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Cross-validation of Precipitation Identification from NOAA/NSSL Ground-Radar-Based National Mosaic QPE (NMQ) System and Crowd-Sourcing-Based mPING Weather Reports

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I Introduction

Precipitation is the most important source of water over land and the critical component of hydrological cycle on the Earth. Accurate identification of precipitation types is prerequisite to reliable quantitative estimates of the spatial precipitation distribution over large scale region based on remote sensing platforms (such as ground radar and space-born precipitation sensors) and closely linked to the hazards monitoring and forecasting.

The precipitation classification algorithm (PCA) embedded in the Next Generation National Mosaic & Multi-Sensor QPE (NMQ/Q2) system is developed aiming to improve radar-based quantitative precipitation estimates (QPE). The meteorological Phenomena Identification Near the Ground (mPING) is the first public-oriented platform to involve the public in the weather event observations. In this study, the PCA's performance is evaluated and quantified by the public reports collected by the mPING over the CONUS and eight cities .

II Study Region and Data

The study region is continental United States (CONUS). The data are composed of NOAA/National Severe Storms Laboratory's (NSSL) next generation, high-resolution (1km/5min) National multi-sensor and Mosaic QPE (Q2) and 203047 mPING reports. Data time spans from Dec. 19, 2012 to Apr. 30, 2013. The mPING reports are considered as reference to assess PCA.

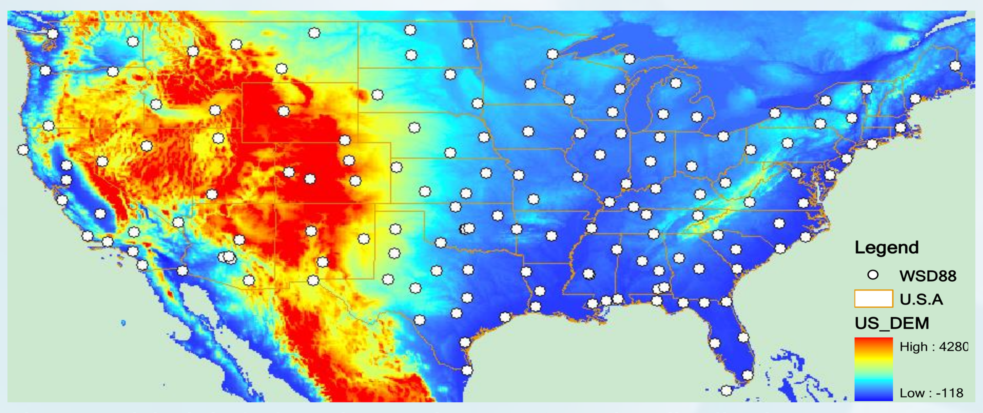

Figure 1 (a)Digital elevation and WSD88 Radar distribution over CONUS.

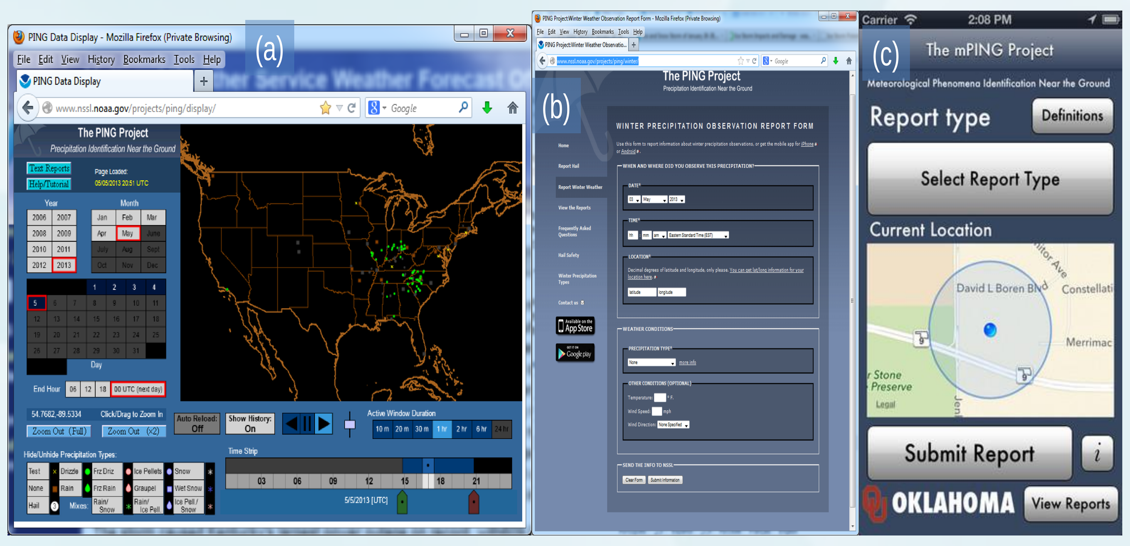

Figure 2 PNG system and user interface

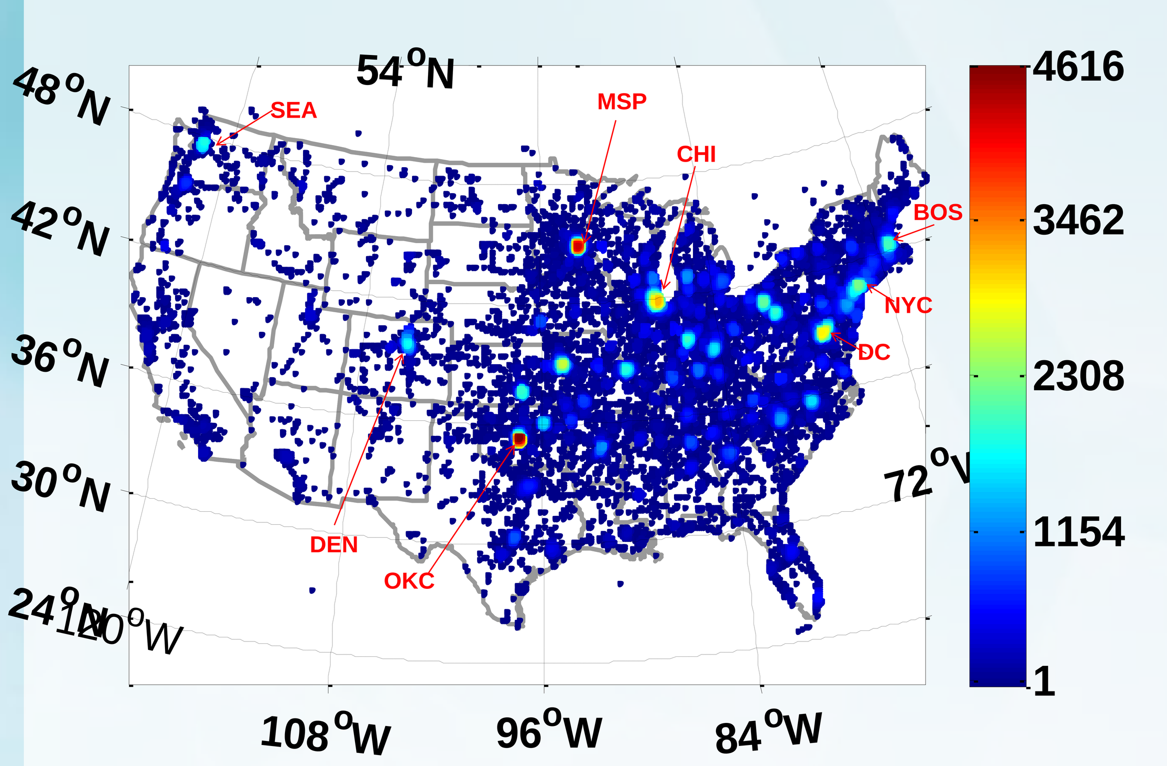

Figure 3 mPING-Q2 matching reports distribution over CONUS from Dec. 19 2012 to Apr. 31 2013.

III Methodology

Time and location matching technology is applied to obtain the instantaneous matching pairs of mPING reports vs. Q2 reports(Figure 3) conditioning on: 1) time difference is less than ±2.5min; 2) both mPING reports and Q2 have valid records; 3) removal of the the non reports of mPING and the no data/precipitation of Q2; 4) mPING reports contained by Q2 grids.

3.1 Group Q2 and mPING precipitation types

Q2 precipitation type product has 11 precipitation types and mPING has 13 precipitation type. Both Q2 and mPING precipitation types were grouped into three precipitation types ,i.e. rain, snow/ice, hail.

Table 1: Groups of Q2 precipitation type definition.

Group	Q2 PCPFlag	precipitation type definition
Removal	-1	No data
	0	No precipitation
Rain	1	Stratiform (rainfall)
	2	Stratiform(Beam bottom>0° C)| Bright band
Snow/ice	3	Snow
	4	Snow (Beam bottom>1km AGL) (overshooting)
Removal	5	Not used
Rain	6	Convective (rainfall)
Hail	7	Hail
Removal	8	Not used
Rain	9	Tropical/warm rain (rainfall)

Table 2: Groups of mPING precipitation type definition.

Group	mPING Flag	precipitation type definition
Rain	1	Drizzle
Snow/ice	2	Freezing drizzle
	3	Sleet
	4	Snow
Removal	5	None
Rain	6	Rain
Snow/ice	7	Freezing rain
	8	Granuel
	9	Wet snow
	10	Mixed rain and snow
	11	Mixed ice pellets and snow
	12	Mixed rain and ice pellets
Hail	13	Hail

Given a binary value of yes/no for both the mPING reports and Q2 prediction, the categorical verification statistics: Probability of Detection (POD), False Alarm Ratio (FAR), Critical Success Index (CSI) are usually used to evaluate the correspondence between the mPING and Q2 reports.

	mPING-Yes	mPING-NO
Q2-Yes	Hit(H)	False Alarm(F)
Q2-No	Miss(M)	Correct Rejection(C)

$$POD = \frac{H}{H+M}$$

$$FAR = \frac{F}{H+F}$$

$$CSI = \frac{H}{H+M+F}$$

In addition to the total POD, CSI and FAR over CONUS, the contingency is also computed as a function of latitude variation to explore the geographical dependence of the performance of PCA of NMQ.

IV Results

Figure 4 gives the daily series public reports collected by mPING from Dec. 19, 2012 to Apr. 30, 2013. Figure 5 shows the Q2 has very high rain POD (93.72%) and moderate snow POD (63.07%) over CONUS. Figure 6 shows that the PCA of NMQ have latitude dependency, especially the snow POD increases as latitude increases. Figure 7 shows Denver, Minneapolis-St. Paul City and Oklahoma City are the top three cities with highest rain POD (>90%). The top three cities with highest snow POD(>60%) are Chicago, Oklahoma City and Minneapolis-St. Paul City, respectively.

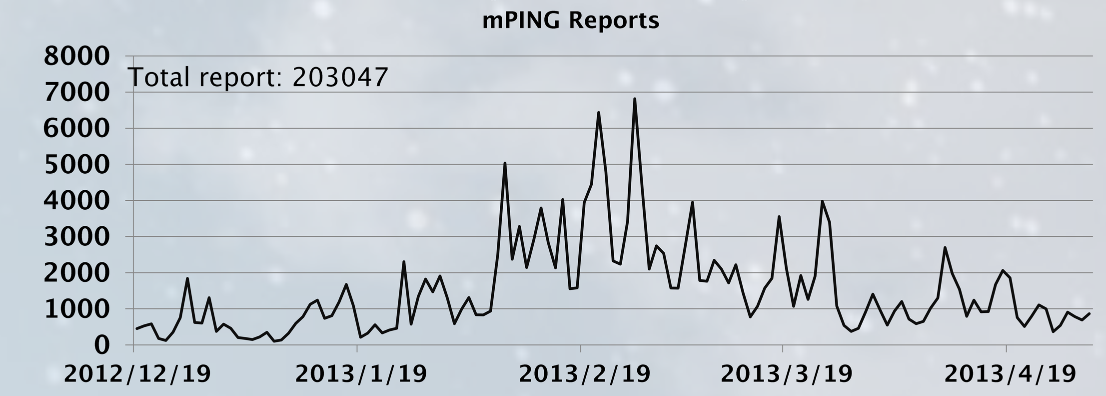

Figure 4. Daily reports collected by mPING.

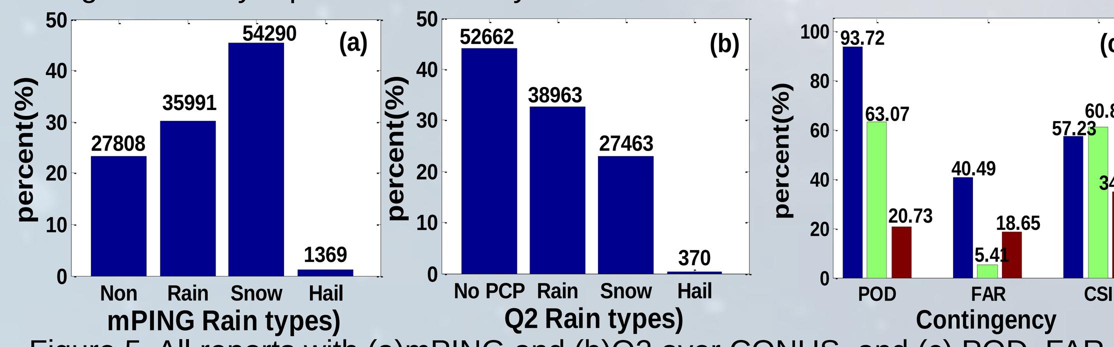

Figure 5. All reports with (a)mPING and (b)Q2 over CONUS, and (c) POD, FAR, CSI conditioned on that both Q2 and mPING have the valid report(i.e. Non of mPING and No PCP of Q2 were removed)

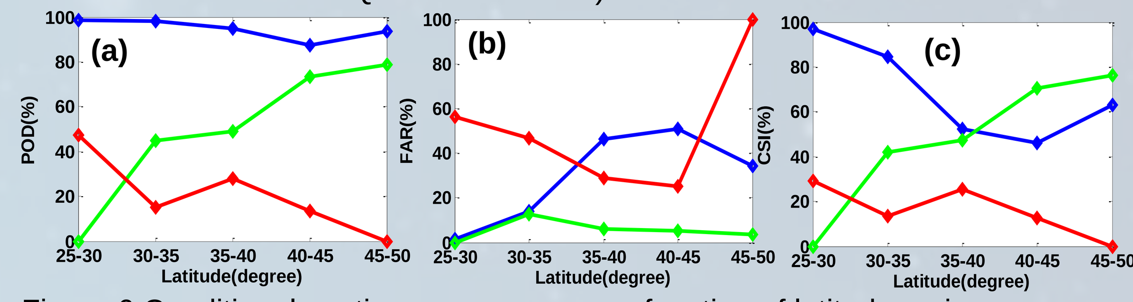

Figure 6 Conditional contingency scores as a function of latitude variance.

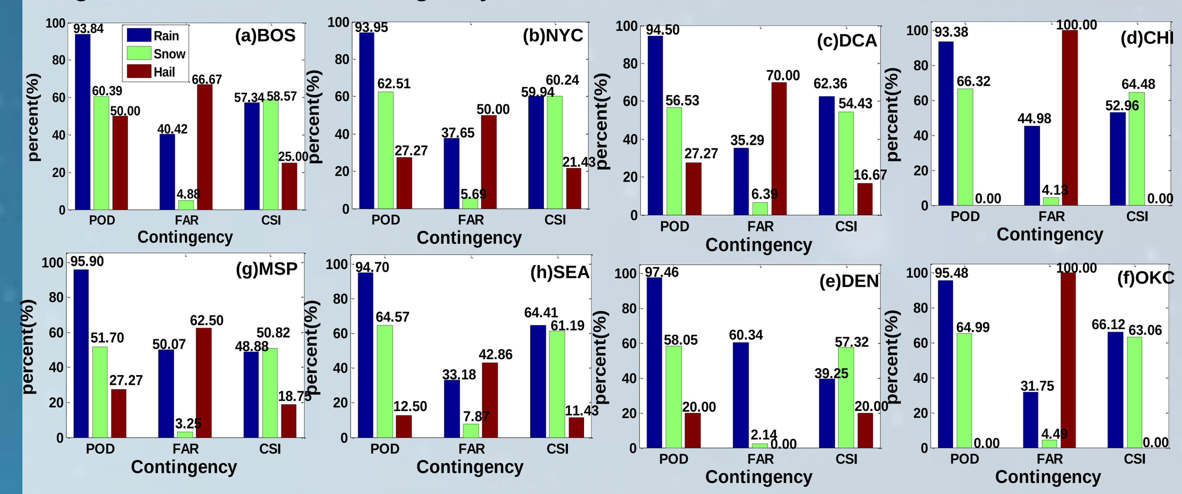

Figure 7 Conditional POD, FAR and CSI in 8 cities.

Table 3. Conditional POD, FAR and CSI in 8 cities.

Type	PING: Snow/Ice	PING: Rain	PING: Hail	Total
Q2: Rain	14085	22008	889	36982
Q2: Snow	24063	1348	29	25440
Q2: Hail	2	127	240	369
Total	38150	23483	1158	62791

Table 4. Conditional POD, FAR and CSI in 8 cities.

City Ab.	Total Report#	Population*	POD (Rain, %)	POD (Snow, %)	POD (Hail,%)
BOS	1978	636,479	93.84	60.39	50
NYC	2354	8,336,697	93.95	62.81	27.27
DCA	3056	632,323	94.50	56.53	27.27
CHI	3180	2,714,856	93.38	66.32	0
DEN	1277	634,265	97.46	58.05	20.00
OKC	3139	599,199	95.48	64.99	0
MSP	2782	392,880	95.90	51.70	27.27
SEA	1256	634,535	94.70	64.57	12.50

V Conclusion

1) Q2 has high rain POD(93.72%) and moderate snow POD(63.07%) over CONUS.
2) The PCA of Q2 has latitude dependency. Snow POD increases from south to north, rain and hail POD decreases from south to north.
3) Q2 is smart and reliable in precipitation classification.
4) mPING is potential to be used for remote sensing and hydrological communities, e.g. the flash flood reports.

Reference:

Kimberly L. Elmore, et.al (2013), mPING: Crowd-Sourcing Weather Reports for Research, Bulletin of the American Meteorological Society(submitted).

Chen, S., et.al (2013), Using Citizen Science to verify Precipitation Type Reports of NOAA/NSSL National Mosaic & Multi-Sensor QPE (NMQ) Products: Are Radars as Smart as Human Beings? Bulletin of the American Meteorological Society(submitted).

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