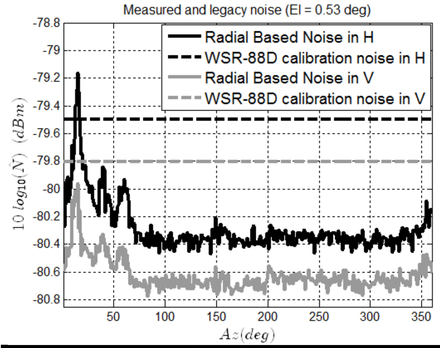
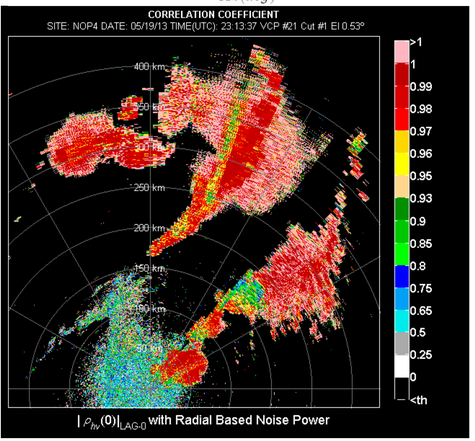
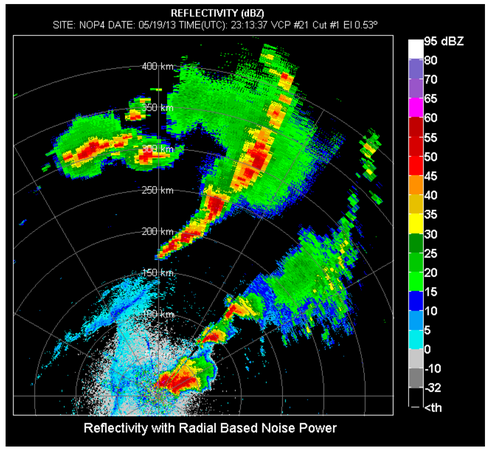
Increasing the value of NEXRAD's dual-polarization upgrade by improving the quality of correlation coefficient

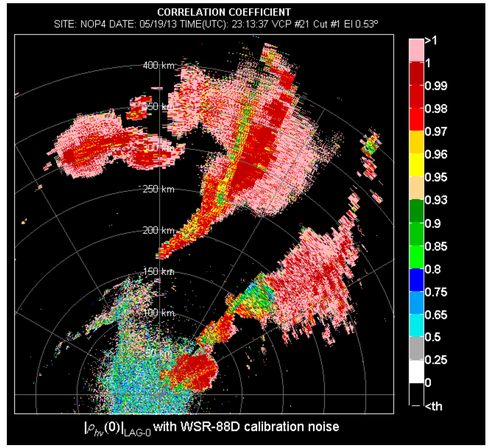
- The correlation coefficient ($|\rho_{hv}(0)|$) is used for classification of radar returns.
- **The correlation coefficient estimates are unusable when larger than one (i.e., invalid).**
- There are three causes to this
  - Mismeasurement of noise powers in the horizontal and vertical channels.
    - ✓ Can be mitigated using the more accurate **radial based noise power estimator (RBNE) (*developed at NSSL and implemented in operations*).**
  - Statistical errors inherent in the legacy correlation coefficient estimator (i.e., $|\rho_{hv}(0)|_{LAG-0}$).
    - ✓ Can be mitigated using **the improved estimator (*developed at NSSL and tasked to be implemented in operations*).**
  - Standard deviation (larger when the number of samples per dwell is small and/or SNR is low).
    - ✓ Can be mitigated by Increasing the number of samples (*M*) used to produce estimates at locations with invalid values.





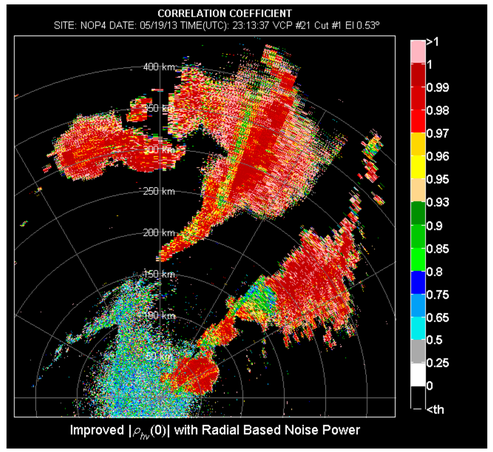


LEGACY PROCESSING (LEGACY WSR-88D NOISE CALIBRATION + LEGACY ESTIMATOR)

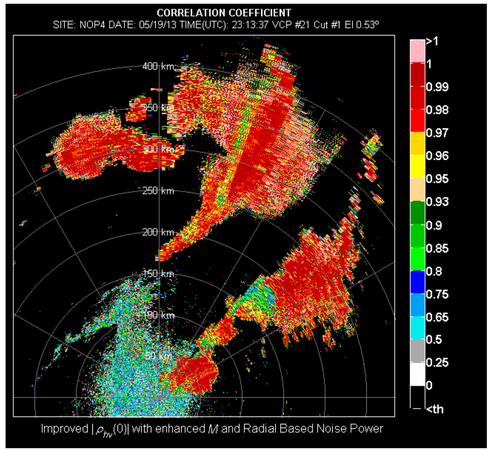


RADIAL BASED NOISE POWER (RBNE) + LEGACY ESTIMATOR

RADIAL BASED NOISE POWER (RBNE) + IMPROVED ESTIMATOR



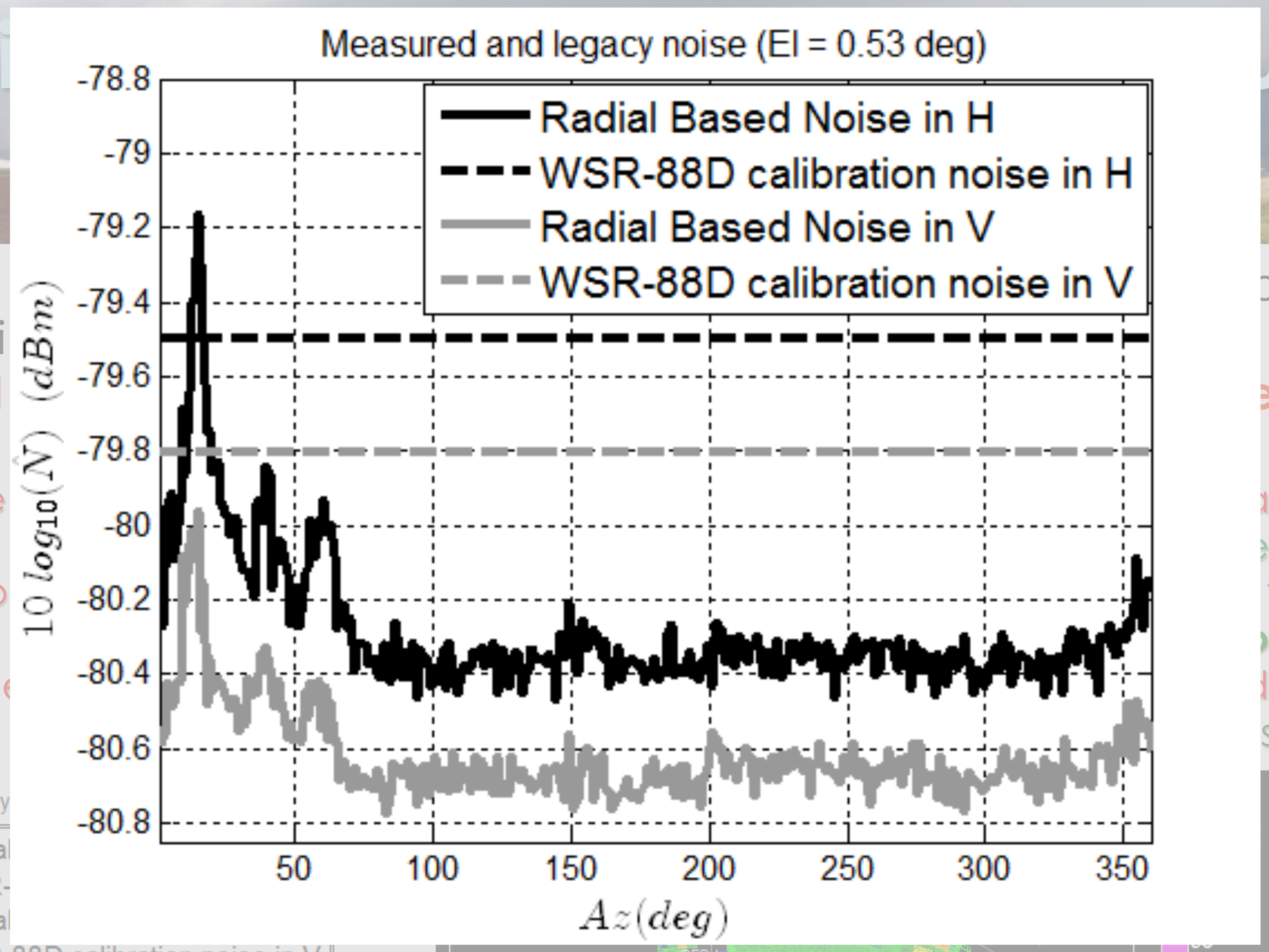
RADIAL BASED NOISE POWER (RBNE) + IMPROVED ESTIMATOR+ ENHANCE SAMPLE SIZE (*M*)



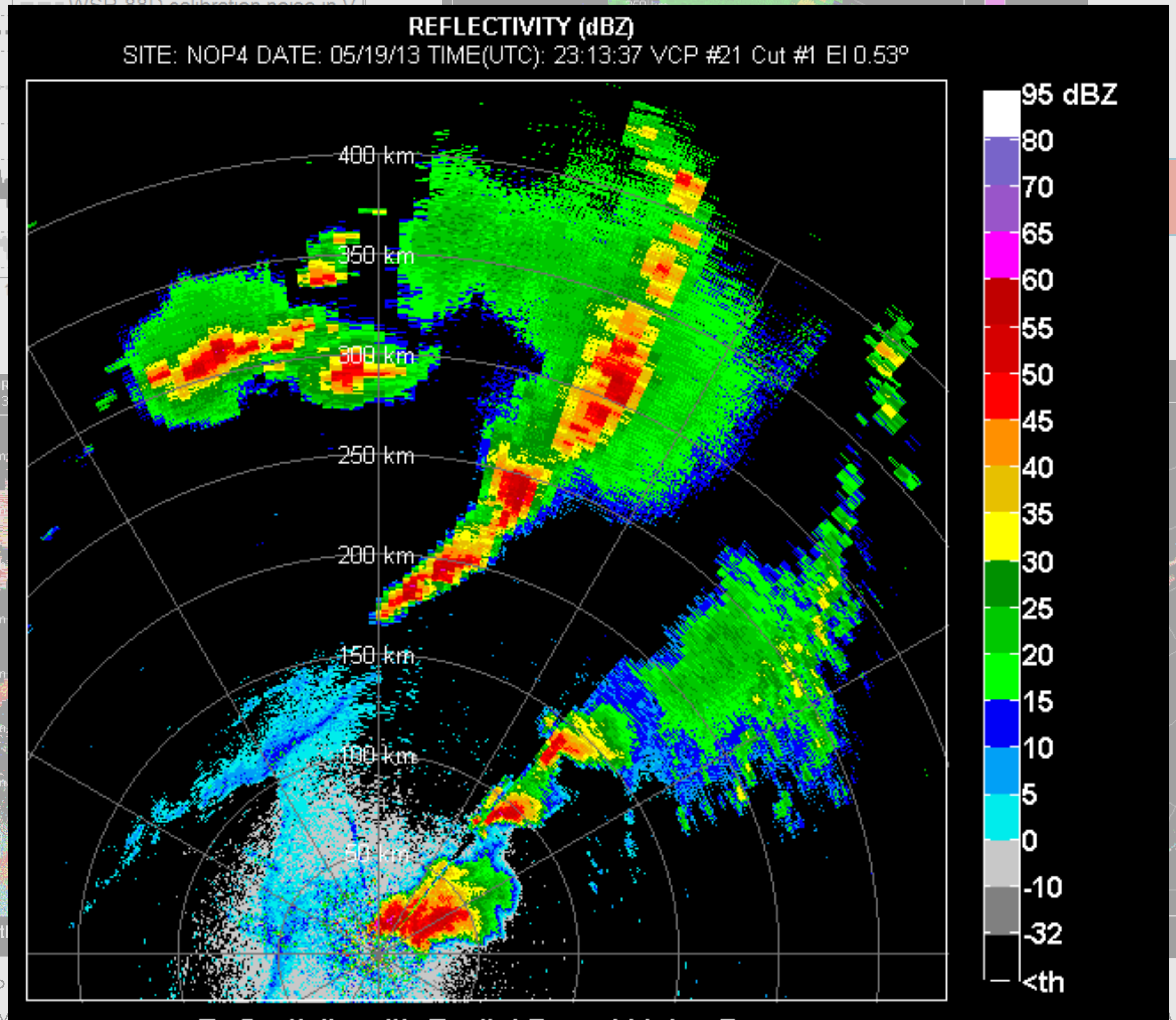
Igor Ivić (CIMMS/NSSL)

Increas… ual-polarization upgrade by improving the quality of correlation coefficient

- The correl… ometeor classification (HCA) and tornado debris recognition.
  - The bi…
- The correl… en larger than one (i.e., invalid).
- There are …
  - Mismeasure… l channels.
    - ✓ Can … ed noise power estimator (RBNE) *developed at NSSL. This technique has been implemented in operations.*
  - Inherent po… timator.
    - ✓ Can … ped at NSSL. *This technique is tasked to be implemented in operations.*
  - Standard de… dwell is small).
    - ✓ Can … s (M) used to produce estimates at bins with invalid values.



PROCESS USING LEGACY ESTIMATOR AND RADIAL BASED NOISE POWER

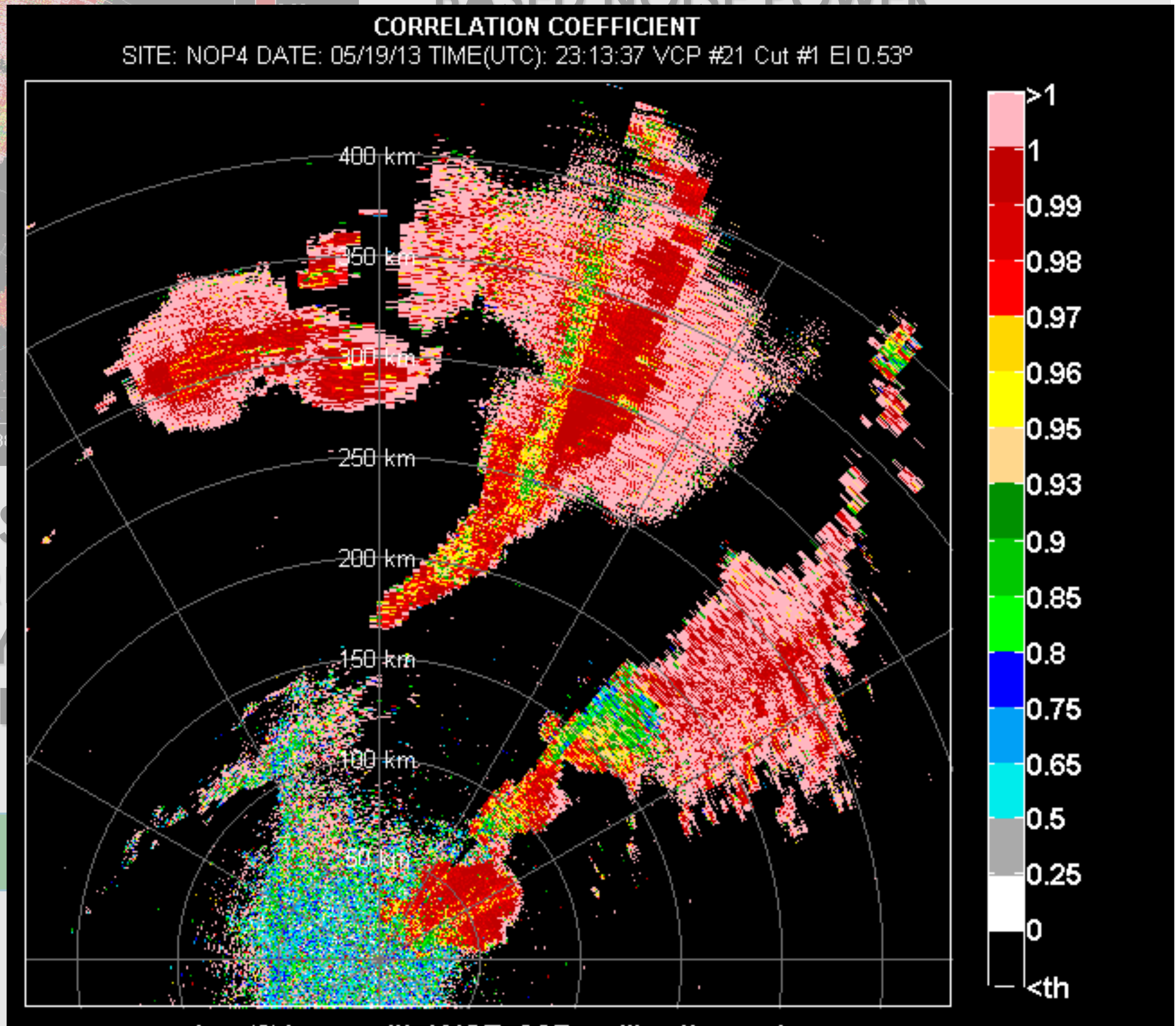


Reflectivity with Radial Based Noise Power

LEGACY PROCESSING

LEGACY PROCESSING (LEGACY WSR-88D NOISE CALIBRATION + LEGACY ESTIMATOR)

… BINS WHER… NVALID BY … PLES F… TH.



$|\rho_{hv}(0)|_{LAG\text{-}0}$ with WSR-88D calibration noise

Improved $|\rho_{hv}(0)|$ with Radial Based Noise Power

… Atmos. Oceanic Technol., **30**, 2737-2753.
… of the Correlation Coefficient on Dual-Polarization Weather Radars. J. Atmos. Oc…
… I. R., Jane C. Krause, Olen E. Boydstun, Amy E. Daniel, Alan D. Free, and Walter D. Zittel, 2014: Effects of Radial-Based Noise Power Estimation on Spectral Moment Estimates. J. Atmos. Oceanic Technol., 31, 2671-2691.

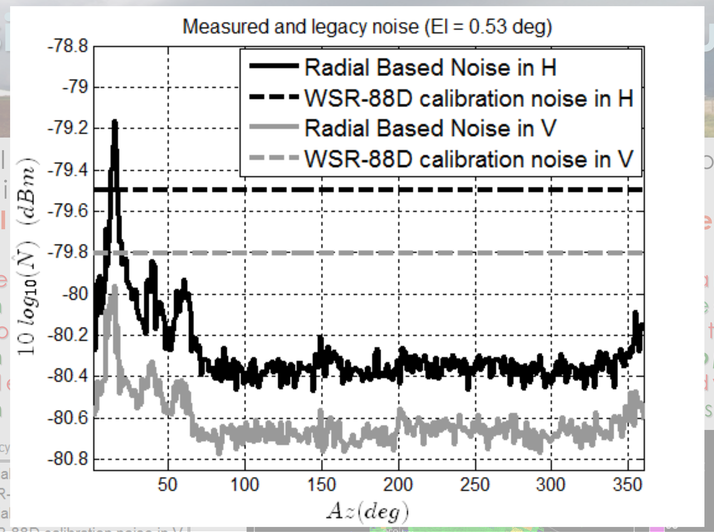
Increasi…ual-polarization upgrade by improving the quality of correlation coefficient

- The correl…
  - The bi…
- The correl…
- There are…
  - Mismeasure…
    - ✓ Can…
  - Inherent po…
    - ✓ Can…
  - Standard d…
    - ✓ Can…

…ometeor classification (HCA) and tornado debris recognition.

…en larger than one (i.e., invalid).

…l channels.
…ed noise power estimator (RBNE) ***developed at NSSL. This technique has been implemented in operations.***
…timator.
…oped at NSSL. This technique is tasked to be implemented in operations.
…dwell is small).
…s (M) used to produce estimates at bins with invalid values.

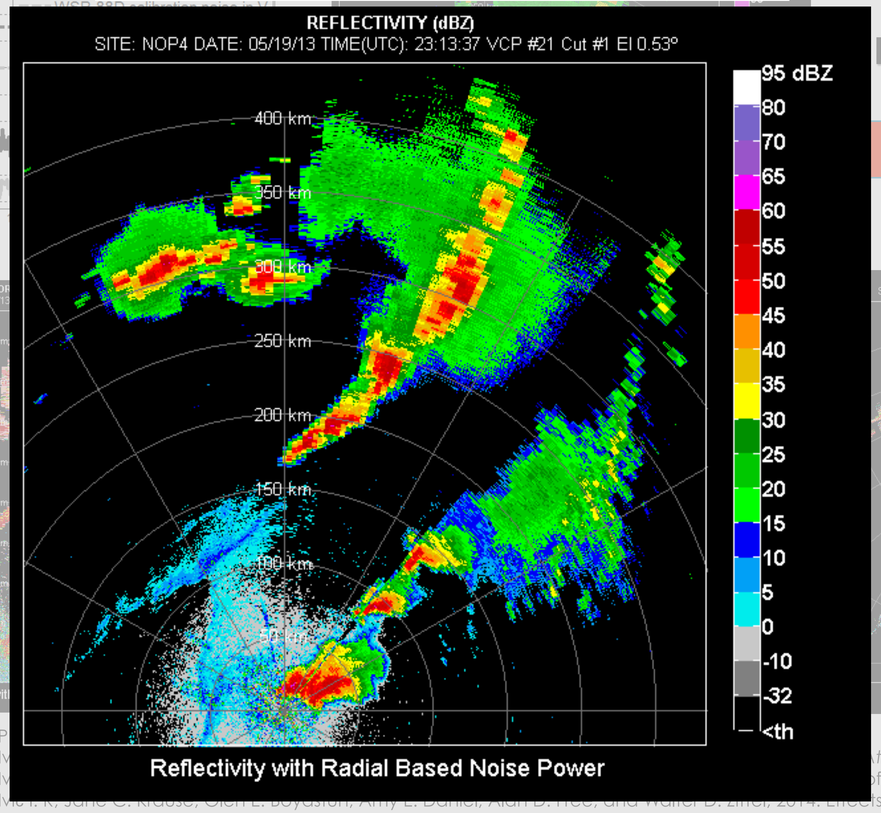


PROCESS USING LEGACY ESTIMATOR AND RADIAL BASED NOISE POWER

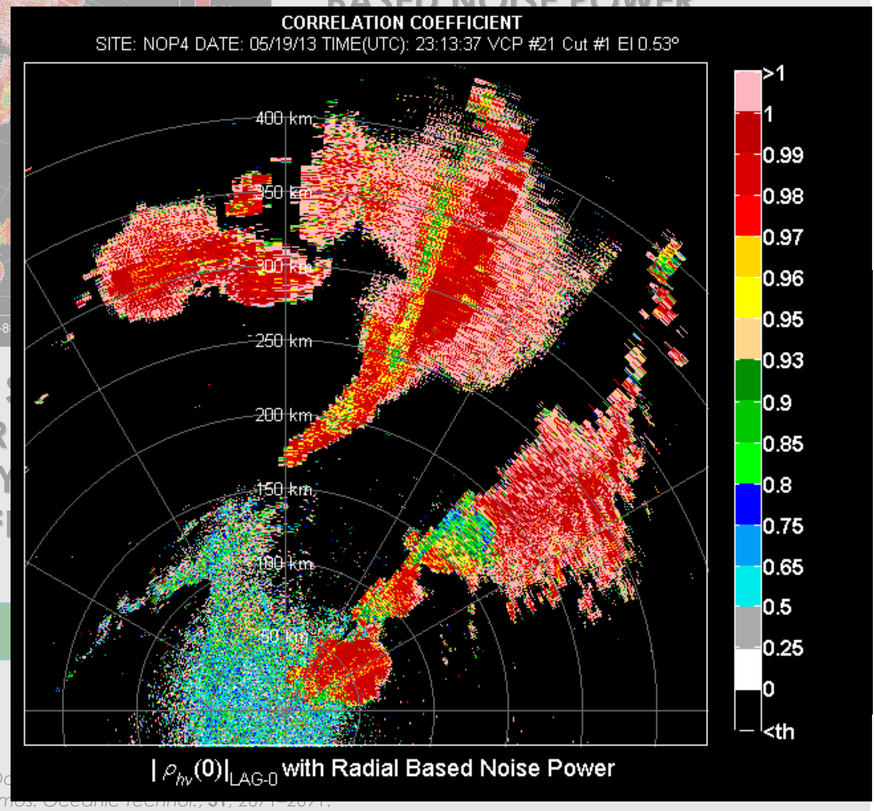
…LEGACY PROCESSING

RADIAL BASED NOISE POWER (RBNE) + LEGACY ESTIMATOR

…BINS WHER…
…IVALID BY…
…APLES F…
…TH.



Reflectivity with Radial Based Noise Power



$|\rho_{hv}(0)|_{LAG\text{-}0}$ with Radial Based Noise Power

…tmos. Oceanic Technol., **30**, 2737-2753.
…f the Correlation Coefficient on Dual-Polarization Weather Radars. *J. Atmos. Oc…*
…Effects of Radial-Based Noise Power Estimation on Spectral Moment Estimates. *J. Atmos. Oceanic Technol.*, **31**, 2671-2691.

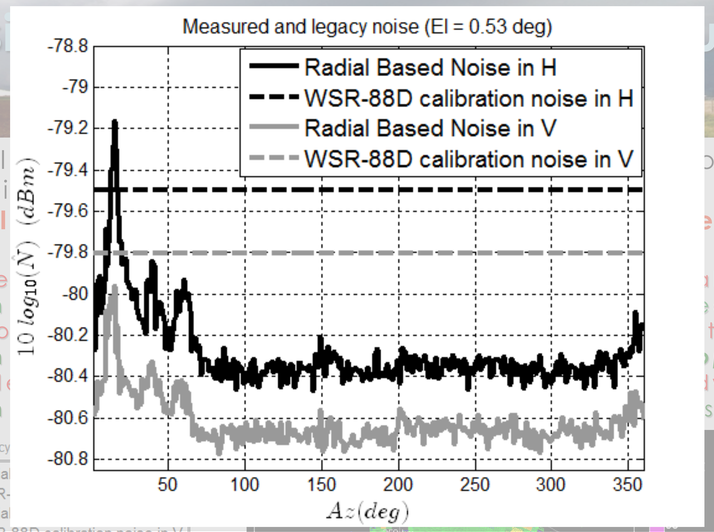
Increasi…ual-polarization upgrade by improving the quality of correlation coefficient

- The correl…
  - The bi…
- The correl…
- There are …
  - Mismeasure…
    - ✓ Can…
  - Inherent po…
    - ✓ Can…
  - Standard d…
    - ✓ Can…

…ometeor classification (HCA) and tornado debris recognition.

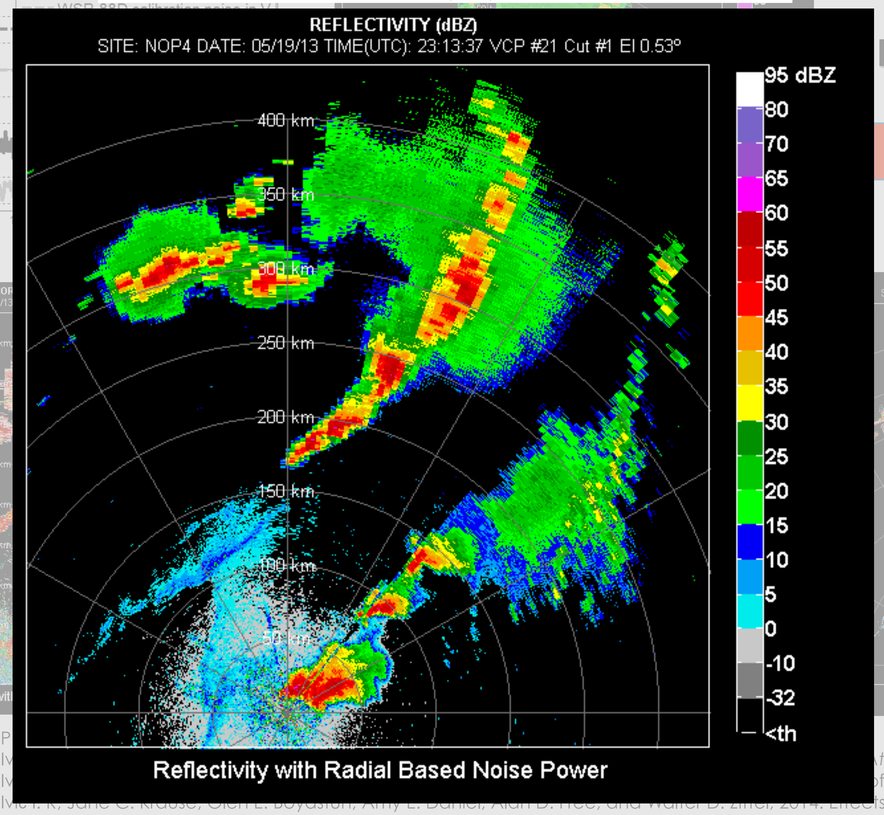
…en larger than one (i.e., invalid).

…l channels.
…ed noise power estimator (RBNE) ***developed at NSSL. This technique has been implemented in operations.***
…timator.
…***oped at NSSL. This technique is tasked to be implemented in operations.***
…dwell is small).
…s (M) used to produce estimates at bins with invalid values.



PROCESS USING LEGACY ESTIMATOR AND RADIAL BASED NOISE POWER

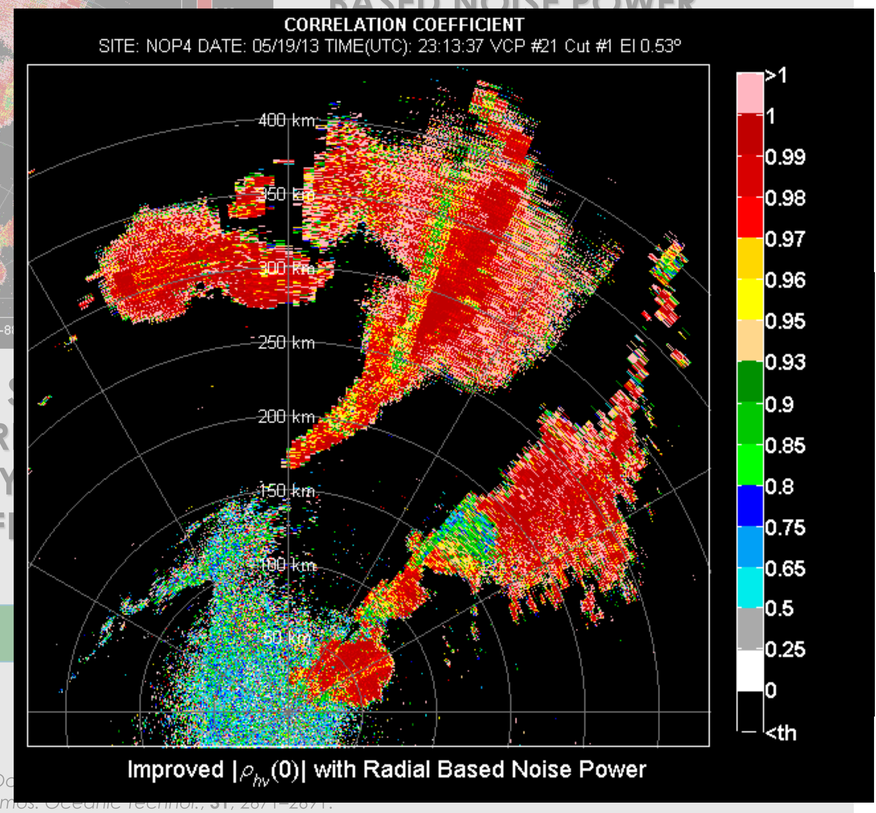
…LEGACY PROCESSING



Reflectivity with Radial Based Noise Power

RADIAL BASED NOISE POWER (RBNE) + IMPROVED ESTIMATOR

BINS WHER… …IVALID BY… …APLES F… …ITH.



Improved $|\rho_{hv}(0)|$ with Radial Based Noise Power

…tmos. Oceanic Technol., **30**, 2737-2753.
…f the Correlation Coefficient on Dual-Polarization Weather Radars. *J. Atmos. Oc…*
…Ivić I. R., Jane C. Krause, Glen E. Boyston, Amy E. Buriel, Alan D. Free, and Walter D. Zittel, 2014: Effects of Radial-Based Noise Power Estimation on Spectral Moment Estimates. *J. Atmos. Oceanic Technol.*, **31**, 2671–2677.

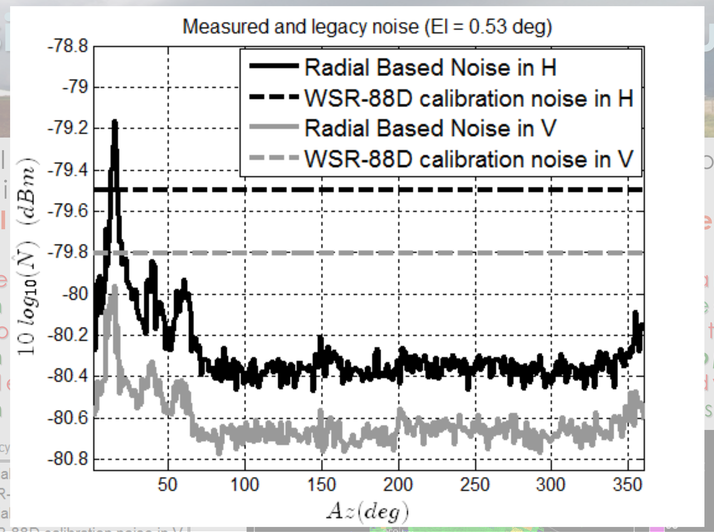
Increasi…ual-polarization upgrade by improving the quality of correlation coefficient

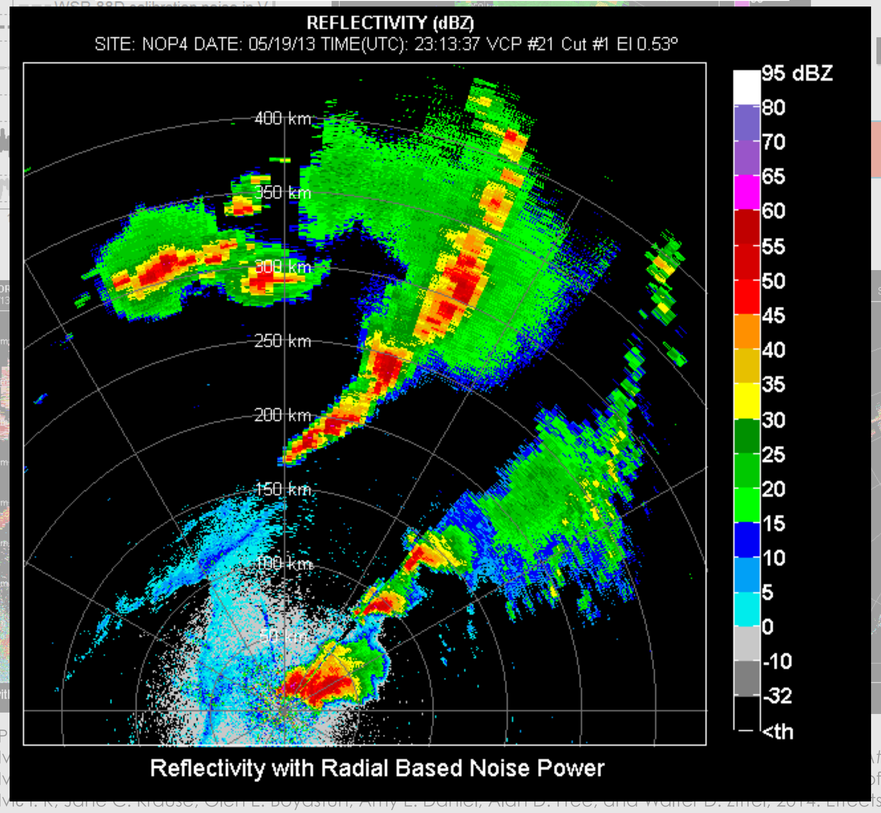
- The correl…
  - The bi…
- The correl…
- There are …
  - Mismeasure…
    - ✓ Can…
  - Inherent po…
    - ✓ Can…
  - Standard d…
    - ✓ Can…

…ometeor classification (HCA) and tornado debris recognition.

…en larger than one (i.e., invalid).

…l channels.
…ed noise power estimator (RBNE) ***developed at NSSL. This technique has been implemented in operations.***
…timator.
…***oped at NSSL. This technique is tasked to be implemented in operations.***
…dwell is small).
…s (M) used to produce estimates at bins with invalid values.

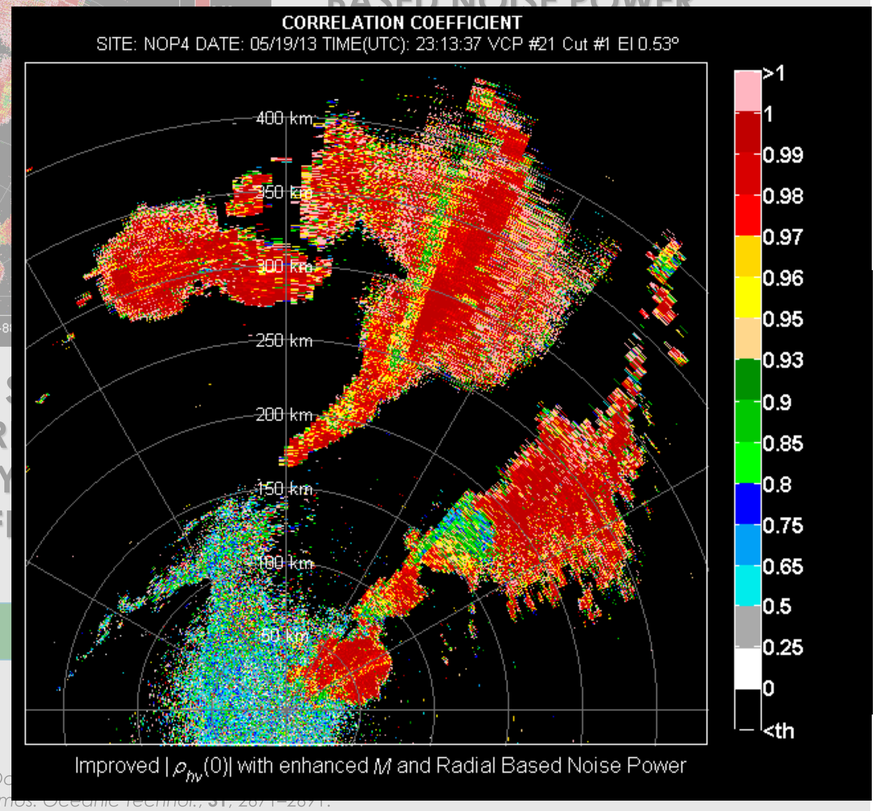




RADIAL BASED NOISE POWER (RBNE)
+
IMPROVED ESTIMATOR
+
ENHANCE SAMPLE SIZE (*M*)

PROCESS USING LEGACY ESTIMATOR AND RADIAL BASED NOISE POWER

BINS WHER… IVALID BY… APLES F… TH.



…tmos. Oceanic Technol., **30**, 2737-2753.
…f the Correlation Coefficient on Dual-Polarization Weather Radars. *J. Atmos. Oc…*
…ts of Radial-Based Noise Power Estimation on Spectral Moment Estimates. *J. Atmos. Oceanic Technol.*, **31**, 2871–2871.

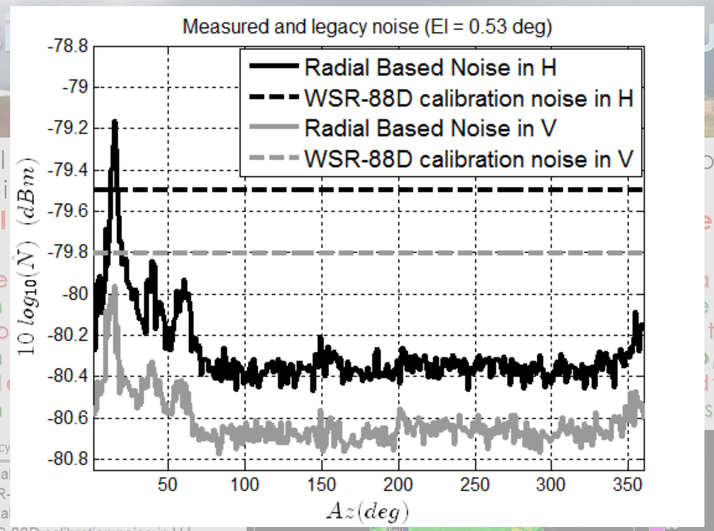
Increasi…ual-polarization upgrade by improving the quality of correlation coefficient

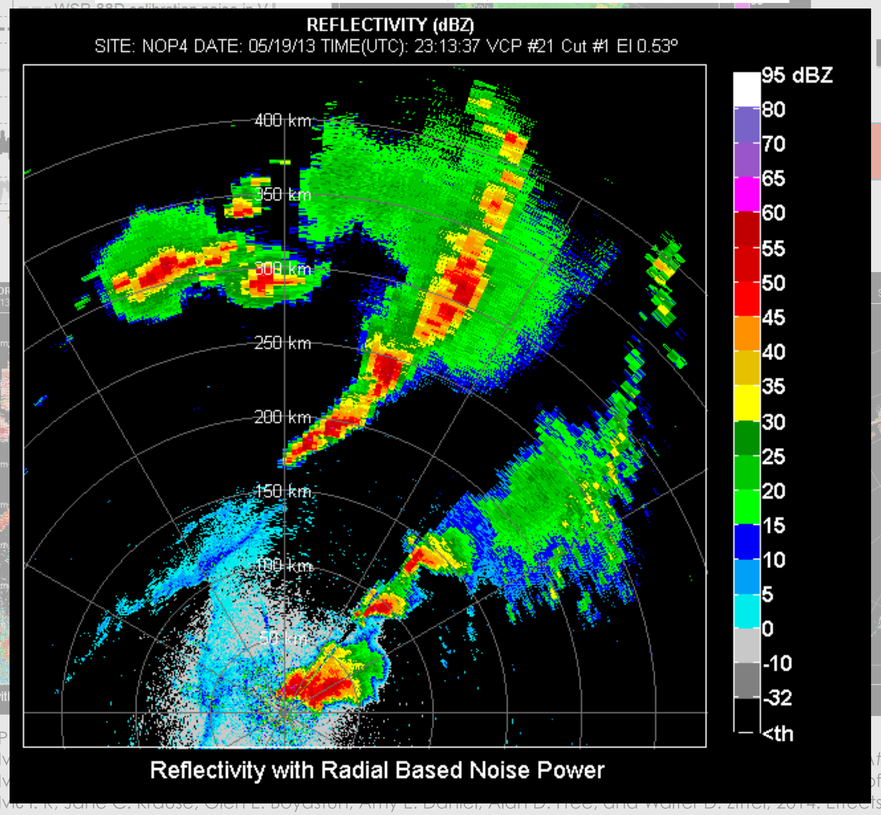
- The correl…
  - The bi…
- The correl…
- There are …
  - Mismeasure…
    - ✓ Can…
  - Inherent po…
    - ✓ Can…
  - Standard d…
    - ✓ Can…

…ometeor classification (HCA) and tornado debris recognition.

…en larger than one (i.e., invalid).

…l channels.
…ed noise power estimator (RBNE) ***developed at NSSL. This technique has been implemented in operations.***
…timator.
…***oped at NSSL. This technique is tasked to be implemented in operations.***
…dwell is small).
…s (M) used to produce estimates at bins with invalid values.





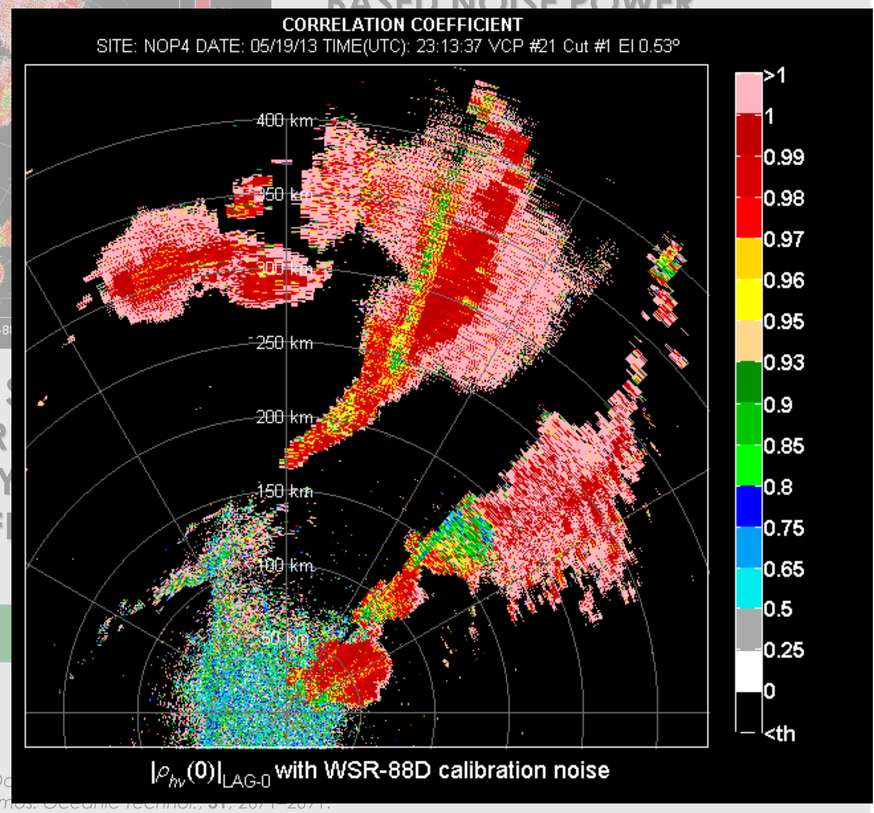
Reflectivity with Radial Based Noise Power

PROCESS USING LEGACY ESTIMATOR AND RADIAL BASED NOISE POWER

LEGACY PROCESSING

LEGACY PROCESSING (LEGACY WSR-88D NOISE CALIBRATION + LEGACY ESTIMATOR)

BINS WHER… IVALID BY… APLES F… TH.



$|\rho_{hv}(0)|_{LAG-0}$ with WSR-88D calibration noise

…tmos. Oceanic Technol., **30**, 2737-2753.
…f the Correlation Coefficient on Dual-Polarization Weather Radars. *J. Atmos. Oc…*
Ivić I. R., Jane C. Krause, Glen E. Boyston, Amy E. Buriel, Alan D. Free, and Walter D. Zittel, 2014: Effects of Radial-Based Noise Power Estimation on Spectral Moment Estimates. *J. Atmos. Oceanic Technol.*, **31**, 2671–2677.