

31<sup>st</sup> CONFERENCE ON HURRICANE & TROPICAL METEOROLOGY

# STORM SURGE ESTIMATION DUE TO THE INCIDENCE OF SIMULTANEOUS TROPICAL CYCLONES IN MEXICO

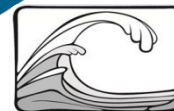
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# THE FACTS: SEPTEMBER 2013



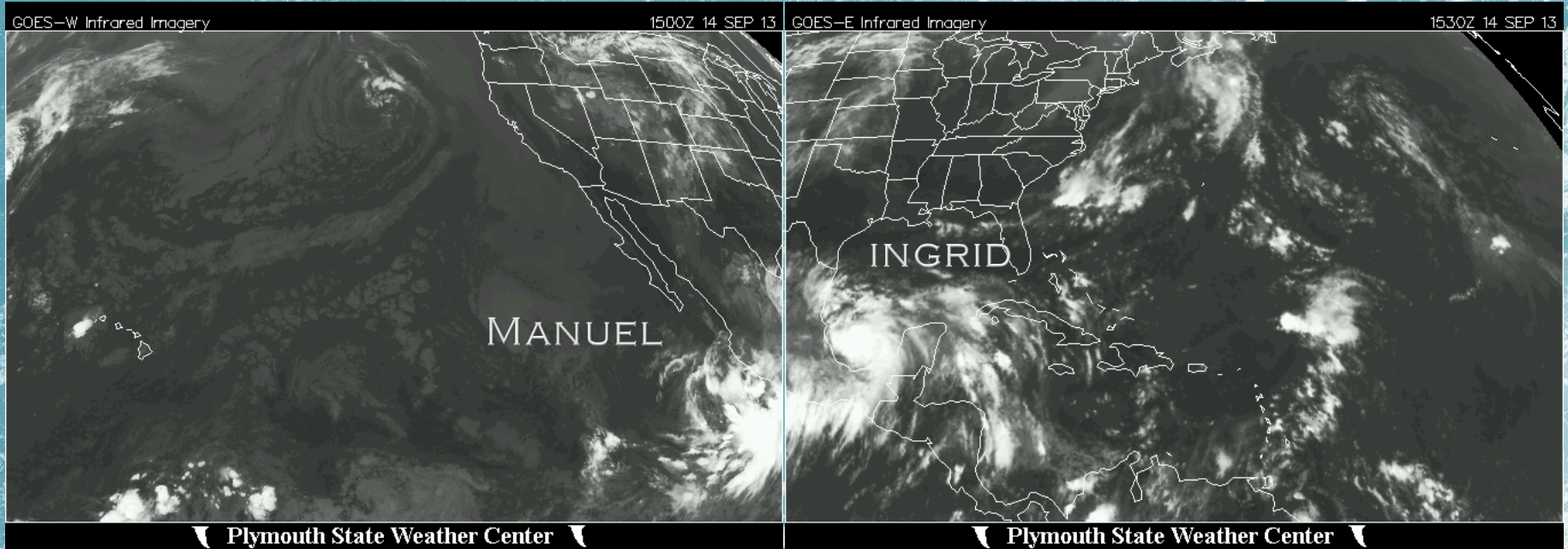
*“Since 1958, Mexico has not suffer from simultaneous events in national territory on both basins.”*

*“Until now, more than 2/3 of the country is suffering the consequences. Practically only three states have not suffered yet.”*

*“In the state of Oaxaca, the rainfall is equivalent to let all the water from the biggest dam of the country fall over the state.”*



# 15-16/09/2013





# DAMAGE TOLL

77 MUNICIPALITIES DECLARED IN DISASTER

1'200,000 AFFECTED PERSONS

92 REGISTERED DEATHS

68,000 DISPLACED HUMANS

29,000 PERSONS IN 551 SHELTERS

> 45,000 STRUCTURES AFFECTED

> 5.7 BILLION USD ECONOMIC LOSSES





# 91 FEDERAL HIGHWAYS INCOMMUNICATED





# FEDERAL SUPPORT (DN-III PLAN)



**9,019 SOLDIERS  
ON DUTY**



**27 TON FOR SHELTER**

**867 TONS OF SUPPLIES**

**256 VEHICLES**

**16 AIRPLANES**

**21 HELICOPTERS**





# ¿HOW FREQUENT WILL SIMULTANEOUS EVENTS AFFECT MEXICO?





# HISTORICAL BACKGROUND

## 14/06/1958



Alma (TS) made landfall in Tamaulipas  
24.975N, 97.577W



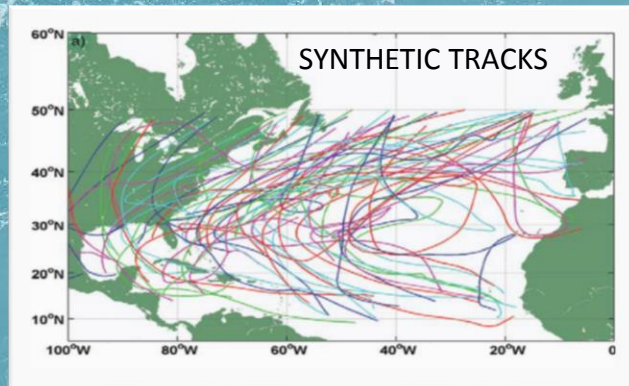
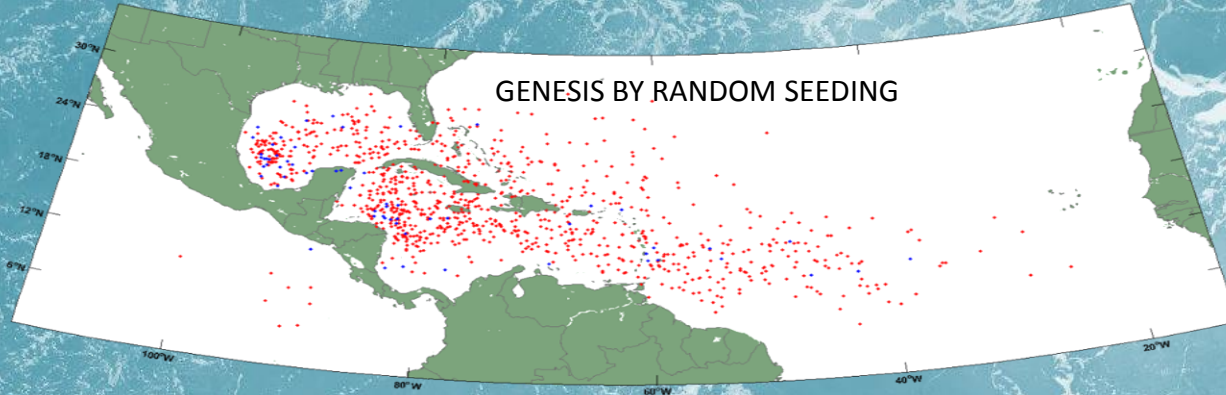
Unnamed (TS) made landfall in Oaxaca  
16.212N, 94.9468W



55 YEARS LATER...  
INGRID (H1) AND MANUEL (TS)



# STATISTICAL/DETERMINISTIC HURRICANE MODEL (EMANUEL ET AL 2006, 2008)





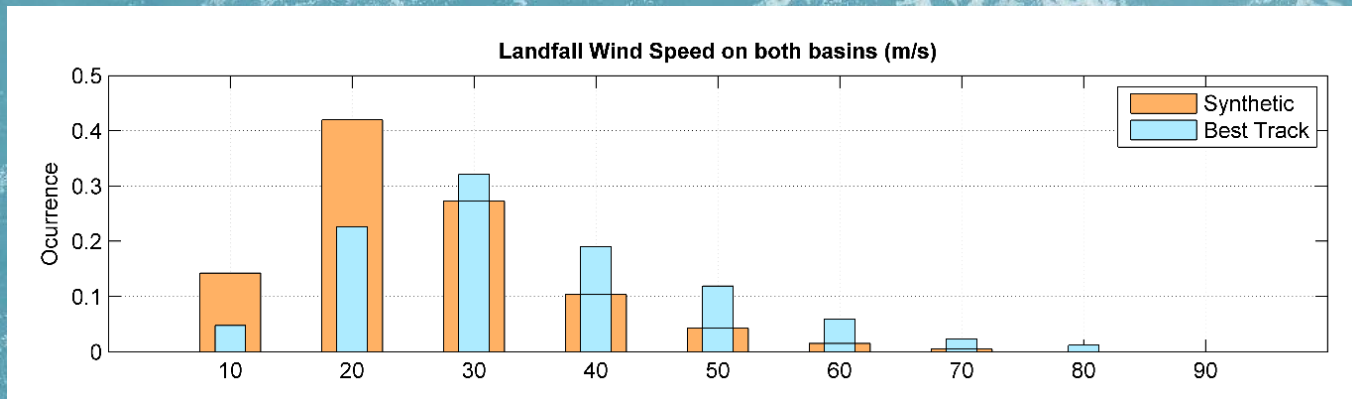
**SIMULTANEOUS EVENTS OCCURRING IN A  
24 HOUR WINDOW**

**GULF OF  
MEXICO**

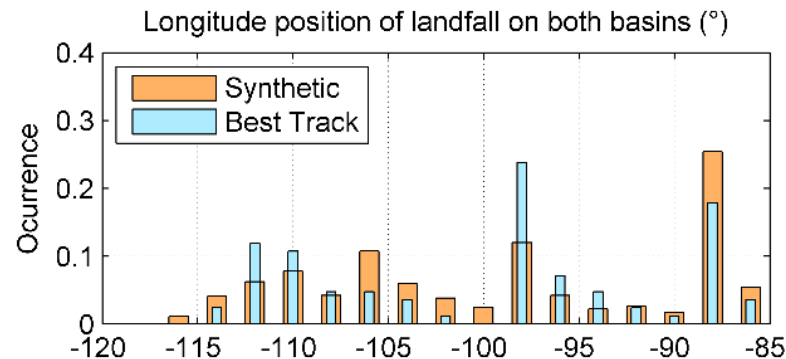
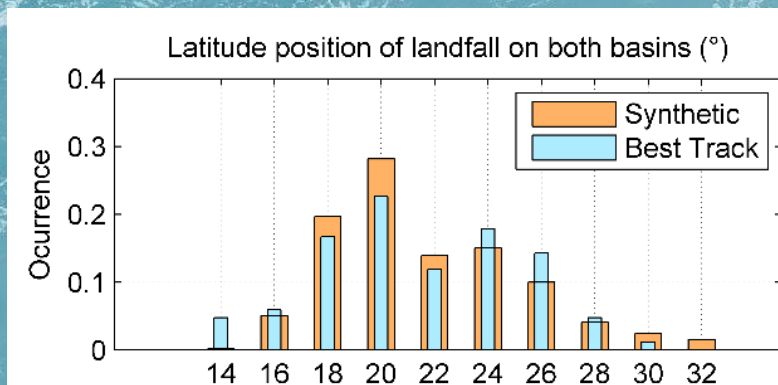
**PACIFIC  
OCEAN**



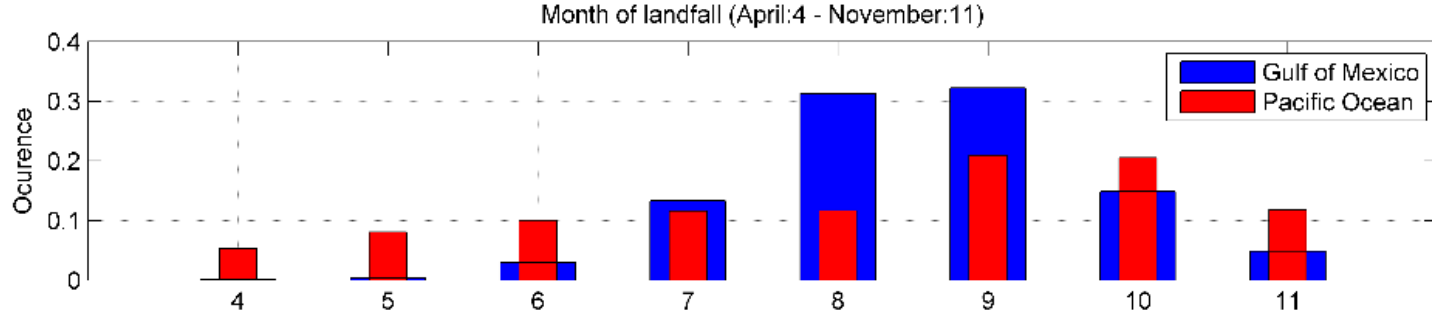
# SYNTHETIC VS BEST TRACK WIND SPEED



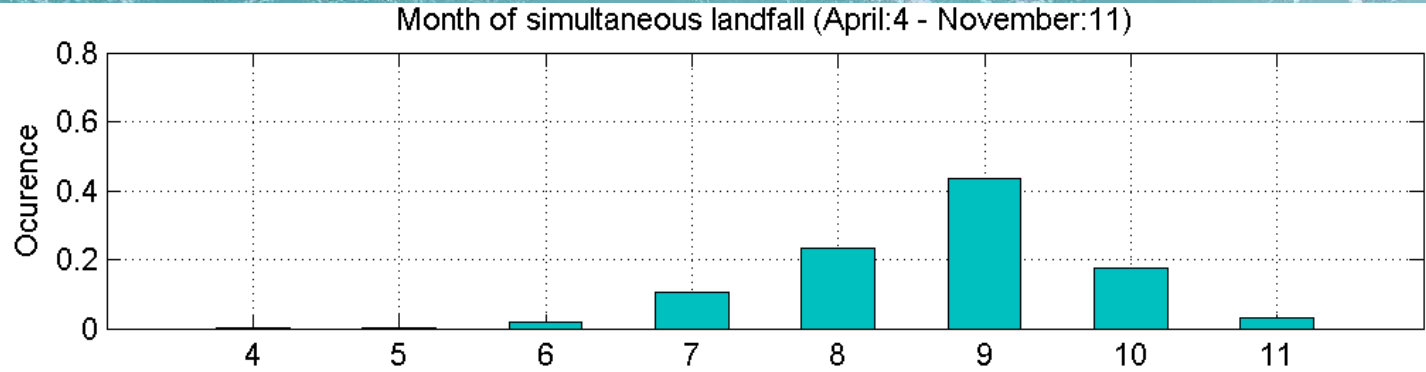
# SYNTHETIC VS BEST TRACK LANDFALL POSITION







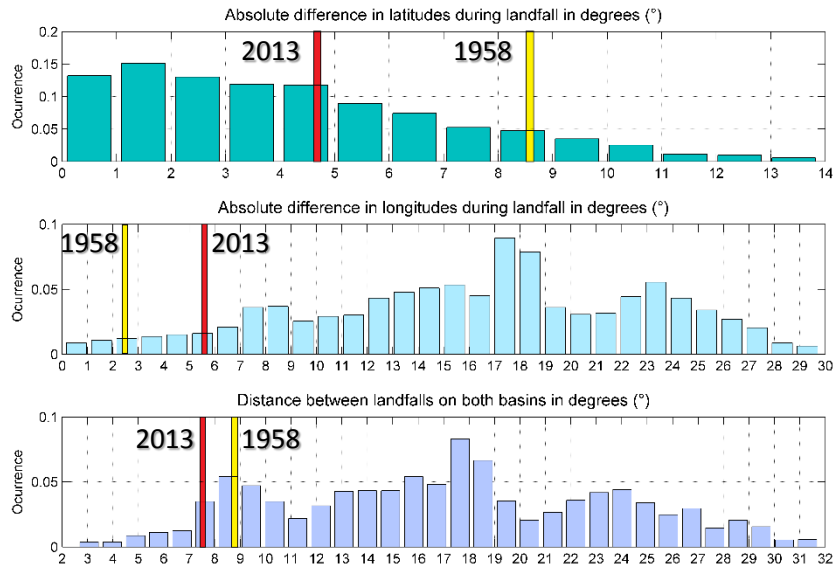
**TOTAL  
LANDFALLS**



**SIMULTANEOUS  
LANDFALLS**



# SIMULTANEOUS LANDFALL POSITIONS





# SIMULTANEOUS EVENT SELECTION BASED ON 1550 EVENTS ON EACH BASIN

## MANZANILLO



CENTER:  
19.063N, 104.297W

SPATIAL TOLERANCE:  
100 KM

TEMPORAL  
TOLERANCE:  
24 HOURS

EVENTS FOUND:  
319

## TAMPICO



CENTER:  
22.260N, 97.780W

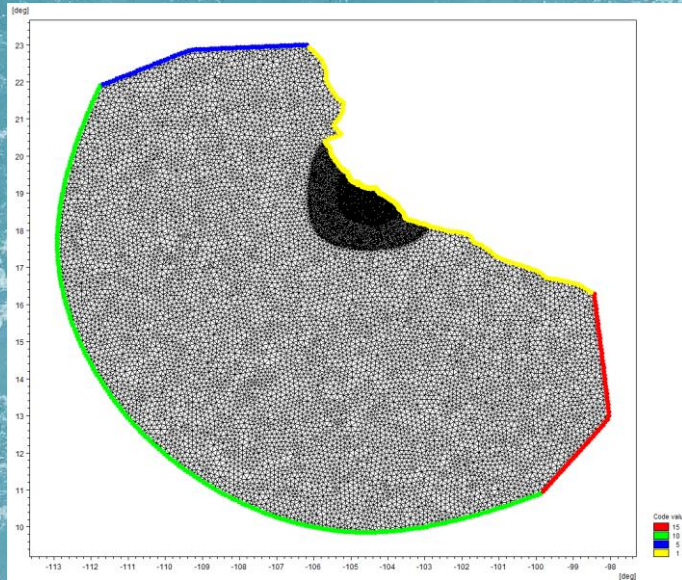


# HYDRODYNAMIC MODEL MIKE 21 FM HD

## DOMAINS WITH VARYING RESOLUTION

NODES: 30,179

ELEMENTS: 59,286

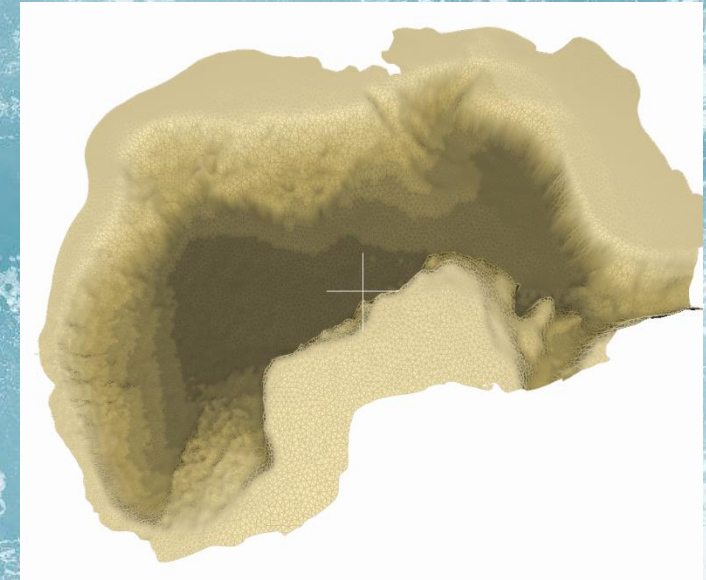


ETOPO I  
+  
NAUTICAL  
CHARTS

Resolution  
Max: 20 km  
Min: 250 m

NODES: 18,125

ELEMENTS: 35,367

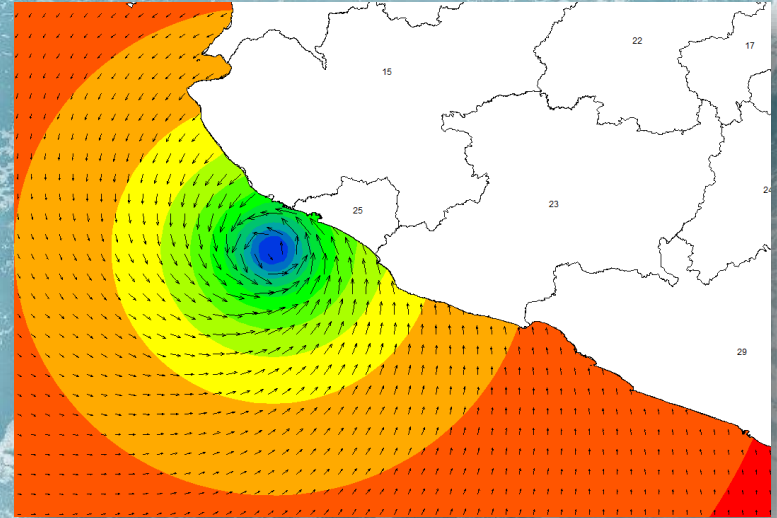




# PARAMETRIC WINDFIELD: EMANUEL & ROTUNNO (2011)

MMDDHH	YYYY	LAT (°)	LONG(°)	V. Max (kn)	Pc (Pa)	R. Max (km)	Pn (Pa)
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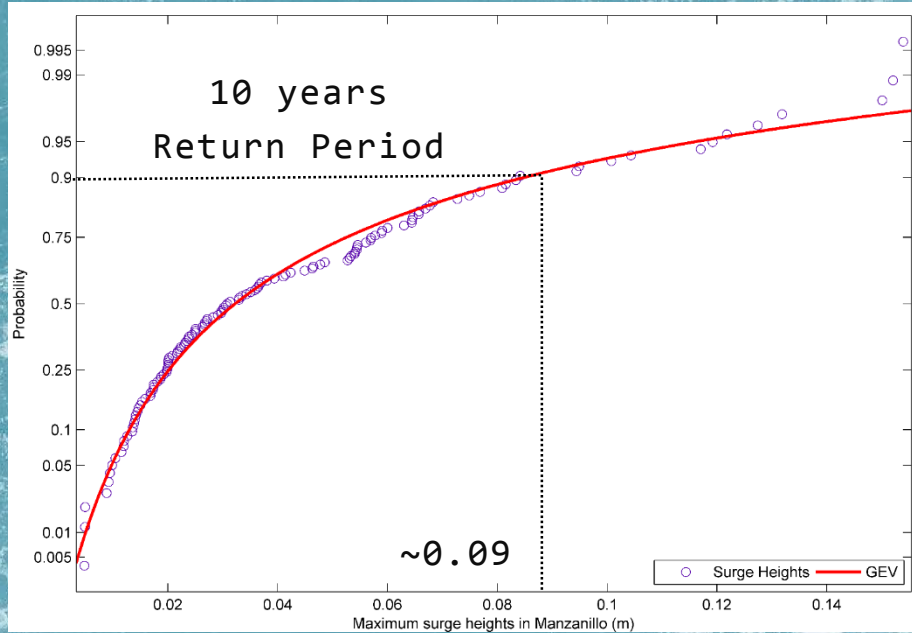
$$V(r) = \frac{2r \left( R_m V_m + \frac{1}{2} f R_m \right)}{R_m^2 + r^2} - \frac{fr}{2}$$



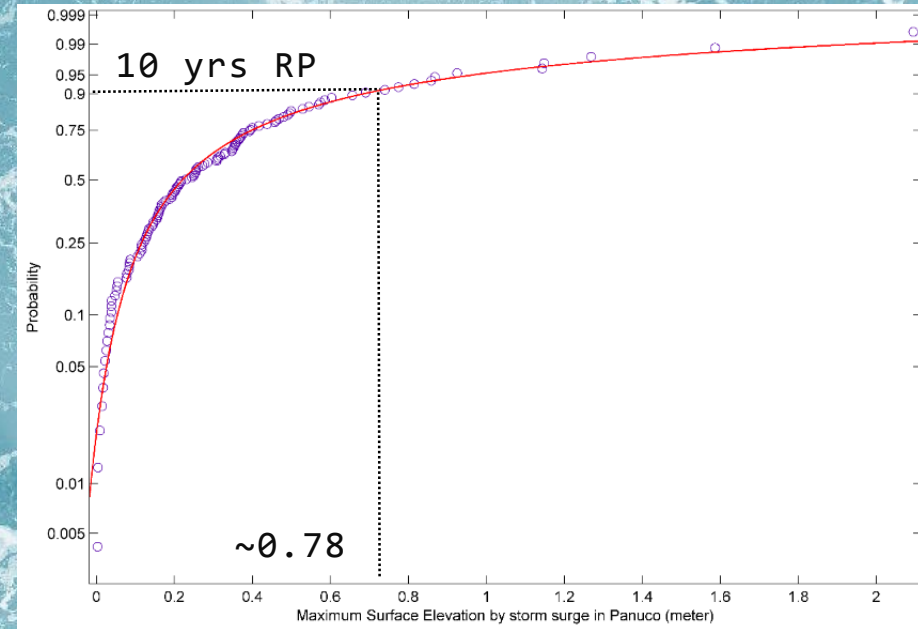


# INDEPENDENT EVENTS MANZANILLO & TAMPICO

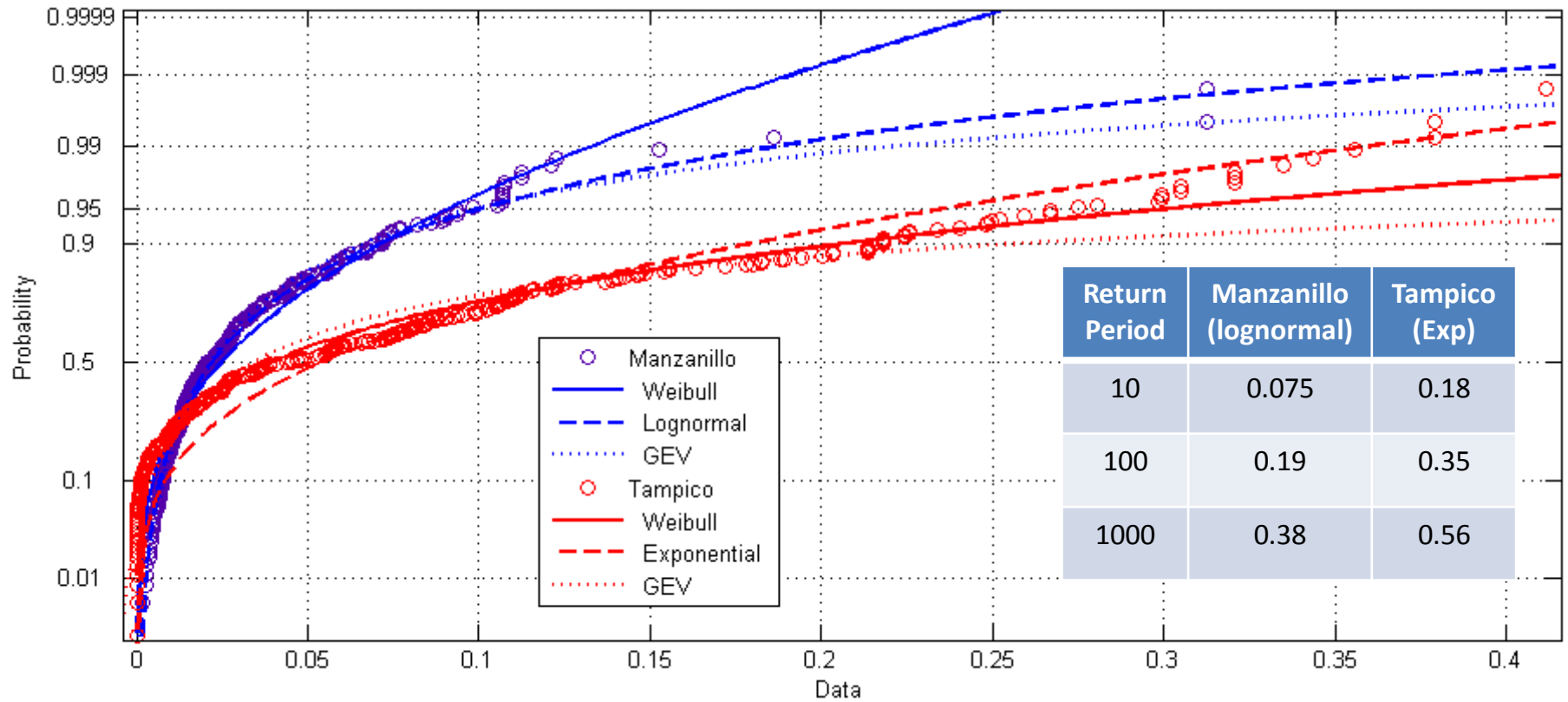
## MANZANILLO



## TAMPICO

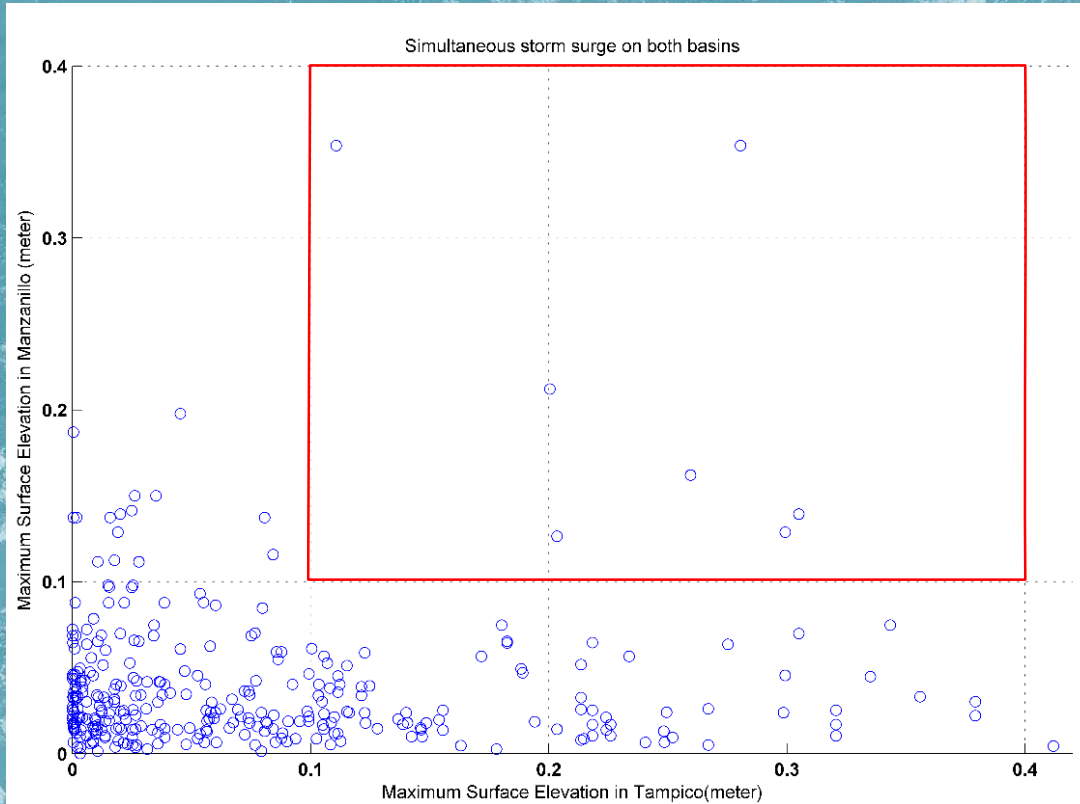


# SIMULTANEOUS EVENTS





# SIMULTANEOUS EVENTS



- 20.6% of the total of events are simultaneous events
- 0.5% of total are simultaneous values above 0.10m
- 97.8% of simultaneous events show values below 0.10m

## CONCLUSION

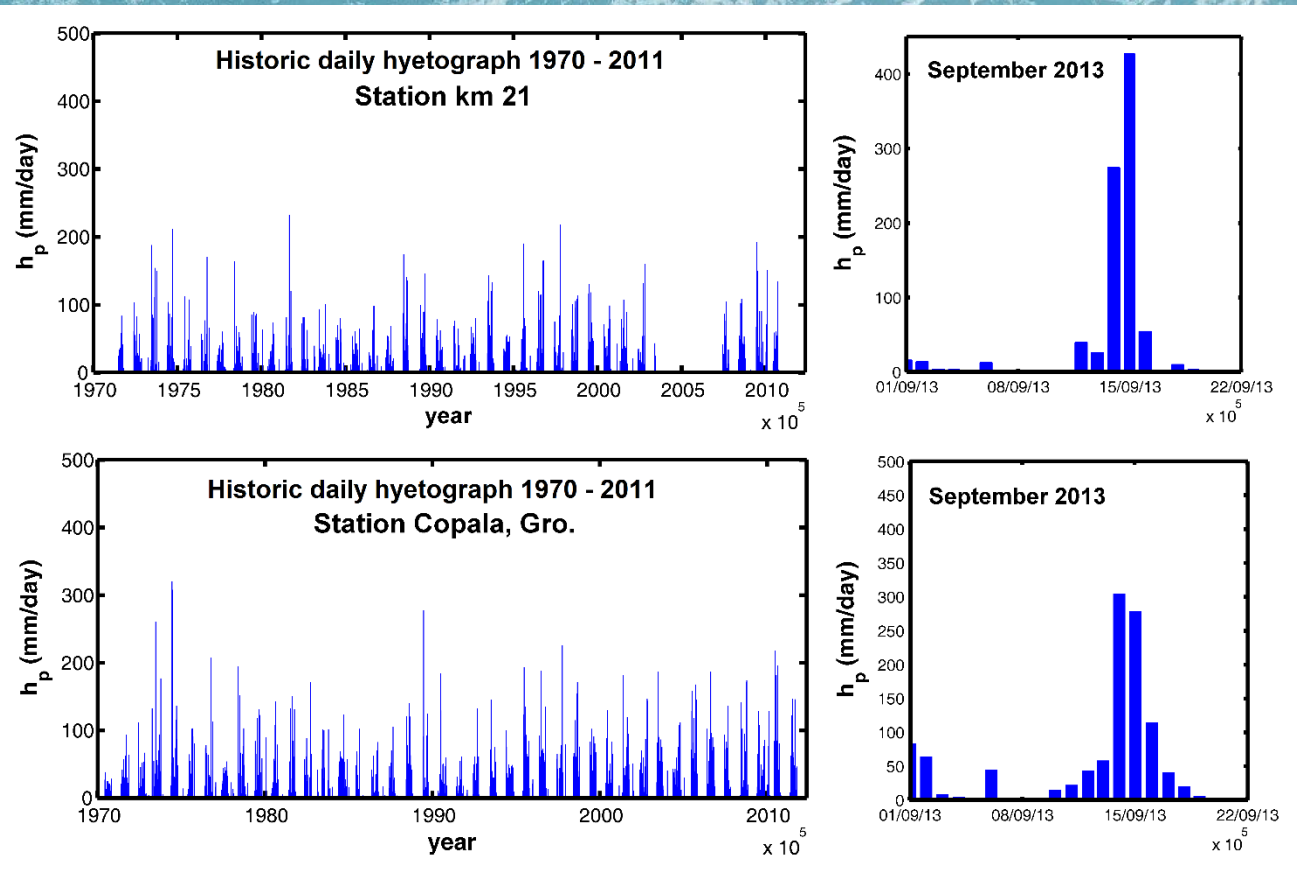
- Synthetic hurricanes are restricted to a time frame from 1980 through 2010, which results in high occurrence of simultaneous events.
- For simultaneous events, the probability of high storm surge levels is extremely low, much lower than for independent events.
- Storm surge analysis should be focused to independent events.

...what about rain and flooding?



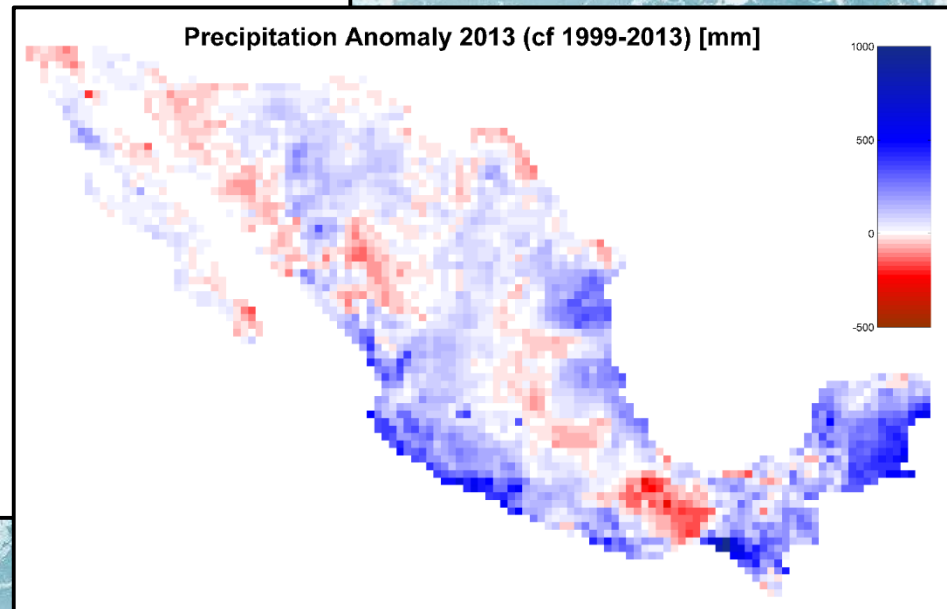
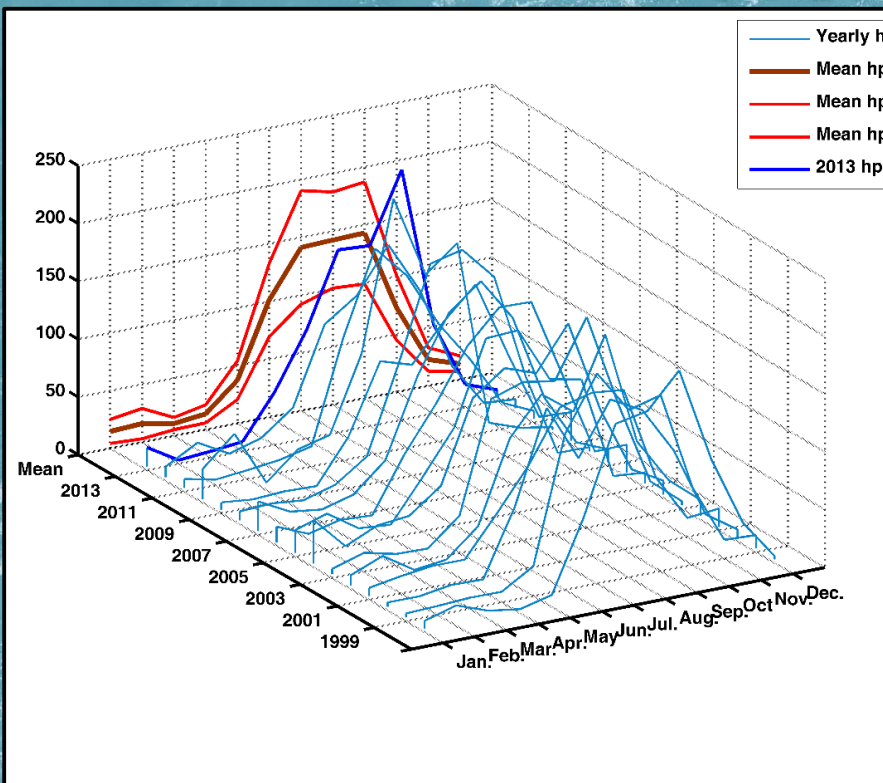
# FUTURE WORK

## RAINFALL & INLAND FLOODING...



# FUTURE WORK

## RAINFALL & INLAND FLOODING...





# ACKNOWLEDGEMENTS

THE AUTHORS WILL LIKE TO THANK:

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# Questions & Answers



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