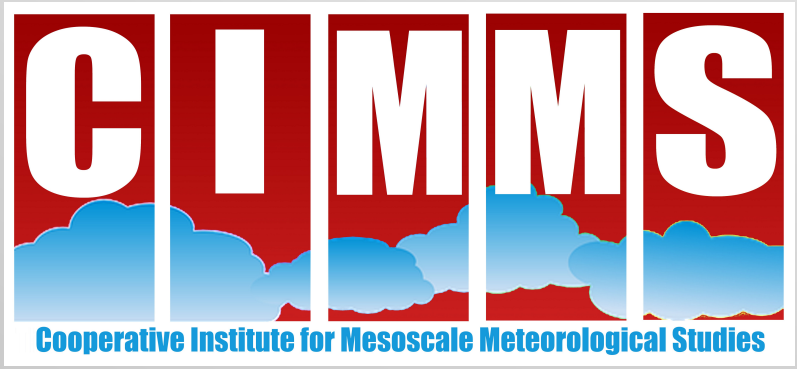
Conditional Probability of Tornado Intensity (CPTI) Algorithm

Multi-Radar Gridded Probabilistic Product

-Training Module-

2019 HWT EWP – Satellite & Radar Experiment



CPTI - Background

- Produces real-time probabilistic tornado intensity grids, conditional on the presence of a tornado, across the contiguous United States
- Based on published research by the Storm Prediction Center:
  - Smith et al., 2015 – *Diagnosing the Conditional Probability of Tornado Damage Rating Using Environmental and Radar Attributes*
  - Thompson et al., 2017 - *Tornado Damage Rating Probabilities Derived from WSR-88D Data*
  - Cohen et al., 2018 – *Simulating Tornado Probability and Tornado Wind Speed Based on Statistical Models*
- **Automates a manually-calculated method of estimating tornado damage intensity probabilities developed by the SPC**

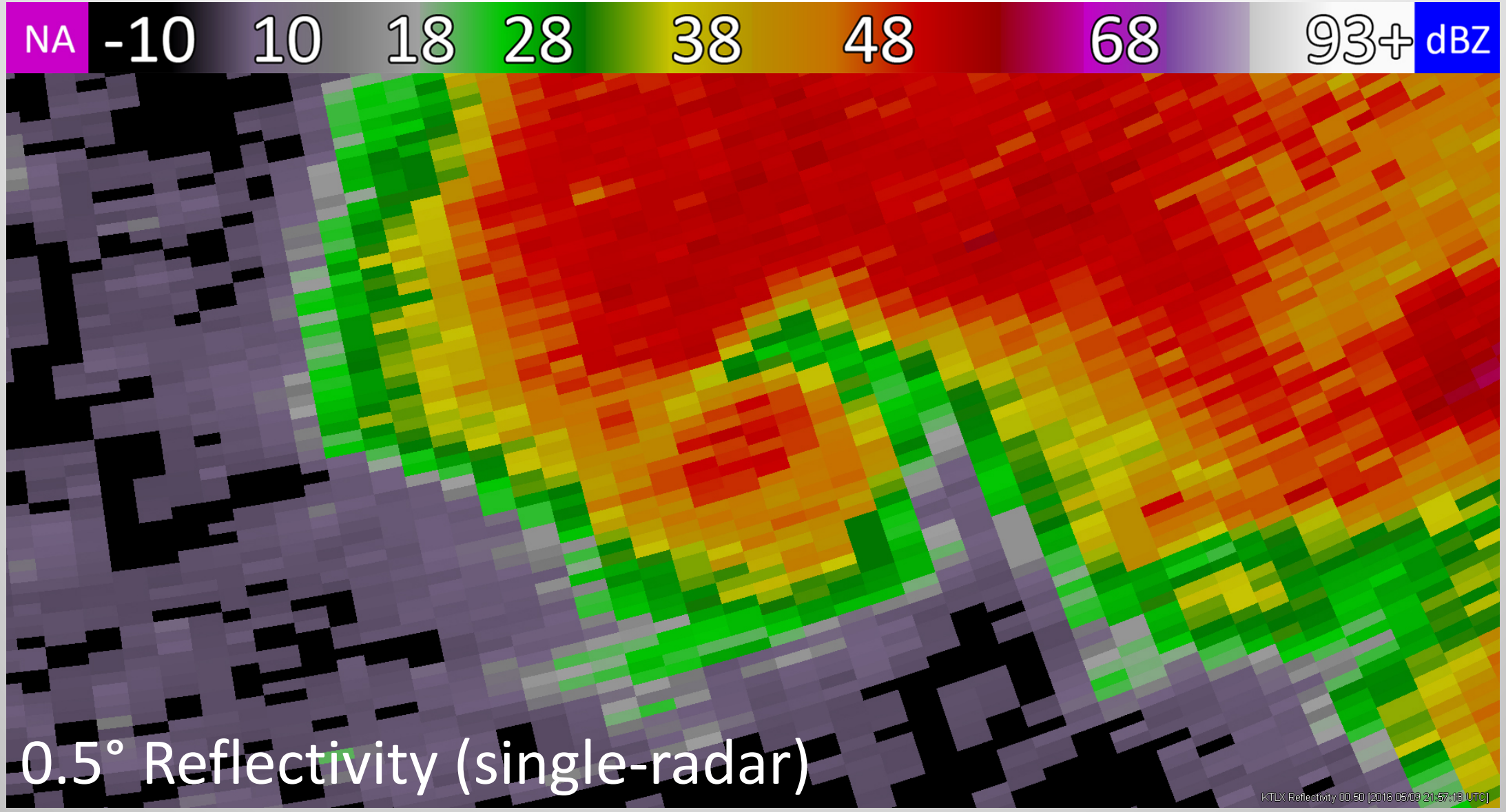
CPTI – Technical Information

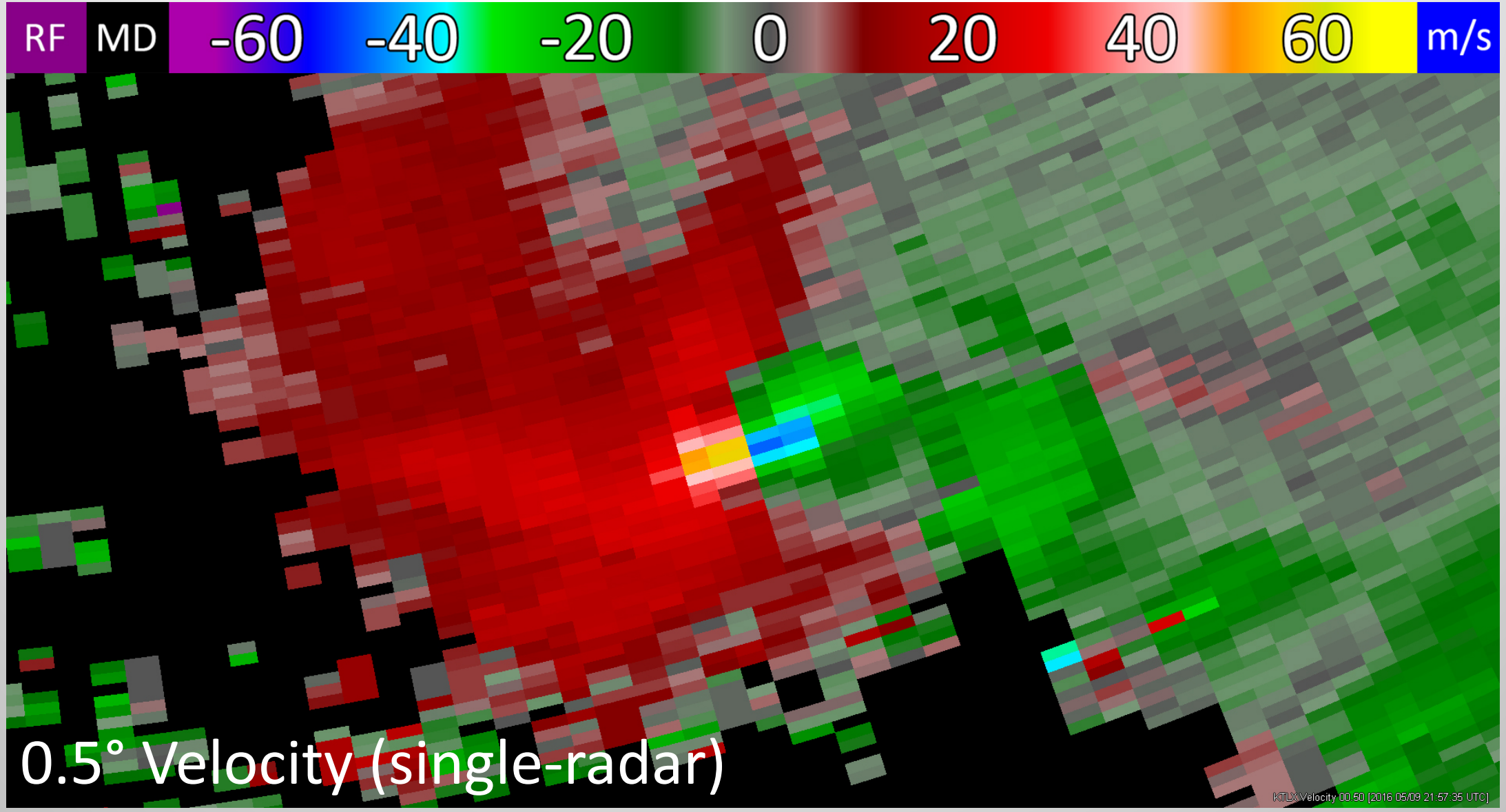
- 7 different binary logistic regression models
  - *80mph+, 95mph+, 110mph+, 125mph+, 140mph+, 155mph+, 170mph+*
- Models are trained over an SPC hand-derived dataset that combines damage-derived tornado wind speeds, radar data attributes, and environmental data for tornado events from 2009-2016
- Inputs:
  - Multi-Radar 0-2km AGL Azimuthal Shear (replaces V_{rot})
  - Multi-Radar 0-2km AGL Minimum Shear Diameter
  - Effective Layer Significant Tornado Parameter (STP)

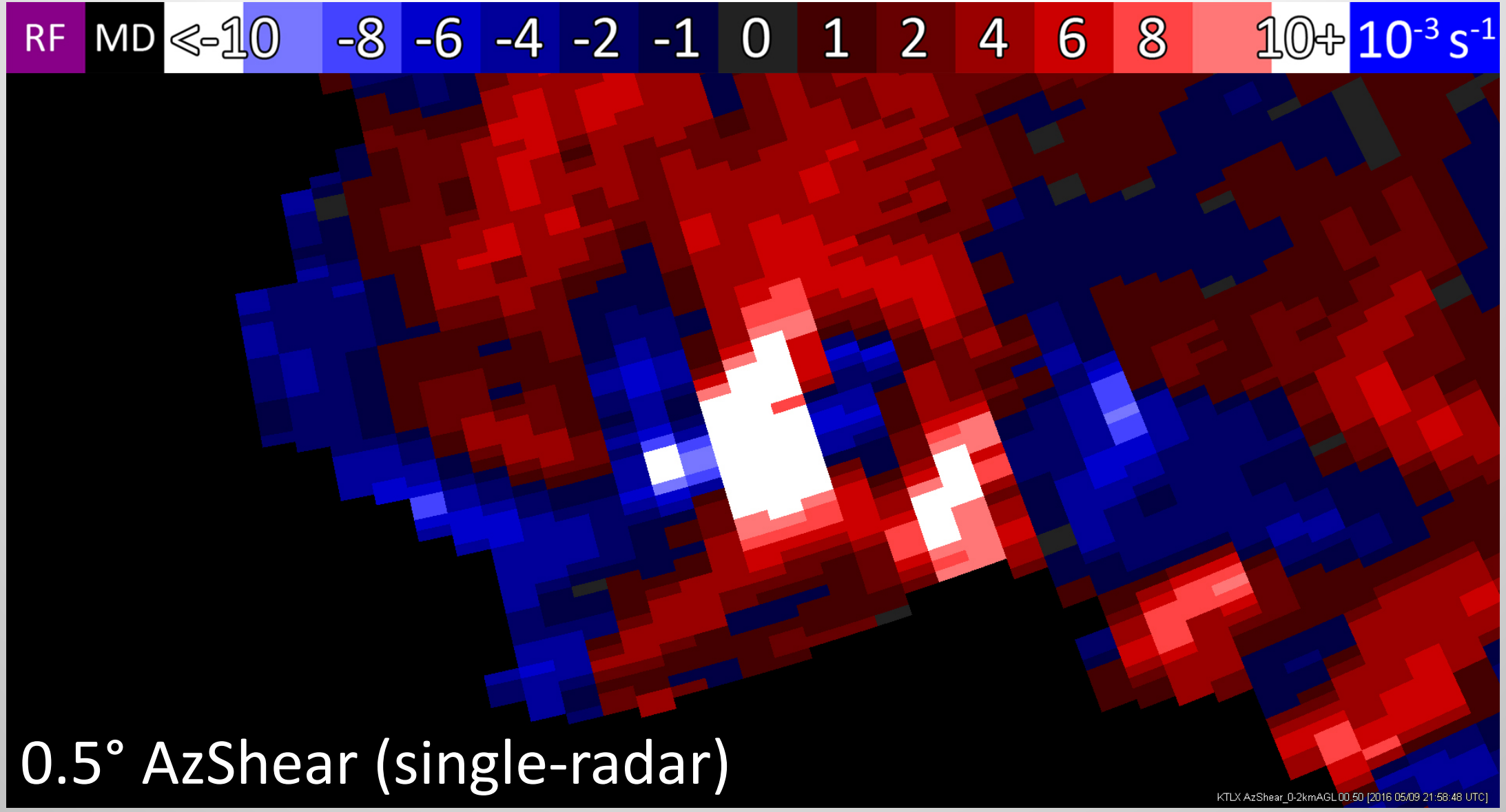
CPTI – Example Case

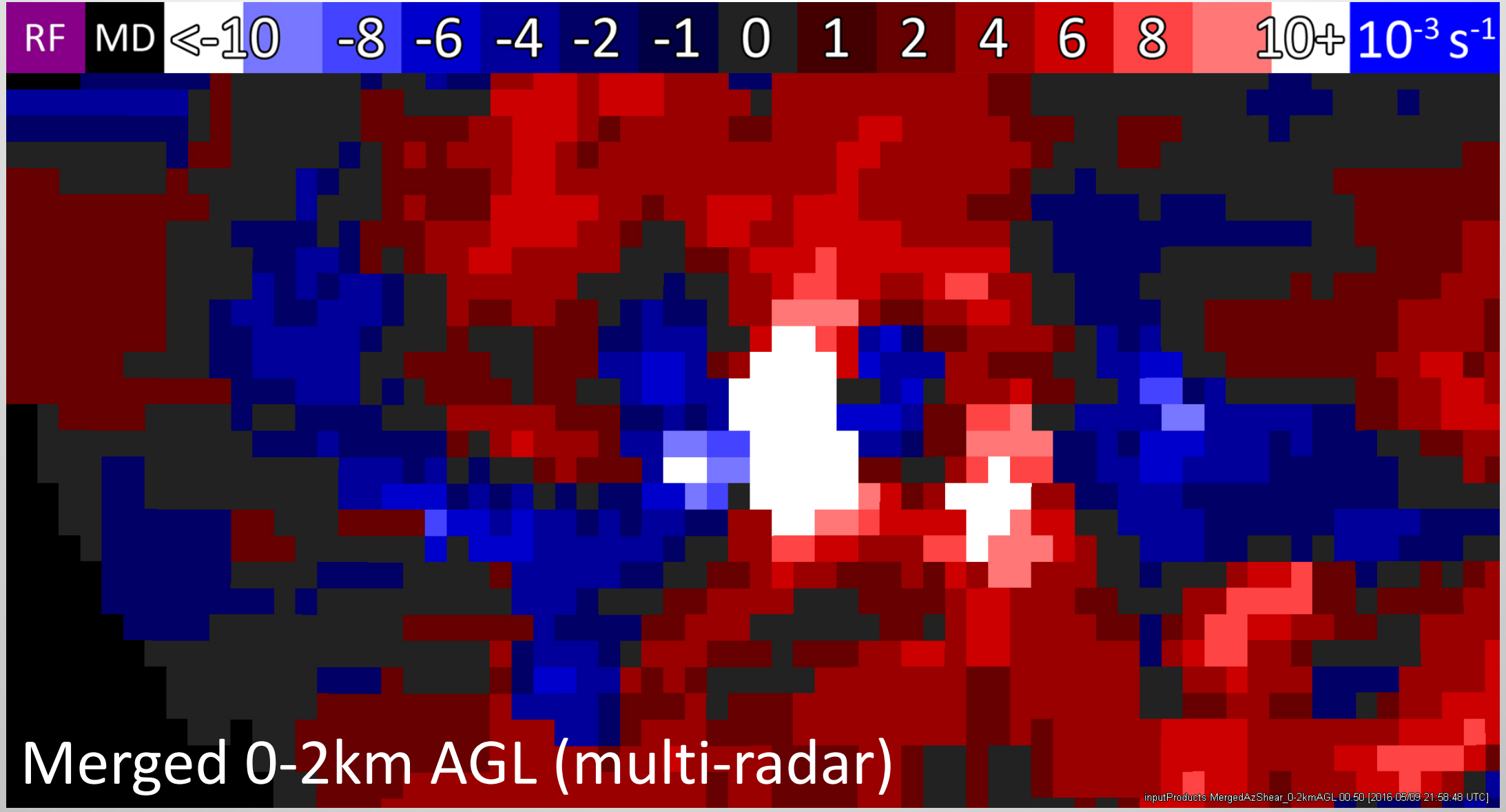
- **May 9, 2016 from KTLX @ 215848**
- *Strong EF3 tornado present at the time of this scan*

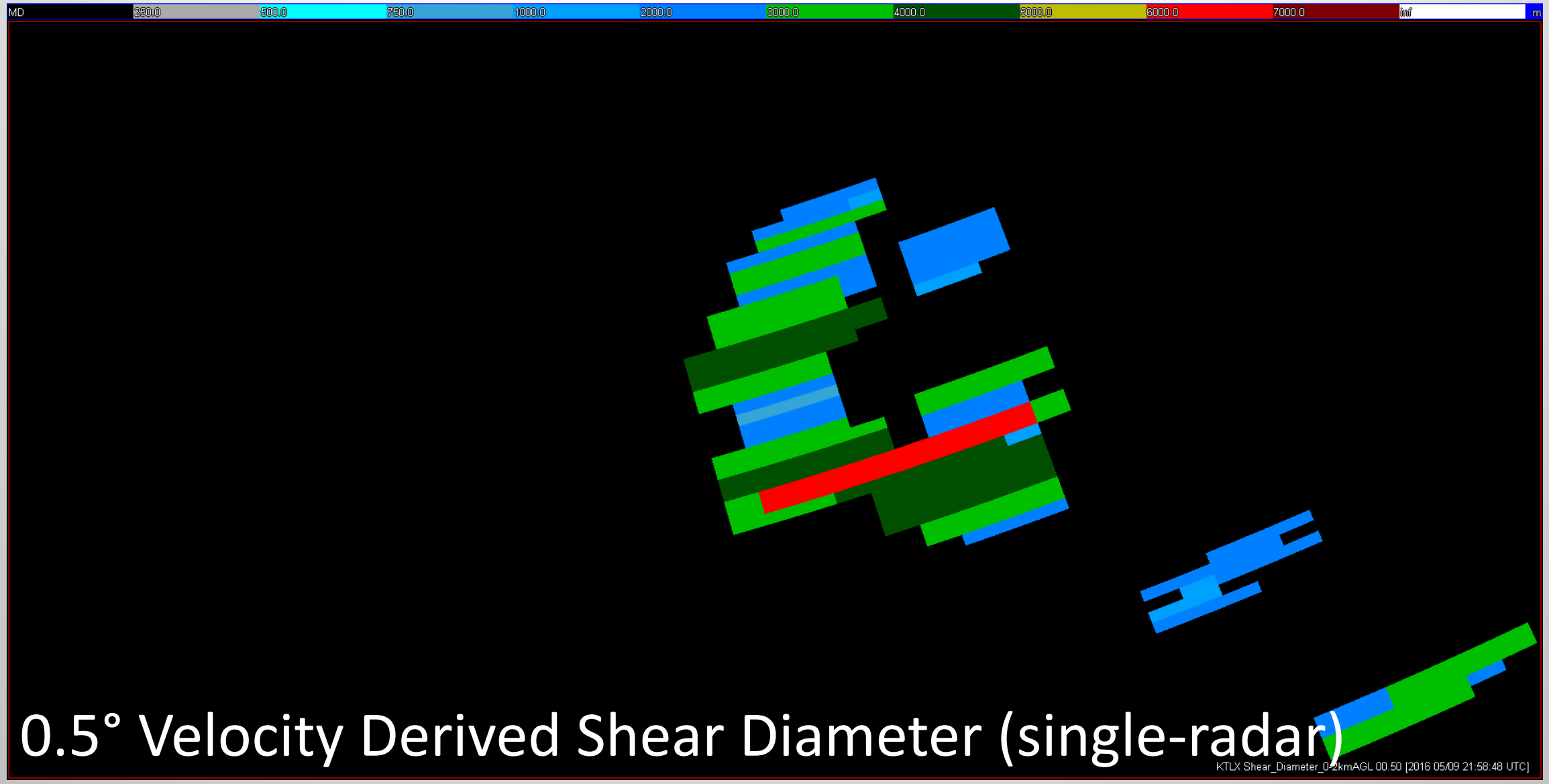
- Example images start with single-radar products, transition to the multi-radar merged products, and then the CPTI products
- Shows the progression on how the multi-radar and CPTI products are generated


NA
-10
10
18
28
38
48
68
93+
dBZ
0.5° Reflectivity (single-radar)
KTLX Reflectivity 00.50 [2016 05/09 21:57:18 UTC]

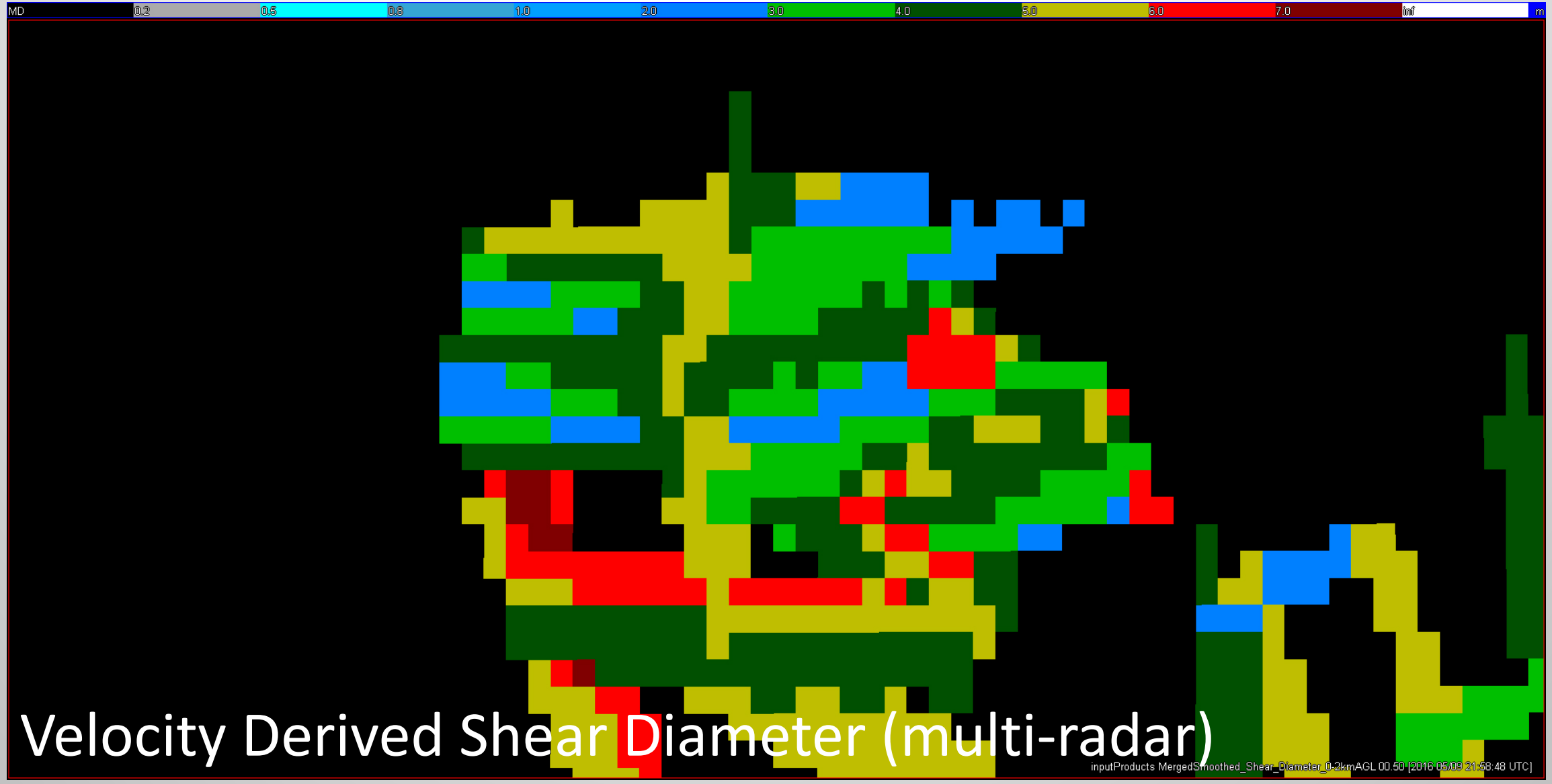

RF
MD
-60
-40
-20
0
20
40
60
m/s
0.5° Velocity (single-radar)
KTLX Velocity 00.50 [2016 05/09 21:57:35 UTC]


RF
MD
<-10
-8
-6
-4
-2
-1
0
1
2
4
6
8
10+
10-3 s-1
0.5° AzShear (single-radar)
KTLX AzShear_0-2kmAGL 00.50 [2016 05/09 21:58:48 UTC]

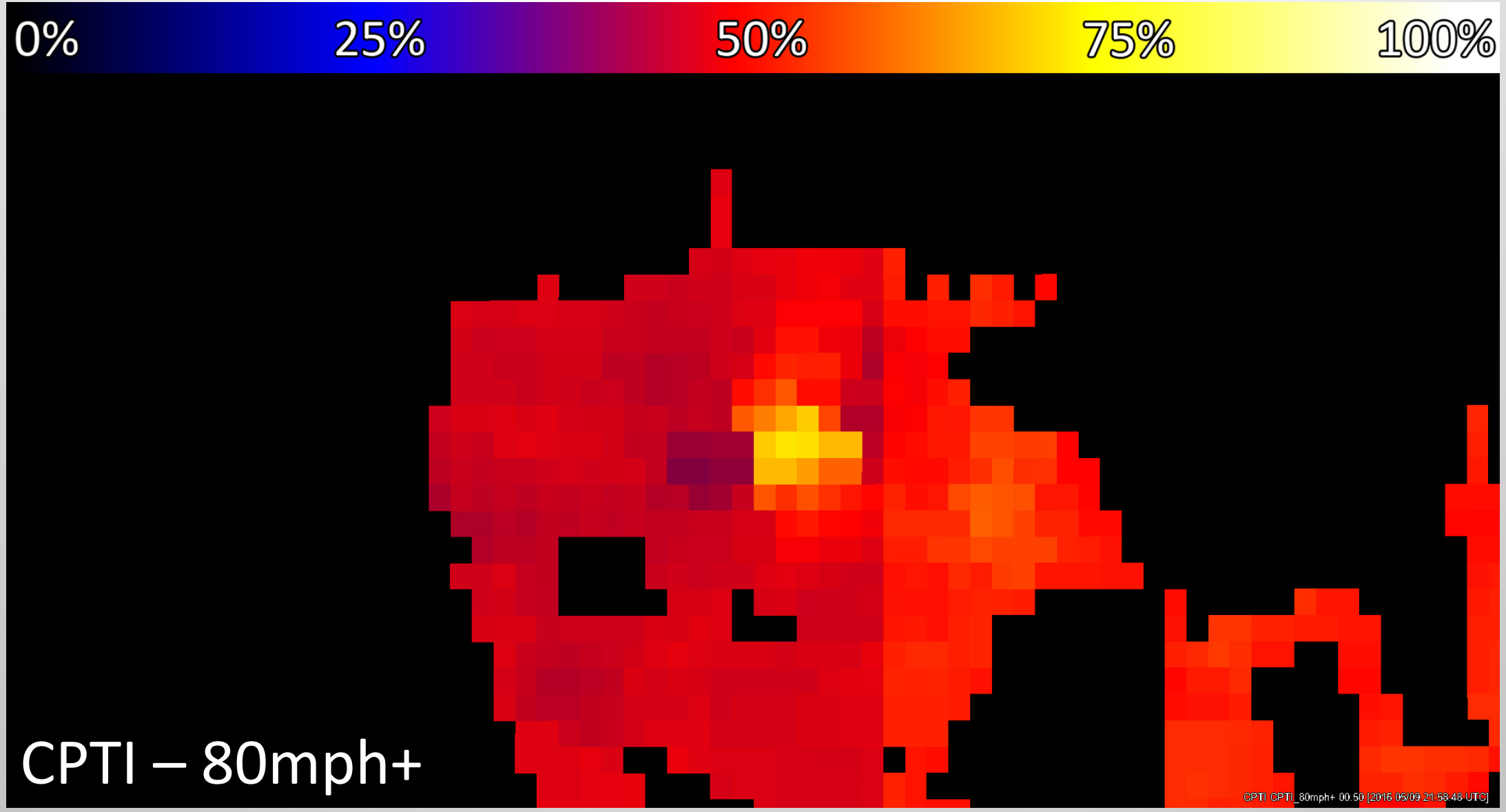

RF
MD
<-10
-8
-6
-4
-2
-1
0
1
2
4
6
8
10+
10-3 s-1
Merged 0-2km AGL (multi-radar)
inputProducts MergedAzShear_0-2kmAGL 00.50 [2016 05/09 21:58:48 UTC]

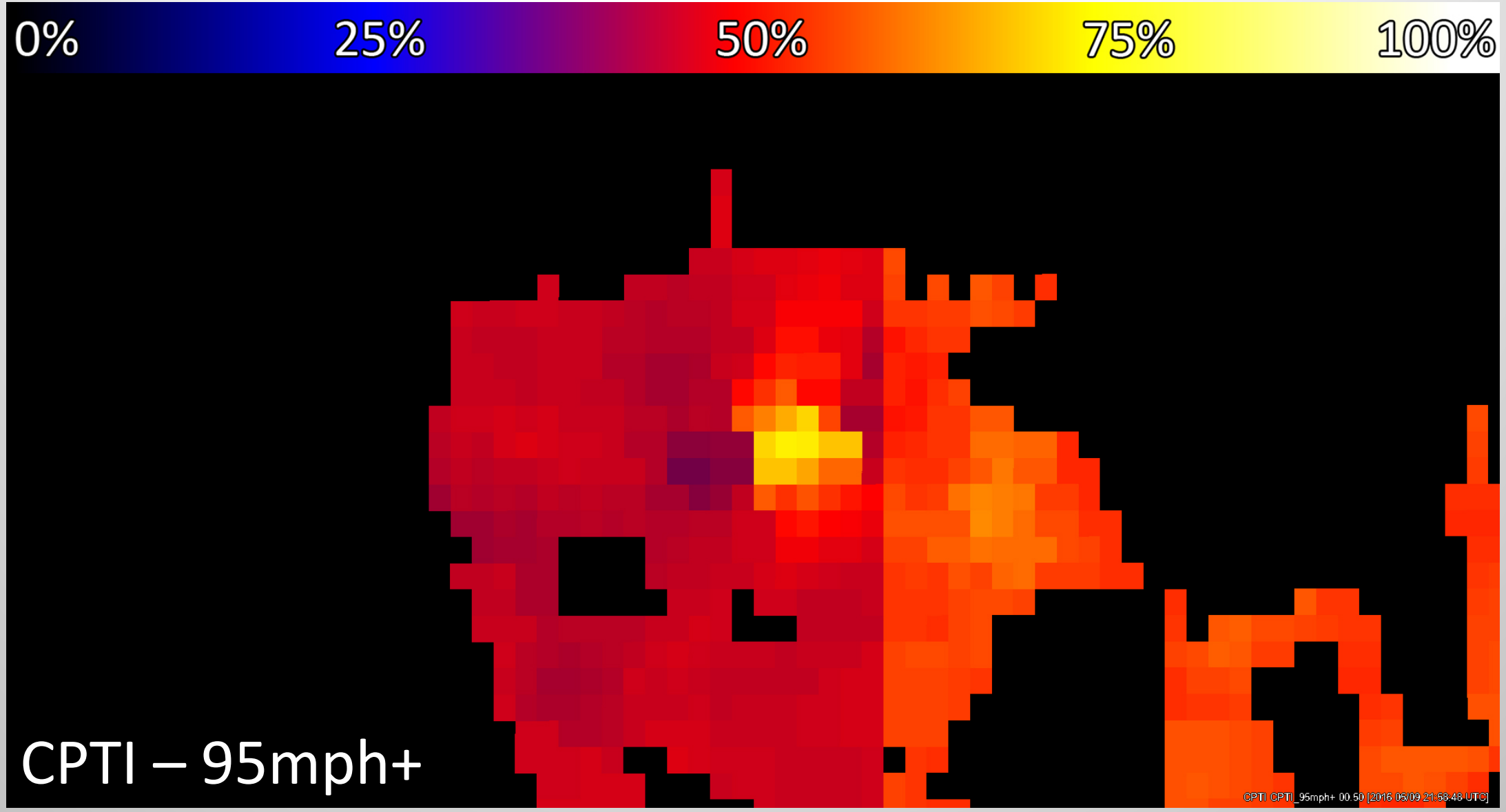


0.5° Velocity Derived Shear Diameter (single-radar)


MD
0.2
0.5
0.8
1.0
2.0
3.0
4.0
5.0
6.0
7.0
inf
m
Velocity Derived Shear Diameter (multi-radar)
inputProducts MergedSmoothed_Shear_Diameter_0-2kmAGL 00.50 [2016-05-09 21:58:48 UTC]


0.0
0.3
0.5
1.0
2.0
2.5
3.0
4.0
5.0
6.0
8.0
10.0
12.0
15.0
+
RAP Derived 40-km Effective Layer STP
merged SIGT 40km_analysis [2016 05/09 21:00:00 UTC]


0%
25%
50%
75%
100%
CPTI – 80mph+
CPTI CPTI_80mph+ 00:50 [2016 05/09 21:58:48 UTC]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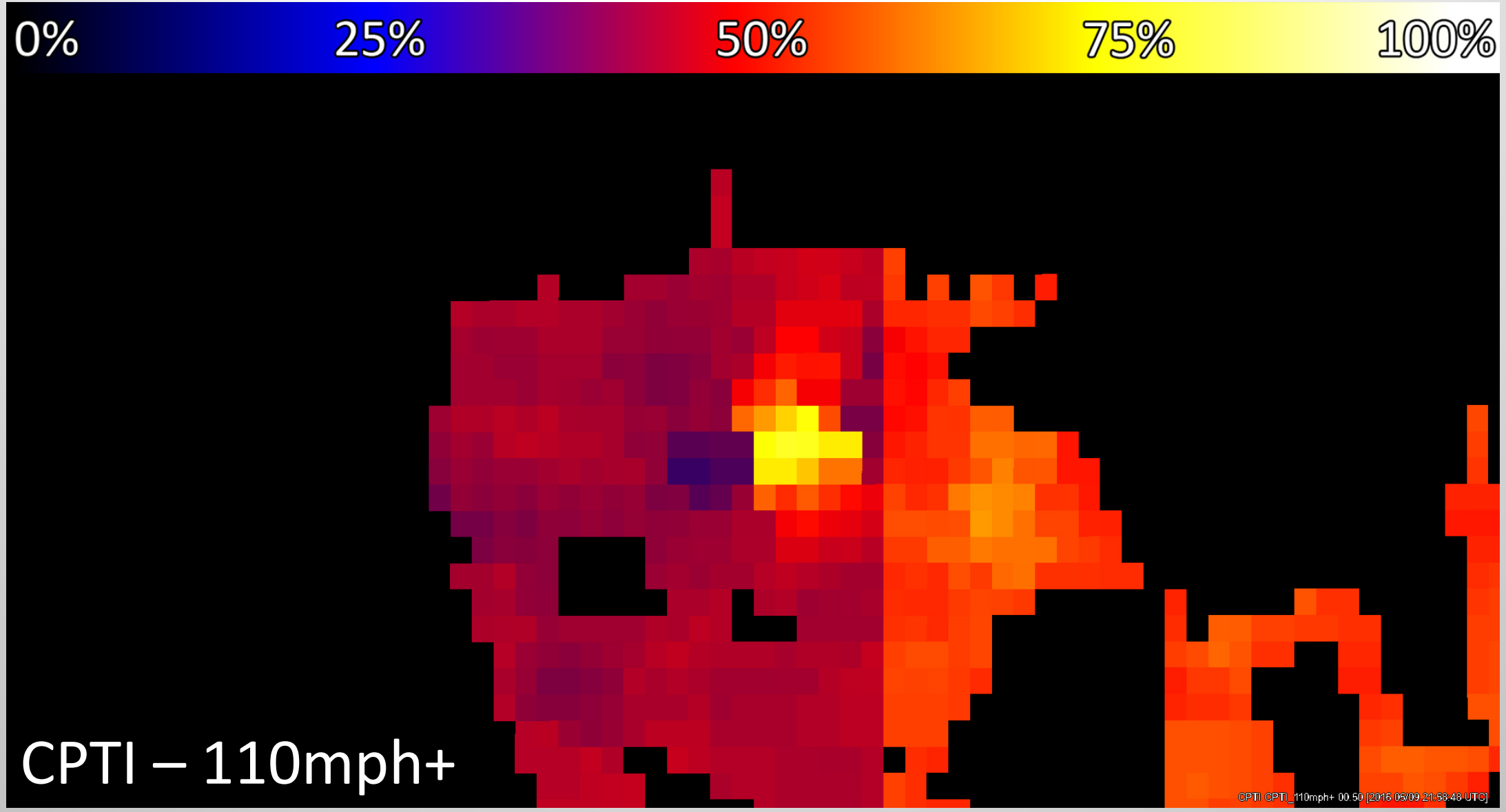
CPTI – 95mph+
CPTI CPTI_95mph+ 00.50 [2016 05/09 21:58:48 UTC]


0%
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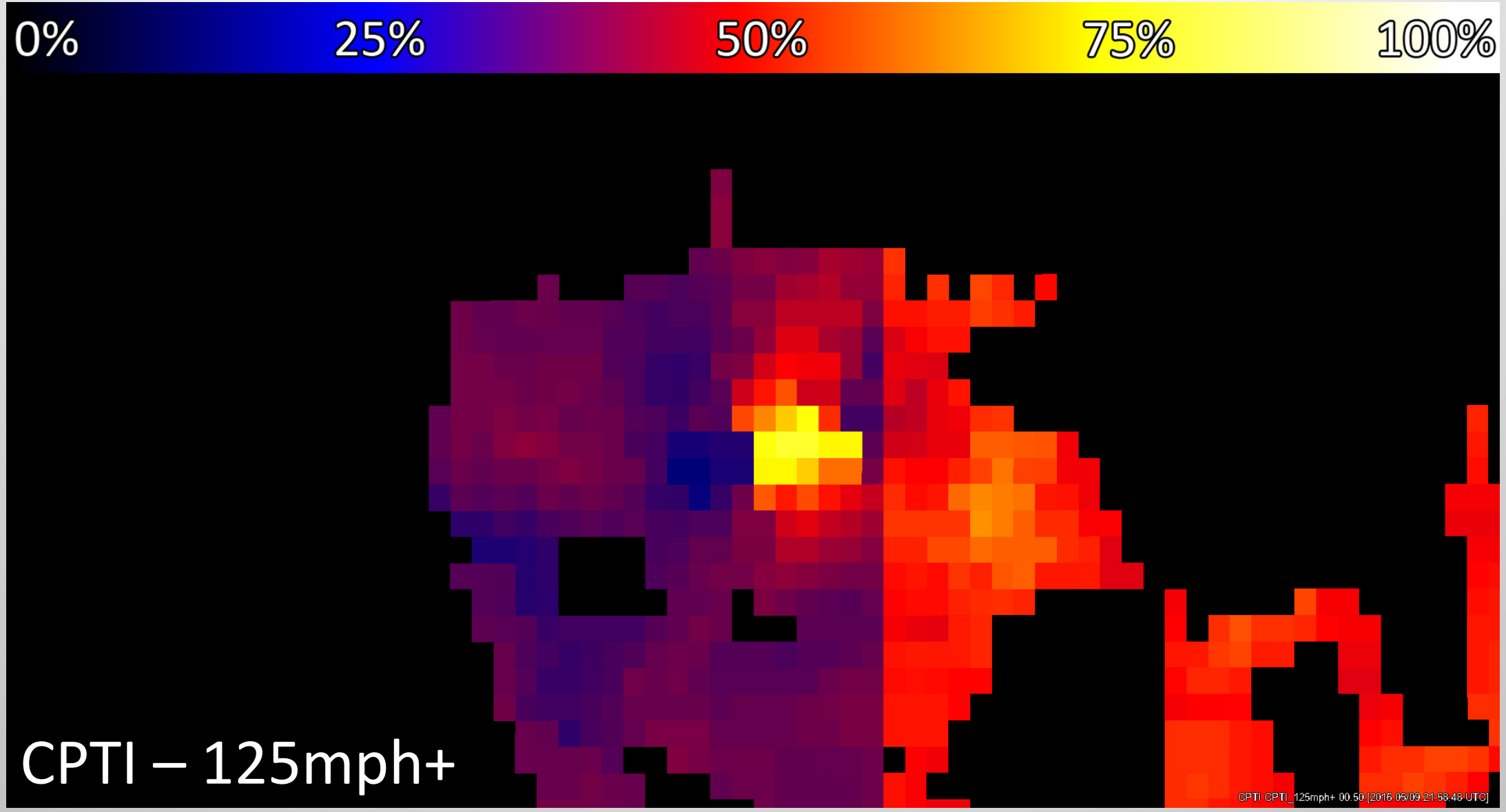
CPTI – 110mph+
CPTI CPTI_110mph+ 00:50 [2016 05/09 21:53:48 UTC]


0%
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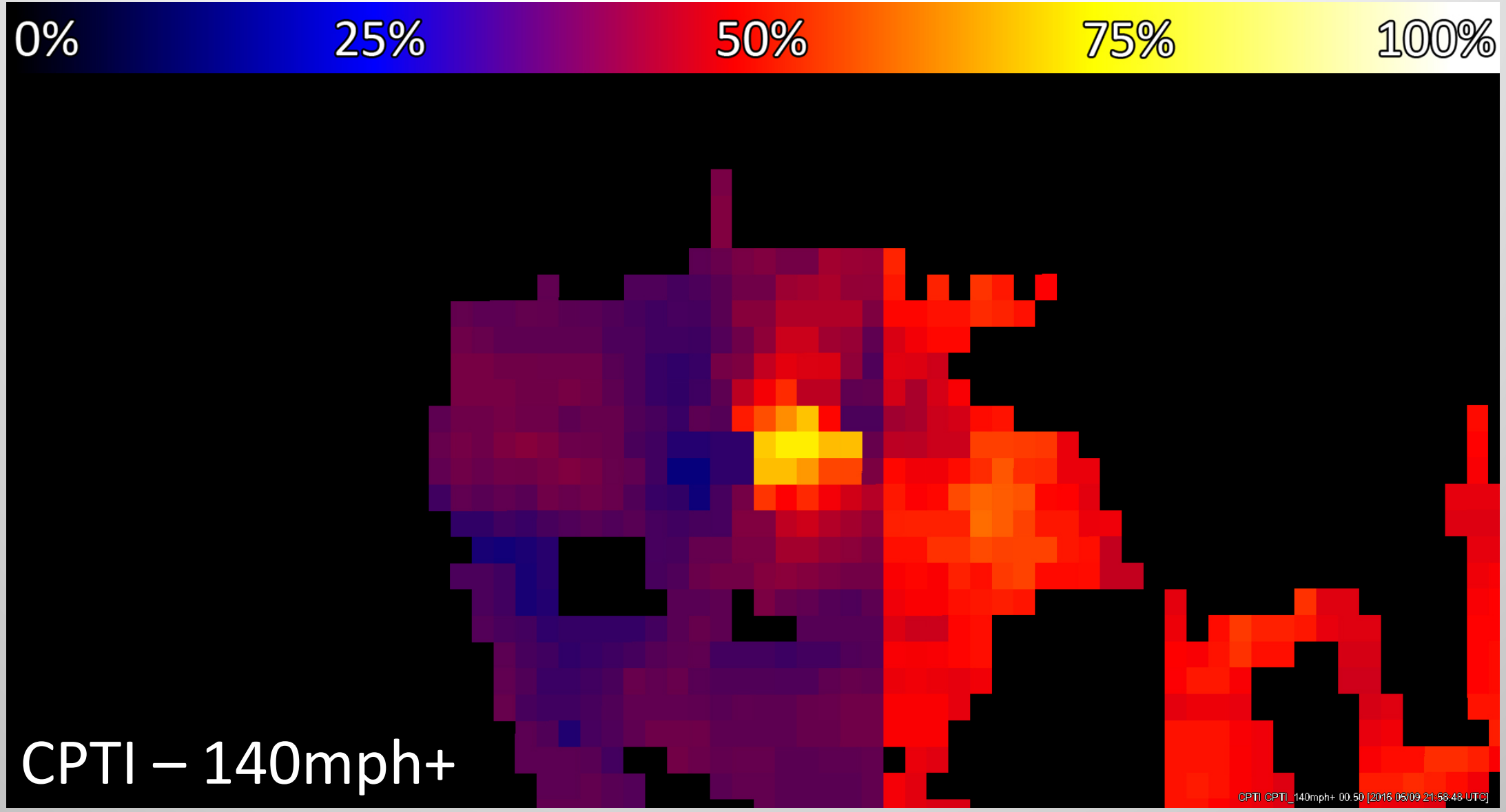
100%
CPTI – 125mph+
CPTI CPTI_125mph+ 00.50 [2016 05/09 21:58:48 UTC]


0%
25%
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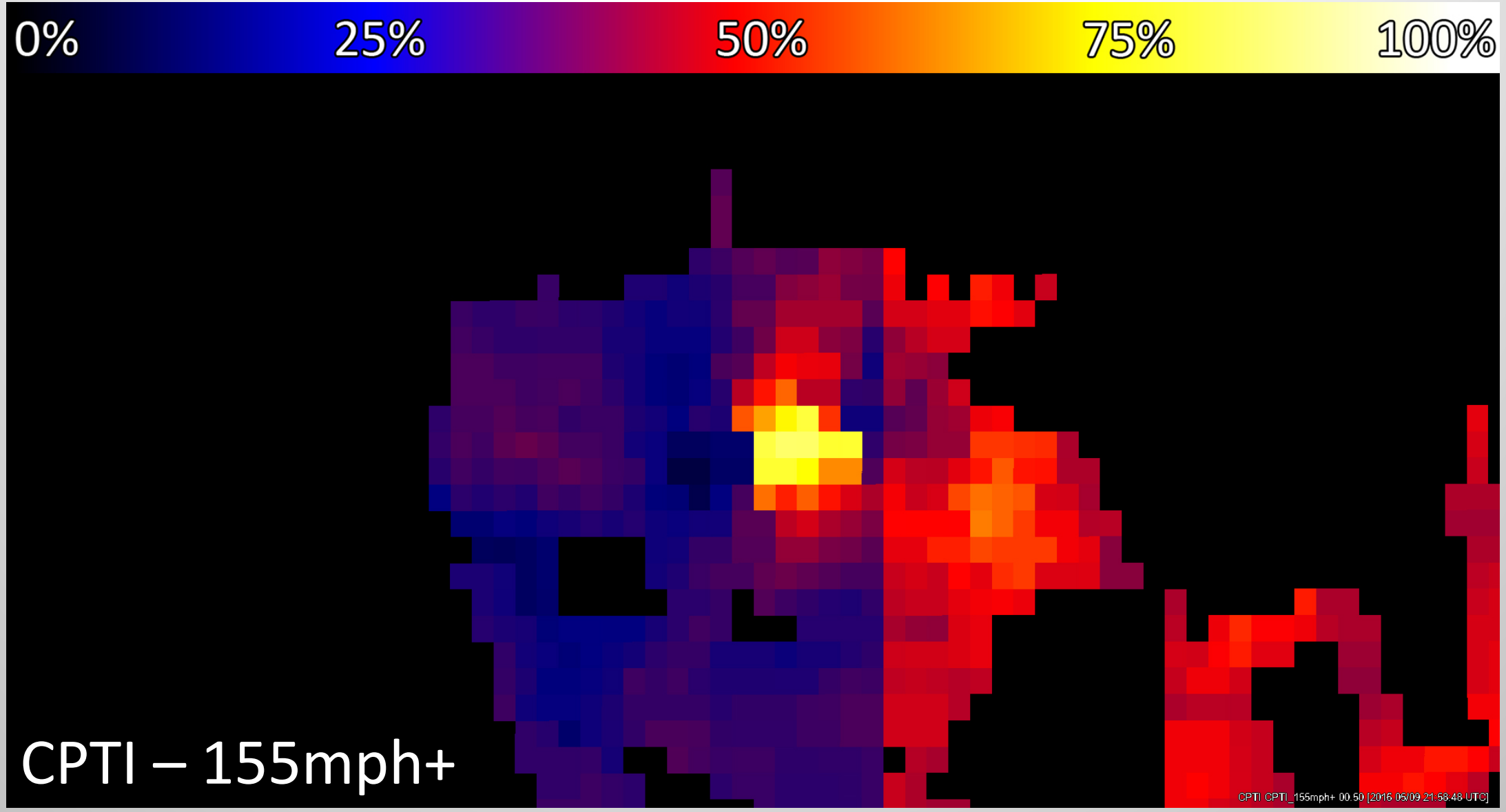
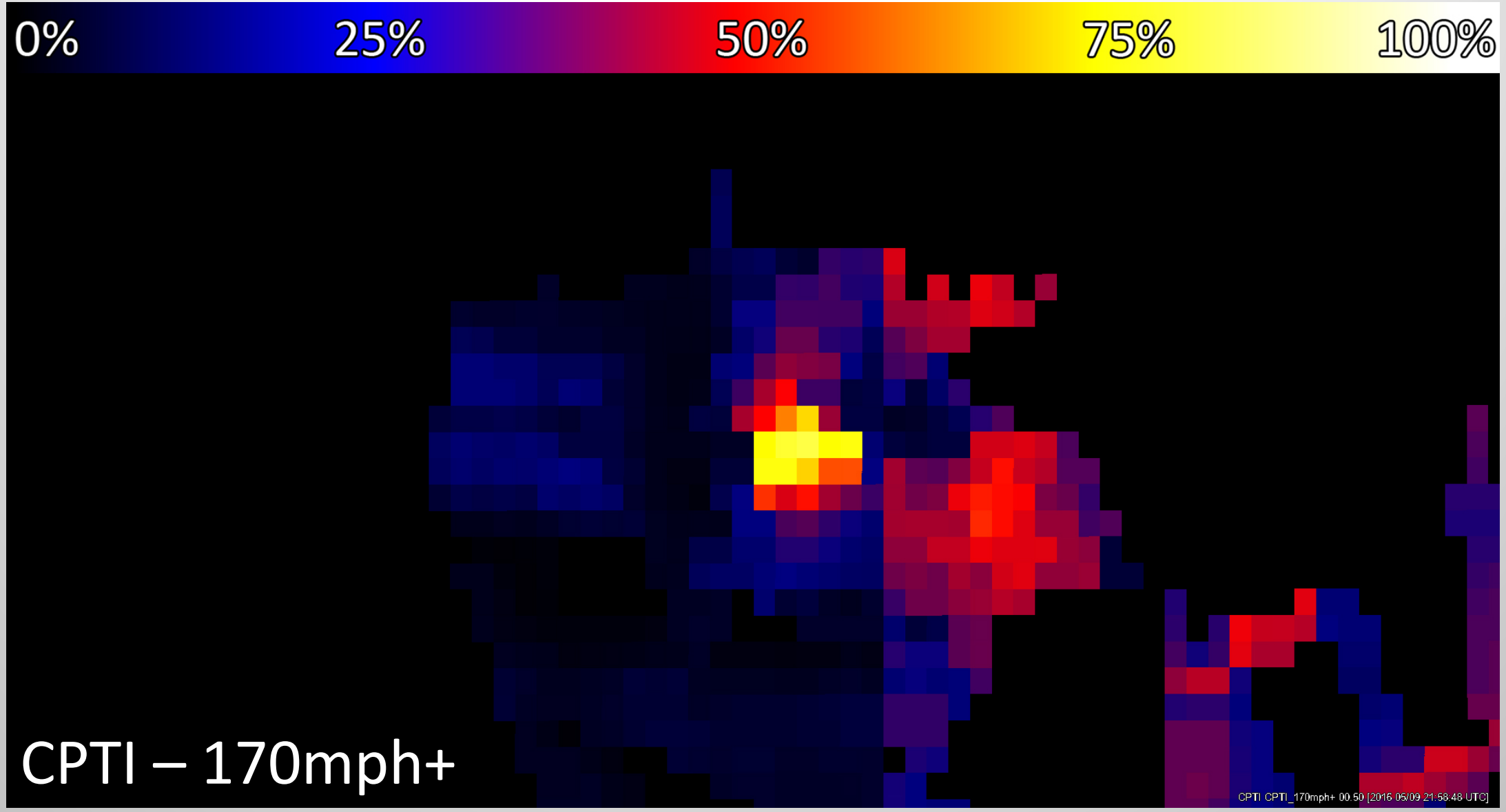
100%
CPTI – 140mph+
CPTI CPTI_140mph+ 00.50 [2016 05/09 21:58:48 UTC]


0%
25%
50%
75%
100%
CPTI – 155mph+
CPTI CPTI_155mph+ 00.50 [2016 05/09 21:58:48 UTC]


0%
25%
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75%
100%
CPTI – 170mph+
CPTI CPTI_170mph+ 00.50 [2016 05/09 21:58:48 UTC]

CPTI – Recommended Usage

- Since the product is conditional on the presence of a tornado, it should be used as guidance if you have a high certainty that a tornado is occurring
- Load CPTI products **ONLY** in a regional or sub-regional display view within AWIPS-II
  - Any larger display views will cause poor AWIPS-II performance
- Examining 7 different products can be A LOT...here are some potential loading suggestions:
  - Load all 7 products in one window and assign each an individual color
    - Experiment with assigning different thresholds for where maximum opacity occurs
  - Only load one product to represent weak, moderate, and strong intensity

CPTI – Additional Usage Notes

- Dampened probabilities associated with the 140mph+ product
- 40-km STP grid can cause “hard” edges and drastic changes in probabilities (20160509 KTLX example)
- Introduction of SAILS in the merged multi-radar products causes “double peaks” to form in the gridded probabilities
  - Caused by the virtual volume technique currently used to create the single-radar layered products that are used for merging