The City College of New York

NOAA-CREST CENTER FOR EARTH SYSTEM SCIENCES AND REMOTE SENSING TECHNOLOGIES

CUERG Coastal Urban Environmental Research Group

NSF

WORKSHOP

"A Socio-technical Framework for Enhancing Resilience in Islanded Communities (ERIC) "

"GEO-PHYSICAL MODELING"

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Context

Hurricane Marie near peak intensity to the southeast of Puerto Rico on September 19,2017

- Maria reached its peak intensity over the eastern Caribbean with maximum sustained winds of 175 mph (280 km/h) making it the tenth-most intense Atlantic hurricane on record.
- For weeks in Maria's wake, most of the island's population suffered from flooding and lack of resources. After 1-month, 29% of the island population still lacked drinking water and 3 Million people (88% of population) were without power. Hundred of thousands of people have been displaced by the storm.
- Total losses from the hurricane are estimated at between $52 and $95 billion, with $17B for the power infrastructure alone. Total, updated, casualties estimated in close to 5000, making Maria the deadliest storm in History.

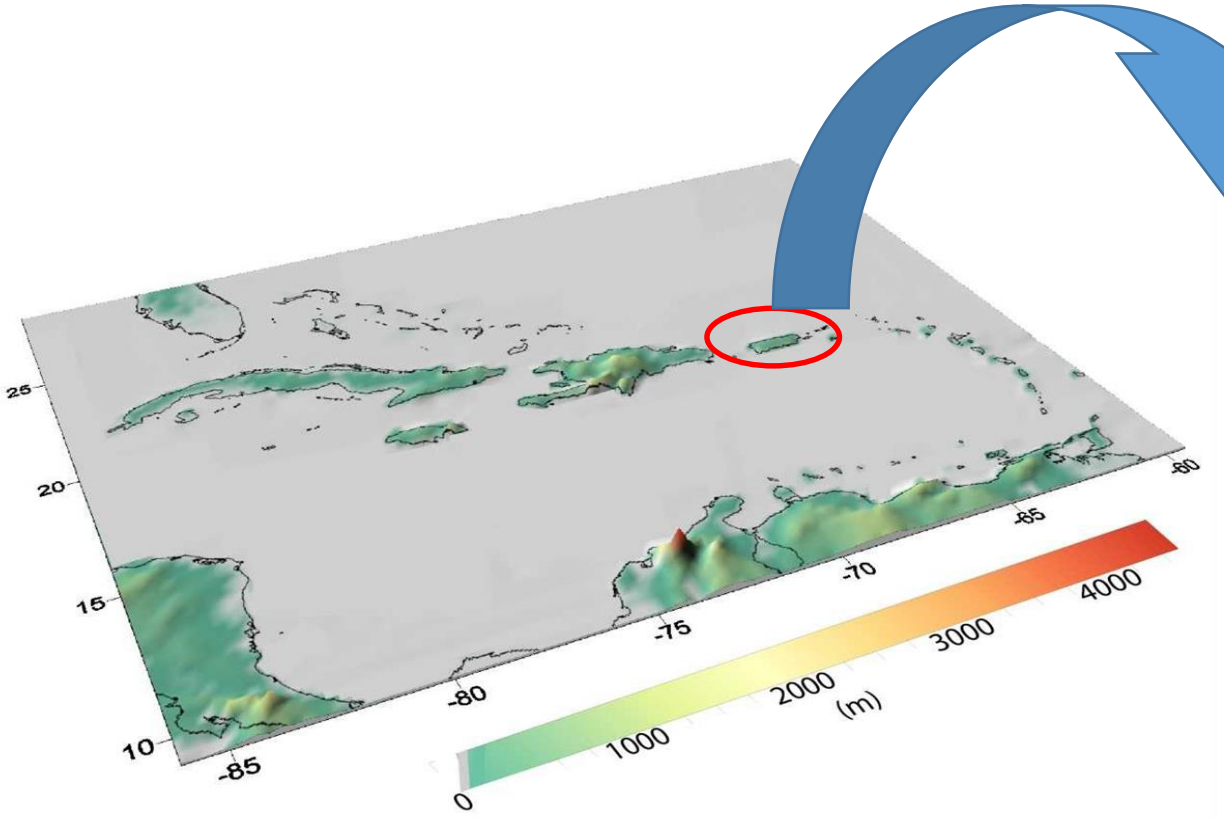
Content

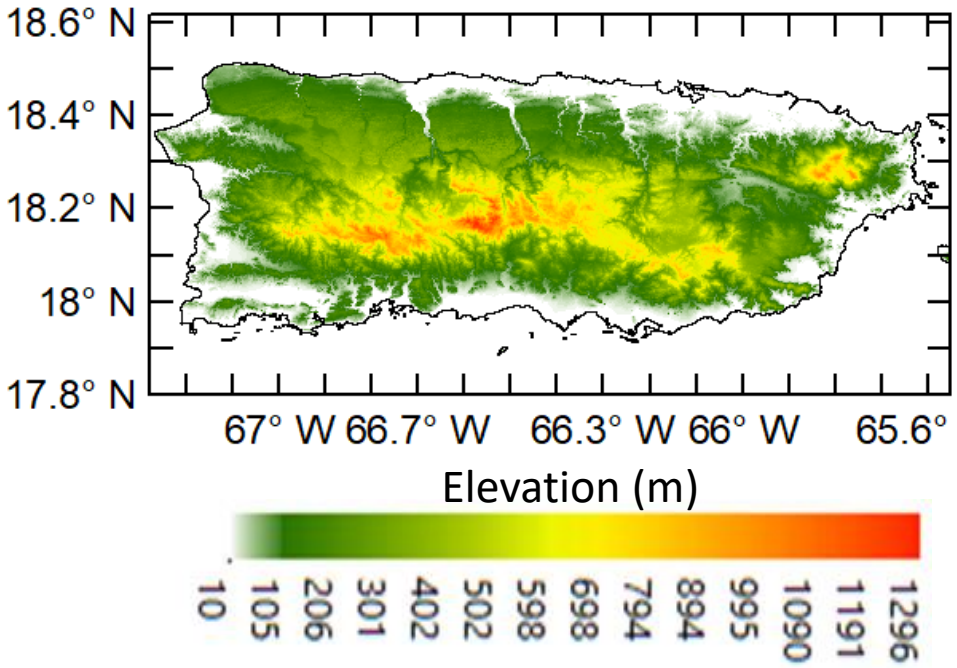
- **Objectives**
- **Spatial Information**
- **Historical records on Sea-Surface Temperature and Vertical Wind Shear**
- **Background**
- **WRF Domain and Parameterizations**
- **Validation**
- **Results “Orographic effects”**
- **Products to share (types and format and where to find it)**
- **Future work**

Objectives

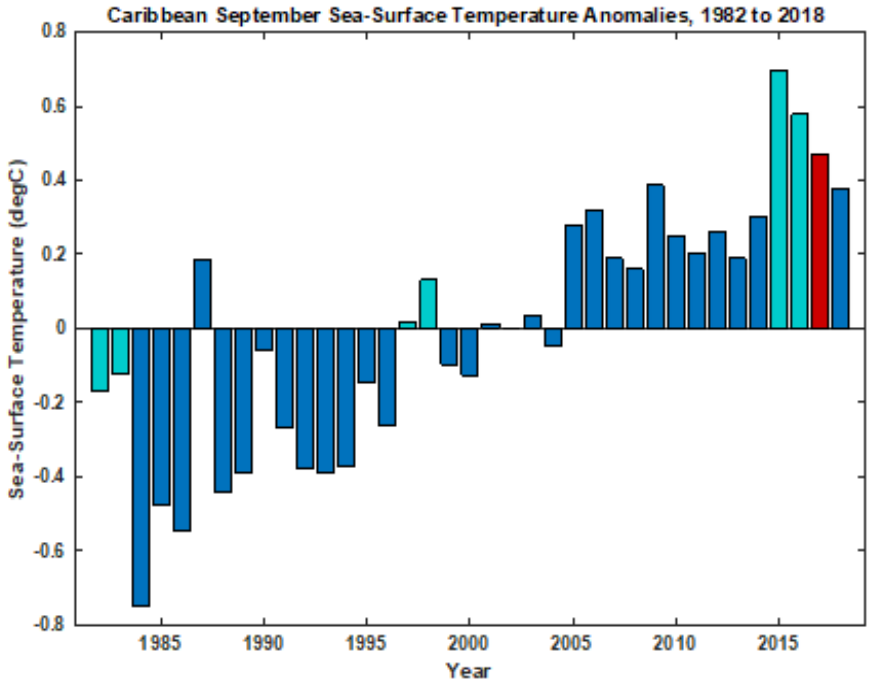
- Replicate hurricane Maria using WRF modeling.
- Provide physical information for damage assessment

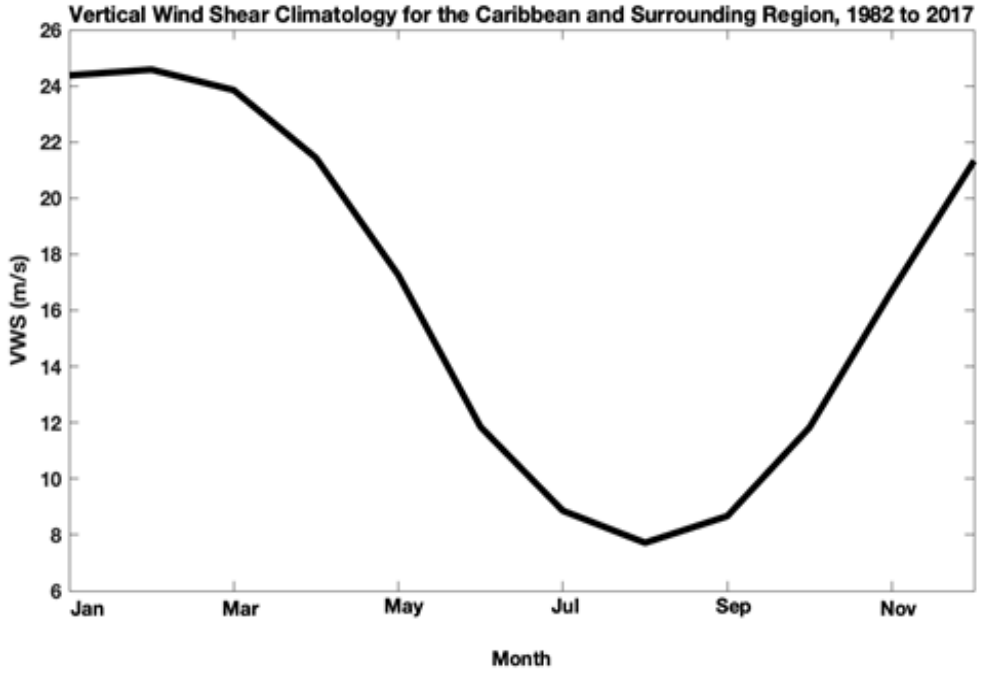
Spatial Information: Region of Interest





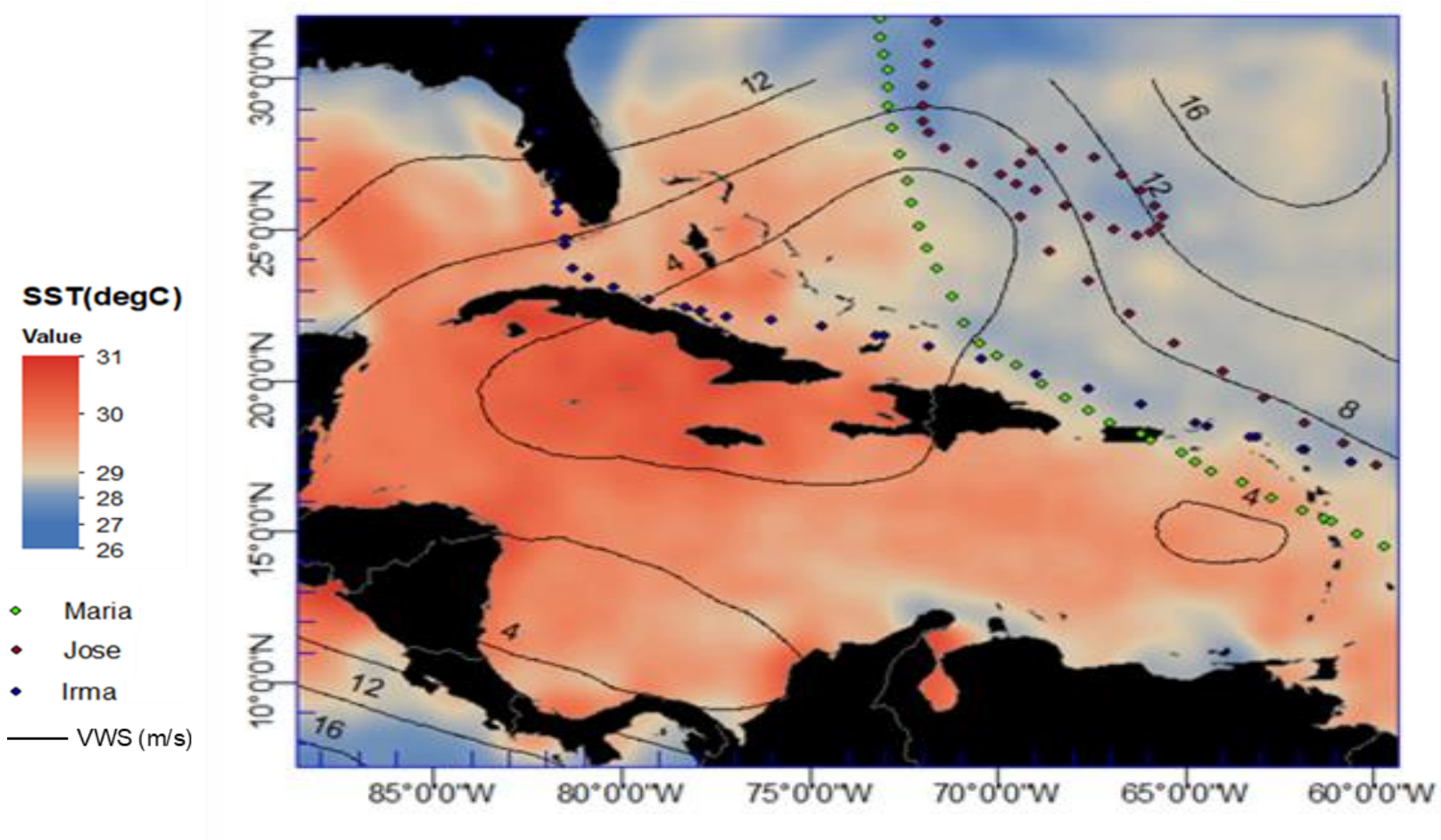
Historical Records on SST and VWS





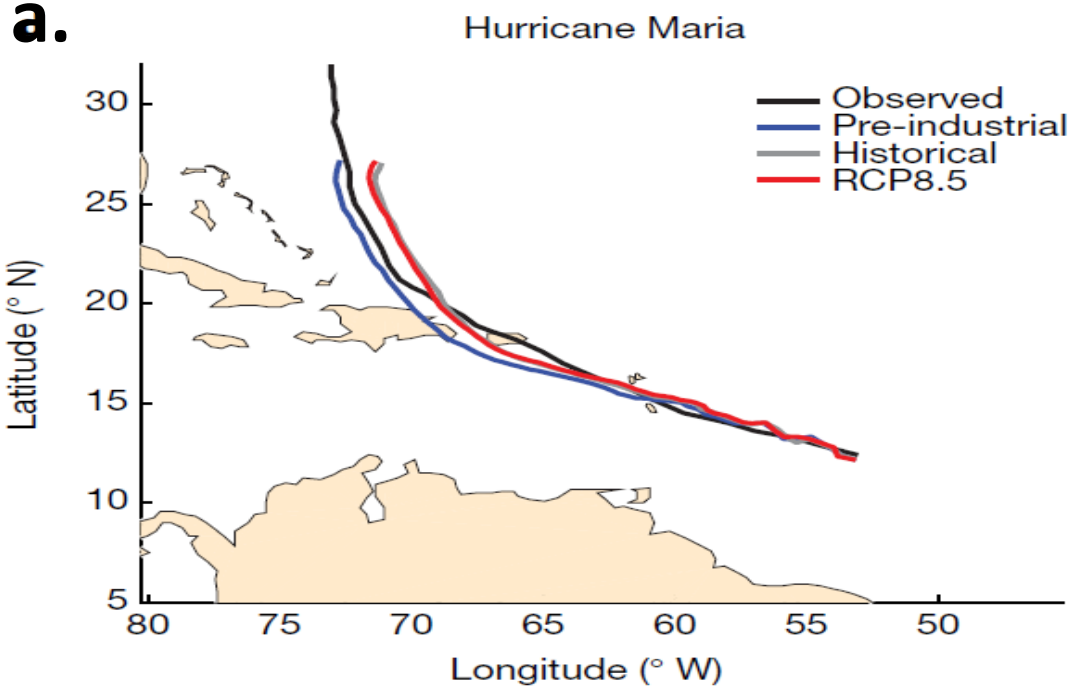
GREEN Bar- **El Niño** Year
Red Bar –September 2017
Blue Bar-Non **El Niño** Year

September 2017 Records on SST and VWS



Background

a.



b.

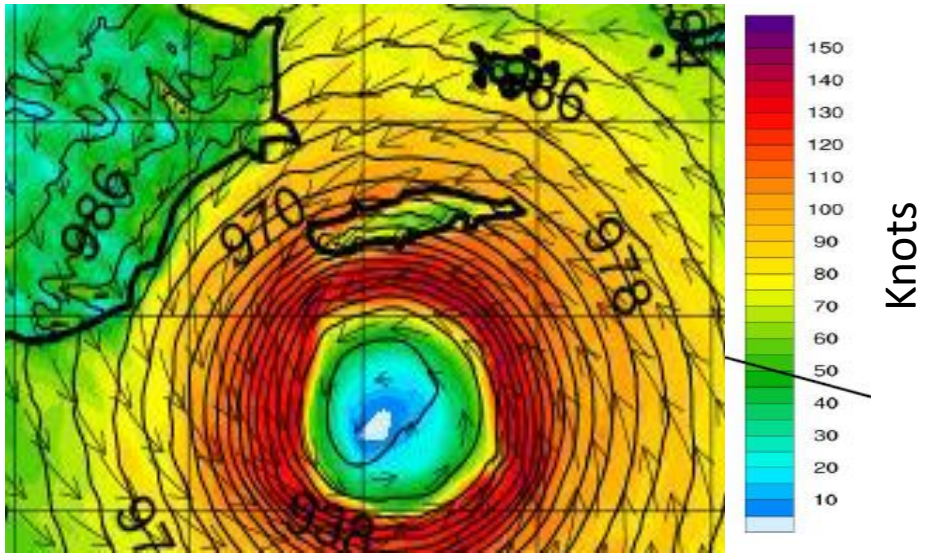


***Figure 1**: Wind speed of Hurricane María (knots) for WRF1 on 20 September 2017 at 11:00:00. The arrows show wind direction.*

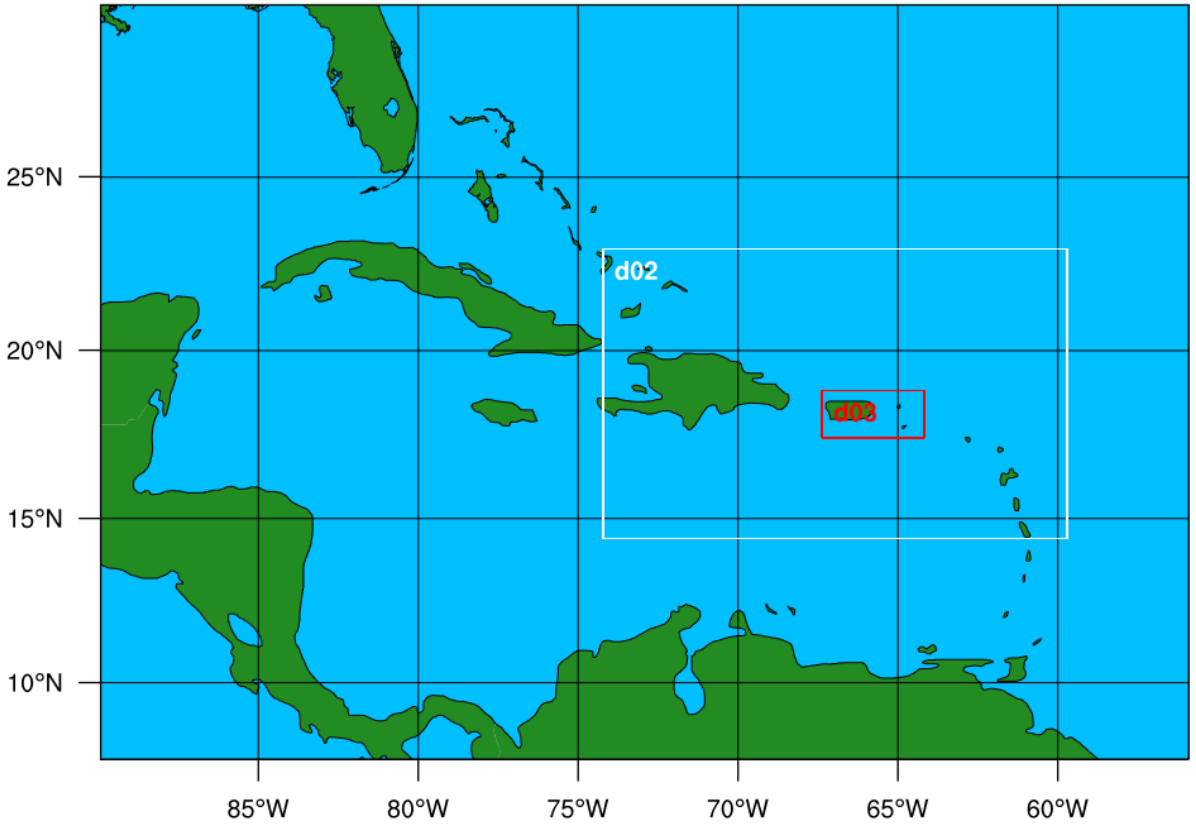
a. Christina M. Patricola et al , Anthropogenic influences on major tropical cyclone events, “Nature” 2018

b. Nathalie G. Rivera-Torres, The Impact of High-Resolution Terrain Data on WRF Simulations of Hurricane María , SOARS® Summer 2018

c. Y Feng et al, Rapid remote sensing assessment of impacts from Hurricane Maria on forests of Puerto Rico , “PeerJPreprints” 2018 https://peerj.com/preprints/26597/

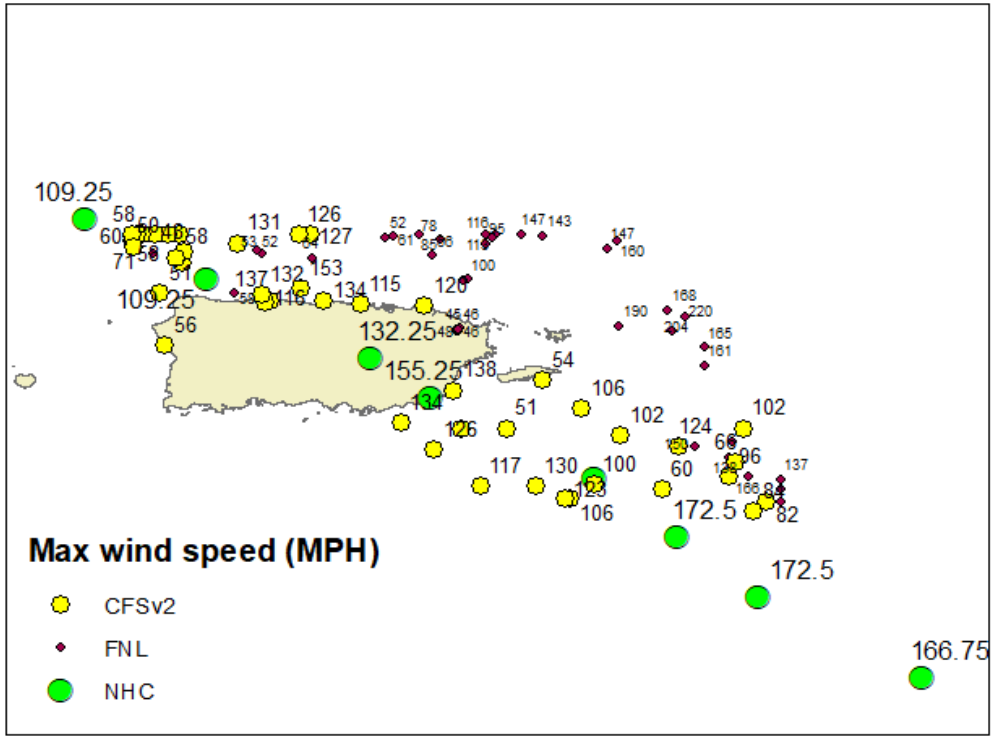
WRF Domain and Parameterizations

WRF Domain configuration

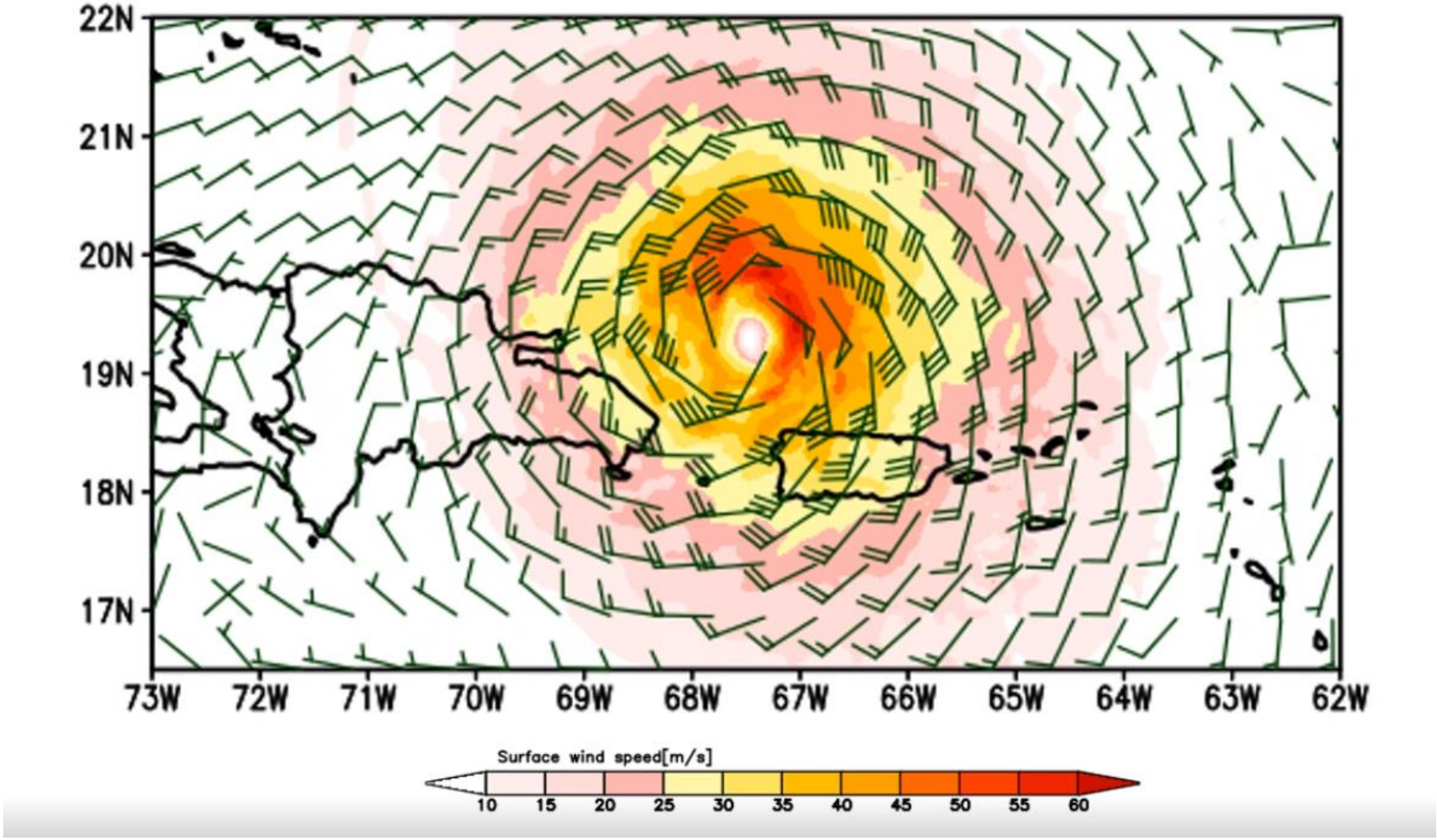


WRF Parameterization	
Microphysics	WRF Single-Moment 6-class scheme
Longwave Radiation	RRTMG
Surface Layer	Quasi-Normal Scale Elimination PBL shcemes's surface layer option
Land Surface	Noah Land Surface Model
Planetary Bounday Layer	Yonsei University Scheme
Cumulus Parameterization	Tiedtke scheme, used only for coarser domain
Boundary and initial condition	NCEP-FNL (1 degree, 6 hourly), CFSv2(0.5 degrees, 6 hourly)

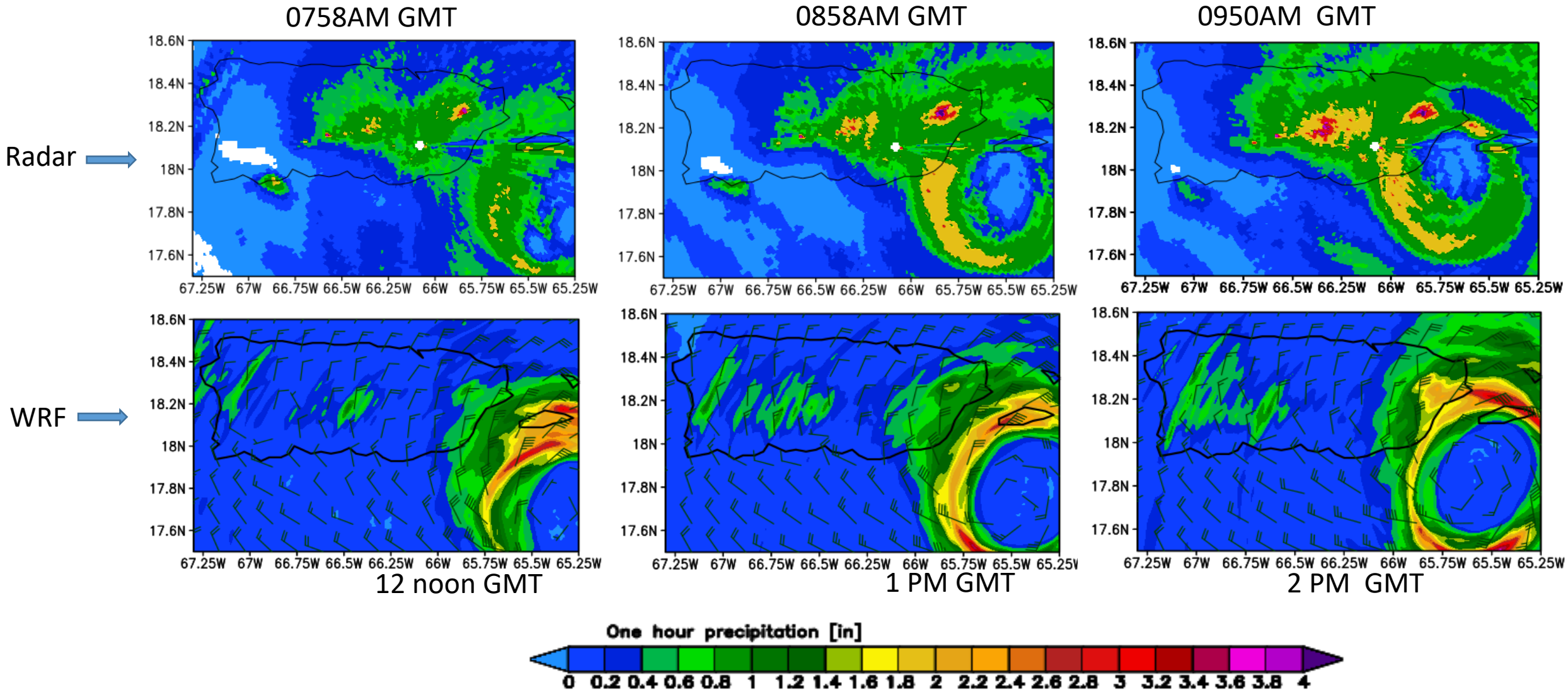
Validation -Summary of hurricane Maria storm track



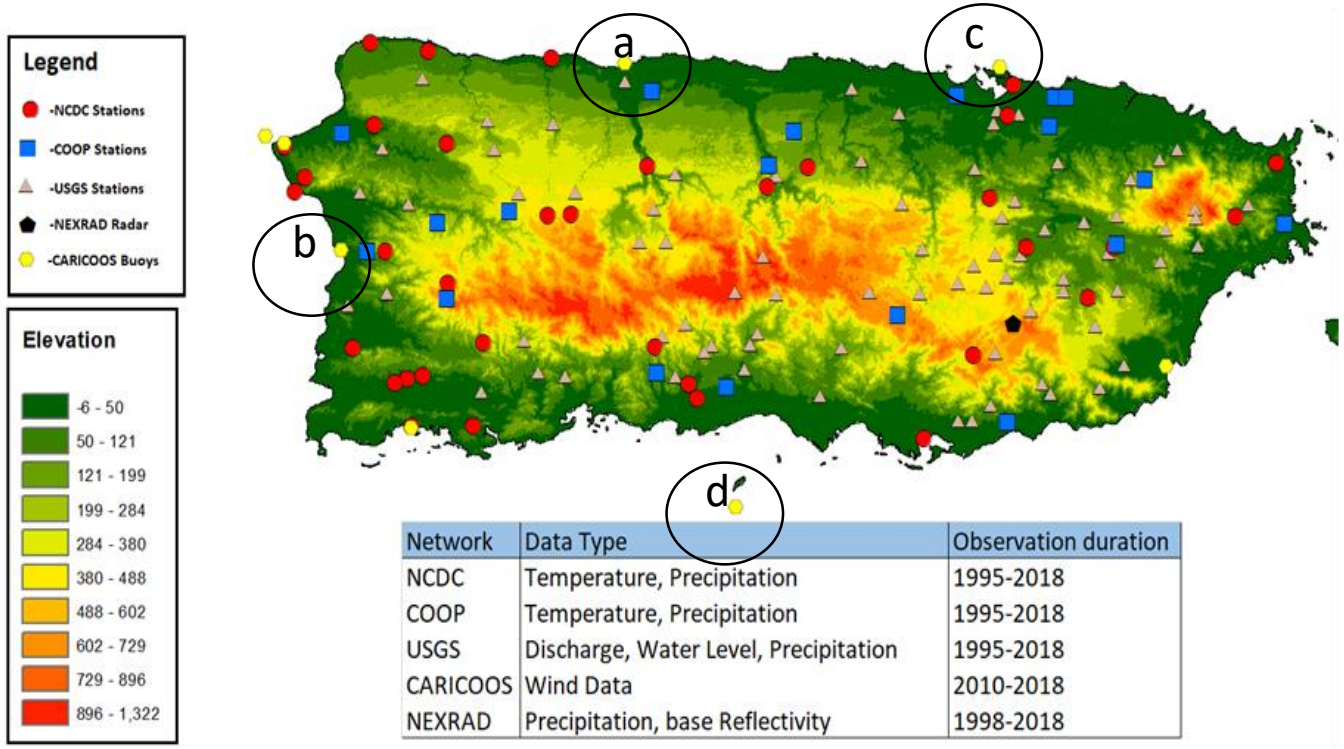
Results-5 km Domain Storm Track (Wind speed)



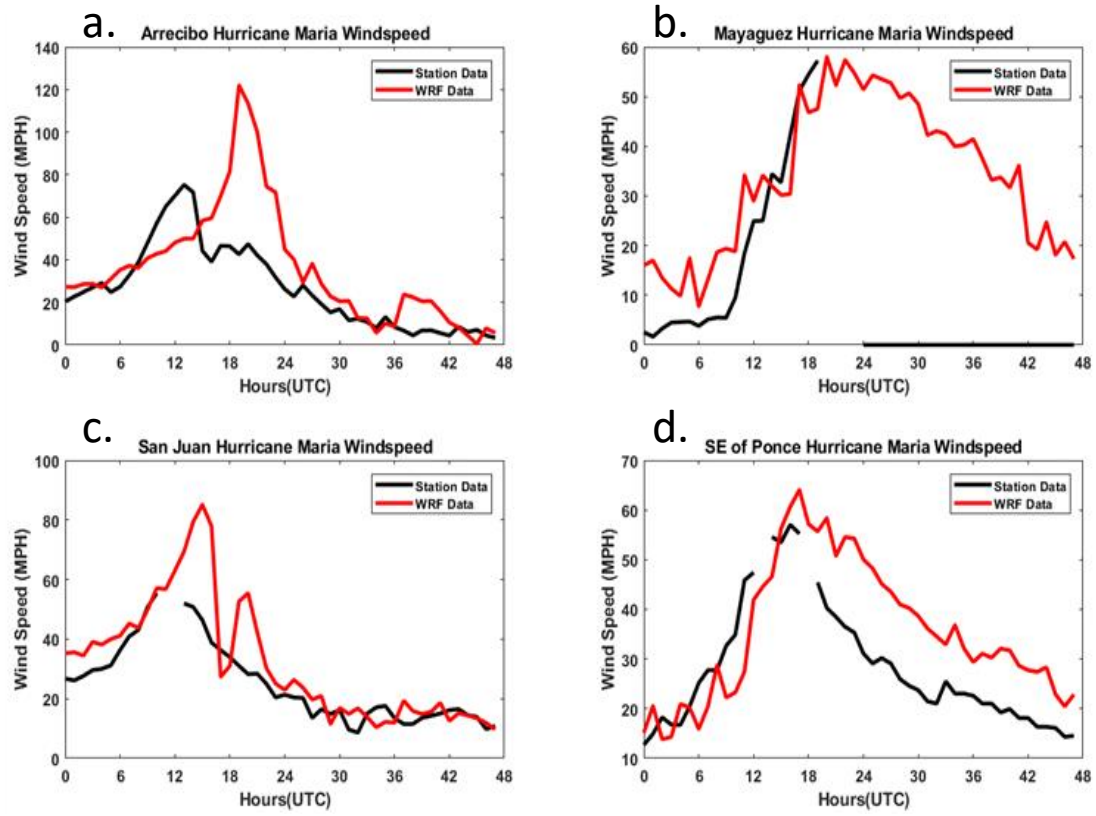
Radar Vs WRF comparison (1-h precipitation)



Validation-Observation network and comparison with WRF results (wind speeds)



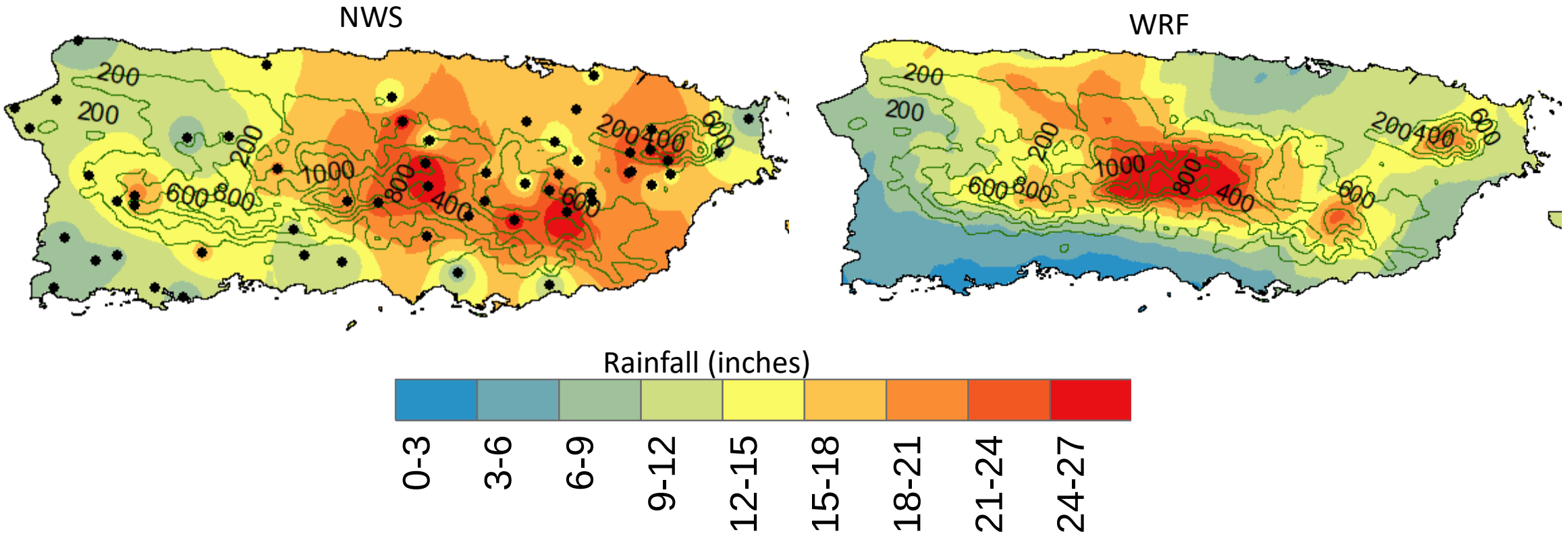
Network	Data Type	Observation duration
NCDC	Temperature, Precipitation	1995-2018
COOP	Temperature, Precipitation	1995-2018
USGS	Discharge, Water Level, Precipitation	1995-2018
CARICOOS	Wind Data	2010-2018
NEXRAD	Precipitation, base Reflectivity	1998-2018



Left - Station locations by network and data type available for each network. Puerto Rico's NEXRAD Radar is included as its own separate network.

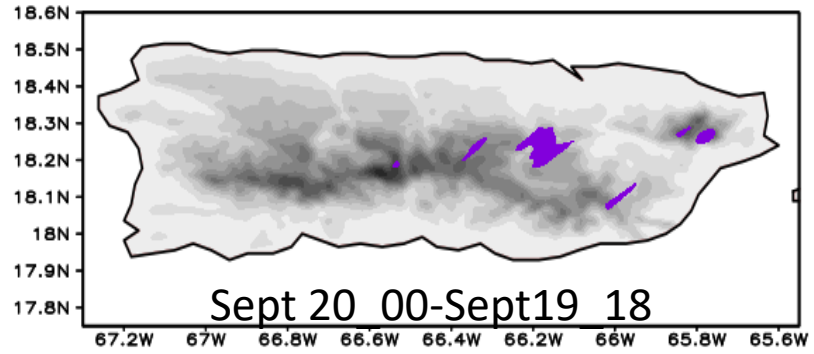
Right- Comparison between observed wind speed data on CARICOOS Buoys and simulated WRF data at equivalent grid points. Maximum simulated wind speed of 120 MPH was located Arecibo among compared locations

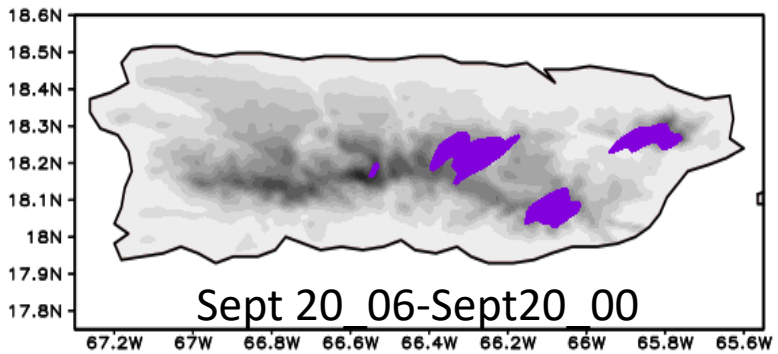
Validation-NWS and WRF Cumulative Rainfall.

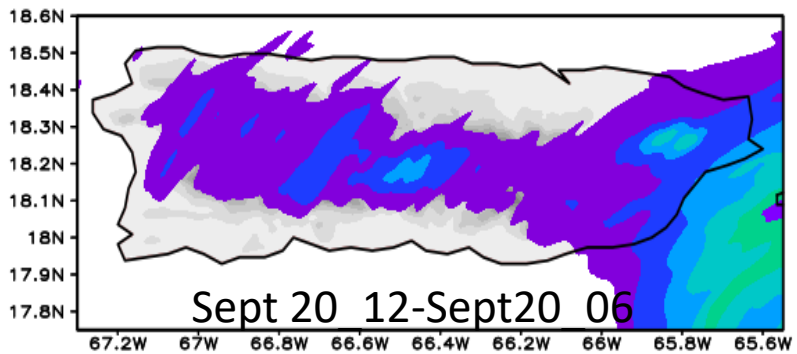


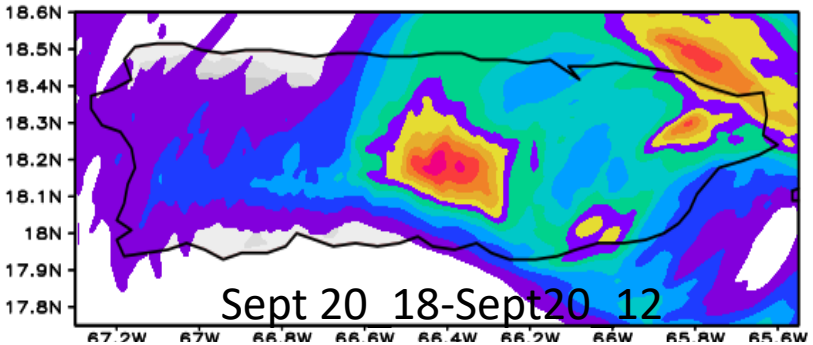
RMSE=7.19”, Normalized RMSE=0.2

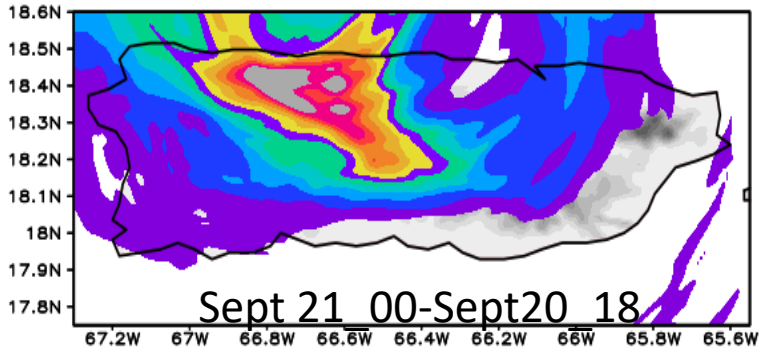
Results-1 km Domain 6-hourly cumulative rainfall

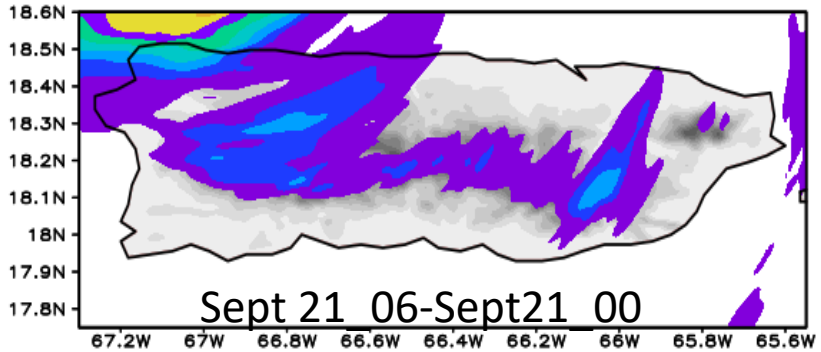


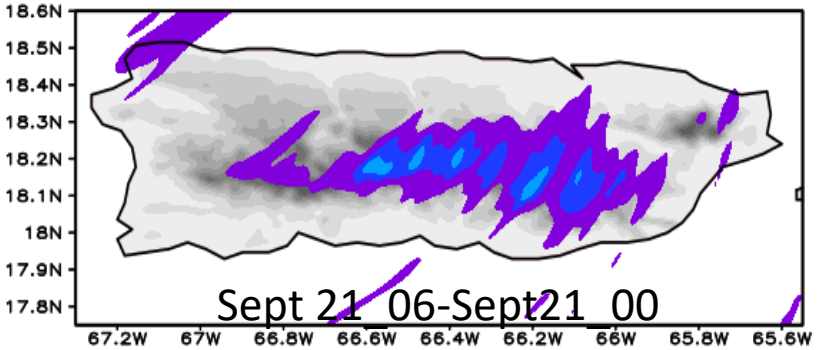


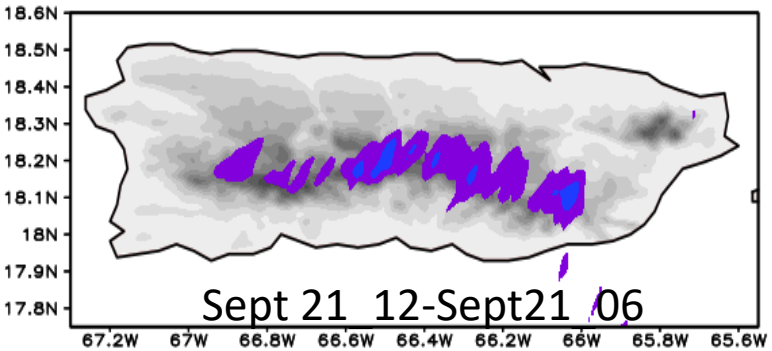


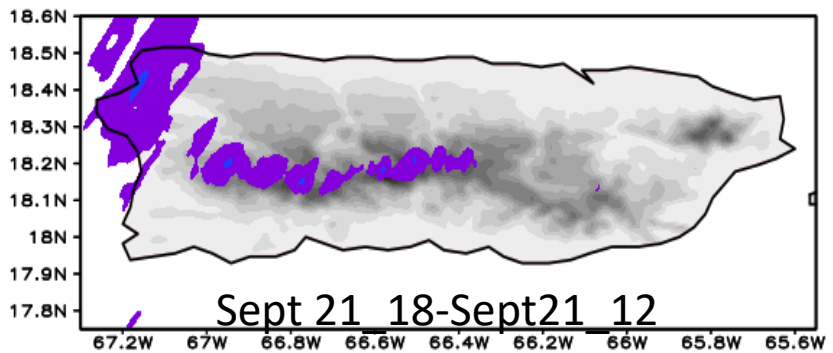




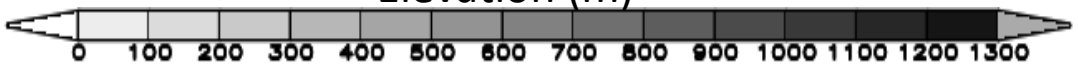






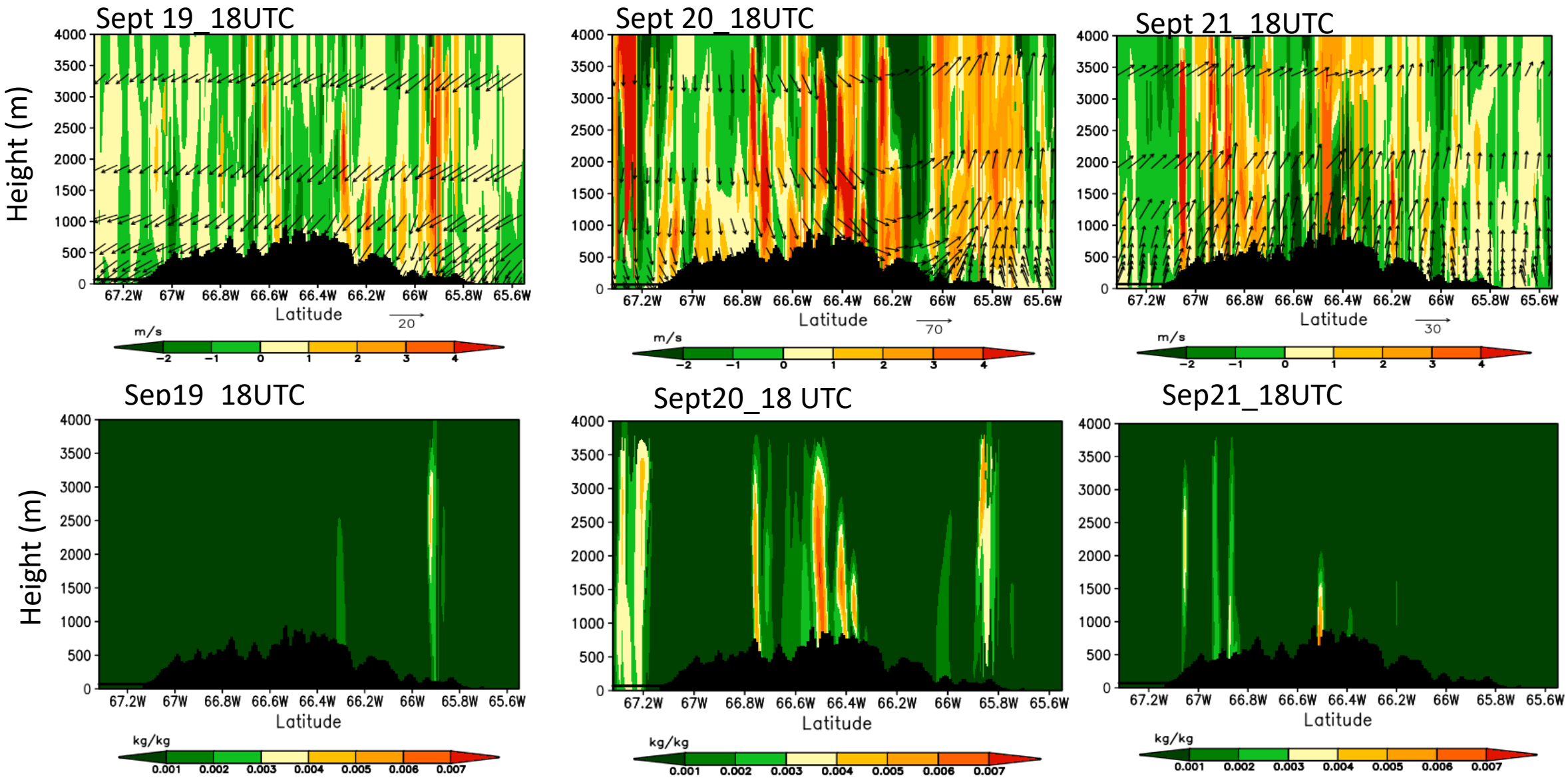


Elevation (m)



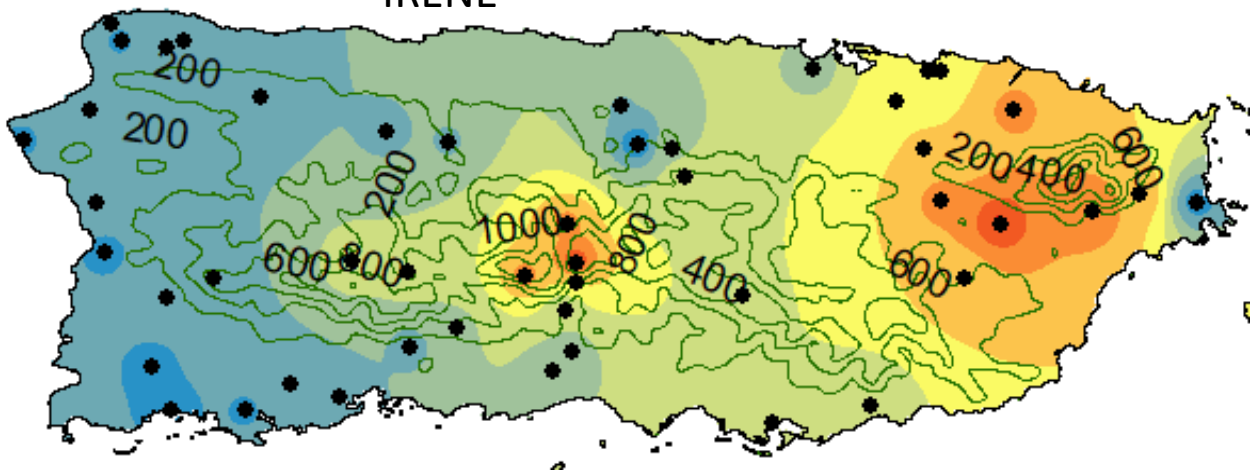
6-hour cumulative precipitation (in)

Orographic Effects

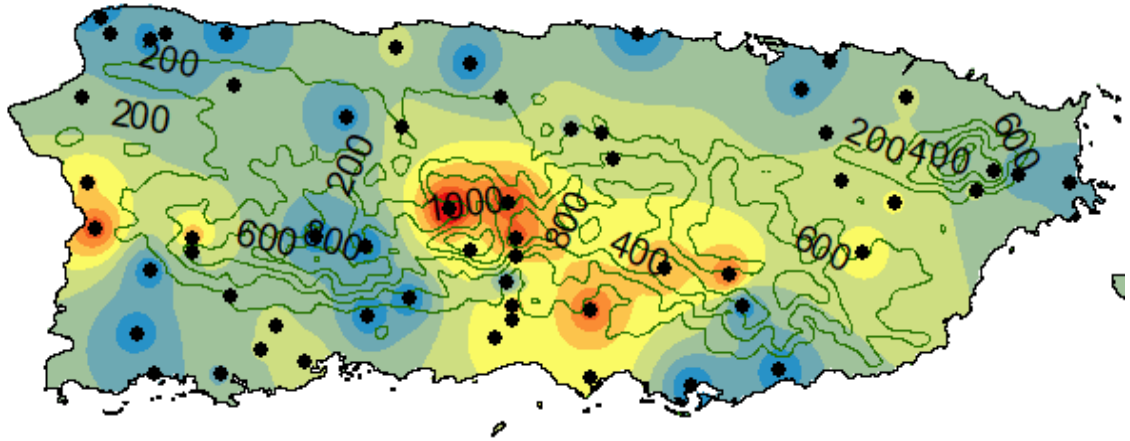


Orographic effects observed in other hurricanes

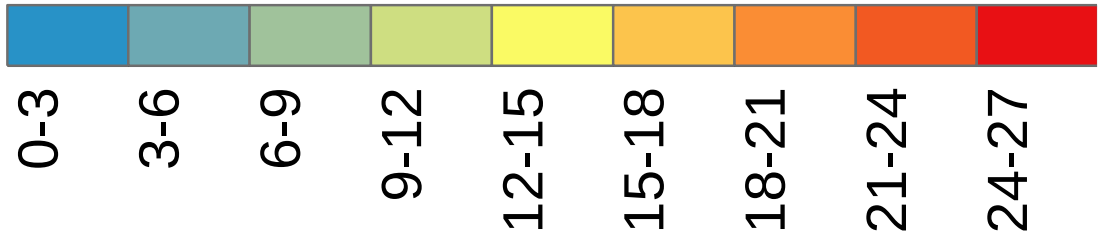
IRENE



GEORGE



Rainfall (inches)



ERIC Project Products

Surface: (5km and 1 km resolution)

2m- Air Temperature, Precipitation, Surface pressure, 2m-specific humidity, 10m wind speed (U,V), Upward and downward heat flux, Short wave and long wave radiation, Total soil moisture content, Surface skin temperature, Cloud fraction

3D (5km and 1 km resolution) at 50 different vertical layers.

U,V,W (wind), Air temperature, Specific humidity, Geopotential height

Fixed fields-(Land Use, Orography)

Format of the data -Netcdf (spatial), text (point)

Data Share Folder : www.eric21.org (in geophysical modeling folder)

Future work

- Journal publications-Weather and Climate Extremes
- Future work would involve studying the combined effects of Irma and Maria on the soil saturation and landslides.
- Understanding common synoptic and local conditions that causes hurricanes in the Caribbean.
- Provide reliable physical information for impacts assessments.

THANK YOU

- Salvador del Cos-CCNY
- Equisha Glenn-CCNY
- Ernesto Rodriguez-NOAA
- Jose Alamo-NOAA

QUESTIONS?