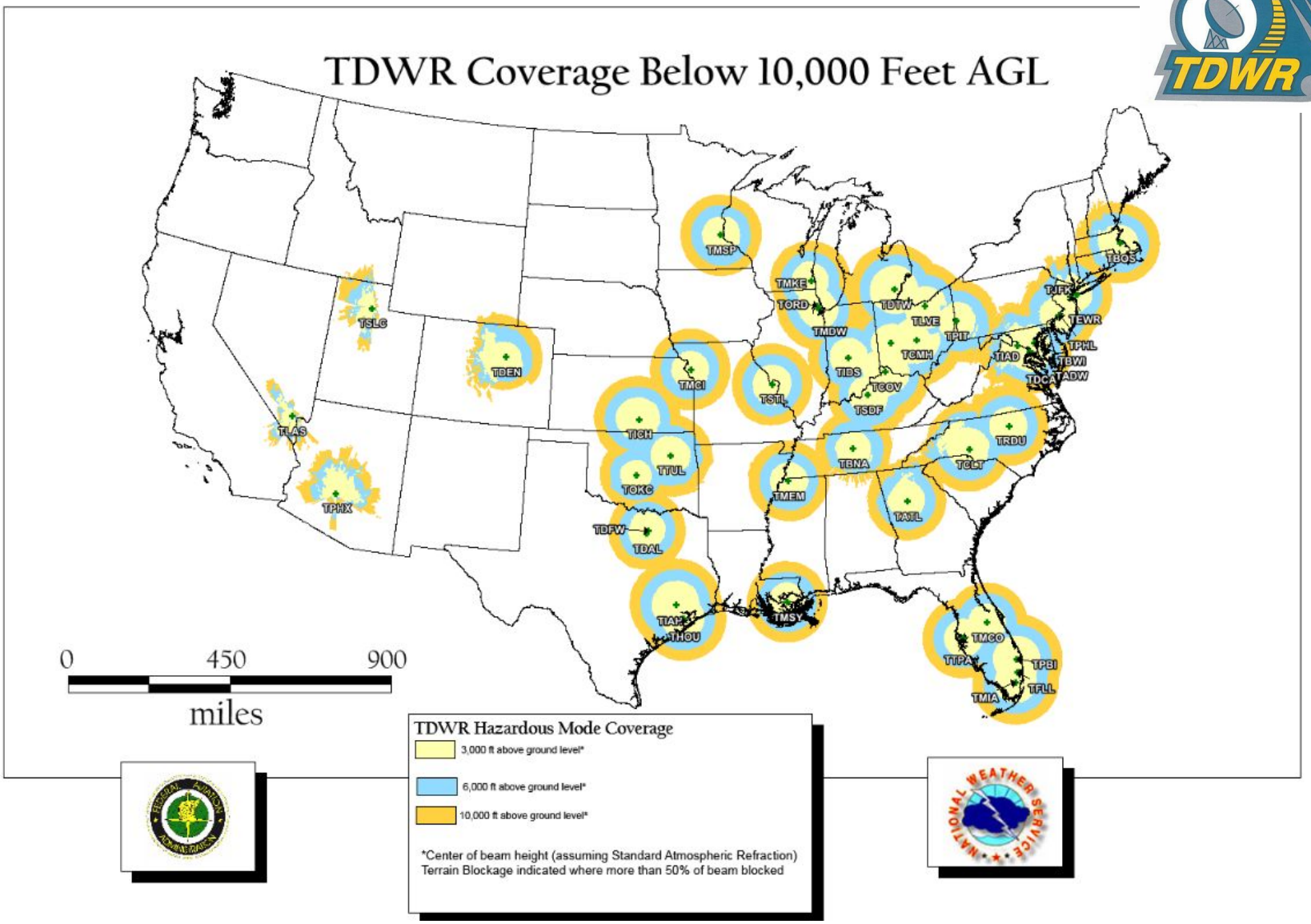
Terminal Doppler Weather Radar and the Supplemental Product Generator

Training Presentation
September 3, 2020

TDWR Mission

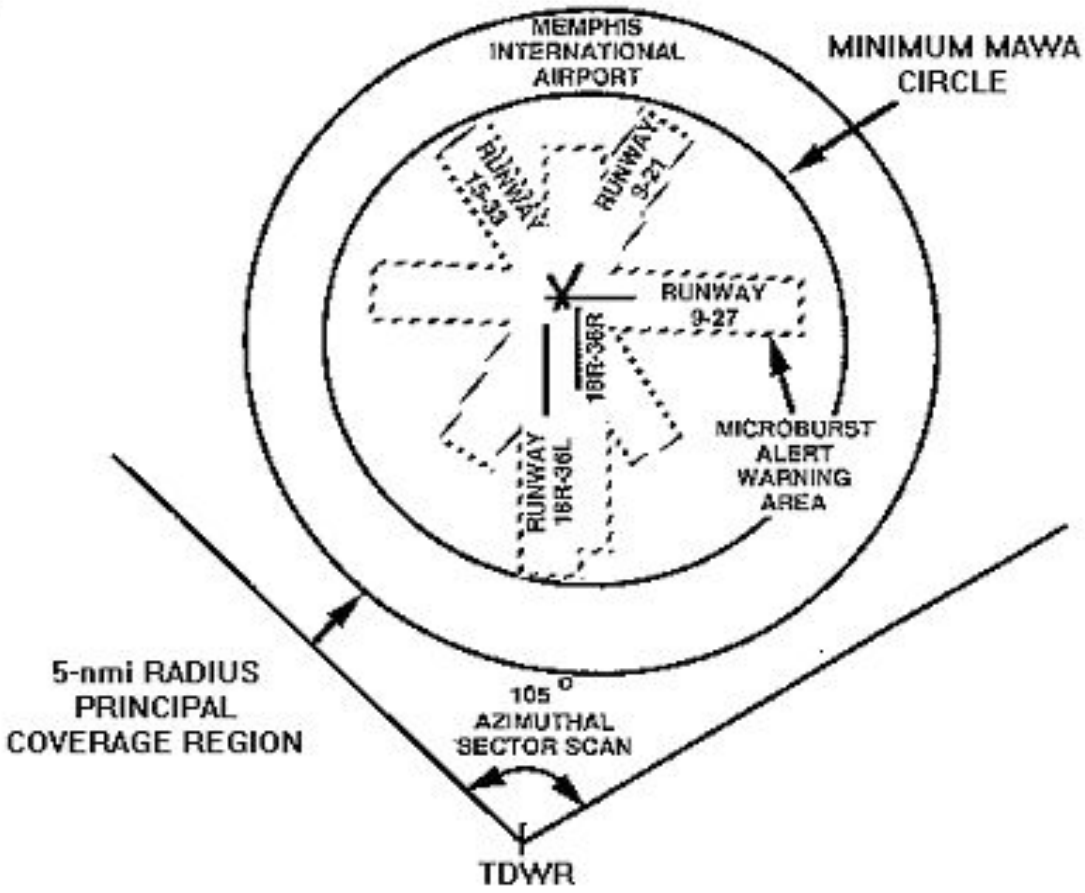
- **T**erminal **D**oppler **W**eather **R**adar Basics
  - FAA radar designed to cover only its associated airport
  - Radar was developed to automatically alert ATCs to existence and location of low-level wind shear hazards within the terminal area of airports
  - Placed close to airports that are vulnerable to and have a history of wind shear conditions
  - Sited specifically to scan atmospheric volumes over and around associated airport


TDWR Coverage Below 10,000 Feet AGL
TMSP
TMKE
TORD
TDTW
TBOS
TJFK
TLVE
TEWR
TMDW
TPIT
TPHL
TCMH
TIAD
TBWI
TDCA
TADW
TSLC
TDEN
TMCI
TSTL
TIDS
TCOV
TSDF
TLAS
TCH
TTUL
TRDU
TBNA
TCLT
TOKC
TMEM
TATL
TPHX
TDFW
TDAL
TIAH
THOU
TMSY
TMCO
TTPA
TPBI
TFLL
TMIA
0
450
900
miles
TDWR Hazardous Mode Coverage
3,000 ft above ground level*
6,000 ft above ground level*
10,000 ft above ground level*
*Center of beam height (assuming Standard Atmospheric Refraction)
Terrain Blockage indicated where more than 50% of beam blocked

TDWR Spatial Sampling

- Microburst Alert Warning Area (MAWA)
  - Used to automatically determine which of two scanning modes to employ.
  - MAWA is defined as a volume over an airport whose height is 6 km and whose horizontal region includes all of the runways, 3 miles final and 2 miles departure.
  - Maximum vertical spacing between each elevation scan no larger than 1 km within the MAWA.
  - High resolution used to detect the rapid evolution of wind shear.
  - Initially performed “sector scans” over the MAWA but now performs only full, 360 degree volume scans

TDWR Airport Coverage



The MAWA (horizontal view) as depicted around Memphis International Airport

TDWR Characteristics

- TDWR Basics
  - C-band radar (5 cm wavelength)
  - 0.55 degree beam sampled every 1.0 degree, azimuthally
  - Spot blanking performed at some sites
  - Clutter filtering performed below approx. 10 degrees elevation
  - Base data is relative to magnetic north

TDWR Temporal Sampling

- TDWR observational requirements
  - Must produce a long-range surveillance scan every 6 minutes. The range of this scan is 460 km (248 nm)
  - Provide a short-range, low level “near surface” (under 1 degree) scan every minute to capture the evolution of wind shear during hazardous weather conditions
  - Like the 88D, must perform sector blanking at some sites (e.g., TCLT).

TDWR Mode Control

- Automatically switches from monitor mode to hazardous weather mode when one of the following conditions occurs within the MAWA:
  - A region of 30 dBZ (precipitation level 2) must be located within 45 km from the airport with a nominal extent of 2.4 km^2 and be at least 2.4 km above ground level, or
  - Hazardous wind condition (such as a wind shear or microburst signature) has been detected.

TDWR Scanning Modes

- TDWR Modes
  - 2 scanning modes – both 6 minutes in duration
    - Monitor Mode and Hazardous Mode
    - Elevation angles are site dependent
      - Base elevation scan ranges from 0.1 to 0.8 degrees
    - First (long-range) cut in each mode is used for range ambiguity mitigation.
  - Occasional non-operational modes
    - Calibration
    - Others?

TDWR Scanning Modes

- Monitor Mode
  - Surveys the weather to determine if criteria for a switch to hazardous mode are met.
  - After a long-range scan at its base elevation, consists of 15 sequential short-range scans ranging from its base elevation, up to a maximum of 60 degrees.
  - Rotation speed is constant rate of 19 deg/sec or 3.2 rpm, clockwise

TDWR Scanning Modes

- Hazardous Mode
  - Optimized to monitor both low and high level conditions over and in proximity to its airport.
  - A base (low elevation) scan is required every minute to monitor for possible low-level wind shear.
  - After a long-range scan at its base elevation, consists of 22 non-sequential scans ranging from its base elevation up to a site dependent maximum that ranges from 20.1 to 55 degrees.
  - Elevation angles can be vastly different for each TDWR due to radar location relative to associated airport.

TDWR Scanning Modes

- Hazardous Mode (continued)
  - In general, the strategy patterns (aloft or low level scans) are the same among all systems.
  - Contains two identical “mini-volumes”, each with a low elevation scan once per minute and aloft scans.
  - Requires just about the same amount of time to complete as monitor mode because it uses a higher antenna rotation rate.
  - Uses a mix of rotation rates from 21.6 deg/sec (3.6 rpm) to 30.0 deg/sec (5 rpm), clockwise

Long Range Scan Characteristics

- Long-Range Scan – 248 nmi* (460 km*)
  - Always the first elevation cut of a volume scan
  - Site dependent base-elevation, ranges from 0.1 to 0.8 deg elevation
  - Reflectivity data only
    - Reflectivity data range is -30 to +80 dBZ
  - Low PRF (no range folding)
  - Aggressive clutter filtering performed over full range with clutter residue editing within 70 km
  - 150 meter range resolution close to radar, 300 meter range resolution beyond 135 km
    - NOTE: SPG combines the 150 meter data into 300 meter data by averaging the returned power of every two bins.
  - *LR reflectivity product display range is reduced to 225 nmi (416 km)
  - Data from this long range scan is used by TDWR in all subsequent short range scans of the volume for range ambiguity mitigation.
    - PRF selection
    - Setting of data quality flags

Short Range Scan Characteristics

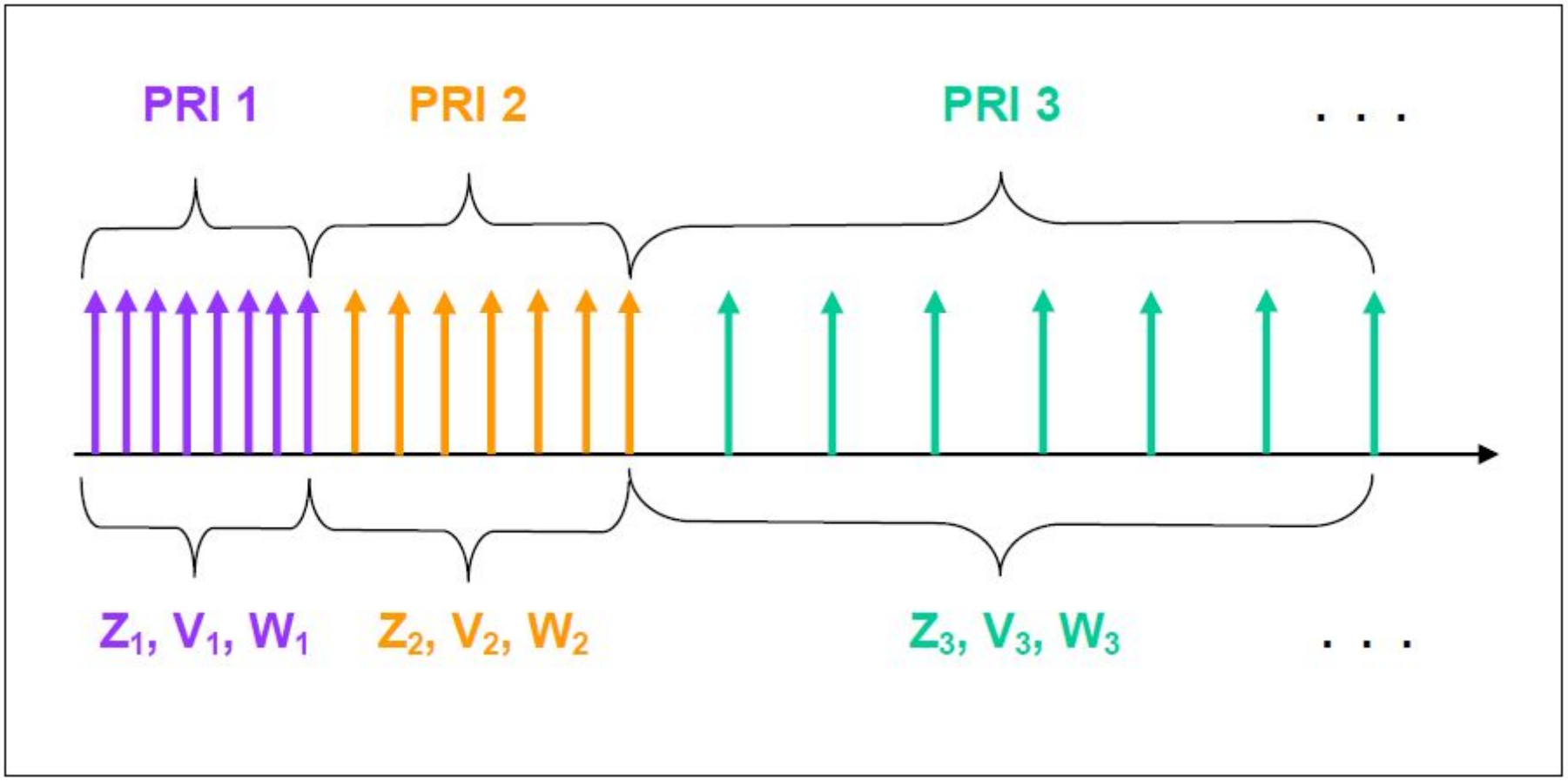
- Short-Range Scans – 48 nmi (90 km)
  - Used for all but the first elevation cut of a volume scan
  - Elevation angles vary by TDWR site
  - Reflectivity, Velocity and Spectrum Width
    - Reflectivity data range is -30 to +80 dBZ
    - Velocity data range is +/- 156 knots
    - Spectrum width data range is 0 to 10 m/sec
  - High PRF (range folding possible in all moments)
  - Aggressive clutter filtering and clutter residue editing performed over full 90 km range
  - Staggered PRT and other waveforms new in “TDWR Build 2”
    http://www.ll.mit.edu/mission/aviation/publications/publication-files/atc-reports/Cho_2010_ATC-363_WW-20740.pdf
  - 150 meter range resolution
  - Data truncated at 70,000 feet above radar level
    - Applicable above approximately 7 degrees elevation

FAA Signal Processing Strategy

- TDWR Build 2 signal processing uses four methods, depending upon elevation angle and weather location.
  - **LP (Long PRI), PRI 3066:** Single Long PRI (Reflectivity only).
    - Used on initial long range scan.
  - **MP (Multi-PRI), aka Block Staggered:** Multiple number of PRIs are block transmitted within the radial (e.g., PRI Set 3, 4, or 5).
    - Used adaptively at surface scan.
    - Good at trip separation even if overlaid powers are strong or spectrally wide, as long as overlaid weather does not span far along radial.
    - Base data is selected and Velocity Dealiasing is performed within each radial using the PRI estimates that are not range folded.
  - **DP (Dual-PRI Phase-Code Mode):** Two PRIs are used, in alternating radials (e.g., PRI 600/836).
    - Used at mid-levels and adaptively at surface scan.
    - Good at trip separation even if overlaid weather has long continuous radial range, as long as the weather is not strong and/or spectrally wide.
    - Dealias Velocity across adjacent radials.
  - **SP (Staggered PRI):** Two PRIs are used in alternating pulses.
    - Used at angles ≥ 11.9° where range folding isn't an issue.
    - Traditional SPRT Velocity Dealiasing
    - Clutter filtering via Meymaris et al. 2009, where I/Q data is split into two evenly spaced time series with interval PRT1 + PRT2. PRI pairs should be [600, 836] below 15.8 deg and [518, 722] above (e.g., at ORD, the staggered PRT clutter filter Nyquist velocities are 9.3 at 15.2 deg, and 10.8 m/s at 20.1 deg).

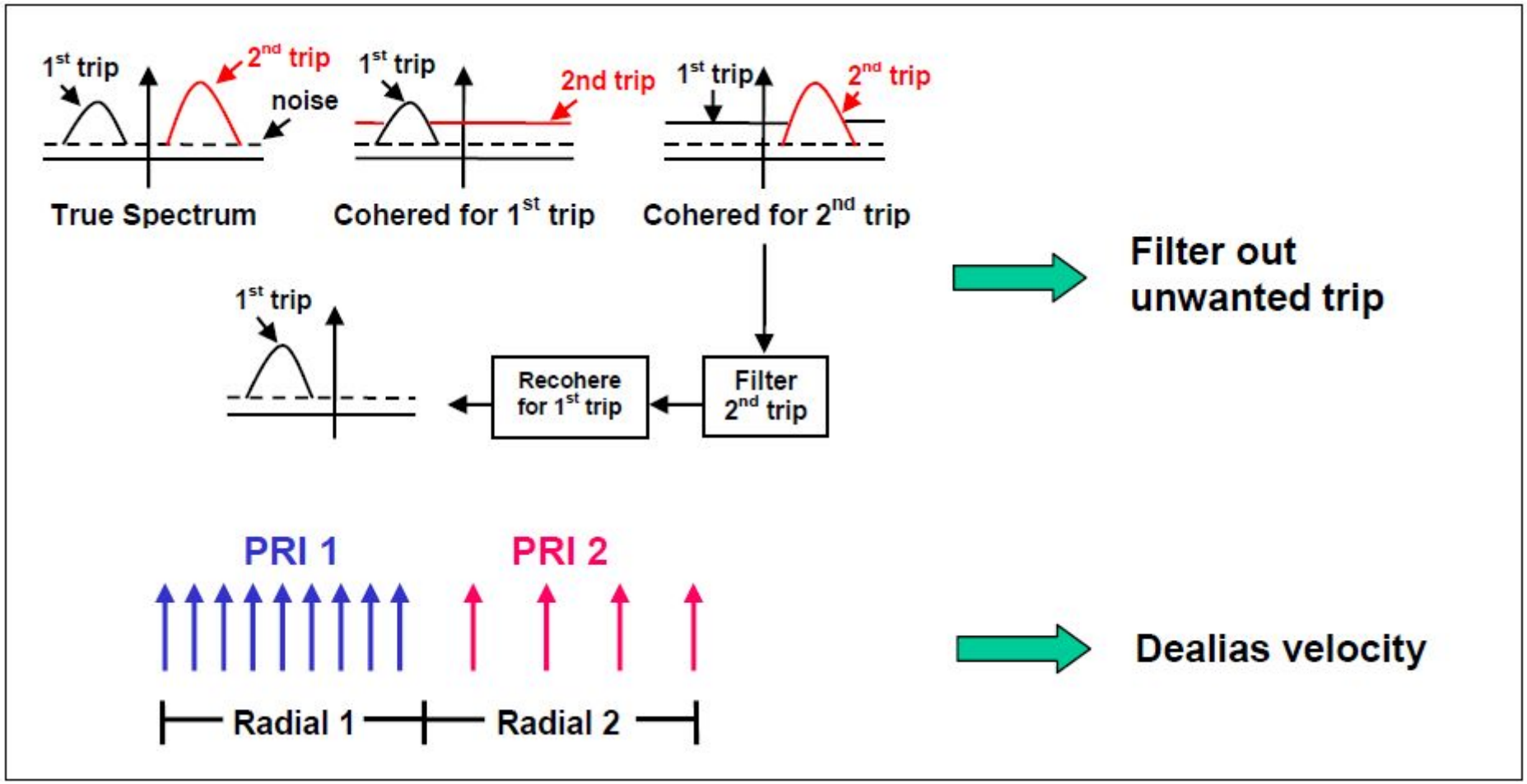
FAA Signal Processing Strategy

Multi-PRI Mode Block Staggered (MP)



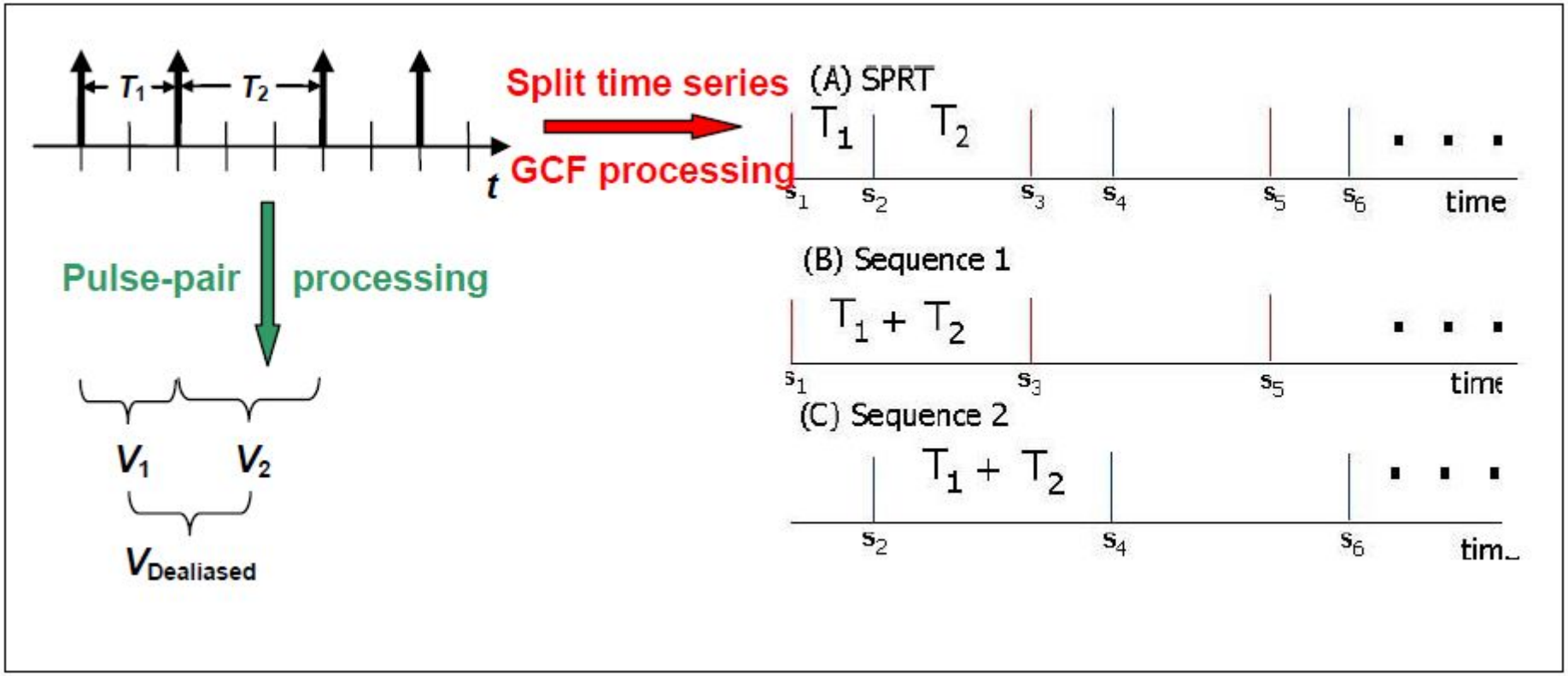
FAA Signal Processing Strategy

Dual-PRI Phase Code Mode (DP)



FAA Signal Processing Strategy

Multi-PRI Mode Staggered (SP)



FAA Signal Processing Strategy

- Two radial header fields indicate the PRI(s) used in the radial: Multi-PRI Flag (MP) and PRI.
  - If MP=0, PRI field is actual PRI value (μsec) used for all pulses in radial.
  - If MP=1, PRI field contains a code interpreted as below:

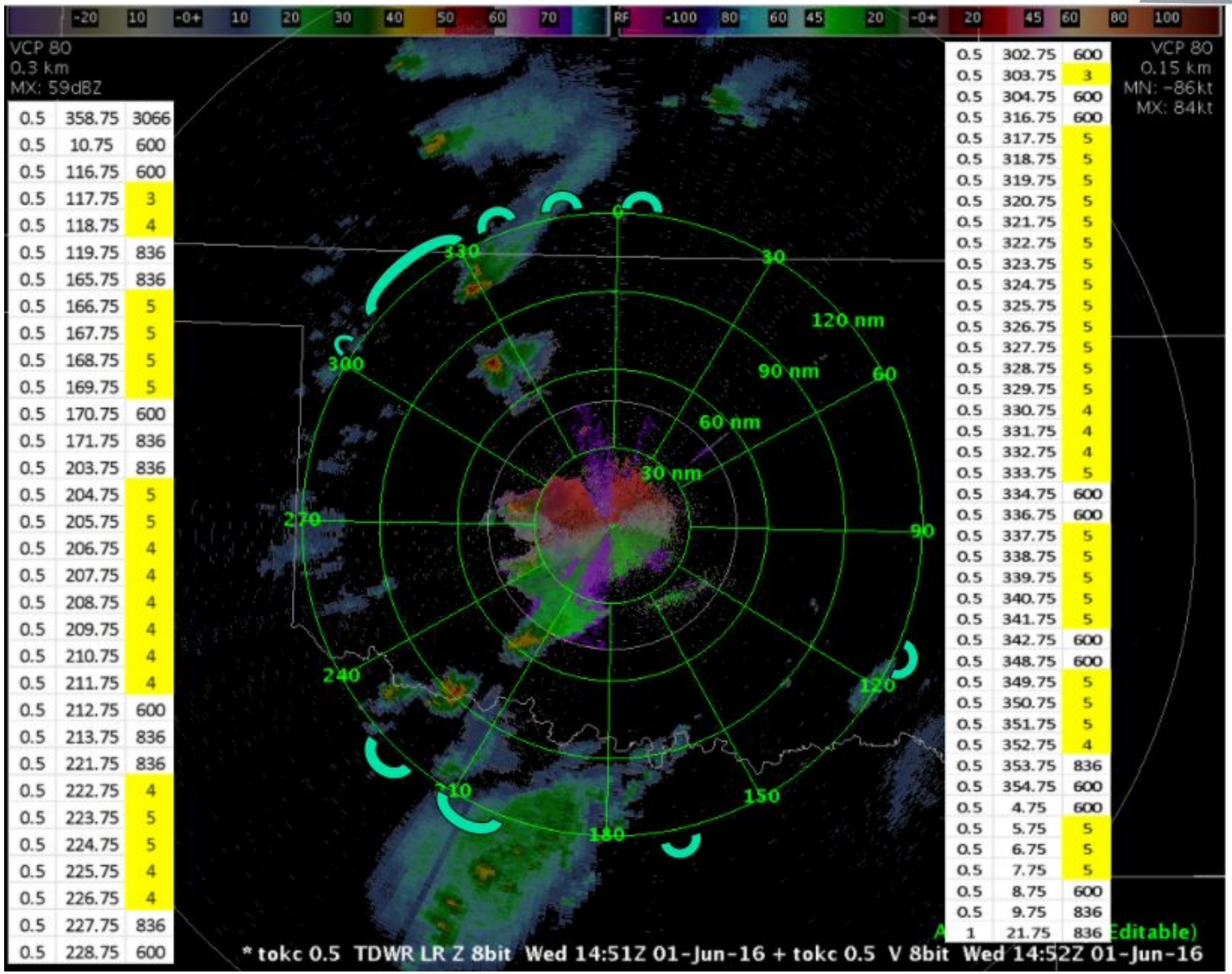
CODE	MP MODE PRI CODES
3	MP: Block staggered: [600, 670, 740, 810] μs, each PRI repeated L times, L dependent on angular scan rate.
4	MP: Block staggered: [698, 798, 898, 998] μs, each PRI repeated M times, M dependent on angular scan rate
5	MP: Block staggered: [600, 648, 696, 744, 792, 840, 888, 936] μs, each PRI repeated N times, N dependent on angular scan rate.
6	SP: Staggered: [600, 836] μs (for elevation < 15.8°), PRIs alternate.
7	SP: Staggered: [518, 722] μs (for elevation ≥ 15.8°), PRIs alternate.

FAA Signal Processing Strategy

Sample Build 2 VCP 80 volume scan data from 5/8/2016 23:22z (TPSF configured as TOKC)

Elevation Cut	Relative Angle	MP Flag	PRI Value/Code
1	Surface	0	LP: Long PRI, 3066 (360 radials)
2	Surface	0	DP: Dual-PRI phase-code, radials alternate PRI 600/836 (311 radials)
		1	MP: Block Staggered, 3 (2 radials); 4 (14 radials); 5 (33 radials)
3,4,5,7,8	Middle	0	DP: Dual-PRI phase-code, radials alternate PRI 600/836 (360 radials)
6	Surface	0	DP: Dual-PRI phase-code, radials alternate PRI 600/836 (312 radials)
		1	MP: Block Staggered, 3 (1 radials); 4 (14 radials); 5 (33 radials)
9	Mid-High	1	SP: Staggered PRT, 6 (360 radials)
10	Surface	0	DP: Dual-PRI phase-code, radials alternate PRI 600/836 (313 radials)
		1	MP: Block Staggered, 3 (2 radials); 4 (12 radials); 5 (33 radials)
11,12	High	1	SP: Staggered PRT, 7 (360 radials)

FAA Signal Processing Strategy



SPG Overview

- Supplemental Product Generator (SPG)
  - SPG originally based on RPG Build 9
  - HCI modified to remove unused functionality
  - SPG has no control over the TDWR RDA
    - Passive listener on a one-way communications cable
  - Preprocessor Module (PPM) added
    - Creates 88D-like base data radials from TDWR radials
    - Interprets quality flags from TDWR to mark data as range folded or below threshold
    - Handles missing data
  - Performs base data logging for archive and playback

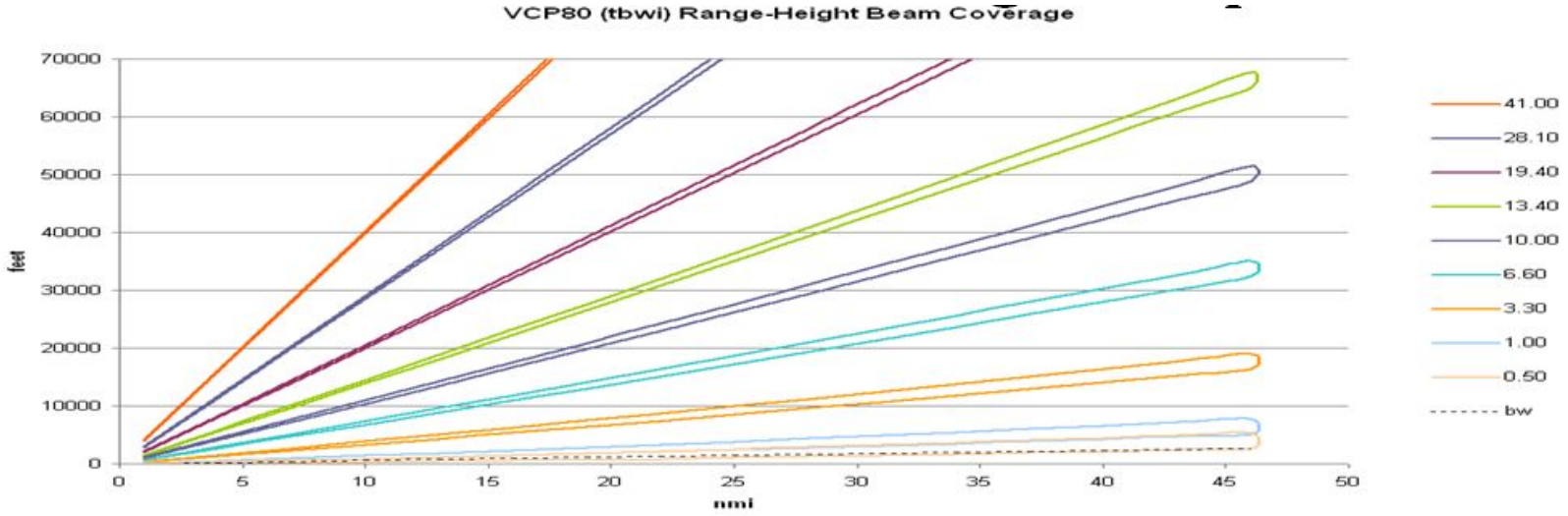
VCP 90 - TDWR Monitor Mode

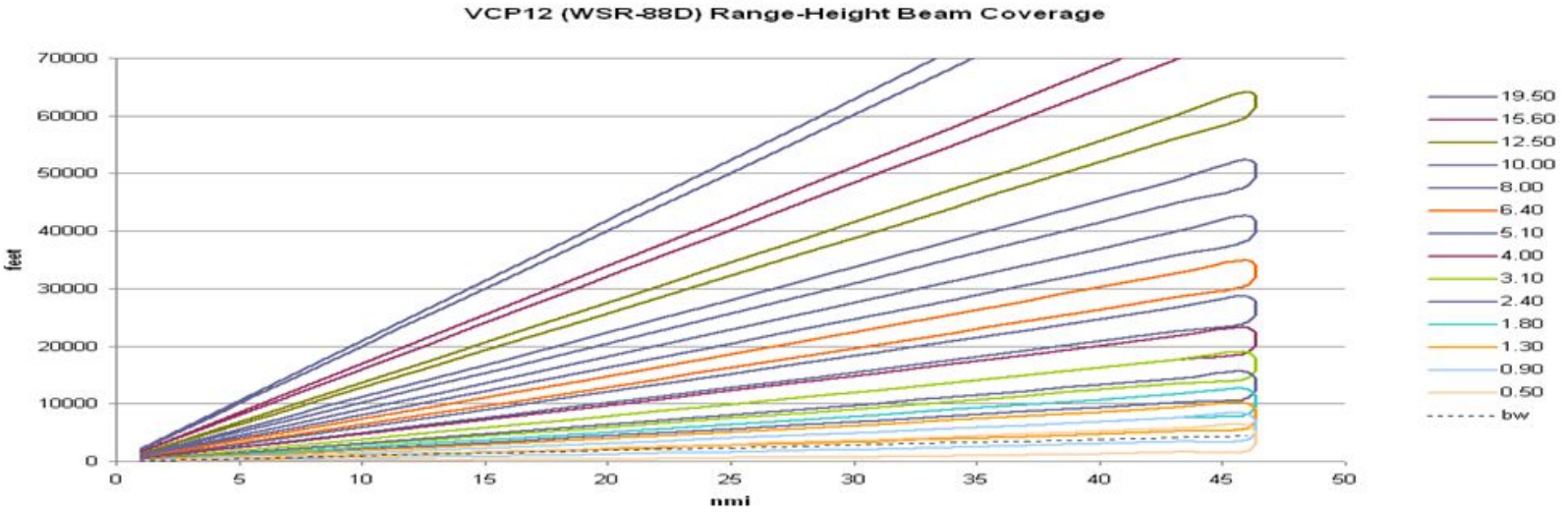
- VCP90 – Monitor Mode
  - Used when no significant weather is near the associated airport
    - Precipitation Weather Mode (A) - may have weather elsewhere
  - 6-minutes to complete
  - Base-elevation angle varies by site, some as low as 0.1 degree
  - Maximum elevation angle is 60 degrees at all sites
  - After the base-elevation long-range scan, 15 short-range elevation scans are performed in sequence, low to high

VCP 80 - TDWR Monitor Mode

- VCP80 – Hazardous Mode
  - Used when significant weather is near the associated airport
    - Precipitation Weather Mode (A)
  - 6-minutes to complete
  - Base-elevation (minimum elevation) angle varies by site with some as low as 0.1 degree
  - Maximum elevation angle varies by site from 55 degrees at Orlando to as low as 20.1 degrees at several sites
  - After the base-elevation long-range scan, 22 short-range elevation scans are performed in a complex sequence:
    - base-elevation short-range scanned once per minute
    - all remaining scans are performed every 3 minutes
  - 3-minute “mini-volume” technique by SPG for some algorithms

TDWR vs. WSR-88D
Volume Scan Coverage





SPG Preprocessor

- SPG's Preprocessor (PPM) task performs the following:
  - Creates 88D-like base data radials from TDWR radials
  - Base data is relative to magnetic north and adjusted to true north from offset TDWR basedata stream
  - Uses SNR threshold adaptable parameter to set data to below threshold (default 1.0 dB)
  - Interprets quality flags (possible RF) to set moment data to range folded
    - Sets short range scan reflectivity data (possible RF) to below threshold
    - No analogy to WSR-88D; Products sometimes have moving "holes"
  - Velocity is quantized from 0.25 m/s precision to 0.5 or 1.0 m/s by PPM, depending on adaptation data setting

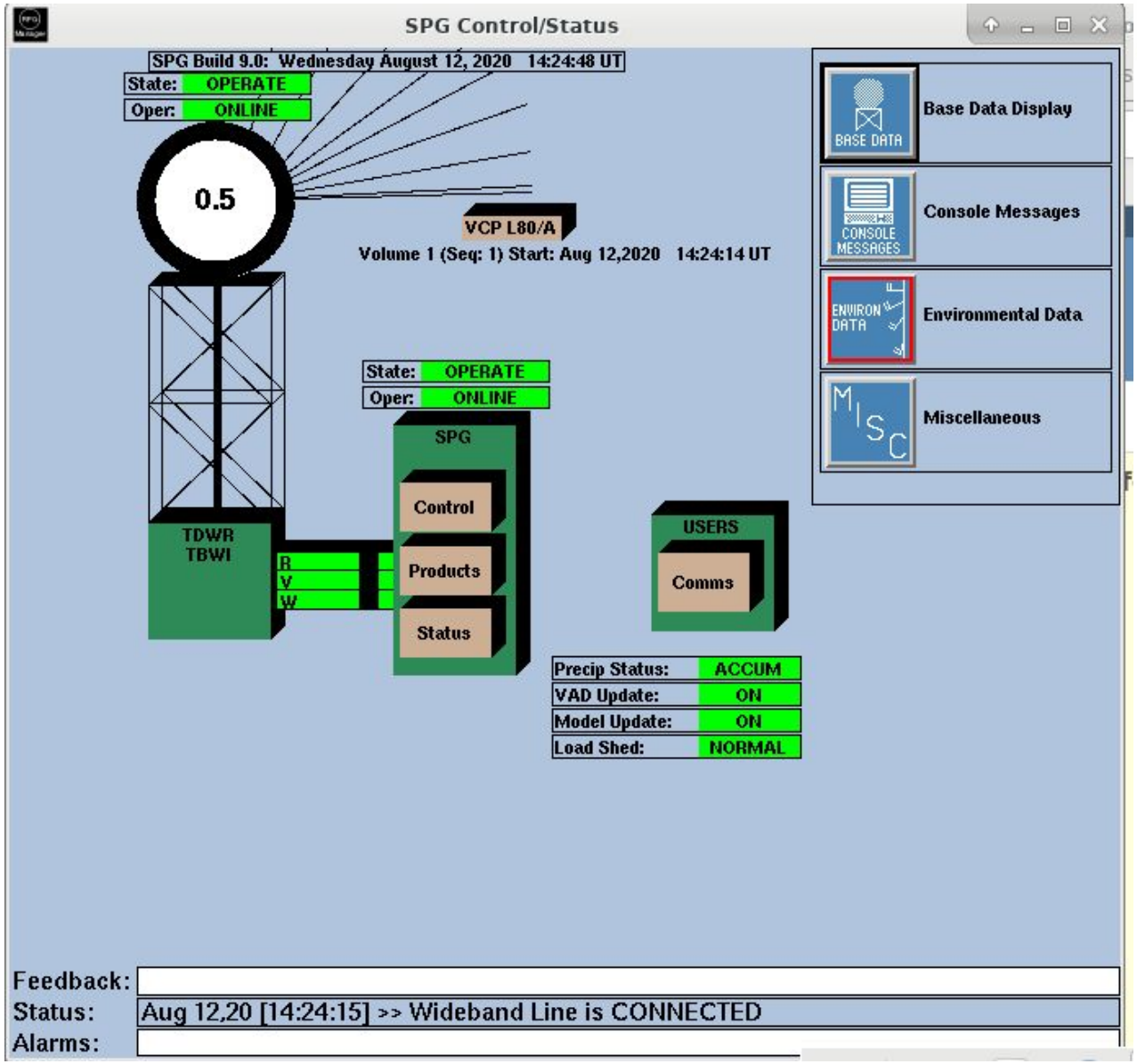
SPG Preprocessor (cont.)

- SPG's Preprocessor (PPM) task functionality (continued):
  - With FAA's "TDWR Build 2", uses TDWR's dealiased velocity
  - Sector Blanking
    - Sets status to enabled if TDWR base data reports it
    - Resets it to disabled if base data does not report it during a compete volume scan
    - Like RPG, SPG products report spot blanking if enabled
  - Forms RDA Status Message to emulate WSR-88D
    - Becomes TDWR Unit Status display on AWIPS
    - VCP change
    - Calibration Mode

SPG Preprocessor (cont.)

- SPG's Preprocessor (PPM) task functionality (continued):
  - Fills missing and "fat" radials caused by:
    - Missing: UDP packet loss
      - Poor quality FAA/WFO communication
      - SPG hardware glitch
      - Unusual SPG activity (e.g., base data compress & burn DVD)
    - Fat: Large delta azimuth, without packet loss
  - Cases
    - Single radials or sectors within an elevation.
    - Crossed elevation: PPM forms End-of-Elevation and Beg-of-Elevation
    - Skipped elevation: Lets downstream task PBD abort the volume scan
  - Mitigation to minimize volume scan aborts
    - PPM formed radial is blank except for bins at max range
    - Informs user of missing data and to distinguish from typical radar data problems (strobes, blockage, spot blanking, glitches)

SPG HCI


SPG Control/Status
SPG Build 9.0: Wednesday August 12, 2020 14:24:48 UT
State: OPERATE
Oper: ONLINE
0.5
VCP L80/A
Volume 1 (Seq: 1) Start: Aug 12,2020 14:24:14 UT
State: OPERATE
Oper: ONLINE
SPG
Control
Products
Status
TDWR
TBWI
R
V
W
USERS
Comms
Precip Status: ACCUM
VAD Update: ON
Model Update: ON
Load Shed: NORMAL
BASE DATA
Base Data Display
CONSOLE MESSAGES
Console Messages
ENVIRON DATA
Environmental Data
MISC
Miscellaneous
Feedback:
Status: Aug 12,20 [14:24:15] >> Wideband Line is CONNECTED
Alarms:

SPG Products: Status

- SPG Status Products
  - General Status Message
  - Free Text Message
  - Archived Status Product
  - GSM, FTM, ASP
    - Product formats, generation method and frequency are identical to WSR-88D versions

SPG Products: Base Data

- SPG Base Products
  - Reflectivity
    - 256 data level, 300 meter resolution, 225 nmi range
    - 256 data level, 150 meter resolution, 48 nmi range
  - Velocity
    - 256 data level, 150 meter resolution, 48 nmi range
  - Spectrum Width
    - 256 data level, 150 meter resolution, 48 nmi range

SPG Products: Derived

- SPG Derived Products
  - Composite Reflectivity
  - VIL
  - Echo Tops
  - CR, VIL and ET
    - Products formats identical to WSR-88D except data range is 48 nmi
    - VCP90: 6-minute updates; includes all elevations
    - VCP80: 3-minute updates; includes all elevations in each mini-volume

SPG Products: Storm Overlay

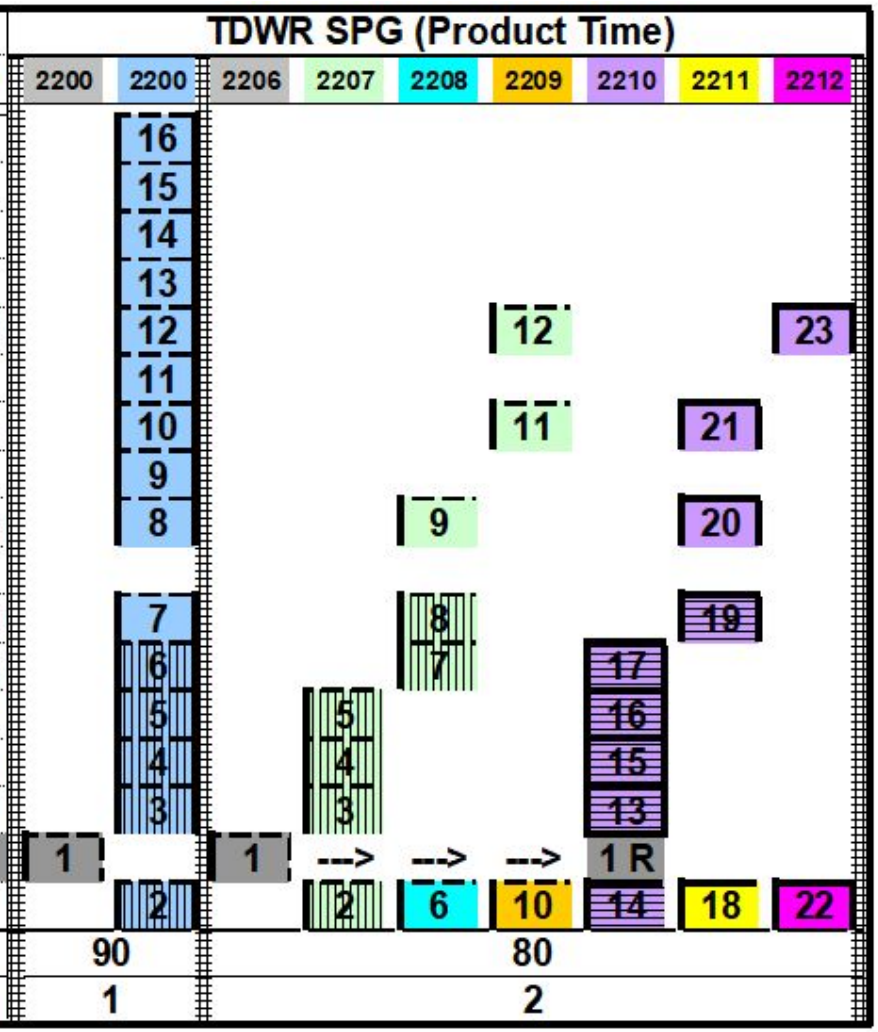
- SPG Storm Attribute Overlay Products
  - Storm Tracking Information
  - Hail Index
  - Mesocyclone Detection
  - Tornadic Vortex Signature
  - STI, HI, MD, DMD and TVS
    - All product formats identical to WSR-88D versions except range is 48 nmi
    - VCP90: 6-minute updates; includes elevations below configurable elevation number
    - VCP80: 3-minute updates; includes elevations below configurable elevation number in each mini-volume

SPG Products: Wind Profile

- SPG Wind Profile Products
  - Velocity Azimuth Display
  - VAD Wind Profile
  - VAD, VWP
    - Product formats identical to WSR-88D versions
    - VCP90: 6-minute updates; includes all elevations
    - VCP80: 6-minute updates; includes the last cut of each short range angle

TDWR SPG (Build 10)
Product / Algorithm Processing

Bin #	Angle	Angle Min	Angle Max	VCP 90	VCP 80
25	60.0	57.6	62.5	60.0	
24	55.0	52.6	57.5	55.0	
23	50.0	47.6	52.5	50.0	
22	45.0	42.6	47.5	45.0	
21	40.0	37.6	42.5	40.0	42.0
20	35.0	32.6	37.5	35.0	
19	30.0	27.6	32.5	30.0	28.1
18	25.0	22.1	27.5	25.0	
17	19.5	18.0	22.0	20.0	19.4
16	16.7	15.7	17.9		
15	14.0	13.1	15.6	15.0	13.4
13	10.0	9.6	11.0	10.0	10.0
10	6.0	5.7	6.6	6.0	6.6
7	3.4	2.7	3.6	3.3	3.3
3	0.9	0.9	1.1	1.0	1.0
2	0.5	0.4	0.8	0.5	0.5
2	0.5	0.4	0.8	0.5	0.5
AWIPS Binning Scheme				bwi	
tbwi example				VNUM	



Algorithms/Products run on scans as indicated by cell side boarder (1 per 6 minute PPS, ULR, VWP), top (derived mini-vol), and patterns (storm analysis mini-volume).

PPS: Long Range Cut

VWP: Last Cut of Each Short Range Angle

ULR: Every Cut

STI, HI, MD, TVS, cat: Cut #'s as noted

CR, VIL, ET: Cut #'s as noted & reuse Long Range cut

Product Times (top) of Base Product Elevation Cuts indicated by cell color

rev2 3/23/2016 istok

SPG Build 11 Software CCRs

- VIL/ET (SPG-SW-20-00015: eDAR Apr 3, 2020)
  - No longer use long range reflectivity cut (#1) because all products from viletalg (VIL, ET) have a max range of 90 km.
  - No longer use repeat 0.5 degree cuts (#6, #10, #18 and #22)
  - No longer copy cut #3 into the second mini-volume
  - Change VCP80 first mini-volume time stamp to time of 2nd elevation cut
  - Correct beam depth calculation to account for modified TDWR Build 2 VCP 80 change
  - These changes combine to make VIL values slightly lower, more so in the second mini-volume
  - Negligible impact seen on ET products

SPG Build 11 Software CCRs

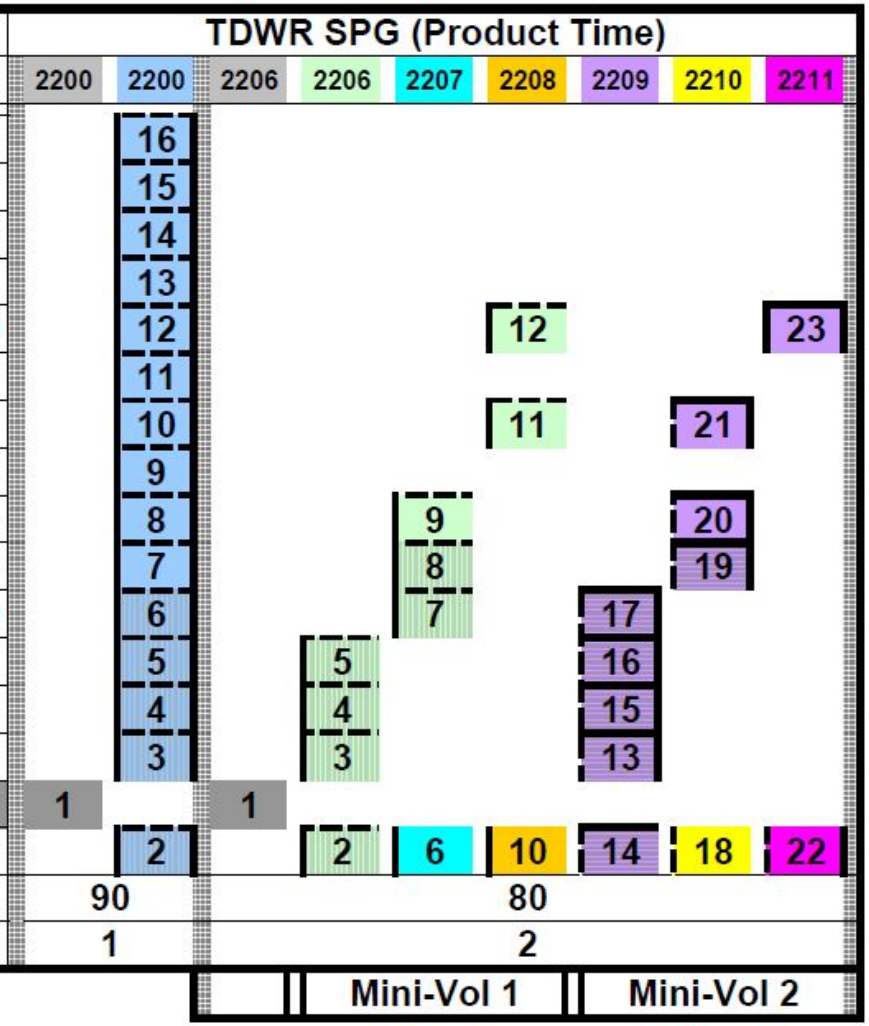
- STI (SPG-SW-20-0021: eDAR Apr 3, 2020)
  - No longer use repeat low elevation cuts in second mini-volume of VCP 80.
  - Impacts storm identification and tracking but changes are not statistically significant.
- CR (SPG-SW-20-0023: eDAR Apr 3, 2020)
  - No longer use long range reflectivity cut
  - No longer repeat 3rd cut in second mini-volume of VCP 80.
  - Removes subtle false increase in echo coverage in second mini-volume.
- TVS (SPG-SW-20-00033)
  - Filter TVS features that are too far from a SCIT cell centroid (same as WSR-88D)

SPG Build 11 Software CCRs

- Remove Rainfall Products (SPG-SW-18-00035 & 37, SPG-SW-19-00015)
  - One-Hour Precipitation
  - Three-Hour Precipitation
  - Storm Total Precipitation
  - User Selectable Precipitation
  - Hybrid Scan Reflectivity
  - Digital Precipitation Array
  - Supplemental Precipitation Data
  - OHP, THP, STP, USP, DHR, HSR, DPA, SPD
    - All product formats are identical to WSR-88D versions
    - VCP90: 6-minute updates; **includes only the first elevation**
    - VCP80: 6-minute updates; **includes only the first elevation**
    - Data is power averaged from 300 meter to 1 km resolution
    - No blockage file used
    - Will use gage-bias if provided by AWIPS

TDWR SPG (Build 11)
Product / Algorithm Processing

Bin #	Bin Angle	Angle Min	Angle Max	VCP 90	VCP 80
27	60.0	57.6	62.5	60.0	
26	55.0	52.6	57.5	55.0	
25	50.0	47.6	52.5	50.0	
24	45.0	42.6	47.5	45.0	
23	40.0	37.6	42.5	40.0	42.0
22	35.0	32.6	37.5	35.0	
21	30.0	27.6	32.5	30.0	28.1
20	25.0	22.1	27.5	25.0	
19	19.5	18.0	22.0	20.0	19.4
17	14.0	13.1	15.6	15.0	13.4
15	10.0	9.6	11.0	10.0	10.0
12	6.0	5.7	6.6	6.0	6.6
9	3.4	2.7	3.6	3.3	3.3
5	0.9	0.9	1.1	1.0	1.0
4	0.5	0.4	0.8	0.5	0.5
4	0.5	0.4	0.8	0.5	0.5
AWIPS Binning Scheme				bwi	
tbwi example				VNUM	



Algorithms/Products run on scans as indicated by cell side boarder (1 per 6 minute PPS, VWP), top (derived mini-vol), and patterns (storm analysis mini-volume).

VWP: Last Cut of Each Short Range Angle

2 / 1 STI, HI, MD, TVS, cat: Cut #'s as noted in mini-vol *1* & *2*

2 / 1 CR(side), VIL/ET(top): Cut #'s as noted.

Product Times (top) of Base & Derived Product Elevation Cuts indicated by cell color

rev4 3/23/2021 istok

TDWR SPG Base Data Logging, Playback, Archive

- SPG maintains 8 day circular log of TDWR native format base data radials (not UDP packet format)
- SPG utility “tdwr2dvd” to compress data and burn to CD or DVD
  - Each DVD can hold about 24 hours.
  - Compression/DVD burning load can induce live UDP packet loss
- SPG playback utility “tpump”
  - As collected (date/time/data/elevations)
  - Set date/time to current time (for better AWIPS compatibility)
  - Emulate another sites elevations (support AWIPS localization)
  - Alter data to test patterns
  - Continuous playback loop mode

TDWR SPG Level II Data, Archive, and Playback

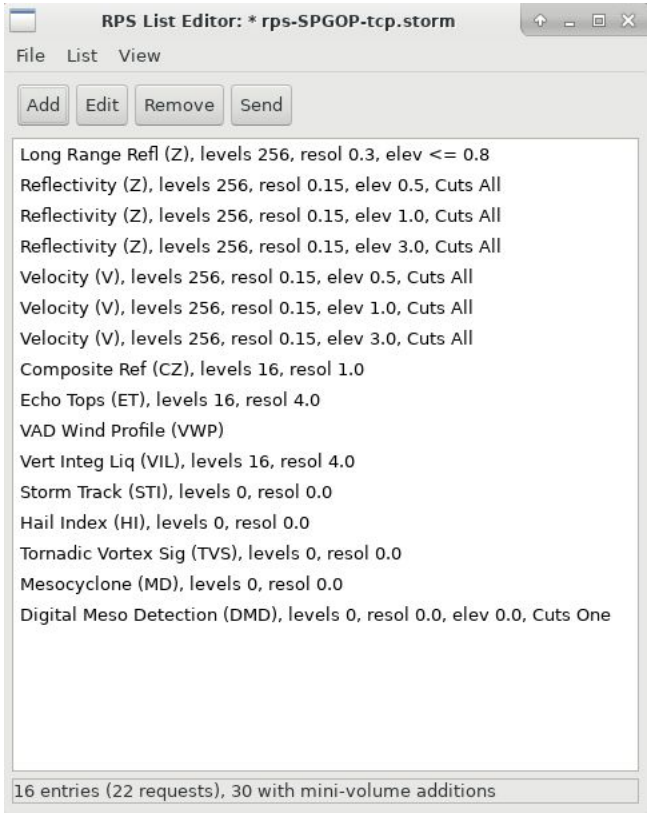
- TDWR SPG Level 2 Data
  - FAA native format converted to NEXRAD Message 31
  - Central collection and NCEI archive began SPG Build 10
  - Play_A2 updated to replay data
    - As collected (date/time/data/elevations)
    - Set date/time to current time (for better AWIPS compatibility)
    - Emulate another sites elevations (support AWIPS localization)
- Can create Level II data files via SPG “tpump” utility

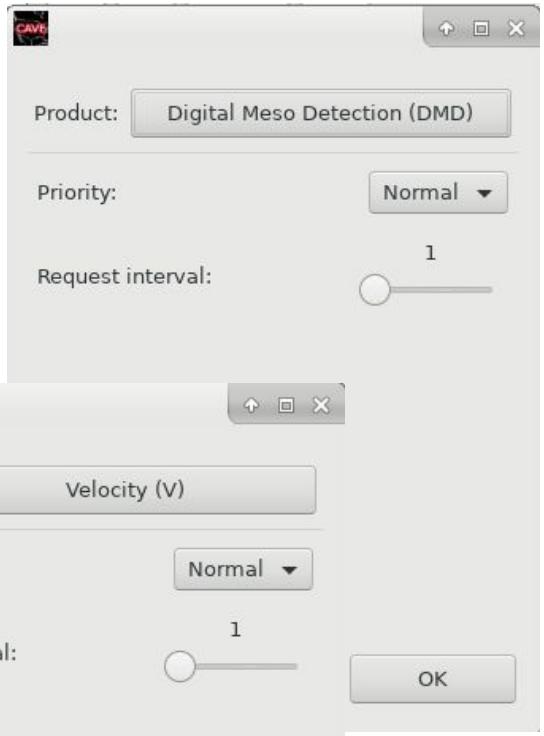
AWIPS Considerations

- RPS
  - One vs All Cuts, Mini-volume scan products (since 2004)
  - With SPG Build 10 and AWIPS 20.2.1 (DCS 21371)
    - One, All Cuts, All elevations, All at or Below, All at or Below/All cuts, Lowest N, Lowest N/All Cuts.
- OTR
  - All Cuts set to 'One' by default (otherwise receive 6 copies of 1st cut)
- Requests for Long Range Reflectivity scan
  - Site specific elevation angle 0.1 to 0.8 deg and resolution 0.3 km
- AWIPS sends part of the RAP model output to the SPG
  - Used to help the NEXRAD hail algorithm in SPG
- AWIPS centrally collects Level III (RPCCDS, NOAAPORT, NCEI)
  - PPS removed in 2019, returned at some sites, but AWIPS 20.2.1 will fix

AWIPS RPS Product Request

- Cuts: All vs. One
  - RPS distributes repeated elevations cuts
- Mini-Volume products
  - Under the hood (automatic)
- All at or below/All Cuts
  - SPG Build 10 and AWIPS 20.2.1 (Oct 2020)





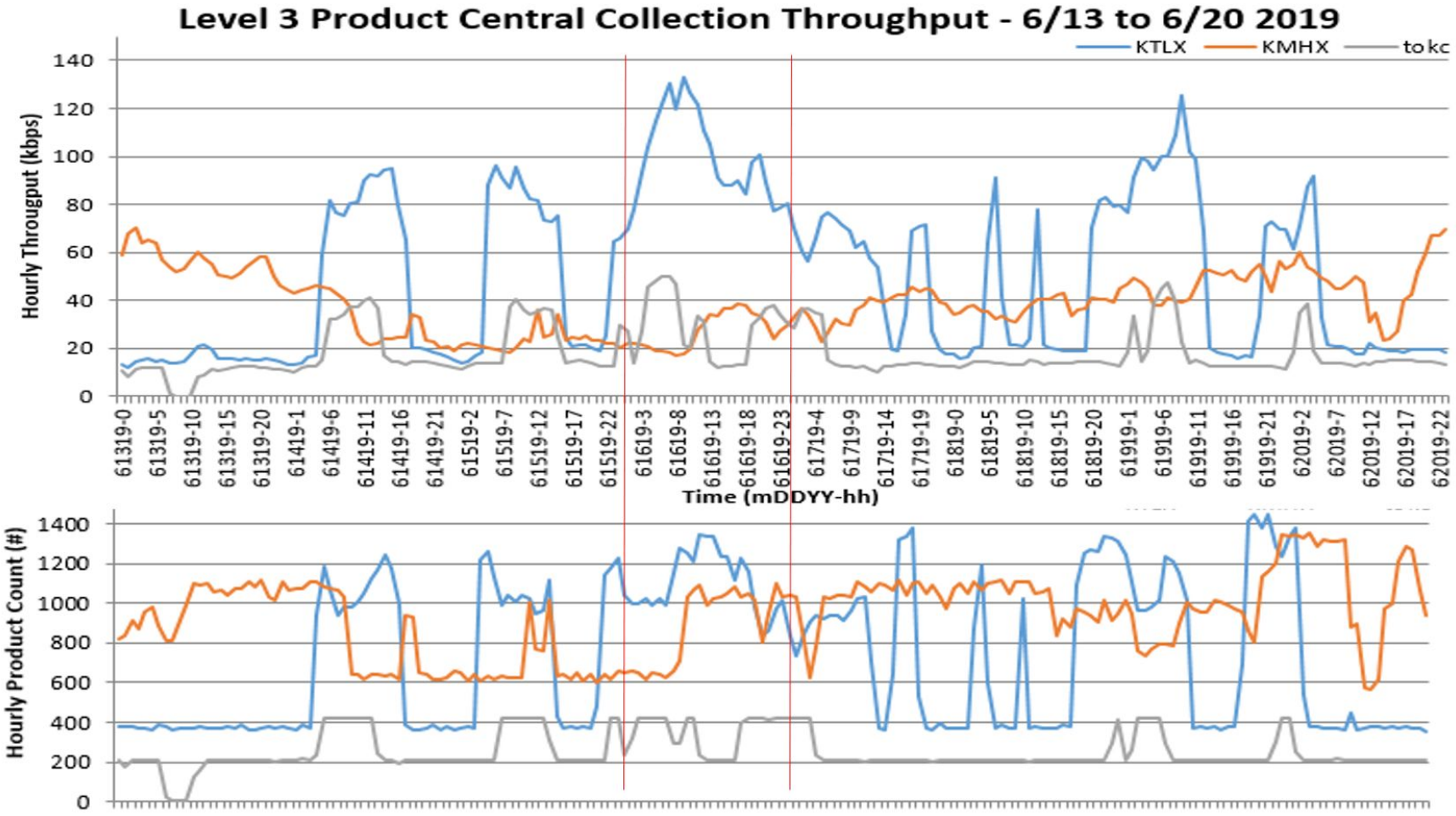
TDWR SPG Site IDs, Associations, and RPCCDS Directories

WFO #	SPGs @ wfo	Sending WFO ID CCCC	TDWR SPG ID xxx	TDWR SPG ID	Radar FTP Site directory	SPG #
1	1	KBOU	DEN	3013	Sl.tden	1
2	1	KBOX	BOS	3004	Sl.tbos	2
3	1	KCLE	LVE	3006	Sl.tlve	3
4	1	KDTX	DTW	3015	Sl.tdtw	4
5	1	KEAX	MCI	3025	Sl.tmci	5
6	1	KFFC	ATL	3002	Sl.tatl	6
7	2	KFWD	DAL	3010	Sl.tdal	7
		KFWD	DFW	3014	Sl.tdfw	8
8	1	KGSP	CLT	3007	Sl.tclt	9
9	2	KHGX	HOU	3018	Sl.thou	10
		KHGX	IAH	3020	Sl.tiah	11
10	1	KICT	ICH	3021	Sl.tich	12
11	3	KILN	CMH	3008	Sl.tcmh	13
		KILN	CVG	3009	Sl.tcvg	14
		KILN	DAY	3011	Sl.tday	15
12	1	KIND	IDS	3022	Sl.tids	16
13	1	KLIX	MSY	3032	Sl.tmsy	17
14	1	KLMK	SDF	3040	Sl.tsdf	18
15	2	KLOT	MDW	3027	Sl.tmdw	19
		KLOT	ORD	3034	Sl.tord	20
16	1	KLSX	STL	3043	Sl.tstl	21
17	4	KLWX	ADW	3001	Sl.tadw	22
		KLWX	BWI	3005	Sl.tbwi	23
		KLWX	DCA	3012	Sl.tdca	24
		KLWX	IAD	3019	Sl.tiad	25
18	1	KMEG	MEM	3028	Sl.tmem	26
19	3	KMFL	FLL	3017	Sl.tfll	27
		KMFL	MIA	3029	Sl.tmia	28
		KMFL	PBI	3035	Sl.tpbi	29
20	1	KMKX	MKE	3030	Sl.tmke	30
21	1	KMLB	MCO	3026	Sl.tmco	31
22	1	KMPX	MSP	3031	Sl.tmsp	32
23	1	KOHX	BNA	3003	Sl.tbna	33
24	2	KOKX	EWR	3016	Sl.tewr	34
		KOKX	JFK	3023	Sl.tifk	35
25	1	KOUN	OKC	3033	Sl.tokc	36
26	1	KPBZ	PIT	3038	Sl.tpit	37
27	1	KPHI	PHL	3036	Sl.tphl	38
28	1	KPSR	PHX	3037	Sl.tphx	39
29	1	KRAH	RDU	3039	Sl.trdu	40
30	1	KSLC	SLC	3042	Sl.tslc	41
31	1	KTBW	TPA	3044	Sl.ttpa	42
32	1	KTSA	TUL	3045	Sl.ttul	43
33	1	KVEF	LAS	3024	Sl.tlas	44
34	1	TJSJ	SJU	3041	Sl.tsju	45

TDWR SPG Product Suite
RPCCDS & SBN/NOAAPORT

PRODUCT	PRODUCT HEADERS		ELEVATION ANGLES (DEGREES)
	RPG HEADER	WMO HEADER	
General Status Message	2/GSM	NXUS6i cccc GSM xxx	Elevation Angle Not Applicable
Long Range Reflectivity – 225 nmi Range	186/DR	SDUS5i cccc TZL xxx	RDA v2: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8
Base Reflectivity – 48 nmi Range	180/DR	SDUS5i cccc TZ0 xxx	0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8
	180/DR	SDUS2i cccc TZ1 xxx	1.0
	180/DR	SDUS2i cccc TZ2 xxx	1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 3.1, 3.3, 3.4, 3.7
Base Radial Velocity - 48 nmi Range	182/DV	SDUS5i cccc TV0 xxx	0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8
	182/DV	SDUS7i cccc TV1 xxx	1.0
	182/DV	SDUS7i cccc TV2 xxx	1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 3.1, 3.3, 3.4, 3.7
Composite Reflectivity 16 Data Levels – 124 nmi Range	37/CR	SDUS5i cccc NCR xxx	Elevation Angle Not Applicable
Echo Tops	41/ET	SDUS7i cccc NET xxx	Elevation Angle Not Applicable
Velocity Azimuth Display Wind Profile	48/VWP	SDUS3i cccc NVW xxx	Elevation Angle Not Applicable
Vertical Integrated Liquid	57/VIL	SDUS5i cccc NVL xxx	Elevation Angle Not Applicable
Storm Tracking Information	58/STI	SDUS3i cccc NST xxx	Elevation Angle Not Applicable
Hail Index	59/HI	SDUS6i cccc NHI xxx	Elevation Angle Not Applicable
Mesocyclone	141/MD	SDUS3i cccc NMD xxx	Elevation Angle Not Applicable
Tornadic Vortex Signature	61/TVS	SDUS6i cccc NTV xxx	Elevation Angle Not Applicable
Free Text Message	75/FTM	NOUS6i cccc FTM xxx	Elevation Angle Not Applicable
Archive III Status Product	152/ASP	SDUS4i cccc RSL xxx	Elevation Angle Not Applicable

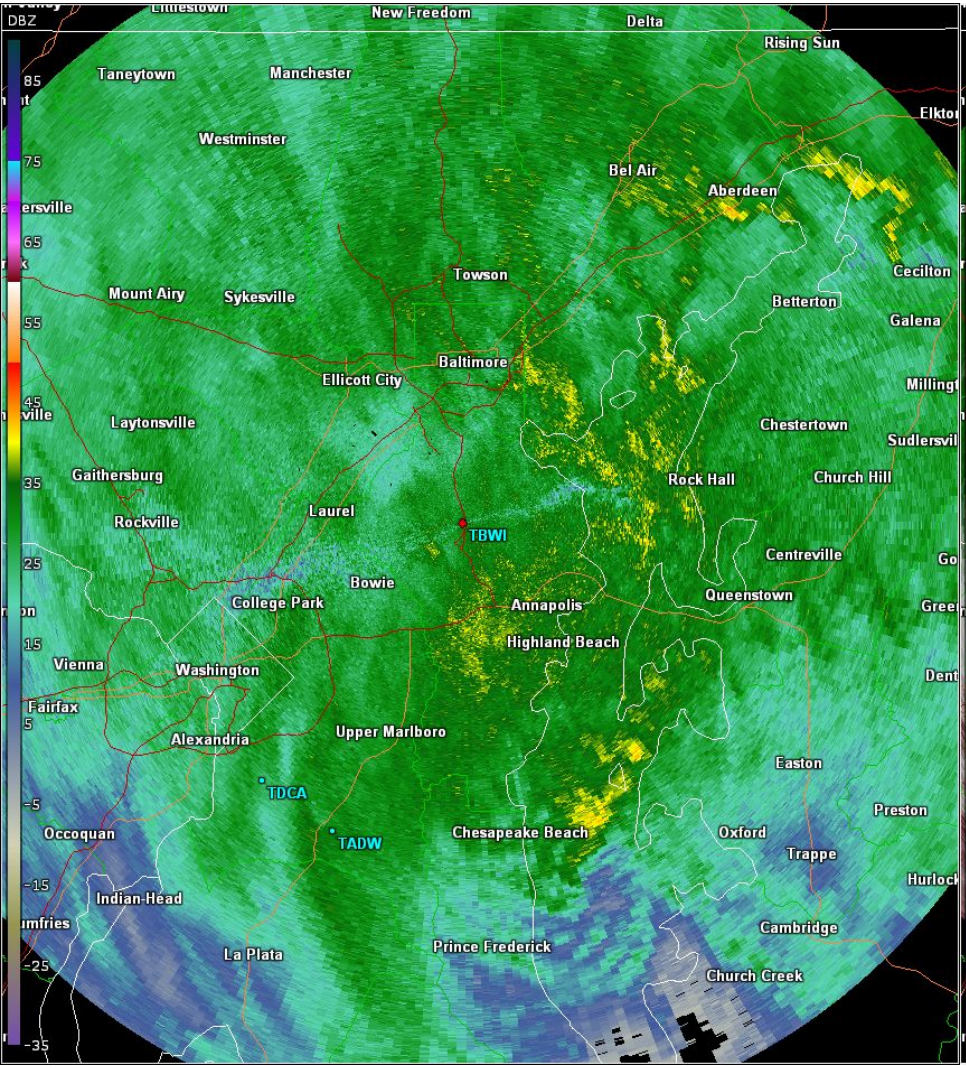
RPCCDS Throughput

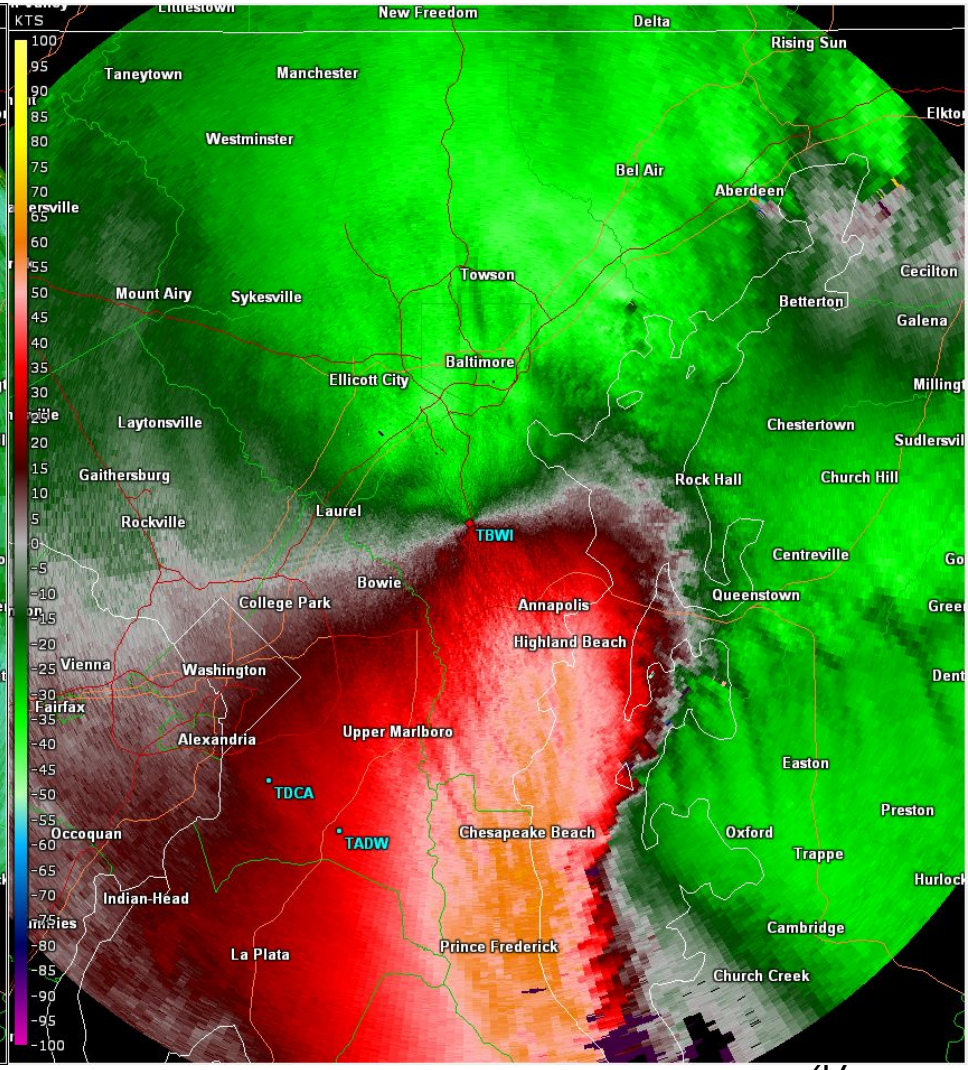


SPG Training - Level II

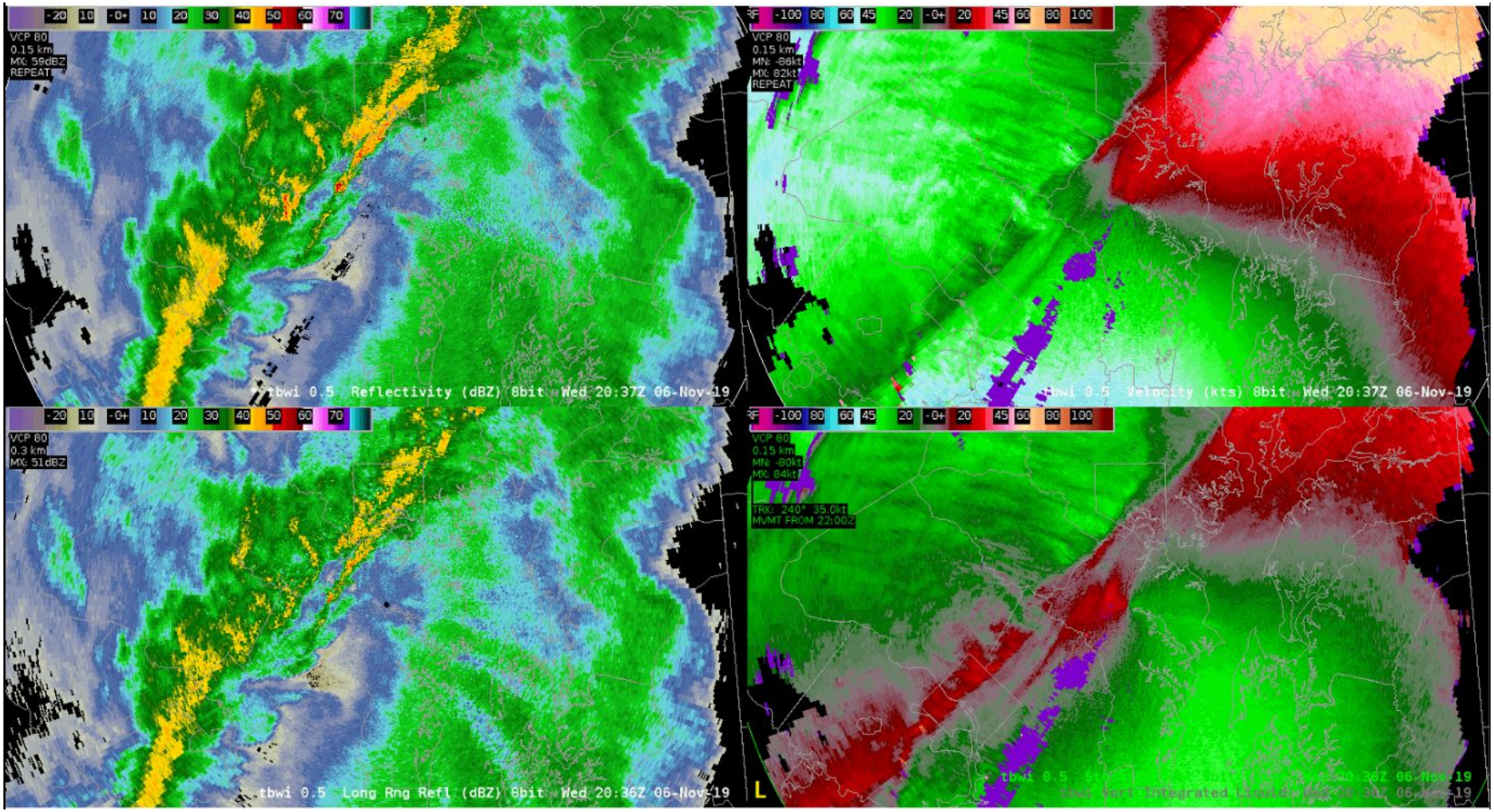
TBWI August 4, 2020 0.5 deg @ 1329Z

Tropical Storm Isaias

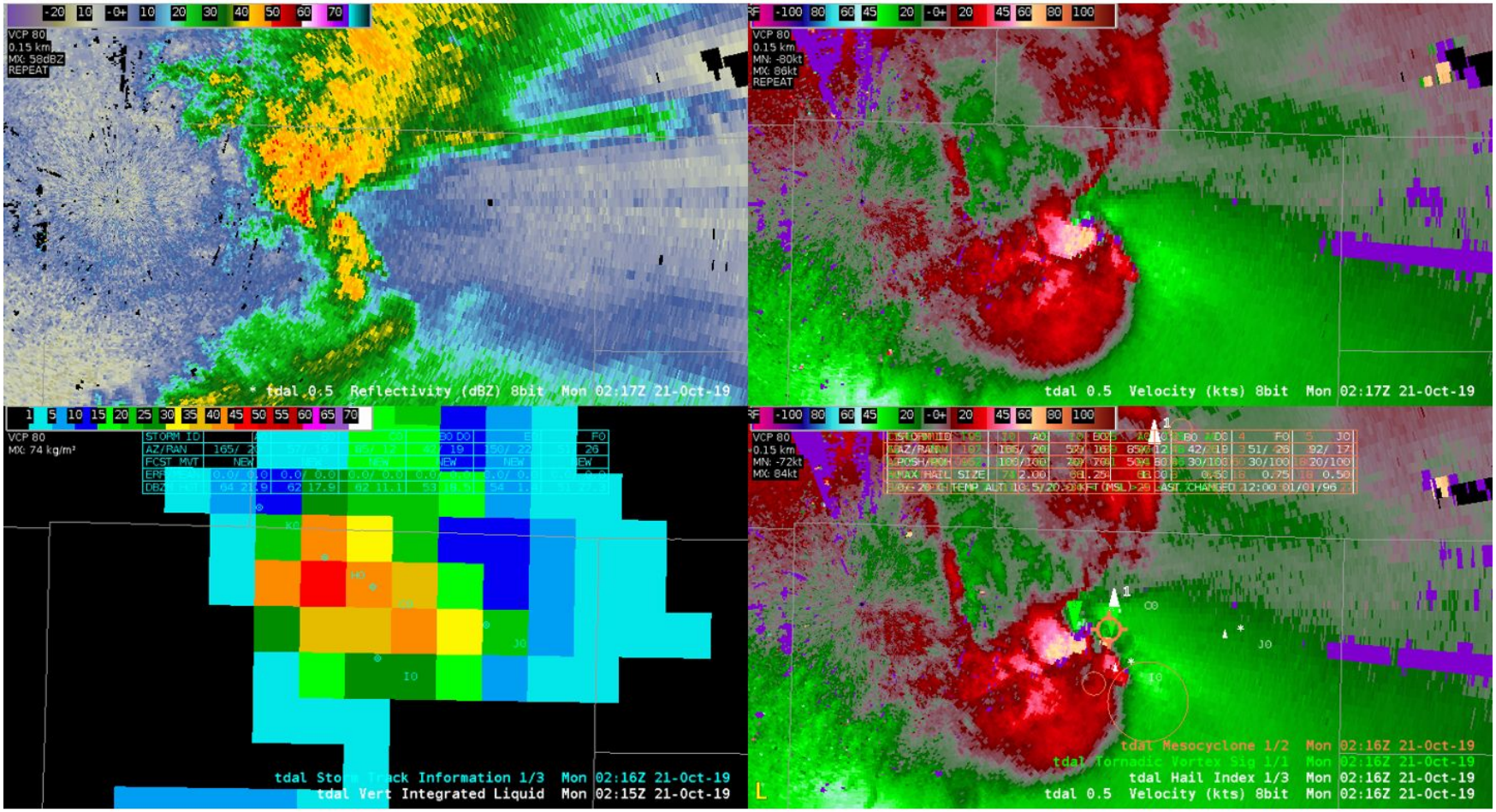




SPG Training – Level II
TBWI November 5, 2019



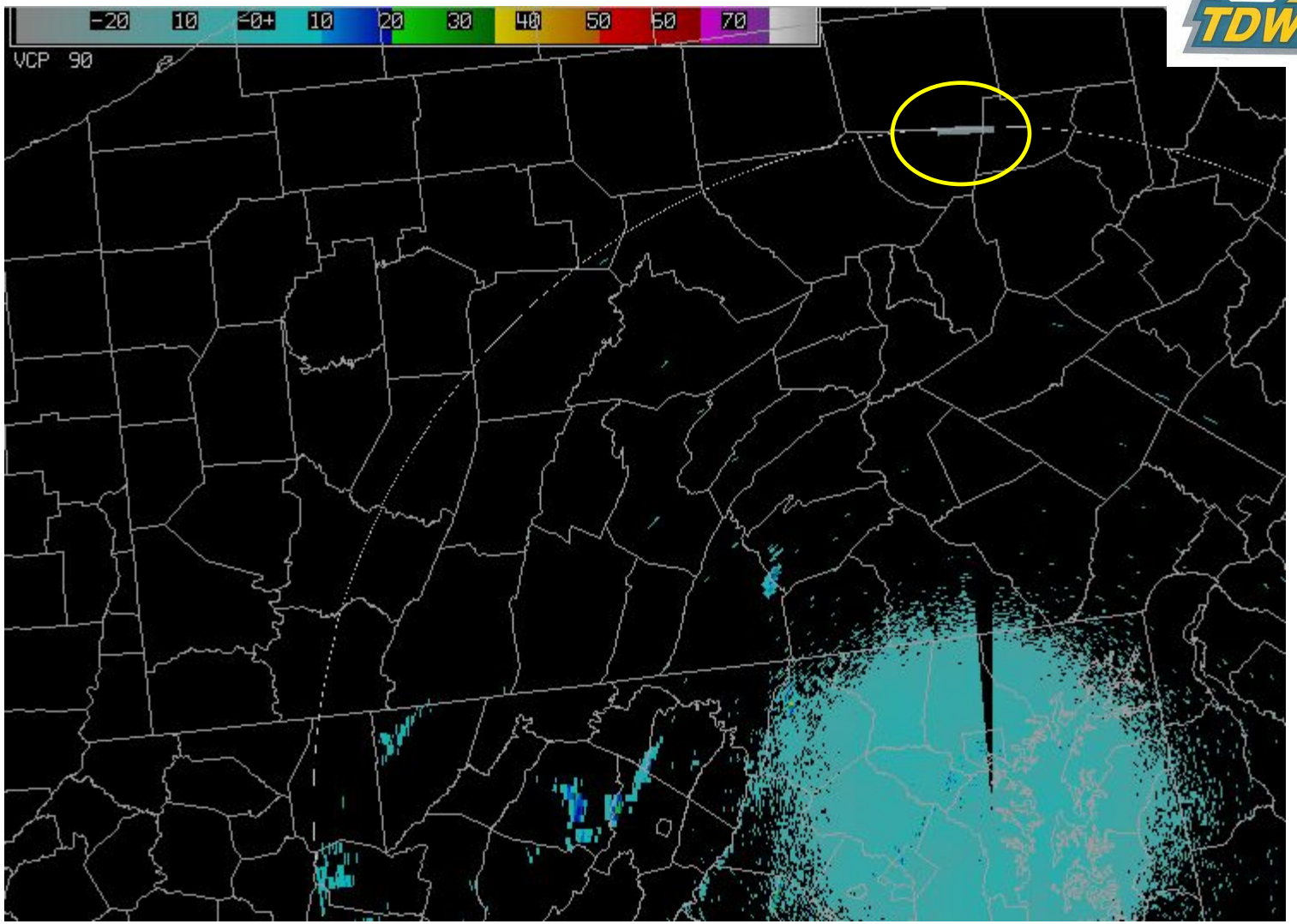
SPG Training - Level II
TDAL October 21, 2019
Dallas Tornado



TDWR SPG Data Quality Considerations

- TDWR Data Quality Issues
  - Data availability
  - Range unfolding
  - Clutter filter effects
  - Interference
  - Attenuation
  - Elevation-dependent noise correction

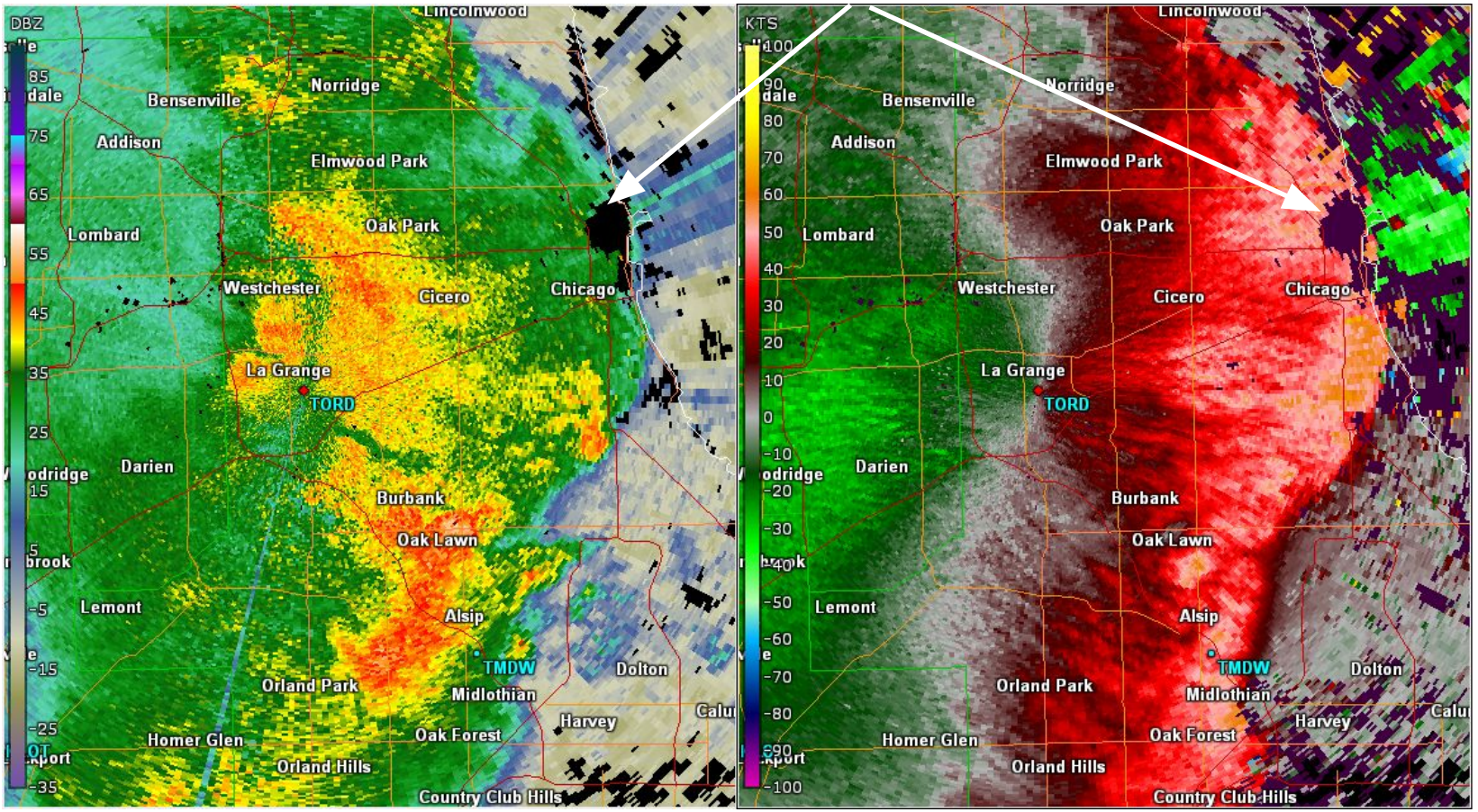
Data Availability - Lost Radials



Missing radials filled with blank radials and marked by several filled bins at the maximum range.

Range-folded obscuration

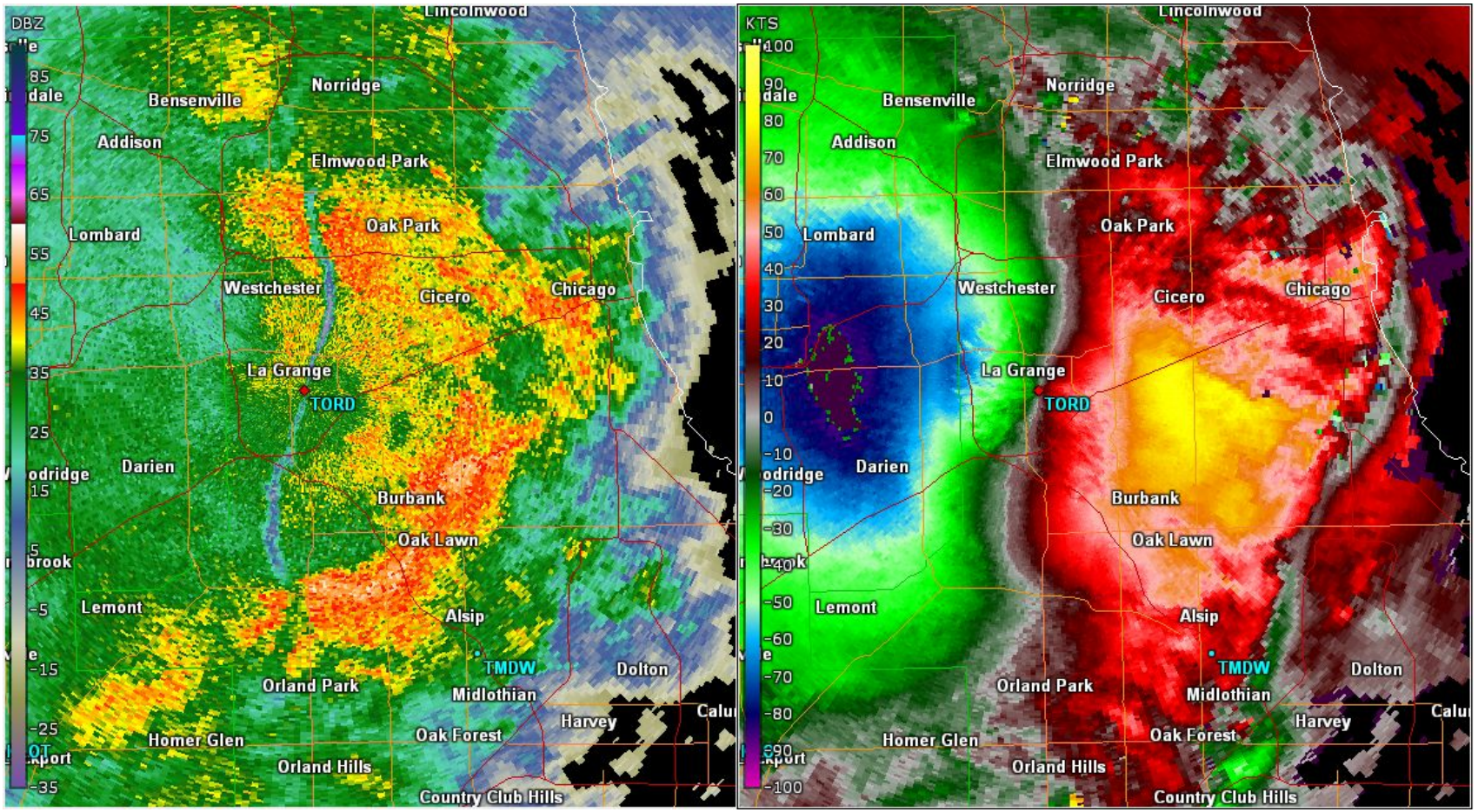
Note sharp transition to “no data”



TORD 10aug2020 2058Z 0.3 deg

Clutter Filter Effects

Zero Isodop

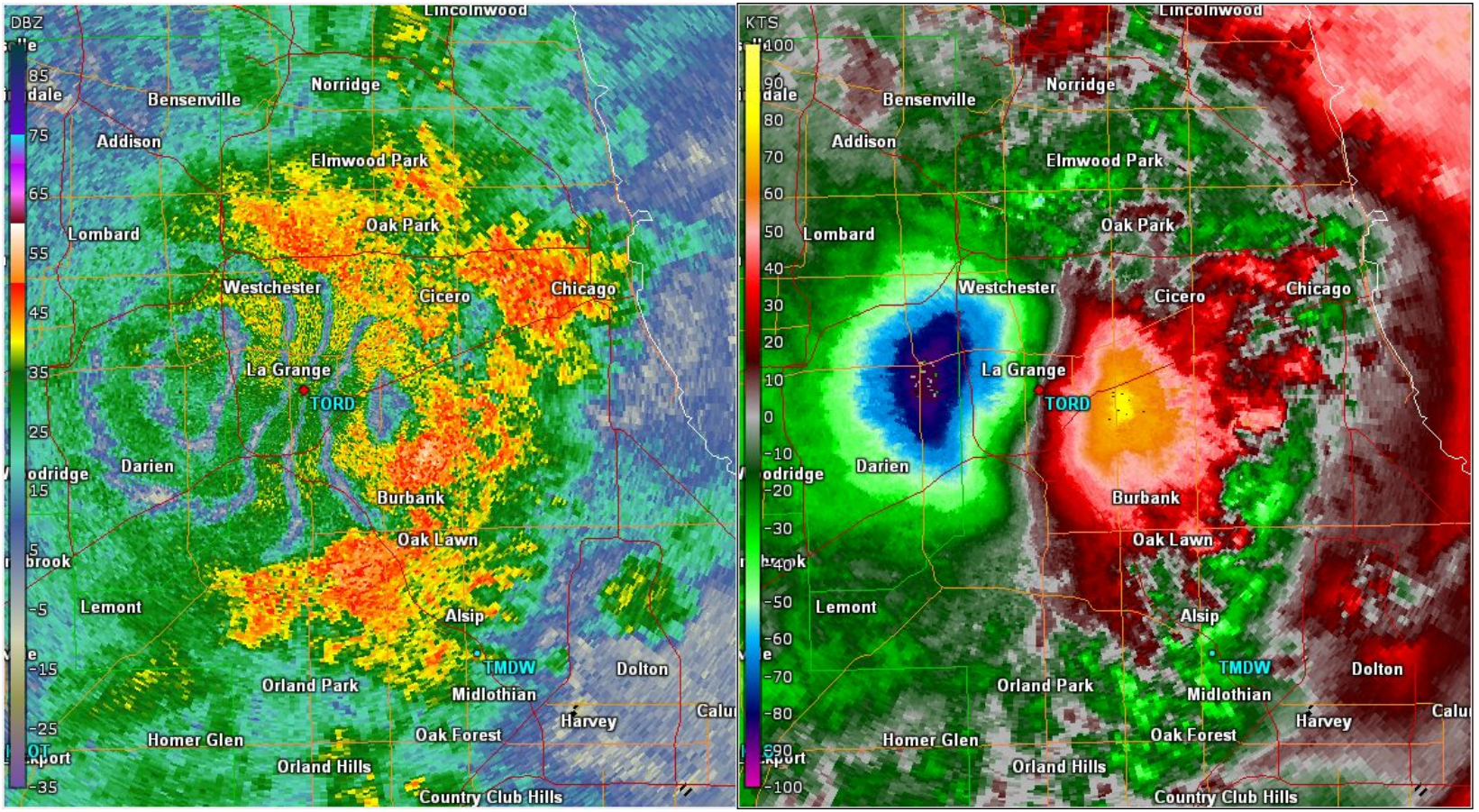


TORD 10aug2020 2101Z 8.7 deg

Note: Velocity > ~85 knots (44 to 48 m/s) marked RF

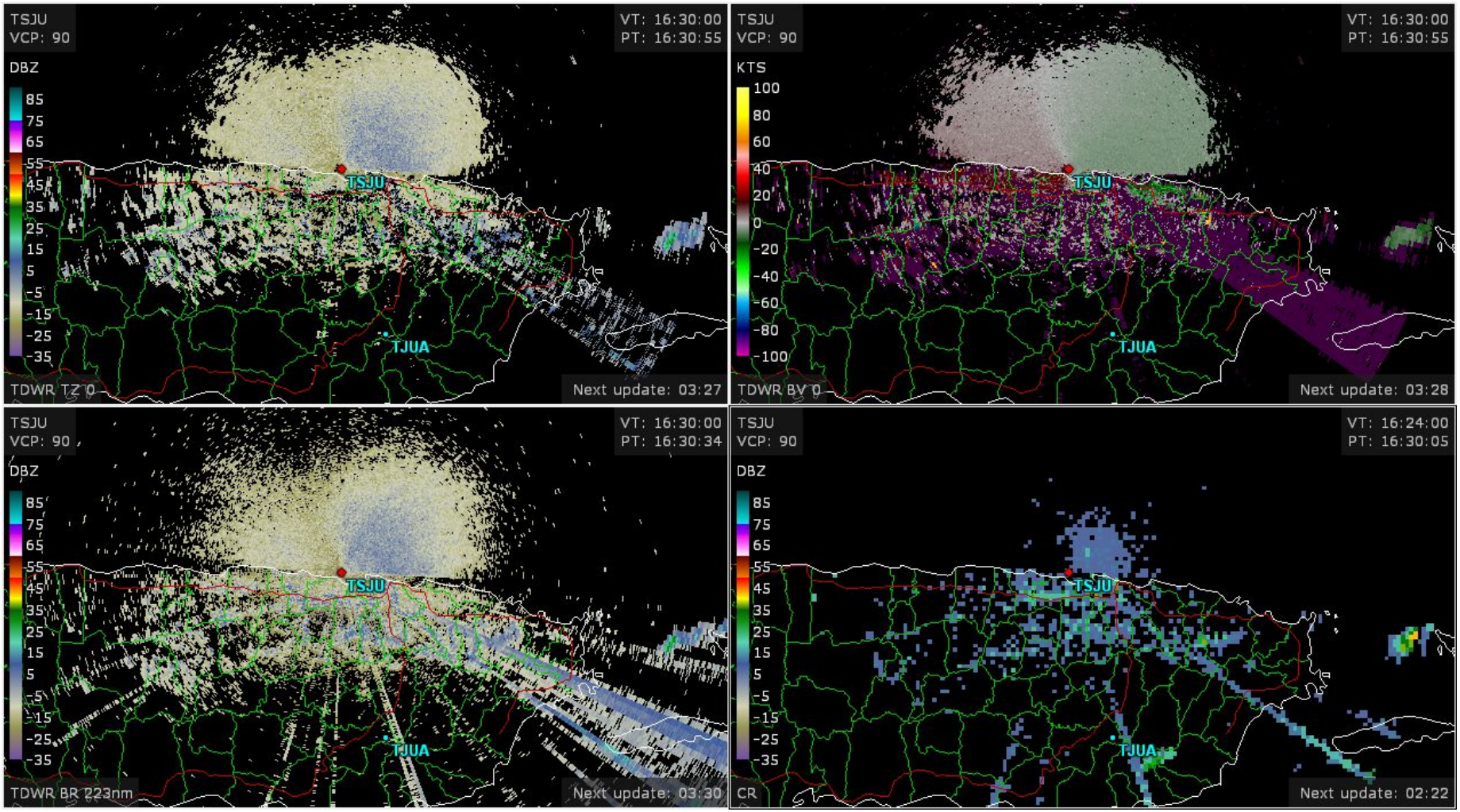
Clutter Filter Effects

Zero Isodop(s)

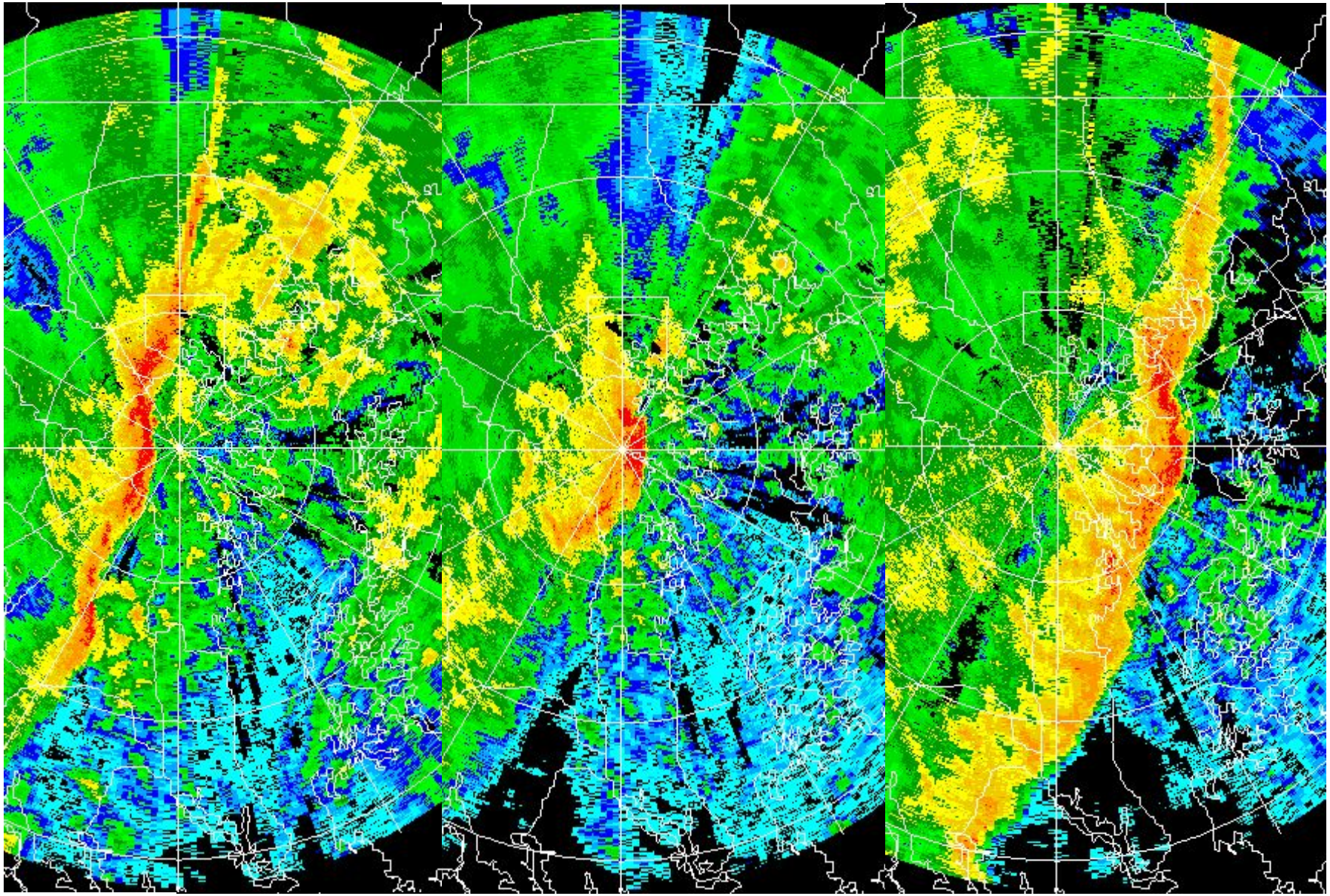


TORD 10aug2020 2101Z 15.2 deg

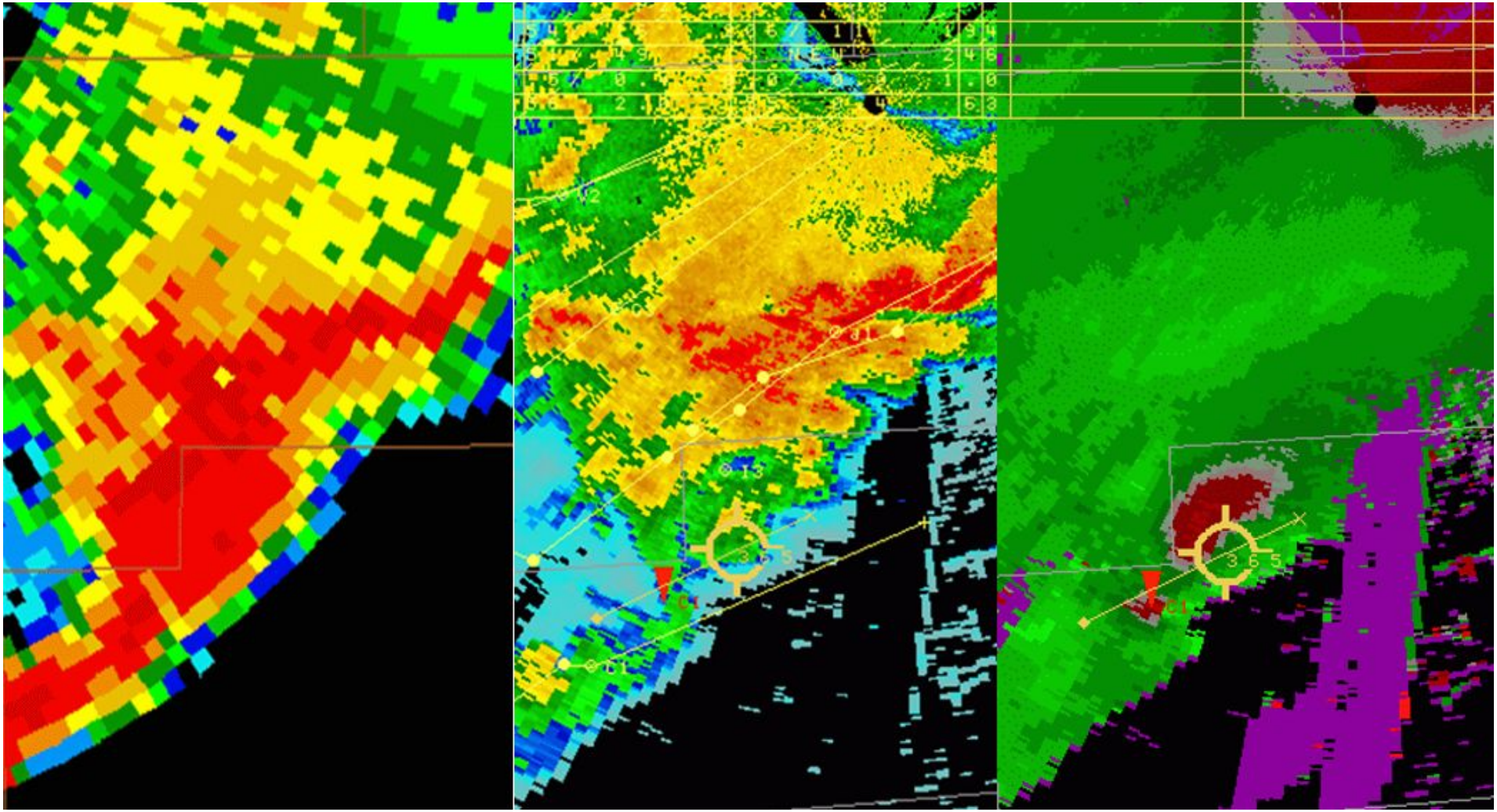
TSJU Interference and Sea Clutter



Attenuation – Impacting Squall Line

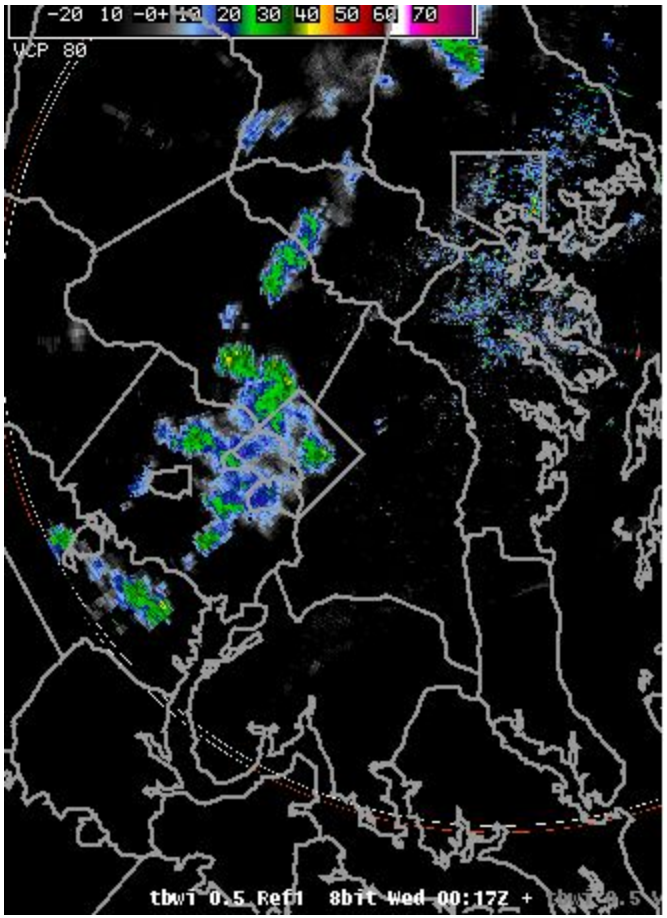


Attenuation – Impacting Supercell

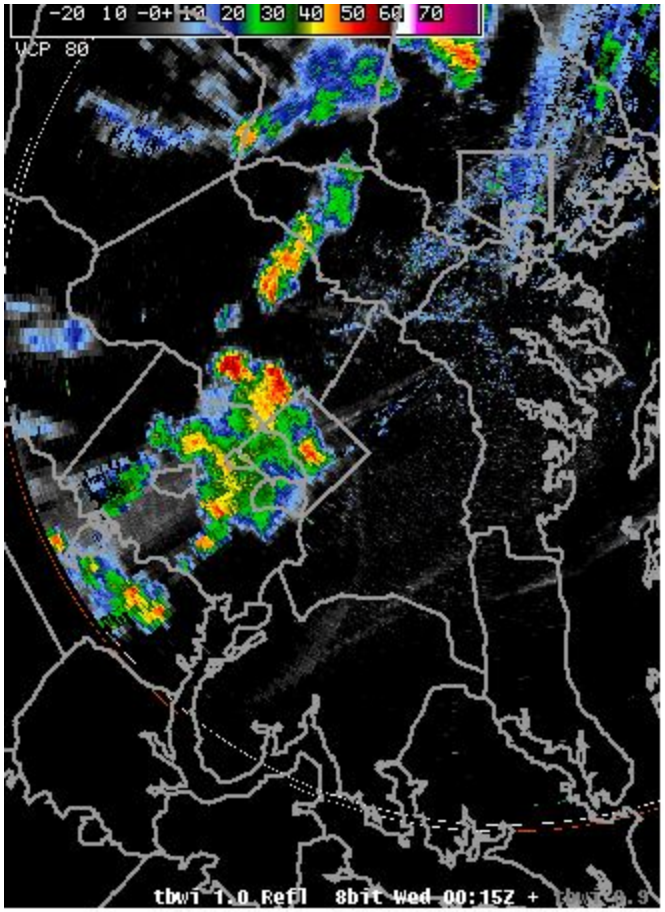


TDWR Elevation-Dependent Noise Correction

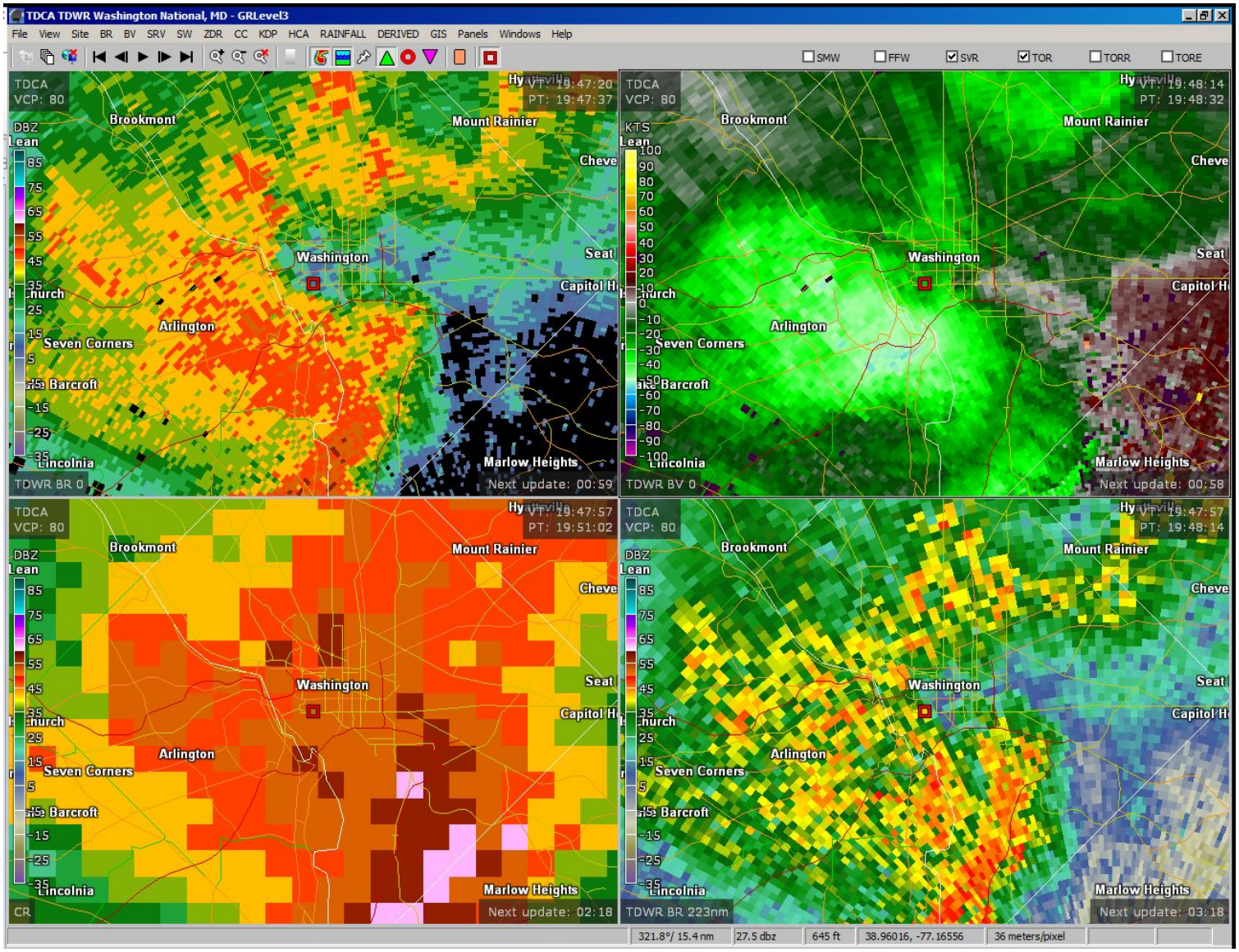
tbwi 0.5 degrees

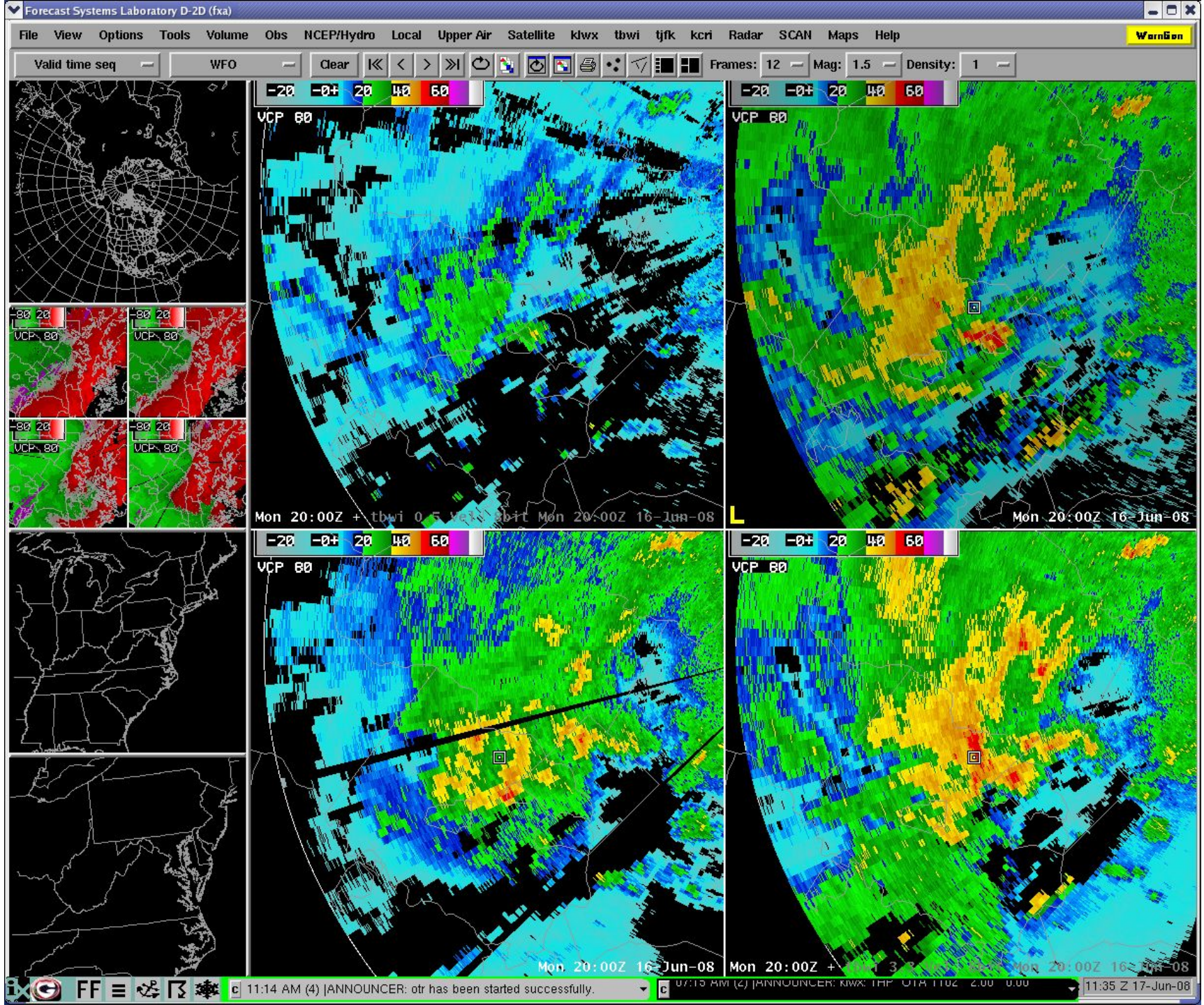


tbwi 1.0 degrees

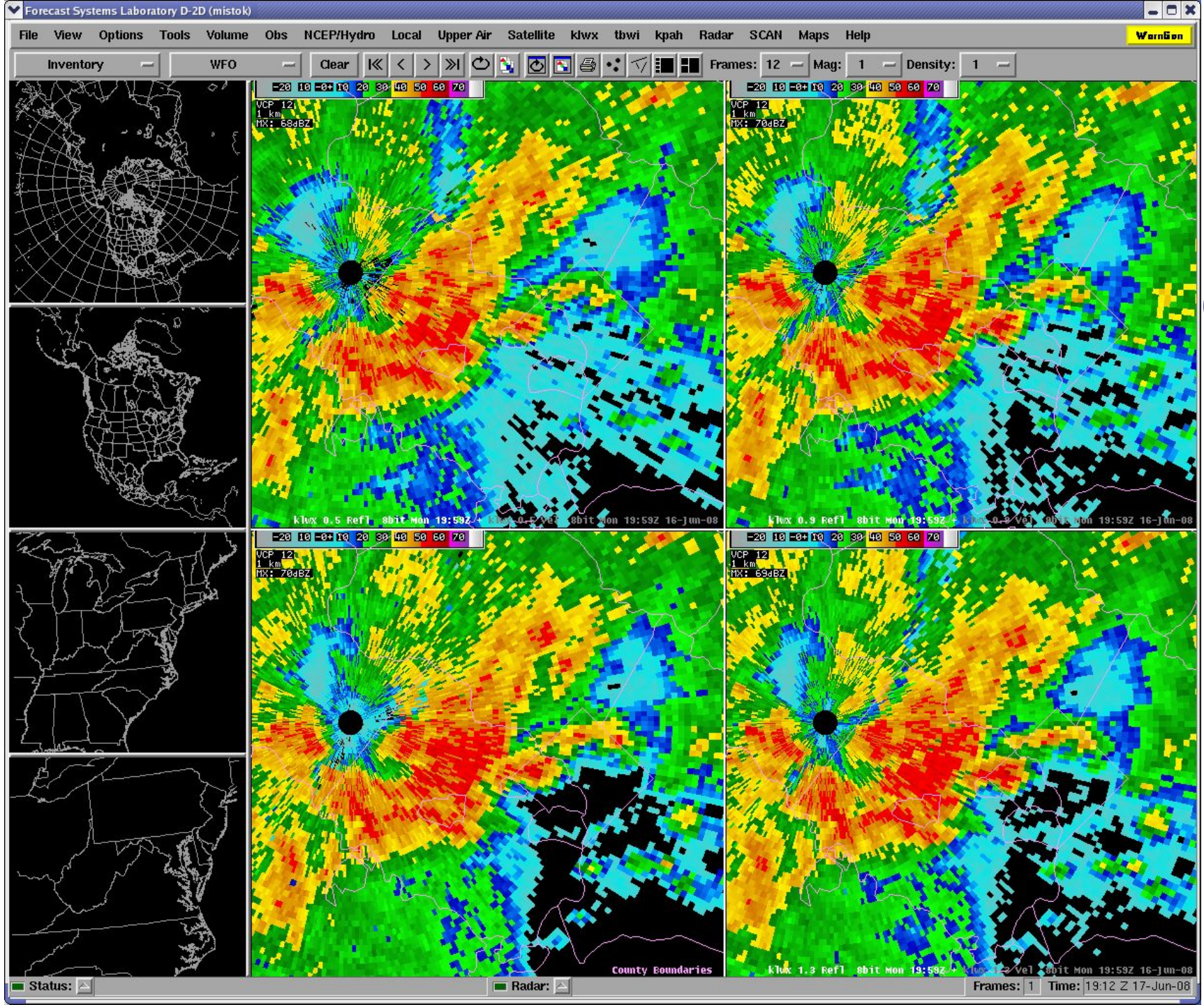


TDWR Elevation-Dependent Noise Correction ??





Bad noise correction TBWI



KLWX same time as TBWI images on previous slide

SPG Data Loss Status

- SPG System Status Log Messages
  - Missing Radials
  - Fat Radials
  - Displayed as elevation index/count
  - May result in a volume scan restart/task cleanup

```
Oct 6,08 [00:16:52] >> Missing Radial: Total 35 (EI/CNT) 1/1 2/9 3/2 4/3 5/5
   6/2 7/2 11/4 12/5 13/2
Oct 6,08 [00:16:52] >> Fat Radial: Total 5 (EI/CNT) 1/1 3/1 8/2 13/1
Oct 6,08 [00:16:52] >> Unexpected Start of Volume Scan 43
Oct 6,08 [00:16:52] >> RPG Task Cleanup For Volume Scan 42
Oct 6,08 [00:16:52] >> Vol: 43 (Seq: 29803) RDA Clock:10/06/08 00:16:52 VCP:
   90
```

TDWR SPG
Data Loss Impact

- Impact could be ranked on a scale 1 to 10
  - 1:none,
  - 2:insignificant,
  - 3:occasional nuisance,
  - 4:frequent nuisance,
  - 5:occasional moderate impact,
  - 6:frequent moderate impact,
  - 7:continuous moderate impact,
  - 8:frequent severe impact,
  - 9: unusable,
  - 10: complete loss of operations.
- Interim SPG Status Web page
  - Data loss, volume aborts, ASP
- Status Log
  - Lost radial patterns
    - Few every volume
    - Many every volume
  - Volume Scan aborts
    - Few per 8 hours
    - Many aborts
    - Few or no completions
  - Complete loss
    - Comms discontinuity alarm (wideband failure)
    - HCI data flow icon stops
- Products
  - Few wedges
  - Many wedges
  - No volume products
  - No products of any kind

SPG Status Page (ROC internal)

NWS SPG TDWR Operational Status as of Tue Oct 14 12:59:52 UTC 2008

Radar Sites - Last receipt of OTR data - Requested 1/hour

Green = normal, Time is Product Volume Scan Time;
Yellow = SPG OTR Responding, Time is Age of Old Product (Radar Likely Not Transmitting Base Data);
Yellow GSM Date = Only GSM Received (SPG Operating, Radar Likely Not Transmitting Base Data);
Orange = 8 Hour Radial Data Loss >= 1%, or 8 Hour Volume Aborts >= 25% (possible communications problems)
Red = SPG Missing or Not Operational.

Operational Field SPGs Status:

tadw Oct 14 12:31 Bld 30 VCP 90	**tatl** Oct 14 12:29 Bld 30 VCP 90	**tbna** Oct 14 12:25 Bld 30 VCP 90	**tbos** Oct 14 12:26 Bld 30 VCP 90	**tbwi** Oct 14 12:24 Bld 30 VCP 90	**tclt** Oct 14 12:24 Bld 30 VCP 90	**tcmh** Oct 14 12:29 Bld 30 VCP 90	**tcvg** Oct 14 12:29 Bld 30 VCP 90	**tdal** Oct 14 12:23 Bld 30 VCP 90	**tday** Oct 14 12:24 Bld 30 VCP 90
tden Oct 14 12:31 Bld 30 VCP 90	**tdfw** Oct 14 12:22 Bld 30 VCP 90	**tdtw** Oct 14 12:25 Bld 30 VCP 90	**tewr** Oct 14 12:29 Bld 30 VCP 90	**tfll** Oct 14 12:23 Bld 30 VCP 80	**thou** Oct 14 12:25 Bld 30 VCP 80	**tiad** Oct 14 12:28 Bld 30 VCP 90	**tiah** 45360 min old Bld 30 VCP 90	**tich** Oct 14 12:21 Bld 30 VCP 80	**tids** Oct 14 12:28 Bld 30 VCP 90
tjfk GSM Oct14 12:34 Bld 30 VCP 80	**tlas** Oct 14 12:25 Bld 30 VCP 90	**tlve** Oct 14 12:30 Bld 30 VCP 90	**tmci** Oct 14 12:25 Bld 30 VCP 80	**tmco** Oct 14 12:19 Bld 30 VCP 90	**tmdw** Oct 14 12:28 Bld 30 VCP 90	**tmem** Oct 14 12:27 Bld 30 VCP 90	**tmia** Oct 14 11:52 Bld 30 VCP 80	**tmke** Oct 14 12:27 Bld 30 VCP 90	**tmsp** Oct 14 12:23 Bld 30 VCP 90
tmsy Oct 14 12:22 Bld 30 VCP 90	**tokc** Oct 14 12:22 Bld 30 VCP 80	**tord** Oct 14 12:30 Bld 30 VCP 90	**tpbi** Oct 14 12:18 Bld 30 VCP 80	**tphl** Oct 14 12:28 Bld 30 VCP 90	**tphx** Oct 14 12:23 Bld 30 VCP 90	**tpit** 63 min old Bld 30 VCP 90	**trdu** 1537 min old Bld 30 VCP 90	**tsdf** Oct 14 12:24 Bld 30 VCP 90	**tsju** Oct 14 12:28 Bld 30 VCP 80
tslc Oct 14 12:22 Bld 30 VCP 90	**tstl** Oct 14 12:29 Bld 30 VCP 90	**ttpa** 19790 min old Bld 30 VCP 80	**ttul** Oct 14 12:25 Bld 30 VCP 90						