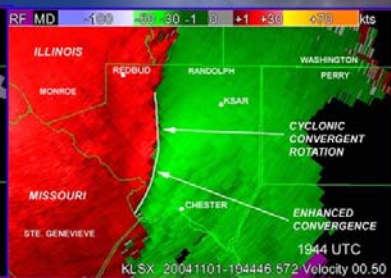
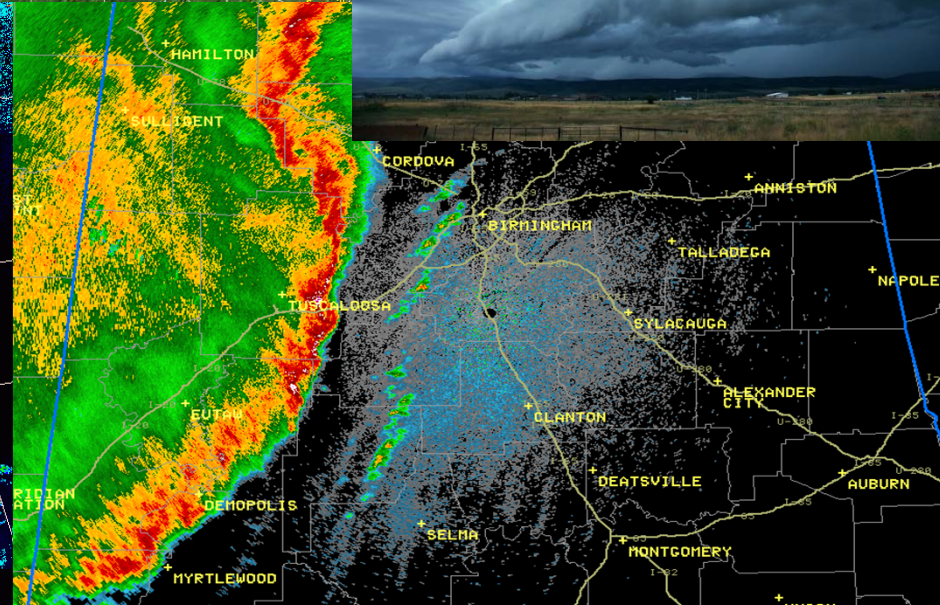
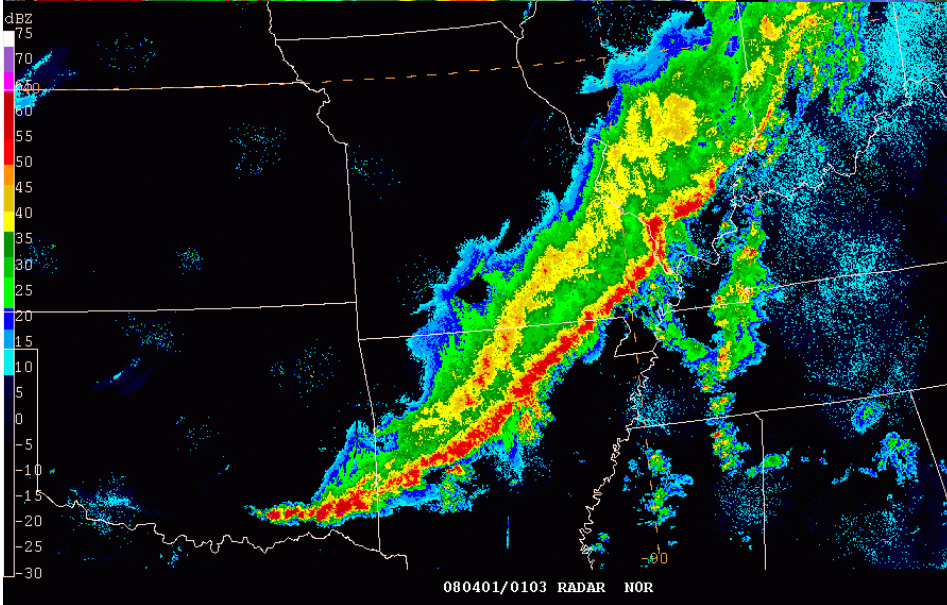
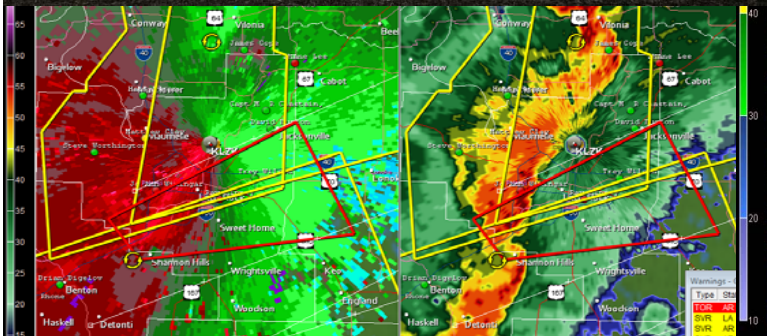


WSR-88D radar imagery from KLSX at 1944 UTC



Reflectivity image showing Quasi-Linear Convective System (QLCS)

Storm-relative velocity image (SRM)



080401/0103 RADAR NOR

Mid-Volume Rescan of Low-Level Elevations (MRLE)

Beyond SAILS - A New Scanning Approach for Sampling the Mid-Levels

Nov 2016

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Operational Need

(From Ron Przybylinski)

- QLCS mesovortices develop quickly
- Usually form within the 4000 to 8000 ft ARL layer
- When QLCS mesovortex genesis is close to the radar
 - genesis layer is not sampled by the 0.5 degree slice.
 - 0.5 degree elevation slice provides velocity data at approx 2000 ft ARL at ~25nm range.
 - SAILS repeats the lowest scan and therefore is not helpful when looking for mesovortex genesis

Operational Need (cont)

- When QLCS mesovortex genesis is close to the radar (0 - 50 nm) more frequent “elevated angles” are needed
- Some Central Plains offices also requested more frequent scanning of elevations higher than 0.5° for hail identification

What Can We Do?

- Design specialized VCPs
 - Not in-line with concept of simplifying VCPs
 - Long logistics tail
- Rethink SAILS
 - Leverage the success of the SAILS concept
 - Rescan multiple elevations (Not just 0.5°)
 - Operator selects number of elevations to rescan
 - Lessons and code from SAILS implementation reduce risk

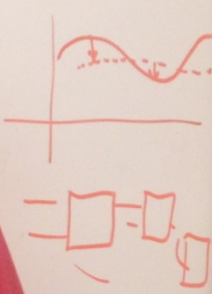
2 7 3 ind = storm_ids[i]
 1 1 1 cell_id = charid[ind]
1 2 3 4 5 6 7 8
8 7 6 5 4 3 2 1 x_c = attrib[i]
 y_c = [i]

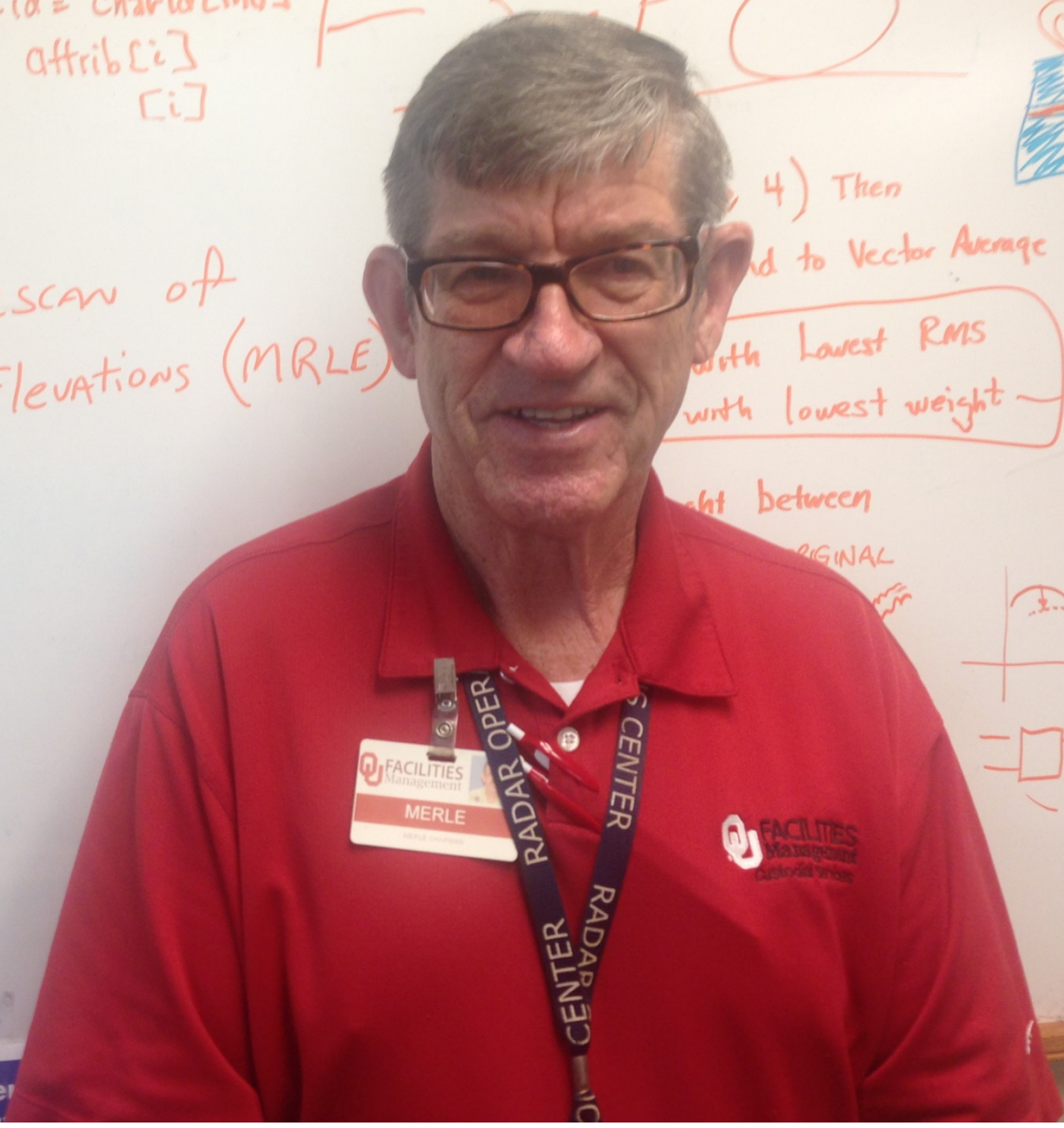
F - P - O



Mid-Volume Rescan of
Low-Level Elevations (MRLE)

4) Then
lead to Vector Average
with Lowest RMS
with lowest weight. →

ht between
ORIGINAL




How Does Mid-Volume Rescan of Low-Level Elevations (MRLE) Work?

- MRLE is a new variant of the proven SAILS concept
- MRLE rescans multiple sequential elevations - not just the lowest (SAILS)
- In the middle (by time) of a volume scan—MRLE rescans the forecaster-selected number of sequential elevation angles
 - The “middle” is determined dynamically due to AVSET
 - The radar resumes normal completion of the volume scan after the rescan of the desired elevations

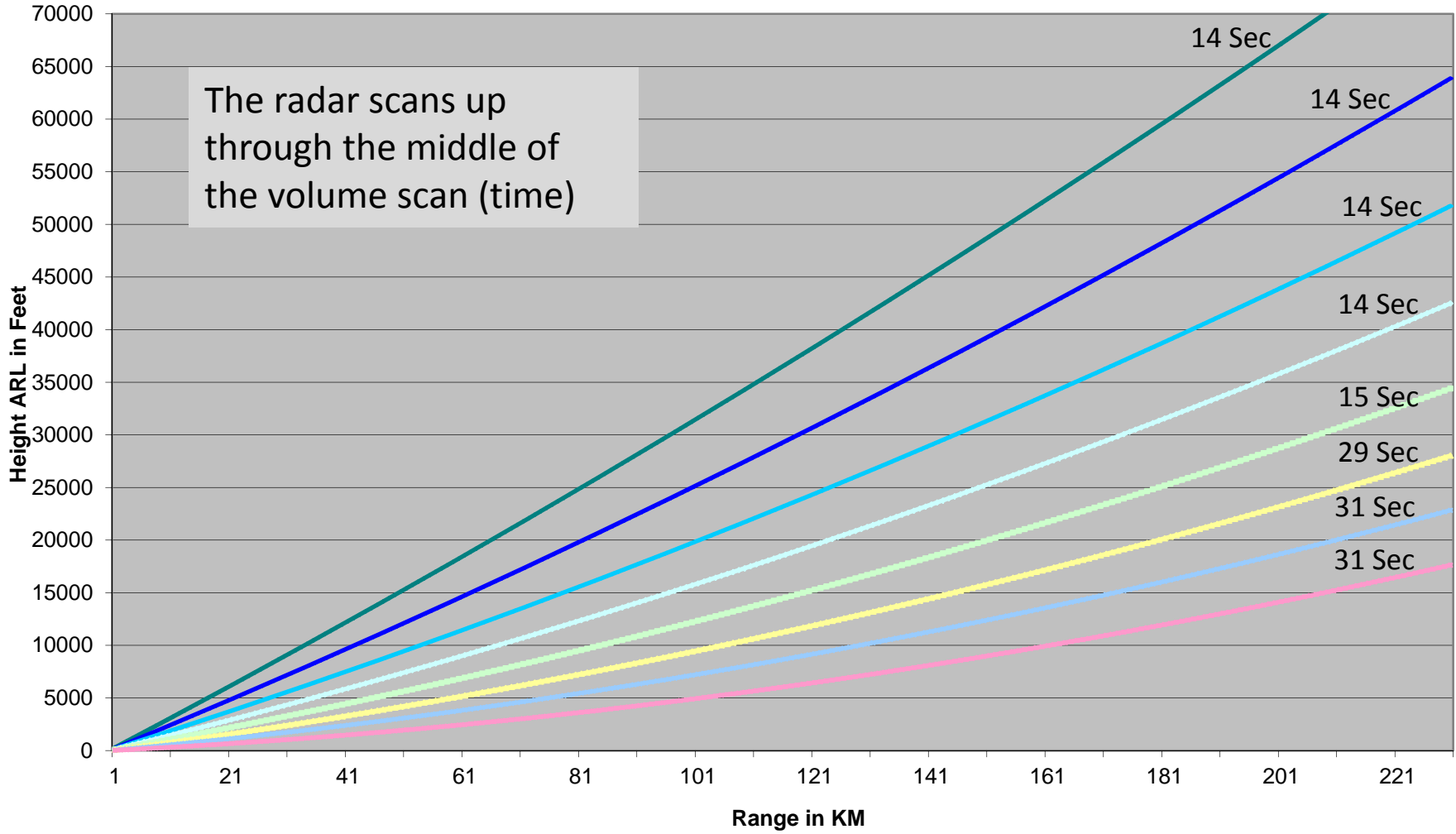
MRLE Implementation

- Based on forecaster expert input and volume scanning time restraints - limit the number of rescanned elevations to four
 - 0.5°, 0.9°, 1.3° and 1.8° elevations
 - KLGX = 0.2°, 0.5°, 0.9° and 1.3°
- Forecaster option - select the desired number of elevations (e.g., 1, 2, 3 or 4)
 - MRLEx1 = 0.5° (For a single elevation, software invokes SAILS)
 - MRLEx2 = 0.5° and 0.9° elevations
 - MRLEx3 = 0.5°, 0.9° and 1.3° elevations
 - MRLEx4 = 0.5°, 0.9°, 1.3° and 1.8° elevations

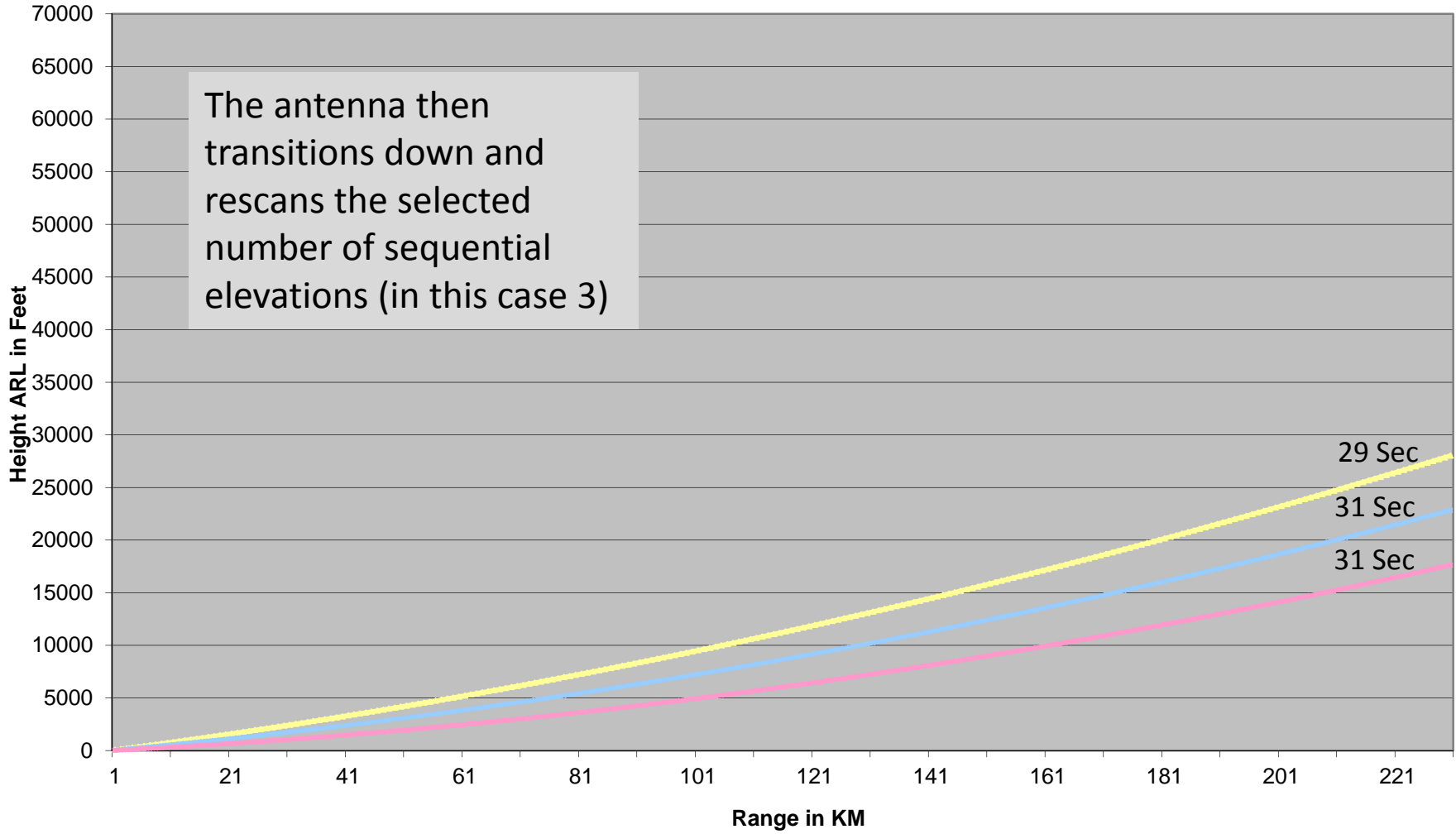
MRLE Example

- In the following example, the forecaster selected MRLE with 3 elevations
 - MRLEx3 = 0.5°, 0.9° and 1.3° elevations
 - VCP duration is equivalent to SAILSx3
- In this example the VCP termination angle is 19.5°
 - AVSET is either OFF or
 - there are radar returns close to the RADAR

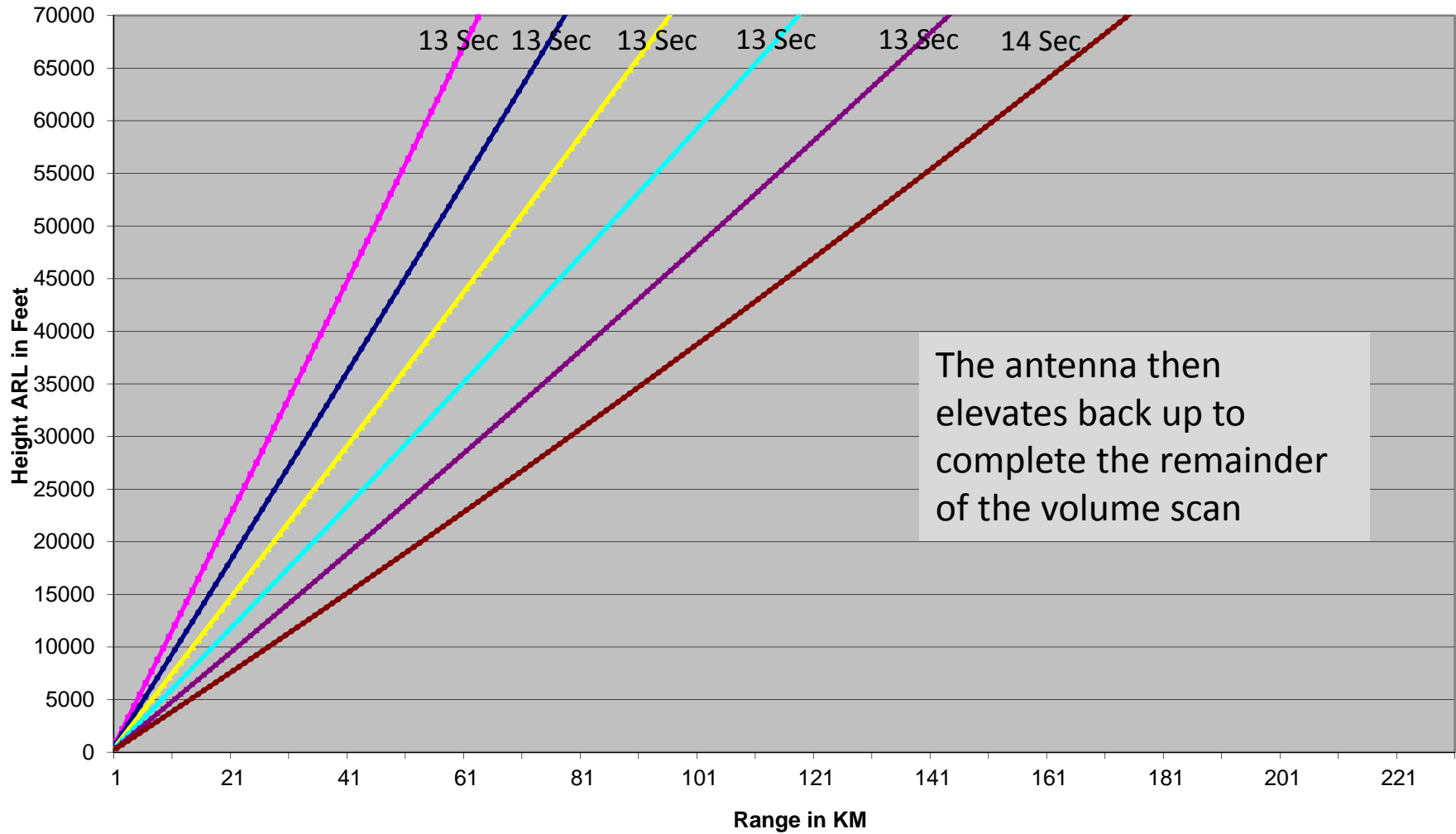
VCP 12 with MRLEx3
Termination angle of 19.5



VCP 12 with MRLEx3
Rescans lowest three elevations



VCP 12 with MRLEx3
Completes volume scan



MRLE Control HCI

The screenshot displays the 'RPG Control/Status' interface. At the top left, the date and time are 'Friday October 21, 2016 19:08:05 UT'. The main status area shows 'State: OPERATE' and 'Oper: ONLINE'. A large circular gauge indicates '0.9 MRLE'. To the right, a table lists various parameters: VCP (215), AVSET (ENABLED), SAILS (DISABLED), MRLE (ACTIVE/3), PRF Mode (MULTI-STORM), and Perf Check In (133649h 13m). Below this, another table shows Mode Conflict (NO), Clear Air Switch (AUTO), and Precip Switch (AUTO). A 'Gen Off' button is visible on the left. The interface includes several control panels: 'Base Data Display', 'Clutter Regions', 'Bypass Map Display', 'Miscellaneous', and 'BLOCKAGE'. A central dialog box titled 'MRLE Control' is open, showing 'MRLE Status: ACTIVE' and a selection for the number of MRLE cuts (0, 1, 2, 3, 4), with '3' selected. Below the selection, a text box explains the options: 'Selecting "0" cuts will disable MRLE. Selecting 1 will rescan the lowest elevation of the VCP (SAILSx1). Selecting 2 will rescan the lowest two elevations, 3 will rescan the lowest three elevations and 4 will rescan the lowest four elevations of the VCP.' At the bottom, a feedback log shows: 'Oct 21,16 [18:59:56] >> MRLE set to 3 cut(s)', 'Status: Oct 21,16 [19:03:51] >> RDA ACKNOWLEDGMENT: Remote VCP Received at RDA', and 'Alarms: Oct 21,16 [15:11:44] >> RPG ALARM CLEARED: RDA <-> RPG COMMUNICATIONS LINK BROKEN'.

MRLE

- Always rescan from the lowest elevation up through the selected elevation (repeating the lowest “n” elevations)
 - MRLE provides information about severe weather signatures at or near the surface
 - MRLE designed to provide continuity up through the selected elevation
- The four-elevation option results in volume scan completion time of ~15 seconds greater than SAILSx3 duration
 - Three elevations equivalent to SAILSx3
 - Two elevations equivalent to SAILSx2

VCP 12 with MRLEx3

Elev	Wave Form	Surv PRF	Dop PRF	Surv Pulses per Second	Dop Pulses per Second	Rotation Rate (DPS)	RPM	Scan Time (Seconds)	Rmax (km)	Rmax (nm)	Vmax (m/s)	Vmax (kts)	Beam Hgt at Rmax (ft)	Cumulative Scan Time
0.5	CS	1		321.89		21.459	3.58	17	466.00	251.46	8.05	15.64	59550	17
0.5	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	8898	32
0.9	CS	1		321.89		21.459	3.58	17	466.00	251.46	8.05	15.64	70223	49
0.9	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	12288	65
1.3	CS	2		350.26		23.351	3.89	15	428.25	231.09	8.76	17.02	70902	80
1.3	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	15677	96
1.8	B	3	5	389.36	1013.51	27.534	4.59	13	385.25	207.88	25.34	49.25	71282	111
2.4	B	4	5	446.43	1013.51	27.533	4.59	13	336.00	181.31	25.34	49.25	70185	125
3.1	B	5	5	512.8	1013.51	28.208	4.70	13	292.51	157.84	25.34	49.25	70105	139
4	B	6	5	602.41	1013.51	28.918	4.82	12	249.00	134.36	25.34	49.25	70179	152
5.1	B	6	5	602.41	1013.51	28.116	4.69	13	249.00	134.36	25.34	49.25	85813	167
0.5	CS	1		321.89		21.459	3.58	17	466.00	251.46	8.05	15.64	59550	184
0.5	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	8898	199
0.9	CS	1		321.89		21.459	3.58	17	466.00	251.46	8.05	15.64	70223	216
0.9	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	12288	232
1.3	CS	2		350.26		23.351	3.89	15	428.25	231.09	8.76	17.02	70902	249
1.3	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	15677	264
6.4	B	6	5	602.41	1013.51	27.357	4.56	13	249.00	134.36	25.34	49.25	104254	278
8	CD		6		1094.89	28.813	4.80	12	137.00	73.93	27.37	53.21	66548	292
10	CD		7		1181.1	29.528	4.92	12	127.00	68.53	29.53	57.40	75785	306
12.5	CD		8		1282.05	29.138	4.86	12	117.00	63.13	32.05	62.30	85994	318
15.6	CD		8		1282.05	29.138	4.86	12	117.00	63.13	32.05	62.30	106139	332
19.5	CD		8		1282.05	29.138	4.86	12	117.00	63.13	32.05	62.30	131046	344
												TOTAL: 5 min 44 secs		

VCP 12 with MRLEx3 – AVSET

Elev	Wave Form	Surv PRF	Dop PRF	Surv Pulses per Second	Dop Pulses per Second	Rotation Rate (DPS)	RPM	Scan Time (Seconds)	Rmax (km)	Rmax (nm)	Vmax (m/s)	Vmax (kts)	Beam Hgt at Rmax (ft)	Cumulative Scan Time
0.5	CS	1		321.89		21.459	3.58	17	466.00	251.46	8.05	15.64	59550	17
0.5	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	8898	32
0.9	CS	1		321.89		21.459	3.58	17	466.00	251.46	8.05	15.64	70223	49
0.9	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	12288	65
1.3	CS	2		350.26		23.351	3.89	15	428.25	231.09	8.76	17.02	70902	80
1.3	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	15677	96
1.8	B	3	5	389.36	1013.51	27.534	4.59	13	385.25	207.88	25.34	49.25	71282	111
2.4	B	4	5	446.43	1013.51	27.533	4.59	13	336.00	181.31	25.34	49.25	70185	125
3.1	B	5	5	512.8	1013.51	28.208	4.70	13	292.51	157.84	25.34	49.25	70105	139
0.5	CS	1		321.89		21.459	3.58	17	466.00	251.46	8.05	15.64	59550	155
0.5	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	8898	171
0.9	CS	1		321.89		21.459	3.58	17	466.00	251.46	8.05	15.64	70223	189
0.9	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	12288	204
1.3	CS	2		350.26		23.351	3.89	15	428.25	231.09	8.76	17.02	70902	221
1.3	D		5		1013.51	25.338	4.22	14	148.00	79.86	25.34	49.25	15677	235
4	B	6	5	602.41	1013.51	28.918	4.82	12	249.00	134.36	25.34	49.25	70179	249
5.1	B	6	5	602.41	1013.51	28.116	4.69	13	249.00	134.36	25.34	49.25	85813	263
6.4	B	6	5	602.41	1013.51	27.357	4.56	13	249.00	134.36	25.34	49.25	104254	278
												TOTAL: 4 min 38 secs		

SAILS, MRLE and AVSET

- SAILS, MRLE and AVSET are All independent functions
 - SAILS and MRLE CANNOT be used together
 - The software will automatically toggle one off when the other is commanded on
 - AVSET will operate with both SAILS and MRLE
 - MRLE will only be allowed for VCPs 12, 212 and 215
- MRLEx# has virtually the same impact on resources as SAILSx#
- The operator may choose to invoke AVSET and either SAILS or MRLE functions

MRLE Elevation Data

- MRLE elevations are tagged as supplemental elevations (like SAILS elevations)
- Level II data
 - Collected and distributed in normal Level II data stream
 - Not sent to met algorithms (MESO, TVS, QPE, etc.,) until each is specifically configured to receive MRLE data
- Level III Products (same as SAILS/MESO SAILS)
 - Base Products - DR (#94), DV (#99), SDR (#153), SDV (#154), and SDW (#155)
 - Dual Pol products DZD (#159), DCC (#161), DKD (#163), DHC (#165), ML (#166), SDC (#167), and SDP (#168)

MRLE Future

- MRLE software included as non-operational in RPG Build 18 (currently under test)
- Use KOUN (NSSL radar) to test MRLE and collect data
- Since MRLE is included in Build 18
 - Execute on KCRI (ROC Testbed radar) when other testing permits
 - Use KCRI to collect resource utilization data

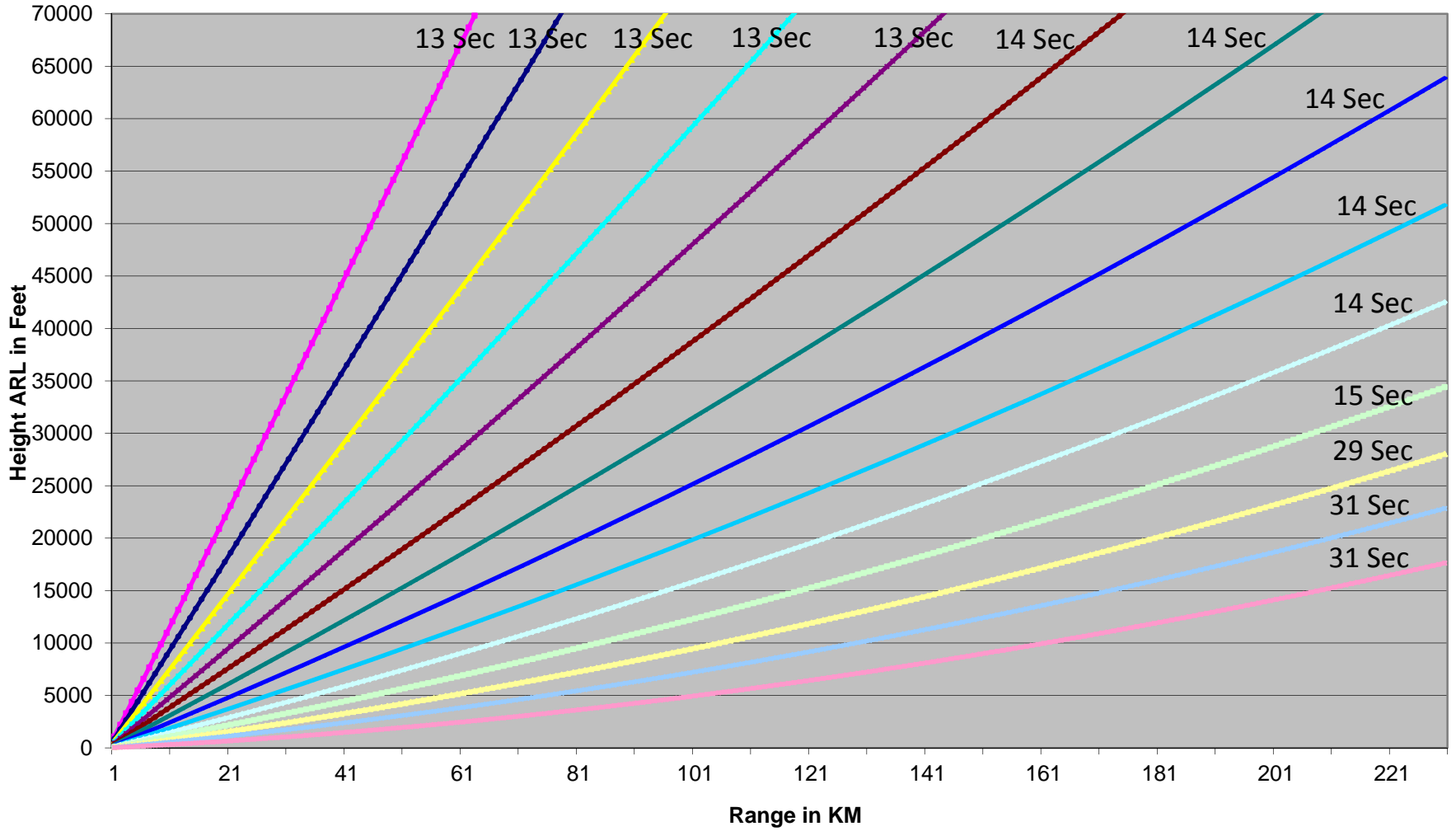
MRLE Future (Cont)

- Continue testing locally through winter/spring
- Goals
 - Conduct a MRLE Field Test after deployment of Build 18 (Summer/Fall 2017)
 - Pending successful Field Test, deploy MRLE as operational in Build 19

Questions ?

BACKUP Slides

VCP 12
Completion Time ~ 180 to 250 Seconds



SAILS x3 with AVSET

Elevation Angles (VCP 12)	VCP 12 Elevation Duration	Term Angle 19.5	AVSET Term Angle 15.6	AVSET Term Angle 12.5	AVSET Term Angle 10.0	AVSET Term Angle 8.0	AVSET Term Angle 6.4
0.5°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.9°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.5°				31 Sec	31 Sec	31 Sec	31 Sec
1.3°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.5°		31 Sec	31 Sec				
1.8°	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec
0.5°				31 Sec	31 Sec	31 Sec	31 Sec
2.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
3.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°			31 Sec				31 Sec
4.0°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°		31 Sec				31 Sec	
5.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°				31 Sec	31 Sec		
6.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°			31 Sec				
8.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	
0.5°		31 Sec					
10.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec		
12.5°	13 Sec	13 Sec	13 Sec	13 Sec			
15.6°	13 Sec	13 Sec	13 Sec				
19.5°	13 Sec	13 Sec					
Duration	243 Sec	336 Sec	323 Sec	310 Sec	297 Sec	284 Sec	271 Sec
0.5 Elevation Update Times	243 Sec	93 Sec, 88 Sec, 72 Sec and 93 Sec*	93 Sec, 74 Sec, 73 Sec and 93 Sec*	62 Sec, 77 Sec, 87 Sec and 94 Sec*	62 Sec, 77 Sec, 87 Sec and 81 Sec*	62 Sec, 77 Sec, 73 Sec and 82 Sec*	62 Sec, 77 Sec, 59 Sec and 83 Sec*
		Avg 89 Sec	Avg 86 Sec	Avg 83 Sec	Avg 79 Sec	Avg 76 Sec	Avg 73 Sec

* 10 Seconds Added to Account for Retrace Time. Avg estimate includes 10 additional seconds to account for elevation transition time