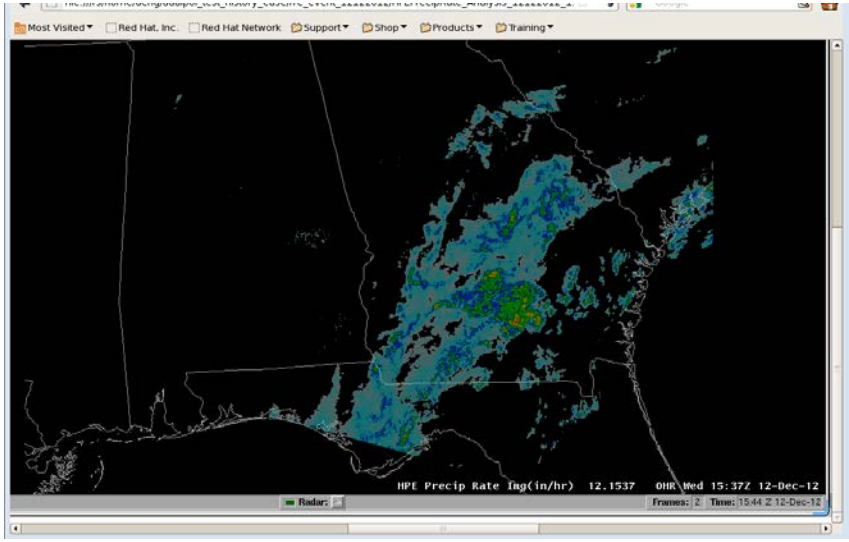
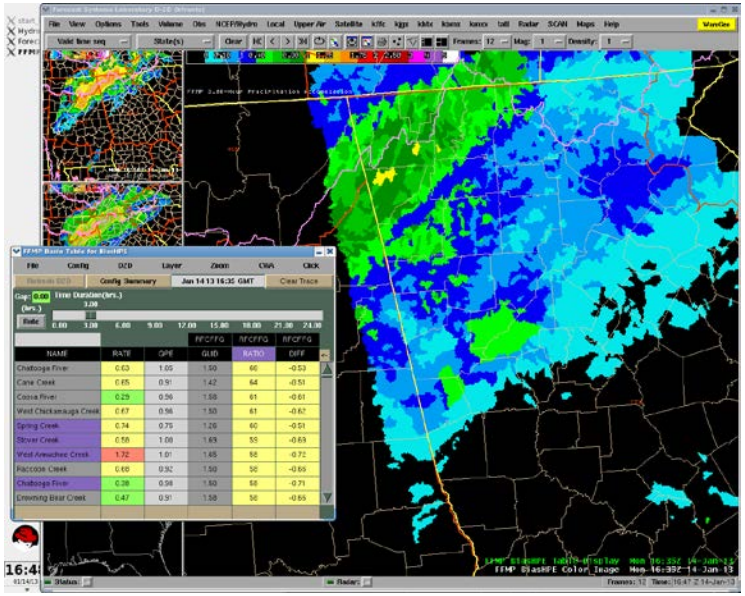
Dual-Pol Update to HPE/HPN





Kent Frantz, Richard Black: *WFO FFC*

Jingtao Deng, Chip Gobs, Alan Harmon,

David Kitzmiller, Dennis Miller, Dan Stein, Paul Tilles: *OHD*

Ed Clark: *HSD*

February 15, 2013

Landline telecon number appears in webinar control screen

Dual-Pol Update to HPE/HPN
Topics for Today:

- Upgrading High-Resolution Precipitation Estimator (HPE) and High-Resolution Precipitation Nowcaster (HPN) to ingest dual-polarization products
- Purpose of field tests
- Documenting results
- Field tester impressions and advice

Landline telecon number appears in webinar control screen

History I:

- Dual-polarization upgrades to WSR-88D now nearly complete
- AWIPS hydro apps not upgraded for dual pol yet:
  - Constraints on OHD resources
  - Need to get existing MPE/HPE into AWIPS II
  - Higher priority projects – ie HEFS
- Chose AWIPS I for initial development/testing:
  - Very limited AWIPS II development capability
  - Uncertainties in AWIPS II deployment and transition

Landline telecon number appears in webinar control screen

History II:

- Completed field tests of AWIPS I upgrade to MPE in 2012 (SERFC, OHRFC)
- Field tests of HPE at WFO Peachtree City
  - Started November 2012
- Plans for upgrading AWIPS II entered with SREC
- Not assigned to AWIPS build; estimate 2014

Development Activity:

- Carried out in AWIPS I to date
- Adapted existing decoders for:
  - Dual-pol digital precipitation rate product (DPR)
  - Dual-pol storm-total precipitation product (DSA)
- Developed remapping software
- Dual-pol gauge/radar bias tables and fields
- Updated HPE with new database tables
- Introduced toggles to switch between dual-pol and single-pol inputs
- Introduced toggle for local/mean field bias correction

Field Test Goals – To Verify:

- Proper decoding/remapping
- Proper generation of DP based products
- Toggling between single-pol and dual-pol modes
- Connectivity with MPE (bias tables)
- Connectivity with FFMP-A
- Acceptable impact on overall system performance

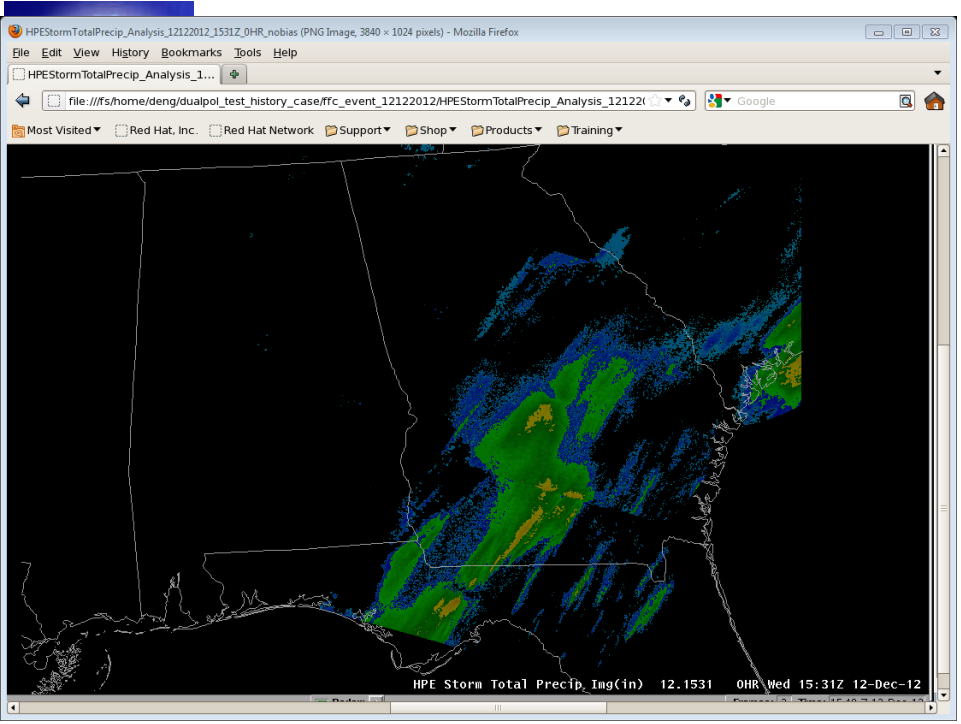
Field Test Site: Peachtree City GA

- *Single-Pol and Dual-Pol 1HR and Storm Total radar products in AWIPS are used in heavy rain detection.*
- *<u>Six</u> Single-Pol radars are ingested into FFMP-A. They are KFFC, KJGX, KHTX, KGSP, KBMX and KMRX. The ORPG Bias is set to "True" at KFFC and KJGX. Dual-Pol radars are not used yet.*
- *FFC CWA - 96 counties or 32,250 sq. miles*
  BMX CWA - 39 counties or 28,318 sq. miles
  MRX CWA - 40 counties or 16,439 sq. miles

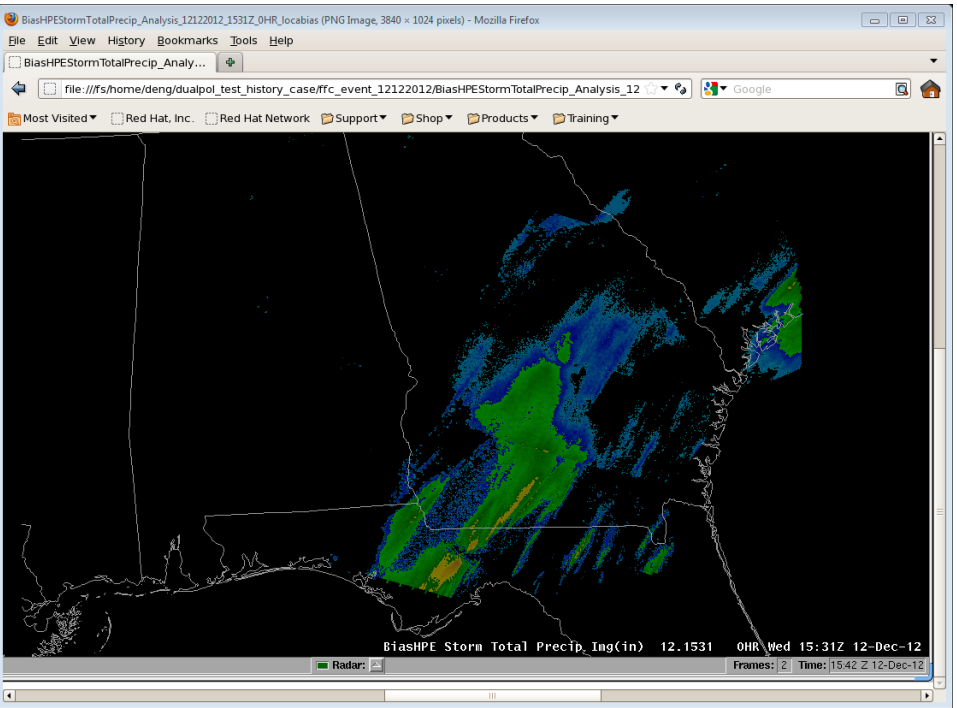
HPE Products:

- Choice of:
  - Single-pol rainfall rate mosaics w/wo bias correction
  - Dual-pol precip rate mosaics w/wo bias correction
- Choice of:
  - 1-h single pol accumulations
  - 1-h dual pol accumulations
- Bias correction choices:
  - local gauge/radar bias correction factors
  - mean-field bias correction for each input radar
- Did not attempt simultaneous dual- and single-pol mosaic generation – timing constraints
  - MPE generates dual-/single-pol products together
  - MPE has graphical comparison capabilities

Sample HPE

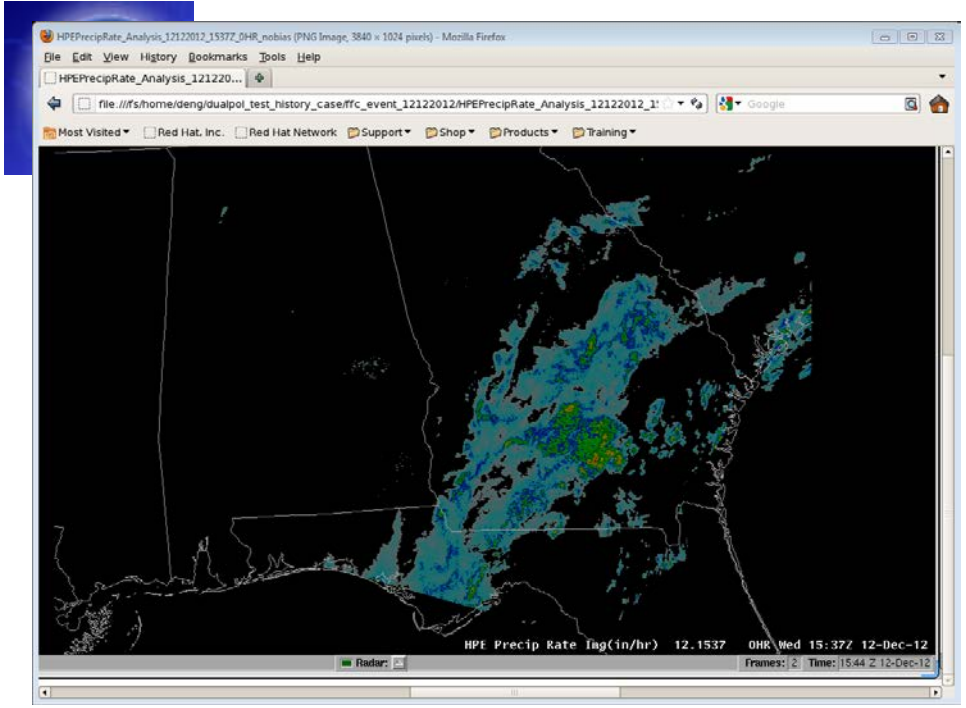


1-H accumulation from dual-pol input

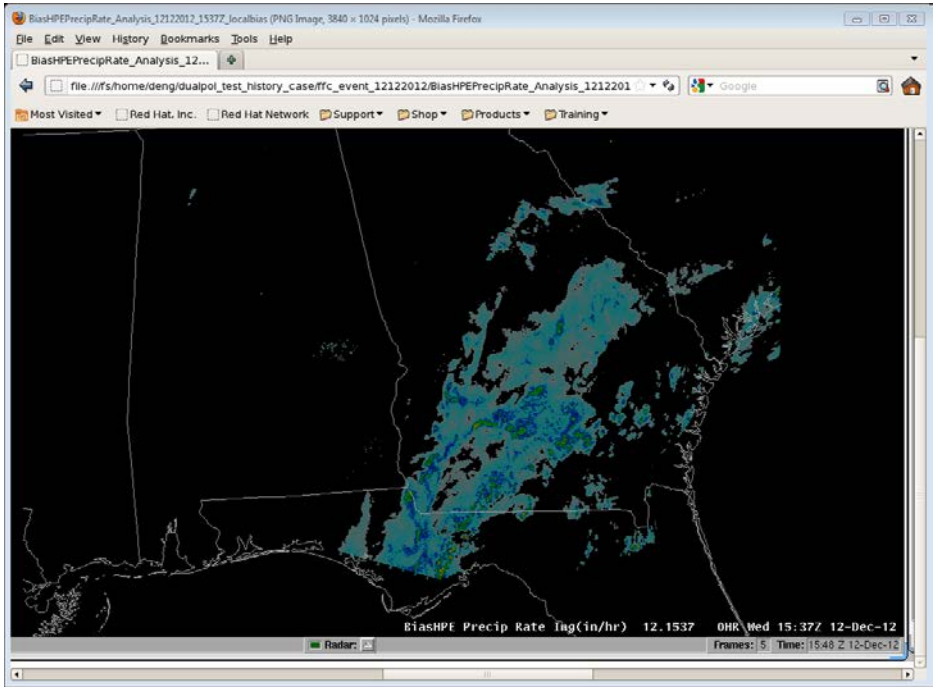


1-H accumulation after bias correction

Sample HPE

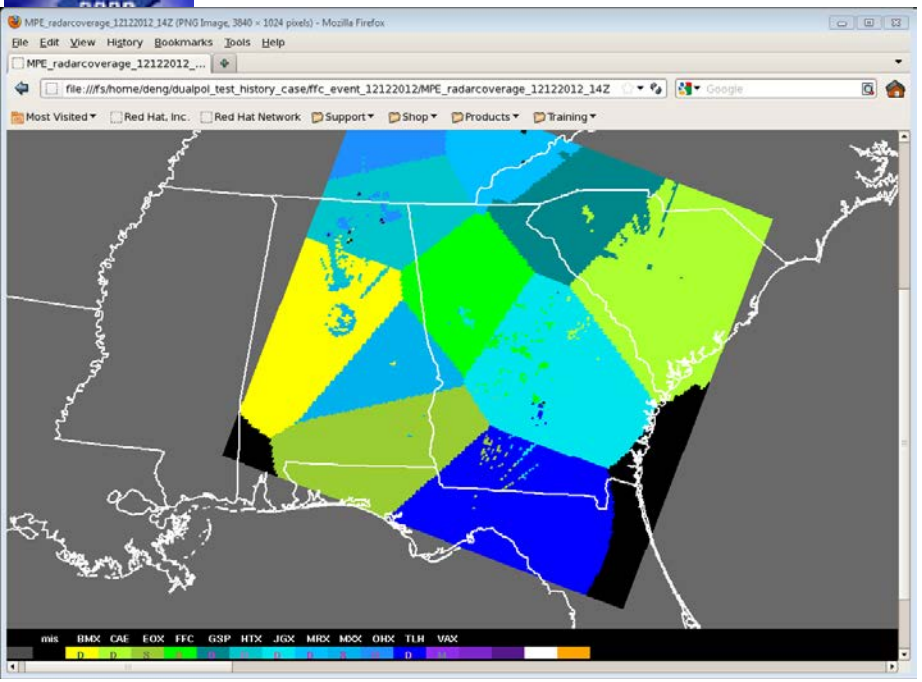


Precip rate from dual-pol input

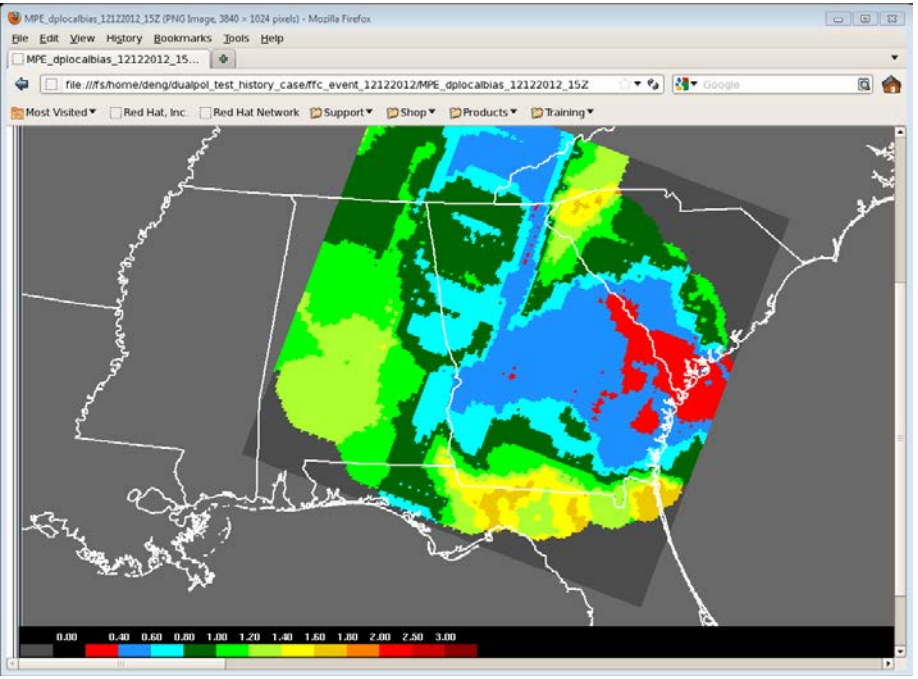


Precip rate after bias correction

MPE input to HPE:



Radar Coverage Map

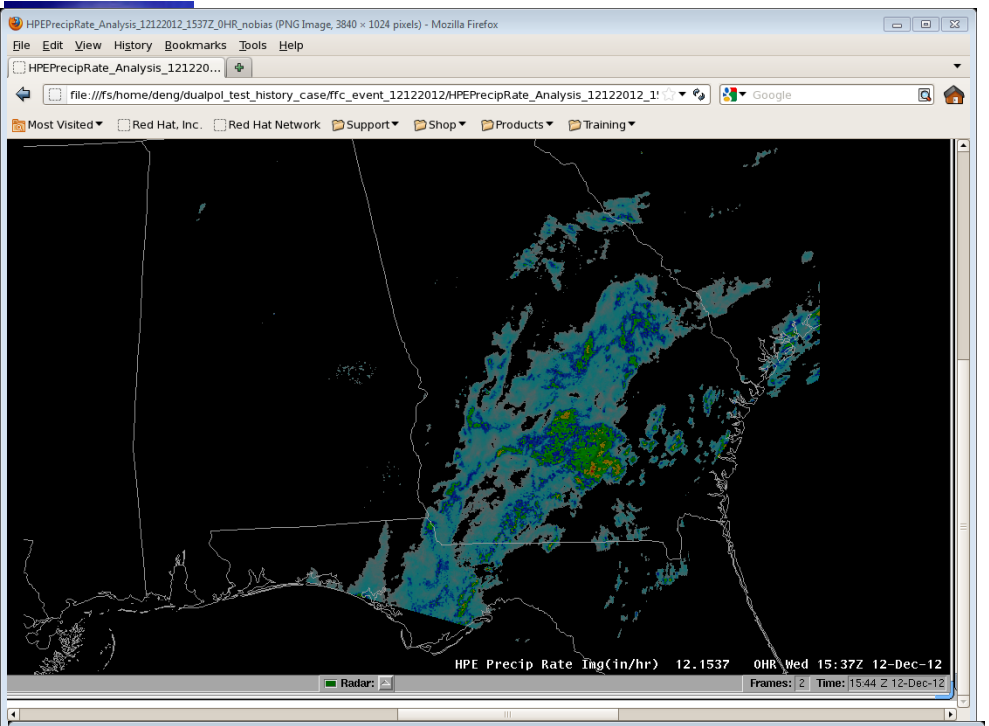


Local gauge/radar bias correction field

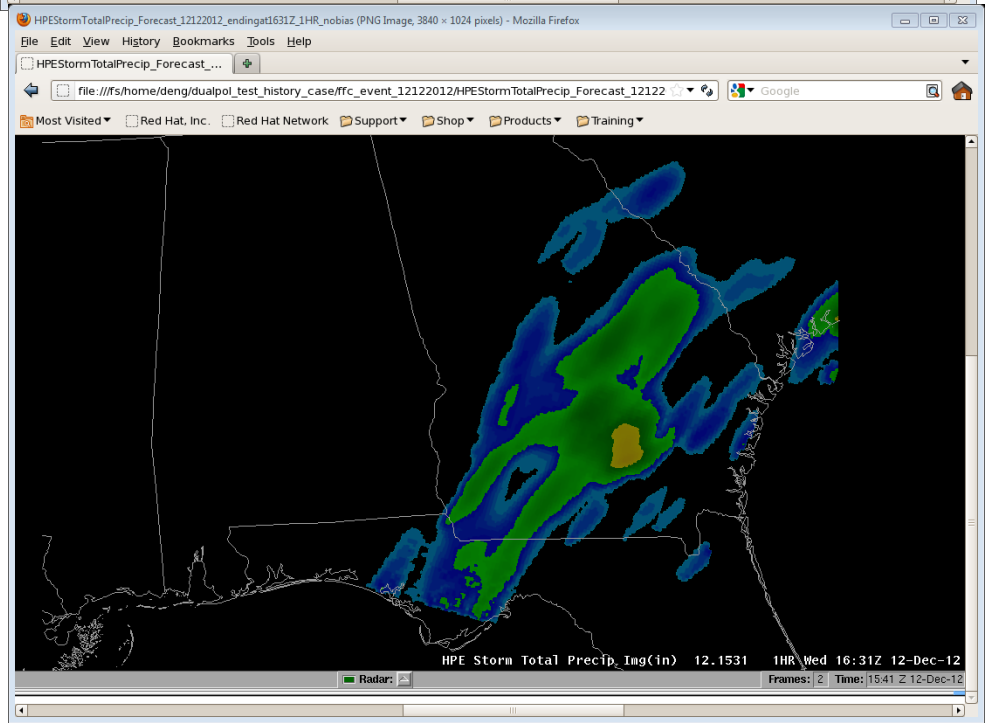
HPN Products:

- Precip rate forecasts:
  - at 15, 30, 45, 60 minute projection
- 1-h precip amount forecasts
- From extrapolation of current precip rate product

Sample HPN



DP initial time precip rate



1-H forecast accumulation

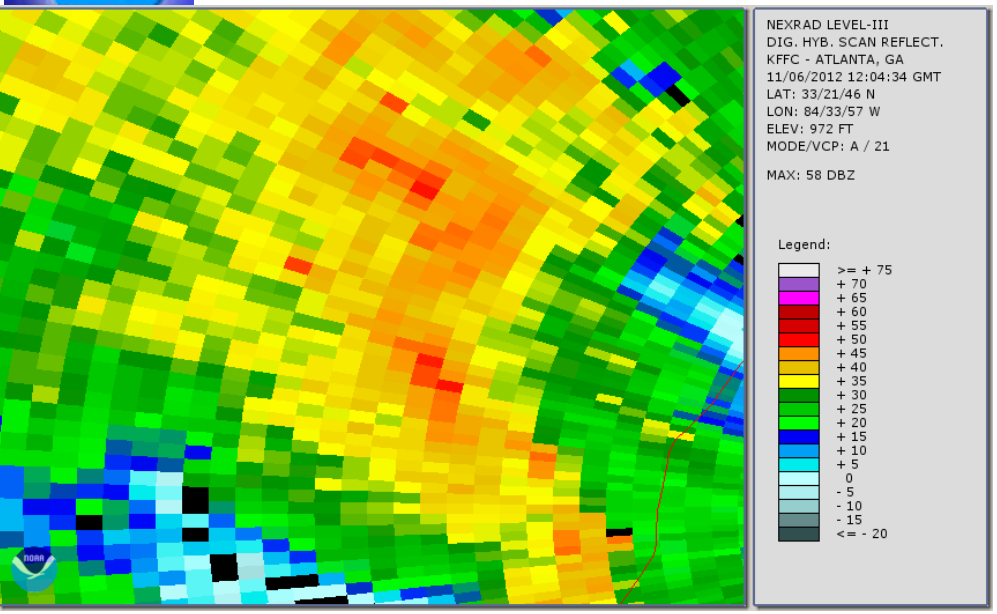
Why Use Dual-Pol?

- Better target identification:
  - Improved filtering of biota and clutter
- Automatic hydrometeor identification
  - Z-R relationships vary greatly in time/space
  - Delineation of warm rain regimes
- Consistent improvement over single-pol QPE
  - Best seen in warm season and close to radar
  - Confirmed by NSSL/ROC/OHD verification

Caveats on Use of Dual-Pol

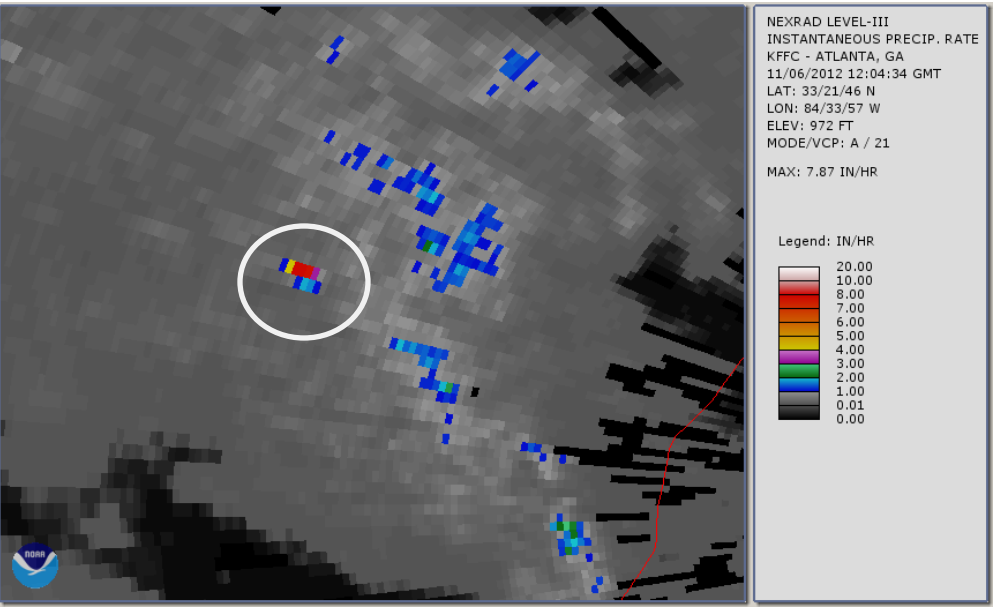
- QPE under melting layer and dry snow:
  - Clear differences in accumulation w/r to range
  - Problems also exist with single-pol
- Problems with ground targets still exist
  - Wind farms, highways still a problem
  - Some new targets that didn't appear with horizontal polarization

Spurious point accumulation?



Higher magnification: DHR shows nothing unusual

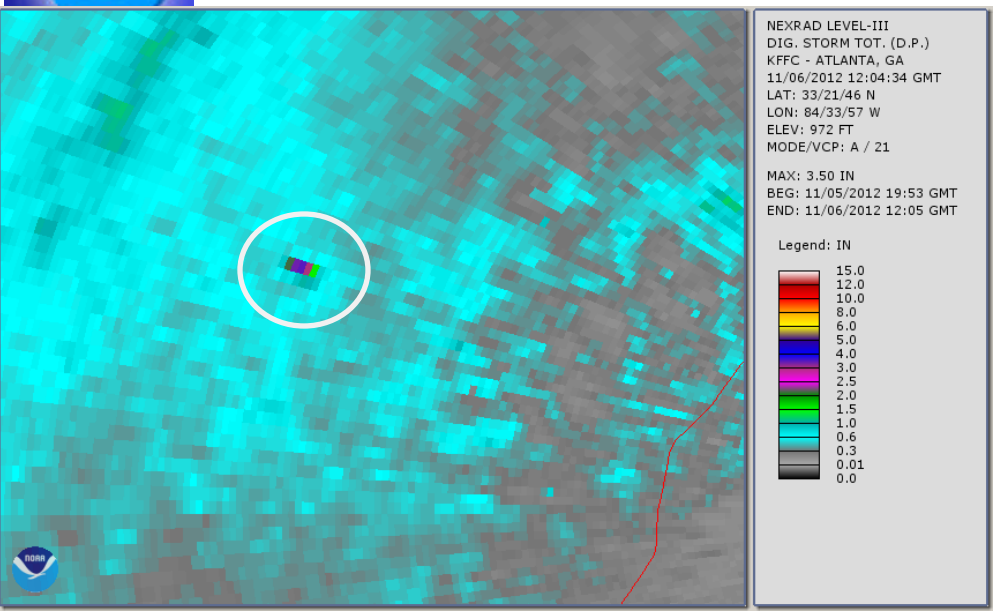
Single-Pol



1206 UTC: DPR shows the small sector of high accumulations

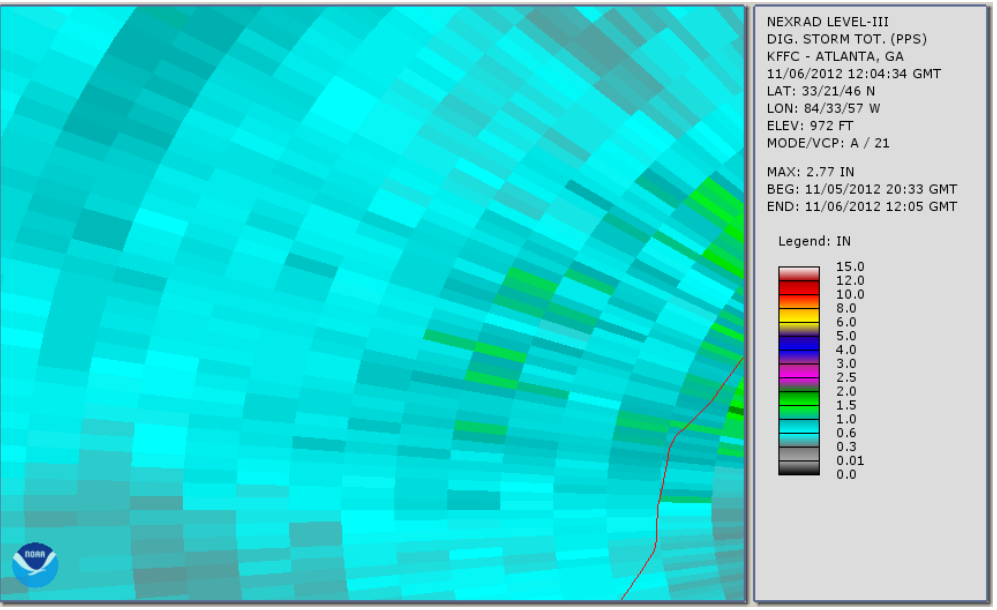
Dual-Pol

Spurious point accumulation?



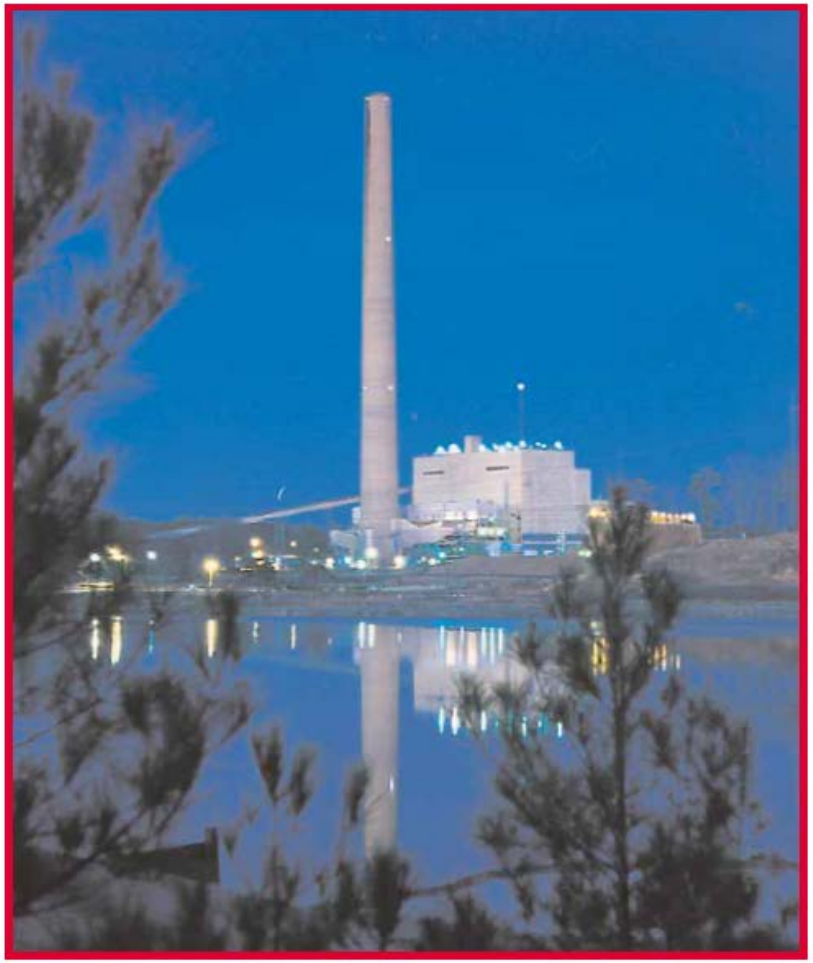
Higher magnification: DSA
1104 UTC: Max value 1.60”

Dual-Pol



1206 UTC: corresponding DSP shows nothing unusual. There were some higher accumulations to the northwest of this sector of the umbrella, hence 2.77” max.

Single-Pol



ROC staff identified a stack in that spot

FFC staff located a power plant

Tall, thin target doesn’t register in horizontal pol

Similar new targets might appear elsewhere

Field Tester Impressions

- *Operating mode – opened 3 separate FFMP-As on one workstation with KFFC DHR input, HPE input and BiasHPE input.*
- *There was no degradation of the system performance at the workstation.*
- *The FFMP-A performed as designed by automatically matching up the images on the separate screens. Still needed to manually adjust the time duration on the tables to match.*

Why Use HPE?

- Some CWAs are best covered by multiple radars
  - A portion of the area is closer to a radar other than the central one – or -
  - The area is so large that multiple radars must be used
- About 30% of CONUS WFOs could benefit
- HPE needed to execute 1-h nowcast (HPN)

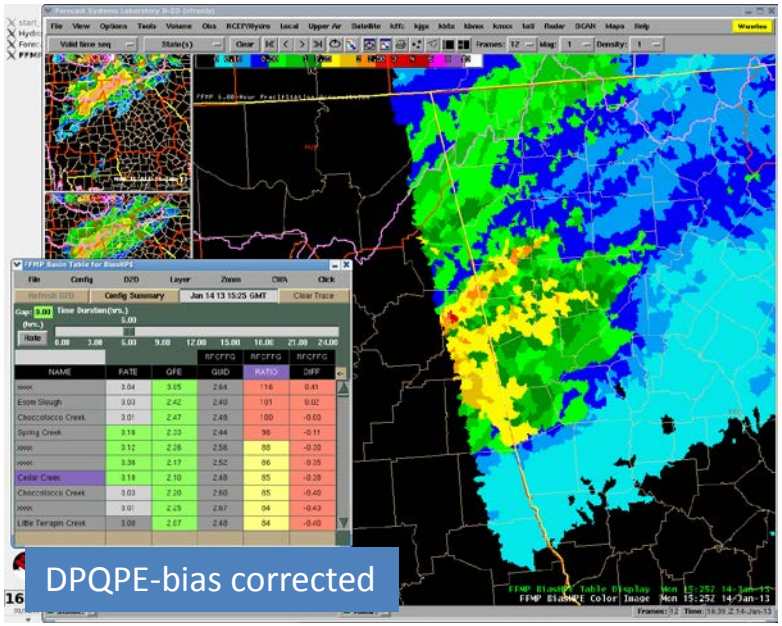
Effects of HPE ~1x1km grid vs. DHR 1°x1km mesh

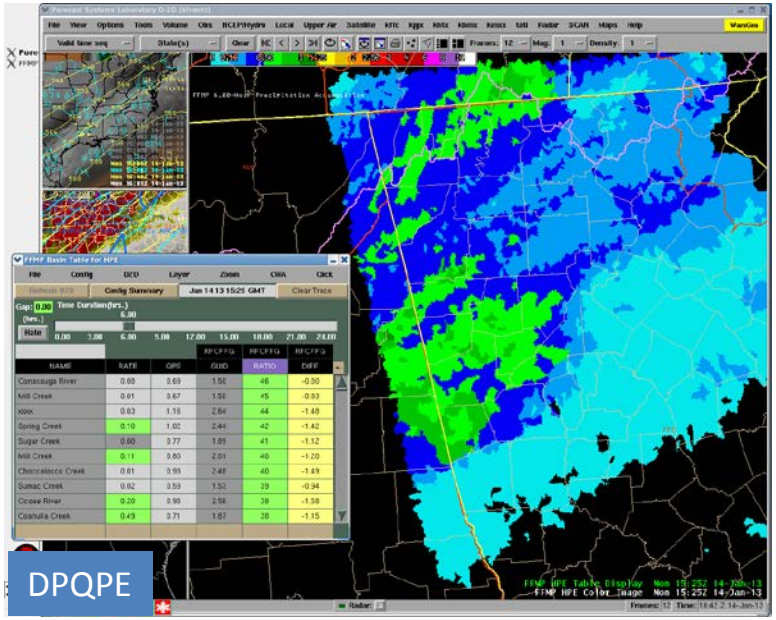
- Near the radar, DHR product has finer mesh than HPE
- HOWEVER:
  - For precip accumulations, very fine grid lowers gauge-radar correlation
  - Apparently due to temporal sampling gaps
  - PPS (and NMQ) assume linear change in rainrate with time over a point in space
  - Not realistic in heavy precip
- Therefore, expect no loss of accumulation accuracy with HPE, relative to DHR

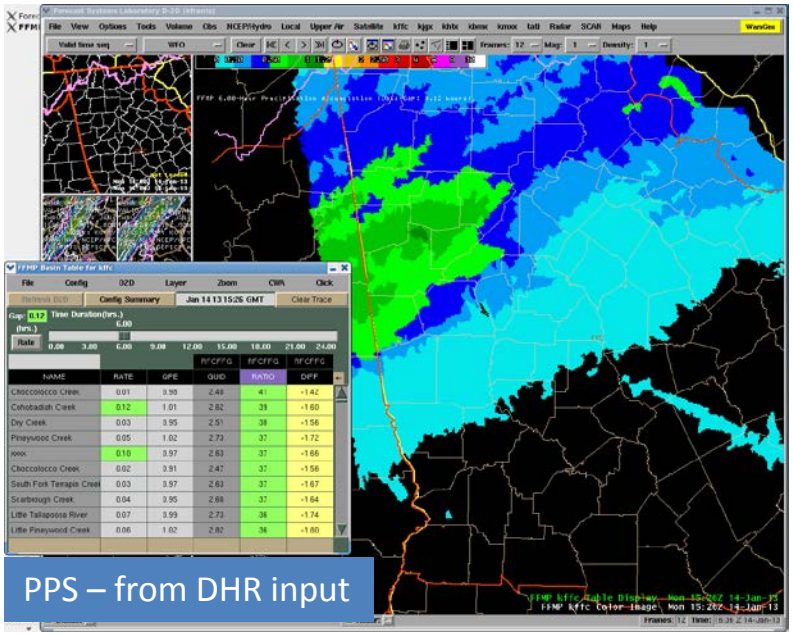
Testing Dual-Pol HPE into FFMP-A

- Verify that the Flash-Flood Monitoring and Prediction (Advanced) system correctly ingests products from the upgraded DP-HPE
- Run within AWIPS-I system at WFO Peachtree City
- Results are for the event of 13-15 January 2013
- Rain caused some flooding over northern Georgia
- Graphics show 6-h, 3-h, and 1-h accumulations
- DP-HPE run with local gauge/radar bias correction

6-h Accumulations Ending 1525 UTC, 14 Jan 2013

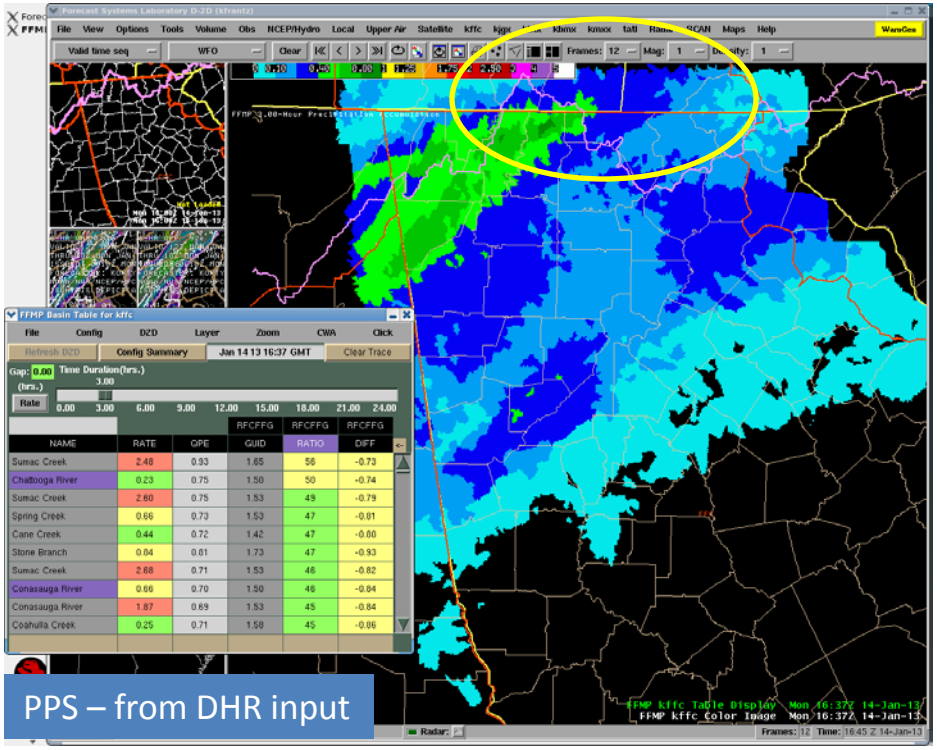




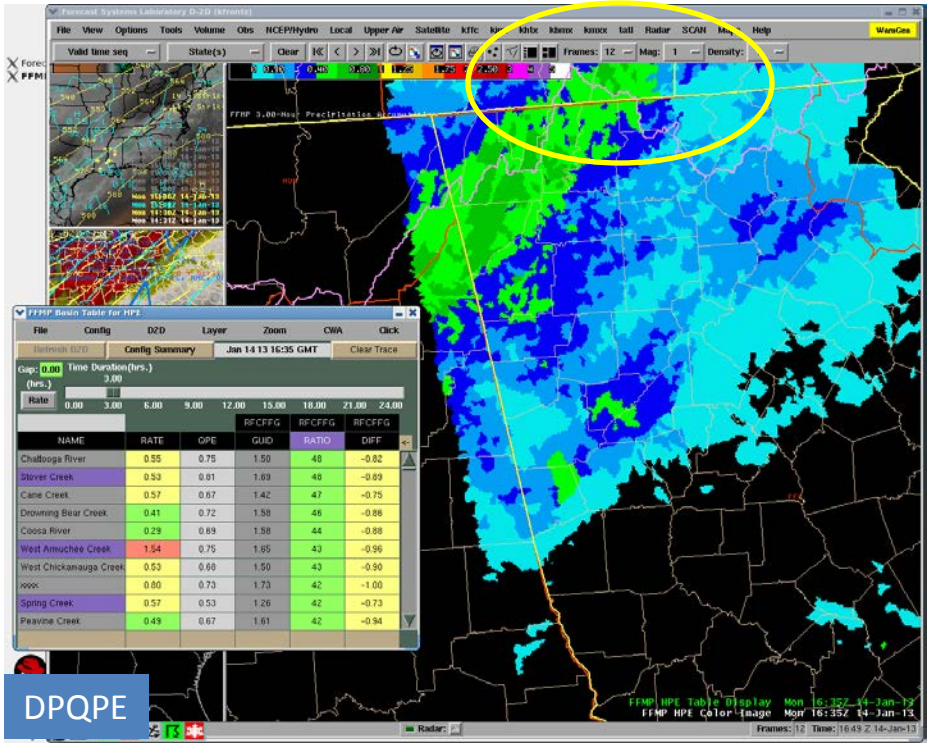


3-h Accumulations Ending 1635 UTC, 14 Jan 2013

Use of mosaic mitigates range-dependent artifacts

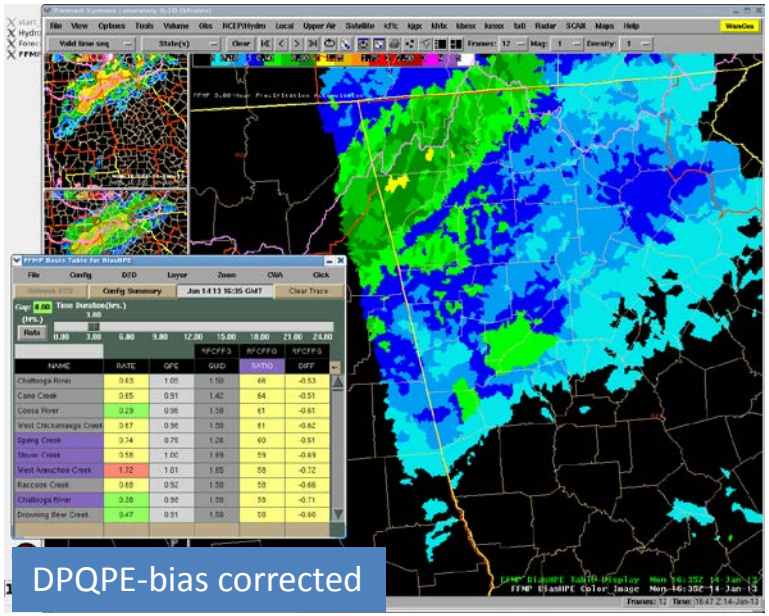


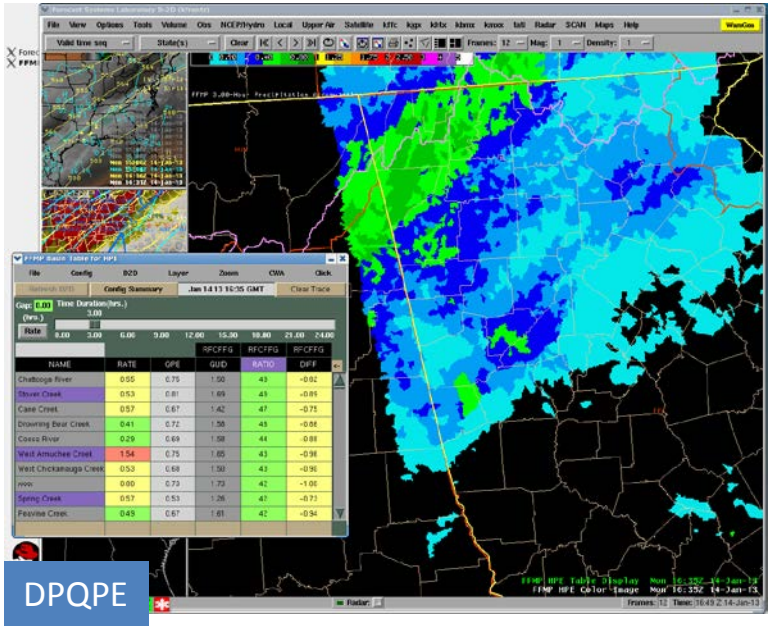
PPS – from DHR input

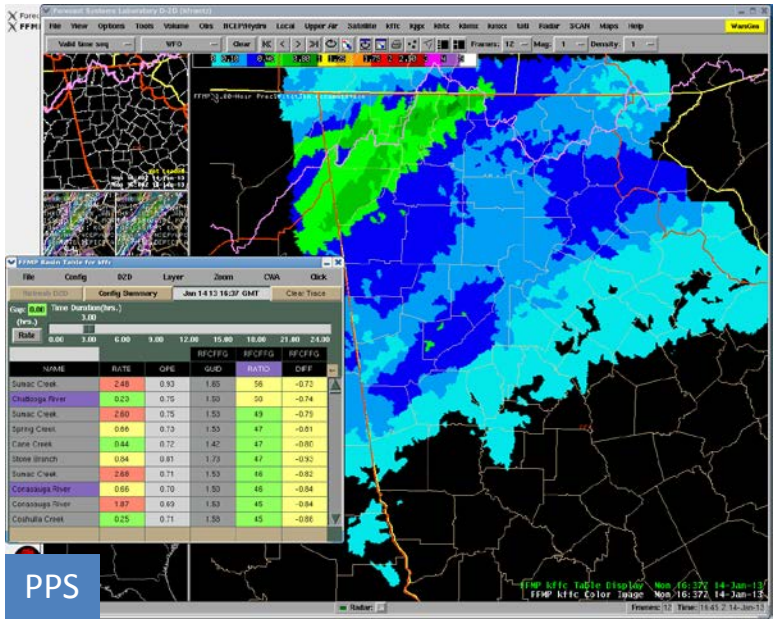


DPQPE

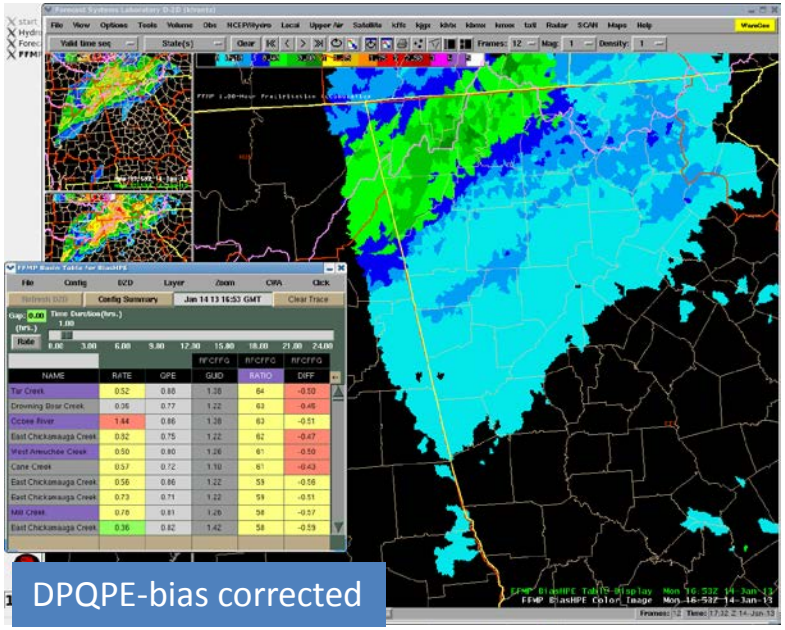
3-h Accumulations Ending 1635 UTC, 14 Jan 2013

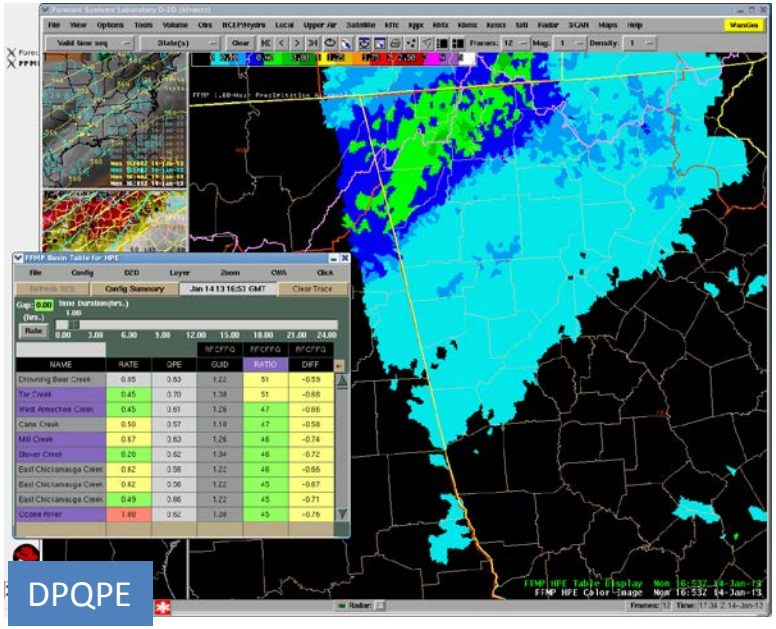


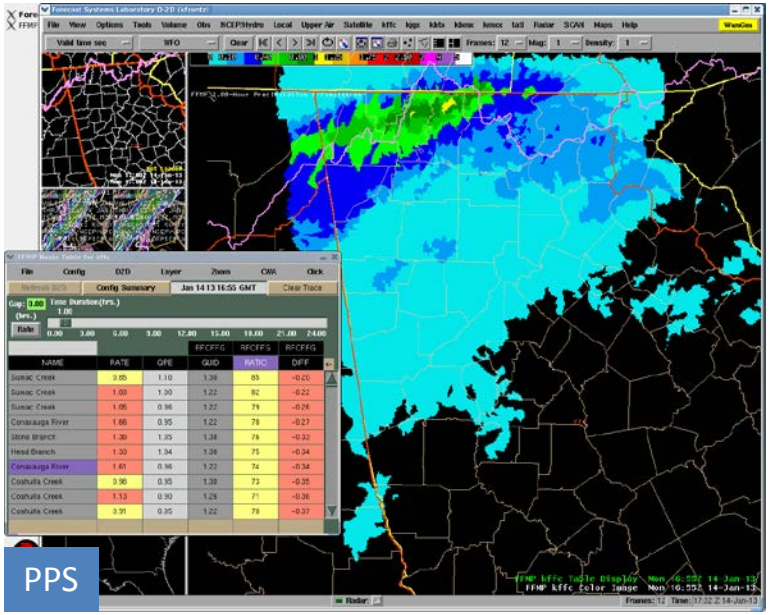




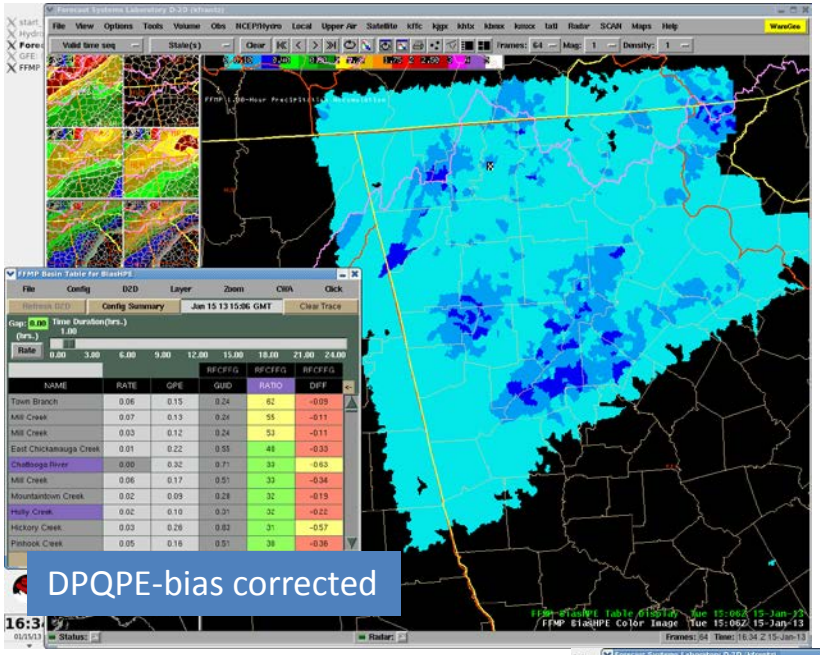
1-h Accumulations Ending 1653 UTC, 14 Jan 2013

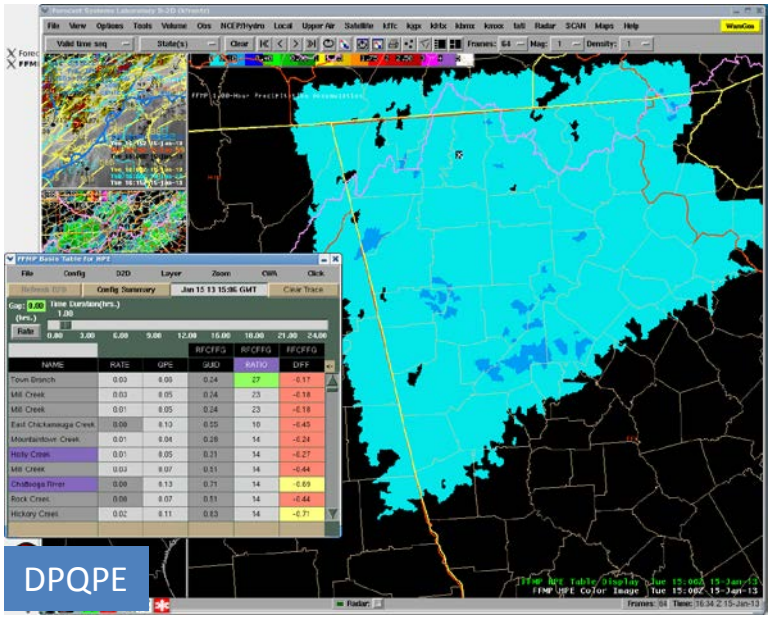


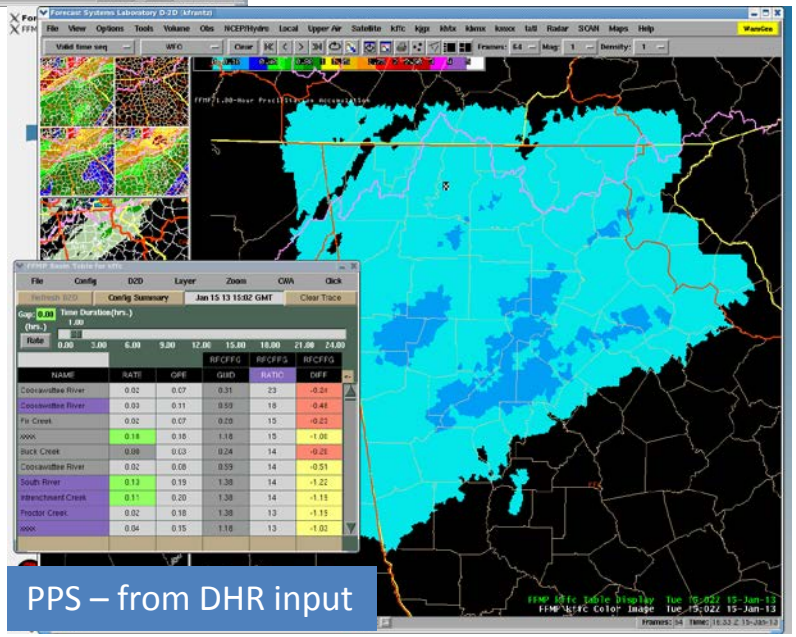




FFMP-A demonstration with dual-pol HPE input
1-h Accumulations Ending 1506 UTC, 15 Jan 2013







Dual-Pol HPE into FFMP-A: Conclusions

- Basin-average accumulations appear to be generated correctly with HPE input
- Interpretation based on:
  - HPE and PPS have similar precipitation coverage area
  - Similar spatial/temporal patterns
- Note only dual-pol or single-pol HPE is generated at one time, for sake of efficiency

Verification and Effects of Gauge/Radar Bias Correction

- Studied two multi-hour events:
  - Jan 13-15th
  - Jan 30-31st
- 1-H and 24-H gauge-radar pairs and graphics from NSSL QVS (http://nmq.ou.edu/qvs-2012.html)
- Radar data from DHR (single-pol) and DPR (dual-pol) data from KFFC

≤ 150 KM RANGE, 0000 UTC 15 JAN

Legacy PPS [source: DHR] vs Gauges

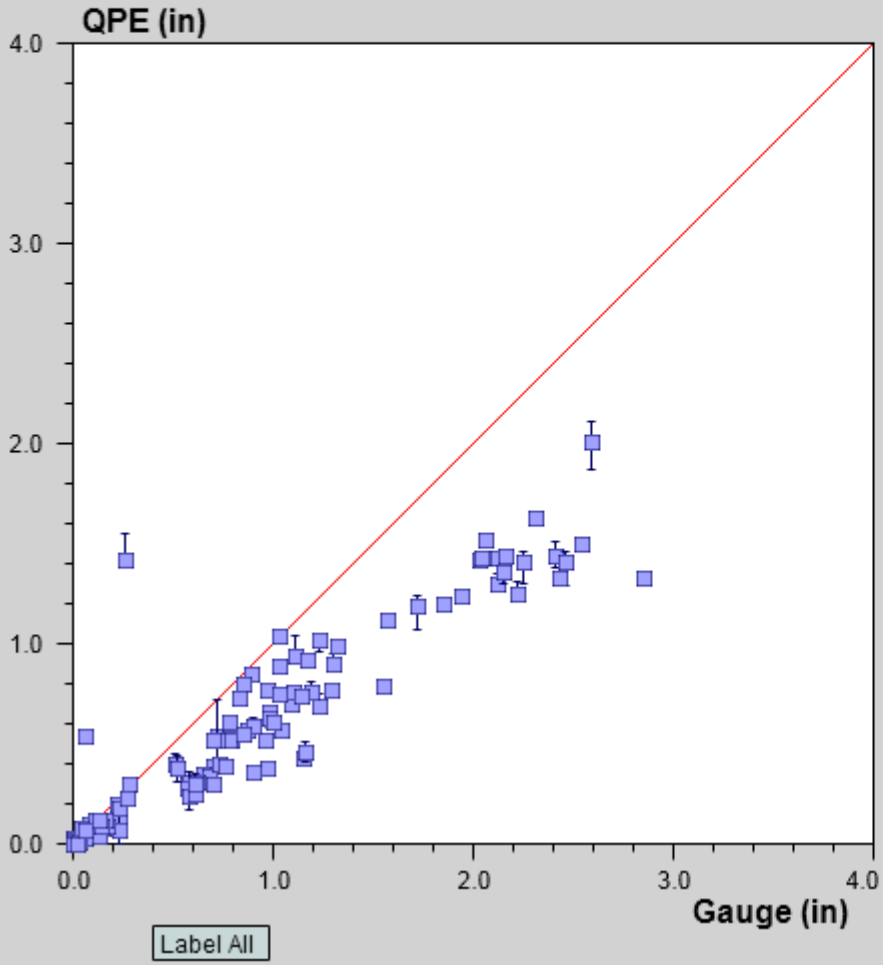
24 hr Accumulation HADS

Valid: 01/15/2013 00:00:00 UTC

KFFC

Q2

Total number Gauge/QPE Pairs:	223
Number removed via manual QC:	6
Number off current plot scale:	0
Number pairs meeting thresholds (N):	132



Statistics

	Min	Avg [SD]	Max	Thresholds Applied Min	Thresholds Applied Max
Gauges:	0.00	0.744 [0.748]	2.85	---	---
QPE:	0.00	0.497 [0.491]	2.01	---	---

Mean Bias (G/R):	1.498	G-R Error Std Dev:	0.329
Additive Bias (G-R):	32.640	Correlation Coeff:	0.942
Mean Error (G-R)/N:	0.247	Fractional Bias:	0.332
Mean Abs Error:	0.276	Fractional RMSE:	0.553
RMSE:	0.412	Fractional Std Dev:	0.443

Contingency Table Functions

Event	POD	FAR	ETS	HSS	PSS
0.10	0.897	0.022	0.643	0.783	0.840
0.25	0.974	0.013	0.910	0.953	0.956
0.50	0.747	0.034	0.523	0.687	0.712
1.00	0.575	0.042	0.466	0.636	0.564

ID	Lat	Long	Gauge	QPE

Azm	Range	Radar		
		KFFC	33.3633	-84.5658

Range Thresholds: Min = 0 km Max = 150 km

Mask: none

Lookup Mode: 3x3

Gauge Accum Completeness: 0 %

35.28

-90.79 -82.58

30.95

≤ 150 KM RANGE, 0000 UTC 15 JAN

Dual Pol QPE [source: DPR] vs Gauges

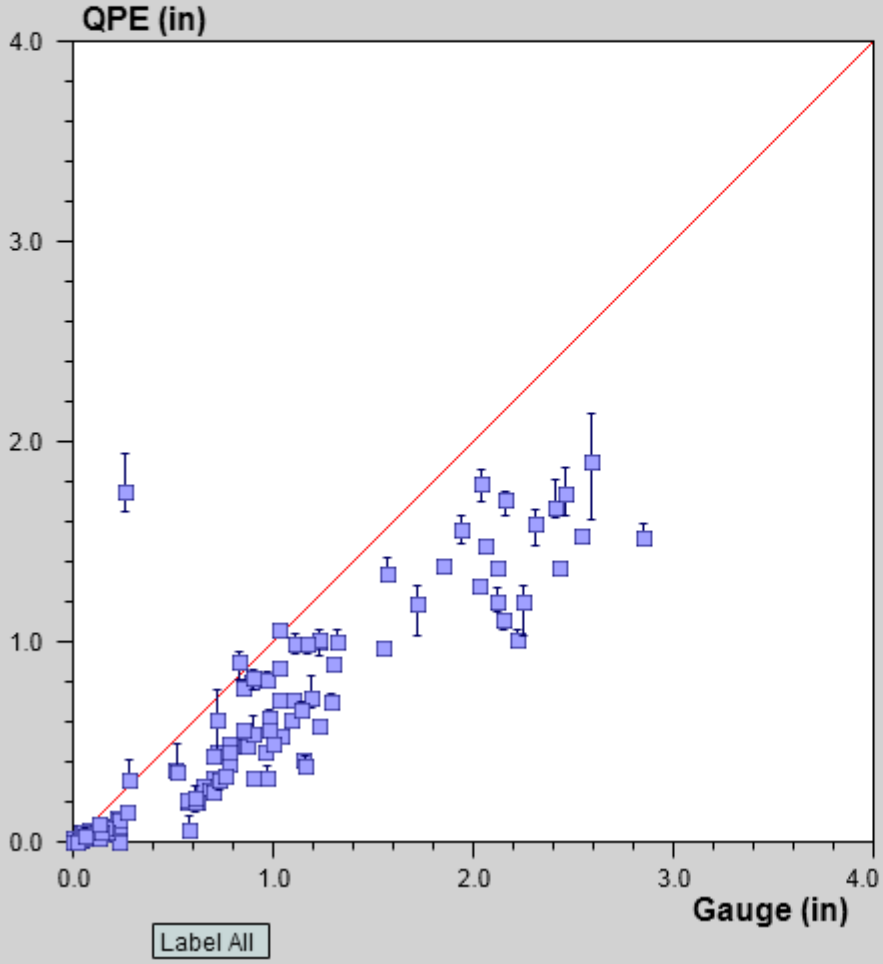
24 hr Accumulation HADS

Valid: 01/15/2013 00:00:00 UTC

KFFC

Q2

Total number Gauge/QPE Pairs:	223
Number removed via manual QC:	6
Number off current plot scale:	0
Number pairs meeting thresholds (N):	131



Statistics

	Min	Avg [SD]	Max	Thresholds Applied Min	Thresholds Applied Max
Gauges:	0.00	0.749 [0.749]	2.85	---	---
QPE:	0.00	0.481 [0.528]	1.90	---	---

Mean Bias (G/R):	1.559	G-R Error Std Dev:	0.334
Additive Bias (G-R):	35.190	Correlation Coeff:	0.920
Mean Error (G-R)/N:	0.269	Fractional Bias:	0.358
Mean Abs Error:	0.294	Fractional RMSE:	0.572
RMSE:	0.429	Fractional Std Dev:	0.446

Contingency Table Functions

Event	POD	FAR	ETS	HSS	PSS
0.10	0.814	0.000	0.533	0.695	0.814
0.25	0.897	0.000	0.780	0.876	0.897
0.50	0.627	0.021	0.402	0.574	0.609
1.00	0.600	0.040	0.491	0.658	0.589

ID	Lat	Long	Gauge	QPE

Azm	Range	Radar		
		KFFC	33.3633	-84.5658

Range Thresholds: Min = 0 km Max = 150 km

Mask: none

Lookup Mode: 3x3

Gauge Accum Completeness: 0 %

35.28

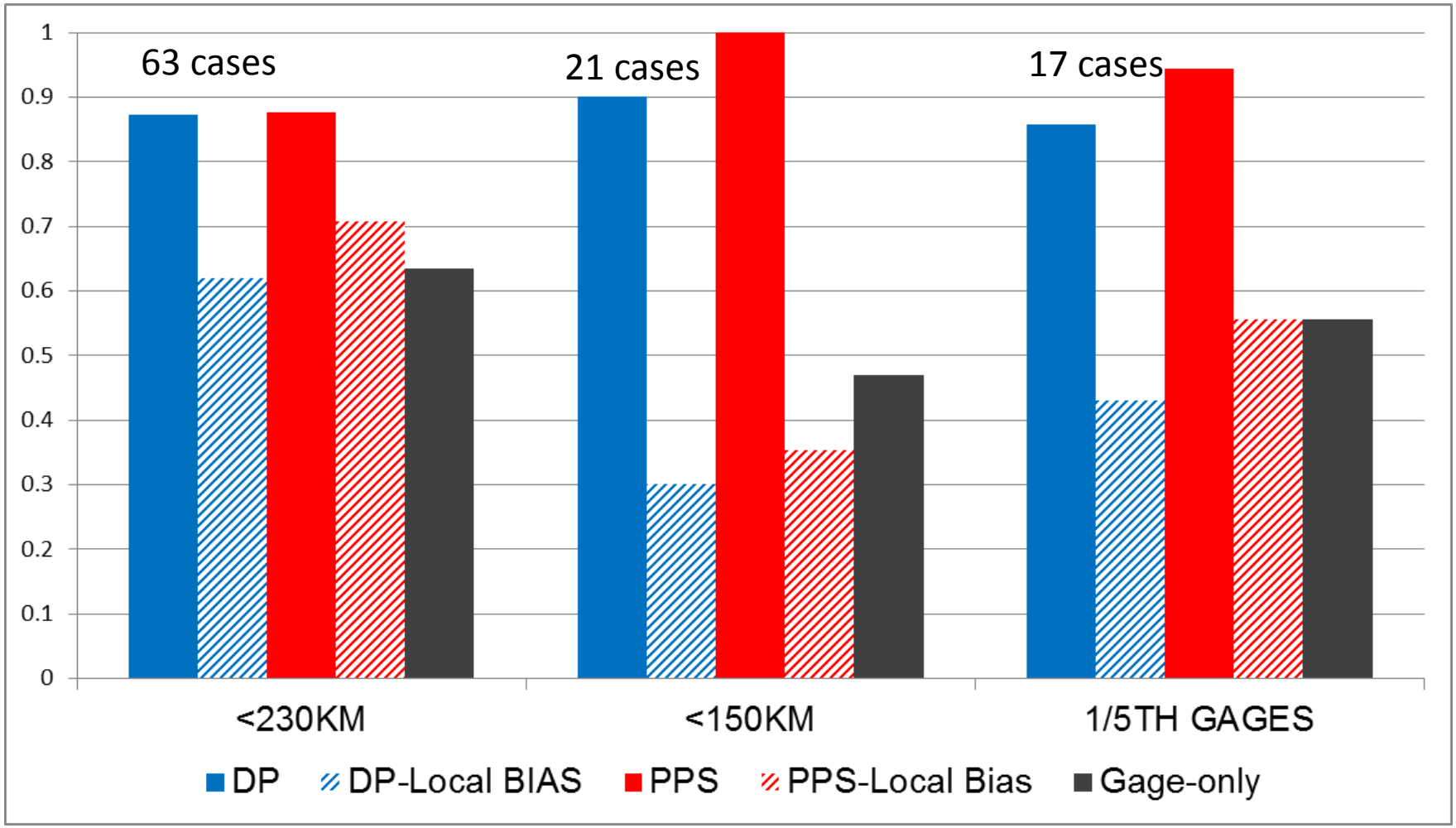
-90.79 -82.58

30.95

Effects of Gauge-Radar Bias Correction Through MPE/HPE

- Offline software emulates mean-field and local bias correction as in MPE and HPE
- Verification statistics collected by cross-validation
- Options to test:
  - Radar range influence
  - Thinning of gauge network
  - Comparison with a gauge-only analysis
- Verification focused on reduction of larger errors

January 14 Event: 1-Hour Gauge Reports ≥ 0.5 inch
Fraction of cases with QPE error > 25%



≤ 150 KM RANGE, 1200 UTC 31 JAN

Legacy PPS [source: DHR] vs Gauges

24 hr Accumulation HADS,COCO

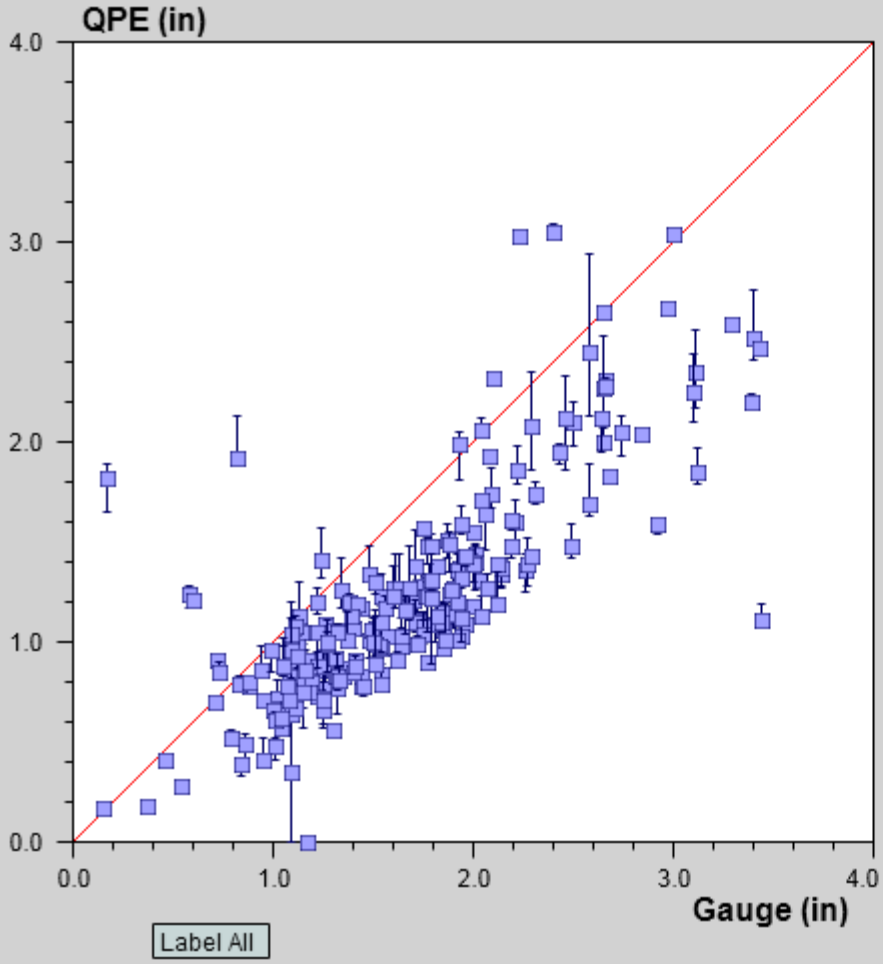
Valid: 01/31/2013 12:00:00 UTC

KFFC

Q2

Total number Gauge/QPE Pairs: 376
Number removed via manual QC: 10
Number off current plot scale: 0

Number pairs meeting thresholds (N): 227



Statistics

	Min	Avg [SD]	Max	Thresholds Applied Min	Thresholds Applied Max
Gauges:	0.15	1.641 [0.618]	3.44	---	---
QPE:	0.00	1.205 [0.532]	3.05	---	---

Mean Bias (G/R):	1.361	G-R Error Std Dev:	0.373
Additive Bias (G-R):	98.770	Correlation Coeff:	0.800
Mean Error (G-R)/N:	0.435	Fractional Bias:	0.265
Mean Abs Error:	0.491	Fractional RMSE:	0.349
RMSE:	0.573	Fractional Std Dev:	0.227

Contingency Table Functions

Event	POD	FAR	ETS	HSS	PSS
0.10	0.996	0.000	0.000	0.000	-99.000
0.25	0.991	0.004	0.245	0.394	0.491
0.50	0.969	0.005	0.261	0.414	0.719
1.00	0.655	0.029	0.106	0.191	0.465

ID	Lat	Long	Gauge	QPE

Azm	Range	Radar		
		KFFC	33.3633	-84.5658

Range Thresholds: Min = 0 km Max = 150 km

Mask: none
Lookup Mode: 3x3
Gauge Accum Completeness: 0 %

35.28
-90.79 -82.58
30.95

≤ 150 KM RANGE, 1200 UTC 31 JAN

Dual Pol QPE [source: DPR] vs Gauges

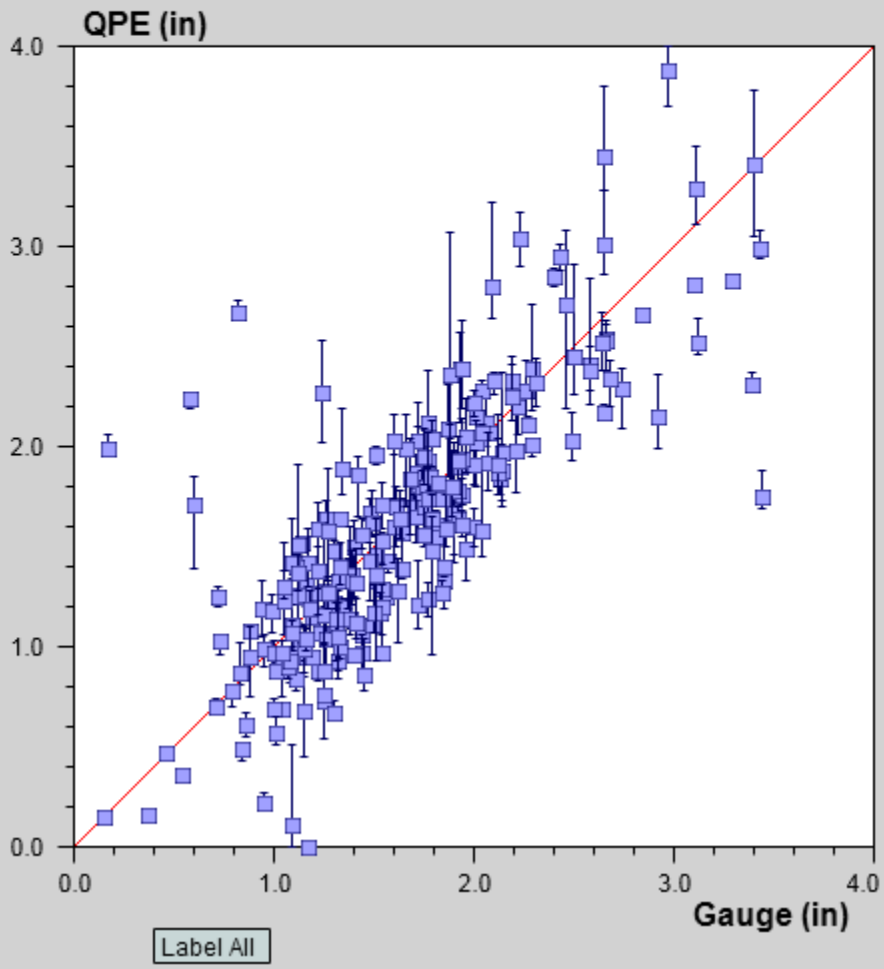
24 hr Accumulation HADS,COCO

Valid: 01/31/2013 12:00:00 UTC

KFFC

Q2

Total number Gauge/QPE Pairs:	376
Number removed via manual QC:	10
Number off current plot scale:	1
Number pairs meeting thresholds (N):	227



Statistics

	Min	Avg [SD]	Max	Thresholds Applied Min	Thresholds Applied Max
Gauges:	0.15	1.641 [0.618]	3.44	---	---
QPE:	0.00	1.604 [0.668]	4.02	---	---

Mean Bias (G/R):	1.023	G-R Error Std Dev:	0.408
Additive Bias (G-R):	8.310	Correlation Coeff:	0.802
Mean Error (G-R)/N:	0.037	Fractional Bias:	0.022
Mean Abs Error:	0.281	Fractional RMSE:	0.250
RMSE:	0.410	Fractional Std Dev:	0.249

Contingency Table Functions

Event	POD	FAR	ETS	HSS	PSS
0.10	0.996	0.000	0.000	0.000	-99.000
0.25	0.982	0.005	0.161	0.277	0.482
0.50	0.978	0.005	0.323	0.488	0.728
1.00	0.859	0.048	0.178	0.302	0.431

ID	Lat	Long	Gauge	QPE

Azm	Range	Radar		
		KFFC	33.3633	-84.5658

Range Thresholds: Min = 0 km Max = 150 km

Mask: none

Lookup Mode: 3x3

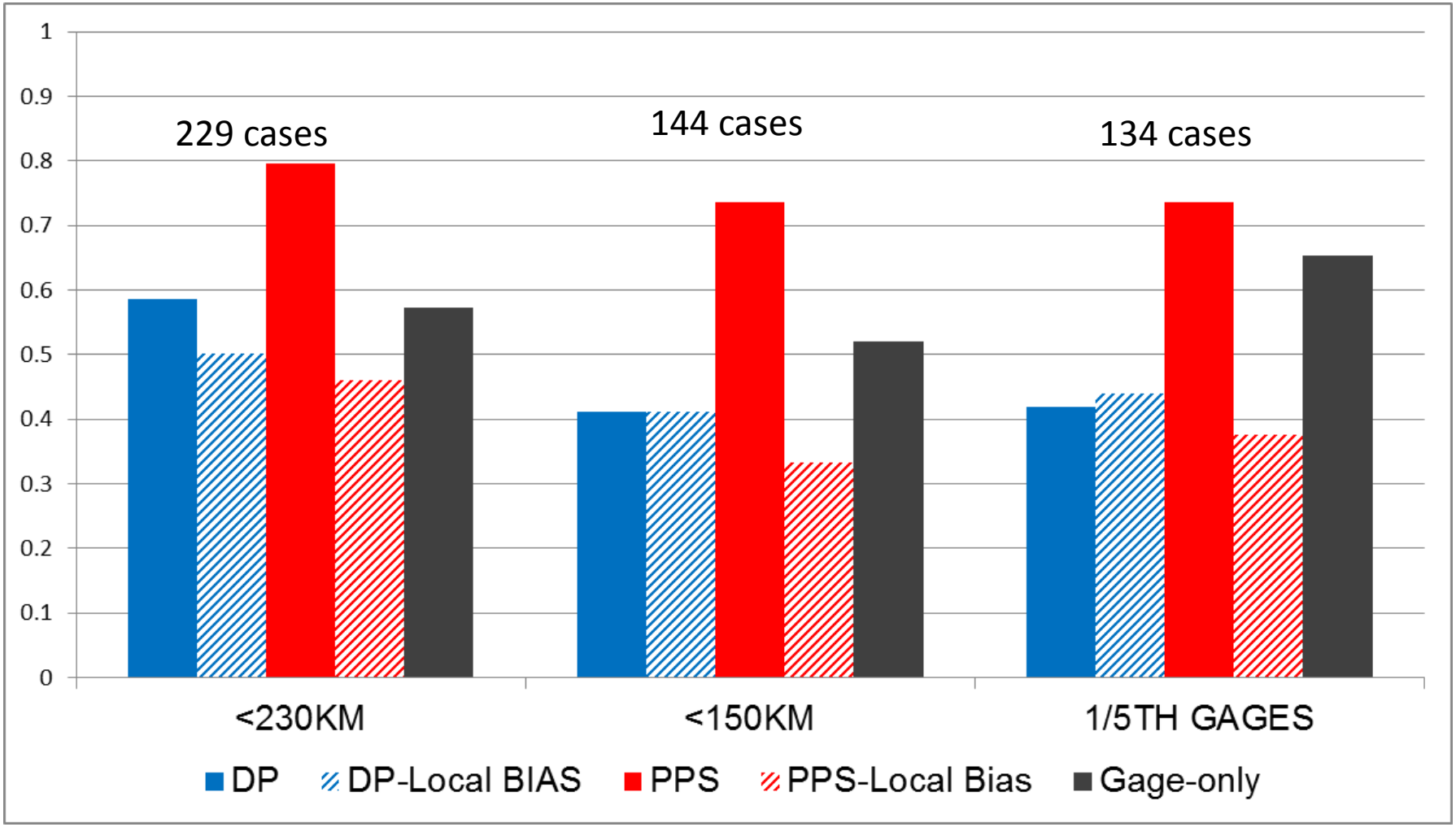
Gauge Accum Completeness: 0 %

35.28

-90.79 -82.58

30.95

January 30 Event: 1-Hour Gauge Reports ≥ 0.5 inch
Fraction of cases with QPE error > 25%



Effects of Gauge-Radar Bias Correction: Summary

- Consistent improvement over raw radar and gauge-only
- Results for both cases show benefit of using closest radar
  - Fewer large errors at range < 150km
- Greatest improvement when original radar QPE had large low bias
  - Jan 14 event

AWIPS II Implementation

- Implementing in AWIPS II will require recoding in Java:
  - Radar product decoder/remappers
  - MPE, HPE fieldgen
  - GUIs for MPE
- We plan on ATANs at WFOs
- Need volunteer offices using HPE in AWIPS II
- Not assigned to AWIPS build; estimate 2014

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- RFC participants at SERFC: Josh Palmer, John Schmidt

Questions? Comments?