NEXRAD Technical Advisory Committee Meeting
March 27, 2007

Super Resolution

Status Update & Decision Brief

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Contributors: Sebastian Torres, Rodger Brown, Eddie Forren (NSSL)
Rich Ice, Dave Warde, Dave Zittel (ROC)

Today's Presentation

- **Super-Resolution & Recombination Evaluation**
  - TAC Decision Request
  - Overview & Background
  - Recombined Base Data Evaluation
  - Recombined Velocity Evaluation
  - Recombined Data – Algorithm Evaluation
  - Super Resolution Engineering Study
  - Status: Baseline Implementation
  - Summary
  - Recommendation

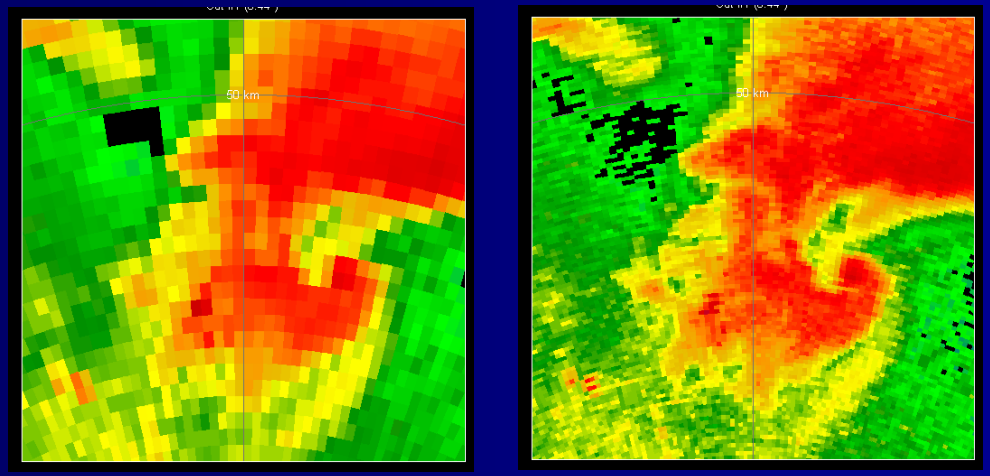
TAC Decision

- Seeking TAC recommendation to …
  - continue Build 10 Baseline Super-Resolution implementation
  - complete Recombination Algorithm performance evaluation

Super-Resolution Data

- Benefits from Super-Resolution data are realized through … (Brown et al. 2002)
  - **Finer range sampling** (250m Reflectivity)
  - **Finer azimuthal sampling** (0.5deg azimuthal sampling, all moments)
  - **Narrower effective antenna pattern…**
    (smaller effective beamwidth)
    - by applying a data window (von Hann)

Legacy Resolution

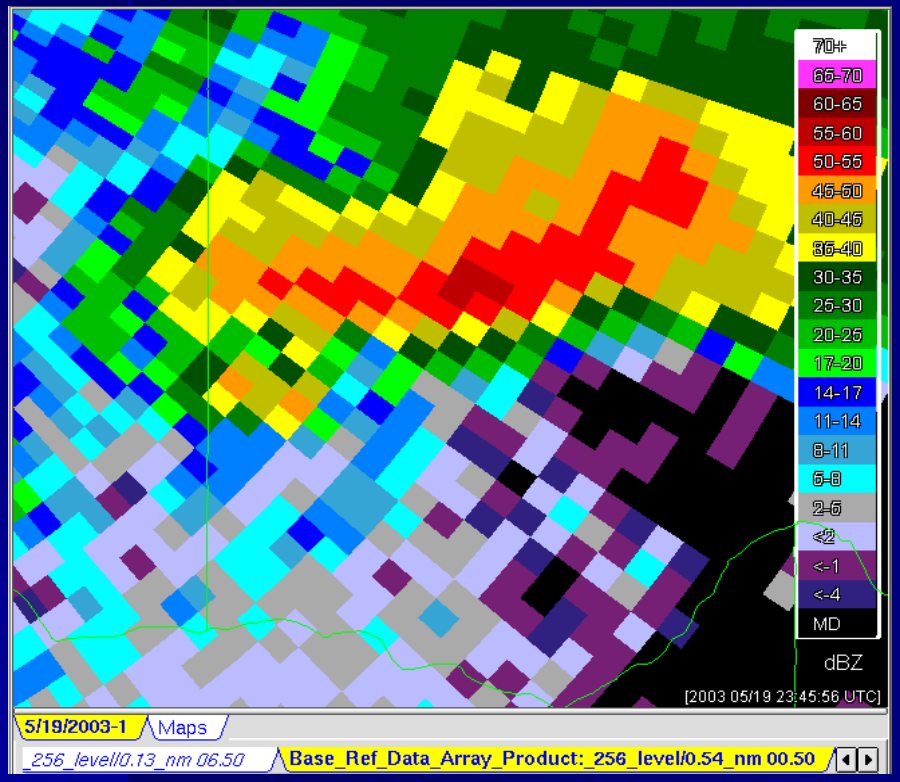


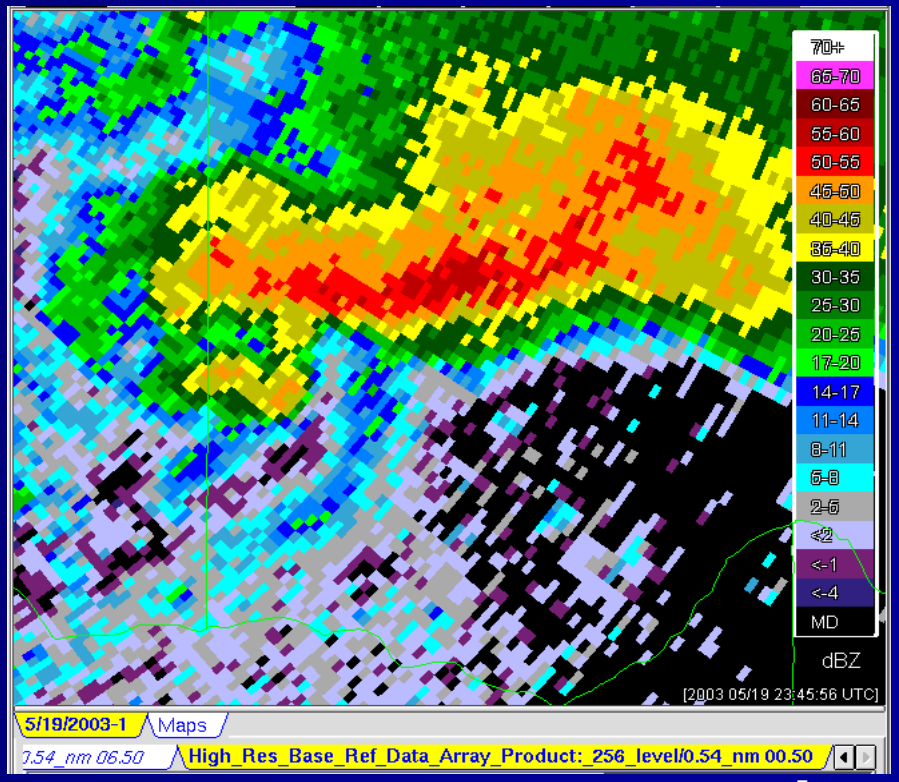
Super Resolution

Legacy Resolution

Super Resolution

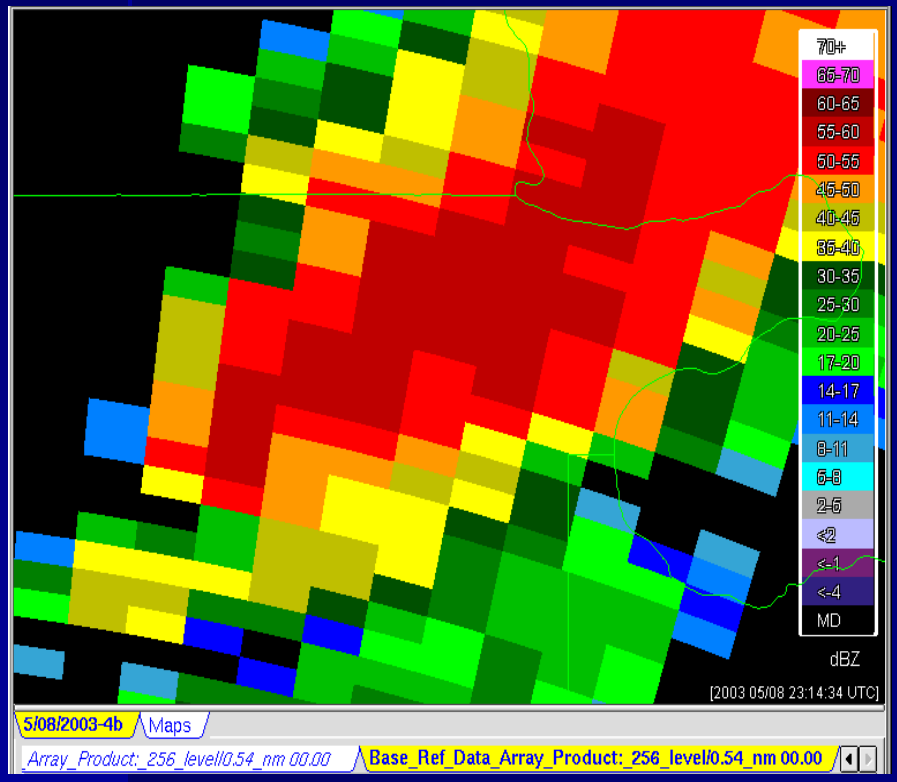
Gust Front

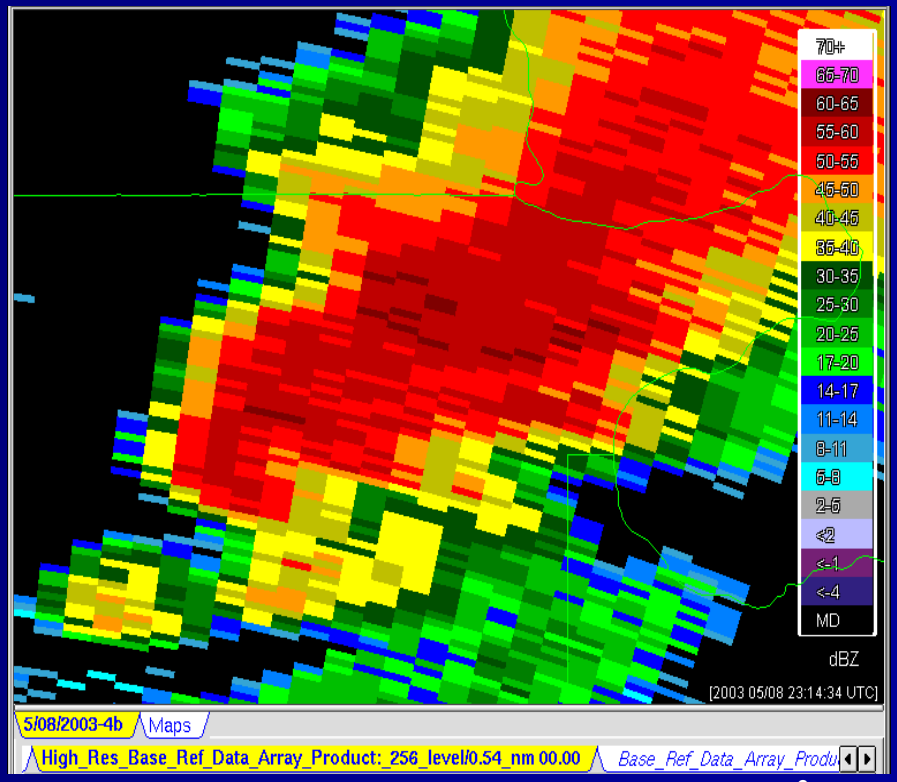




Legacy Resolution **Super Resolution**

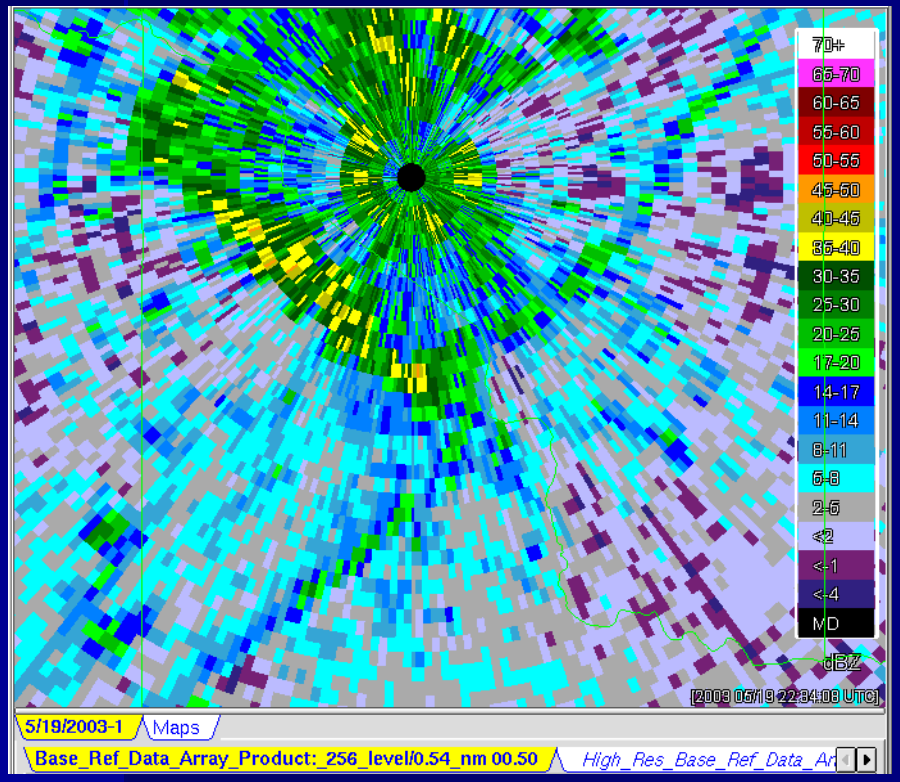
Hook Echo at 140 km

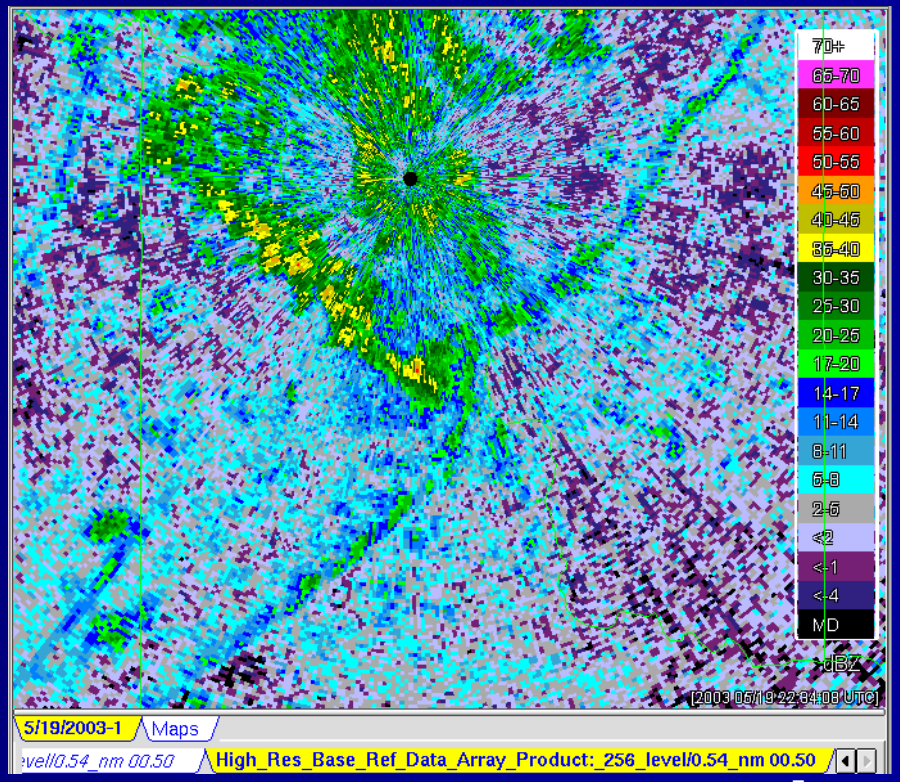




Legacy Resolution **Super Resolution**

Boundaries / Convective Initiation



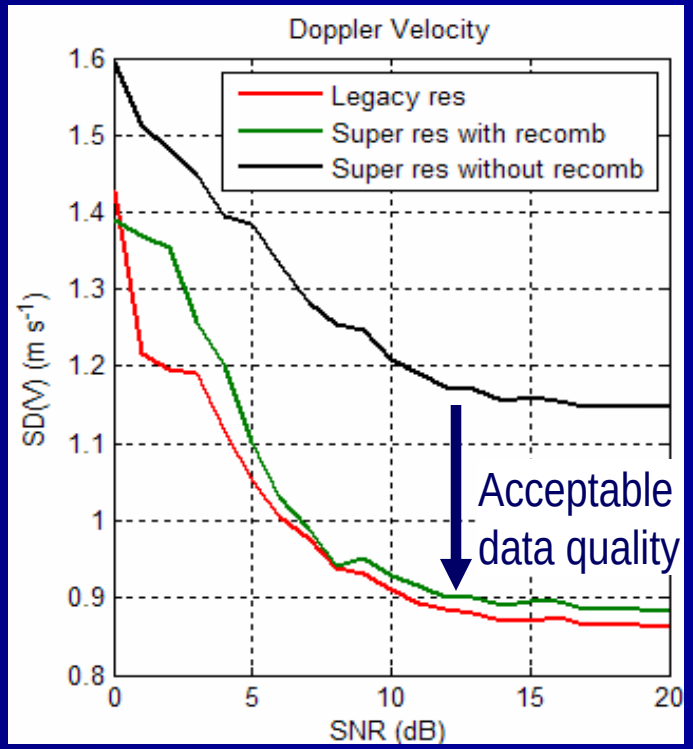


Super Resolution: Key Points

- Super Resolution
  - Half Degree Azimuthal Resolution for all moments & 250m Range Resolution for Reflectivity
  - ORDA will provide Super-Resolution data stream to the RPG
- Sample every half degree and apply …
  - Von Hann Window to non-clutter regions (reduces effective beamwidth)
  - Blackman Window to clutter regions (compatibility with GMAP)
- Super-Res only applied to split cuts of VCPs (i.e. lowest elevation cuts)
- Super-Res datastream initially only used for visualization purposes
- A “Recombination Algorithm” was developed to convert the super-resolution datastream into a “legacy” resolution datastream to serve the existing algorithms

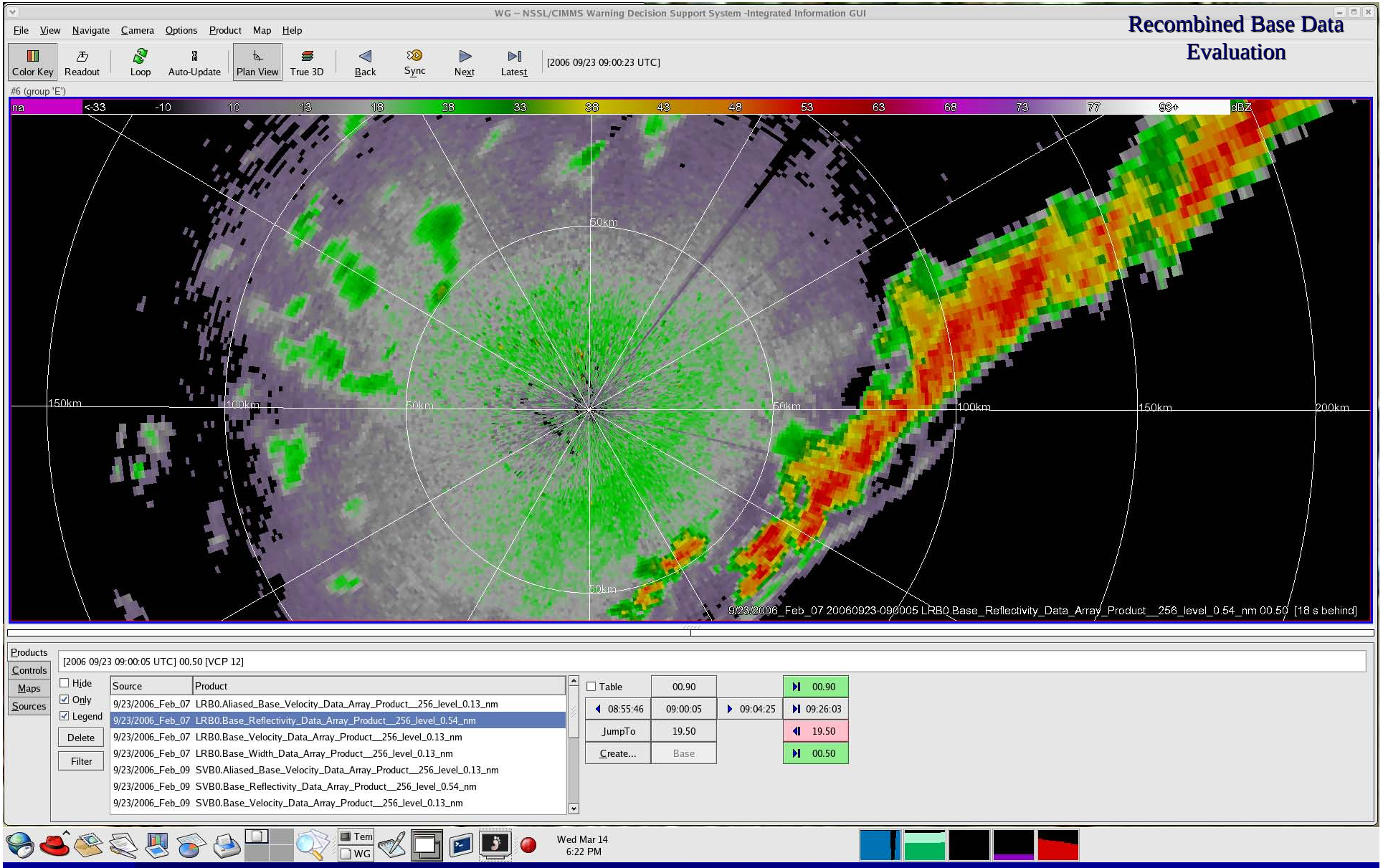
Super Resolution: Recombination Algorithm

- RPG algorithms expect data with legacy resolution and quality
- Super-resolution data does not have the required resolution or quality *for the algorithms* (it's superior for visualization)
  - Radial recombination: low risk and acceptable data quality
    - Two super-resolution radials are **recombined** to form one legacy-resolution radial
    - Recombination assumes bimodal spectrum
    - Must deal with *missing* data
      - SNR thresholds
      - Overlaid echoes



Recombine Base Data and Algorithm Evaluation

- 8 Cases (373 total volume scans)
  - 2 cases (volume scans: 33, 64) from ’03 (RRDA)
  - 3 cases (volume scans: 27, 17, 22) from ’04 (RRDA)
  - 3 cases (volume scans: 81, 45, 84) from ’06 (ORDA)
- New Data Collection
  - As Testbed schedule and Nature allows
- 3 Base Data Moments
- 18 Algorithms
- Level-I data was converted and played back through an off-line ORDA system
  - Playback takes approximately 2.5 x real time
  - Playback issues
- Base data types evaluated
  - Recombined Super Resolution
  - Legacy Resolution (Rectangular Window)

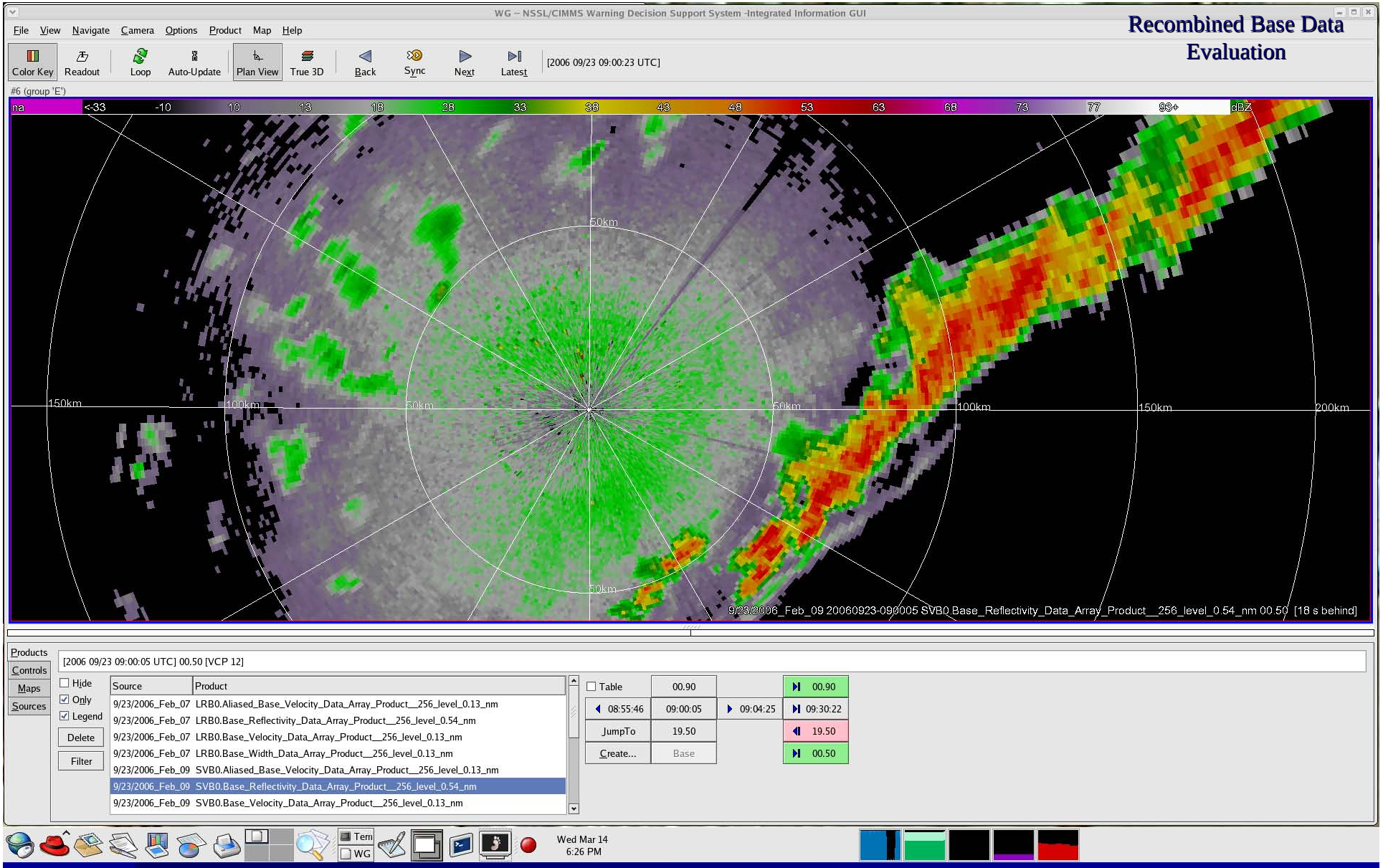


Recombined Base Data Evaluation

9/23/06

09:00

Rectangular - Reflectivity



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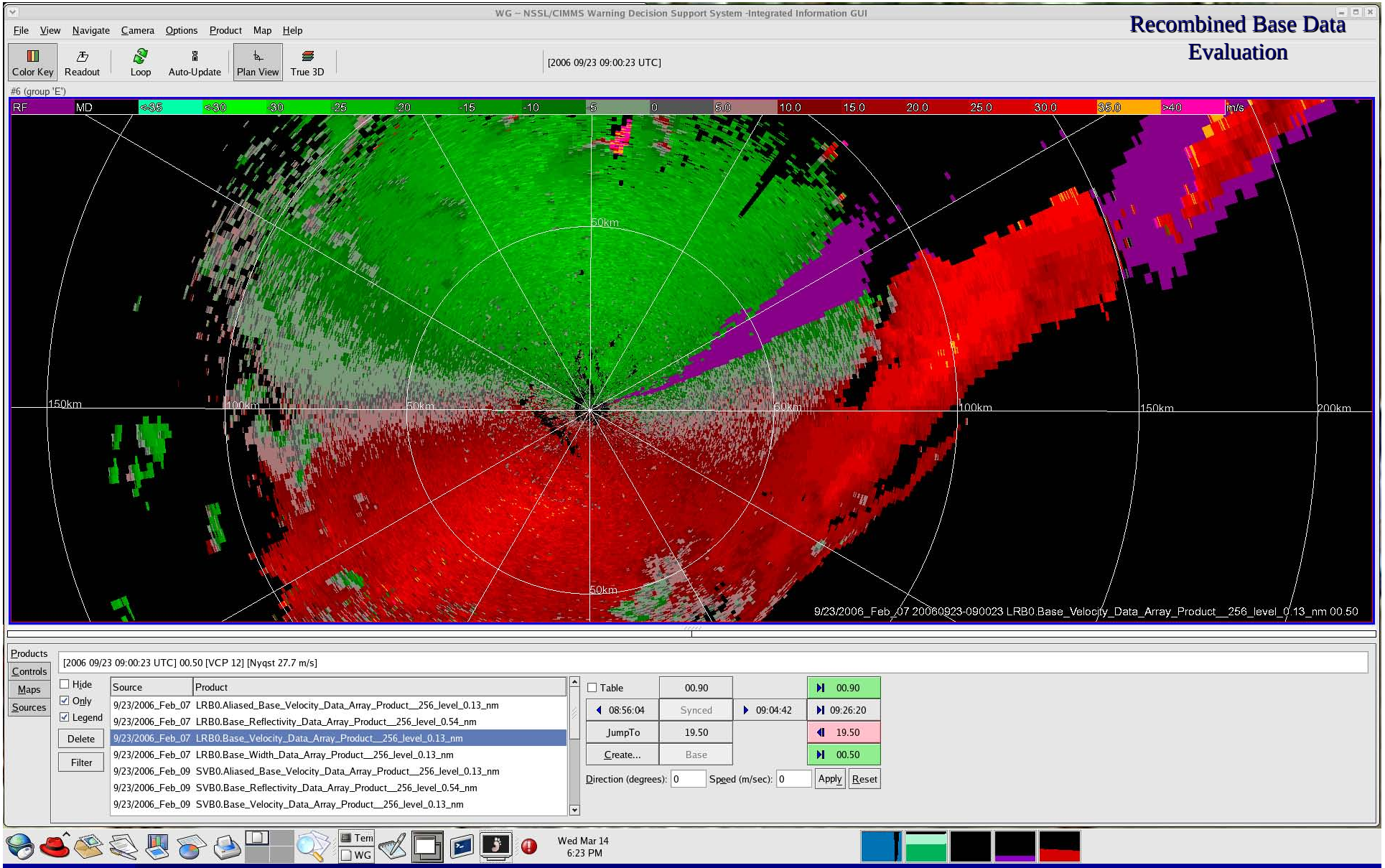
Recombine - Reflectivity

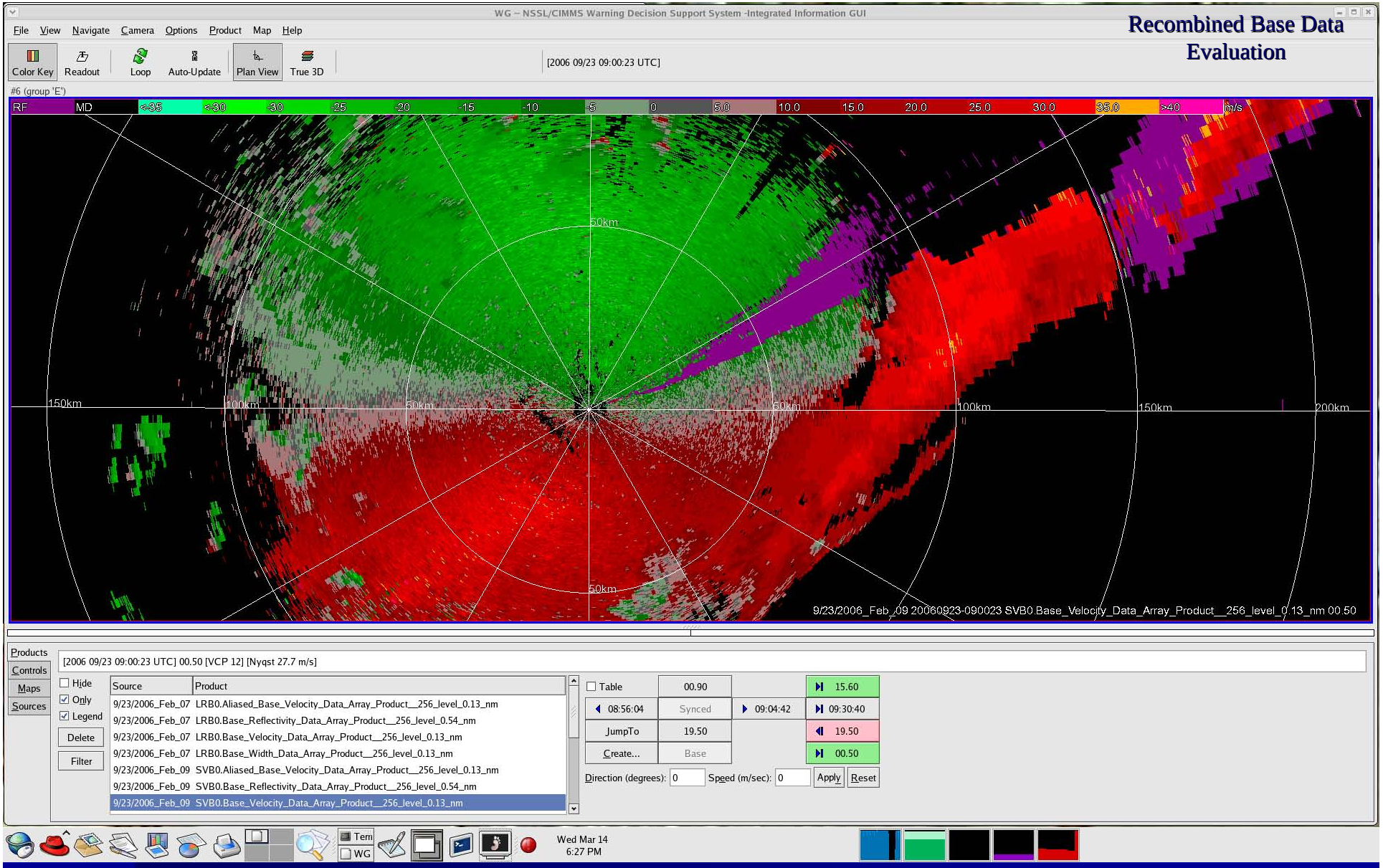


Recombined Base Data Evaluation

9/23/06

09:00

Rectangular - Velocity



Recombined Base Data Evaluation

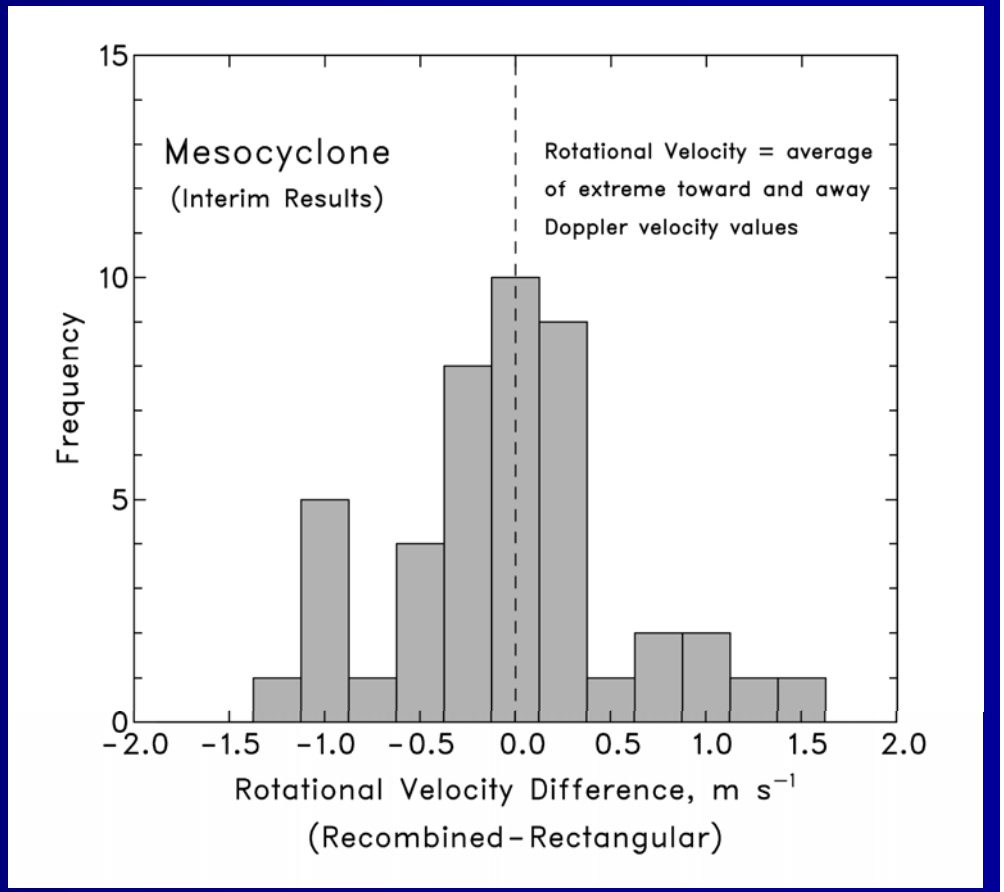
9/23/06

09:00

Recombine - Velocity

Recombined Velocity Evaluation

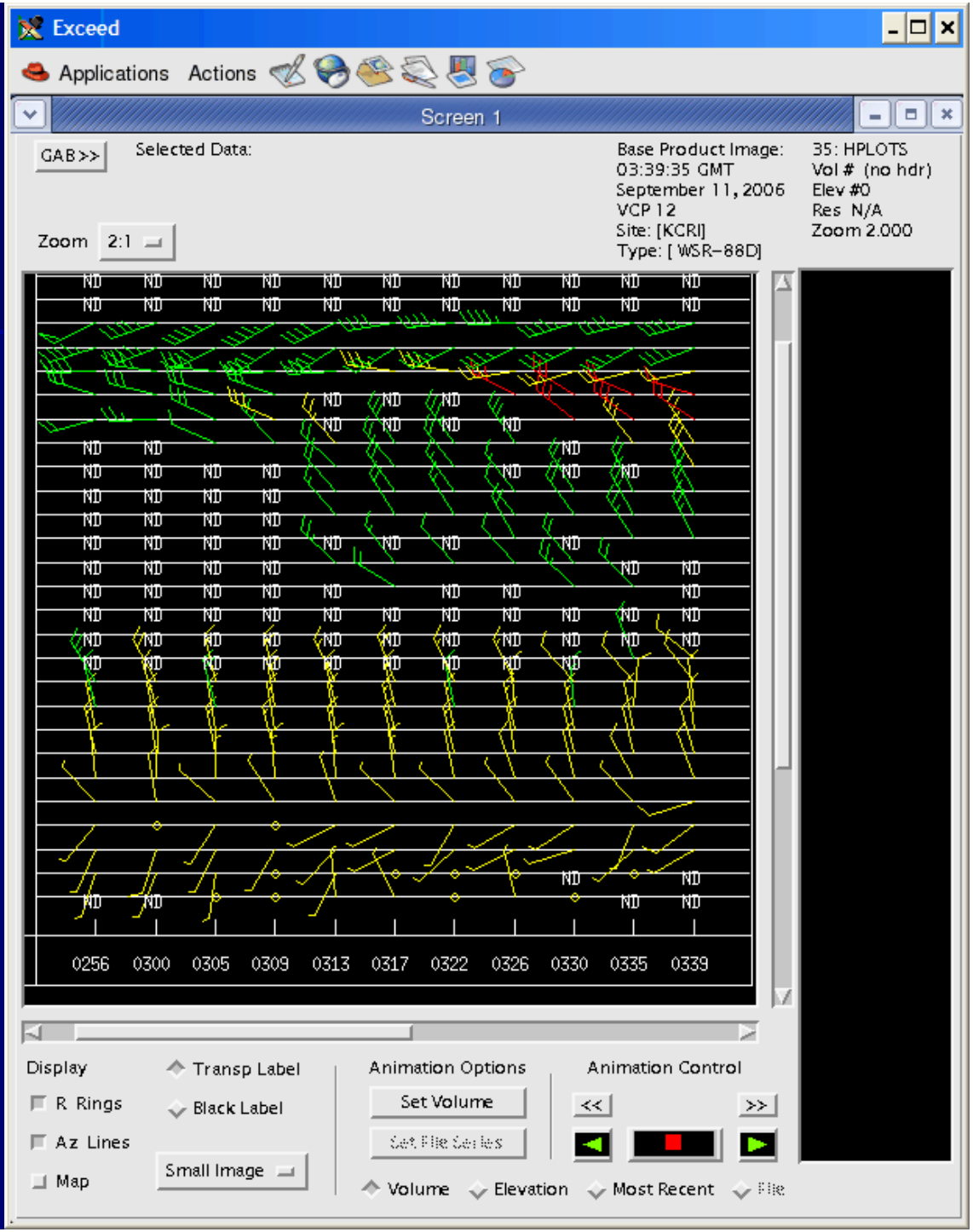
- Rodger Brown (NSSL) examining recombined vs rectangular velocity basedata
- Identifying mesocyclone signatures and computing rotational velocities
- Work is ongoing … graphic represent interim results
  - Essentially 50% of data points are within ± 0.25 m/s
  - 75% of data points are within ± 1.00 m/s
  - There are 9 outliers beyond ± 2.5 m/s
  - Total of 56 mesocyclone signatures



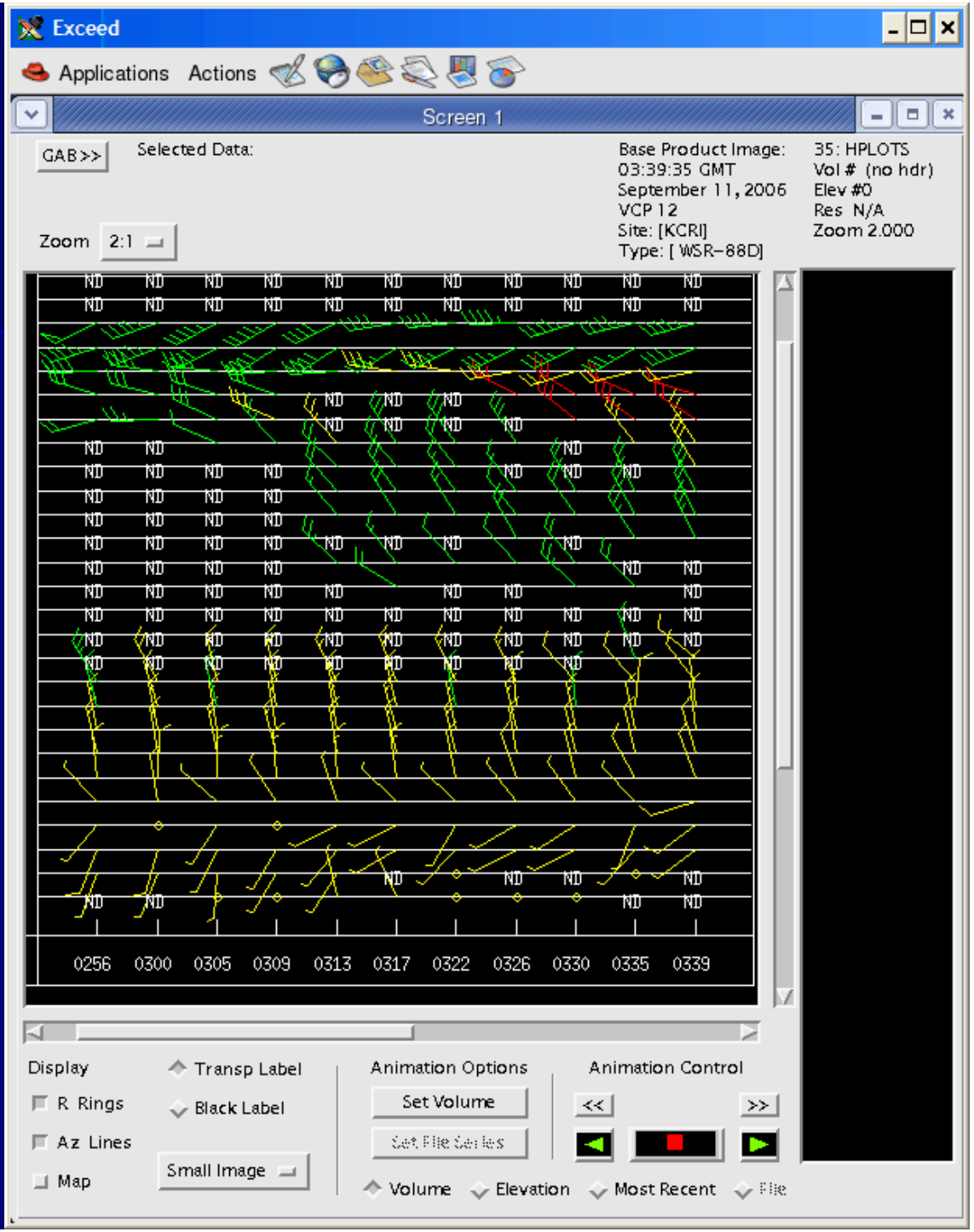
Algorithm Evaluation

- Mesocyclone Detection Algorithm
- Tornado Vortex Signature
- Echo Tops
- Enhanced Echo Tops
- Clutter Likelihood Reflectivity
- Clutter Likelihood Doppler
- One Hour Precipitation
- Three Hour Precipitation
- Storm Total Precipitation
- VAD Wind Profile
- Storm Tracking Information
- Hybrid Scan Reflectivity
- Vertically Integrated Liquid
- Digital VIL
- One Hour Snow Water
- One Hour Snow Depth
- Storm Total Snow Water
- Storm Total Snow Depth

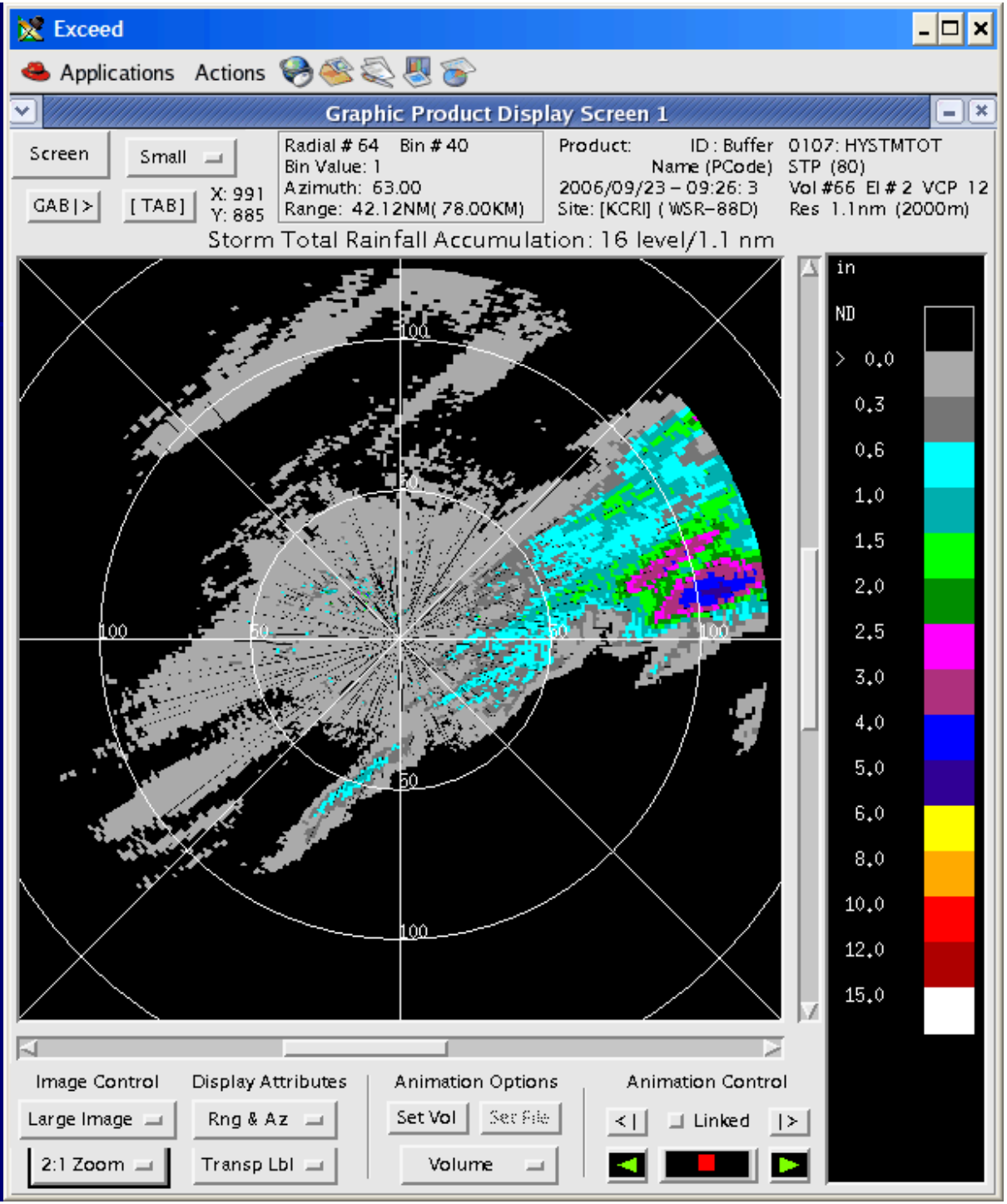
Recombined VWP



Rectangular VWP

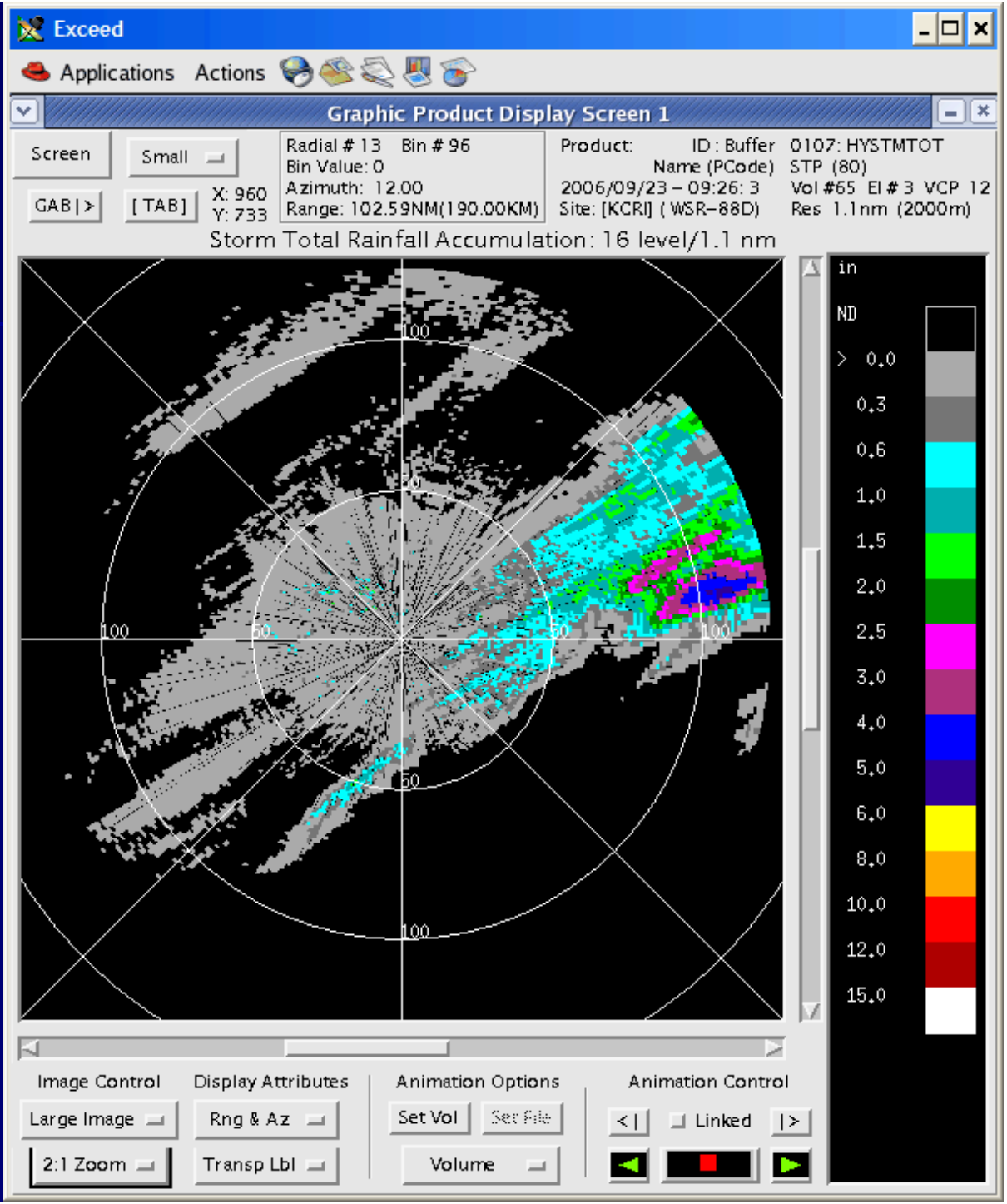


Recombined STP

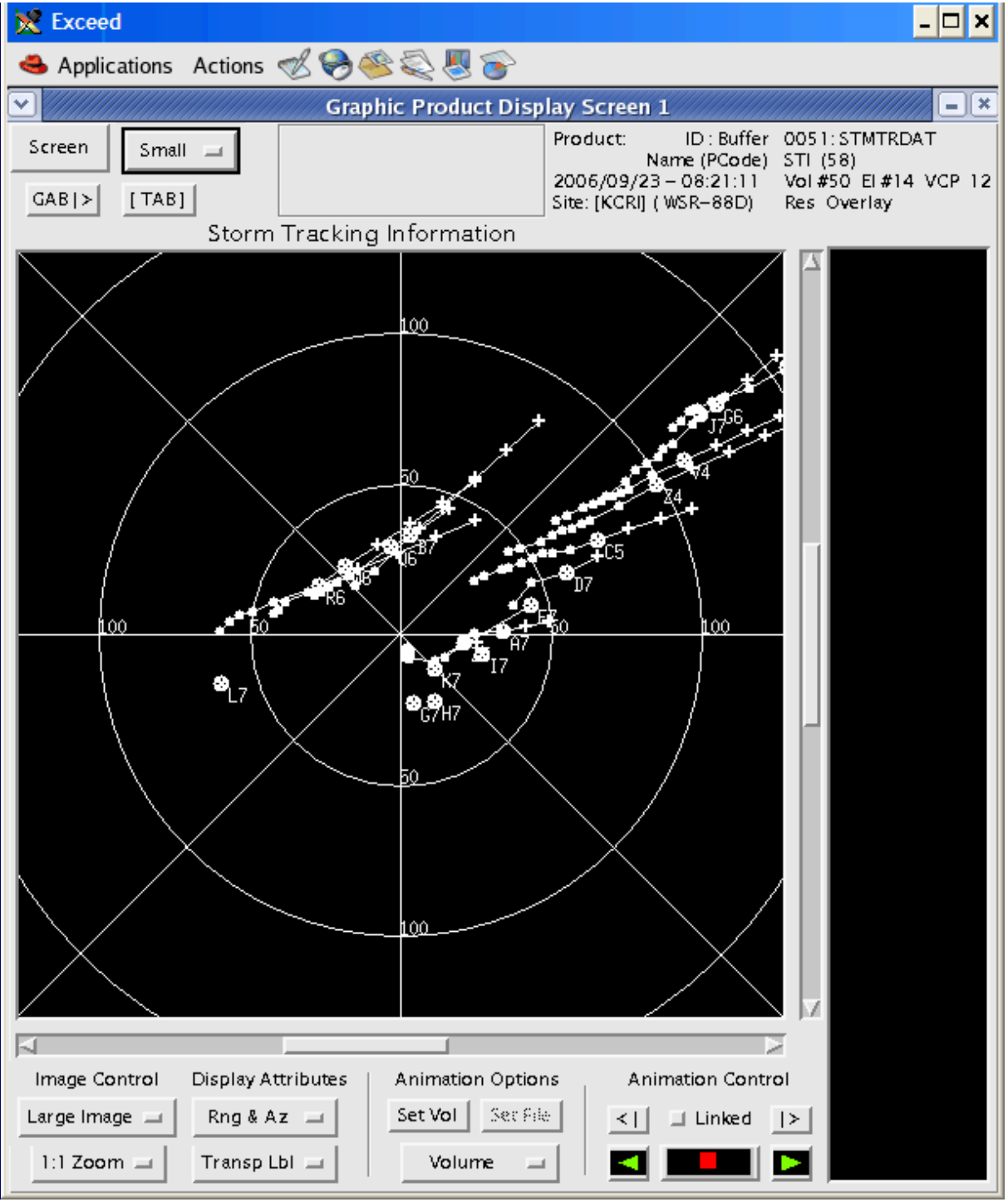


Recombined Data
Algorithm Evaluation

Rectangular STP

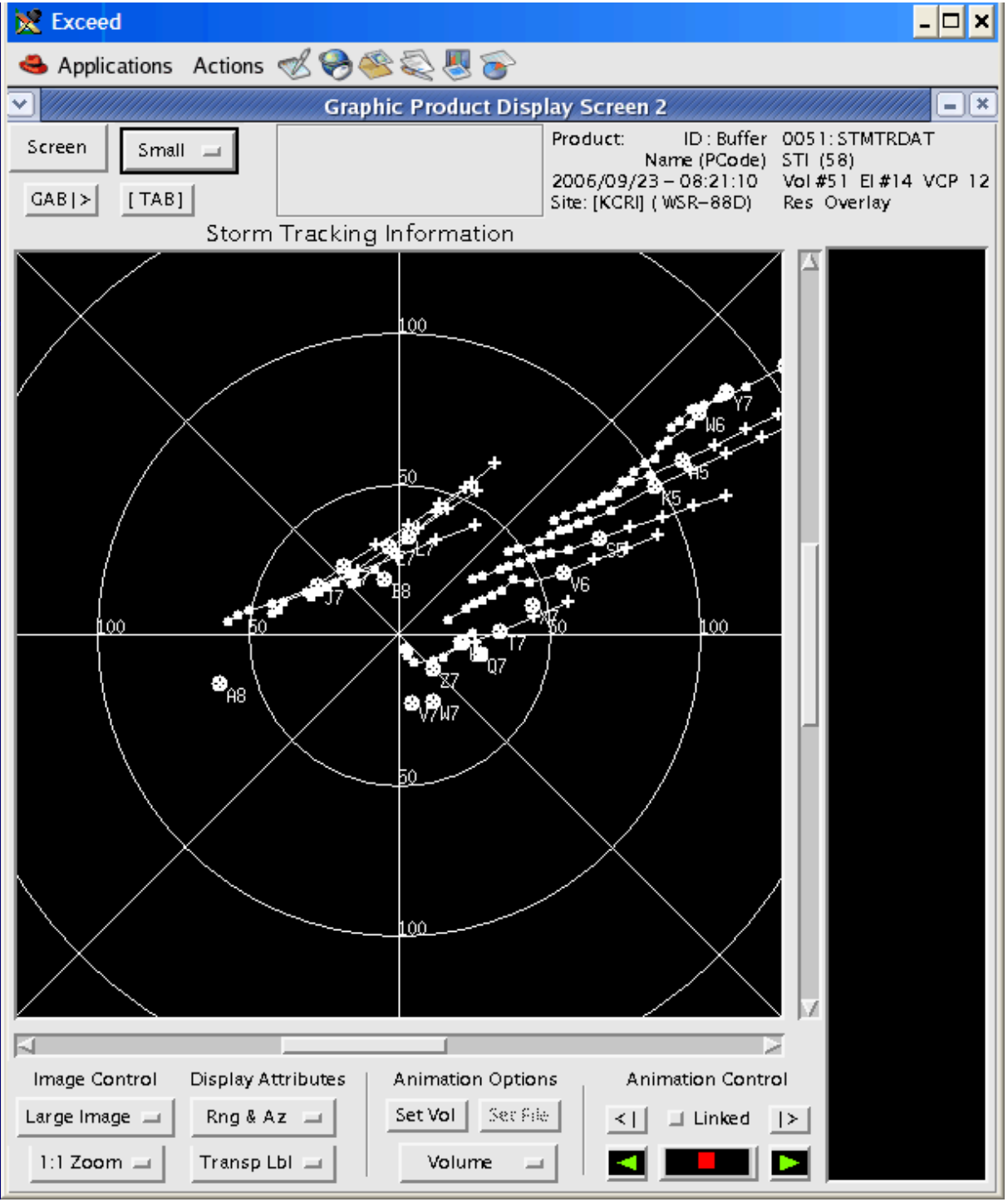


Recombined SCIT

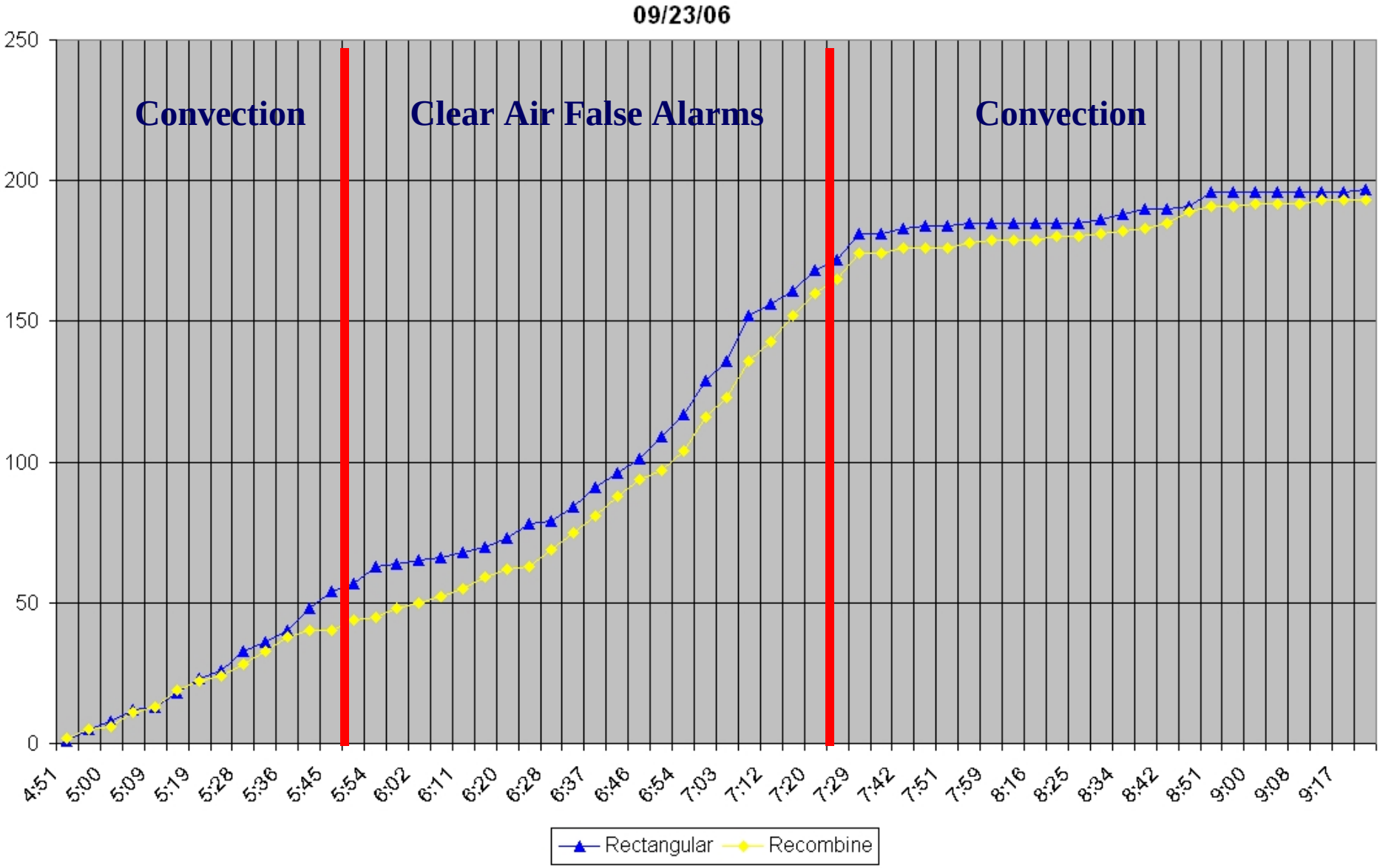


Recombined Data
Algorithm Evaluation

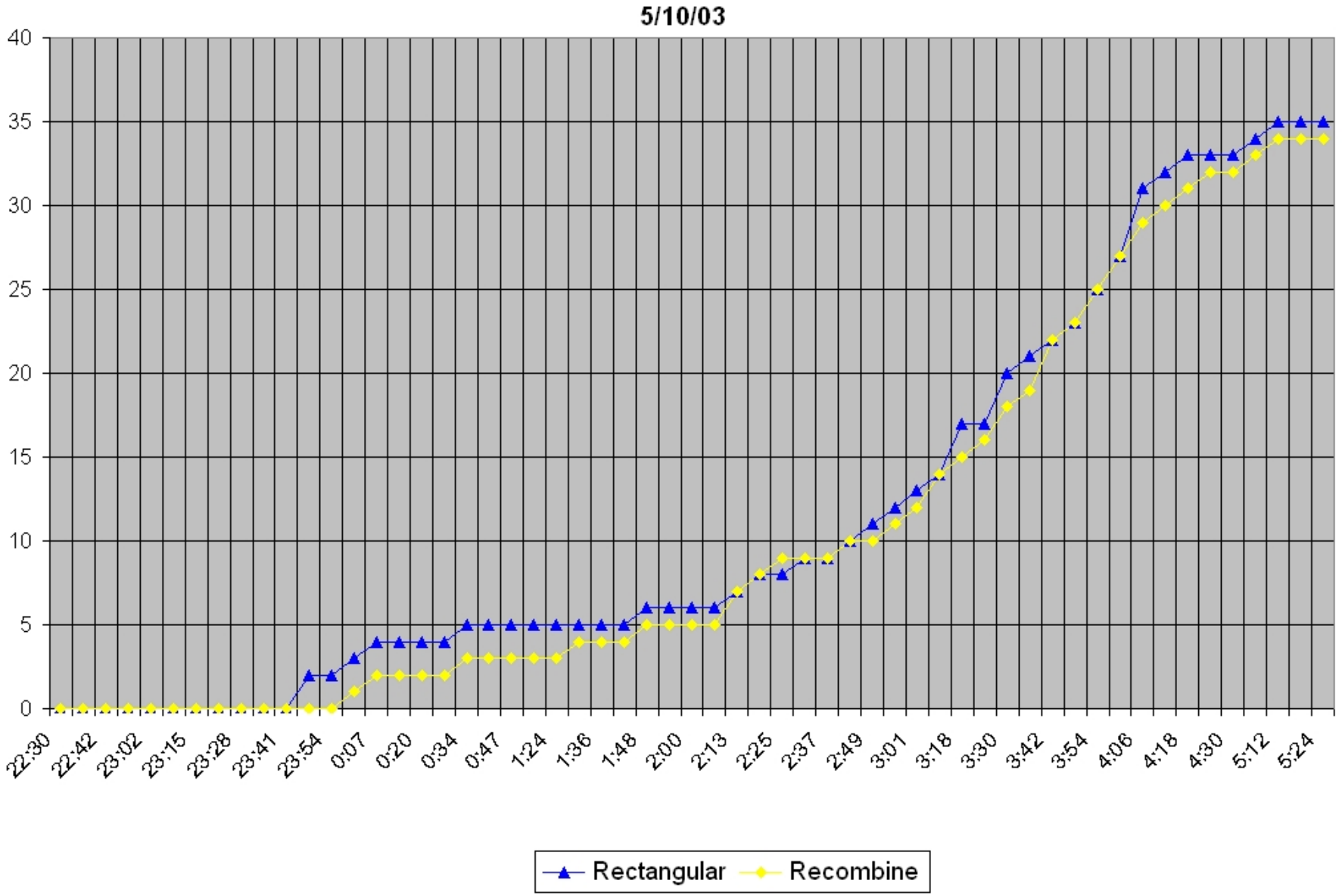
Rectangular SCIT



Meso Detections - Accumulation



TVS Detections - Accumulation



Engineering Study

- Analysis dependant upon stable ORDA Playback capability
- Clutter suppression level confirmed with regression analysis, minor dB-for-dB optimization adjustment identified
- Tested application of legacy resolution generated clutter map to Super Resolution data processing, no issues identified to date
- Summary: no major engineering issues related to base data identified so far.

Status: Baseline Implementation

- Build 10 Baseline Implementation
  - Baseline implementation of Super Resolution is currently on track for Build 10
  - Processing and data handling has been implemented in the RDA
  - Data handling, the recombination algorithm and super-res products have been implemented in the RPG
    - NSSL and ROC Software Engineering working to validate recombination algorithm implementation
  - Super Resolution currently being tested on KCRI

Baseline Implementation

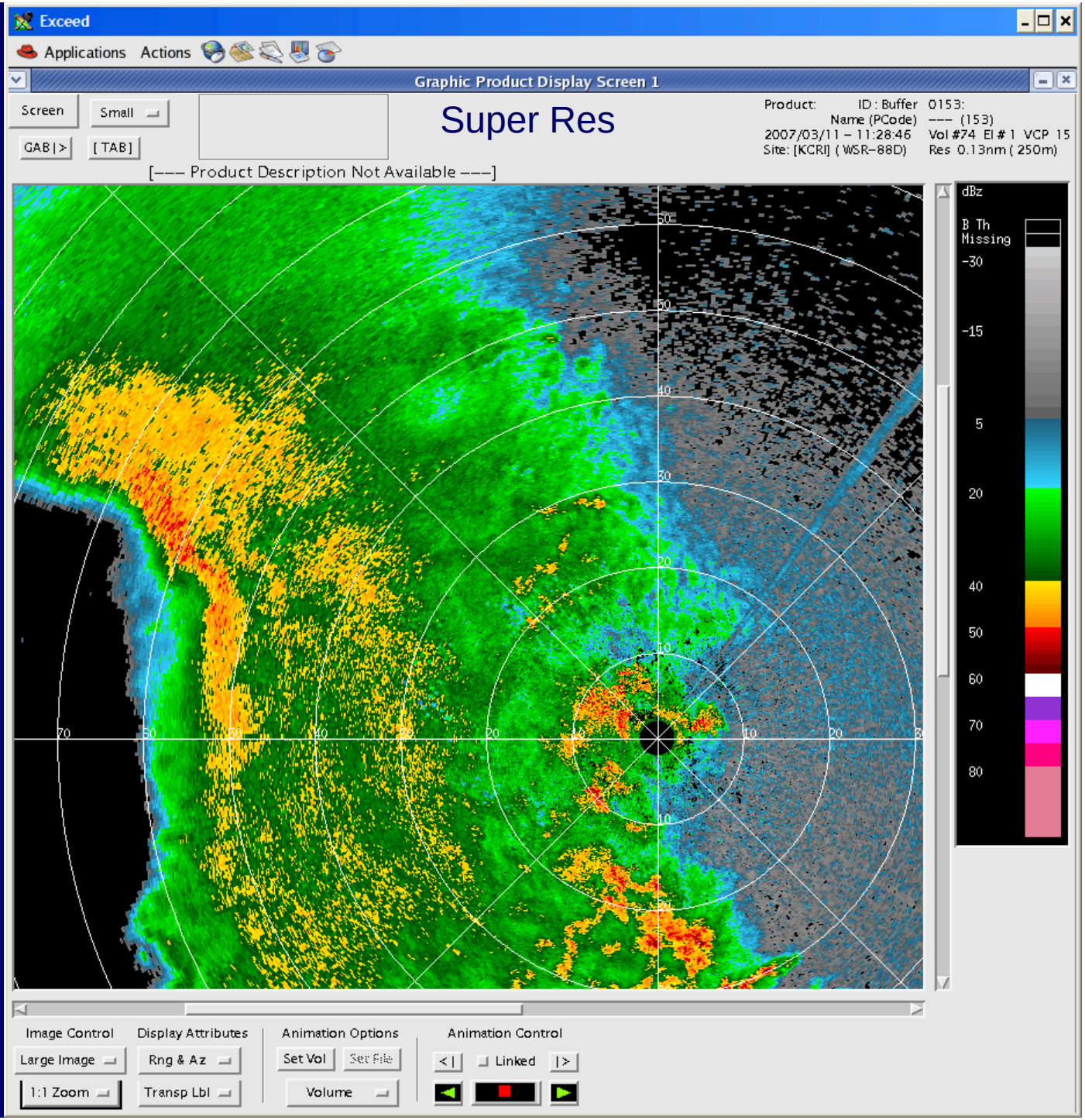
KCRI Testbed

KCRI

Super-Res

1128Z

03/11/07



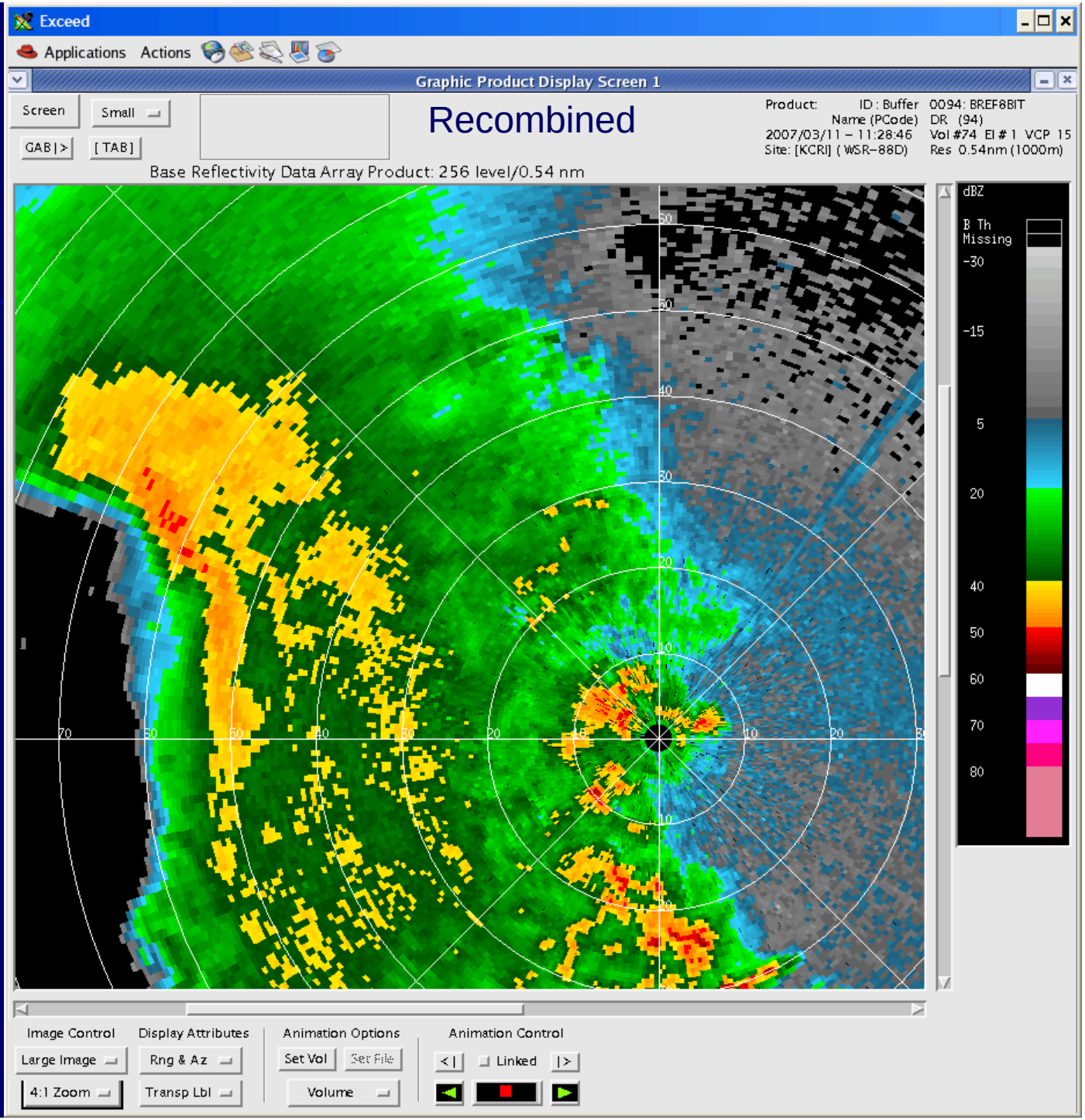
Baseline Implementation

KCRI

Recombined

1128Z

03/11/07



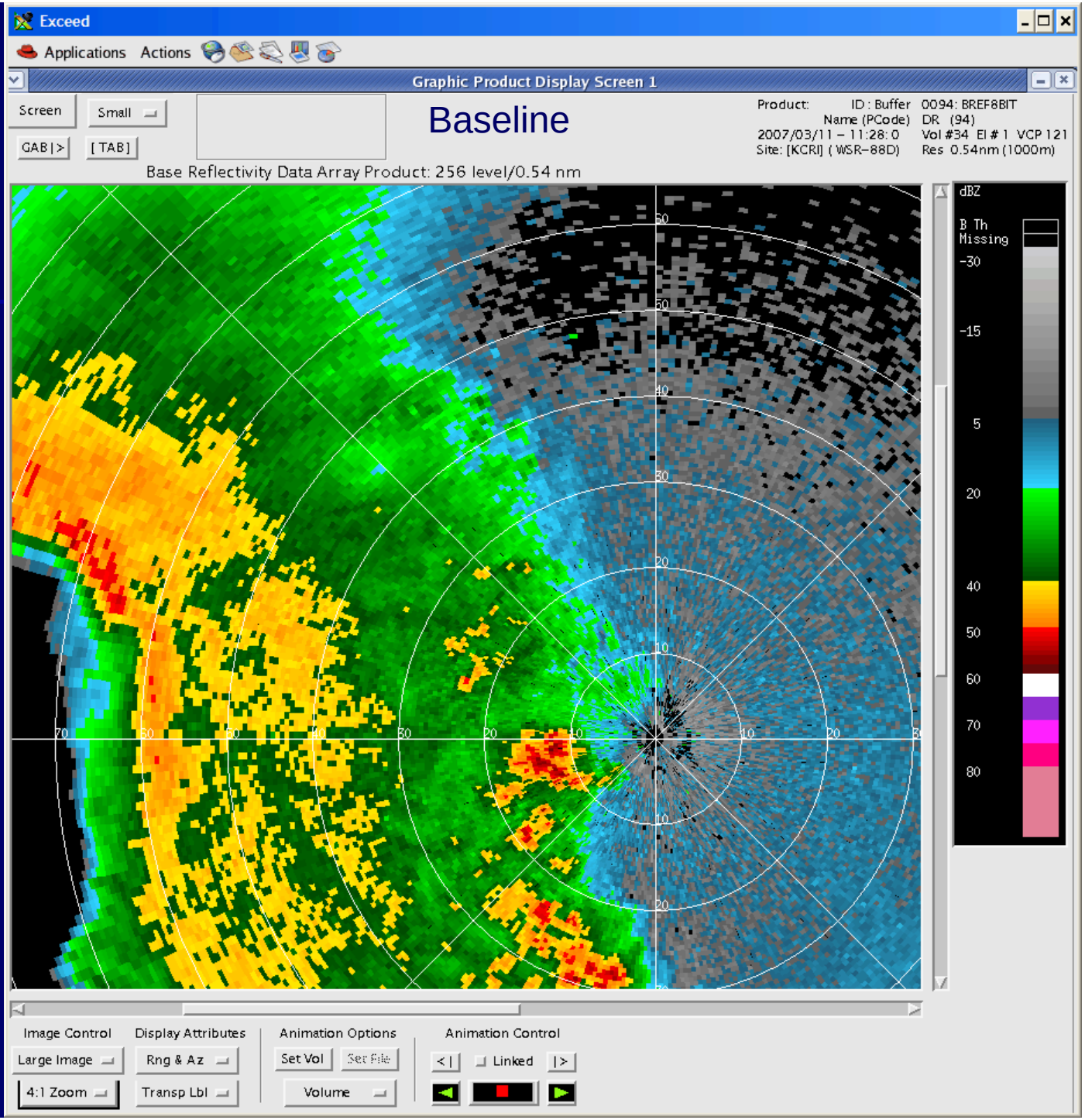
Baseline Implementation

KTLX

Baseline

1128Z

03/11/07



Summary: Recombination Evaluation

- Analysis continues of recombined base data & algorithm results
  - Continue to evaluate the ORDA Playback for expected function
    - ORDA Playback issues are investigated and resolved as encountered
  - Some anomalies observed believed to be artifacts related to playback, data conversions and/or the Super-Res RPG prototype
    - Some fixed, others will list as watch items for operational implementation

Summary: Recombination Evaluation

- Analysis continues of recombined base data & algorithm results
  - In general, reflectivity basedata and products look reasonable
    - Exception: High Res VIL & Hi Res Echo Top (both consumers of DQA) show slight rotation of image
  - In general, velocity basedata and products look reasonable
    - Have found MDA false alarms to be extremely sensitive to slight variations in the basedata
  - Very limited examination of Spectrum Width
    - Noted Sigmet SW bias with Rectangular window
- Preliminary Conclusion: No show-stoppers observed to date

Recommendation

- Recommend interim approval to continue Build 10 Baseline Super Resolution implementation
- NSSL/ROC will complete quantitative analyses
  - If analyses suggest ***no significant operational impact***, recommend **final approval to activate for Build 10**
  - If analyses suggest ***significant operational impact***, recommend **Super Resolution be disabled for Build 10**

Questions

Discussion