



Implementation and Preliminary Assessment of PQPF Guidance at NWS Miami-South Florida and Detroit/Pontiac, Michigan

Ian Lee NOAA/NWS Detroit/Pontiac, Michigan

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Acknowledgements

Co-authors

- Bruce Veenhuis NOAA/NWS Weather Prediction Center
- James Nelson NOAA/NWS Weather Prediction Center
- Keith Brill NOAA/NWS Weather Prediction Center
- Dr. Pablo Santos NOAA/NWS Miami-South Florida
- Kevin Scharfenberg NOAA/NWS Miami-South Florida
- Joseph Maloney NOAA/NWS Miami-South Florida
- James Thomas NOAA/NWS Miami-South Florida
- Jerry Wiedenfeld NOAA/NWS Milwaukee/Sullivan, Wisconsin



Motivation

- Forecasting QPF continues to be a challenge for National Weather Service (NWS) forecast offices
 - Especially when forecasting extreme amounts (10% exceedance level)
- Heavy rainfall events are low frequency/high impact events
 - Probabilistic guidance can provide clues to a potential significant event
 - QPF critical to forecasting liquid, snow, and ice amounts
- The Probabilistic QPF Experiment (PQPF) began in late 2016
 - Building off of ongoing work with Probabilistic Winter Precipitation Forecast Experiment (PWPF)
 - Focus on utilizing probabilistic guidance as a driver of QPF forecast operations
 - 7 pilot NWS offices along with the NWS Weather Prediction Center (WPC)
- Goal: How can we better communicate QPF information to support Impact-based Decision Support Services (IDSS)?



Participating NWS Offices

- Detroit/Pontiac, MI
- Miami, FL
- Melbourne, FL
- Taunton, MA
- Milwaukee/Sullivan, WI
- Wichita, KS
- Salt Lake City, UT
- Weather Prediction Center (WPC)









Background - What is PQPF?

- An attempt to provide a range of plausible QPF outcomes in a consistent messaging framework
- PQPF guidance is produced 4 times per day by WPC
 0000, 0600, 1200, 1800 UTC
- Combines WPC's deterministic QPF with information from a 46-member ensemble
 - <u>http://origin.wpc.ncep.noaa.gov/pqpf/about_pqpf_pr_oducts.shtml</u>
- Sent to WFOs via the Satellite Broadcast Network (SBN)





PQPF Statistical Methodology

- Uses a binormal probability density function (PDF) to describe the forecast uncertainty
- Mode initially set to WPC deterministic QPF
- Variance controlled by model ensemble variance
- At local Weather Forecast Offices (WFOs), PDF is then adjusted setting the WFO QPF to the mode
- Ensures consistency with the WFO deterministic forecast



 $10^{\rm th},\,50^{\rm th},\,and\,90^{\rm th}$ percentiles taken from PDF for IDSS messaging

- 10th best case scenario (Expect At Least This Much)
- 50th most likely scenario* (Most Likely)
- 90^{th} reasonable worst case scenario (Potential For This Much)

*Note: 50^{th} percentile can float anywhere between 12^{th} and 88^{th} percentiles depending on variance distribution





PQPF Known Challenges

- Model ensemble used to generate PQPF is heavily weighted toward global, coarser resolution members
 - Currently working to include more hi-res members
- WFOs have noted PQPF 90th percentile often under predicts the observed maximums in convective situations
 - Under-dispersive of potential reasonable worst-case scenarios
- Limits utility for IDSS







Ongoing PQPF Development

- WPC is working to improve PQPF in convective situations and produce better overall statistical reliability
- Testing experimental PQPF which combines statistical regression with neighborhood probability techniques
 - 5-km Stage 4 QPE used as observation
 - Predictors derived from WPC Super-Ensemble mean
- Effectively gives greater emphasis to higher resolution guidance in convective situations to resolve higher observed QPF events









Ongoing PQPF Development

30.00 25.00 20.00 15.00 10.00 7.00 5.00 4.00 3.00 2.502.00 1.75 1.50 1.25 1.00 0.75 0.50 0.25 0.10 0.01



170824/1200F072 72-HR WPC POPF 90TH PERC



Comparison for Hurricane Harvey 72-hr PQPF Issued 22 Aug. 2017 at 1200 UTC

Experimental 90th percentile produces higher local maximums but there is still location error



170824/1200F072 72-HR WPC PQPF 90TH PERC



Implementation

- PQPF guidance populated four times a day in the AWIPS Graphical Forecast Editor (GFE)
 - A "Sigma" grid is created and represents the distribution spread from the multi-model ensemble guidance from WPC
 - WFO 72 hr Probabilistic StormTotalQPF (PQPFStormTotalQPF) grid serves as the mode of the derived distribution from WPC
 - Percentile grids created to represent PDF distribution
 - 5^{th} , 10^{th} , 25^{th} , 50^{th} , 75^{th} , 90^{th} , 95^{th} percentiles
 - 10th percentile (Expect At Least This Much), 50th percentile (most likely), 90th percentile (Potential For This Much/10% exceedance)
 - Probability of exceedance grids created for 1.00, 2.00, 4.00, 8.00, and 16.00 inches
 - A "perfect" forecast should verify close to the mode of the distribution
- Gridded output then converted to web-based graphics and probability tables for internal evaluation
 - Data output available real-time on WPC's website







Preliminary Verification

Local office gridded verification also done through BOIVerify program

NWS Milwaukee/Sullivan, WI 60-day Verification 1 October 2017 - 1 December 2017

			Official Stats					Heidke Comparison							
Forecas	t Hour	ur % Correct % too d		% too wet	ET >=	' s о .5 Н	official leidke	fficial Rai Amoung Guidance	nk G	Best Guidance		2nd Best Guidance		rd Best uidance	WorstGuidance
12		47.3	29.9	22.8	0.1	30 (0.325	8 out of 15		CMWF 0.433	WF	PCGuide 0.401	С	ONSAII 0.363	CMCreg 0.051
TotalQPF Cor	tinge	ency Tab	les												
								12 - Forecast QPF							
							0	0-0.1	0.1- 0.25	0.25- 0.5	0.5-1	1-2	>2	Total	
					Ob	0	133053	26944	3466	33	38	375	0	163909	
		<u> </u>				0-0.1	71006	46763	19552	3619	579	854	0	142373	
Blue Red	Blue = over-forecast Red= under-forecast					0.1- 0.25	4747	23842	20766	27105	3492	577	0	80529	
100						0.25- 0.5	1267	3584	13804	30540	13637	2131	52	65015	
						0.5-1	0	0	5891	19771	15592	10684	4011	55949	
						1-2	0	0	349	4500	10743	6207	4977	26776	
						>2	0	0	0	0	70	45	34	149	
						Total	210073	101133	63828	85568	44151	20873	9074	534700	
ial StormTotal	QPF F	Percentil	e Verific	ation											
											_				
		Total Case Info					Percentile Reliability								
			Т	otal Case	Info					Perce	ntile Re	eliabilit	У		

Key takeaways:

- At local level, PQPF guidance typically verifying in the middle of model guidance
- Bias towards higher PW regimes also evident
- Room for improvement in percentile bin verification



Case Study 1 - 5 Jun 2017 1200 UTC to 8 Jun 2017 1200 UTC

Convective



What actually happened?

- 508+ mm (20+ in) of rain fell in Collier County (max. near Marco Island and Everglades City)
- Wide swath of 254+ mm (10+ in) across southwest FL (PWAT max ~58 mm (2.30 in) near daily records)
- PQPF guidance struggled with magnitude of convection (widespread observed above 90th percentile)



Case Study 2 - 14 Oct 2017

Synoptic/Stratiform



What actually happened?

- 50.8-127 mm (2-5 in) of rain across central and southern Michigan
- Widespread poor drainage and river flooding, especially SW Michigan (PWAT ~25.4 mm (1 in), avg. for mid Oct.)
- PQPF guidance performed better with 90th percentile in synoptically-driven stratiform setup



Case Study 3 - 9 Sept 2017 0000 UTC to 12 Sept 2017 0000 UTC



What actually happened?

- Hurricane Irma
- Wide swath of 254+ mm (10+ in) across southern FL
- PQPF guidance performed much better with well-forecast hurricane track

Application • How can we use this information in a DSS framework?



Chance of Rain Accumulation Tabular Output Select a county option from menu below 12/02/2017 0700PM to 12/05/2017 0700PM What's this?										
		Cour	nty: All 🔻							
Location	At least	Likely	Potential for	>=1"	>=2"	>=4"				
Adrian, MI	0	<1	<1	3%	0%	0%				
Ann Arbor, MI	0	<1	<1	4%	0%	0.0%				
Bad Axe, MI	0	<1	<1	4%	0%					
Bay City, MI	<1	<1	<1	3%	0%					
Caro, MI	0	<1	<1	4%	0%					
Detroit, MI	0	<1	<1	2%	0%					
Flint, MI	0	<1	<1	3%	0%					
Howell, MI	0	<1	<1	2%	0%					
Lapeer, MI	0	<1	<1	2%	0%	0%				
Midland, MI	<1	<1	<1	4%	0%	0%				
Monroe, MI	0	<1	<1	3%	0%	0%				
Owosso, MI	0	<1	<1	3%	0%	0%				
Pontiac, MI	0	<1	<1	3%	0%	0%				
Port Huron, MI	0	<1	<1	2%	0%	0%				
Saginaw, MI	0	<1	<1	4%	0%	0%				
Sandusky, MI	0	<1	<1	3%	0%	0%				
		Switch to	Switch to Range Range Exceed	ance						







Conclusions and Future Work

- PQPF guidance can provide an added skill in the communicative forecast process
- Still room to better improve statistical verification
 - Need to better estimate binormal parameters
 - Continue exploring use of statistical training based on past events
- PQPF guidance in the IDSS world
 - Value in use of probabilistic information
 - Provides envelope of scenarios for NWS core partners to plan and prepare
- Future Work
 - PQPF Experiment planned to go public Spring 2018
 - Possible expansion of NWS pilot offices
 - Integration with NWS PWPF Experiment





Questions?

To contact: Ian.Lee@noaa.gov