

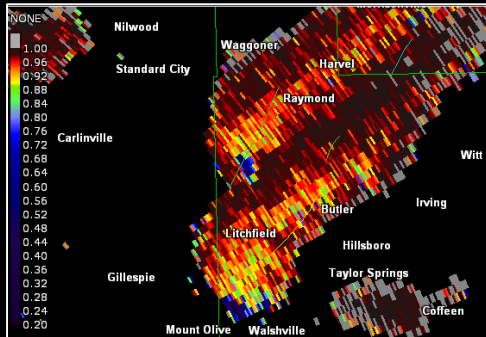
Tornadic Debris Signatures on 12/1/2018 in the LSX CWA



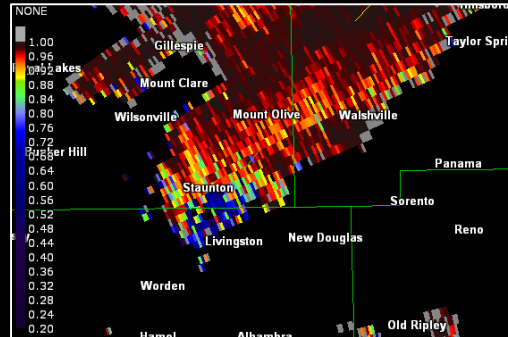
Lewis Kanofsky
NWS St. Louis, MO



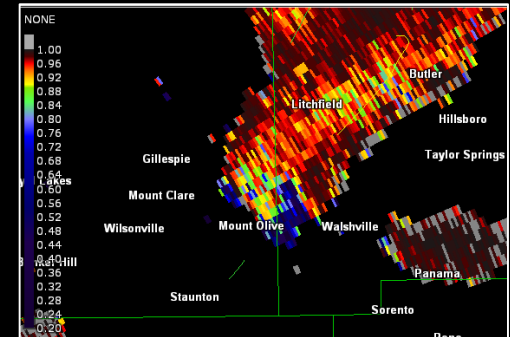
Dual-pol signatures on 12/1/2018



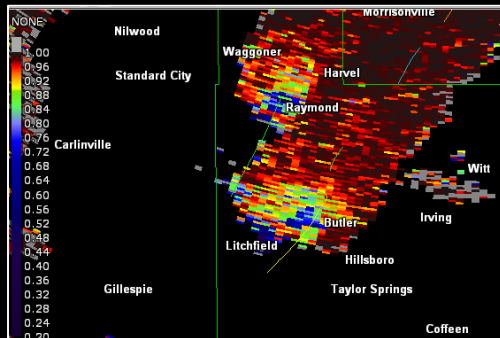
TDS



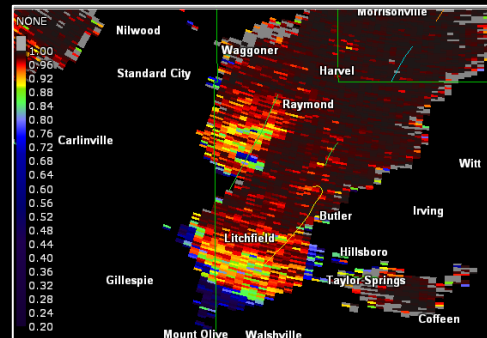
Inflow



NBF

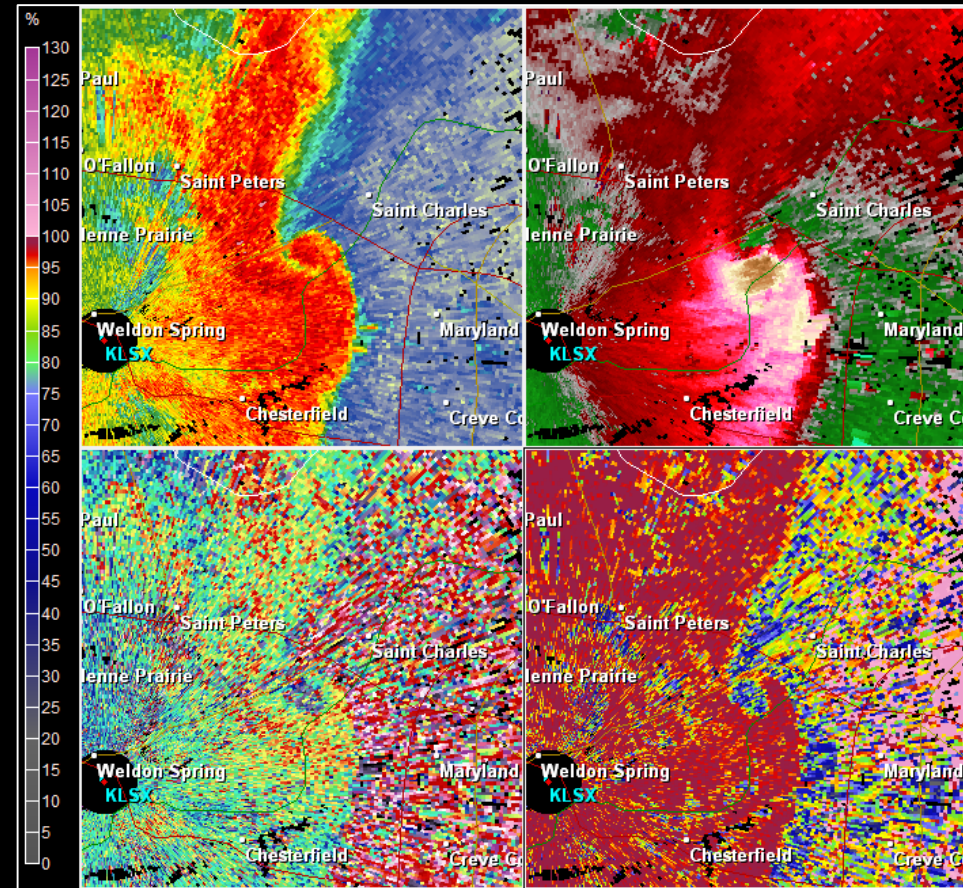


TBSS



Side lobes

Tornadic Debris Signature (TDS)



KLSX
0106 z
5/31/2013

not to scale

TDS identification

Required

CC reduction*

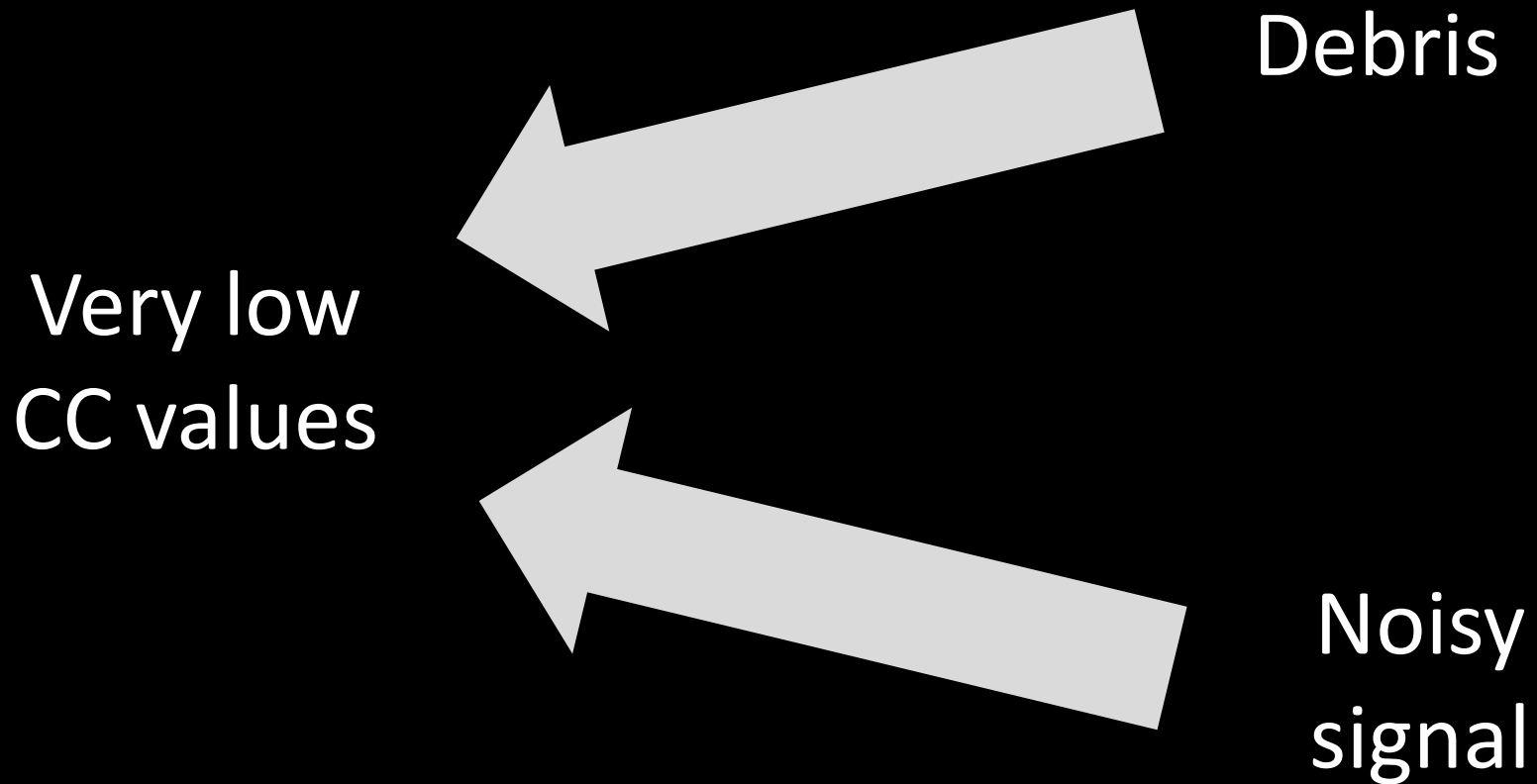
Appropriate
velocity signature

High enough Z**

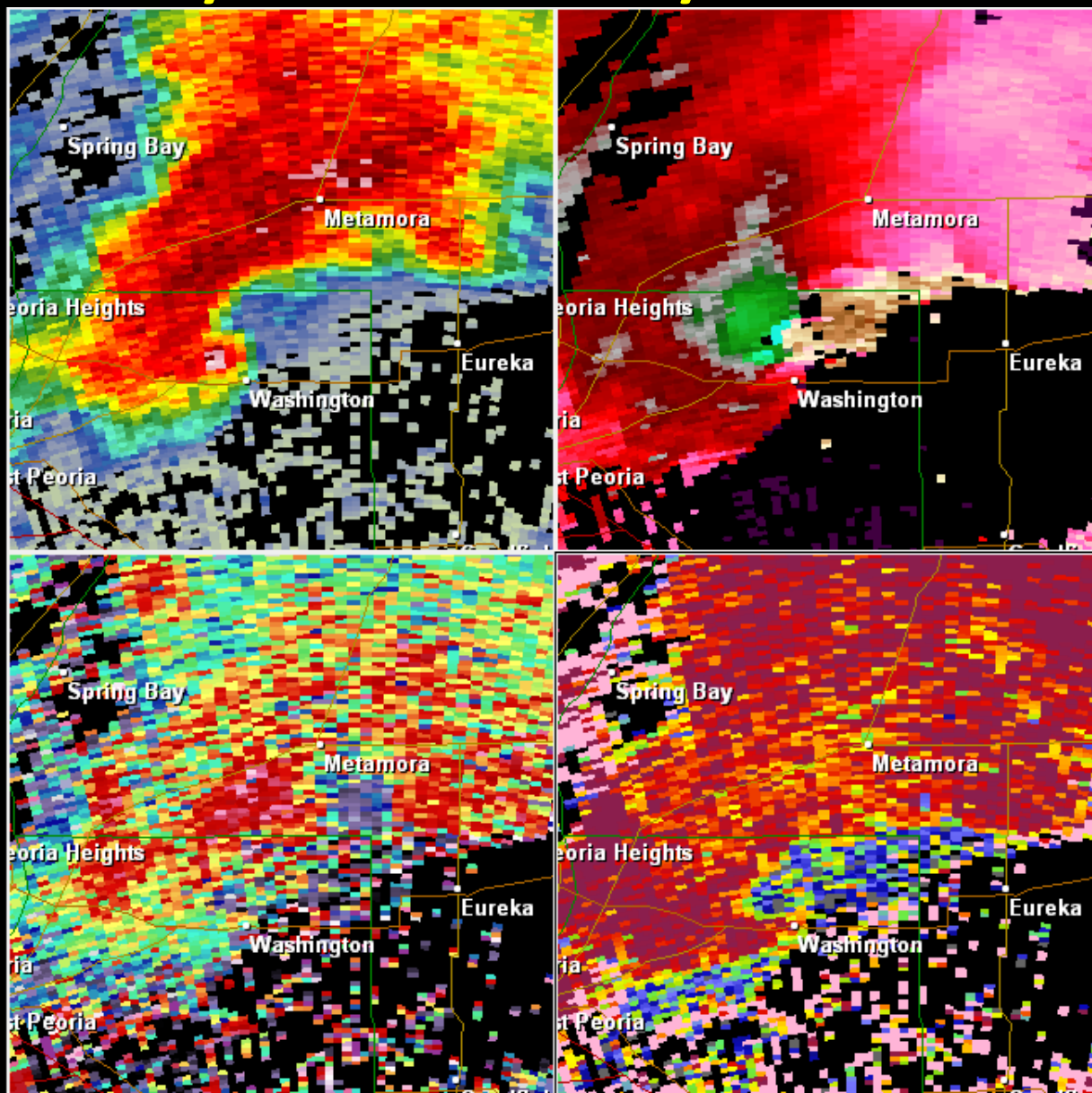
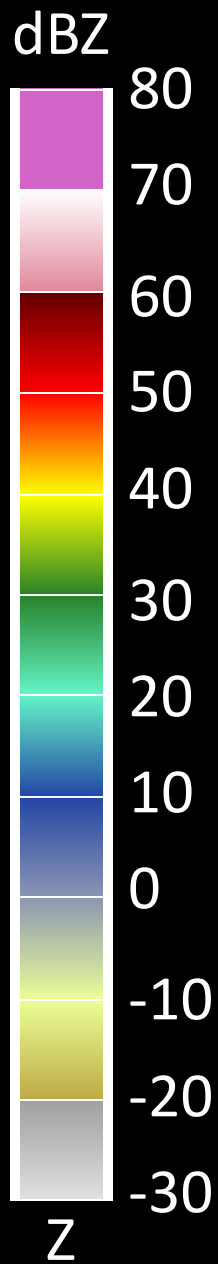
* $CC \leq 0.70$ or 0.80 in some studies

** Z threshold varies by study, typically $\geq 20\text{-}30$ dBZ

Why reflectivity matters

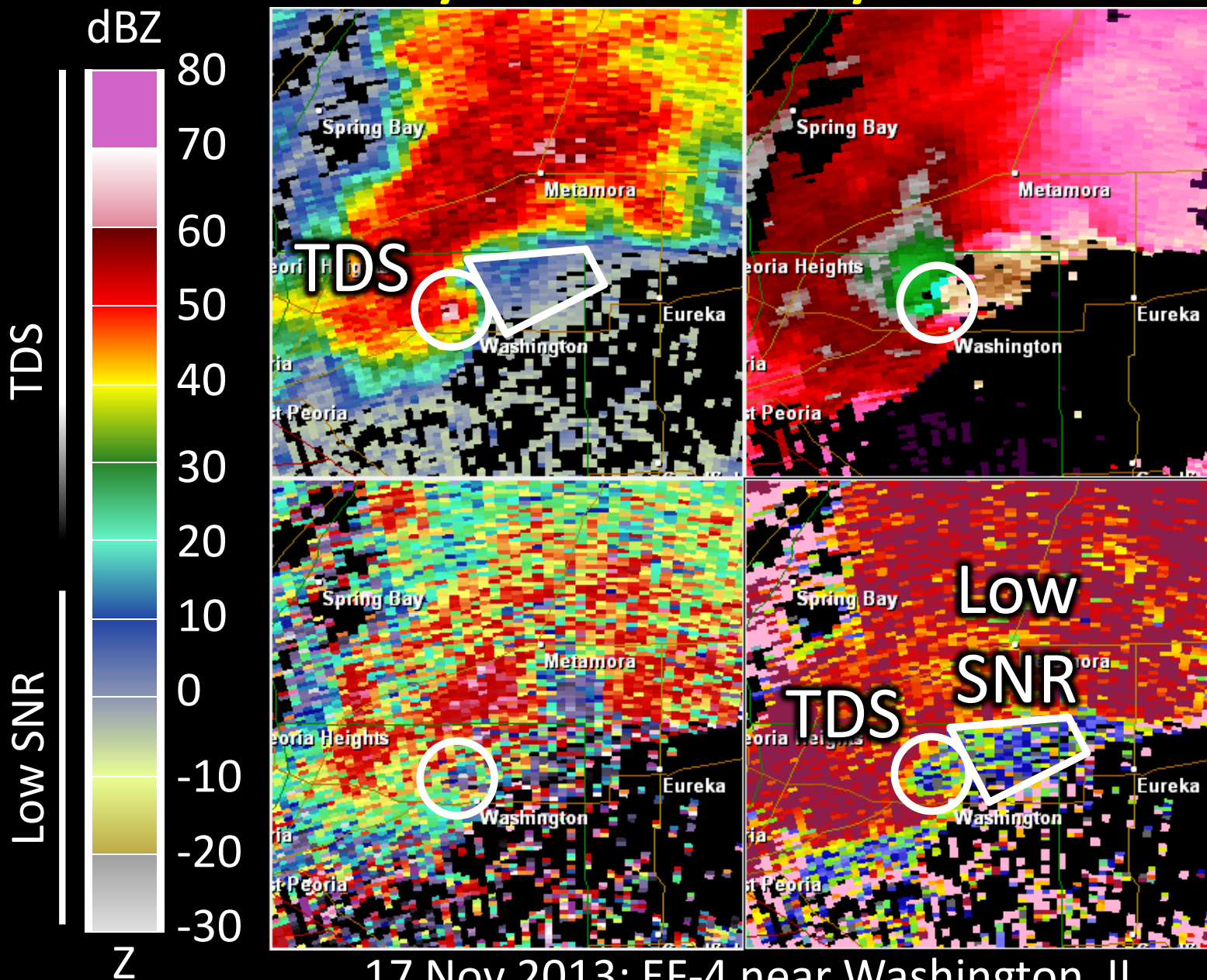


Why reflectivity matters



17 Nov 2013: EF-4 near Washington, IL

Why reflectivity matters



TDS identification

Required

**Admired
(but not required)**

**May or may not
be present**

CC reduction*

Appropriate
velocity signature

High enough Z**

Spatial and
temporal
continuity

ZDR near zero***

* $CC \leq 0.70$ or 0.80 in some studies

** Z threshold varies by study, typically $\geq 20\text{-}30$ dBZ

*** $ZDR \leq 0.5$ in some studies

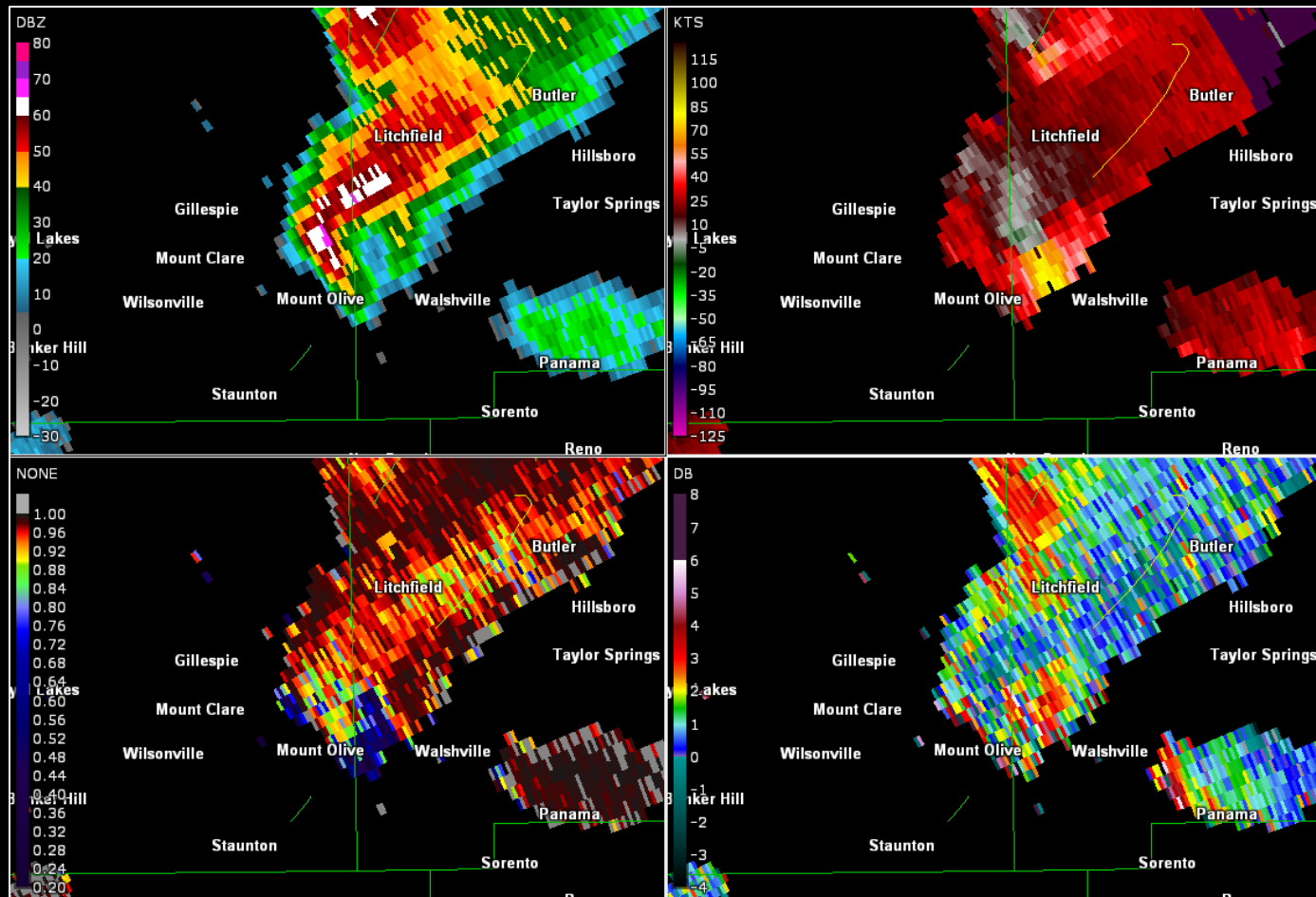
CC characteristics

- Inflow
- Non-Uniform Beam Filling (NBF)
- Three-Body Scatter Spike (TBSS)
- Side lobes

TDS vs. inflow

TDS vs. inflow

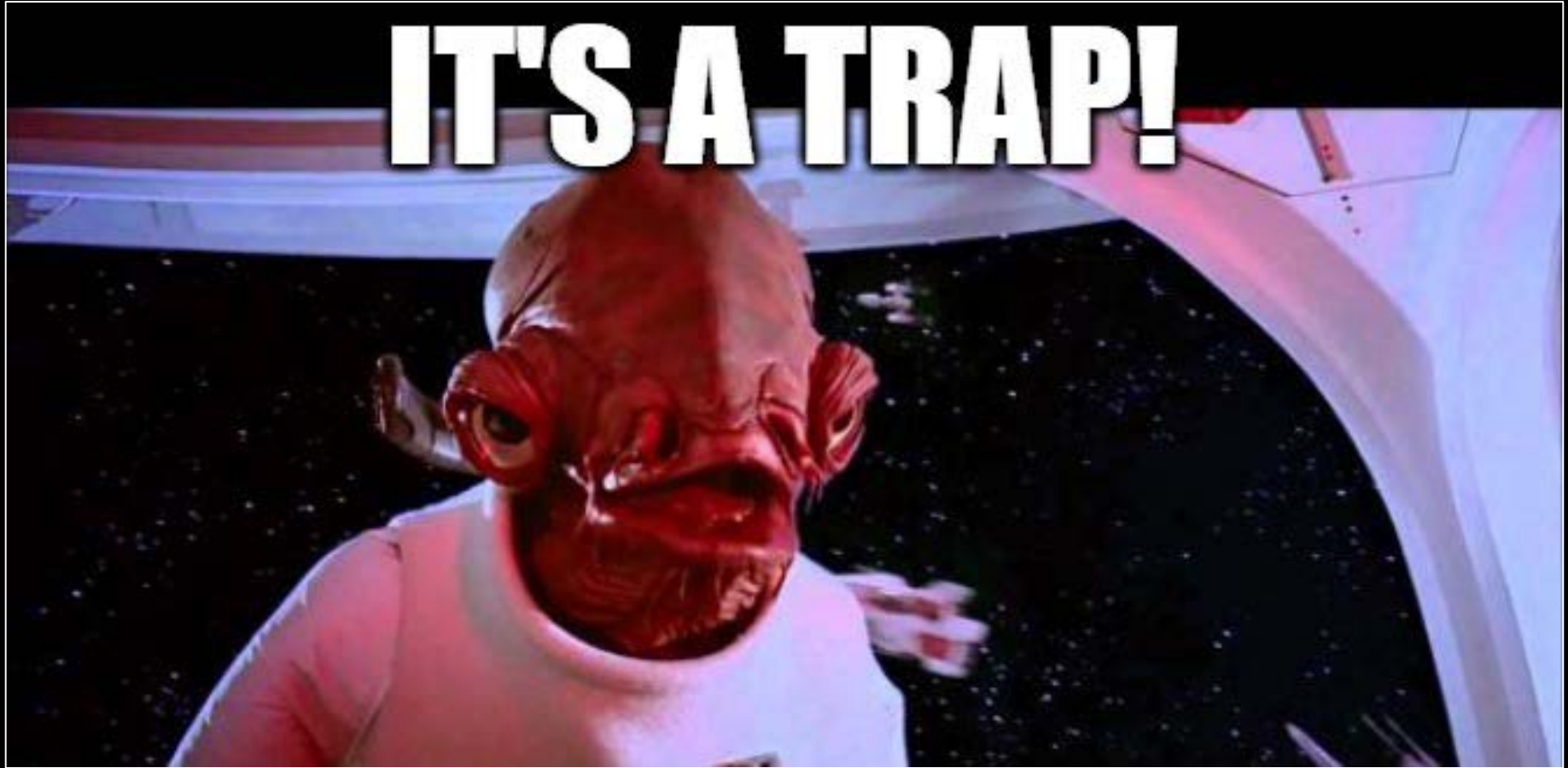
“Hey, look at that CC!” ...



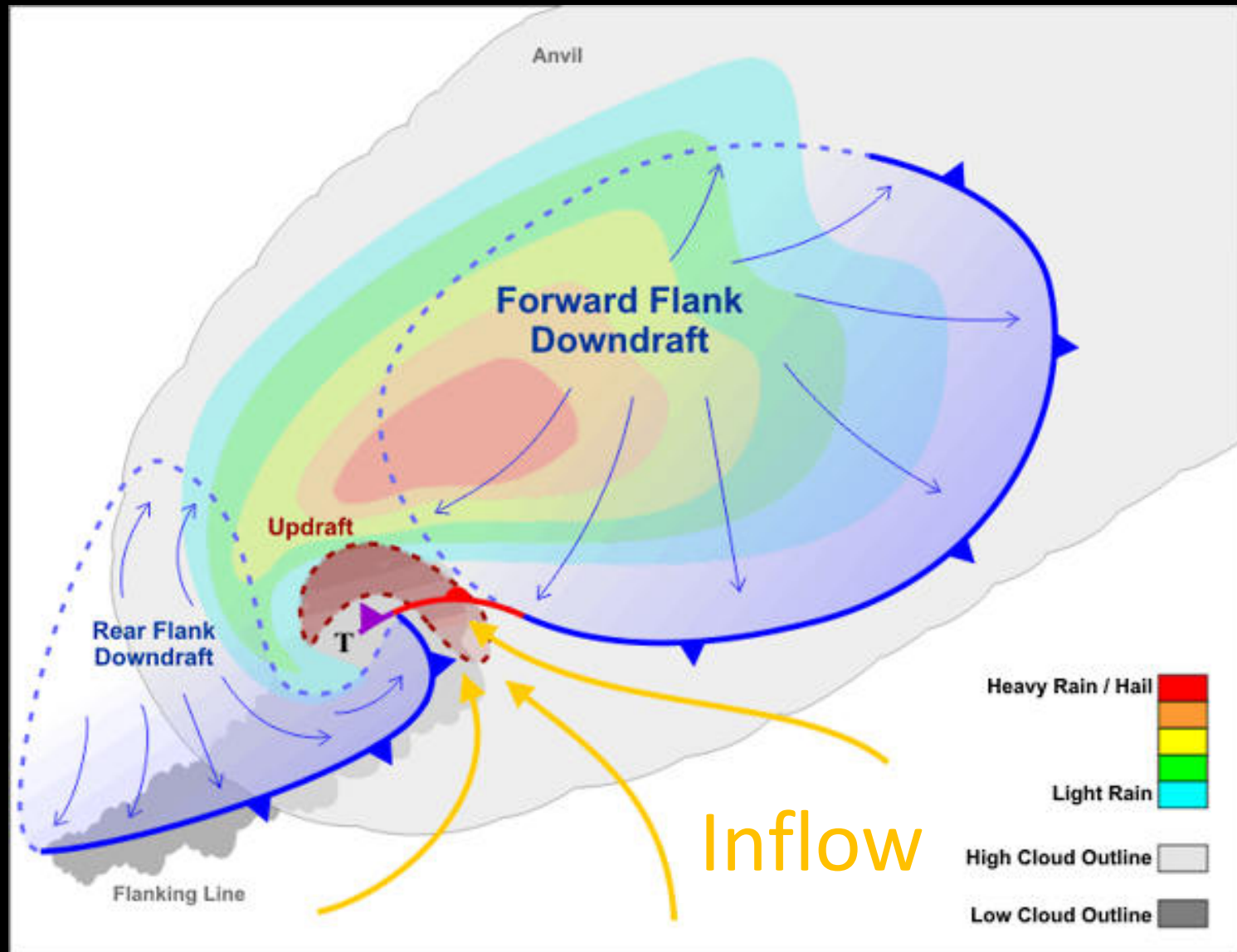
KLSX 2210z

TDS identification

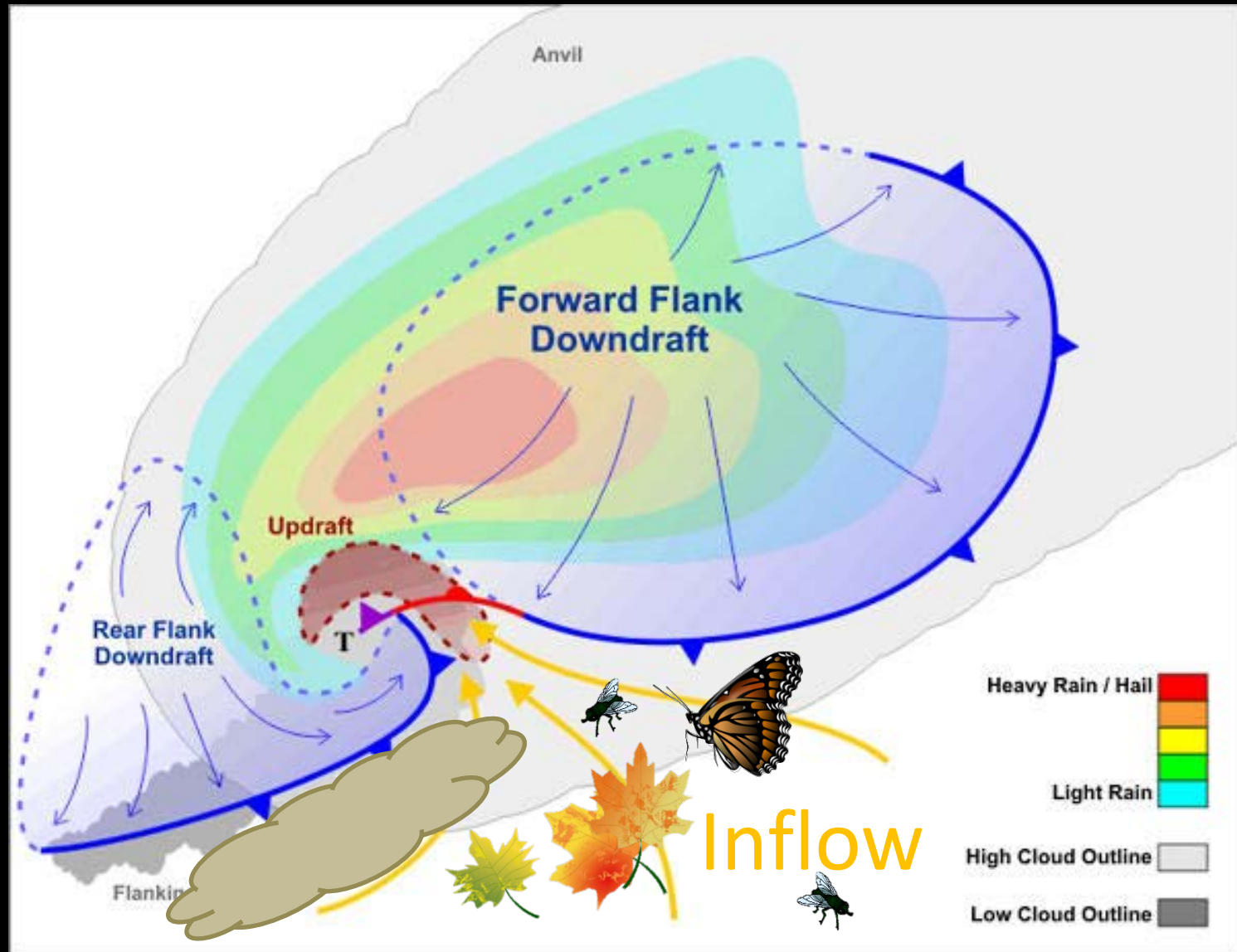
IT'S A TRAP!



Inflow



Inflow

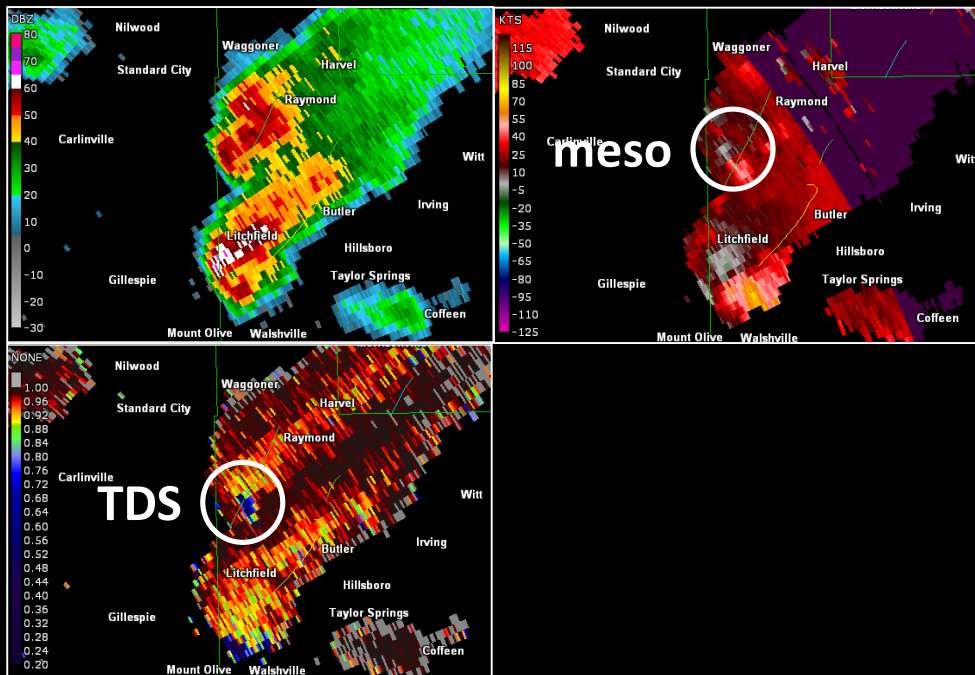


Inflow may contain dusts, insects, leaves, etc.

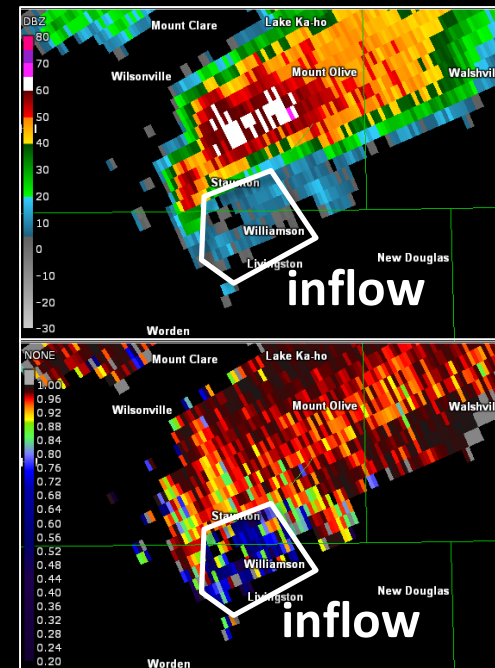
CC characteristics: TDS vs. inflow

- Low CC + high Z
- Within the mesocyclone
- Self-contained CC “hole”
- Lowest CC values are contained within the storm

- Low CC + low Z
- Inflow region of the storm
- Messy, ragged, ill-defined
- Lowest CC values extend to the edges of the storm

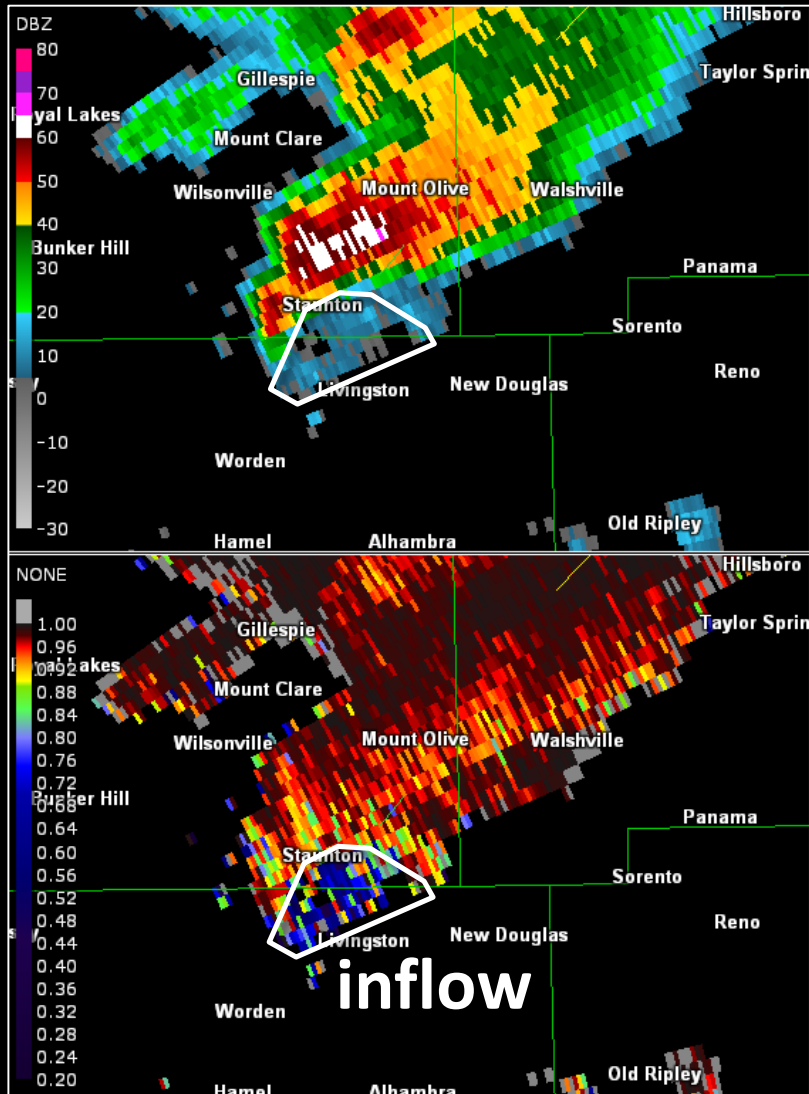


KLSX 2214z

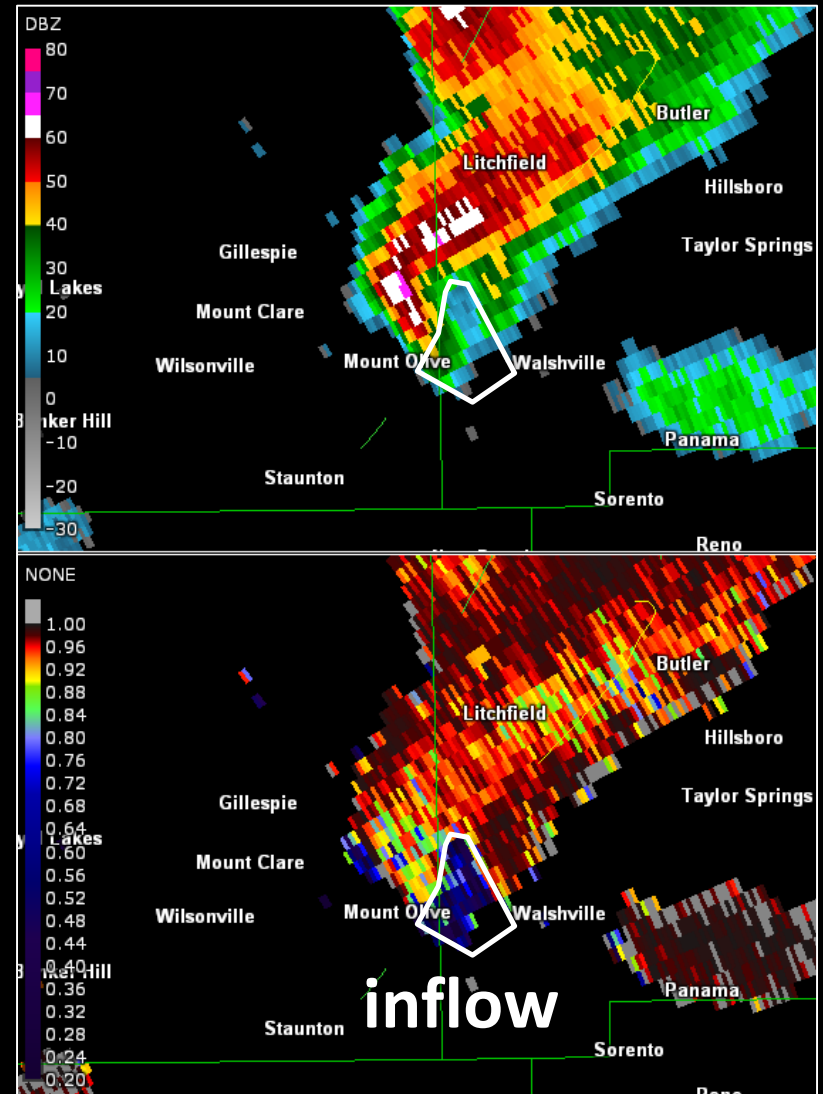


KLSX 2153z

Inflow examples from 12/1/2018



KLSX 2153z



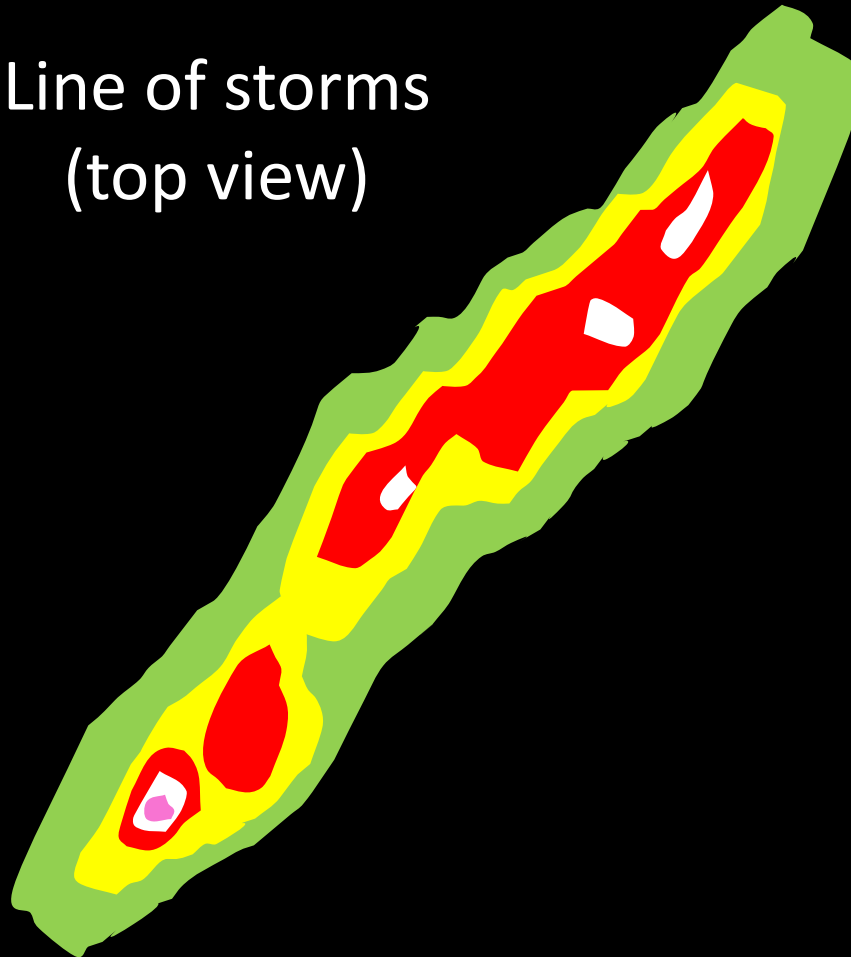
KLSX 2210z

TDS vs. NBF

NBF

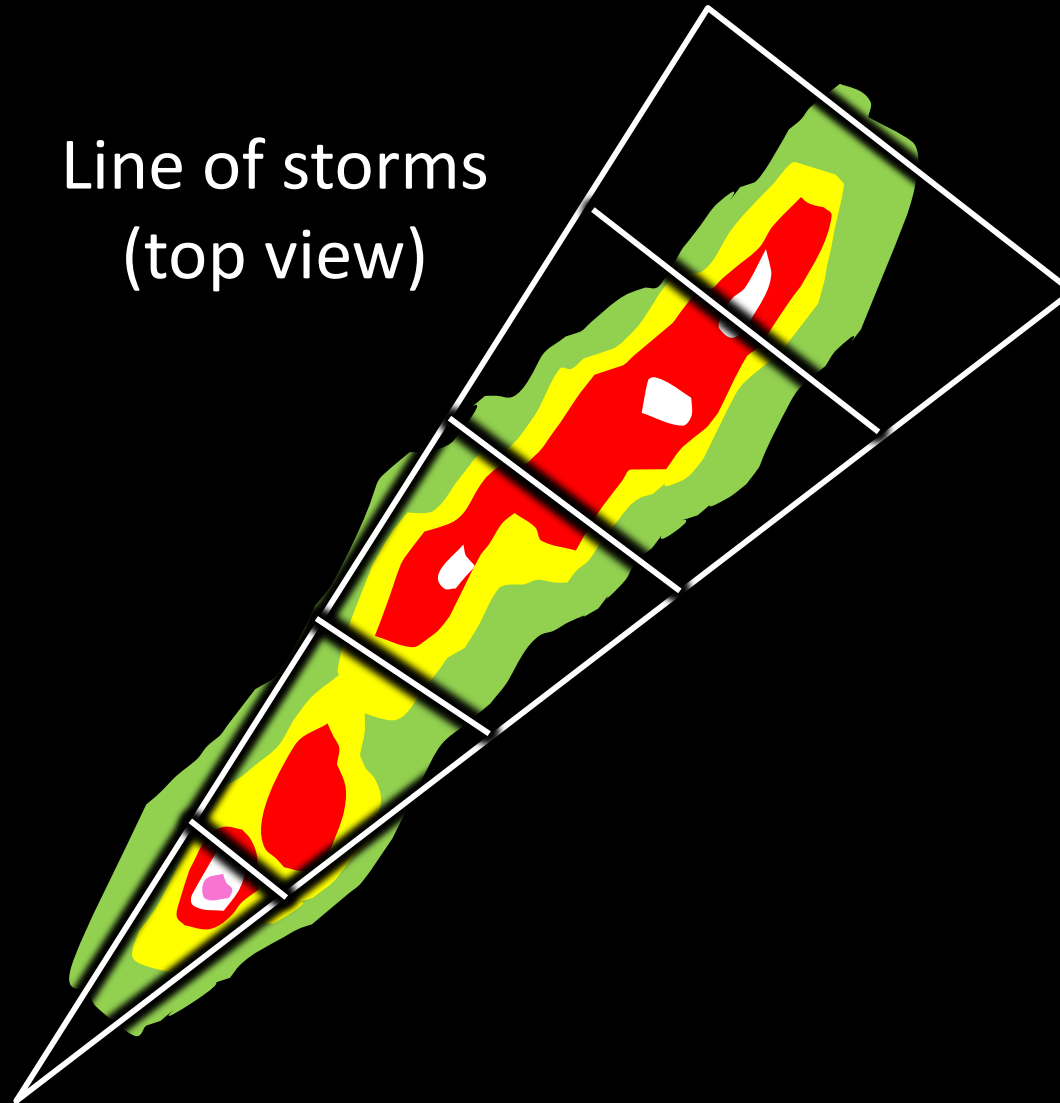
Strong reflectivity gradients within the pulse volume

Line of storms
(top view)



NBF

Strong reflectivity gradients within the pulse volume



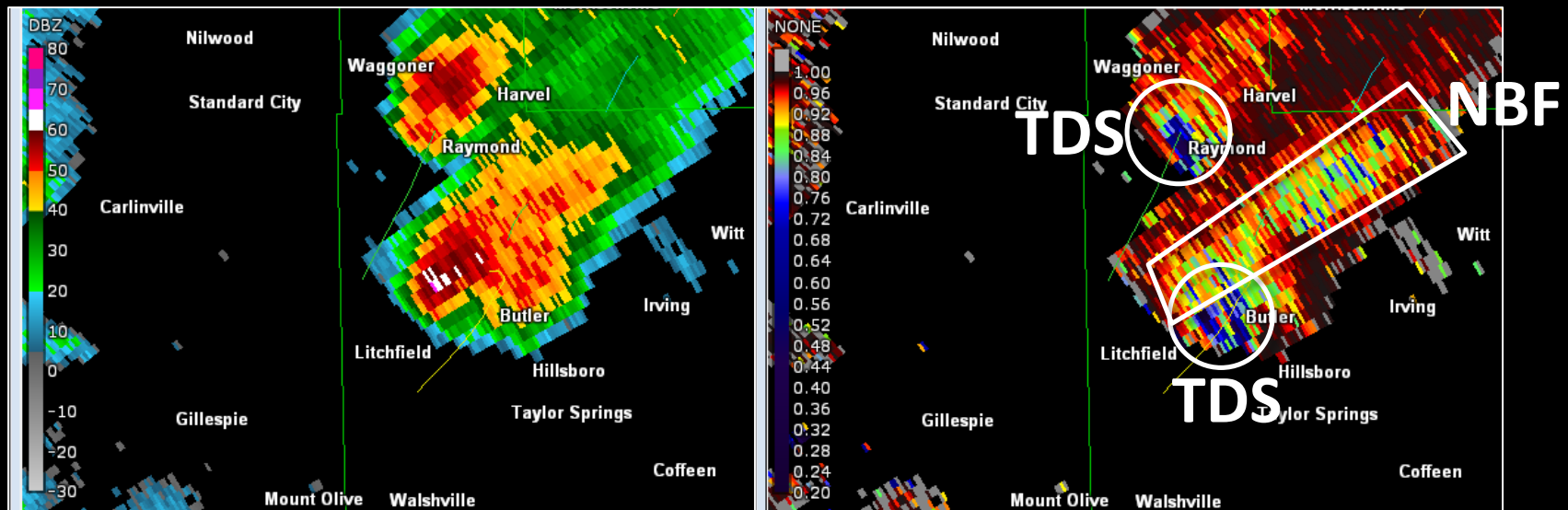
CC characteristics: TDS vs. NBF

TDS

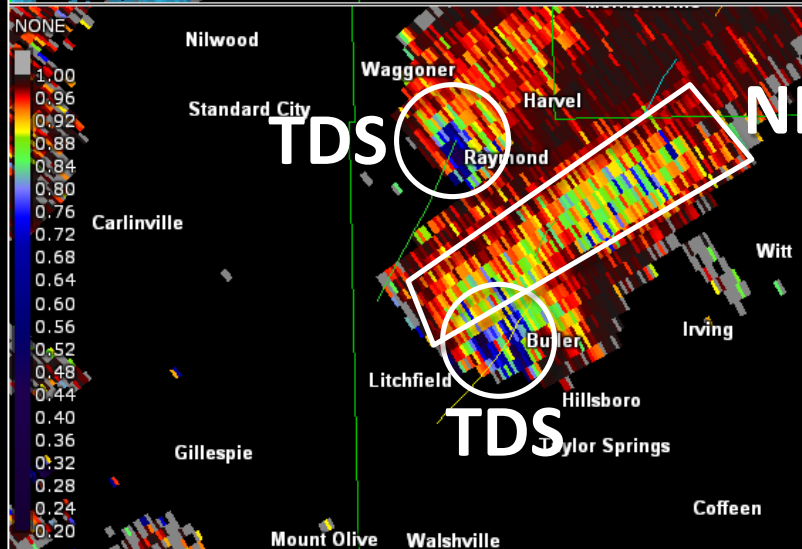
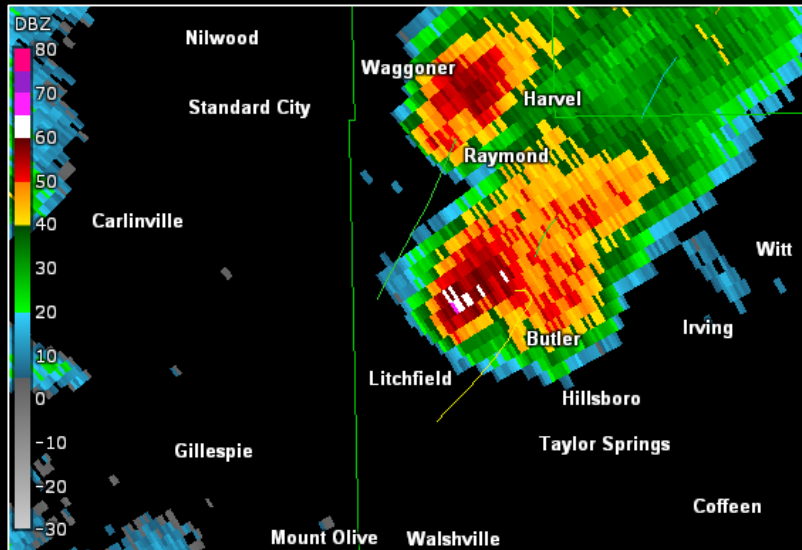
- Compact
- Vaguely circular
- Moves with the storm
- Same location on different radars

NBF

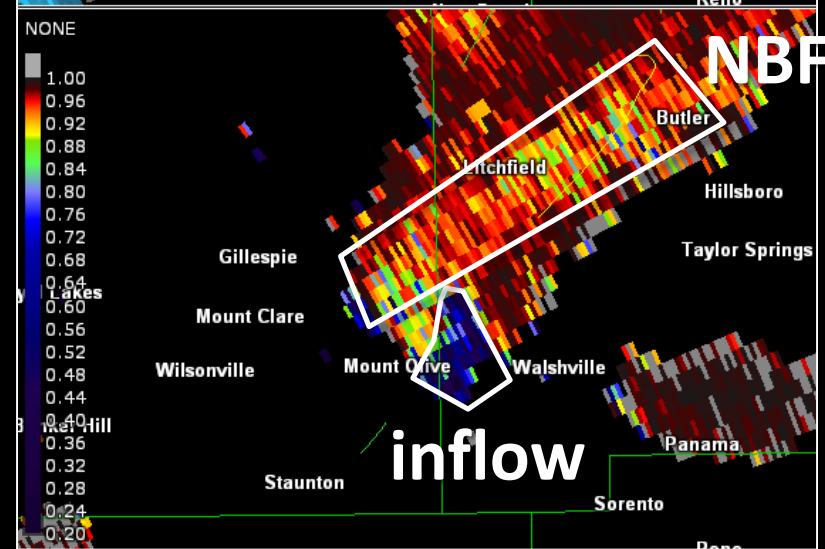
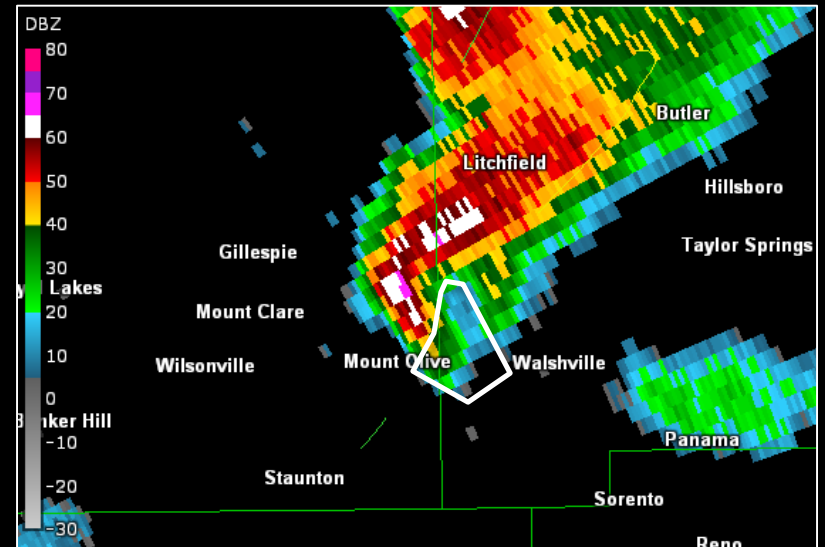
- Much longer than it is wide
- Down-radial “streaks”
- Appears locked in place
- Inconsistent between radars (depends on viewing angle)



NBF examples from 12/1/2018



KLSX 2227z



KLSX 2210z

TDS vs. TBSS

TBSS

Thunderstorm

Hail



Radar



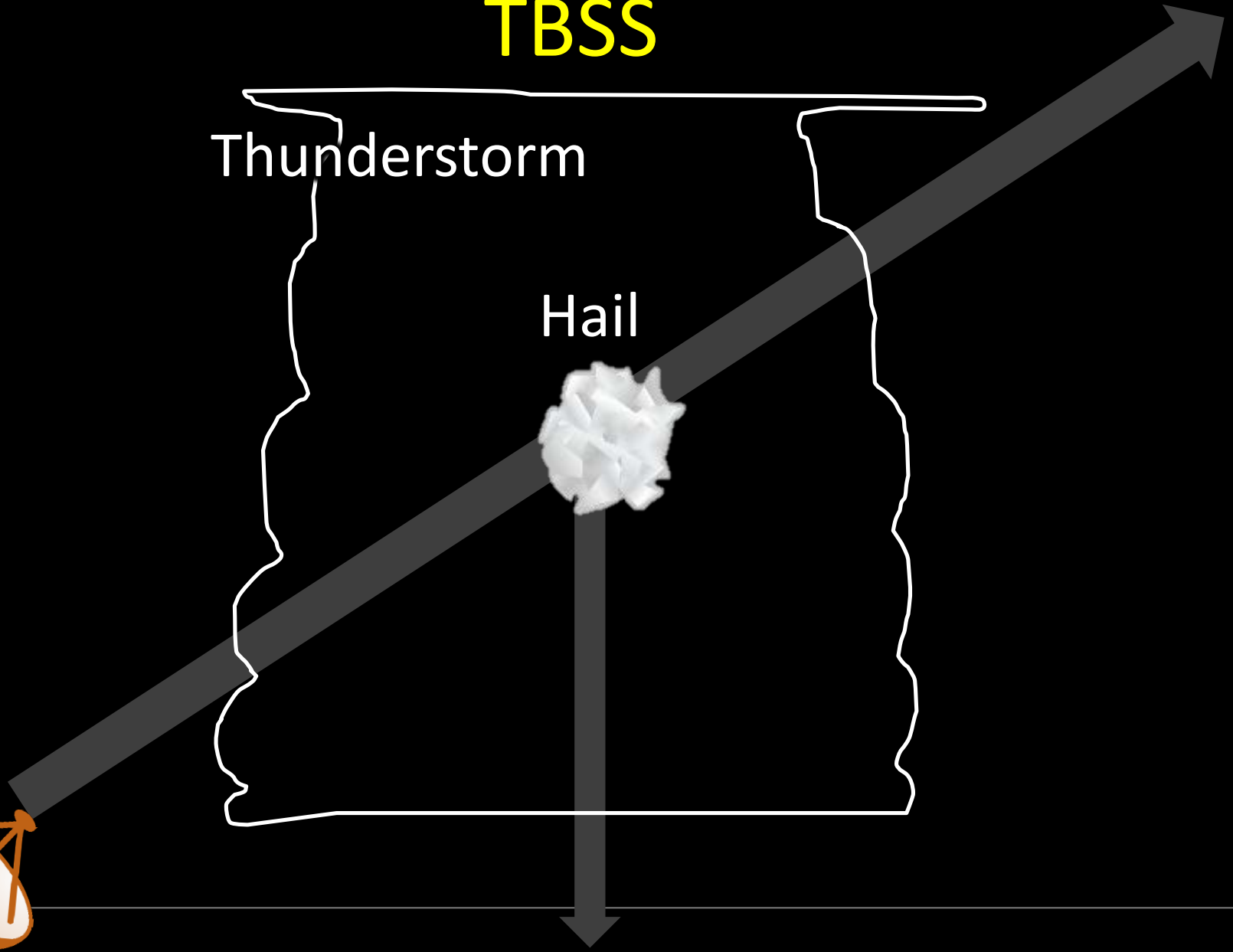
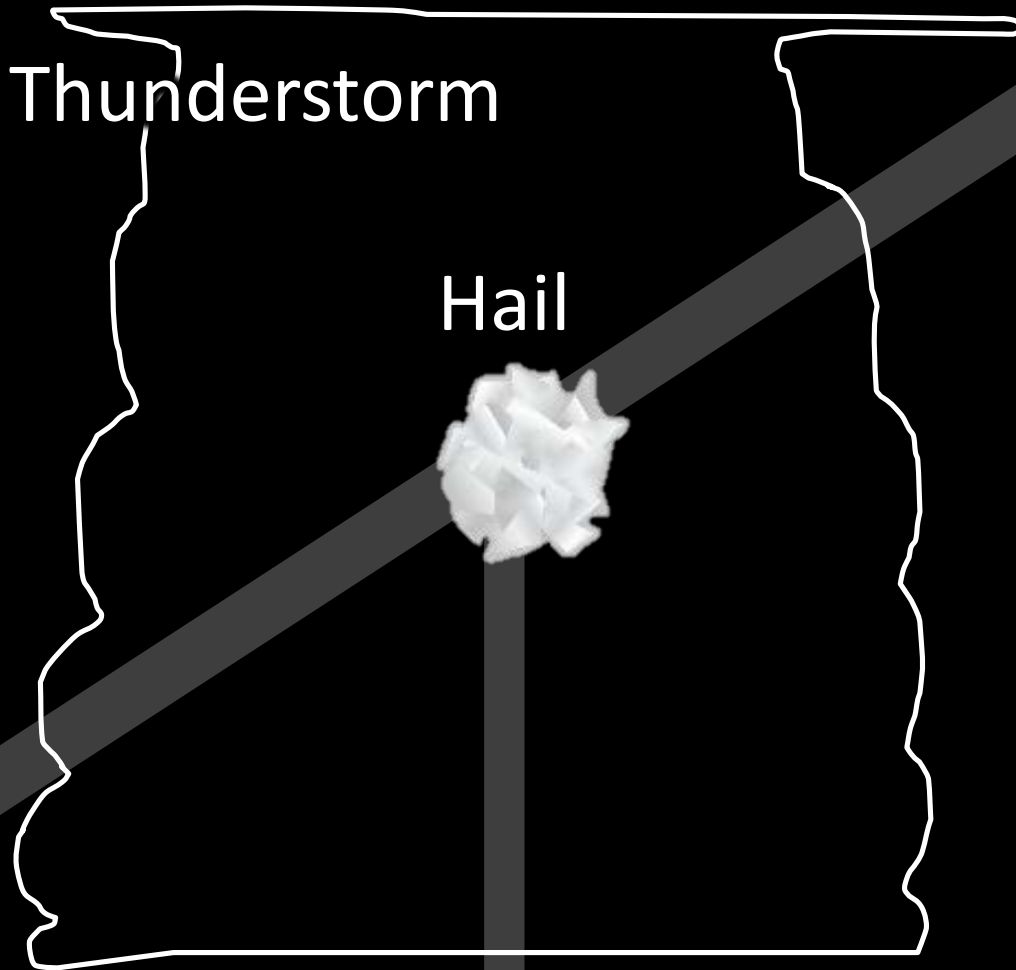
TBSS

Thunderstorm

Hail



Radar



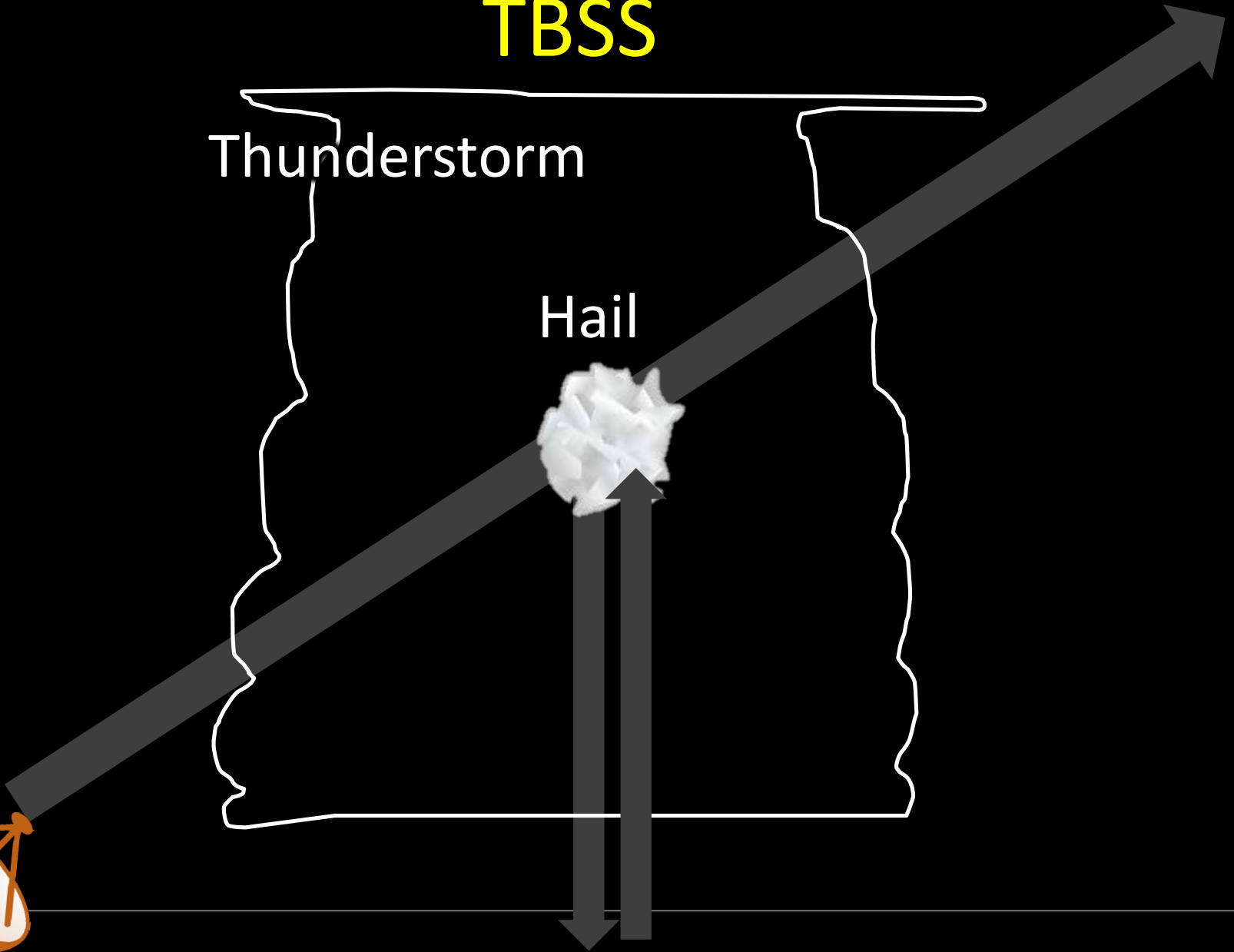
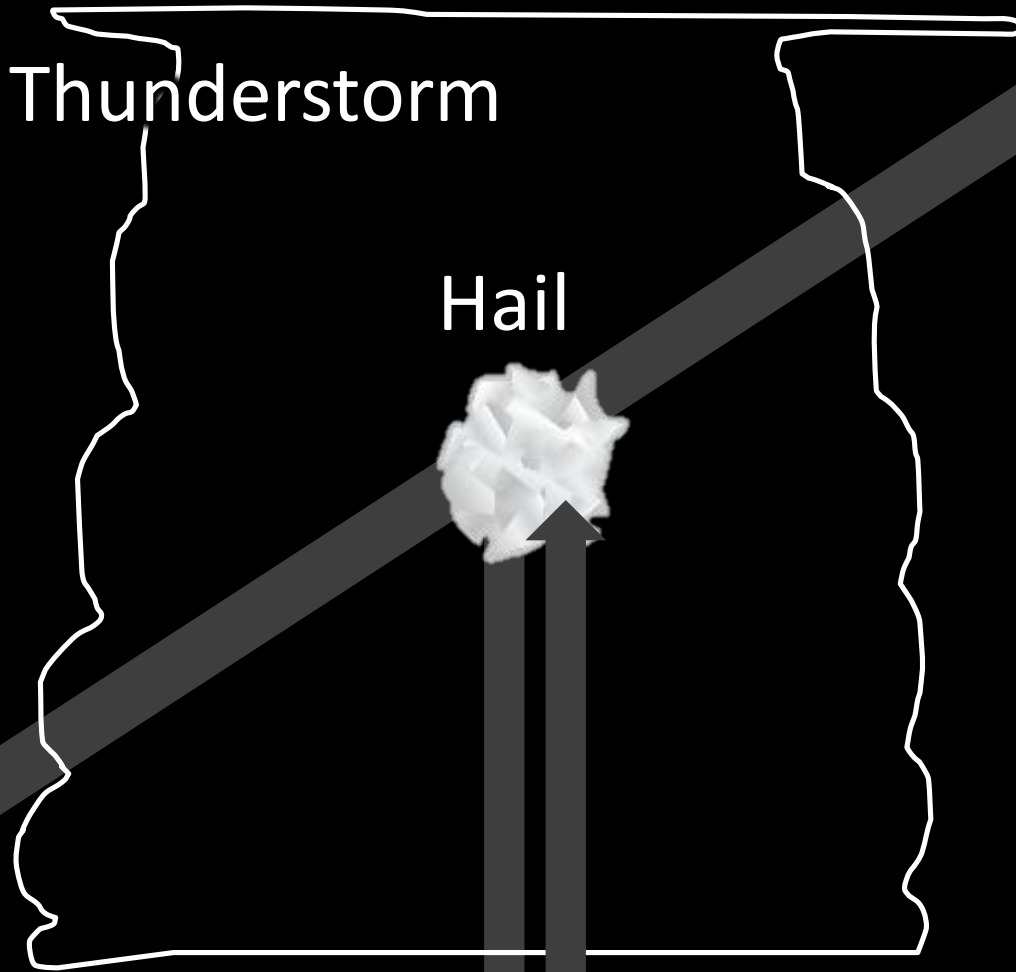
TBSS

Thunderstorm

Hail



Radar



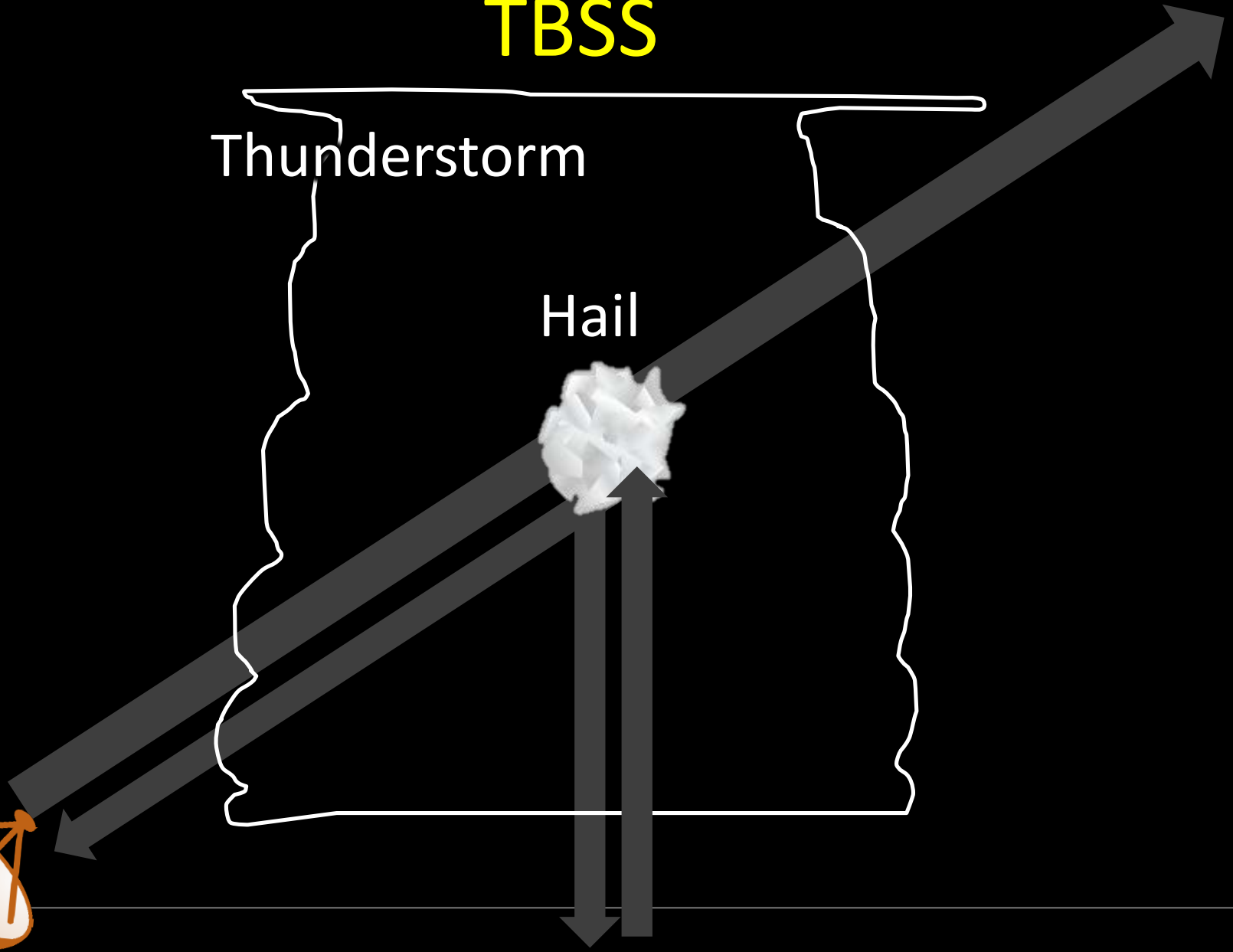
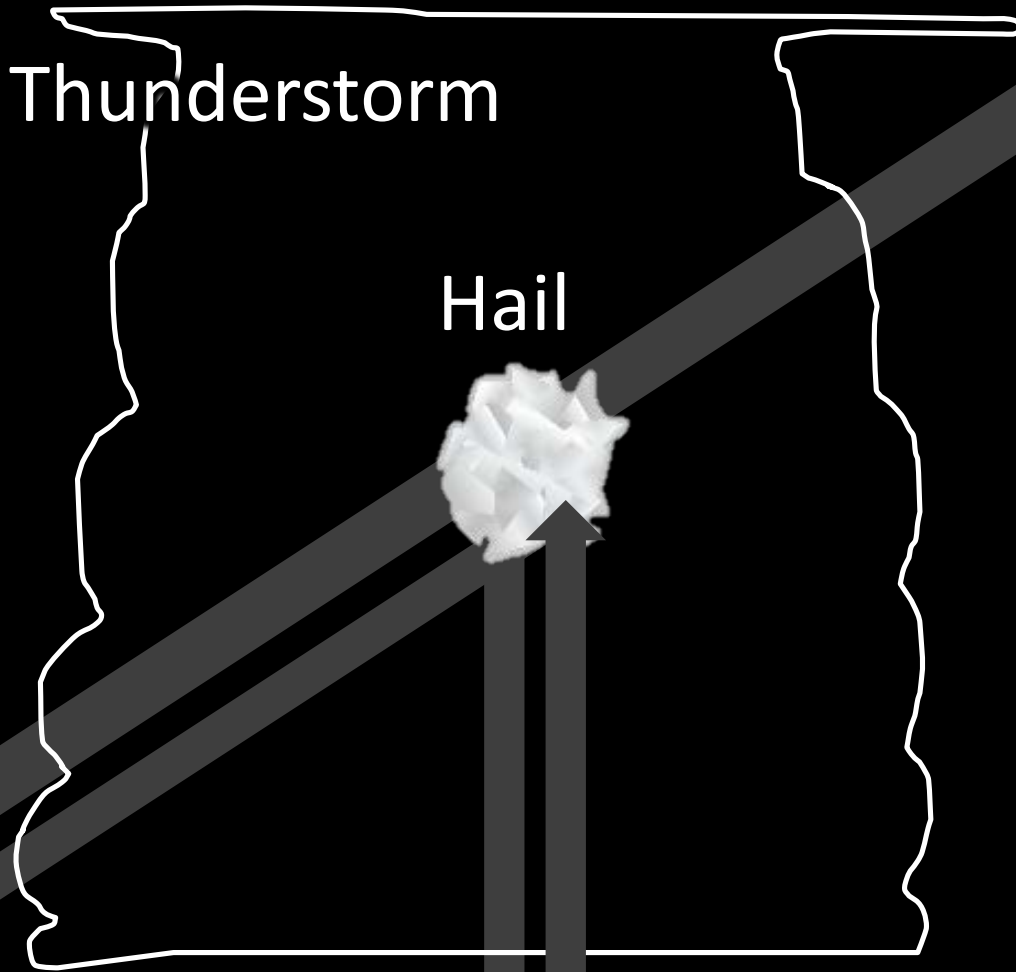
TBSS

Thunderstorm

Hail



Radar



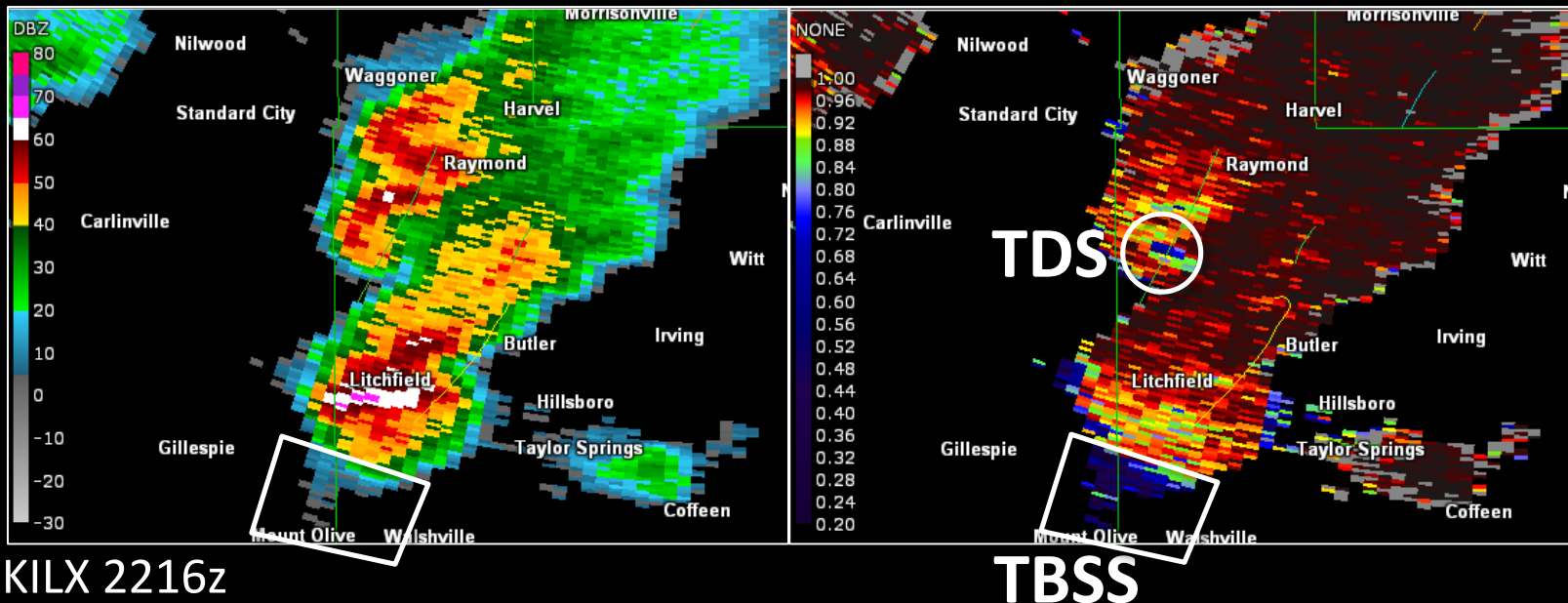
CC characteristics: TDS vs. TBSS

TDS

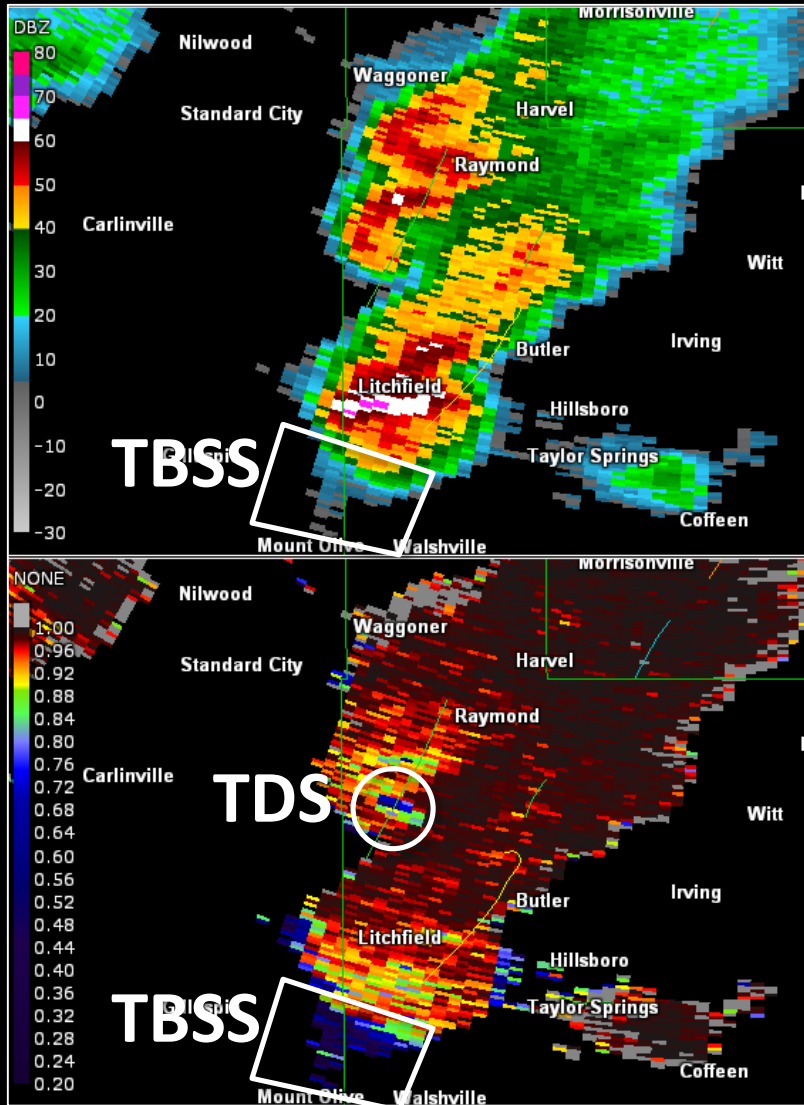
- Low CC + high Z
- Self-contained CC dropout or “hole”
- Lowest CC values are contained within the storm

TBSS

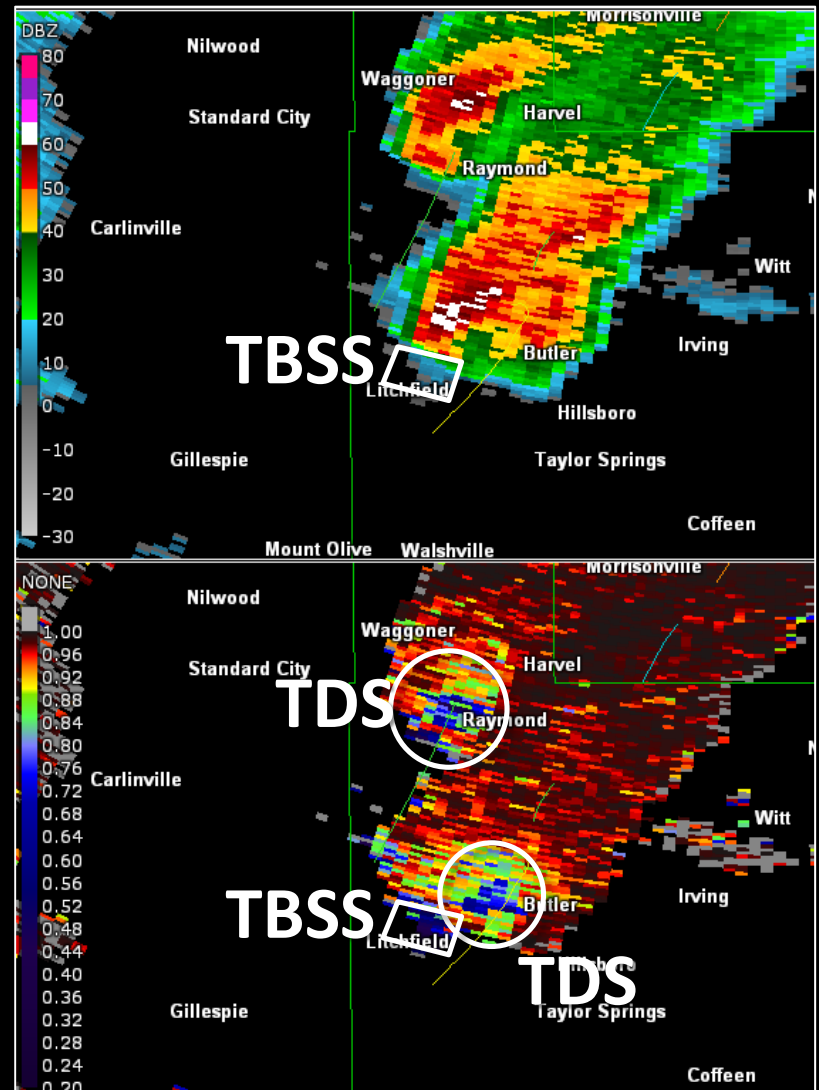
- Low CC downradial of high Z
- Downradial “smear” or “shadow”
- Lowest CC values are outside of the storm



TBSS examples from 12/1/2018



KILX 2216z

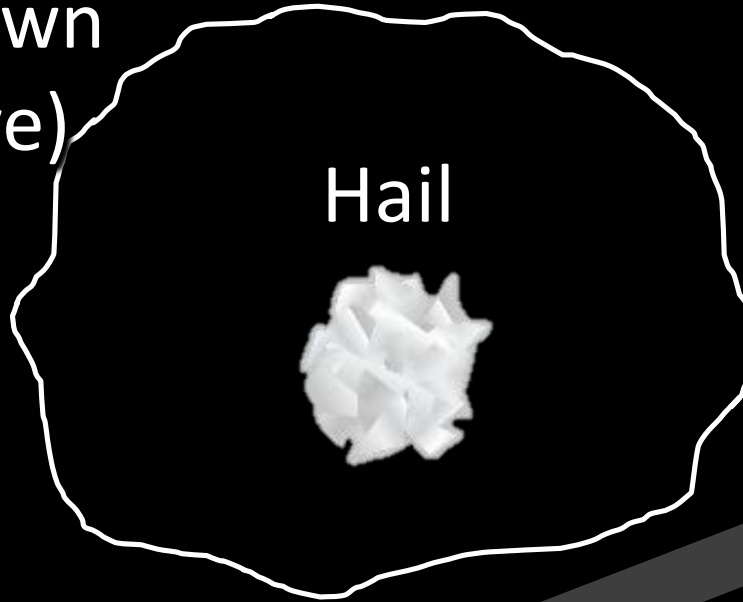


KILX 2226z

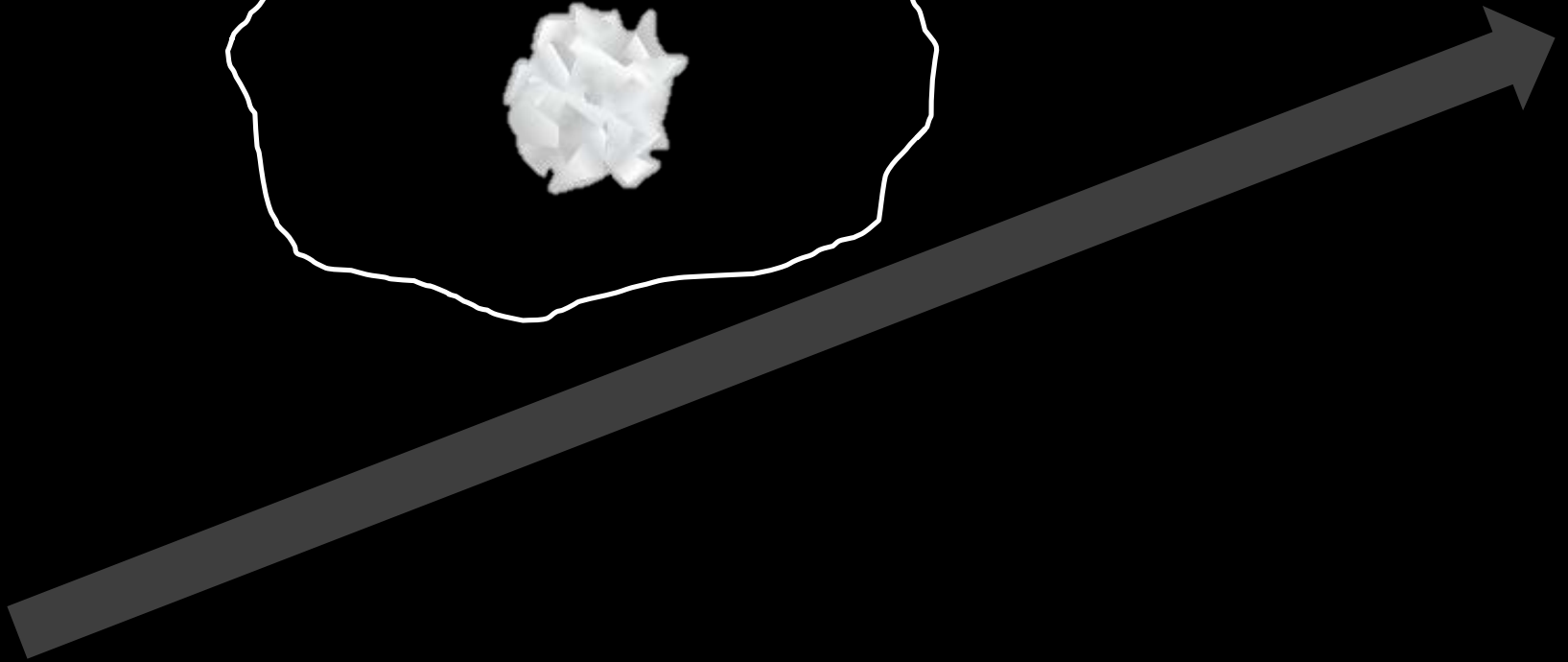
TDS vs. side lobe

TDS vs. side lobe

Thunderstorm
(looking down
from above)



Radar

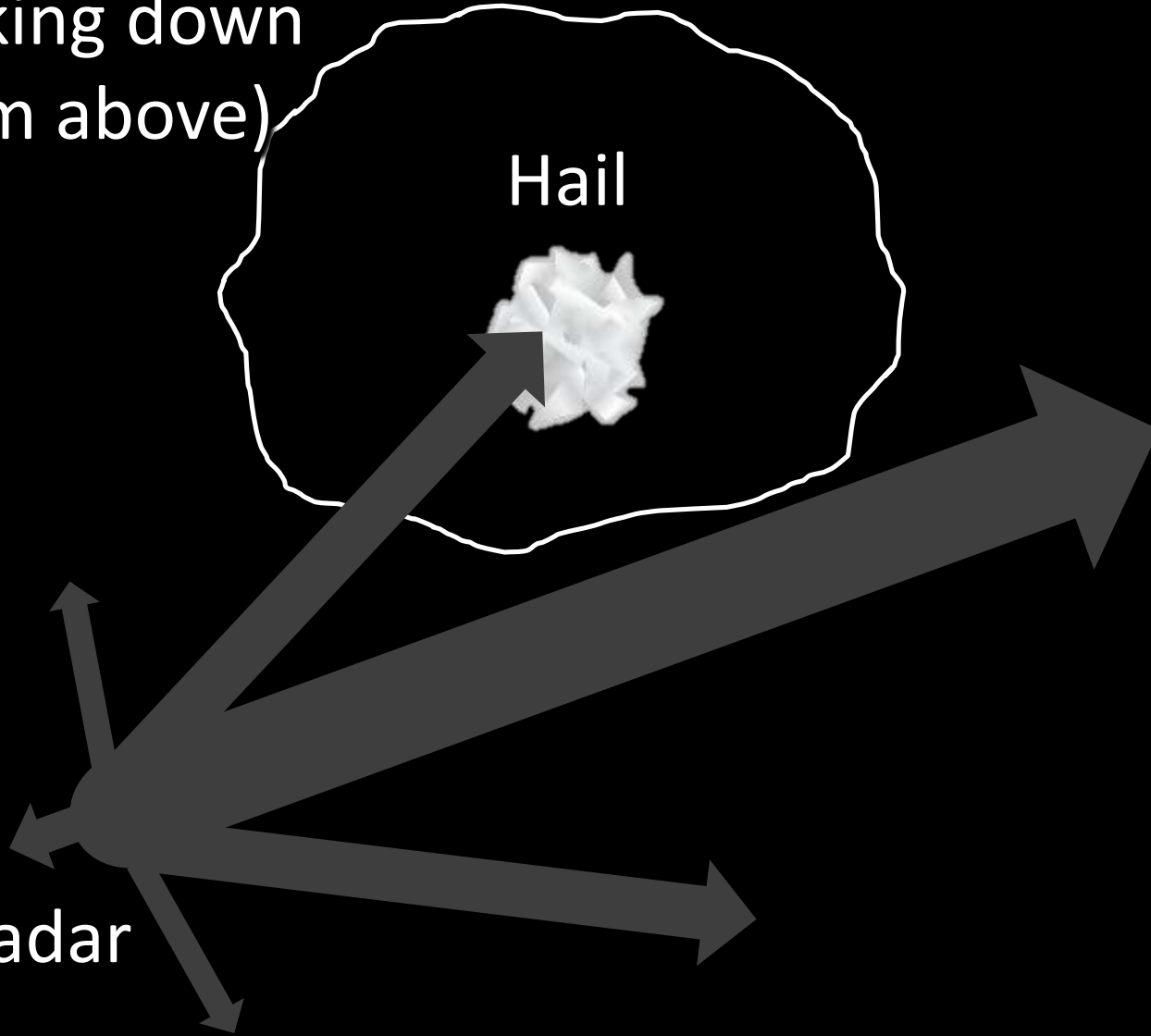


TDS vs. side lobe

Thunderstorm
(looking down
from above)

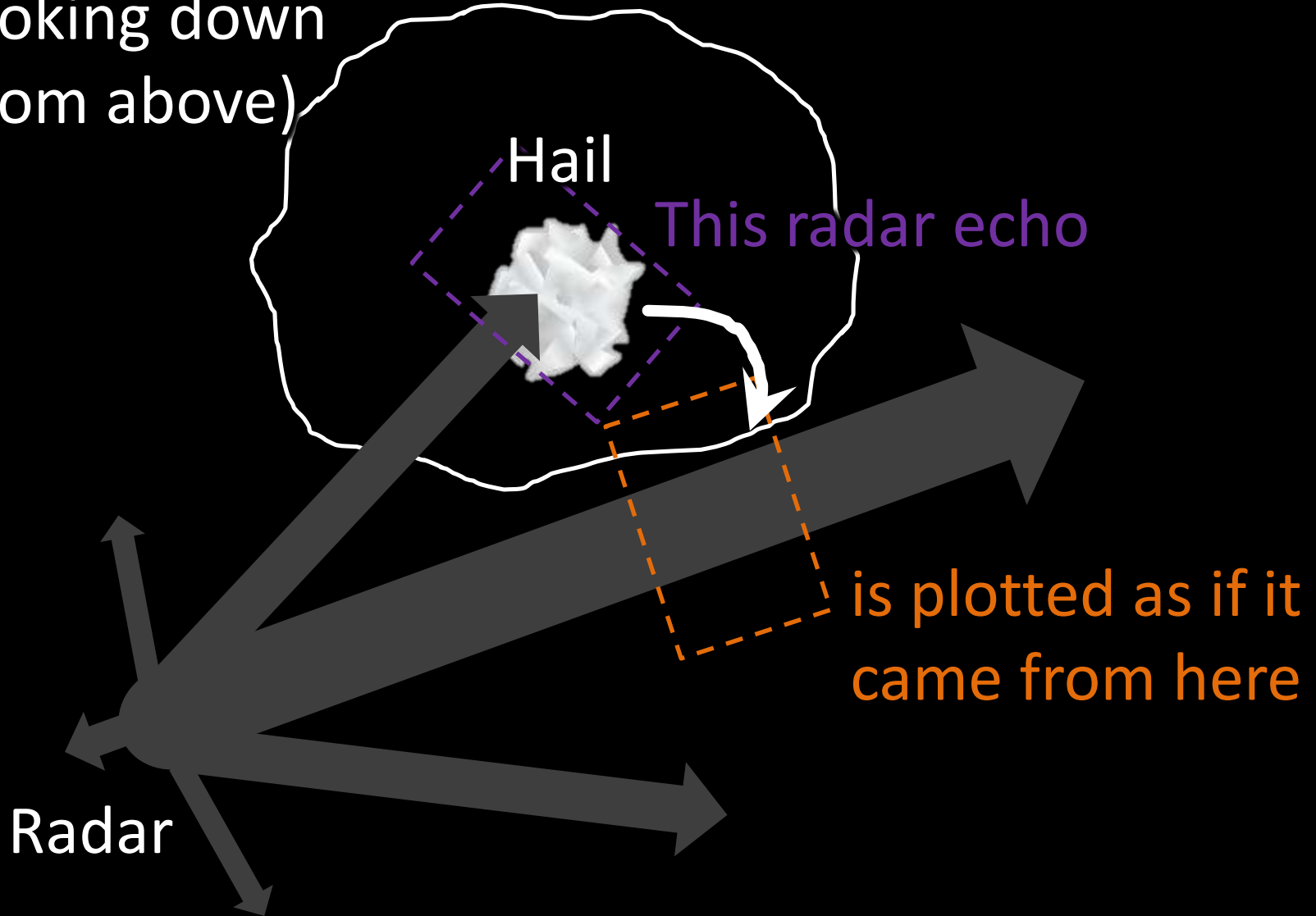
Hail

Radar



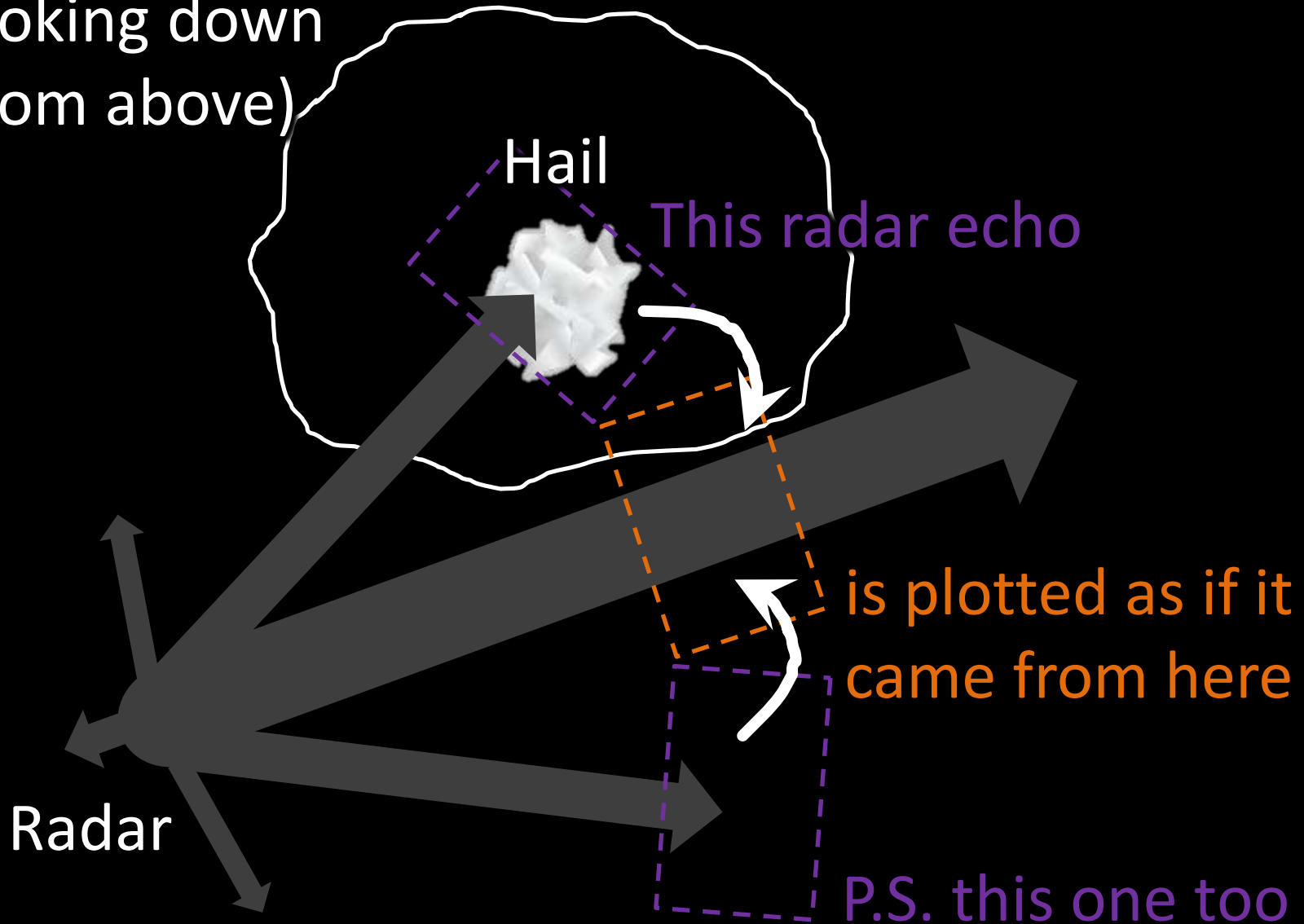
TDS vs. side lobe

Thunderstorm
(looking down
from above)



TDS vs. side lobe

Thunderstorm
(looking down
from above)



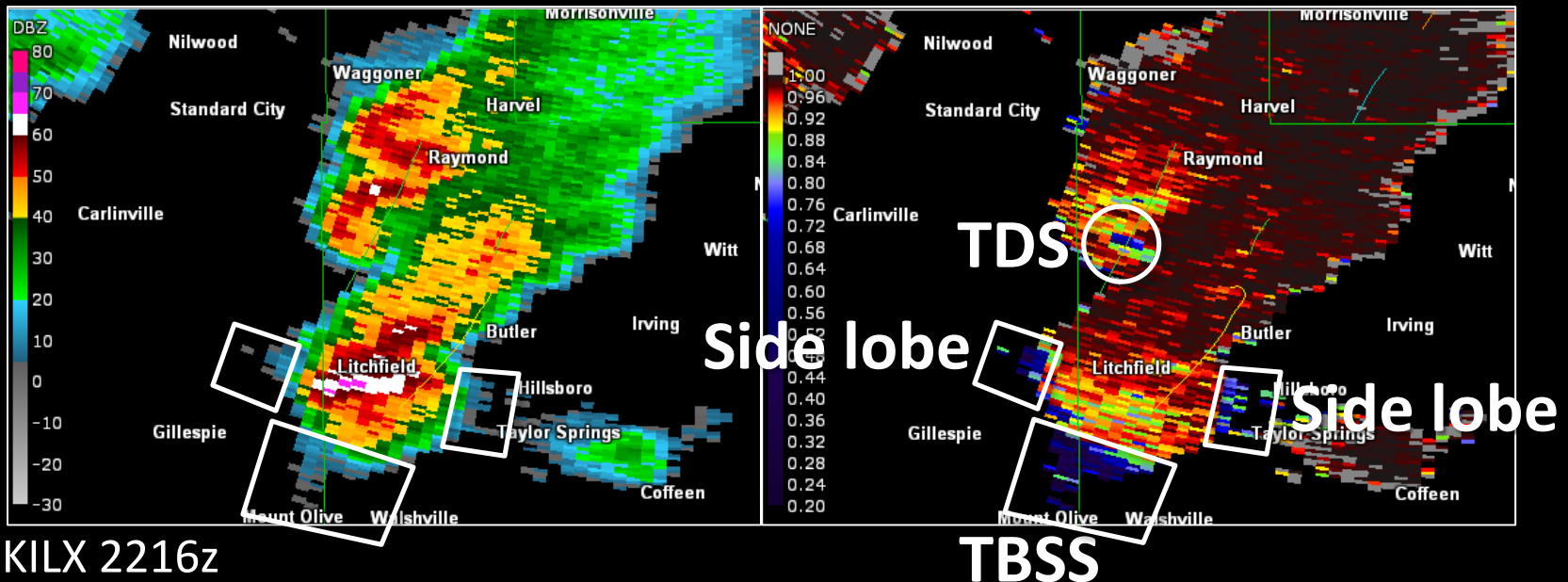
CC characteristics: TDS vs. side lobe

TDS

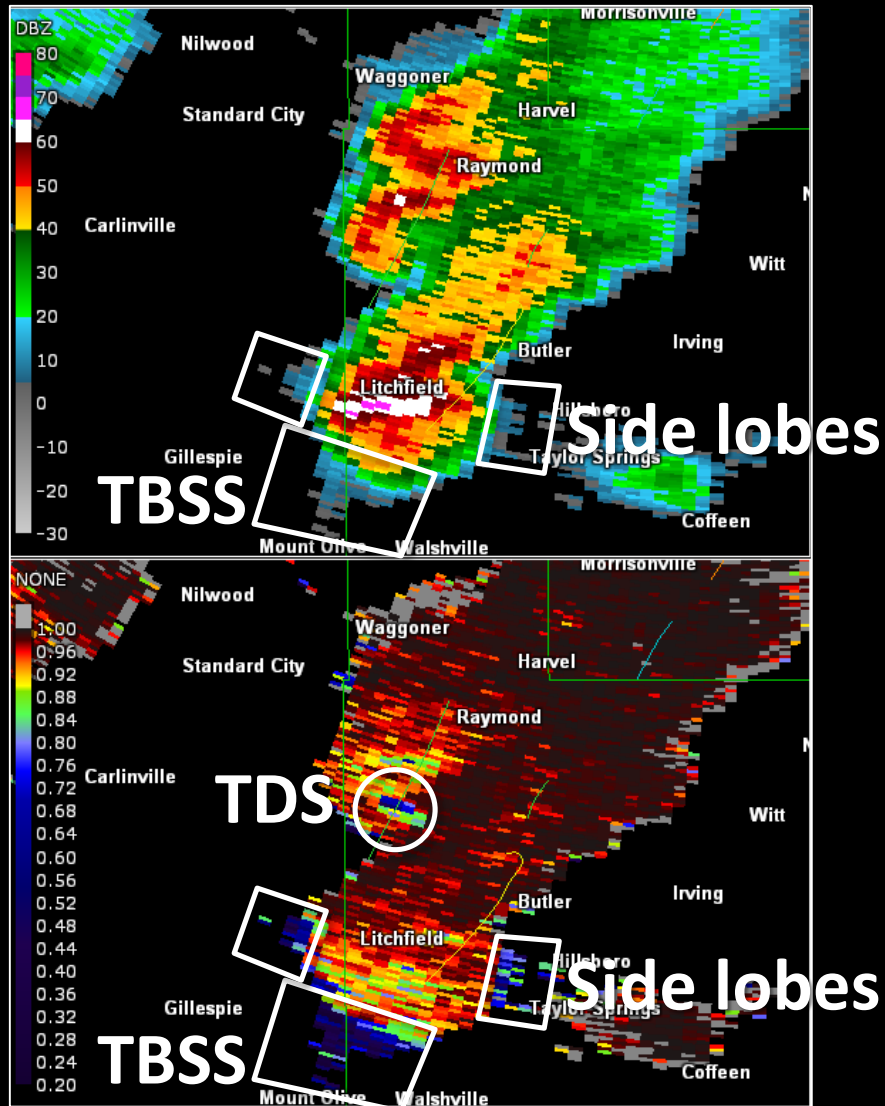
- Low CC + high Z
- Self-contained CC dropout or “hole”
- Lowest CC values are contained within the storm

Side lobe

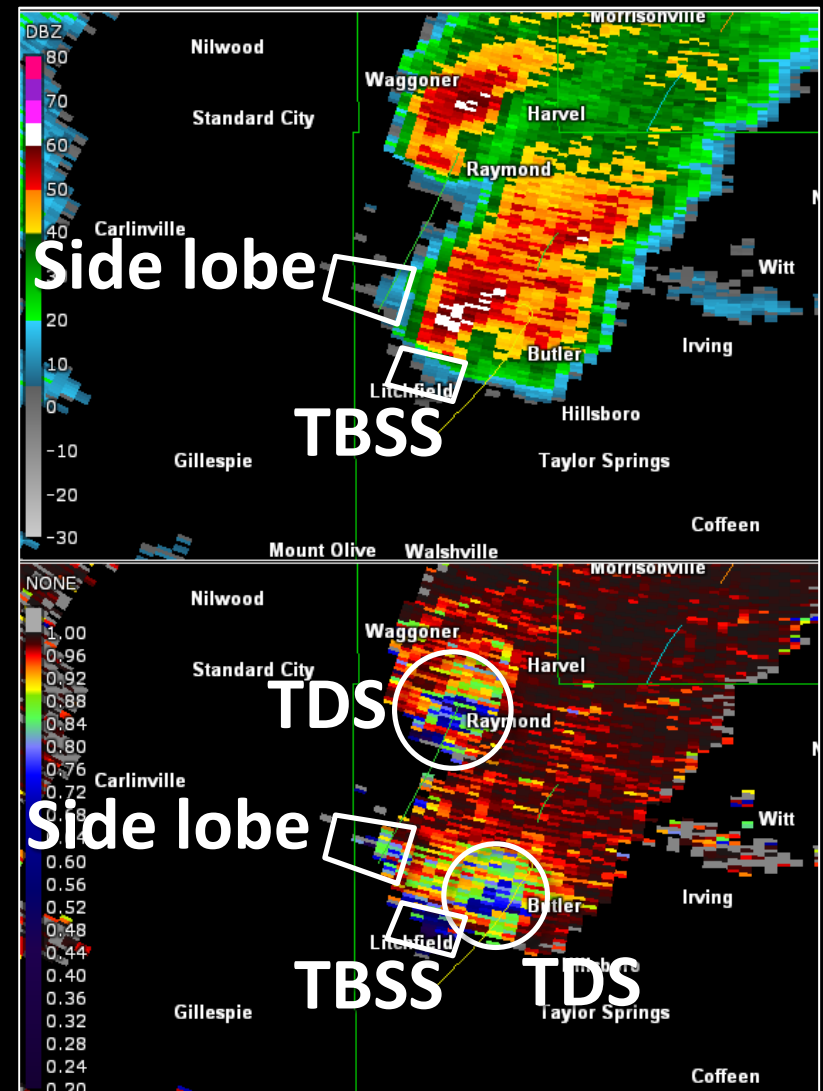
- Low CC brackets high Z
- Cross-radial “smearing” on the storm’s edges
- Lowest CC values are outside of the storm



Side lobe examples from 12/1/2018



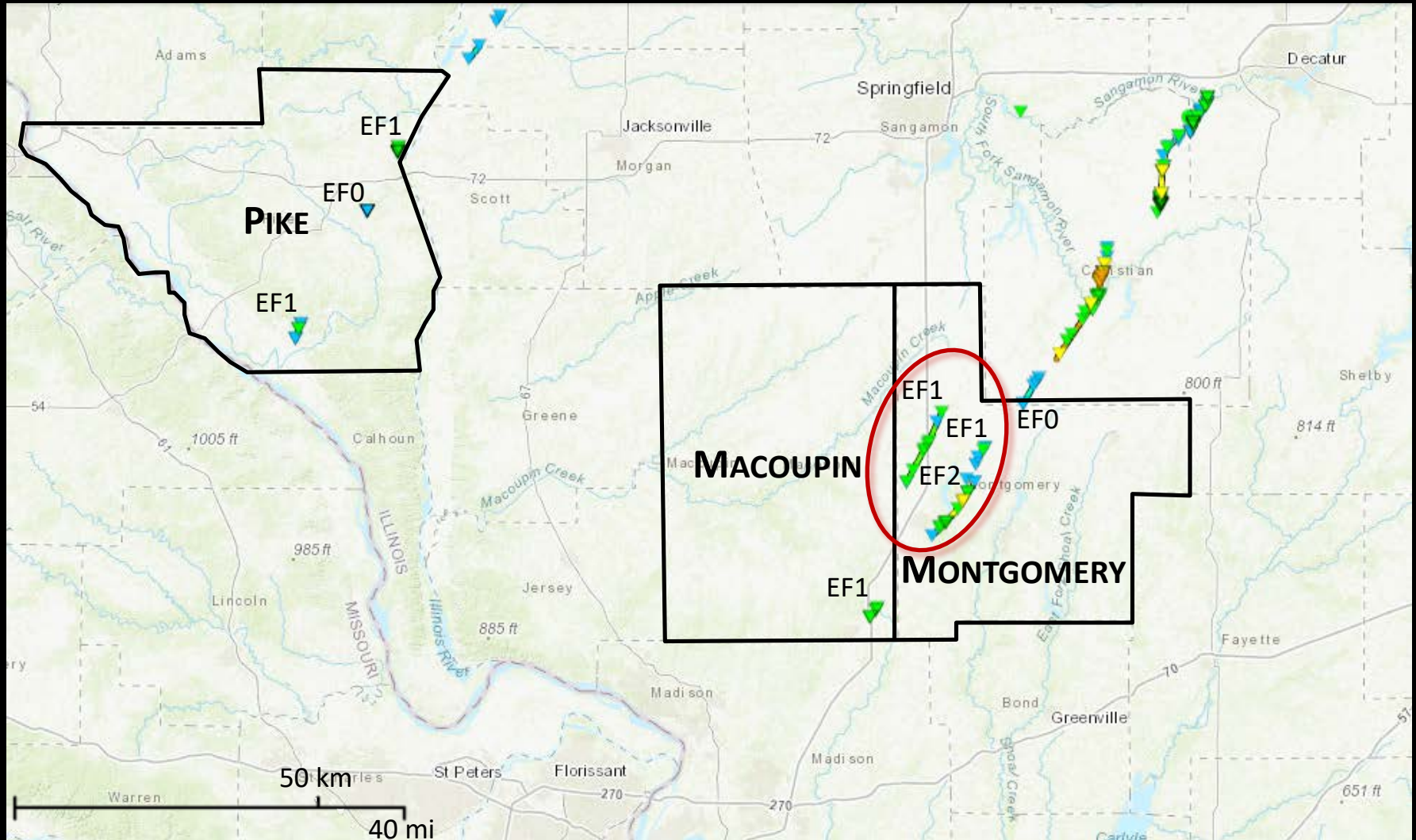
KILX 2216z



KILX 2226z

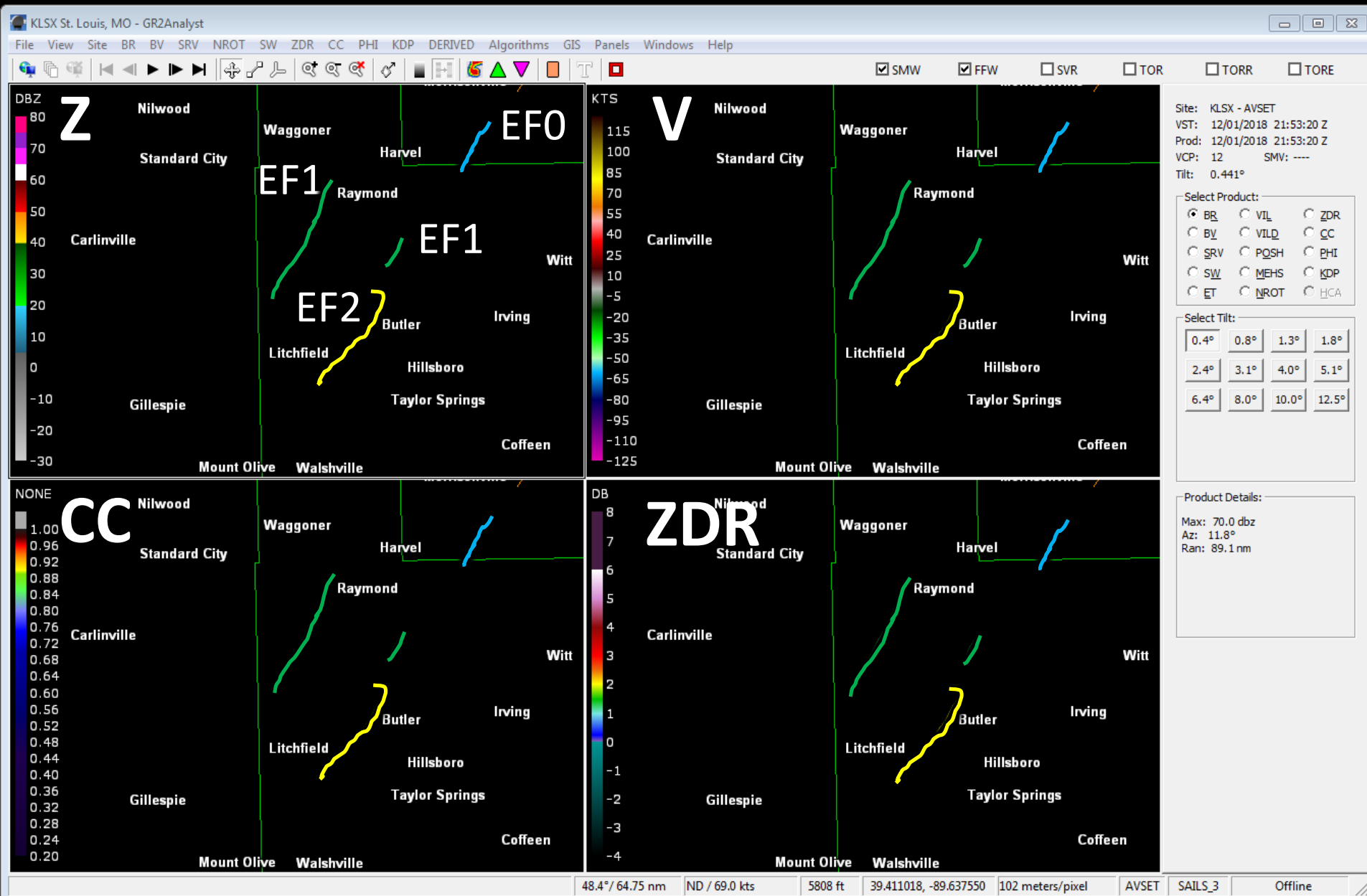
Radar data from 12/1/2018

Montgomery County, IL

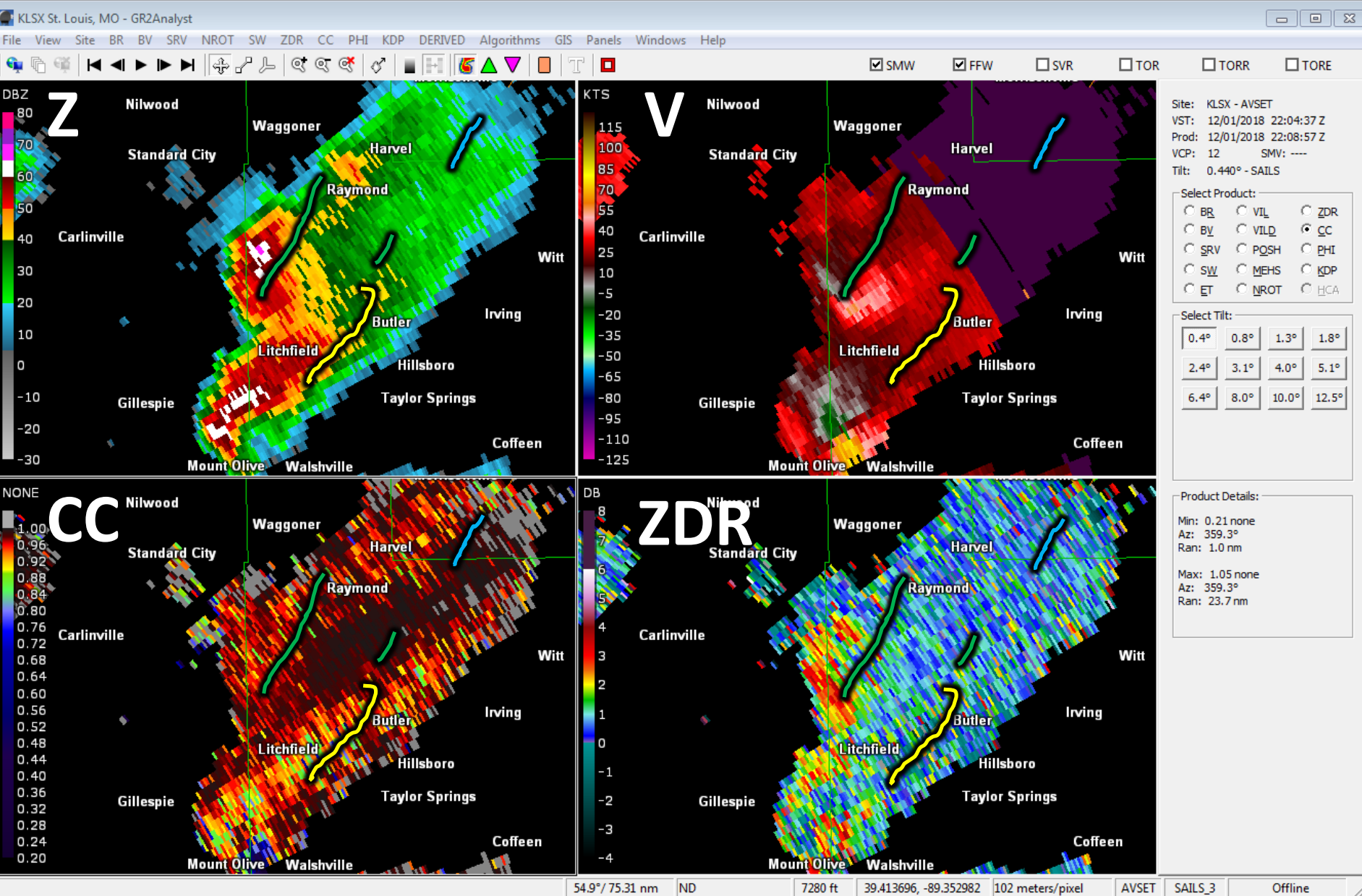


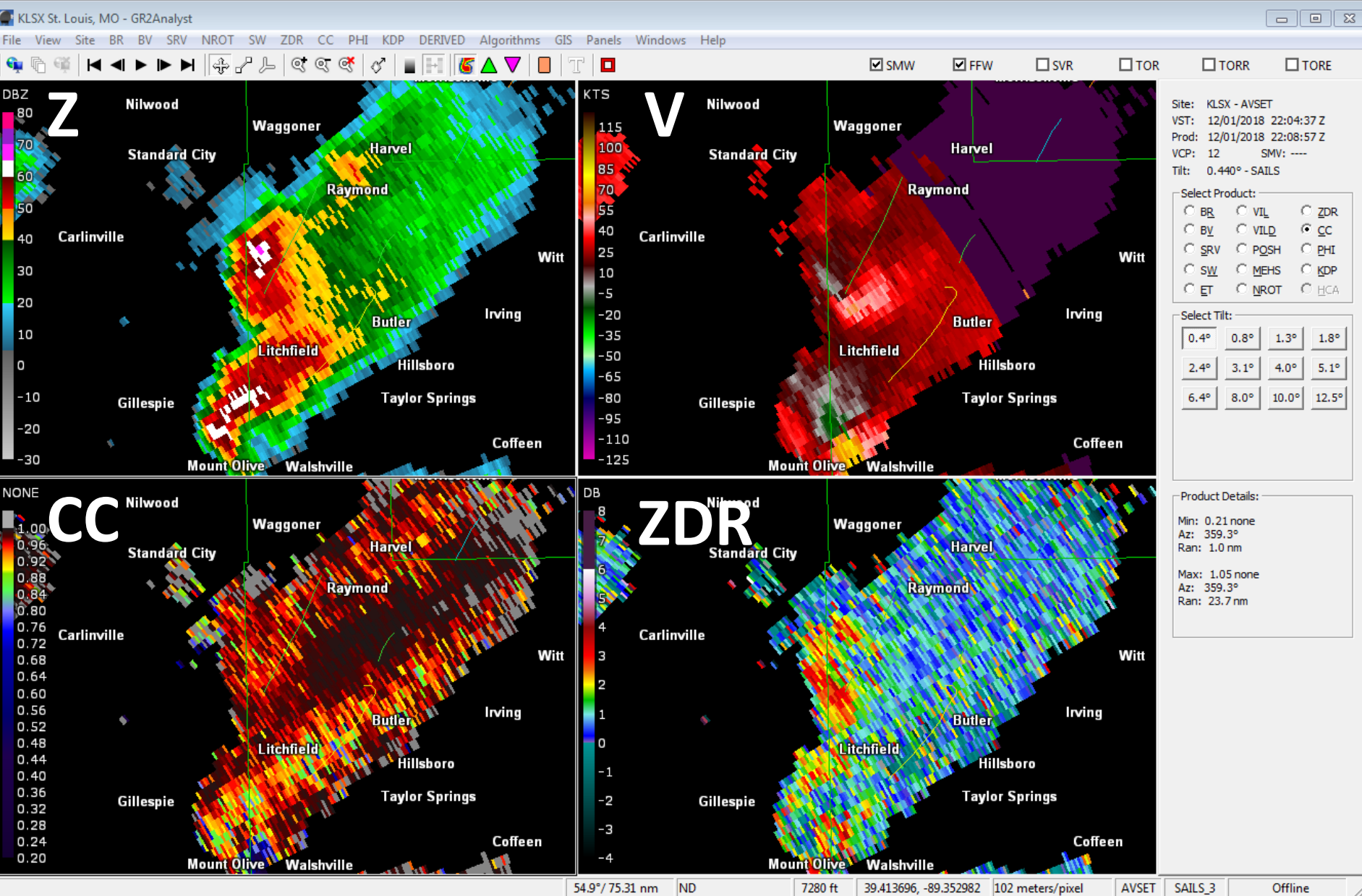
01 Dec 2018
KLSX

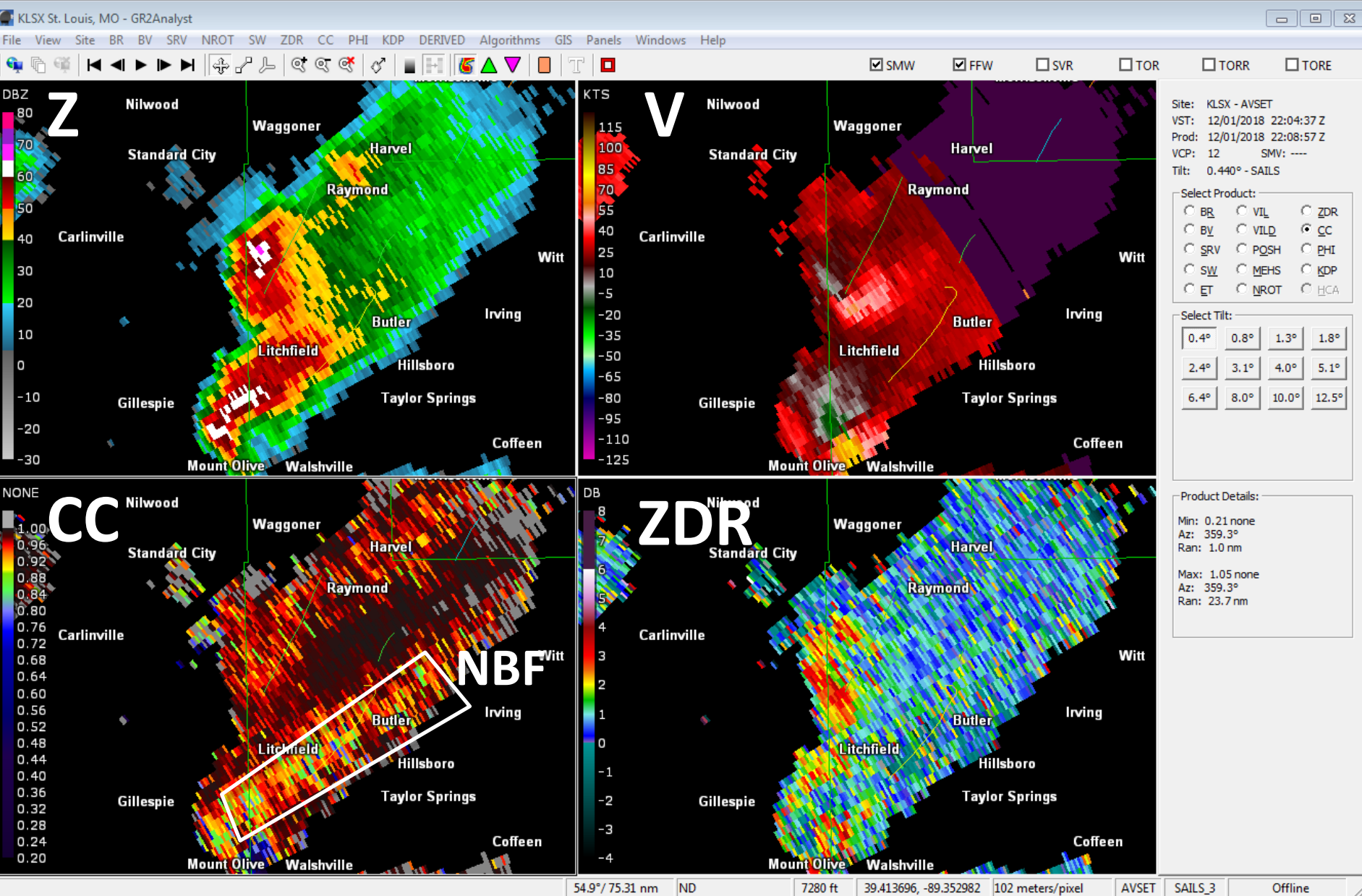
Surveyed tornado paths shown in GR2

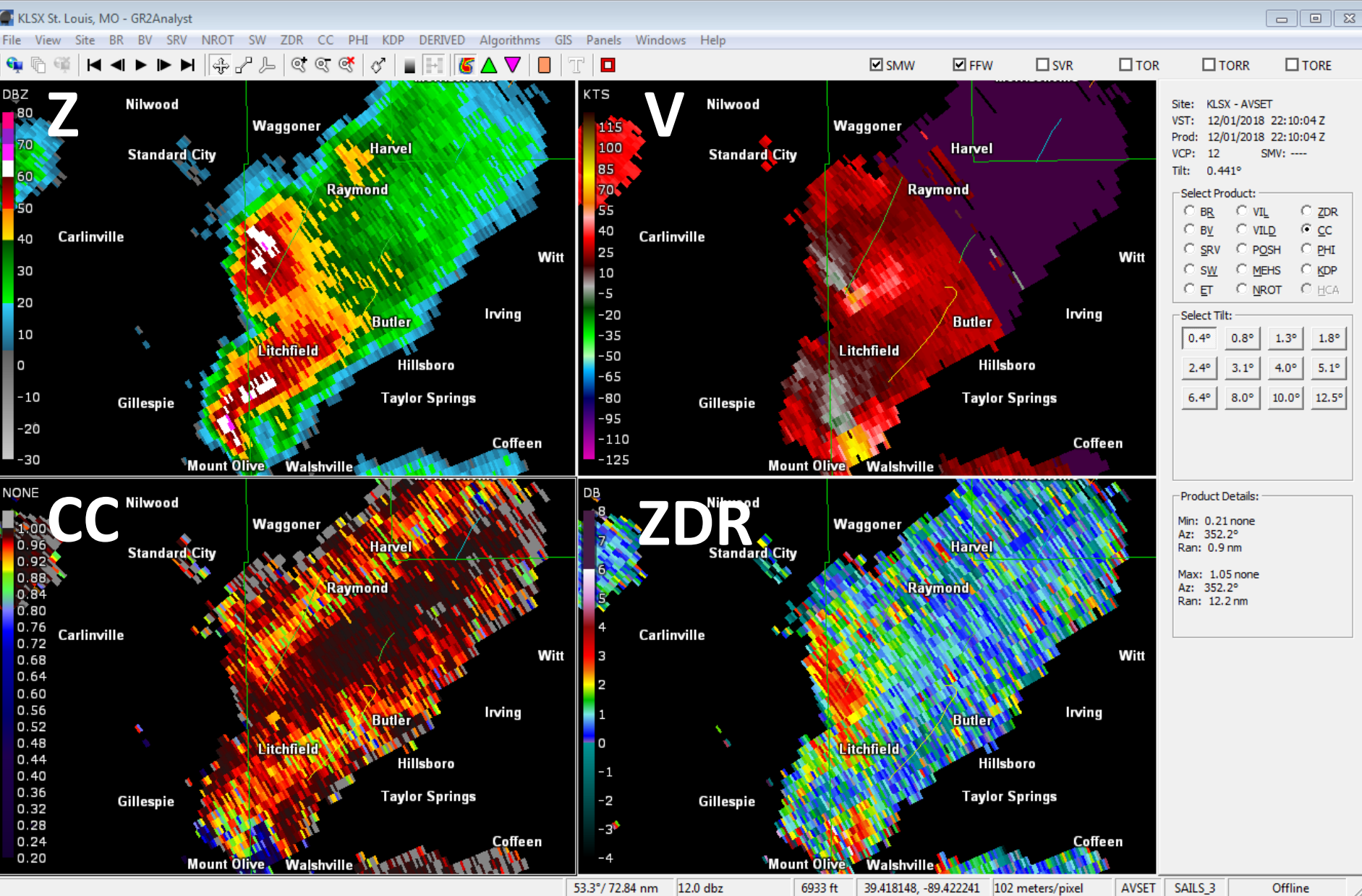


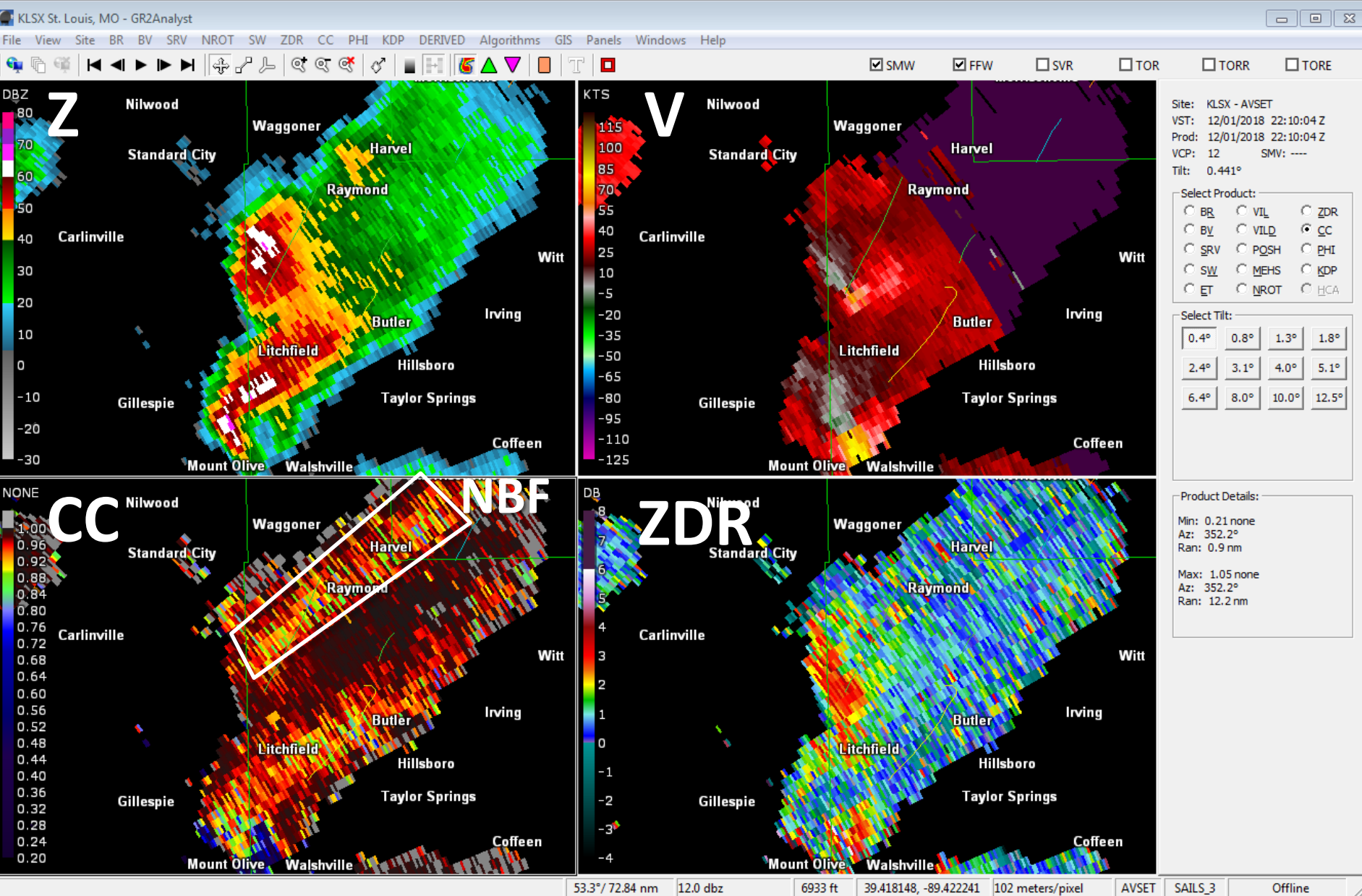
KLSX

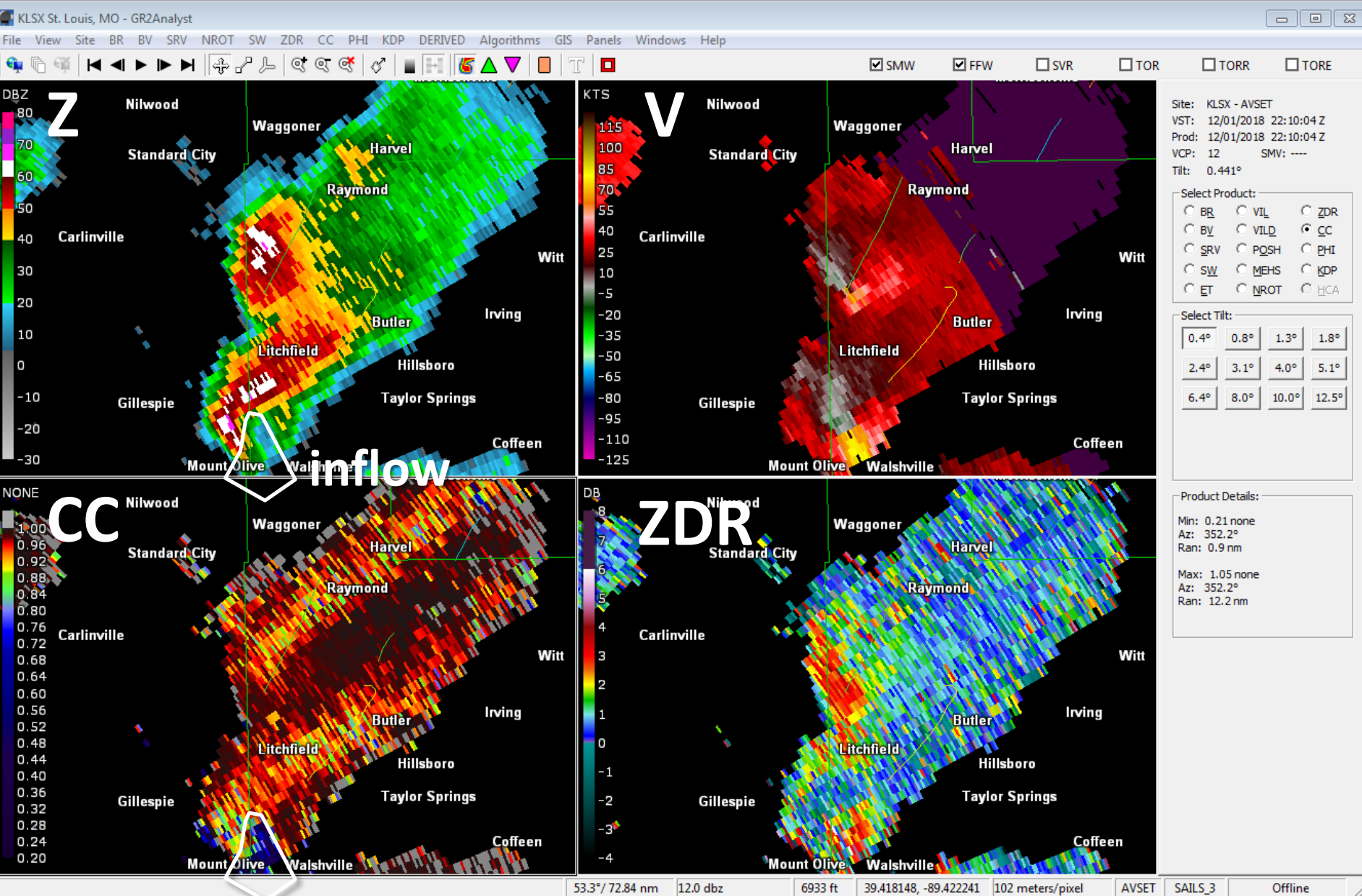




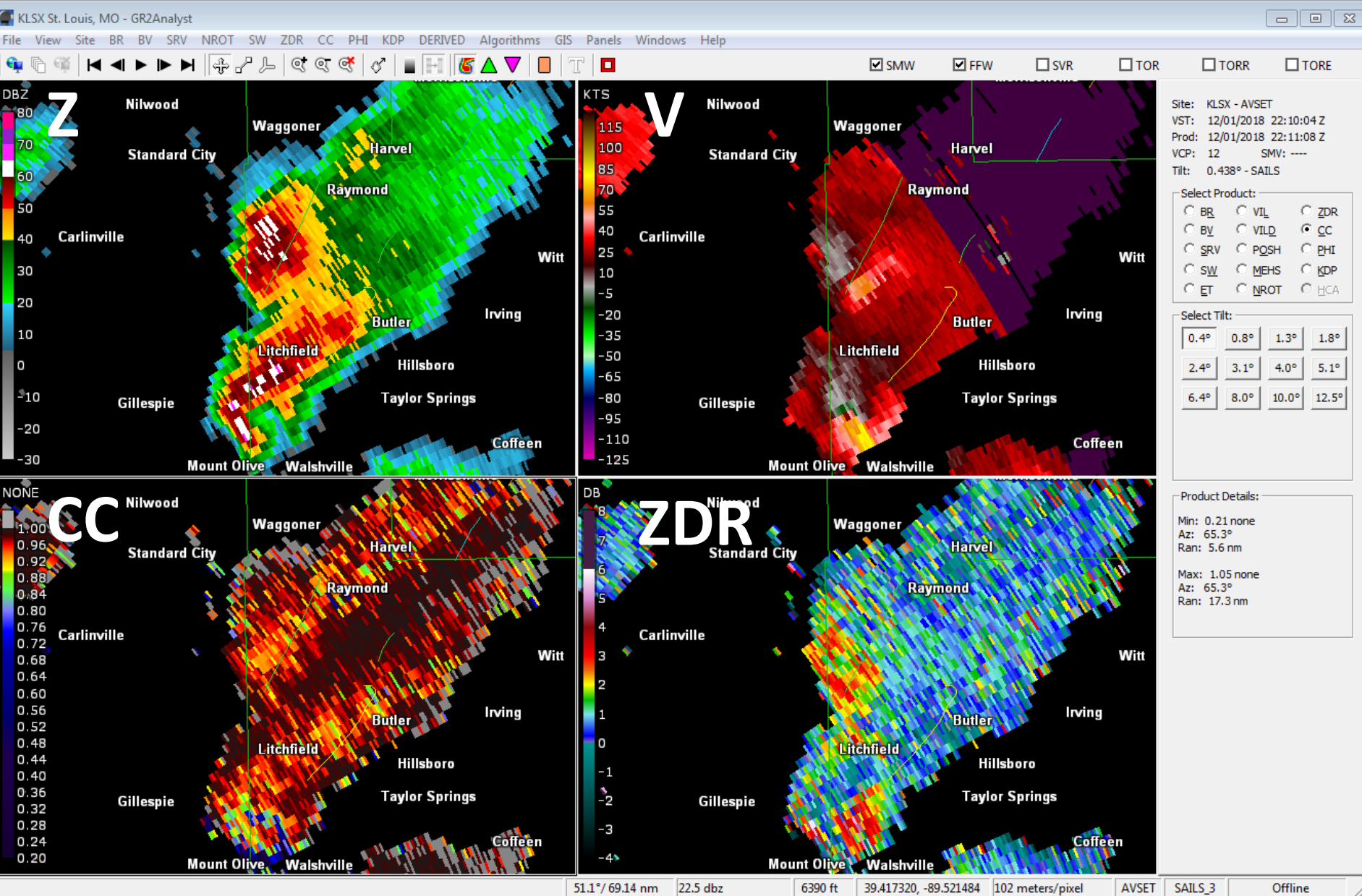


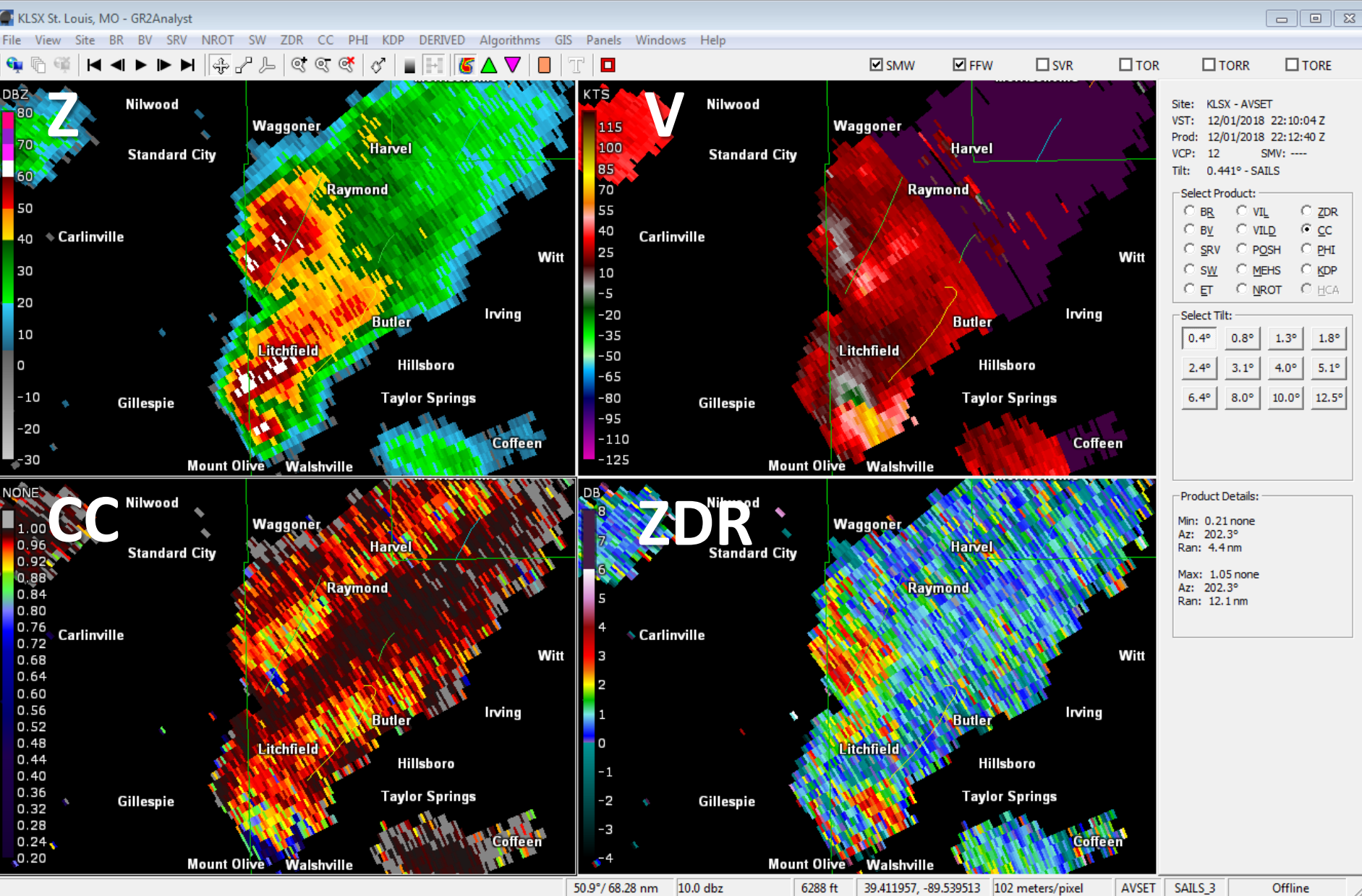


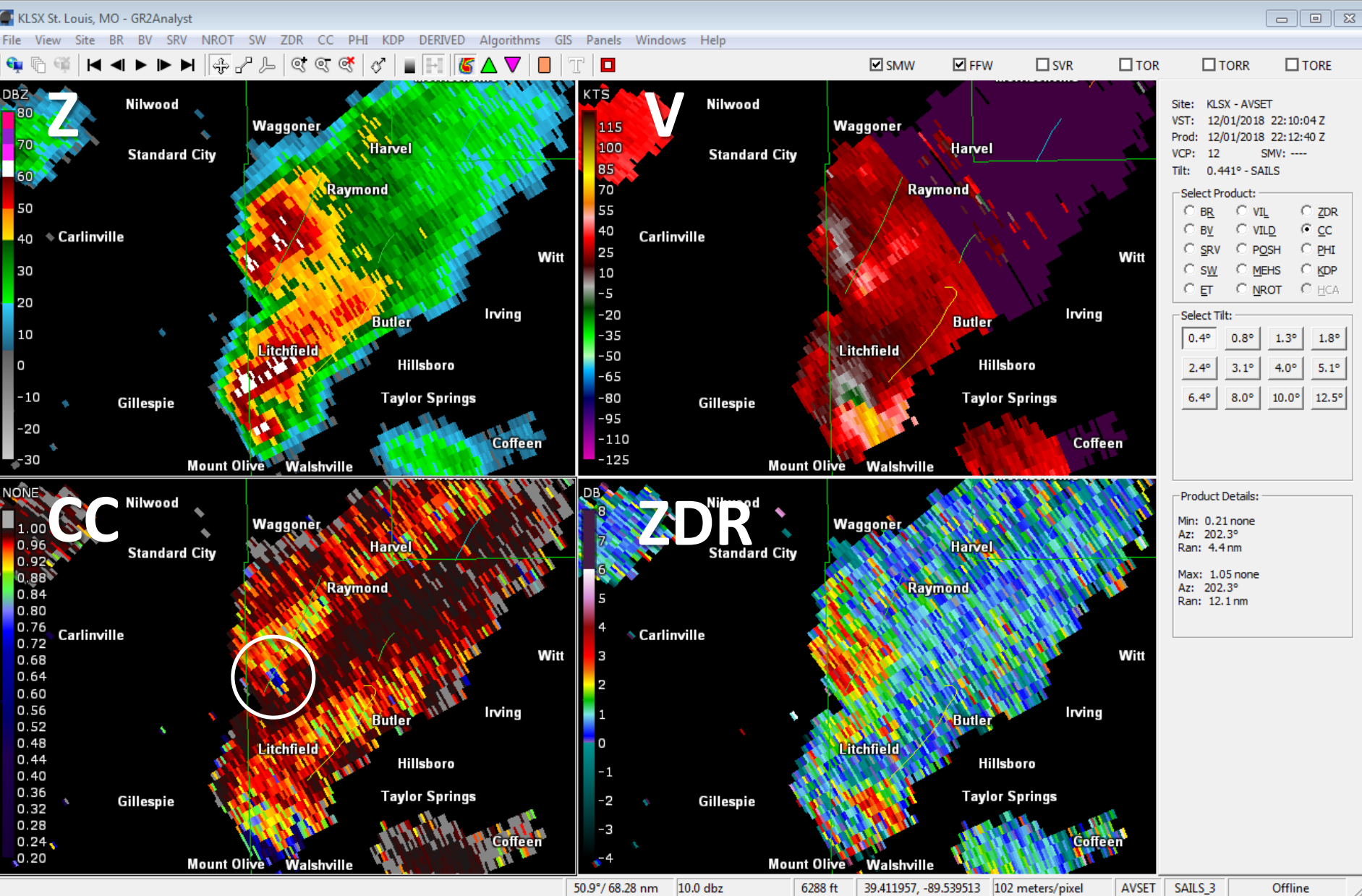


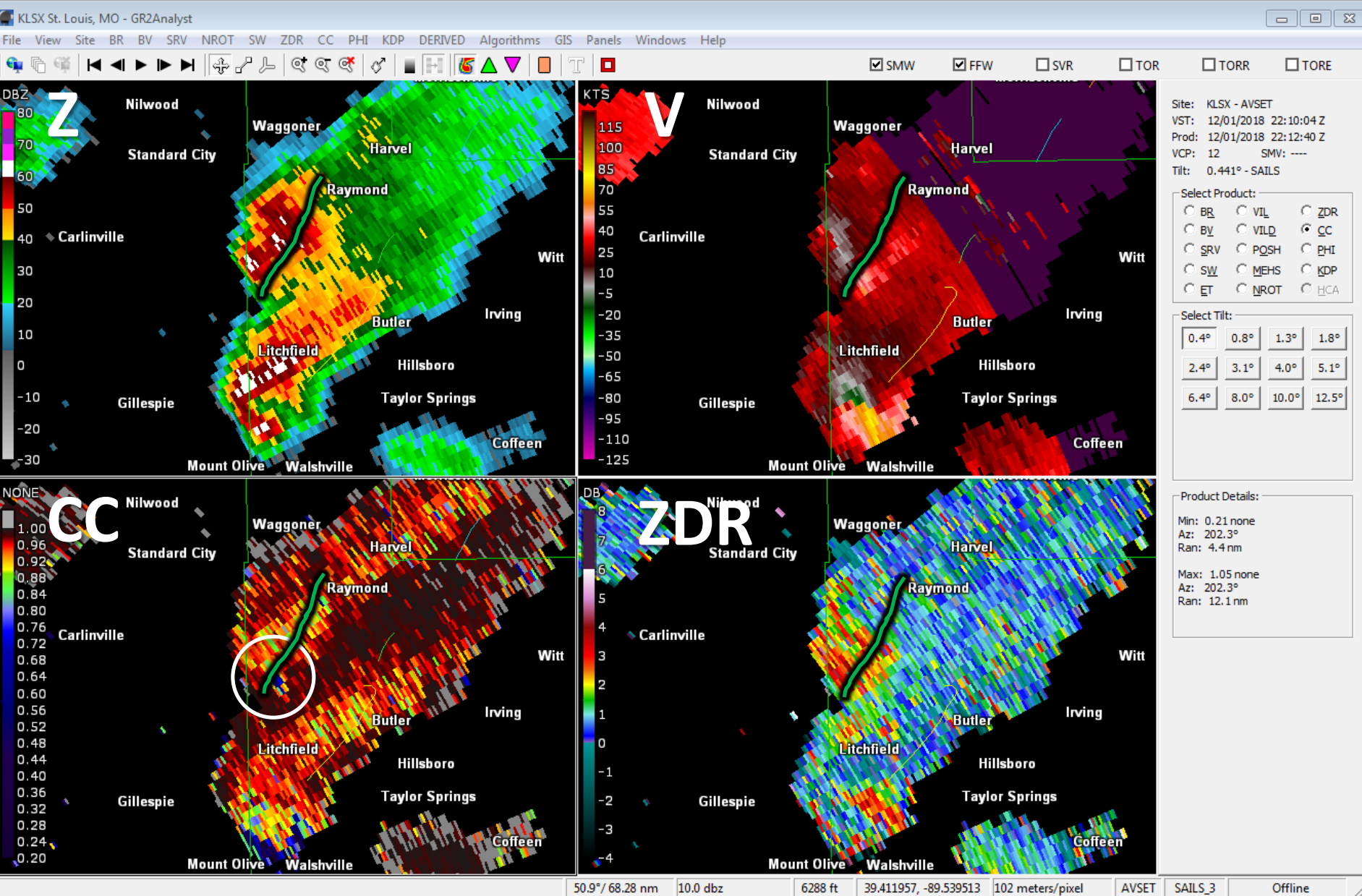


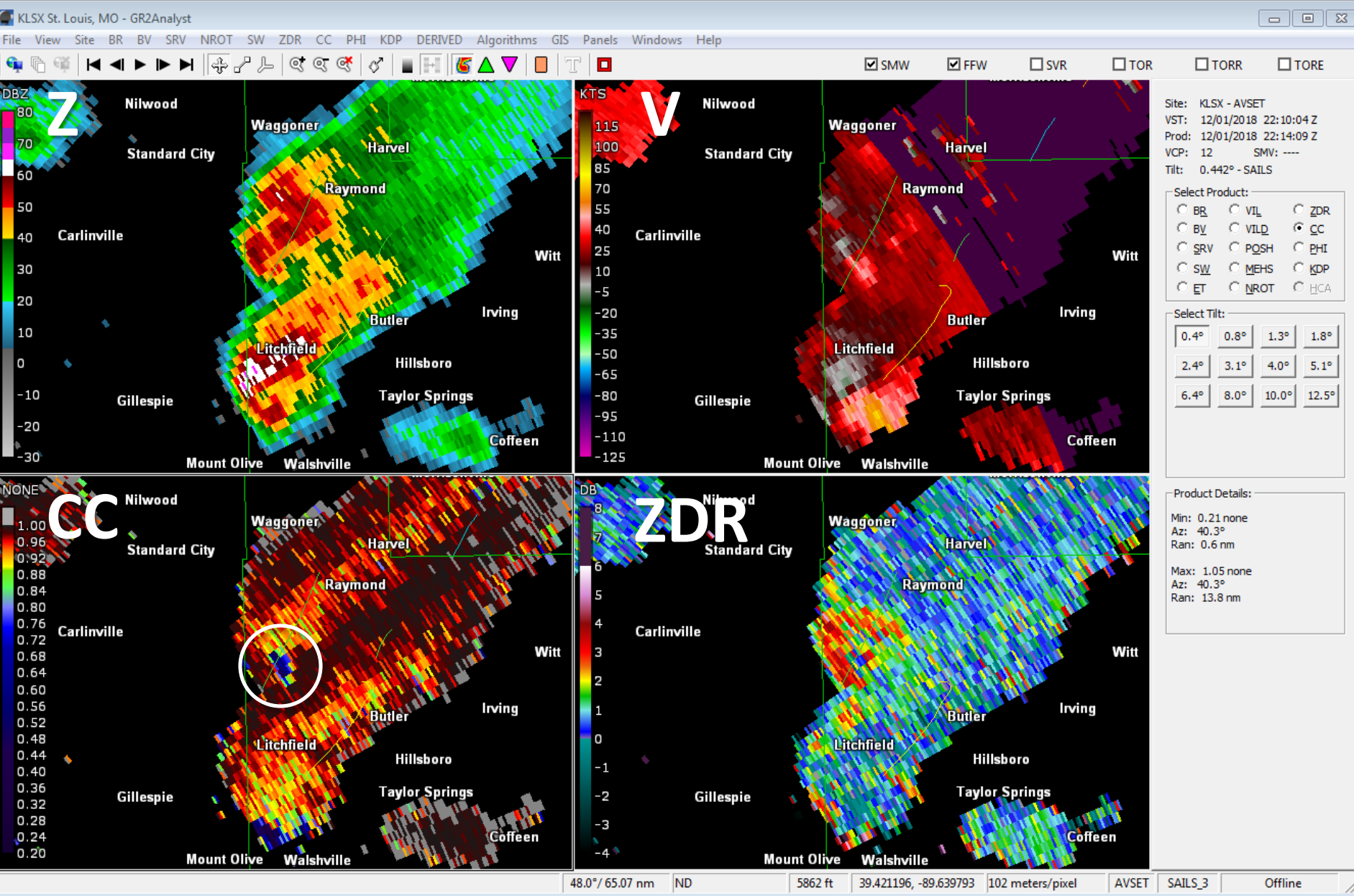
inflow

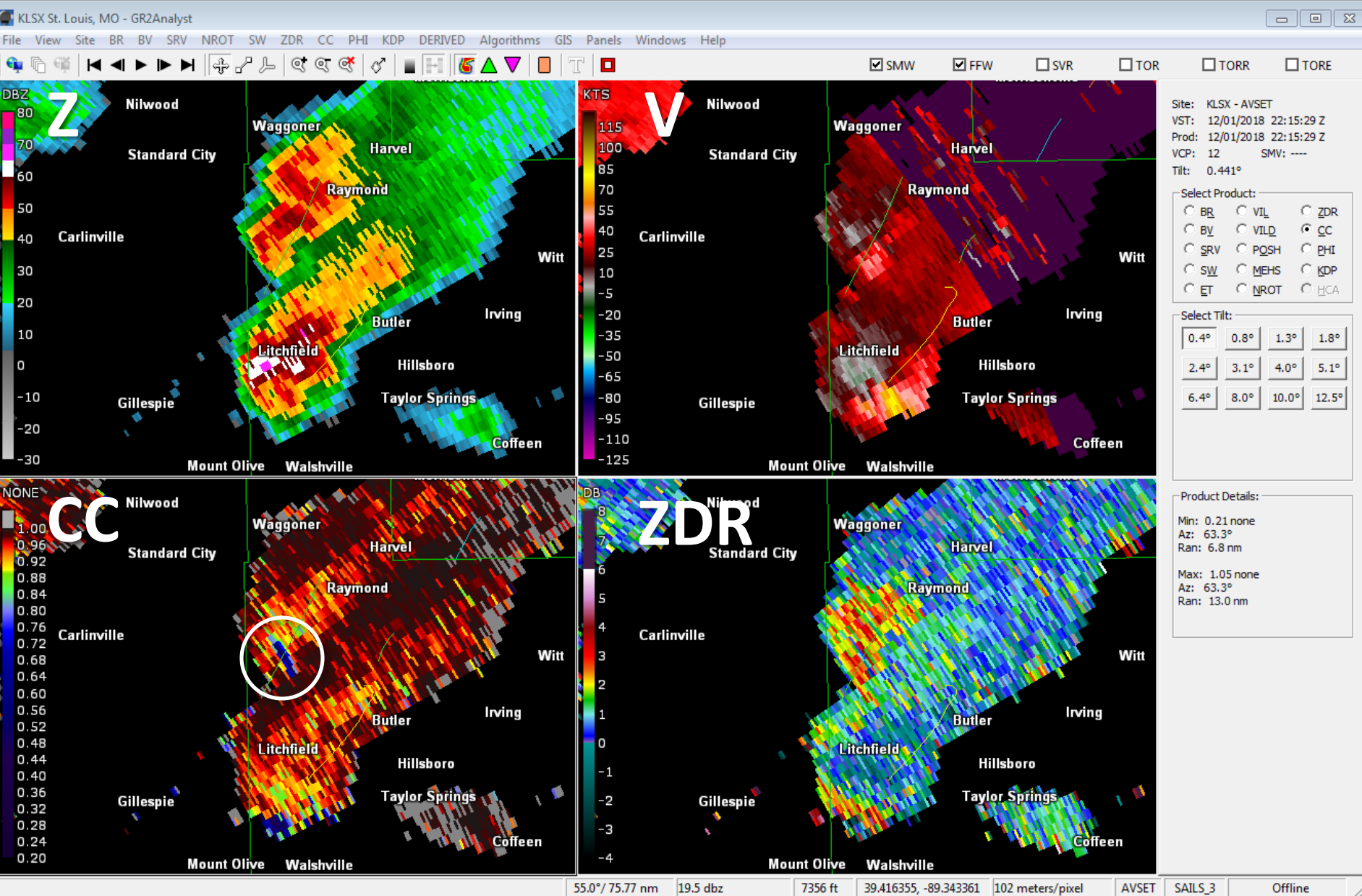












DB

ZDR

8

7

6

5

4

3

2

1

0

-1

-2

-3

-4

DB

ZDR

8

7

6

5

4

3

2

1

0

-1

-2

-3

-4

DB

ZDR

8

7

6

5

4

3

2

1

0

-1

-2

-3

-4

Site: KLSX - AVSET

VST: 12/01/2018 22:15:29 Z

Prod: 12/01/2018 22:15:29 Z

VCP: 12SMV: ----

Tilt: 0.441°

Select Product:

☐ BR

☐ VIL

☐ ZDR

☐ BV

☐ VILQ

☒ CC

☐ SRV

☐ PQSH

☐ PHI

☐ SW

☐ MEHS

☐ KDP

☐ ET

☐ NROT

☐ HCA

Select Tilt:

0.4°

0.8°

1.3°

1.8°

2.4°

3.1°

4.0°

5.1°

6.4°

8.0°

10.0°

12.5°

Product Details:

Min: 0.21 none

Az: 63.3°

Ran: 6.8 nm

Max: 1.05 none

Az: 63.3°

Ran: 13.0 nm

55.0°/ 75.77 nm

19.5 dbz

7356 ft

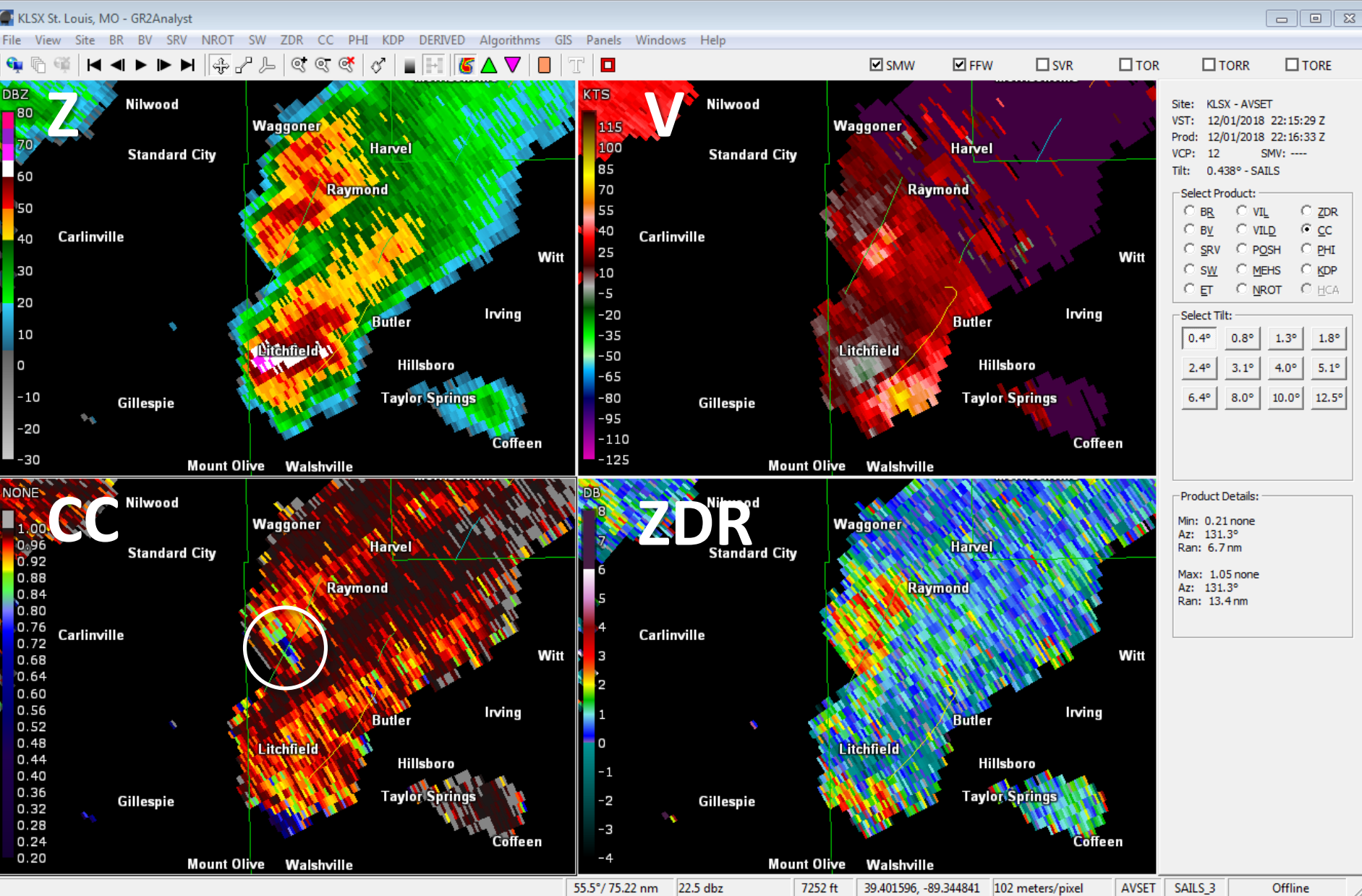
39.416355, -89.343361

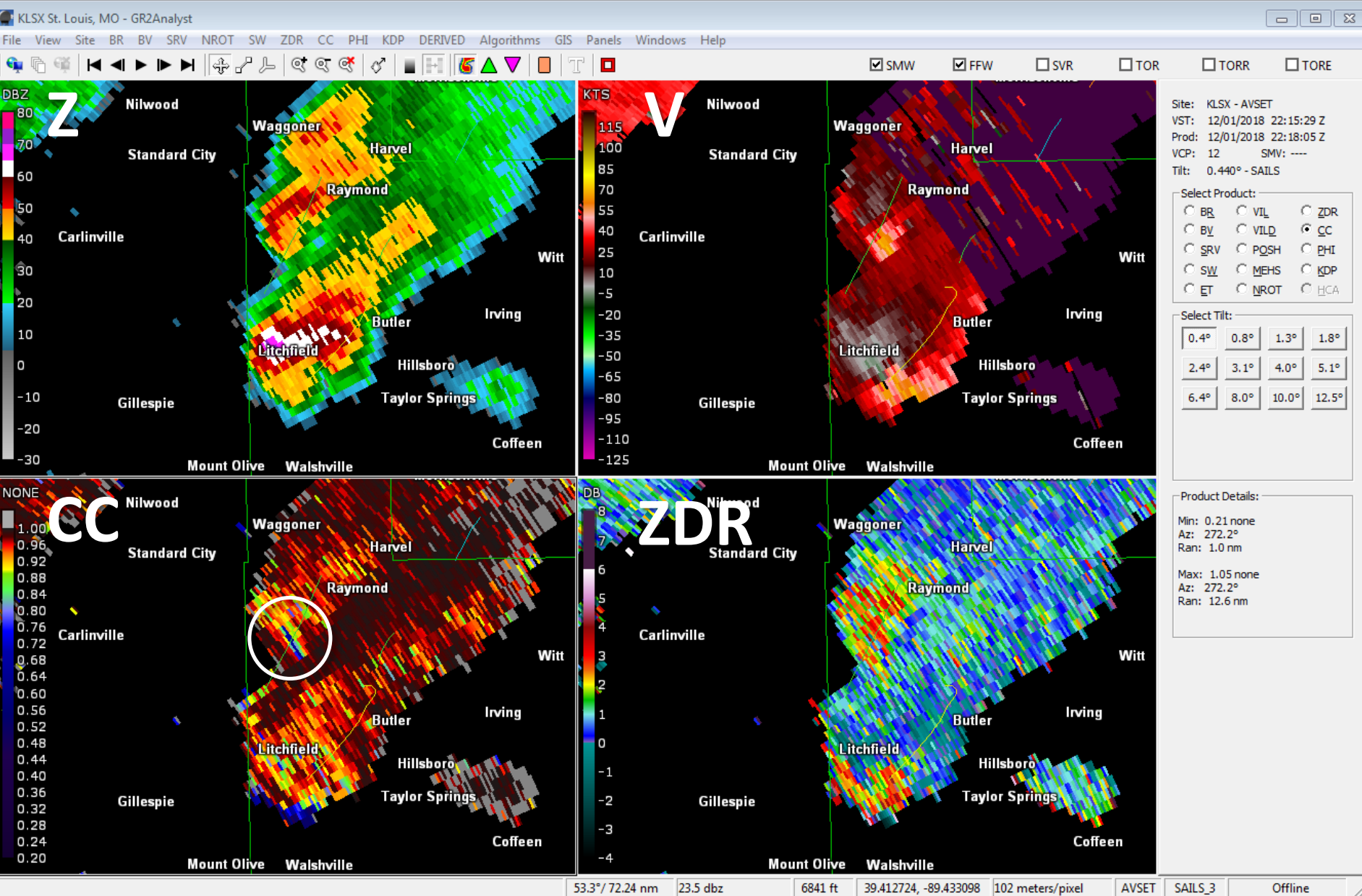
102 meters/pixel

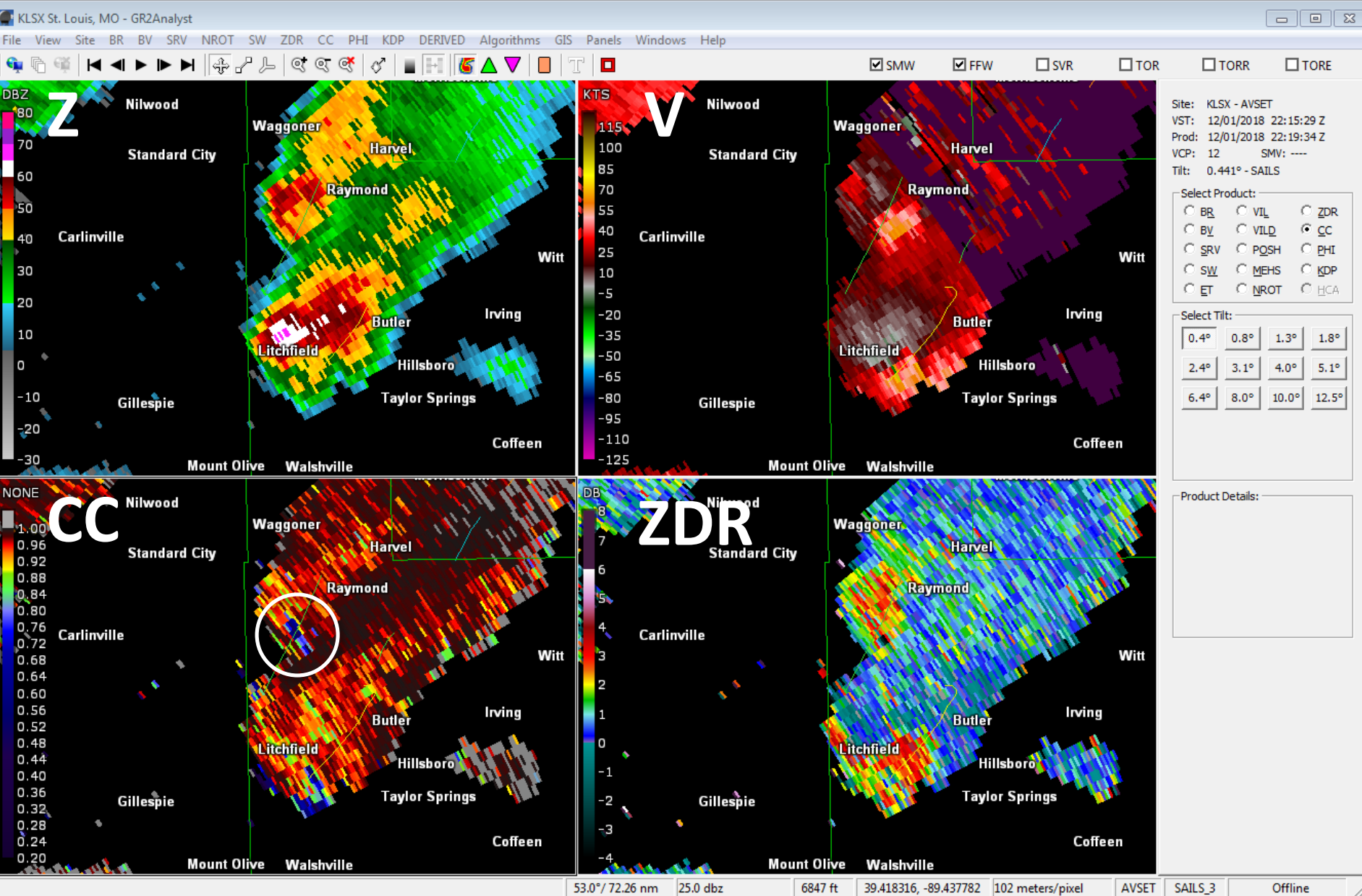
AVSET

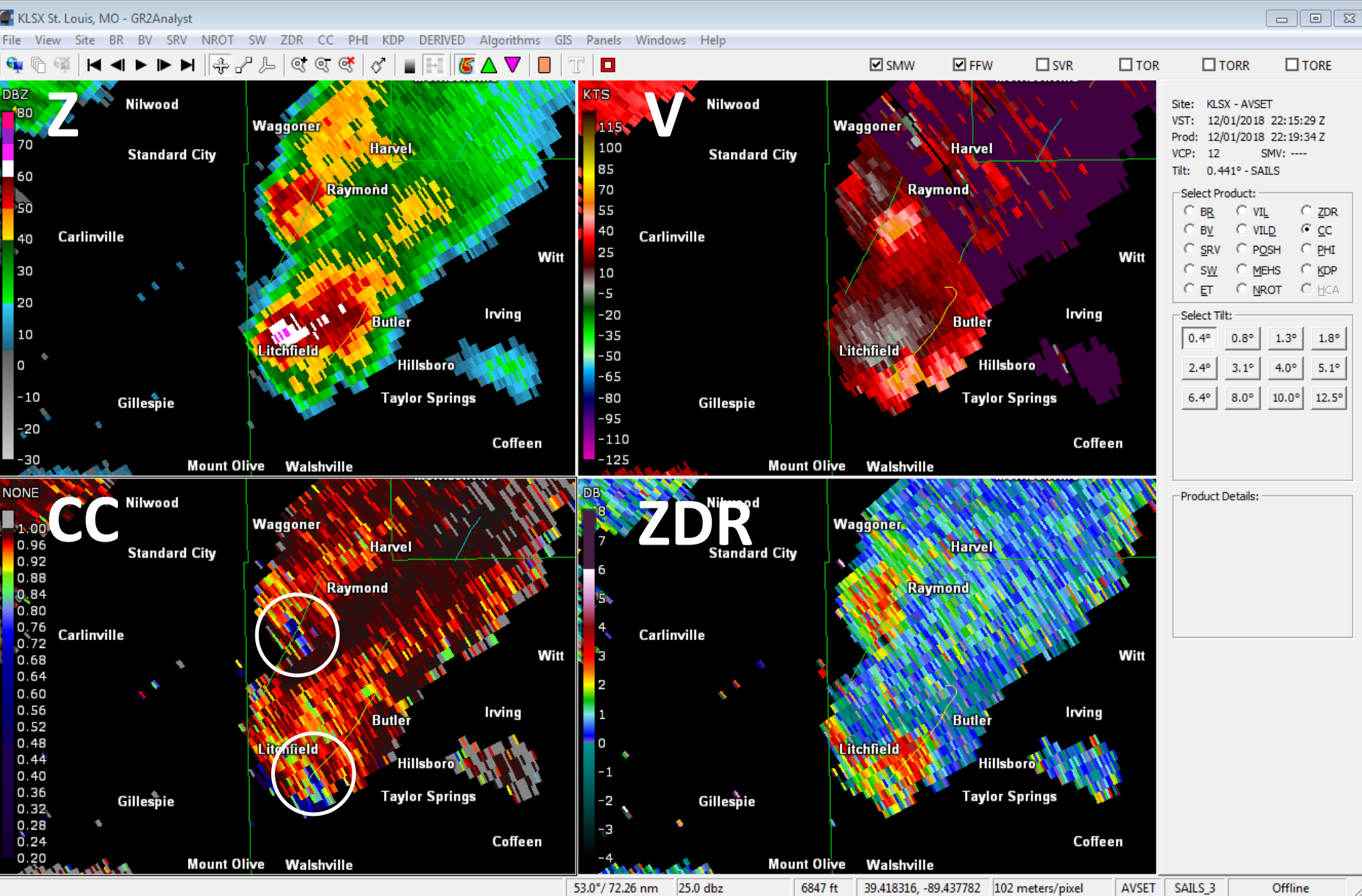
SAILS_3

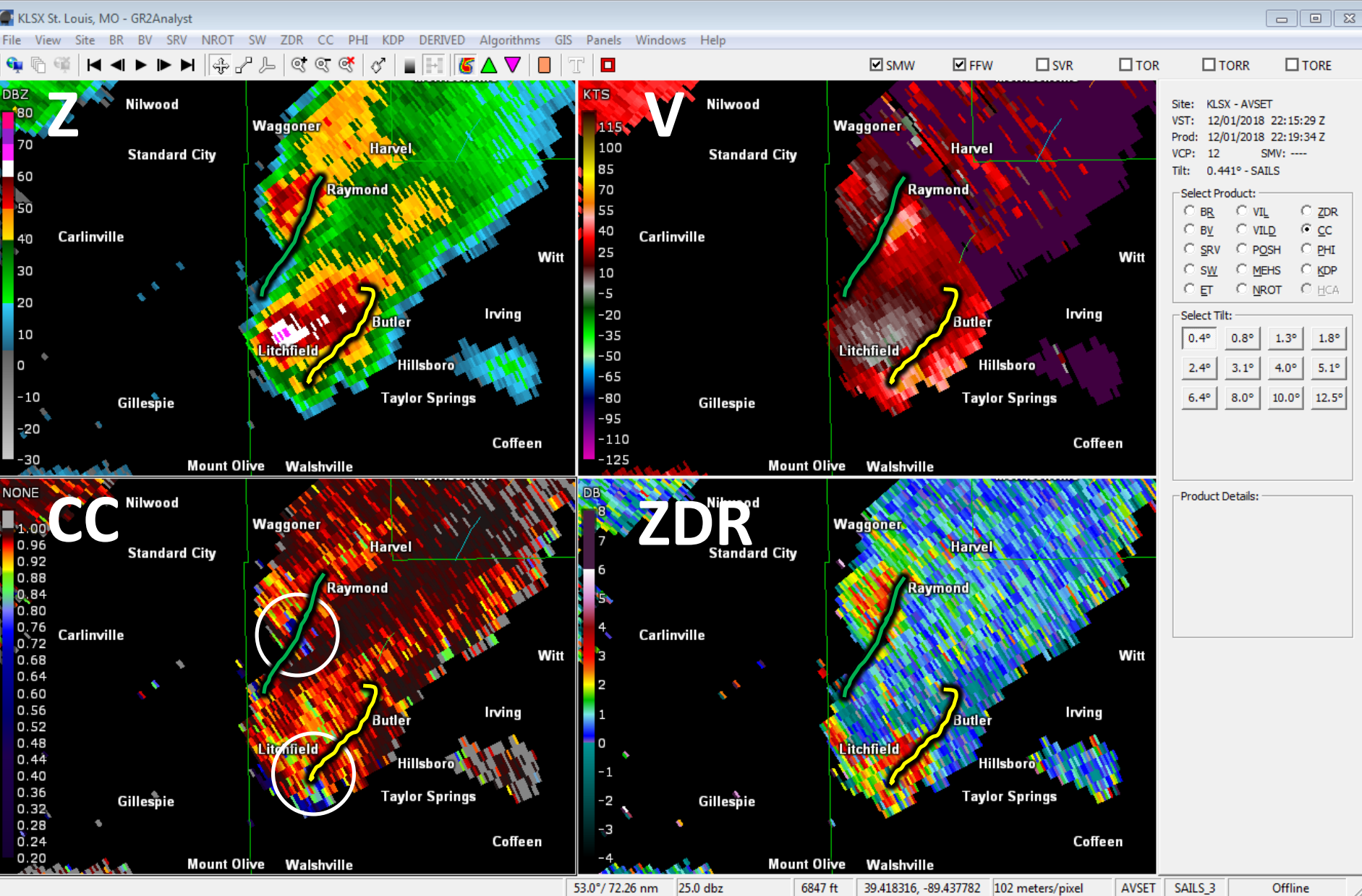
Offline

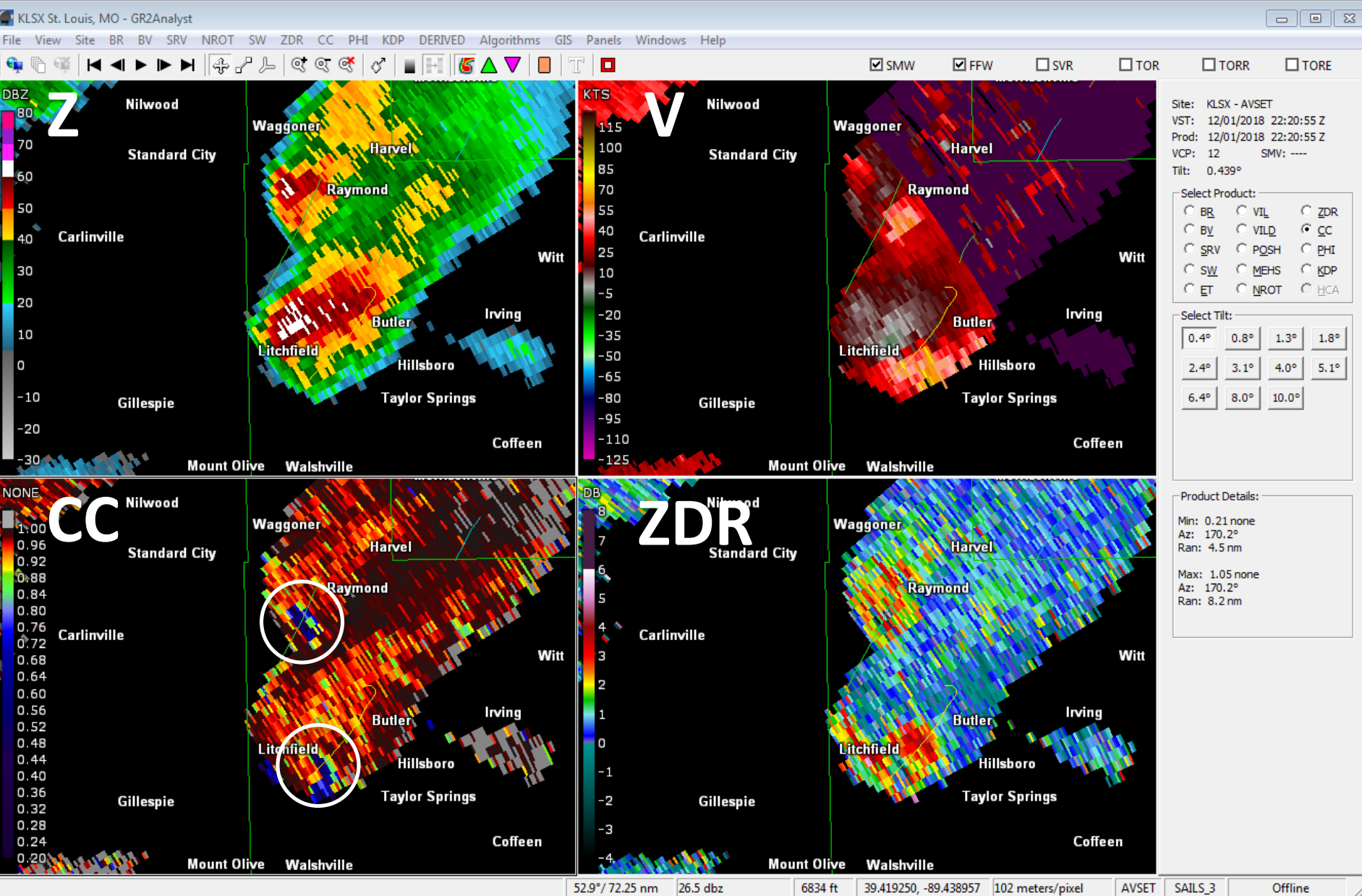


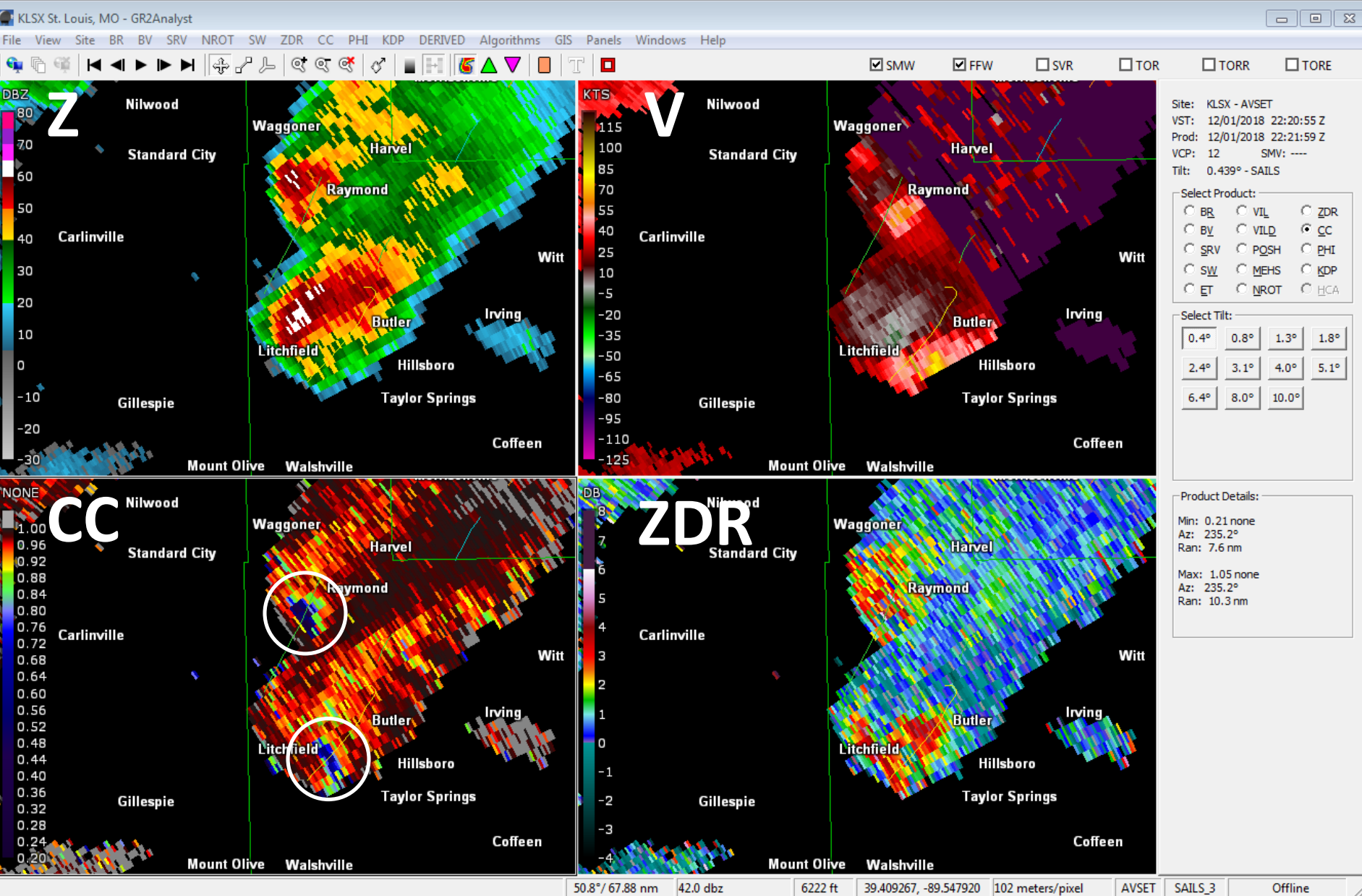


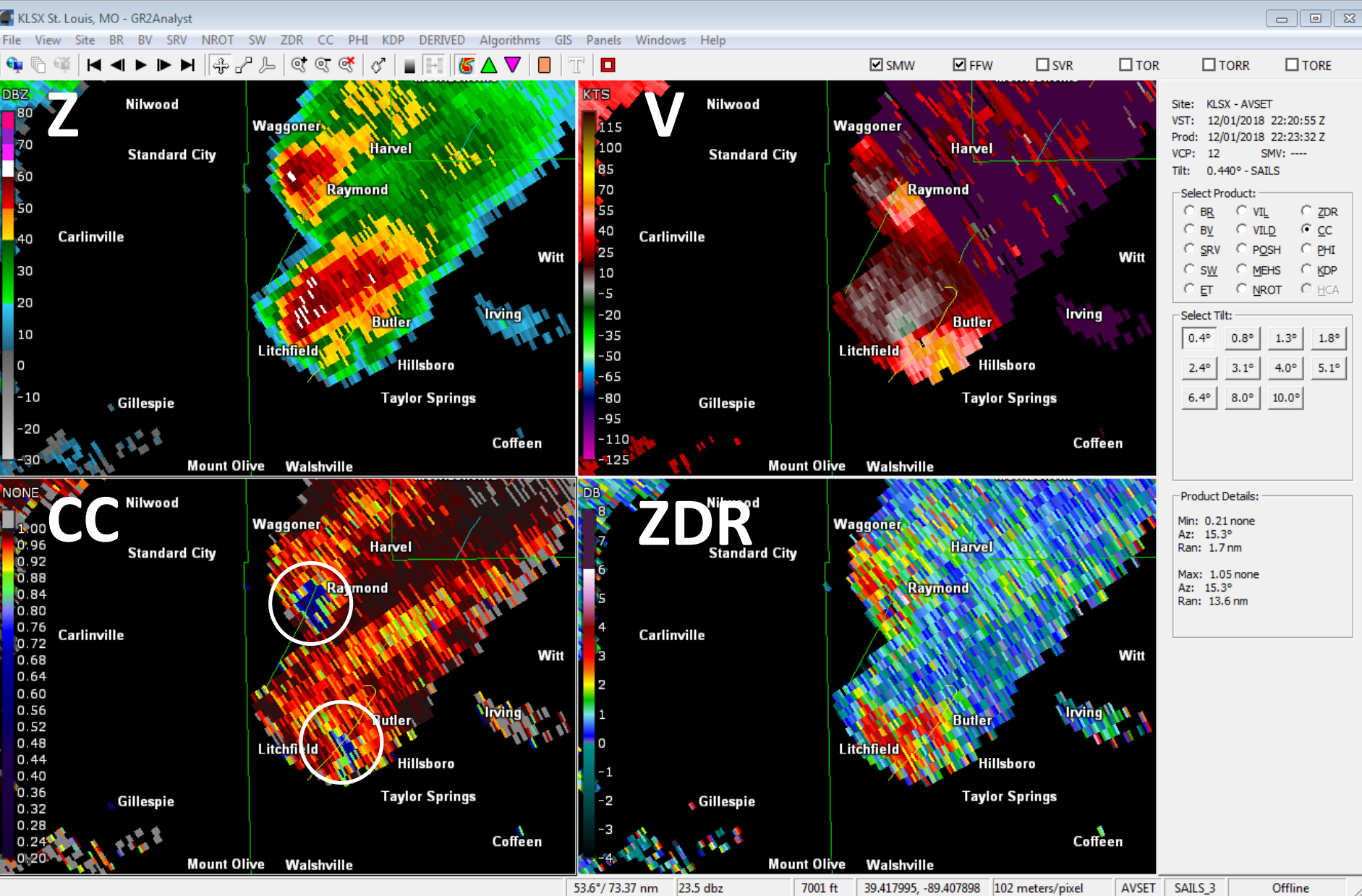






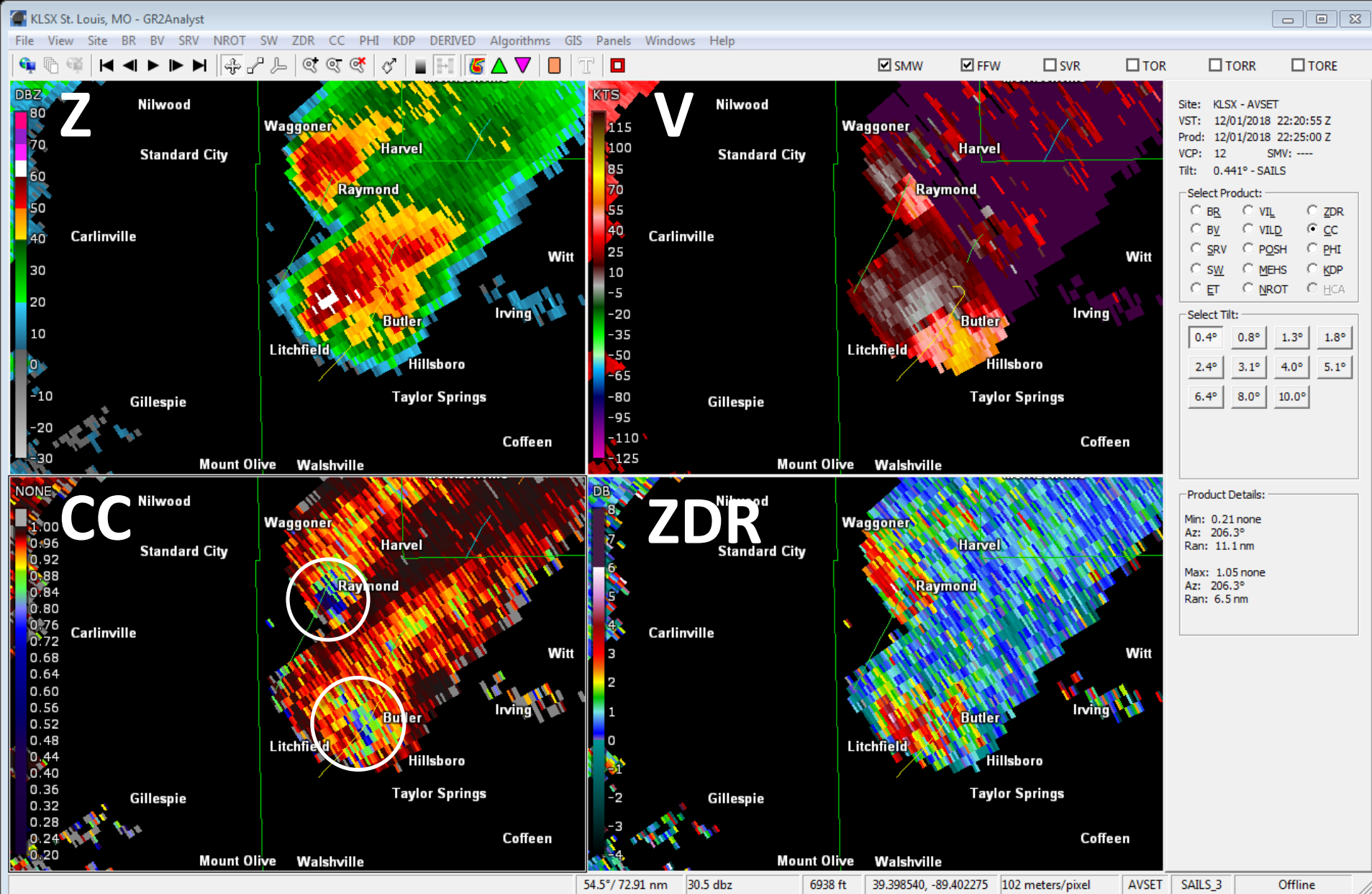


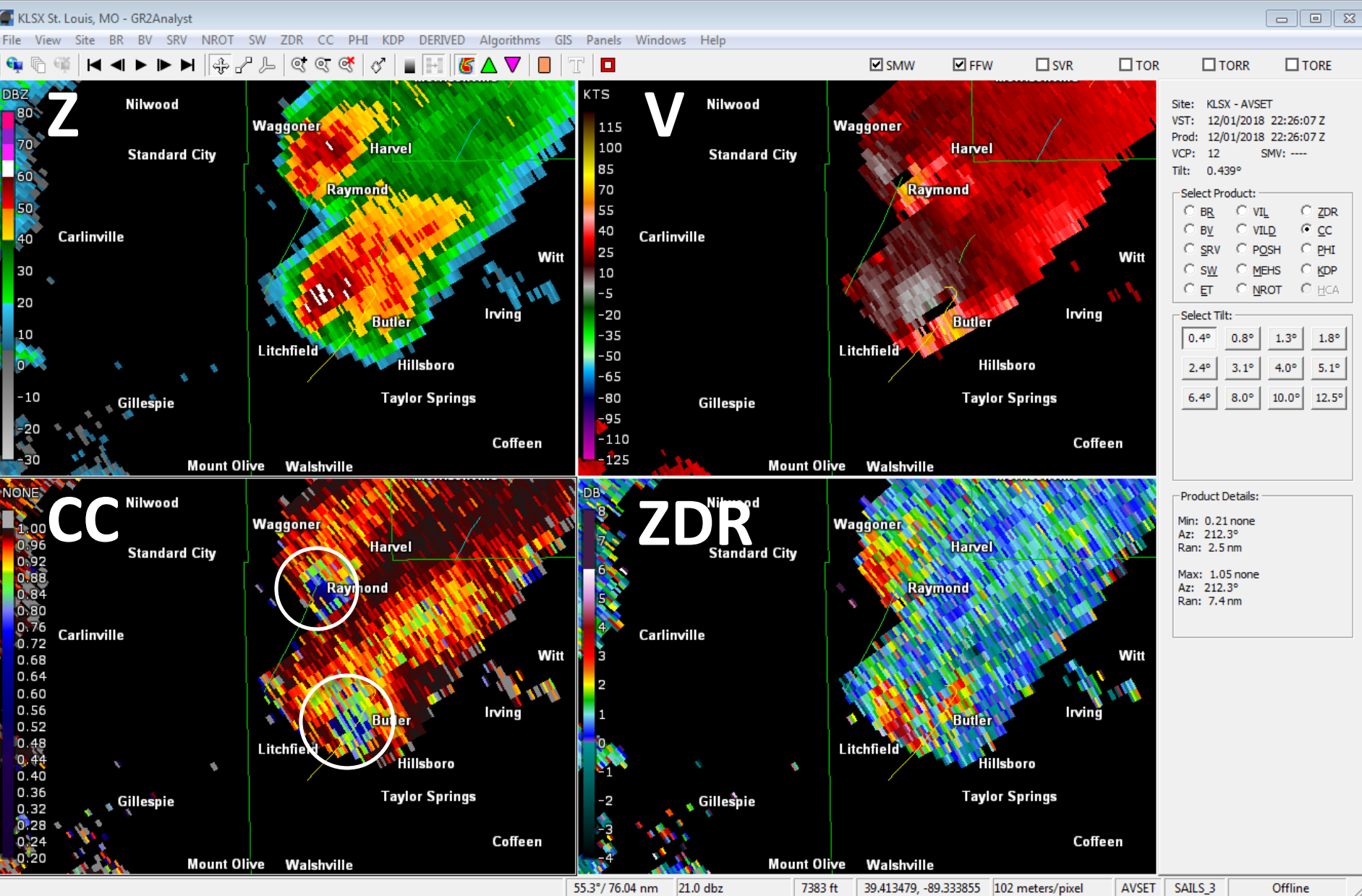


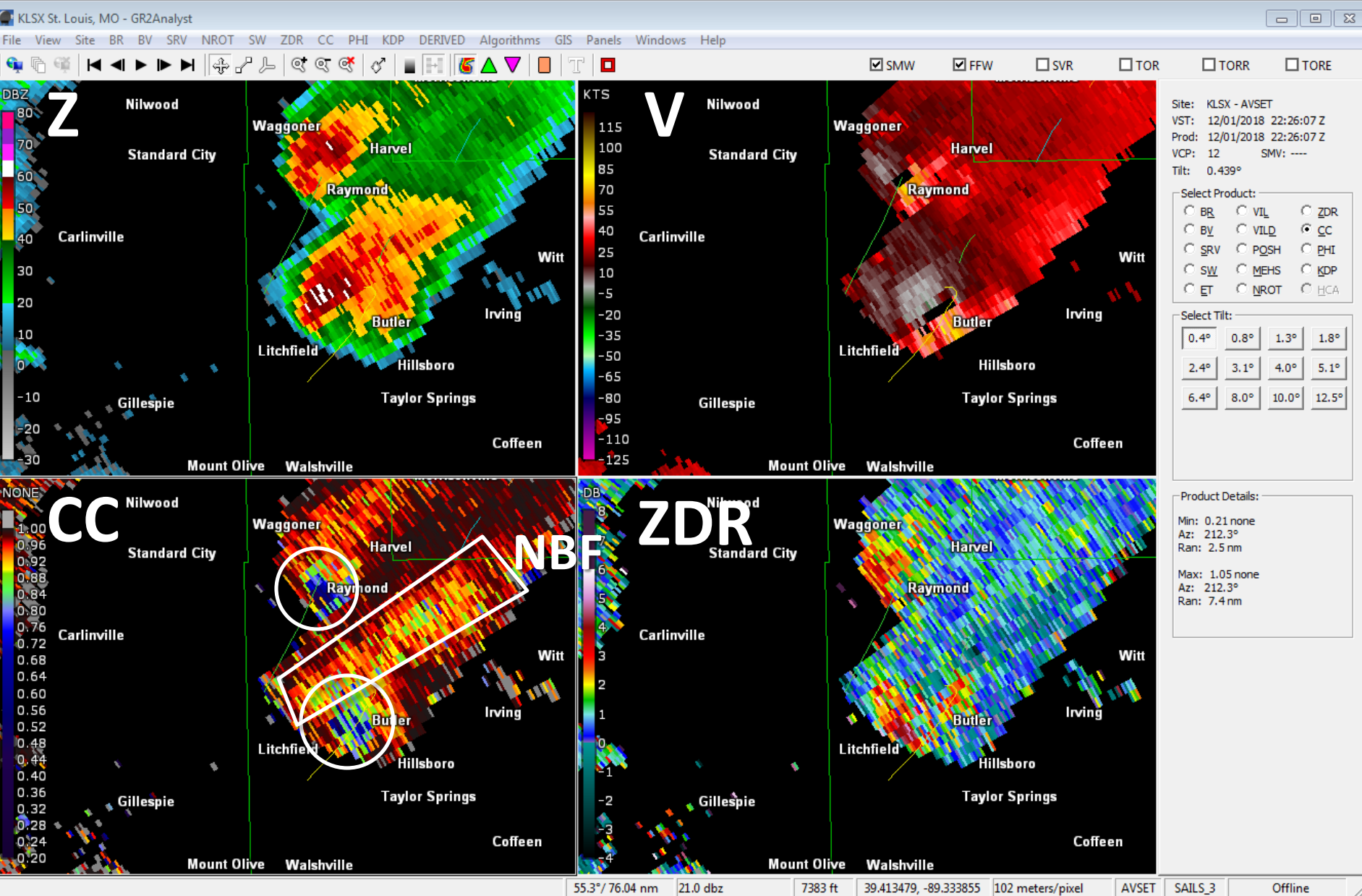


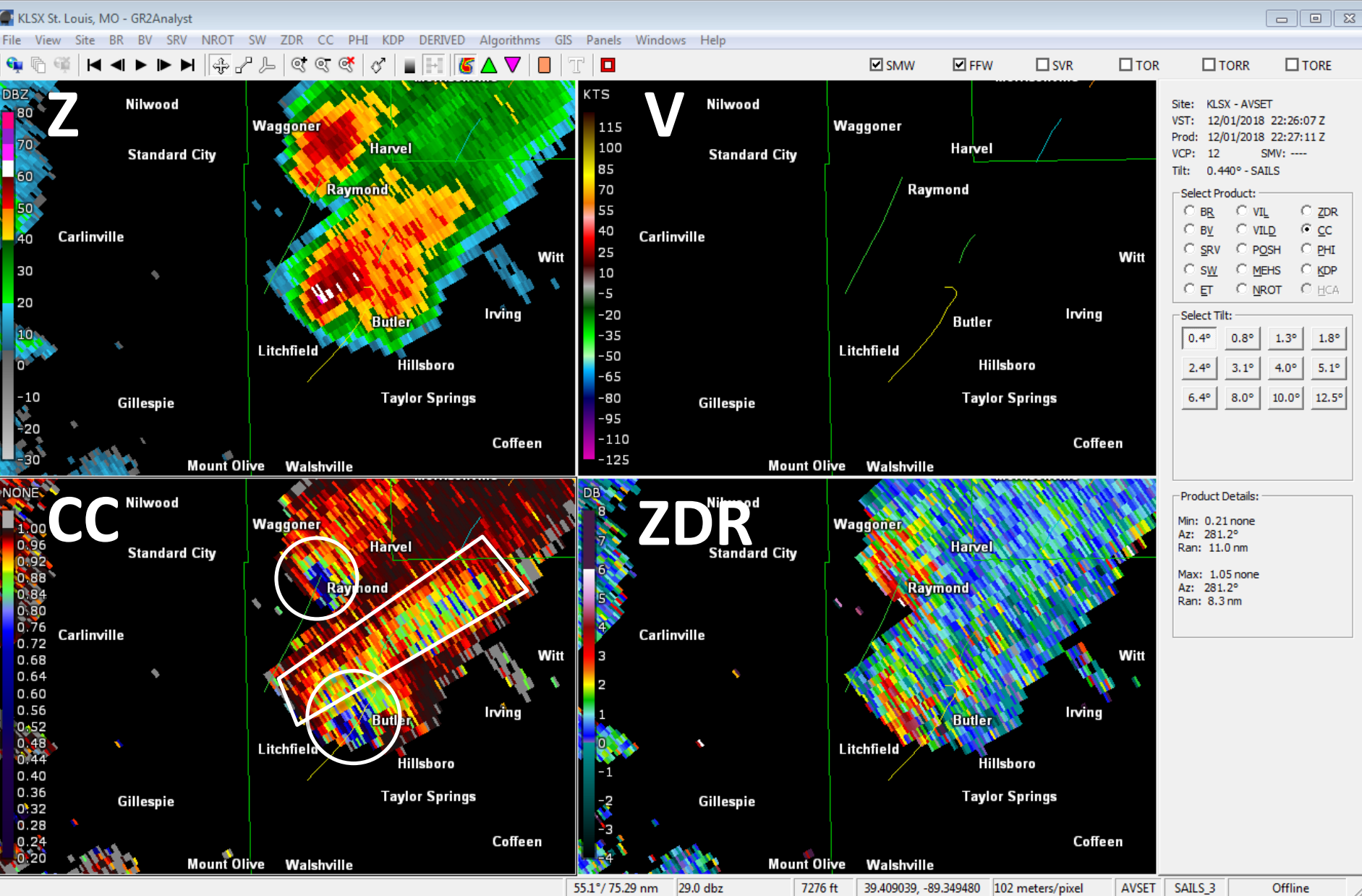
2225z

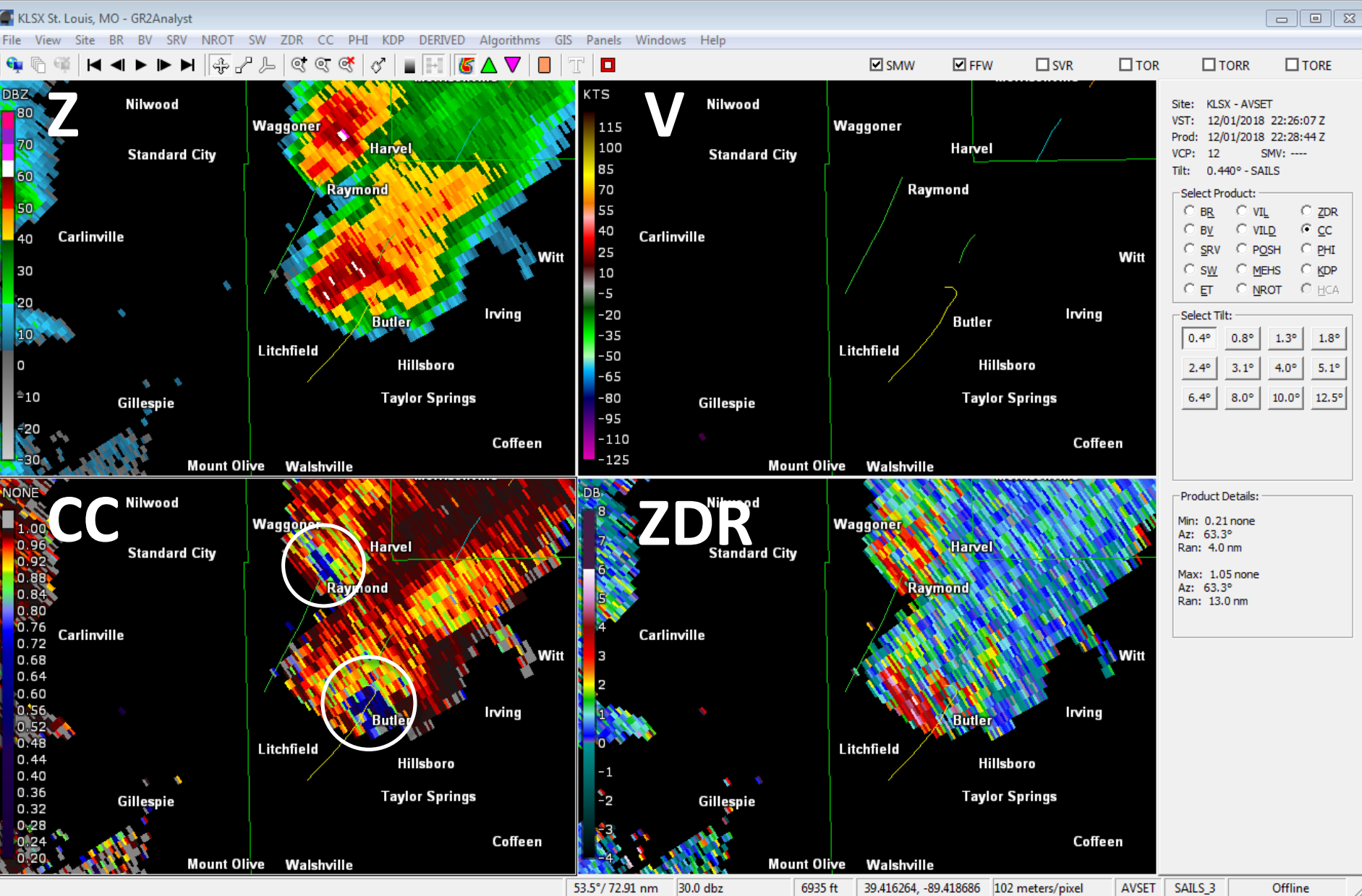
0.5°

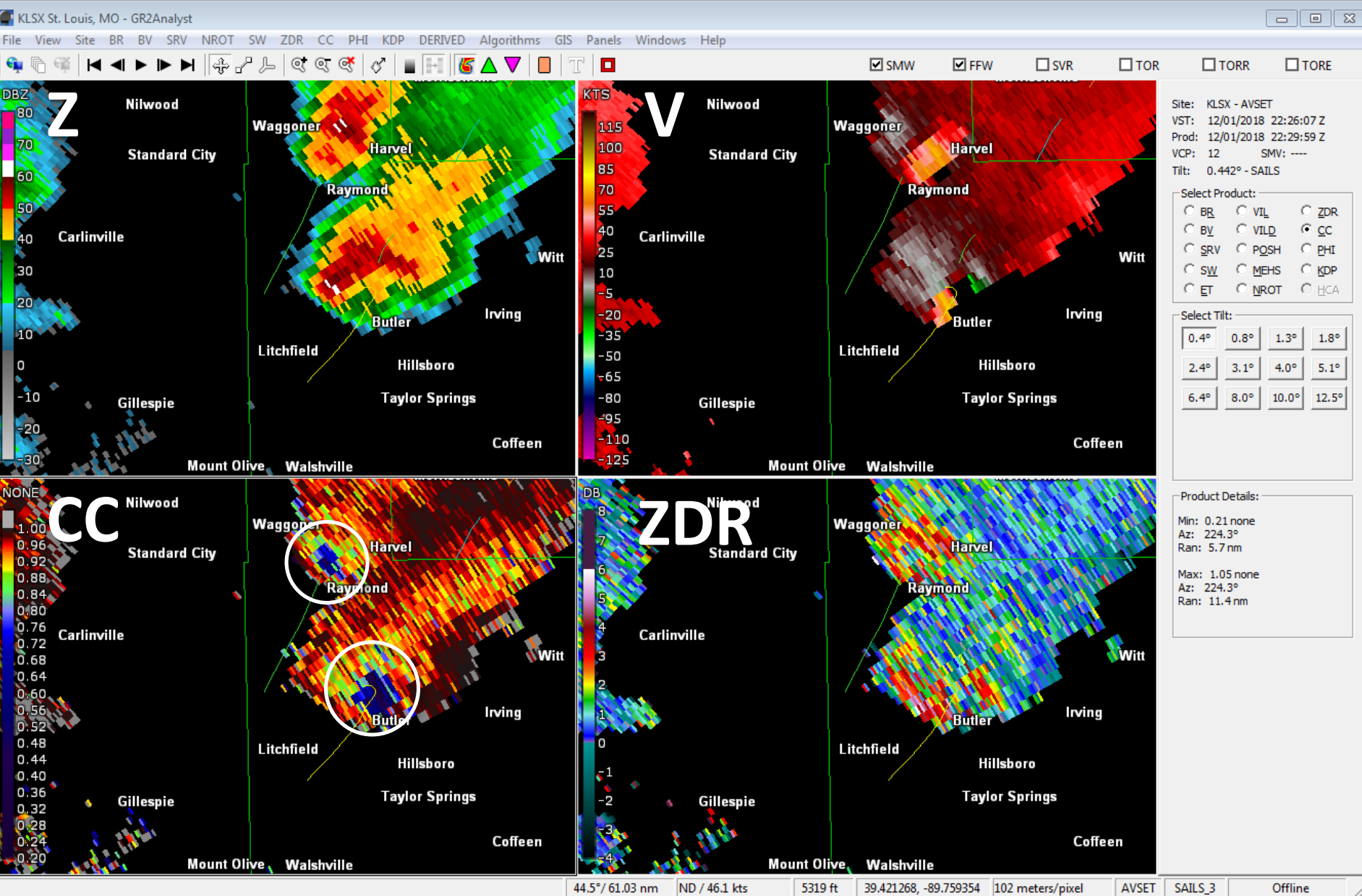






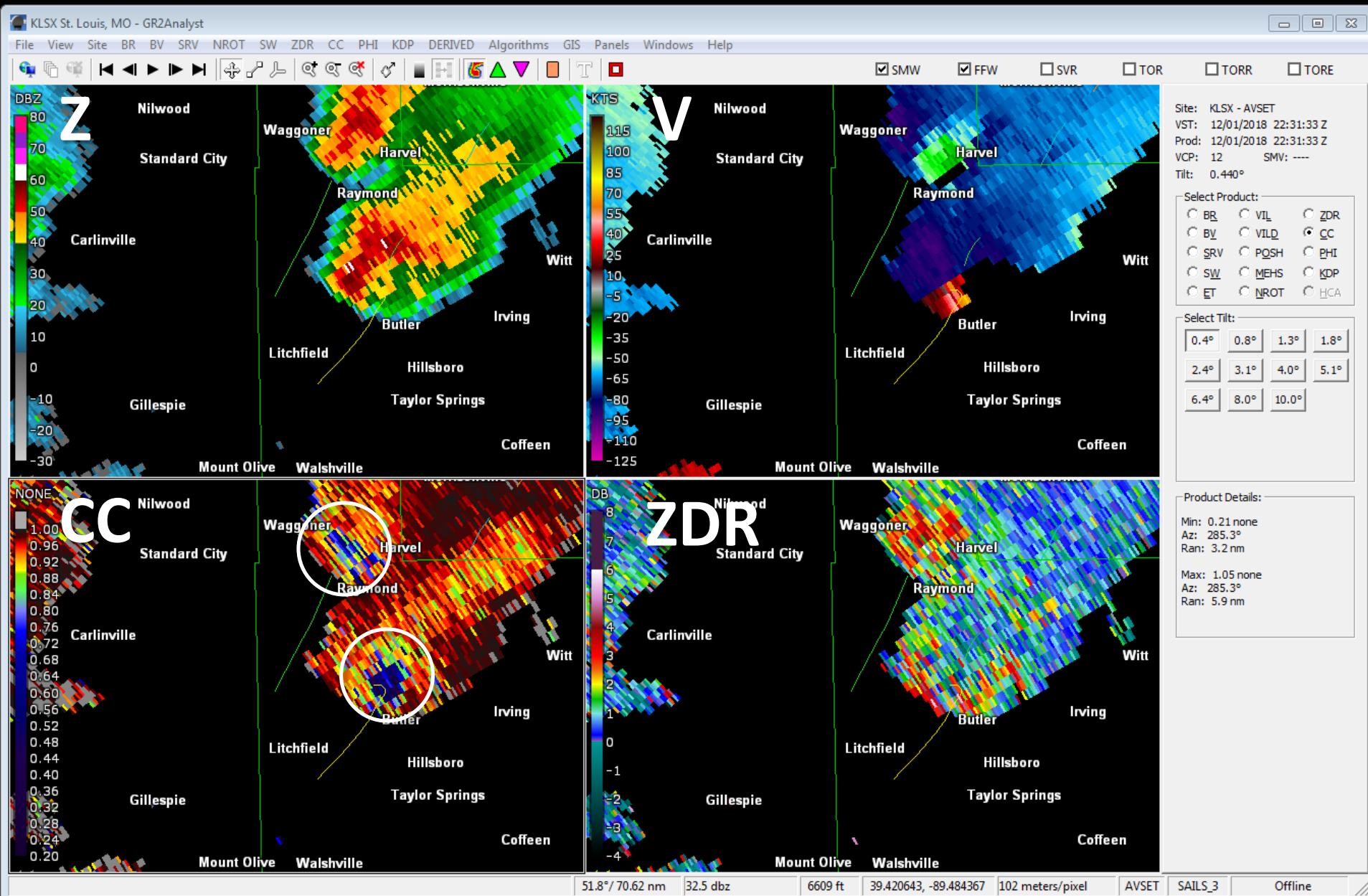


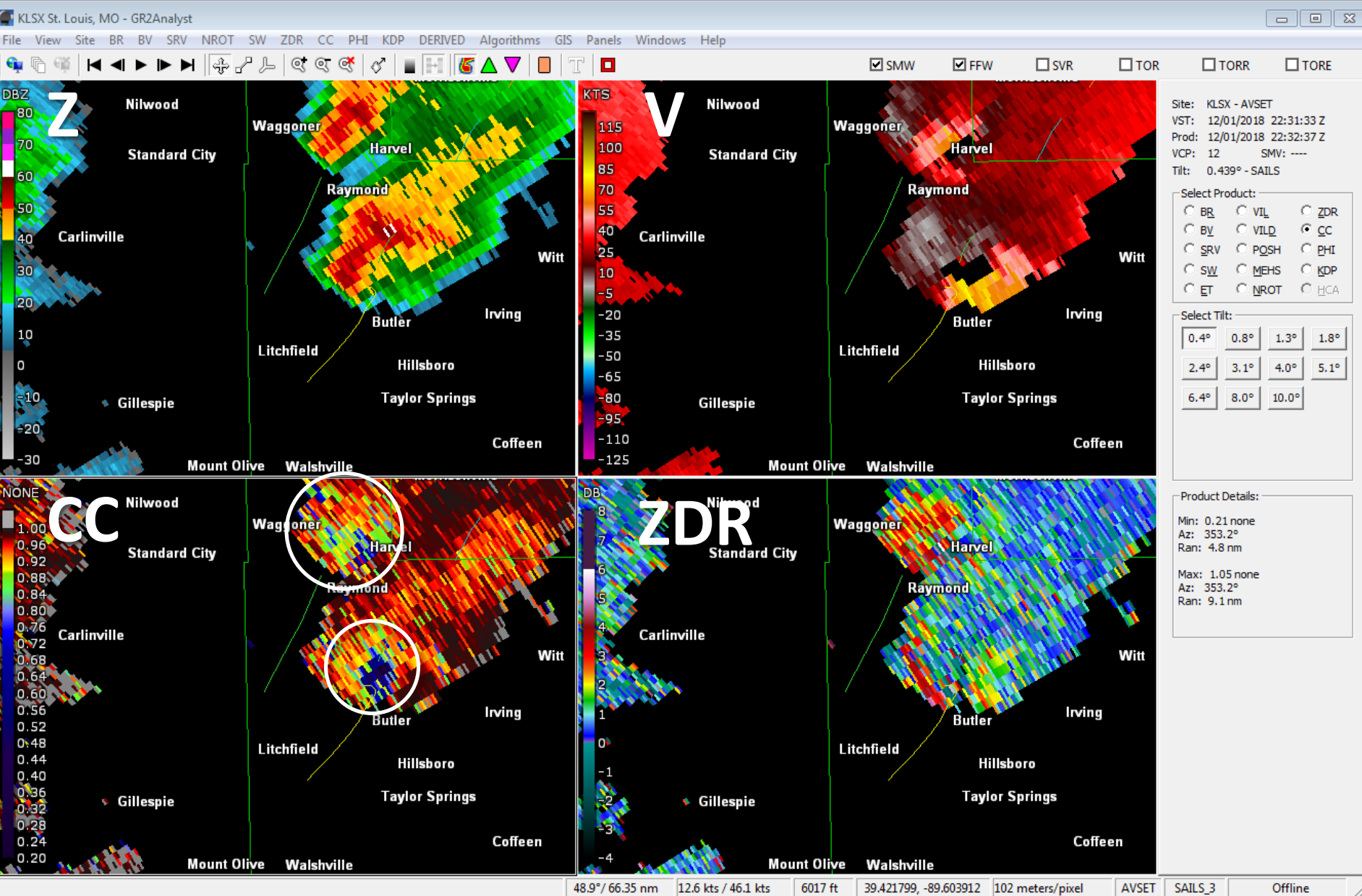


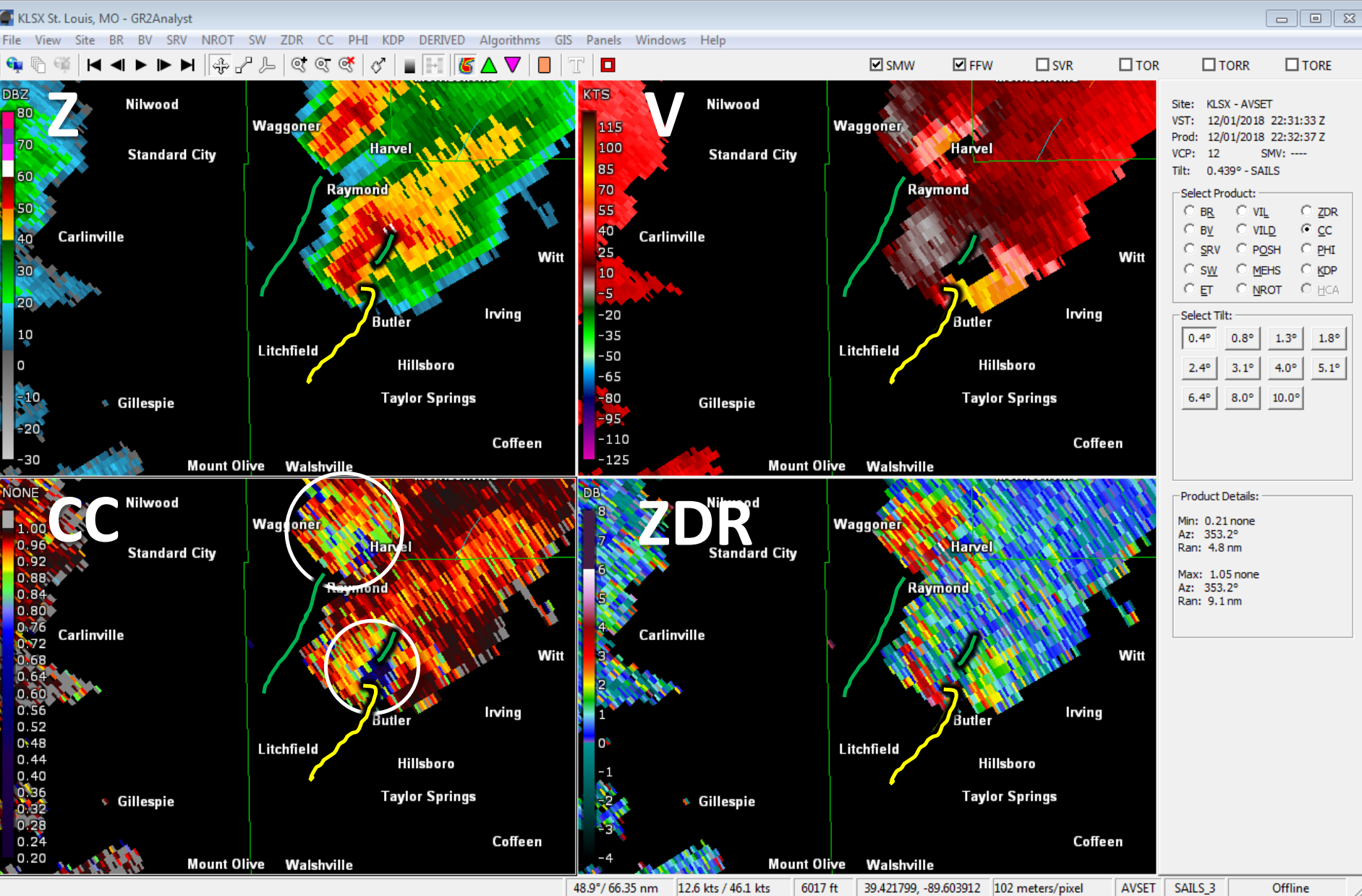


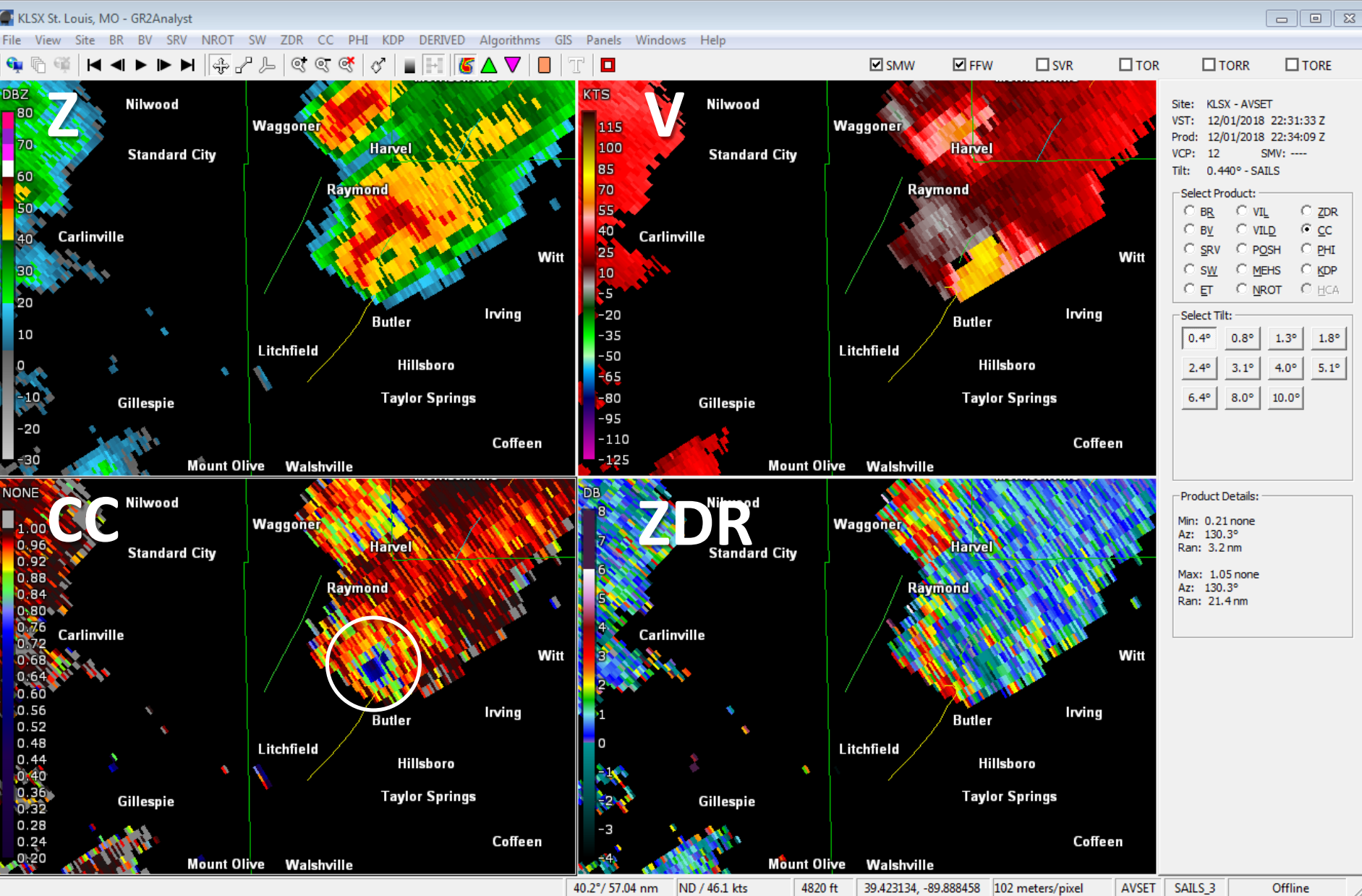
2231z

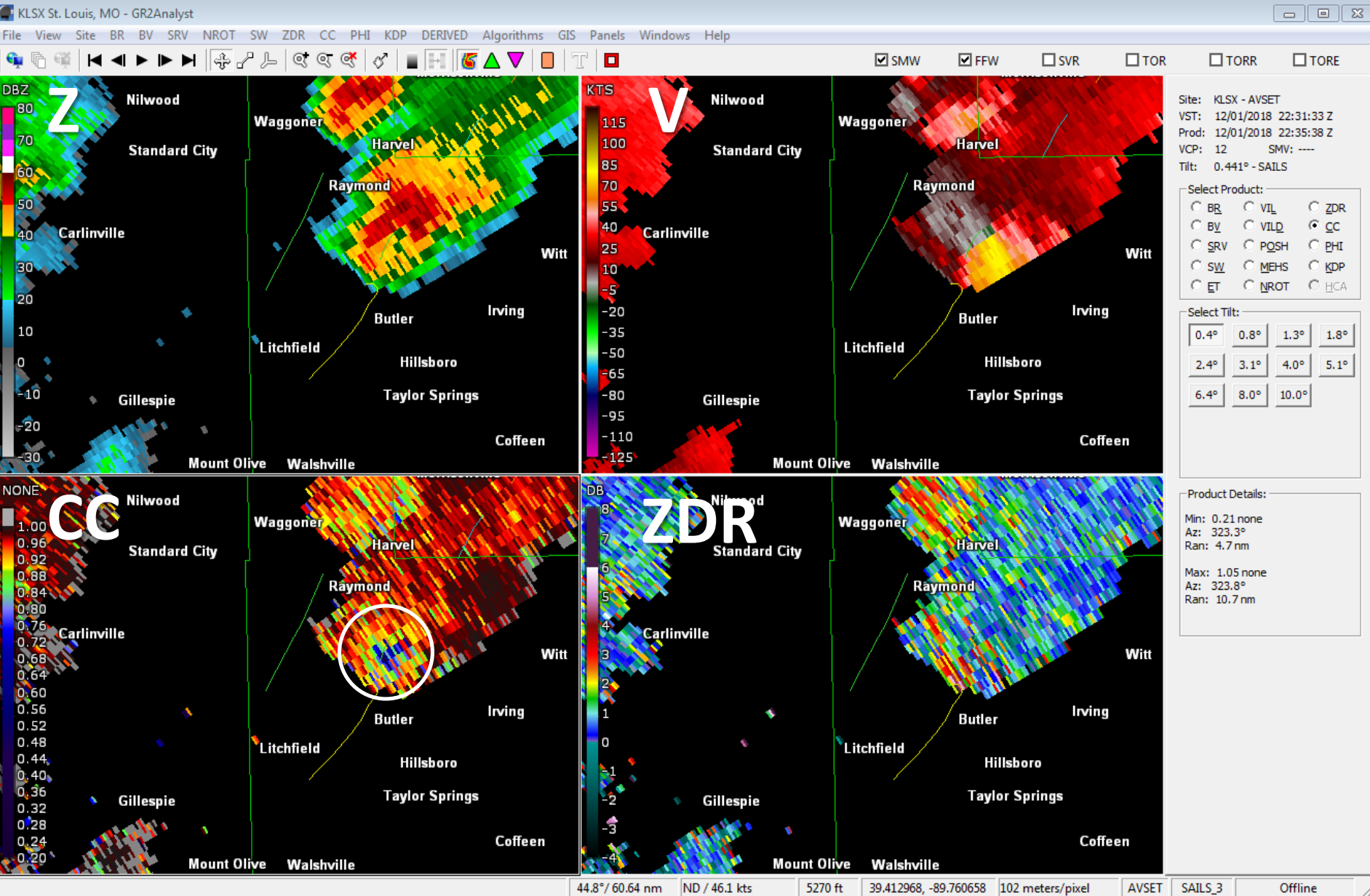
0.5°

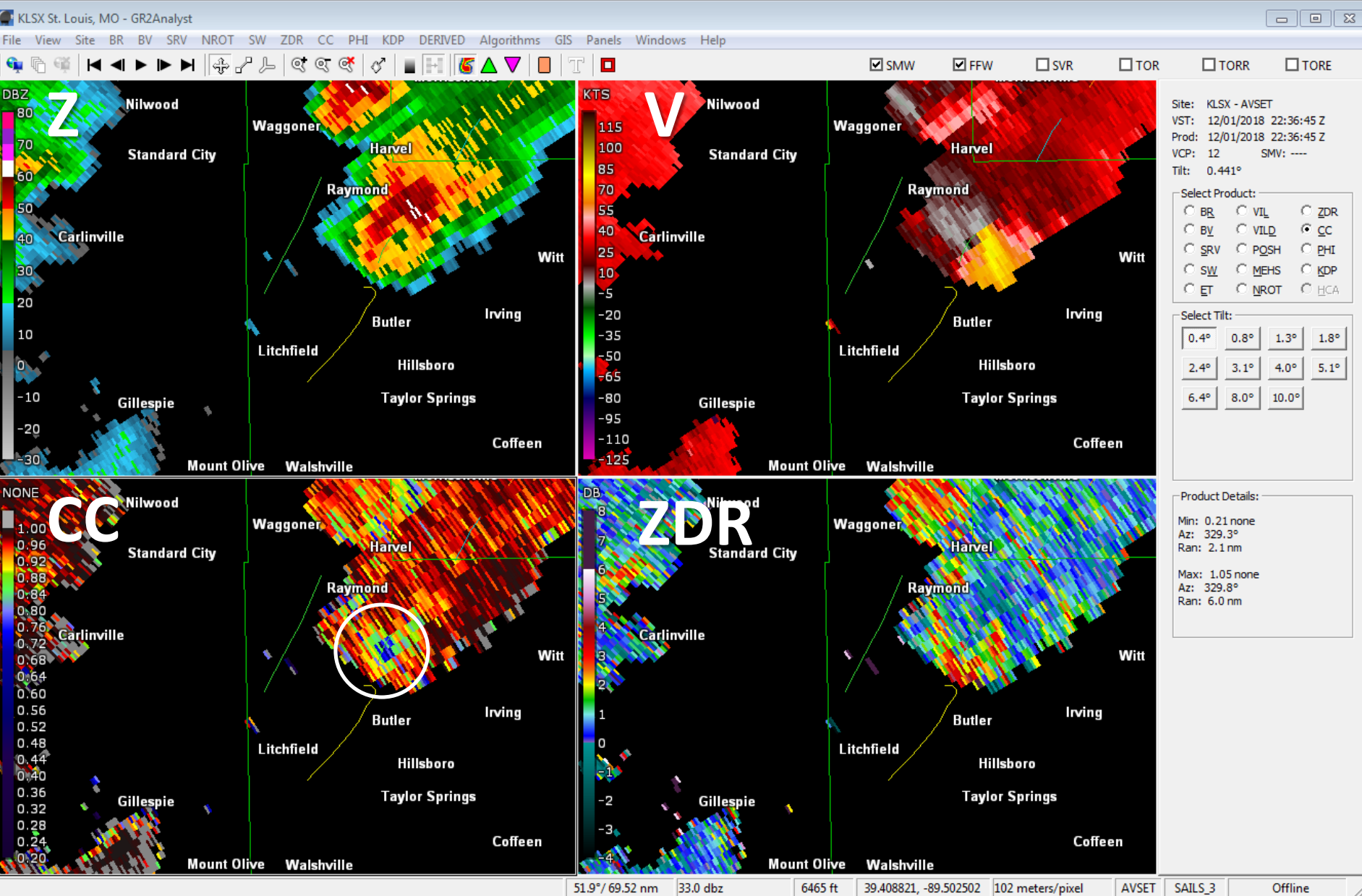






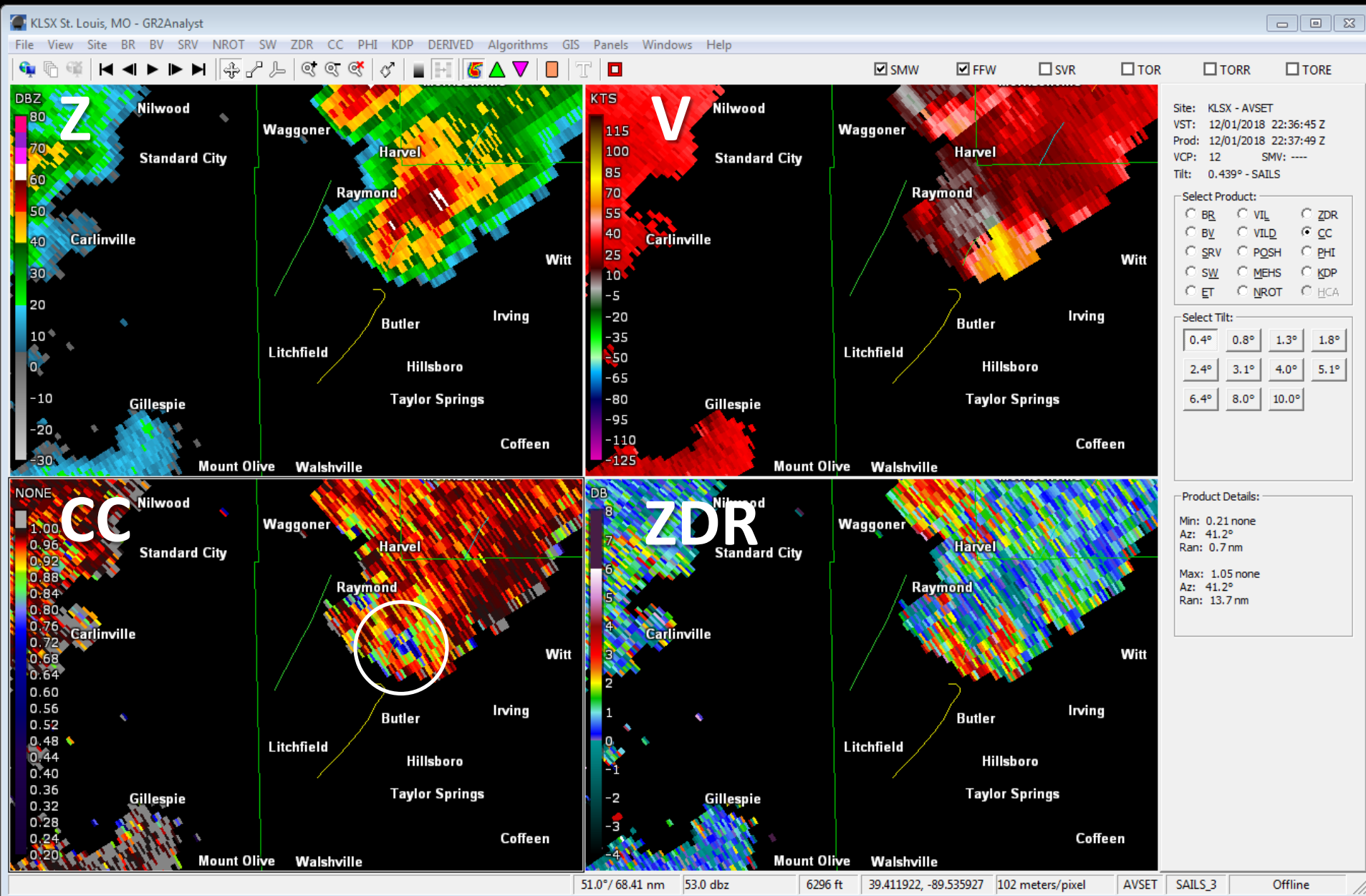


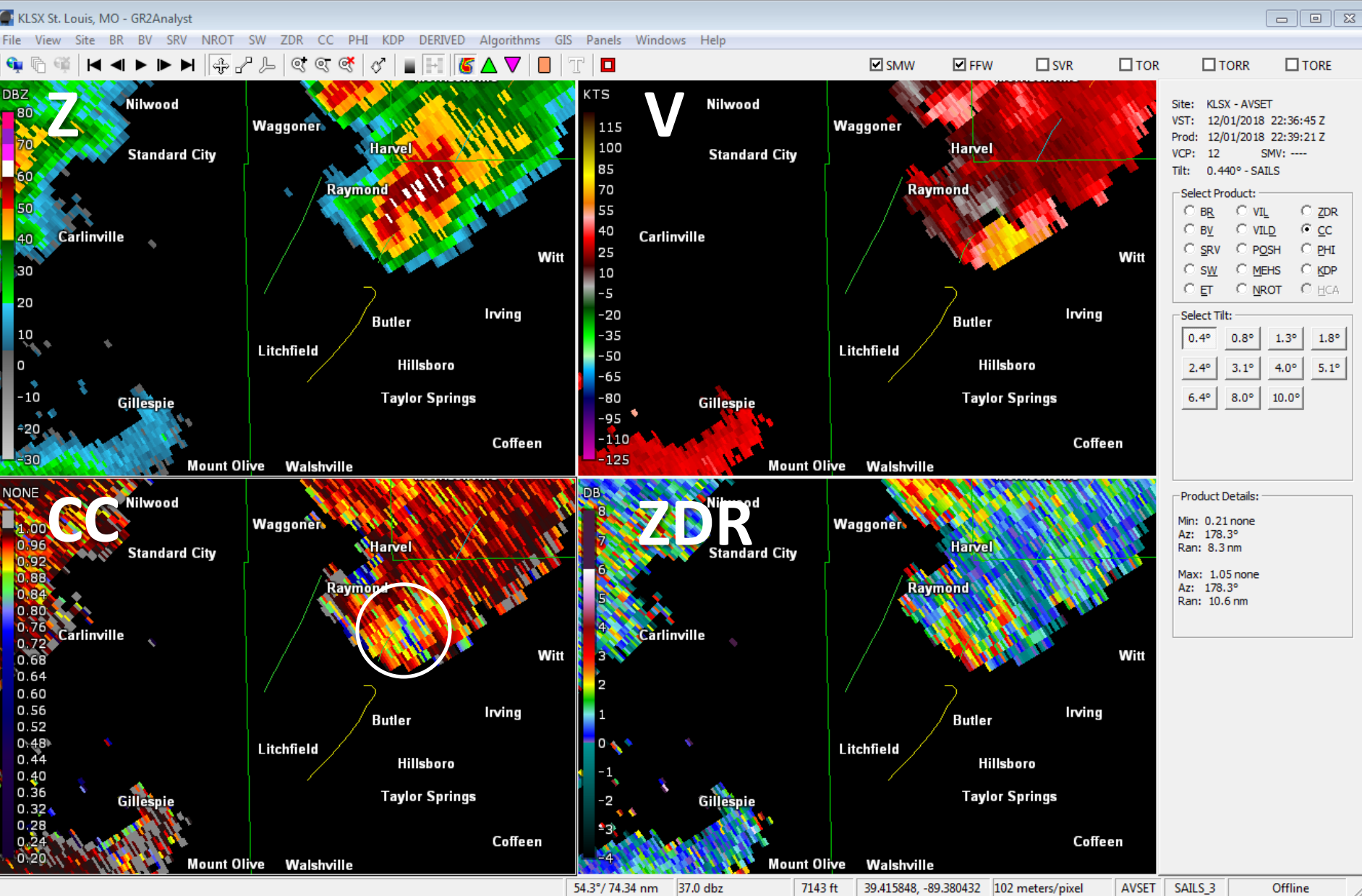


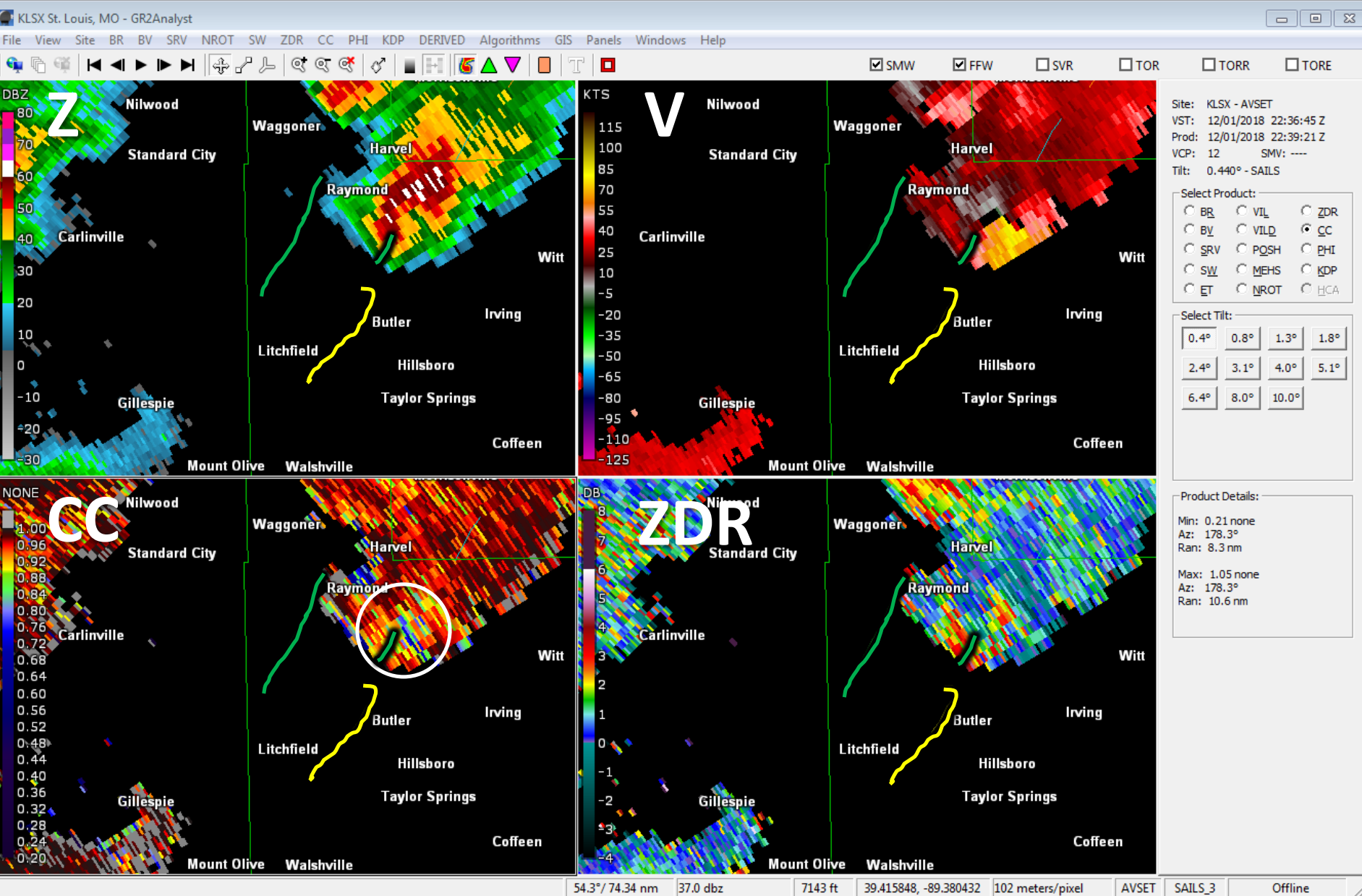


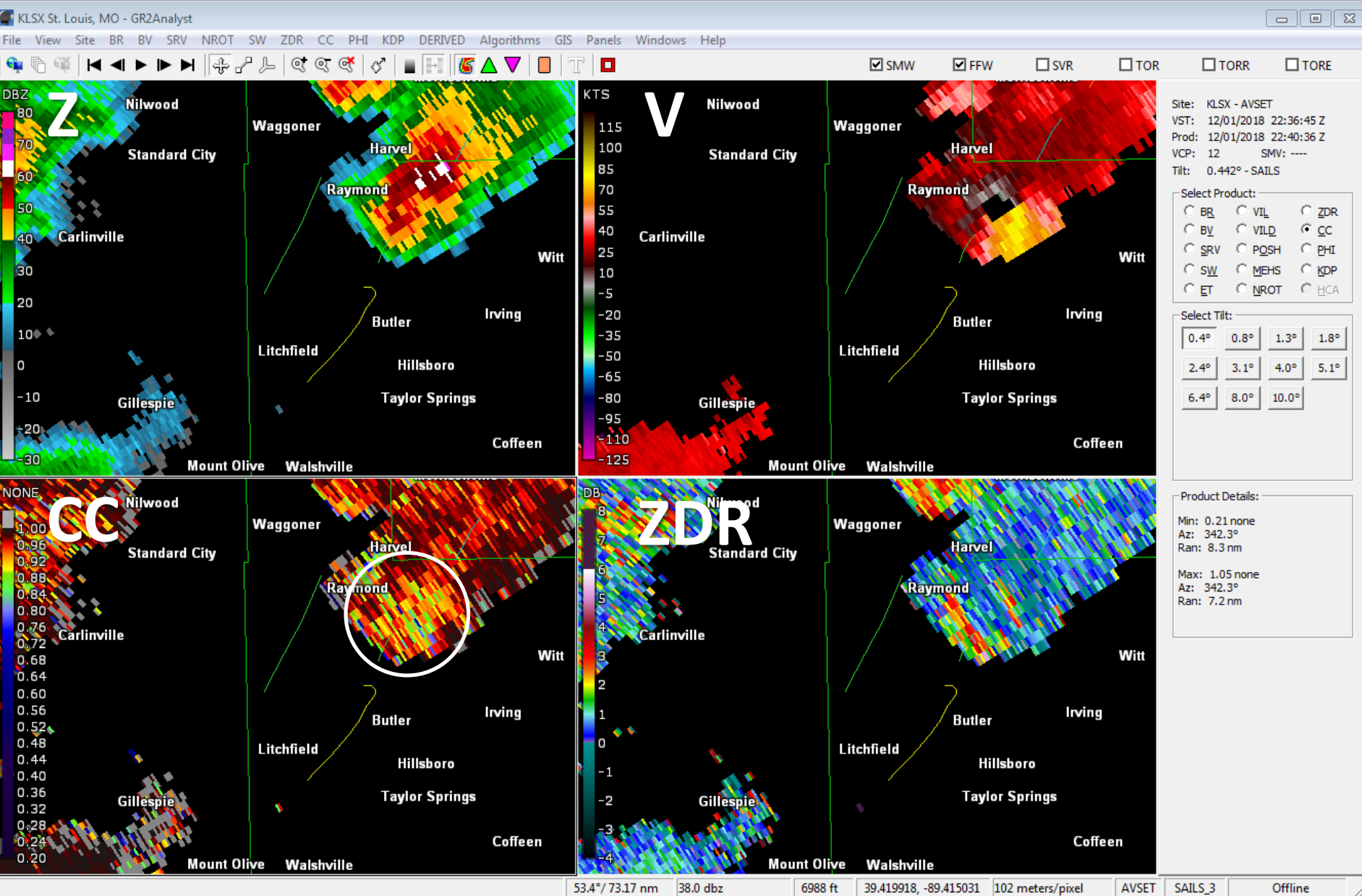
2237z

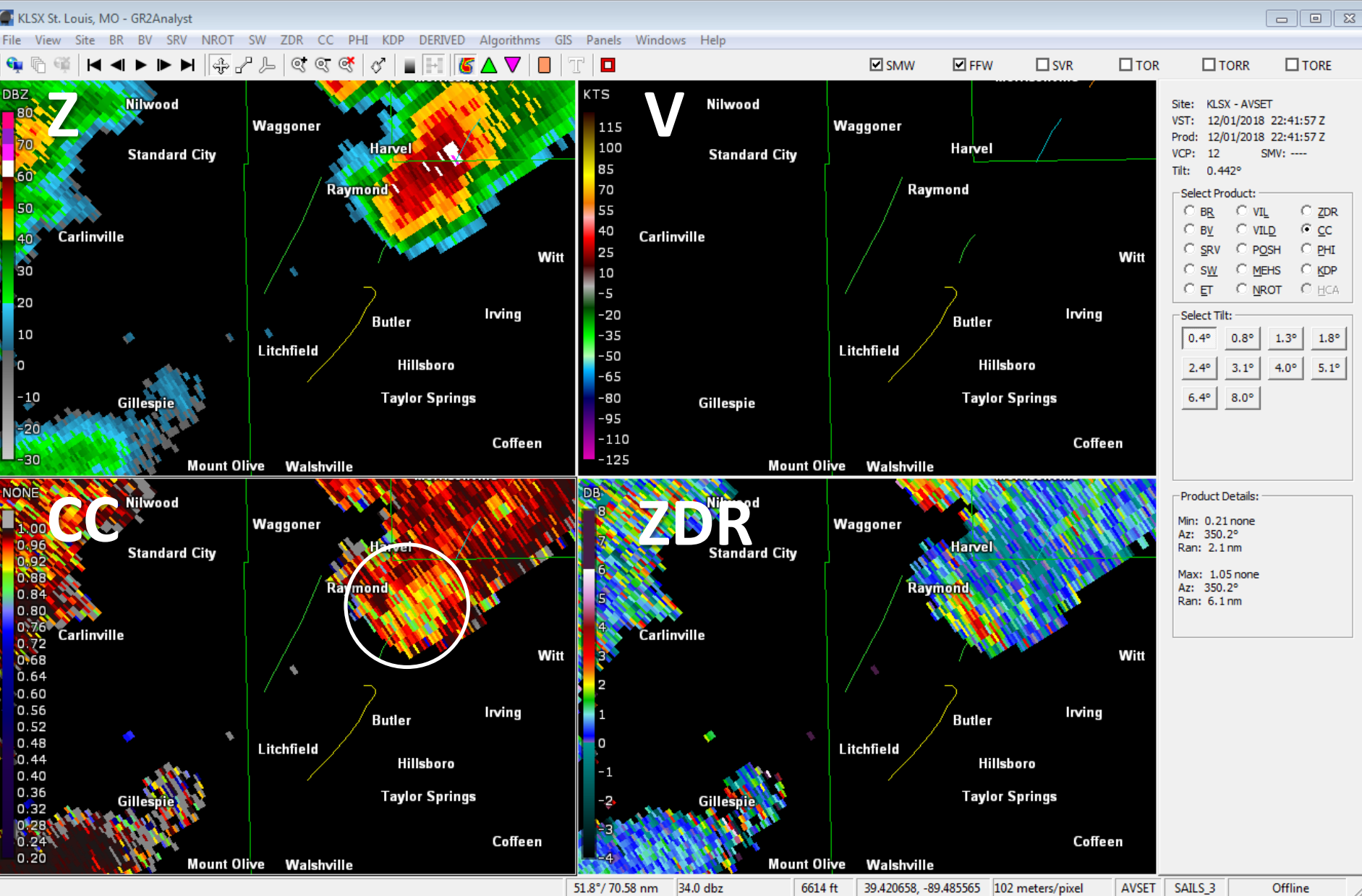
0.5°



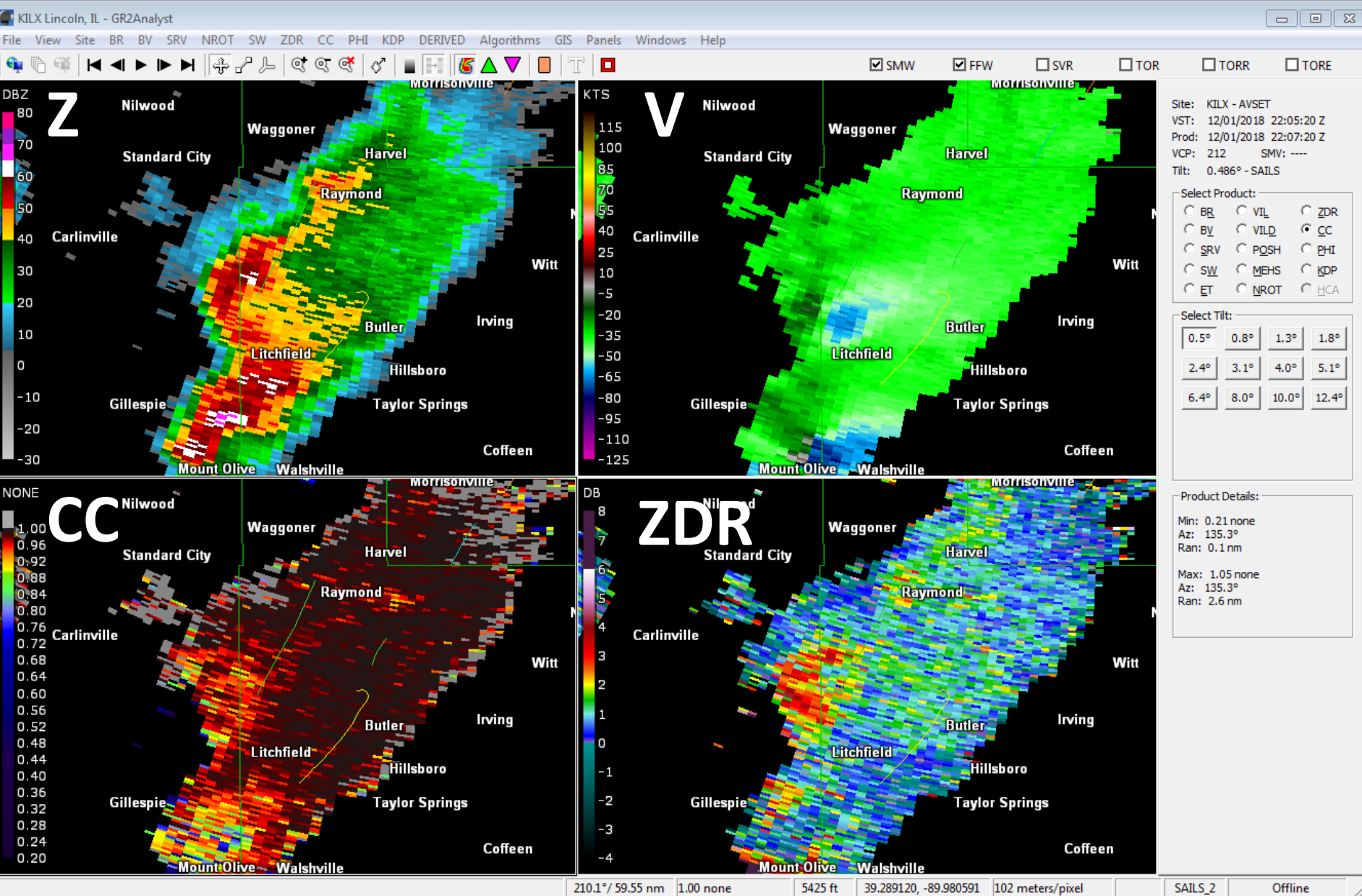


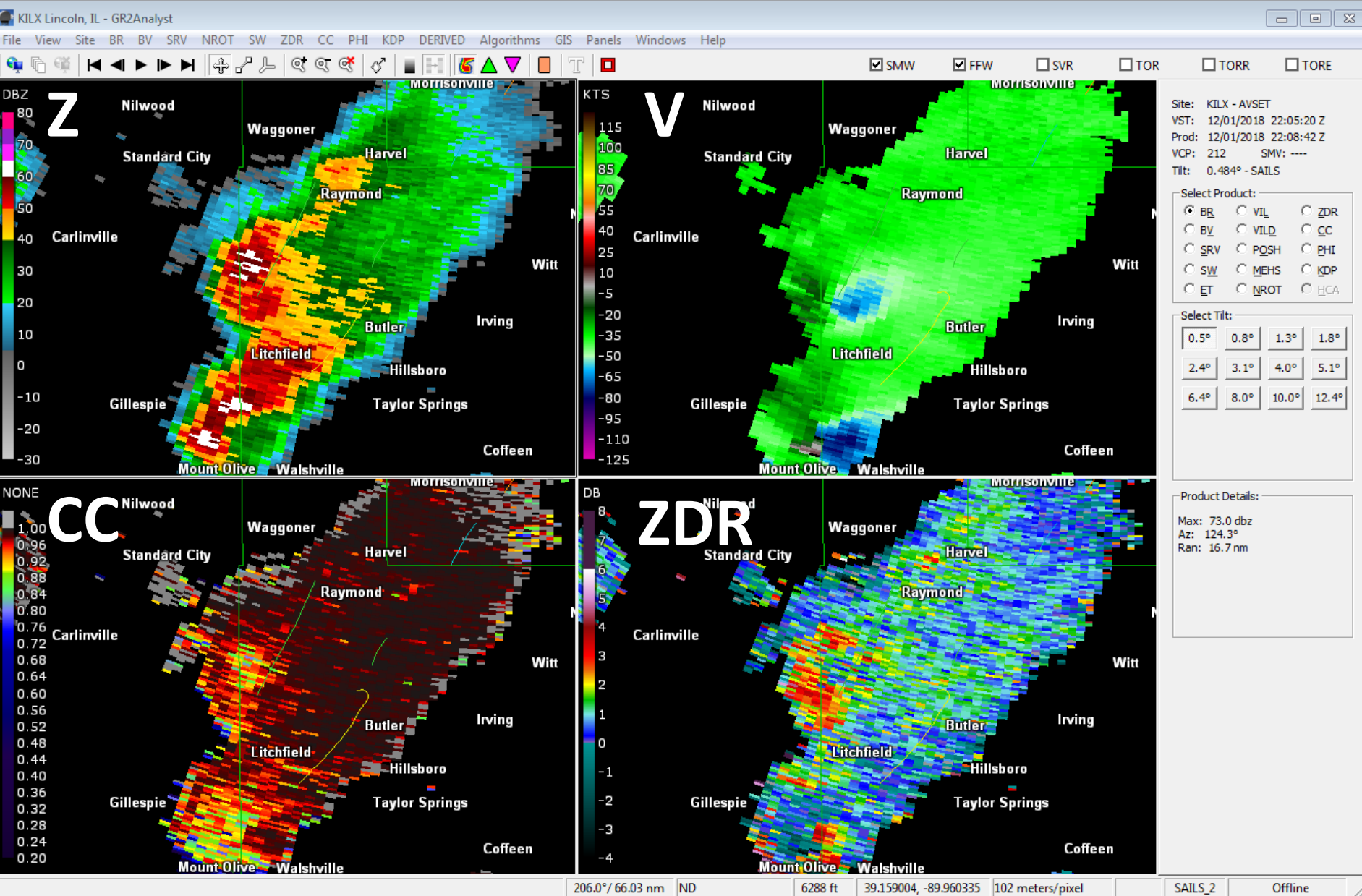


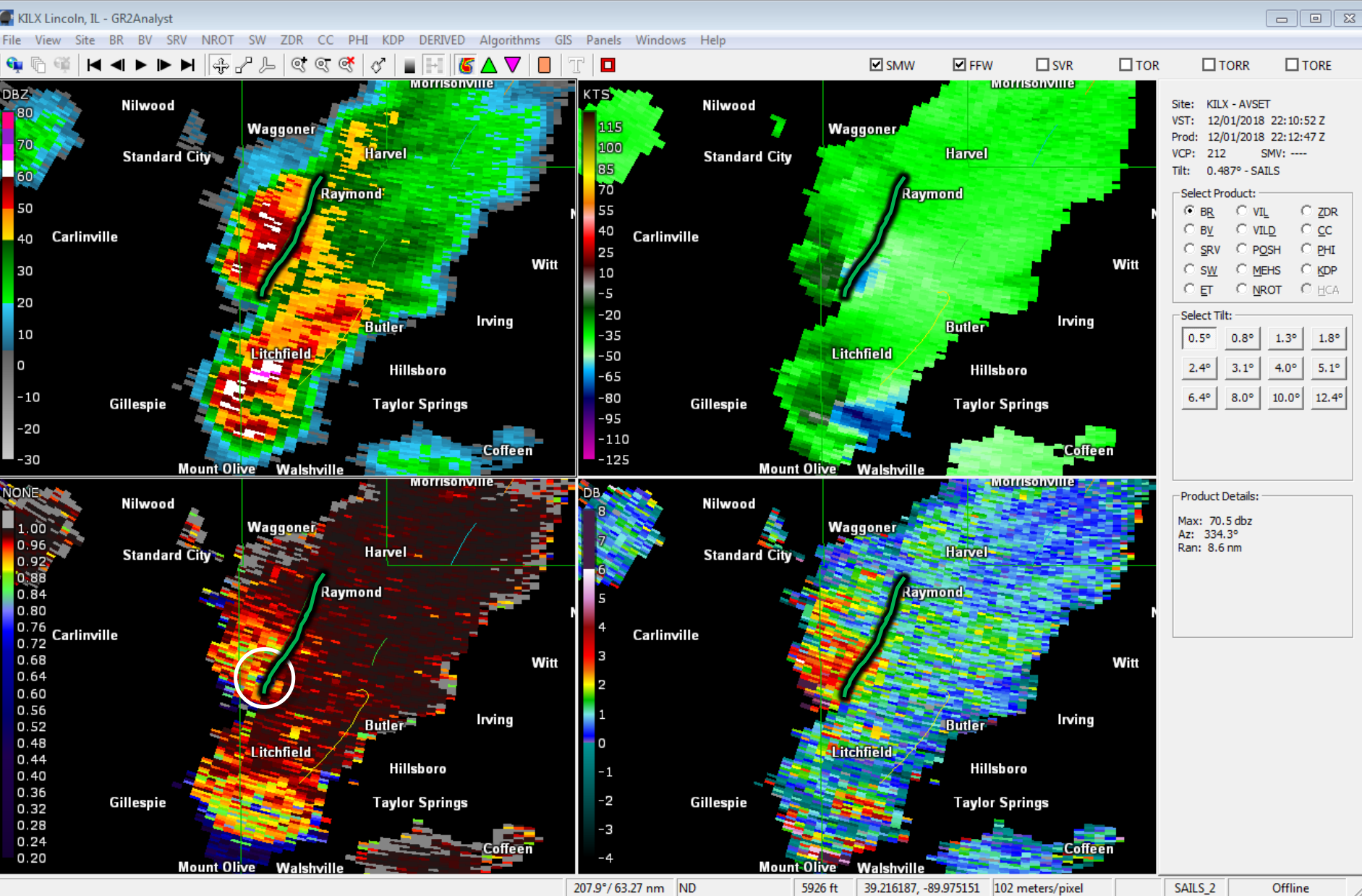




Alternate view from KILX

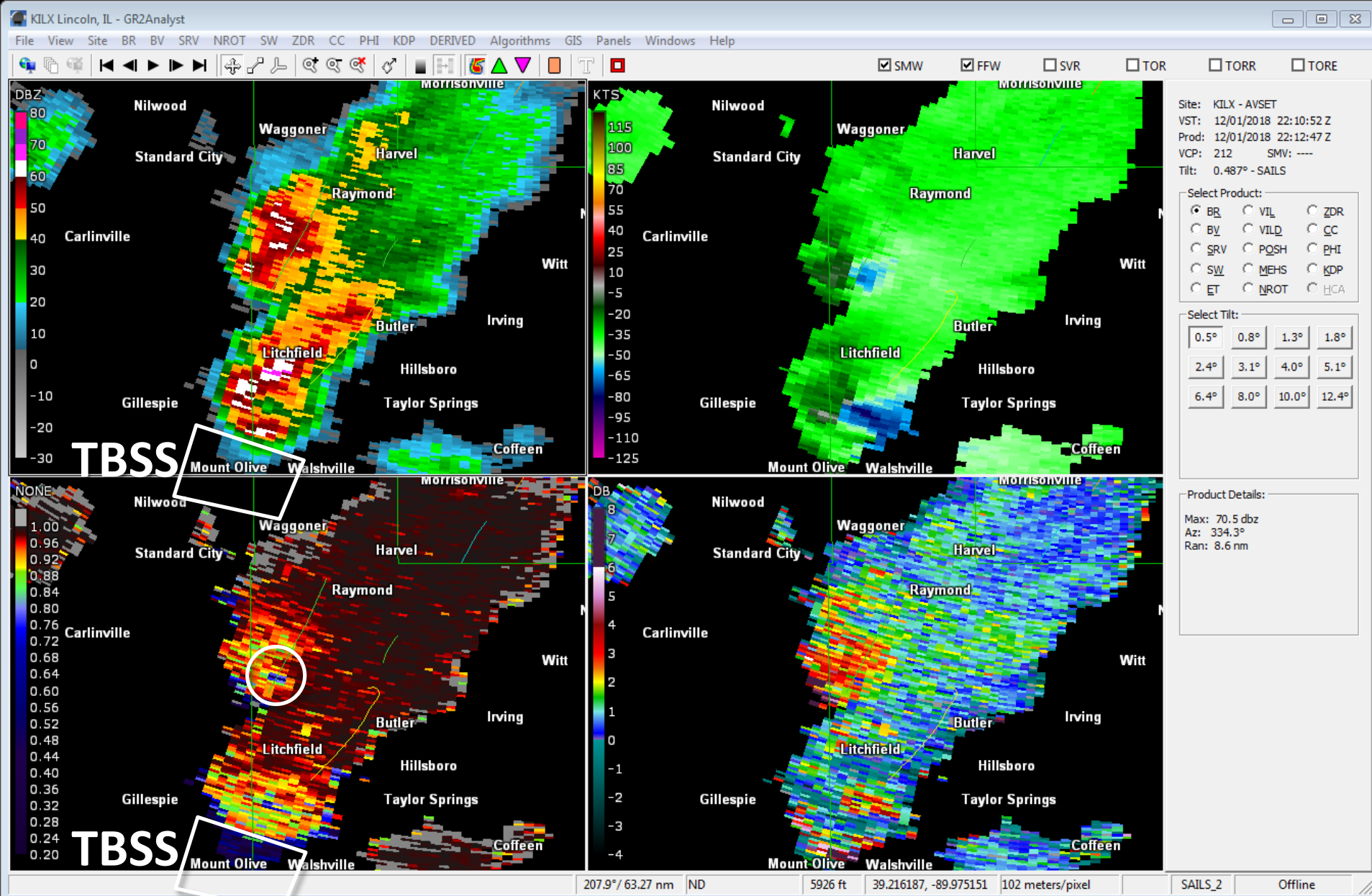


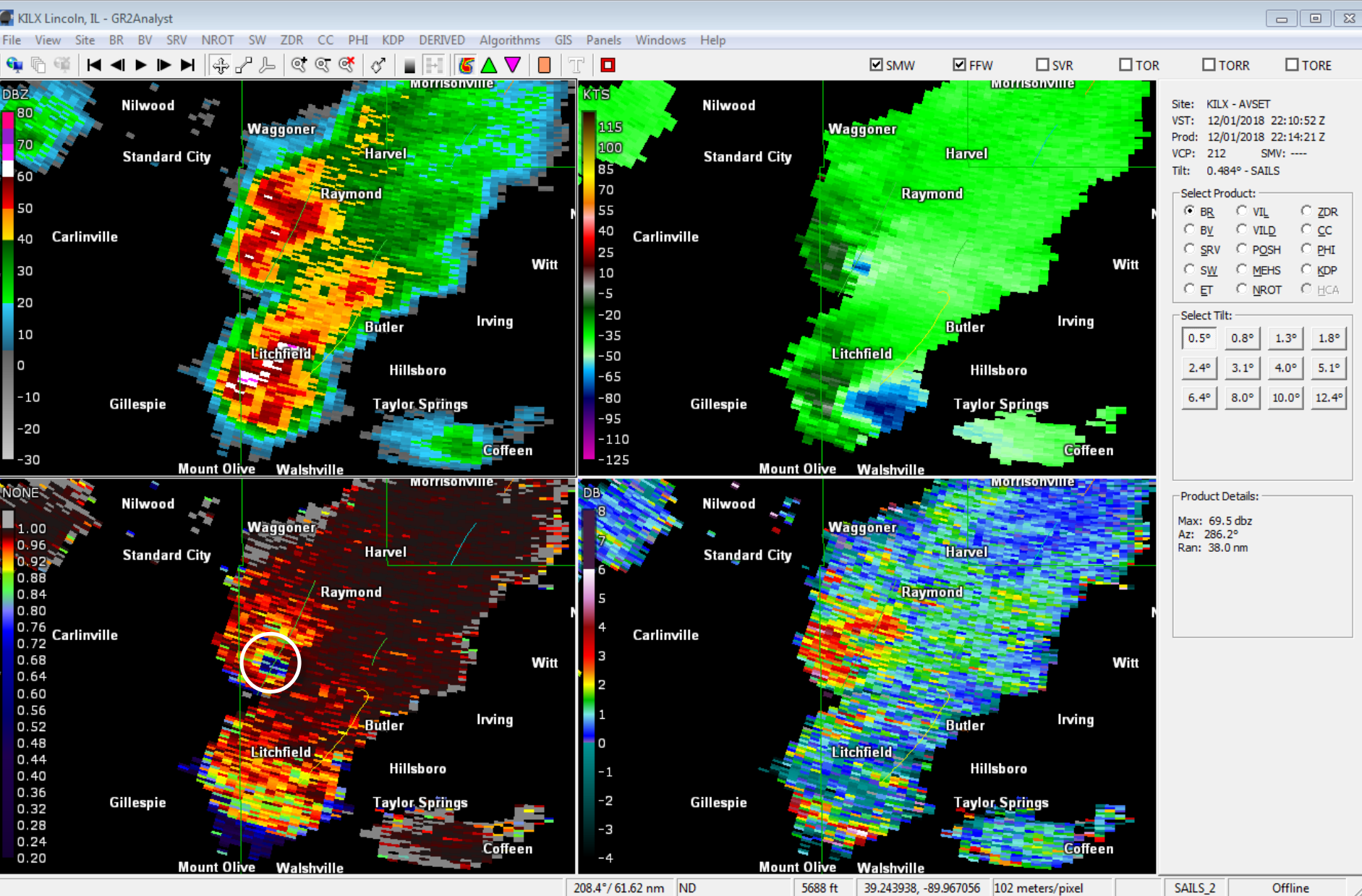




2212z

0.5°





NONE

1.00

0.96

0.92

0.88

0.84

0.80

0.76

0.72

0.68

0.64

0.60

0.56

0.52

0.48

0.44

0.40

0.36

0.32

0.28

0.24

0.20

DB

8

7

6

5

4

3

2

1

0

-1

-2

-3

-4

Site: KILX - AVSET

VST: 12/01/2018 22:10:52 Z

Prod: 12/01/2018 22:14:21 Z

VCP: 212 SMV: ----

Tilt: 0.484° - SAILS

Select Product:

☒ BR

☐ VIL

☐ ZDR

☐ BV

☐ VILQ

☐ CC

☐ SRV

☐ POSH

☐ PHI

☐ SW

☐ MEHS

☐ KDP

☐ ET

☐ NROT

☐ HCA

Select Tilt:

0.5°

0.8°

1.3°

1.8°

2.4°

3.1°

4.0°

5.1°

6.4°

8.0°

10.0°

12.4°

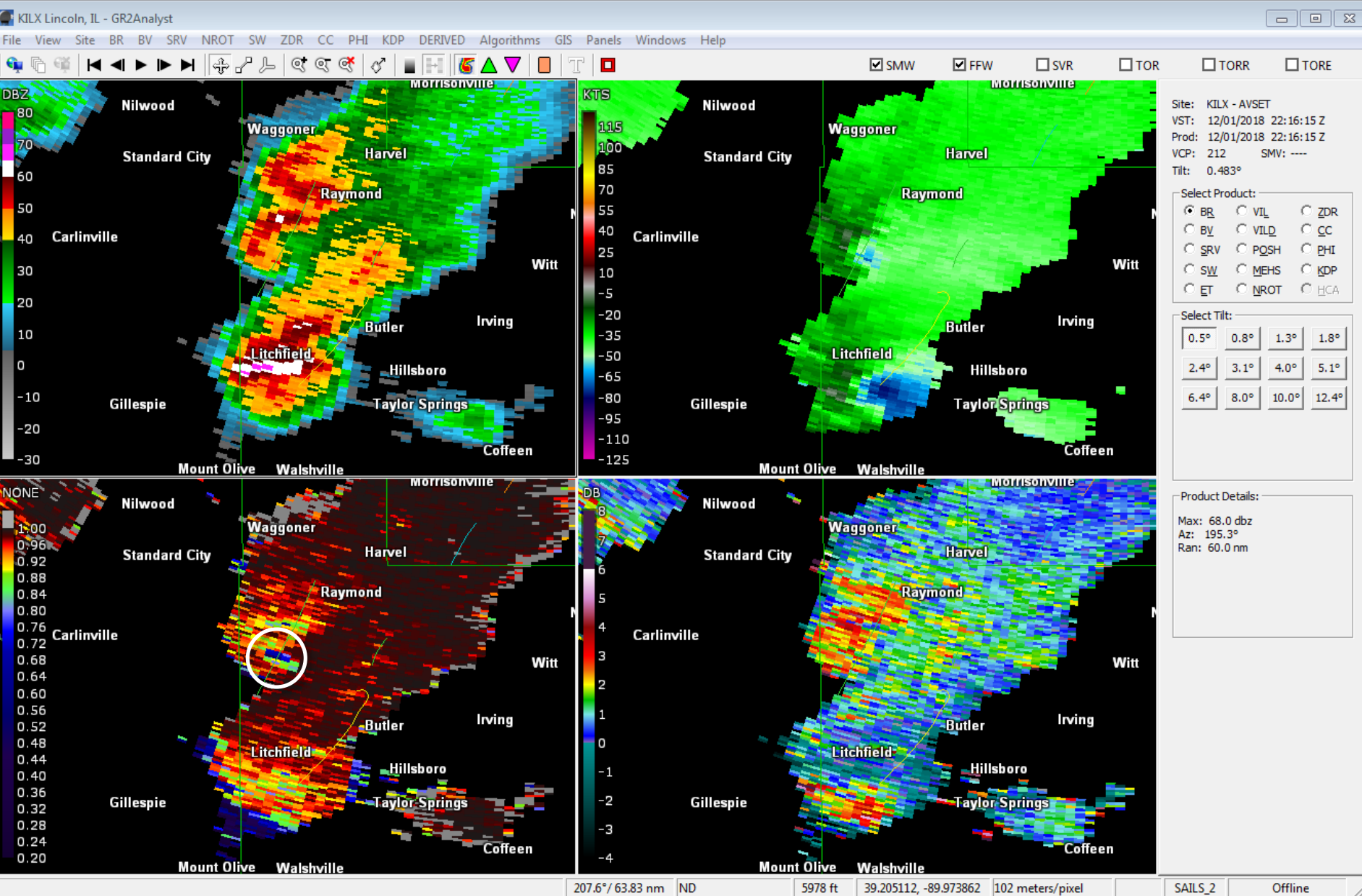
Product Details:

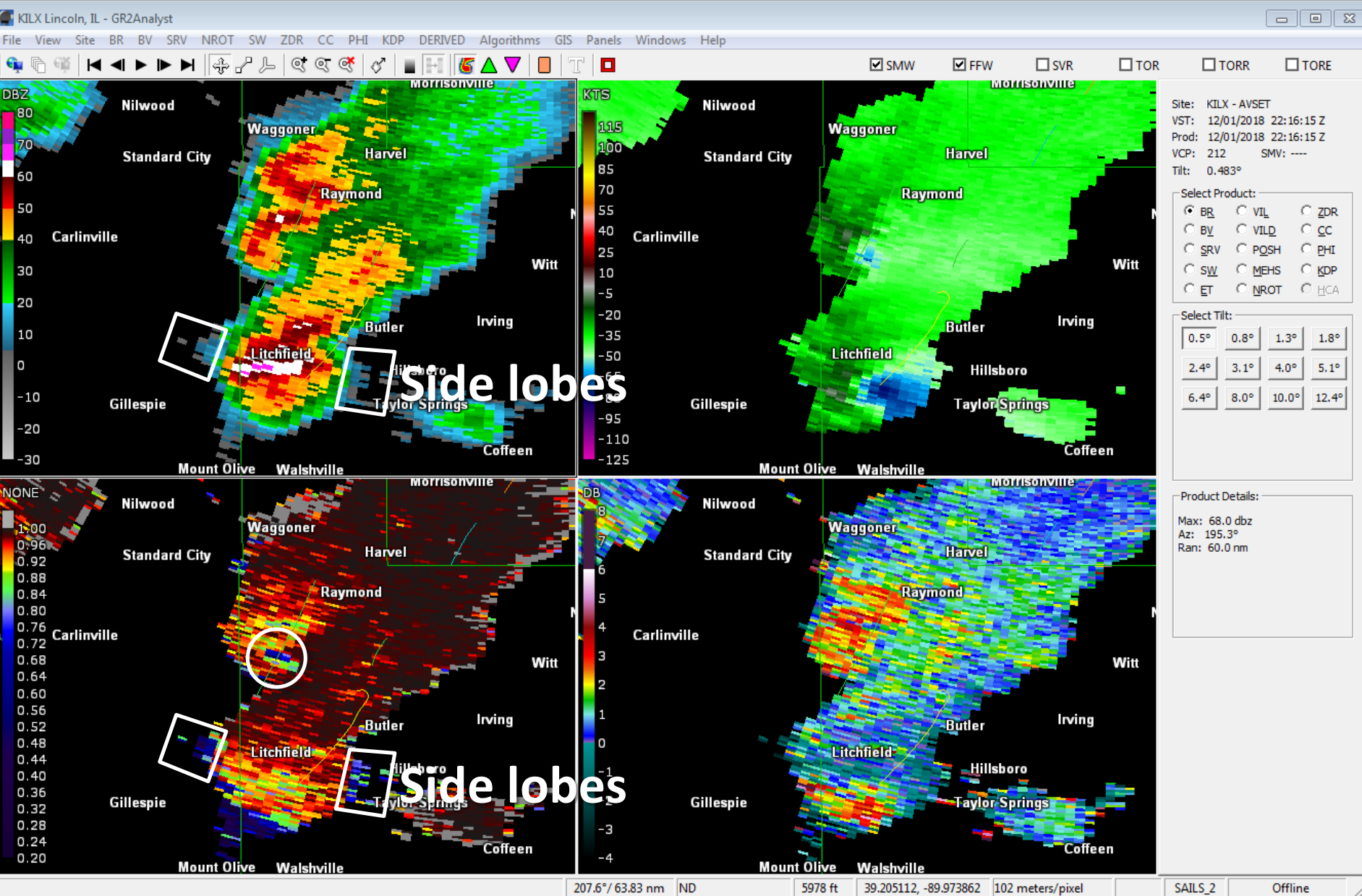
Max: 69.5 dbz

Az: 286.2°

Ran: 38.0 nm

208.4° / 61.62 nm ND 5688 ft 39.243938, -89.967056 102 meters/pixel SAILS_2 Offline





Product Details:

Max: 68.0 dbz

Az: 195.3°

Ran: 60.0 nm

207.6°/63.83 nm

ND

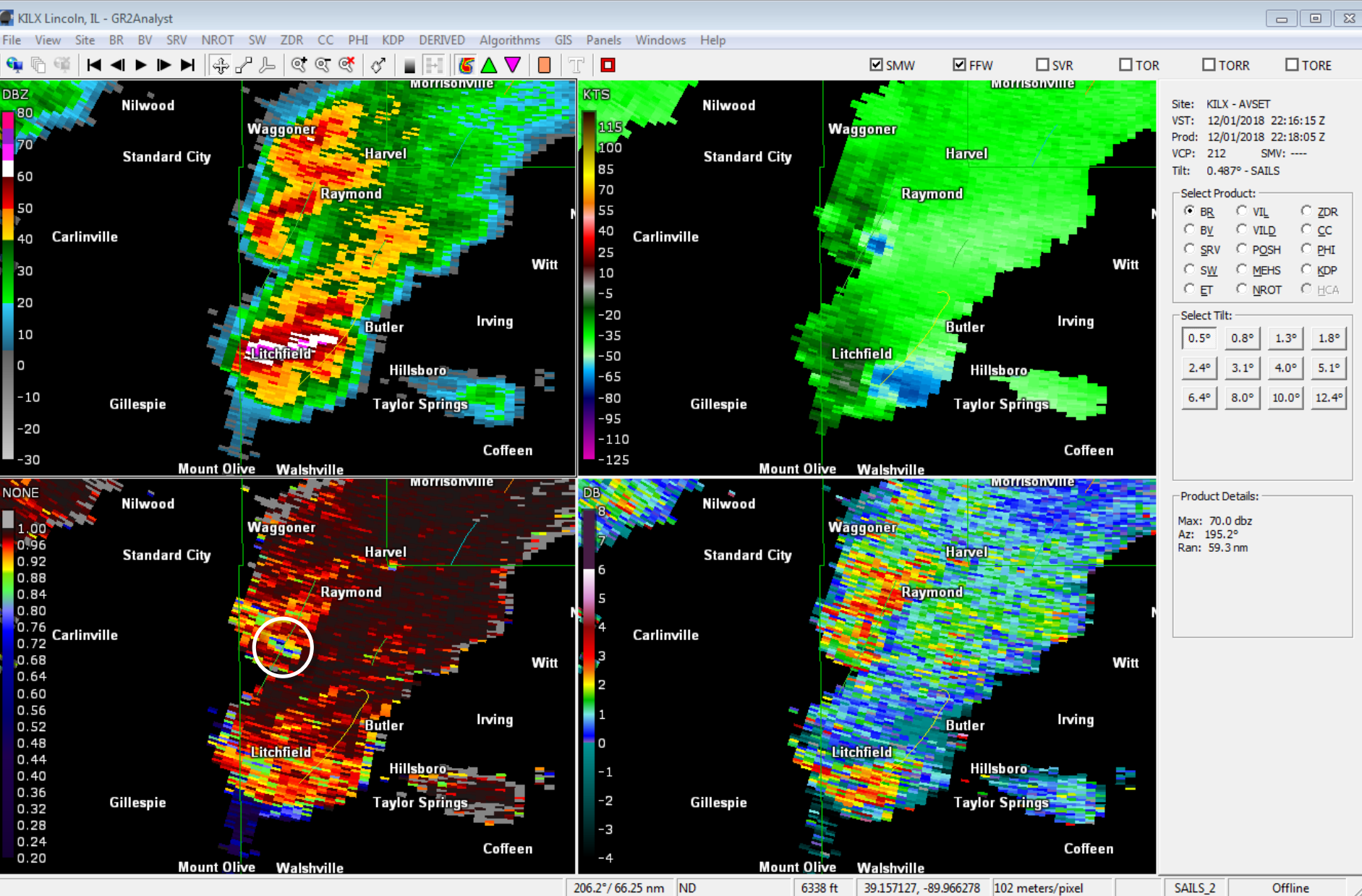
5978 ft

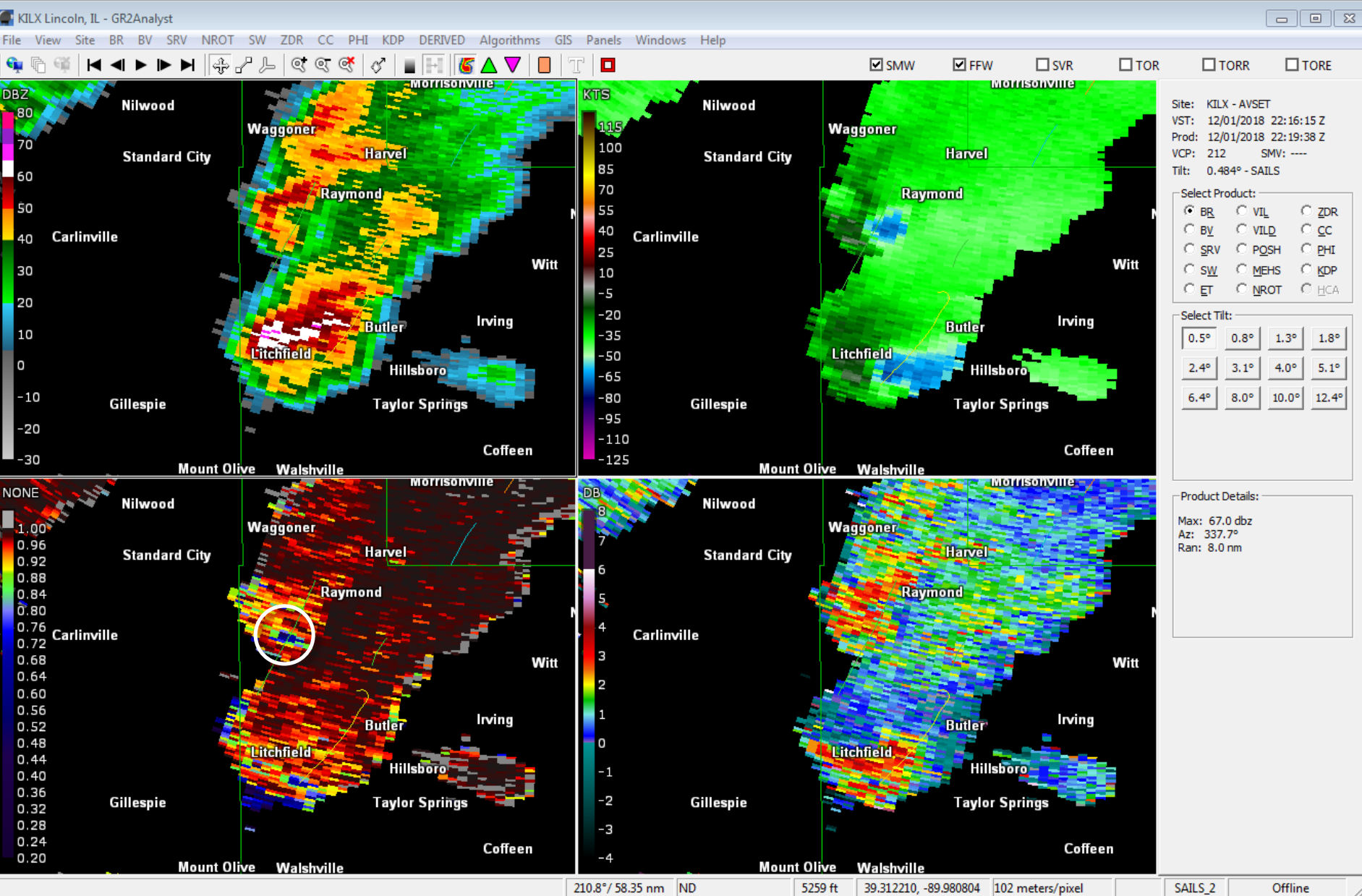
39.205112, -89.973862

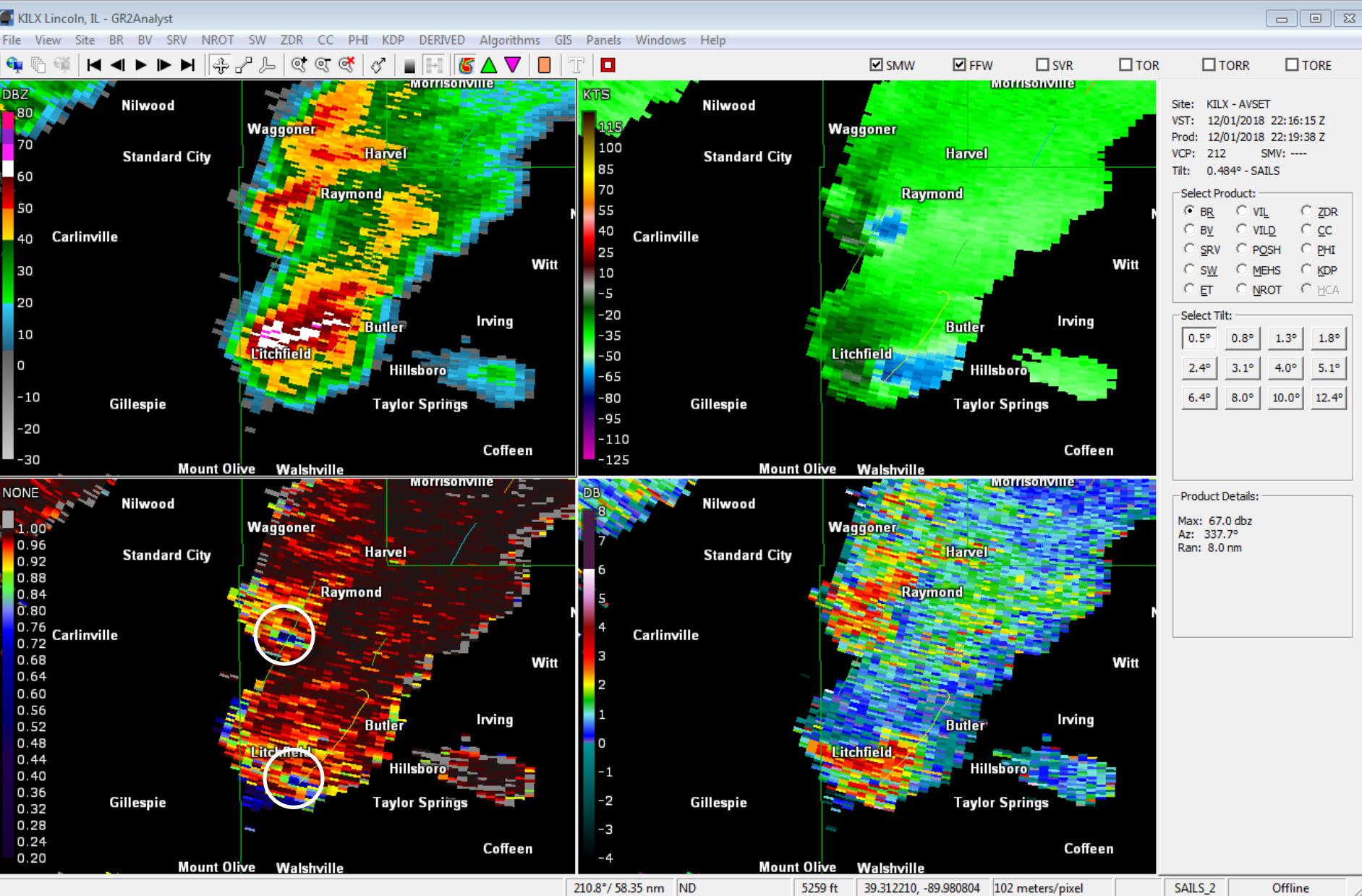
102 meters/pixel

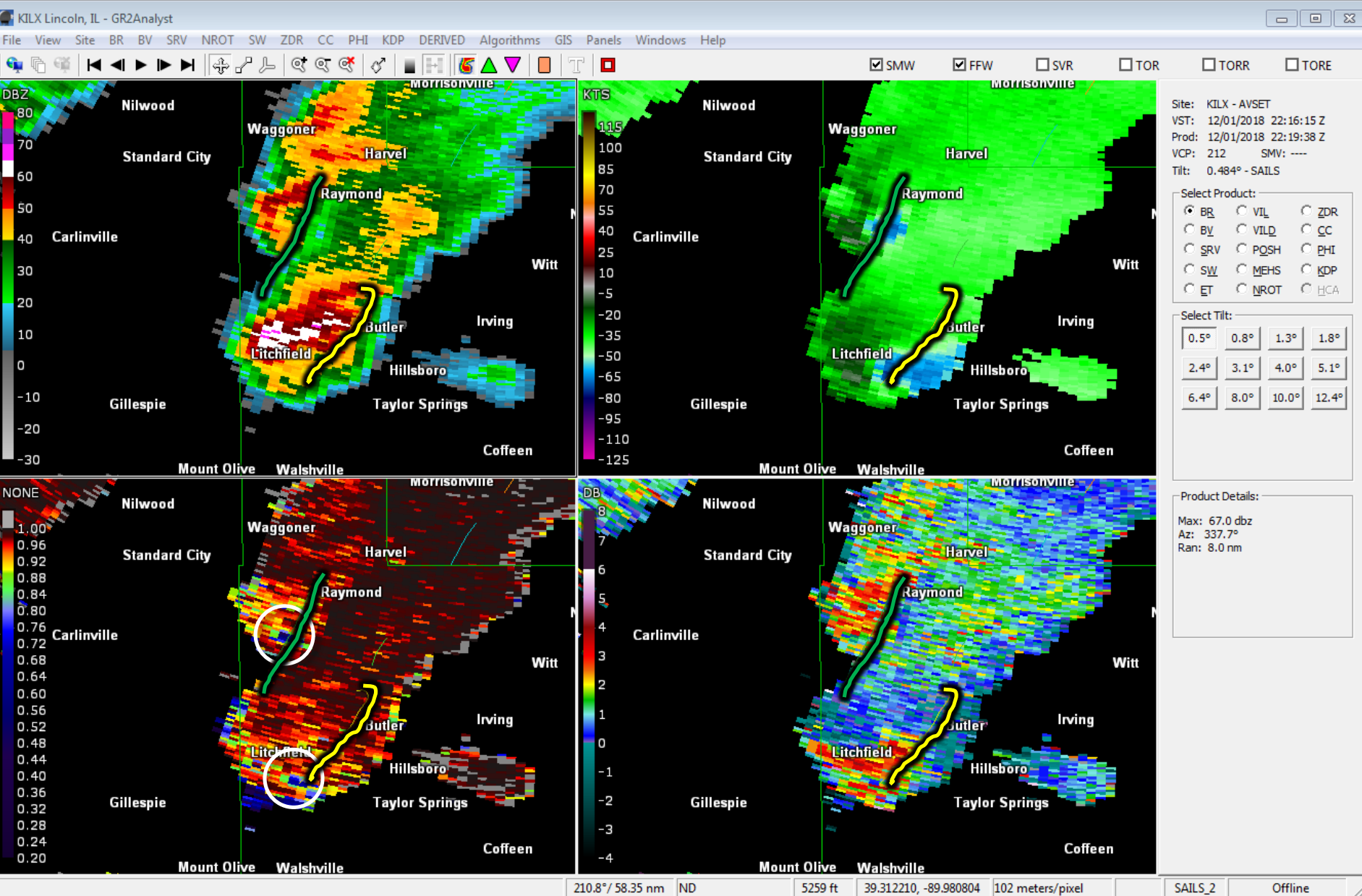
SAILS_2

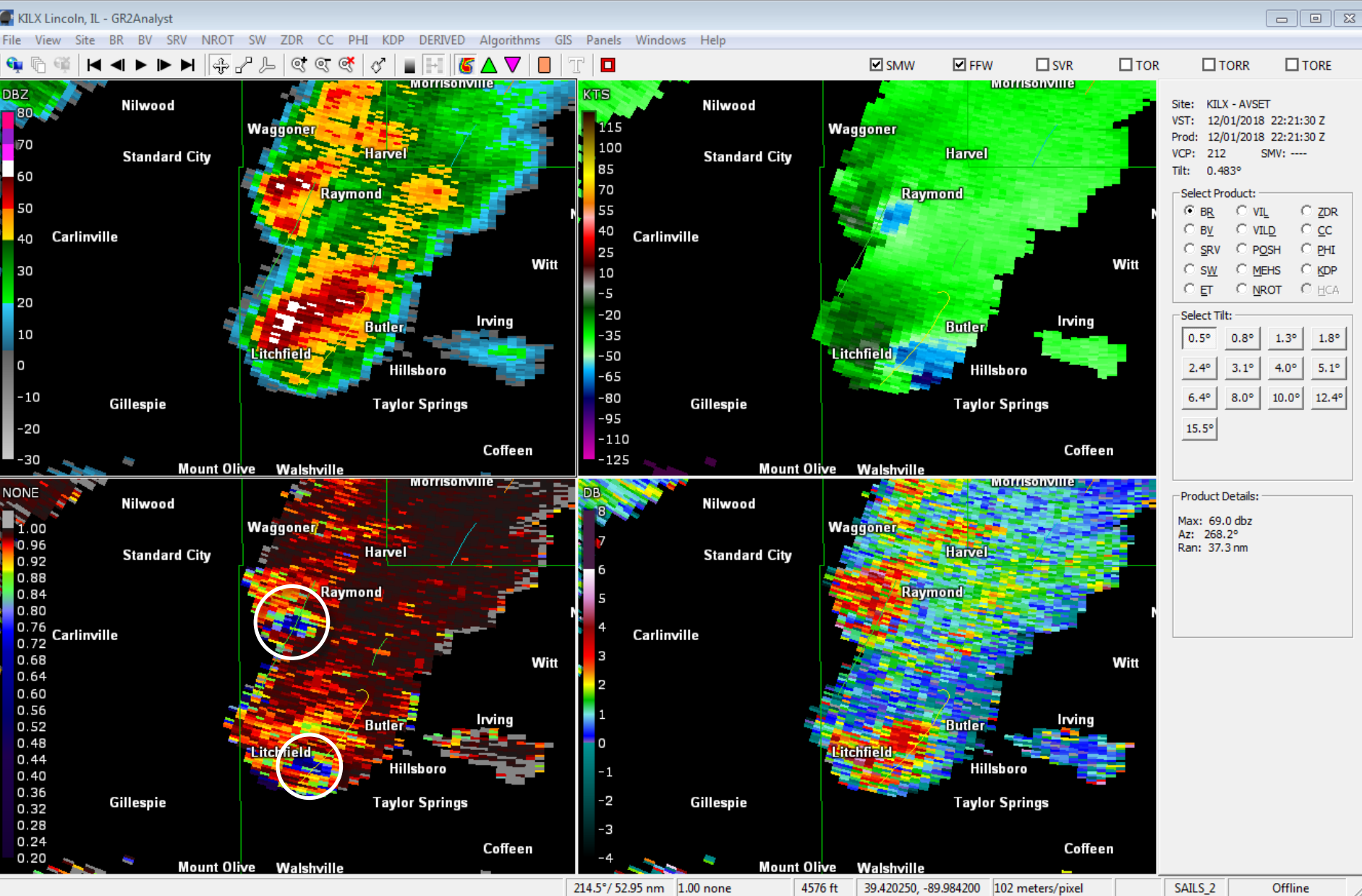
Offline

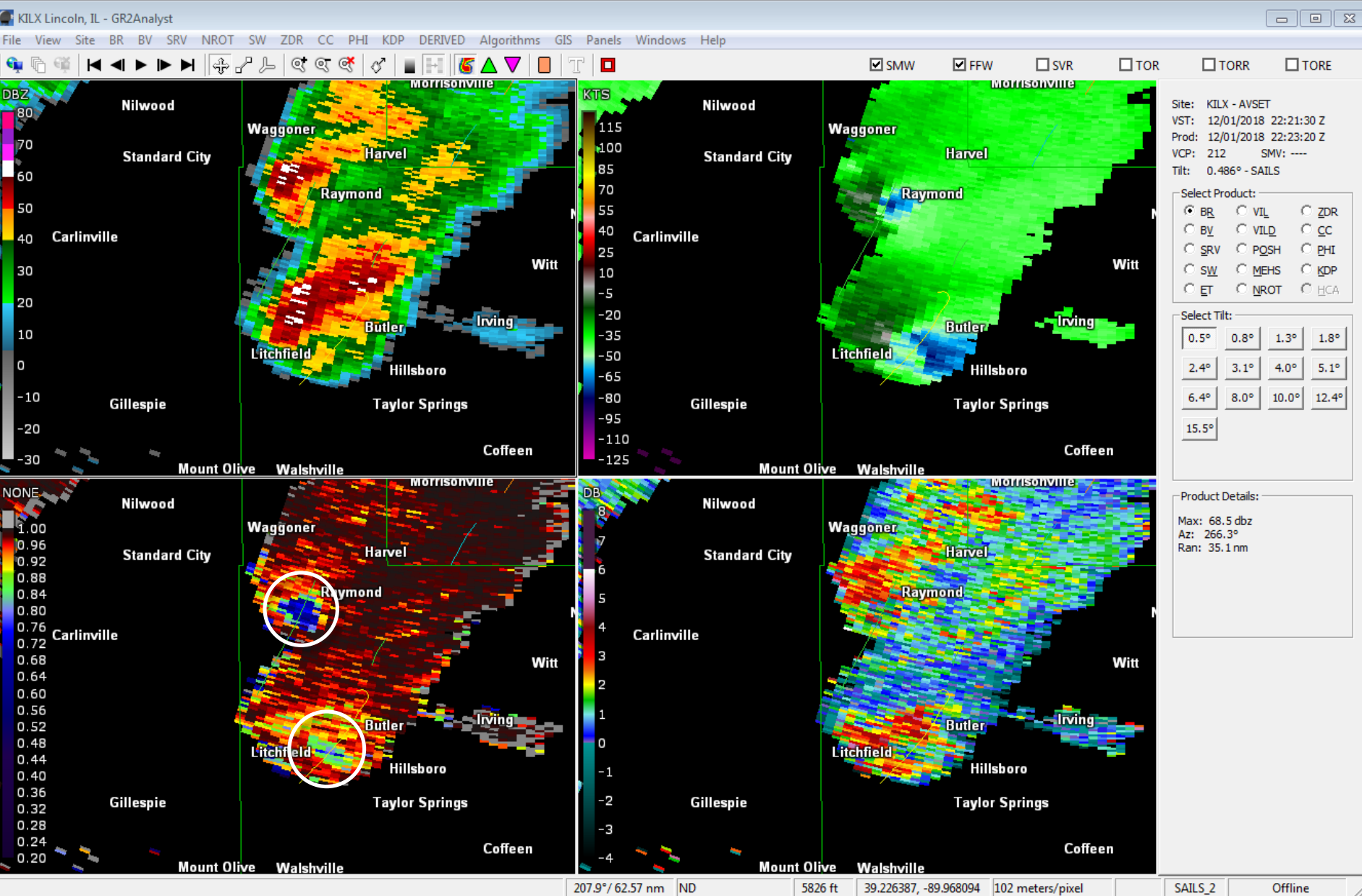


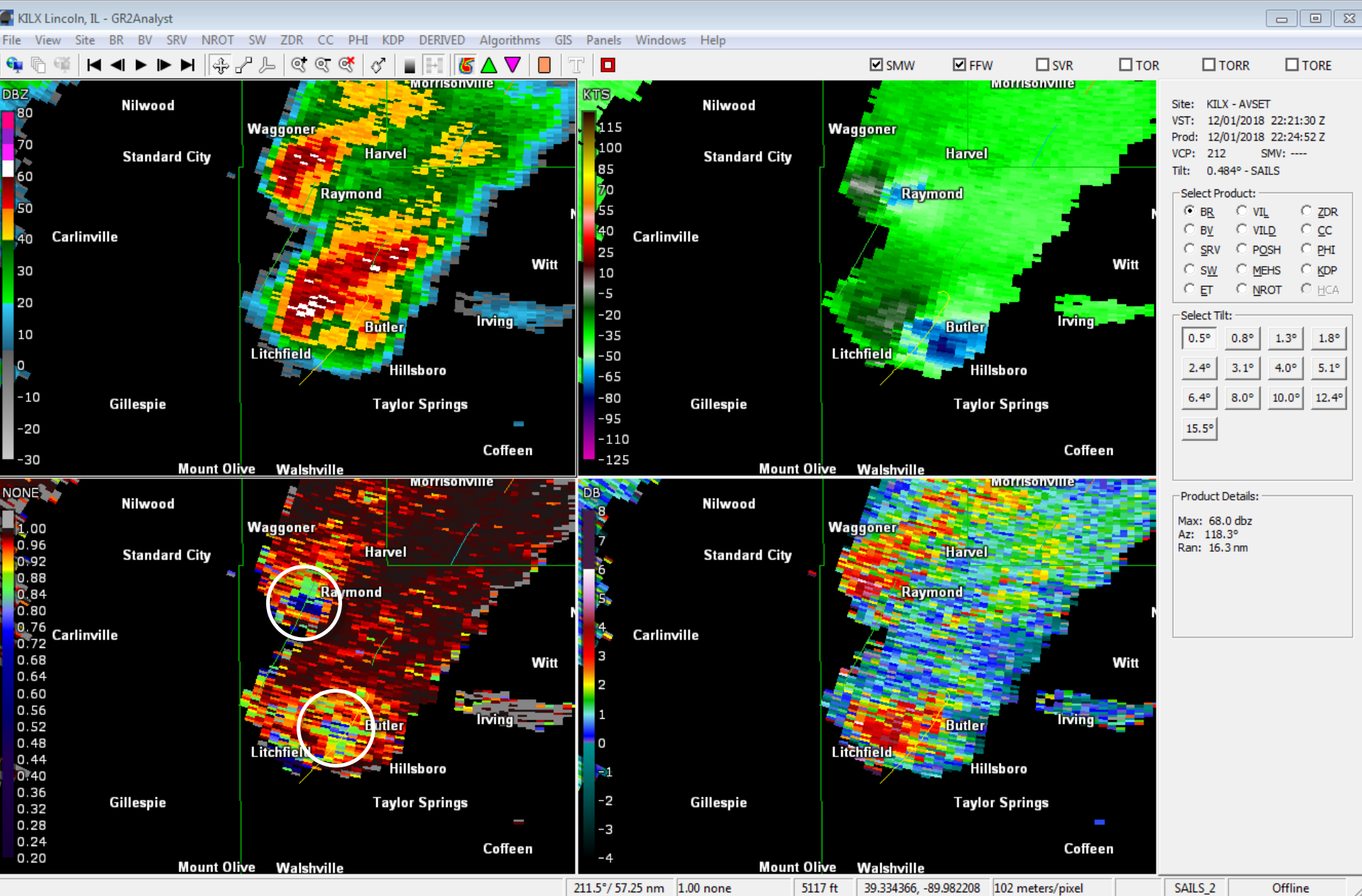












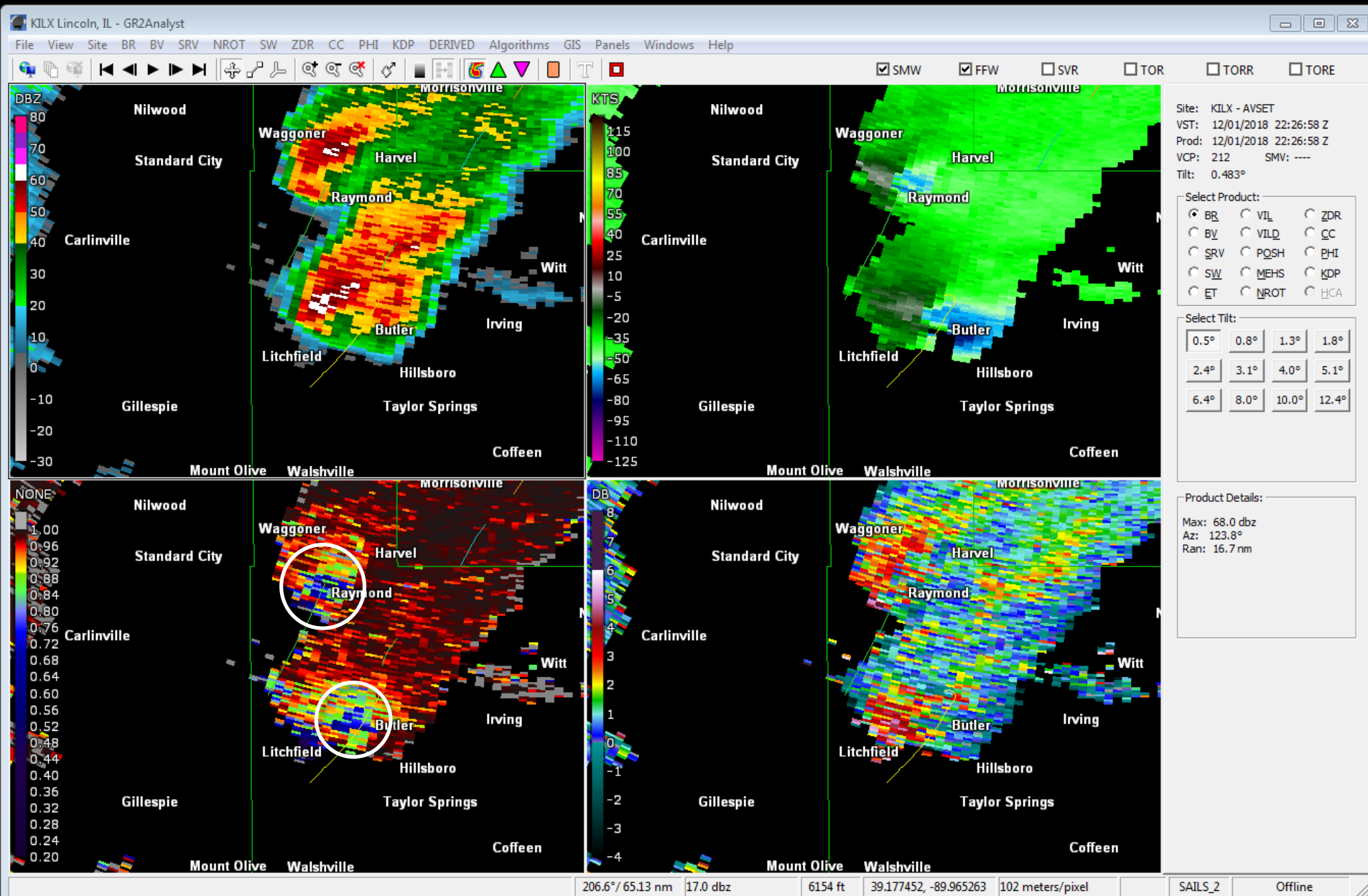
01 Dec 2018

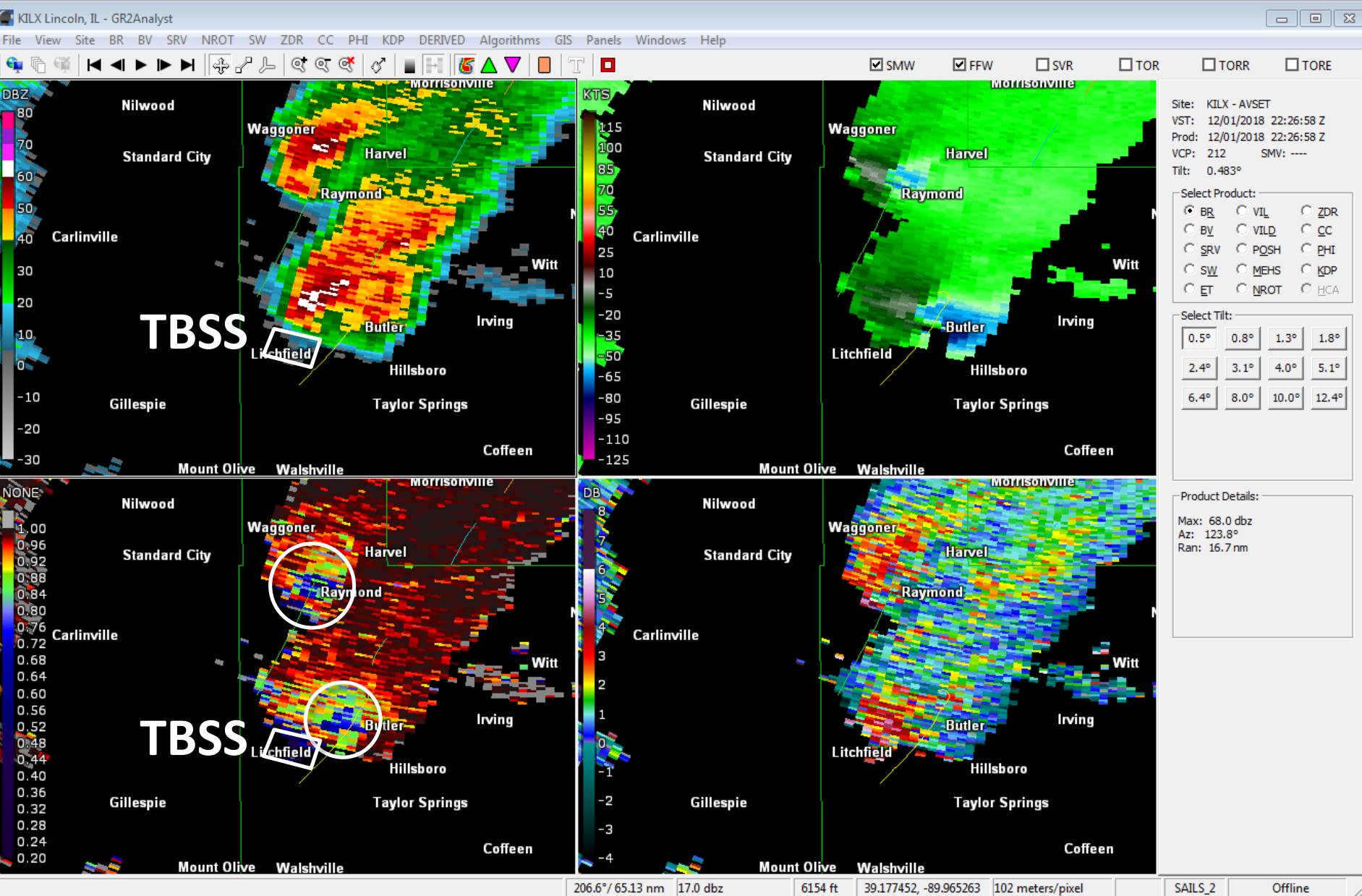
NBF contamination on the northern storm?

2226z

KILX

0.5°





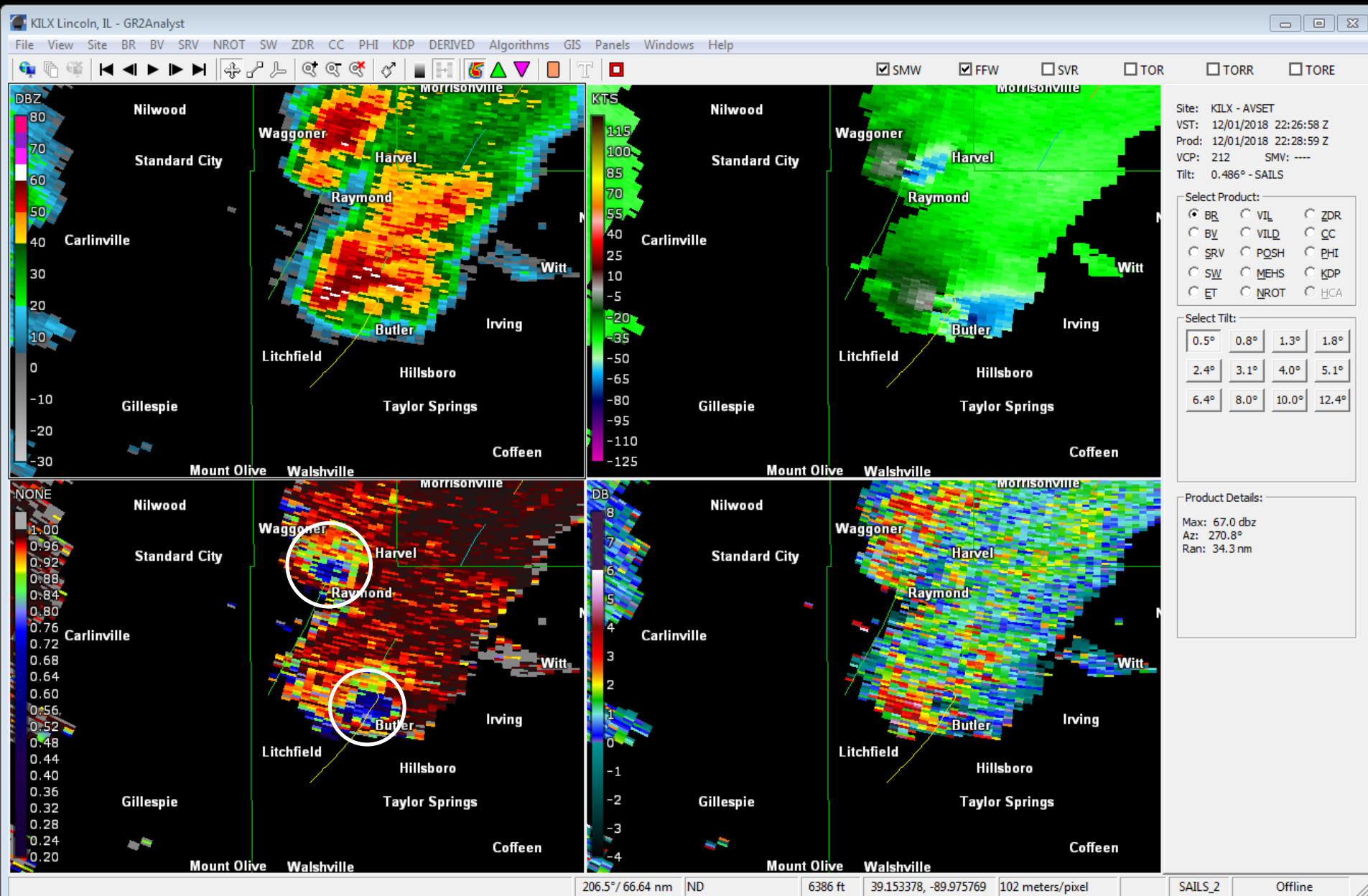
01 Dec 2018

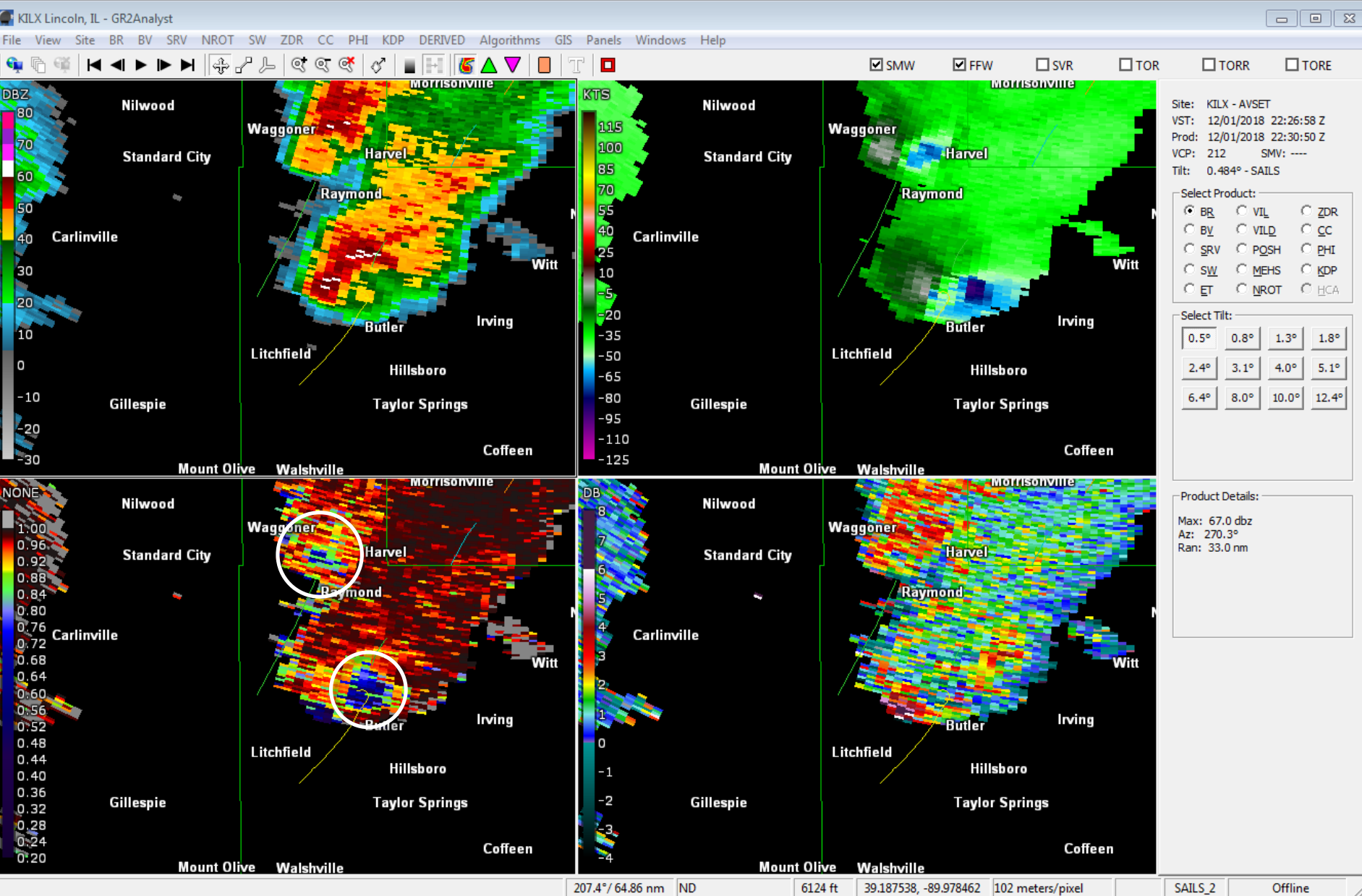
NBF contamination on the northern storm?

2228z

KILX

0.5°





01 Dec 2018

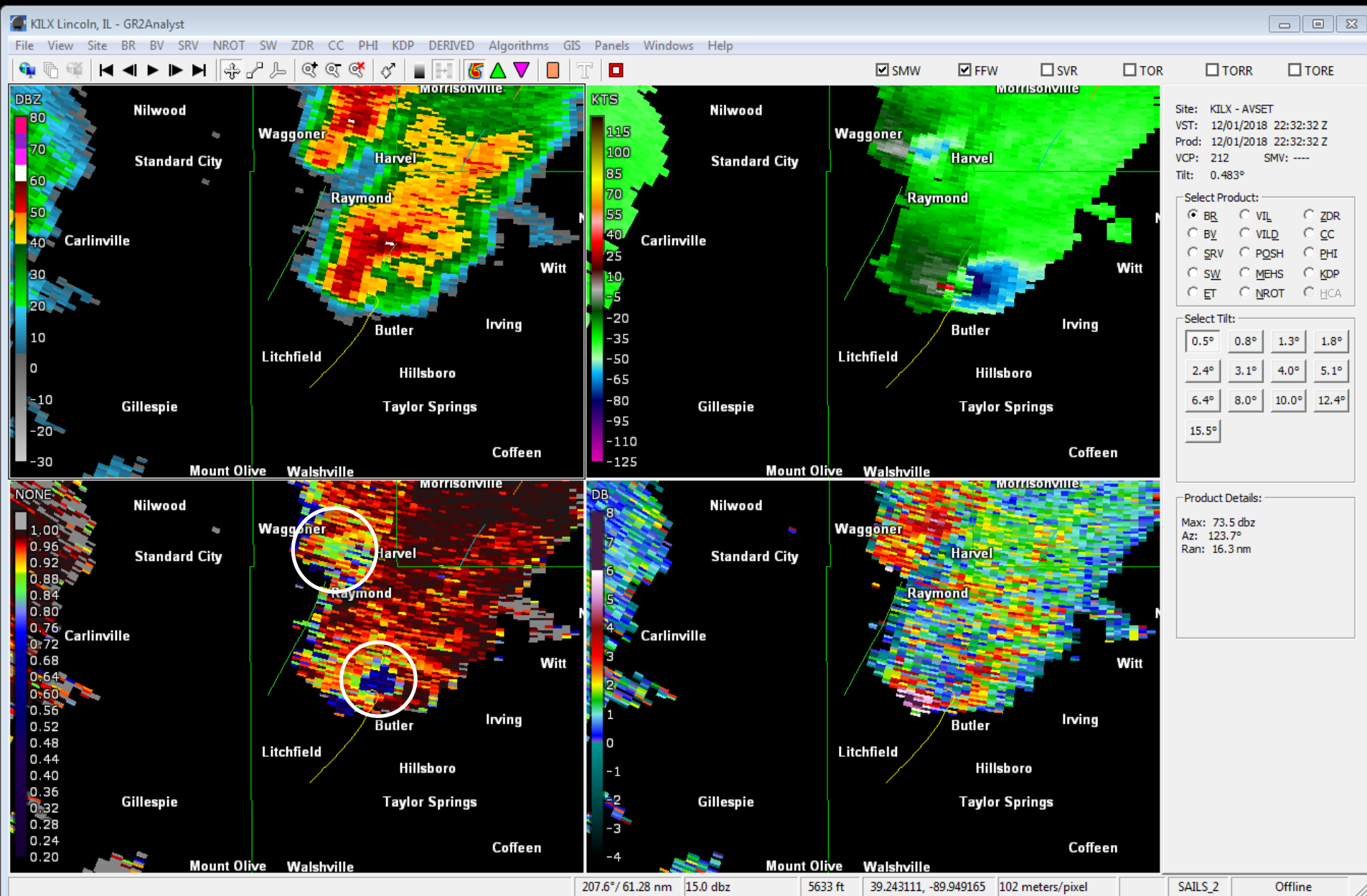
NBF contamination on the northern storm?

2232z

KILX

TBSS contamination on the southern storm?

0.5°



01 Dec 2018

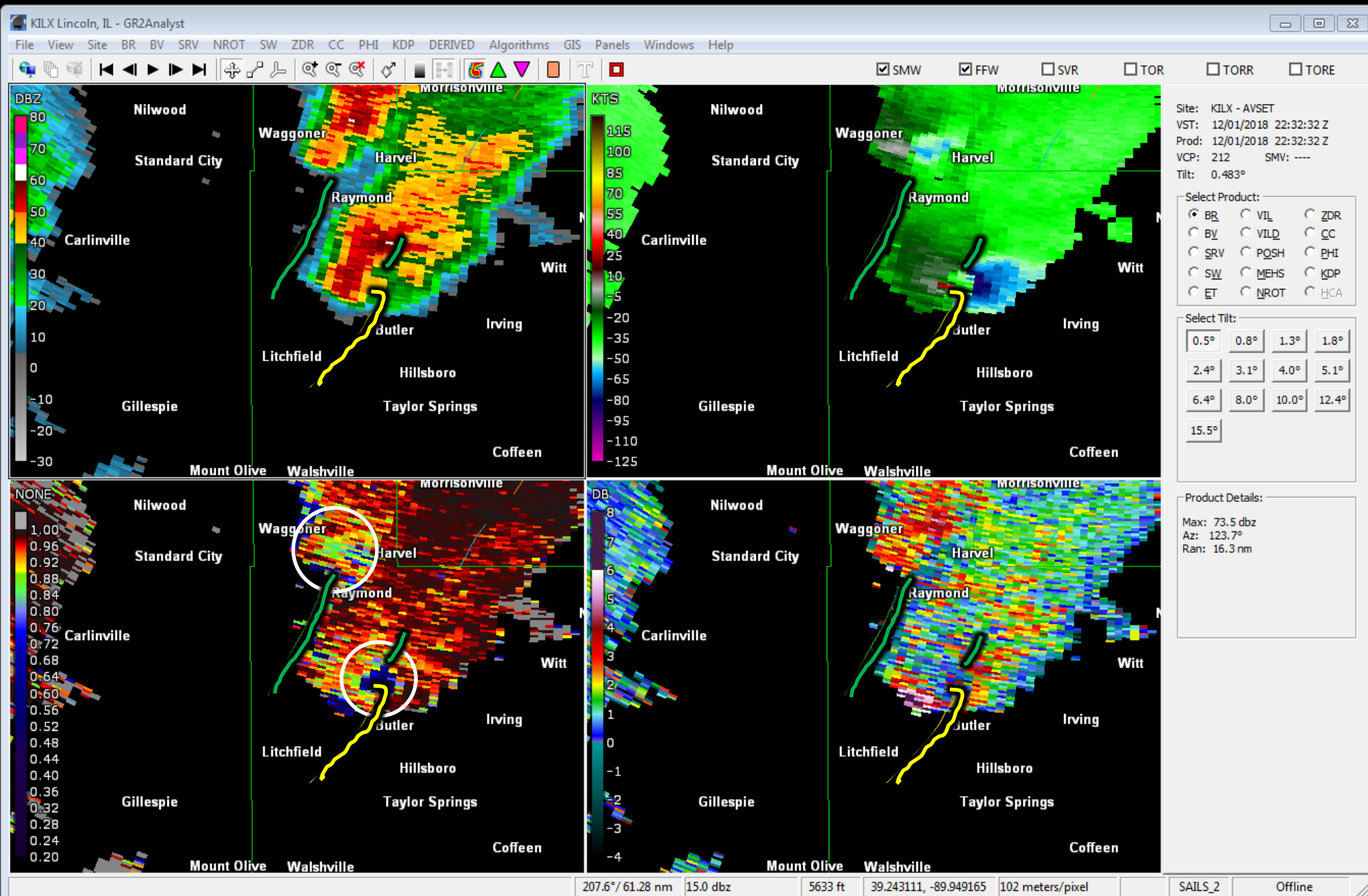
NBF contamination on the northern storm?

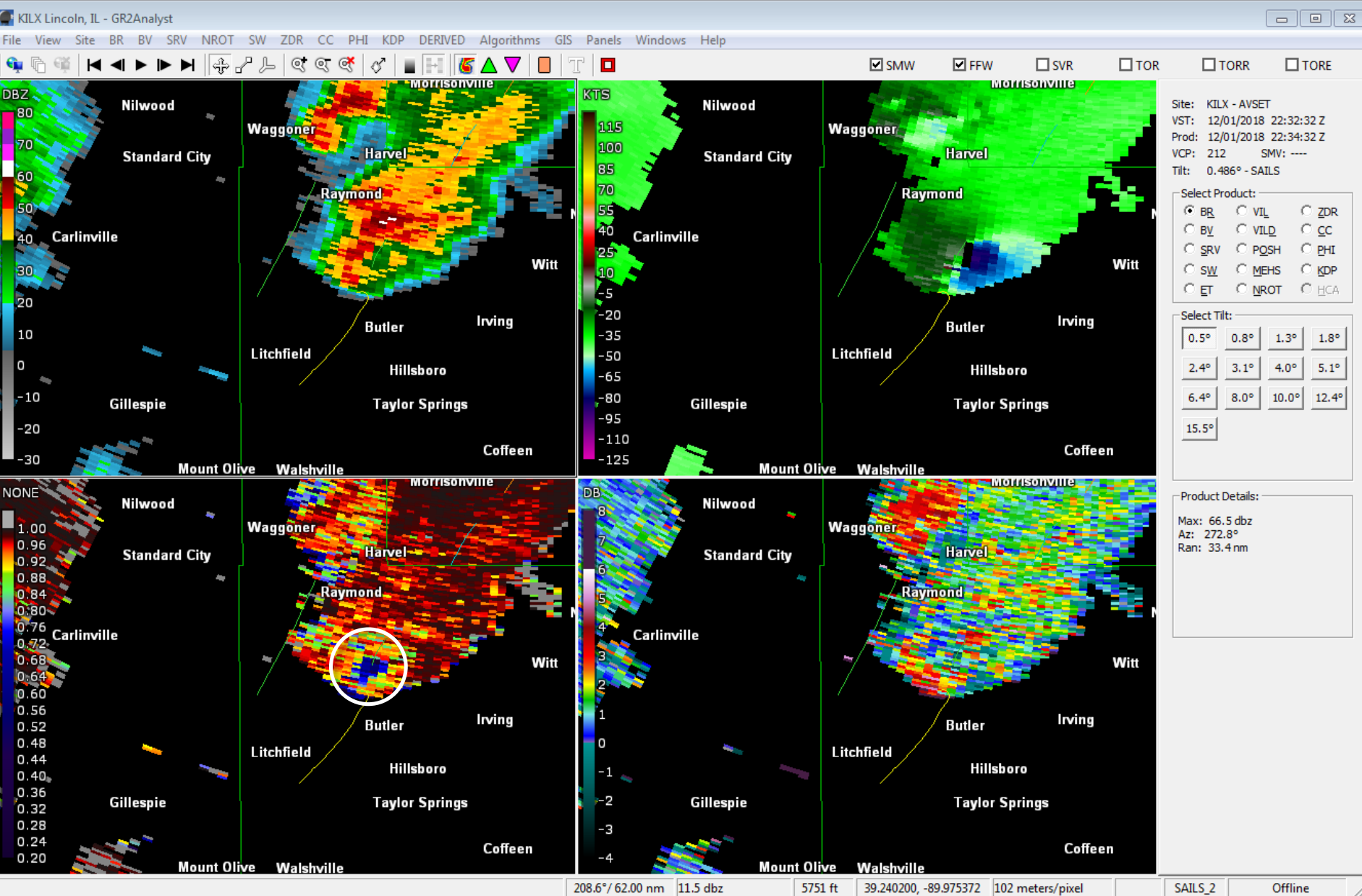
2232z

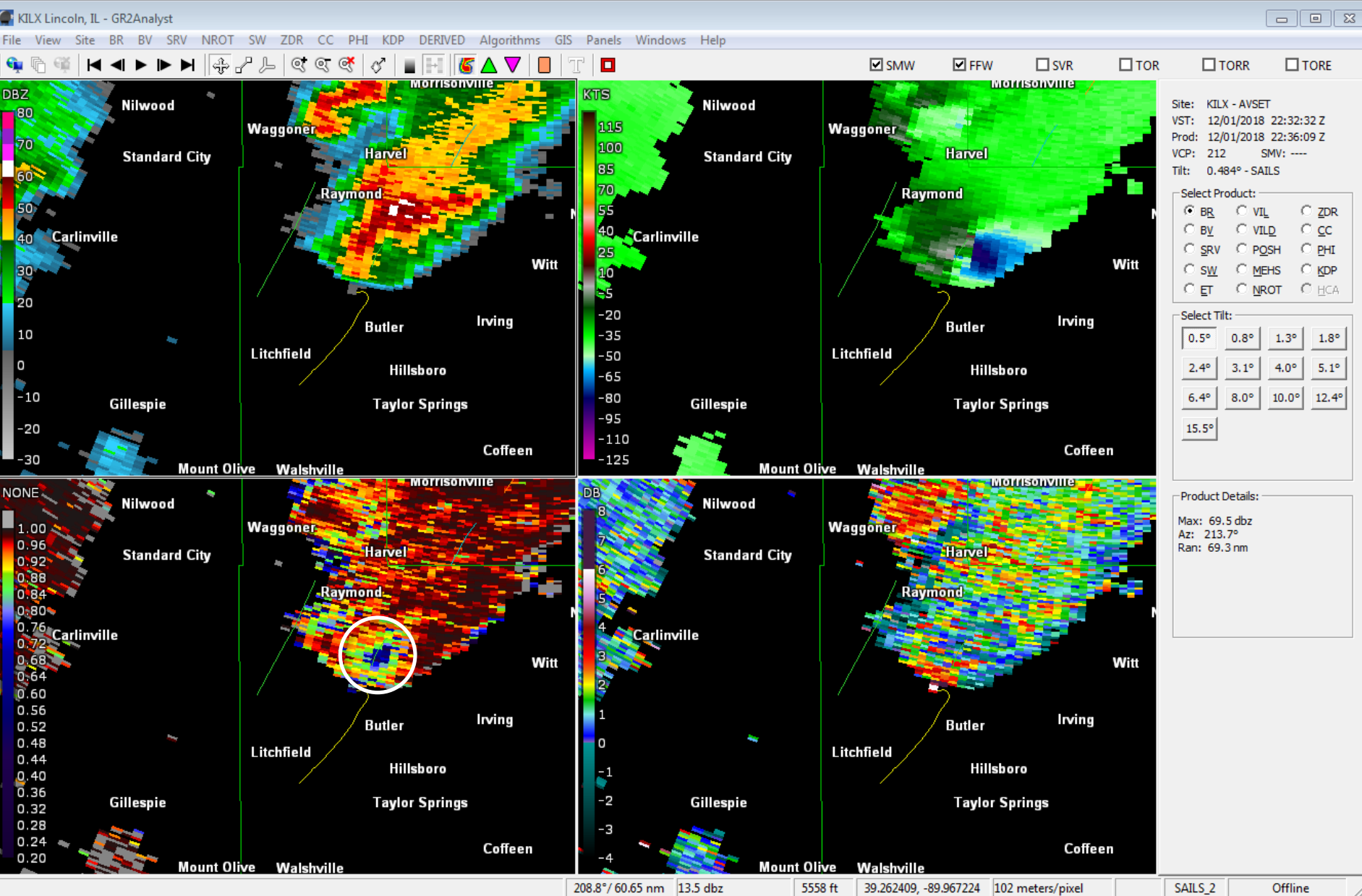
KILX

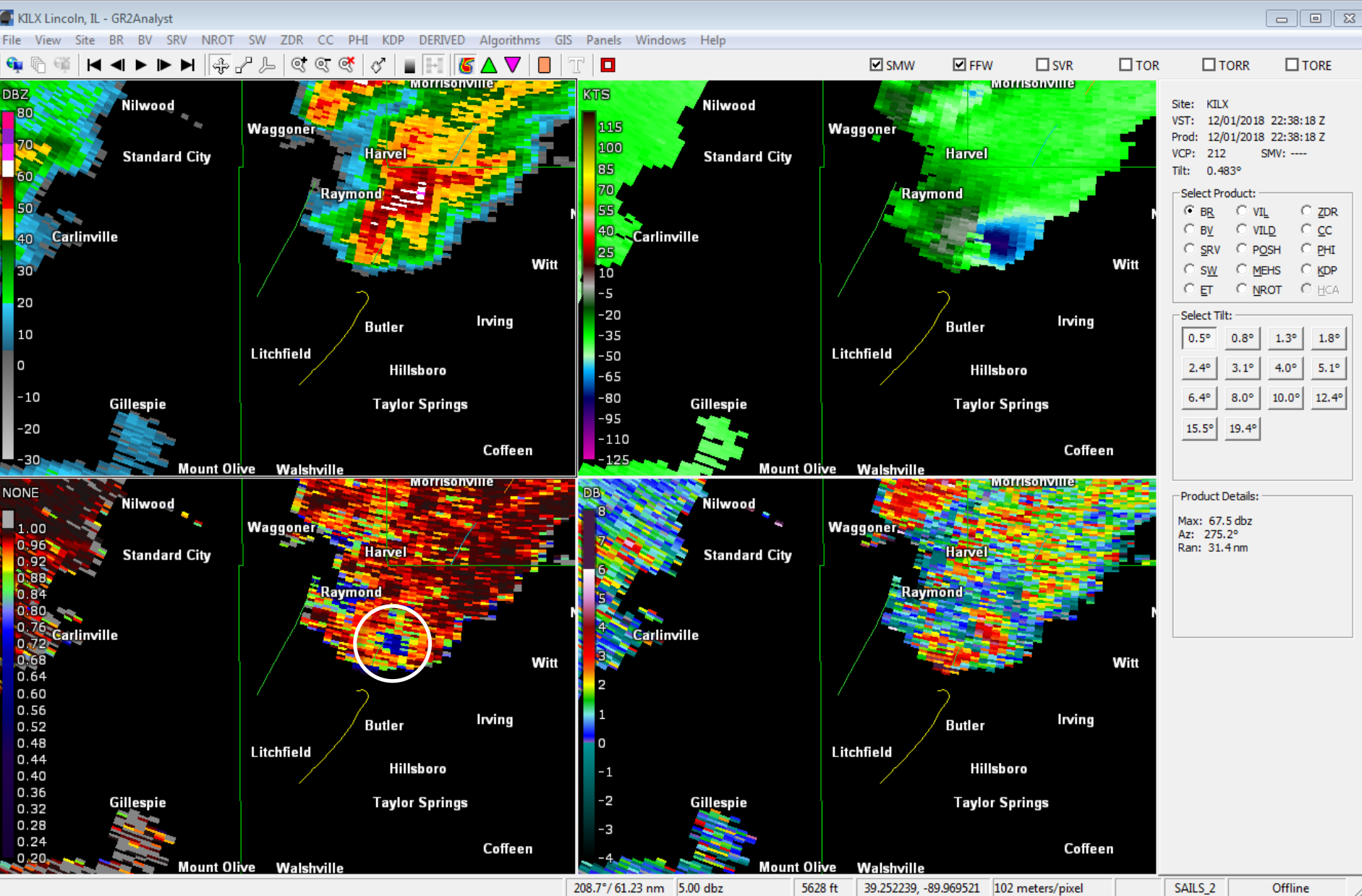
TBSS contamination on the southern storm?

0.5°

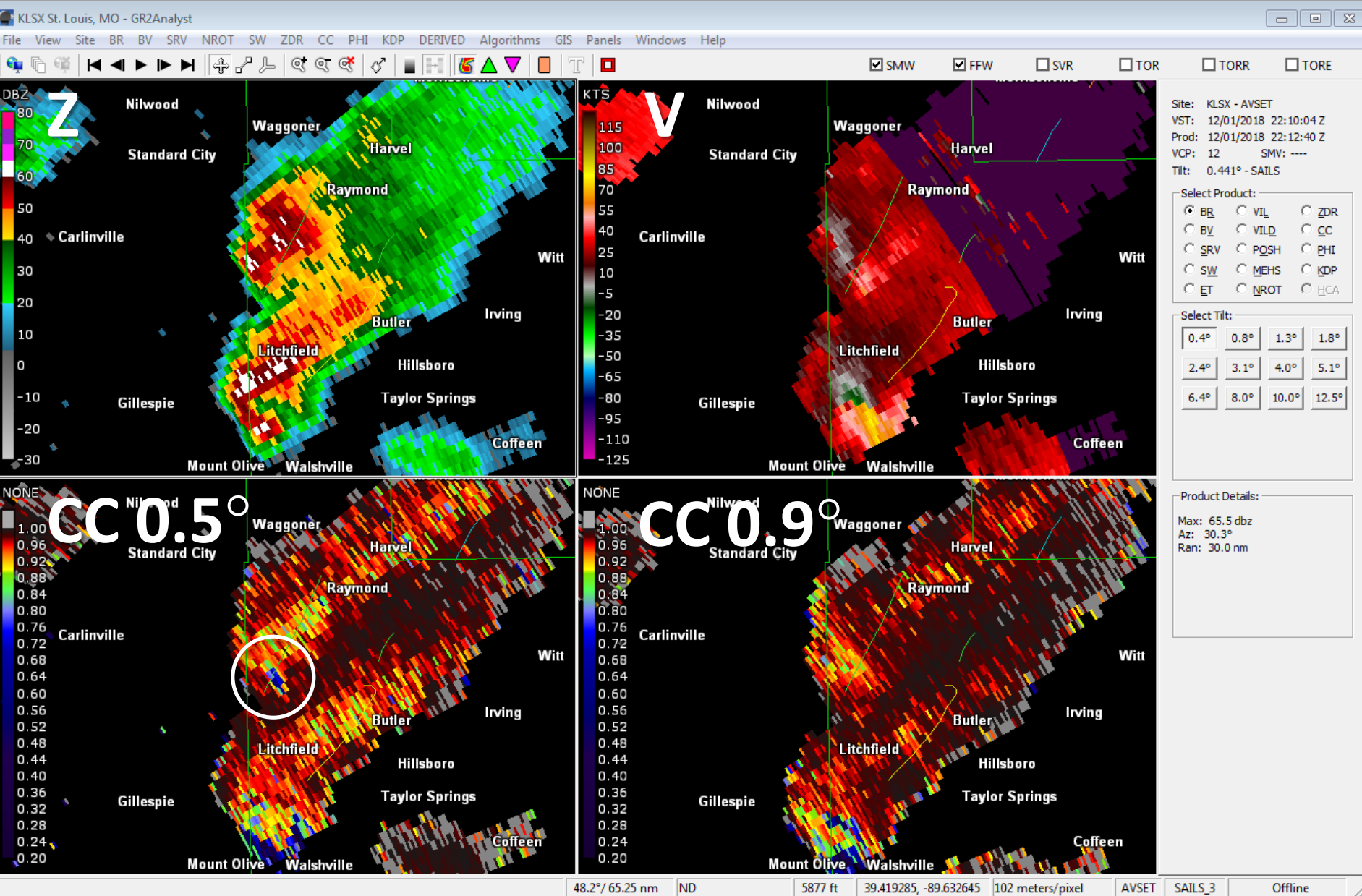


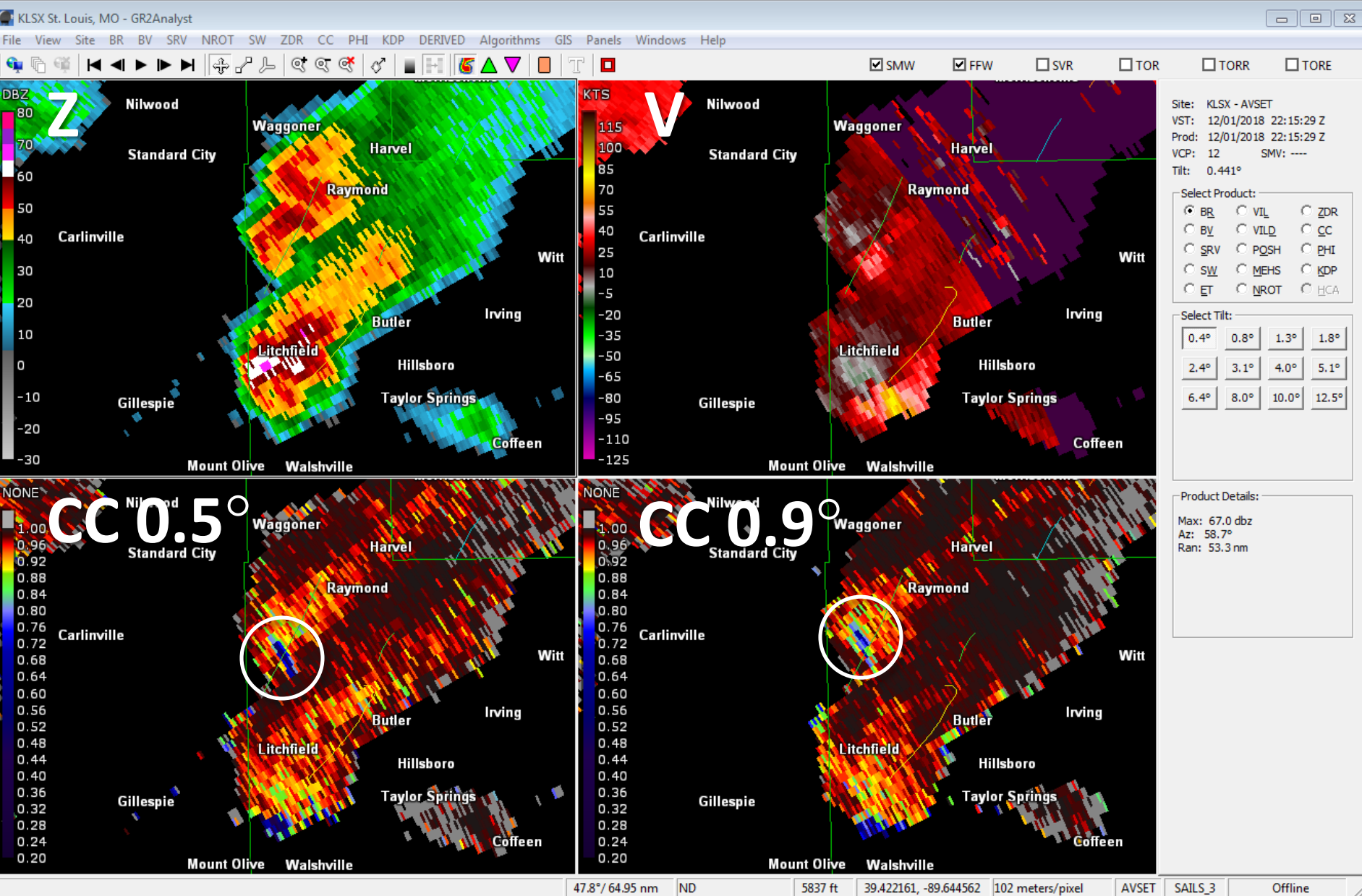


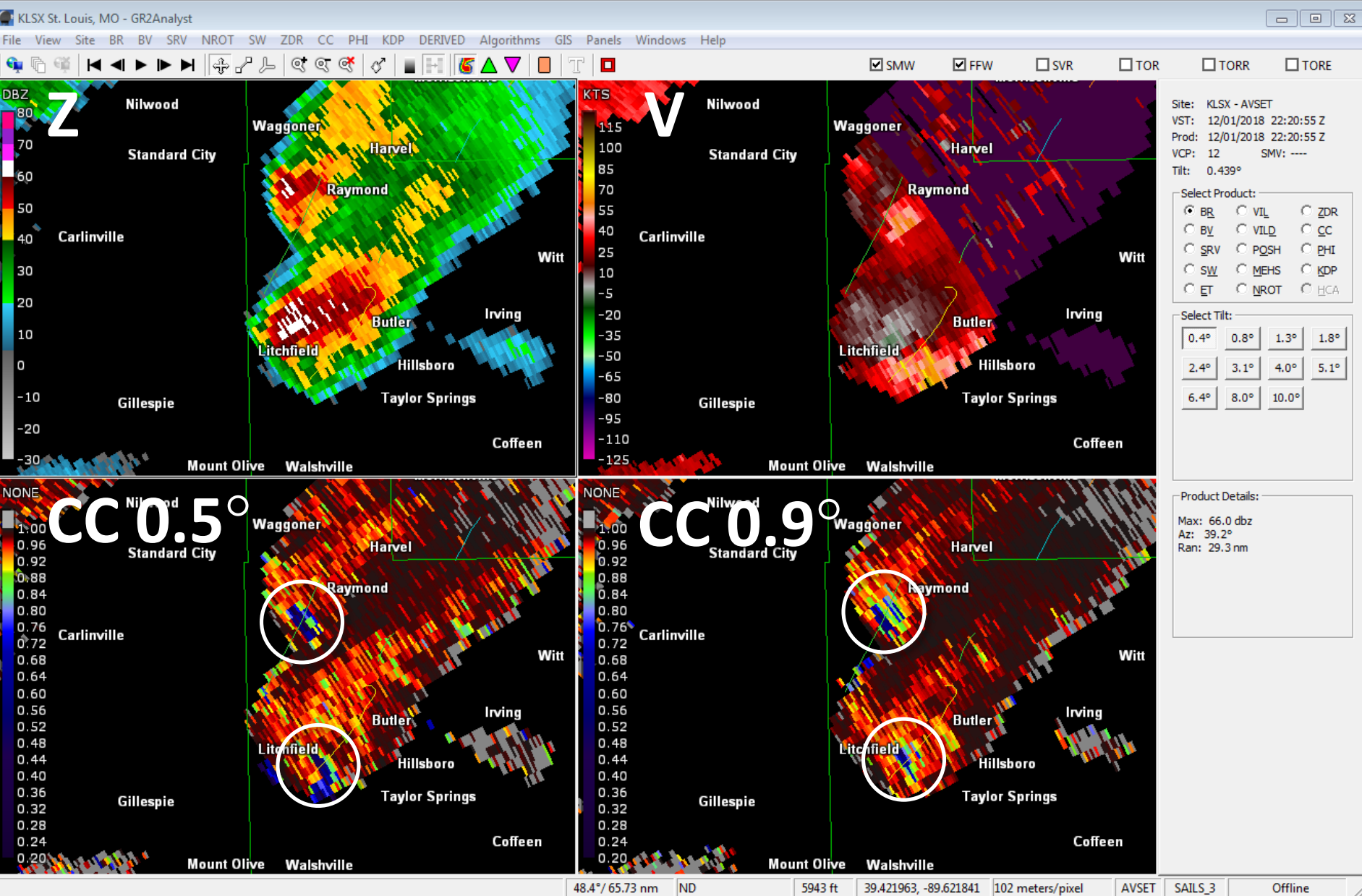


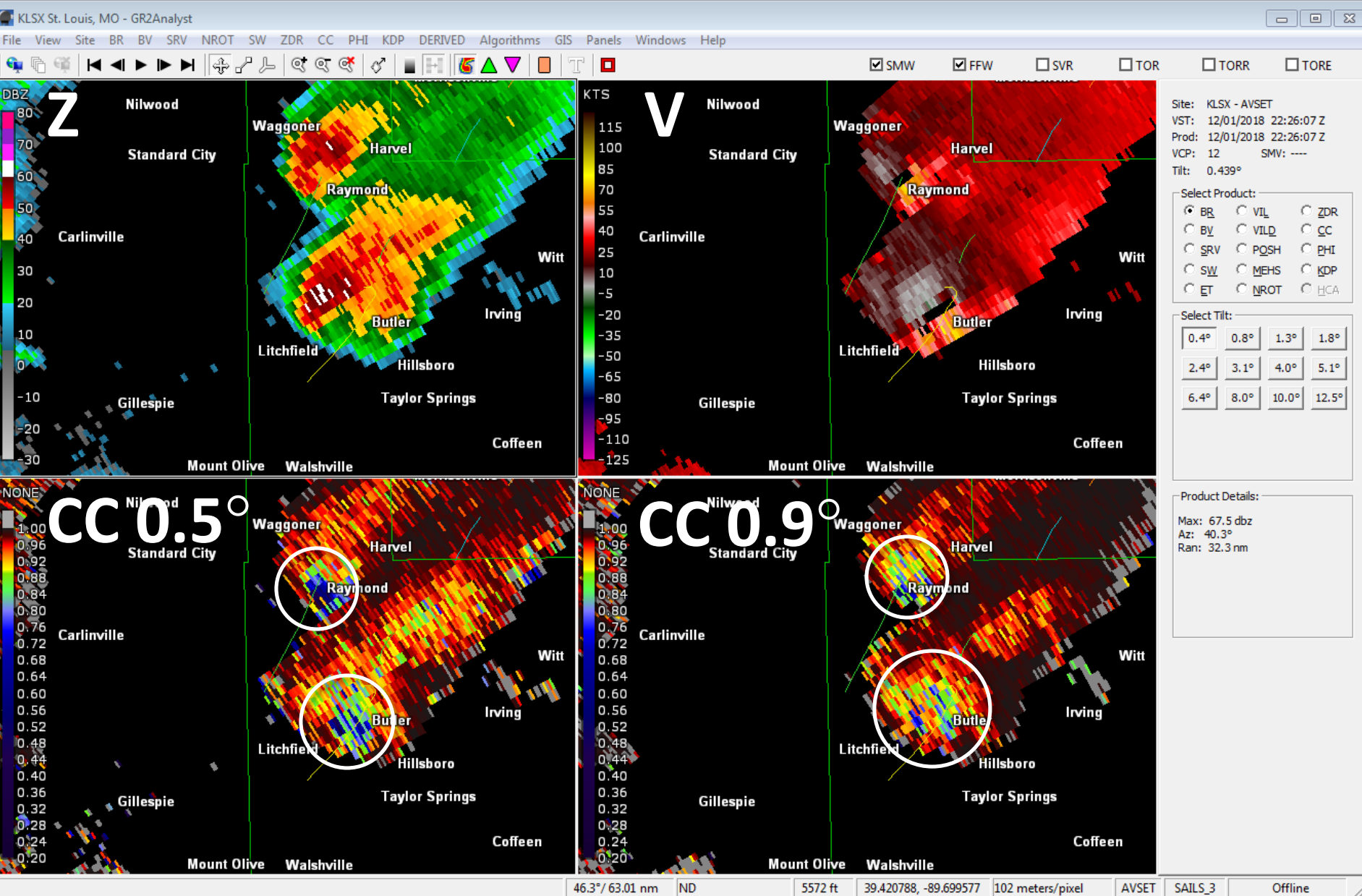


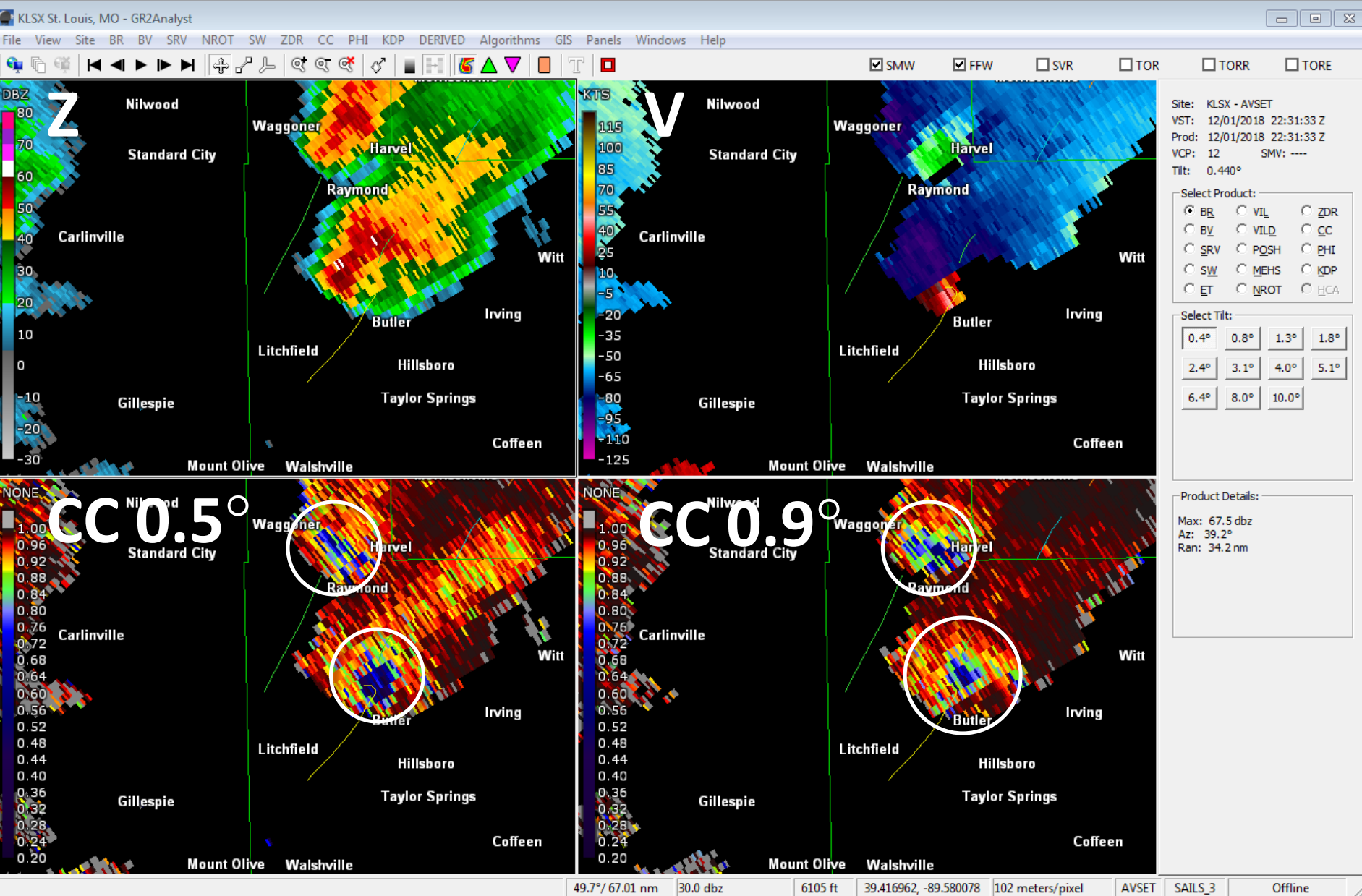
KLSX vertical continuity

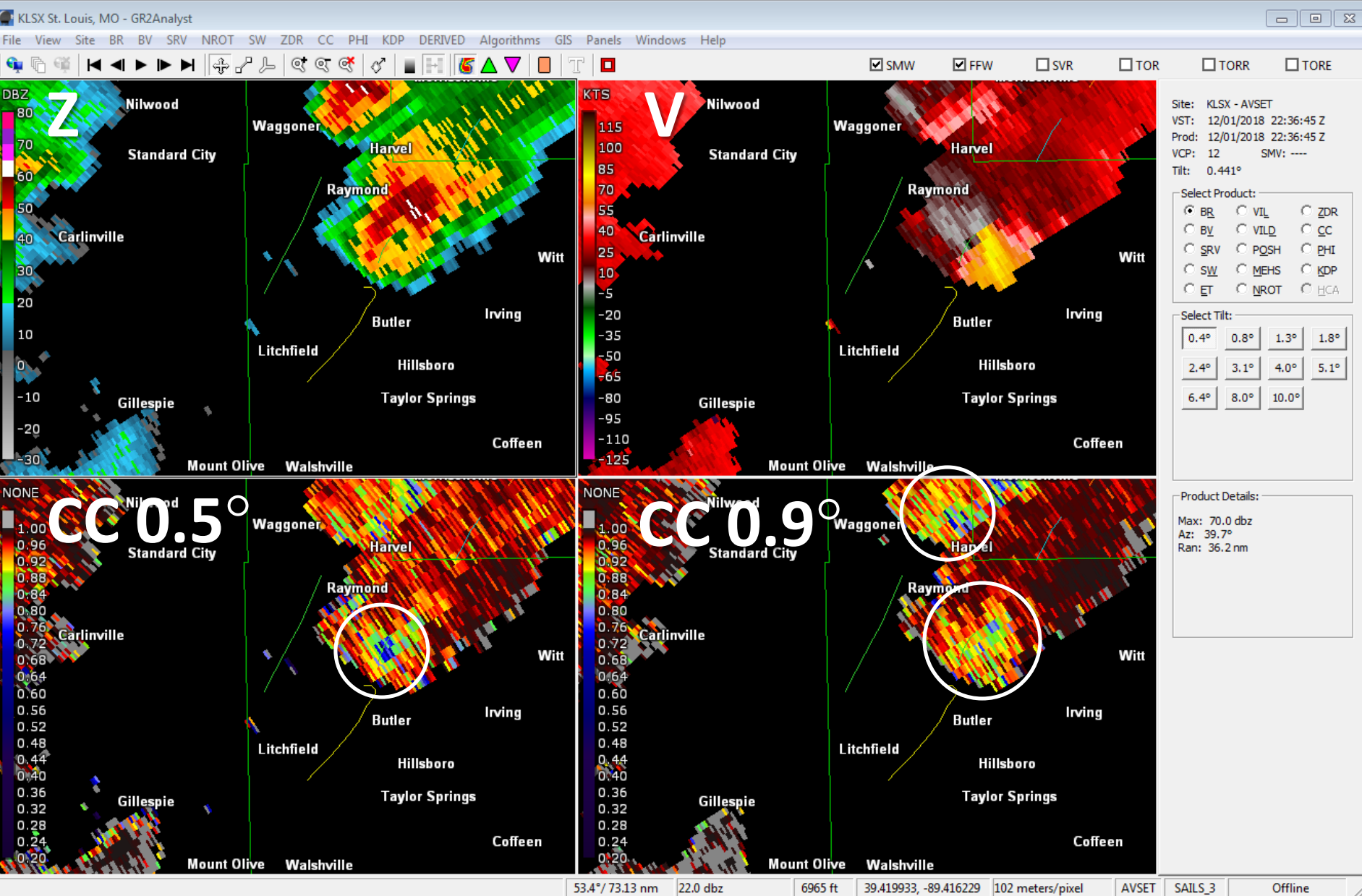


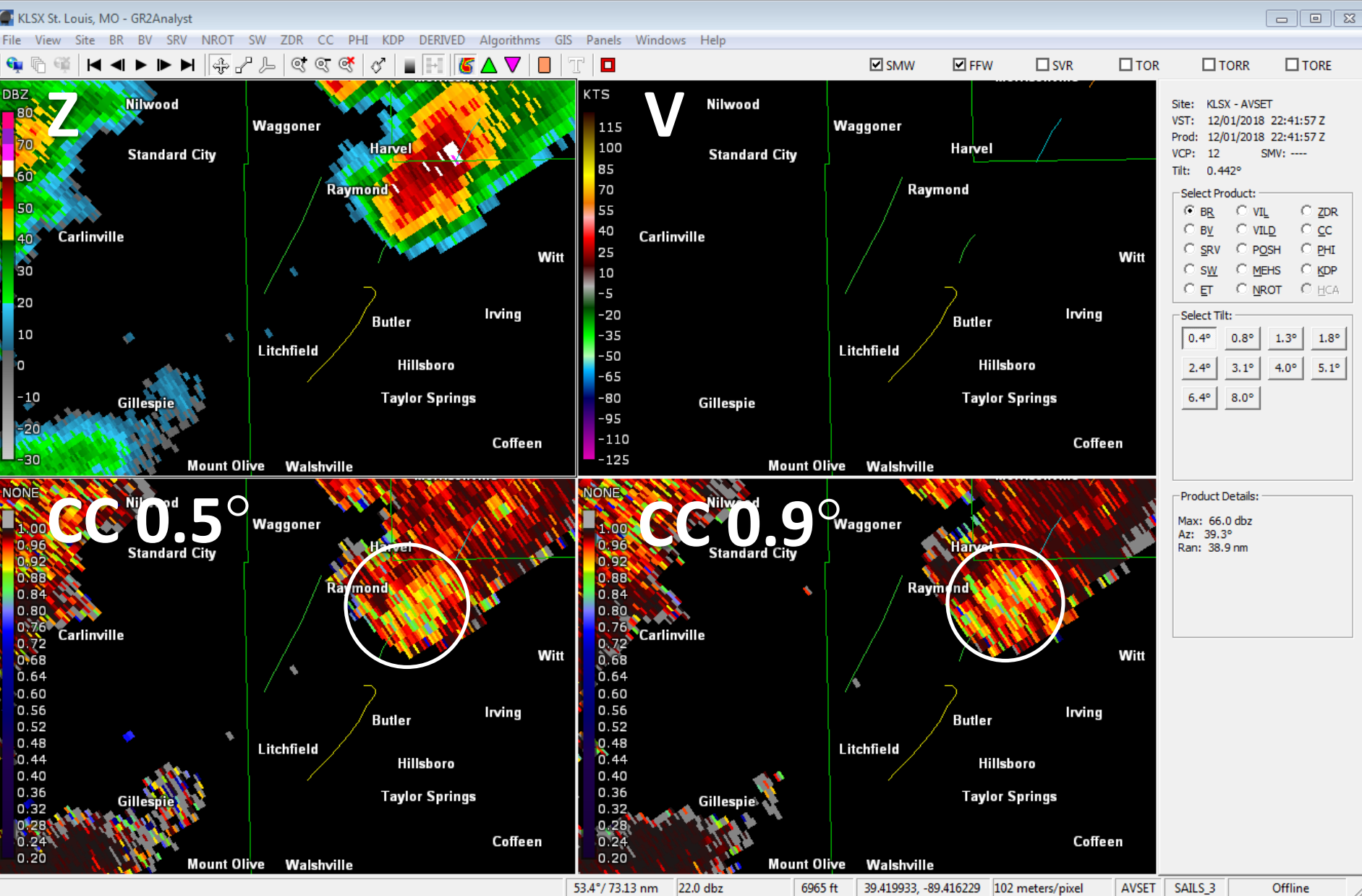




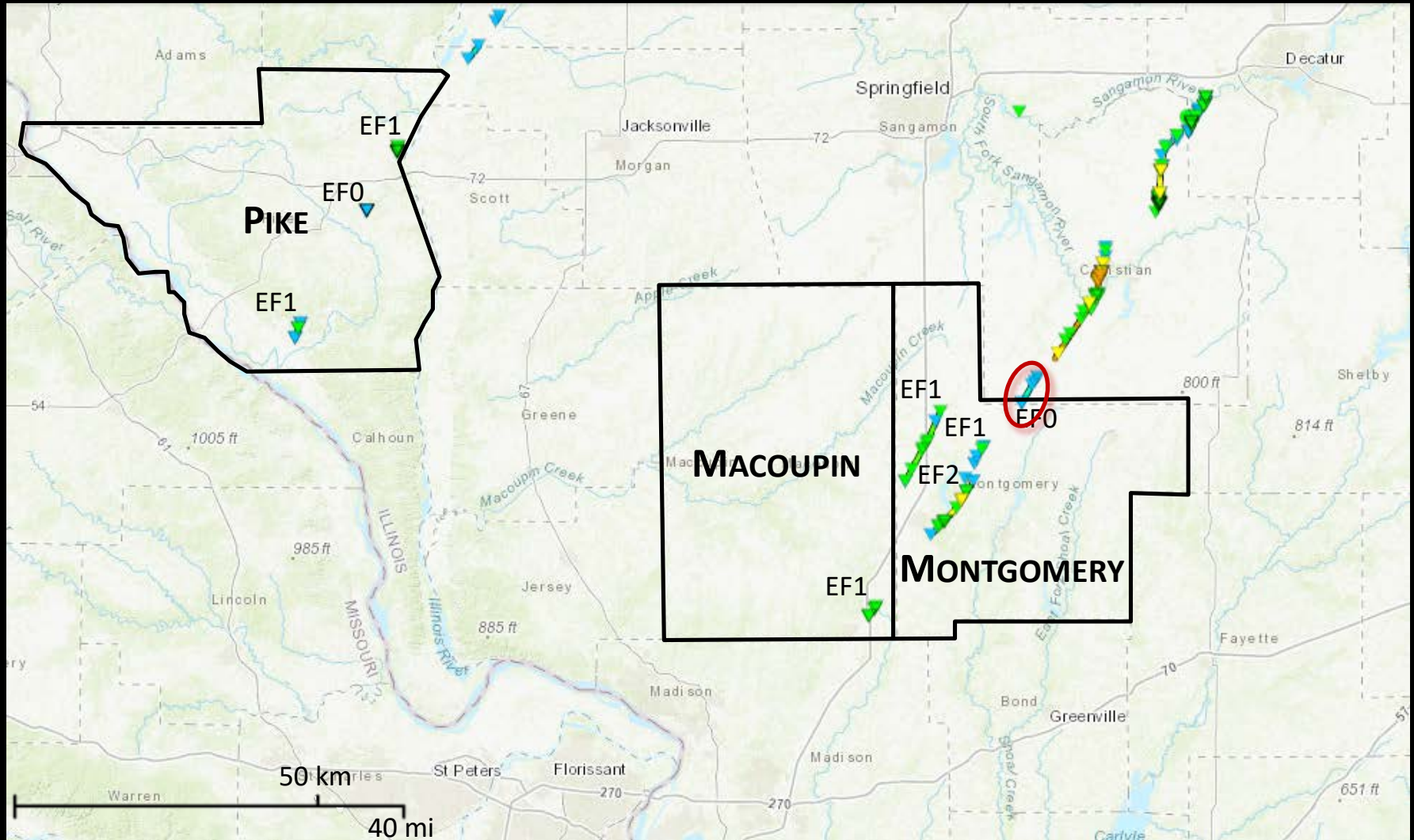








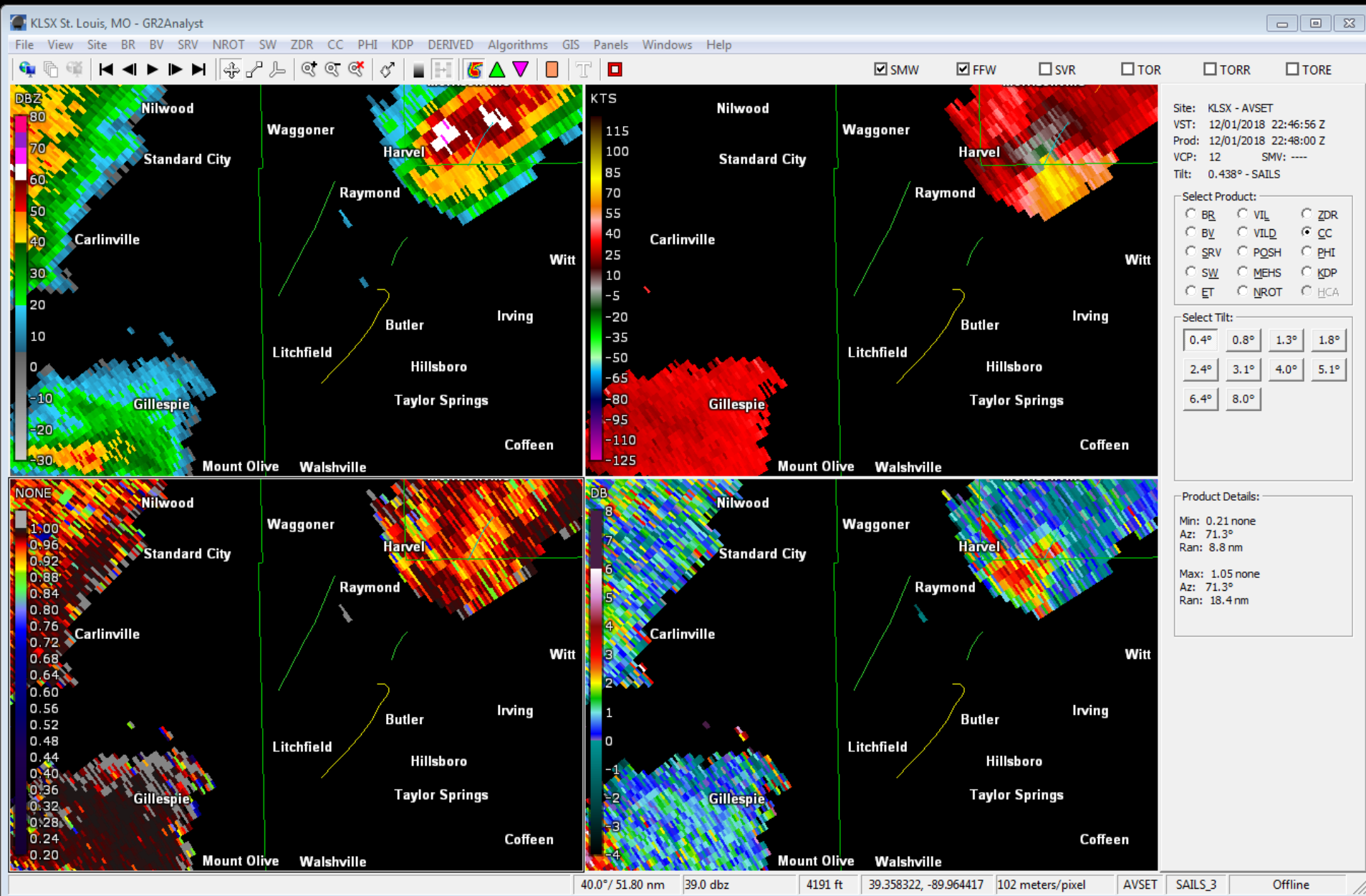
Montgomery/Christian county line



KLSX

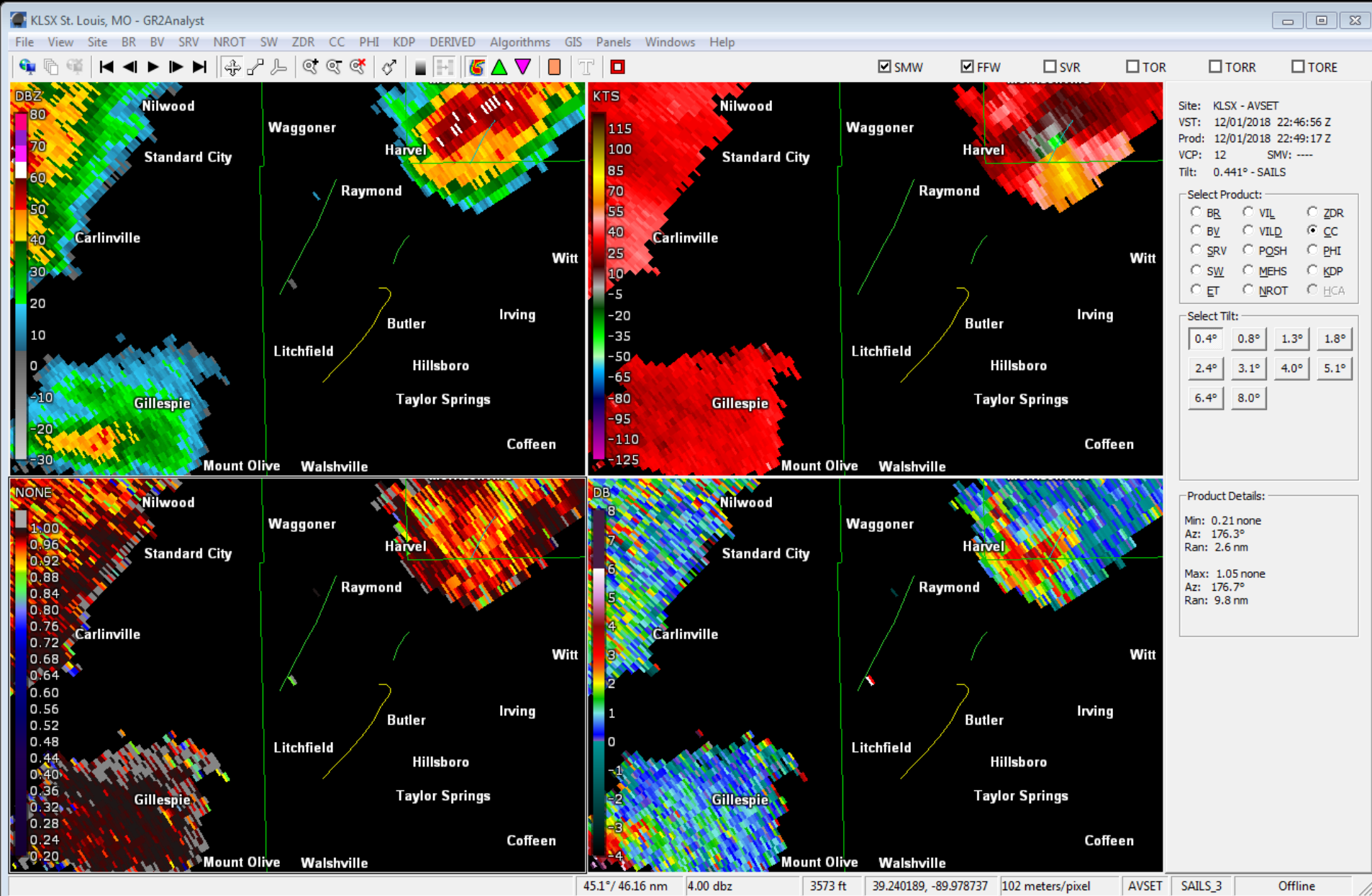
2248z

0.5°



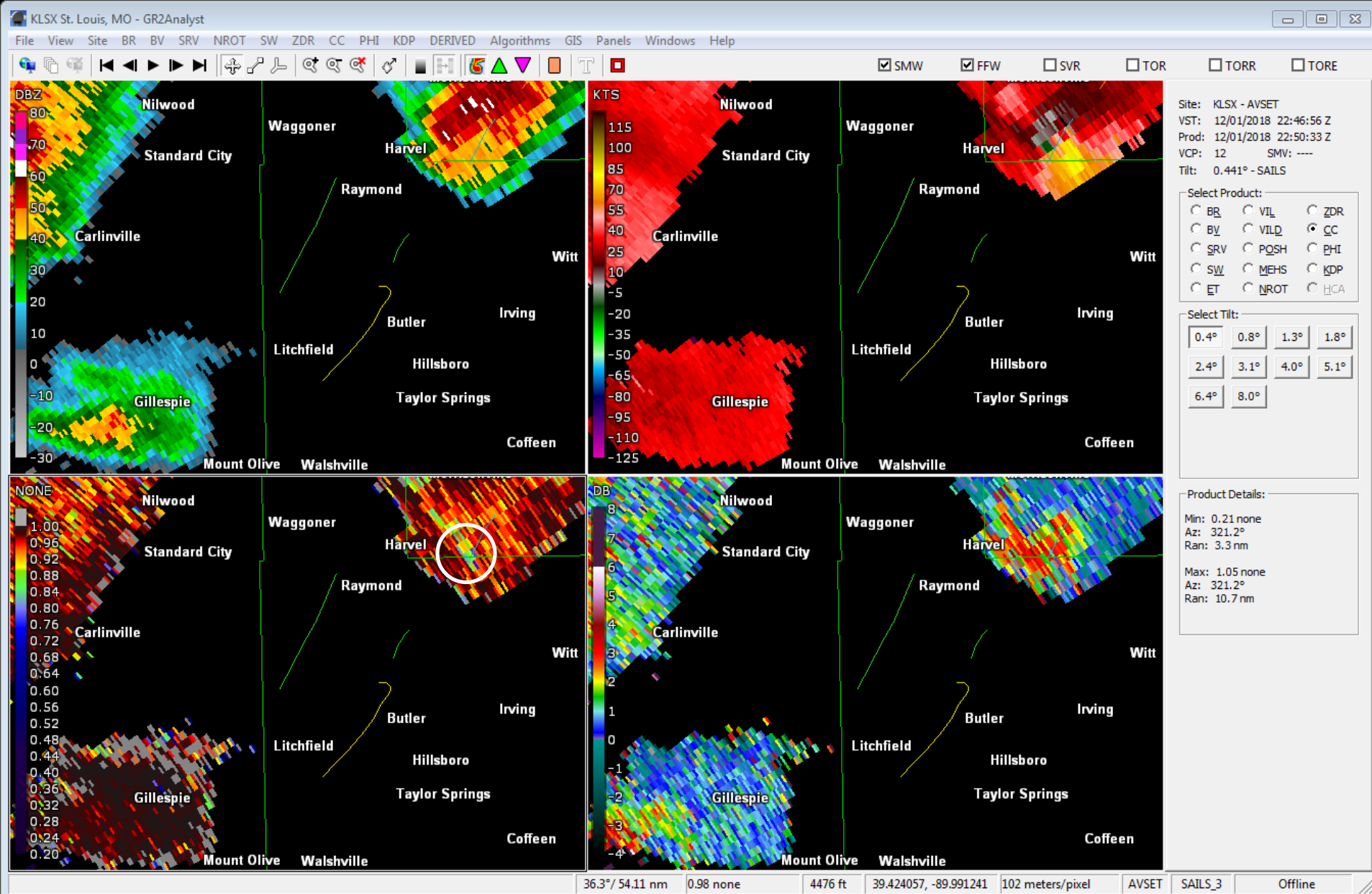
2249z

0.5°



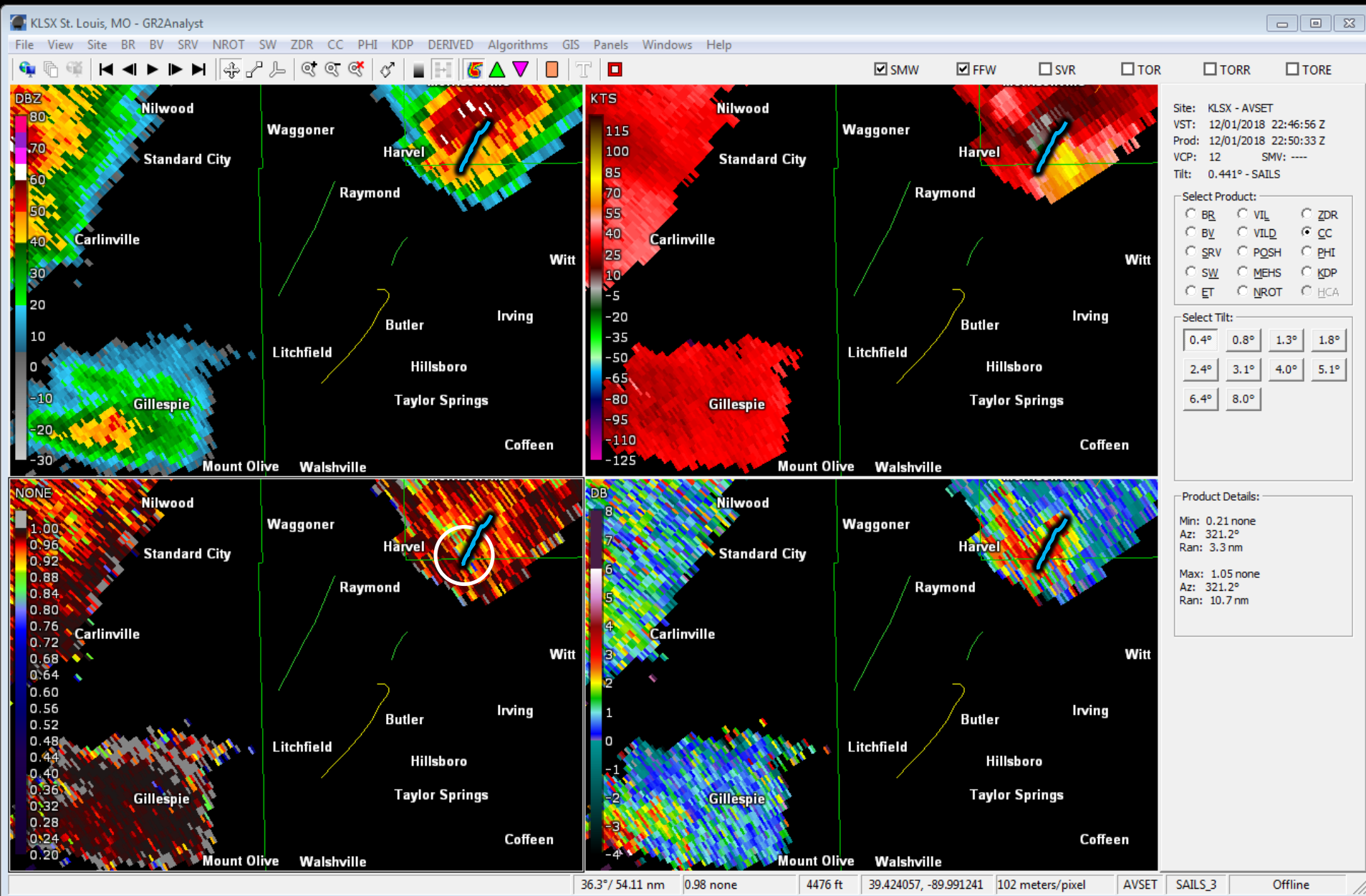
2250z

0.5°

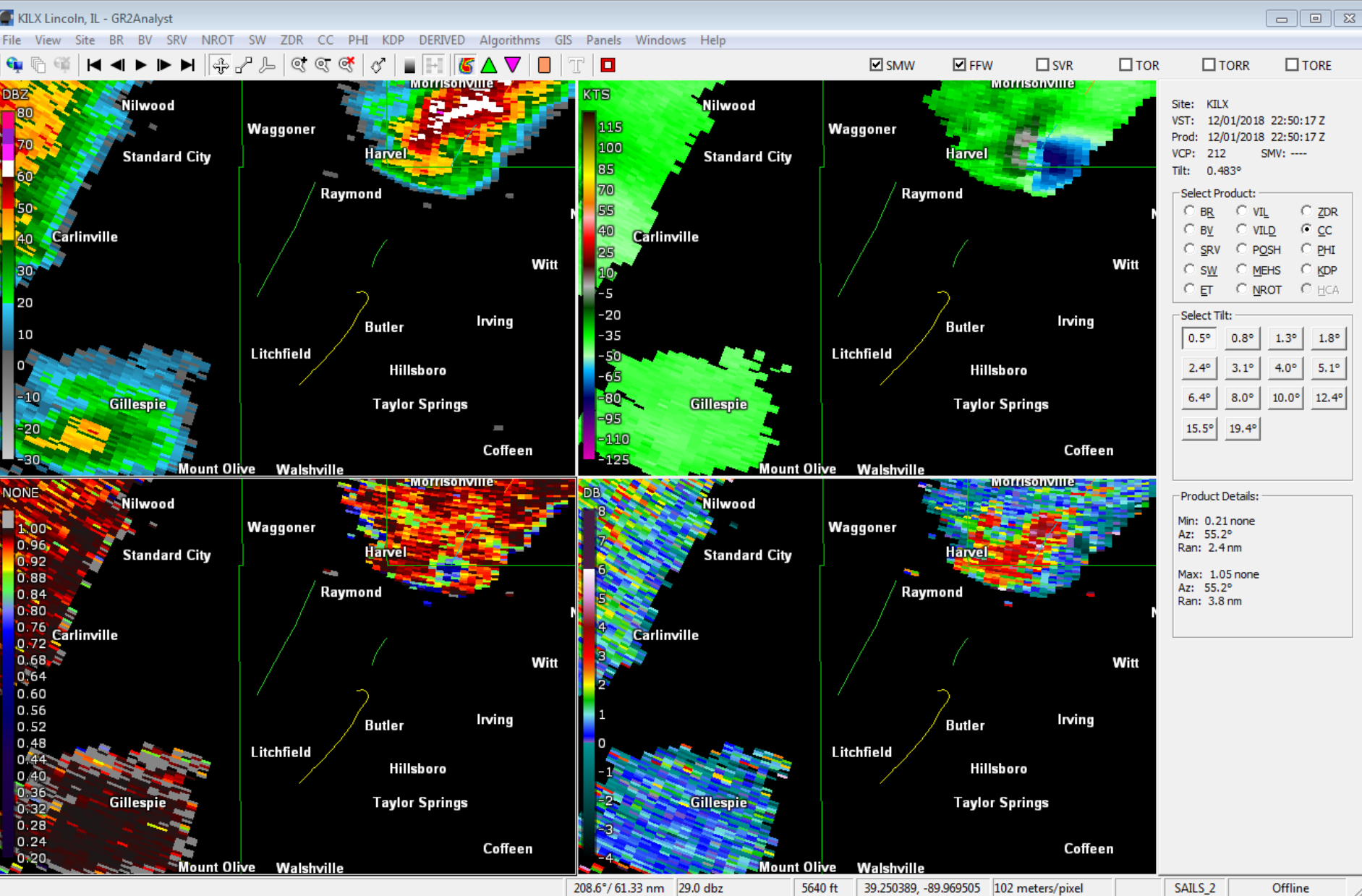


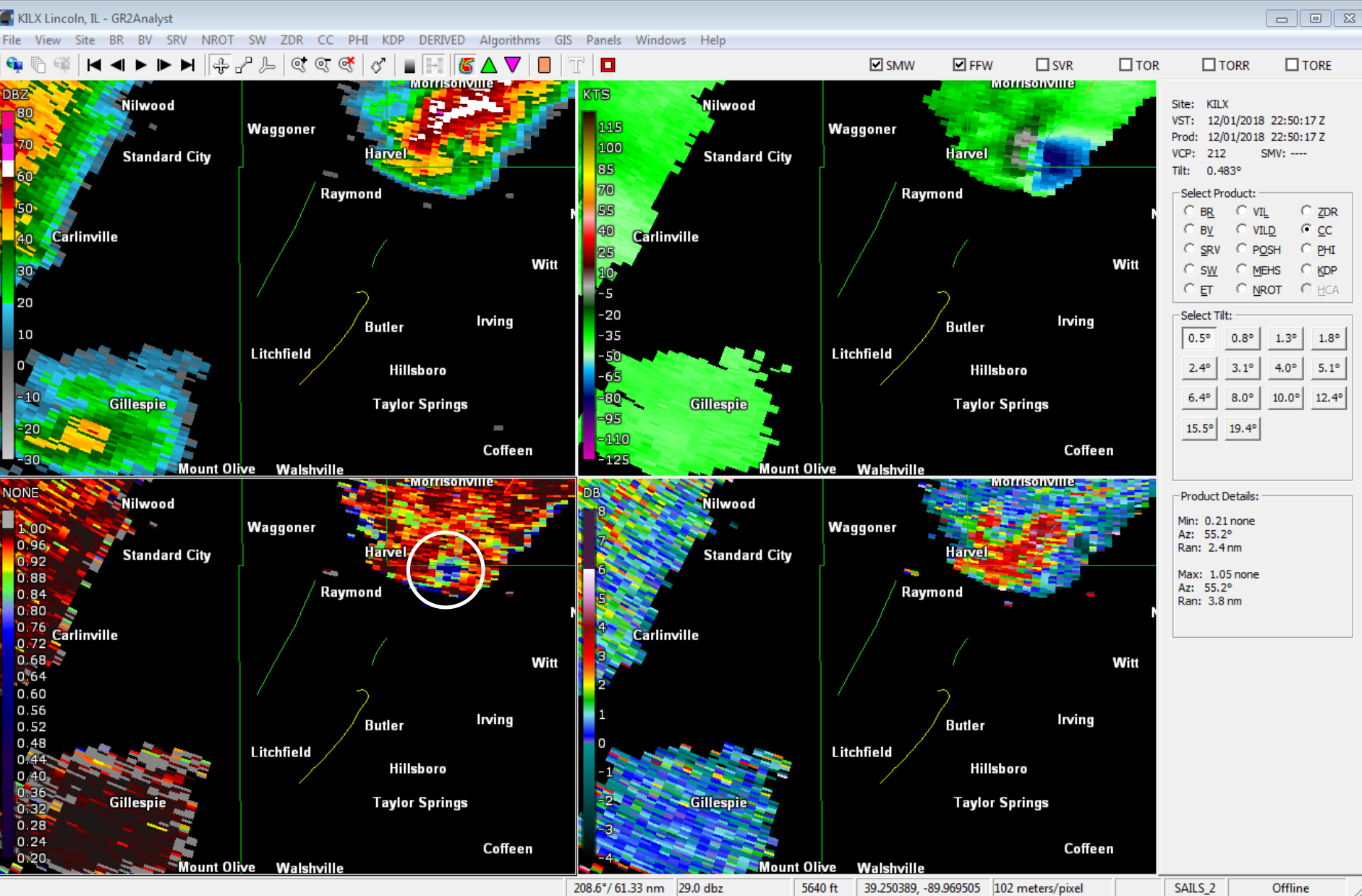
2250z

0.5°



Alternate view from KILX





Product Details:

Min: 0.21 none

Az: 55.2°

Ran: 2.4 nm

Max: 1.05 none

Az: 55.2°

Ran: 3.8 nm

208.6°/ 61.33 nm

29.0 dbz

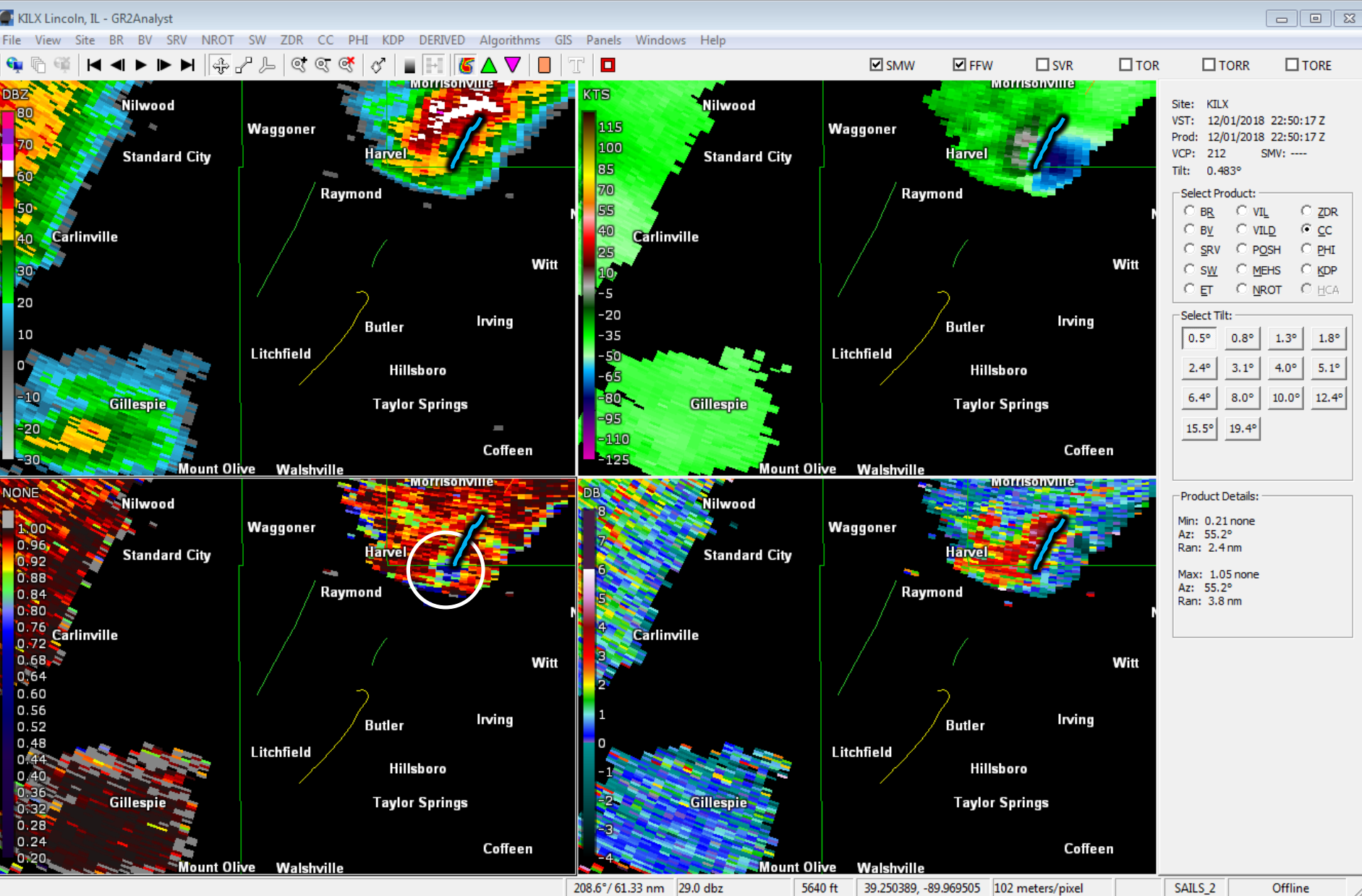
5640 ft

39.250389, -89.969505

102 meters/pixel

SAILS_2

Offline



208.6° / 61.33 nm

29.0 dbz

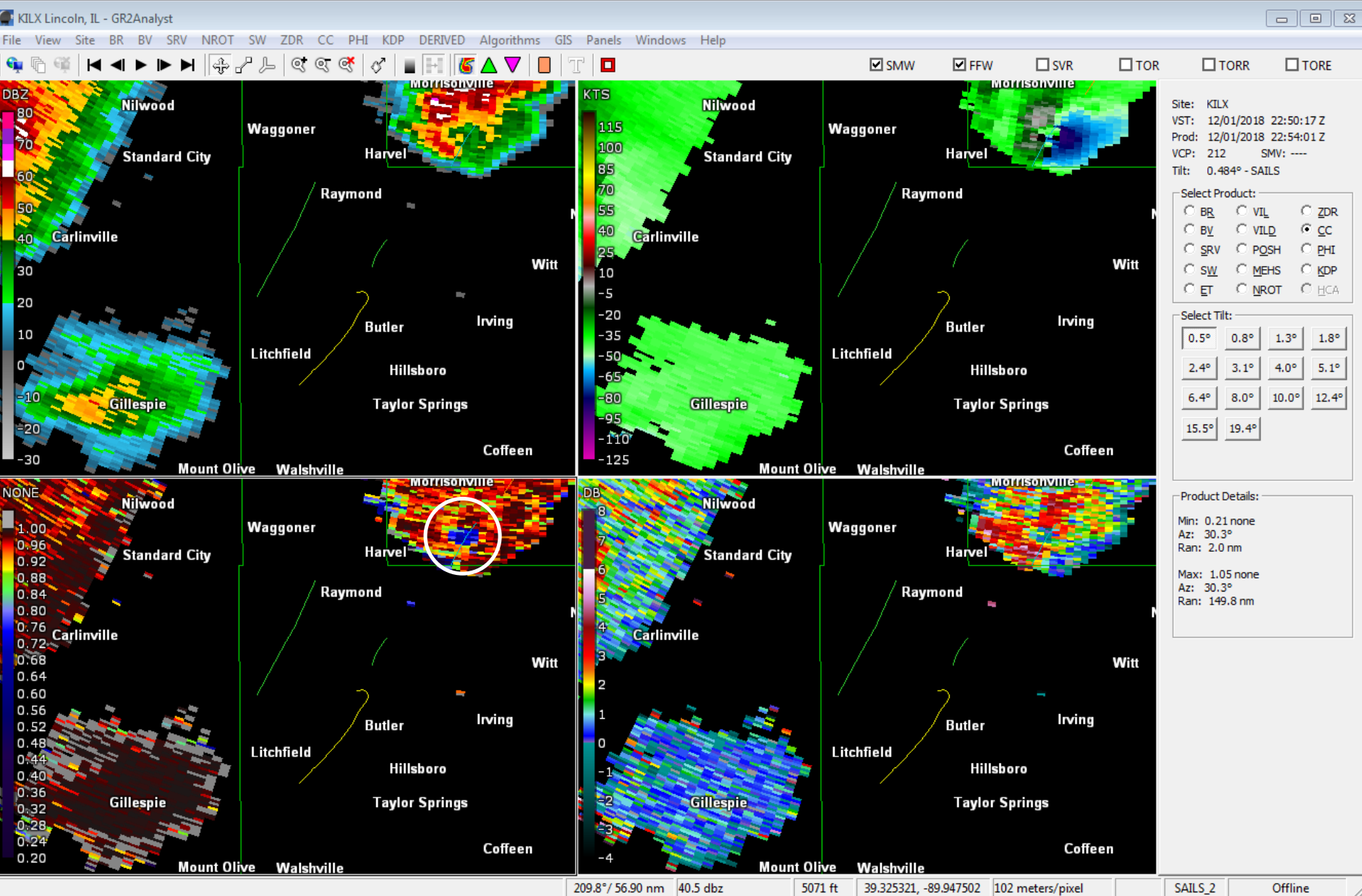
5640 ft

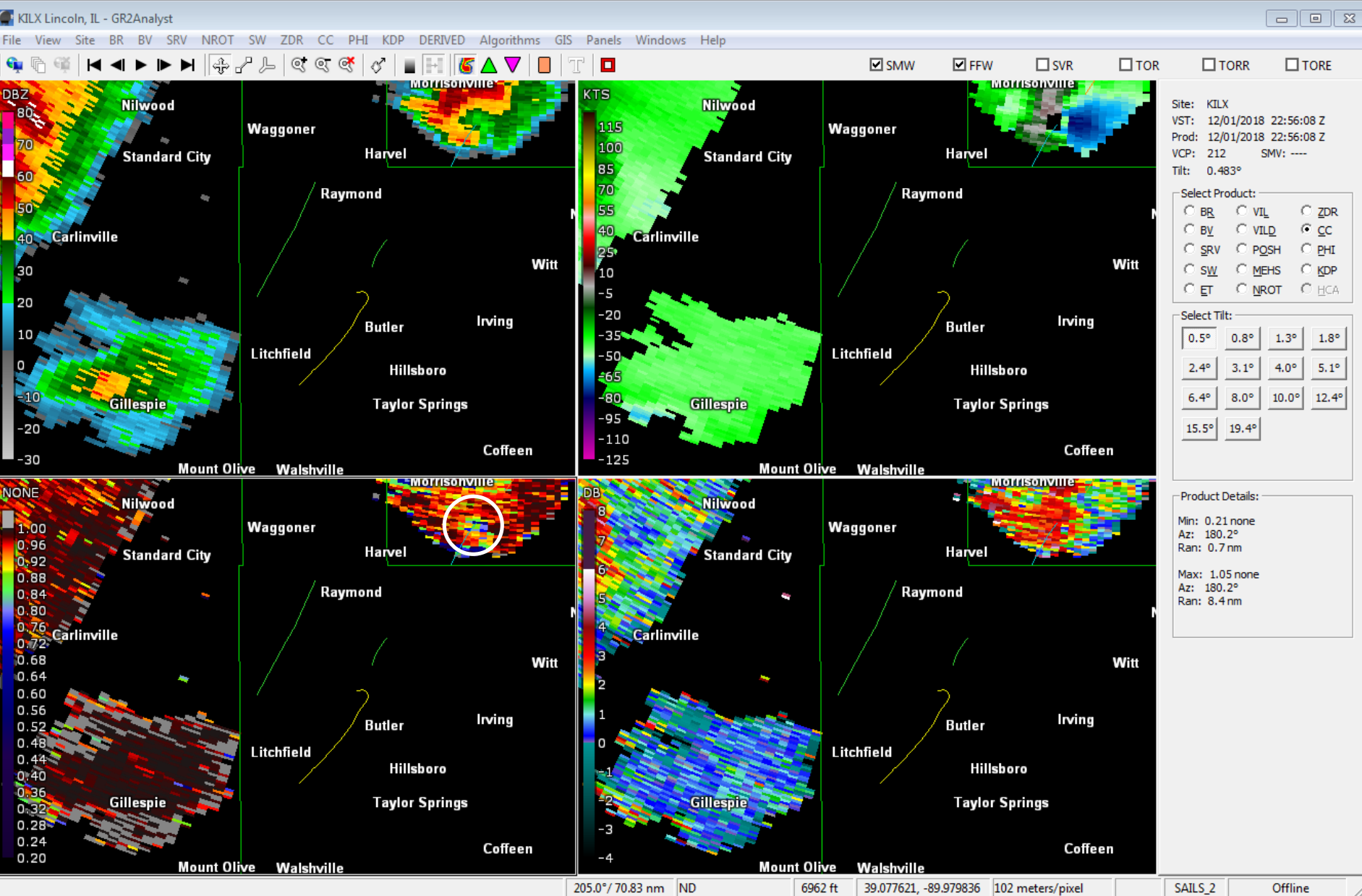
39.250389, -89.969505

102 meters/pixel

SAILS_2

Offline





What to notice about these TDSs

- Appeared suddenly
- Had vertical continuity
- Locations were consistent with storm structure
- TDSs sometimes persisted after the tornado had lifted
- Behaved like a plume
 - Broadened and weakened with time
 - This is common, especially at greater distances from the radar
- Spotted early with SAILS and multiple radars
- Reasonably consistent between multiple radars

What to notice about these radar artifacts

- Inflow
 - Attention-grabbing CC values near the hook
- NBF
 - Radial dependency
 - Inconsistent between radars
- TBSS
 - Radial dependency
 - Inconsistent between radars
- Side lobes
 - Often subtle
 - Weak returns on the edge of the storm

Dual-pol questions?

NWSChat: nws-lewis.kanofsky

Email: Lewis.Kanofsky@noaa.gov