Ready to begin

Failure Modes

David L. Andra, Jr.
Science and Operations Officer
WFO Norman, Oklahoma

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Failure Mode:

The manner in which a system fails.

Examples

- Technology - WSR-88D klystron fails preventing access to critical data.
- Conceptual – Forecaster fails to recognize small storm as mini-supercell.
- Organizational – Absence of well defined job roles and mission priorities leads to failure in SA.

Failure Mode and Effects Analysis

A technique employed by engineers to improve system performance.

Failure Mode and Effects Analysis

- 1. Define failure mode.
- 2. Identify cause of failure.
- 3. Identify effects of failure.
- 4. Corrective action.

An Example

- *Failure mode*: Conceptual
- *Cause*: Failed to identify mini-SC
  - Mini-SC characteristics not understood by forecaster
- *Effects*: Injuries and loss of life
- *Correction*: Training for staff on mini-SC structure and evolution

Strategy to Improve

- Try to eliminate the failure mode.
- Minimize the severity of the failure.
- Reduce the occurrence of the failure mode.
- Improve the detection.

Other Considerations

Some failures are more preventable than others!

Examples

- *Relatively easy to prevent*:
  - Failure mode: Conceptual
  - Cause: Classic SC not recognized
    - Forecaster only uses 0.5 deg R product
  - Effect: Loss of life, feature on Dateline
  - Correction: Training, etc.

Examples

- *Nearly impossible to prevent:*
  - Failure mode: Technological
  - Cause: mini-SC at long range and embedded stratiform pcpn, night, sparse population. Brief tornado.
  - Effect: mobile home destroyed with loss of life.
  - Correction: maybe better VCPs or new radar?

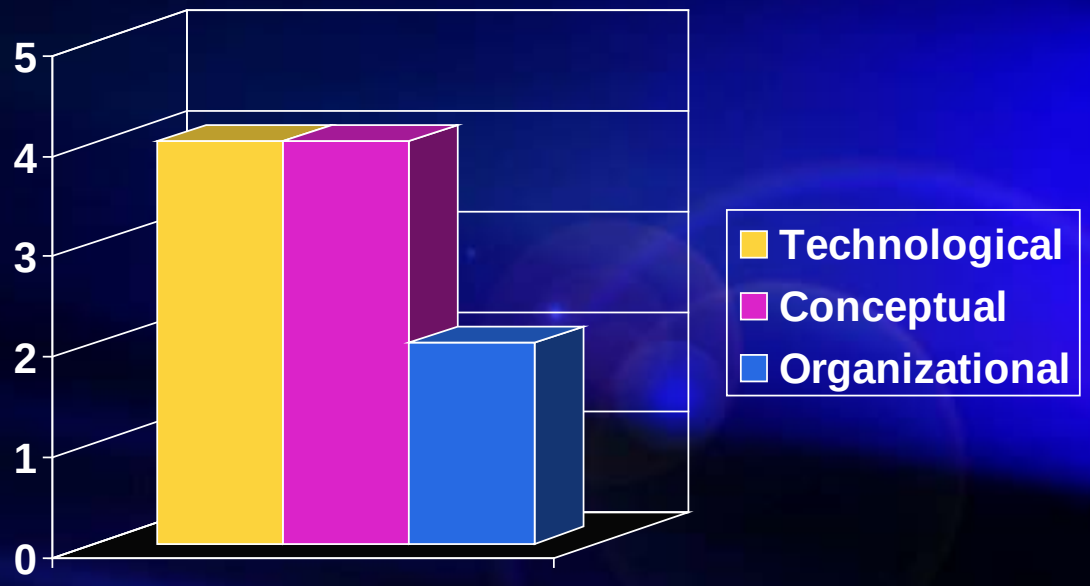
Ten Recent Disasters

(since 1989)

Complete Embarrassment

AOG

By Failure Mode



Failure Mode and Effects Analysis (FMEA) is only a tool to identify potential or actual points of failure and identify corrective action.

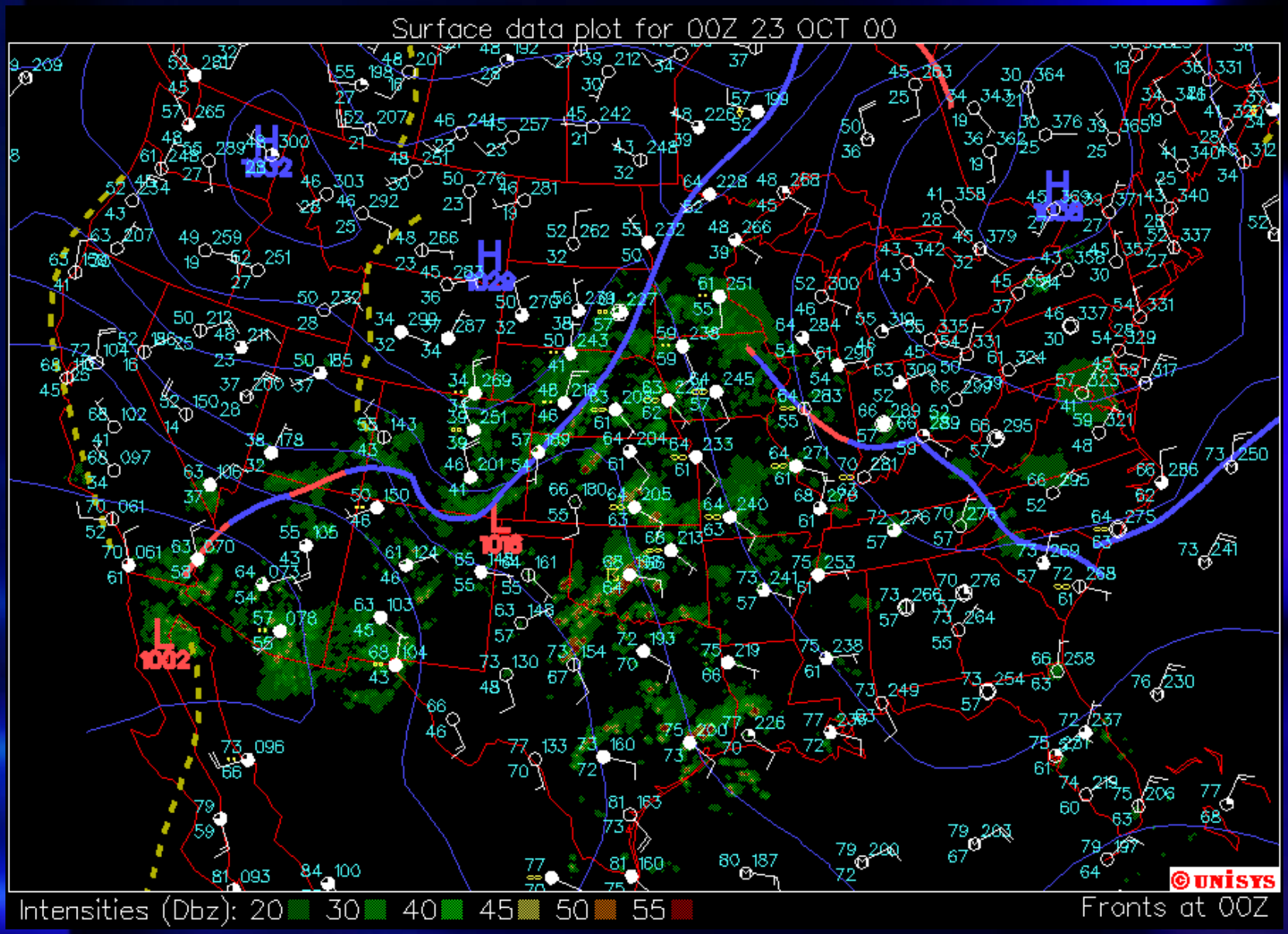
A Case Analysis

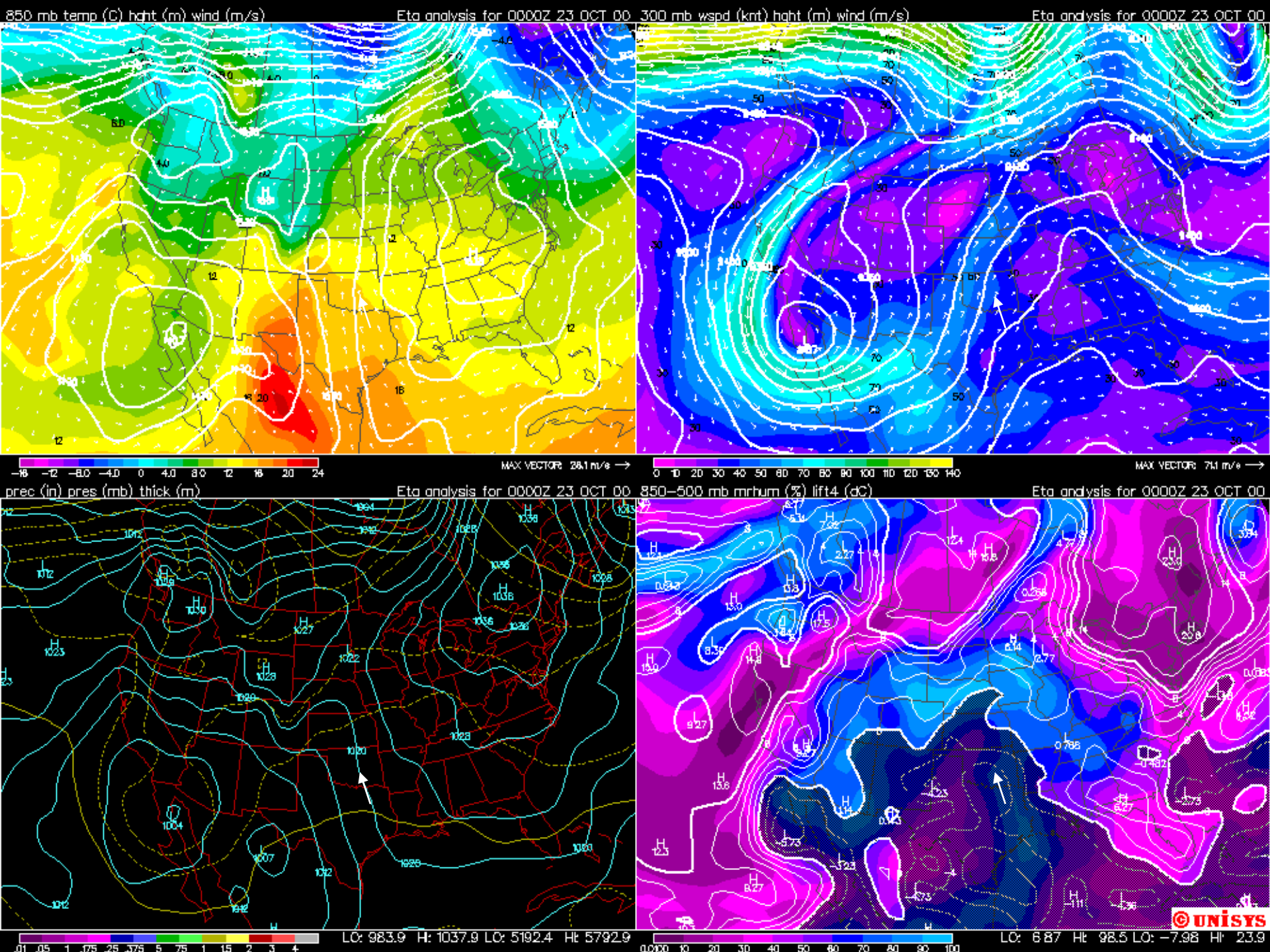
A nearly unwarned tornado in OKC metro area

WFO Norman

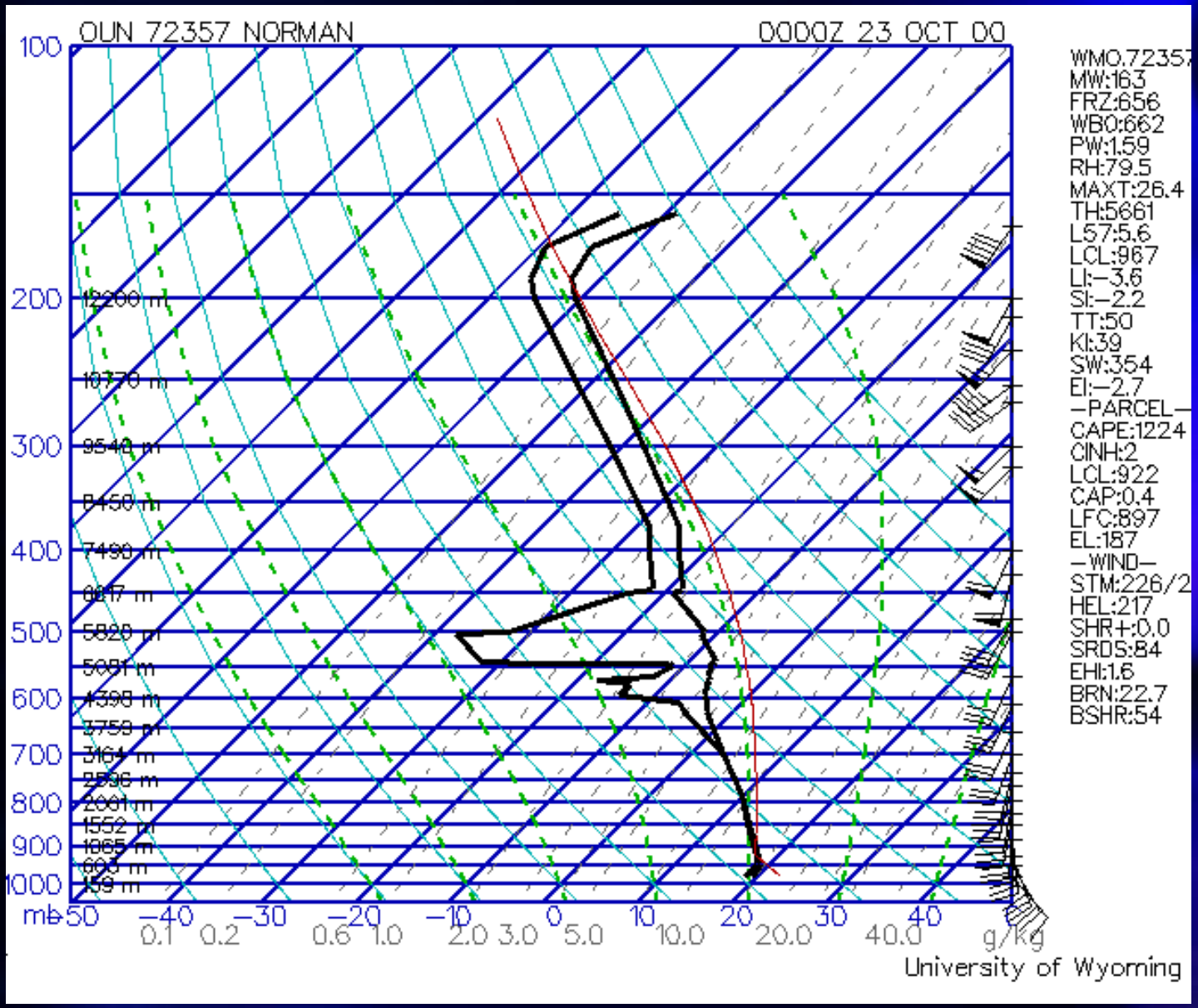
October 22, 2000

Surface 00Z


Surface data plot for 00Z 23 OCT 00
Intensities (Dbz): 20 30 40 45 50 55
Fronts at 00Z
©UNISYS


850 mb temp (C) hght (m) wind (m/s)
Eta analysis for 0000Z 23 OCT 00
300 mb wspd (knt) hght (m) wind (m/s)
Eta analysis for 0000Z 23 OCT 00
MAX VECTOR: 28.1 m/s
MAX VECTOR: 71 m/s
prec (in) pres (mb) thick (m)
Eta analysis for 0000Z 23 OCT 00
850-500 mb mrhum (%) lift4 (dC)
Eta analysis for 0000Z 23 OCT 00
LO: 983.9 HI: 1037.9 LO: 5192.4 HI: 5792.9
LO: 6.87 HI: 98.5 LO: -7.98 HI: 23.9
©UNISYS

00Z OUN Raob


OUN 72357 NORMAN
0000Z 23 OCT 00
WMO:72357
MW:163
FRZ:656
WB0:662
PW:1.59
RH:79.5
MAXT:26.4
TH:5661
L57:5.6
LCL:967
LI:−3.6
SI:−2.2
TT:50
KI:39
SW:354
EI:−2.7
−PARCEL−
CAPE:1224
CINH:2
LCL:922
CAP:0.4
LFC:897
EL:187
−WIND−
STM:226/2
HEL:217
SHR+:0.0
SRDS:84
EHI:1.6
BRN:22.7
BSHR:54
100
200
300
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700
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mb
−50
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20
30
40
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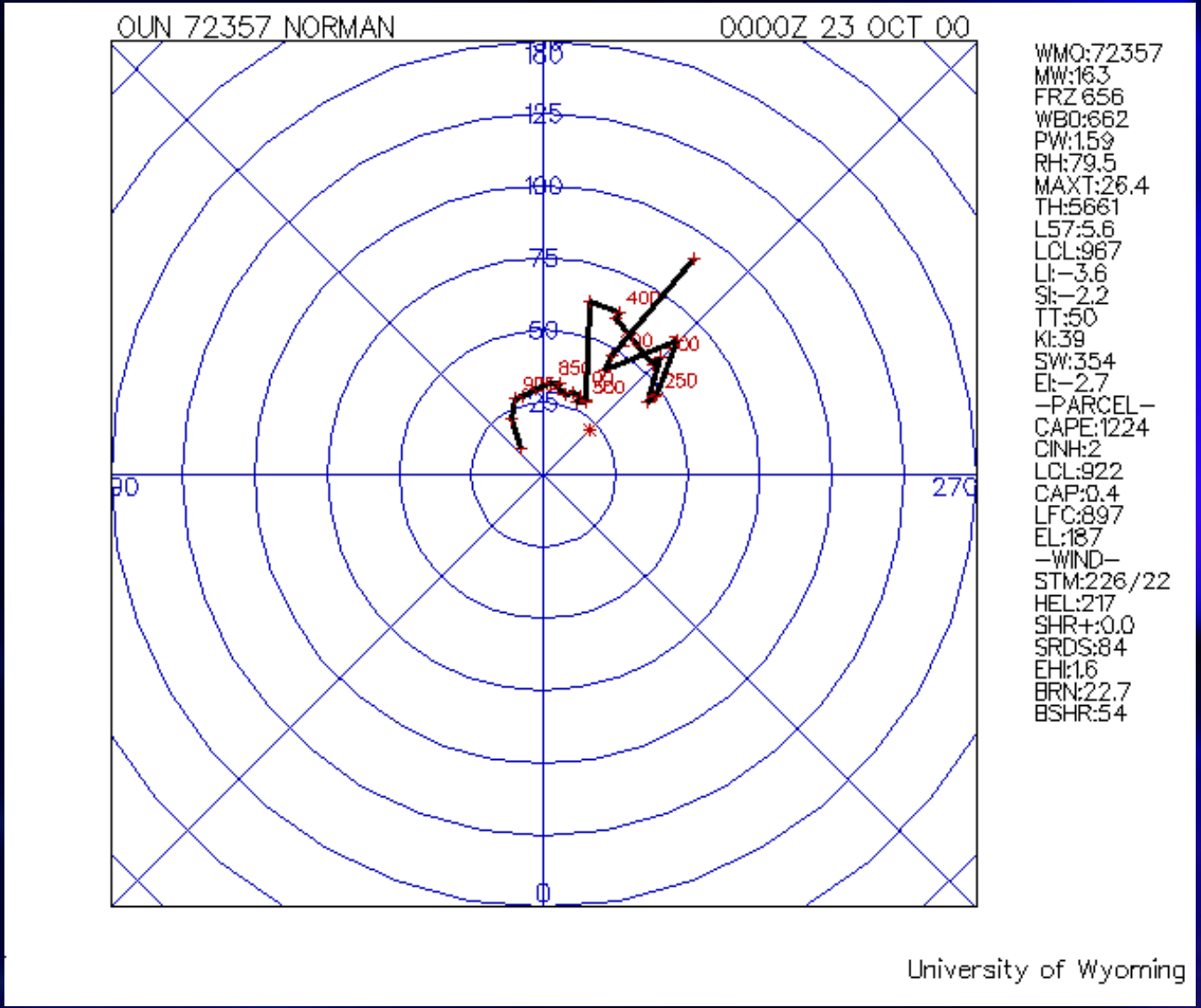
g/kg
University of Wyoming

00Z OUN Hodograph



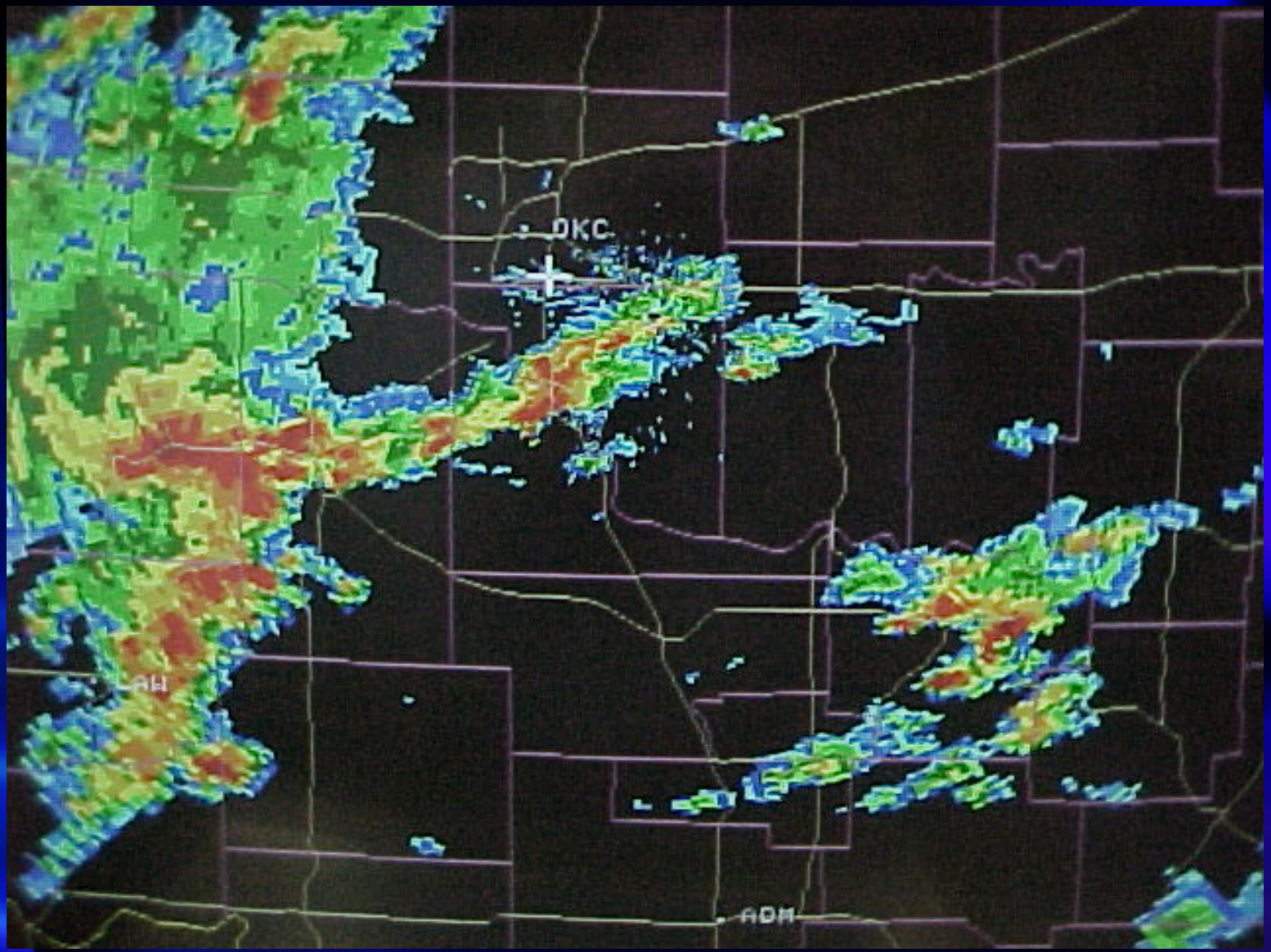
Considerations

- Tornado day before
- Midday AC “NO SVR”
- Tornado watch by early evening
- Dayshift held over “just in case”
- New staff member stopped by
- Initially one warning forecaster

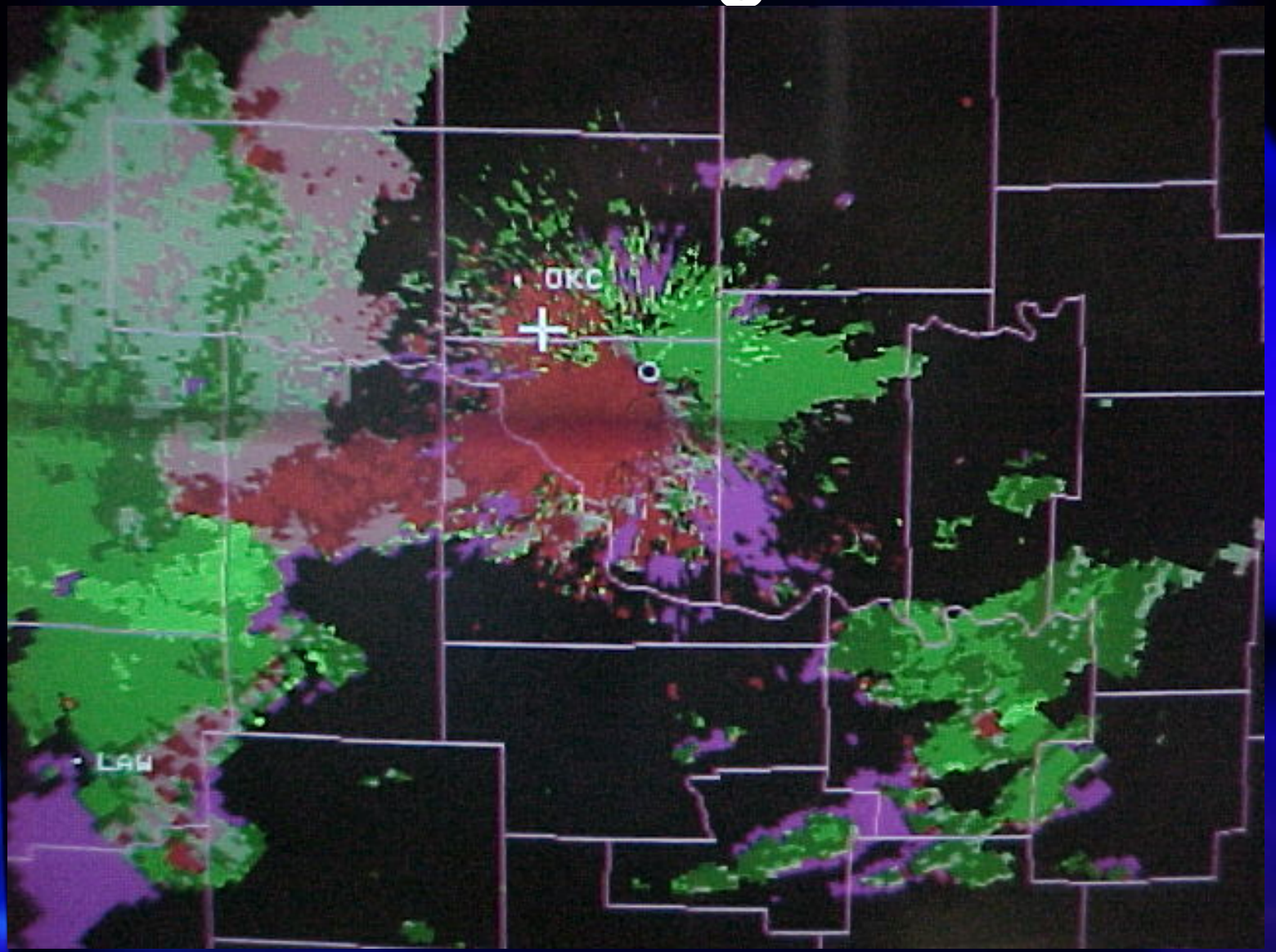
What happened

- 5 tornadoes in CWA
- One F1, remainder *rated* F0
- F1 occurred in relatively dense population area
- No significant injuries
- No significant lead time

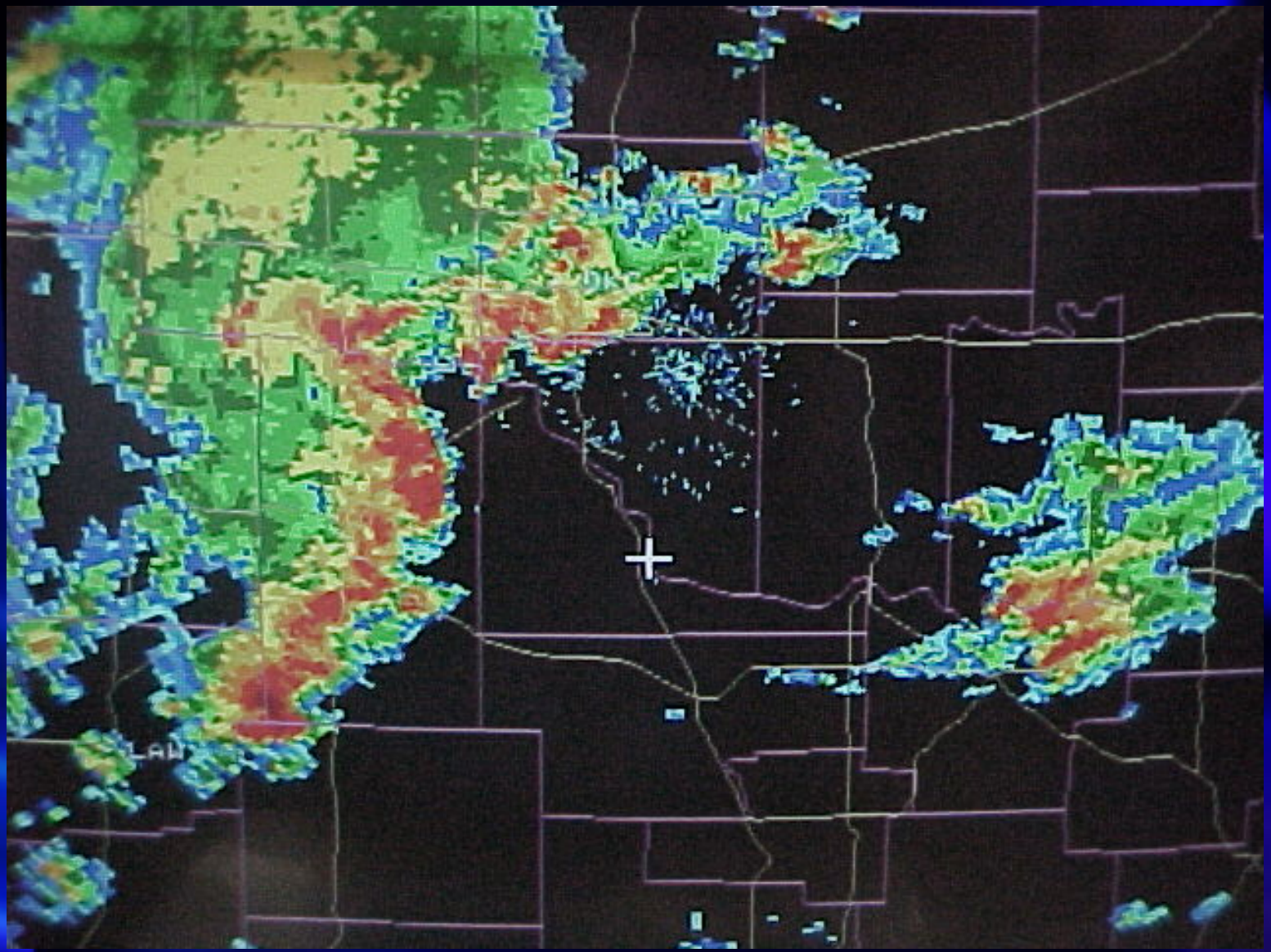
Several storms of concern



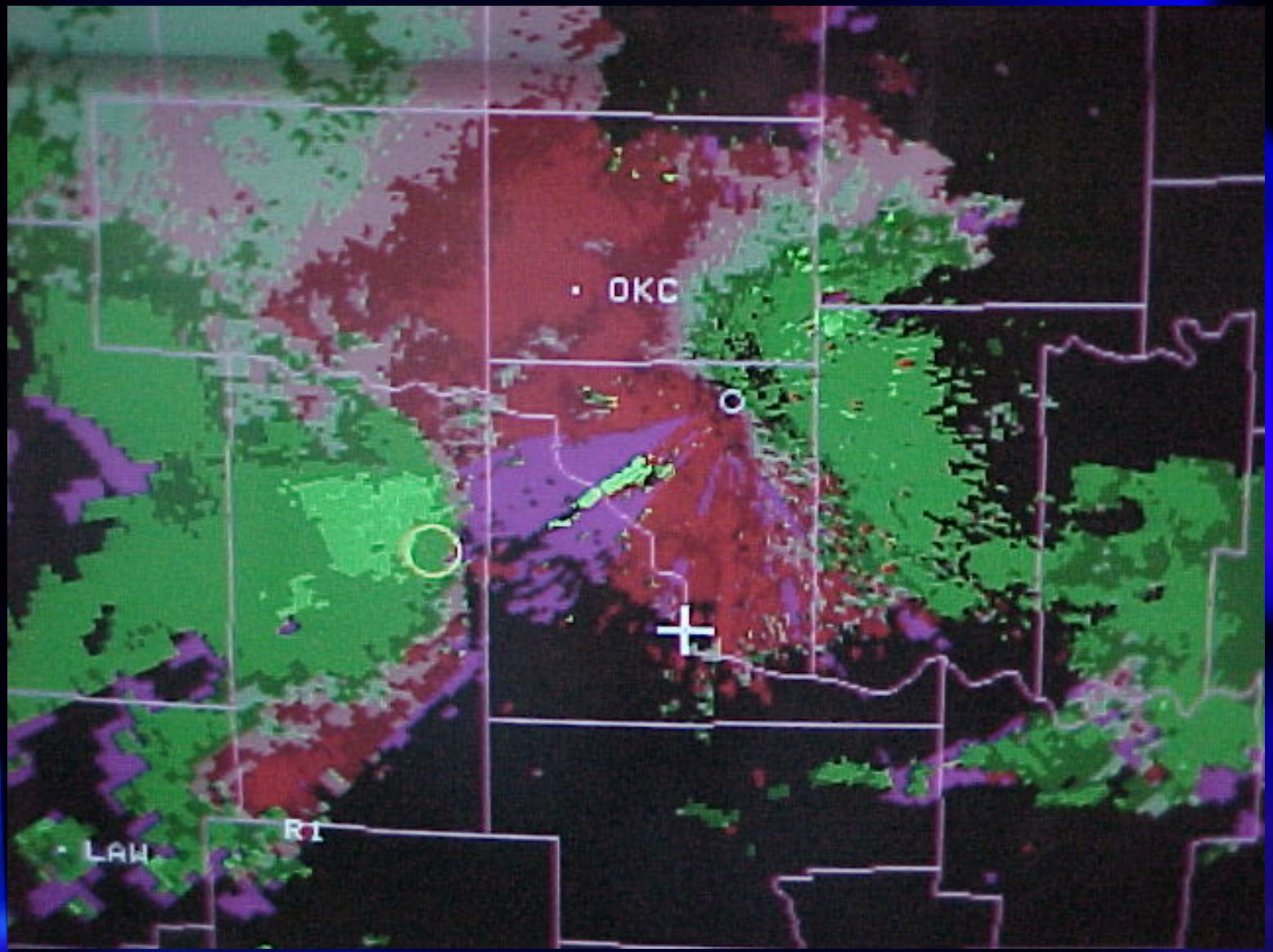
Tornado warnings SE & NW



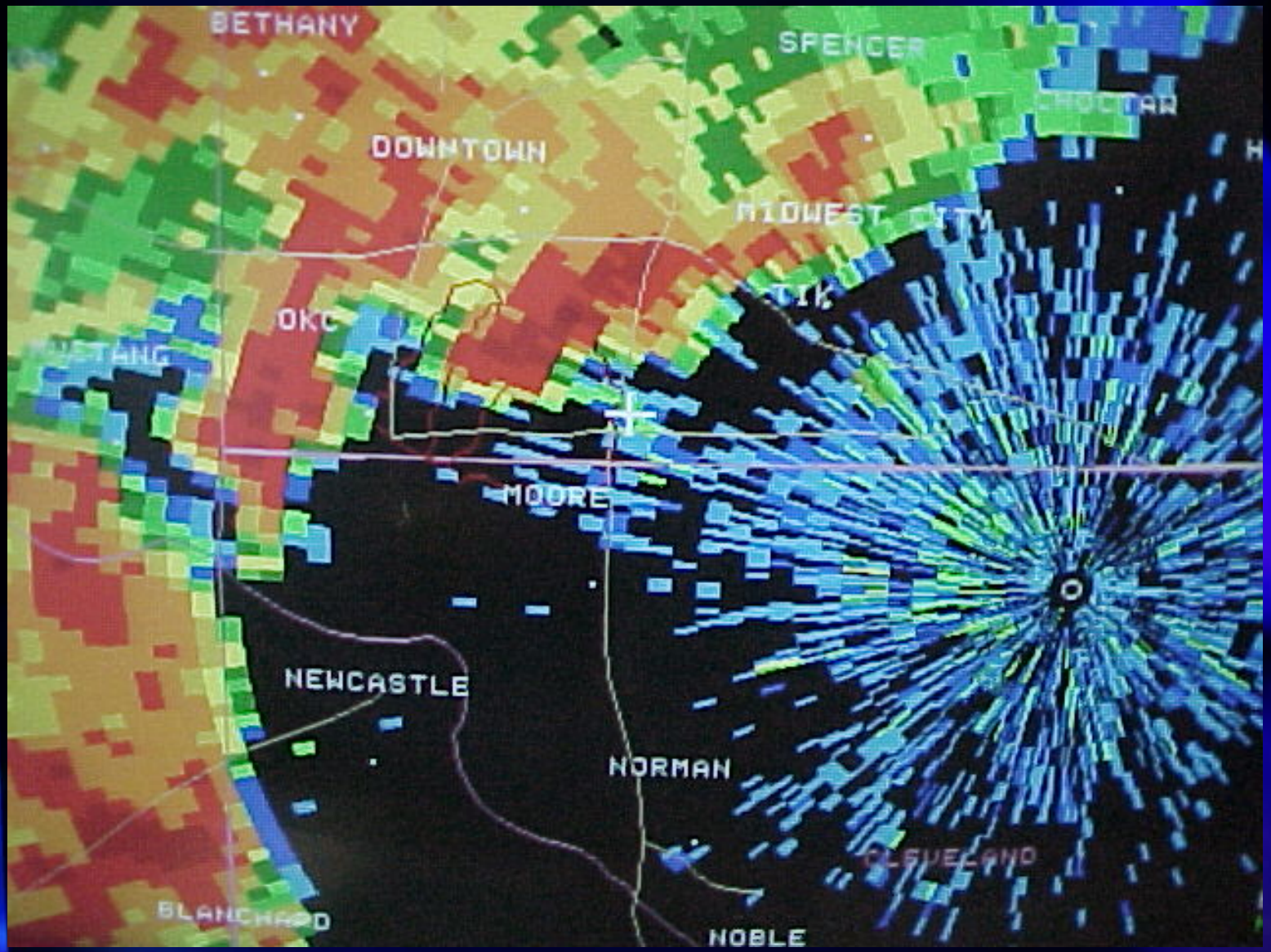
About 30 minutes later



Interesting signature W of RDA



Tornado at cursor



F1 tornado occurring

Was this a failure?

Could have had more lead time!

Failure Mode and Effects Analysis

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Analysis

- *Failure mode*: Organizational
- *Cause*: Failed to identify mini-SC tornado threat
  - Ambiguity in staffing caused breakdown in lines of responsibility
- *Effects*: Not too much, could have been worse!
- *Correction*: Re-emphasize intra-staff coordination and strengthen structure of duties

Questions and comments?