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

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Agenda

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

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

- **Self-Calibrating Multivariate Precipitation Retrieval.**
- 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

Exceptions to the Rule...

Colder Clouds: Vertical Convection
Highest Vapor elevation and lower top cloud temperature. BT Band 4 < 235 K

Hot Clouds: Horizontal Convection
Lower vapor elevation and higher top cloud temperature. (BT Band 4 > 235 K)
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

Channel 1    Channel 3    Channel 4
Potential Rainfall Indicators
MODIS Clouds Products

Cloud Water Path (g-m²) - Band: 3.7 um

Cloud Optical Thickness - Band: 3.7 um

Cloud Effective Radius (micros) - Band: 3.7 um
SCaMPR: Colder Cloud Event
July 18, 2013
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.
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References

