

Puerto Rico Student Test Bed

By Víctor Marrero-Fontánez Manuel A. Vega-Cartagena **CASA SLC Members UPRM Graduate Students**



University of

Massachusetts Amherst



University of Oklahoma





Puerto Rico Mayaguez

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Overview

- What is CASA?
 - Student Test Bed (STB)
- Magnetron Radar
 - Quantitative Precipitation Estimation (QPE) Study
 - Data Validation
 - Radar Specifications
- Off-the-Grid Radar
 - Antenna



What is CASA?

- <u>Collaborative Adaptive Sensing of the Atmosphere</u>
- NSF Engineering Research Center Program
 - Established in 2003
- Objective
 - To create a new engineering paradigm in observing, detecting and predicting weather and other atmospheric phenomena.
- Partner Universities
 - University of Massachusetts
 - Colorado State University
 - University of Oklahoma
 - University of Puerto Rico at Mayaguez



Student Test Bed

- Objective
 - To establish a QPE sensing network starting in the western end of the island taking into consideration coverage gaps from NEXRAD.
- Radar Sites
 - Three sites were selected based on geographical data and sociological impact. These are located in Mayagüez, Aguadilla and Lajas.



Student Test Bed



QPE Study

- <u>Quantitative Precipitation Estimation</u>
 - One of main efforts of CASA
 - Studies using 2-D video disdrometer performed
 - QPE using attenuating wavelength
 - X-Band Radar



QPE Study

- Path-Integrated Attenuation (PIA)
 - Study performed by Delrieu et al. [1]
 - Grenoble, France
 - Surface Reference Technique
 - Ratio of mountain returns
 - Presence and absence of rain
 - Later used for rain rate calculations
 - Rain rate retrieval algorithm not yet selected



QPE Study

- Methodology
 - Low elevation angle
 - Identify mountain cluttered radar bins using apparent reflectivity
 - Calculate average Z_a over cluttered bins during dry period
 - Compare to average Z_a during rain event
 - Perform rain rate retrieval



Data Validation

Several Tipping-Bucket Rain Gauges

- Located along propagation path

- Joss Waldvogel Impact Disdrometer
 - Rain Drop Size Distribution (DSD)
 - Expected Reflectivity Calculations



- Raytheon Marine X-Band Radar
- Single Polarization
 - Magnetron
 - F = 9.41 GHz
 - P_{peak} = 25 kW
 - Duty Cycle_{max} = 0.001





- Modifications
 - Antenna
 - 1.22m Parabolic Dish
 - G = 38 dB
 - 2.0° HPBeamwidth
 - Spinner
 - Originally 25 RPM
 - Lowered to 3 RPM





- Modifications
 - Data System
 - Linux based Mini-ITX embedded system
 - 12 Bit ADC for sampling video signal
 - 802.11b data transport to data archive server
 - Control
 - FPGA on PCI bus for timing signals and antenna position encoder data





- Location
 - Roof of electrical engineering building at UPRM
 - Tower already installed







casa

OTG Antenna

- Physical size: 17" by 17"
- Material: TLY-3 from Taconic
 - Er = 2.2, h = 0.787mm
- Resonant Frequency = 9.38GHz[*]
- Antenna tested in RadLab.
- The antenna did not perform as expected.

[*] result given by Designer

Single polarization 16 x 16 antenna array



OTG Antenna

- BW of single-pol antenna: 9.25 - 9.6 GHz [VSWR < 2].
- Higher side-lobes in left side of the pattern due to undesired radiation in the corporate feed.





OTG Antenna

Port1

- A multi-layer antenna is under design for dual polarization.
- Both polarizations are fed by aperture coupling.
- The array antenna will have rows of these patches connected in series.
- Resonant Frequency: 9.5 GHz [*]
- Cross-polarization: Around 29 dB for a single patch for each polarization is expected.
- This patch exhibits linear polarization and/or circular polarization if desired.

Dual polarization patch antenna

Latest Achievements

• Radar antenna moved to Stefani building rooftop.







Questions







- [1] Delrieu, G. et al., "Rain Measurement in Hilly Terrain with X-Band Weather Radar Systems: Accuracy of Path-Integrated Attenuation Estimates Derived from Mountain Returns", *Journal of Atmospheric and Oceanic Technology*, Vol. 16, pp. 405-415, April 1999.
- [2] Rincón, R.F. et al. "Estimation of Path-Average Rain Drop Size Distribution using the NASA/TRMM Microwave Link", IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Vol. 3, 9-13 July, 2001.

