MODIS AND GOES DATA TO DETECT WARM RAINING CLOUDS IN PUERTO RICO AND CARIBBEAN BASIN

Joan M. Castro-Sánchez
Department of Civil Engineering
Advisor: Dr. Nazario D. Ramírez-Beltrán
Department of Industrial Engineering
University of Puerto Rico at Mayaguez
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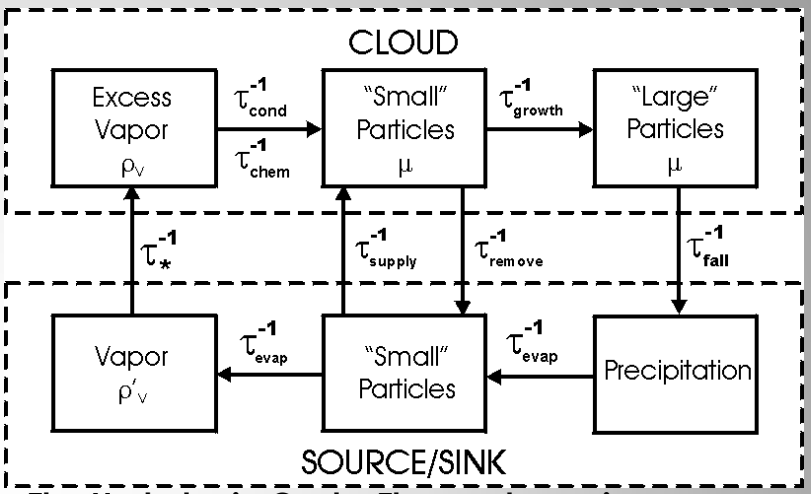
Agenda

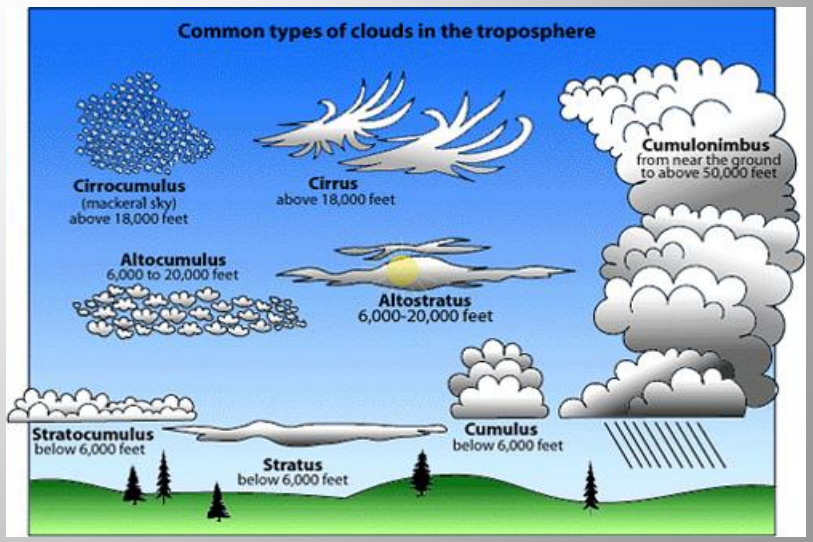
- *Rain Identification*
- *SCaMPR*
- *Hot Cloud Detection Problems*
- *Cloud Products Potential Indicator*
- *Preliminary Results*
- *Future Work*

Introduction

- ***A cloud rainfall event is the result of a complex thermodynamic process that starts with nucleation of cloud drops, continues with drop growth, and finishes with water drop precipitation.***

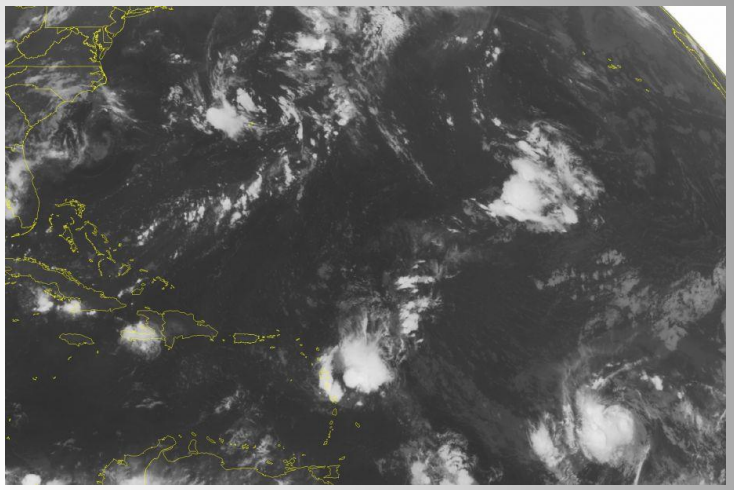


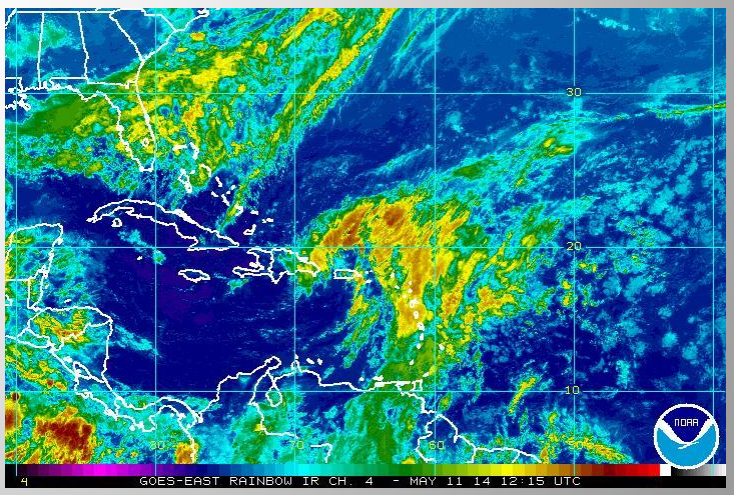
The Hydrologic Cycle: Thermodynamic processes which govern cloud microphysics. Source: National Weather Service (2010)



Rainfall Cloud Identification

- Caribbean Rainfall Causes:
- Low Pressure Systems
- Tropical Systems (waves, storms, and hurricanes) summer and autumn season
- Cold Fronts: winter and spring season
- Troughs during all year
- Orographic Effects (water vapor, mountains and winds integrations)





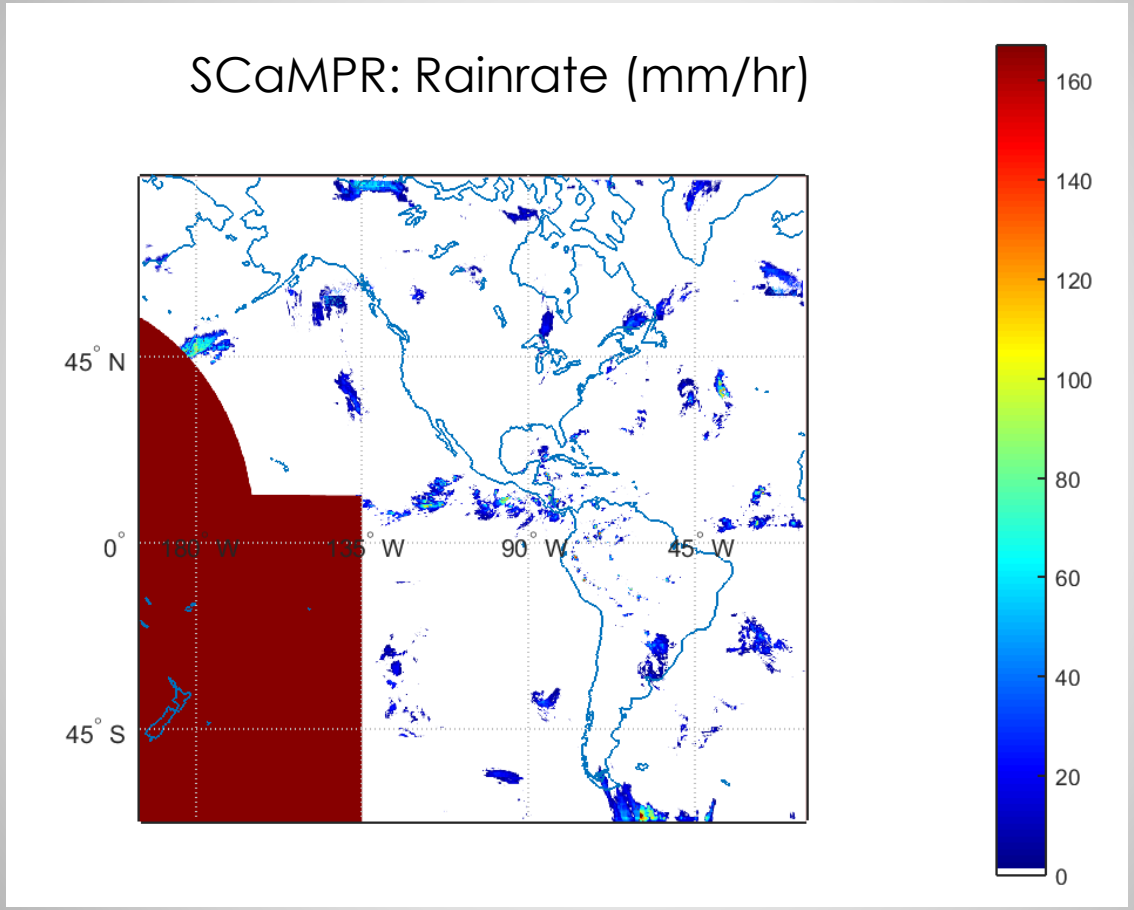
SCaMPR

- **S**elf-**C**alibrating **M**ultivariate **P**recipitation **R**etrieval.
- Developed by Robert Kuligowski (NOAA-NESDIS).
- SCaMPR is an algorithm that combines the relative strengths of infrared (IR)- based and microwave (MW)-based estimates of precipitation.
- Detection and estimation process is separated by two steps: (1) rain/no rain classification using discriminant analysis, (2) and precipitation rate calibration using regression.

SCaMPR

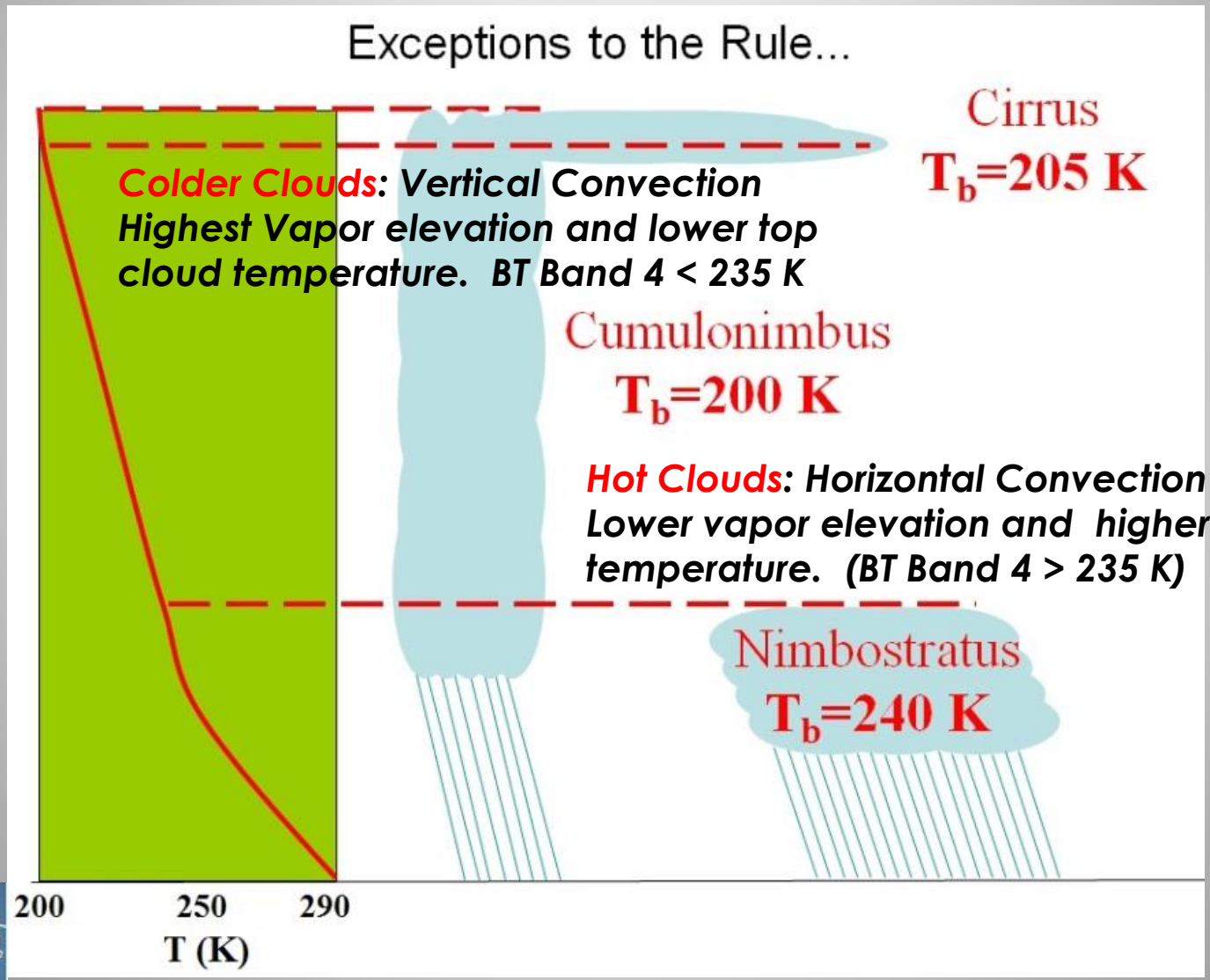
- *SCaMPR uses GOES bands 3 (6.7 microns) and 4 (10.7 microns) brightness temperatures.*
- *Spatial Resolution: 4 km*
- *Temporal Resolution: 15 minutes*
- *Output: Rainrate (mm/hr) and Accumulate Precipitation (mm, 1, 6, and 24 hours)*

SCaMPR: Domain



Latitude: (70 N, 60 S)
Longitude: (165 E, 15 W)
September 29, 2008 at 1745 UTC

Rainy Cloud Detection Problems



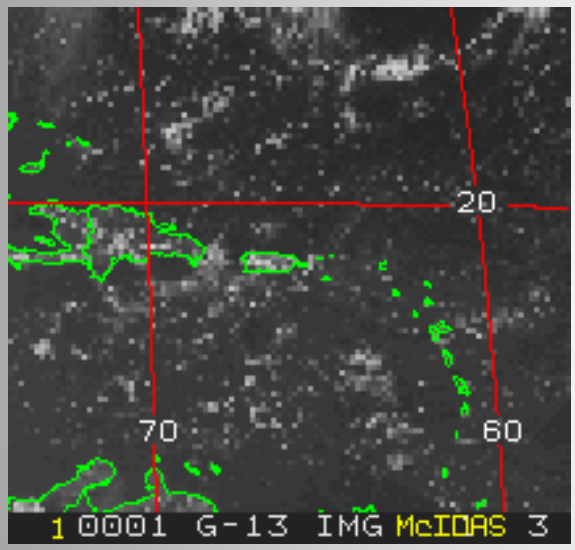
Potential Rainfall Indicators

- *Cloud Product combines infrared and visible techniques to determine physical and radiative cloud properties.*

- *GOES: Visible and IR Bands (0.65, 3.9, 6.7, 10.7 um) – Passive Sensor – Geostationary*
- *Visible Reflectance (Visible Band)*
- *Effective Radius: (IR Bands 2 and 4)*
- *Albedo (Bands 2)*
- *Bands Ratio (Bands 2,3 and 6)*
- *Band Differences (Bands 2,3 and 6)*

- *MODIS: Microwave Bands(1.6, 2.1, 3.7 um) – Active Sensor – Orbital*
- *Liquid Water Path (g/m^2)*
- *Optical Thickness (Cloud depth)*
- *Effective Radius (Dropsize Distribution)*

Potential Rainfall Indicators GOES Bands



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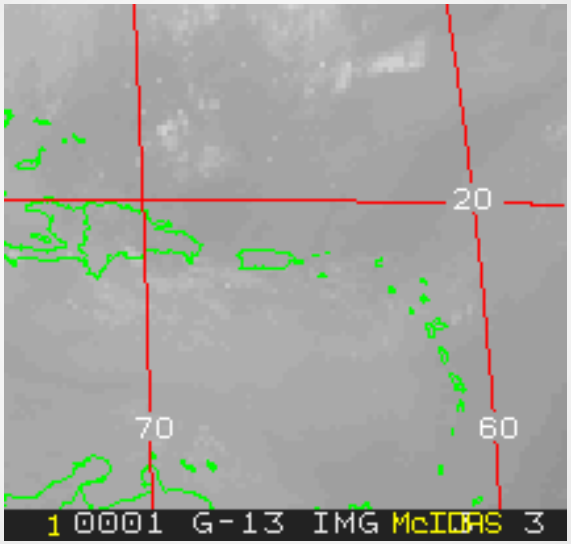

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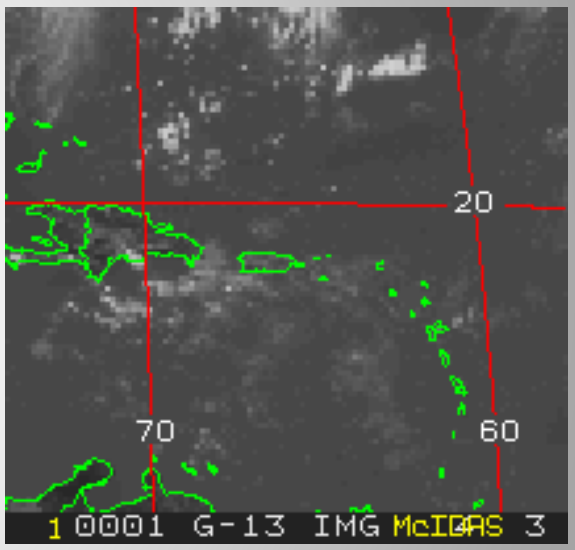
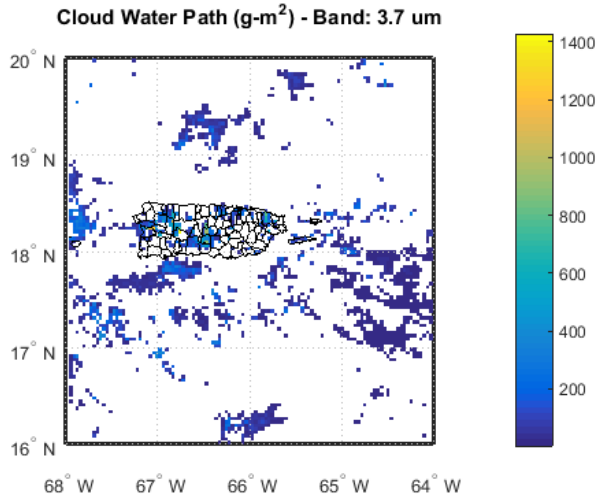
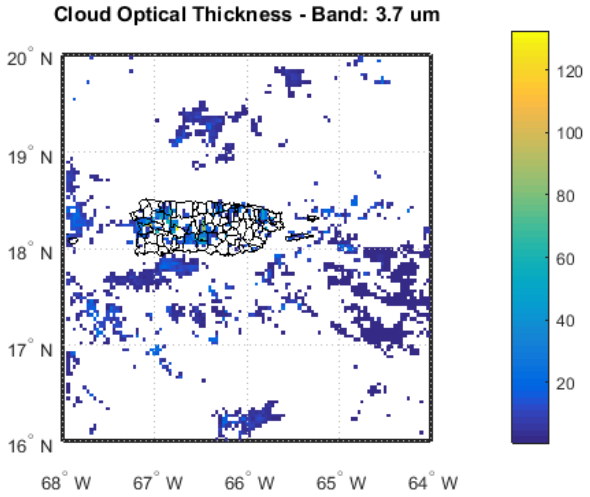
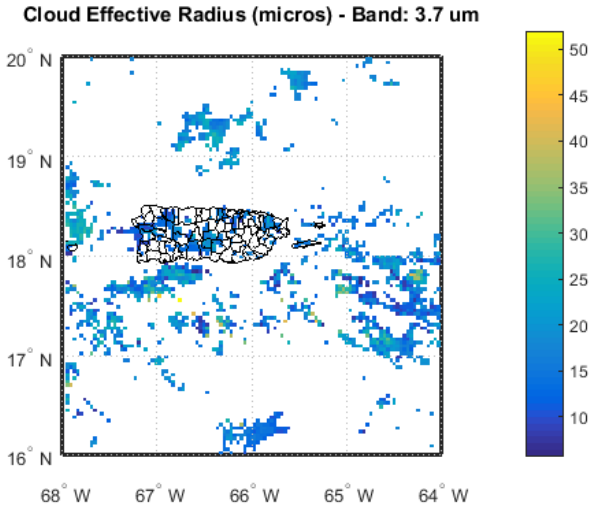


Channel 4

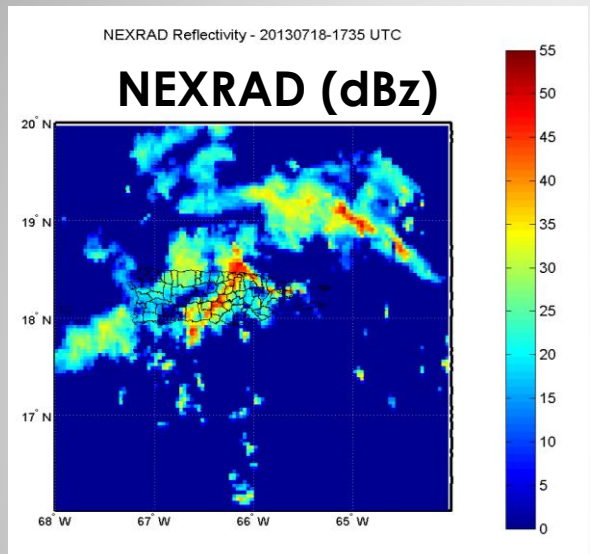
Potential Rainfall Indicators MODIS Clouds Products



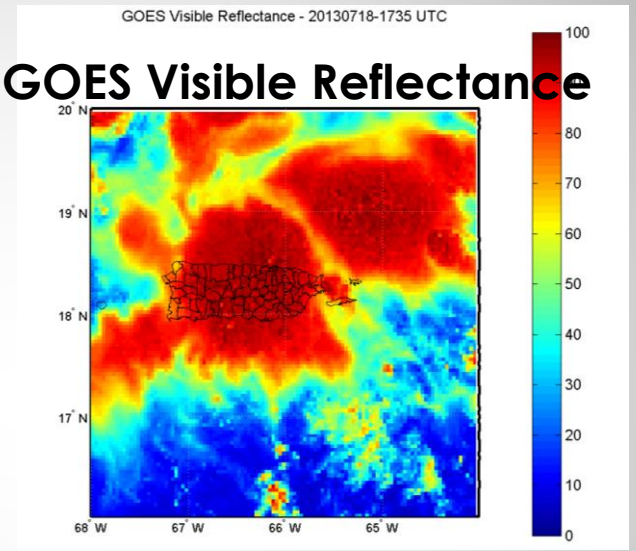




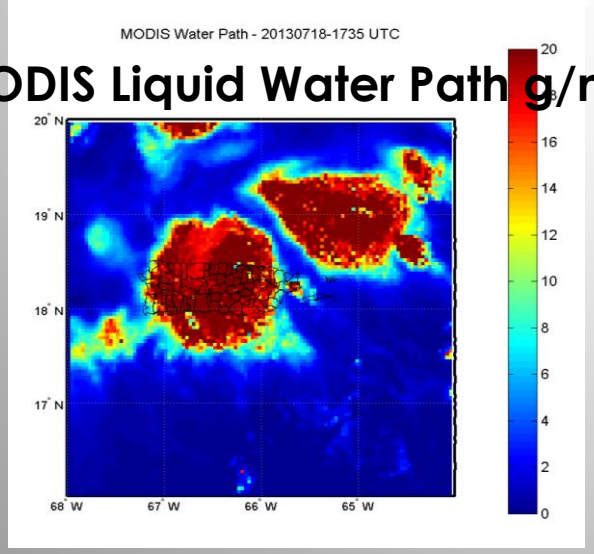
SCaMPR: Colder Cloud Event
July 18, 2013



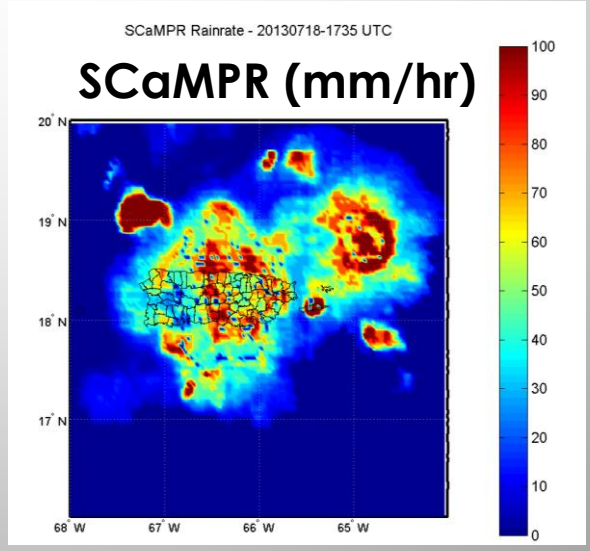
NEXRAD (dBz)



GOES Visible Reflectance

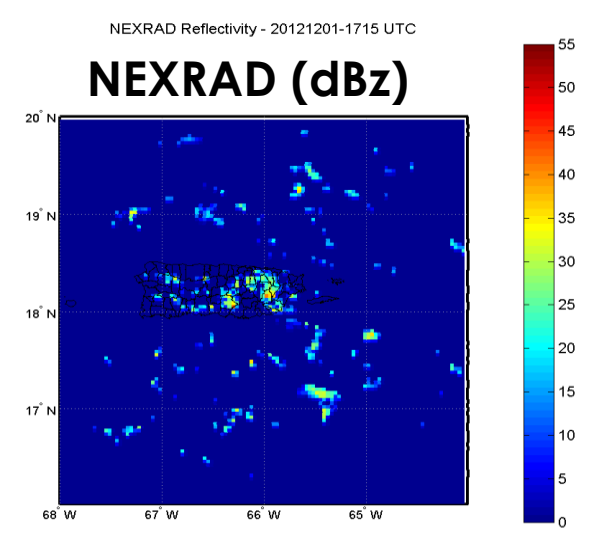


MODIS Liquid Water Path g/m^2

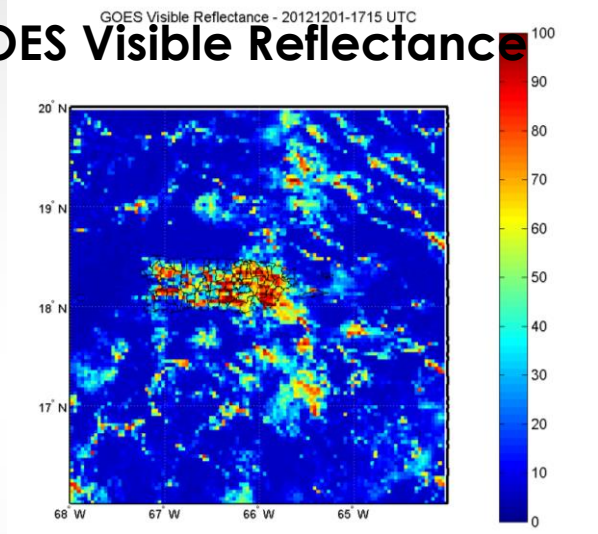


SCaMPR (mm/hr)

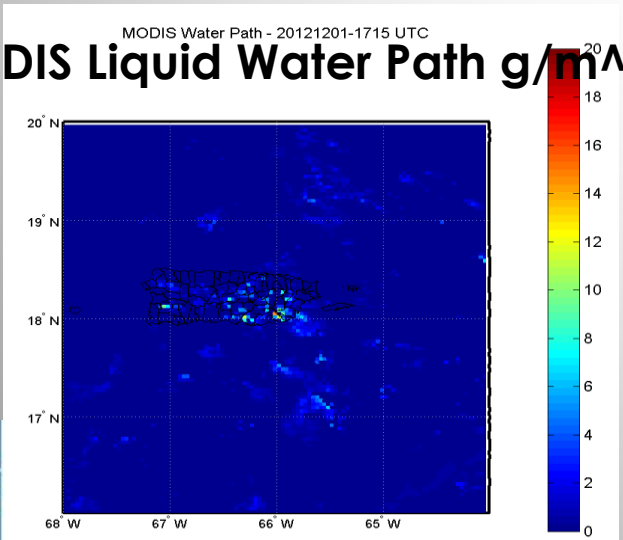
SCaMPR: Hotter Cloud Event December 1, 2012



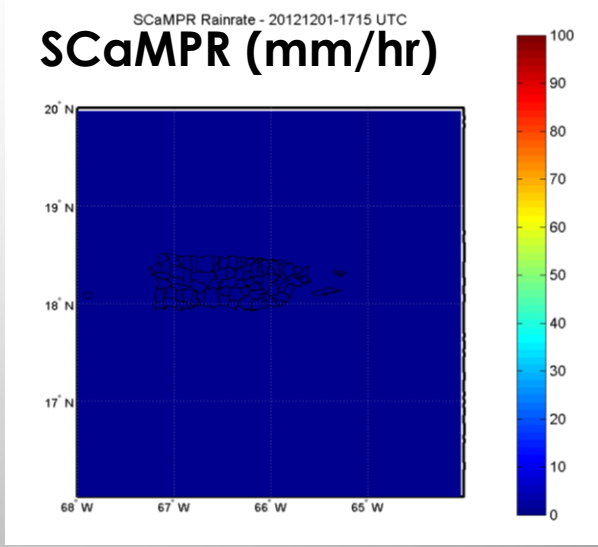
NEXRAD (dBz)



GOES Visible Reflectance



MODIS Liquid Water Path g/m^2

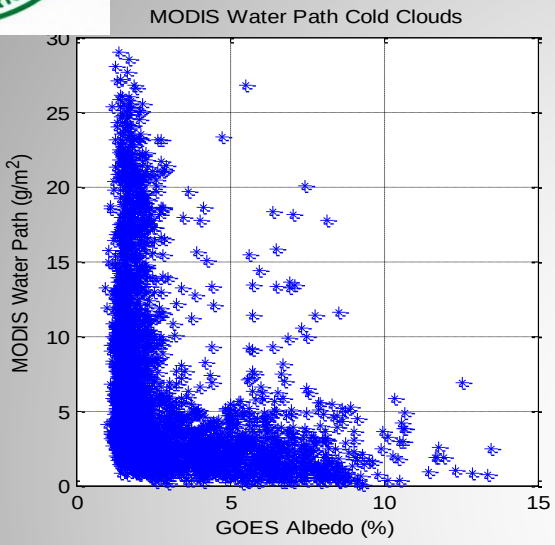


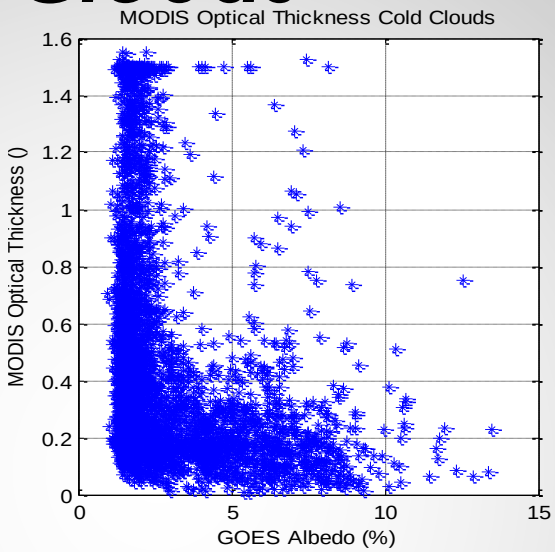
SCaMPR (mm/hr)

Dispersion Analysis

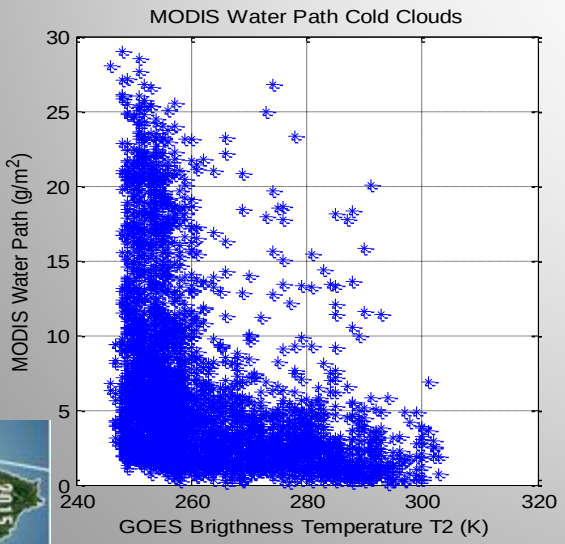
- *Identify potential interaction by NEXRAD Rainrate and MODIS Cloud Products.*
- *Find potential colder and hotter cloud interaction between MODIS and GOES Cloud Products.*
- *6 Rainfall Events are selected : 3 colder cloud and 3 hotter clouds events.*
- *Evaluation Period: 2008 - 2015*

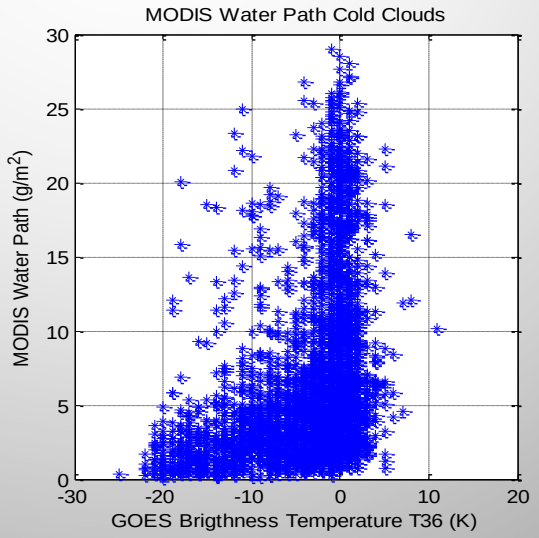
Preliminary Results: Cold Clouds





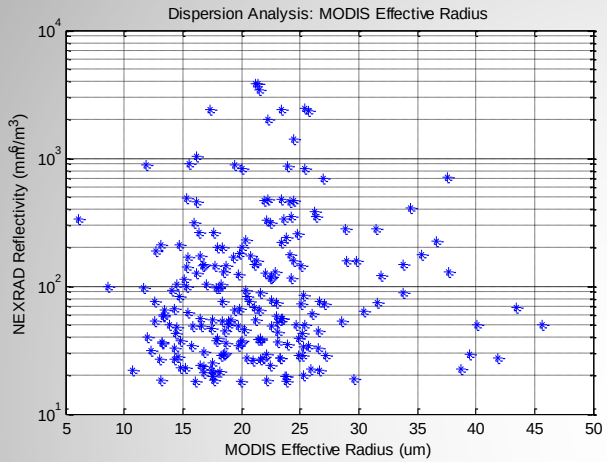
Inverse interaction between MODIS Water Path and Optical Thickness with GOES Albedo Product.

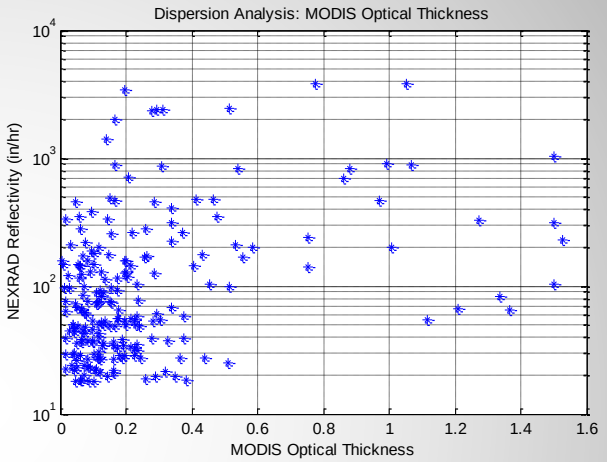


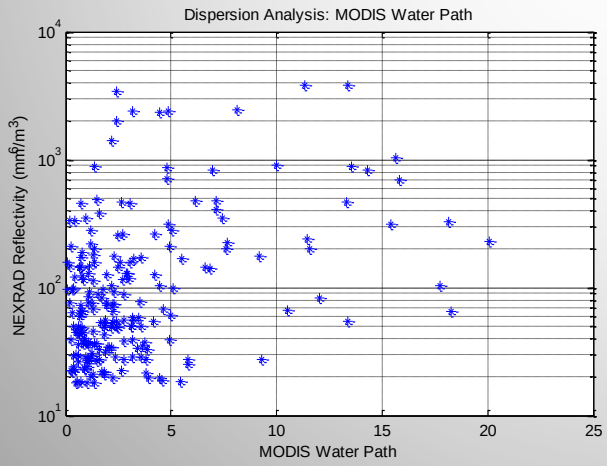


Positive interaction between MODIS Water Path and Cloud Top Bands 3 and 6 Differences.

Preliminary Results: Hotter Clouds

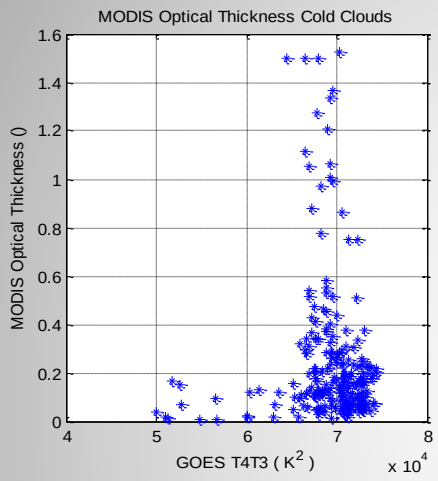


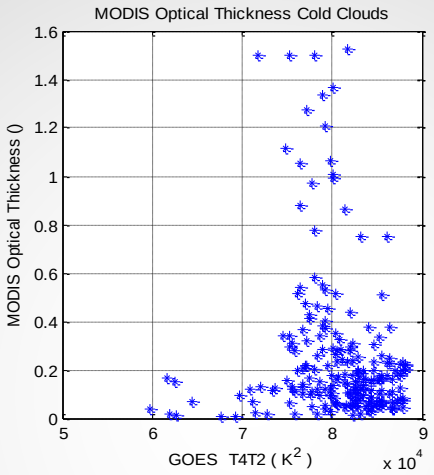


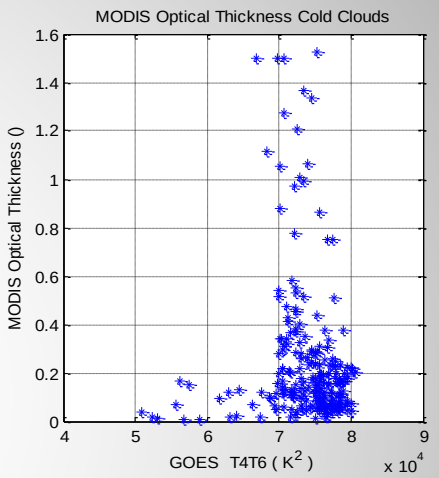


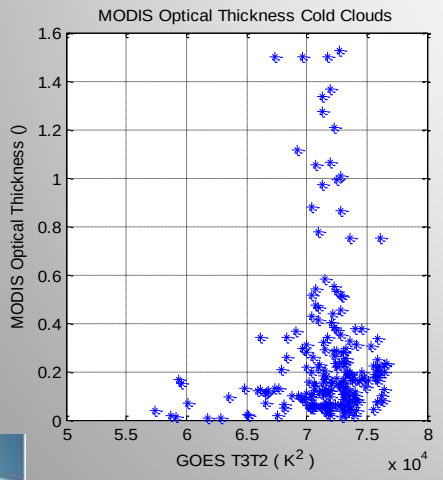
Potential Logarithm interaction between NEXRAD Rainrate and MODIS Optical Thickness and Liquid Water Path.

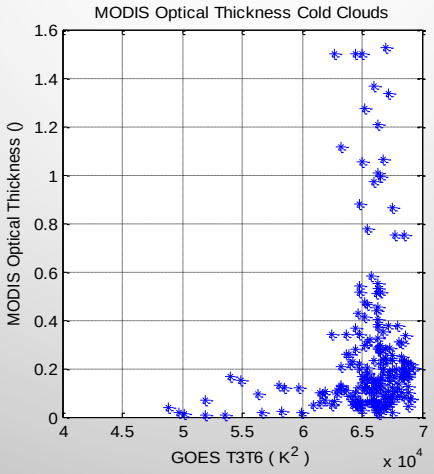
Preliminary Results: Hotter Clouds

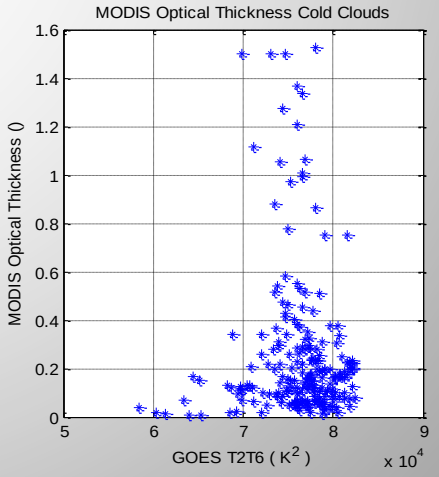






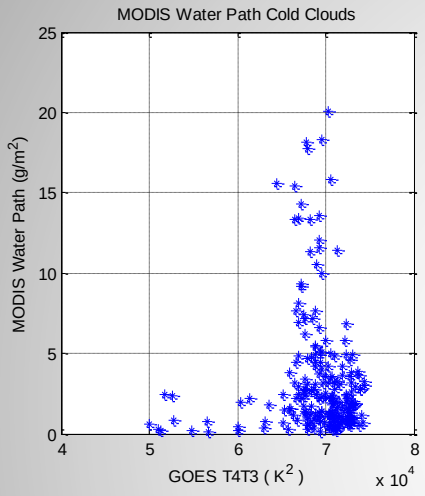


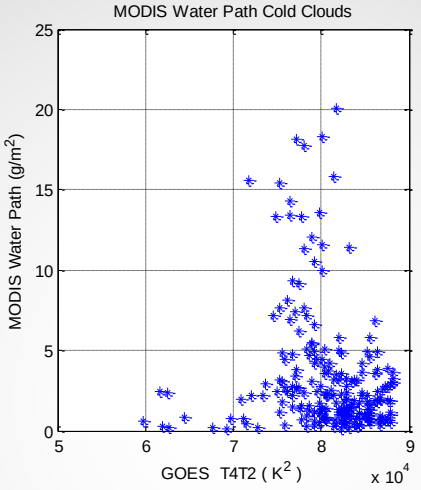


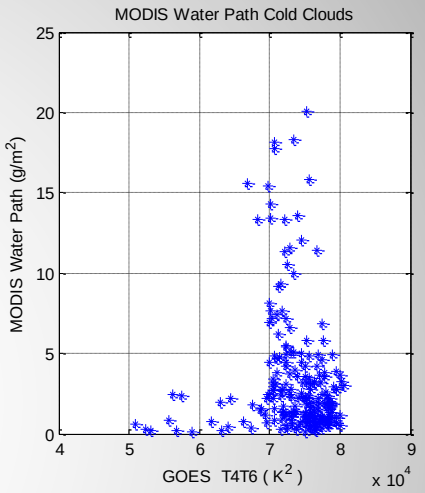


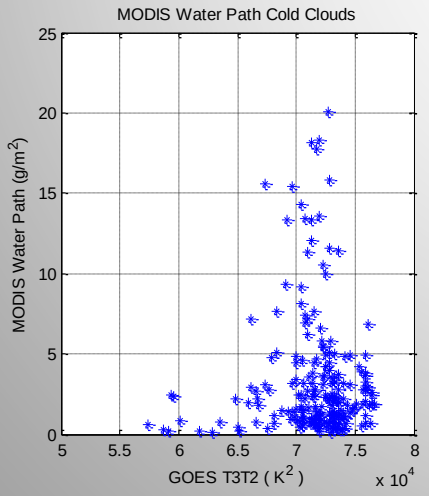
Positive interaction between Optical Thickness and GOES Bands

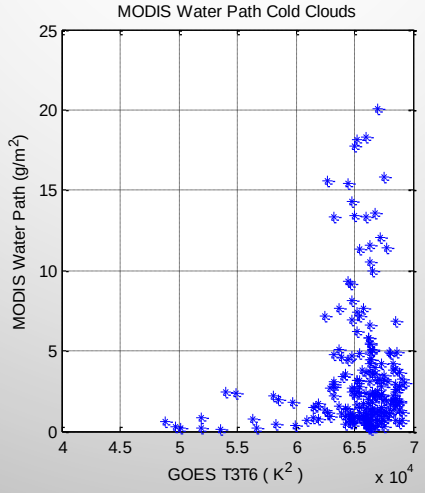
Preliminary Results: Hotter Clouds

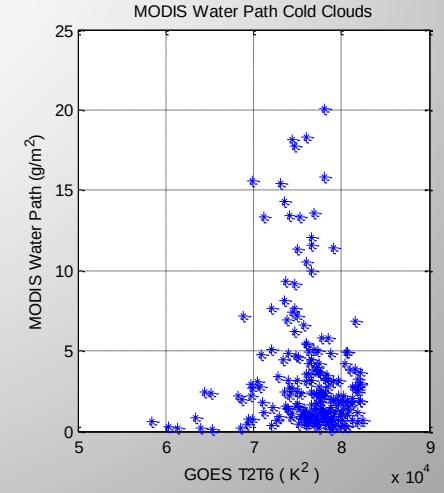












Positive interaction between Liquid Water Path and GOES Bands

Future Work

- *Develop new formulas to estimate Liquid Water Path and Optical Thickness using GOES Bands (Top Cloud Differences).*
- *Improve hotter cloud detection for SCaMPR (Top Cloud Combinations).*
- *Generate new empirical equations to estimate SCaMPR rainrate based on GOES Products for daytime and nighttime.*

ACKNOWLEDGEMEI

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References

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- *Scofield, R. A., and R. J. Kuligowski, 2003:* ***Status and outlook of operational satellite precipitation algorithms for extreme-precipitation events****. Mon. Wea. Rev.,* ***18****, 1037-1051.*