



A reconstruction of landfalling tropical cyclones on the Pacific coast of Mexico from 1850 to 1949

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Tropical cyclones: Current characteristics and potential changes under a
warmer climate (IAI-CRNII-o48)

<http://cabernet.atmosfcu.unam.mx/IAI>

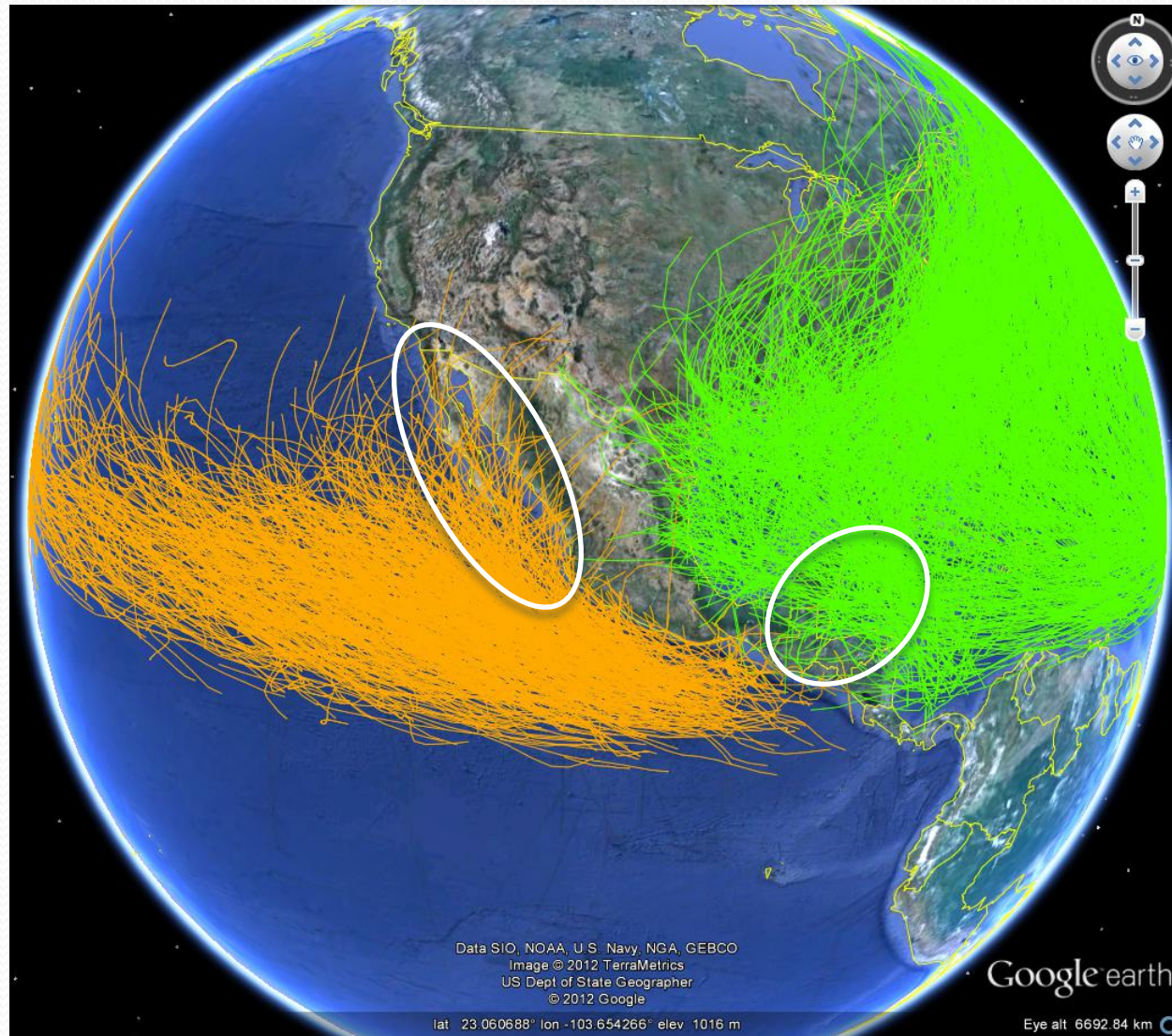
Introduction

- ◆ Official NHC database in Eastern Pacific basin starts in 1949, compared to 1850 in the North Atlantic basin
- ◆ The time series is too short to evaluate natural variability of frequency and trajectories
- ◆ Landfalling cyclones cause most of the impact to society



Our OBJECTIVE is to try to extend the time series of landfalling cyclones backwards in time

TC climatology: Landfalls in Mexico hide Baja California and Yucatan



From official NHC database

Previous studies: Reconstructed trajectories 1921-1969

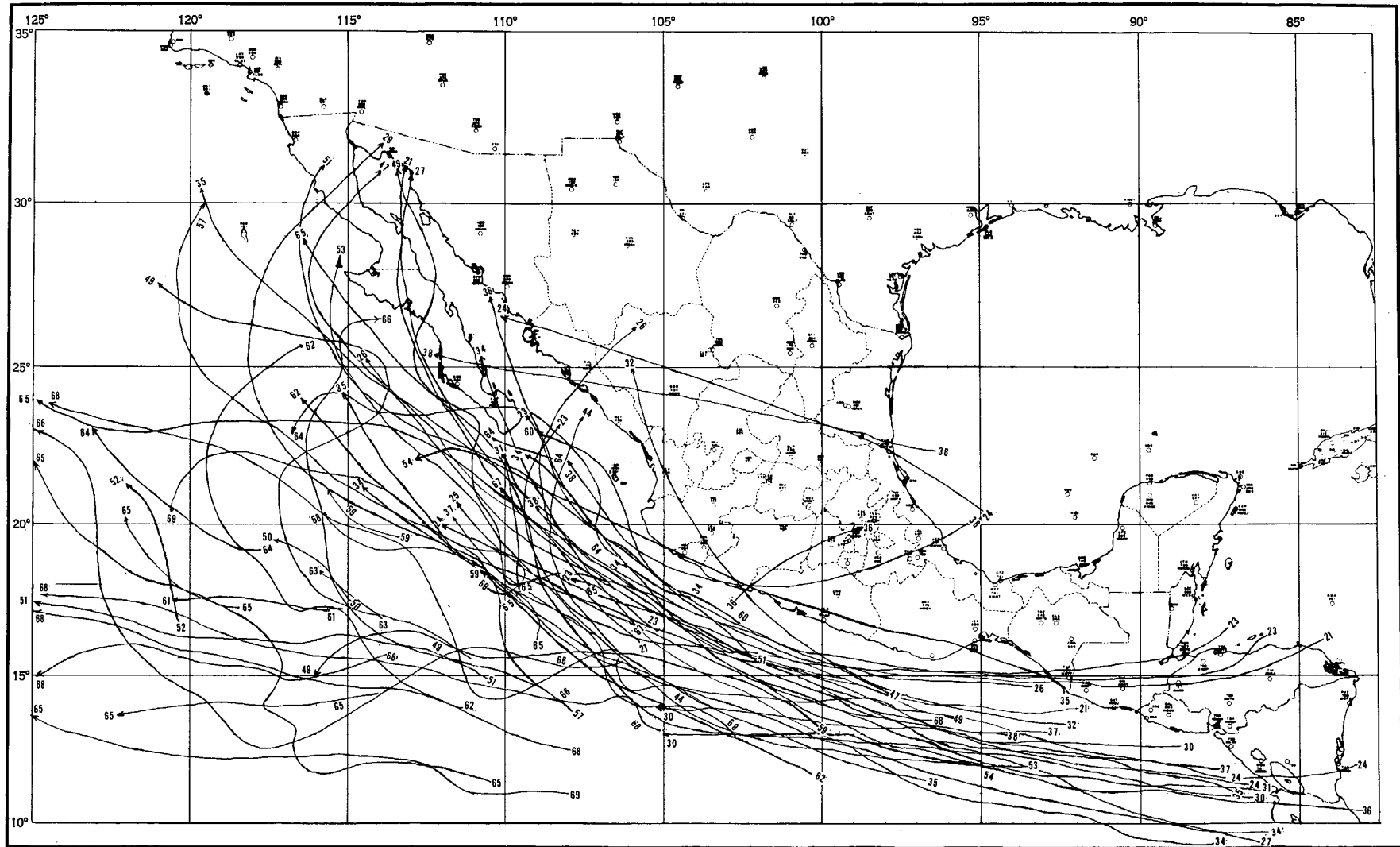


FIGURE 1.—Trajectories of hurricanes and tropical storms during August 1921-1969; the 21 near the trajectory represents the year 1921, the 23 represents 1923, etc.

14 landfalls

(Serra, 1971)

Previous studies: Total Landfalling TCs in (1951-2000)

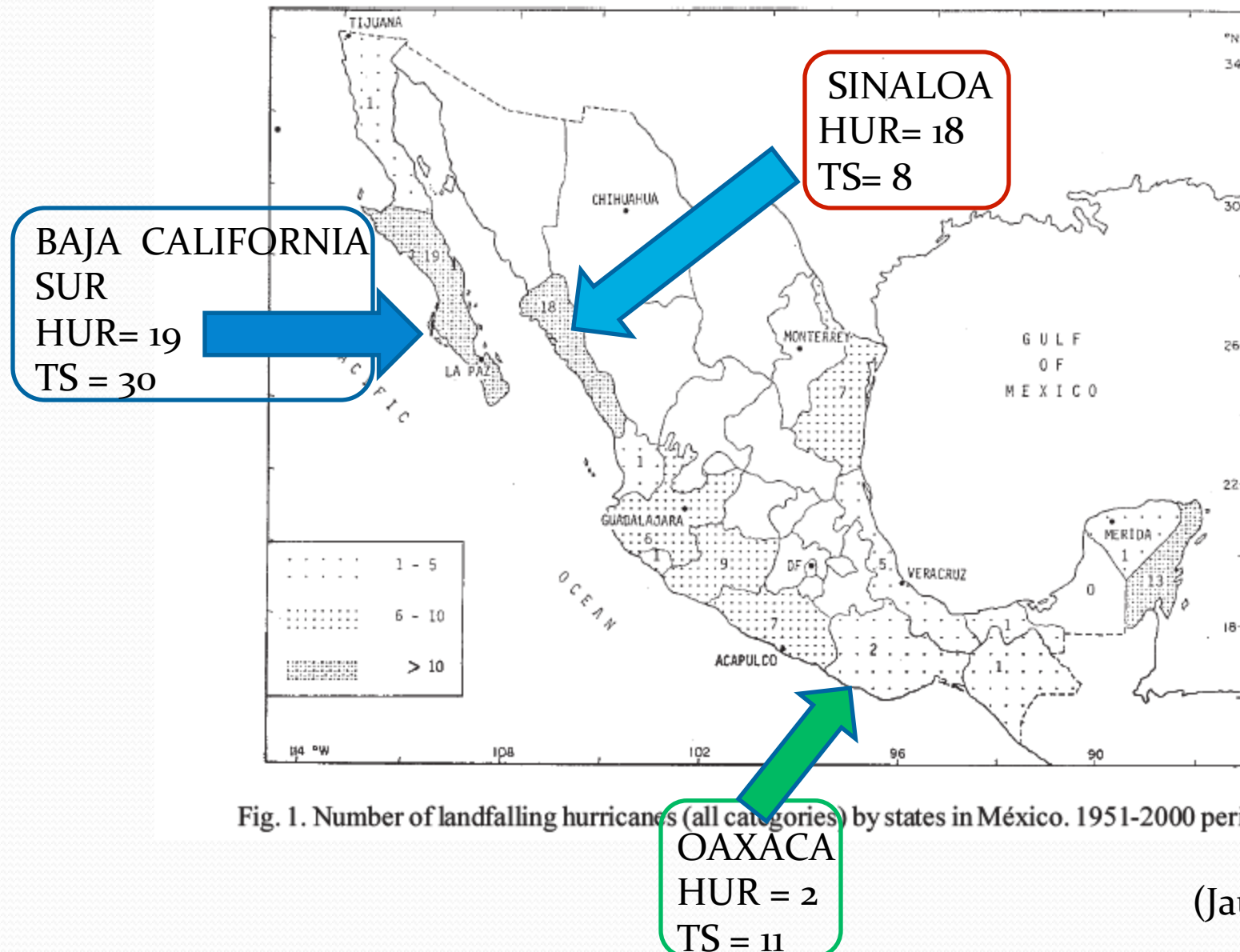
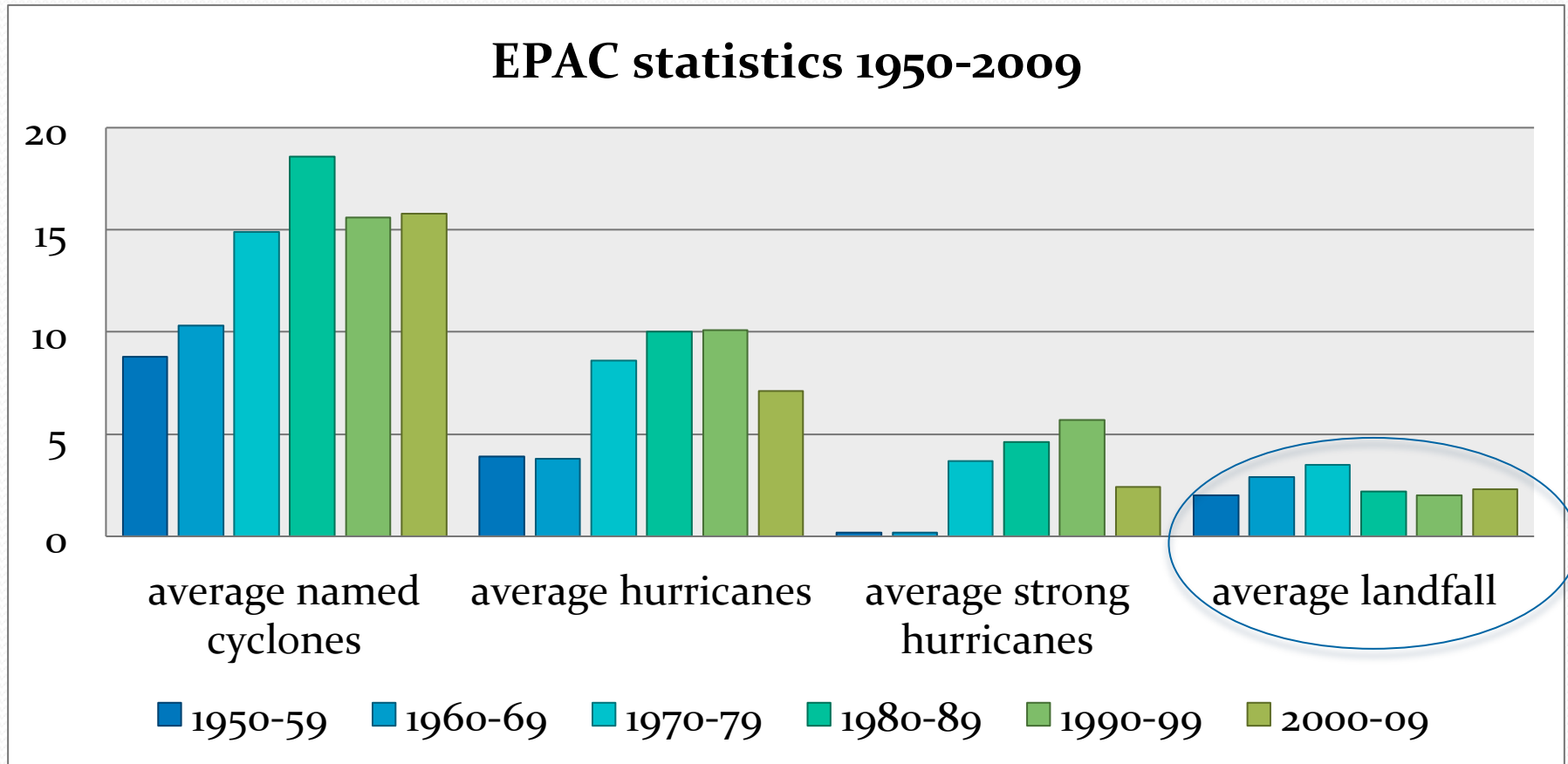


Fig. 1. Number of landfalling hurricanes (all categories) by states in México, 1951-2000 period.

(Jauregui, 2003)

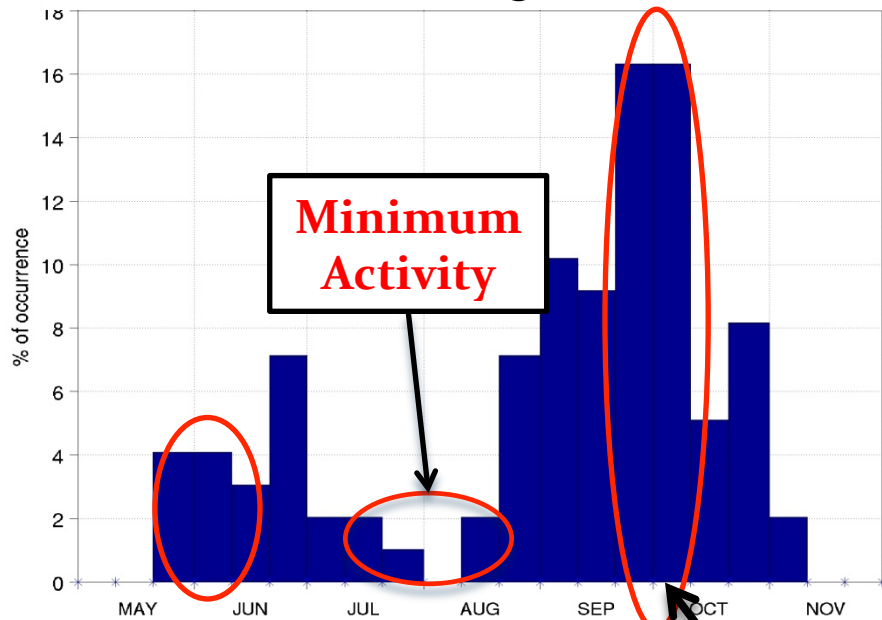
- What has happened in the last 60 years?



From official NHC database

EPAC satellite era

Landfalling dates



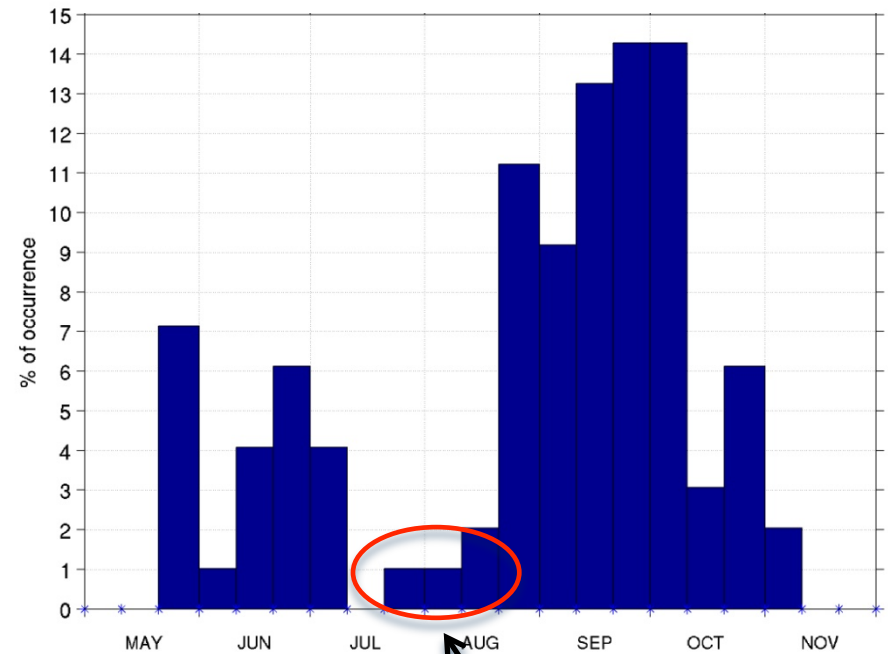
Minimum Activity

10-30 May
before rains start in most of Mexico
DRY SOIL

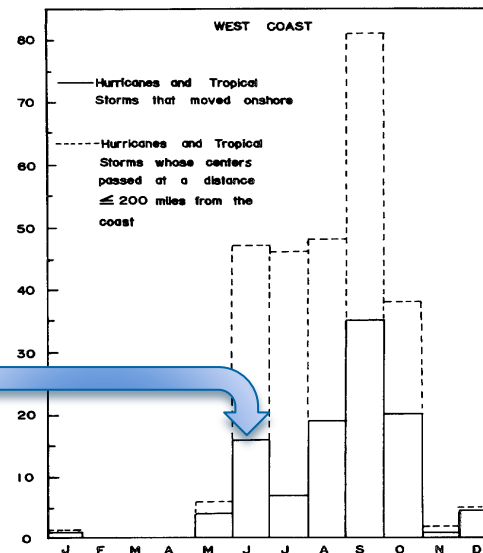
10-30 September
when rains are present in most of Mexico
WET SOIL

For 1921-1969 Serra (1971) reported

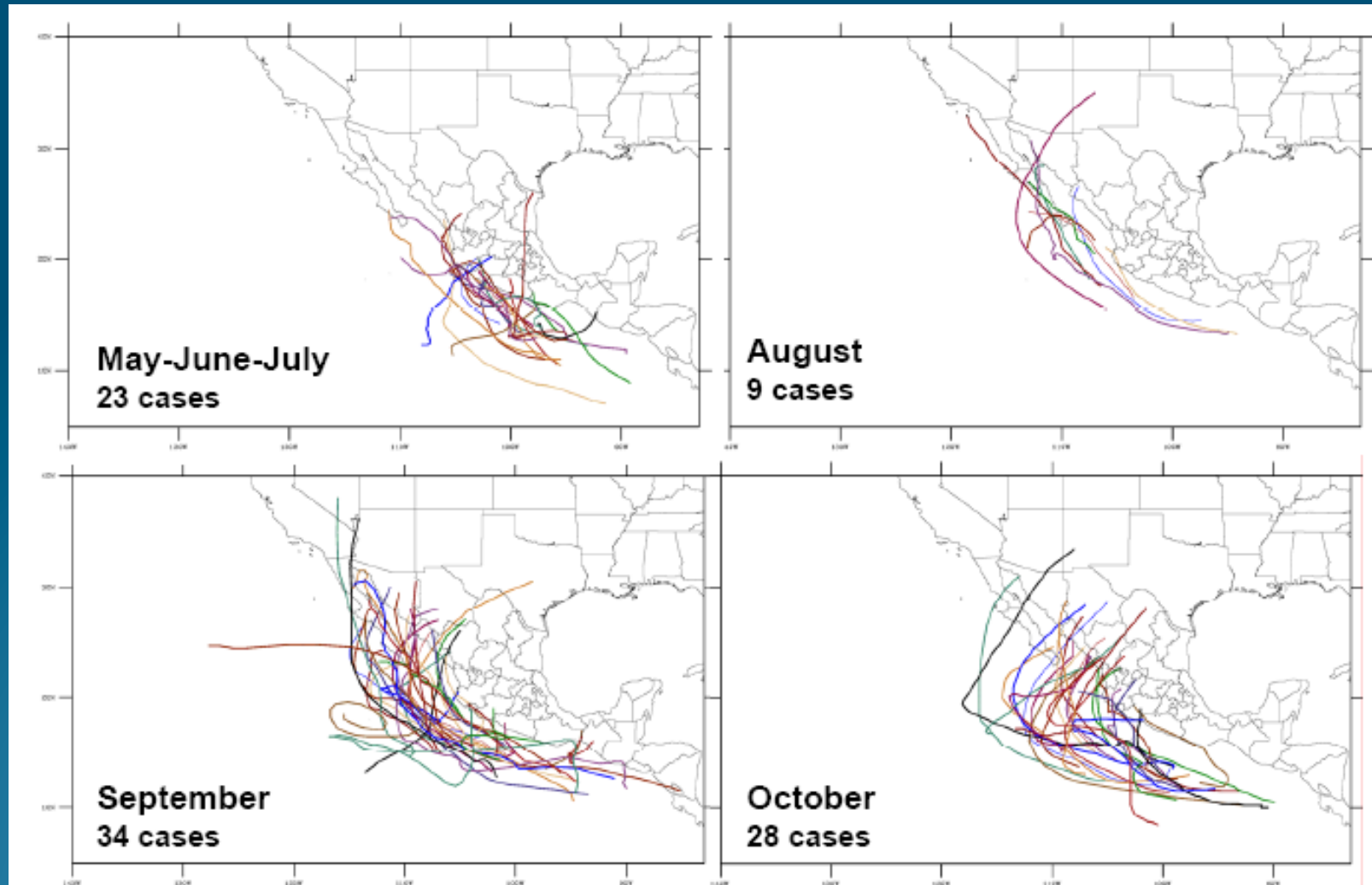
Formation dates of landfalling TC



Minimum Activity



Large intra-seasonal land-fall variability (satellite era)



(Farfan, et al, 2012)

Historical Reconstruction

Methodology:

Visits to repositories in different cities: Mexico City, Chilpancingo, Acapulco, Guadalajara, Mazatlan, Culiacan, La Paz

Repositories:

Federal, State and local libraries

Regional government offices

Sources:

Newspapers

Official bulletins

Diaries



Source: Archivo Historico Municipal de Mazatlan



Information about damages:

*“Mr. State Governor:
On the 24th at 22:00 a strong cyclone affected the city. Two hundred and seventy palapa houses were destroyed, leaving 200 homeless families, 3 dead and numerous injured... Roads were damaged and telegraph lines were down...”*

“New catastrophe by a cyclone in Puerto Vallarta”, reported in the newspaper El Sol, Guadalajara, 24 October 1925

Official municipal report



“Numerous houses destroyed by the cyclone”,
Newspaper El Demócrata Sinaloense, Mazatlán,
22 September 1928



Los culiacanenses, desde el puente, observando la gran creciente del río Tamazula.

Meteorological information:

“...On the 20th, a warning was issued to all ports that a cyclone was affecting the city, with heavy rains starting at 5 am.... By 4pm, the rain was light but constant... At 6:30pm the winds from the SE rotated to the East and lasted for 24 hours, reaching 159 km/hr. By the next morning winds were light and from the South...”

DATABASE

A special fiche was designed to transfer all the information found for each record.

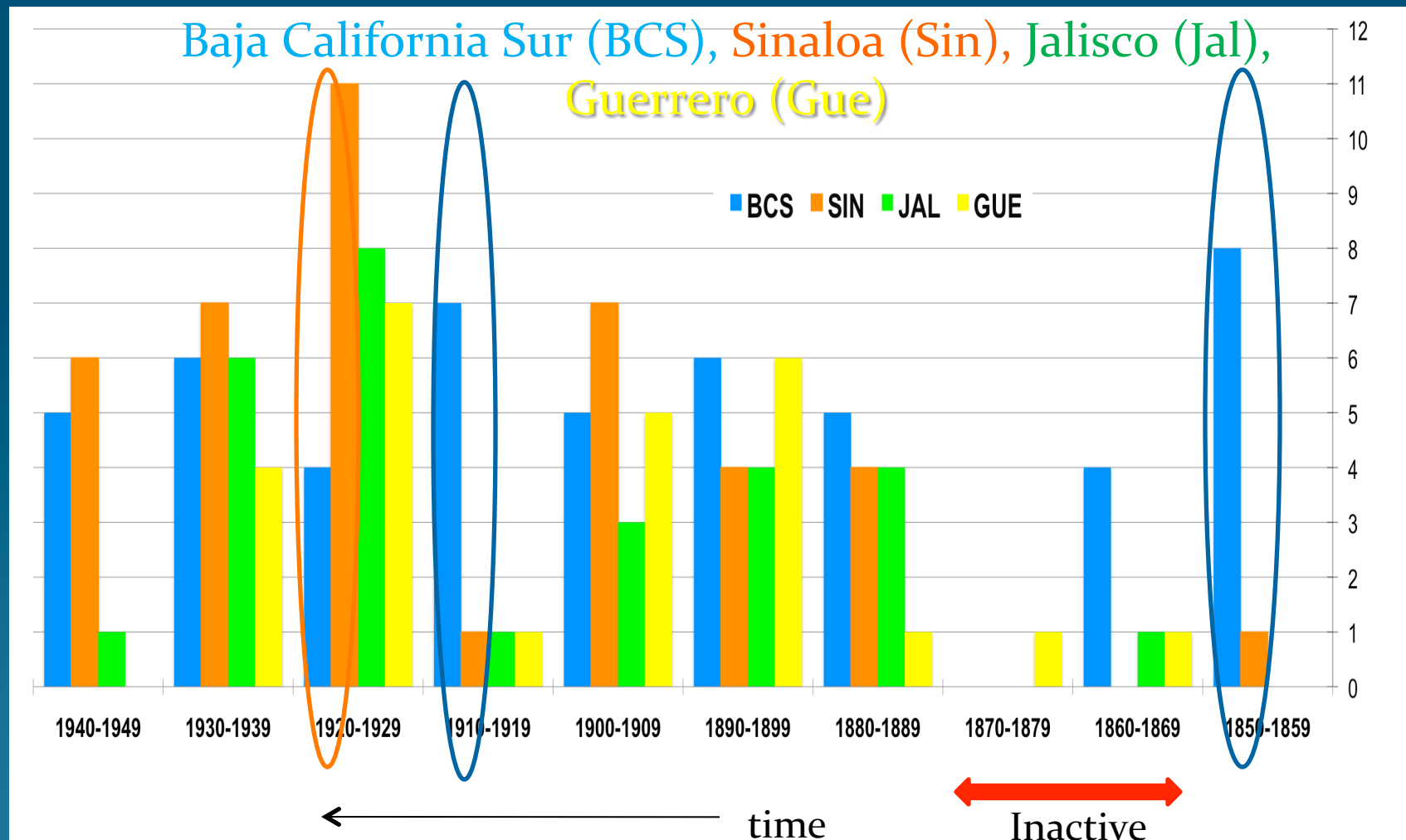
Source information and digital files with photos of the original newspaper

Immediate effects: rains, winds, storm surge, landslide,...

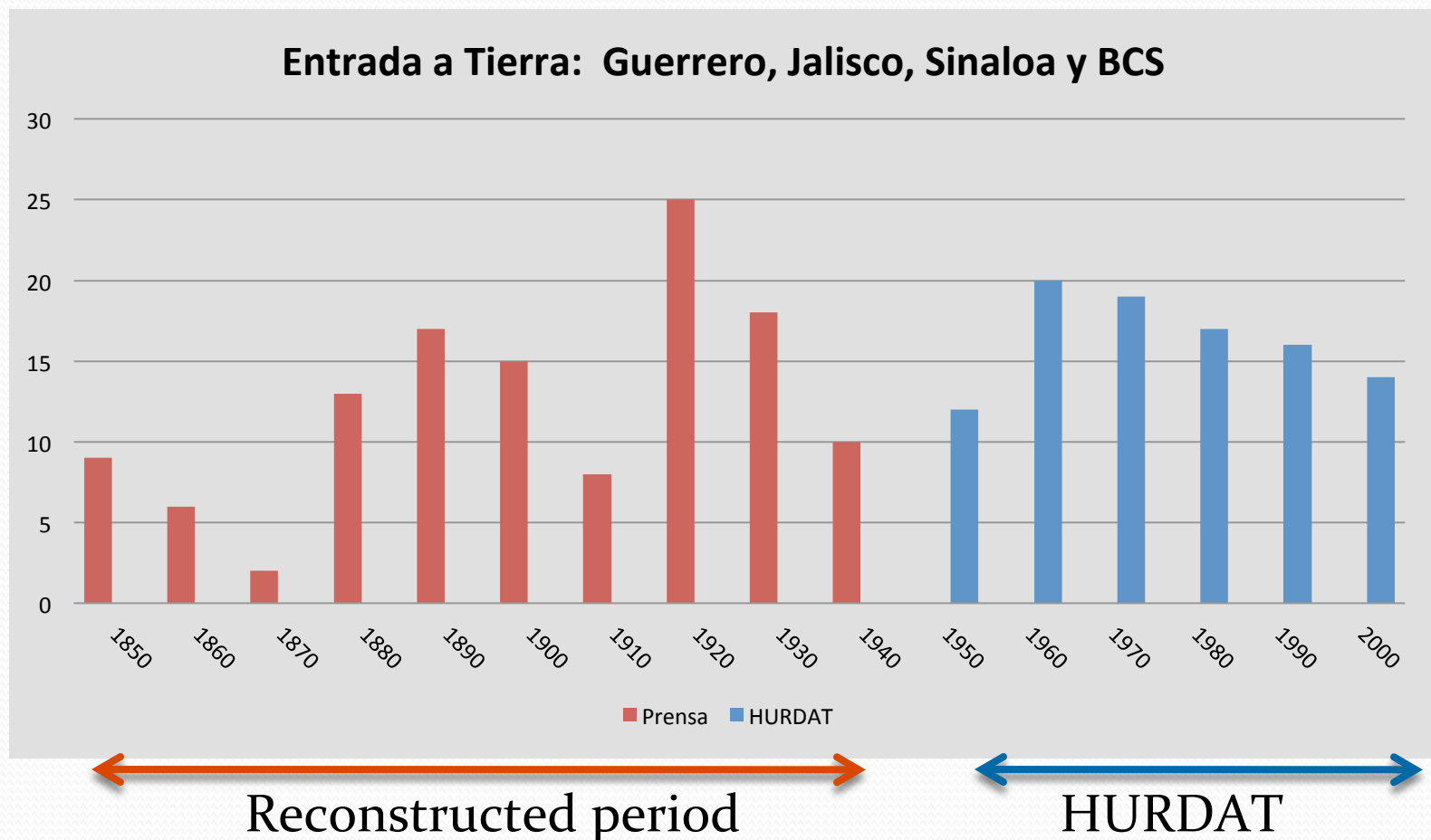
The impacts were carefully classified: number of casualties, injured, missing, evacuated; damages to property (houses, cattle, crops), industry; city infrastructure such as schools, hospitals, roads, ports, communications, etc.

Huracanes en Acapulco 1850-1950			
Ficha: 40		Por Betty Bracamontes	
Entidad federativa:	Municipio:	Lugar:	Fecha:
Imagen:	Nombre o número:	Trayectoria:	
	Tipo de fuente:		
Fuente:			
Repositorio:			
Manifestación:	(Perturbación, Depresión, Tormenta tropical, Huracán)		
Características físicas:	(Categoría, tamaño, temperatura, presión barométrica, viento y precipitación pluvial)		
Efectos			
Inundación:	Lahar:	Brisa:	
Deslave:	Flujo de escombros:	Marea de tormenta:	
Derrumbe:	Marejada:	Oleaje:	
Avenida lenta:	Avenida súbita:	Azolve:	
Otro:			
Impactos			
Muertos:	Viviendas:		
Heridos y/o enfermos:	Edificios eclesiásticos:		
Damnificados:	Edificios civiles:		
Desaparecidos:	Centros educativos:		
Evacuados:	Centros hospitalarios:		
Reubicados:	Industrias:		
Afectados:	Presas:		
Epidemias:	Drenaje:		
Pérdidas animales:	Suministro de agua potable:		
Pérdidas agrícolas:	Comunicaciones y transportes:		
Pérdidas económicas:	Energía:		

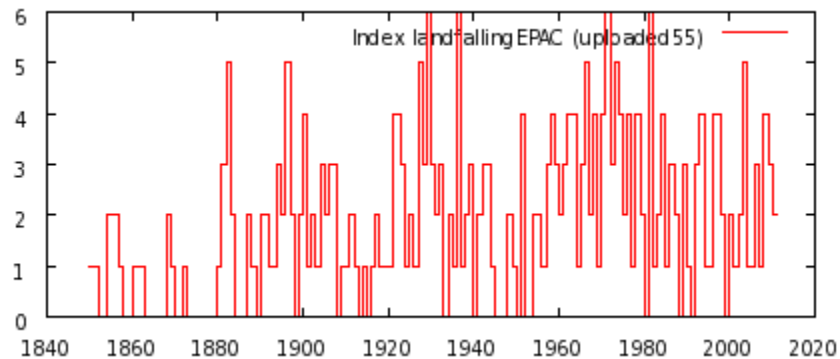
Historical records of landfalling TCs in 4 Mexican States:



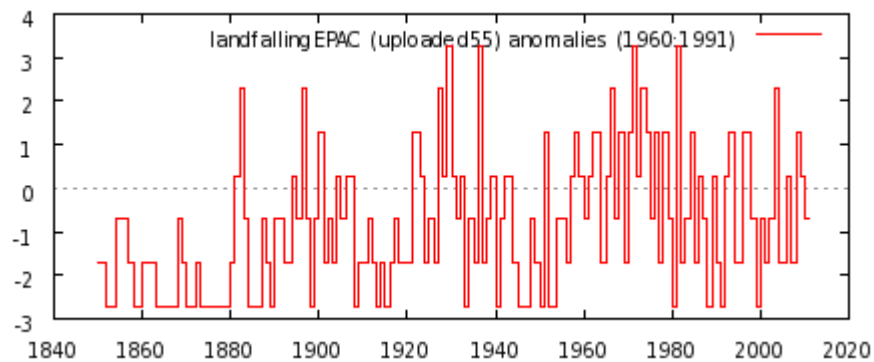
Record of landfalling TCs in EPAC: Guerrero, Jalisco, Sinaloa and BCS (1850-2010)



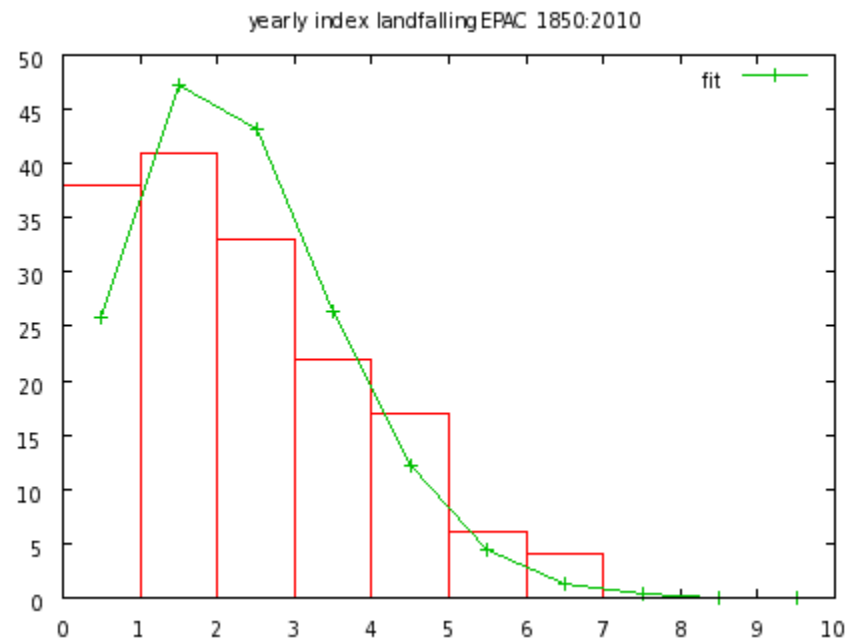
Reconstructed landfalling timeseries



Anomalies

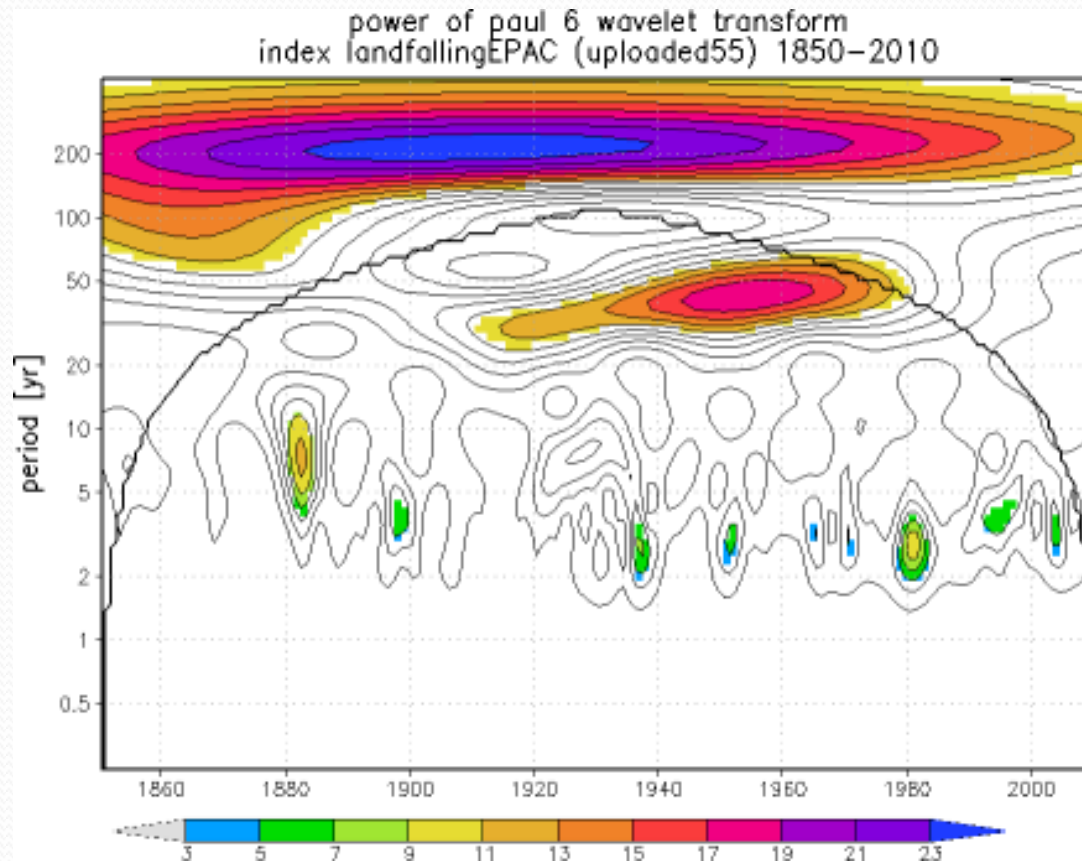


parameter	value	95% CI
N:	155	
mean:	1.8 ± 0.2	1.6 ... 2.1
s.d.(n):	1.6 ± 0.2	1.4... 1.7
skew:	0.7 ± 0.3	0.4 ... 0.9



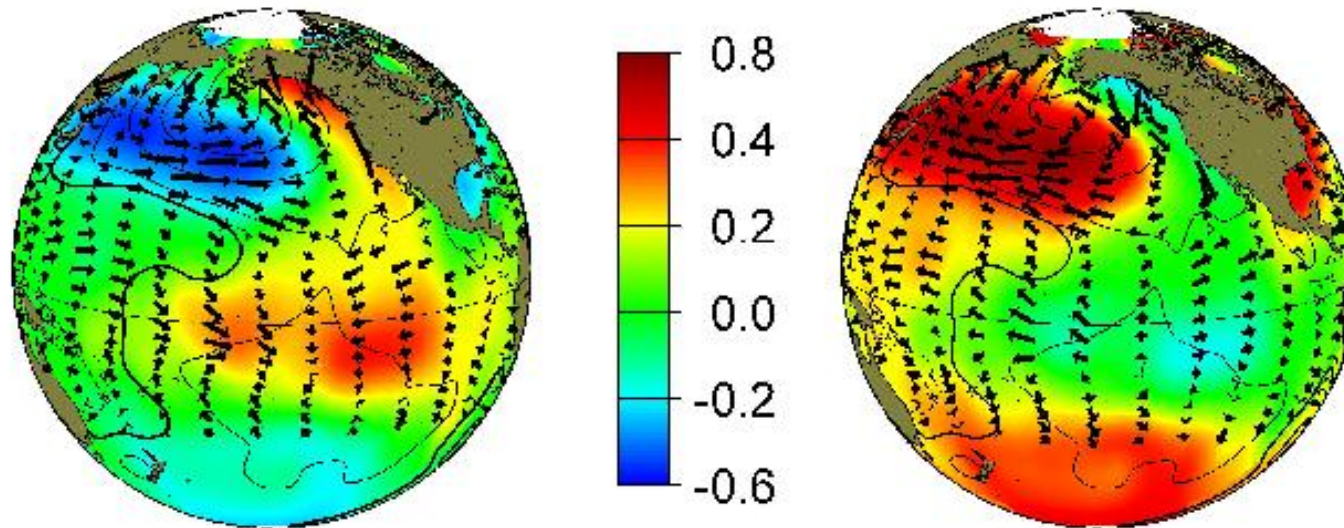
Correlation coefficient

period	Index	Spearman
1850-2010	NAO	0,22
1866-2009	SOI	0,13
1900-2010	PDO	0,31
1856-2010	Niño3	0,22

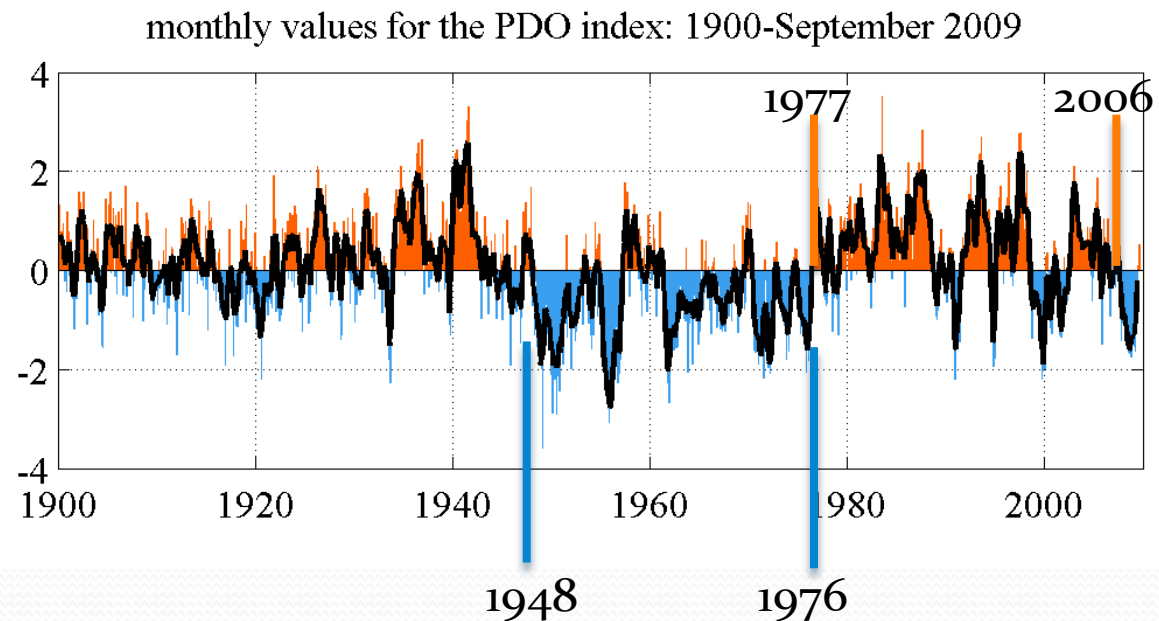


Wavelet (1850 - 2010)
Black curve: cone of
influence

- Large scale decadal variability in the Pacific

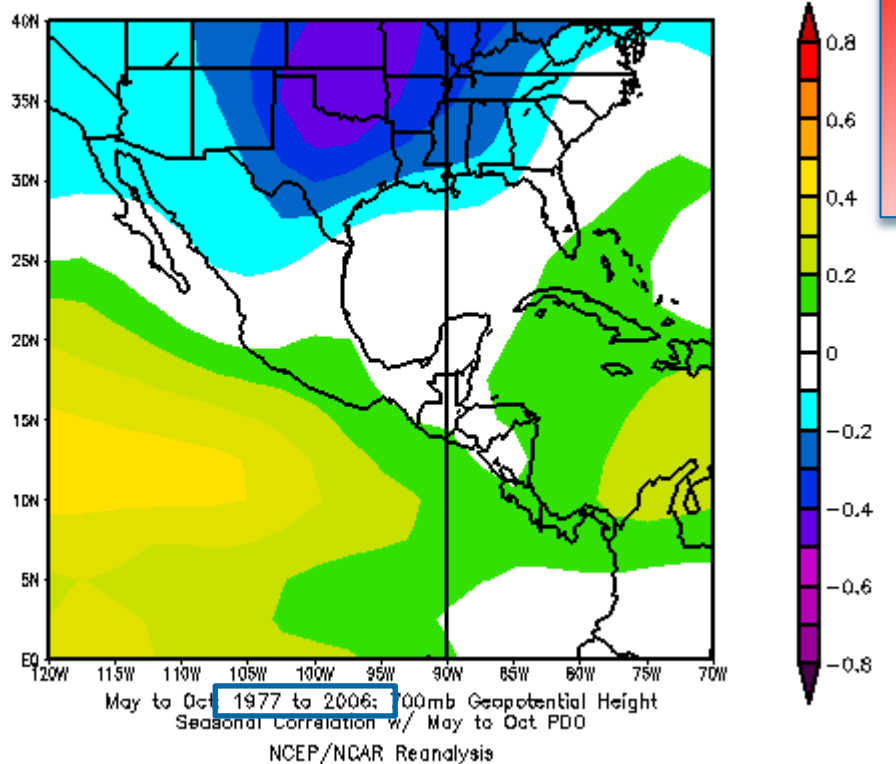


PDO index



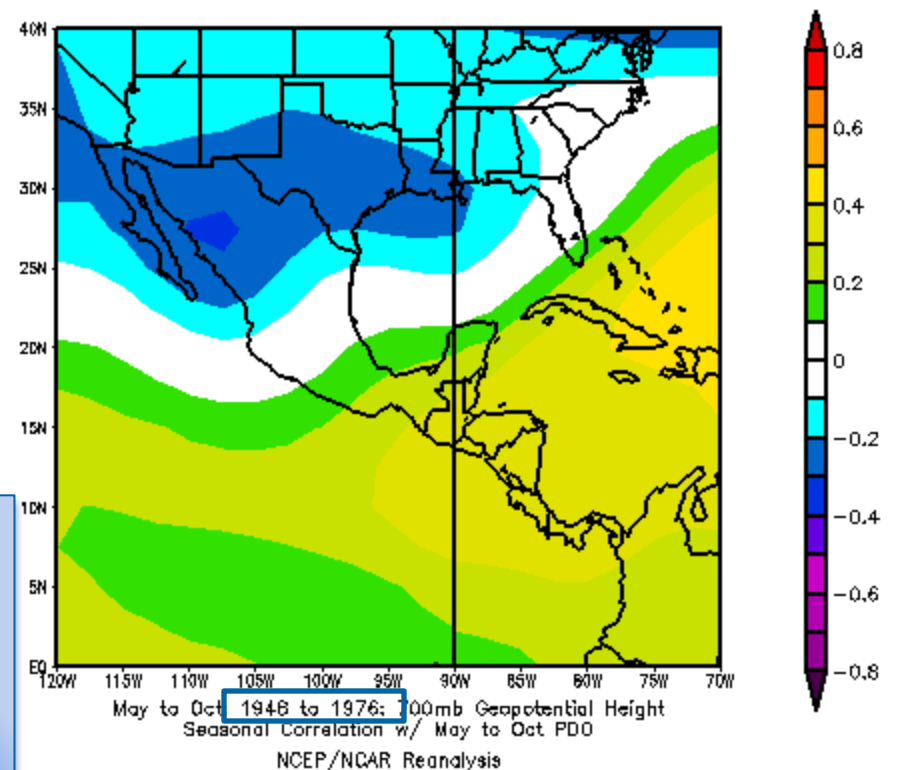
(Mantua et al, 1997)

- Large scale decadal variability in the Pacific



1977-2006
Positive
PDO index

1948-1976
Negative
PDO index





Summary

- From NHC database, hurricanes and major hurricanes in the EPAC basin have *decreased* in last decade, while number of landfalling TCs remains fairly constant
- Large *intraseasonal* variability of land-falling cyclones
- Landfalling time-series were *reconstructed* from historical records and newspapers *back to 1850*, for 4 Mexican States in the Pacific
- Variability *comparable* to that observed in NHC database

Summary

- Average of 1.8 ± 1.6 landfalls per year
- Largest correlation with *PDO* index
- A very rich database with thousands of records has been generated, not only about physical but social-economic aspects

Future work:

1. Funds from IAI already available to continue the reconstruction to 1500 AD with historians and social anthropologists, led by V. Garcia-Acosta
2. Collaboration with Kam-biu Liu already initiated, with several cores obtained in Guerrero, Jalisco and BCS, currently being analyzed

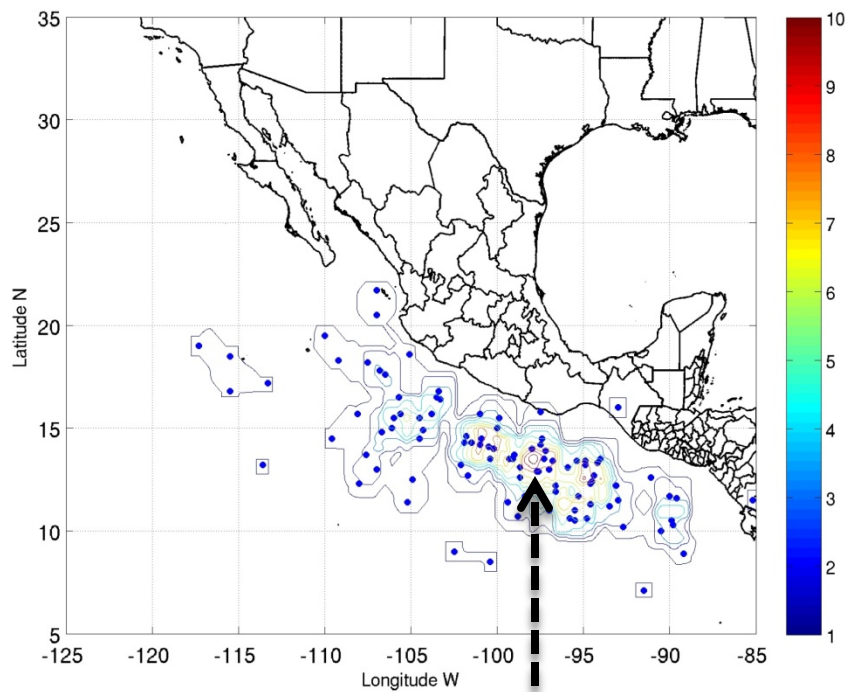


Landfalling TCs:

Where they start, when they start, where they land?

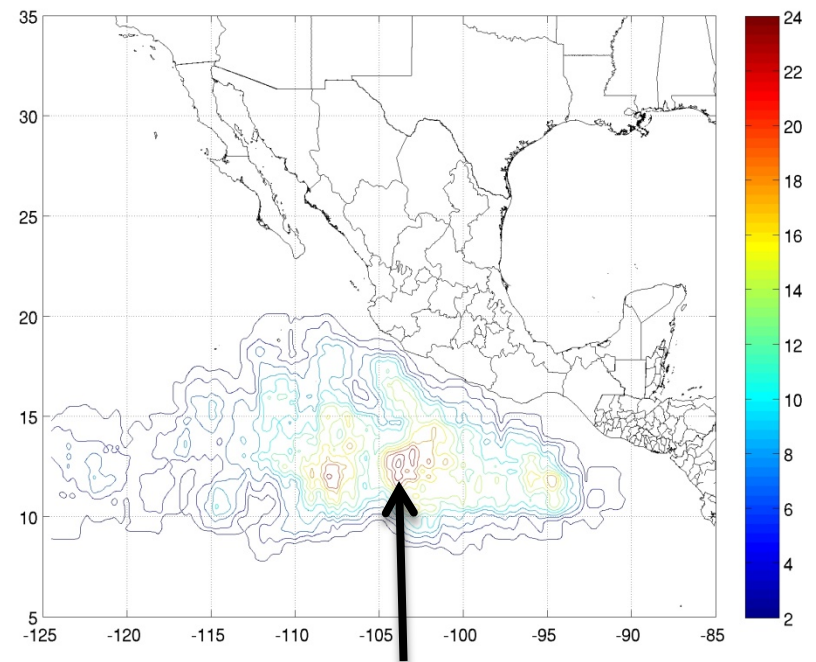
On average about 15% of the total named cyclones make landfall

Genesis location of landfalling TC



(14N, -97.5W)

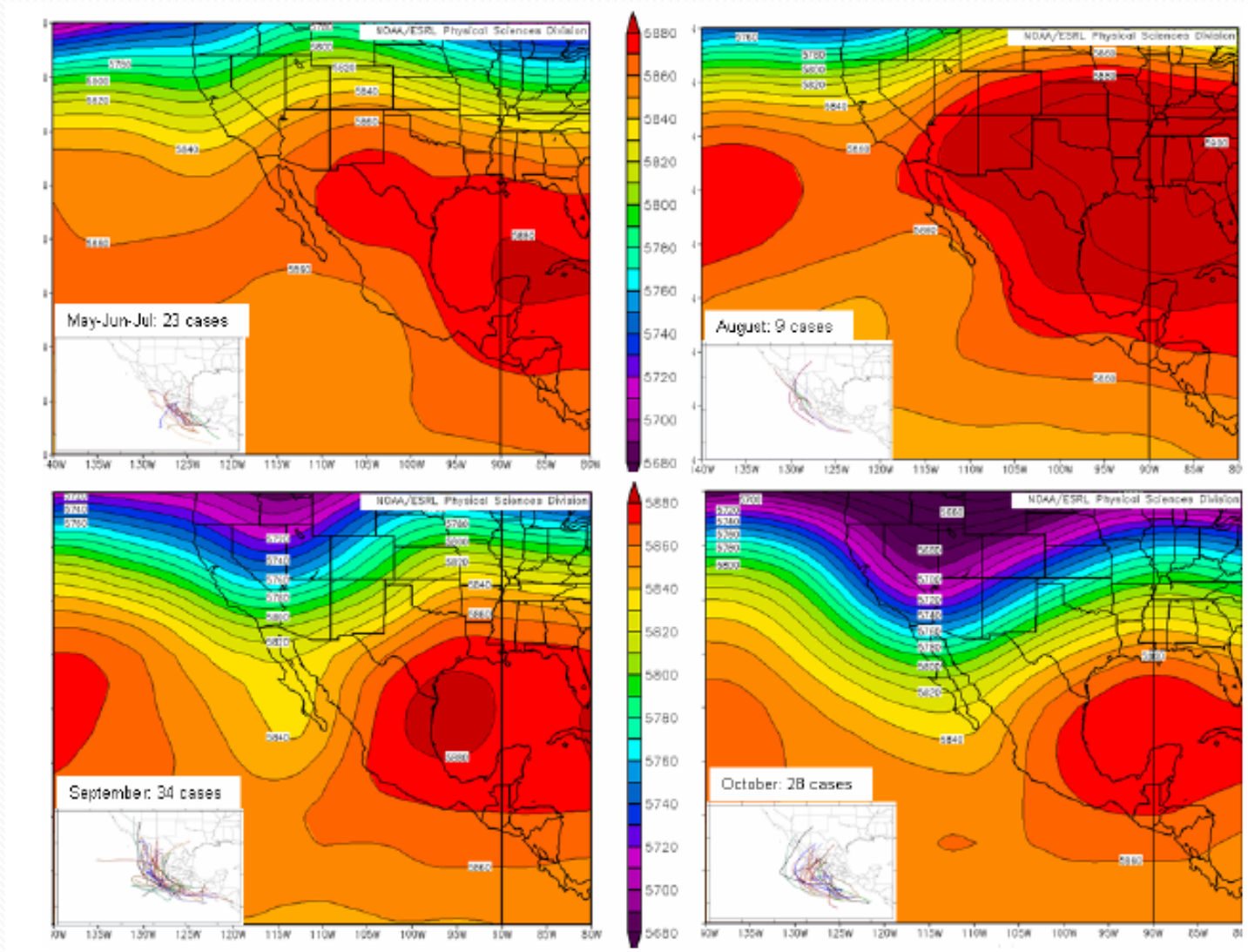
Genesis location of non-landfalling TC



(13.5N, -103W)

(Romero-Centeno et al, 2011)

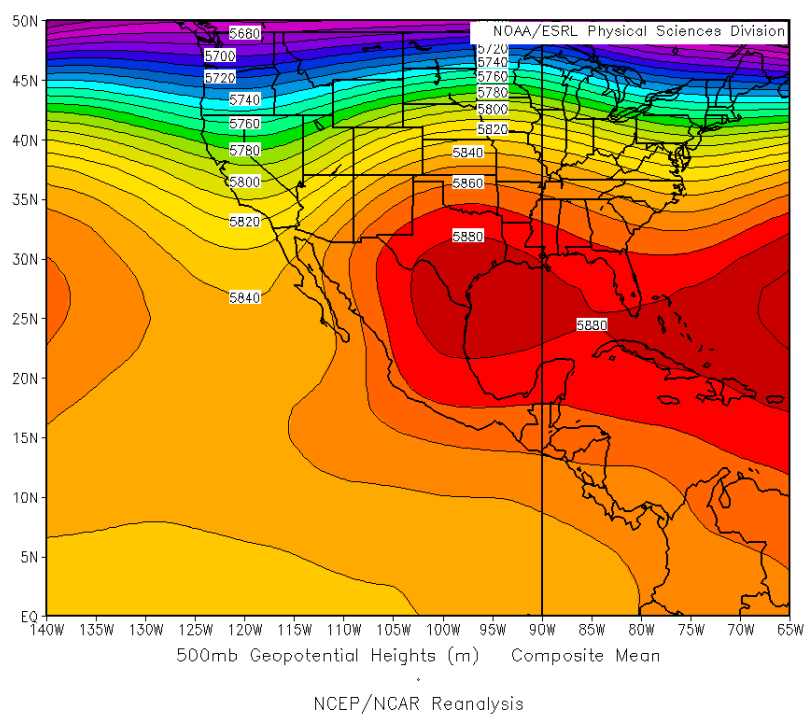
Variability associated to large-scale patterns



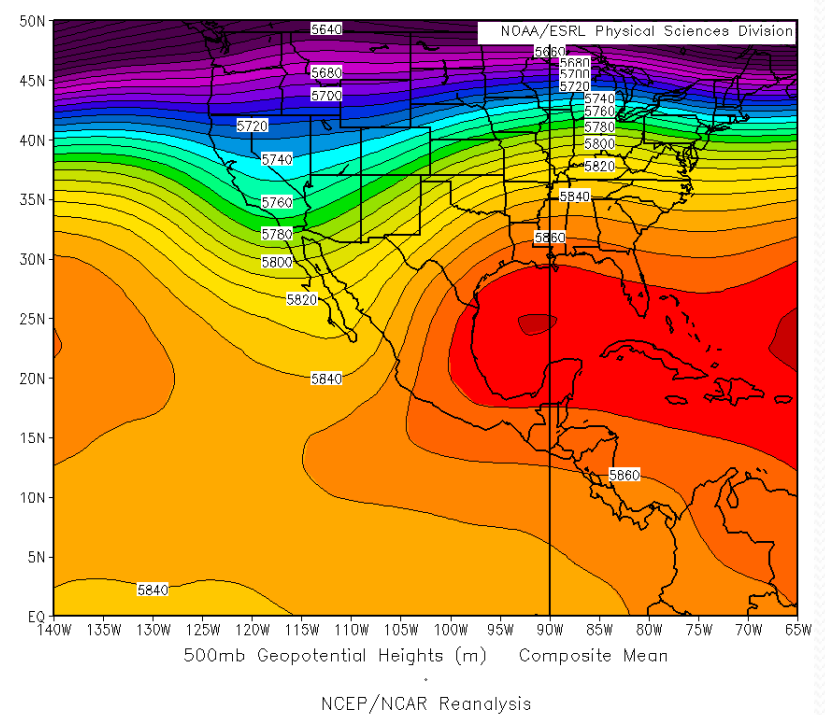
(Farfan, et al, 2012)

Variability associated to large-scale patterns: 1949-2010

Baja peninsula landfall



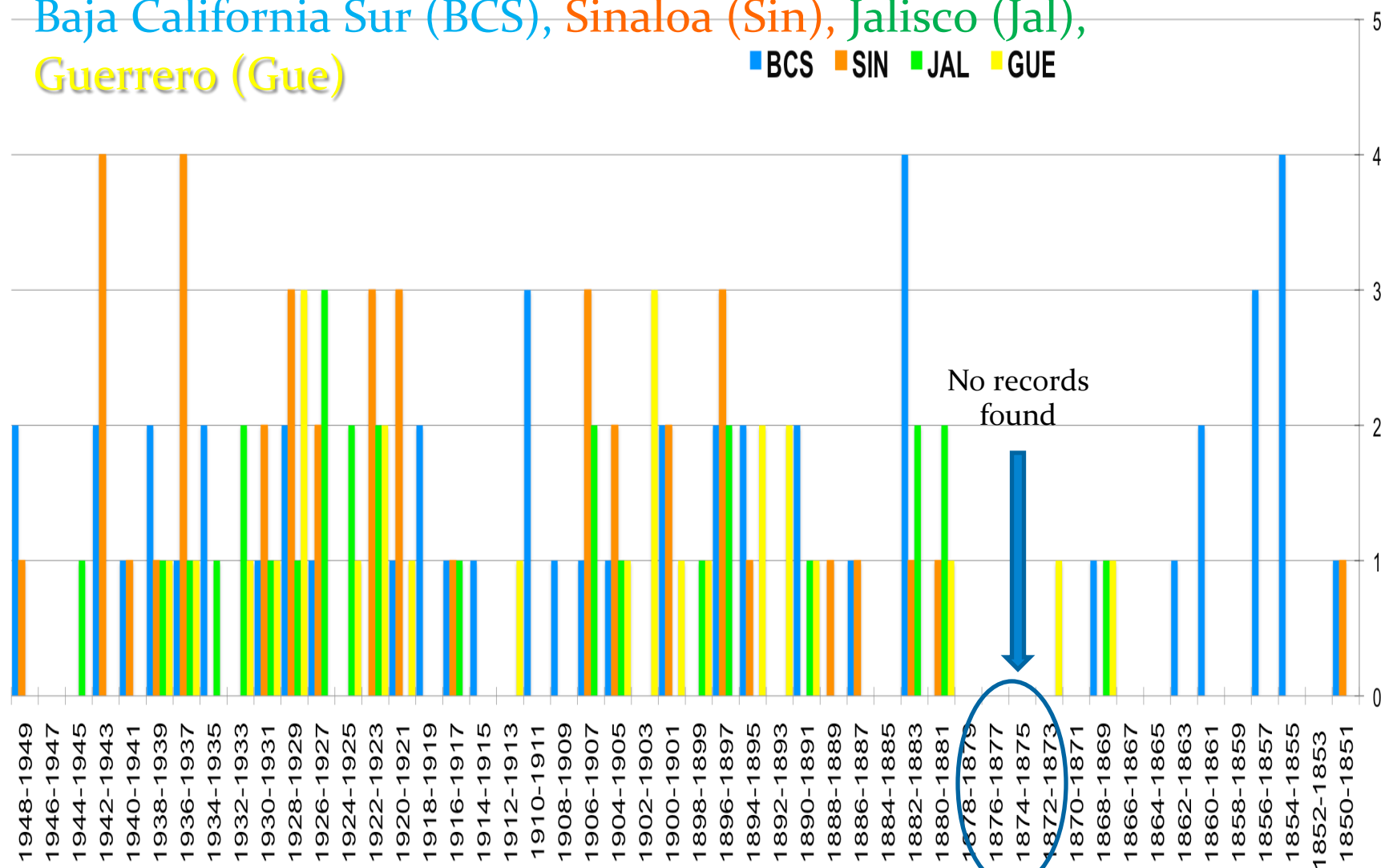
Mainland landfall



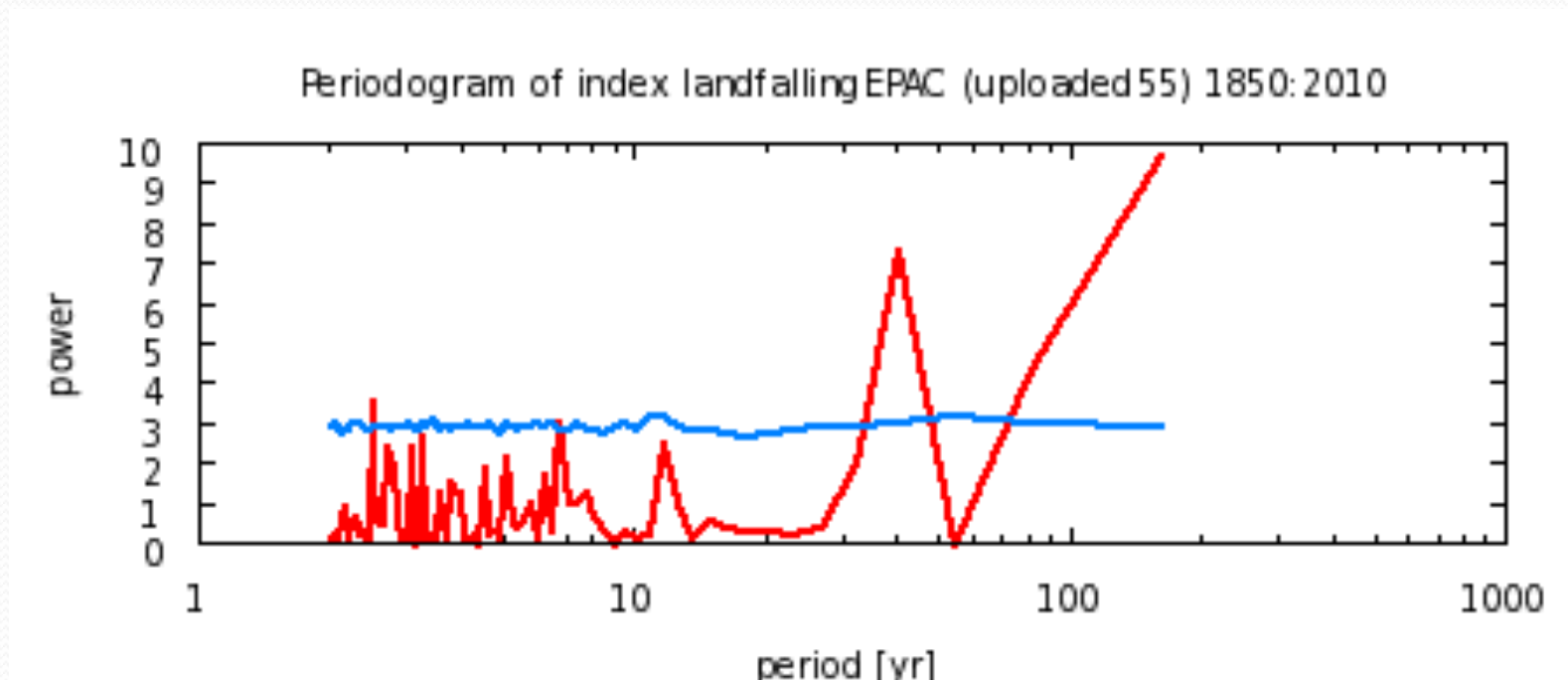
Historical records of landfalling TCs in 4 Mexican States

Baja California Sur (BCS), Sinaloa (Sin), Jalisco (Jal), Guerrero (Gue)

BCS SIN JAL GUE



Periodogram (1850 - 2010)



Autocorrelation (1850 - 2010)

