Hurricane climatology and structure

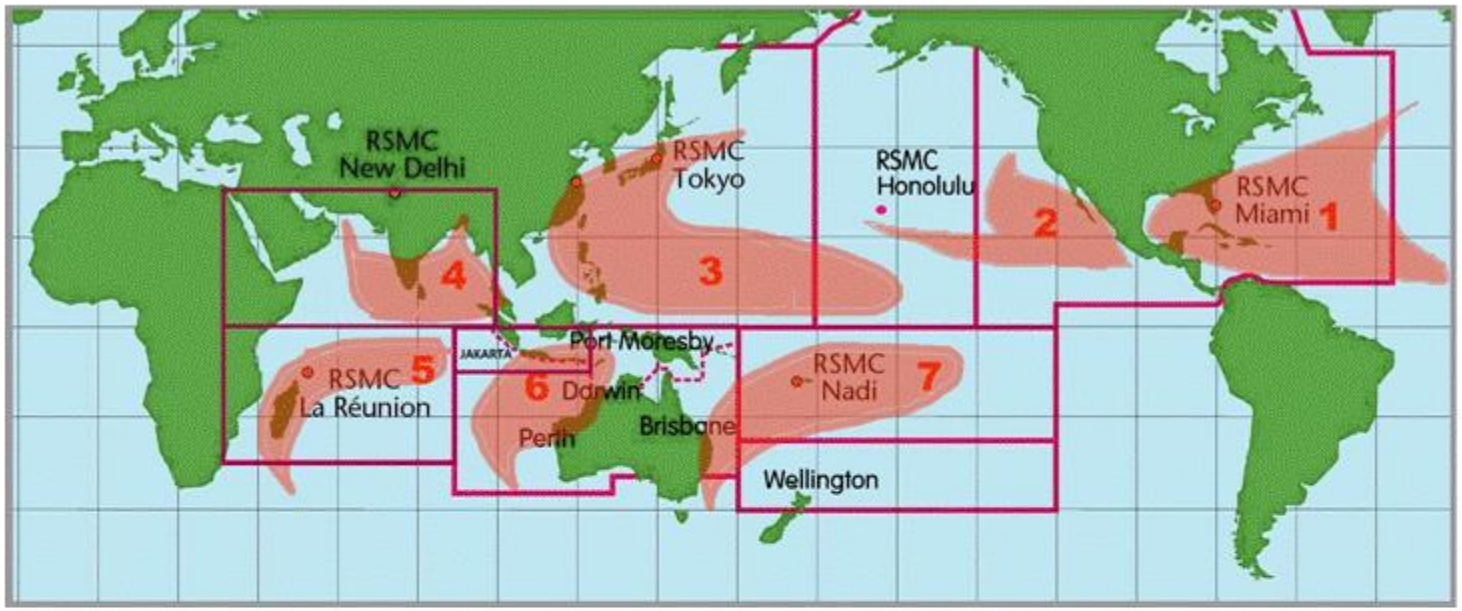
Pat Fitzpatrick

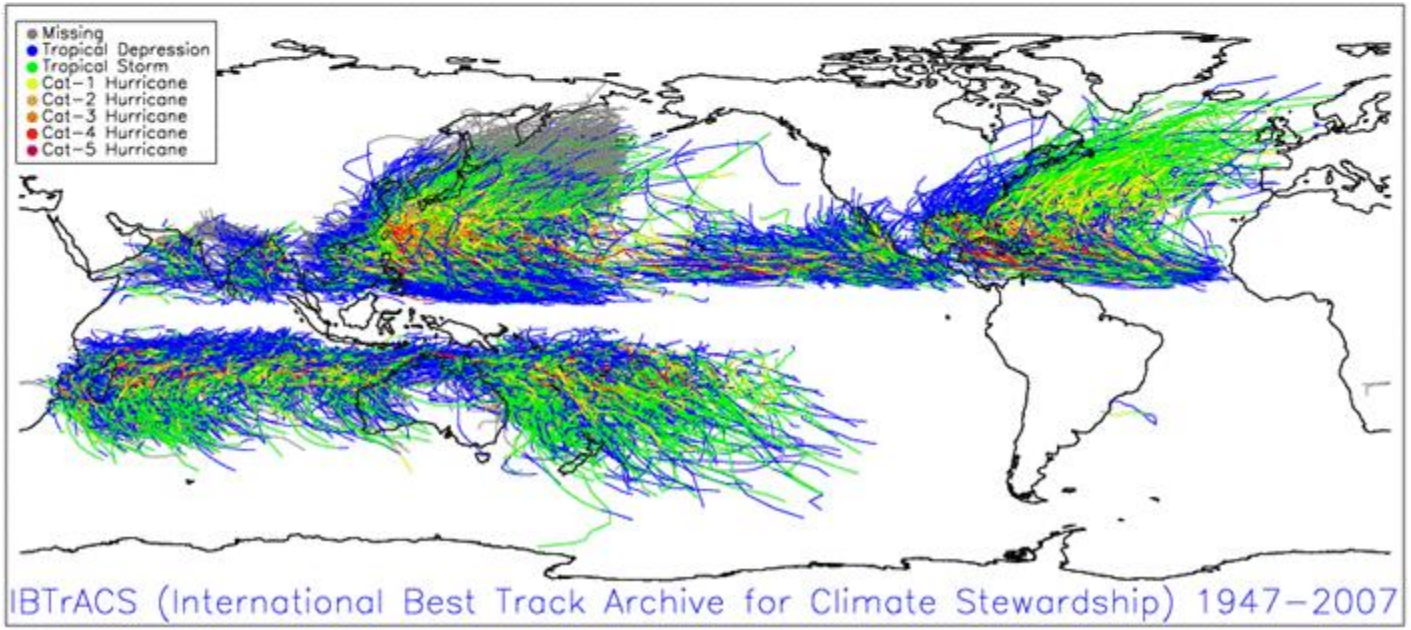
Tropical cyclone (several definitions):

1) A warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat and moisture from the ocean. In this they differ from extratropical cyclones, which derive their energy from horizontal temperature contrasts in the atmosphere (baroclinic effects).

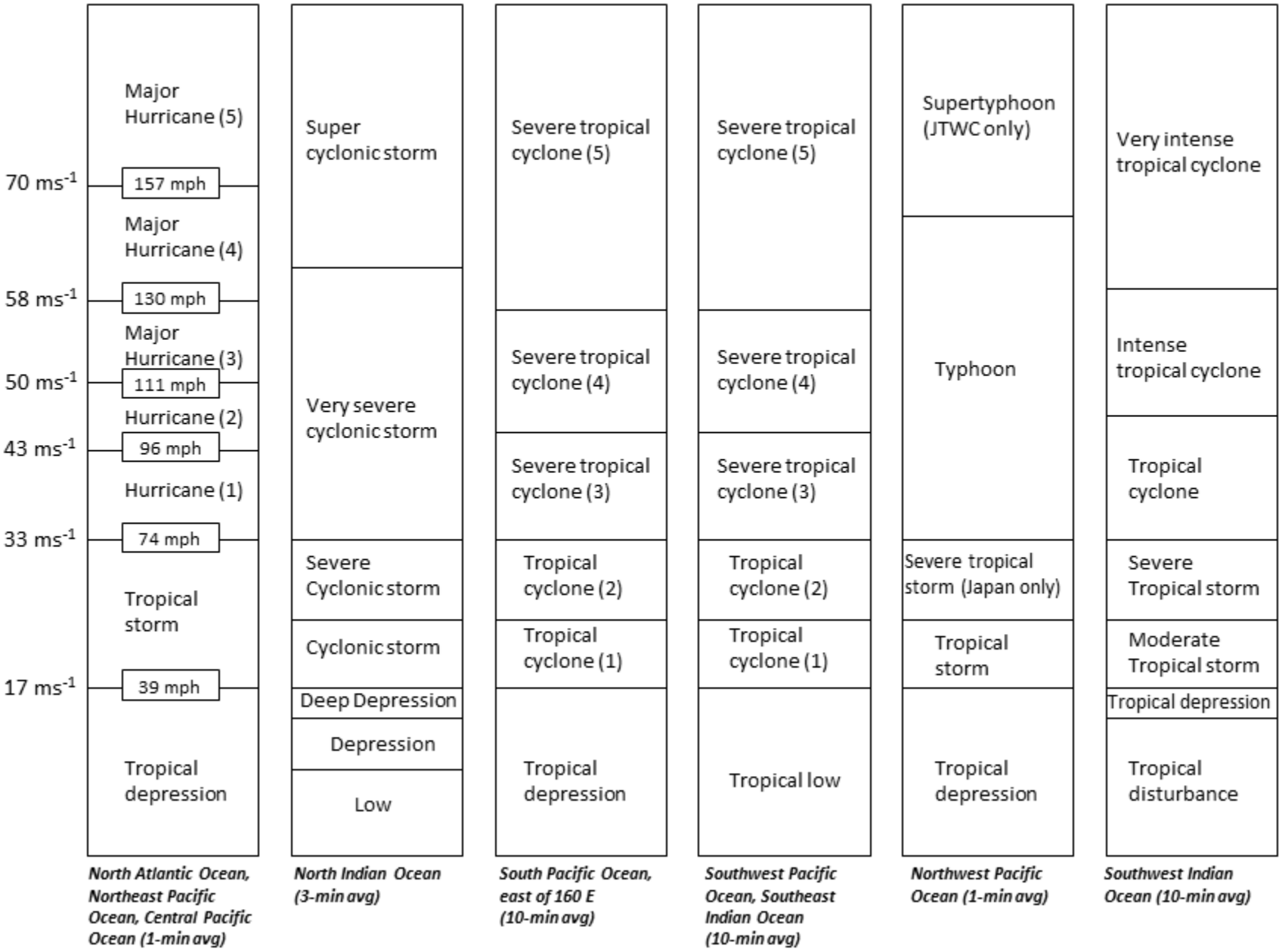
2) A synoptic-scale to meso-scale low pressure system which derives its energy primarily from: 1. evaporation from the sea in the presence of high winds and low surface pressure; and 2. condensation in convective clouds concentrated near its center.

Tropical cyclone is actually a generic term, and although its usually associated with “tropical storms” and “hurricanes” (in Atlantic terminology), it also includes *subtropical cyclones* and *monsoon depressions*.


RSMC
New Delhi
RSMC
Tokyo
RSMC
Honolulu
RSMC
Miami
1
2
3
4
5
6
7
RSMC
La Réunion
JAKARTA
Port Moresby
Darwin
Perth
Brisbane
RSMC
Nadi
Wellington


Missing
Tropical Depression
Tropical Storm
Cat-1 Hurricane
Cat-2 Hurricane
Cat-3 Hurricane
Cat-4 Hurricane
Cat-5 Hurricane
IBTrACS (International Best Track Archive for Climate Stewardship) 1947-2007

Tropical cyclone classification schemes in different ocean basins

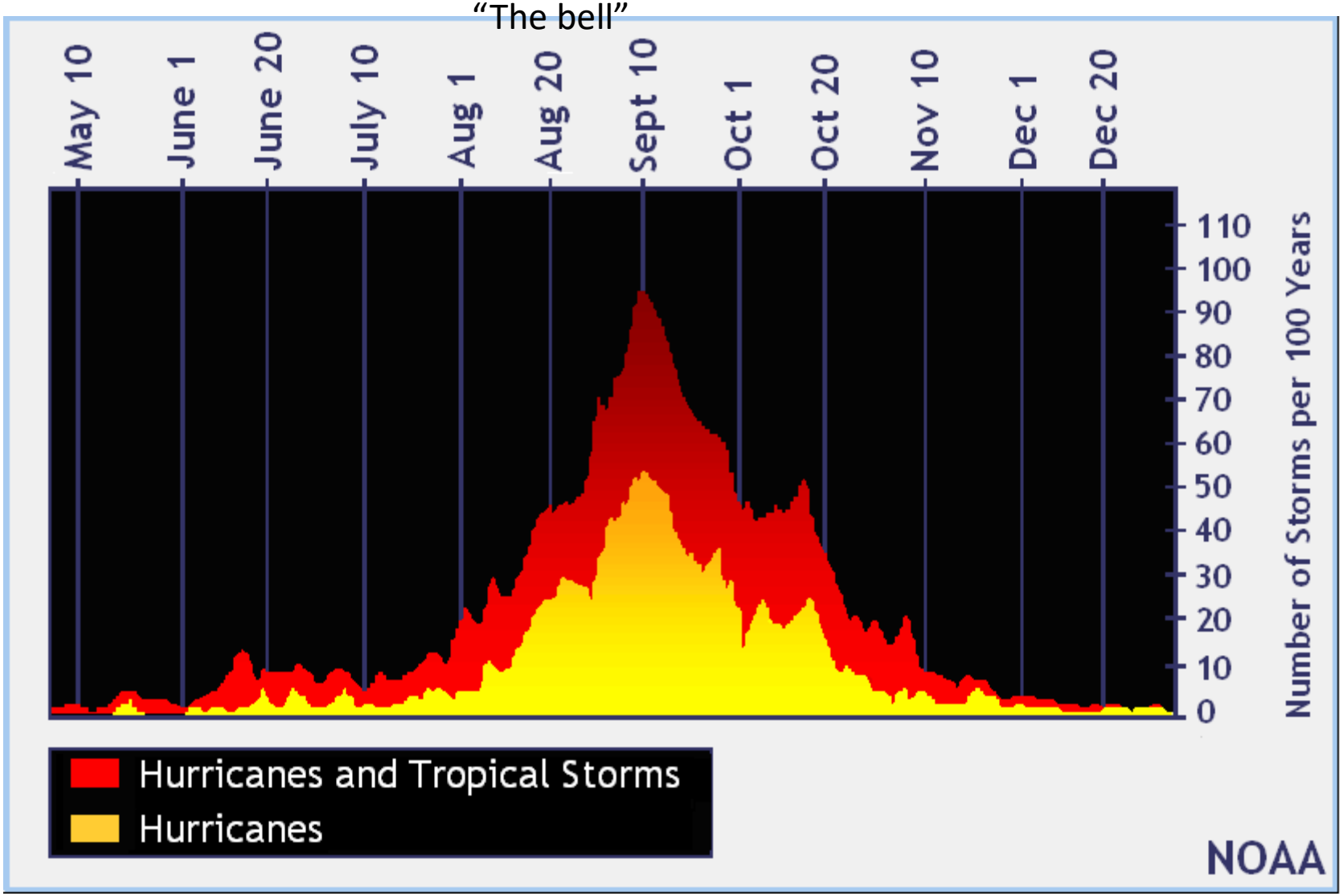


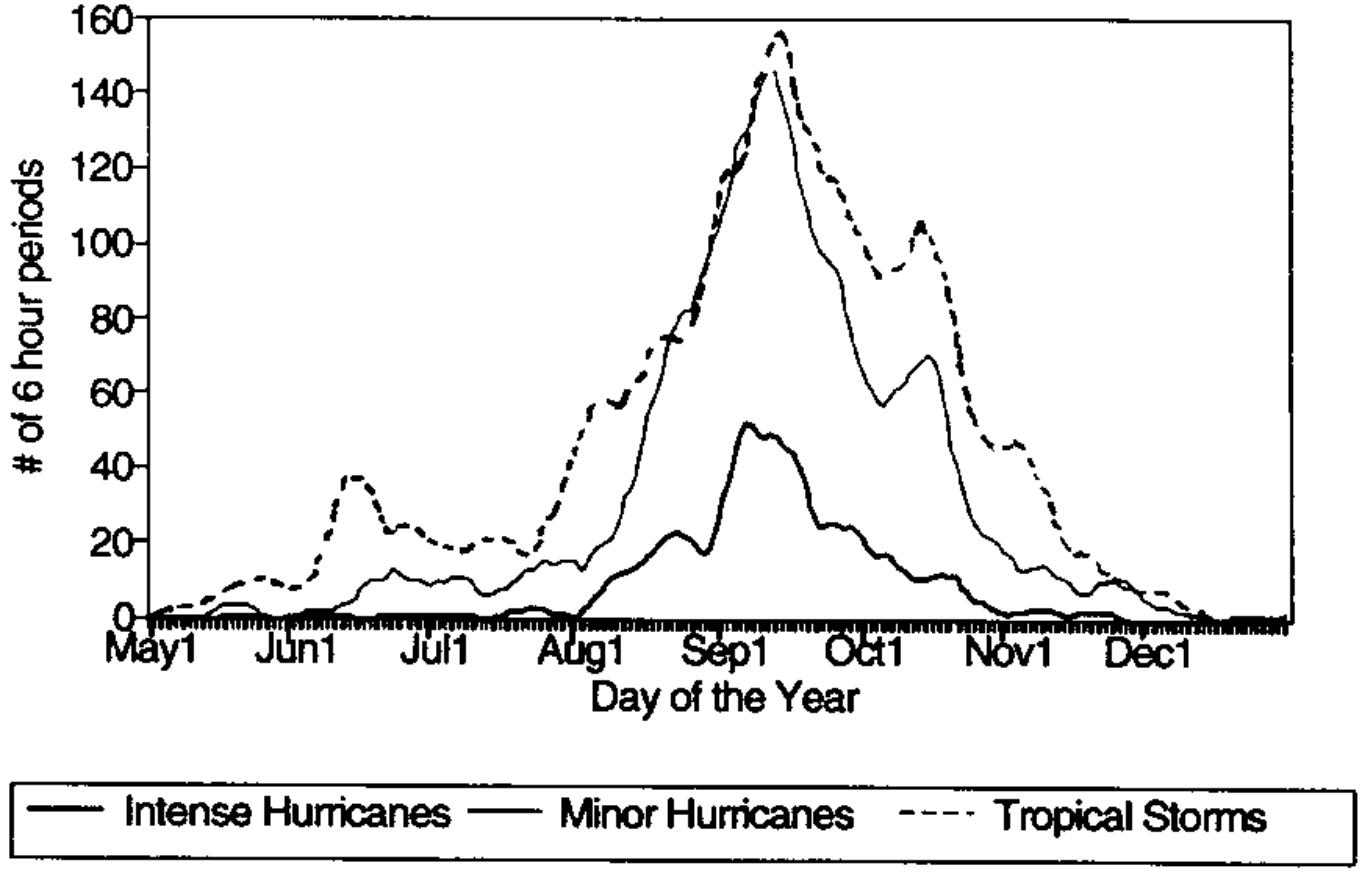
	Max sustained wind (kts)					
	< 34	**34-47**	**48-63**	**64-89**	**90-115**	**> 115**
Beaufort number & descriptive term	up to 7	8.Gale 9. Strong gale	10. Storm 11. Violent storm	12. Hurricane		
SW Indian Ocean	Tropical depression	Moderate tropical storm	Severe tropical storm	Tropical cyclone	Intence tropical cyclone	Very intense tropical cyclone
Arabian Sea & Bay of Bengal	Depression or Severe depression	Cyclonic storm	Severe cyclonic storm	Very severe cyclonic storm		Super cyclonic storm
NW Pacific	Tropical depression	Tropical storm	Severe tropical storm	Typhoon		Super typhoon
NE Pacific & N Atlantic*	Tropical depression	Tropical storm		Hurricane		
S Pacific (E of 160E)	Tropical depression	Tropical cyclone (gale)	Tropical cyclone (storm)	Tropical cyclone (hurricane)		
SW Pacific & SE Indian	Tropical low	Tropical cyclone		Severe tropical cyclone		
US Saffir-Simpson Scale*	-	-	-	1	2-3	4-5
Australian Scale	-	1	2	3	4	5

* *US uses 1-minute average winds*

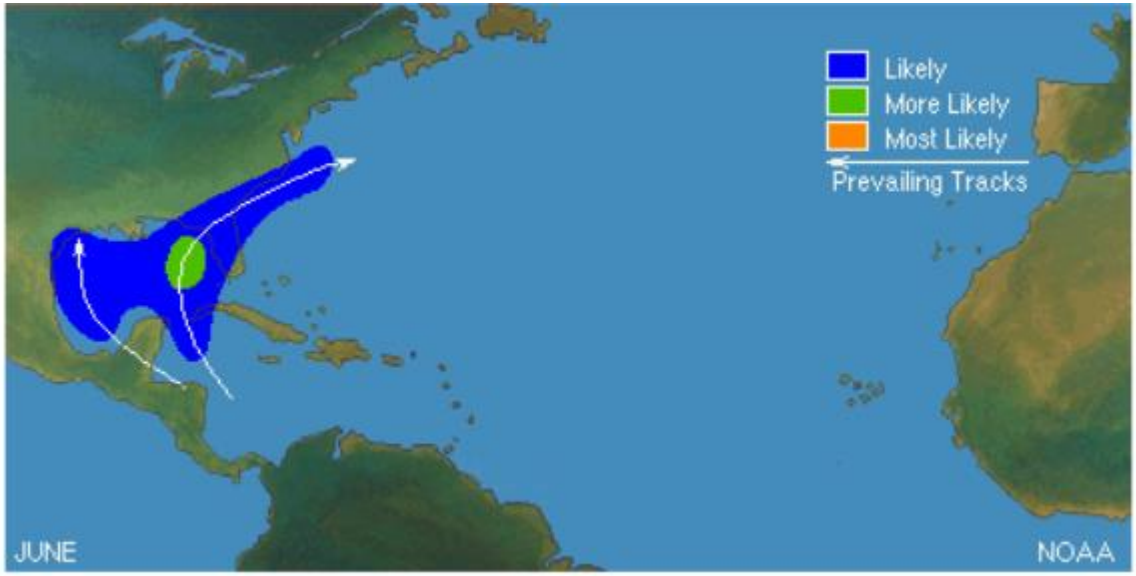
Atlantic Ocean climatology

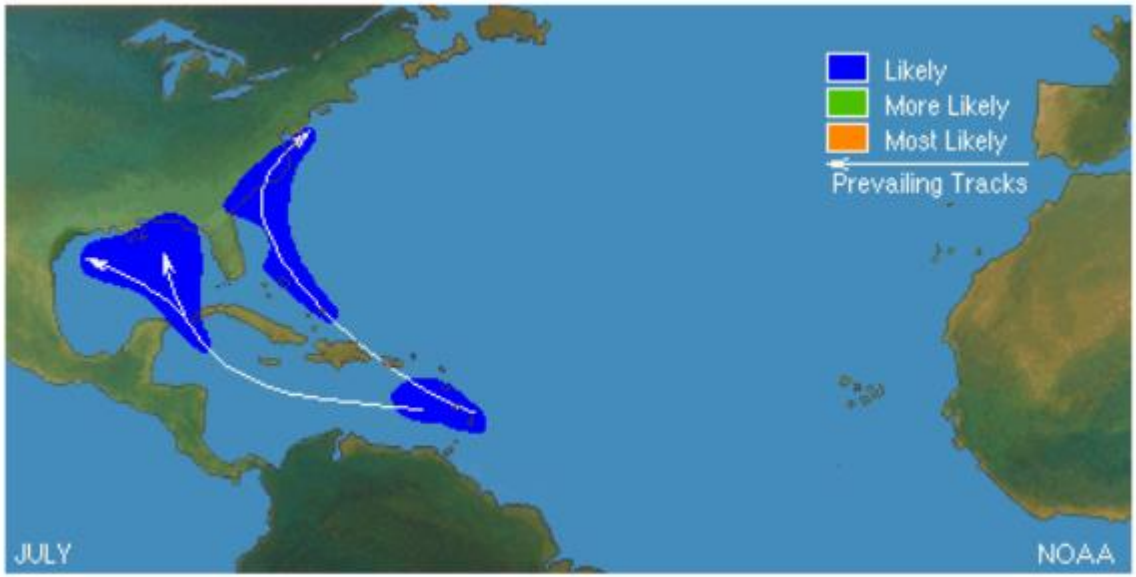
"The bell"




160
140
120
100
80
60
40
20
0
# of 6 hour periods
May1
Jun1
Jul1
Aug1
Sep1
Oct1
Nov1
Dec1
Day of the Year
Intense Hurricanes
Minor Hurricanes
Tropical Storms

Climatological Areas of Origin and Typical Hurricane Tracks by Month





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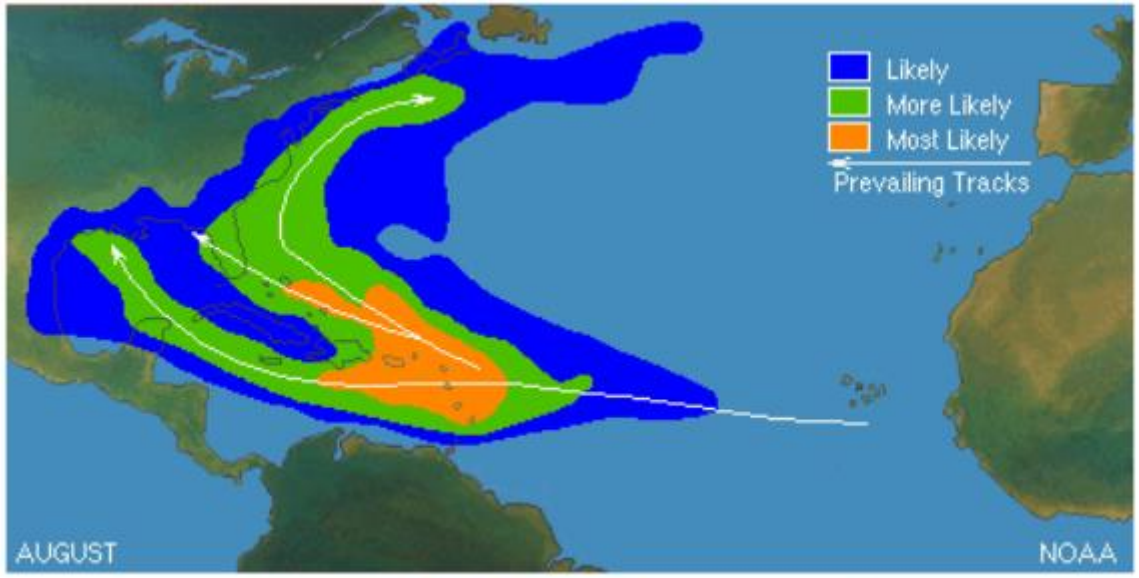

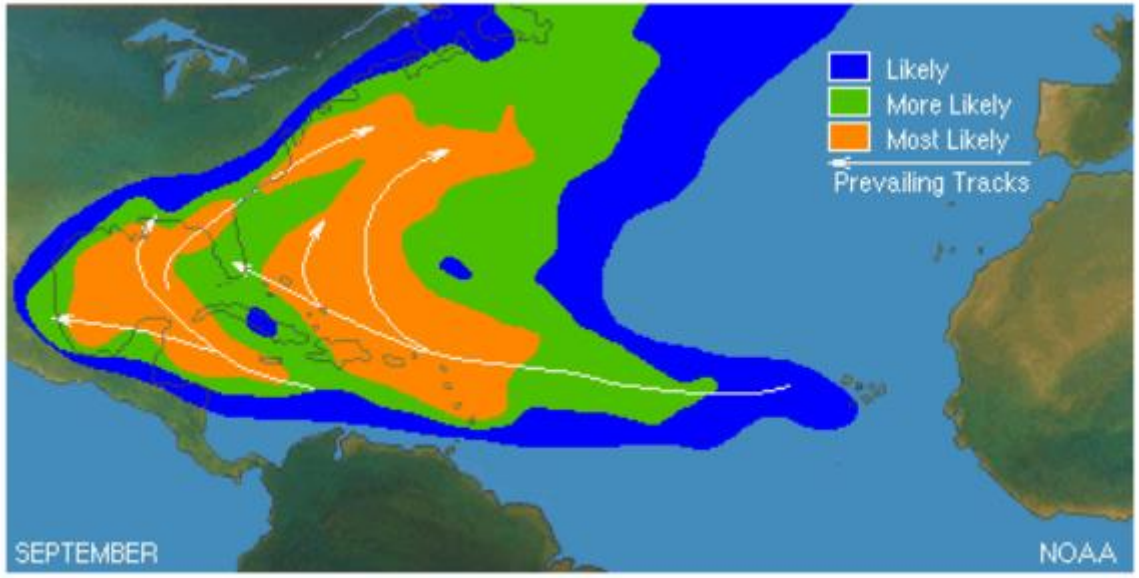

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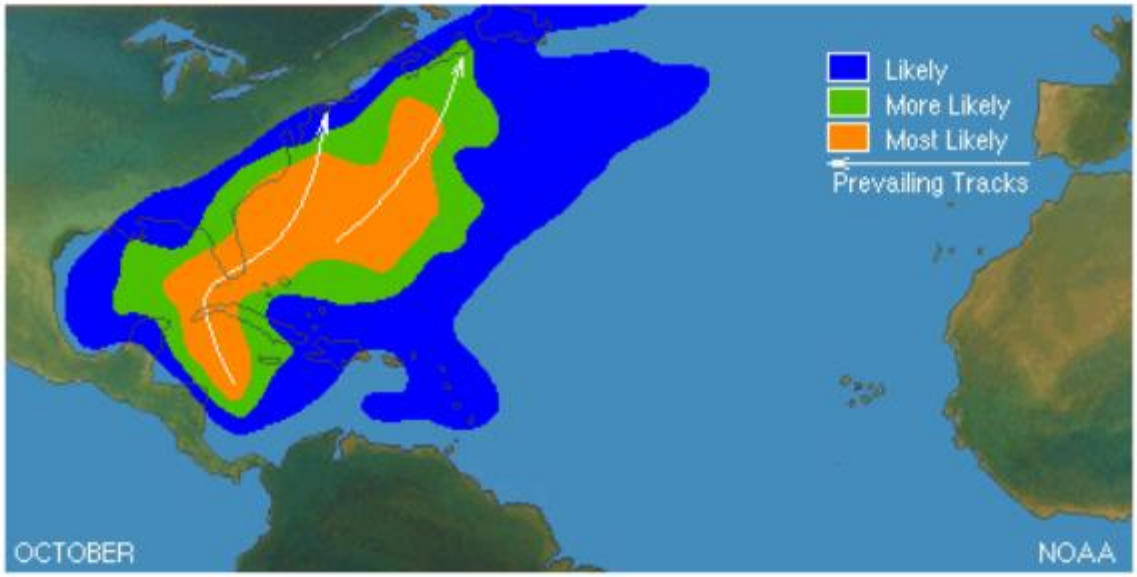
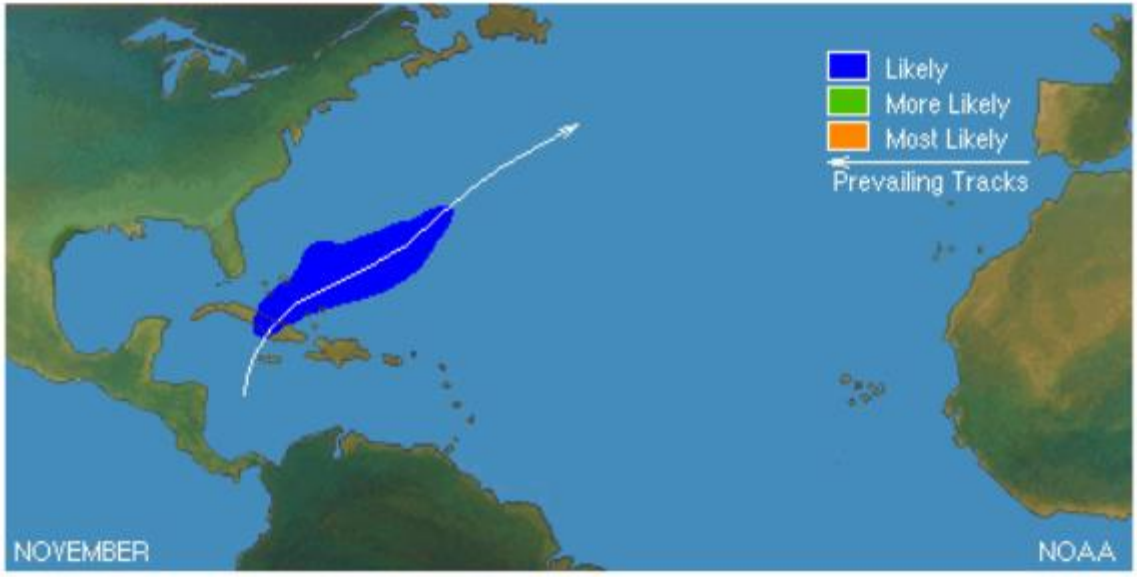
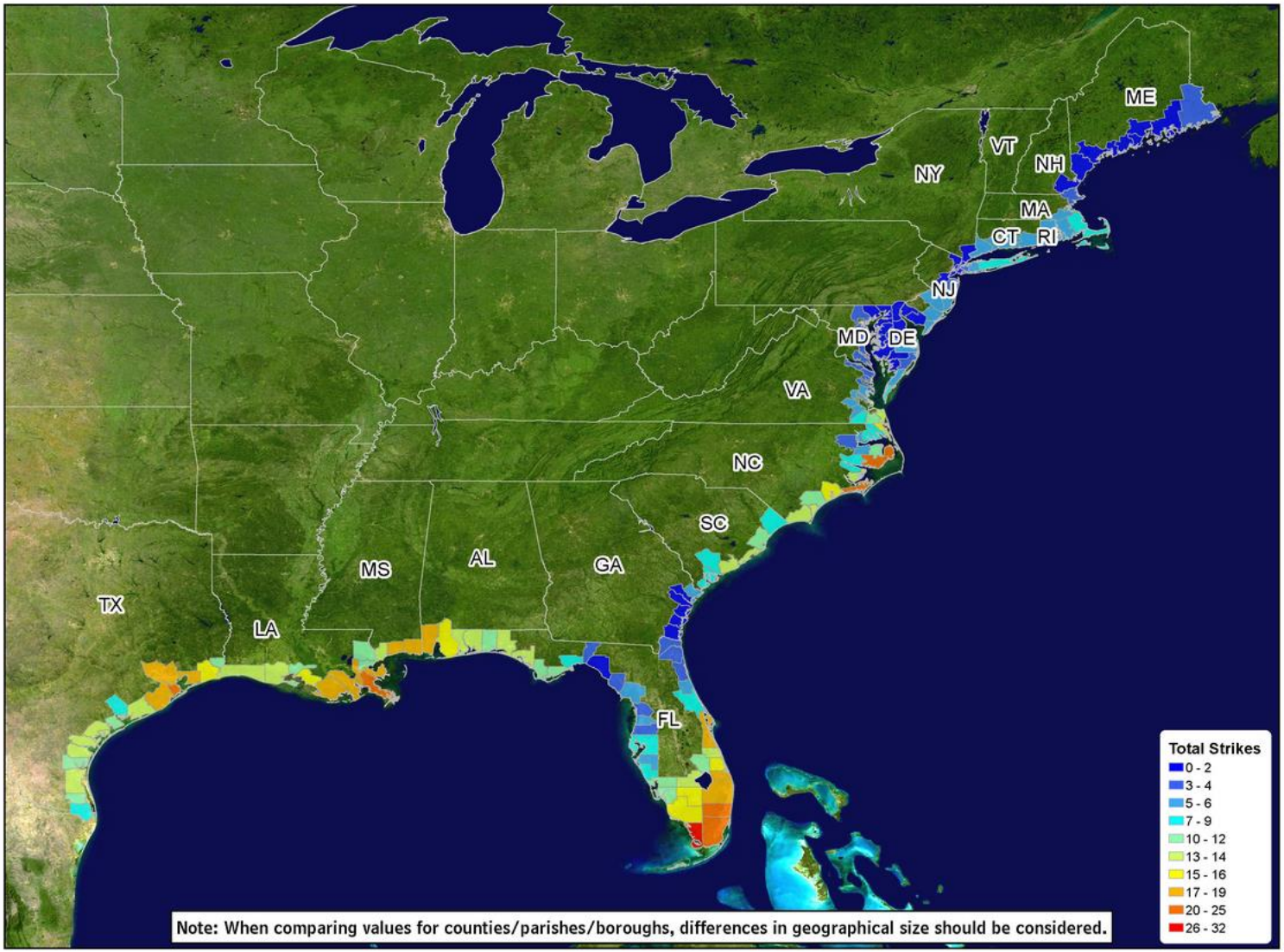


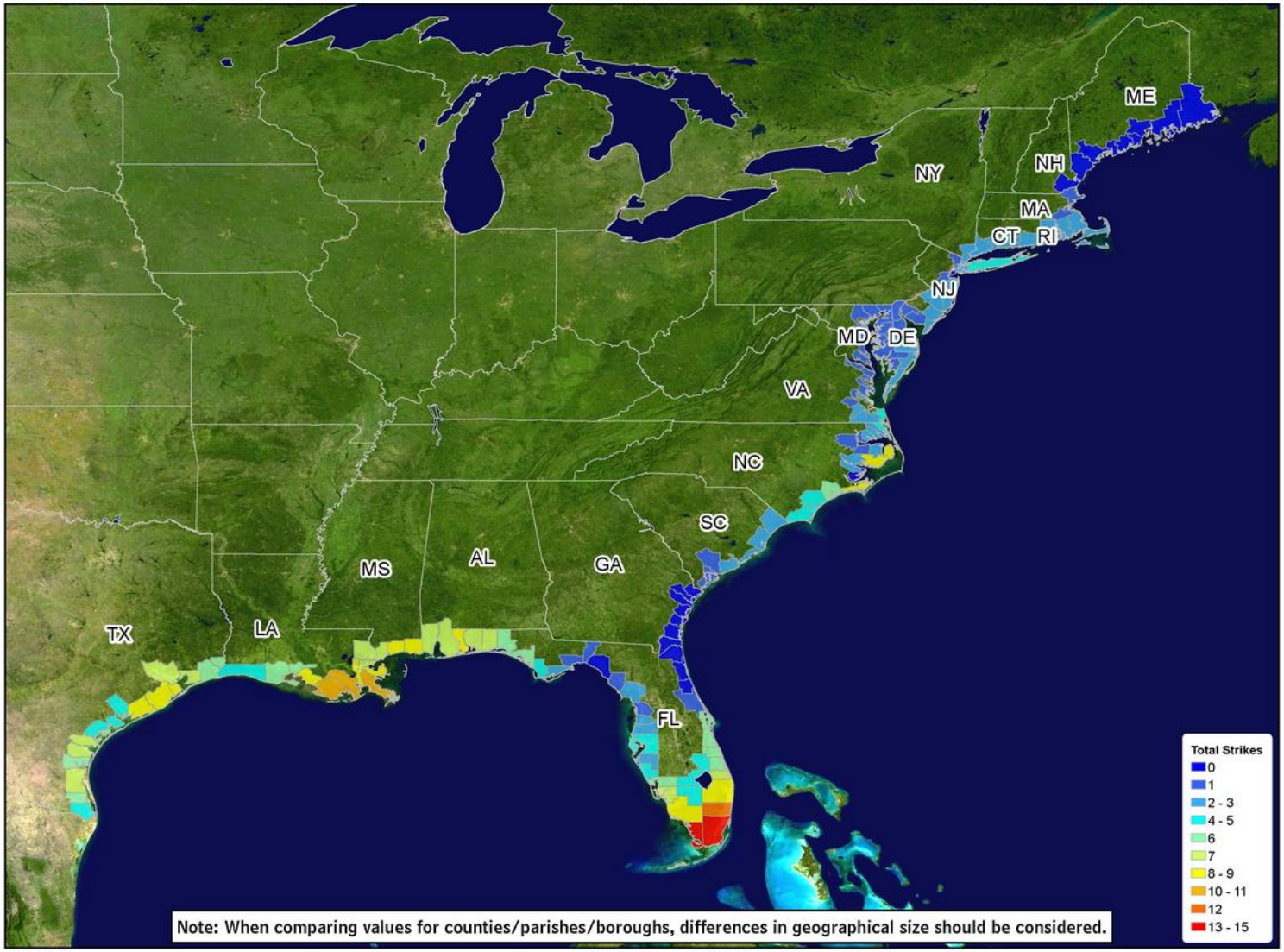


1900-2010 U.S. Hurricane Strikes by counties



From http://www.nhc.noaa.gov/climo/

1900-2010 U.S. Major Hurricane Strikes by counties



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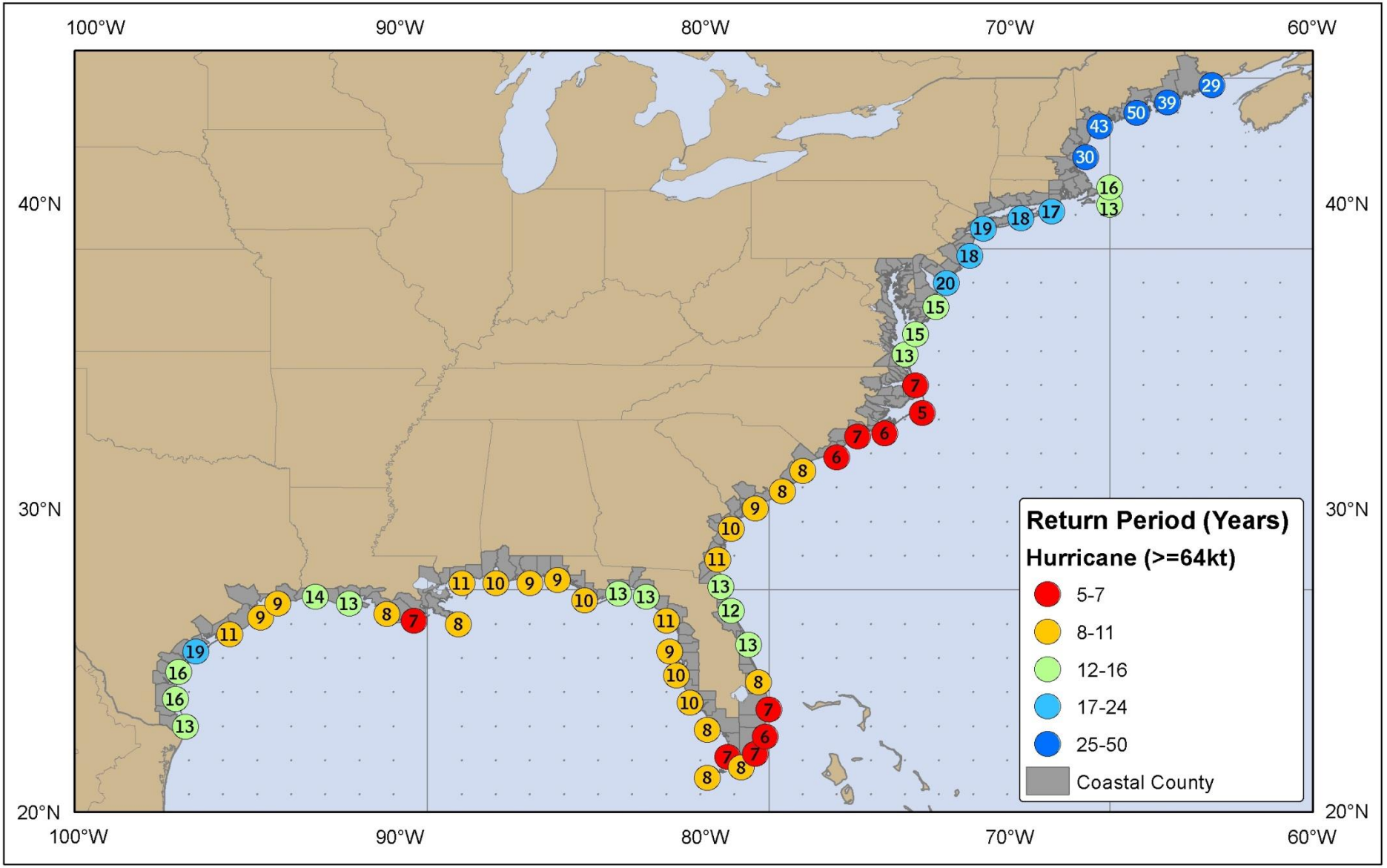
Return periods, U.S. hurricanes



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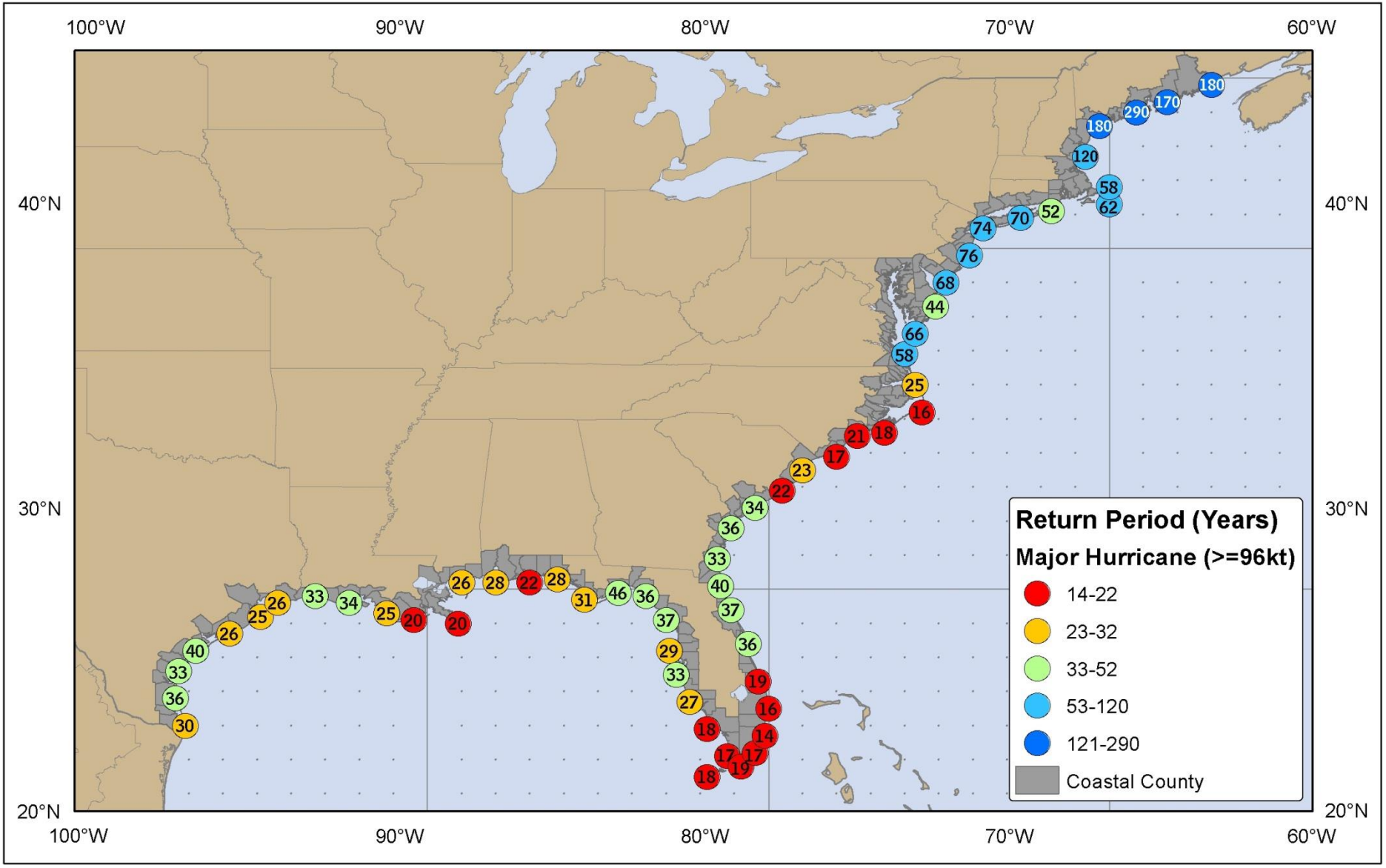

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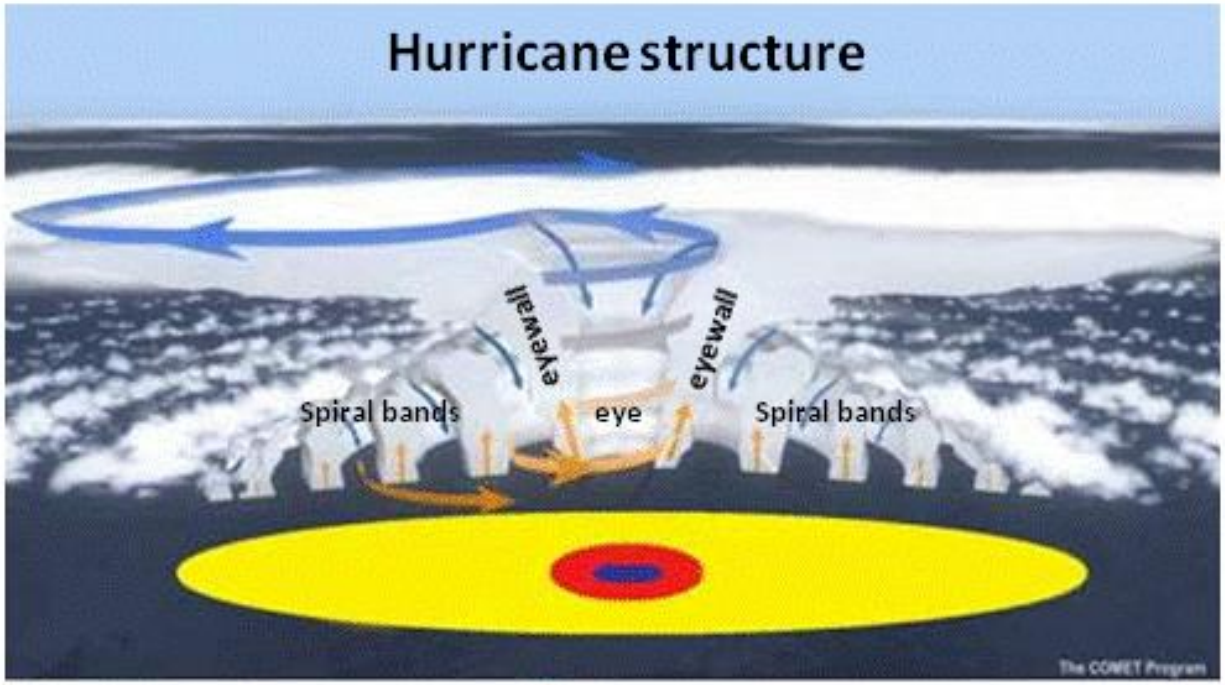
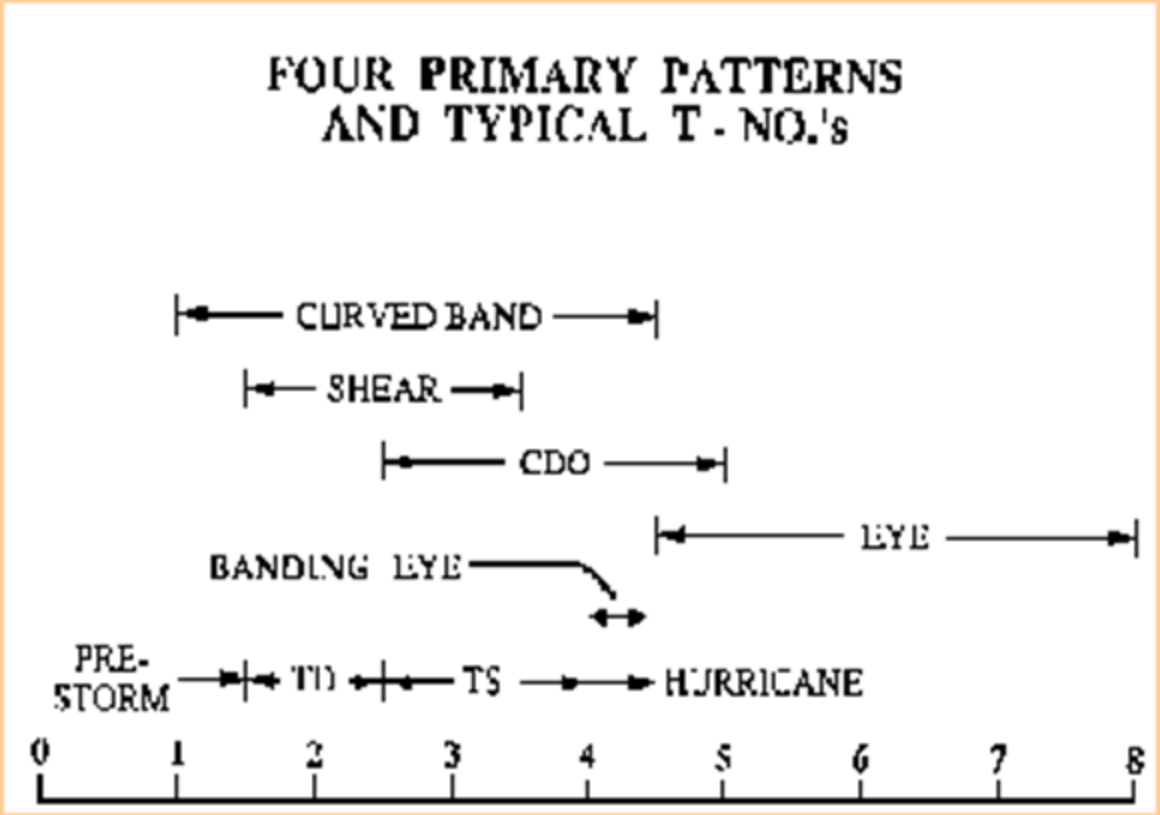
- See http://www.nhc.noaa.gov/climo/ for additional maps

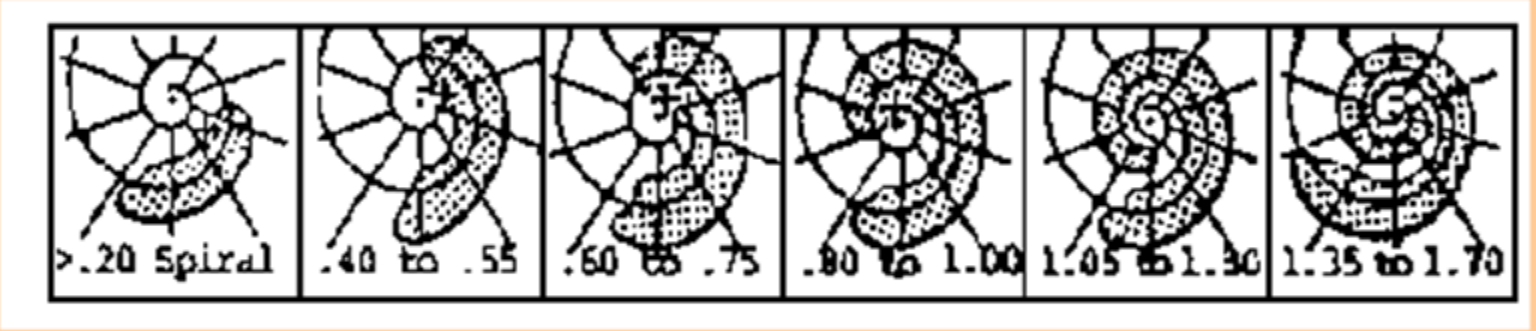

Hurricane structure
eyewall
eyewall
Spiral bands
eye
Spiral bands
The COMET Program
Light Winds
Very Strong Winds
Transition from very strong winds to light winds at the outer edge

Hurricanes follow a general pattern from formation to maturity.
Pattern is so consistent forecasters use the Dvorak technique to estimate intensity

Patterns and Associated T Numbers

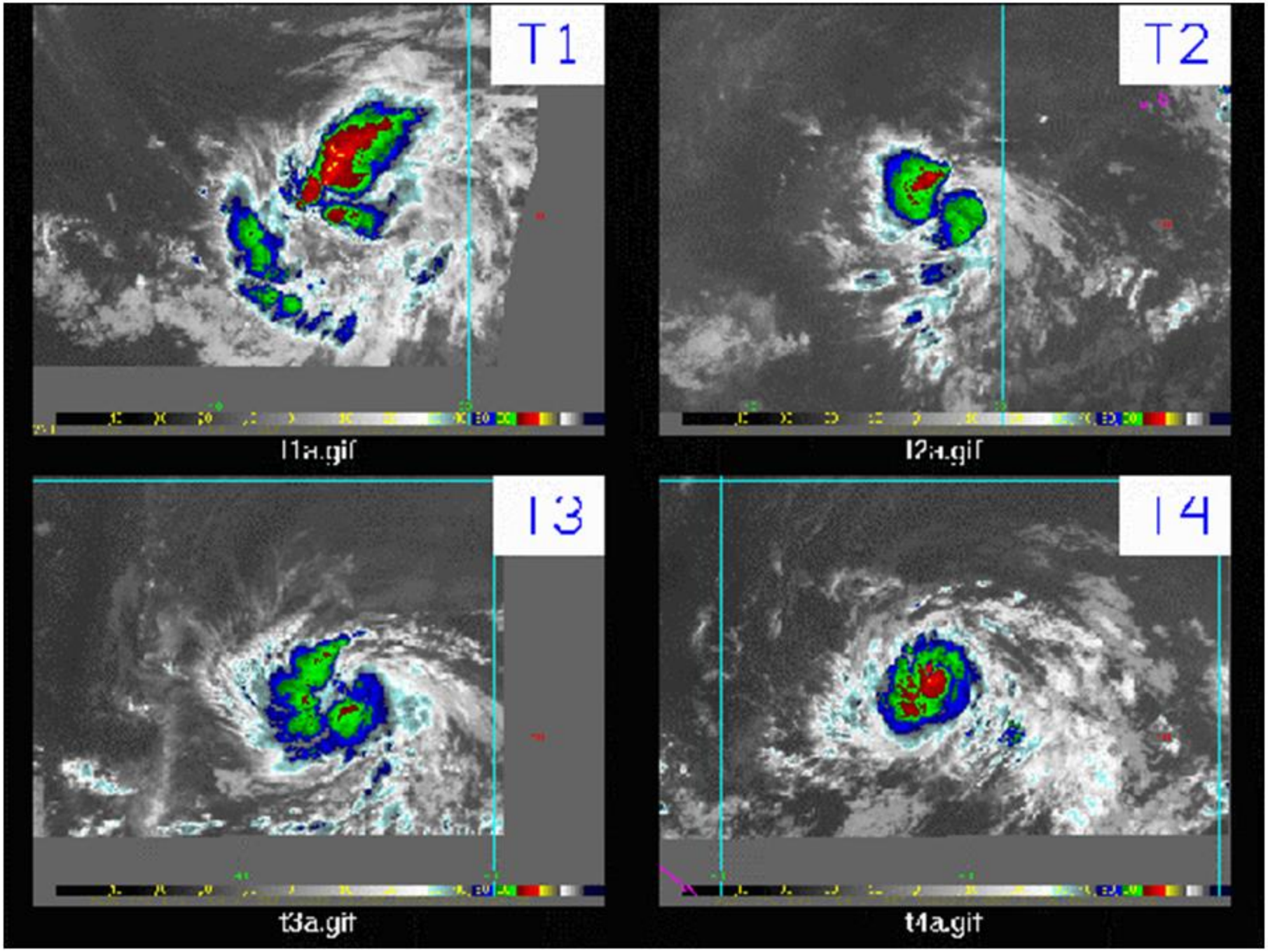


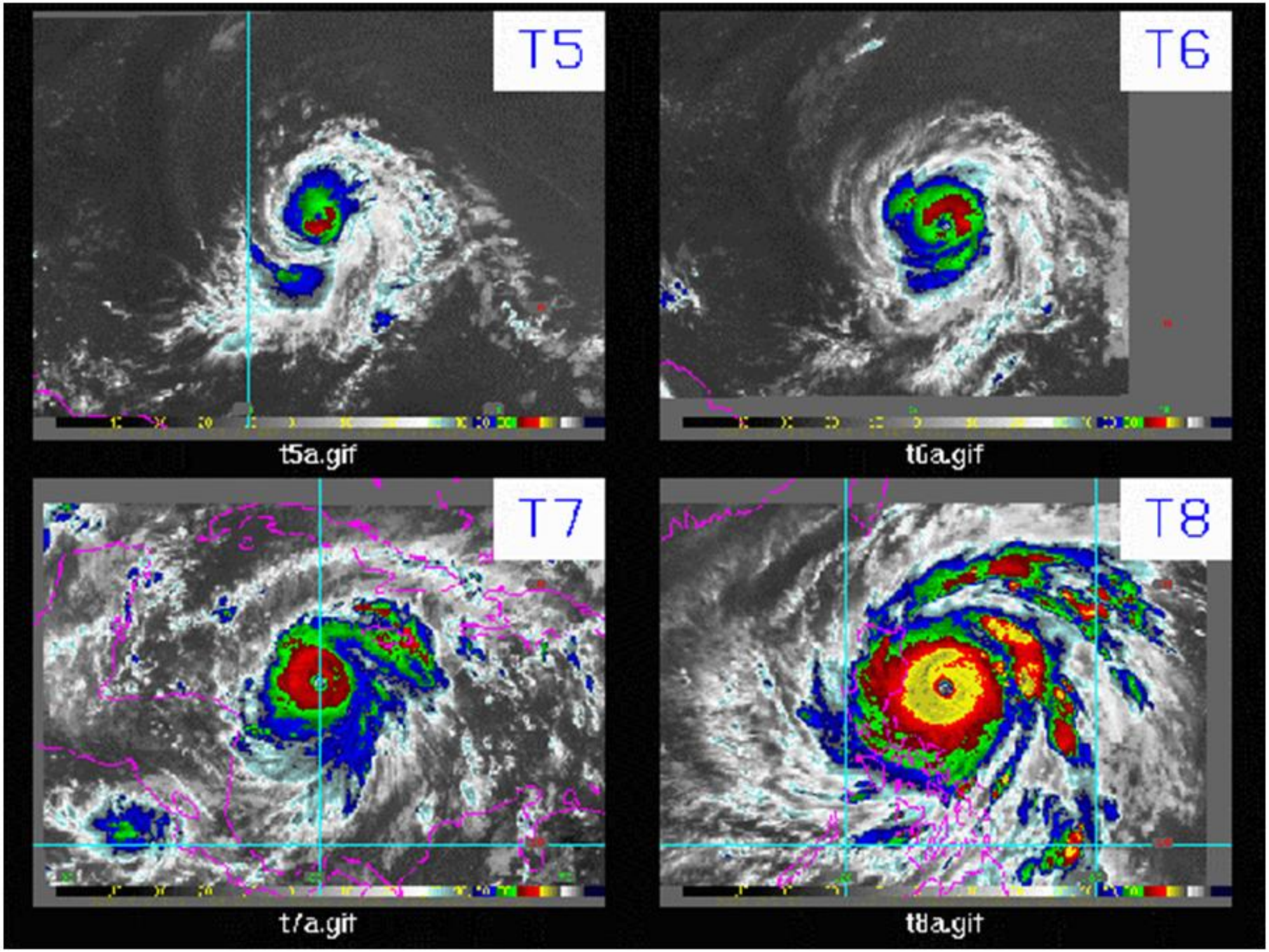
Curved Band Pattern Cont'd



1.0 2.0 2.5 3.0 3.5 4.0 4.5

DT Number


T1
T2
t1a.gif
t2a.gif
T3
T4
t3a.gif
t4a.gif


T5
T6
t5a.gif
T7
T8