

Expected vs. Observed Values of ZDR

Presentation to TAC Committee
29 February 2012

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Objectives

1. Know the expected values of ZDR for liquid and ice phase meteorological echoes
2. Apply the knowledge of expected ZDR values to real-world examples



Outline

1. What is Differential Reflectivity (ZDR)?
2. General Physical Interpretation of ZDR
3. Expected values of ZDR in rain
4. Expected values of ZDR in snow/ice crystals
5. Operational examples

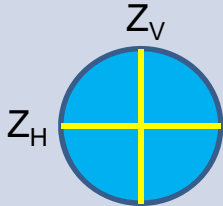
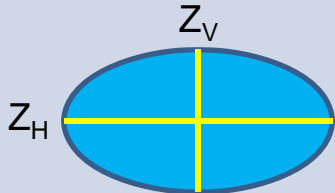
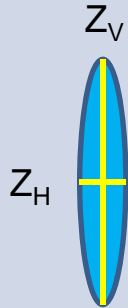
1. Differential Reflectivity (ZDR)

Definition	Possible Range of Values	Units	Abbreviated Name
Difference between the horizontal and vertical reflectivity factors	-7.9 to +7.9	Decibels (dB)	ZDR

$$ZDR = Z_H - Z_V$$







2. General Physical Interpretation (Overall)

- *Good indicator of mean drop shape*
- Horizontal = (+)
- Vertical = (-)
- Spherical = 0

<u>Spherical</u> (drizzle, small hail, etc.)	<u>Horizontally Oriented</u> (rain, melting hail, etc.)	<u>Vertically Oriented</u> (i.e. vertically oriented ice crystals)
		
$Z_H \sim Z_V$	$Z_H > Z_V$	$Z_H < Z_V$
$Z_H - Z_V \sim 0$	$Z_H - Z_V > 0$	$Z_H - Z_V < 0$
ZDR ~ 0 dB	ZDR > 0 dB	ZDR < 0 dB

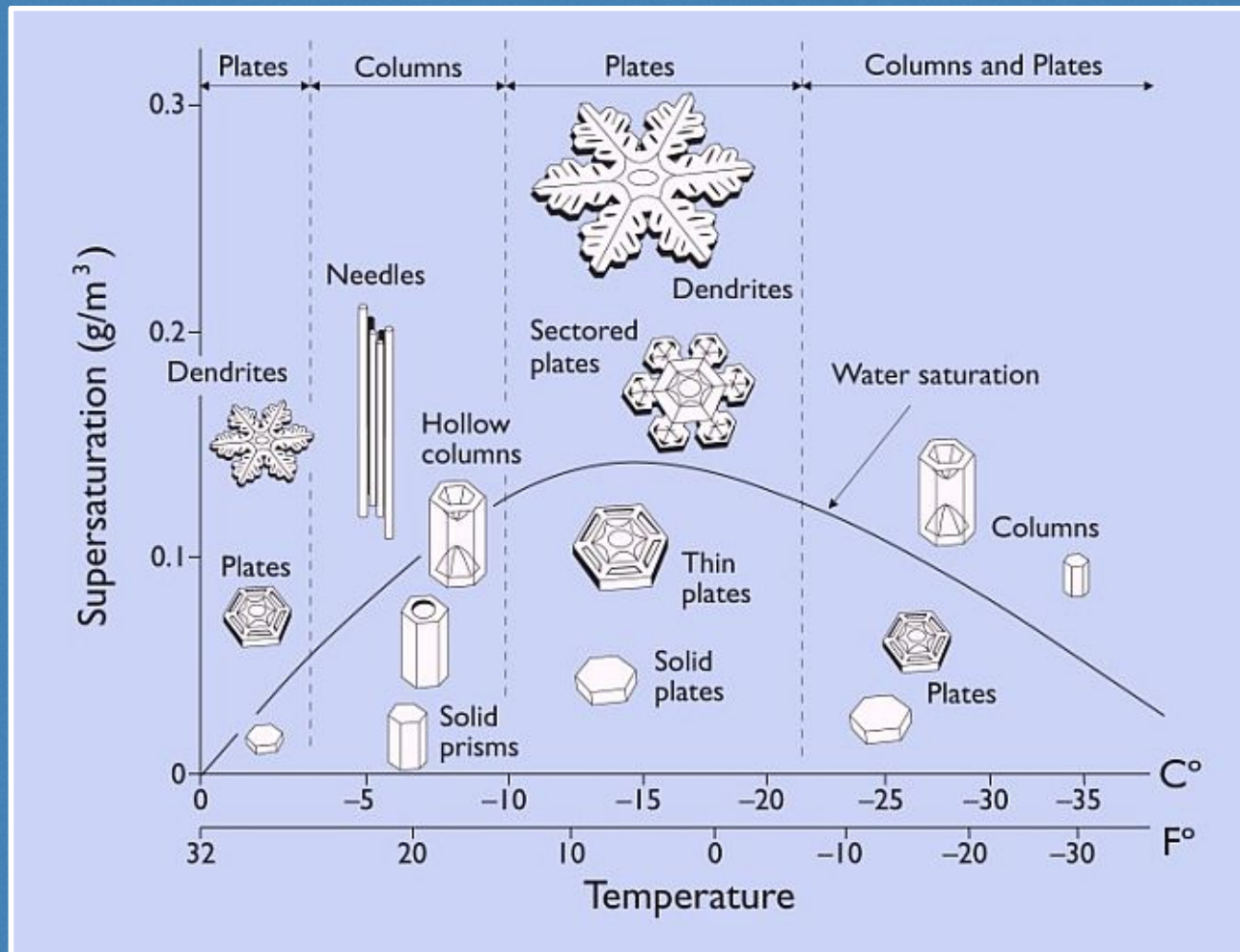
3. Expected Values in Rain

- Strong relationship between raindrop diameter and shape
- Leads to strong relationship between raindrop size and ZDR

Major Axis Diameter (mm)	Image	ZDR (dB)
< 0.3 mm		~ 0.0 dB
1.35 mm		~ 1.3 dB
1.75 mm		~1.9 dB
2.65 mm		~2.8 dB
2.90 mm		~3.3 dB
3.68 mm		~4.1 dB
4.00 mm		~4.5 dB

Data from Wakimoto and Bringi (1988)

4. Expected Values in Snow/Ice



Complex shapes = complex ZDR values

4. Expected Values in Snow/Ice

Snow	ZDR
Dry / Aggregated	0.2 to 0.3 dB
Wet / Melting	2 to 3 dB (noisy)
Ice Crystals	ZDR
Low-density / Random orientation	< 1 dB
High-density / Preferred Orientation (Horizontal)	As high as 4 to 5 dB
High-density / Preferred Orientation (Vertical)	- 2 to 0 dB

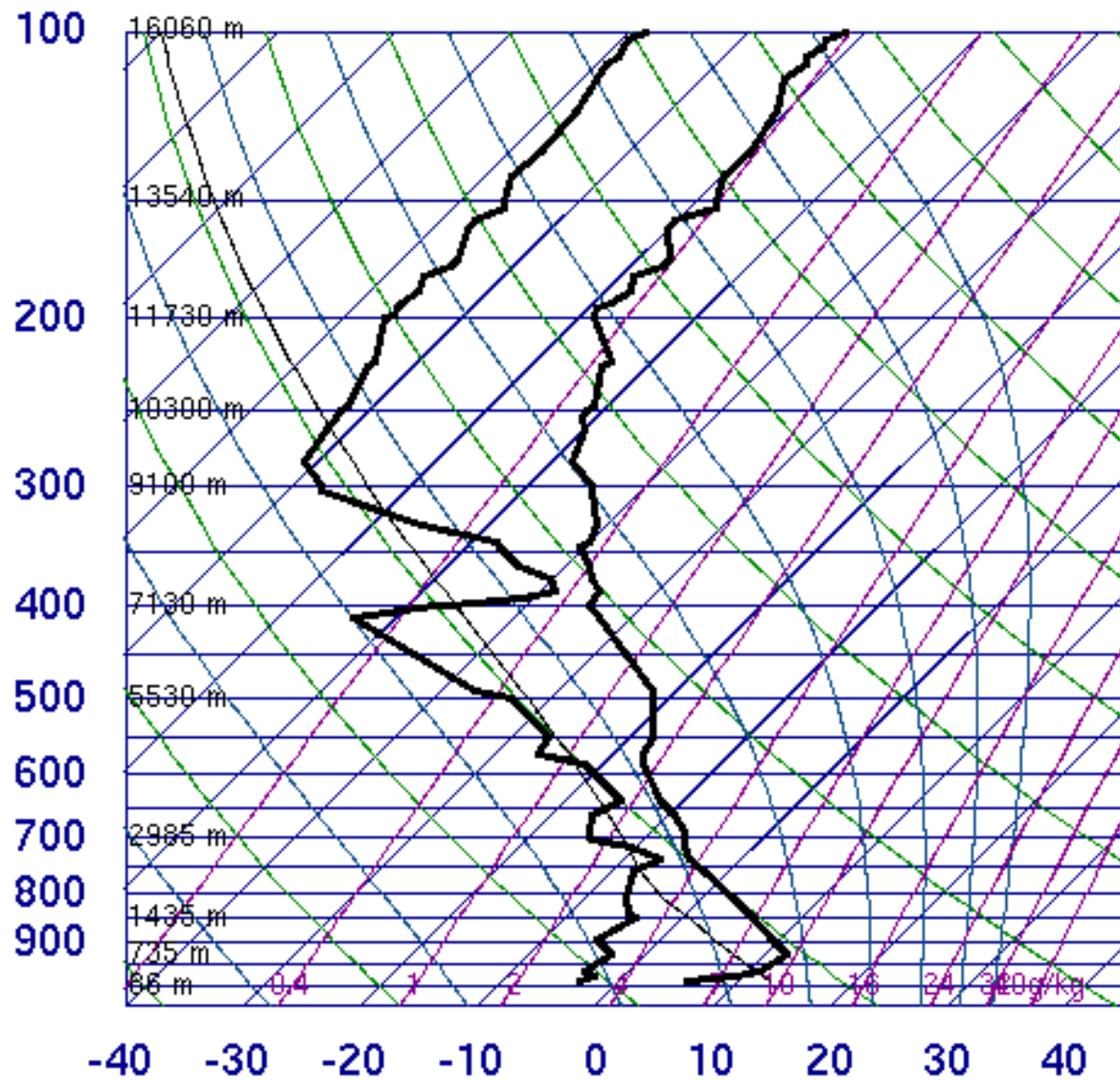
Knowing crystal type is crucial to anticipating ZDR values

What Are We Seeing in the Real World?

- Rain event → KOHX (22 Feb 2012)
- Rain event → KFFC (21 Jan 2012)
- Rain event → KMHX (Aug 2011)
- Snow event → KAPX (17 Jan 2012)
- Snow event → KAPX (13 Jan 2012)
- Transition event → KAMA (19 Dec 2011)



72327 BNA Nashville



SLAT	36.25
SLON	-86.57
SELV	180.0
SHOW	5.94
LIFT	10.61
LFTV	10.60
SWET	163.9
KINX	15.30
CTOT	17.30
VTOT	27.30
TOTL	44.60
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	-9999
EQTV	-9999
LFCT	-9999
LFCV	-9999
BRCH	0.00
BRCV	0.00
LCLT	266.9
LCLP	778.6
MLTH	286.7
MLMR	3.10
THCK	5444.
PWAT	11.58

12Z 22 Feb 2012

University of Wyoming

90



60

45

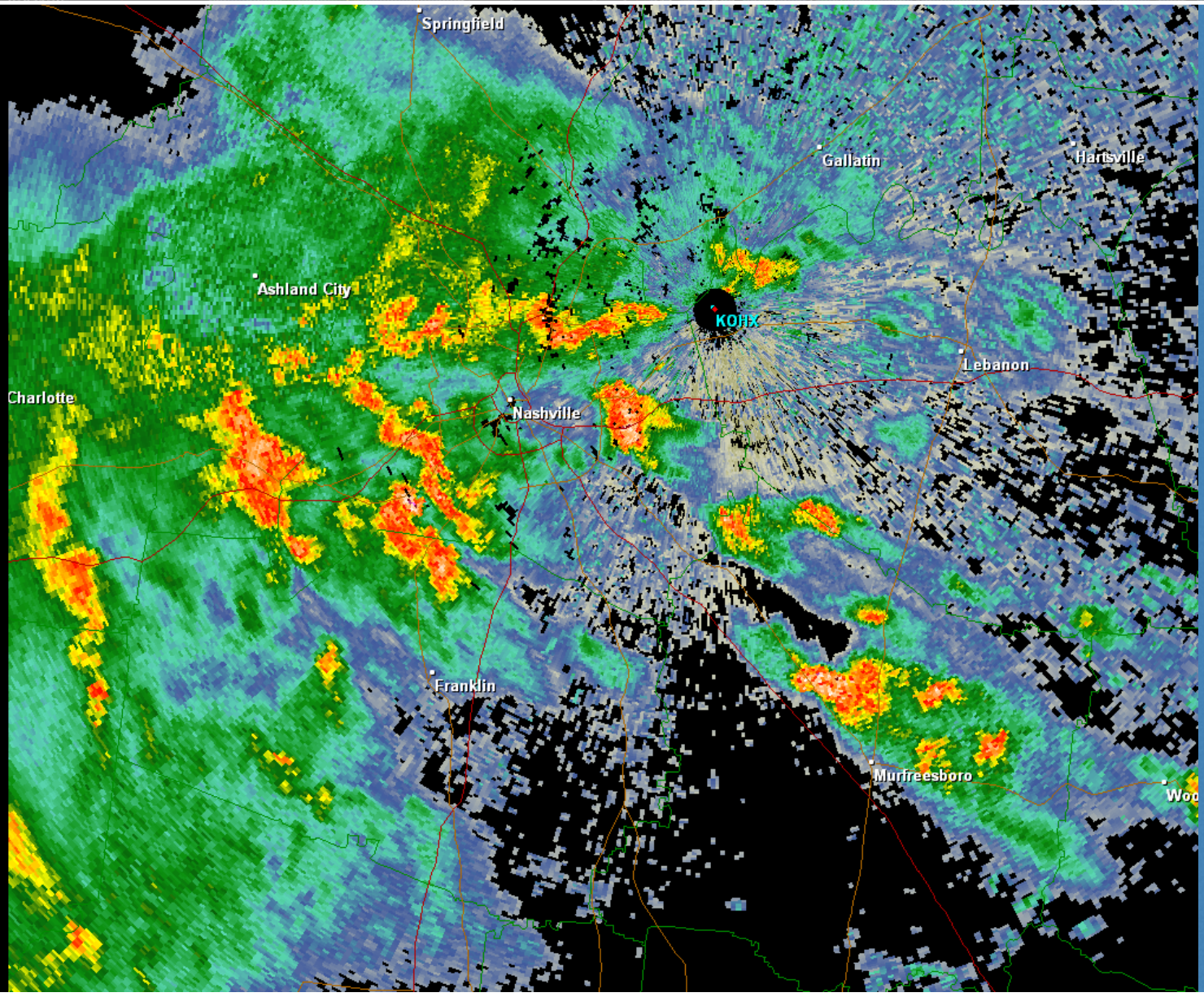
35

25

0

-15

0.5 deg Z – KOHX (22 Feb 2012)



8

DB

0.5 deg ZDR – KOHX (22 Feb 2012)

5

4

3

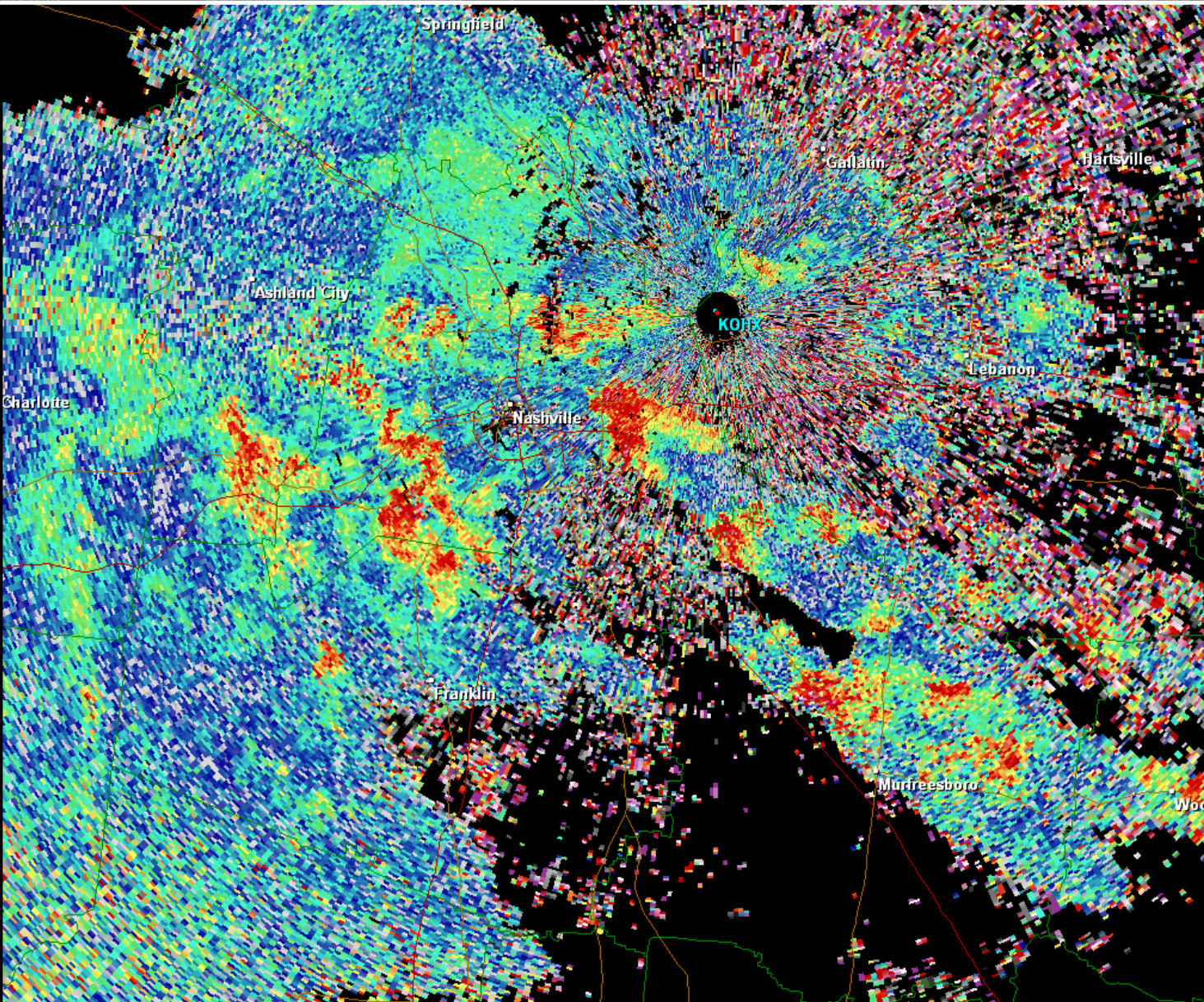
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1

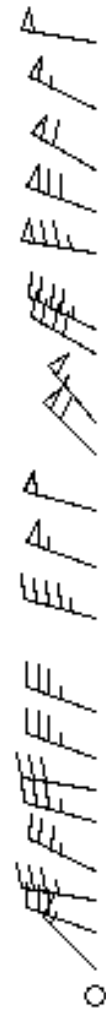
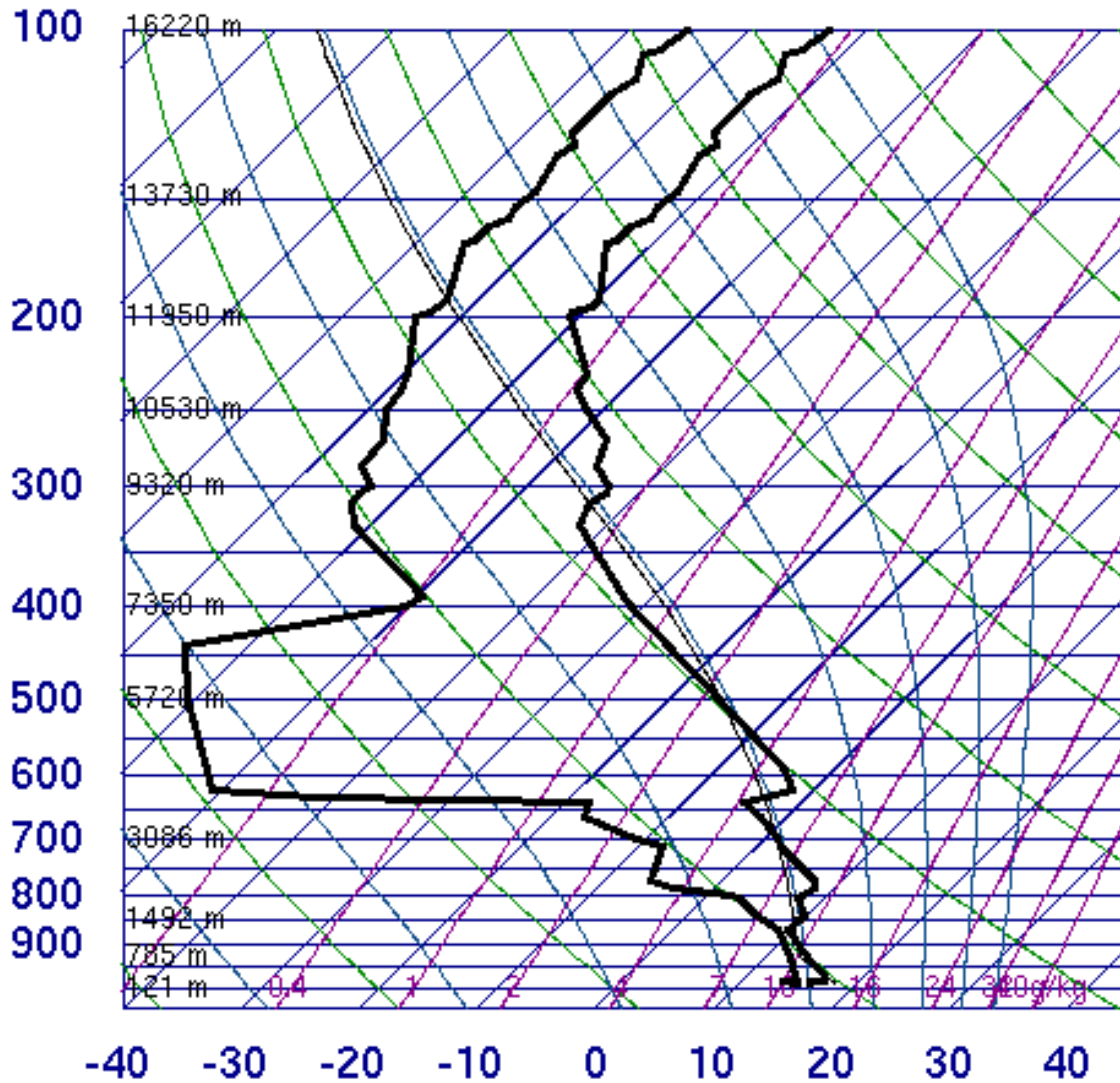
0

-1

-4



72215 FFC Peachtree City



SLAT	33.36
SLON	-84.56
SELV	244.0
SHOW	1.87
LIFT	-0.20
LFTV	-0.55
SWET	175.5
KINX	20.30
CTOT	22.50
VTOT	25.50
TOTL	48.00
CAPE	305.6
CAPV	350.4
CINS	-4.07
CINV	-2.95
EQLV	310.7
EQTV	310.6
LFCT	895.4
LFCV	900.8
BRCH	4.88
BRCV	5.60
LCLT	286.1
LCLP	927.4
MLTH	292.4
MLMR	10.27
THCK	5599.
PWAT	21.00

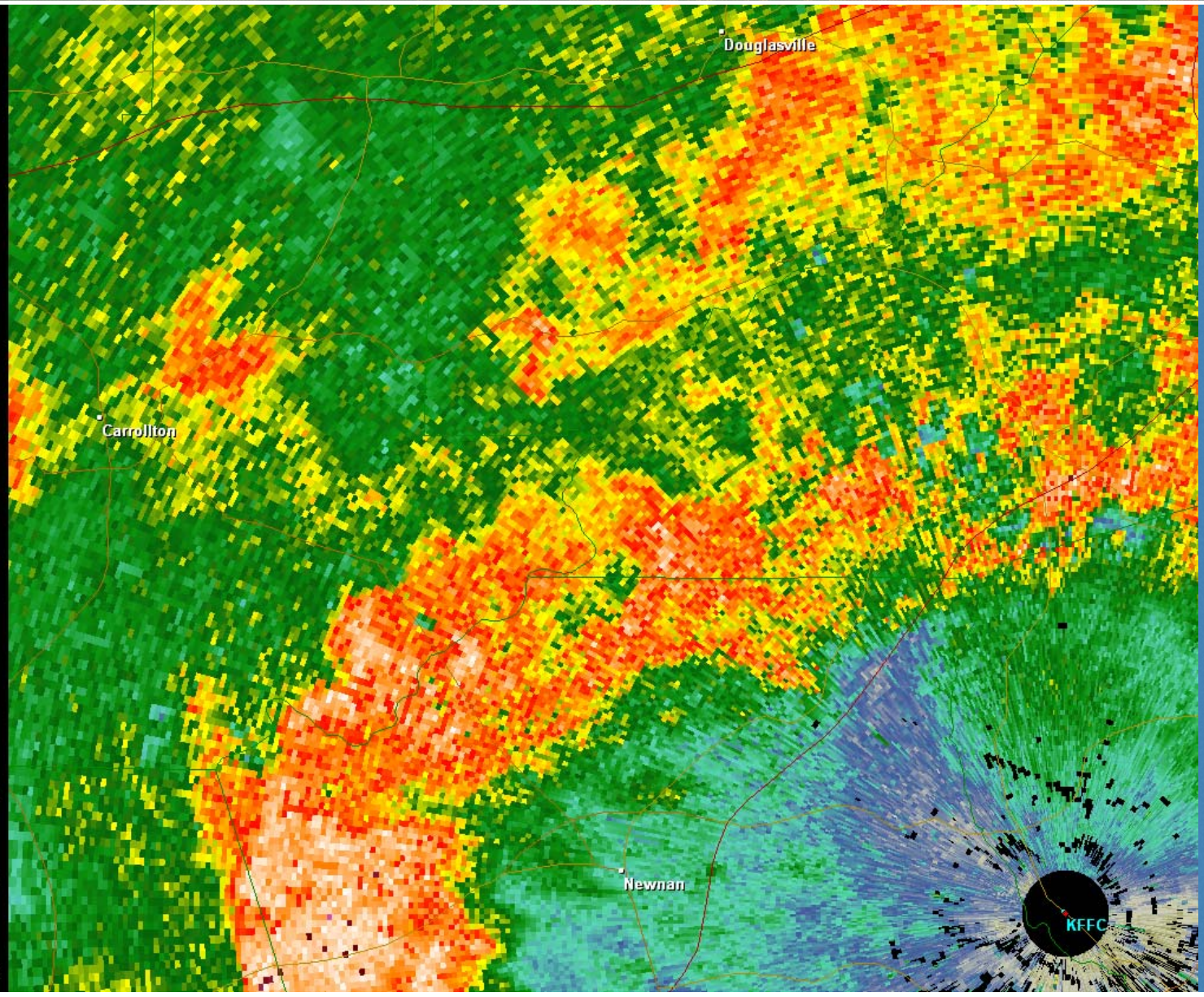
00Z 22 Jan 2012

University of Wyoming

90



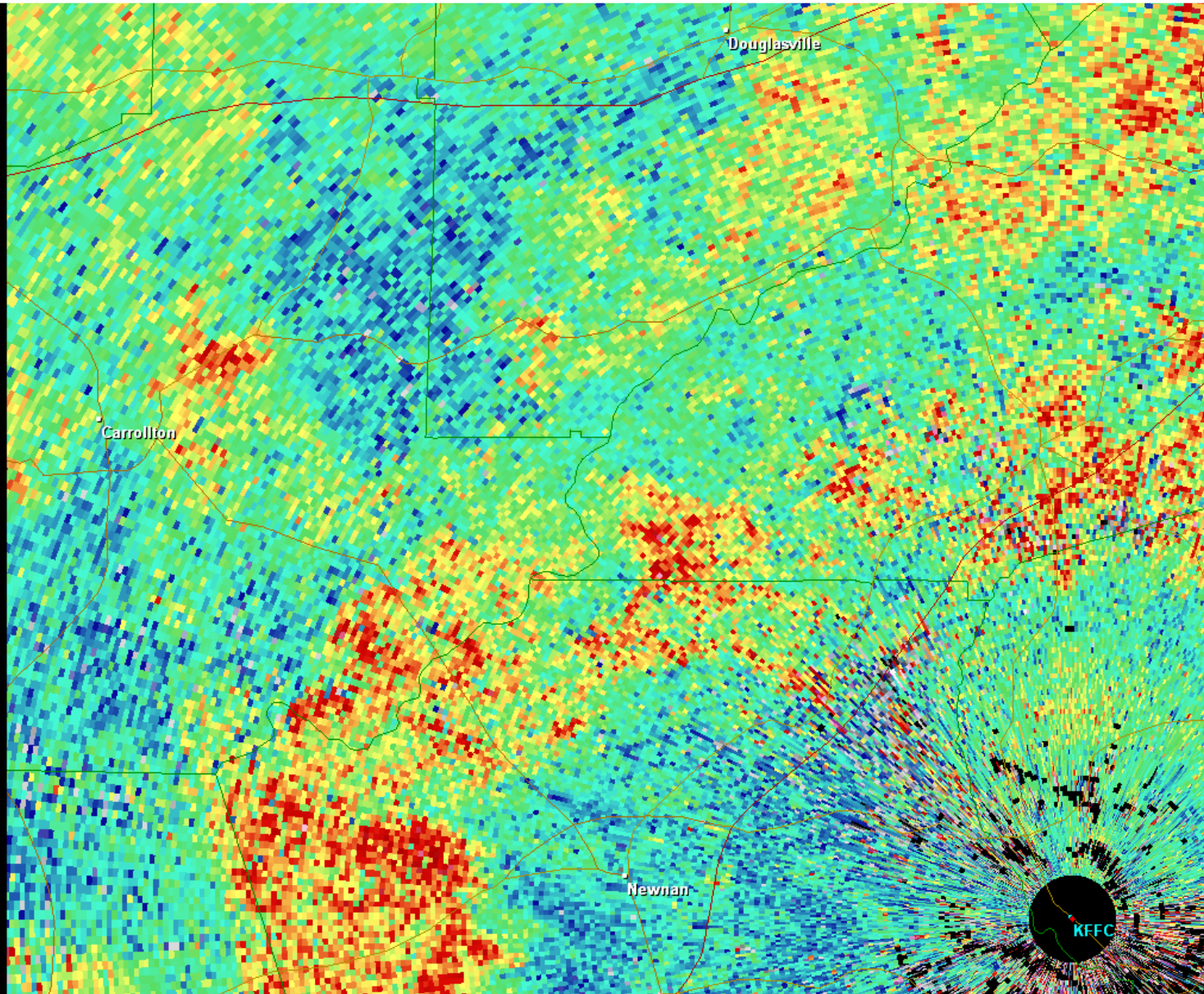
0.5 deg Z – KFFC (21 Jan 2012)



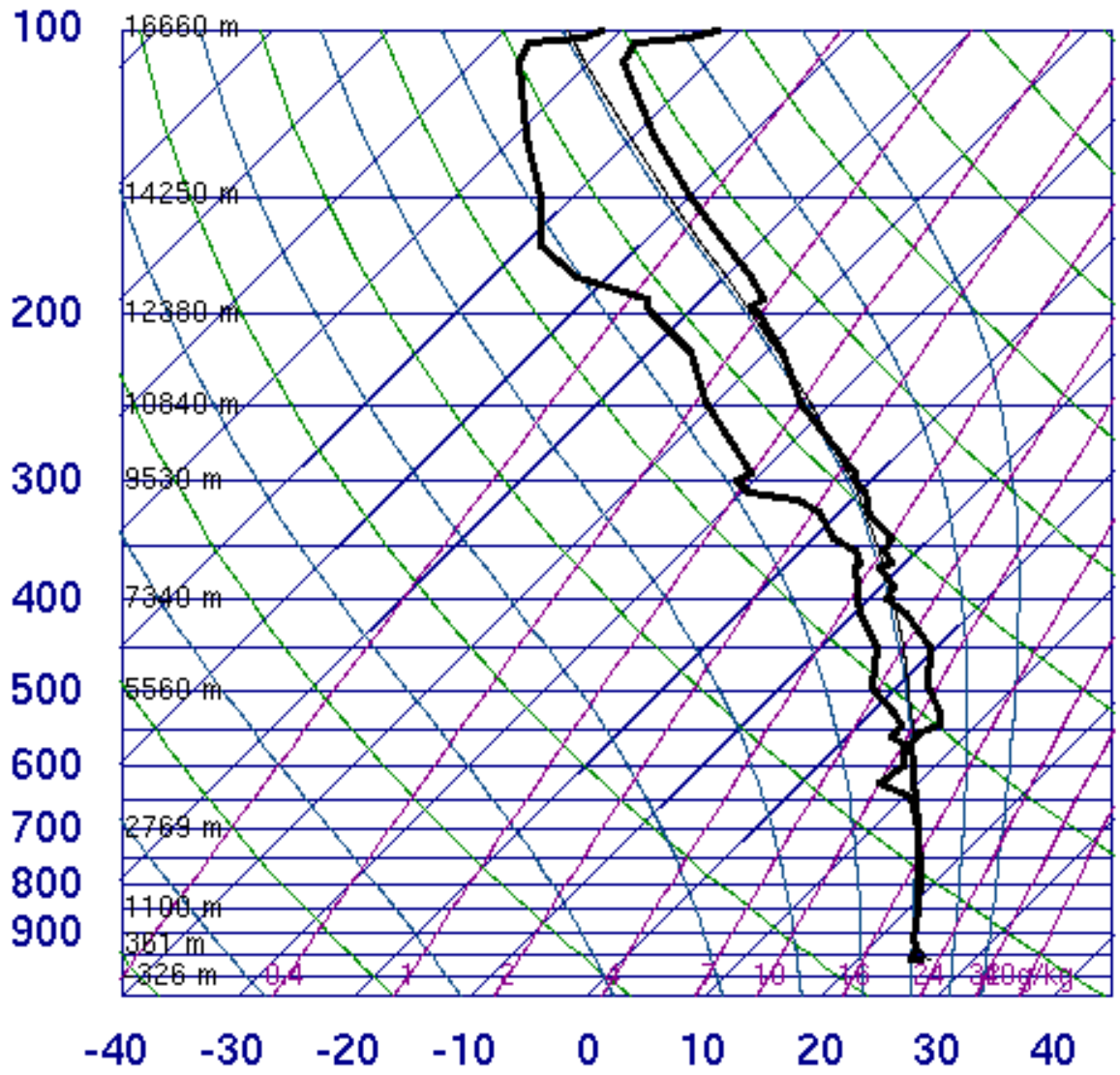
8



0.5 deg ZDR – KFFC (21 Jan 2012)



72305 MHX Newport



SLAT	34.78
SLON	-76.88
SELV	11.00
SHOW	1.63
LIFT	1.77
LFTV	1.51
SWET	426.5
KINX	38.40
CTOT	17.60
VTOT	17.60
TOTL	35.20
CAPE	40.90
CAPV	58.61
CINS	0.00
CINV	0.00
EQLV	228.1
EQTV	227.1
LFCT	922.4
LFCV	922.0
BRCH	2.38
BRCV	3.41
LCLT	297.0
LCLP	935.3
MLTH	302.8
MLMR	20.51
THCK	5886.
PWAT	79.44

12Z 27 Aug 2011

University of Wyoming

90



0.5 deg Z – KMHX (27 Aug 2011)

60

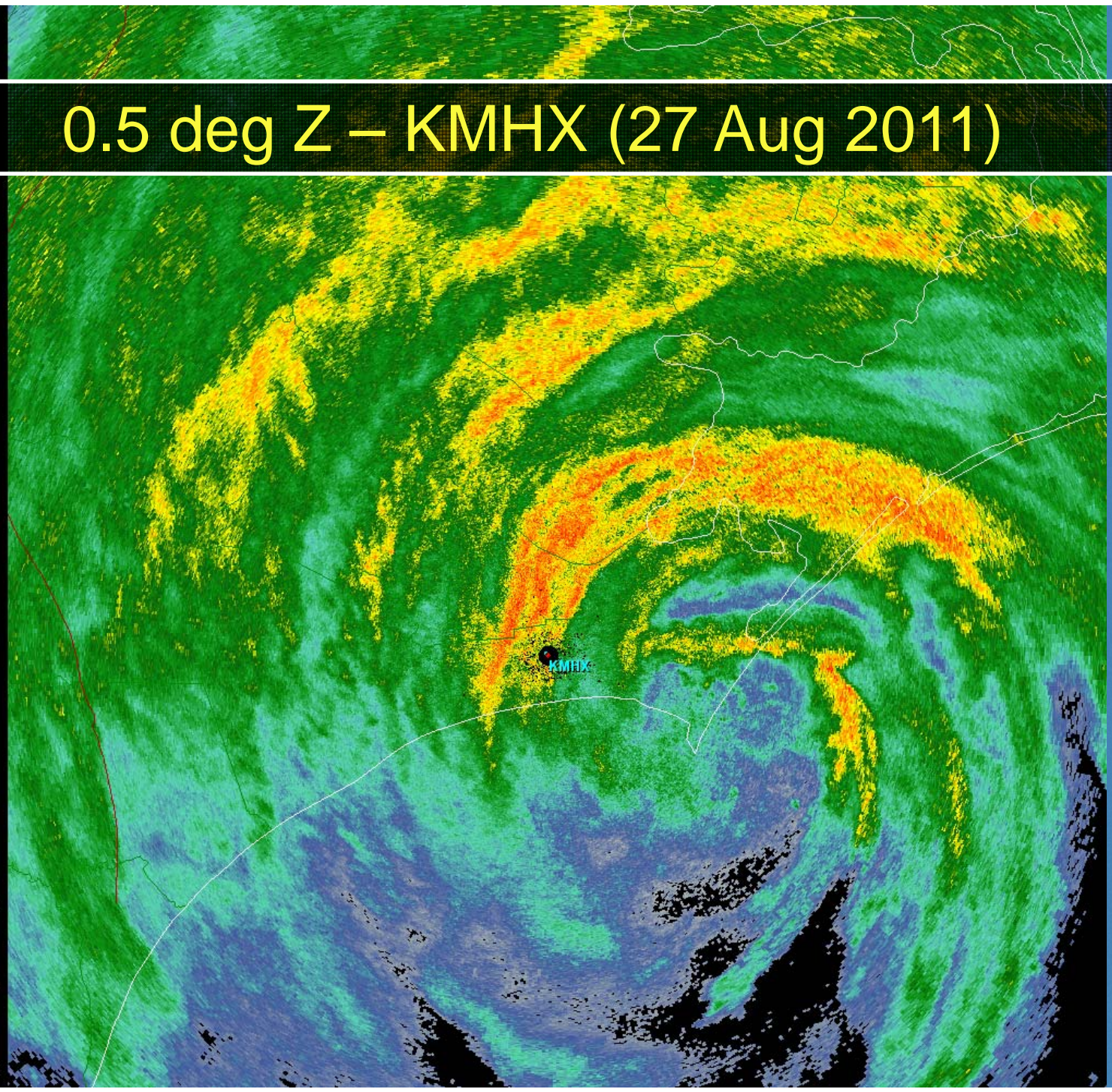
45

35

25

0

-15



8

DB

8

0.5 deg ZDR – KMHX (27 Aug 2011)

5

4

3

2

1

0

-1

-4

6

5

4

3

2

1

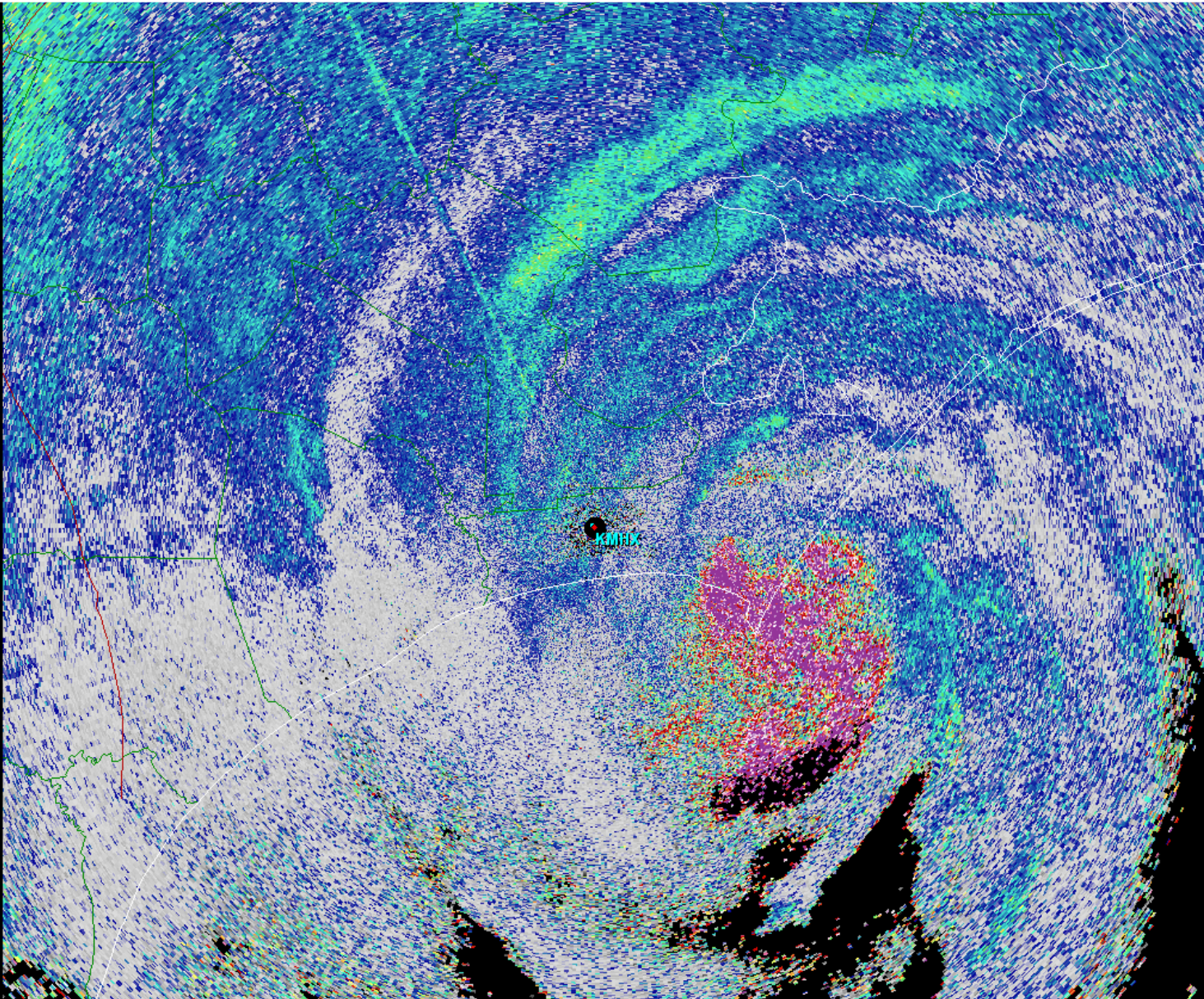
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-1

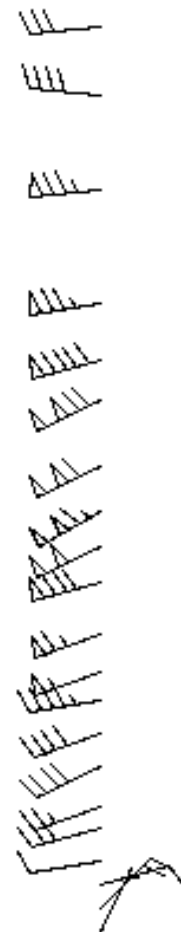
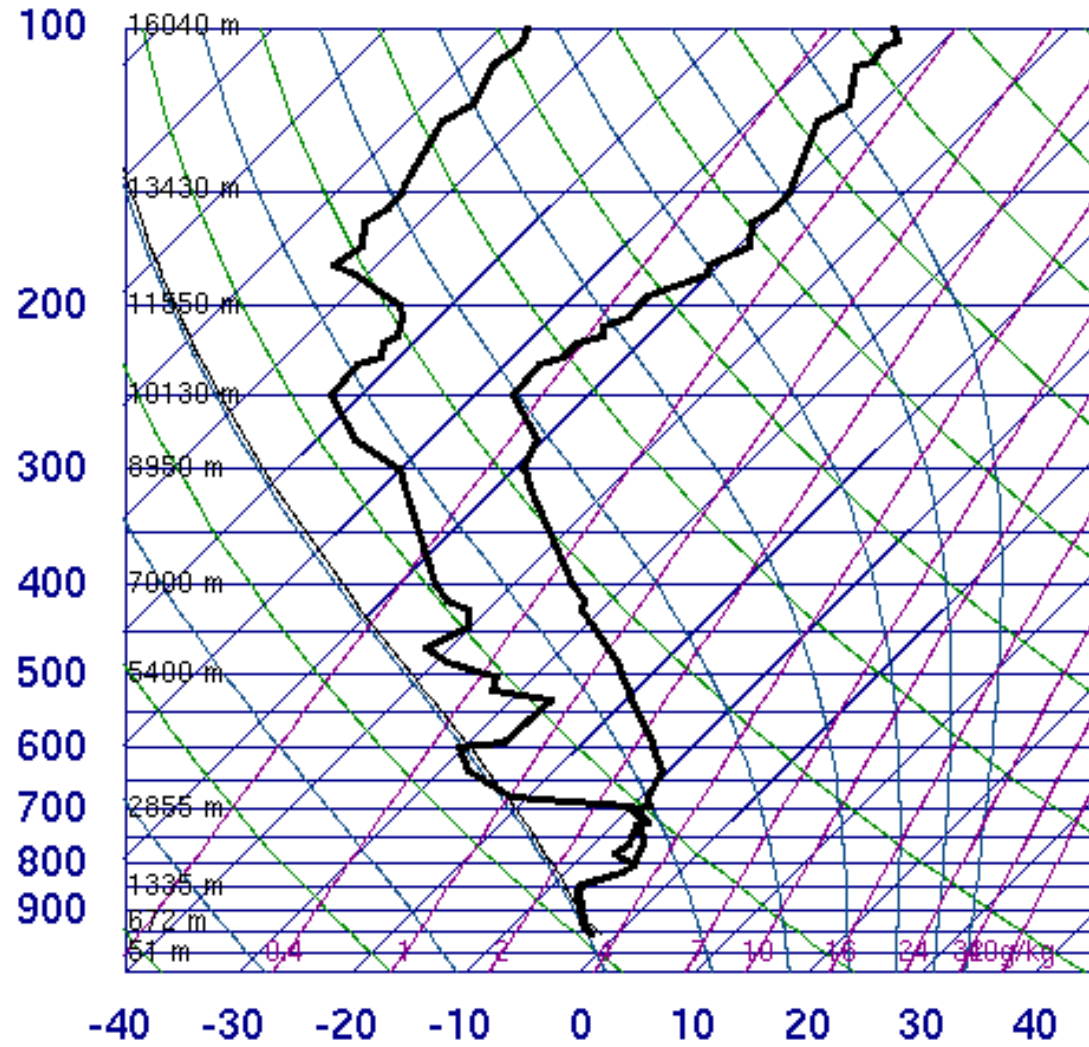
-2

-3

-4



72634 APX Gaylord



SLAT	44.91
SLON	-84.71
SELV	446.0
SHOW	16.84
LIFT	18.47
LFTV	18.50
SWET	79.00
KINX	7.20
CTOT	15.00
VTOT	15.20
TOTL	30.20
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	-9999
EQTV	-9999
LFCT	-9999
LFCV	-9999
BRCH	0.00
BRCV	0.00
LCLT	268.7
LCLP	919.8
MLTH	275.2
MLMR	3.02
THCK	5349.
PWAT	9.54

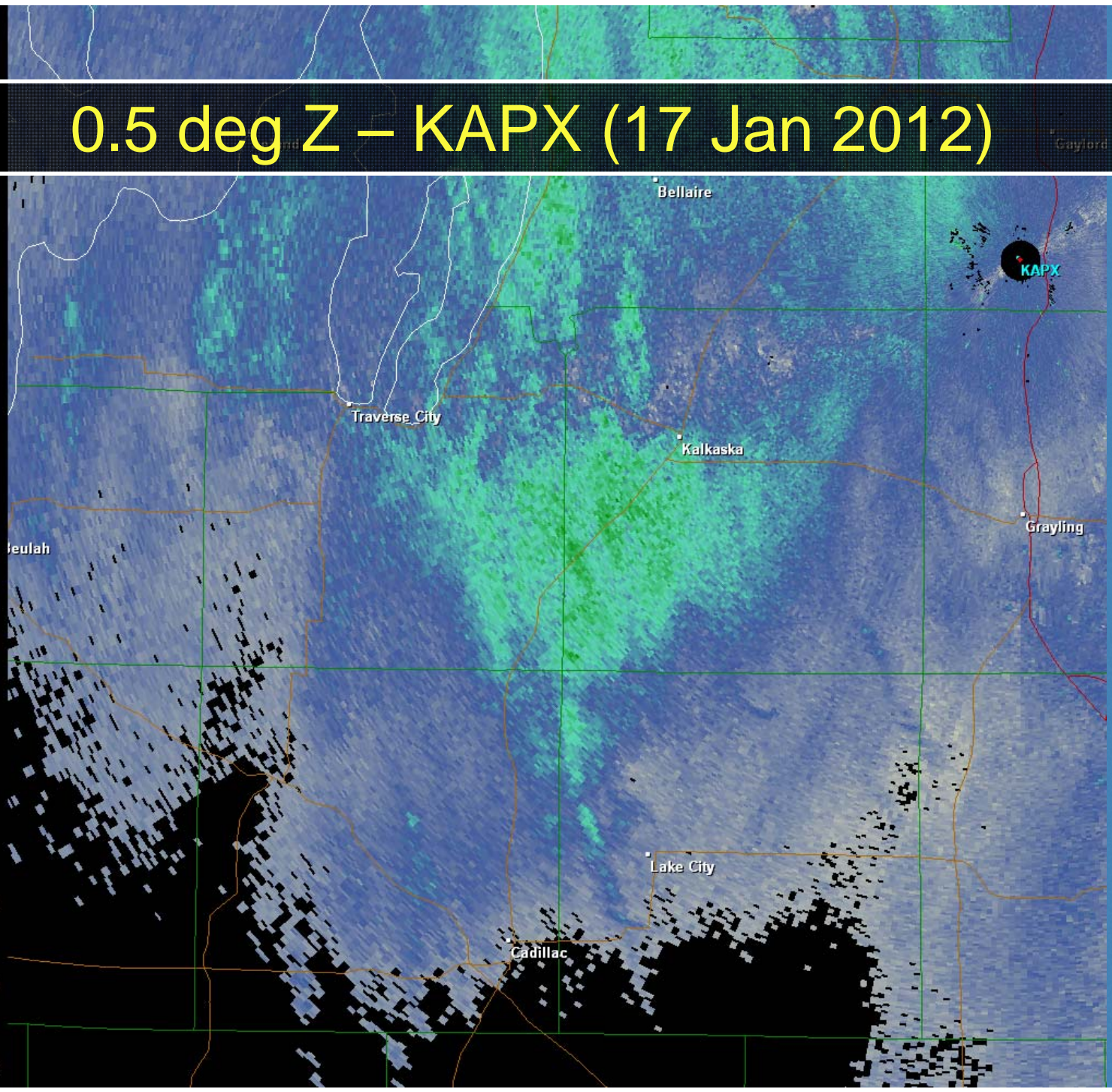
12Z 17 Jan 2012

University of Wyoming

90



0.5 deg Z – KAPX (17 Jan 2012)



60

45

35

25

0

-15

8

DB

0.5 deg ZDR – KAPX (17 Jan 2012)

5

4

3

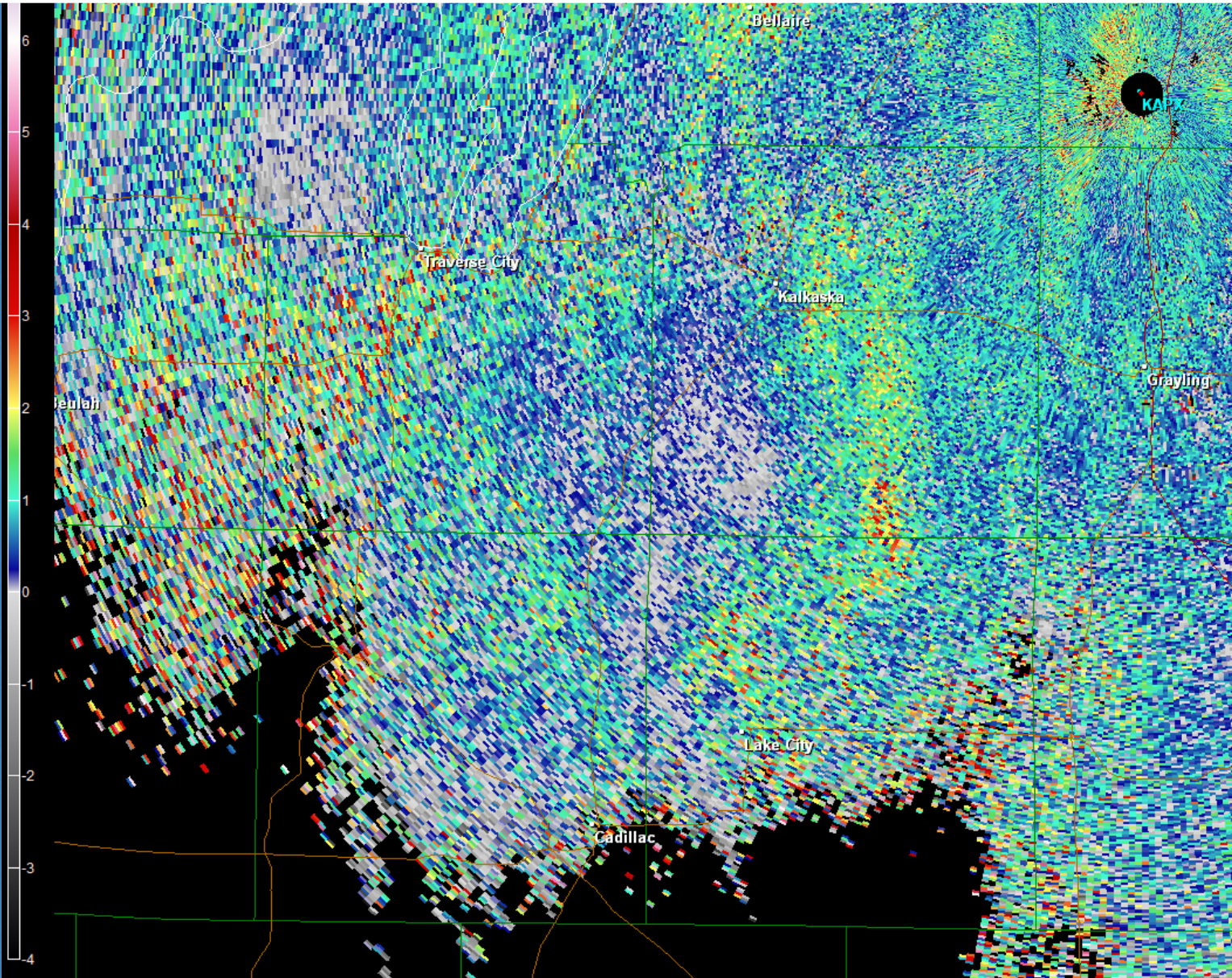
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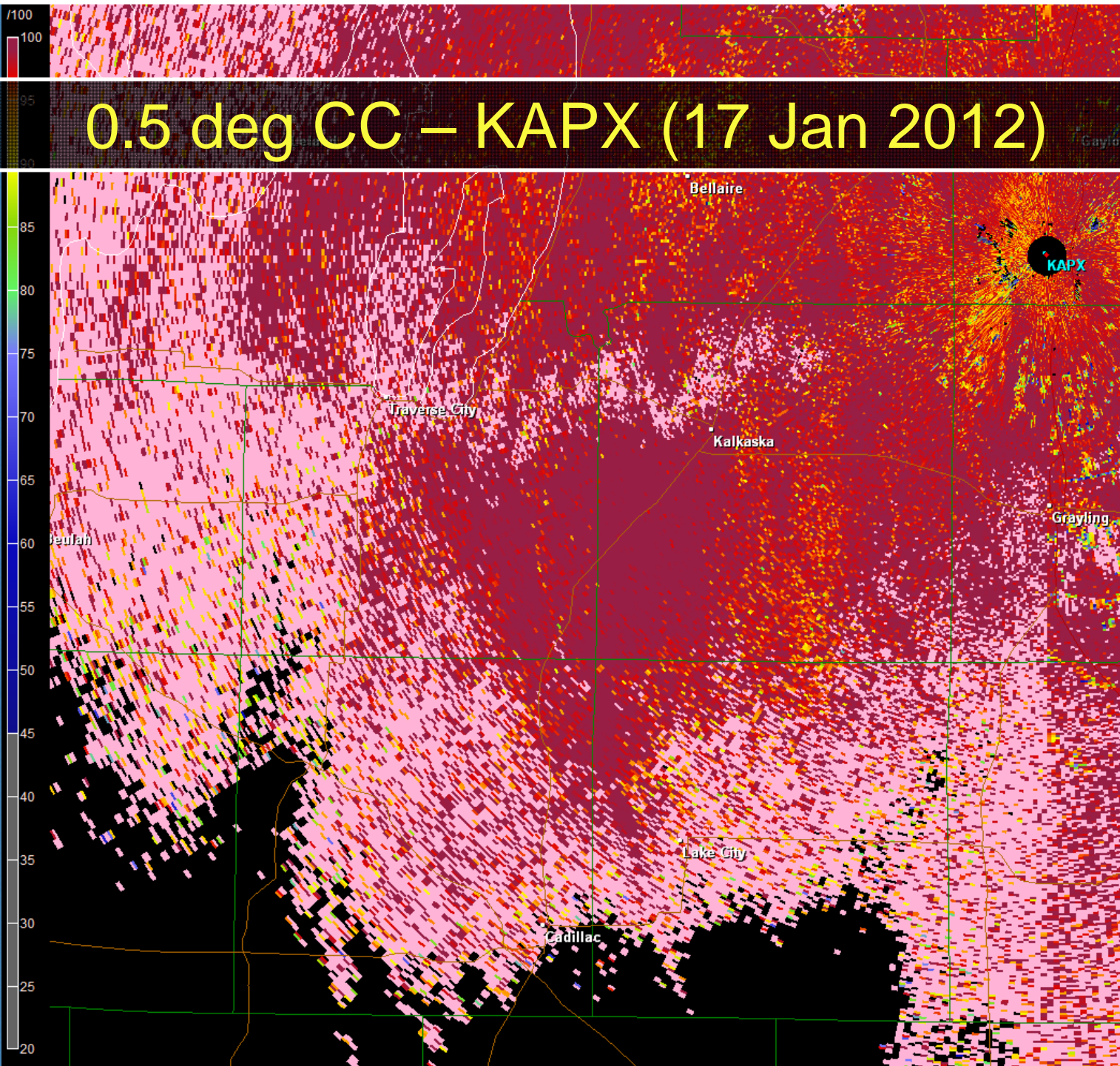
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-1

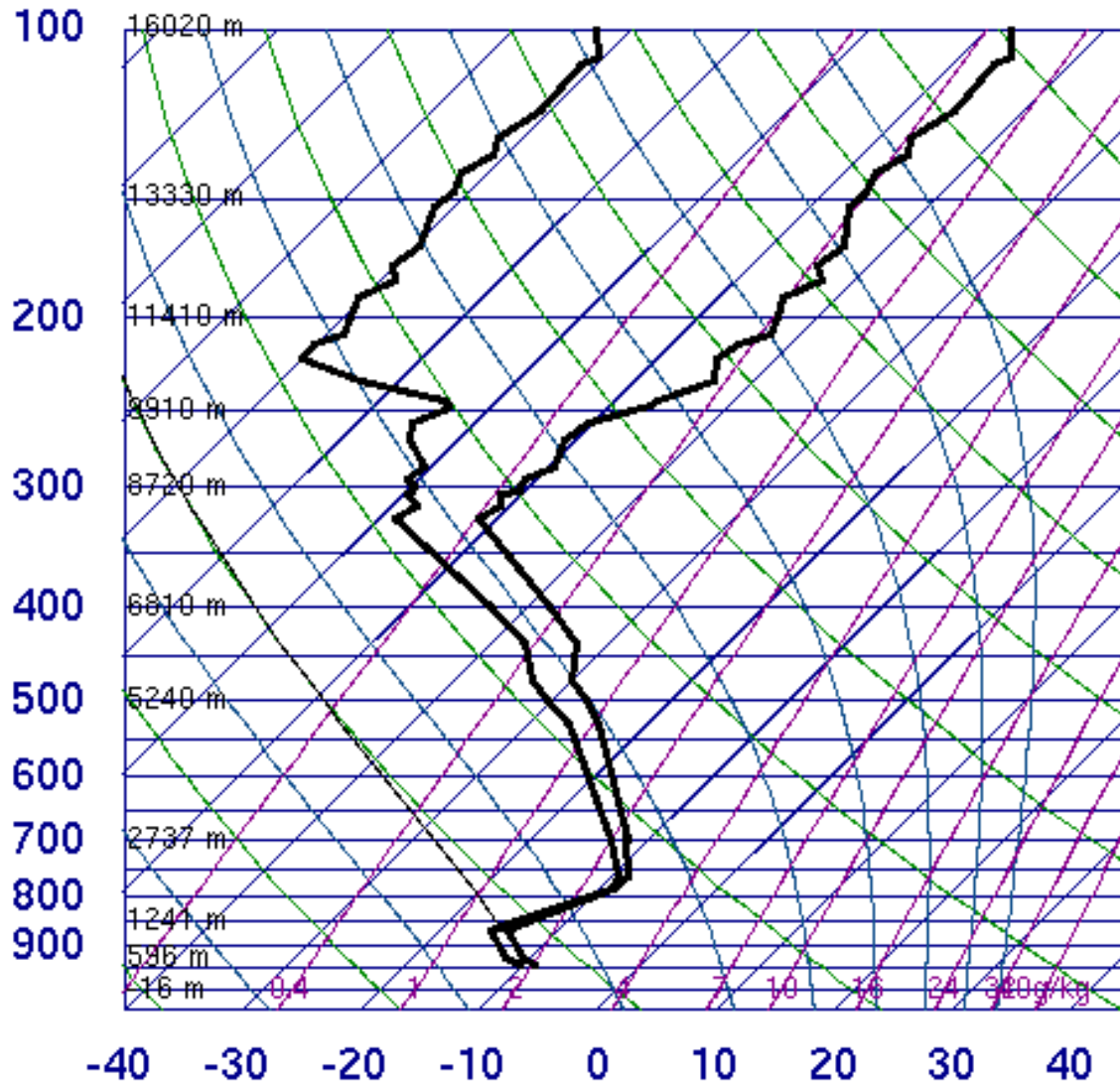
-4



0.5 deg CC – KAPX (17 Jan 2012)



72634 APX Gaylord



SLAT	44.91
SLOE	-84.71
SELV	446.0
SHOW	19.37
LIFT	22.24
LFTV	22.32
SWET	72.01
KINX	-1.60
CTOT	12.80
VTOT	14.00
TOTL	26.80
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	-9999
EQTV	-9999
LFCT	-9999
LFCV	-9999
BRCH	0.00
BRCV	0.00
LCLT	260.0
LCLP	891.9
MLTH	268.7
MLMR	1.58
THCK	5256.
PWAT	7.88

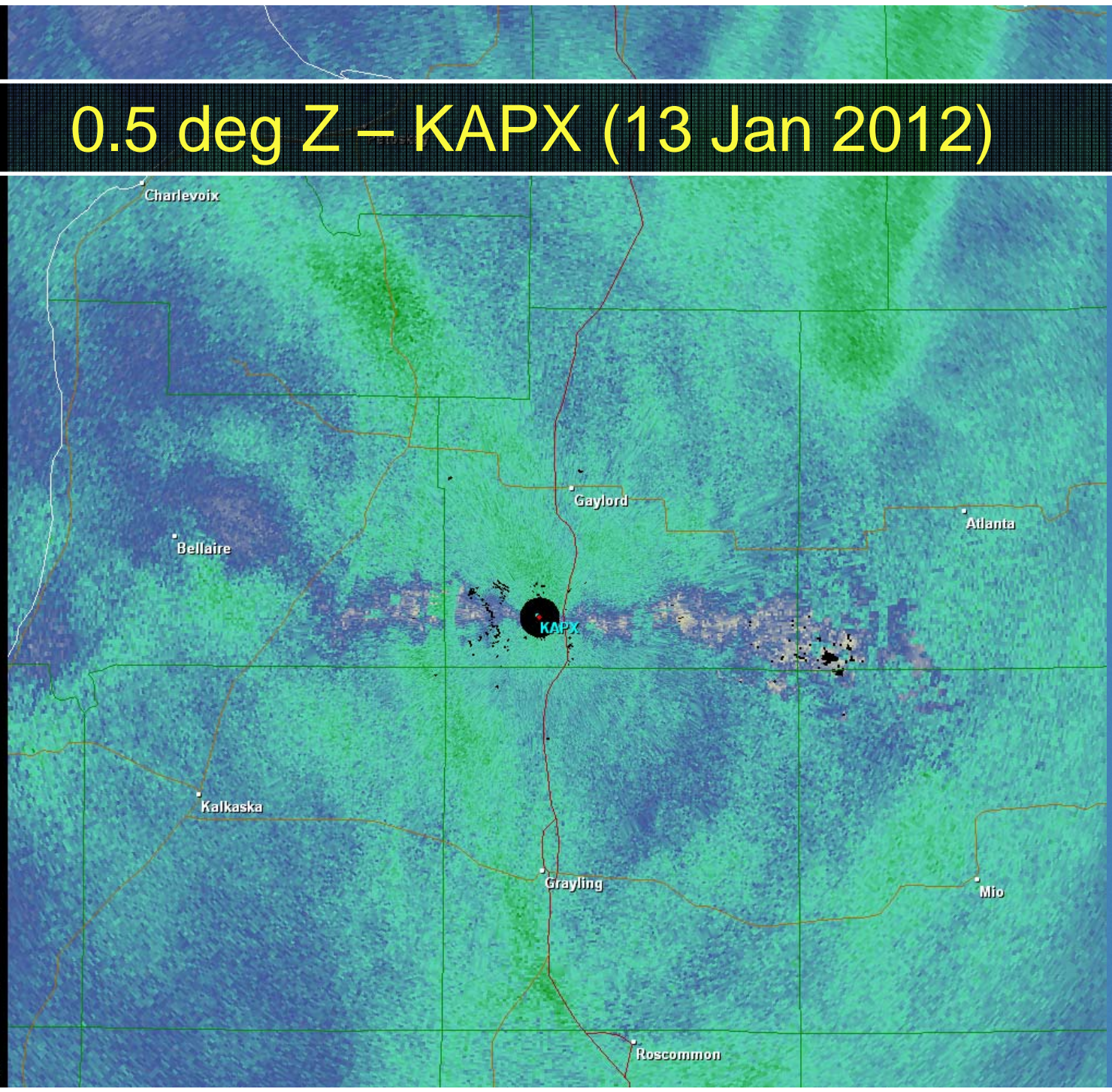
12Z 13 Jan 2012

University of Wyoming

90



0.5 deg Z – KAPX (13 Jan 2012)



0

-15

60

45

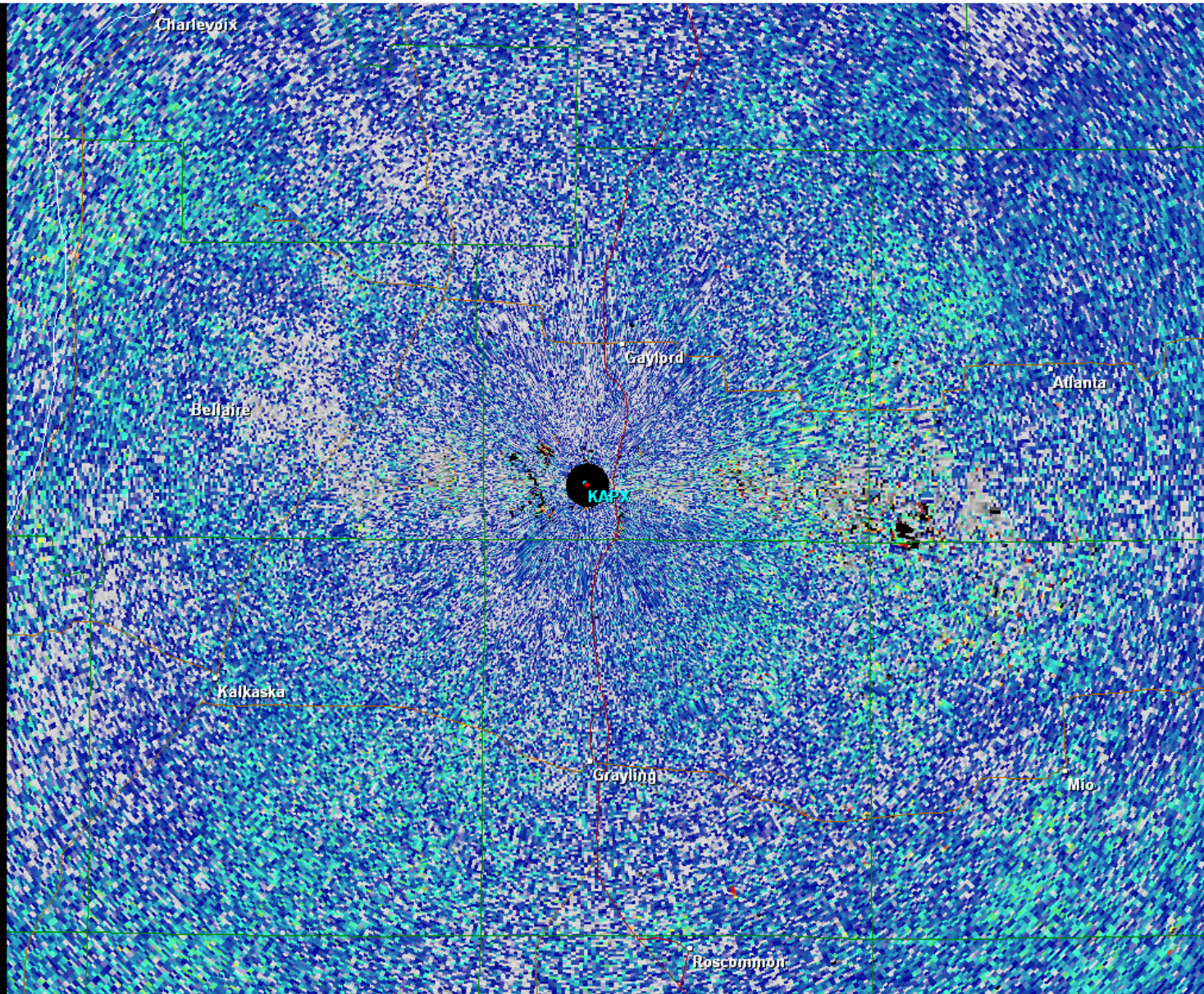
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0.5 deg ZDR – KAPX (13 Jan 2012)



5

4

3

2

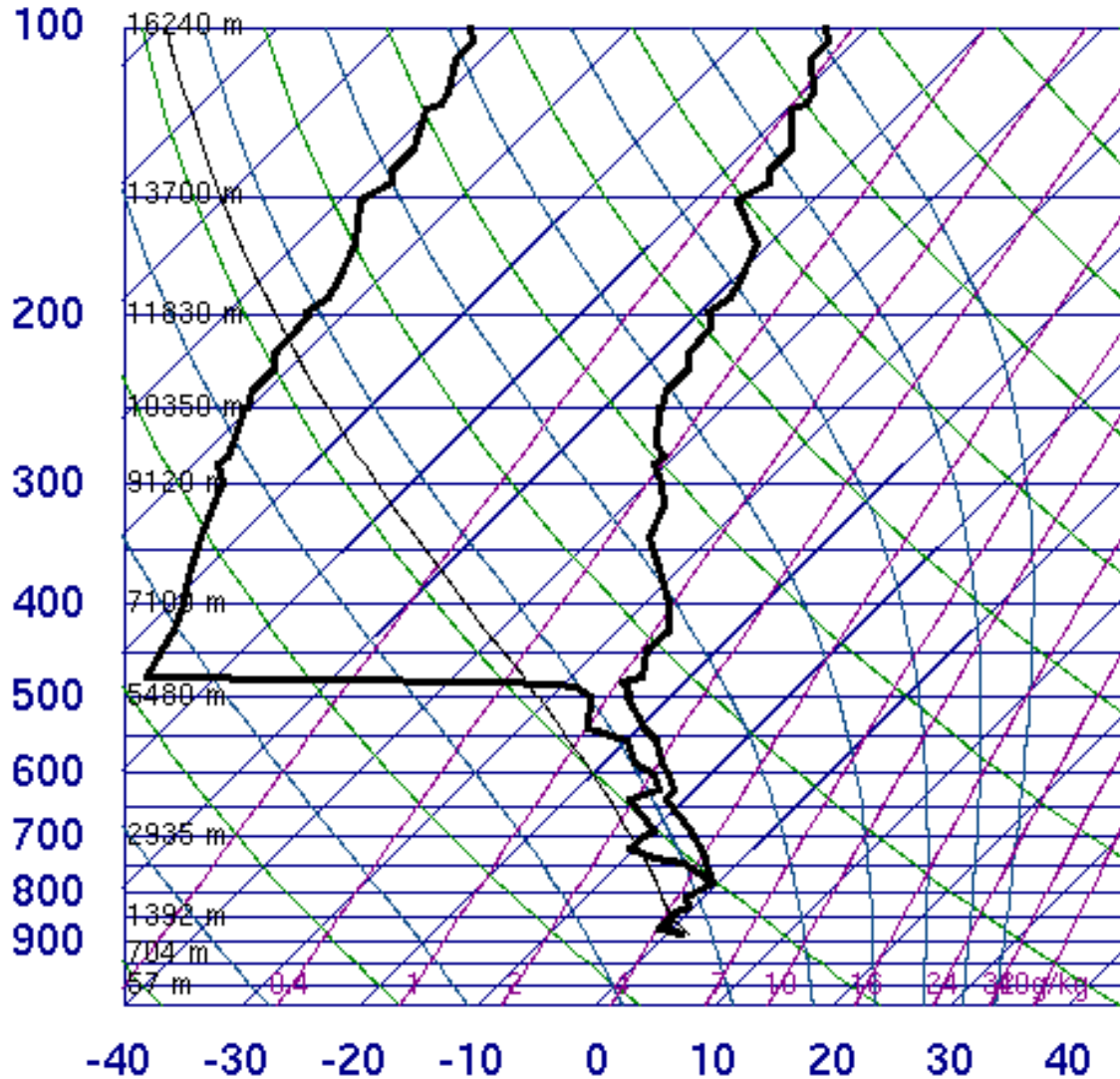
1

0

-1

-4

72363 AMA Amarillo Arpt(Awos)



SLAT	35.23
SLON	-101.70
SELV	1099.
SHOW	7.67
LIFT	7.59
LFTV	7.64
SWET	72.01
KINX	17.00
CTOT	22.30
VTOT	22.40
TOTL	44.70
CAPE	0.00
CAPV	0.00
CINS	0.00
CINV	0.00
EQLV	849.7
EQTV	849.6
LFCT	851.5
LFCV	851.5
BRCH	0.00
BRCV	0.00
LCLT	272.1
LCLP	851.5
MLTH	284.9
MLMR	4.20
THCK	5423.
PWAT	11.00

00Z 20 Dec 2011

University of Wyoming

90



0.5 deg Z – KAMA (19 Dec 2011)

Dalhart

Dumas

Channing

Vega

Amarillo



8

DB

8

0.5 deg ZDR – KAMA (19 Dec 2011)

5

4

3

2

1

0

-1

-4

6

5

4

3

2

1

0

-1

-2

-3

-4

Dalhousie

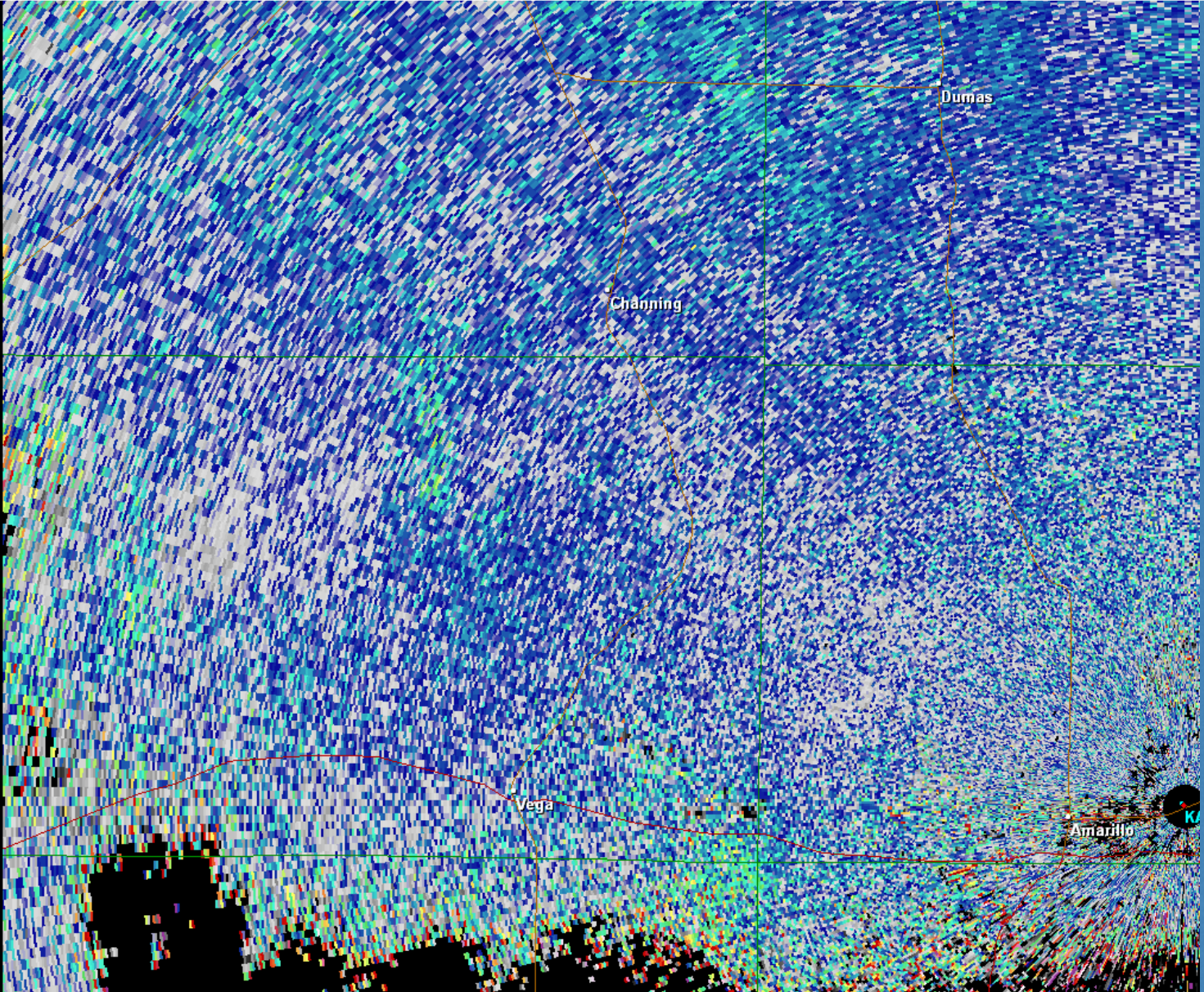
Dumas

Channing

Vega

Amarillo

KAMA



Summary - Typical Values of ZDR

Typical Values for ZDR (dB)

