IMPROVING SATELLITE PRECIPITATION DETECTION USING GLOBAL PRECIPITATION MEASUREMENT (GPM) AND GROUND BASED RADAR (NMQ)

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INTRODUCTION

Global Precipitation Measurement (GPM) Mission is a NASA/JAXA core observatory satellite which launched on February 28th, 2014 and has since been collecting precipitation data worldwide. As a harbinger of wider global precipitation measurement accuracy, the GPM follows in the footsteps of NASA's Tropical Rainfall Measurement Mission (TRMM), but with greater latitudinal range and higher precipitation detection precision. This project aims to identify inconsistency between GPM and ground-based radar. Two datasets, GMI (GPM Microwave Imager) and NMQ (National Mosaic & Multi-sensor Quantitative Precipitation Estimate), are constrained to sift out missing and poor quality data—the datasets are then averaged over an identical footprint at the pixel level and correlated to find the relative agreement. Higher correlation with heavy rain rates are found by correlating rainfall data from the first four months (March 4th-July 7th) in GPM's operation with the on ground radar detection network, as well as an increasing correlation towards summer months.

RESEARCH QUESTIONS

How accurate are the retrieval products we are receiving?

For which levels of precipitation (light, moderate, heavy) are the satellite and ground-based radar best correlated?

How does this correlation change seasonally, from Spring into Summer months?

METHODS

CONSTRAINING DATASETS

-Radar Quality Index threshold of 1.0-

-Missing data and outside orbit swath points ignored-

-Regional constraint: contiguous United States with latitude and longitude [20.,55.,-130.,-60.]-

-Moving average with 3 point edge (both sides) for smoothing of noisy data-

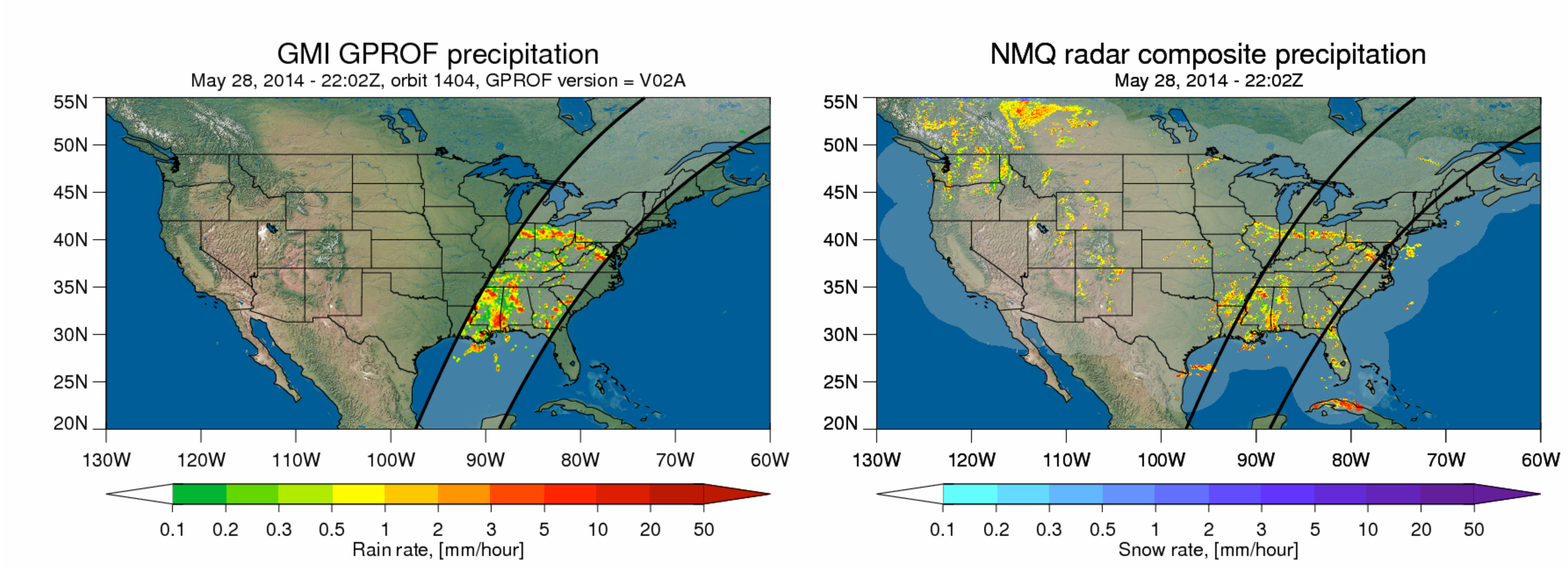

Figure 1. A side by side comparison of an example GMI Orbit (#1404) and the paired NMQ precipitation field. (Created by Joshua M. King.)

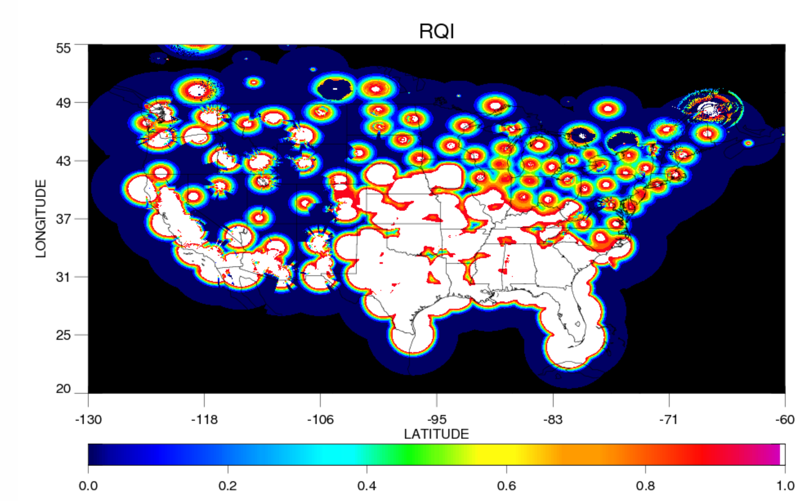

Figure 2. Radar Quality Index: domain over CONUS, showing the network of radars that create NMQ.

RAIN RATE CORRELATIONS

The main density plot (*Figure 4* at right) ranges from March 4th to July 7th, meaning that all rain rates of each orbit overpass of each day (about 6-7 over CONUS) within the date range have been concatenated, correlated and plotted.

By dividing rain rates into three sections (*Figure 3* below), [0.0-2.5], [2.5-7.6],[7.6-10.0] mm/hr we display whether heavier rain rates are more highly correlated than moderate, and moderate more than light.

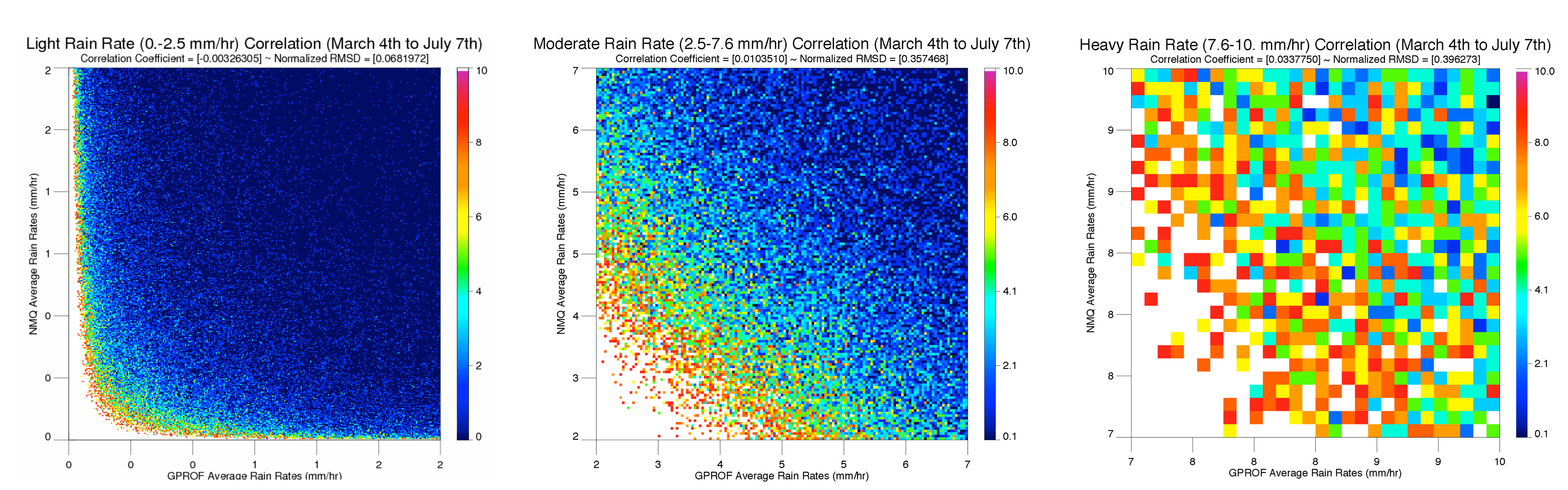

Figure 3. Light, moderate and heavy rain rate correlation plots.

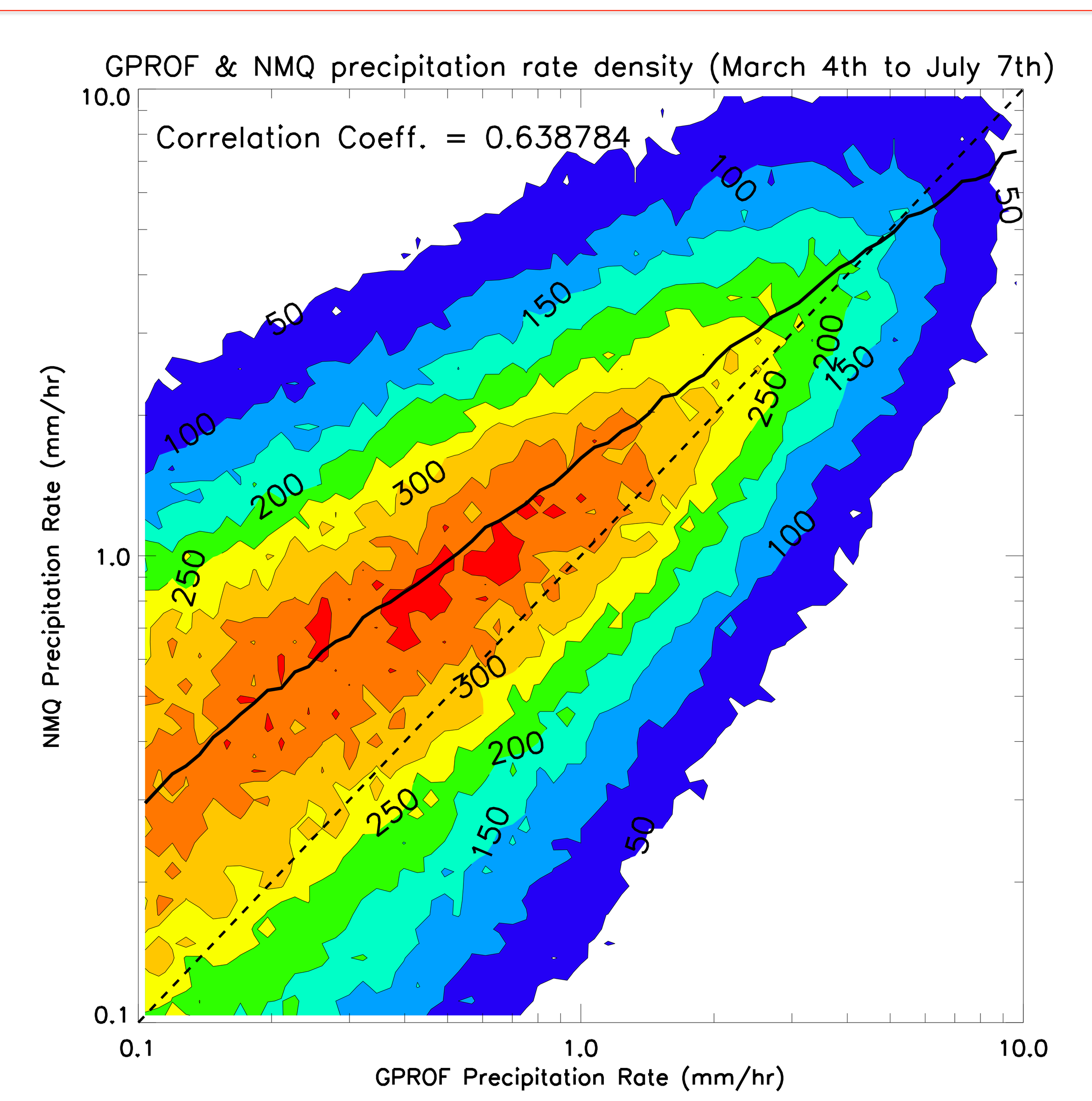

Figure 4. Main density plot from March 4th to July 7th. Mean trend line of x,y coordinates plotted, along with 1 to 1 line.

SEASONAL ANALYSIS

The correlation coefficient of each day of orbits from spring to summer. Time series shows a decrease in variability and a slight increase in correlation of .0005 per day over 120 days; showing a .06 total correlation coefficient increase. This is about 10% of the total correlation coefficient.

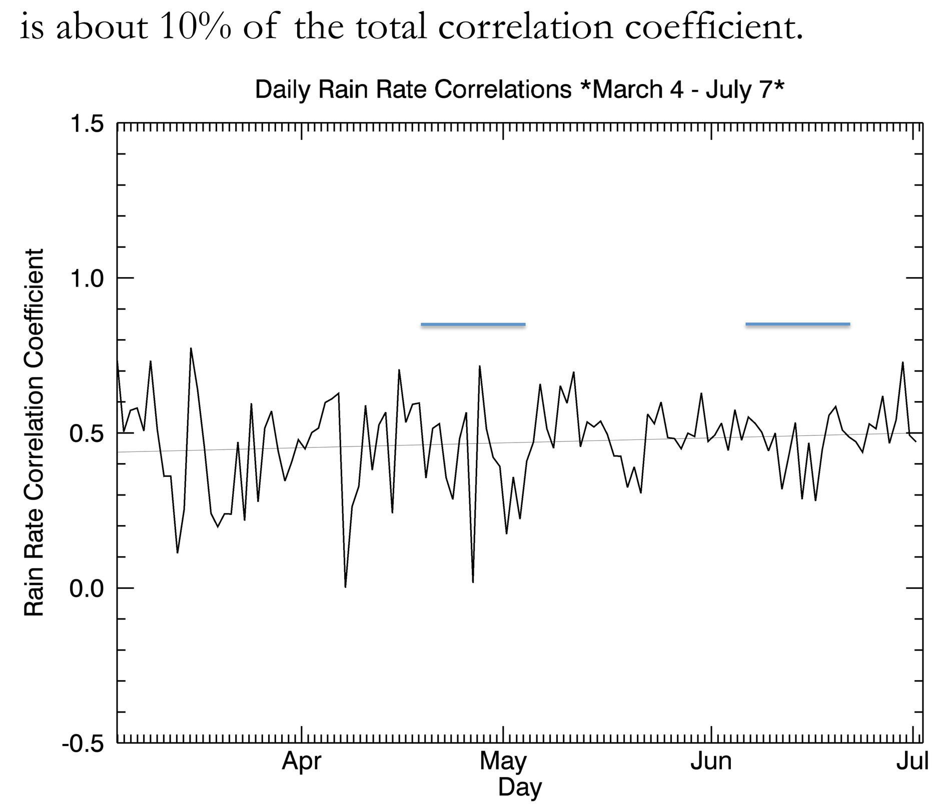

Figure 5. A time series of the correlation coefficient of each day from March 4th to July 7th.

TEMPORAL CONSISTENCY

Consistency over 8 day periods in April-May and in June.

June 7th – June 14th

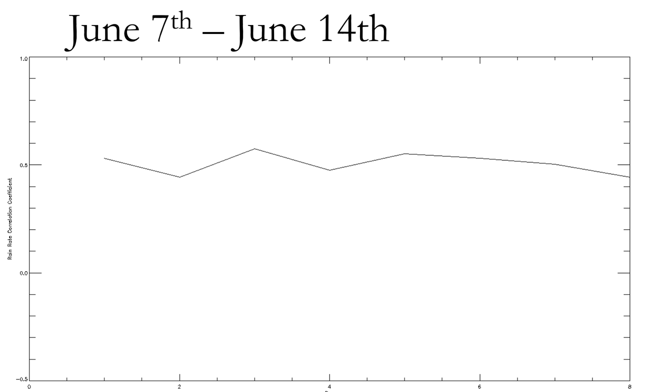

Figure 6. Example of 8 day period in June showing consistent rain rate correlation, ranging from (0.575) to (0.442).

April 26th – May 3rd

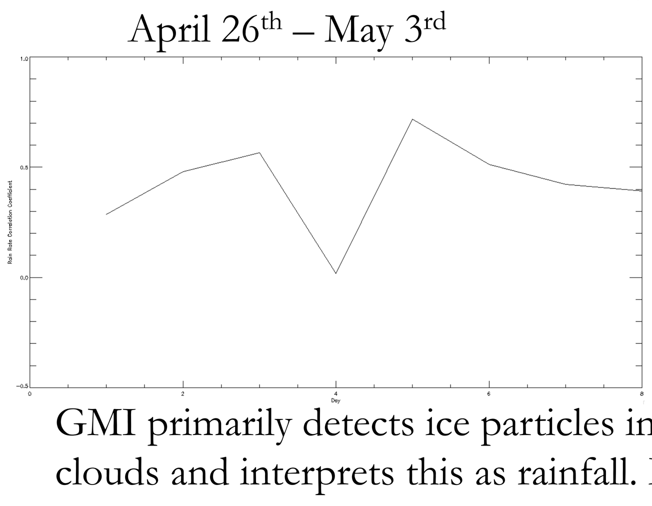

Figure 7. Example of 8 day period in from April to May showing inconsistent rain rate correlation coefficients, ranging from (0.718) to (0.286).

GMI primarily detects ice particles in the upper region of clouds and interprets this as rainfall. Most cloud ice particle formation results in precipitation, however, lighter precipitation may not be characterized by ice particle formation if the temperature of the cloud is above -4° C.

STATISTICS

	CORRELATION COEFFICIENT
0.0-2.5 (MM/HR)	-0.0033
2.5-7.6 (MM/HR)	0.0104
7.6-10. (MM/HR)	0.0338
0.0-10. (MM/HR)	0.6388

RAIN RATE (mm/hr)	STANDARD DEVIATION	ERROR %
GMI(0.0-2.5)	.205	30.4%
NMQ(0.0-2.5)	.279	
GMI(2.5-7.6)	1.29	3.00%
NMQ(2.5-7.6)	1.30	
GMI(7.6-10.)	.685	.261%
NMQ(7.6-10.)	.683	

As the rain rate becomes heavier, the correlation increases.

The difference in the standard deviations of the two datasets is about a third for light rain rates, indicating a large uncertainty. For moderate rain rates this difference decreases by a factor of 10, and for heavier by a factor of 100, thereby furthering our evidence for heavier precipitation being of greater certainty.

CONCLUSIONS

1. GMI and NMQ have a correlation coefficient of .6388.
2. Moving into the summer months, GMI and NMQ become more highly correlated suggesting that for heavier, convective precipitation systems GMI performs increasingly better than for mixed phase, light precipitation. Further, GMI detects ice aloft as an accurate prediction of precipitation, however, does a poorer job of predicting on-ground rain.

FURTHER RESEARCH

Understanding how the thermodynamic environment of cloud formation impacts the life cycle of the cloud, and the ice formation in a cloud is essential to predicting the consequent precipitation.

I will be focusing on the understanding of these concepts and their contribution to variability in precipitation detection for my Senior Project at Bard College.

ACKNOWLEDGEMENTS

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