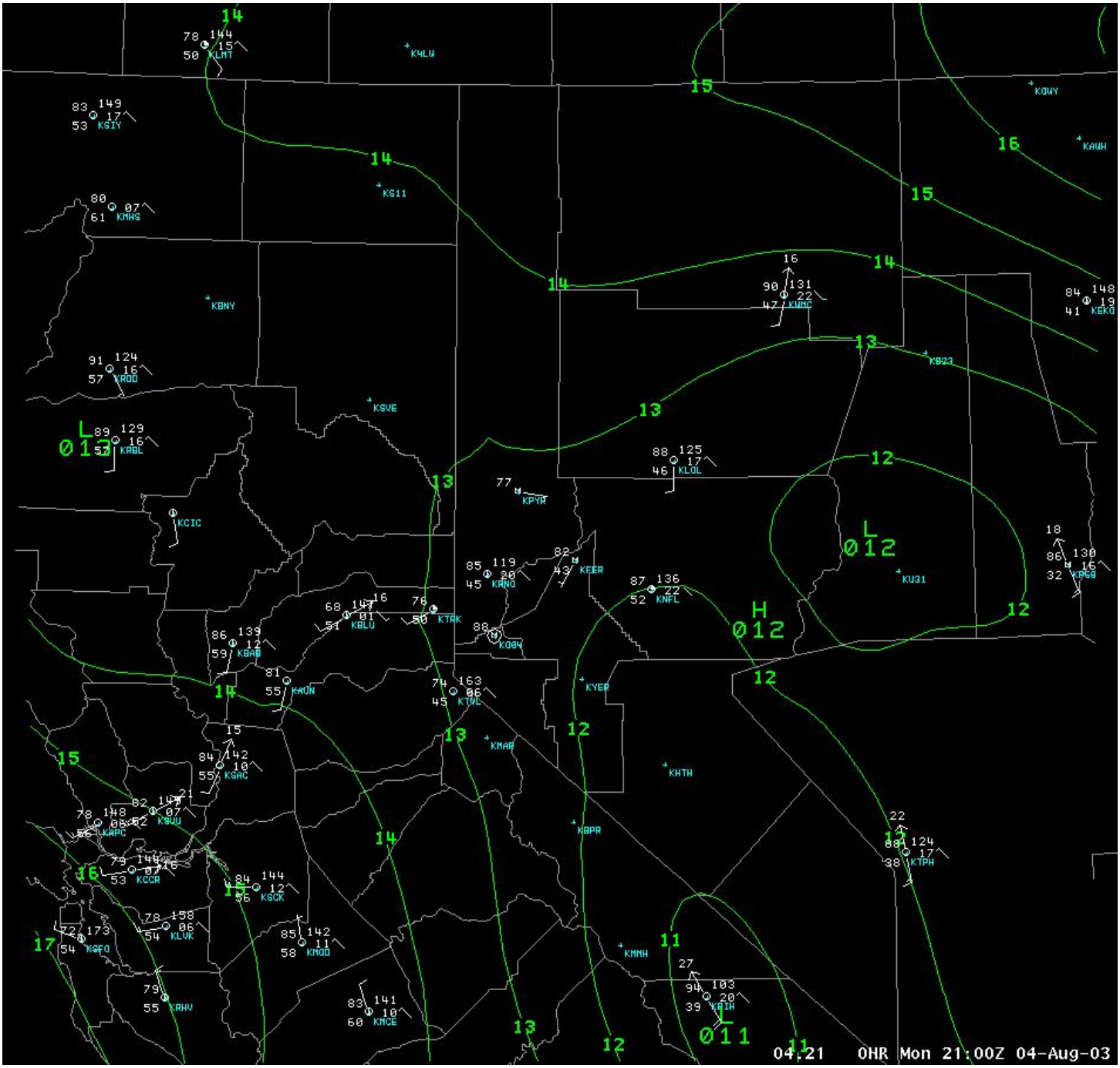


Figure 6

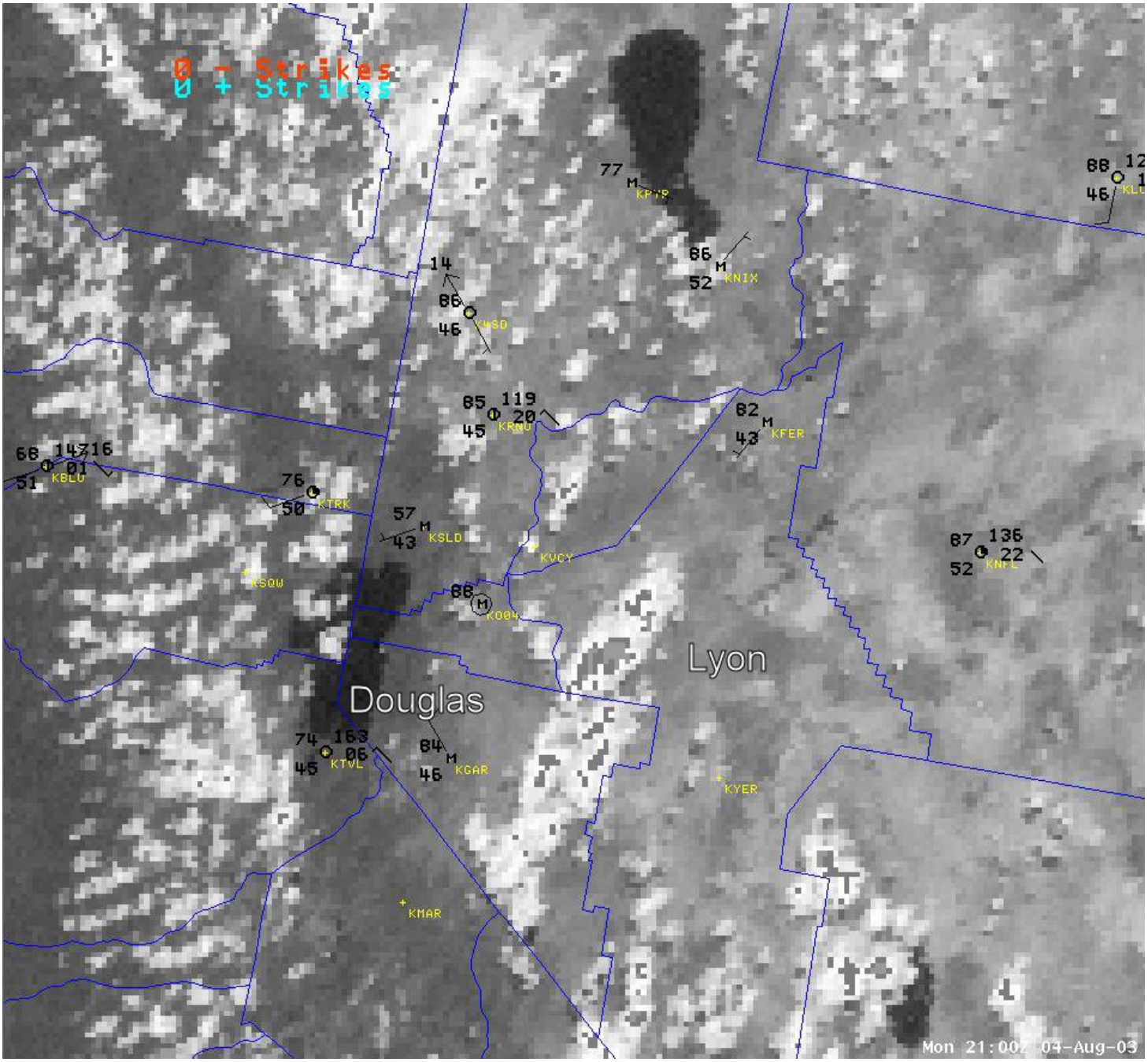

0 - Strikes
0 + Strikes
Douglas
Lyon
KBLU
KTRK
KSLD
KSQW
KVCV
KO04
KRNO
KFER
KNIX
KTVL
KGAR
KYER
KMAR
Mon 21:00 04-Aug-03

Figure 7

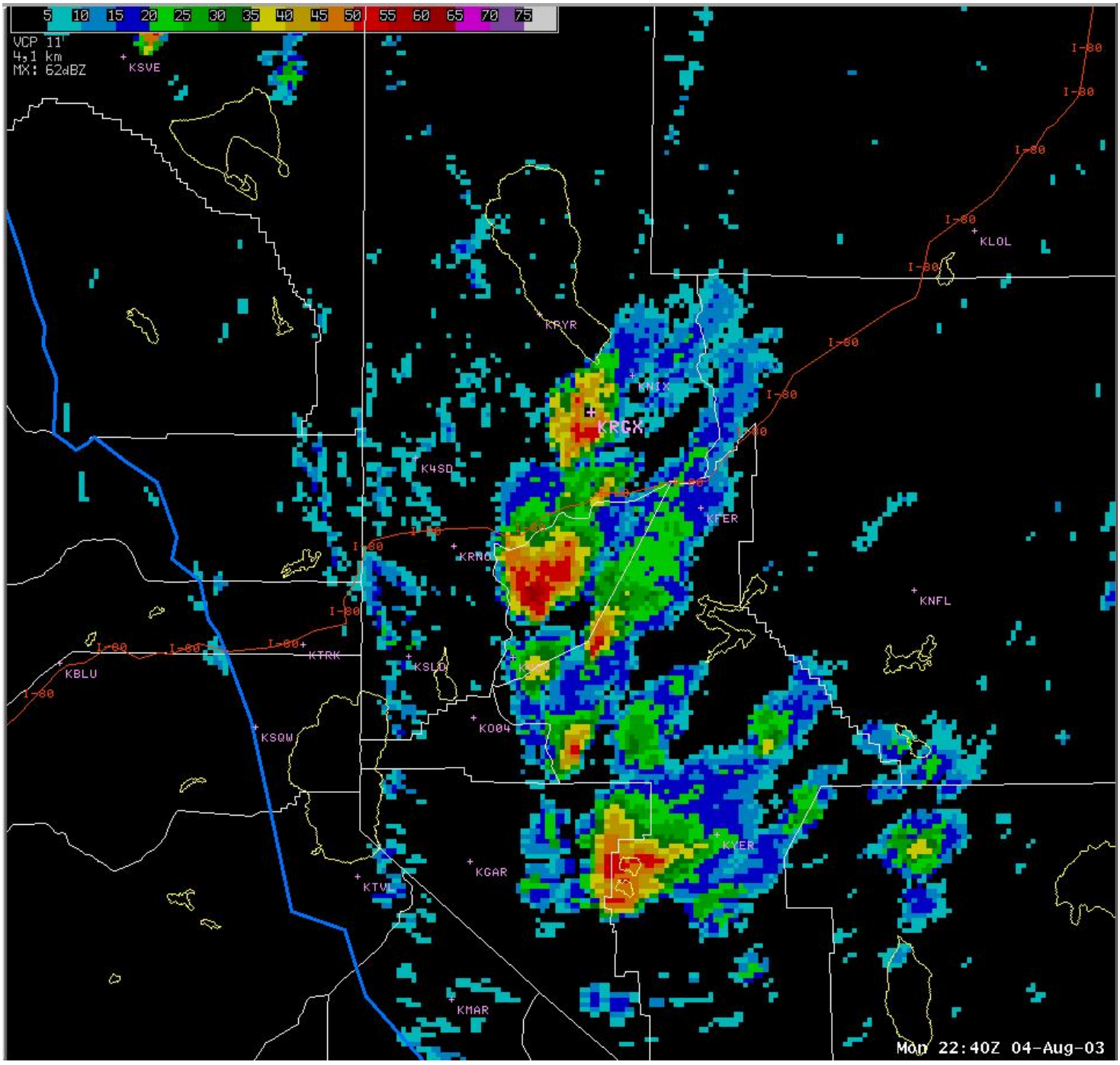

5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
VCP 11
4.1 km
MX: 62dBZ
KSVE
KLOL
KRYR
KFTG
KRGX
K4SD
KFER
KRNO
KNFL
KTRK
KBLU
KSLC
KSQW
KO04
KVER
KGAR
KTVL
KMAR
I-80
Mon 22:40Z 04-Aug-03

Figure 8

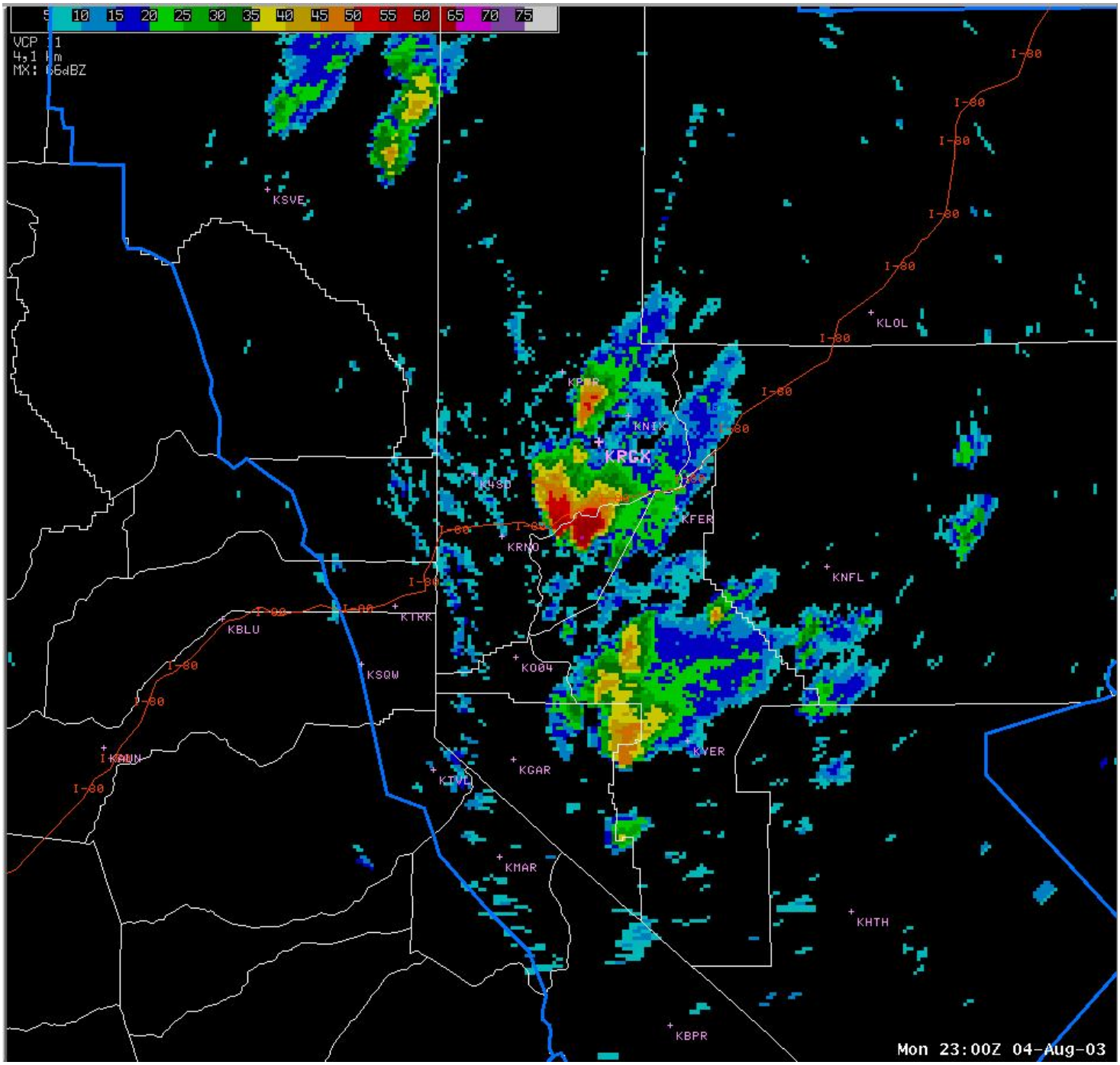

5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
VCP 11
4,1 km
MX: 66dBZ
KSVE
KLOL
KPUX
KNIX
KRCK
KFTG
KFER
KRNO
KNFL
KTRK
KBLU
KSQW
KO04
KAUN
KGAR
KTVL
KVER
KMAR
KHTH
KBPR
I-80
Mon 23:00Z 04-Aug-03

Figure 9

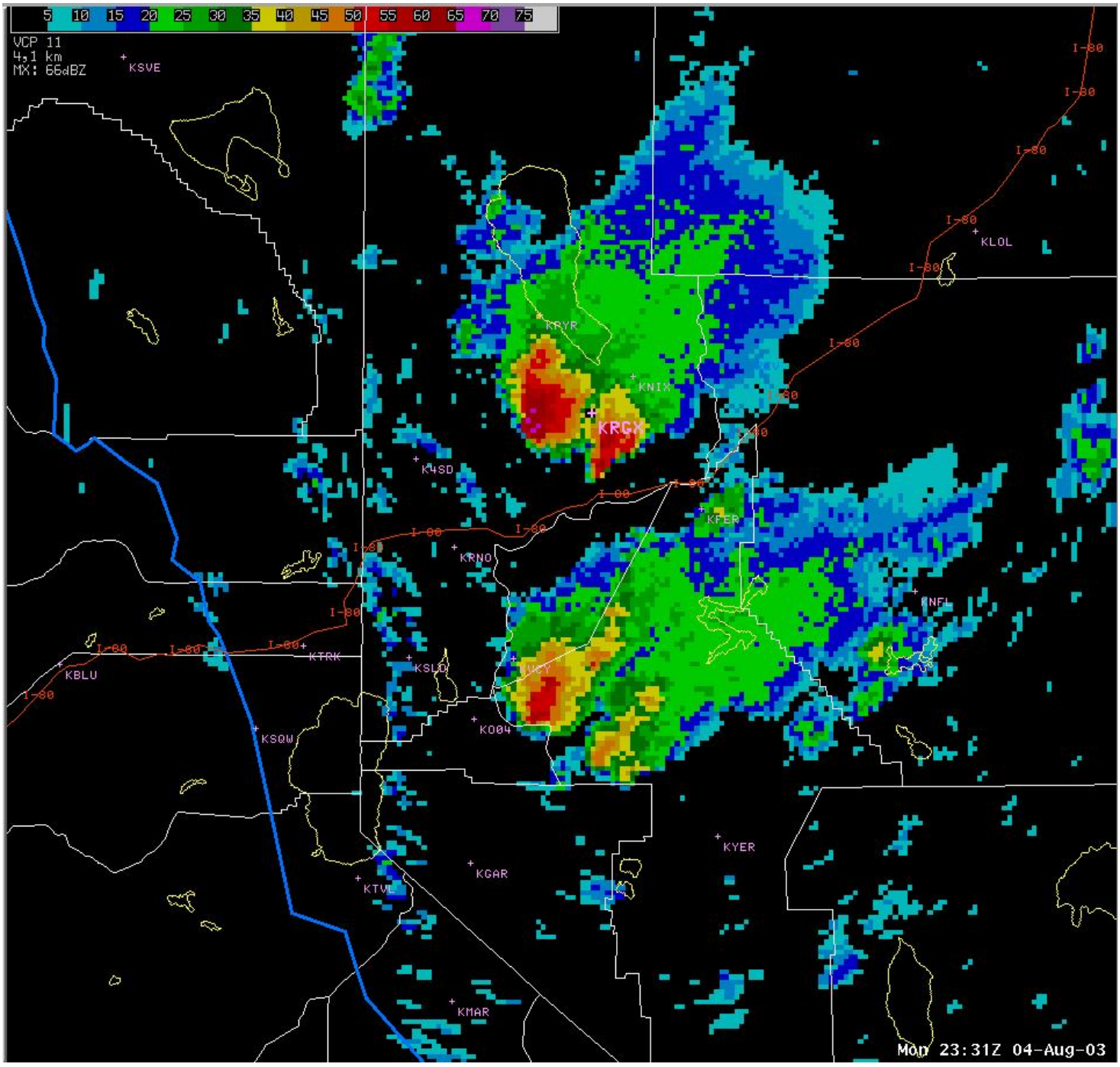

5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
VCP 11
4,1 km
MX: 66dBZ
KSVE
KLOL
KRYR
KNIX
KRGX
K4SD
KFER
KRNO
KBLU
KTRK
KSLC
KSQW
KO04
KYER
KGAR
KTVL
KMAR
Mon 23:31Z 04-Aug-03

Figure 10

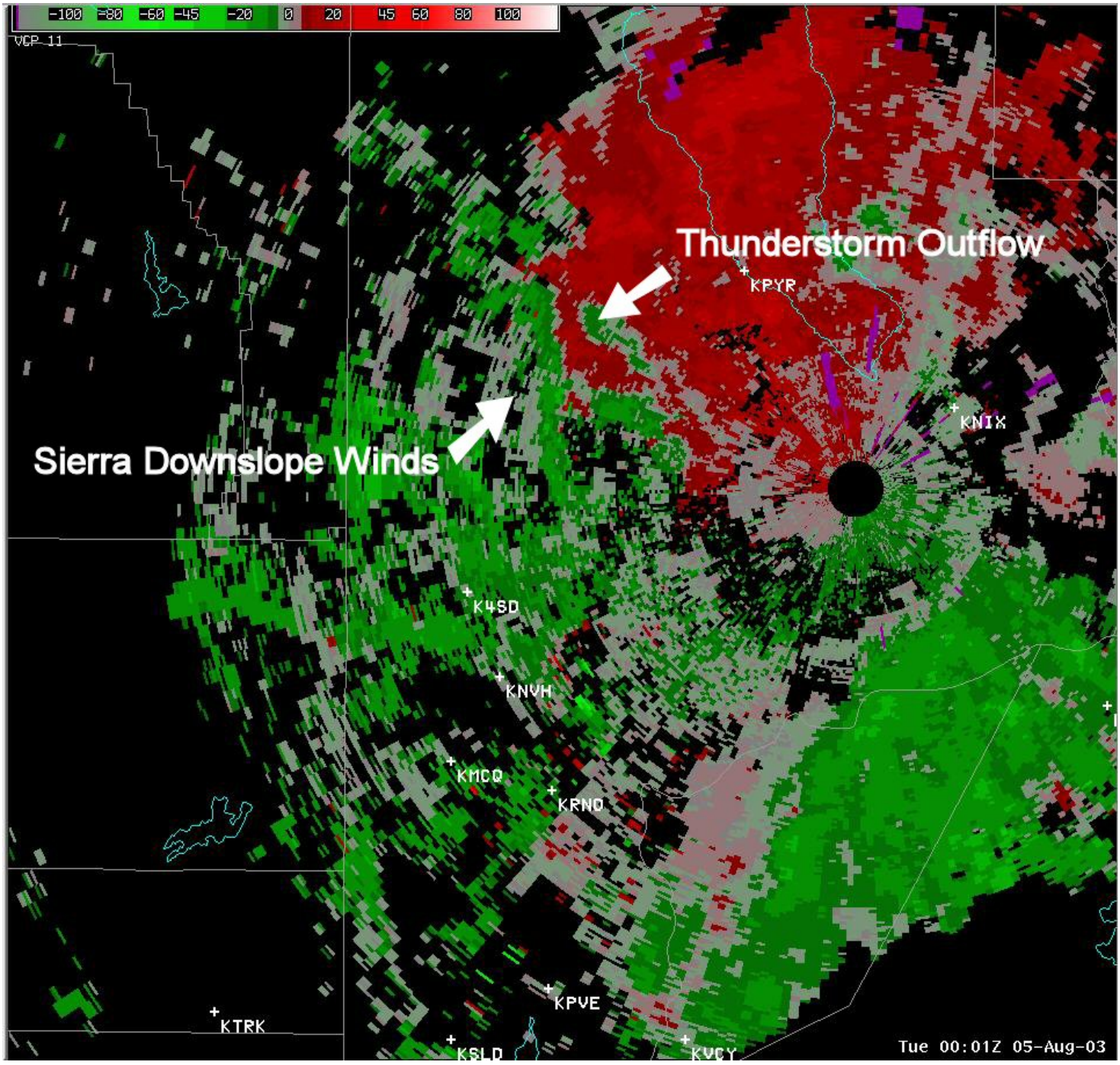

-100 -80 -60 -45 -20 0 20 45 60 80 100
VCP 11
Thunderstorm Outflow
KPYR
KNIX
Sierra Downslope Winds
K4SD
KNVH
KMCQ
KRNO
KPVE
KTRK
KSLD
KVCY
Tue 00:01Z 05-Aug-03

Figure 11

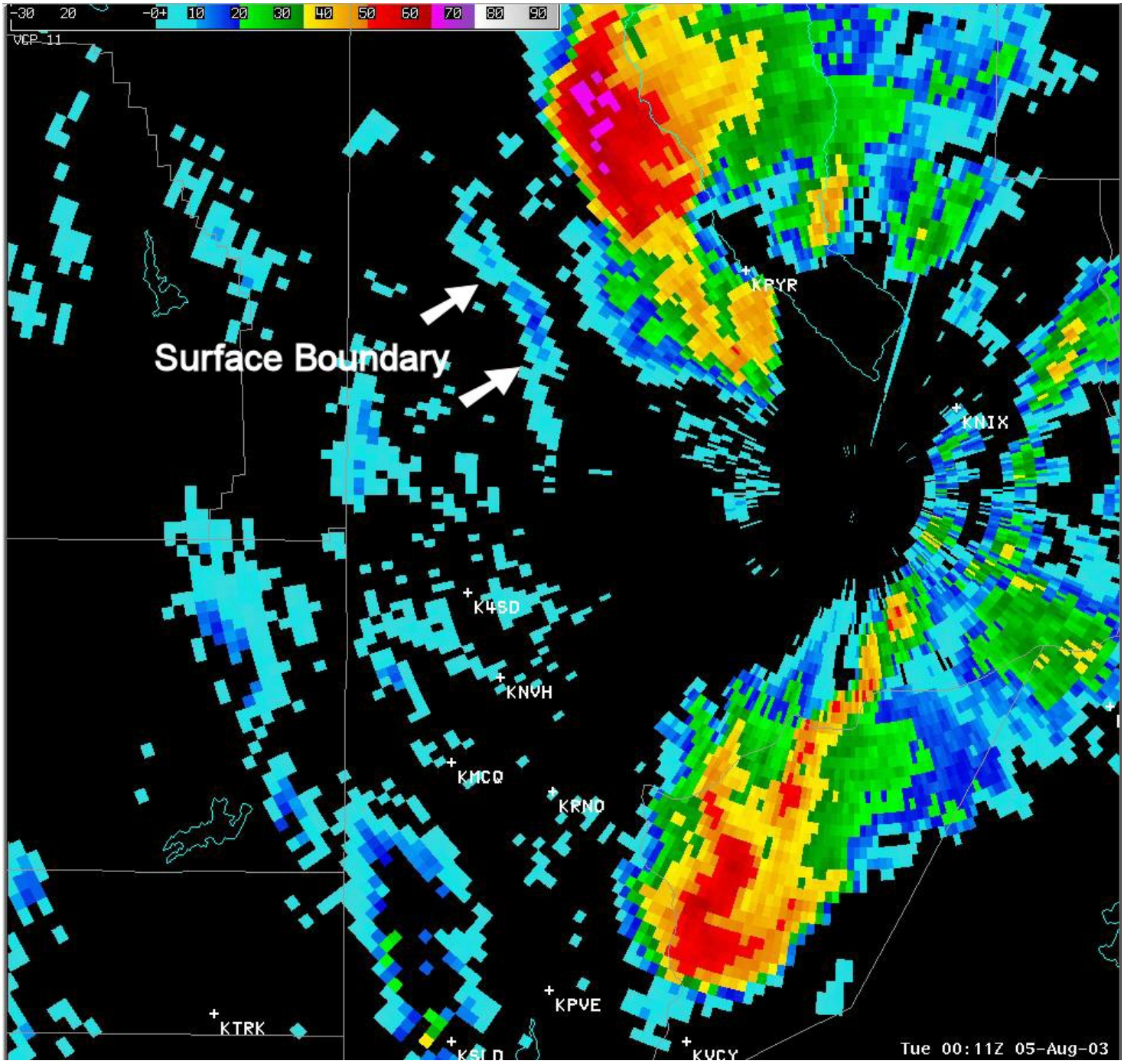
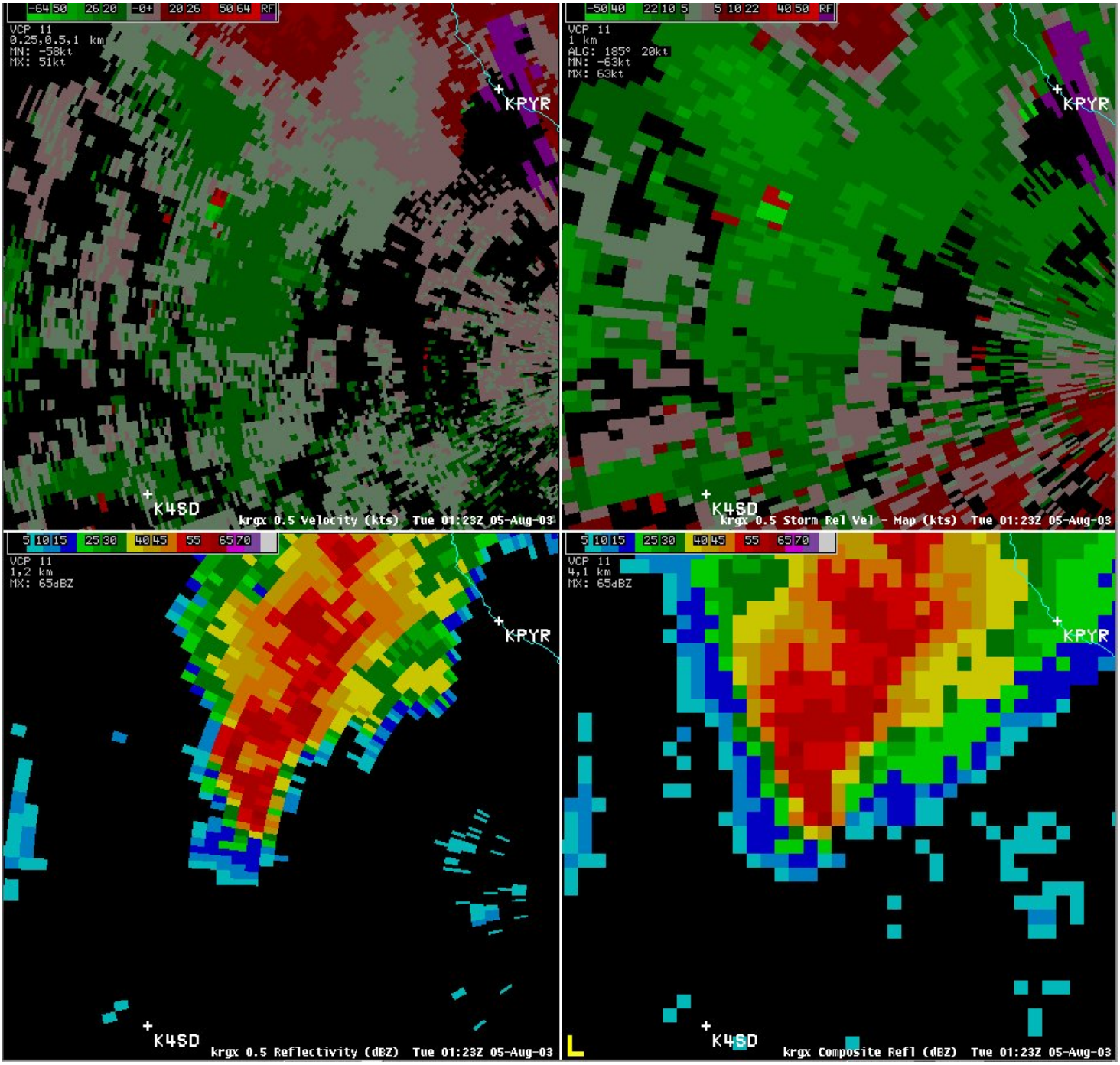

-30 20 -0+ 10 20 30 40 50 60 70 80 90
VCP 11
Surface Boundary
KRYR
KNIX
K4SD
KNVH
KMCQ
KRND
KPVE
KTRK
KSLD
KVCY
Tue 00:11Z 05-Aug-03

Figure 12


VCP 11
0.25,0.5,1 km
MN: -58kt
MX: 51kt
KRYR
K4SD
krgx 0.5 Velocity (kts) Tue 01:23Z 05-Aug-03
VCP 11
1 km
ALG: 185° 20kt
MN: -63kt
MX: 63kt
KRYR
K4SD
krgx 0.5 Storm Rel Vel - Map (kts) Tue 01:23Z 05-Aug-03
VCP 11
1,2 km
MX: 65dBZ
KRYR
K4SD
krgx 0.5 Reflectivity (dBZ) Tue 01:23Z 05-Aug-03
VCP 11
4,1 km
MX: 65dBZ
KRYR
K4SD
krgx Composite Refl (dBZ) Tue 01:23Z 05-Aug-03