Using ORPG to Enhance NEXRAD Products to Support FAA Critical Systems

David J. Smalley
Betty J. Bennett

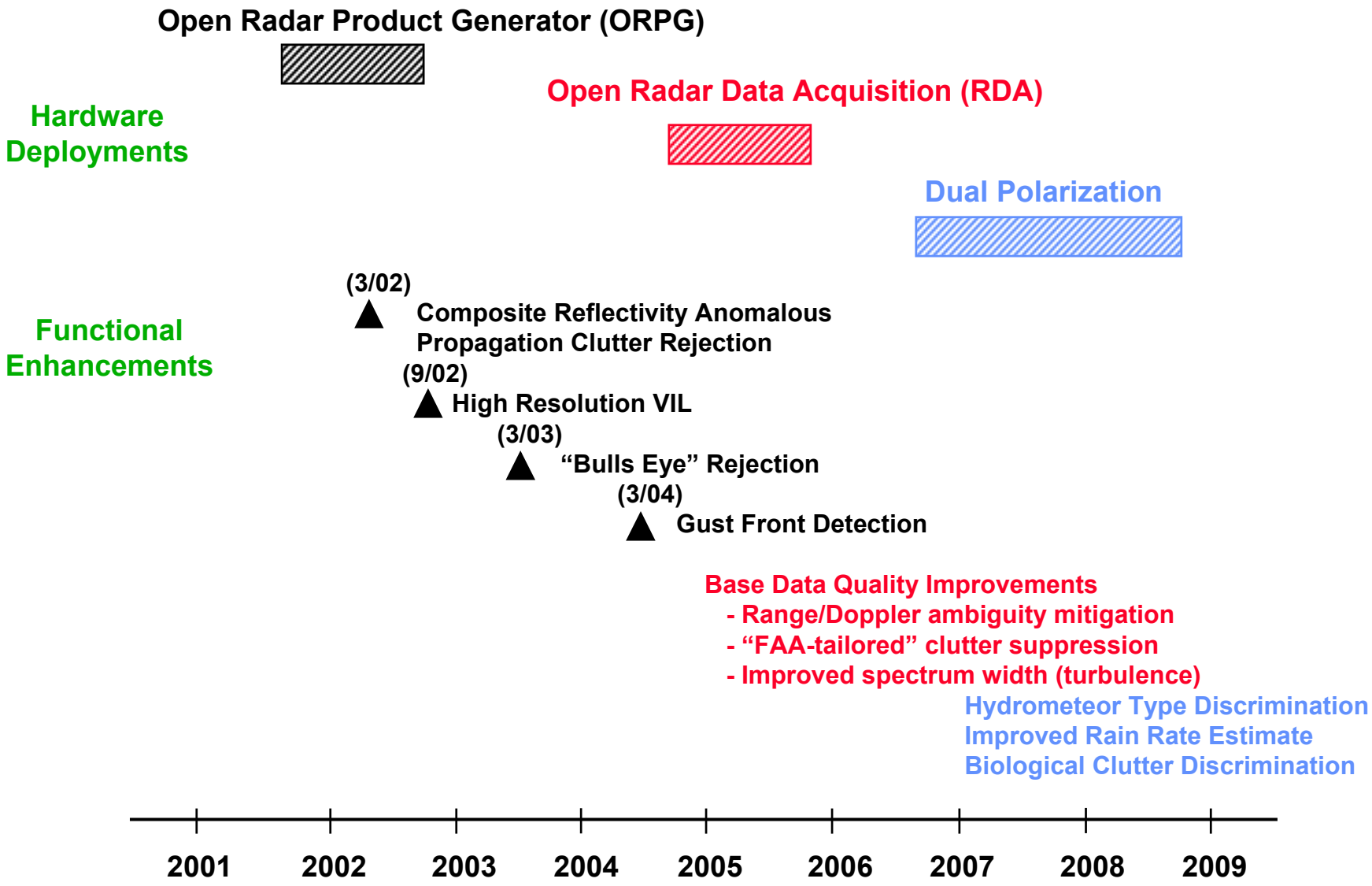
13 May 2002

50 years
MIT LINCOLN LAB

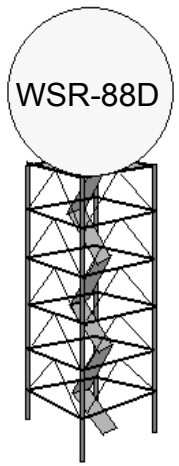
Outline

- ORPG Overview
- Lincoln Laboratory ORPG Research Network
- Algorithm Discussion
  - AP Edit
  - High Resolution VIL
  - Data Quality Assurance
- Summary

NEXRAD Enhancement Timeline



ORPG CODE
Common Operations and Development Environment



NEXRAD Site

Operational Open RPG

Lincoln Laboratory

NEXRAD data

Open RPG CODE Clone

Algorithm Design and Testing

New Algorithms Improved Algorithms

ORPG/CODE Release Control

NEXRAD ROC

- **ORPG CODE will serve as the basis for**
  - **Enhance existing algorithms**
  - **Integrate new algorithms**

Key FAA Systems that Benefit from Improved NEXRAD Algorithms

Integrated Terminal Weather System

Medium Intensity Airport Weather System

<u>NEXRAD Algorithms</u>

AP Edited Comprefl

High Resolution VIL

Data Quality Assurance

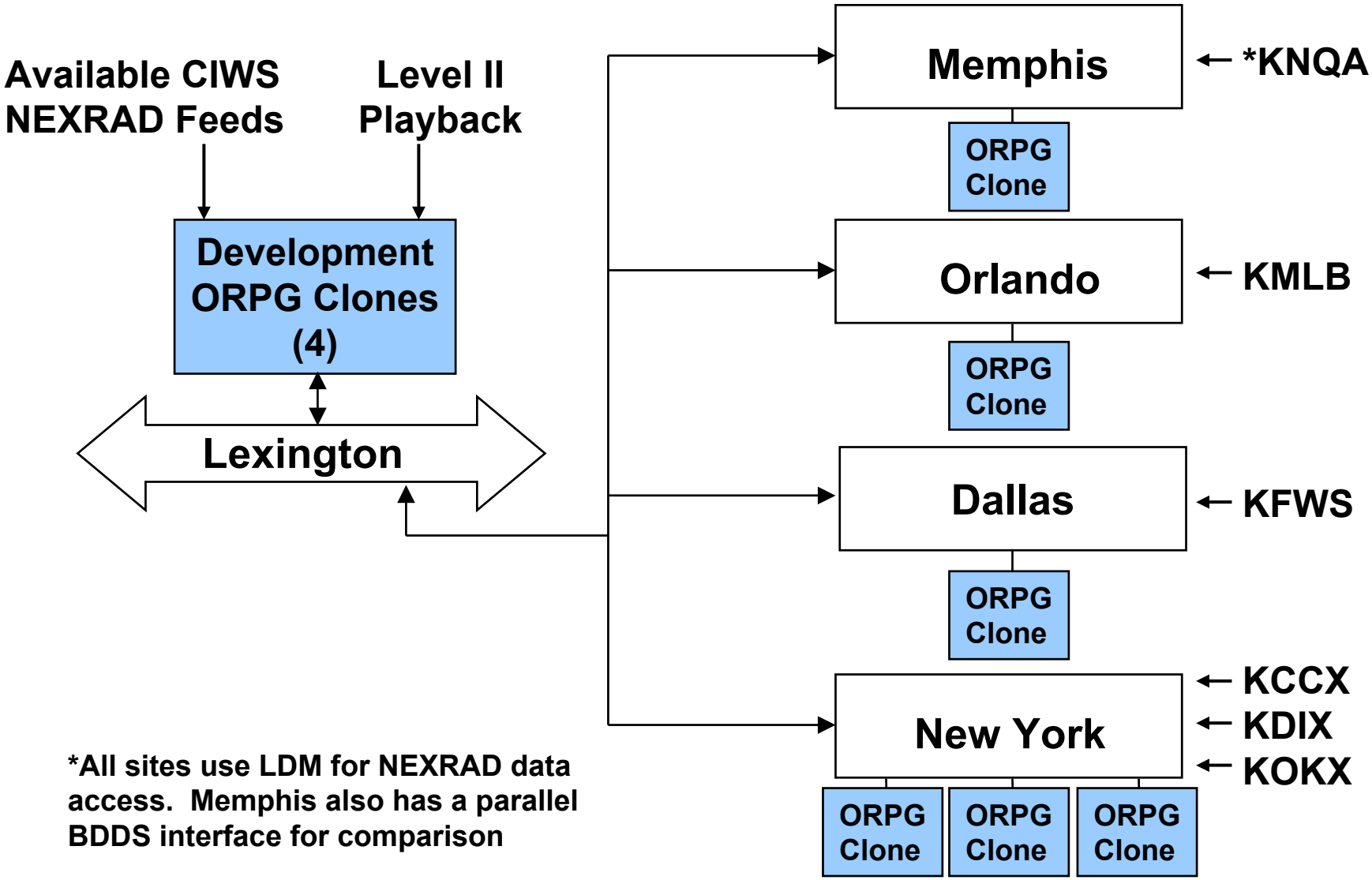
Enhanced Echo Tops

MIGFA

Weather And Radar Processor

Corridor Integrated Weather System

ORPG Algorithm Development Facilities



*All sites use LDM for NEXRAD data access. Memphis also has a parallel BDDS interface for comparison

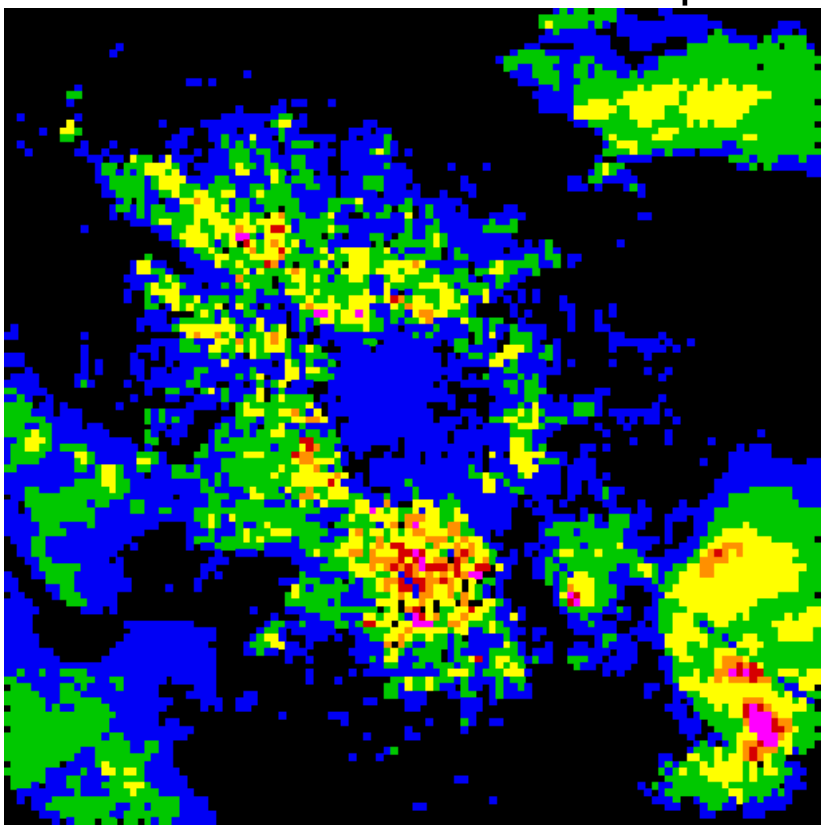
Algorithm Enhancement Schedule

Product	ORPG Build	Deployment Date
Improved Anomalous Propagation (AP) Editing for Composite Reflectivity	1.2	In Progress
High Resolution Digital Vertically Integrated Liquid Water (VIL)	2	Sept. 2002
Data Quality Assurance (DQA)	3	March 2003
Enhanced Echo Tops (EET)	4	Sept. 2003
Machine Intelligent Gust Front Algorithm (MIGFA)	5	March 2004

Build 1 - Improved AP Edit Product on the ORPG

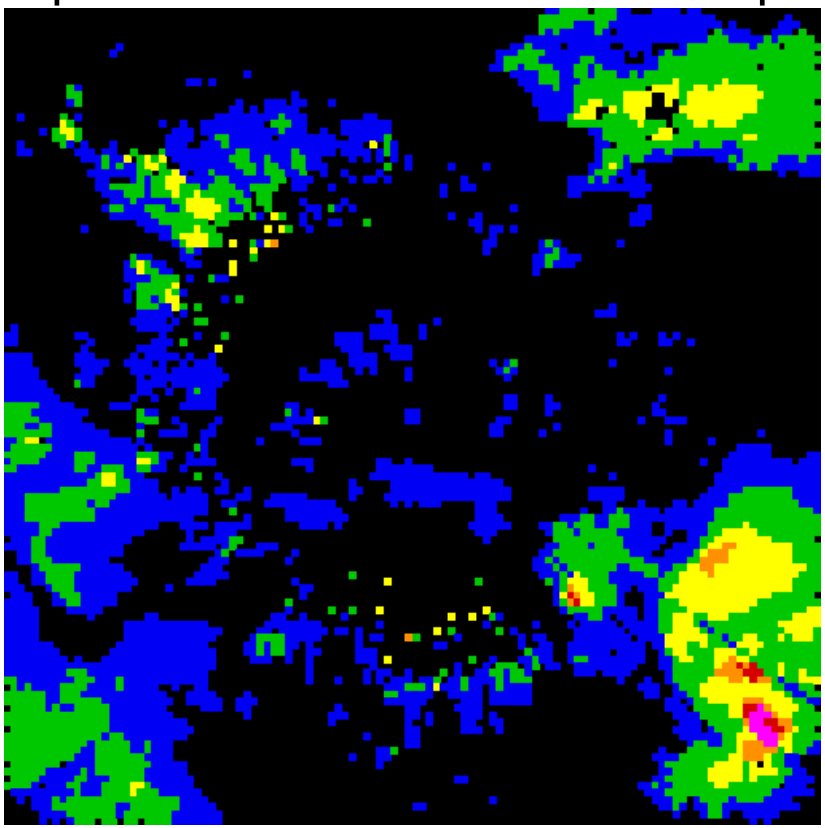
Amarillo AP Event: 05/25/1994 0322 UTC

Build 1 ORPG AP Edit Comprefl



460 km

Improved Build 1.2 AP Edit Comprefl



dBZ

4 km x 4 km resolution

Tested AP Adaptation Parameter Settings

ADAPTATION PARAMETER									★		RANGE
Min Clutter Reflectivity	10	10	5	10	5	10	10	5	5	5	5 - 20 dBZ
Omit All Altitude	1	1	1	1	1	1	1	1	1	1	0 - 5 km
Accept if Altitude	3	3	3	3	3	3	3	3	3	3	0 -10 km
Omit All Distance (Outer)	45	45	45	45	45	45	45	45	45	45	0 - 100 km
Accept if Distance (Outer)	103	103	103	103	103	103	103	103	103	103	0 - 300 km
Reject if Distance (Outer)	230	230	230	230	230	230	230	230	230	230	0 - 300 km
Accept if Maximum Elevation	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0 - 5 deg.
Reject if Maximum Elevation	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	0 - 15 deg.
Reject if Minimum Velocity	1.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0	2.0	1.5	0 - 5 m/s
Reject if Minimum Spectrum Width	0.5	1.0	1.0	2.0	2.0	1.0	1.0	2.0	2.0	1.5	0 - 5 m/s
Accept if Minimum Velocity	1.0	1.0	1.0	2.0	2.0	1.0	1.0	2.0	2.0	1.5	0 - 5 m/s
Accept if Minimum Spectrum Width	0.5	1.0	1.0	2.0	2.0	1.0	1.0	2.0	2.0	1.5	0 - 5 m/s
Clutter Bloom/Dilation(CBD) Phase	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No, Yes
CBD Maximum # Range Bins	4	8	8	8	8	8	8	8	8	8	0 - 20 bins
CBD Maximum Reflectivity	10	30	30	30	30	30	30	30	30	30	0 - 30 dBZ
Median Averaging(MA) Phase	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No, Yes
MA Maximum Range Bin Difference	1	1	1	1	1	4	4	4	4	4	0 - 5 bins
MA Maximum Cross Range	2	2	2	2	2	8	2	8	2	2	0 - 10
Median Filter Percent Good	50.0	50.0	50.0	50.0	50.0	90.0	90.0	90.0	90.0	90.0	0 - 100 %

Build 1 Settings

Approximate MIT/LL

Minimal dBZ

Increased Doppler

Min. dBZ + Incr. Dop.

"Scatter Filter" E

Build 1.2 Settings

"Scatter Filter" C

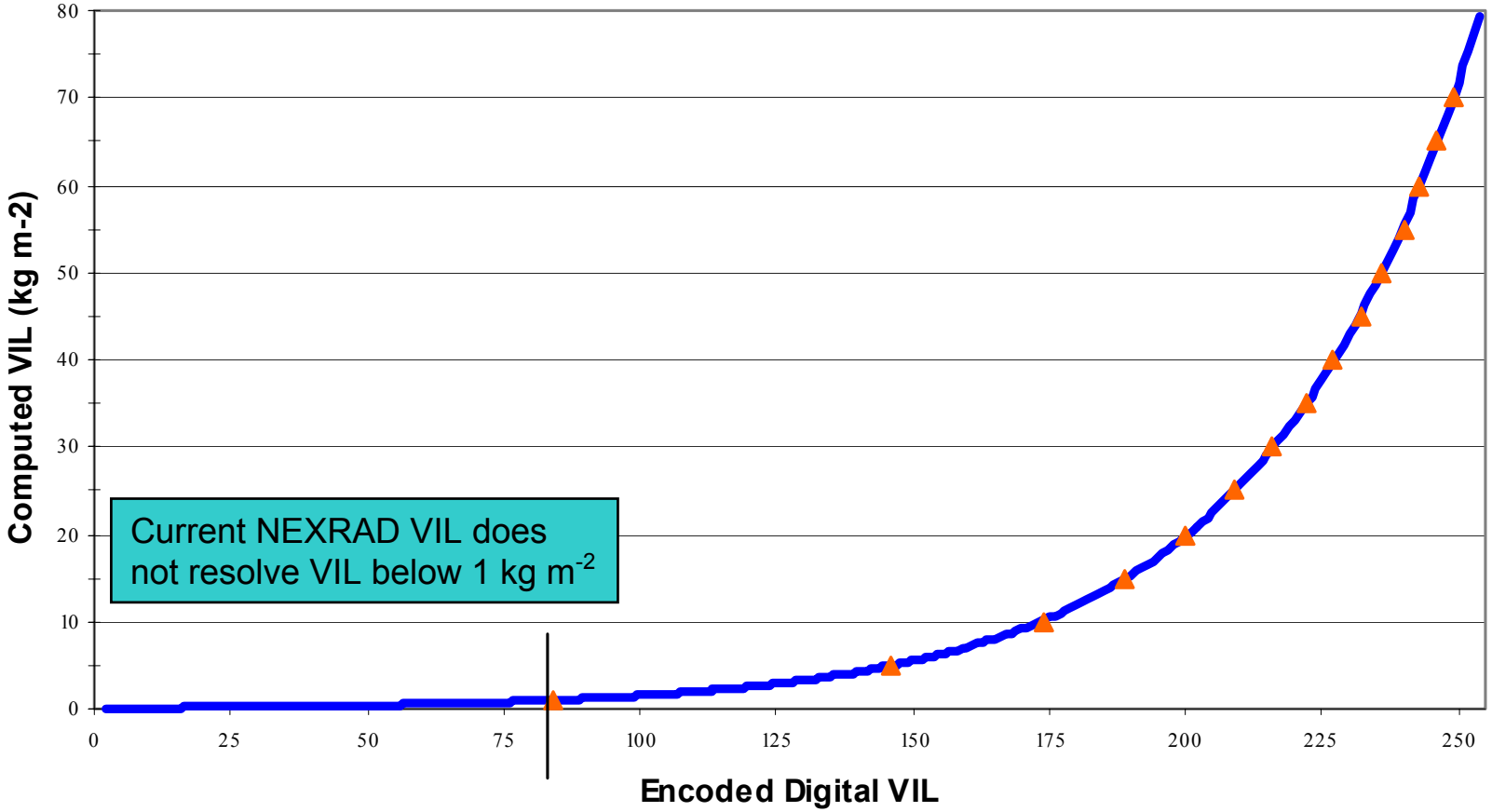
"Scatter Filter" B

"Scatter Filter" A

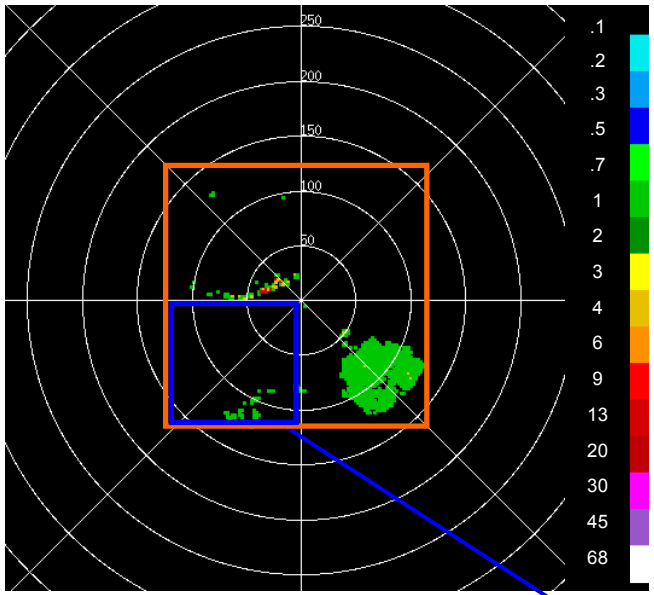
Build 2 – High Resolution Vertically Integrated Liquid (HRVIL)

- VIL an excellent proxy for severe convection
  - Critical flight planning element
  - Even small changes in VIL important
- Two problems with existing NEXRAD VIL
  - Coarse spatial resolution (4 km)
  - Coarse data level resolution (16 levels)
- MIT/LL FAA solution – HRVIL
  - Polar format VIL maintains inherent radar resolution
  - 256 data levels replace 16 data levels
- Key FAA systems will utilize HRVIL
  - CIWS, MIAWS, WARP
  - NCWF, TCWF

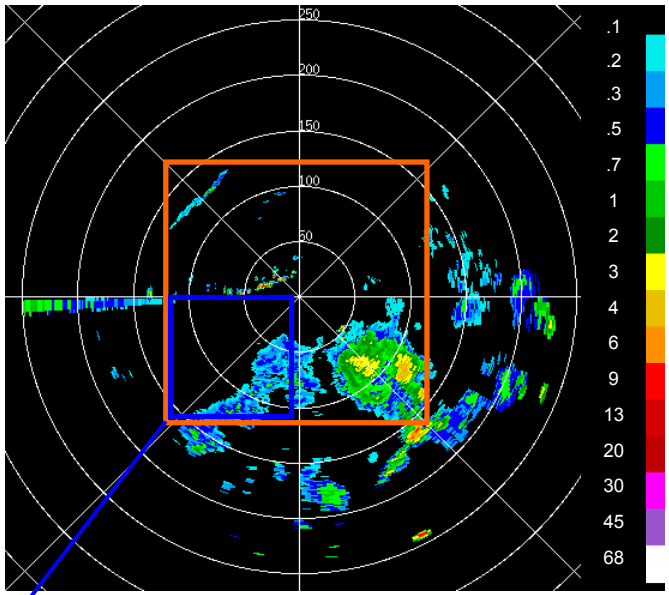
High Resolution VIL Curve Compared to Current VIL Data Levels



Current and High Resolution VIL Comparison



230 km range of current VIL product denoted by orange box



Current VIL product

230 km range

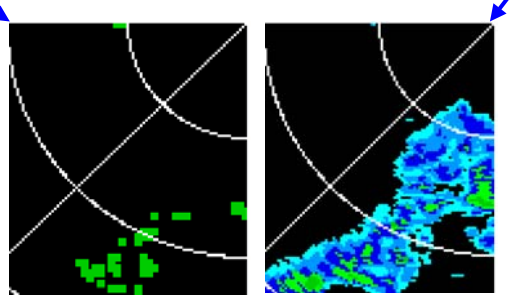
18 dBZ min. threshold

4 x 4 km resolution

Cartesian

16 data levels

continues in Build 2



Southwest quadrant zoom

Build 2 HighRes VIL product

460 km range

no dBZ threshold

1 degree x 1 km resolution

Polar

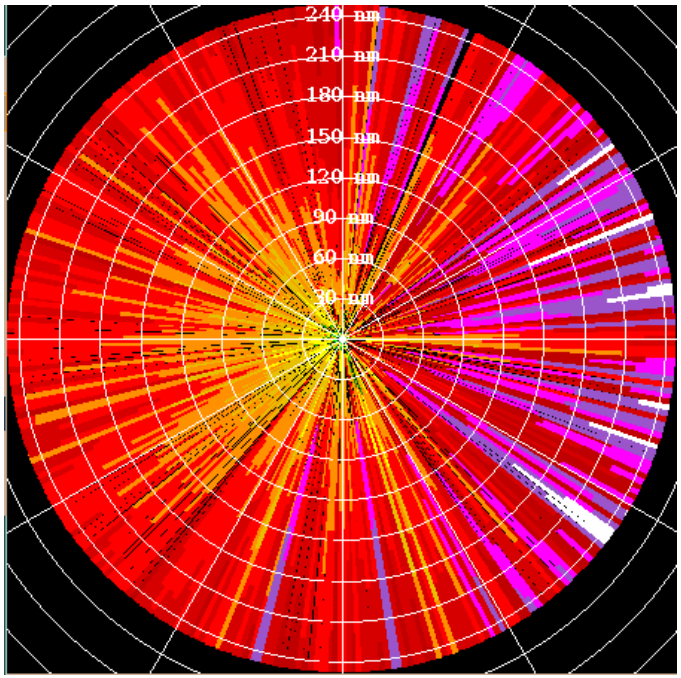
253 data levels

release September 30, 2002

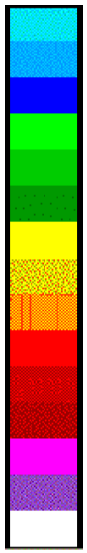
Build 3 – Data Quality Assurance (DQA)

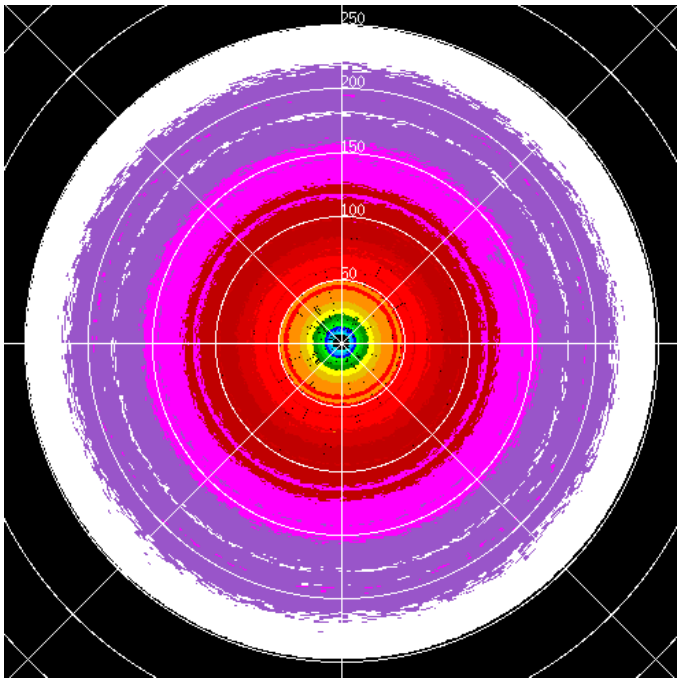
- Purpose is to provide “cleaned-up” reflectivity to HRVIL
- To include AD (Artifacts Detection) and AP editing
  - AD editing adapted from Unisys algorithm for WARP
  - AP editing to be full MIT/LL AP Editing scheme
- WARP interest: use to generate a new DQA comprefl
- CIWS: use AD edit portion for mosaics
- Others: use as input for future NEXRAD algorithms

Data Quality Assurance Algorithm



920 km





Base Data → Remove Constant Power Functions along radials

Remove AP using Enhanced AP Editing Algorithm

→ High Resolution VIL

→ Composite Reflectivity

→ Future Products

Summary

- ORPG CODE is a major advance in algorithm transfer process
- Lincoln exploitation of ORPG CODE significantly improving NEXRAD inputs to key FAA systems
  - Integrated Terminal Weather System (ITWS)
  - Weather and Radar Processor/Display System Replacement (WARP/DSR)
  - Medium Intensity Airport Weather System (MIAWS)
  - Corridor Integrated Weather System (CIWS)
- Developing good technology transfer relationship with NEXRAD Radar Operations Center (ROC)
- Future Algorithms: MIGFA, Enhanced Echo Tops, Multi-Scale Tracker