AUTOMATED VOLUME SCAN EVALUATION AND TERMINATION (AVSET)

TAC Technical Decision Brief
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Briefing Purpose

- Provide updated information concerning the Automated Volume Scan Evaluation and Termination (AVSET) function
- Brief the current status of the development and testing of AVSET
- Obtain a Technical Recommendation to implement AVSET for NEXRAD SREC consideration

Operational Need

- Operator survey results
  - Over 62% of respondents rate faster Volume Coverage Pattern (VCP) updates (more frequent low elevation updates) as the “Most Important VCP Improvement” the ROC could provide

Background

- Currently WSR-88D VCPs automatically and continuously scan predefined elevation angles
- Once invoked, a VCP executes regardless of the areal coverage or significance of the return
- Data for each elevation angle is updated once within the defined VCP scanning time interval

Faster VCP Updates

- Only two ways to achieve faster VCP updates
  - Rotate the antenna faster
    - May impact base data quality (e.g., increased variance, reduced clutter filter performance, etc.,)
    - May result in hardware maintenance issues
  - Sample fewer elevations
    - Impossible to predefine a new VCP for every operational scenario

Automated Volume Scan Evaluation and Termination (AVSET)

- Dynamic Volume Scanning
  - Treat each volume scan independently within the constraints of the VCP definition
  - Dynamically control the number of scanning angles based on the sampled meteorological return

AVSET Concept

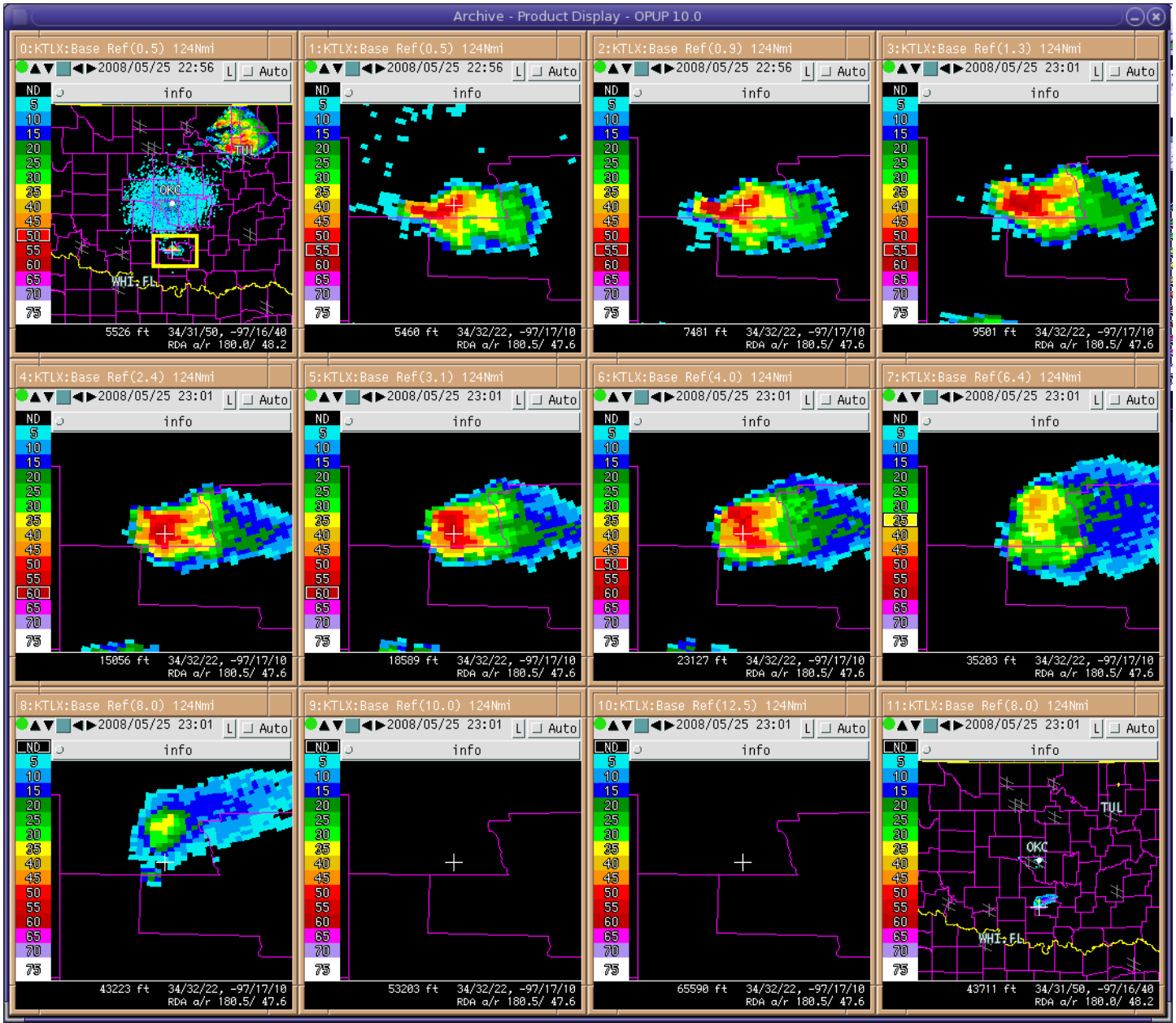
- AVSET terminates the current volume scan if minimum thresholds for reflectivity are not met
  - Will shorten the elapsed time between product updates when there is little or no data above a predefined value on the higher elevation tilts
  - Does not change the antenna rotation rates
  - Does not impact the quality of the base data estimates

AVSET Program Outline

- AVSET only executes on elevations above 5 degrees
  - If the areal coverage of ≥18dBZ is **less** that 80 km² (total over the entire radar coverage area)
  - **AND** the areal coverage of ≥30dBZ is **less** than 30 km² (total over the entire radar coverage area)
  - **AND** the areal coverage of 18dBZ and greater has not increased by 12 km² or more since the last volume scan
  - ***THEN*** AVSET terminates the volume scan **AFTER** completion of the next higher elevation.

NOTE: The thresholds are adaptable and will be modified if warranted by test results

AVSET Execution Example

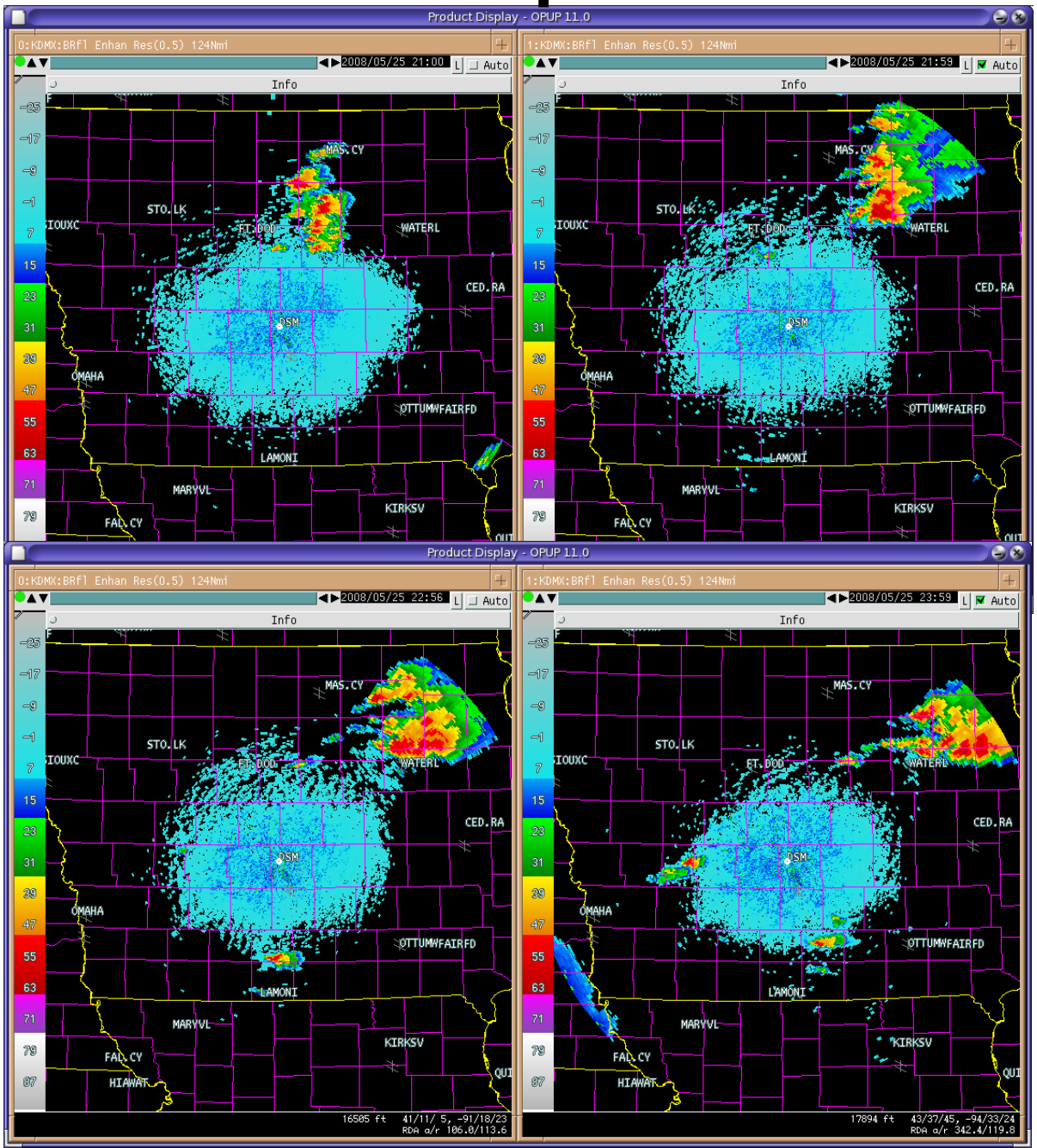


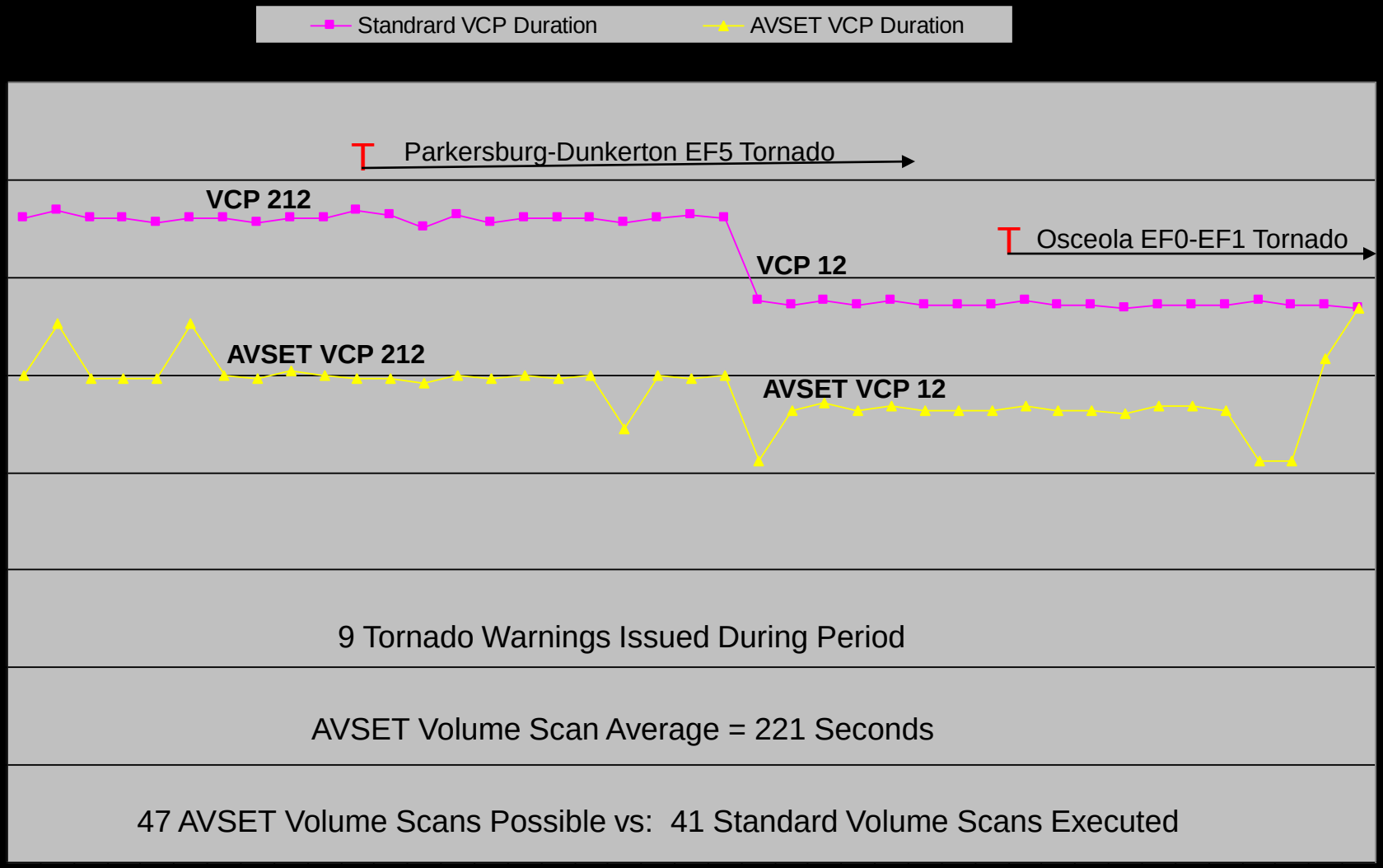
AVSET-Controlled VCP Completion Times

AVSET-Controlled Shortest VCP 11		AVSET-Controlled Shortest VCP 12		AVSET-Controlled Shortest VCP 212		AVSET-Controlled Shortest VCP 21	
Elevations	Time (sec)	Elevations	Time (sec)	Elevations	Time (sec)	Elevations	Time (sec)
0.5	19	0.5	17	0.5	17	0.5	32
0.5	19	0.5	14	0.5	21	0.5	32
1.5	18	0.9	17	0.9	17	1.5	32
1.5	19	0.9	14	0.9	21	1.5	32
2.4	22	1.3	17	1.3	17	2.4	32
3.4	20	1.3	14	1.3	21	3.4	32
4.3	20	1.8	15	1.8	15	4.3	32
5.3	21	2.4	14	2.4	14	6.0	32
6.2	21	3.1	14	3.1	14	9.9	25
		4.0	14	4.0	14		
		5.1	14	5.1	14		
		6.4	13	6.4	13		
Scan time	179		177		197		281
Ret/Trans	13		13		13		15
Total Time	**192**		**190**		**210**		**296**

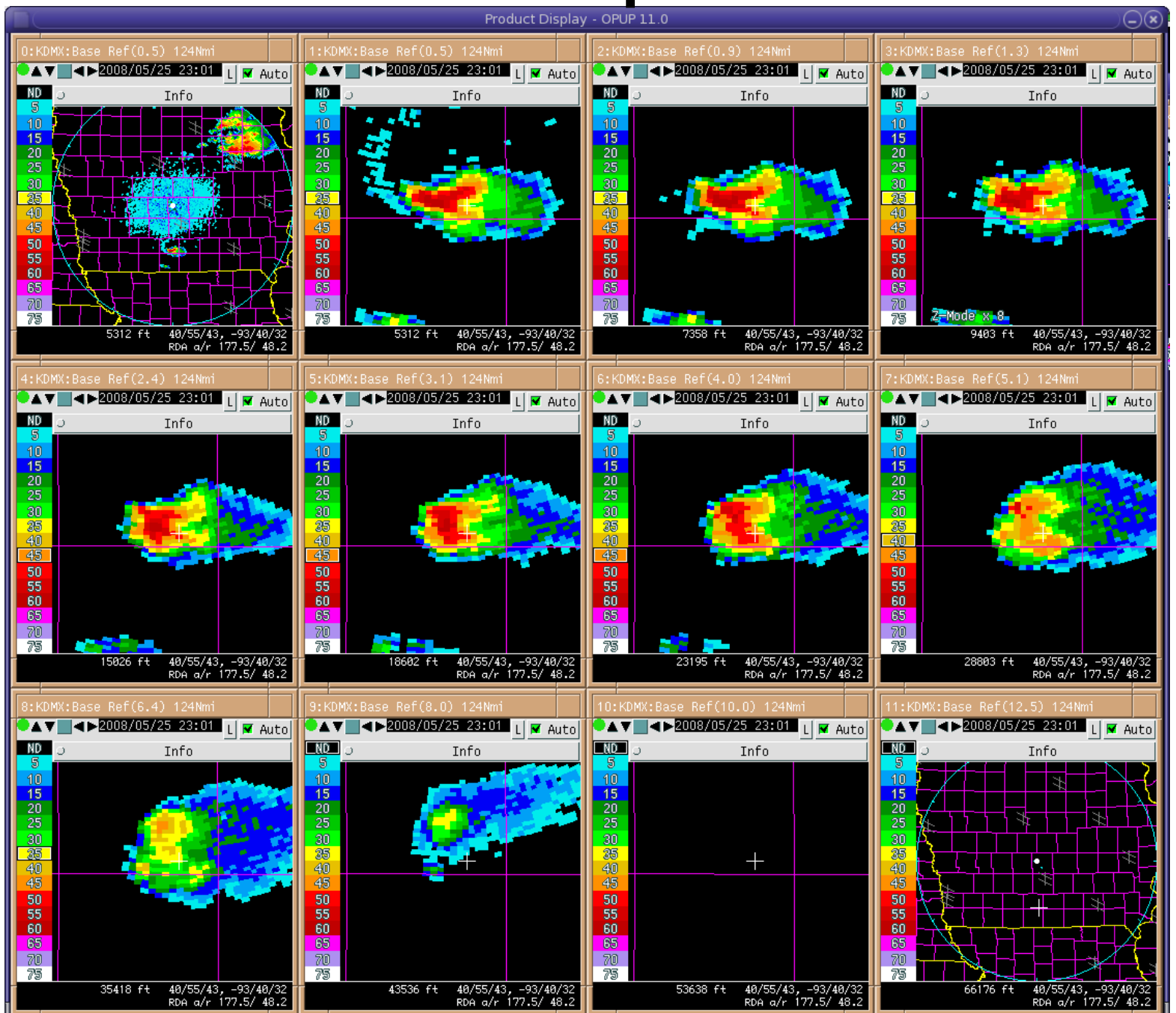
Average VCP Completion Time (Seconds)	VCP 11	VCP 12	VCP 212	VCP 21
	293	256	277	346

AVSET Example - KDMX




Standrard VCP Duration
AVSET VCP Duration
Parkersburg-Dunkerton EF5 Tornado
VCP 212
Osceola EF0-EF1 Tornado
VCP 12
AVSET VCP 212
AVSET VCP 12
9 Tornado Warnings Issued During Period
AVSET Volume Scan Average = 221 Seconds
47 AVSET Volume Scans Possible vs: 41 Standard Volume Scans Executed

AVSET Example - KDMX



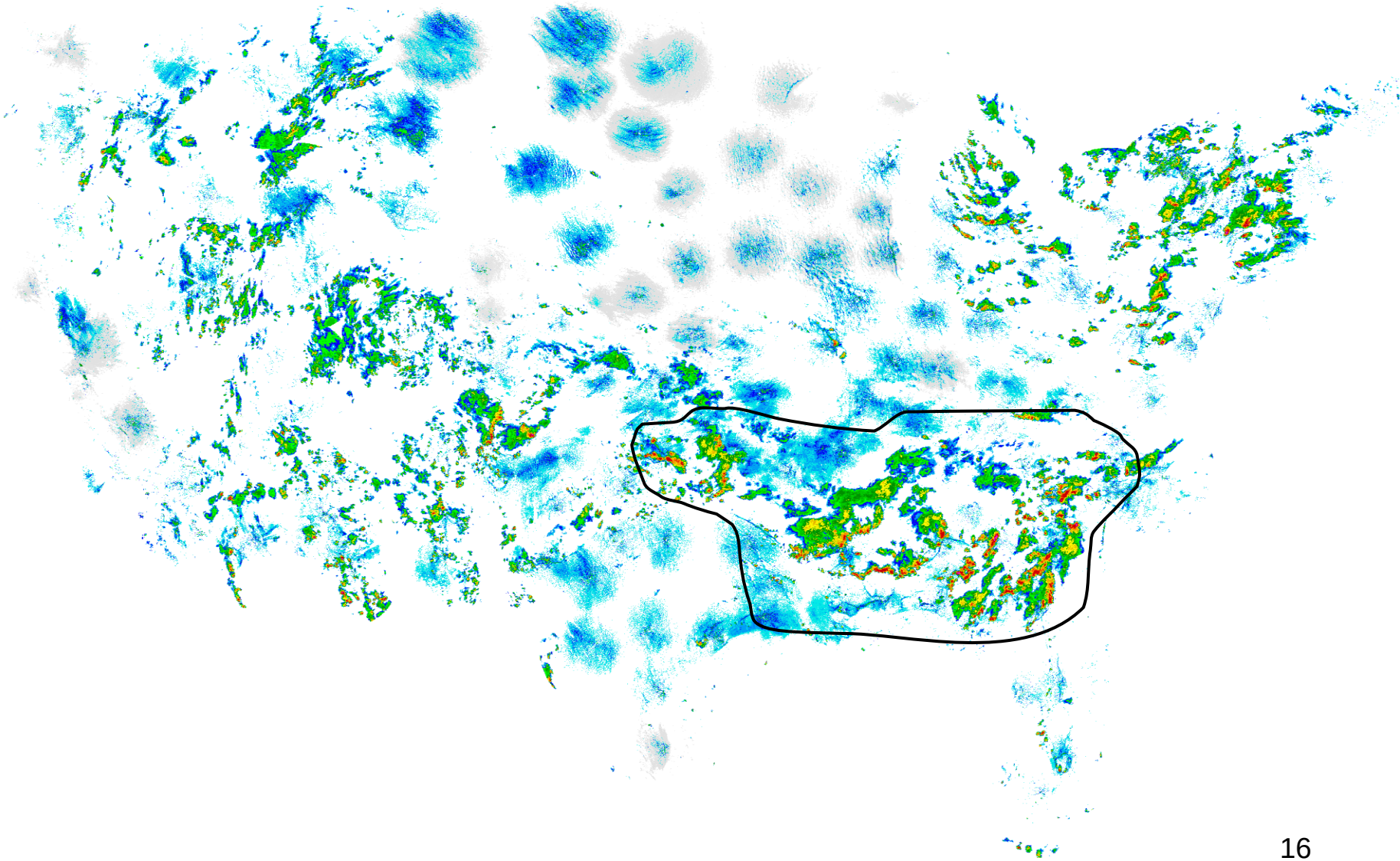
Areas of Interest

- Level II Bandwidth Impacts
  - Shortened volume scan times
  - More frequent product updates
- Cone-of-Silence
- Impacts on user-systems – beyond bandwidth

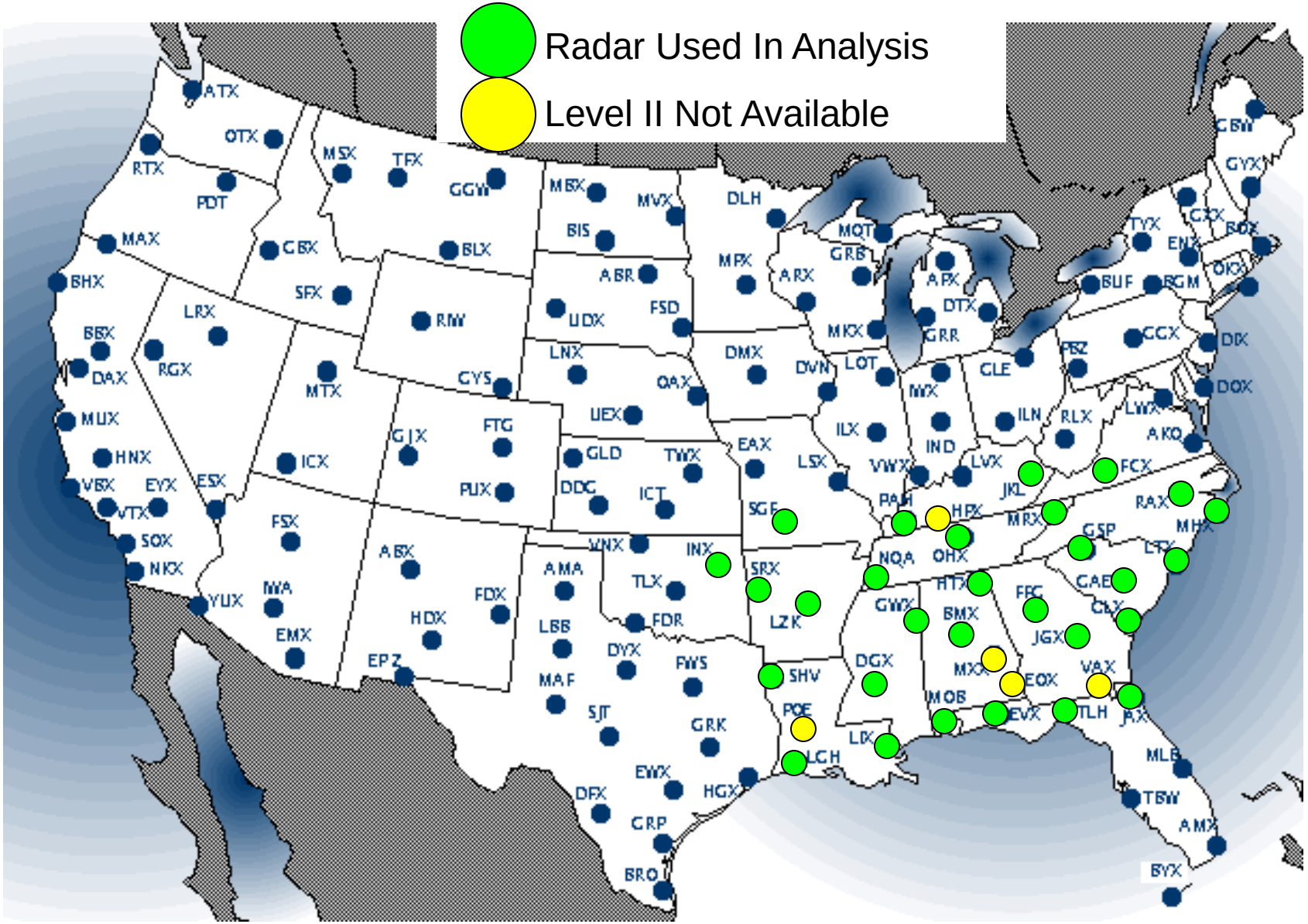
Bandwidth Impact Analysis

- Faster volume coverage pattern updates also result in increased bandwidth required to transmit Level II data.
- AVSET's impact on single site communications load can be significant 25-30%
- The cumulative Level II impact for the network cannot be estimated using these "worst case" single site figures.

National Radar Mosaic from Aug 7, 2008 21:48Z



WSR-88D Radar Locations

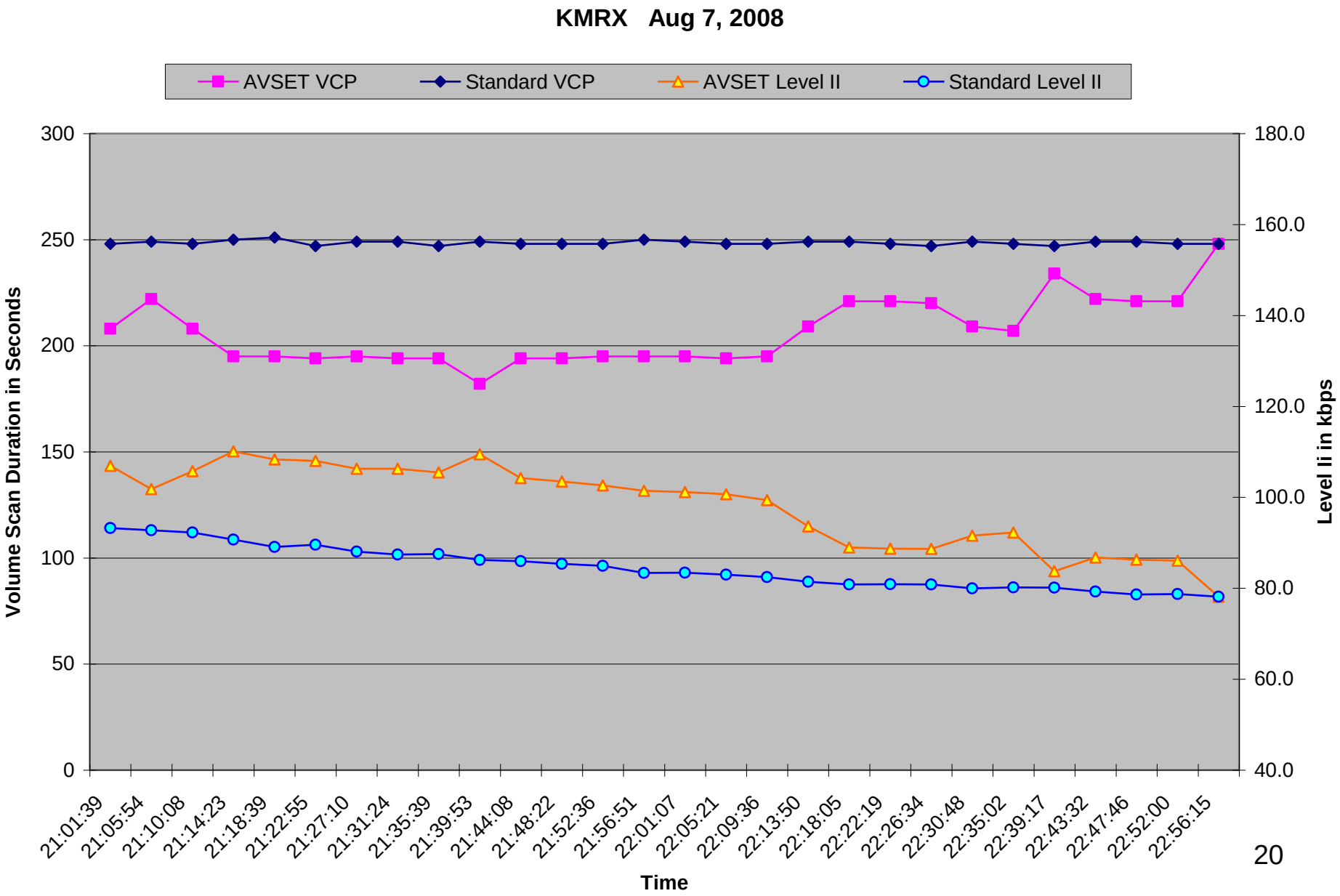


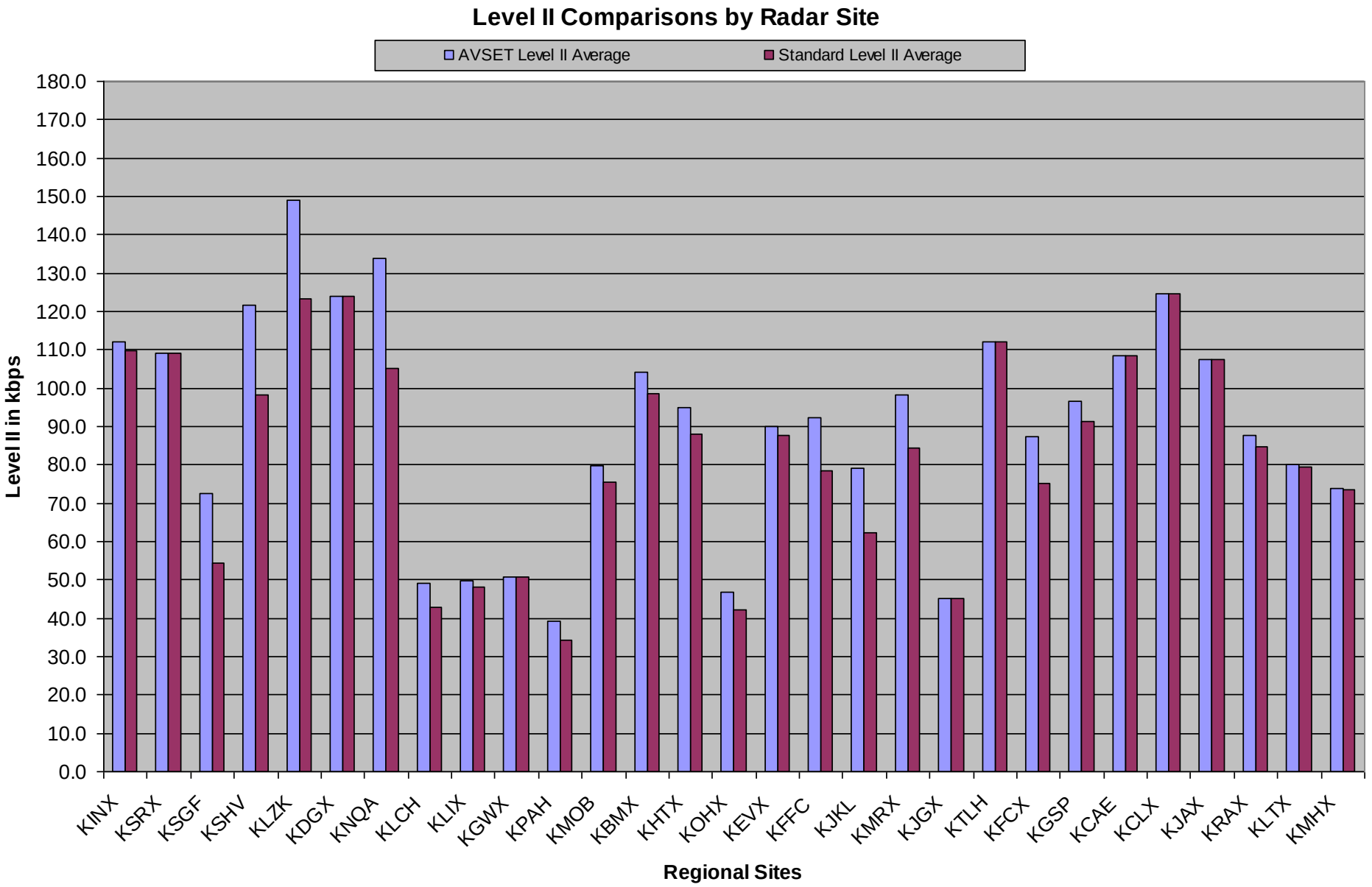
Radar Information

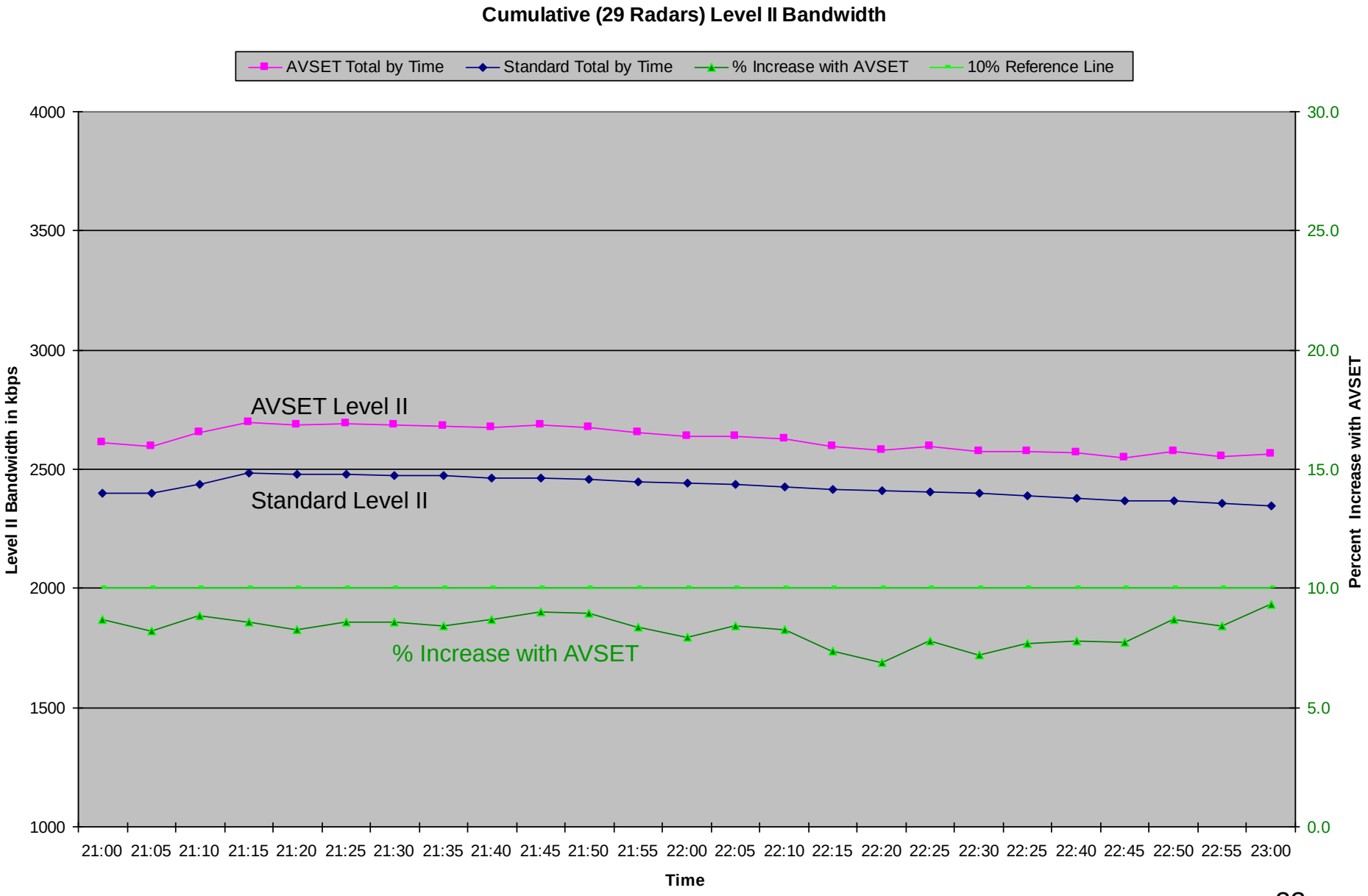
Radar	State	ICAO	VCP	Super Res
Birmingham	Al	KBMX	212	yes
Huntsville	AL	KHTX	12	yes
Mobile	AL	KMOB	212	yes
Little Rock	AR	KLZK	12	yes
Fort Smith	AR	KSRX	12	yes
Northwest Florida	FL	KEVX	212	yes
Jacksonville	FL	KJAX	212	yes
Tallahassee	FL	KTLH	121	yes
Atlanta	GA	KFFC	212	yes
Robins	GA	KJGX	12	no
Jackson	KY	KJKL	12	yes
Paducah	KY	KPAH	21	yes
Lake Charles	LA	KLCH	21	yes
New Orleans	LA	KLIX	21	yes
Shreveport	LA	KSHV	12	yes
Springfield	MO	KSGF	11	yes
Brandon	MS	KDGX	12	yes
Columbus	MS	KGWX	12	no
Wilmington	NC	KLTX	212	yes
Morehead CitY	NC	KMHX	12	yes
Raleigh	NC	KRAX	12	yes
Tulsa	OK	KINX	12	yes
Columbia	SC	KCAE	212	yes
Charleston	SC	KCLX	12	yes
Greer	SC	KGSP	12	yes
Knoxville	TN	KMRX	12	yes
Memphis	TN	KNQA	212	yes
Nashville	TN	KOHX	21	yes
Roanoke	VA	KFCX	12	yes

Analysis Execution

- 29 of the 34 radars in the identified area were included in analysis
  - 5 radars did not have Level II data available
- Two hour window of Level II data replayed for AVSET analysis 2100Z-2259Z
  - Time of original mosaic 21:48Z
- No Clear-Air VCP data used
- Level II Data replayed thru development RPG executing AVSET emulation code


KMRX Aug 7, 2008
AVSET VCP
Standard VCP
AVSET Level II
Standard Level II
Volume Scan Duration in Seconds
Level Ii in kbps
Time
300
250
200
150
100
50
0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
21:01:39
21:05:54
21:10:08
21:14:23
21:18:39
21:22:55
21:27:10
21:31:24
21:35:39
21:39:53
21:44:08
21:48:22
21:52:36
21:56:51
22:01:07
22:05:21
22:09:36
22:13:50
22:18:05
22:22:19
22:26:34
22:30:48
22:35:02
22:39:17
22:43:32
22:47:46
22:52:00
22:56:15


Level II Comparisons by Radar Site
AVSET Level II Average
Standard Level II Average
Level II in kbps
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
KINX
KSRX
KSGF
KSHV
KLZK
KDGX
KNQA
KLCH
KLIX
KGWX
KPAH
KMOB
KBMX
KHTX
KOHX
KEVX
KFFC
KJKL
KMRX
KJGX
KTLH
KFCX
KGSP
KCAE
KCLX
KJAX
KRAX
KLTX
KMHX
Regional Sites


Cumulative (29 Radars) Level II Bandwidth
AVSET Total by Time
Standard Total by Time
% Increase with AVSET
10% Reference Line
AVSET Level II
Standard Level II
% Increase with AVSET
Level II Bandwidth in kbps
Percent Increase with AVSET
Time
4000
3500
3000
2500
2000
1500
1000
30.0
25.0
20.0
15.0
10.0
5.0
0.0
21:00 21:05 21:10 21:15 21:20 21:25 21:30 21:35 21:40 21:45 21:50 21:55 22:00 22:05 22:10 22:15 22:20 22:25 22:30 22:25 22:40 22:45 22:50 22:55 23:00

Regional Analysis Summary

ICAO	VCP	AVSET VCP Duration Sec)	Standard VCP Duraton (sec)	% Decrease in Volume Scan Duration w/ AVSET	AVSET Level II Average (kbps)	Standard Level II Average (kbps)	% Increase Level II (kbps) w/ AVSET
KBMX	212	244	262	6.9	104.3	98.7	5.61
KHTX	12	227	252	9.9	95.0	88.1	7.83
KMOB	212	260	279	6.8	79.9	75.4	5.89
KLZK	12	200	249	19.7	148.9	123.3	20.75
KSRX	12	248	248	0.0	109.3	109.3	0.00
KEVX	212	270	278	2.9	90.1	87.6	2.89
KJAX	212	268	268	0.0	107.5	107.5	0.00
KTLH	121	329	329	0.0	112.1	112.1	0.00
KFFC	212	221	269	17.8	92.5	78.4	17.91
KJGX	12	250	250	0.0	45.3	45.3	0.00
KJKL	12	181	249	27.3	79.2	62.2	27.43
KPAH	21	285	338	15.7	39.2	34.2	14.62
KLCH	21	288	339	15.0	49.1	42.8	14.67
KLIX	21	327	338	3.3	49.7	48.2	3.19
KSHV	12	192	249	22.9	121.6	98.2	23.84
KSGF	11	181	284	36.3	72.4	54.5	32.75
KDGX	12	249	249	0.0	124.0	124.0	0.00
KGWX	12	249	249	0.0	50.7	50.7	0.00
KLTX	212	269	272	1.1	80.2	79.5	0.78
KMHX	12	246	248	0.8	73.8	73.4	0.66
KRAX	12	236	246	4.1	87.8	84.8	3.56
KINX	12	243	250	2.8	112.2	109.7	2.34
KCAE	212	271	271	0.0	108.3	108.3	0.00
KCLX	12	248	248	0.0	124.7	124.7	0.00
KGSP	12	235	254	7.5	96.5	91.3	5.70
KMRX	12	204	248	17.7	98.1	84.4	16.16
KNQA	212	203	269	24.5	133.8	105.2	27.18
KOHX	21	296	337	12.2	46.9	42.2	11.18
KFCX	12	200	247	19.0	87.3	75.1	16.28
	AVERAGE	**246**	**271**	**9.5**	**90.4**	**83.4**	**9.01**

Bandwidth Conclusion

- During this widespread convective event, with AVSET being enabled for all 29 radars, the increase in the regional Level II bandwidth requirement caused by the execution of the AVSET function was less than 10% throughout the entire test period.

Cone-of-Silence

- In Clear-Air Mode, the field has always accepted the risk of the possibility that a “new” updraft (return) would develop above 4.5 degrees (close to the radar).

- AVSET will always scan at least through the 6.2º elevation slice which is about 2 degrees higher than the Clear-Air VCPs. This scanning restriction results in a significantly smaller “cone-of-silence” than we currently accept.

  - The “cone-of-silence” for AVSET is approximately 14kft ARL at a range of 20nm (7kft ARL at a range of 10nm).
  - The “cone-of-silence” for VCPs 31/32 is approximately 10kft ARL at a range of 20nm (5kft ARL at a range of 10nm).

Cone-of-Silence

- Threshold (< 80 km^2 of 18dBZ) is used to "forecast" the likelihood of meaningful meteorological return two elevation angles above the processed elevation.
  - If the areal coverage is below the threshold on the 6.4° elevation slice then it is expected that there will not be notable return present on the 10° elevation slice and above.
  - In the context of height ARL there are significant differences between the elevation slices (see Table 1).
    - For example, at 40 nm the center of the beam for the 6.4° elevation is approximately 27,000ft ARL, while the center of the beam for the 10° elevation is approximately 42,000ft ARL; a difference of ~15,000ft.

Table 1: Beam Height (ARL) For Elevation Angles at Selected Ranges

Range	VCP 12 Elevation Angles					
	5.1°	6.4°	8.0°	10.0°	12.5°	15.6 °
20nm	11 kft	14 kft	17 kft	21 kft	26 kft	32 kft
40nm	23 kft	27 kft	34 kft	42 kft	52 kft	65 kft
60nm	35 kft	43 kft	53 kft	65 kft	>70 kft	>70 kft

NOTE: The vertical beam width at the referenced ranges is approximately 2000ft, 4000ft and 6000ft respectively.

Cone-of-Silence

- To address rapidly developing convection very close to the radar AVSET looks for increasing reflectivity areal coverage between scans.
- If the reflectivity areal coverage increases by 12km^2 since the last volume scan AVSET
  - Does Not terminate the volume scan
  - Reduces threshold values and continues the volume scan
- It is unlikely that return would not be detected for more than a few minutes.
  - In the case where there AVSET terminates the volume scan at 6.4 degrees, the VCP update time is approx 190 seconds.

Impacts on User Systems

- AVSET exercised on KCRI since Build 11
- AWIPS – No problems identified
- OPUP – No problems identified
- FAA User Systems – No problems identified

Testing Results

- AVSET can reduce volume scan duration by up to 100 seconds
- Bandwidth
  - Individual Level II bandwidth can increase by approx 28%
  - Individual Narrowband bandwidth increases by approx 25%
  - “Regional” Bandwidth increases approx 10%
  - Bandwidth solution required for Dual Pol will handle AVSET implementation
- AVSET Cone-of-Silence less than Clear-Air Mode VCPs
  - Enhanced logic to address rapid cell growth close to radar

AVSET Future Plans

- NWS OSIP Gate 3 scheduled for Nov 24 2009
  - AVSET released back to SREC
- Brief SREC on AVSET status
- Submit Test ECPs to perform field tests at selected sites
  - Assess AVSET operational effectiveness and field acceptance
  - Ensure no unforeseen problems arise
- Submit CCR to make AVSET Operational in Build 13

AVSET Summary

- The AVSET function evaluates the return on each elevation above 5° and terminates the current volume if the areal coverage thresholds are not met.

- AVSET shortens the elapse time between data collection on low elevation angles (and generating volume-based products) during periods when little or no data are available on the higher tilts.

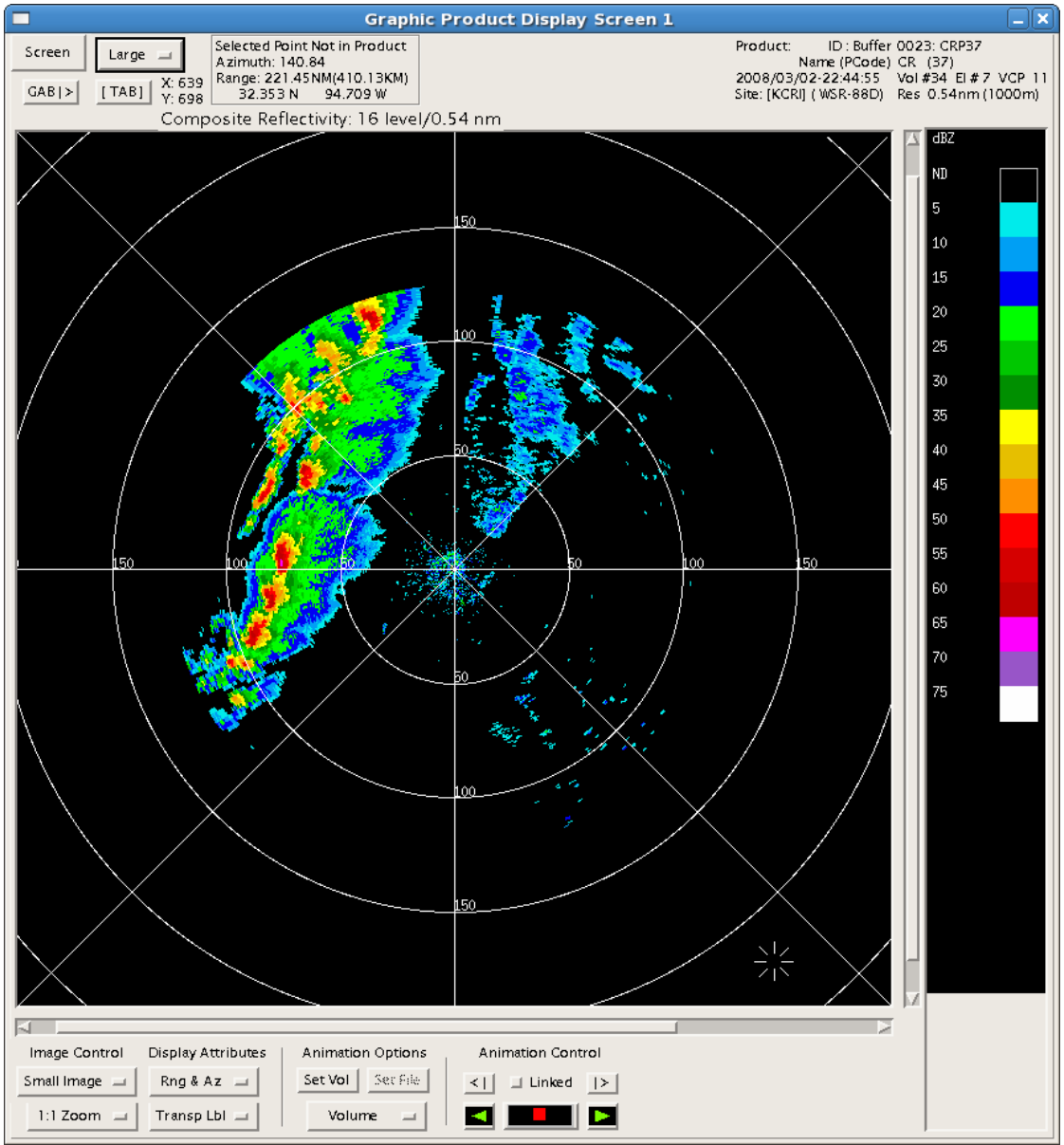
- The AVSET function results in faster volume scan updates without impacting the quality and accuracy of the base data estimates.

Recommendation

- Approve AVSET for NEXRAD SREC consideration

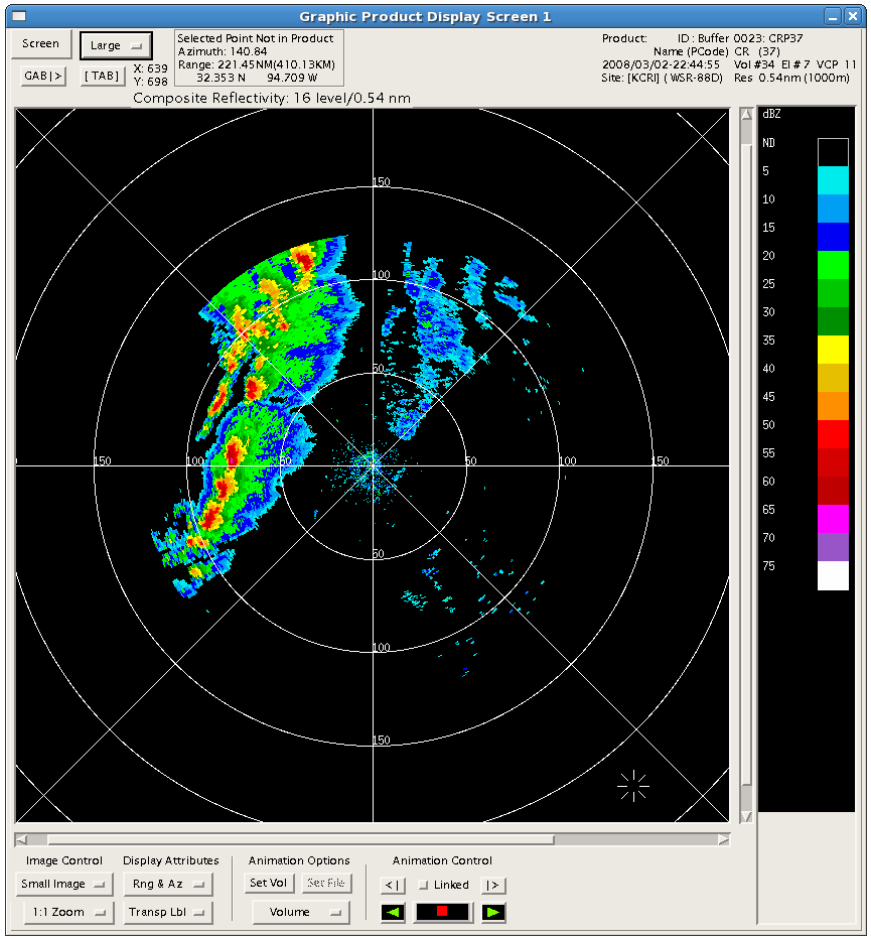
Backup Slides

KTLX Composite Reflectivity Product

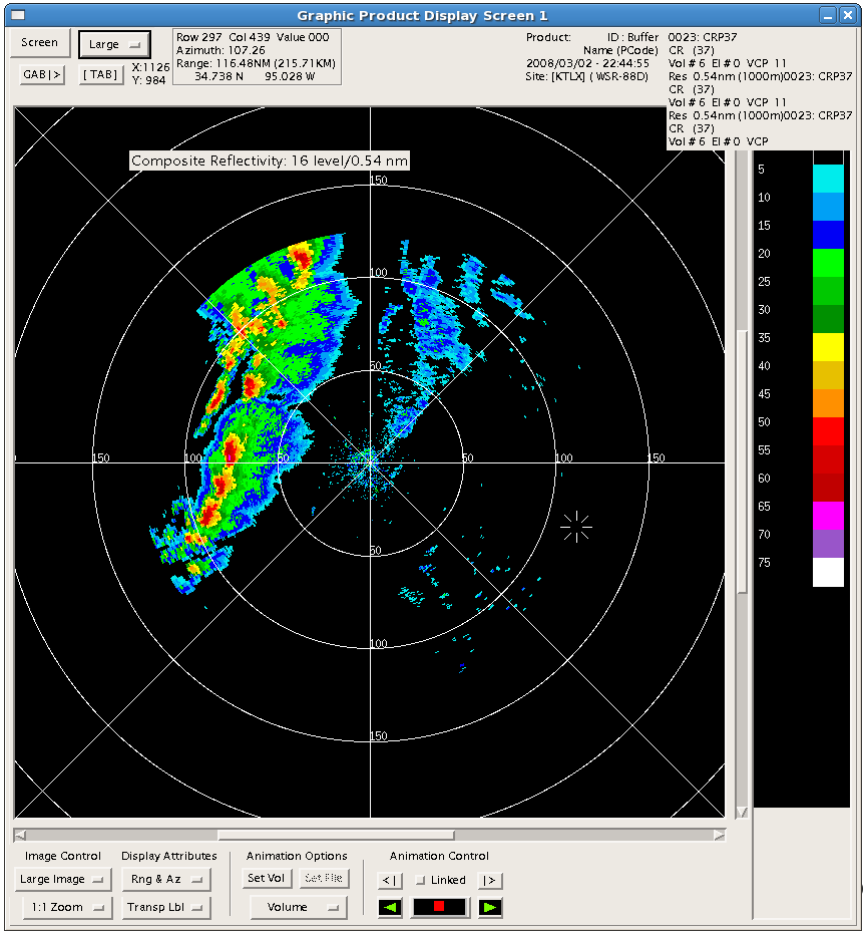


KTLX Composite Reflectivity Products

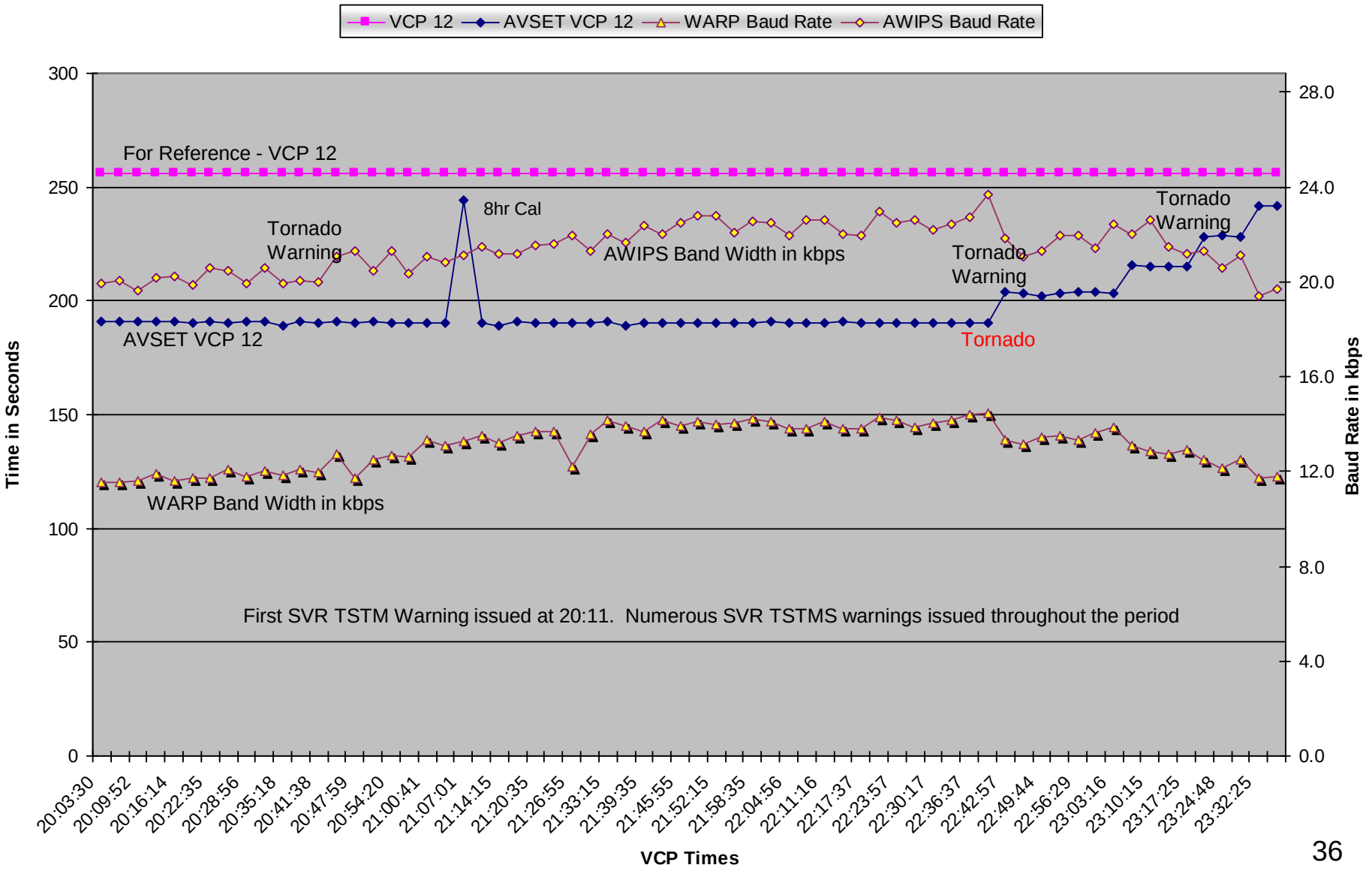
KTLX AVSET-Controlled VCP 11



KTLX Standard VCP 11

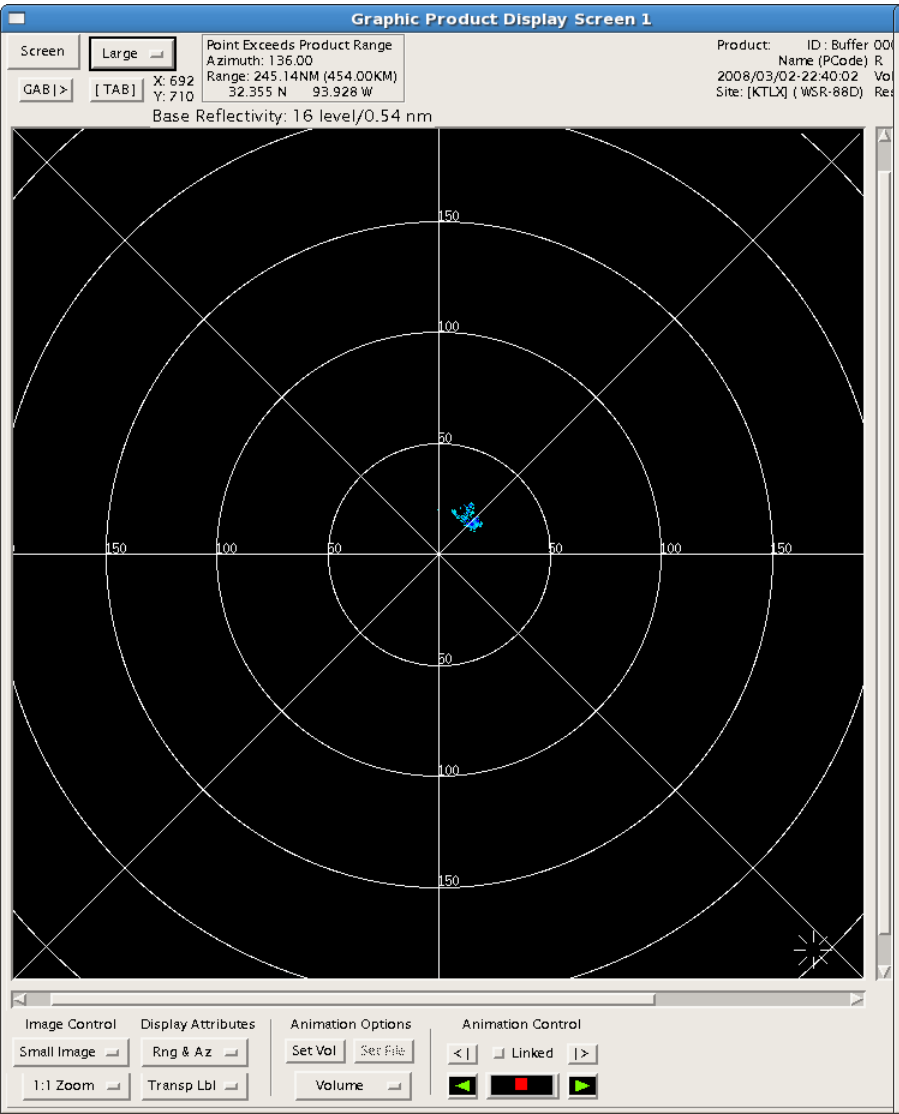


AVSET Comms Test for WARP and AWIPS
KCRI Mar 2, 2008 Data

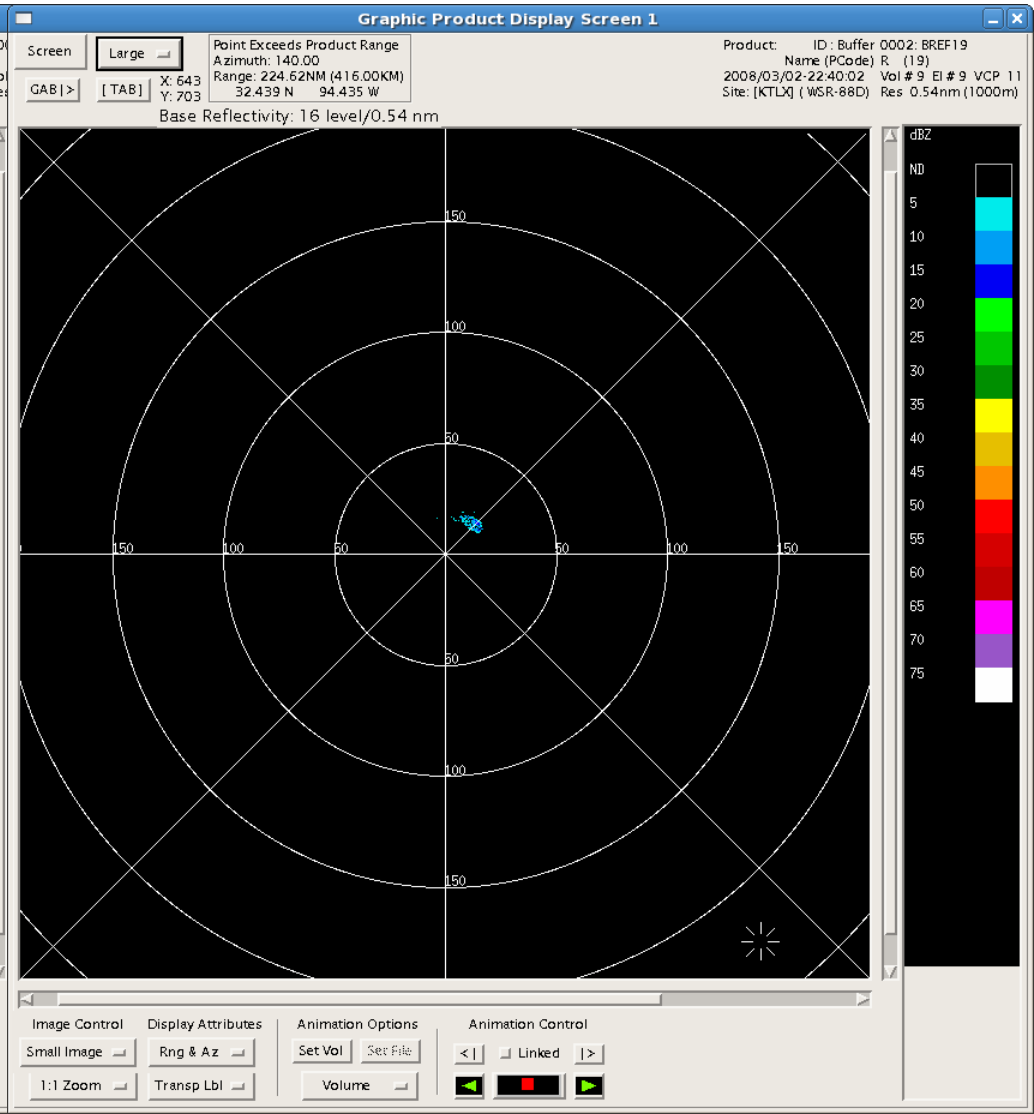


KTLX Reflectivity Products

KTLX 7.5º 22:40



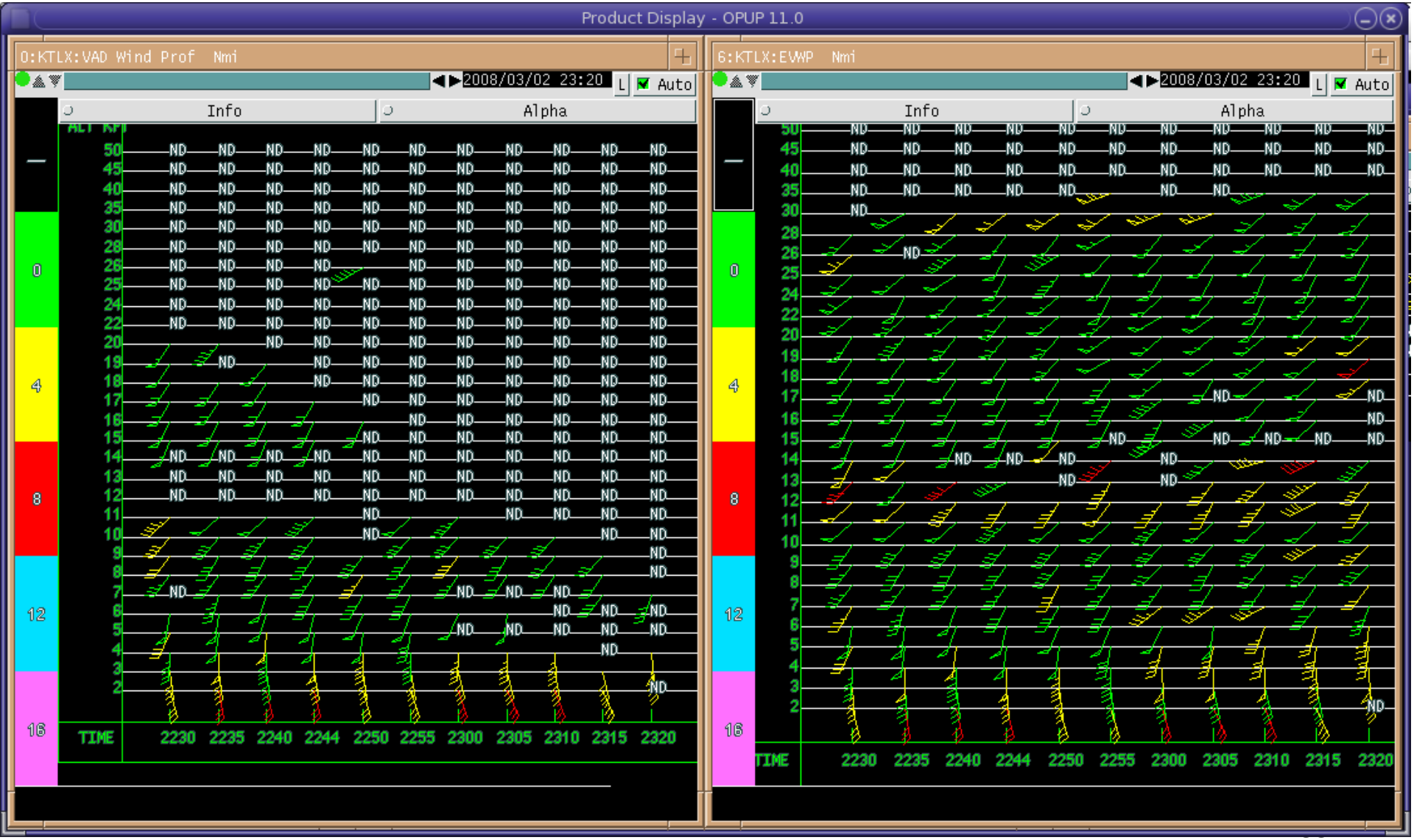
KTLX 8.7º 22:40



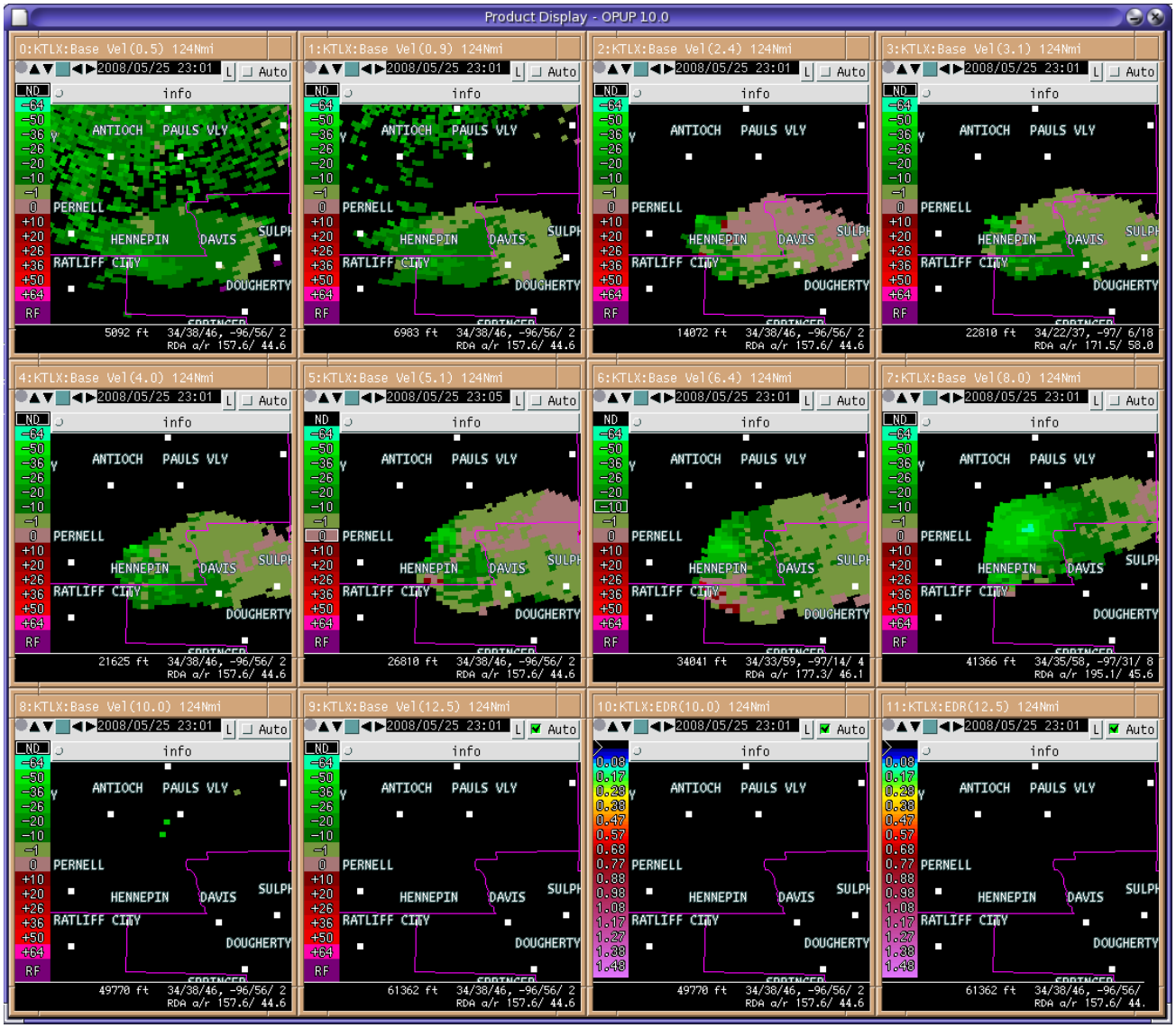
KTLX VWP
Mar 2 2008 23:20

Original VWP

Enhanced VWP

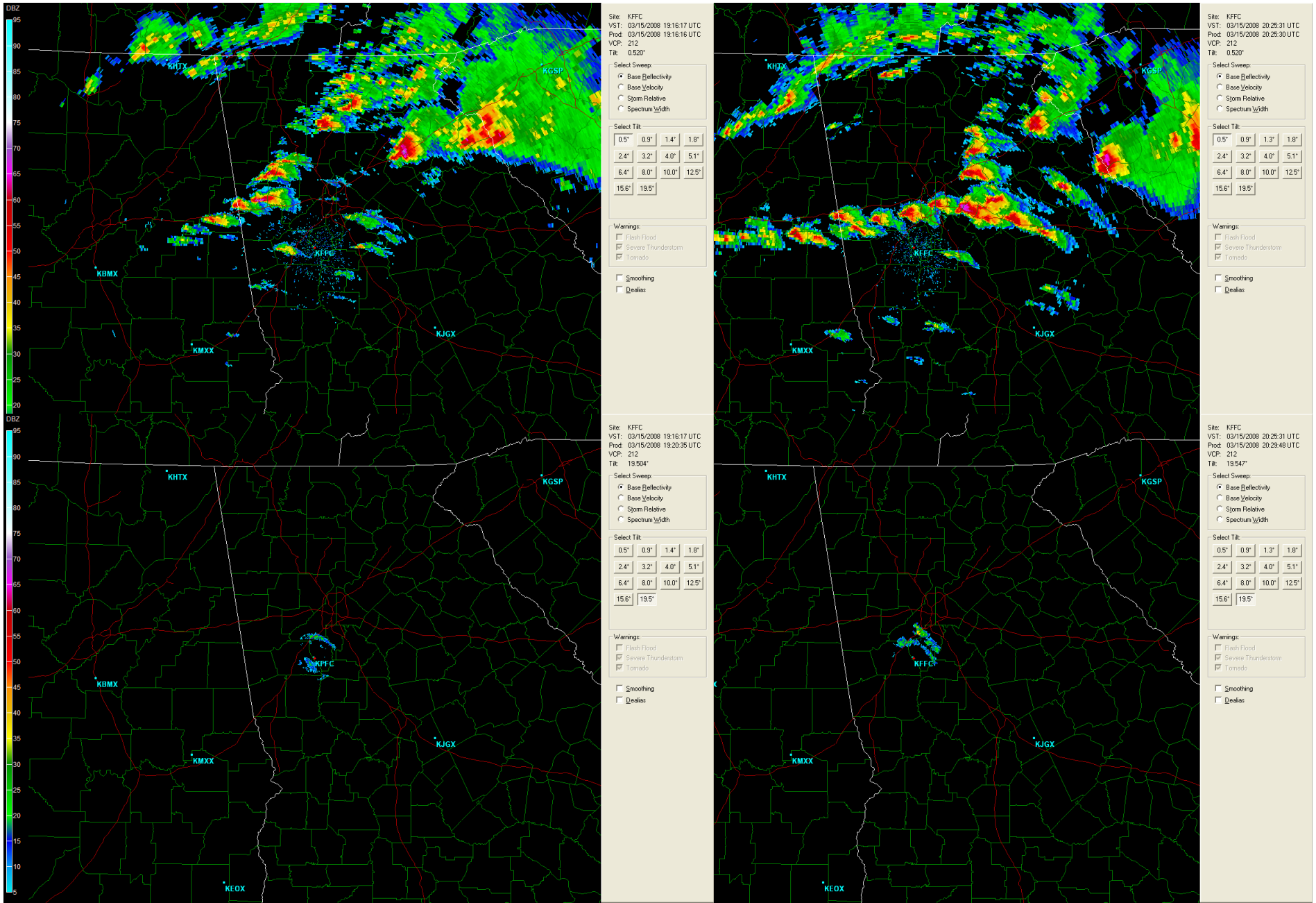


KTLX


Product Display - OPUP 10.0
0:KTLX:Base Vel(0.5) 124Nmi
1:KTLX:Base Vel(0.9) 124Nmi
2:KTLX:Base Vel(2.4) 124Nmi
3:KTLX:Base Vel(3.1) 124Nmi
4:KTLX:Base Vel(4.0) 124Nmi
5:KTLX:Base Vel(5.1) 124Nmi
6:KTLX:Base Vel(6.4) 124Nmi
7:KTLX:Base Vel(8.0) 124Nmi
8:KTLX:Base Vel(10.0) 124Nmi
9:KTLX:Base Vel(12.5) 124Nmi
10:KTLX:EDR(10.0) 124Nmi
11:KTLX:EDR(12.5) 124Nmi
2008/05/25 23:01
Auto
info
ANTIOCH
PAULS VLY
PERNELL
HENNEPIN
DAVIS
RATLIFF CITY
DOUGHERTY

KFCC 19:16

KFCC 20:25



KFCC 21:28

KFCC 22:28