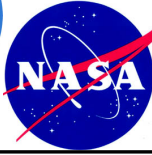# Toward a Framework for Systematic Evaluation of NASA Precipitation Radar Estimates using NOAA/NSSL National Mosaic QPE Products

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Context

Characterization of the error associated to satellite surface rainfall estimates ; focus on TRMM Precipitation Radar and future GPM dual-frequency precipitation radar (DPR)

Objectives

- objective 1 : derive **reference rainfall values** using ground-based measurements from **NOAA/NSSL National Mosaic and QPE system (NMQ/Q2)**
- objective 2 : **characterize errors in PR rain rate estimates** (instantaneous, 5 km)

Application

TRMM-TMI, AQUA-AMSRE, DMSP-SSM/I, Megha-Tropique-MADRAS, GPM-DPR and GPM-GMI (after launch) satellites

TRMM-PR estimated rainfall
Ground radar reference rainfall
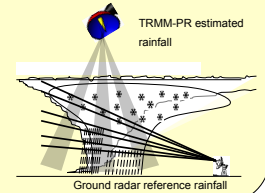
Reference rainfall

Background: NMQ-Q2

Q2 provides 3D reflectivity mosaics and QPE products over CONUS at 1-km²/5-min resolution
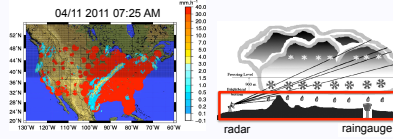
Real-time platform to develop, test, and assess advanced techniques in quality control, data integration and precipitation estimation.
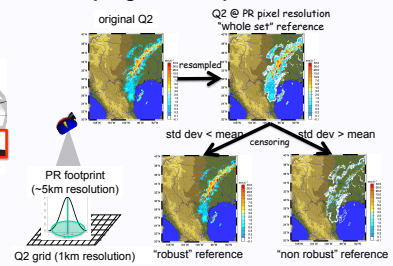
http://nmq.ou.edu
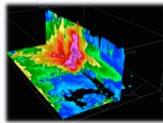
NMQ-Q2: 3 levels of refinements

04/11 2011 07:25 AM

radar   raingauge

1. native Q2 rain rate   "N"   985 000 comparison pairs
2. bias corrected Q2   "B"   725 000 comparison pairs
   - raingauge; hourly bias applied to 5min native Q2 rain rate
3. good sampling conditions   "B+RQI" 395 000 comparison pairs
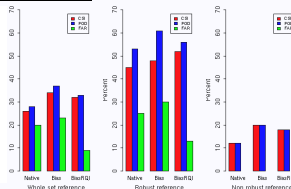   - filtered with Radar Quality Index

Resampling Q2 to PR pixel resolution

original Q2   Q2 @ PR pixel resolution "whole set" reference
resampled
std dev < mean   censoring   std dev > mean
"robust" reference   "non robust" reference
PR footprint (~5km resolution)
Q2 grid (1km resolution)

Evaluation covers March to May 2011 for each TRMM overpass in lower CONUS
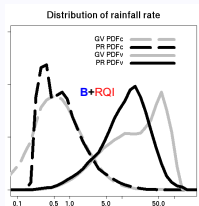
Rainfall data analysis

contingency tables

PR Estimates		Bias+RQI corrected Q2		
		> 0.	= 0.	Σ estimates
> 0.	whole set	32 %	3 %	137978
	robust	52 %	7 %	94533
	non robust	18 %	0 %	43178
=0.	whole set	65 %	0. %	254921
	robust	41 %	0. %	64620
	non robust	81 %	0. %	190301
Σ reference	whole set	380087	12812	392899
	robust	146608	12545	159153
	non robust	233479	0	233479

Whole set reference   Robust reference   Non robust reference
Native   Bias   Bias(RQI)

contingency mean rain rates and volumes

PR Estimates		Bias+RQI corrected Q2	
		> 0.	= 0.
> 0.	whole set	4.92 / 5.45	2.07 / 0.00
	robust	5.60 / 7.27	2.07 / 0.00
	non robust	3.63 / 2.01	-
=0.	whole set	0.00 / 0.28	
	robust	0.00 / 0.74	
	non robust	0.00 / 0.12	

	Native Q2	Bias corrected Q2	Bias + RQI corrected Q2
Excess of rain volume implied in False Alarms	13.70 %	15.45 %	5.36 %
Discarded rain volume due to Misses	11.70 %	10.07 %	7.46 %

probability distribution occurrence & rain volume

Distribution of rainfall rate
GV PDFₒ / PR PDFₒ / GV PDFᵥ / PR PDFᵥ
B+RQI
Rain rate [mm.hr⁻¹]

evaluated detection threshold: ~0.3 mm.h⁻¹

Quantitative error modelling

scatterplot and classical criteria

PR vs. Reference comparison
B+RQI
PR (mm/h)
Reference (mm/h)
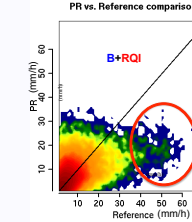
PR	Native		Bias corrected		Bias+RQI corrected	
	Reference	PR	Reference	PR	Reference	PR
Mean	6.20	5.07	6.07	5.38	7.27	5.6
standard deviation	12.53	7.80	12.04	8.03	13.76	8.26
MRE / reference (%)	-	-18 %	-	-11 %	-	-23 %
Correlation / reference	-	0.61	-	0.6	-	0.64

error modeling

residual error : $\varepsilon(A,t) = PR - \text{Reference}$
goal: characterize the residual QPE error with conditional probability distributions

Residuals [mm.hr⁻¹]   Reference [mm.hr⁻¹]
Conditional bias [mm.hr⁻¹]   Reference rainfall [mm.hr⁻¹]
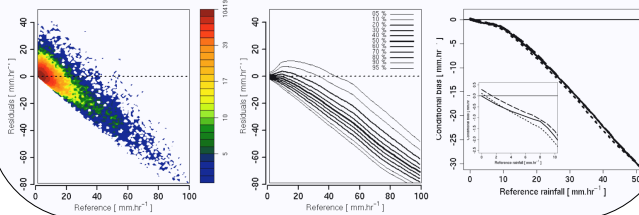
Conclusions

- Q2-based reference estimates **are not an absolute reference** but we have tools to refine and **maximize the reference quality** while **maintaining a large sample**
- the error model (of systematic and random parts) is **empirical** and depends on climatological context and reference

We noted:
- **increased consistency** between PR estimates and Q2 reference with each **data quality step** (robustness assessment, bias correction, RQI filter)
- **detection issue** of PR with light rain rates due to lack of sensitivity
- **underestimation** with PR at high rainrates due to…factors still being explored

I have initial results and am soliciting your feedback on the following topics!!

- PR version 6 and version 7 evaluation: first results
- error factors to be taken into account: PIA, NUBF
- GPROF-TMI evaluation: first results

References

P.-E. Kirstetter, Y. Hong, J.J. Gourley, et al.: *"Toward a Framework for Systematic Error Modeling of NASA Spaceborne Radar with NOAA/NSSL Ground Radar-based National Mosaic QPE"*, **JHM** submitted
P.-E. Kirstetter, N. Viltard et M. Gosset: *"Toward an Error Model for BRAIN Precipitation Estimation in West Africa"*, **QJRMS** accepted