Sea Breeze, Trade Wind, and Terrain Influence on Rainfall Location over Western Puerto Rico

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MOTIVATION

SEA BREEZE CIRCULATIONS

Heavy rainfall events are common in western Puerto Rico. However, the precise rainfall location and intensity varies day to day. We hypothesize that such variation depends on the sea breeze, predominant winds, and the complex terrain of the island.

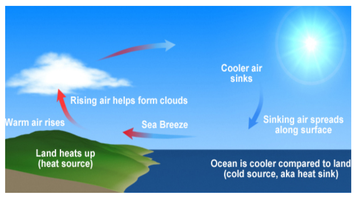

Figure 1. Sea breeze circulations are induced by land-sea thermal differences.

APPROACH

PERIOD: JANUARY 2010-AUGUST 2017

NWS-SJU: Soundings	+	MGZP4: Wind Data	Characterize predominant winds Determine sea breeze
NEXRAD Level 2: Radar Image	+	MSWEP: 3hr Rainfall Accumulation	Determine rainfall location
NCAR WRF			Simulate wind behavior

Summer Cases:

- 4 Easterly Cases
- 4 Northeasterly Cases
- 4 Southeasterly Cases

Figure 2. The island of Puerto Rico with some ground stations on the western side(from red line to left), the National Weather Service and its reflectivity radar. The Mayagüez town is highlighted in yellow.

Key for acronyms:
NWS-SJU= National Weather Service San Juan, PR
MGZP4= Ground Station: Mayagüez Harbor Station, PR
MSWEP= Multi-Source Weighted Ensemble Precipitation
NCAR= National Center for Atmospheric Research
WRF= Weather Research and Forecasting v4.2 Model

KEY RESULTS

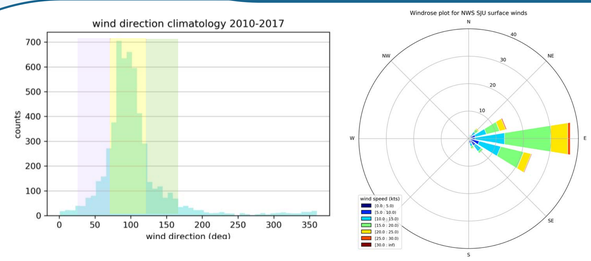

Figure 3. The histogram (Left) and the windrose (Right) demonstrate that winds in Puerto Rico come predominantly from the east with some northeasterly and southeasterly winds.

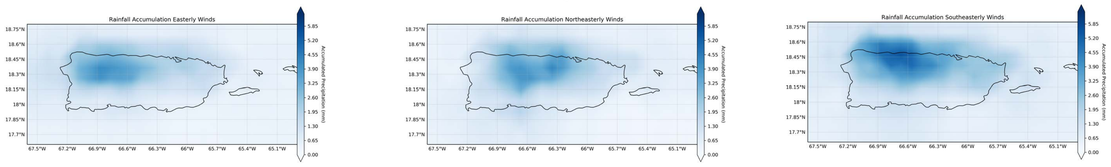

Figure 4. Average rainfall accumulation plots from the year 2010 to 2017 for easterly winds (Left), northeasterly winds (Center), and southeasterly winds (Right) in Puerto Rico.

Easterly Case: 2016-08-15

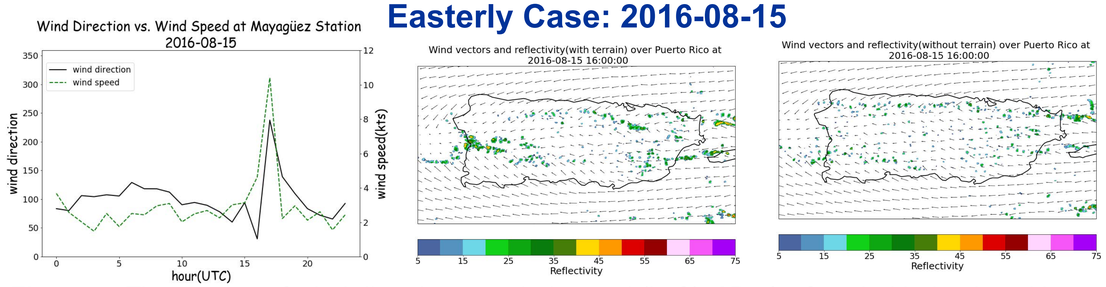

Figure 5. Time series of wind direction vs. wind speed (Left), 2D plot for wind behavior with terrain (Center), and 2D plot for wind behavior without terrain (Right).

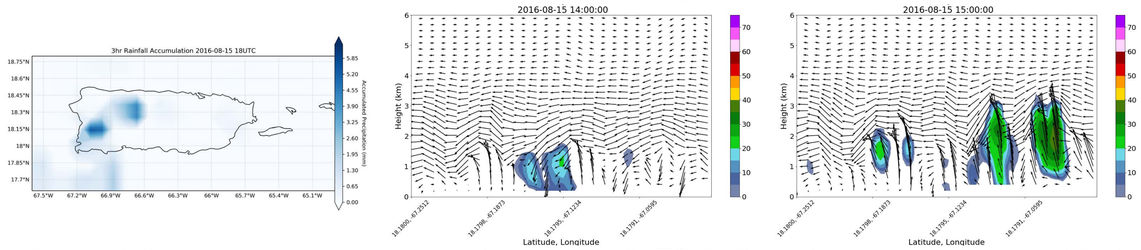

Figure 6. 3hr average rainfall accumulation plot at 18UTC (Left), vertical cros sectional plot for the evolution of sea breeze with terrain at 14UTC to 15 UTC respectively (Center & Right).

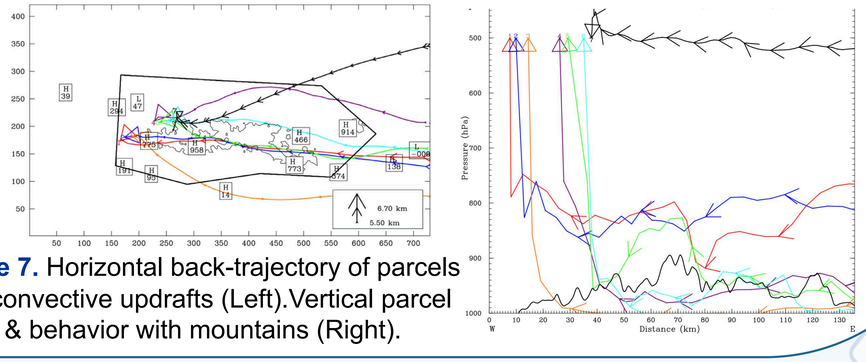

Figure 7. Horizontal back-trajectory of parcels from convective updrafts (Left).Vertical parcel levels & behavior with mountains (Right).

CONCLUSIONS

- **The initial location of rainfall depends on background conditions, but once formed the event is modulated by local factors and convergence intensity.**
- **Trade winds influence the eddies that form around the mountains, thus reinforcing the sea-breeze circulation and convergence in western Puerto Rico.**
- **Model simulations with and without terrain show that sea breezes only form when terrain is present.**

FUTURE WORK

- **Test simulations on other islands with complex terrain.**
- **Investigate factors that determine heavy vs. light precipitation events.**
- **Further investigate why sea breezes form in WRF simulations with terrain.**

REFERENCES

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