

Initiative to bridge research and education into a sustainable weather network

Dr. Ricardo J. Morales De Jesús & Mr. Manuel S. Sanfiozeno De Orbeta
Physical Sciences Department & Geography Department
University of Puerto Rico – Río Piedras Campus
P.O. Box 23323, San Juan, Puerto Rico 00931-3323
rjmorales@uprrp.edu

The island of Puerto Rico, located in the Caribbean region, can be suitable scenario for cutting edge meteorology and climatology research of tropical marine environments. Puerto Rico has an area of 100 miles long by 35 miles wide; with a variety of micro climates that are subjected to extreme atmospheric disturbances, mostly hurricanes. The convenience of higher education research institutions and several research groups concerned with interdisciplinary interests on climate and climate change provides scientific expertise in several fields, for example the Caribbean Climate Studies group can be highlighted. The above mentioned conditions make the study of the meteorology and climatology of Puerto Rico a challenge and a desired goal. Also the topics of weather and climate have been identified as a common ground where research scientists, educators, alumni, teachers and students from Puerto Rico can share research activities with mutual benefit. An outreach initiative, named Education and Climate, is being developed to provide a virtual learning environment for the education and research communities to share the administration of a research quality network of weather stations. A growing need of high quality meteorological data is evident and the implementation of sensor networks is seen as one of the most promising alternatives to provide it. The inclusion of schools in the network is sought to provide for our educational and scientific needs. Several teacher training initiatives have been implemented to strengthen the project and will be presented in detail. Our project links research and education, with activities centered on the contribution of the teachers and their students, and a positive outcome is expected.

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Introduction:

The recent growth of interest in climatic implications of human affairs, and the needed research investigations on meteorology, led us on the pursuit of a sustainable weather observation network. We thought, if the scholar community gains interest in their regional meteorology, and share experiences among experts, and peers a good level of understanding would emerge. We the native peoples of the Caribbean Sea Islands have so much to share to the world on our own, so we decided to study the Meteorology of the Eastern Side of the Island of Puerto Rico. Our research group, "Educación y Clima" or Education and Climate, is dedicated to the installation, maintenance, calibration, data collection from 14 weather stations that constitute the Puerto Rico Weather Web, PRWW. Also we coordinate teacher training in field, conceptual and research activities through a virtual community and field trips. Two research assistants and two computer programmers, under my supervision as a research advisor and the guide of an expert in database design. We are integrating data management strategies through remote access databases on the Internet, Distance Learning Meteorology Courses and Research Training Activities. Educators facilitate collaboration, with technological tools, between teachers and interdisciplinary scientists to study the Caribbean Climate.

As a personal note, I among them am pursuing a career on these matters. As an Associate Professor of the Physical Sciences Department, from the University of Puerto Rico in Río Piedras, I coordinate the Education and Climate Project to host the research activities of the Puerto Rico Weather Network. My interest on Caribbean Climate come from early in my career, my Doctoris Philosophiae from the University of Puerto Rico earned in May 2002 was based on the molecular characterization of organic matter on atmospheric aerosols and ocean water samples. Once the proposed composition is decided, a comparison performed through computer searches on a mass spectra library database from real and standardized samples. The analytical techniques used whereof Organic Extraction, Gas Chromatography and Mass Spectrometry. The goal of the research was to prove the origin, including a Research Cruise in the Caribbean, of the atmospheric aerosols believed to be active on the formation of cloud condensation nuclei. The climatic implications are to be determined, but the role of oceanic aerosols on the formation of clouds was to be gained. My colleague, Dr. Raul Blanco González, studied the distribution of these aerosols among different volatility and solubility regimes in the atmosphere by sampling at different elevations. The active process of atmospheric transformation was proved by the sampling of different locations among natural and human influenced environments. Results were consistent and statically valid; an oceanic source of organic material can be related to the composition of CCN active atmospheric particles that were sampled during several years in Puerto Rico. ^{1,2}



Image 1: From Context to Concept, the research of Caribbean clouds.

There are at least five main research groups in Puerto Rico interested in climate studies. The main example given here by the Caribbean Climate Studies Group, The CCSG, in charge of Dr. Jorge González from the University of Puerto Rico in Mayaguez, was a solid foundation for the initial collaborations that brought to existence to the Puerto Rico Weather Network. The website <http://cmg.uprm.edu> illustrates the diversity of approaches used by this research group, from LIDAR aerosol research, statistical analyses, climatic modeling, among others. In the spring of 2004 his research group, in collaboration with the Physical Sciences Department, UPRRP, performed with high standards the Atlas Mission, <http://www.cmg.uprm.edu/atlas/>. The main results of the mission are summarized in high resolution thermal images of the metropolitan area of San Juan, the capital city of Puerto Rico, and the Caribbean National Forest, a Long Term Ecological Research Site from the National Science Foundation of USA. The city of San Juan, Puerto Rico is now recognized to show the Urban Heat Island phenomena.³

The thermal gradient between highly urbanized surfaces and the natural spaces were determined, surface temperature and surface albedo was proved with an airplane based thermal imaging system. In the follow up research campaign, in summer of 2005, in collaboration with Dr. Charles Hall, Dr. Jorge González, Mr. David Murphy, Mr. Manuel Sanfioenzo, the first research sensor network was installed and maintained by our research group. The correlation between the meteorological parameters of temperature and relative humidity and land use and land cover characteristics was studied with 13 sensors along the gradient of El Yunque (CNF-LTER-NSF) to the city of Dorado on the western edge of the metropolitan area of San Juan. The collaboration evolved into the current Puerto Rico Weather Web, through the integration of school teachers into the research activity.

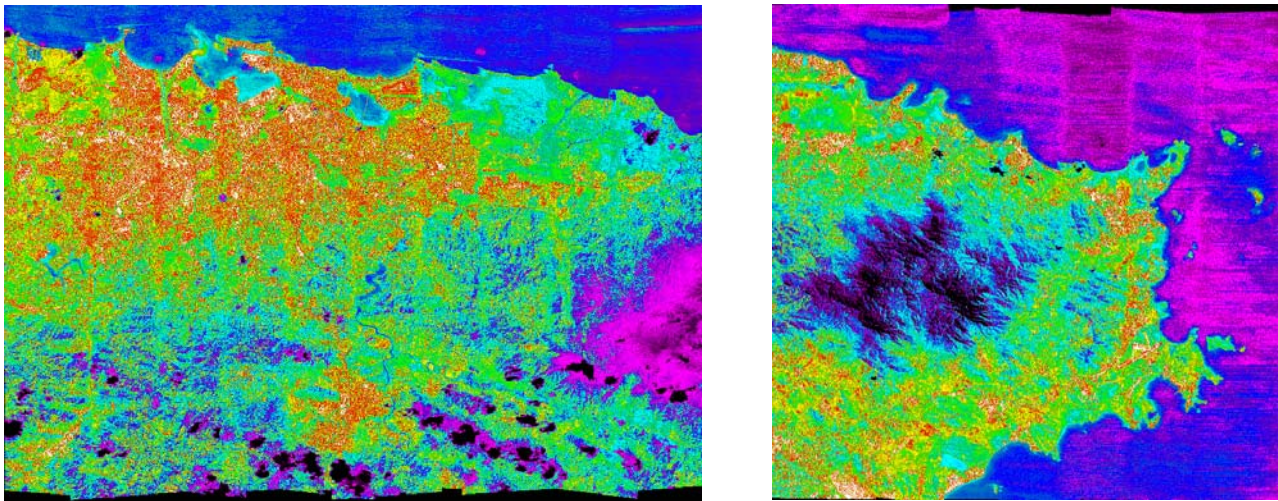


Image 2: Surface Temperature Images of the metropolitan area of San Juan and El Yunque National Forest taken during February 2004 during the Atlas Mission.

<i>Puerto Rico Weather Web Members</i>				
ID	Institution	Latitude	Longitude	Elevation
EC001	San Juan Heads Lighthouse Natural Reserve, Fajardo	N 18° 23' 11.1"	WO 65° 37' 10"	41m
EC002	East Peak, El Yunque	N 18° 16' 08"	WO 65° 45' 30"	1041m
EC003	Liberata Iraldo School, Rio Grande	N 18° 23' 08"	WO 65° 51' 45"	22m
EC004	Angel P. Millan School, Carolina	N 18° 23' 18"	WO 65° 56' 10"	19m
EC005	Petra Zenon De Fabery School, Trujillo Alto	N 18° 22' 09"	WO 66° 00' 36"	60m
EC006	UPR Rio Piedras, Geography Department	N 18° 24' 22"	WO 66° 02' 58"	41m
EC007	Jose Julian Acosta School, Old San Juan	N 18° 28' 05"	WO 66° 06' 49"	89m
EC008	Francisco Gaztambide Vega School, Bayamon	N 18° 20' 07"	WO 66° 12' 01"	127m
EC009	ESC. Publica Marcelino Canino Canino, Dorado	N 18° 25' 48"	WO 66°16'28"	24m
EC010	Superior Vocacional de Cidra School, Cidra	N 18° 10' 02"	WO 66° 09' 43"	433m
EC011	Dra. Conchita Cuevas School, Gurabo	N 18° 15' 06 "	WO 65° 58' 30"	59m
EC012	Teodoro Aguilar Mora School, Yabucoa	N 18° 02' 43"	WO 65° 52' 46"	19m
EC013	Juan J. Maunes Pimentel School, Naguabo	N 18° 12' 30 "	WO 65° 44' 07"	86m
EC014	German Rickehoff School, Vieques	N 18° 09' 28"	WO 65° 23' 30"	19m

Table 1. Members and geographic coordinates of the PRWN participants.

Puerto Rico Weather Web:

The weather web is composed of fourteen Davis Advantage Pro2 weather stations. The meteorological parameters being measured are temperature, relative humidity, barometric pressure, precipitation and wind speed and direction, three specific locations also have solar radiation and UV sensors. The weather stations will be administered by the school teachers their students and the Education and Climate research group. The Internet database website is intended to be available early in January 2007 for every member to upload the meteorological data into a common database.

Puerto Rico Weather Web Network 2006



Image 3: Map showing Eastern Puerto Rico with PRWW stations as red suns.

¹ Morales De Jesús, R., **2002**, PH. D. Thesis Dissertation titled A Source Apportionment Study of the Caribbean Submicron Organic Aerosols. University of Puerto Rico.

² Blanco González, R., **2002**, PH. D. Thesis Dissertation titled Methodology for the Identification of Organic Compounds in Wet Precipitation, Gases and Submicron Aerosols by Gas Chromatography and Mass Spectrometry. University of Puerto Rico.

³ González, J. & Luvall, J., et al. Urban Heat Islands Developing in Coastal Tropical Cities. EOS, Transactions, AGU, Vol. 86, No. 42, 18 October 2005, p. 397-403.