Sea Breeze and Orographic lifting in Western Puerto Rico

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Overview: Microclimates are everywhere in Puerto Rico, which is only 100 miles long and 35 miles across. The topography and available moisture creates an interesting weather pattern and scale. It is not uncommon to see a flooded road while raining and just 100 meters away have that same road completely dry and sun shining on it. Even though there are a few synoptic scale patterns that help increase the chance of "widespread" rain, in terms of microclimate, most of the rain we receive is due to the local effects of sea breeze convergence and orographic lifting. (I wrote "widespread" because relative to the island, it is a widespread event. However, compared to the mid-latitudes or other places in the mainland U.S. this is actually a very small area.)

These local effects allow for some big variations in precipitation within small distances. To give you an idea of how much this variation can be, consider the size of the island (about 100 miles long by 35 miles across), and then consider the fact that on the northeast side of the island there is a rain forest which observes on average about 200 inches of rain a year, while in the southwestern side of the island there is actually a "dry forest" (with cacti and everything) which on average observes only about 30 inches of rain a year. However, we will focus on the west-southwestern side of the island where these local effects cause a difference of about 67 inches of rain a year between 2 stations that are only about 14 linear miles apart.

Image of mainland Puerto Rico using Google Earth.

Close-up of the location of stations used for comparison, using Google Earth I estimated the linear distance between them, which was 14.26 miles.

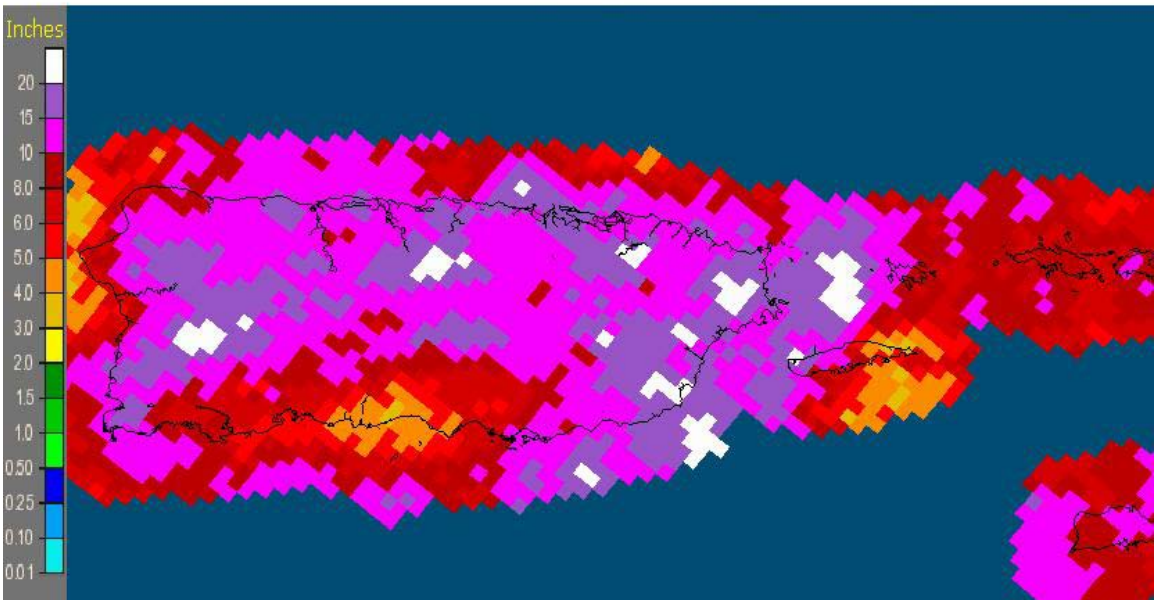
The stations used for comparison were Maricao Fish Hatchery and Magueyes Island. Maricao Fish Hatchery has an average rainfall of 97 inches per year with 120.6 rain days a year, making an average of 0.80 inches of rain per rain day. Magueyes Island's average is 30.23 inches a year with 83.3 rain days a year, making for 0.36 inches of rain per rain day. The difference is not only the amount of rain total but also rain rate. The rain rate in Maricao Fish Hatchery is higher due to the prevalence of thunderstorms.

Synoptic-Scale ingredients: Not much in the synoptic scale is needed to trigger precipitation over Maricao Fish Hatchery. We have abundant moisture (usually about 1.8-2.2 inches PW consistently during the months of May-November) which combined with local effects alone causes rainfall in that area. However, having divergence aloft due to an upper-level trough or some other feature increases the chances of developing thunderstorms in the area where there is also sea breeze convergence and diurnal heating causing 3-5 inches of localized rain in just a few hours.

IC4.3: AWOC Winter Microclimates Exercise

Arrows represent sea breeze direction, and the red outline represents an approximation of the typical area where sea breeze convergence occurs. This however does not mean that this is the only place where sea breeze occurs in Puerto Rico.

San Juan, PR (SJU): May, 2011 Monthly Observed Precipitation
Valid at 6/1/2011 1200 UTC- Created 6/3/11 21:38 UTC



Radar estimated precipitation for the month of May 2011. Notice the “V” shape of higher precipitation on the western side of the island.

Impact of microclimate on the forecast: We know that under certain conditions thunderstorms are very likely for that area, especially on the convective months (mostly May through November), therefore, as a rule of thumb, we look for synoptic scale features that would inhibit or enhance convection, moist air mass, no thick overcast skies, and light winds that won't interfere with the sea breeze. We also use the upper air soundings to determine instability and potential for thunderstorms.

Numerical Models: At the scale that things happen in Puerto Rico, the common numerical models such as the NAM and the GFS are very limited as they are unable to see what happens in such a small scale. Most of the time, the models are used as guidance to determine whether there is synoptic scale patterns that may affect the wind speed and direction and if there is anything that would significantly inhibit or enhance thunderstorm development during the convective months.