

HURRICANE ACTIVITY AND DROUGHTS IN MEXICO

by

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October 18th, 2006
Mexico City



AgroClima[®]

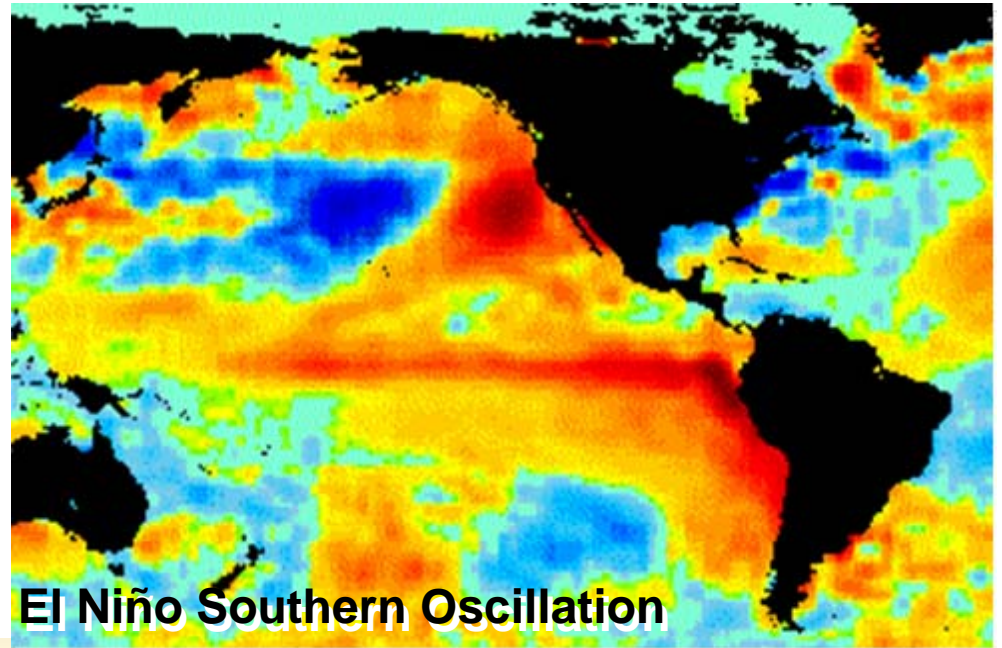
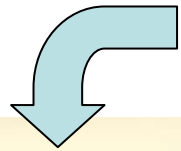
Informática Avanzada S.A. de C.V.

* Hydrologist
Director of Agroclima Informática Avanzada, S.A.



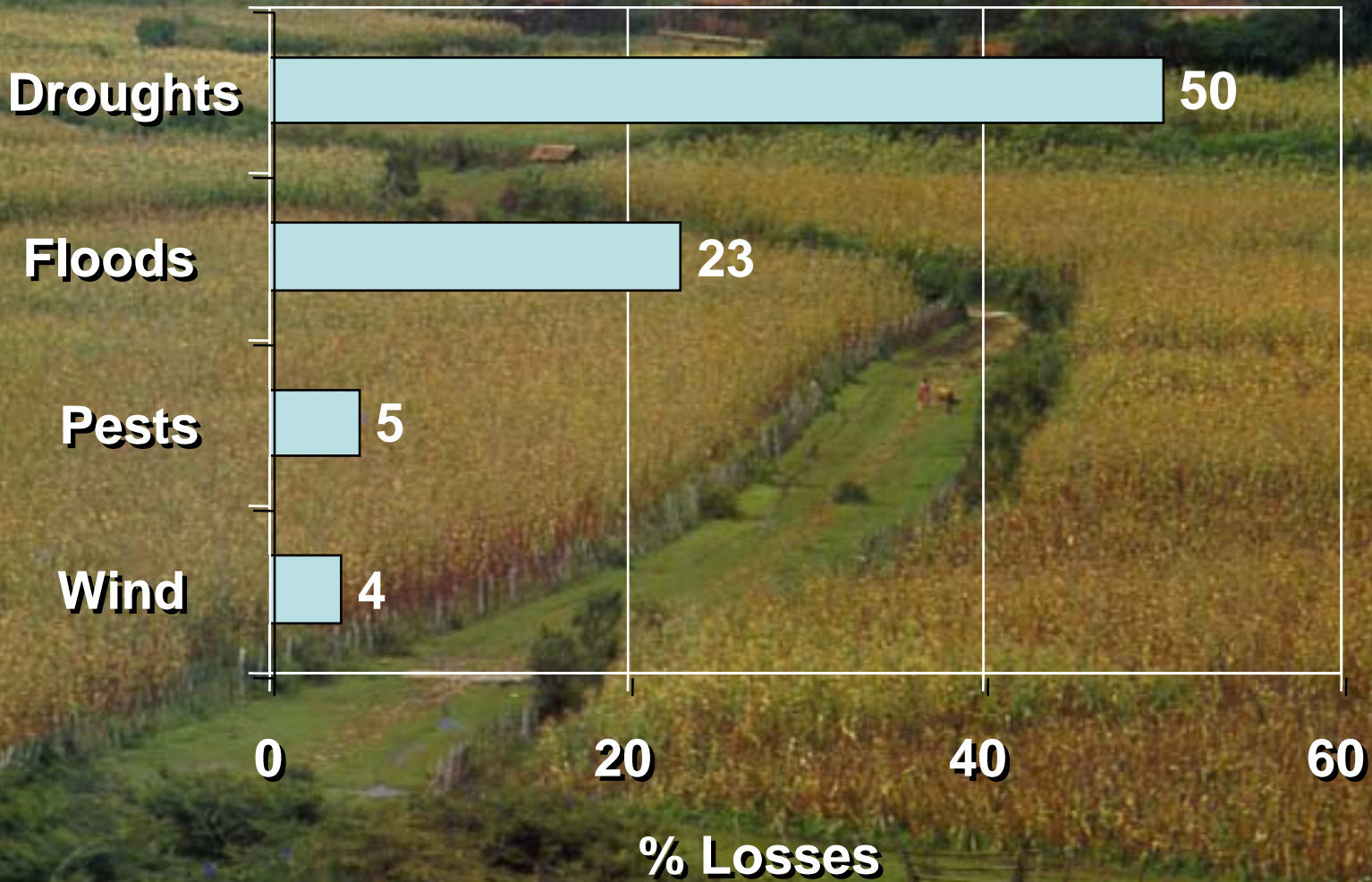
Agriculture is a very risky economic activity

**High inter-annual
climate variability**



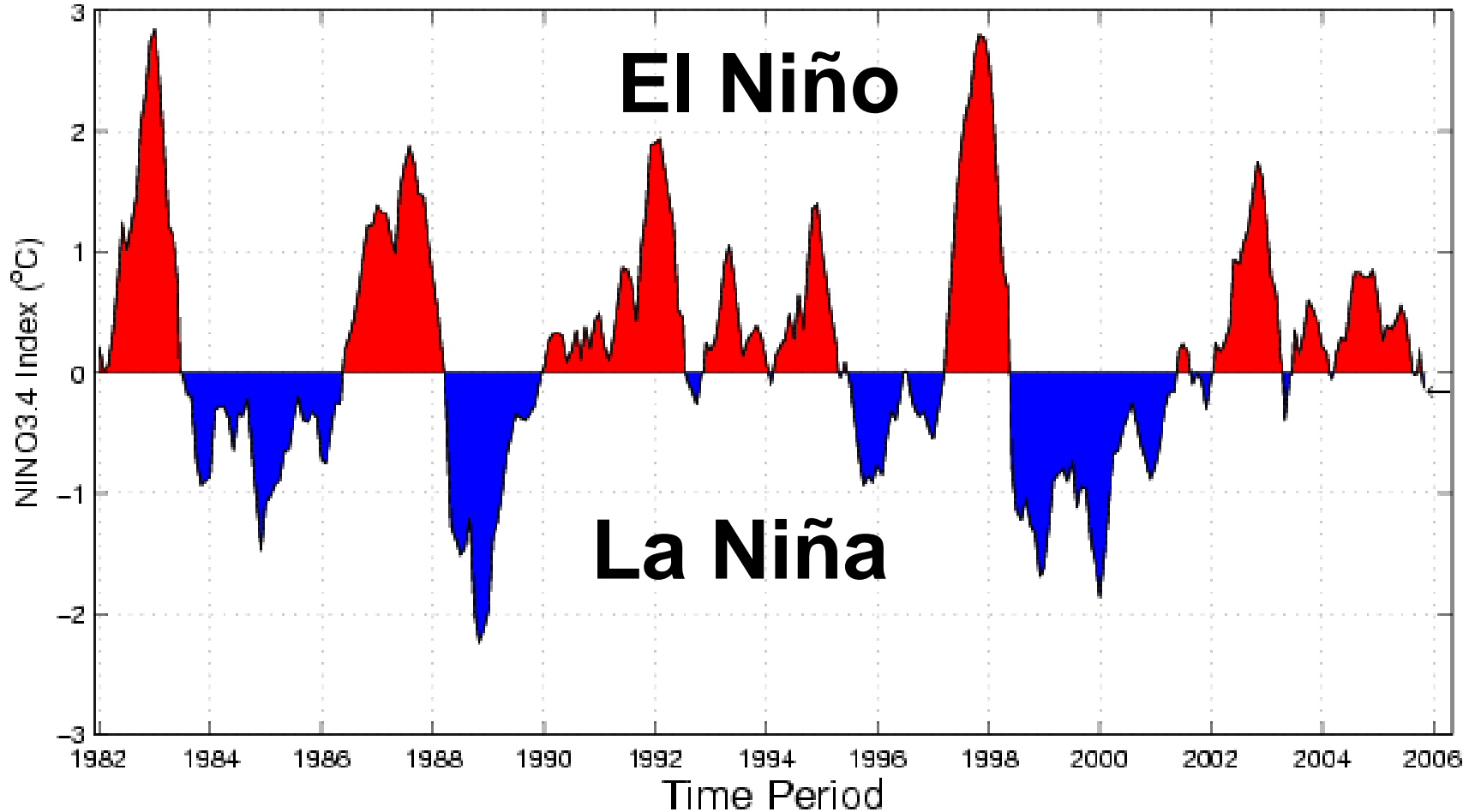
***Induce high
uncertainty in
food production***

Crop losses in rain-fed agriculture of Mexico



The presence of El Niño Southern Oscillation highly modify the climate of Central America and Mexico

Historical Sea Surface Temperature Index

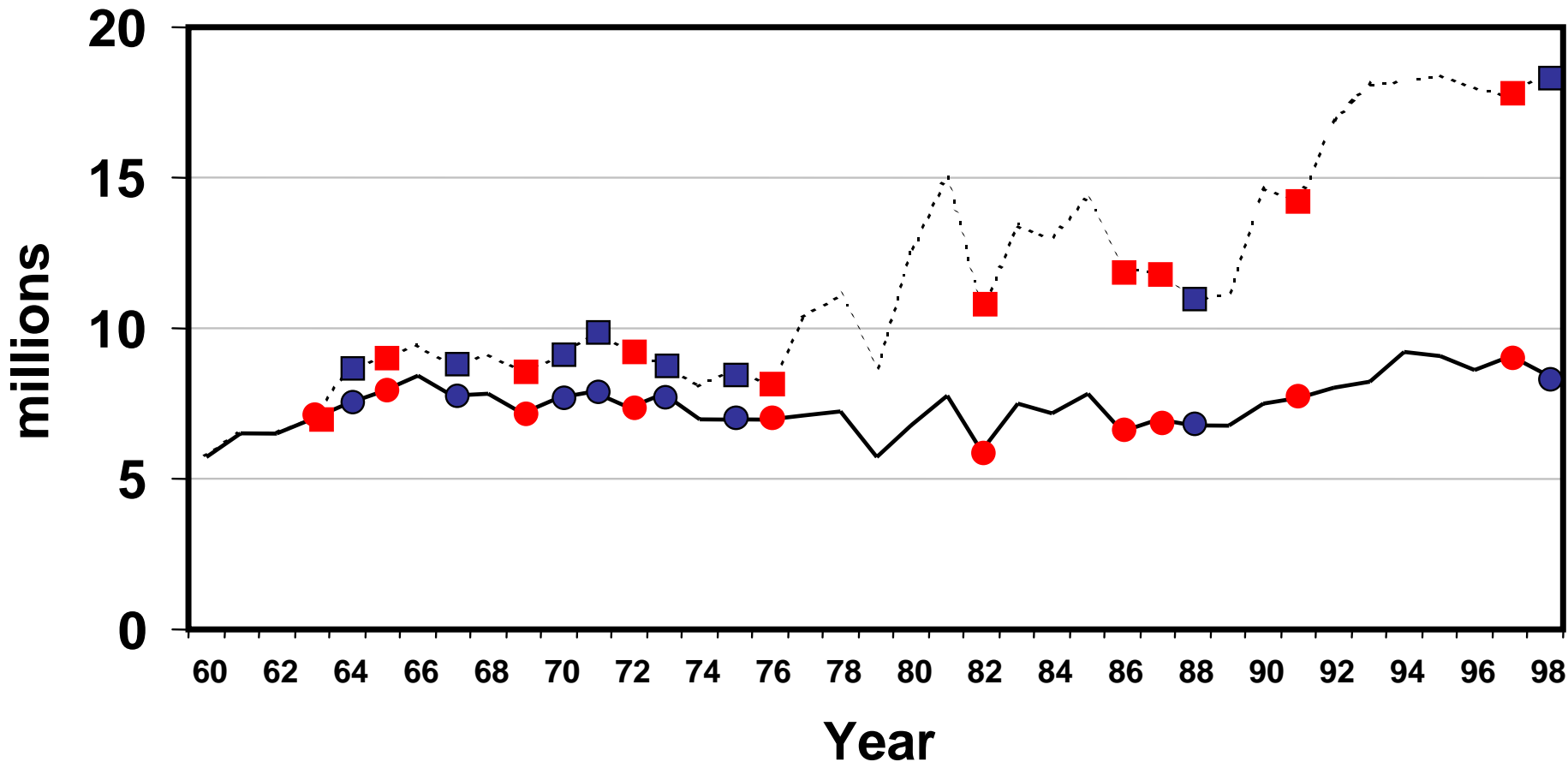


CHANGES IN RAINFALL PATTERNS



—	1995	734 mm	Neutral	Month
—	1997	661	El Niño	Weather Station in Huamantla, Tlax.
—	1998	675	La Niña	

TREND OF MAIZE PRODUCTION IN MEXICO AND ENSO EVENTS



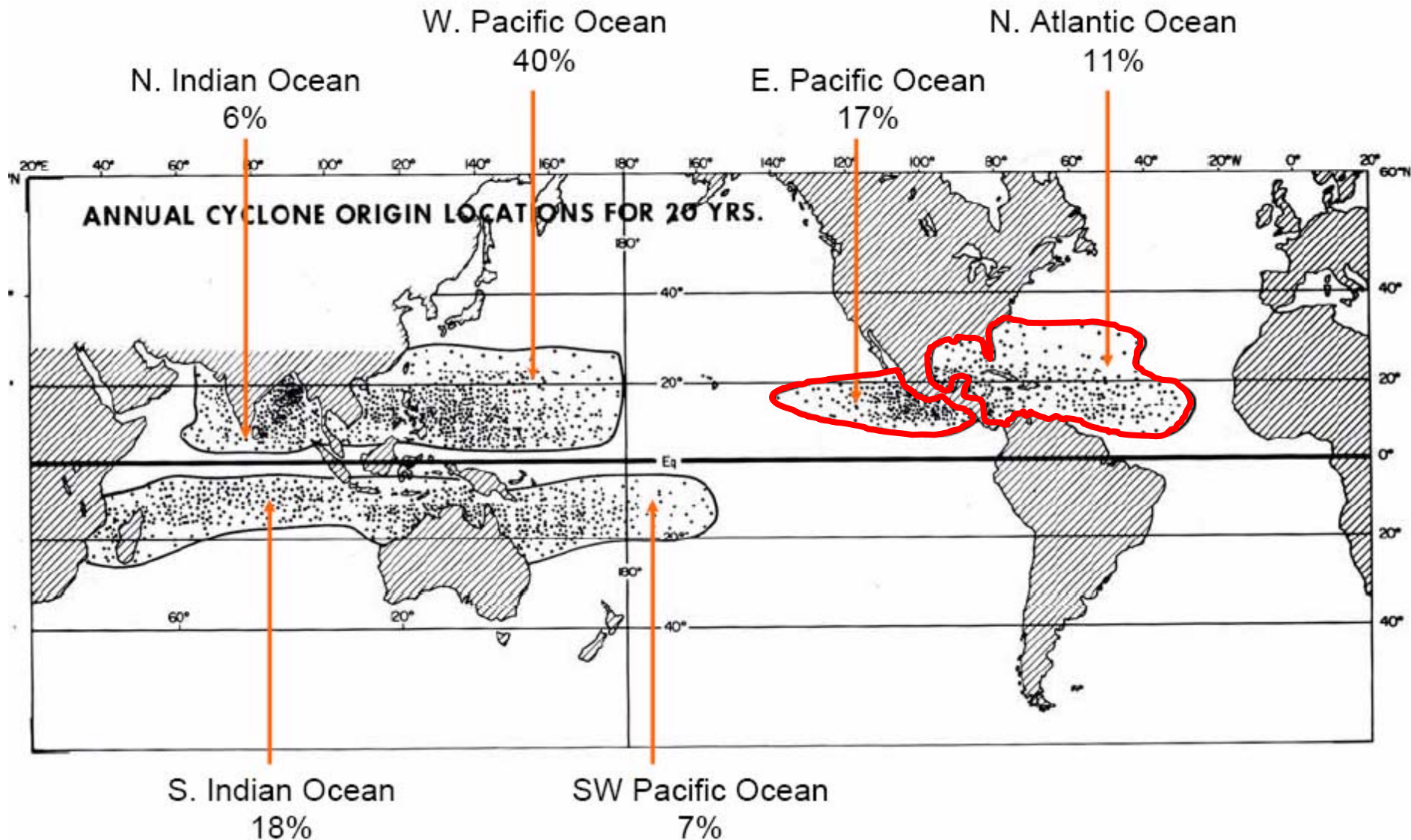
..... Prod (tons) — Area (ha)

■ El Niño

■ La Niña

REGIONAL CICLONIC ACTIVITY

Number of Tropical Storms



ENSO & HURRICANES

- El Niño means more action in Pacific, suppression in Atlantic
- La Niña and Neutral conditions more activity in Atlantic, suppression Pacific

WILMA HURRICANE

Formed [October 15, 2005](#)

Dissipated [October 25, 2005](#)

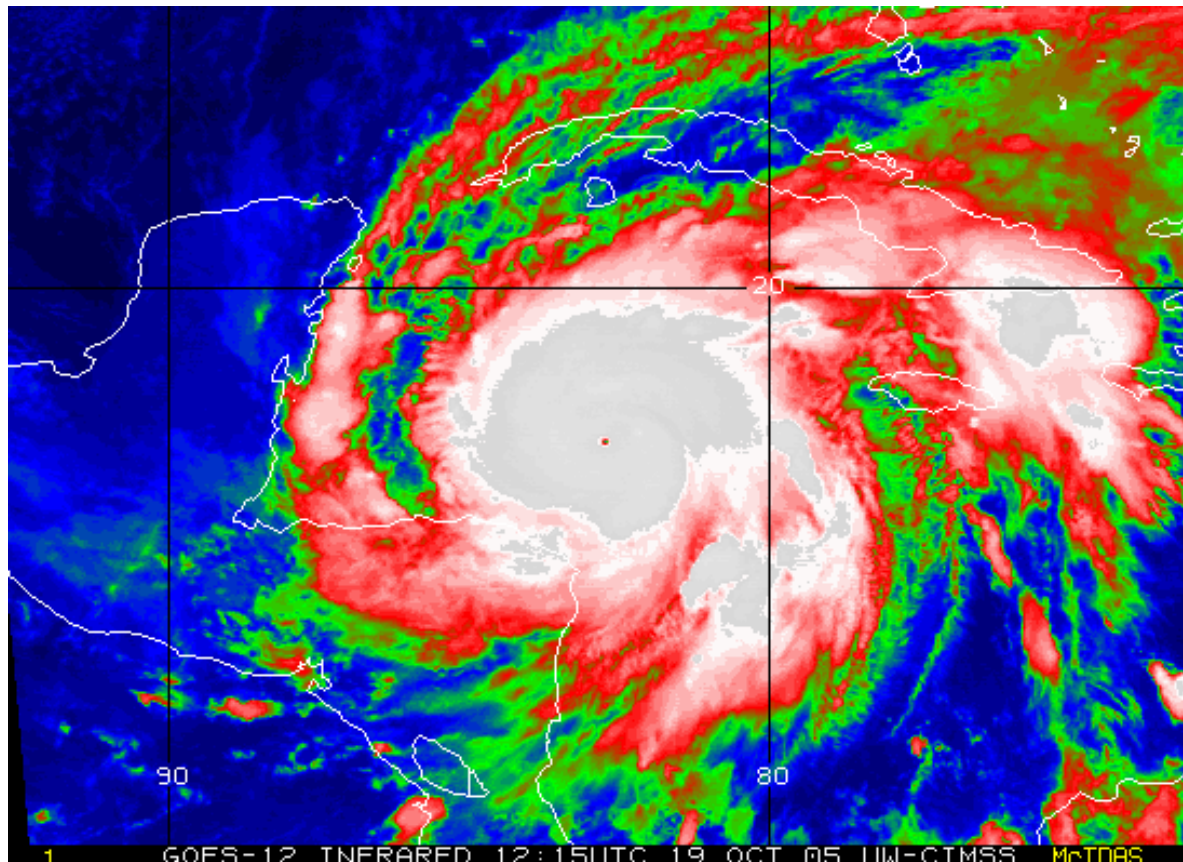
Highest winds 185 mph (295 km/h)

Lowest pressure 882 mbar (hPa)

Lowest pressure ever recorded in an Atlantic hurricane

Damages \$16-20 billion USD

Fatalities 22 direct, 40 indirect



ENSO, HURRICANES AND DROUGHTS

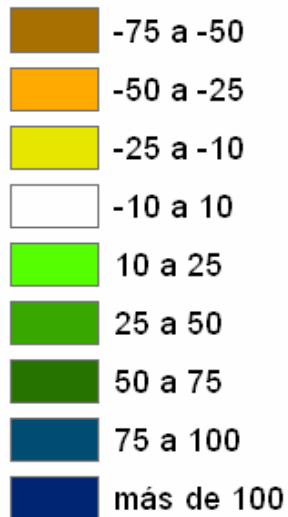
1996	Neutro
1997	Strong El Niño
1998	La Niña
1999	La Niña

PRECIPITATION ANOMALY

Aug-Sep-Oct, 1996

NEUTRAL YEAR

% Dev.
Avg Precip.



Fausto (Sep)

Simbología

- Huracán
- Tormenta Tropical
- Depresión Tropical

Herman (Sep-Oct)

Josephine (Ago)

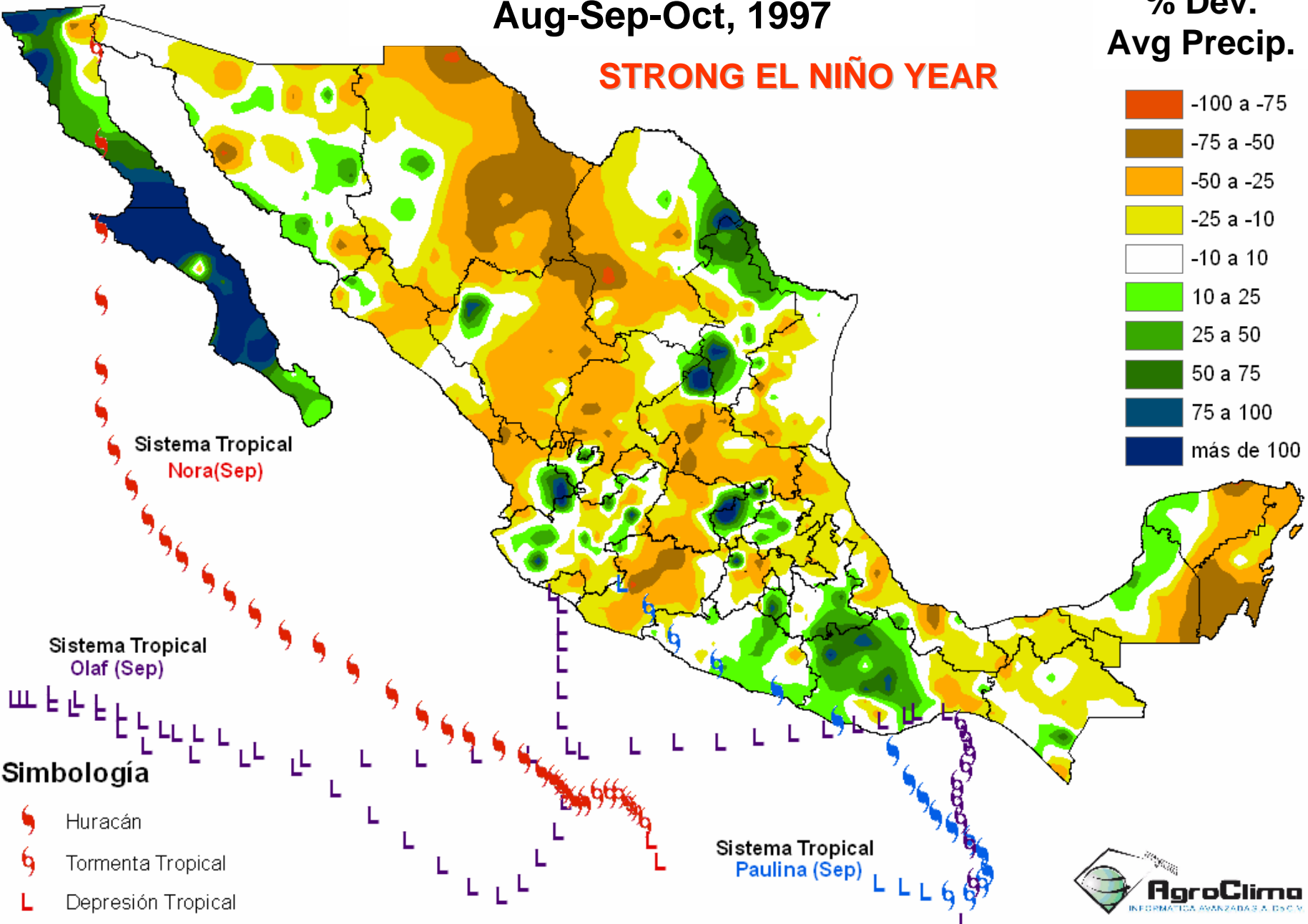
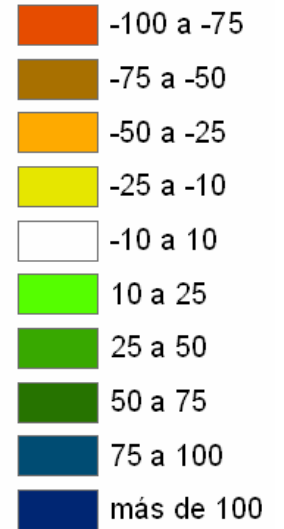
Dolly (Ago)

PRECIPITATION ANOMALY

Aug-Sep-Oct, 1997

STRONG EL NIÑO YEAR

% Dev.
Avg Precip.



Sistema Tropical
Nora(Sep)

Sistema Tropical
Olaf (Sep)

Sistema Tropical
Paulina (Sep)

Simbología

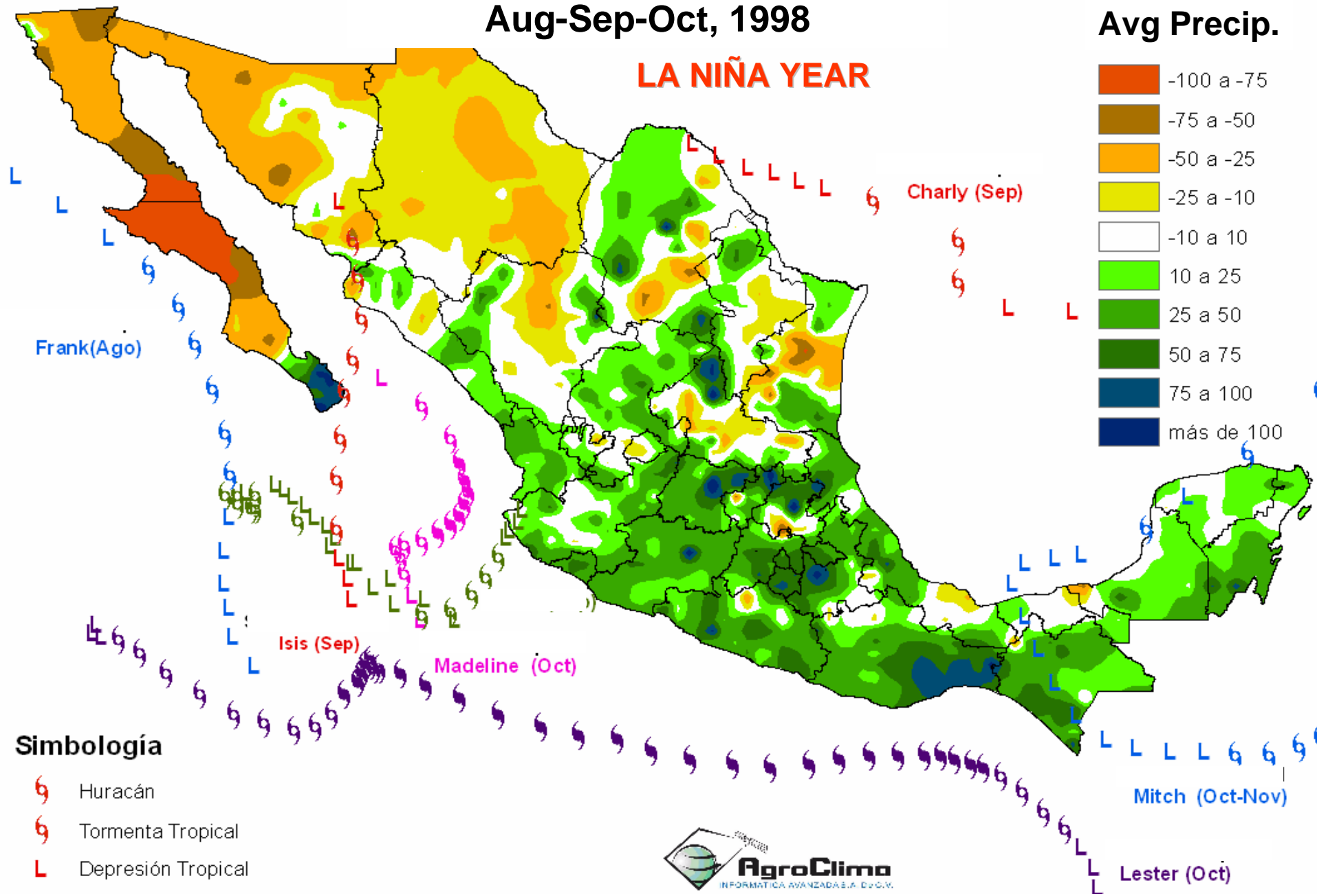
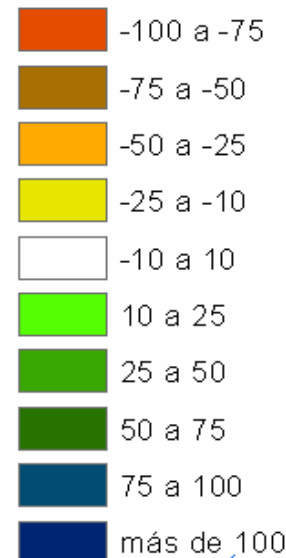
- Huracán
- Tormenta Tropical
- Depresión Tropical

PRECIPITATION ANOMALY

Aug-Sep-Oct, 1998

LA NIÑA YEAR

% Dev.
Avg Precip.



Simbología

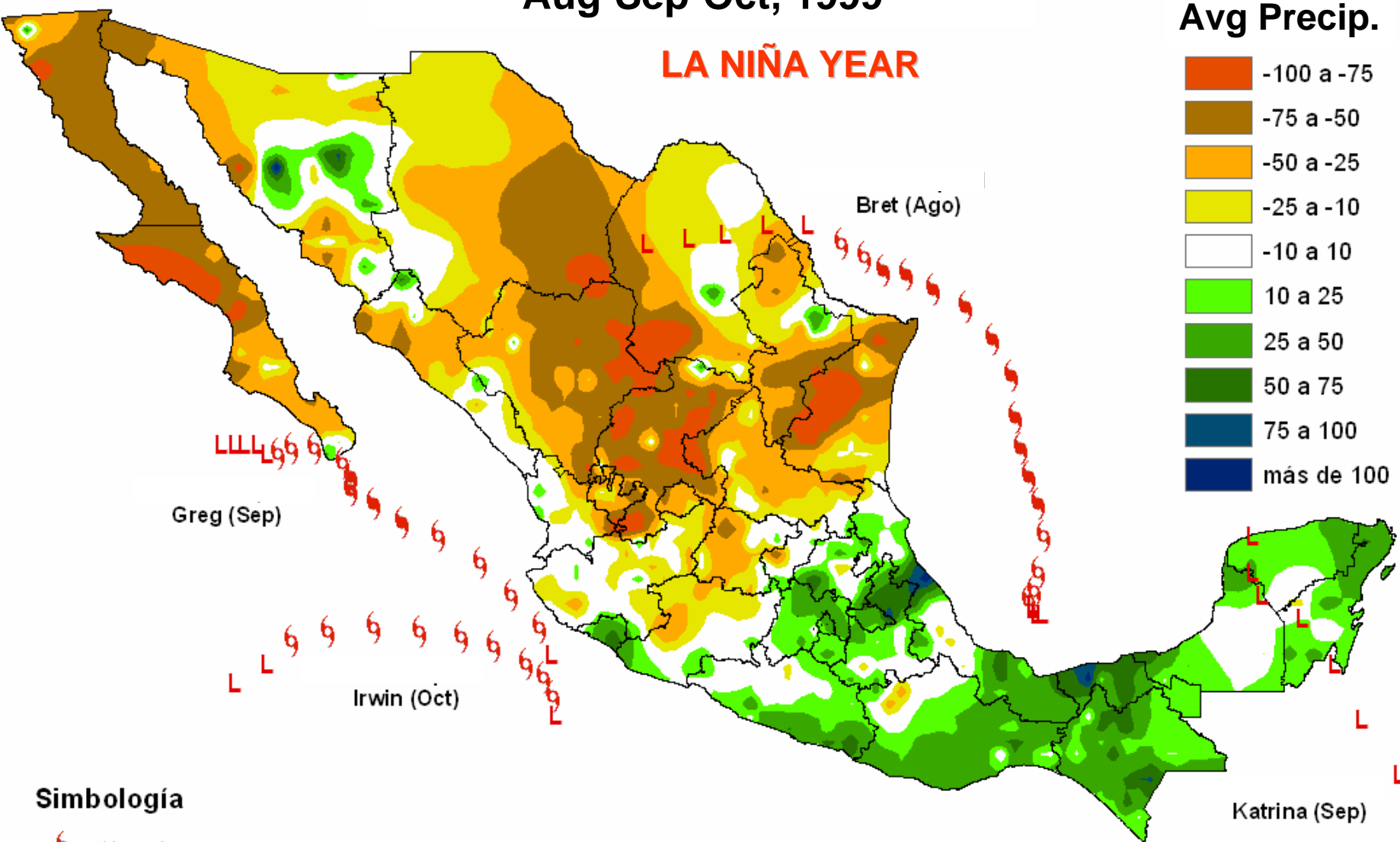
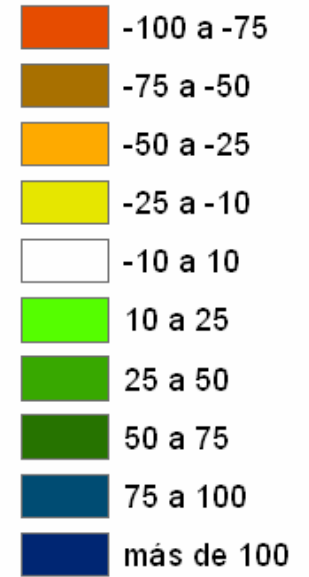
- 6 Huracán
- 6 Tormenta Tropical
- L Depresión Tropical

PRECIPITATION ANOMALY

Aug-Sep-Oct, 1999

LA NIÑA YEAR

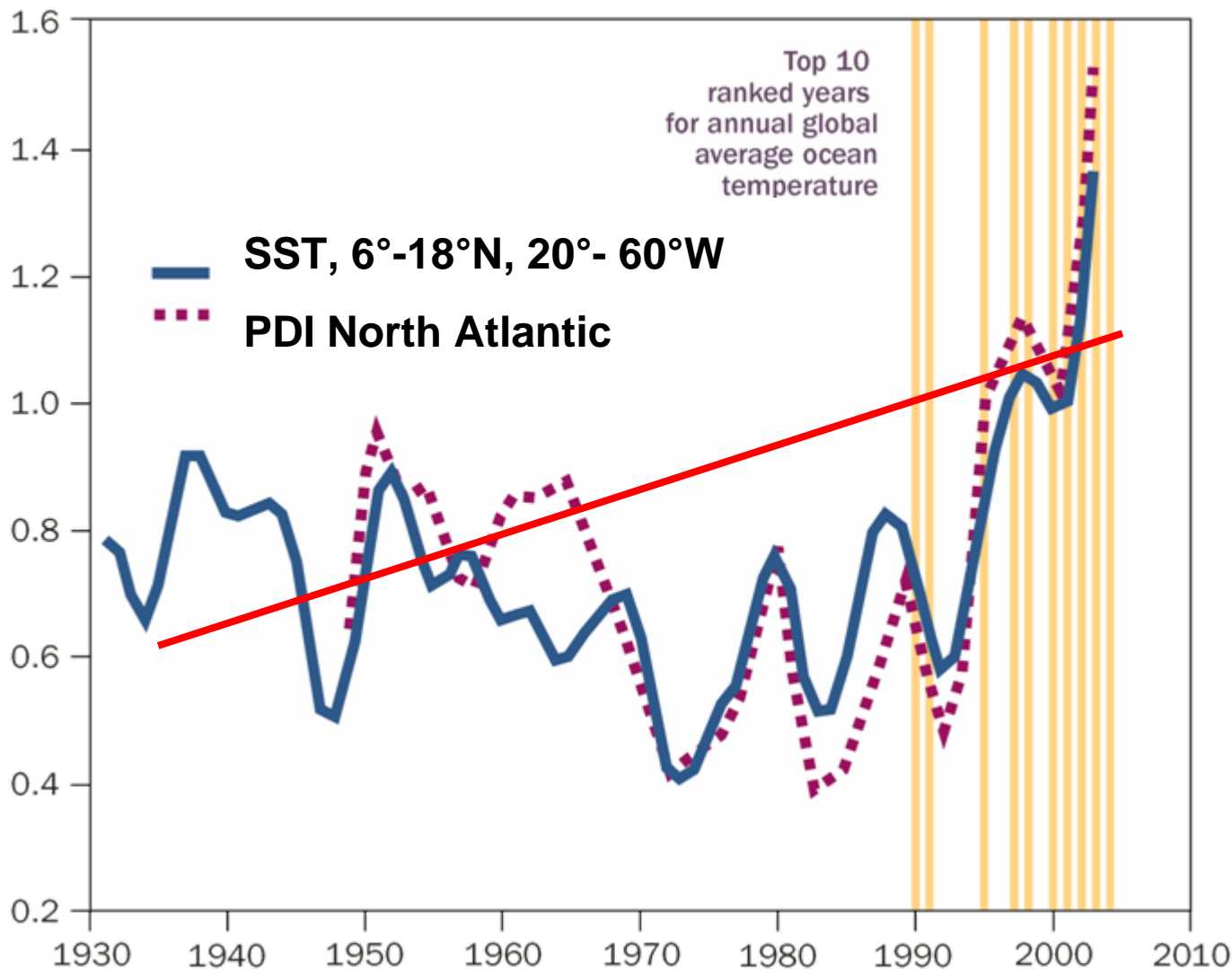
% Dev.
Avg Precip.



Simbología

- 9 Huracán
- 6 Tormenta Tropical
- L Depresión Tropical

Total Annual Dissipated Energy by Tropical Cyclones in the North Atlantic



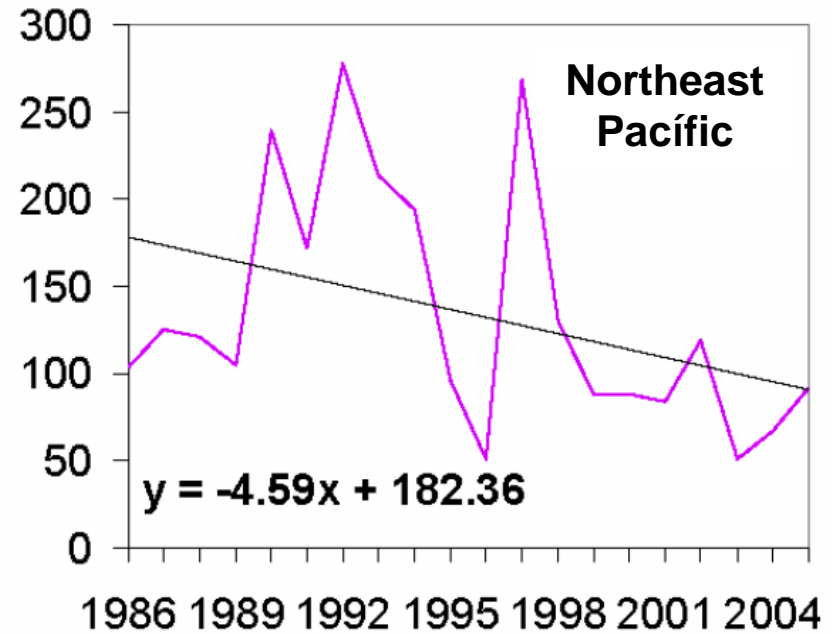
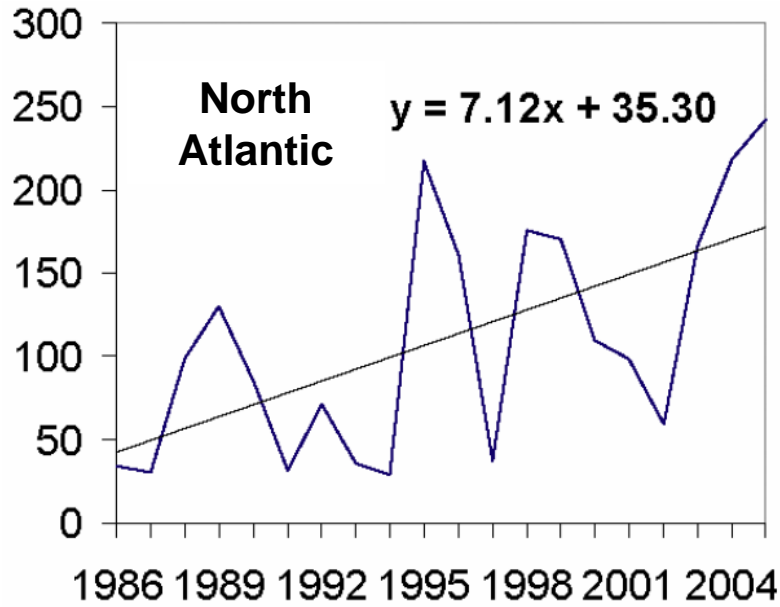
Emanuel (2005)

SST = Sea Surface Temperature

NORTH HEMISPHERE

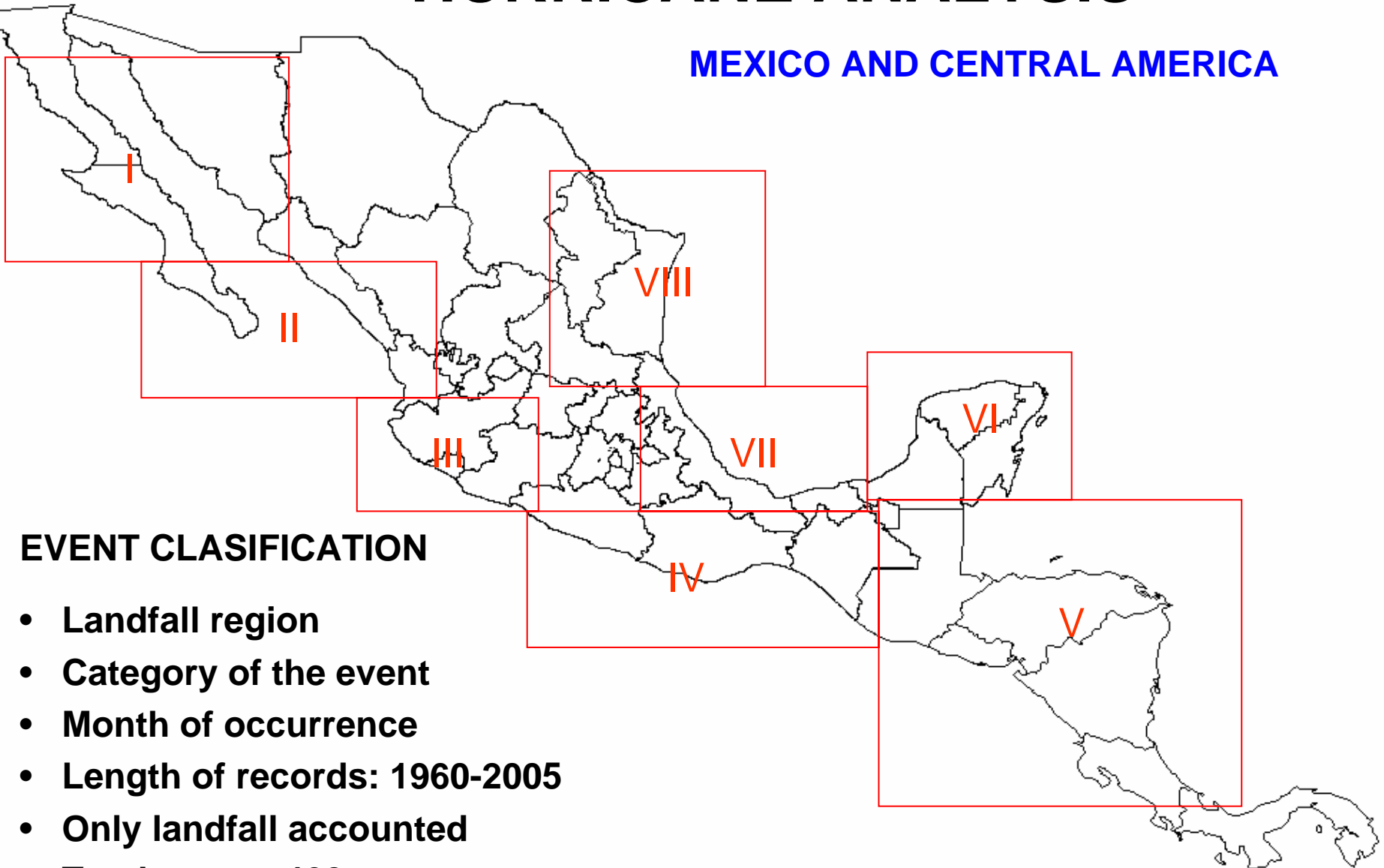
(Accumulated Cyclone Energy)

Klotzbach (2006)



HURRICANE ANALYSIS

MEXICO AND CENTRAL AMERICA



EVENT CLASIFICACION

- Landfall region
- Category of the event
- Month of occurrence
- Length of records: 1960-2005
- Only landfall accounted
- Total event: 460
- Events cat. 3,4,5: 191

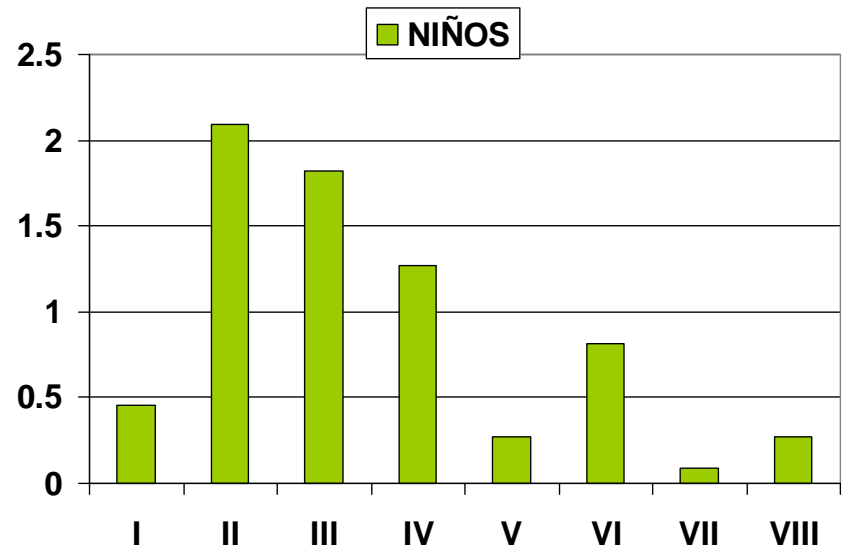
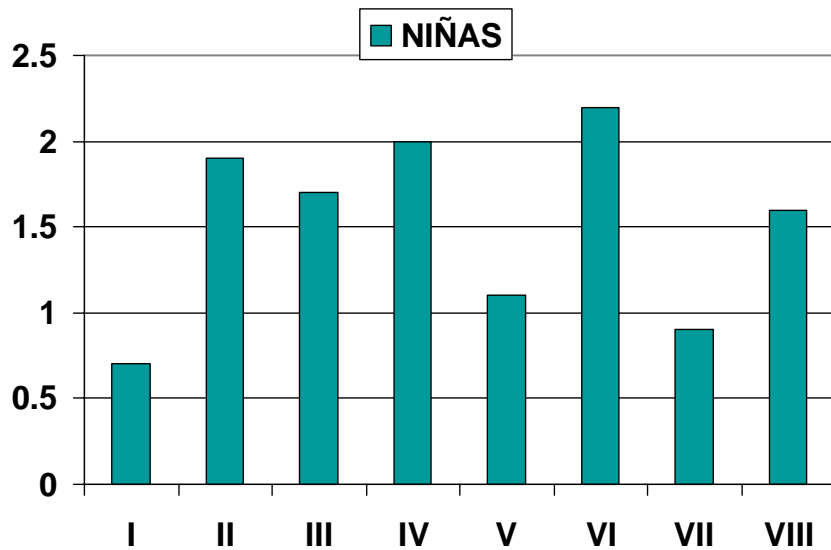
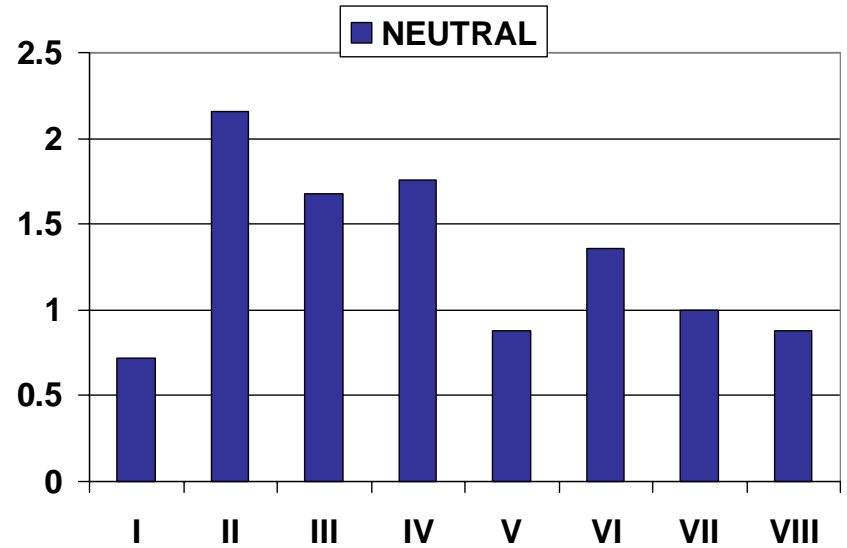
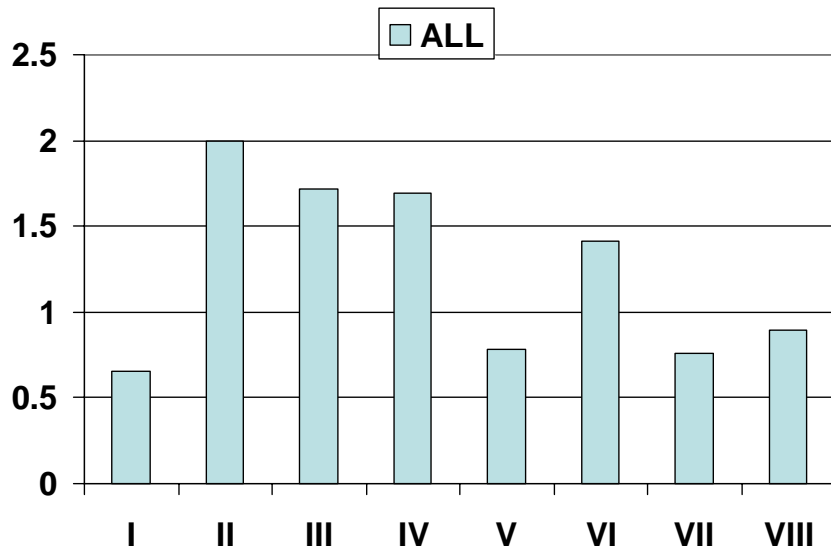
YEARS CLASSIFICATION BASED ON THE ENSO INDEX

Japanese Meteorological Agency, SSTA

1960 - 2005

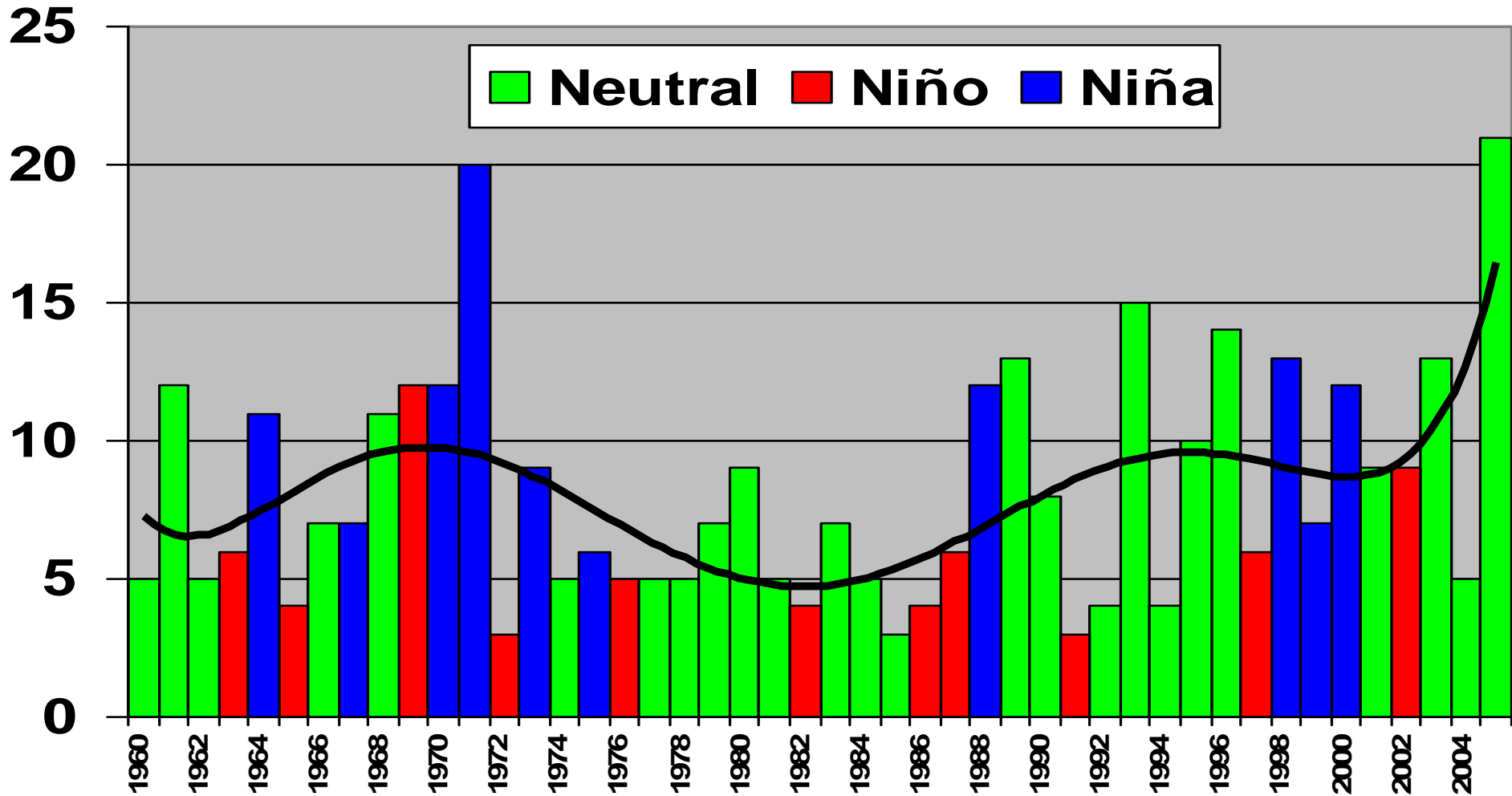
LA NIÑA	NEUTRAL	EL NIÑO
1963-1964	1960-1961	1962-1963
1966-1967	1961-1962	1964-1965
1969-1970	1965-1966	1968-1969
1970-1971	1967-1968	1971-1972
1972-1973	1976-1977	1975-1976
1973-1974	1977-1978	1981-1982
1974-1975	1978-1979	1985-1986
1987-1988	1979-1980	1986-1987
1997-1998	1980-1981	1990-1991
1998-1999	1982-1983	1996-1997
	1983-1984	2001-2002
	1984-1985	2004-2005
	1988-1989	
	1989-1990	
	1991-1992	
	1992-1993	
	1993-1994	
	1994-1995	
	1995-1996	
	1999-2000	
	2000-2001	
	2002-2003	
	2003-2004	
	2005-	

AVERAGE ANNUAL HURRICANES BY REGION



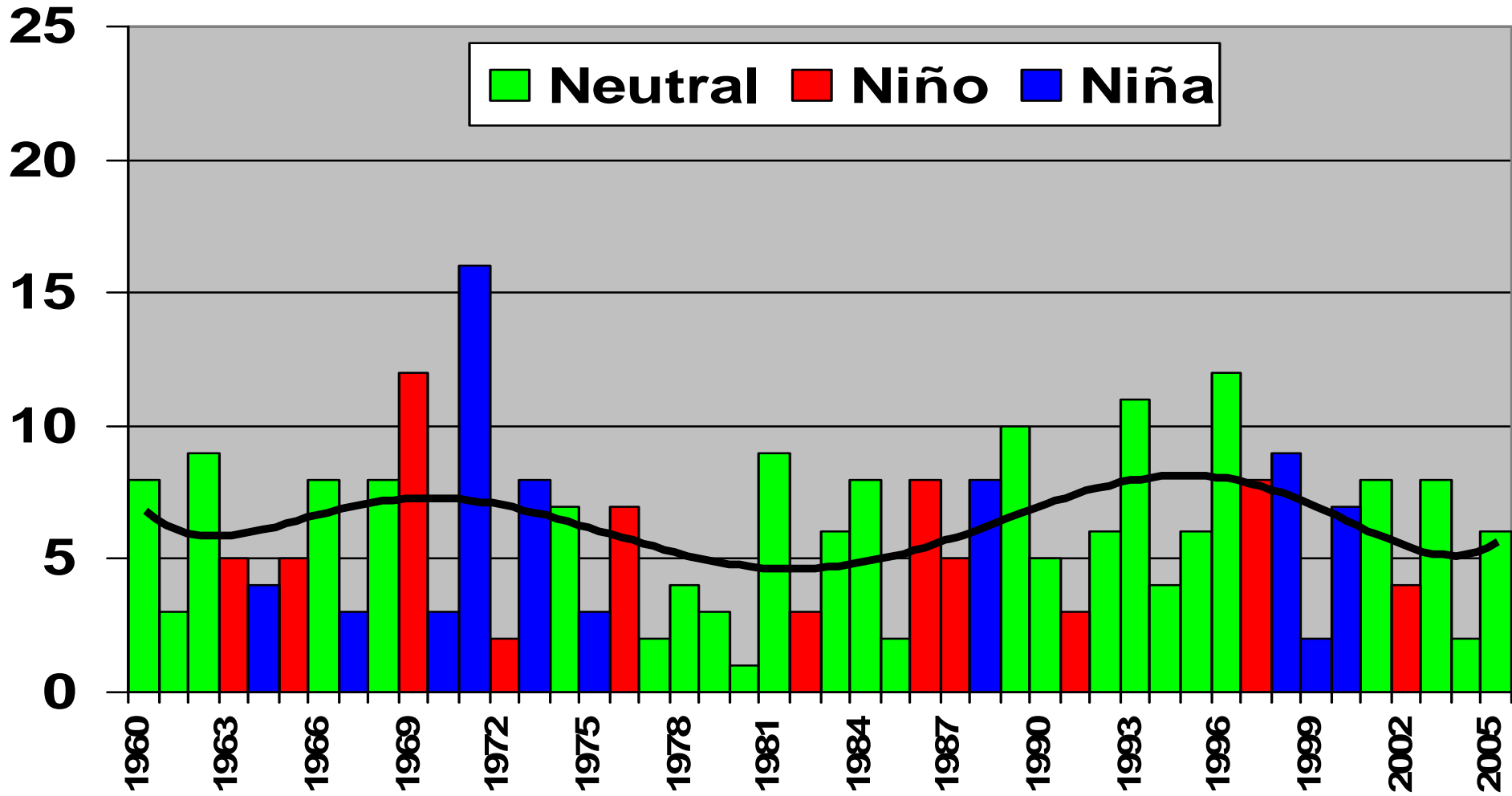
ATLANTIC

Hurricanes per year



PACIFIC

Hurricanes per year



MODELING HURRICANE LANDFALL

Assuming that ...

The occurrence of one hurricane can be treated as an independent event from the occurrence of another hurricane, thus ...

The occurrence of hurricanes can be modeled with a Poisson distribution:

$$\Pr (X = x) = \frac{e^{-\mu} \mu^x}{x!} \quad x = 0, 1, 2, \dots$$

μ = avg annual hits

$$\text{Probability of at least one hurricane} = 1 - \Pr (X=0)$$

PROBABILITY OF HURRICANE LANDFALL

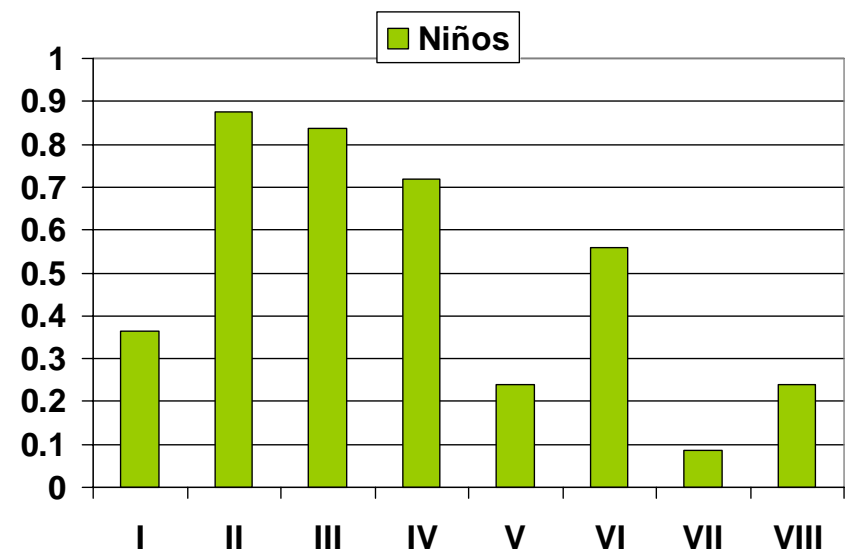
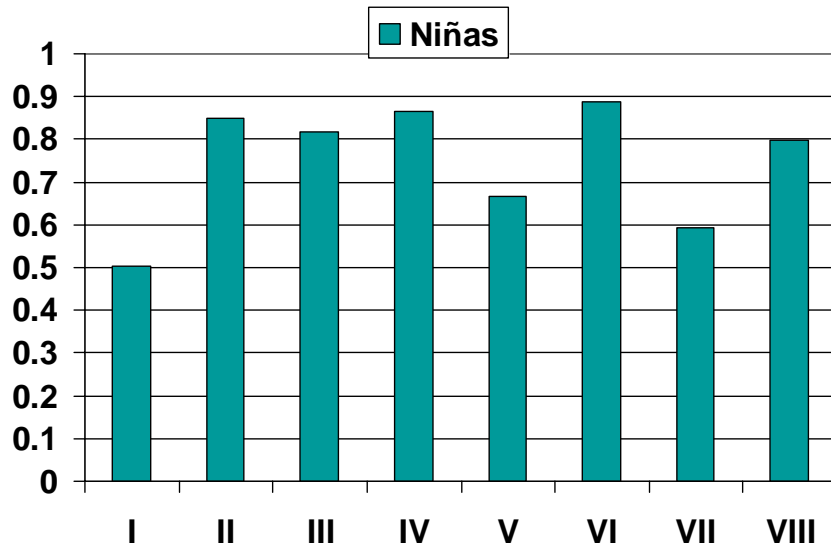
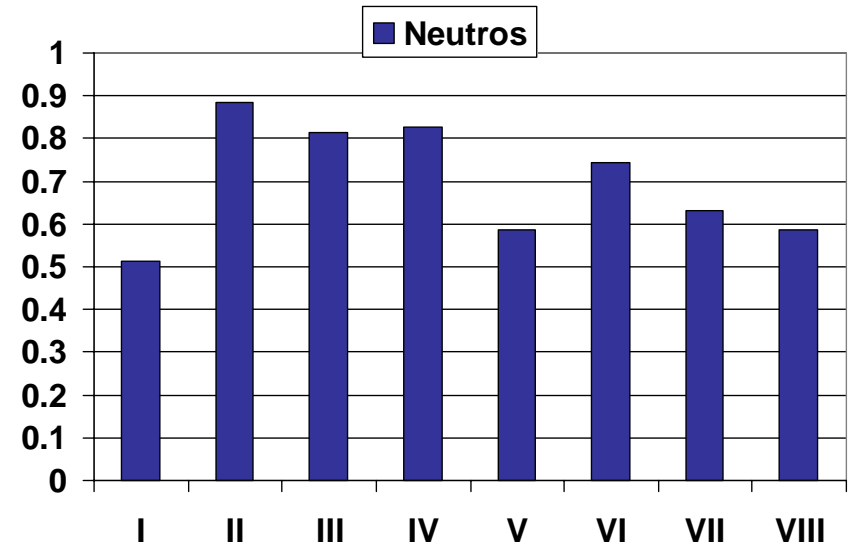
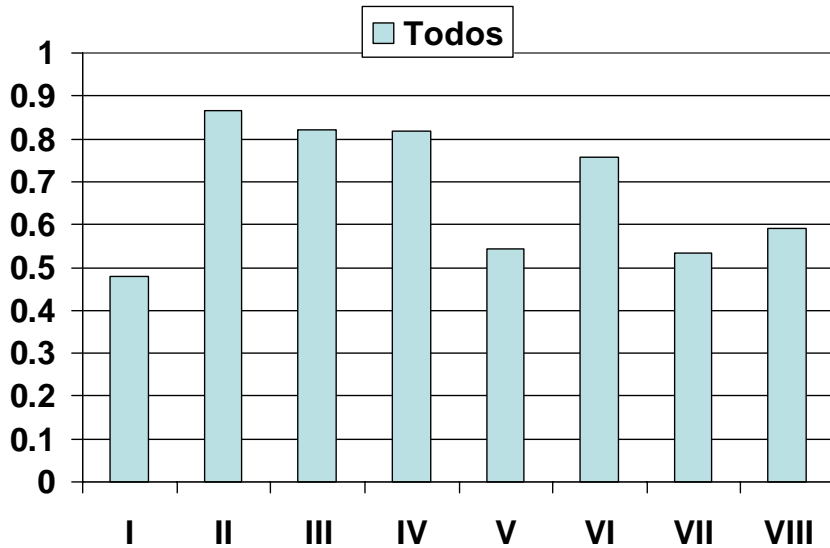
ALL EVENTS

	PACIFIC				ATLANTIC			
	I	II	III	IV	V	VI	VII	VIII
ALL	0.479	0.865	0.820	0.817	0.543	0.757	0.533	0.590
NEUTRAL	0.513	0.885	0.814	0.828	0.585	0.743	0.632	0.585
NIÑAS	0.503	0.850	0.817	0.865	0.667	0.889	0.593	0.798
NIÑOS	0.365	0.876	0.838	0.720	0.239	0.559	0.087	0.239

CATEGORY 3, 4 y 5

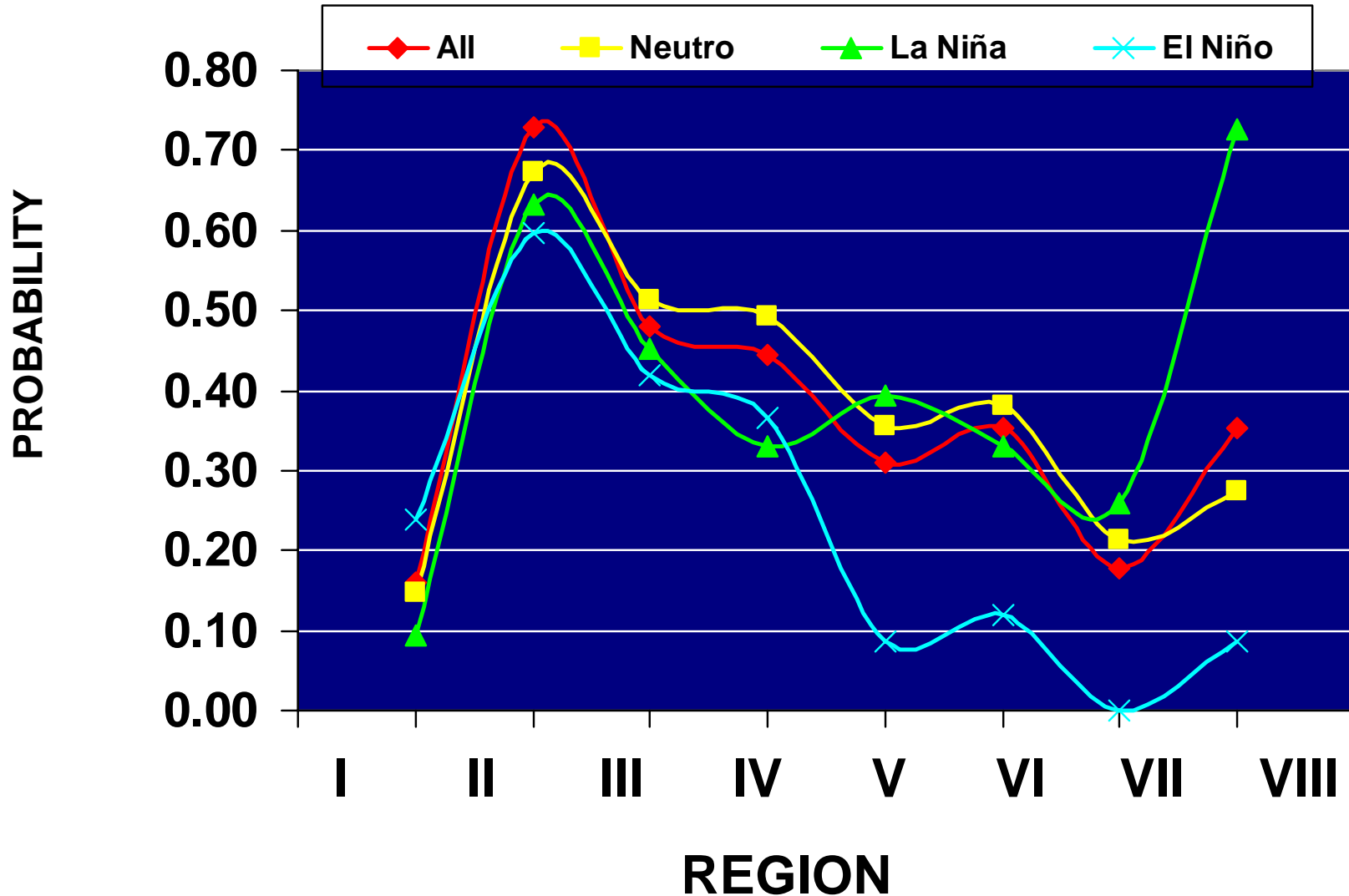
	PACIFIC				ATLANTIC			
	I	II	III	IV	V	VI	VII	VIII
ALL	0.160	0.729	0.479	0.444	0.309	0.353	0.178	0.353
NEUTRAL	0.148	0.674	0.513	0.493	0.356	0.381	0.213	0.274
LA NIÑA	0.095	0.632	0.451	0.330	0.393	0.330	0.259	0.727
EL NIÑO	0.239	0.597	0.420	0.365	0.087	0.239	0.000	0.087

PROBABILITY OF HURRICANE LANDFALL, ALL CAT.



PROBABILITY OF HURRICANE LANDFALL CAT. 3, 4, 5

By ENSO Phase



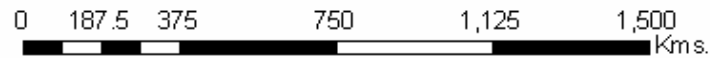
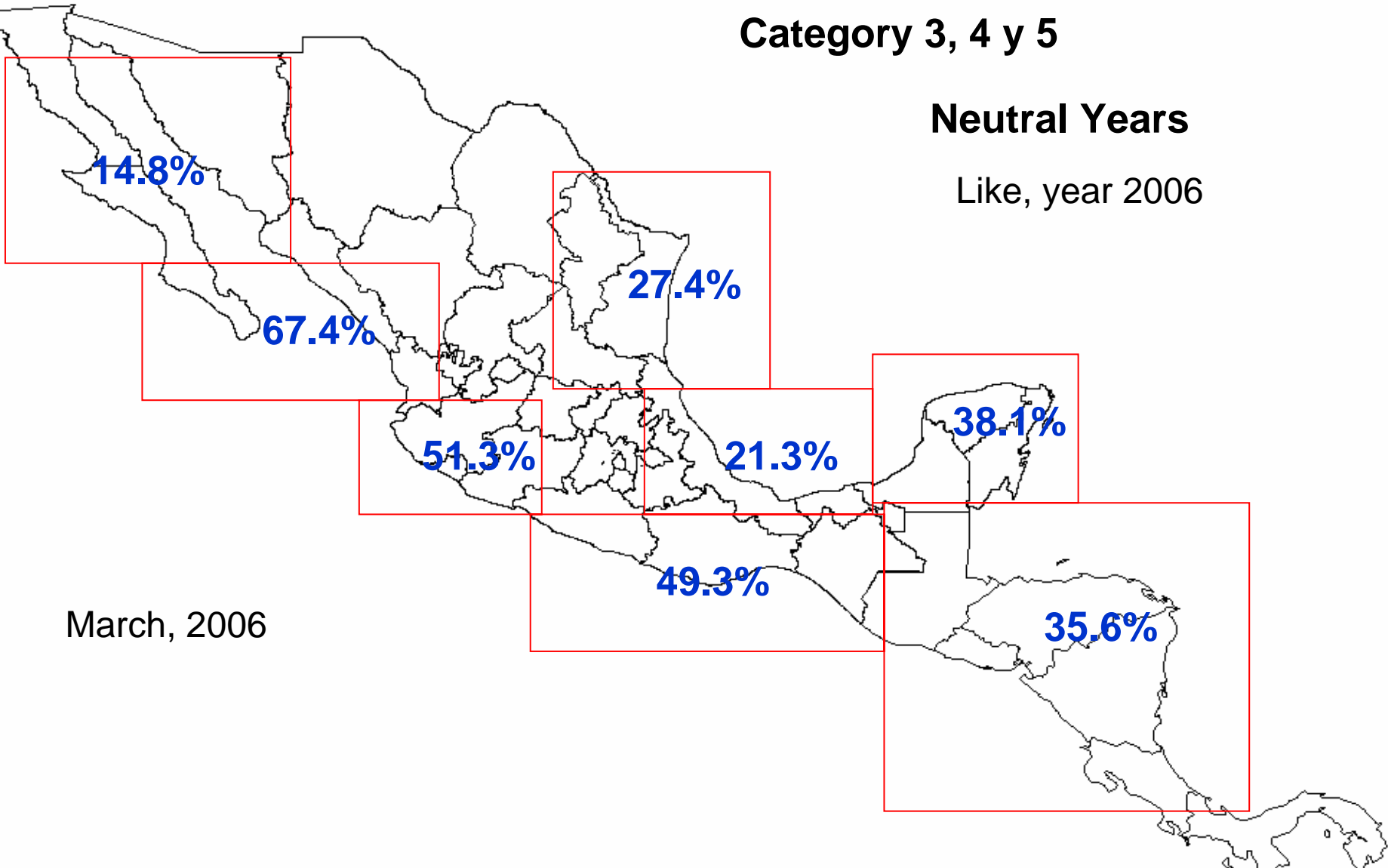
PROBABILITY OF HURRICANE LANDFALL

Category 3, 4 y 5

Neutral Years

Like, year 2006

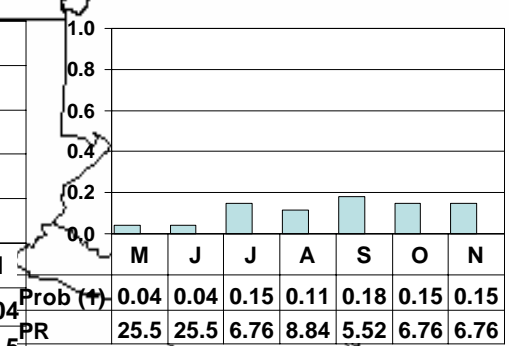
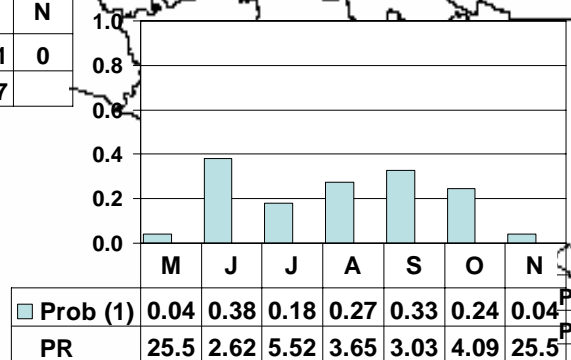
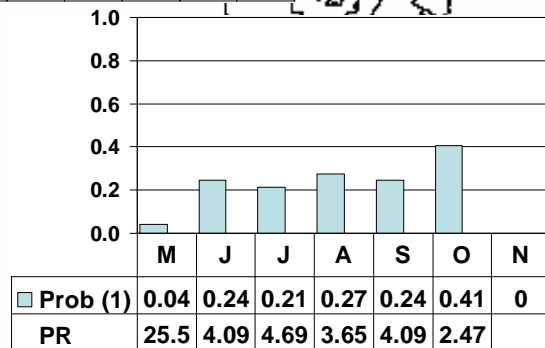
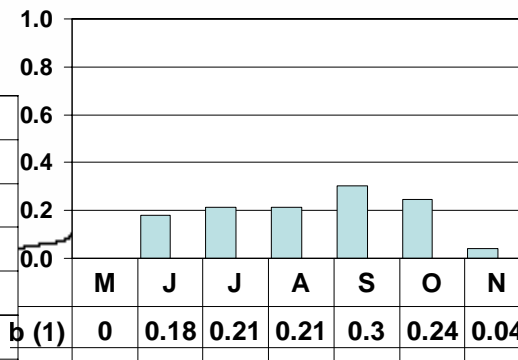
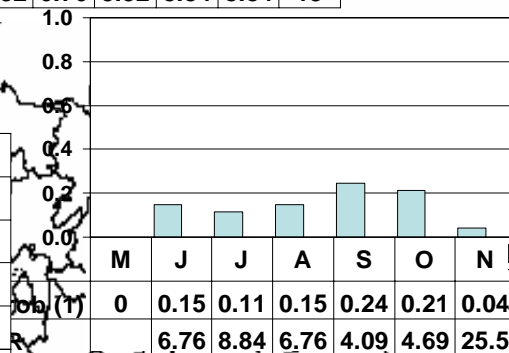
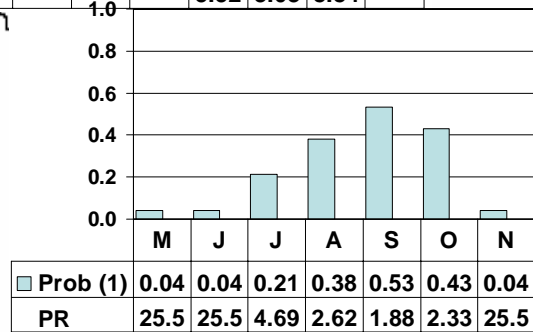
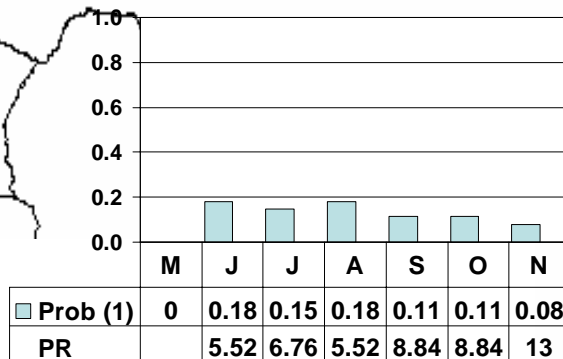
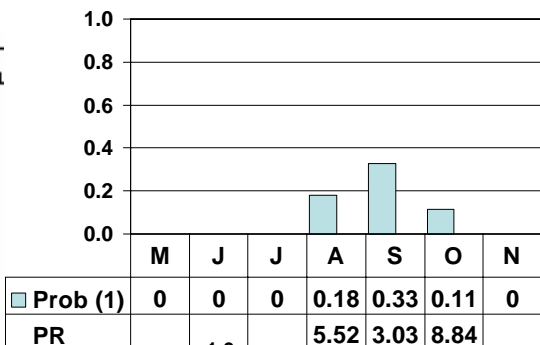
March, 2006



MONTHLY PROBABILITY

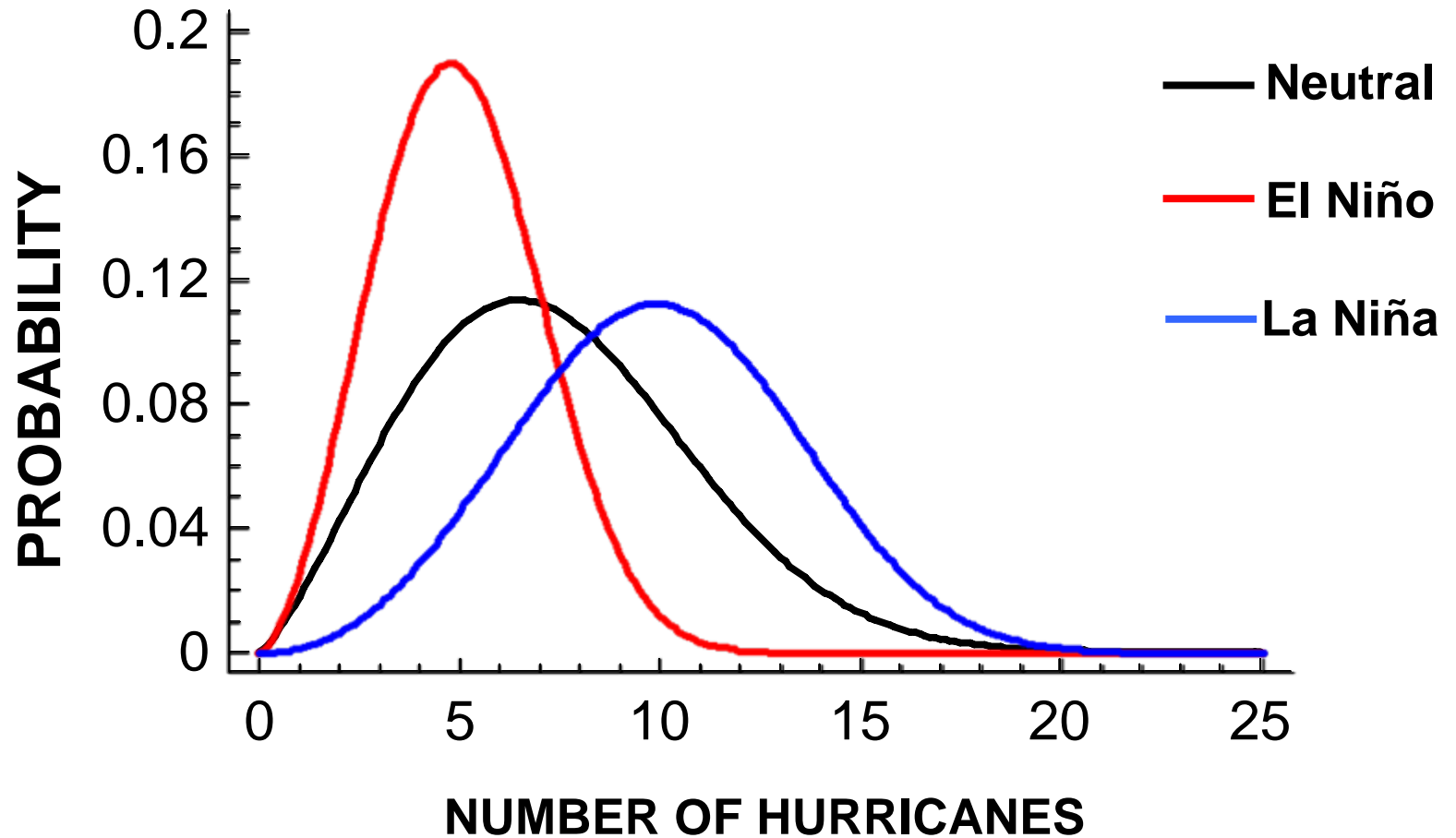
HURRICANE LANFALL AND RETURN PERIOD

NEUTRAL



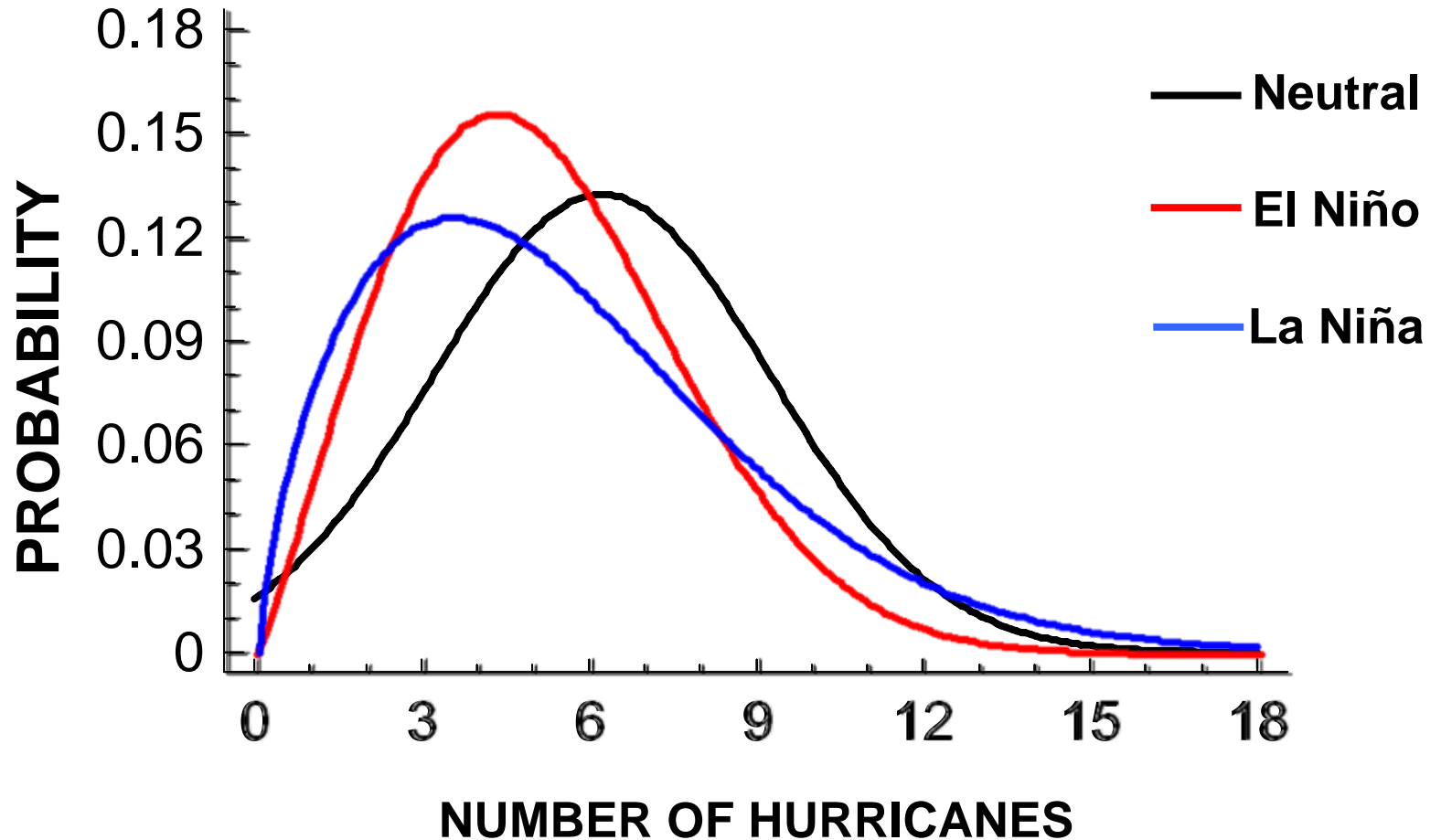
ATLANTIC

PROB. DENSITY FUNCTION OF HURRICANE LANDFALL



PACIFICO

PROB. DENSITY FUNCTION OF HURRICANE LANDFALL



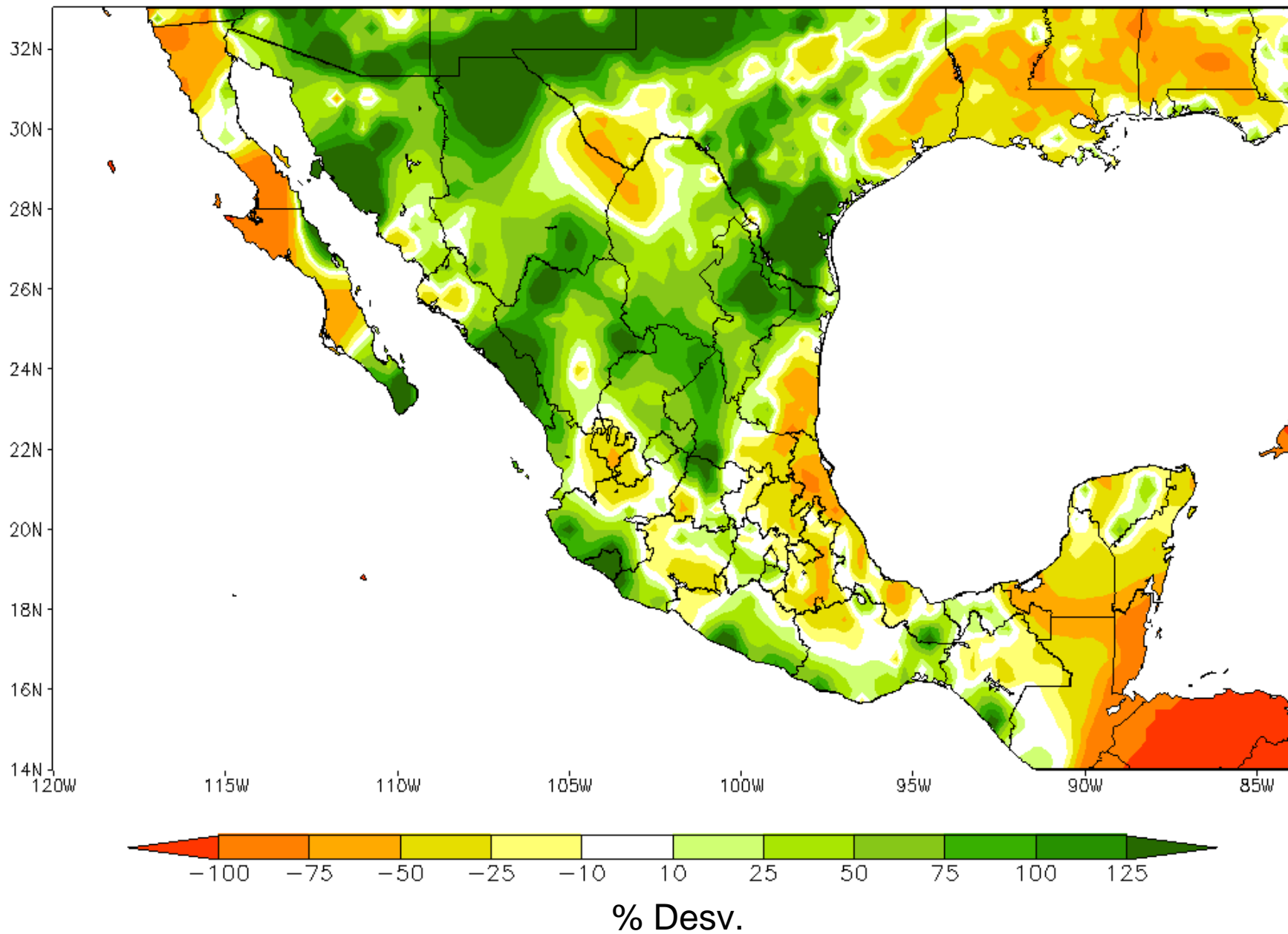
HURRICANE ACTIVITY IN YEAR 2006



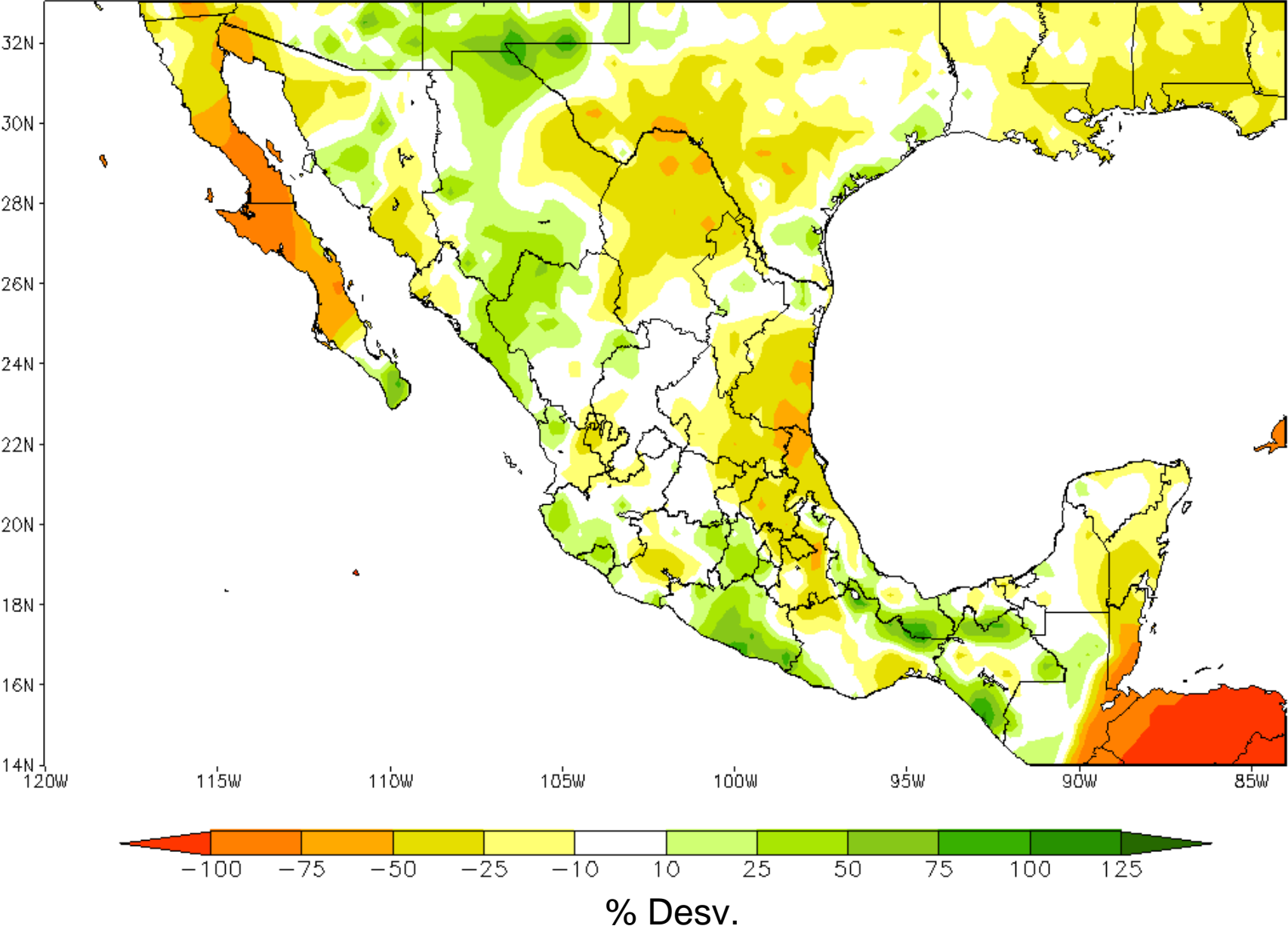
HURRICANE LANDFALL IN YEAR 2006



PRECIPITATION ANOMALY IN SEPTEMBER DE 2006



ACCUMULATED PRECIPITATION ANOMALY IN YEAR 2006



ABANDON SOYBEANS FIELD DUE TO DROUGHT IN SOUTHERN TAMAUlipAS

OCT, 2006



CONCLUSIONS

A large contribution of precipitation for agricultural use come from hurricane impacts

Analyses of hurricanes landfall can be help to identify regions that would be subjected to summer drought.

Modeling of hurricane landfall by areas and intensity of the event would provide relevant information of regions likely to occur drought conditions.