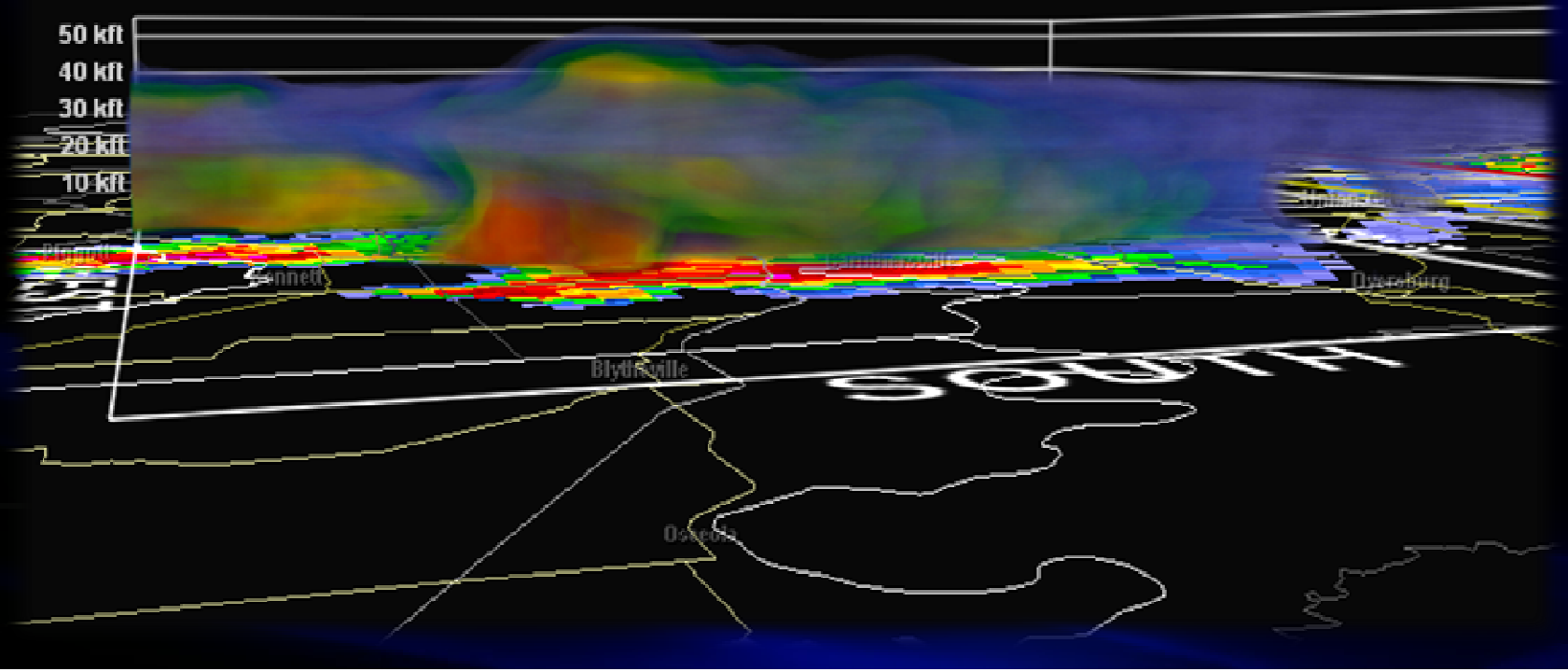
GRLevel2 Analyst:
Two & Three Dimensional Radar Analysis

Kevin Terry



What GR2Analyst Can Do

- **Volumetric Display**
  - **View Real Time Three-Dimensional Rendering of Radar Data to Aid in Identifying Potential for Imminent Severe Weather Occurrences**

- **Cross Sections**
  - **Create Vertical Cross Sections on the Fly and Move or Rotate the Initial Plane using Slider Bars**

- **High Resolution Derived Products (1km x 1° x 230km grid – 256 data levels)**
  - **Echo Tops**
  - **VIL**
  - **VIL Density**
  - **MEHS (Maximum Expected Hail Size)**
  - **POSH (Probability of Severe Hail)**
  - **NROT (Normalized Rotation)**

- **Mesocyclone and Hail Detection**
  - **Independent of the WSR-88D Algorithms**

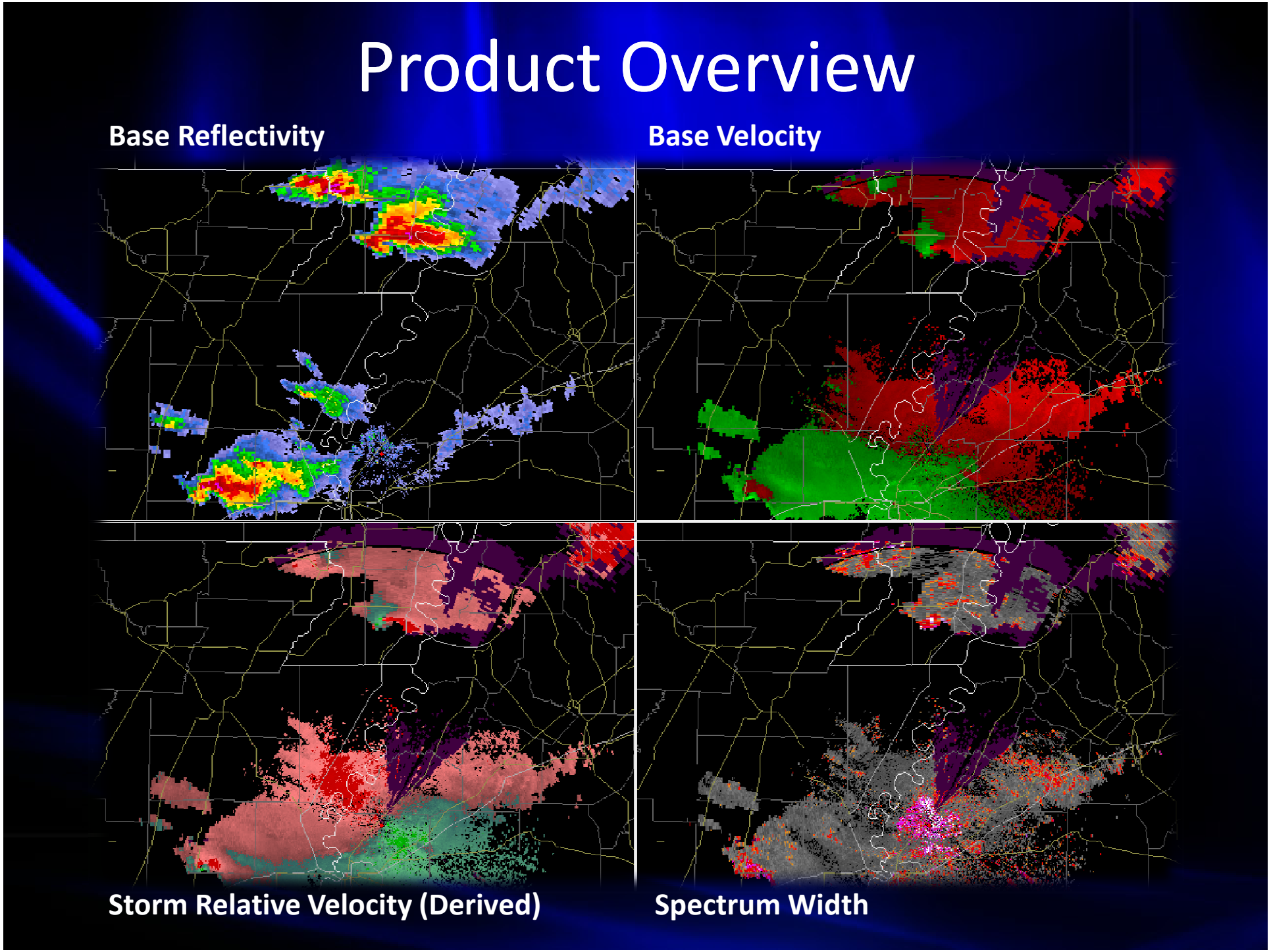
- **Incorporation of Real Time Rapid Update Cycle (RUC) Environmental Data**
  - **To Determine Critical Temperature/Height Data for Hail Detection and Wind Profile Data for Velocity Dealiasing**

A Few Basics

- Data Source is Nexrad Level-II
  - Standard Products include Base Reflectivity, Base Velocity, and Spectrum Width
  - All Tilts Included
  - Input Storm Motion Vector to Derive SRV; Also used to Correct for Data Tilting in Hail Products and Volumetric Data due to Storm Motion
    - Click the "Set Storm Motion Vector" Button on the Toolbar 
      - Dialog Box Follows to Enter Azimuth/Speed Information
    - Storm Motion Can Also be Set on the Radar
      - Set Radar Back One or More Frames
        - Right Click on a Trackable Radar Feature and Select "Place Marker Here"
      - Go Forward to Latest Frame
        - Right Click on Radar Feature and Select "Storm Motion From Marker"
  - Other 2-D Products Derived From Base Data

- Other Features
  - Two/Four Panel Option – Panel Settings Can Be Saved for Frequently Used Views
  - Ability to Display Warning Polygons in Real Time
  - Shapefile Support
  - Customizable Color Tables for All Products

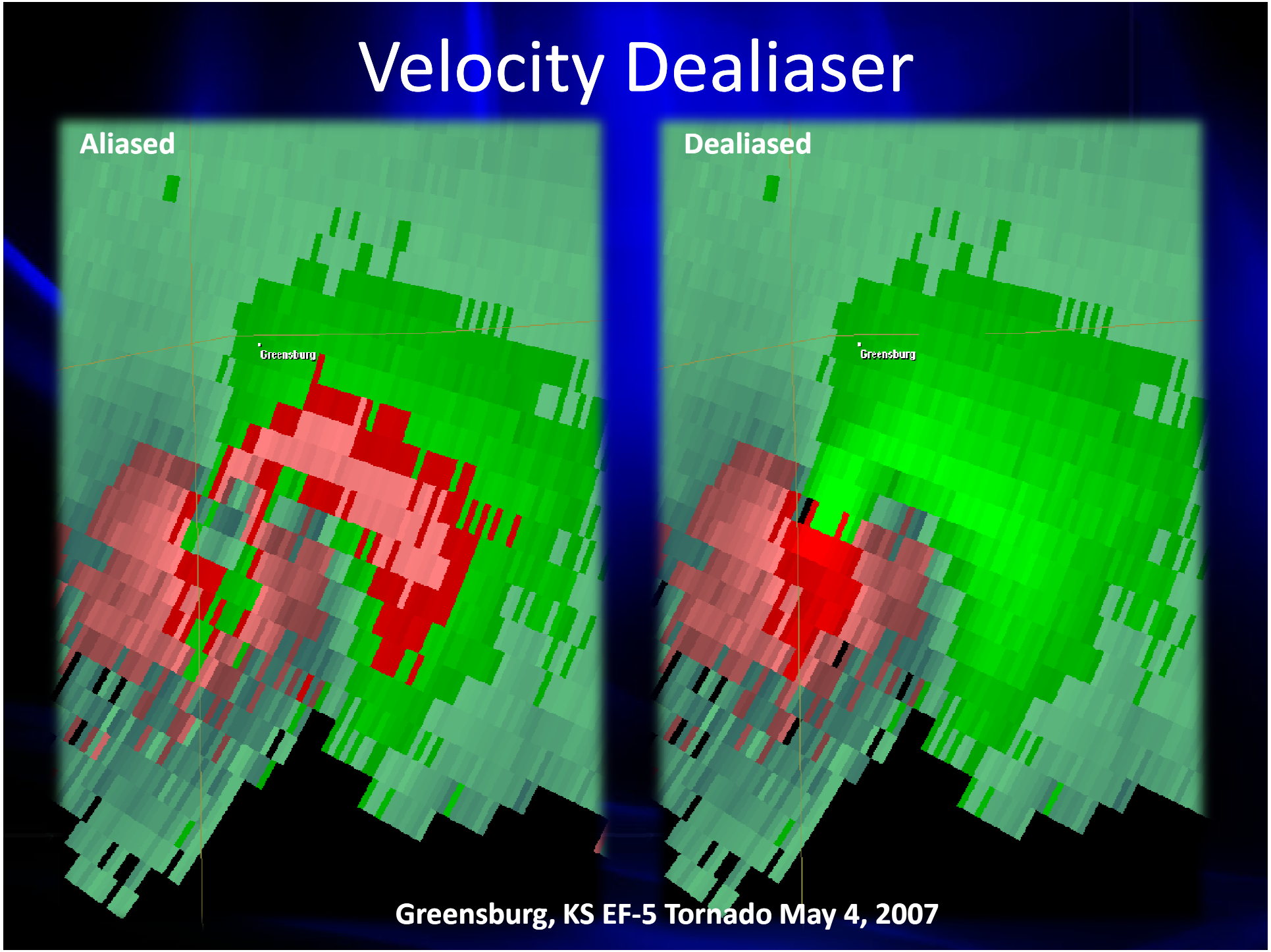
Product Overview



Velocity Dealiaser

- The Raw Level-II Data Sent Out to the Servers is Aliased
  - GR2Analyst has a Dealiasing Algorithm
    - Several Passes Conducted
    - Wind Profile Data from Latest RUC Soundings (Downloaded Automatically when Polling Live Data) is also used as a Check
- The Dealiasing Algorithm Will Fail…
  - In Noisy Velocity Patterns
  - In Areas of Very High Spectrum Width
- By Default Unresolved Values will be Converted to ND
  - Can be Changed by Going to View → Dealias Settings…
  - Also There You Can Disable Option to Use Latest RUC Wind Profile Data
- To Enable Dealiasing
  - Make Sure a Velocity Product is Active in the Main Screen
  - Click on the Dealiasing Toggle Button in the Toolbar 

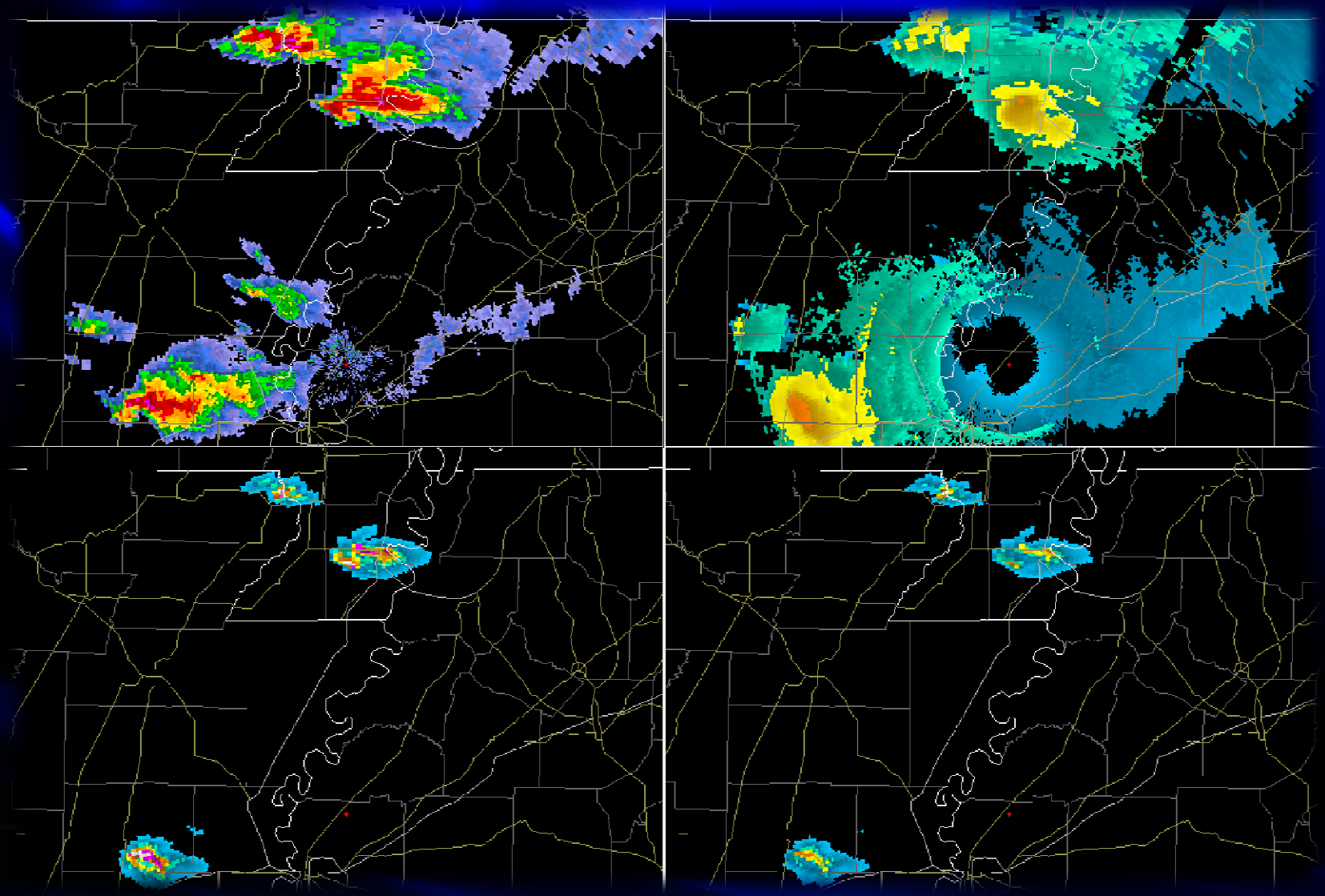
Velocity Dealiaser



Product Overview

Base Reflectivity

Echo Tops



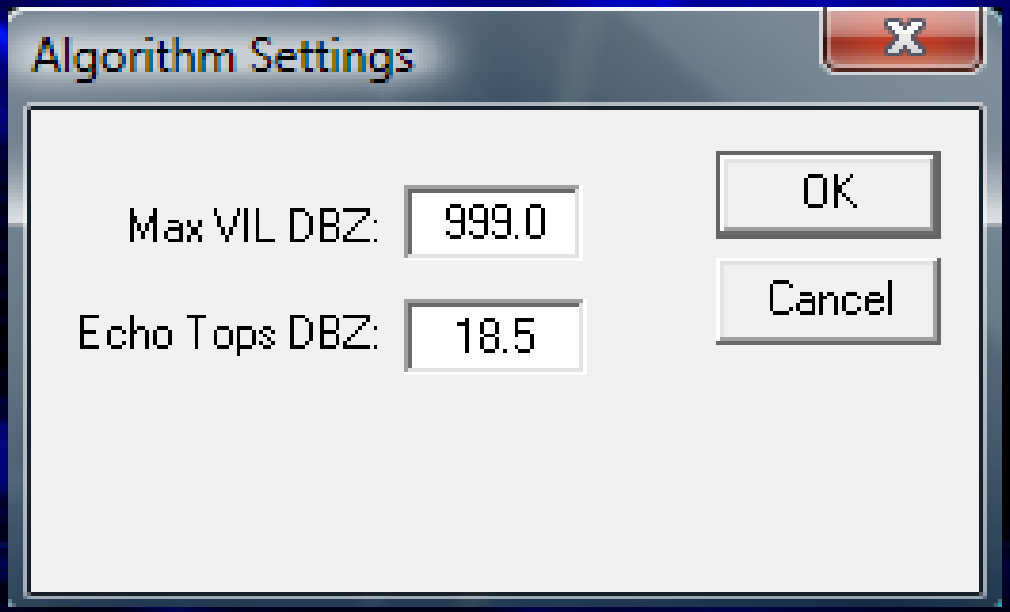
Vertically Integrated Liquid

VIL Density

Echo Tops/VIL Algorithm Settings

- **Algorithms → Algorithm Settings…**
  - **Max VIL dbZ**
    - **Default – 999.0 dbZ (Uncapped VIL/Max Output Value 125.0 kg/m^2)**
    - **NWS Standard – 56.0 dbZ**
  - **Echo Tops dbZ**
    - **Default & NWS Standard – 18.5 dbZ**

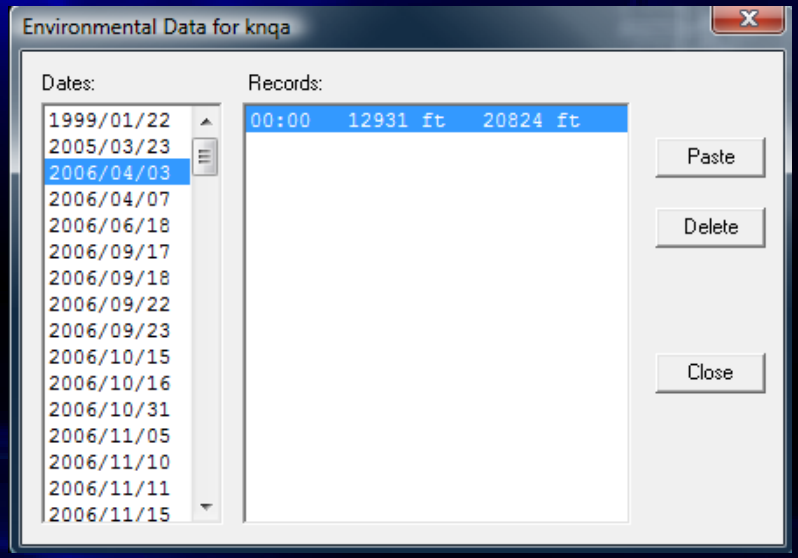
- **Note…Changing Either of these Settings will change the output of VIL Density**



Hail Detection Algorithm

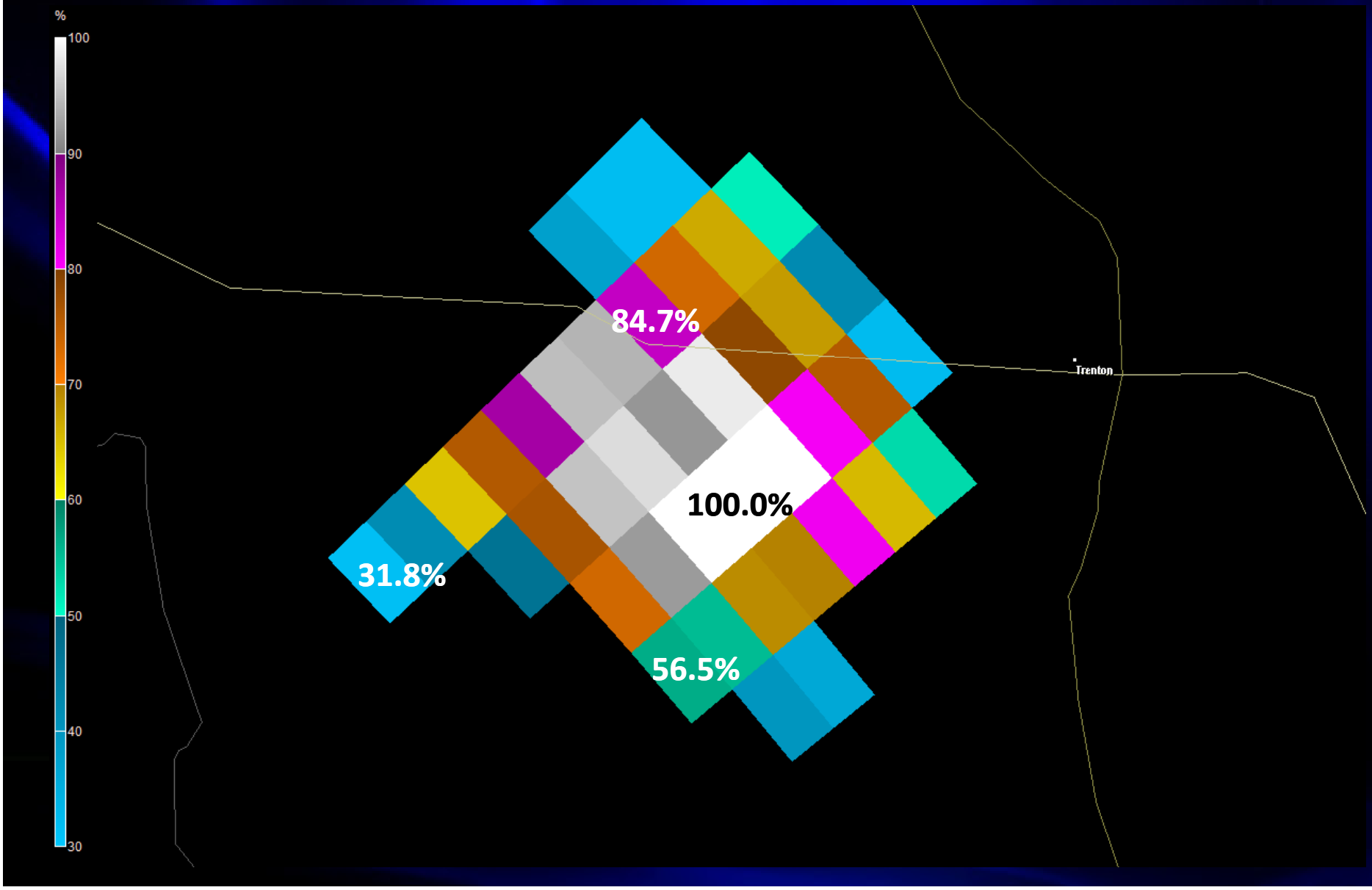
- GR2Analyst Implements an NSSL Hail Detection Algorithm
  - Still Uses the 0C and -20C Height – Retrieved from Latest RUC Soundings.
  - Reflectivity Values Weighted: Values below 40 dbZ are Assigned a 0. Values 40-50 dbZ go from 0 to 1. Values 50 dbZ and above are assigned a 1
  - Reflectivity Height Also Weighted: Below 0C Height = 0. Between 0C and -20C Height = 0 to 1. Above -20C Height = 1
  - Severe Hail Index (SHI) Derived from this Information, Which is Used to Derive the Graphical Hail Products (POSH & MEHS)
  - Storm Motion Vector is Used to Correct for Data Tilting due to Storm Motion, Thus the SMV that is Input will Affect the Hail Output

- 0/-20 Heights (in MSL) Stored in Algorithms → Environmental Data…
  - Dates on the Left. Each Hour of Saved Height Data on the Right
  - In Addition to Automatic RUC Data Retrieval, Data can be Manually Pasted from Clipboard when in FSL Format/ASCII Text (Copy ALL Data)
  - If No Height Data is Set, Values Default to 10,000/20,000 Ft
  - Heights in ARL can be Viewed when Using MEHS, in the "Product Details" Section to the Right of the Main Radar Display.



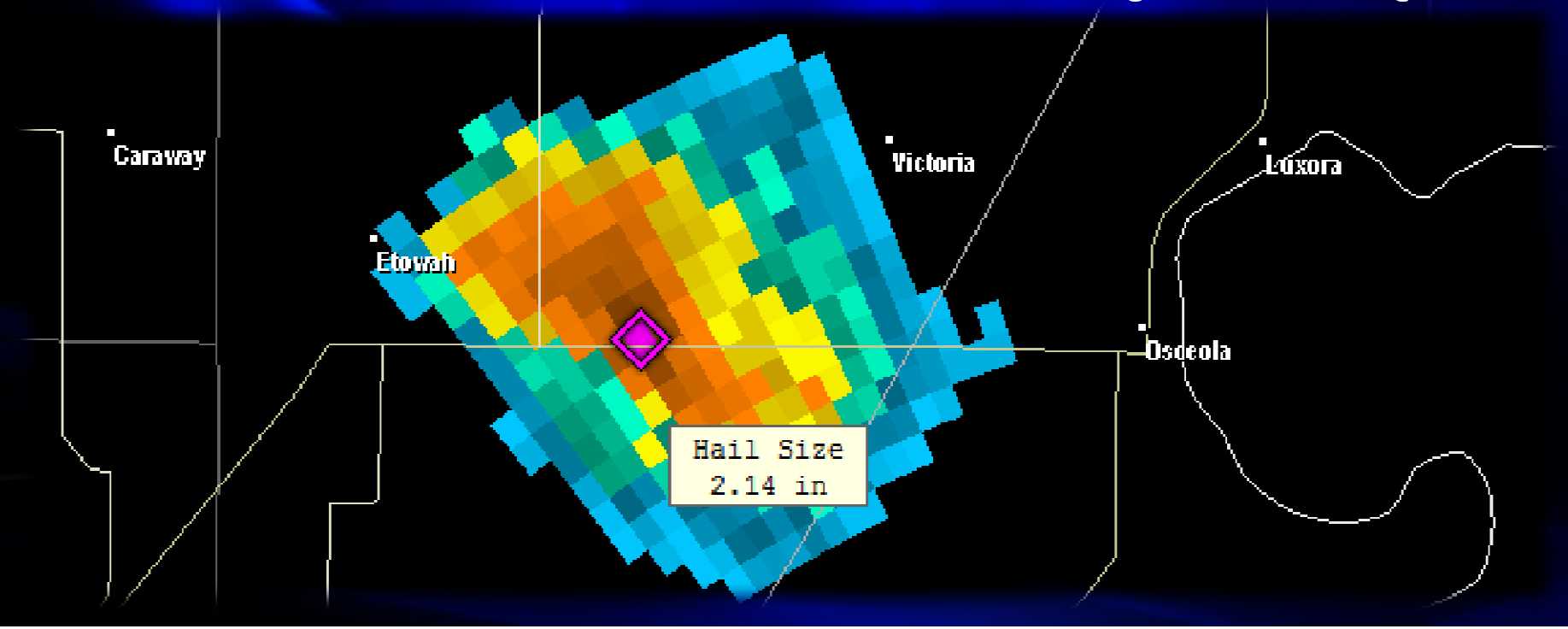
Probability of Severe Hail

- **Probability (Expressed as a Percent) That Hail of a Severe Level, ¾" or Larger, is Occurring**

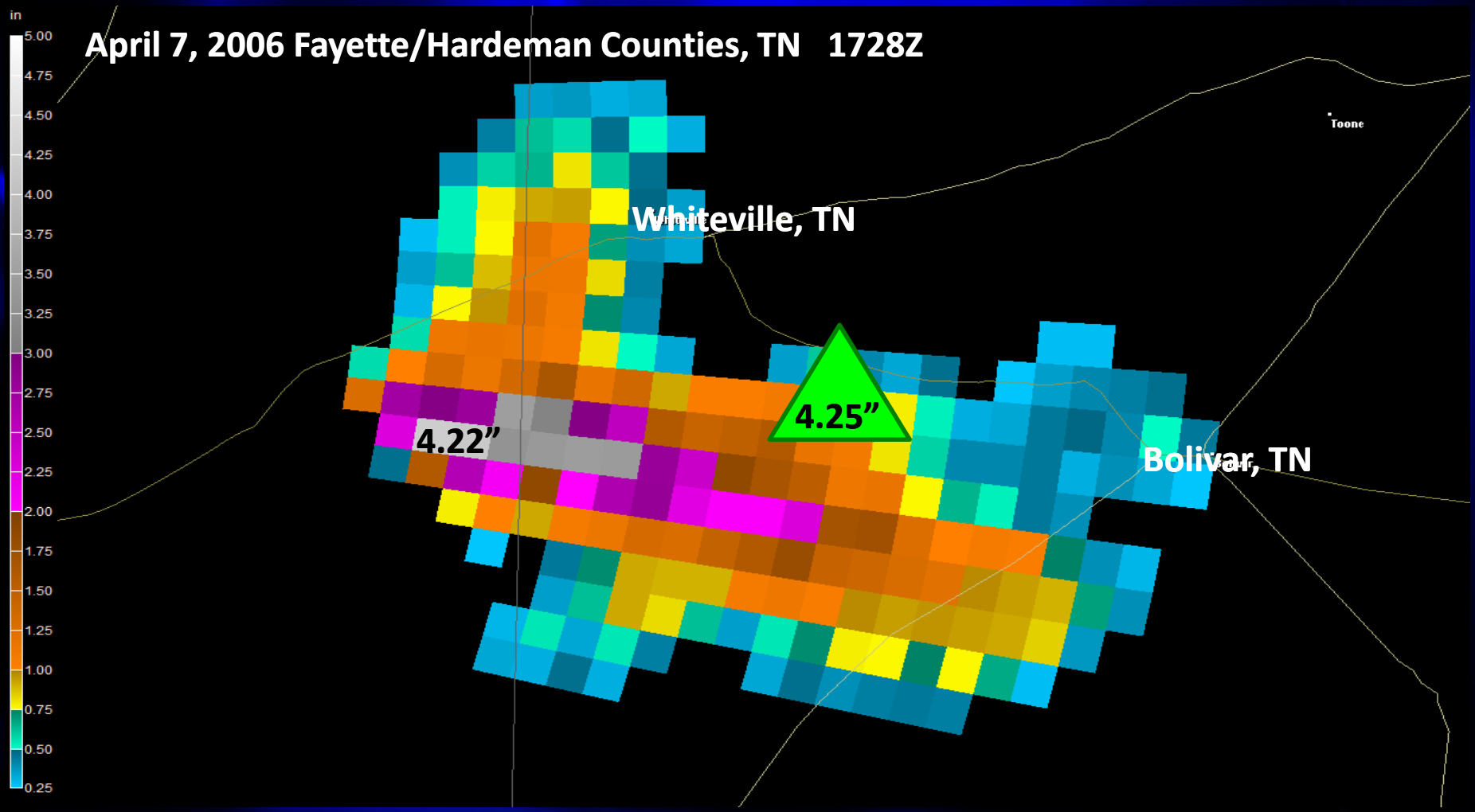


Maximum Expected Hail Size

- Largest Possible Hail Size, Not Necessarily an Average. Highest Possible Value 5.00”
  - Works Best in Spring Environments and/or Supercell Storms
  - Because Reflectivity Height is Used, Highest Values Usually Appear ~2 Volume Scans Before Surface Verification – Thus, Could be Useful in Providing More Lead Time
- MEHS Also Viewable using Hail Icon Attributes
  - Click on the “Show Hail Icons” Button on the Toolbar 
  - Icons Display as Diamonds. Color of Diamond Correlates to MEHS as Based on Color Table in Use. Mouse-Over Icon to Display Tip Box with MEHS Output
  - Icon Size: Small…0.25” to 1.00”. Medium…1.00” to 1.75”. Large…1.75” or Larger



Maximum Expected Hail Size

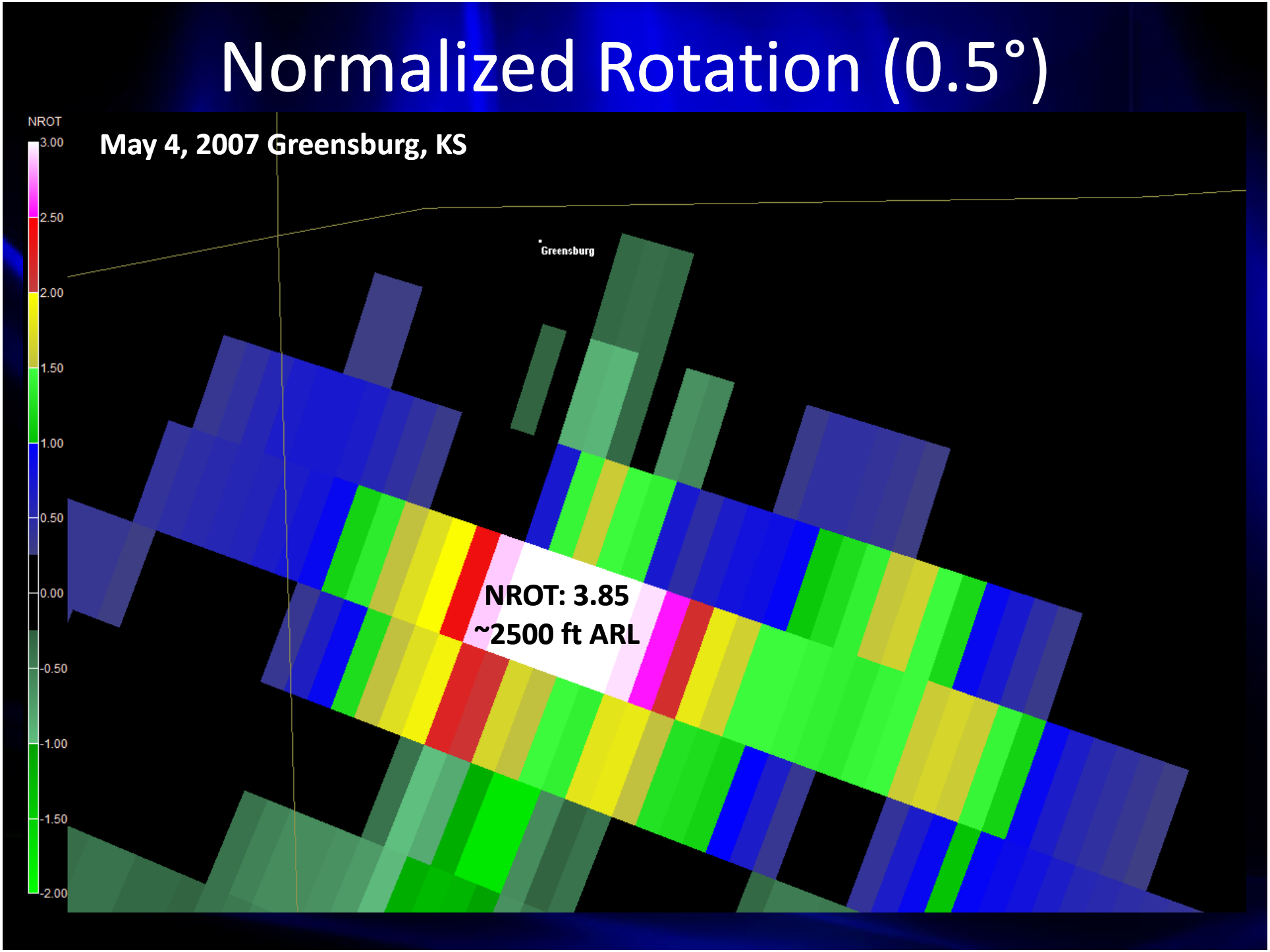


- *MEG STORM DATA: April 7, 2006*
  - *1135-1145 CST (1735-1745Z)…Bolivar-Whiteville…Hardeman…TN…Hail(4.25”)…50K Property Damage*

Normalized Rotation

- Finds Rotation in Dealiased Base Velocity (BVD)
  - Unresolved Aliased Velocity is Ignored
  - 2D Filter Applied to Each BVD Bin, Fits a Second Order Surface to, and Simultaneously Takes the Azimuthal Gradient of, the Surrounding 5x5 bins (3x3 if not Enough Data Available). Similar to LLSD Algorithm developed by Smith/Elmore (OU/NSSL).
  - Result is True Rotation (ROT)
- Significance of True Rotation Value Varies with Range from the RDA
  - ROT Divided by a Piecewise-Linear Curve Given in the MDA Settings Dialog Box to Remove Range Dependency.
  - Result is Normalized Rotation (NROT)
    - Available for All Tilts
    - Range of -5 to +5 (Negative Values are Anticyclonic)
    - Values of 1.0 or Higher are Significant
    - Values of 2.5 or Higher are Extreme

Normalized Rotation (0.5°)

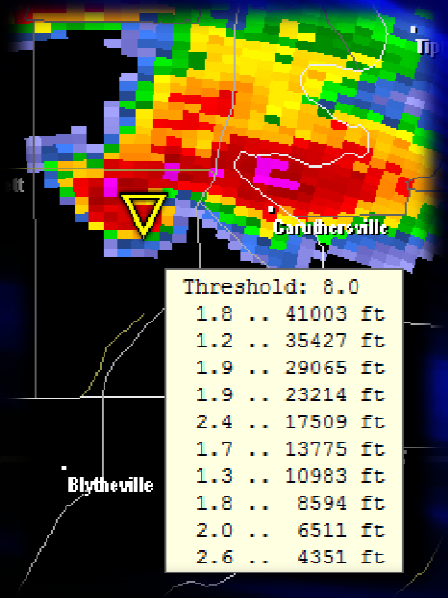


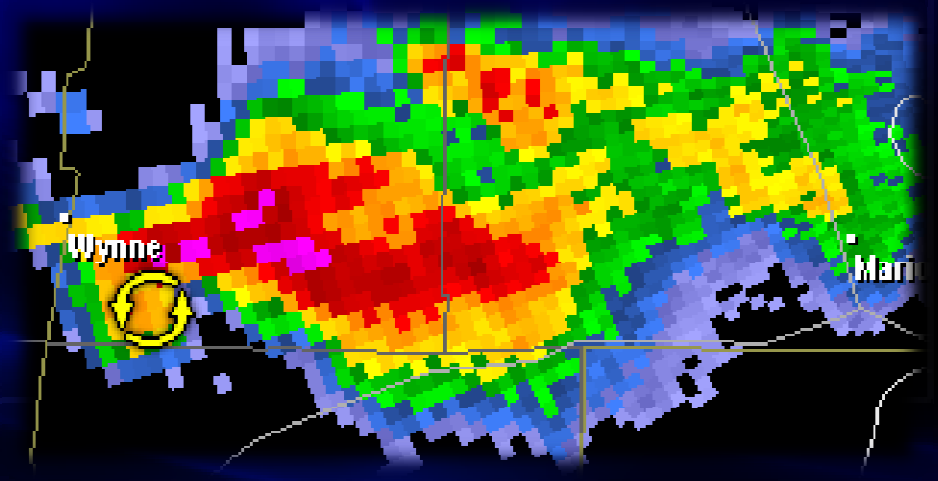
Mesocyclone Detection Algorithm

- GR-MDA
  - Uses NROT to Find and Vertically Correlate Areas of Rotation.
  - Searches Radial Pairs of NROT, Looking for Two Azimuthally-Adjacent Bin Pairs that Average 1.0 or Higher to Create 2D Rotations
  - Then Looks Vertically for 3D Rotations/NROT Stacks
    - If Stack Meets the Count of Consecutive Tilts Needed, as Specified in the MDA Settings Dialog Box using a Separate Piecewise-Linear Curve, it is a Positive Match for the MDA
  - All the Matches that Result go through a Series of Tests
    - If Base of Rotation is above 10kft, It is Tossed
    - Those without a VIL >= 5 within 10km of the NROT Stack are also Tossed
    - For Two Rotations Within Short Distance of One Another…Weaker is Tossed, Stronger Kept
    - Those that Remain are Displayed by Enabling the "Show MDA Icons" Button in the Toolbar 
- Note…Gate-to-Gate Velocity Deltas are NOT used in Rotation Calculations

Mesocyclone Detection Algorithm

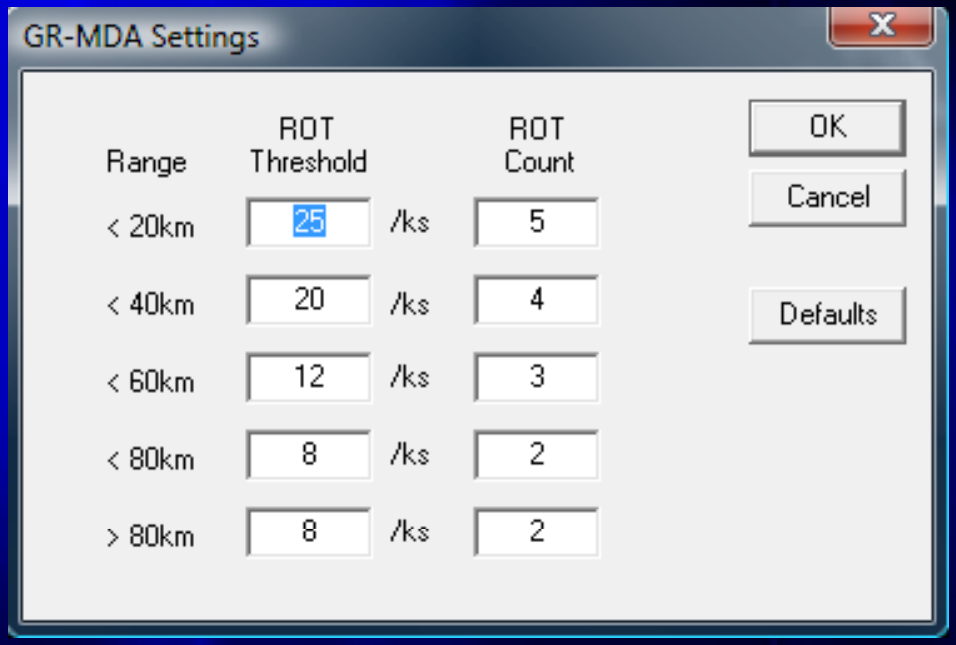
- Inverted Triangle: Base of Rotation Less than 5000ft
- Rotation Circle: Base Above 5000ft
- Icon Color Dependent on Average NROT through All Tilts
  - Green: 1.0-1.5 (Weak)
  - Yellow: 1.5-2.0 (Moderate)
  - Red: 2.0-2.5 (Strong)
  - Purple: 2.5 or Higher (Extreme)
- Mouse-Over MDA Icon to View Attributes
  - Threshold: ROT/Shear Amount (/ks) Necessary To Trigger MDA at that Range
  - The Following Sets of Numbers are "NROT Value .. Height ARL in Ft."





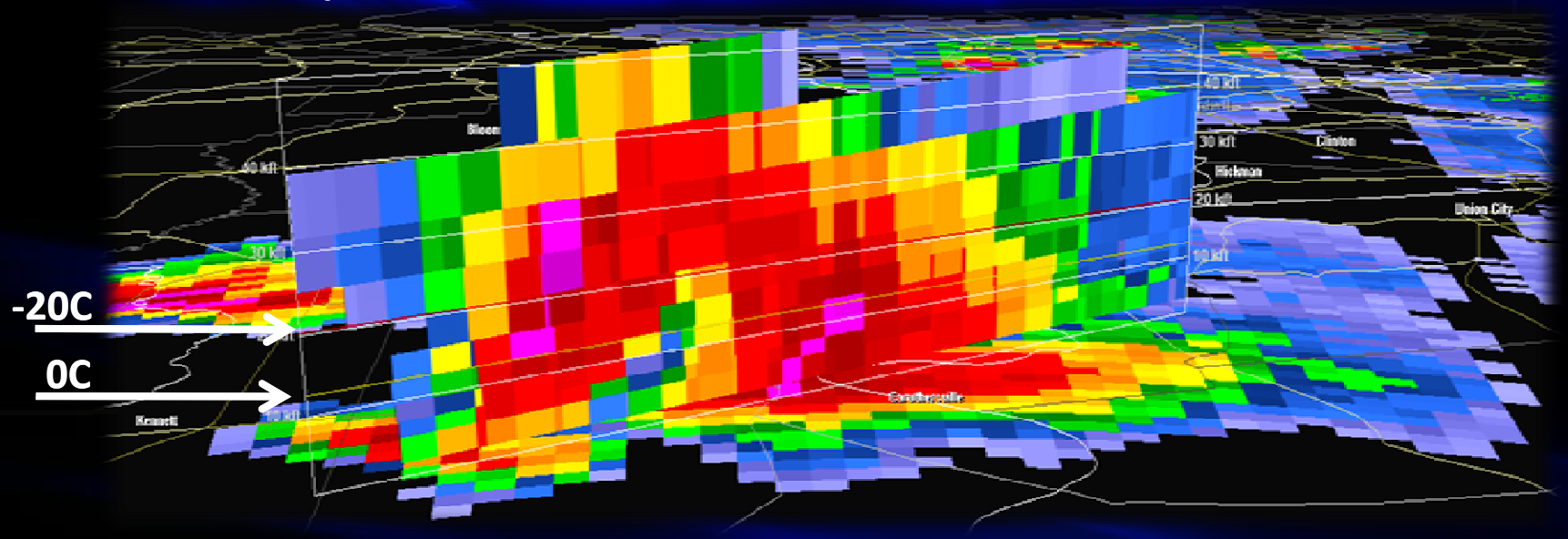
GR-MDA Settings

- Algorithms → MDA Settings…
  - Piecewise-Linear Curves
    - Left: Range from RDA
    - Center: ROT/Shear Threshold (/ks)
    - Right: ROT Count/Threshold
  - Default Settings
    - < 20km…25/ks…5 Tilts
    - < 40km…20/ks…4 Tilts
    - < 60km…15/ks…3 Tilts
    - < 80km…8/ks…2 Tilts
    - > 80km…8/ks…2 Tilts
  - These Values Work Best in "Classic" Severe Weather Setups and Supercells
    - Lower ROT Counts for Low-Topped Storms
    - Lower ROT Thresholds by Small Proportions for Smaller/Weaker Tornado Setups
    - Lowering Values Too Much will Fill the Screen with Meaningless Icons



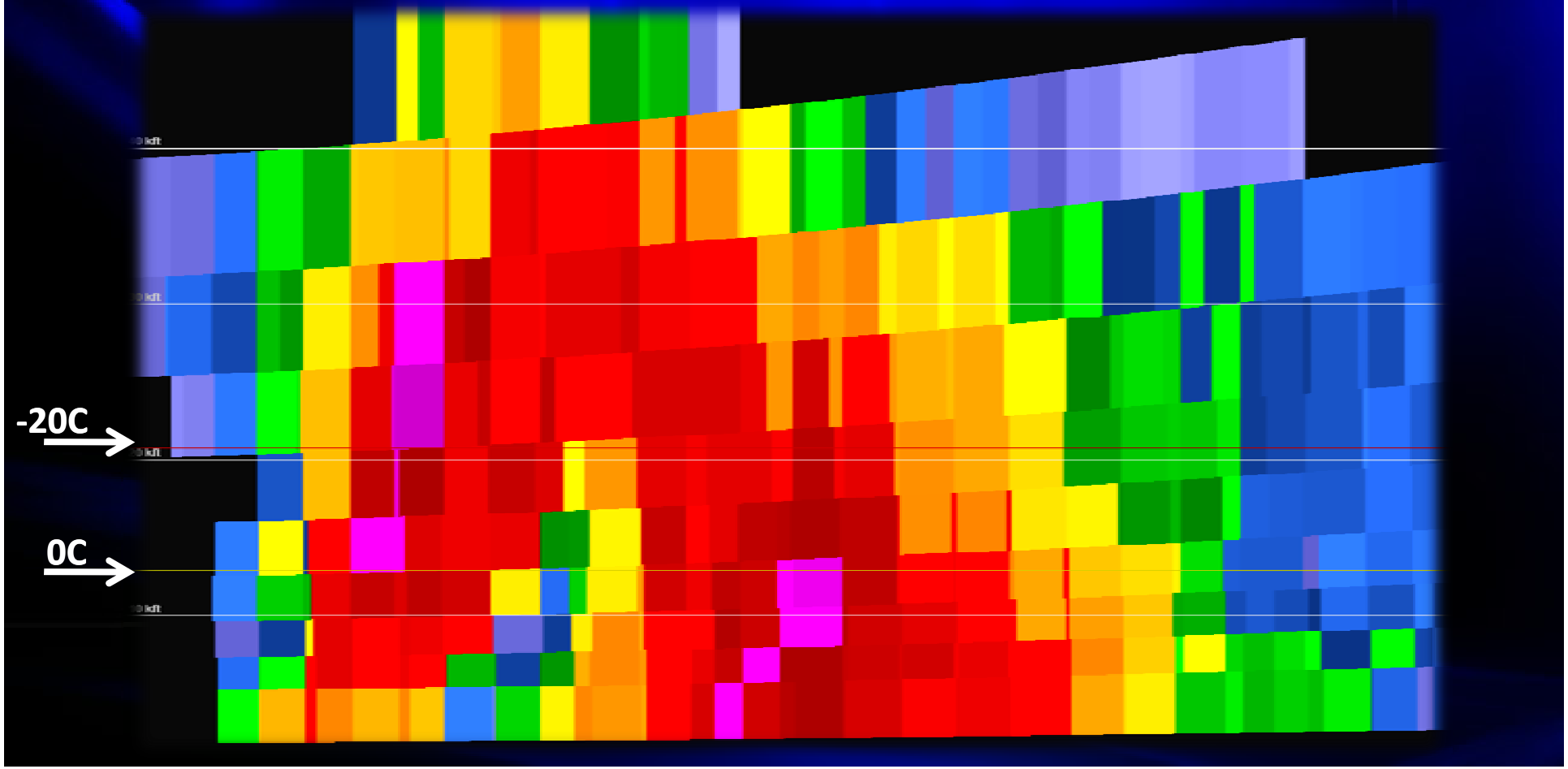
Cross Sections

- Vertical Cross Sections Easily Produced
  - Click the "Cross Section Mode" Button on the Toolbar 
    - Click and Drag a Line Across a Portion of the Radar Screen to Set Initial Cross Section Plane
    - Separate Window Will Open With Cross Section View Selected
- Labeled Height Bars Every 10,000 Feet
- Yellow Line is 0C Height
- Red Line is -20C Height
- Click and Drag to Pan Around Cross Section Area
- Use the Scroll Wheel to Zoom In/Out
- Hit "Refresh" to Update to Latest Data Since Initial Cross Section Creation



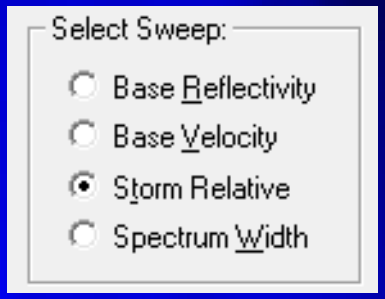
Cross Sections

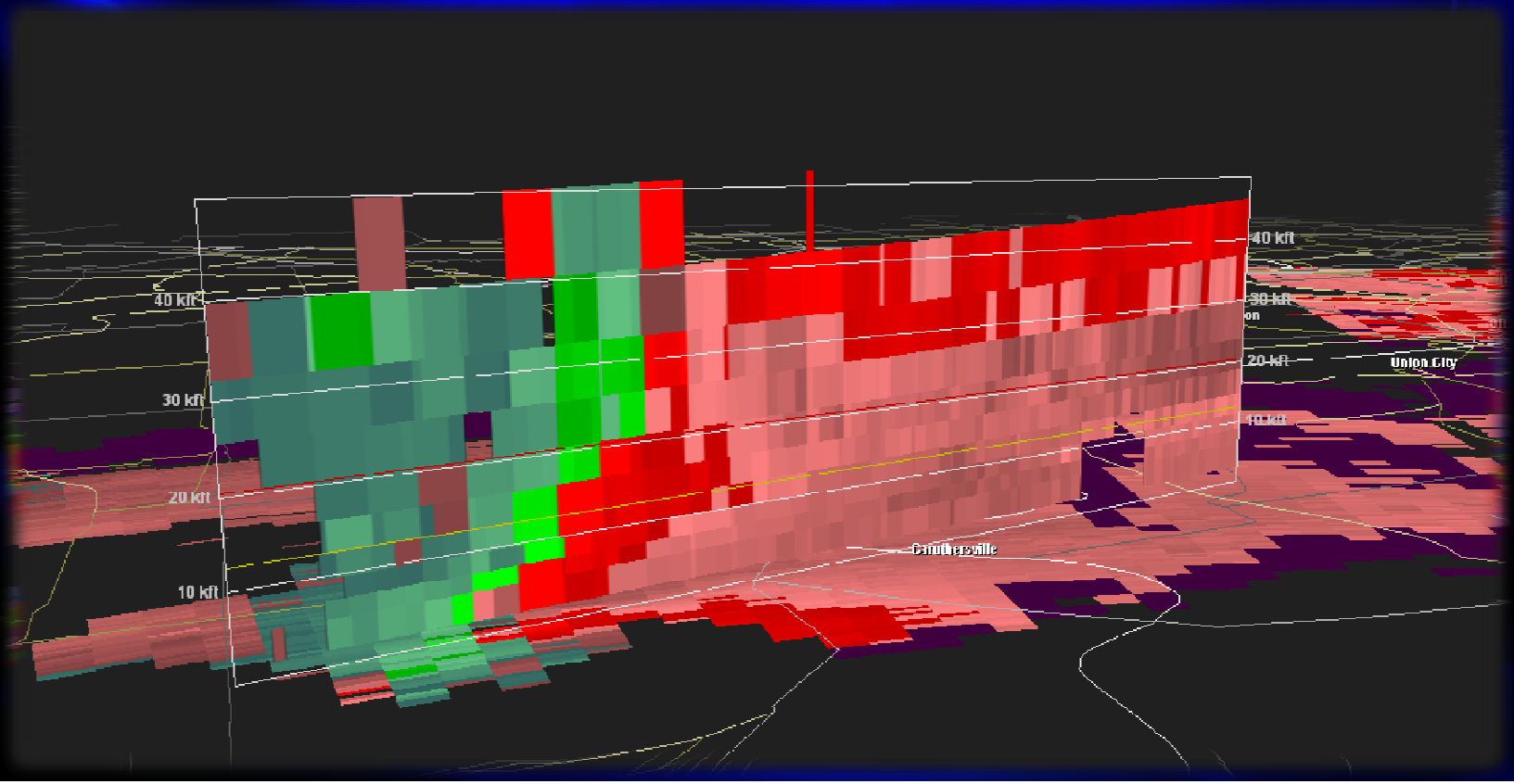
- Although In-Situ 3D Mode is Default, Classic 2D Mode Also Available
  - Select the 2D Radio Button under “Mode” to the Right of the X-Section Screen
  - 0C and -20C Heights Still Displayed
  - Height and Width Can Also be Edited under “Window” to the Right of the X-Section Screen



Cross Sections

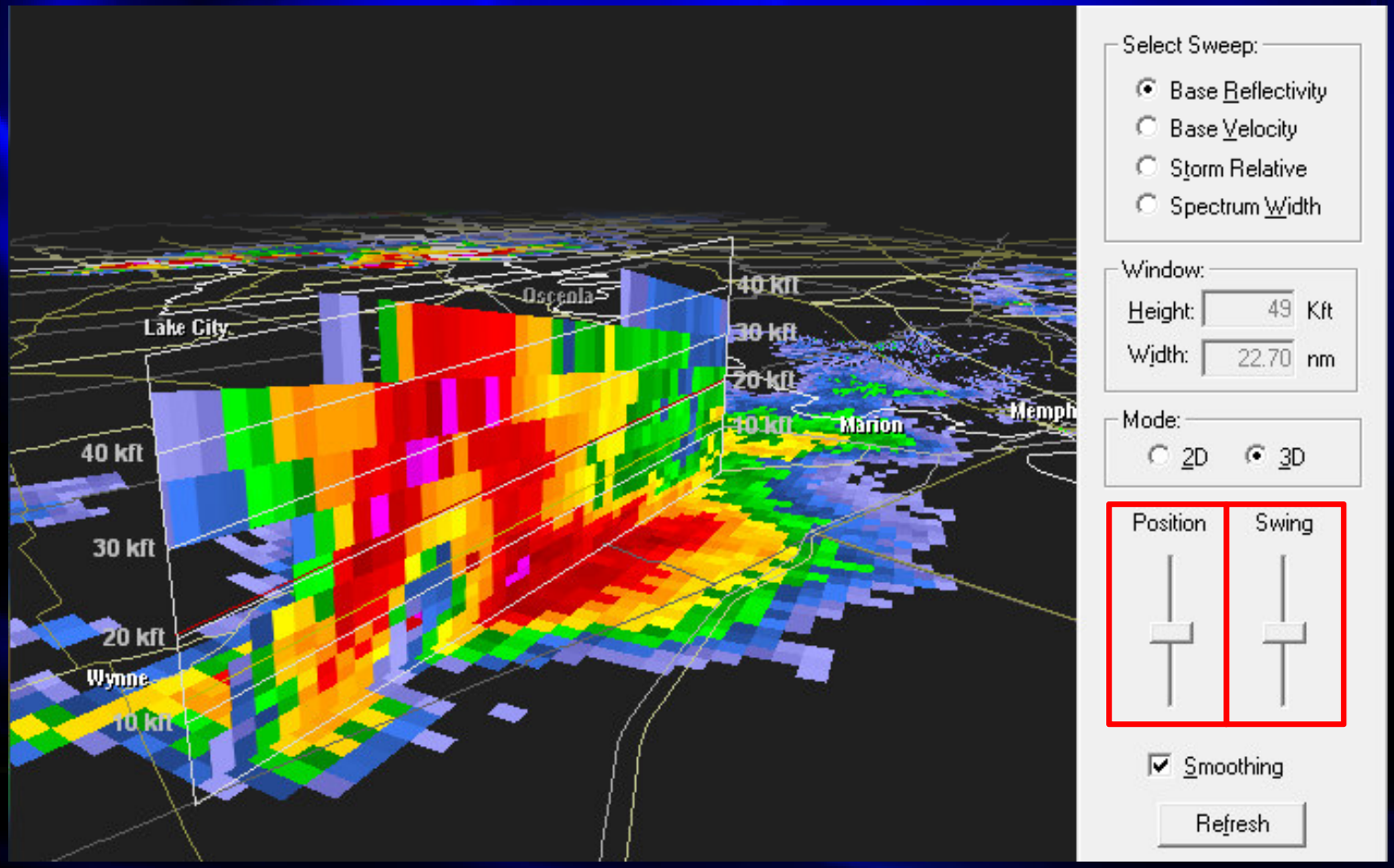
- **Cross Section Available for Several Products**
  - **Base Reflectivity**
  - **Base Velocity**
  - **Storm Relative Velocity**
  - **Spectrum Width**





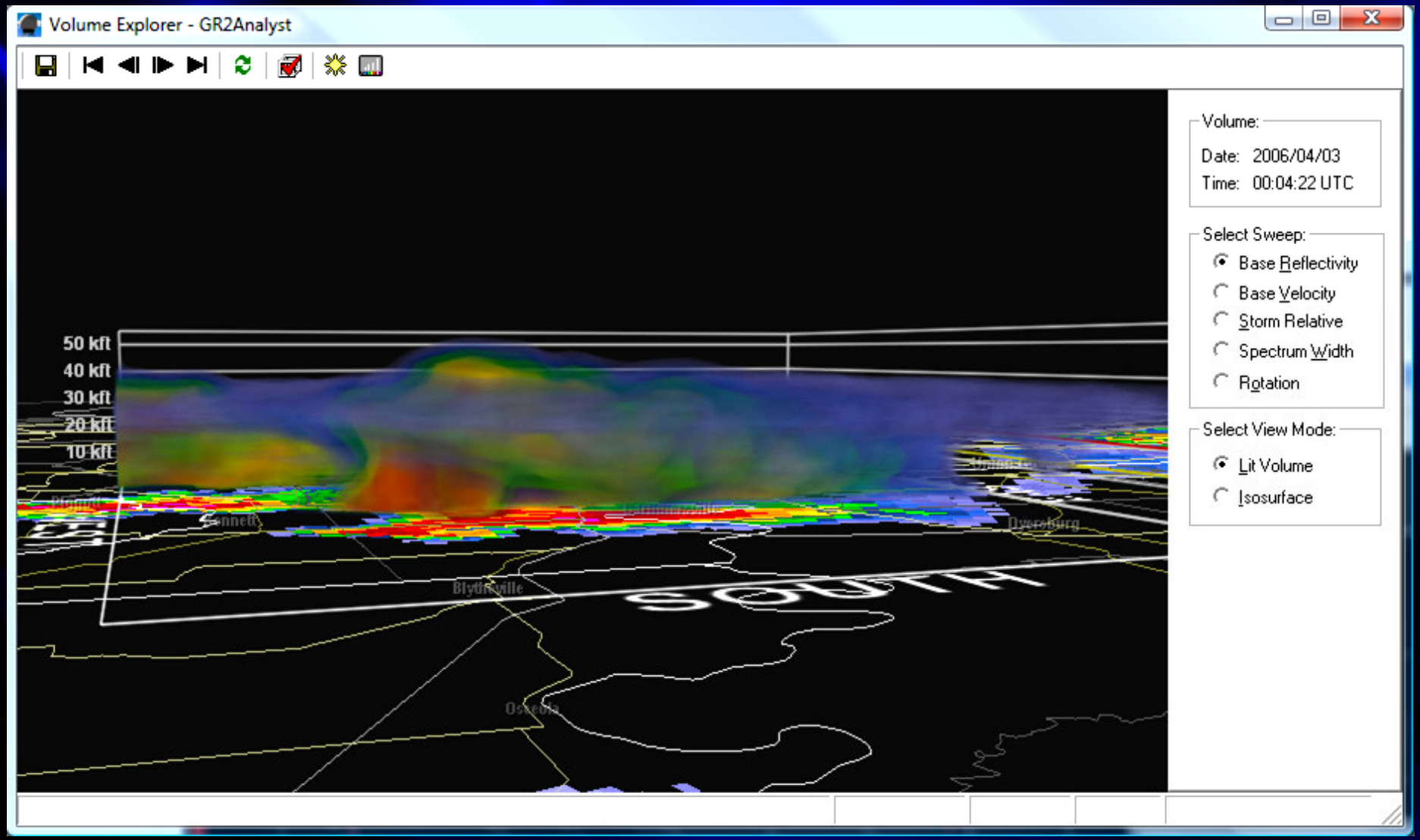
Cross Sections

- **Initial Cross Section Plane can be Adjusted Using the Two Slider Bars**
  - **Position Bar Moves the Plane Back and Forth**
  - **Swing Bar Rotates the Plane About the First Point (Click) of the Initial Plane**



Volume Explorer

- **Three Dimensional & High Quality Volumetric Representation of Radar Data**
  - **Viewable for BR, BV, SRV, SW, and NROT Products**

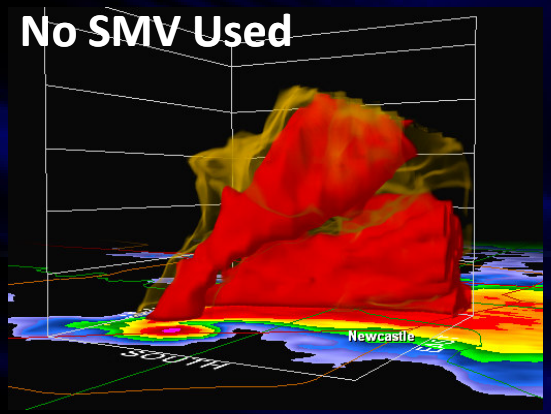


Volume Explorer

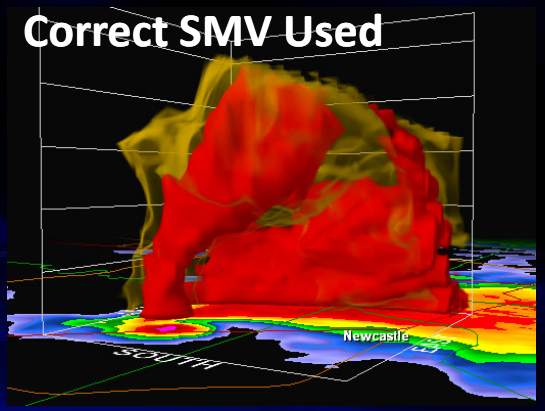
- To View Volumetric Data
  - Click the "Volume" Button on the Toolbar
    - Select a Square Area To Explore
    - Separate Window Will Open Volume View Selected
- Two Height "Walls" with Labeled Height Bars Every 10,000 Feet
- Cardinal Directions also Displayed at Base of Volume Area
- Yellow Line is 0C Height
- Red Line is -20C Height
- Click and Drag to Pan Around Volume
- Use the Scroll Wheel to Zoom In/Out
- Hit "Refresh" Button to Update to Latest Data Since Initial Volume Creation

- Note…SMV is Used to Correct Volumes for Data Tilting with Height due to Storm Motion. Make Sure Proper SMV is Used

No SMV Used

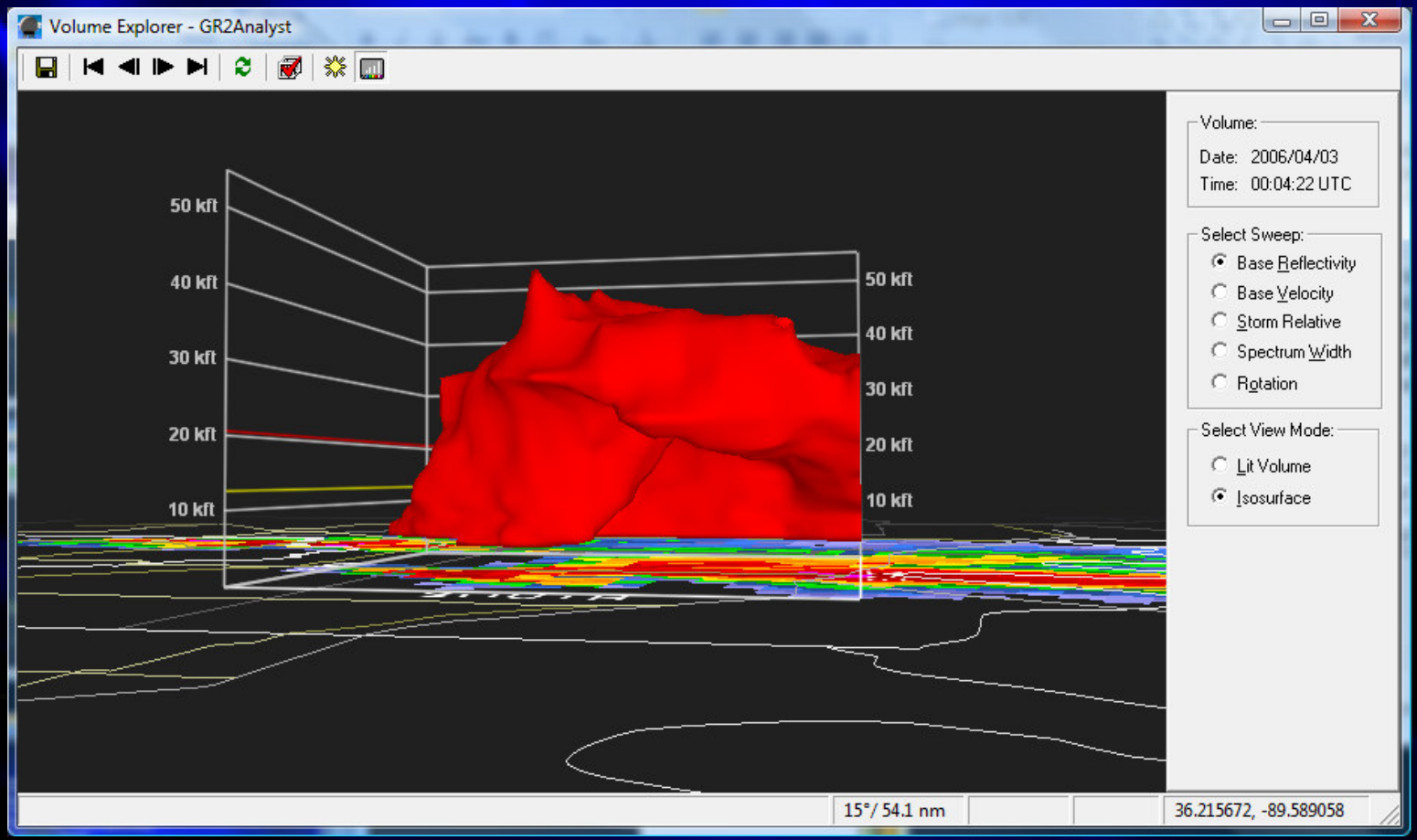


Correct SMV Used



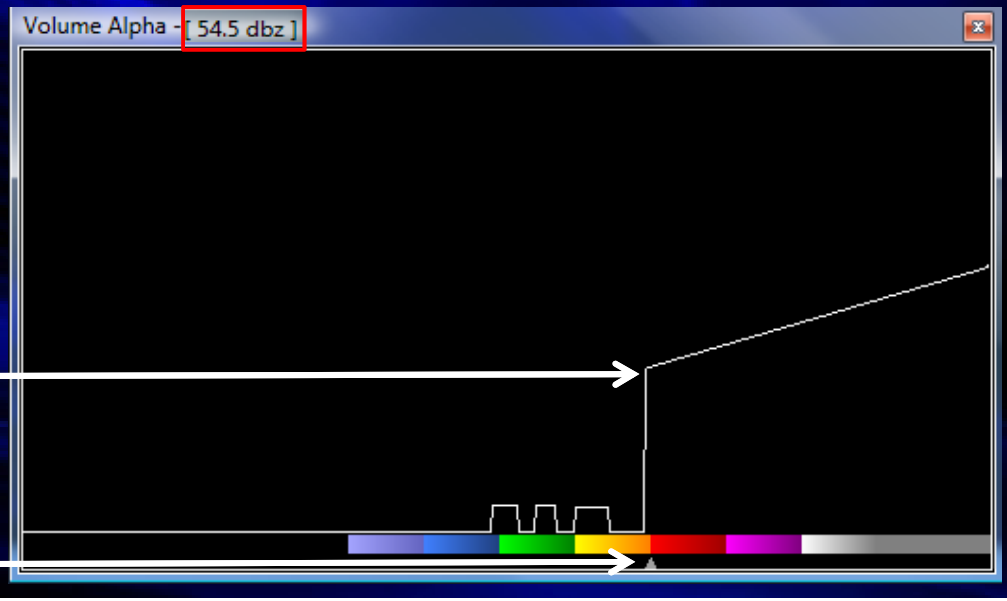
Volume Explorer

- **Two View Modes Available**
  - **Lit Volume**
    - **Multiple Layers and Masks, with Differing Transparency Values Possible**
  - **Isosurface**
    - **Single Non-Transparent Layer at Set Value Limit**



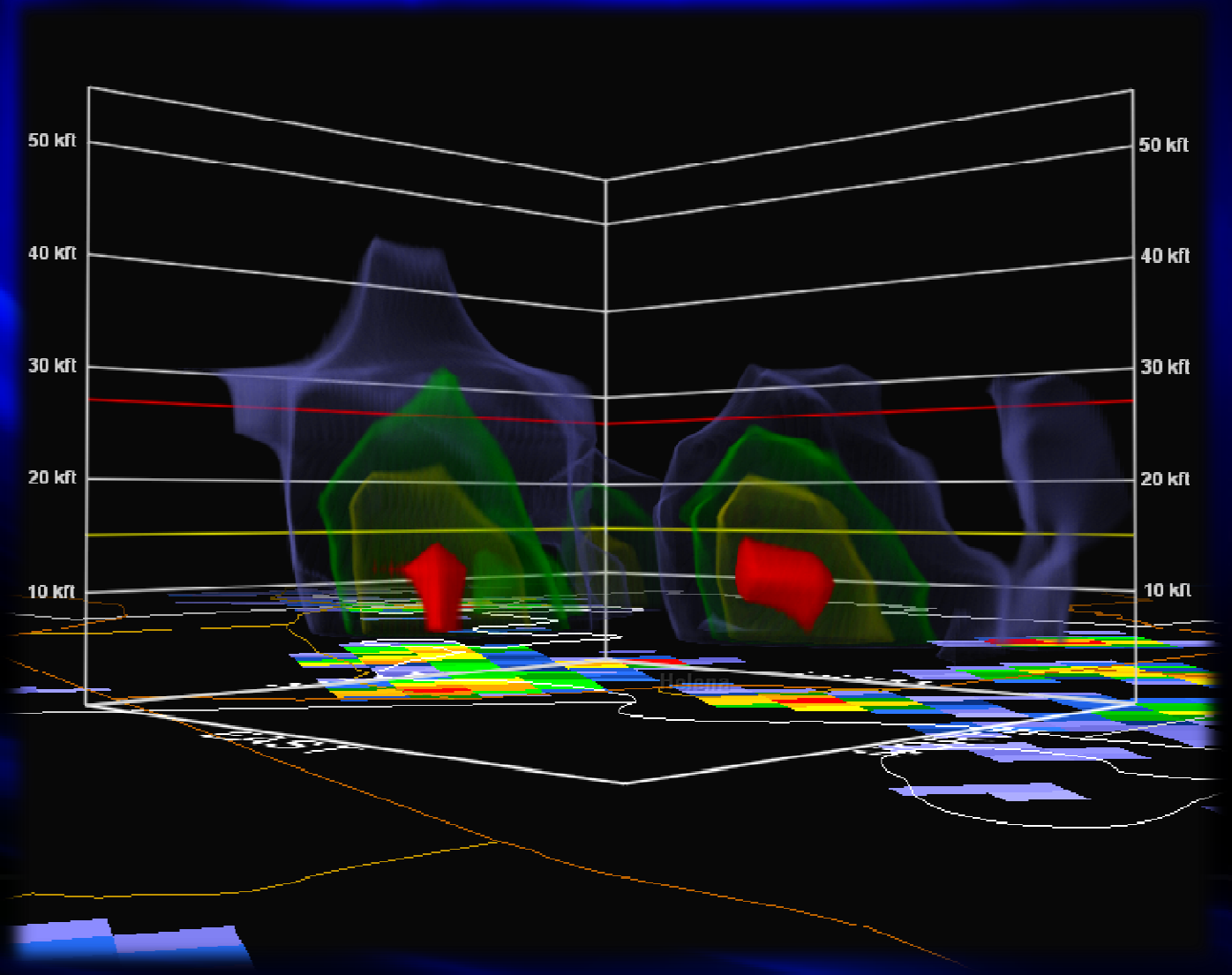
Volume Explorer

- Volume Alpha Settings
  - Click the "Volume Alpha Settings" Button on the Volume Toolbar 
  - Lit Volume
    - Top Portion of Alpha Settings Window – Crosshair Cursor
    - Click & Drag White Color Line to Alter Transparency of Various Data Levels
    - Pulling Line to the Top Results in Full Non-Transparency
    - Bottom is Complete Transparency
  - Isosurface
    - Bottom Portion of Alpha Settings Window – Horizontal Arrows Cursor
    - Drag White Triangle Below Color Bar to Adjust Isosurface Limit
- Data Value at Cursor Viewed in Title Bar
- Right Click on Window to Save Created Alpha Table/Load Previously Saved Tables



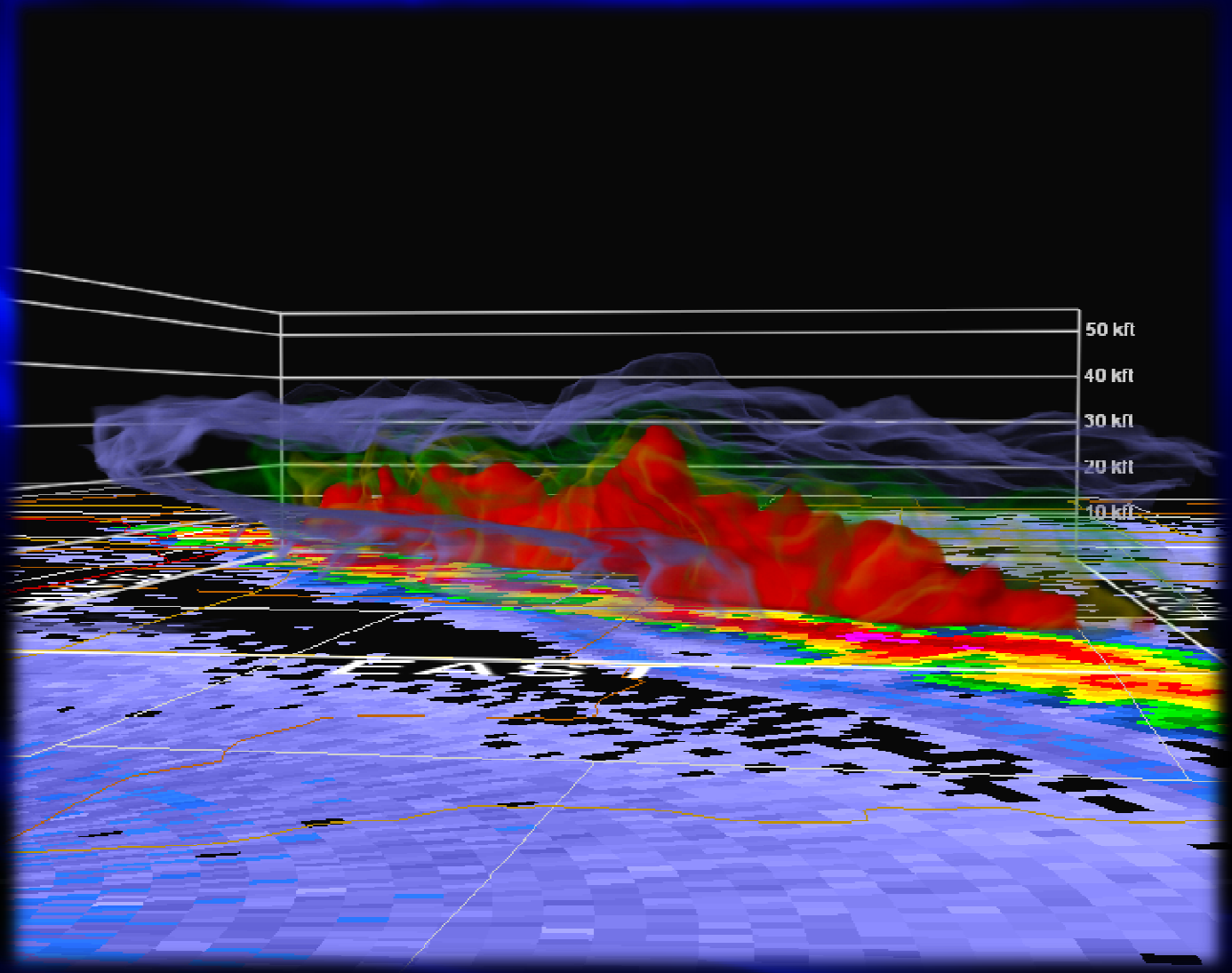
Volume Datasets – Thunderstorm Types

- **Single-Cell Thunderstorms – September 10, 2007 Tunica County, MS**



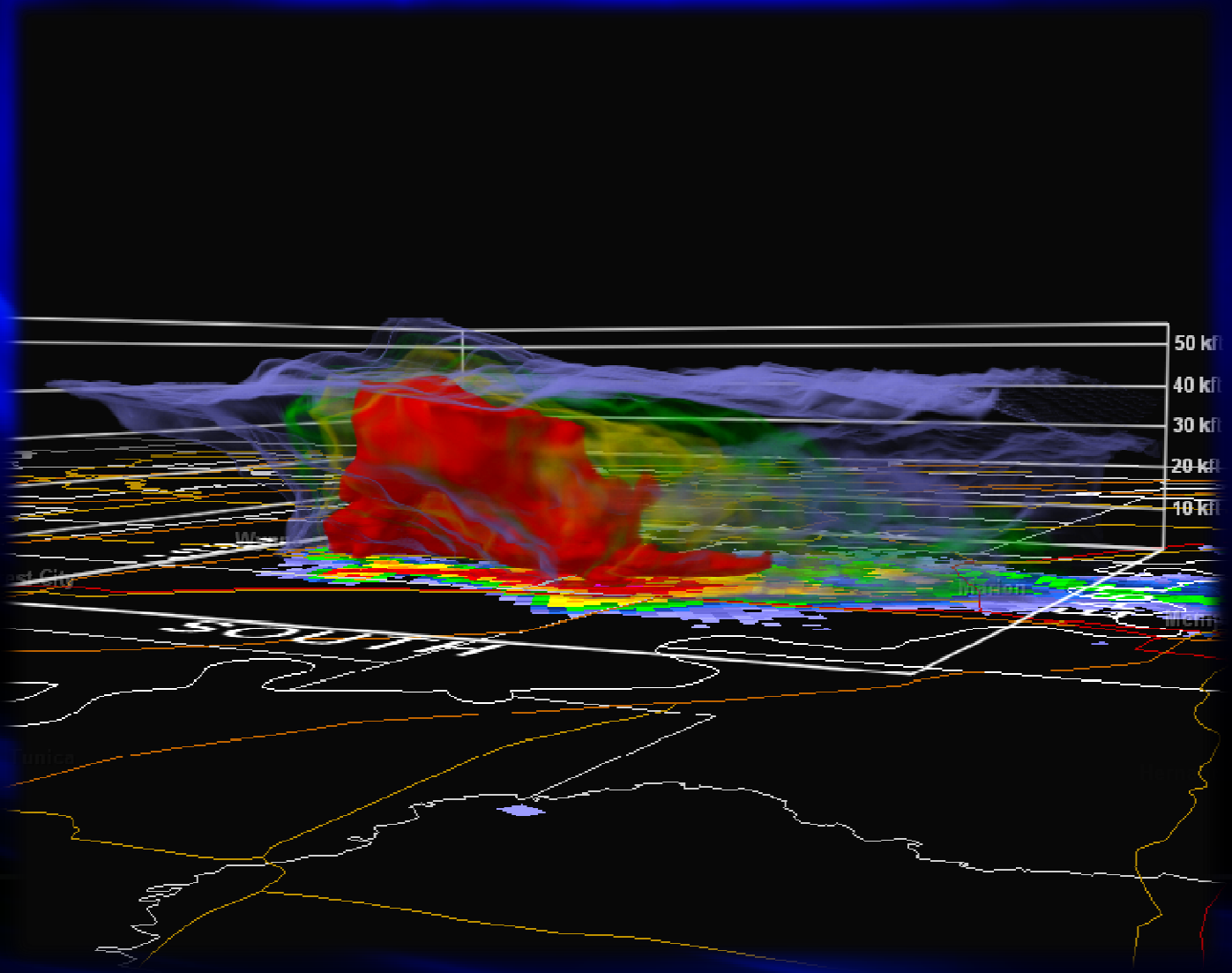
Volume Datasets – Thunderstorm Types

- **Multicell Thunderstorms – May 4, 2003 Southwest Missouri**

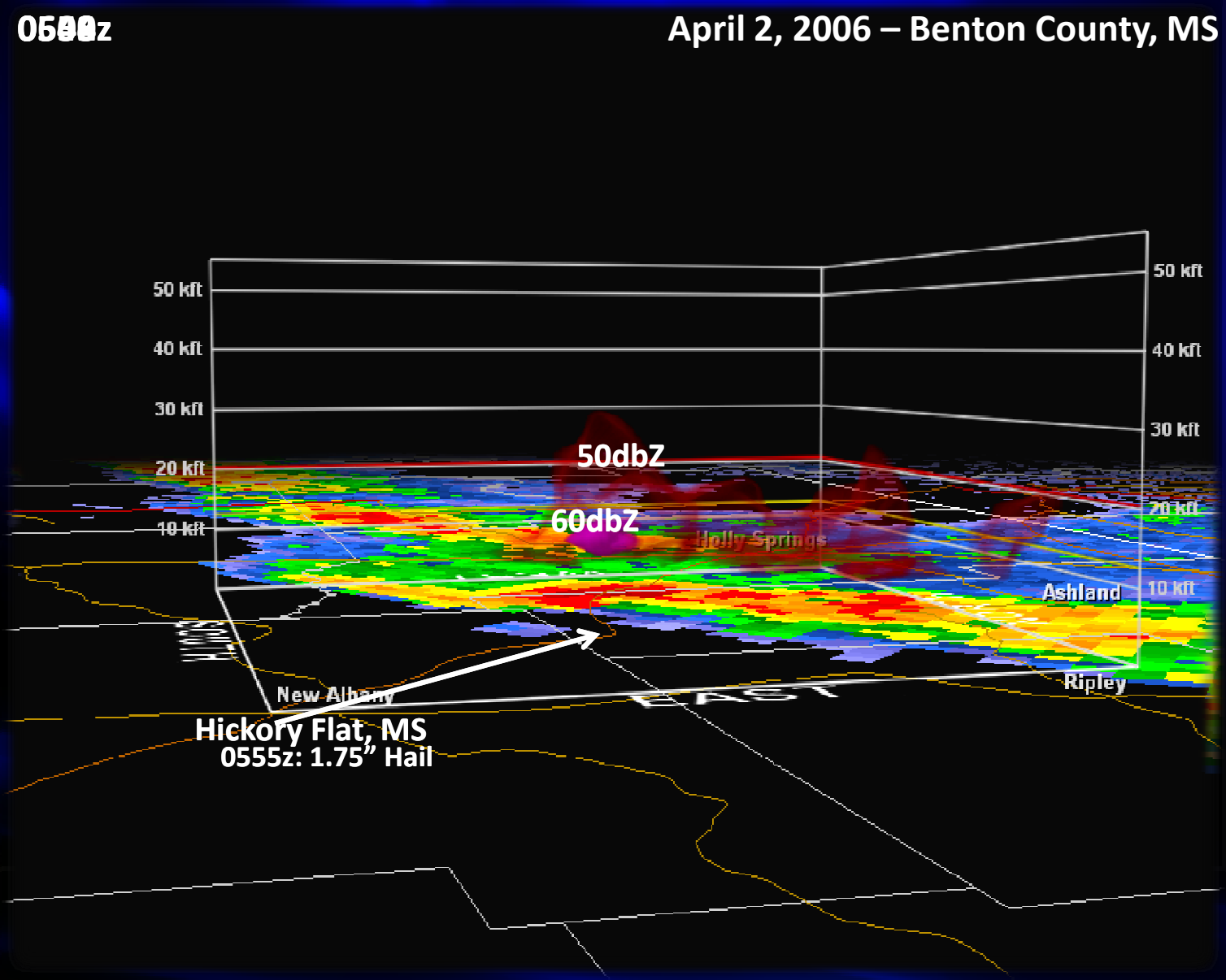


Volume Datasets – Thunderstorm Types

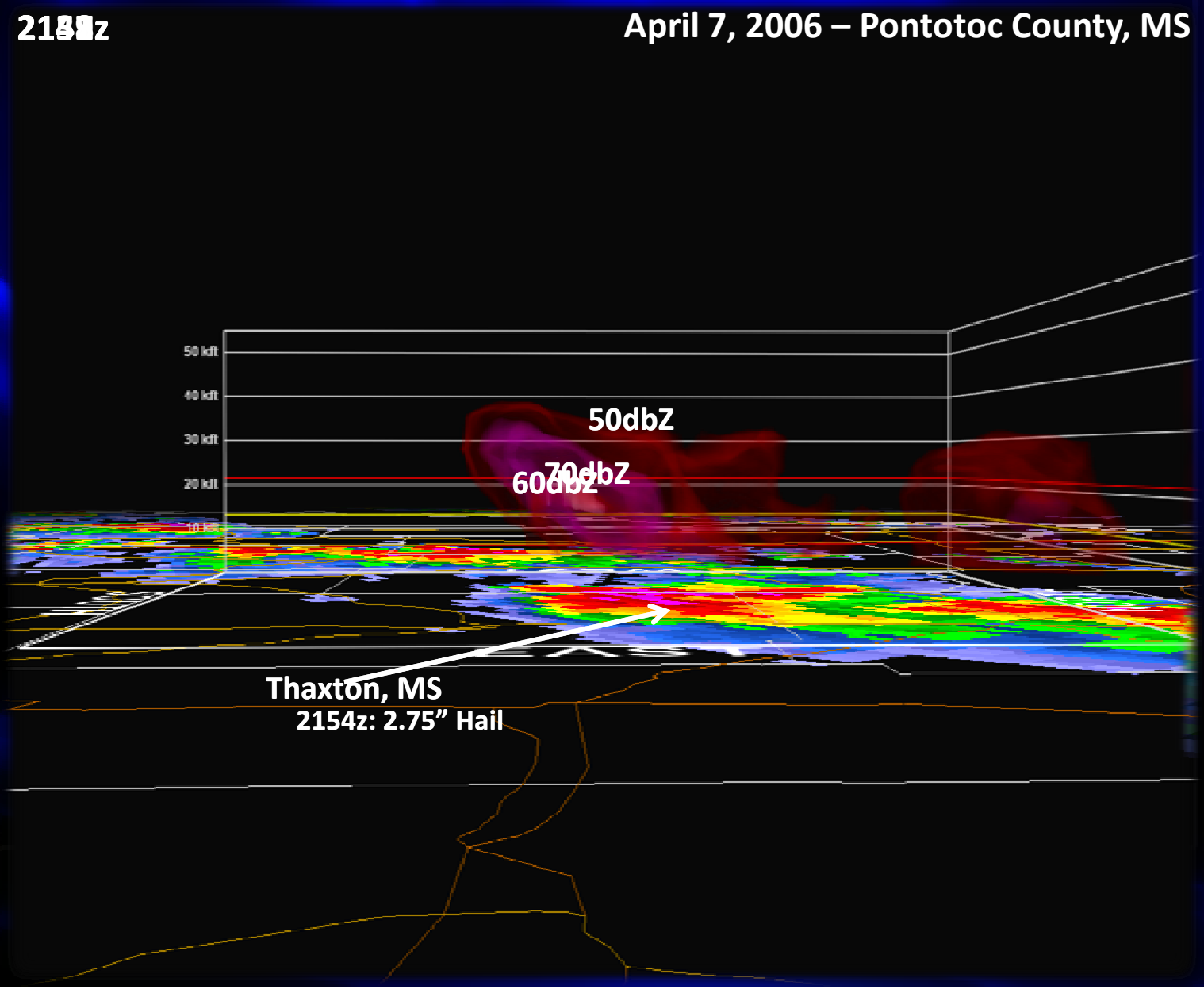
- **Supercell Thunderstorm – April 2, 2006 Cross County, AR**



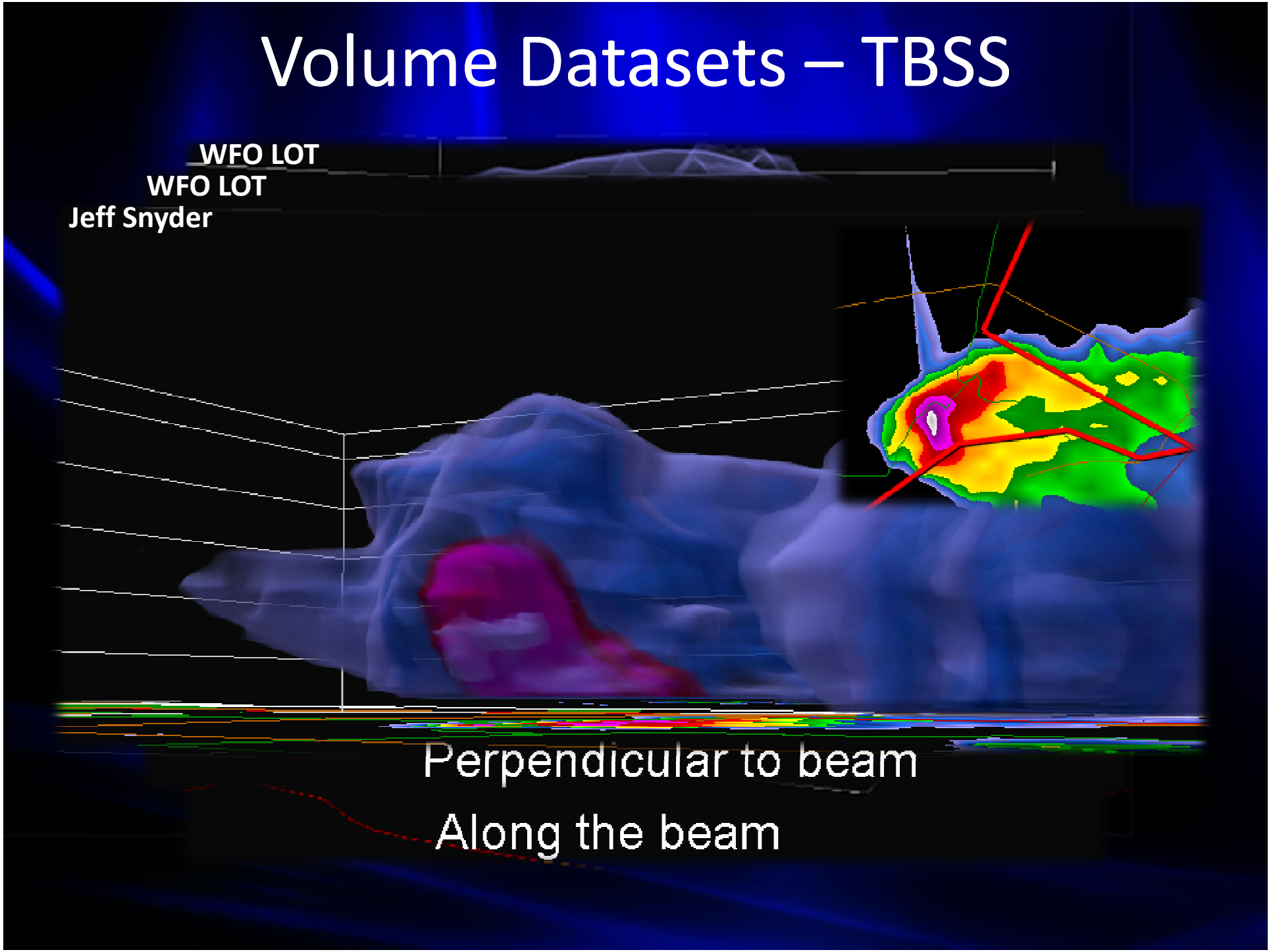
Volume Datasets – Large Hail



Volume Datasets – Giant Hail

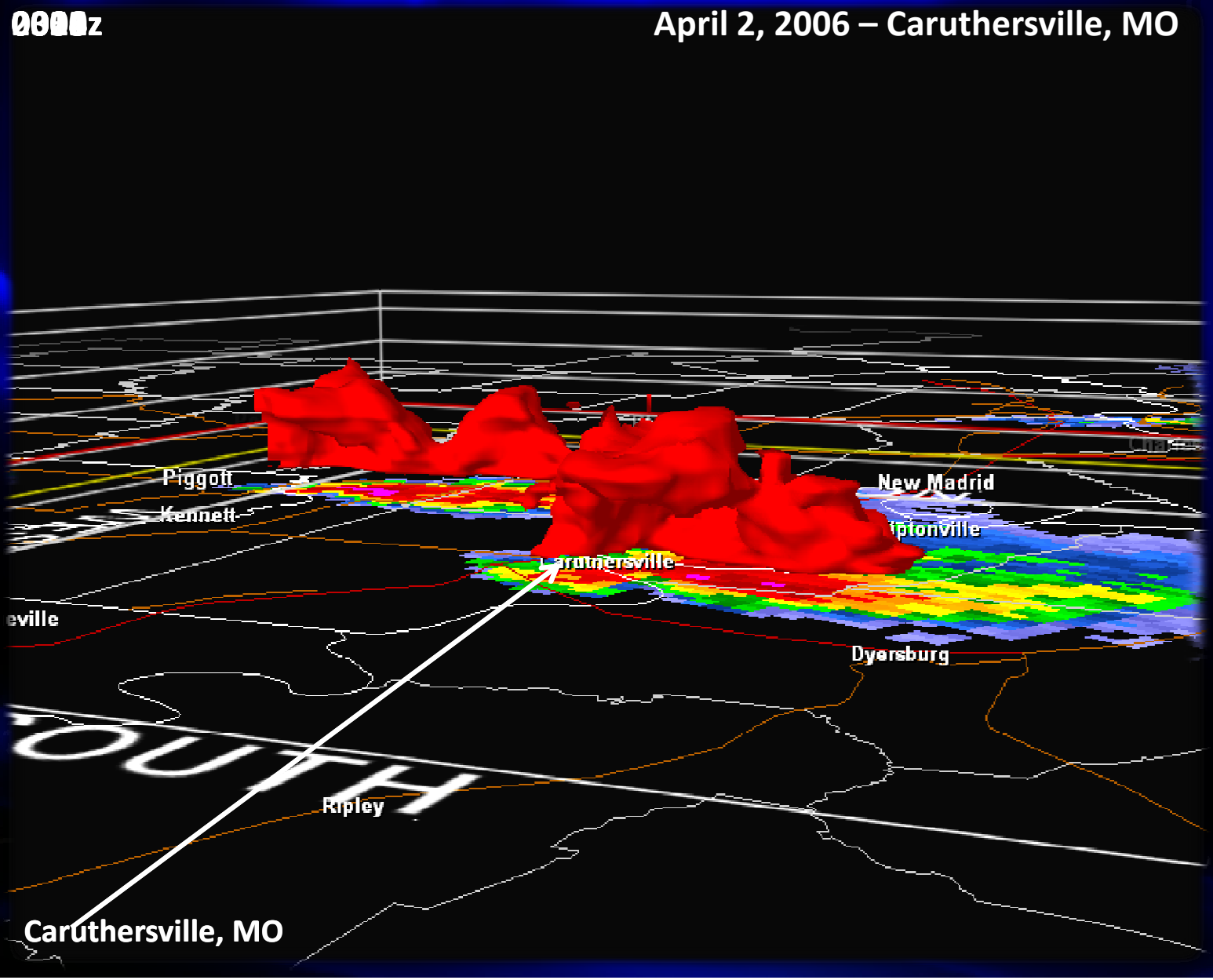


Volume Datasets – TBSS



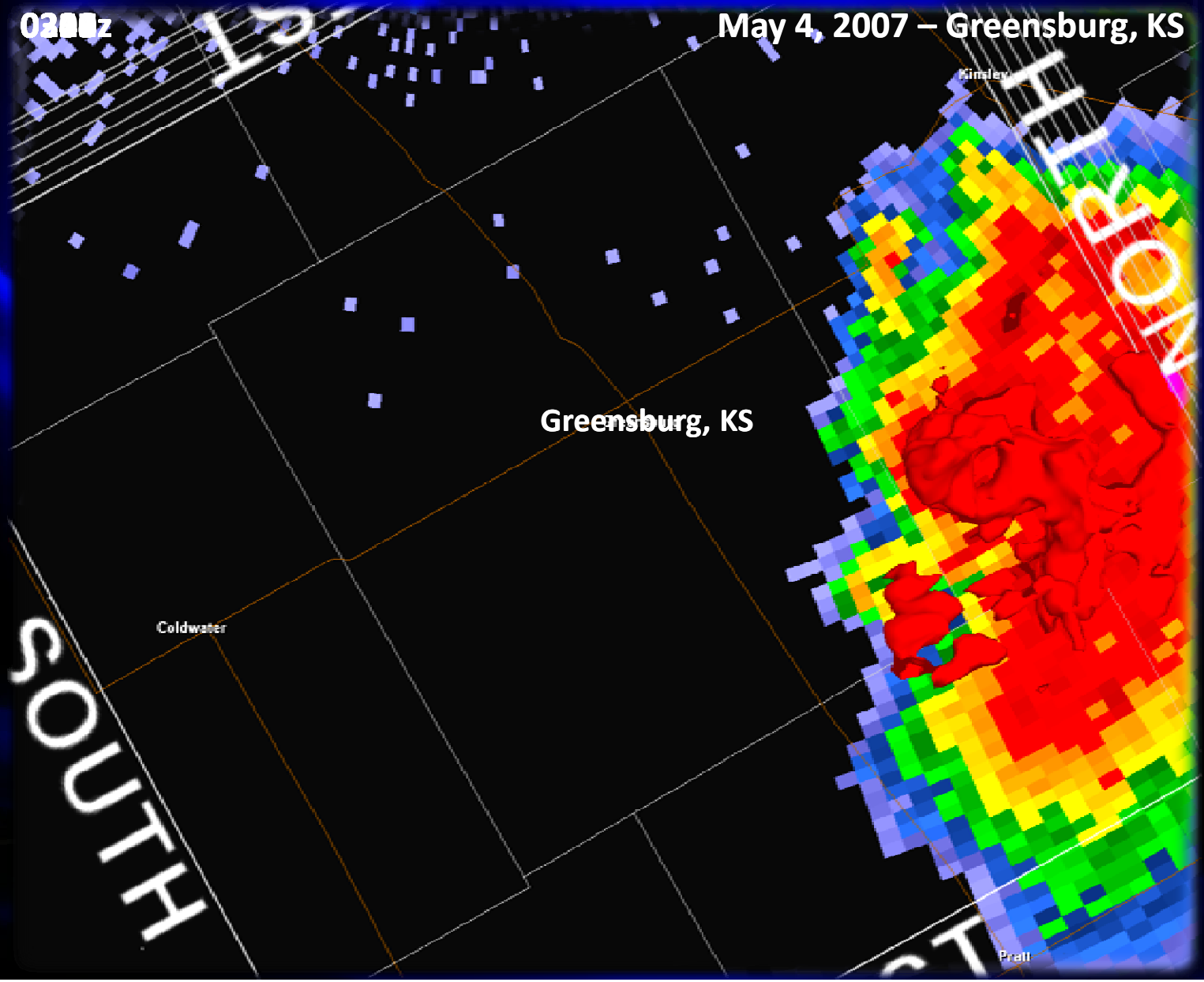
Volume Datasets – Strong Tornado

Isosurface Set to 50dbZ



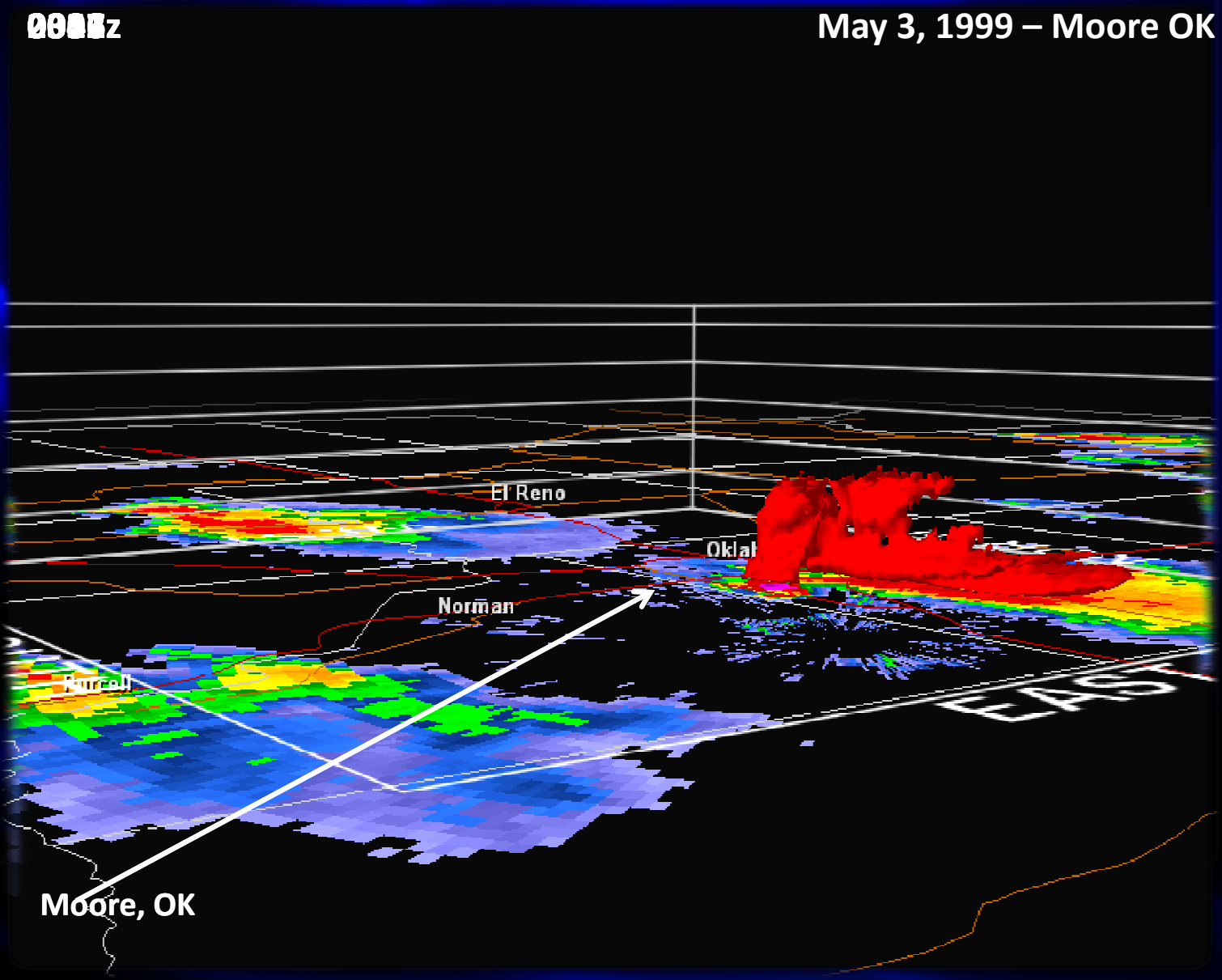
Volume Datasets – Violent Tornado

Isosurface Set to 55dbZ



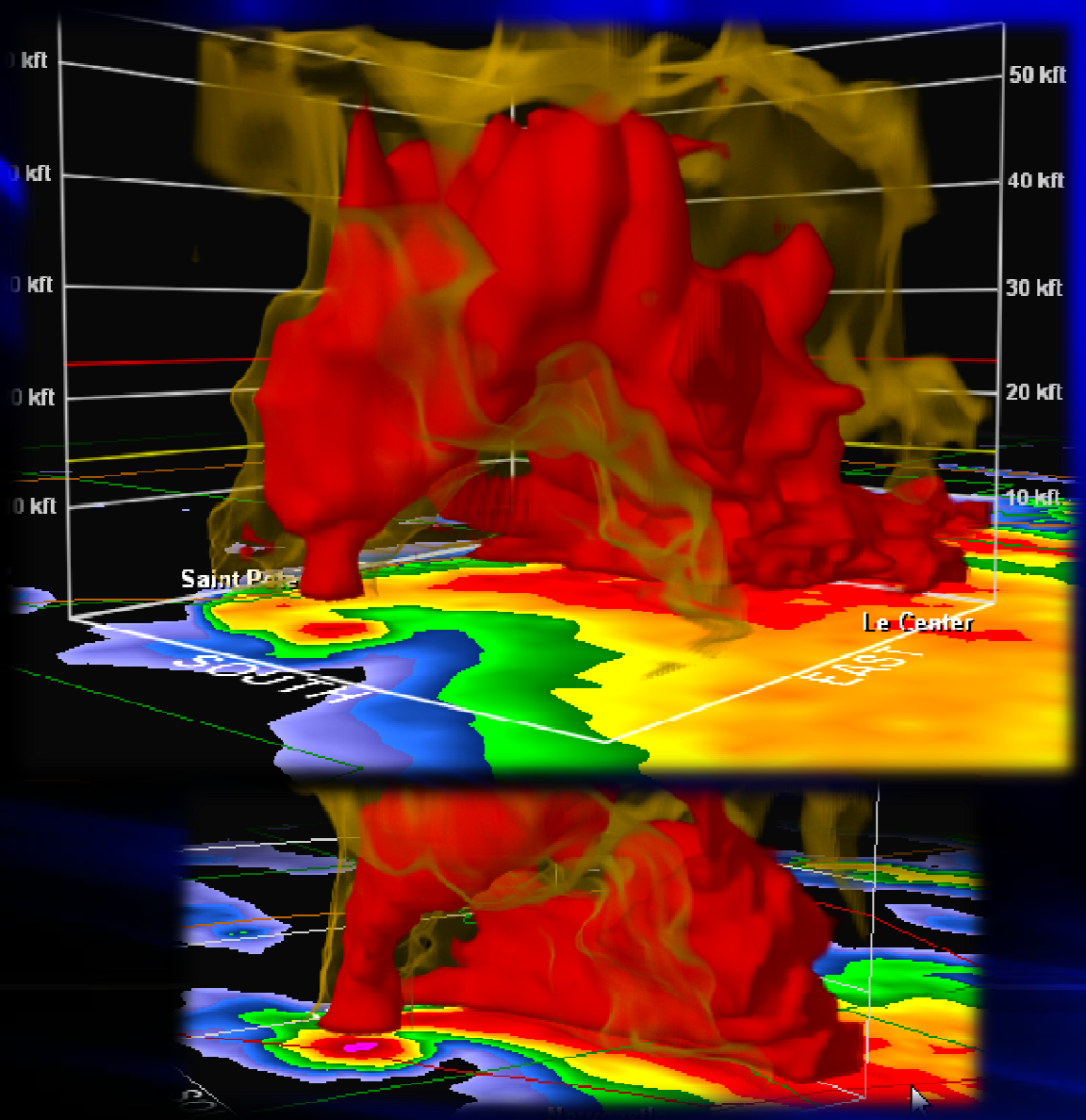
Volume Datasets – Violent Tornado

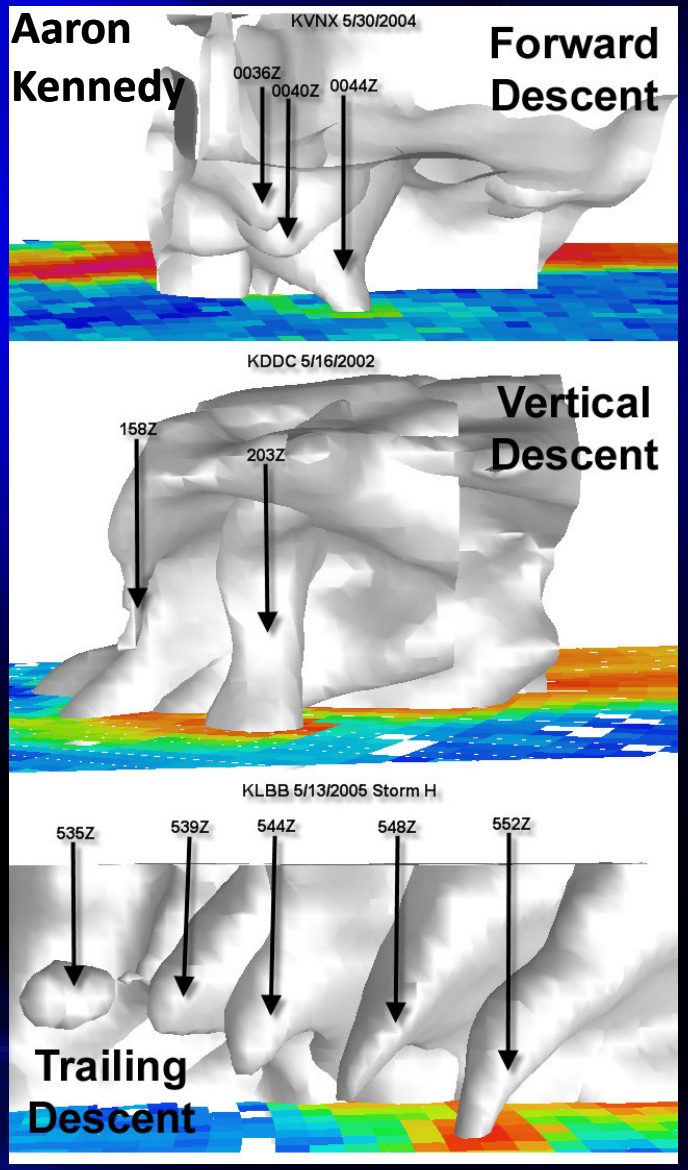
Isosurface Set to 50dbZ



The "DRC"

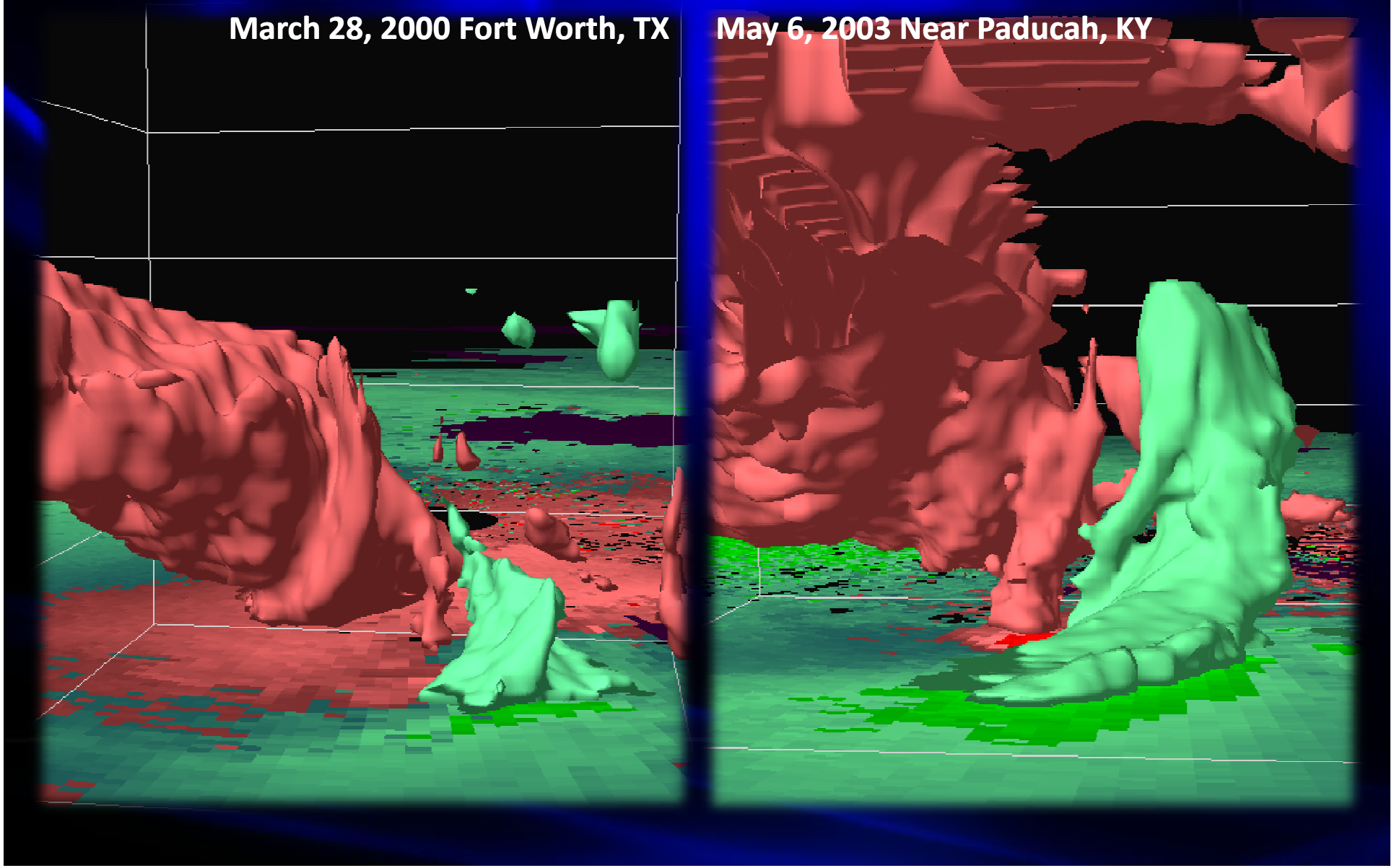
Descending Reflectivity Core





Volume Datasets – Other Examples

Storm Relative Velocity



For More Information…

- **GRLevelX Homepage**
  - **http://www.grlevelx.com**
- **GRLevelX Owners' Support Forum**
  - **http://www.grlevelx.com/owners**
- **Creating Alpha Tables for Volume Explorer**
  - **http://www.grlevelx.com/gr2analyst/using_volume_renderer.htm**
- **NCDC HDSS Access System (Level-II Data Archive)**
  - **http://has.ncdc.noaa.gov**
- **FSL RAOB Database**
  - **http://raob.fsl.noaa.gov**
- **Census 2000/TIGER Shapefile Data**
  - **http://arcdata.esri.com/data/tiger2000/tiger_download.cfm**

- **See Supplemental Manual for Further Information on Program Functionality and Use**
  - **http://www.meteor.iastate.edu/~jgehrts/Manual_Aug20.pdf**