Variations of Typhoon Activity in Asia - Global Warming and/or Natural Cycles?

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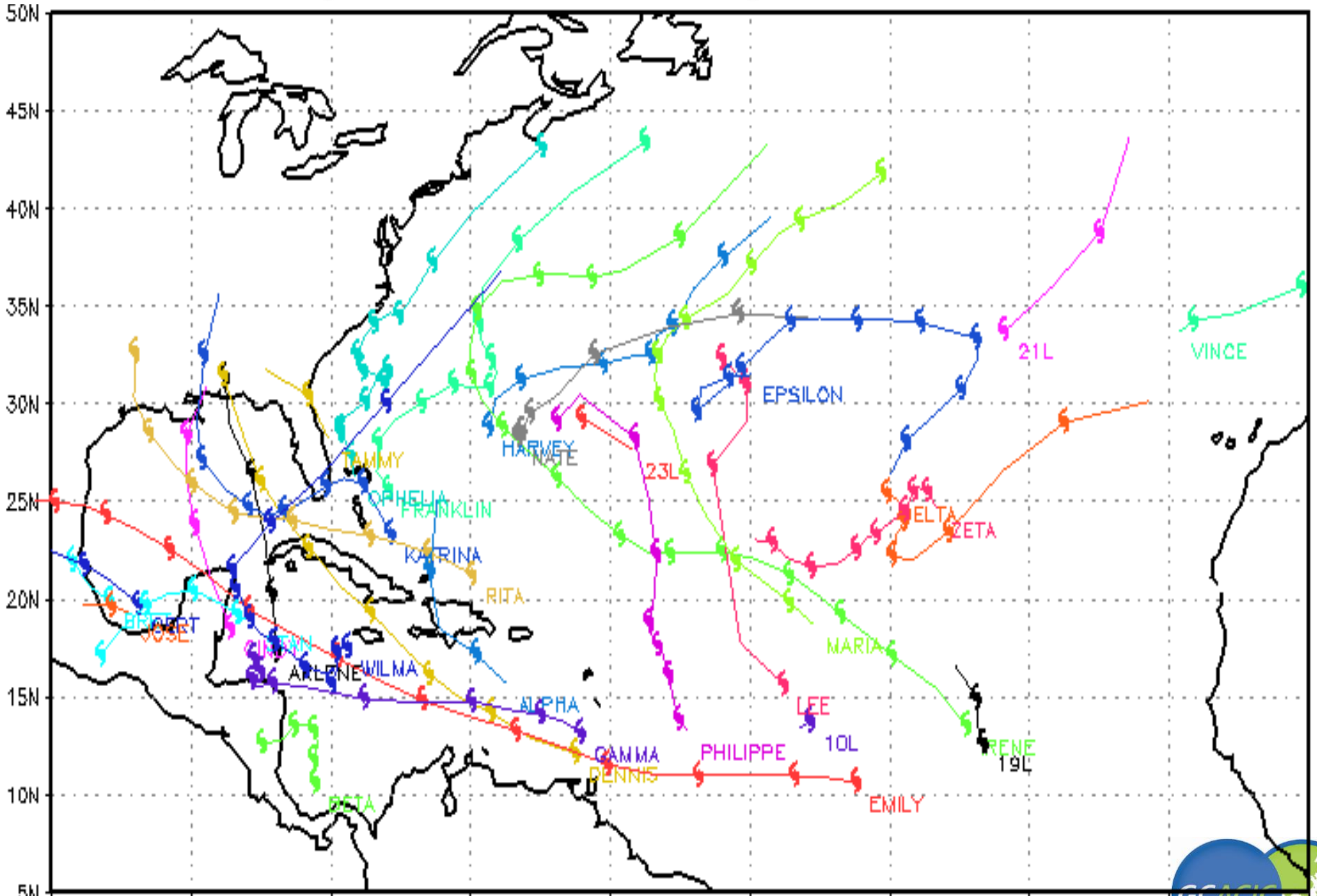
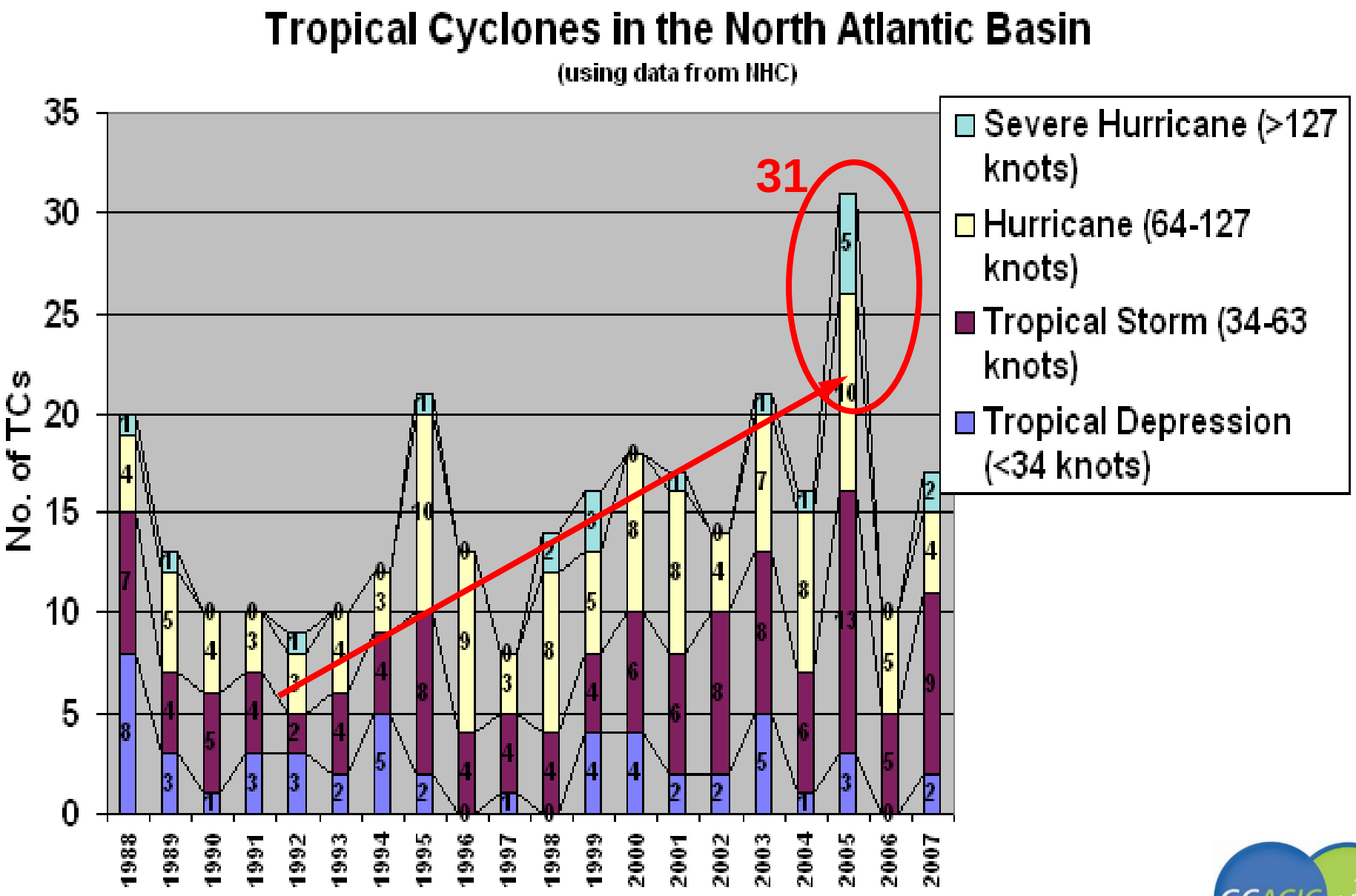
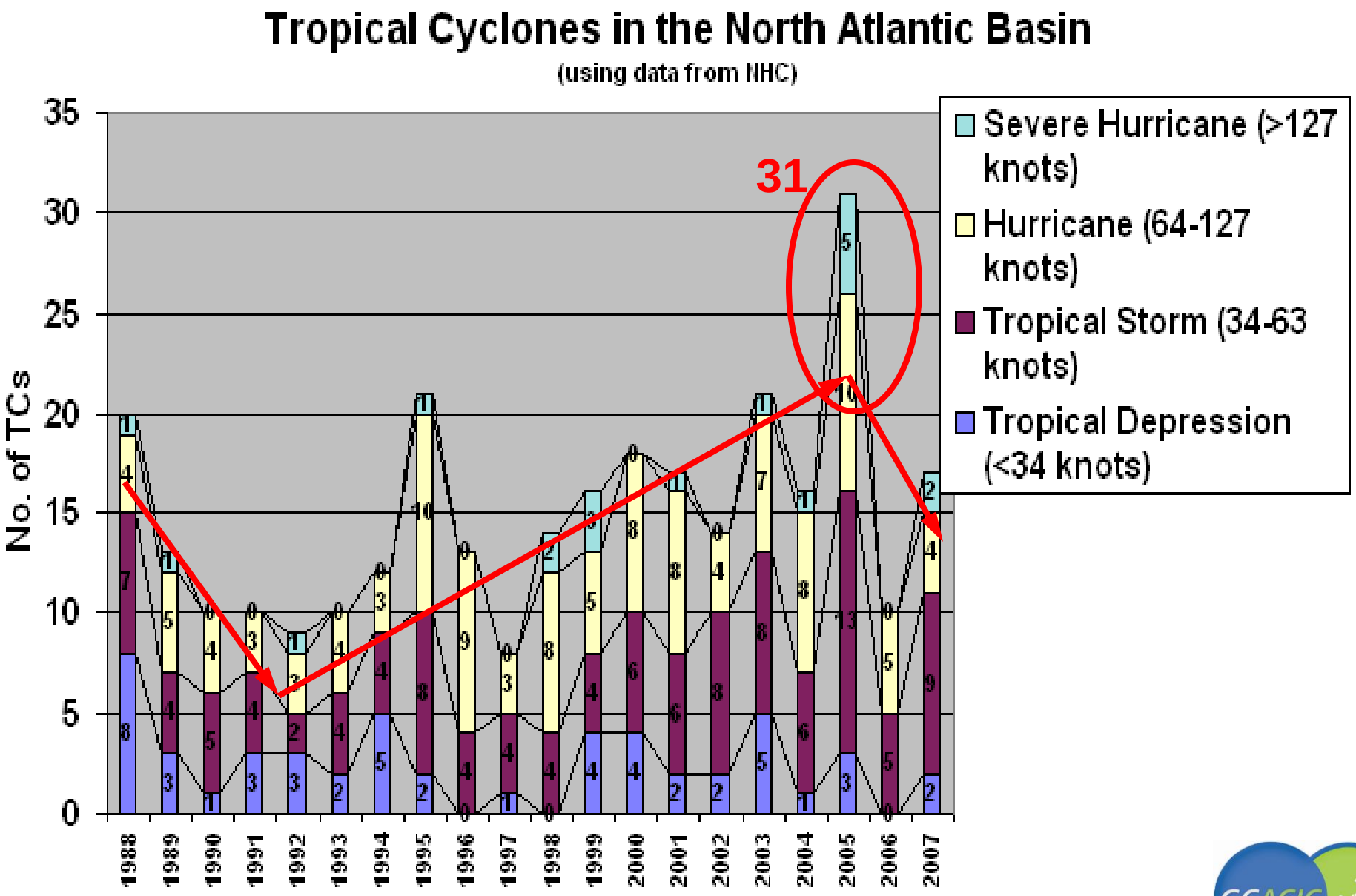
Tropical Cyclones Affecting the Atlantic in 2005



Tropical Cyclones Affecting the Atlantic



Tropical Cyclones Affecting the Atlantic

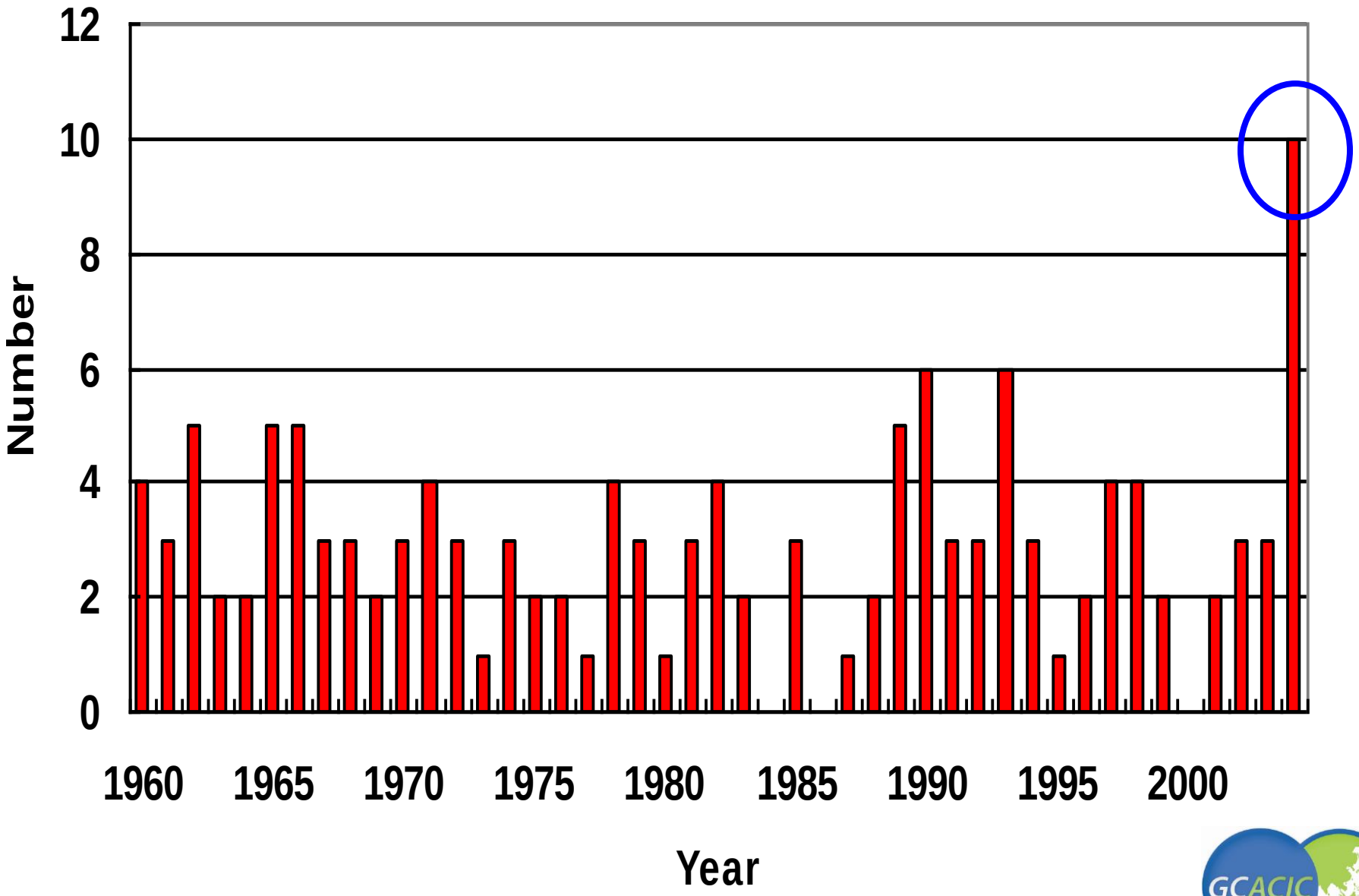


Outline

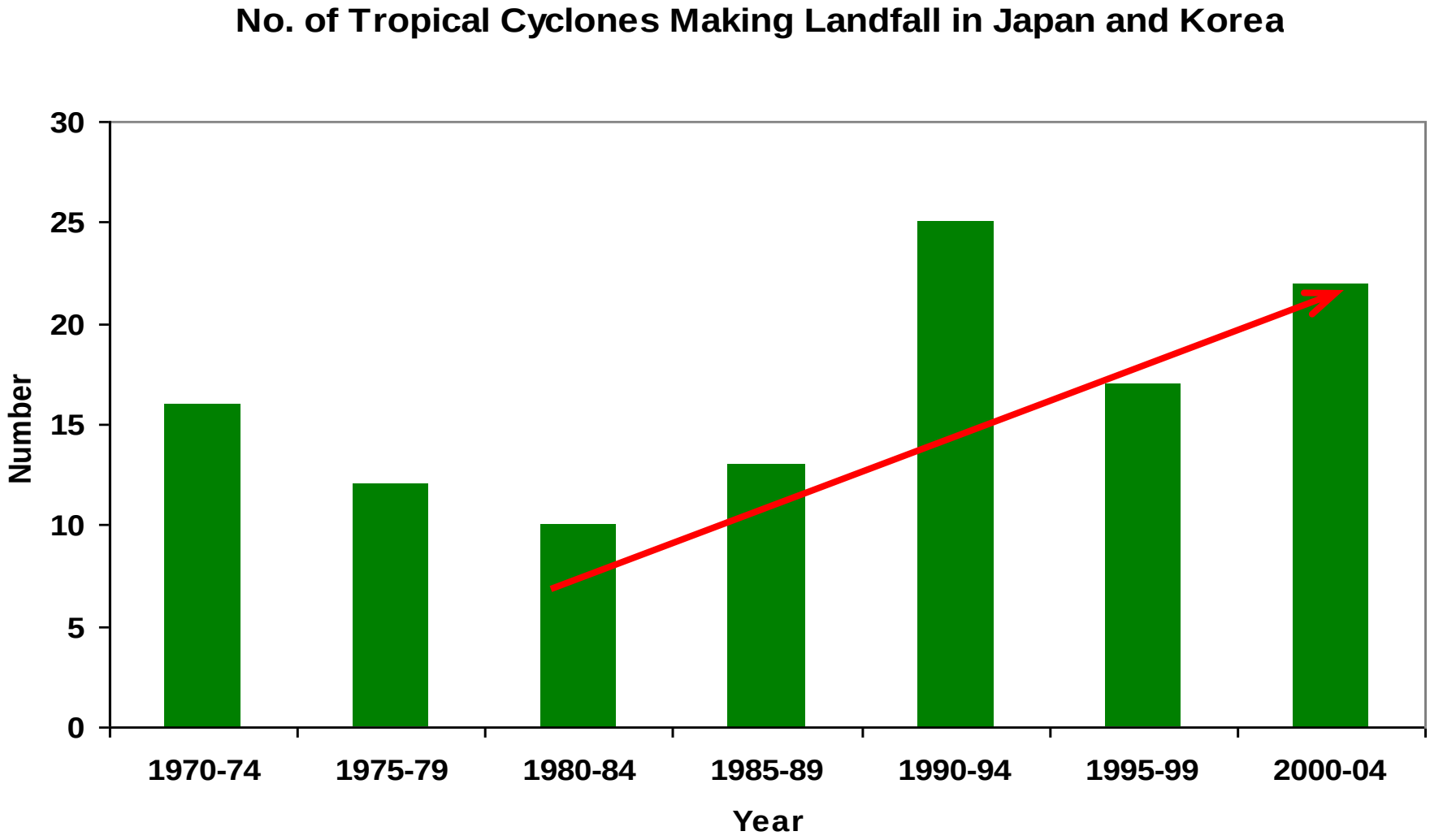
- The “common” perception and conclusion
- Problems with such a perception and conclusion
- The common myth
- What actually causes variations in typhoon activity?
- What can we expect for the future?

The “Common” Perception

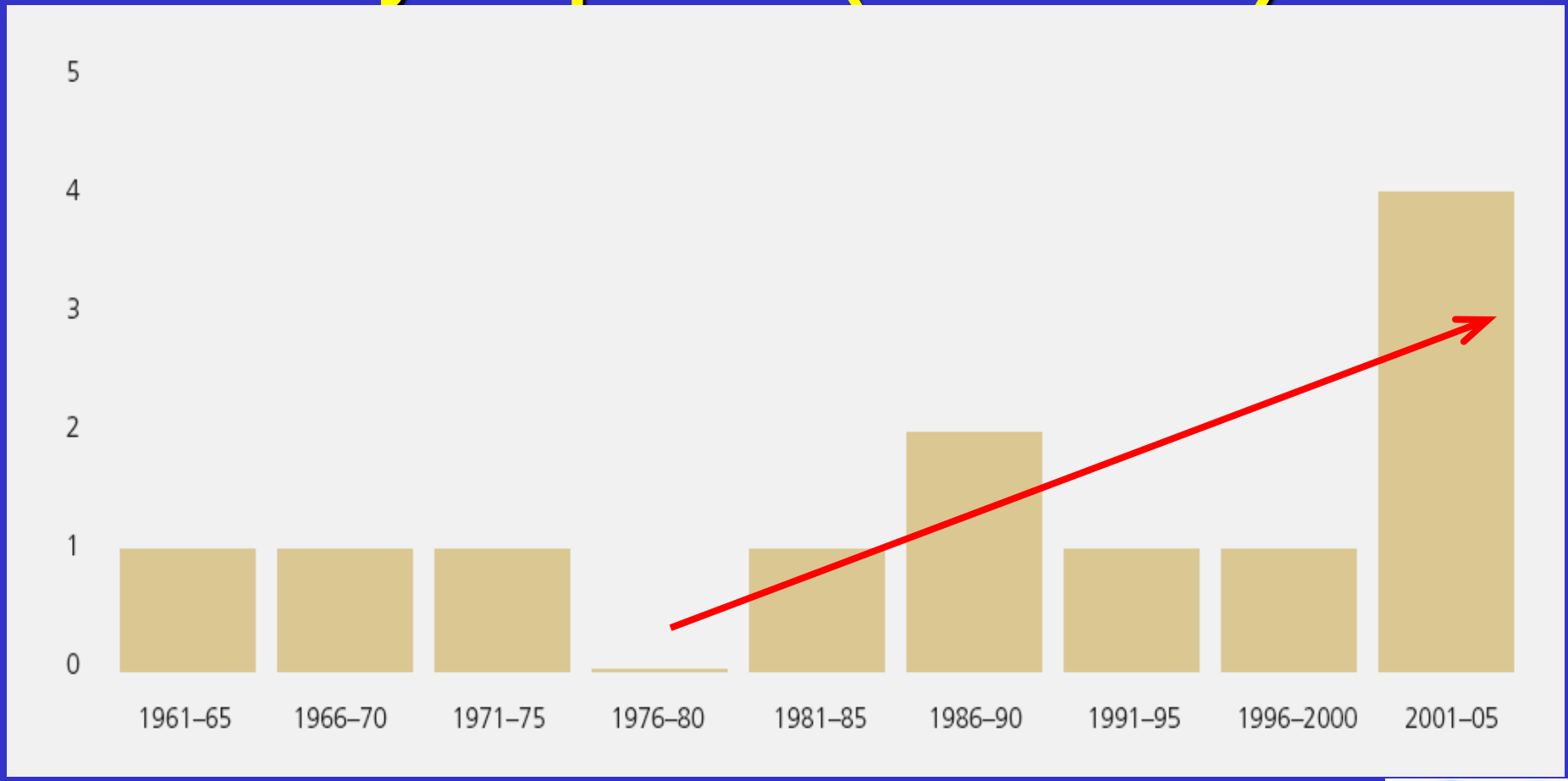
Number of Tropical Cyclones Making Landfall in Japan



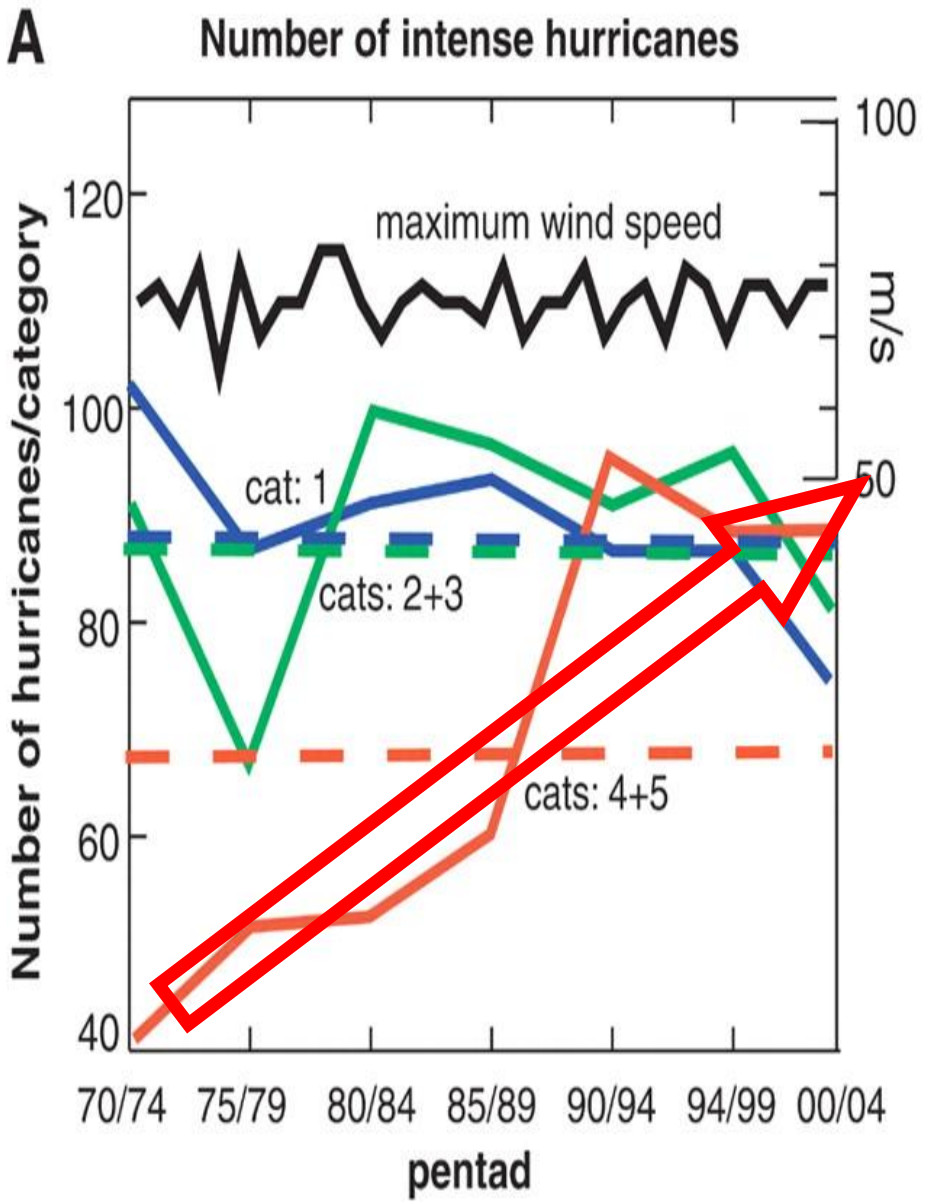
Number of Tropical Cyclones Making Landfall in Japan and Korea Every 5-year period (1970-2004)

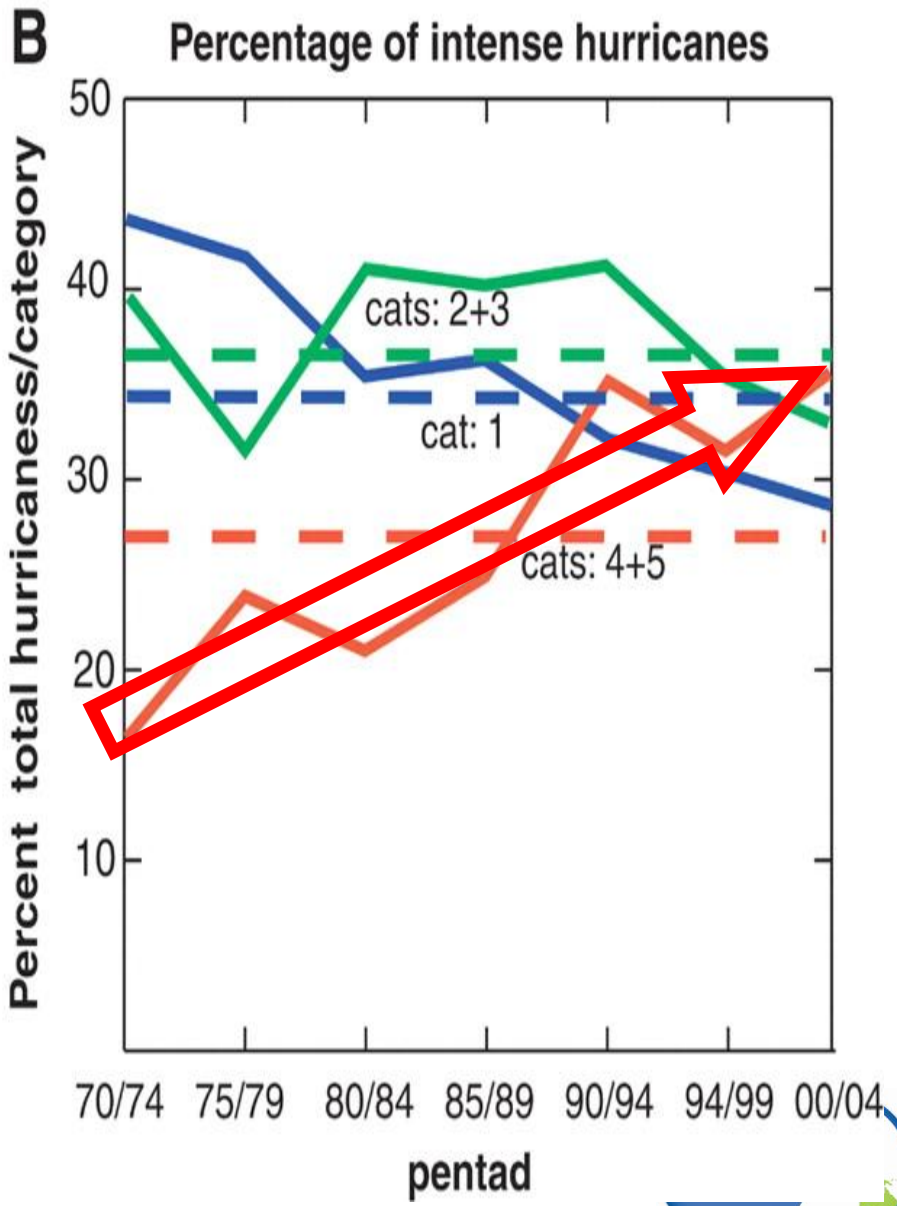


Number of Typhoons Making Landfall in Zhejiang Province, China During each 5-year period (1960-2005)



Webster et al.'s (2005) *Science* paper

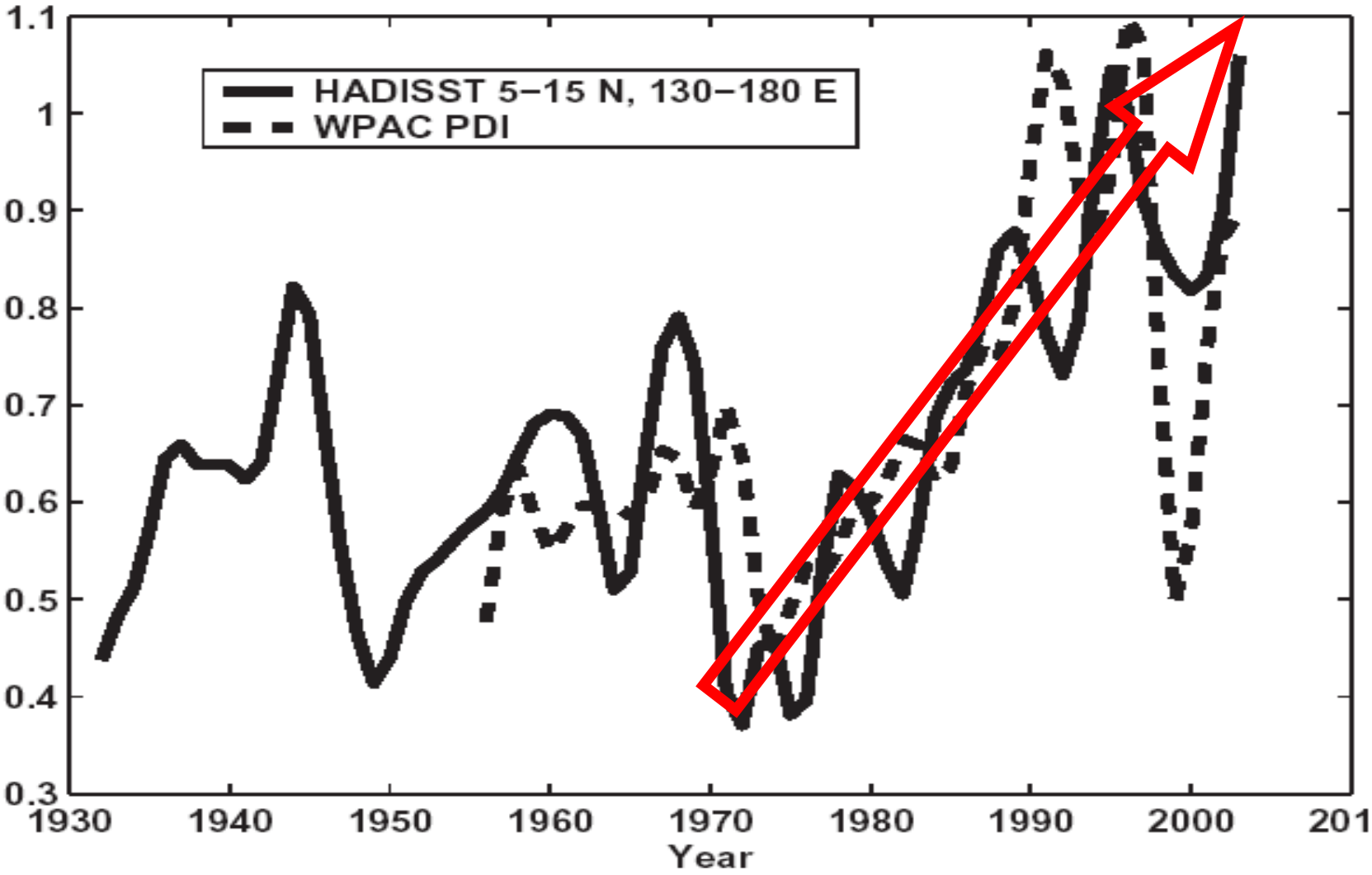




Emanuel's (2005) *Nature* paper

W. North Pacific

PDI: (max wind)^3



The "Common" Conclusion

Tropical cyclone activity and that of intense typhoons in the western North Pacific, as well as the number of tropical cyclones making landfall along the Asian coast have been on the *increase as a result of global warming*.

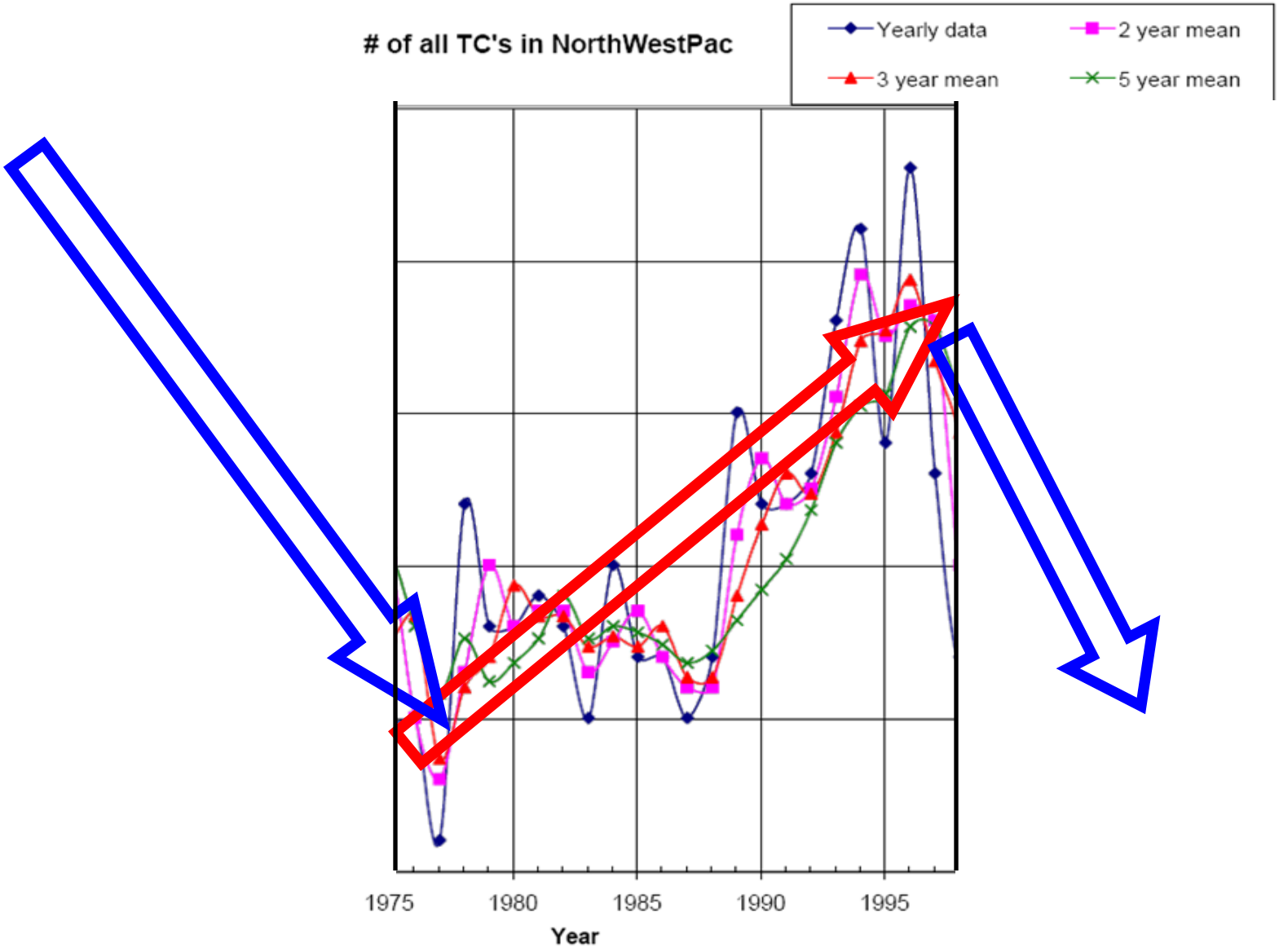
Questions

1. Is tropical cyclone activity in the western North Pacific increasing?
2. Is intense typhoon activity in the western North Pacific increasing?
3. Is the number of landfalling tropical cyclones along the Asian coast increasing?
4. Can changes in such activities be explained by those caused by global warming? If not, can we still explain such changes?

Question 1:

Is tropical cyclone activity in the western North Pacific increasing?

Number of TCs in WNP (from JTWC)



Question 1:

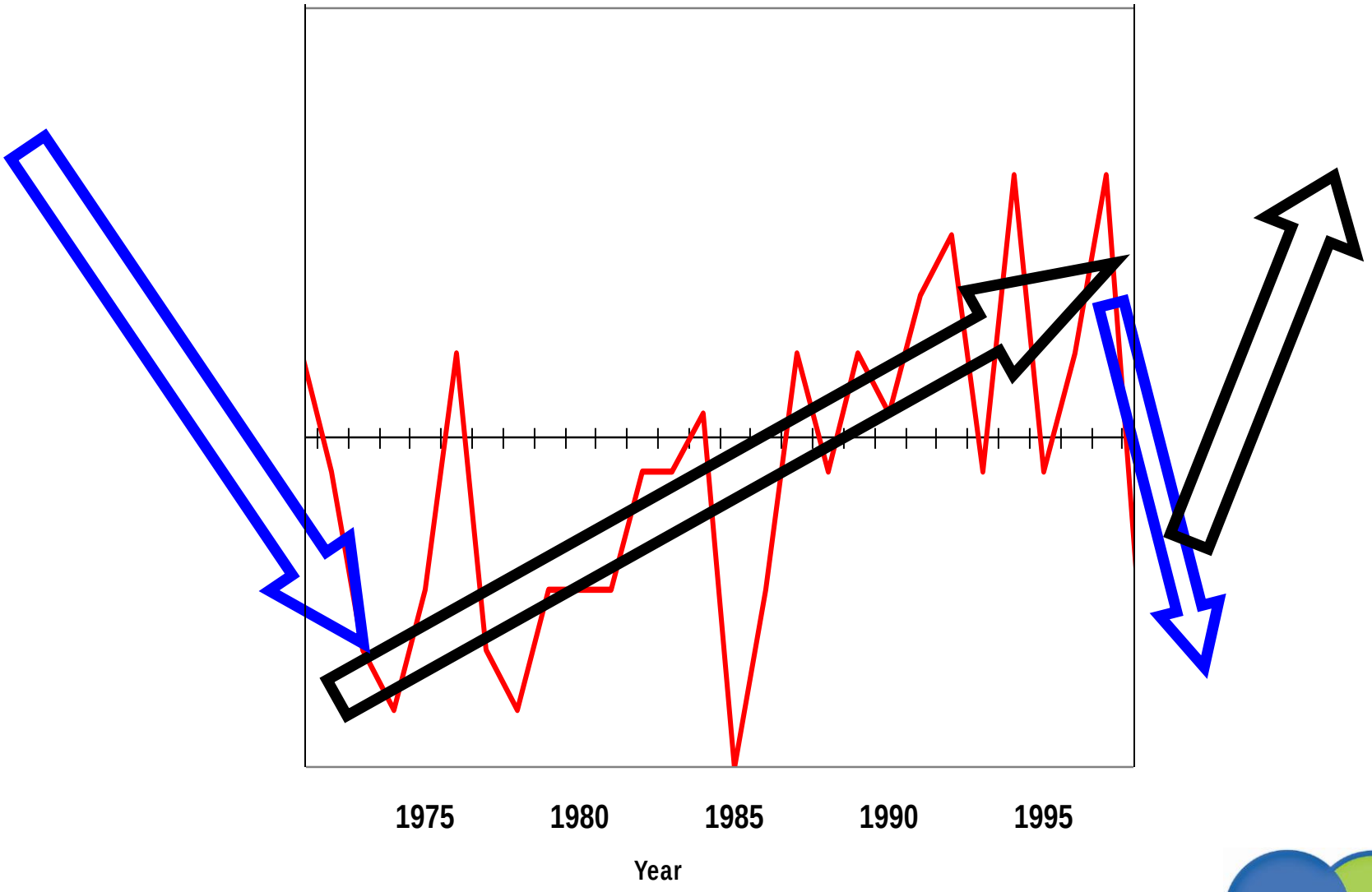
Is tropical cyclone activity in the western North Pacific increasing?

Answer: No

Question 2:

Is intense typhoon activity in the western North Pacific increasing?

Standardized Number of Cat 4 & 5 Typhoons



No. of Category 4 and 5 Typhoons

	1975-89	1990-2004
Number	75	115
Percentage	32	42

No. of Category 4 and 5 Typhoons

	1960-74	1975-89	1990-2004
Number	105	75	115
Percentage	37	32	42

Question 2:

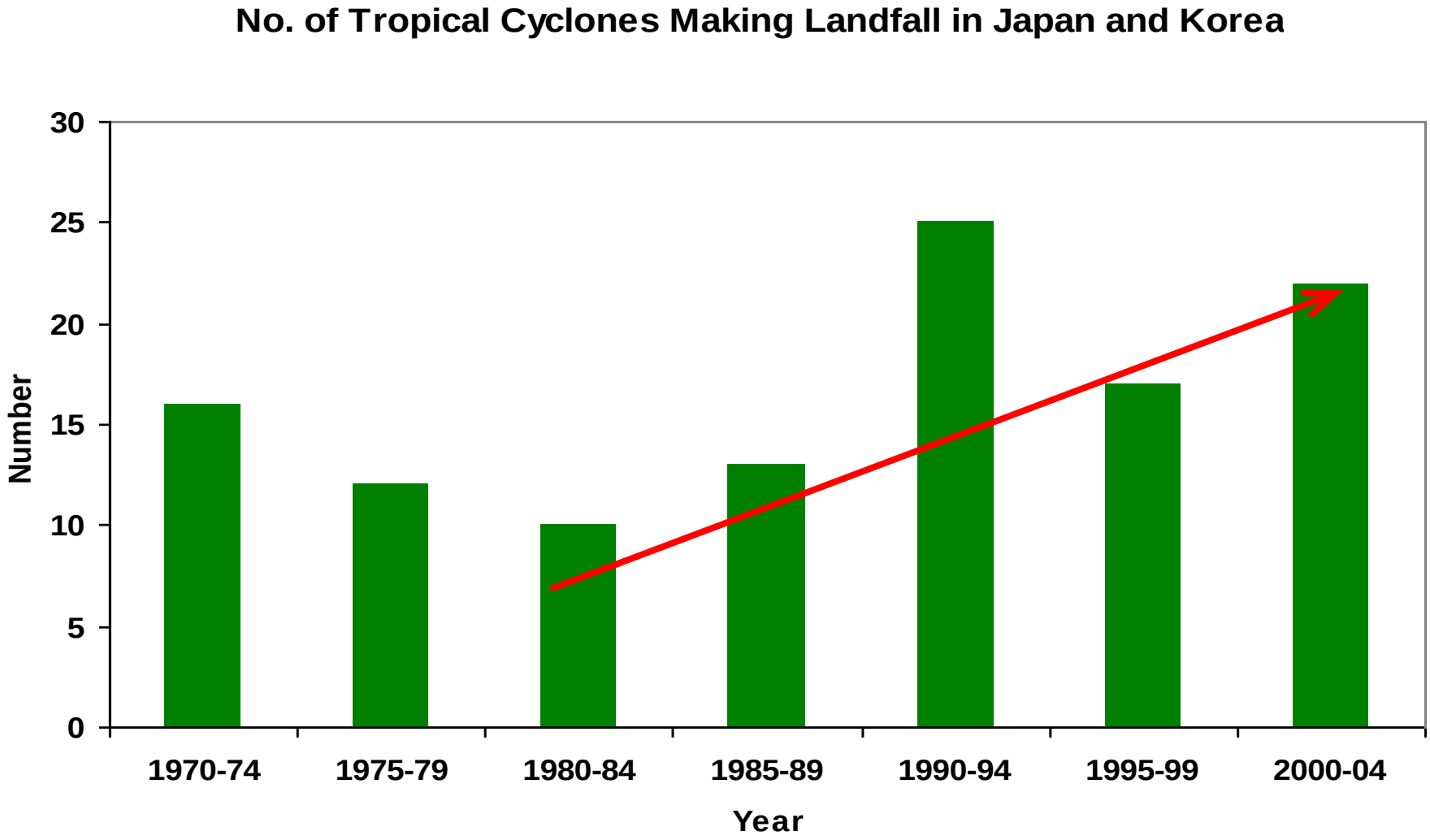
Is intense typhoon activity in the western North Pacific increasing?

Answer: No

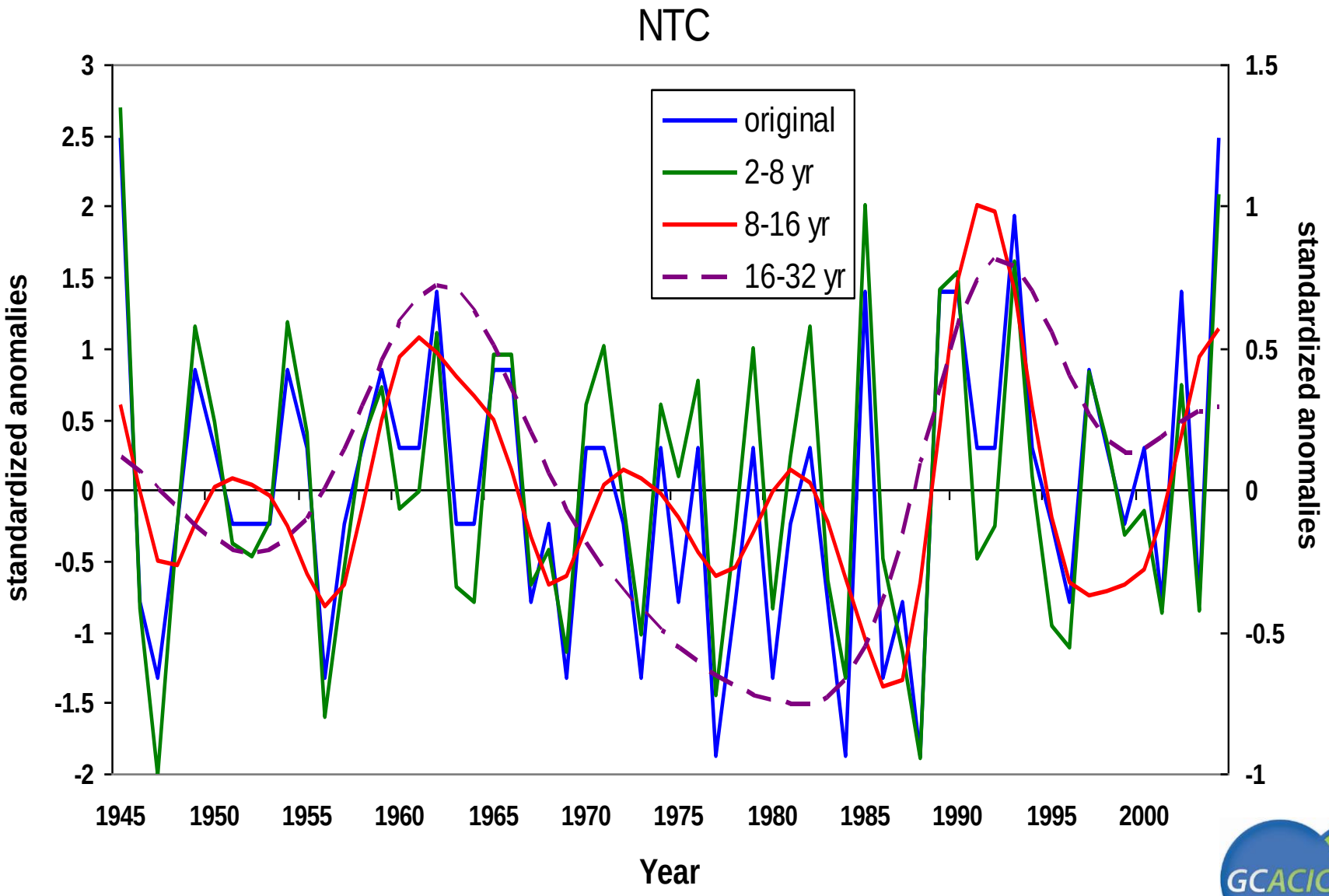
Question 3:

Is the number of landfalling tropical cyclones along the Asian coast increasing?

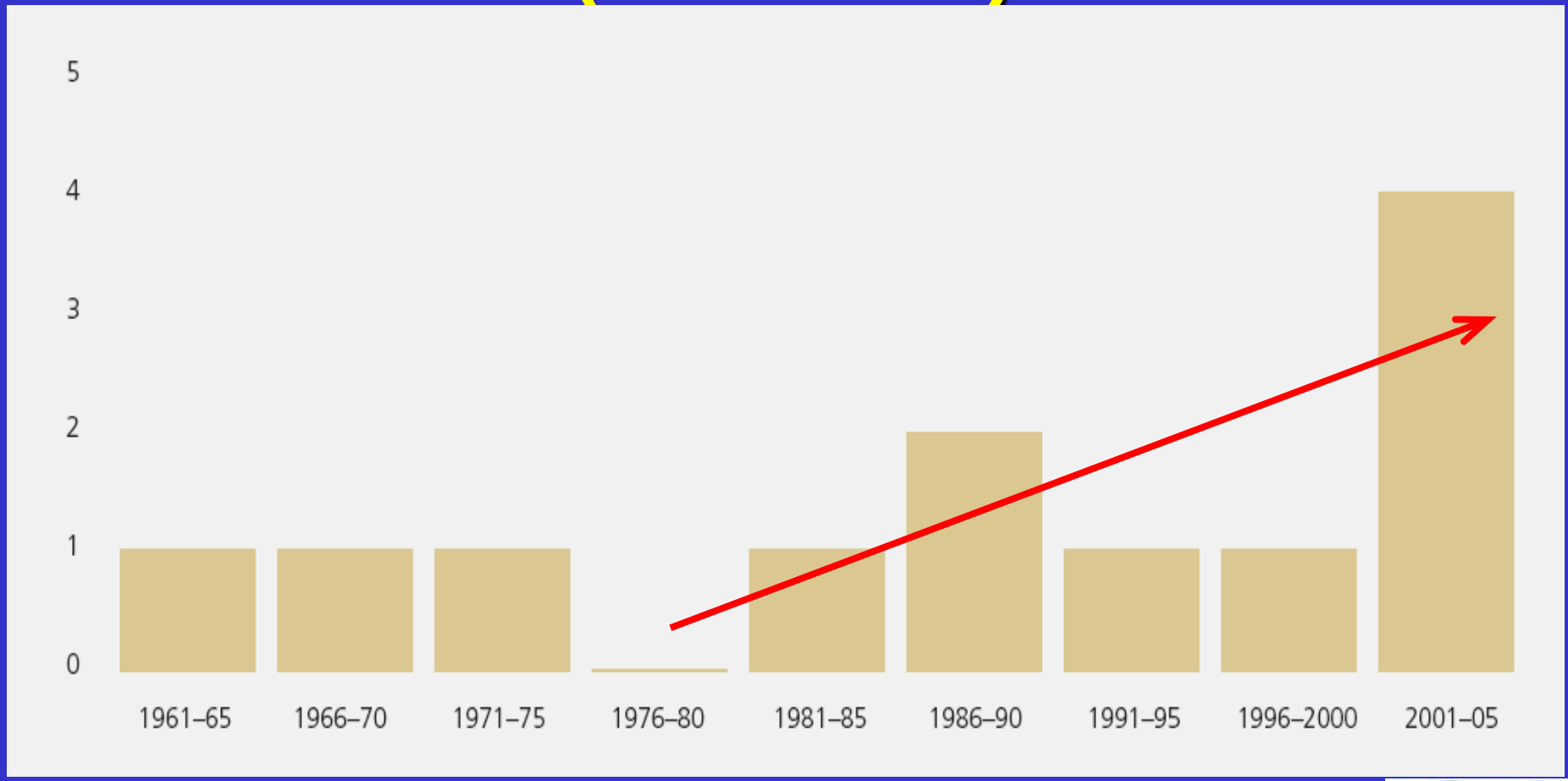
Number of Tropical Cyclones Making Landfall in Japan and Korea Every 5-year period (1970-2004)



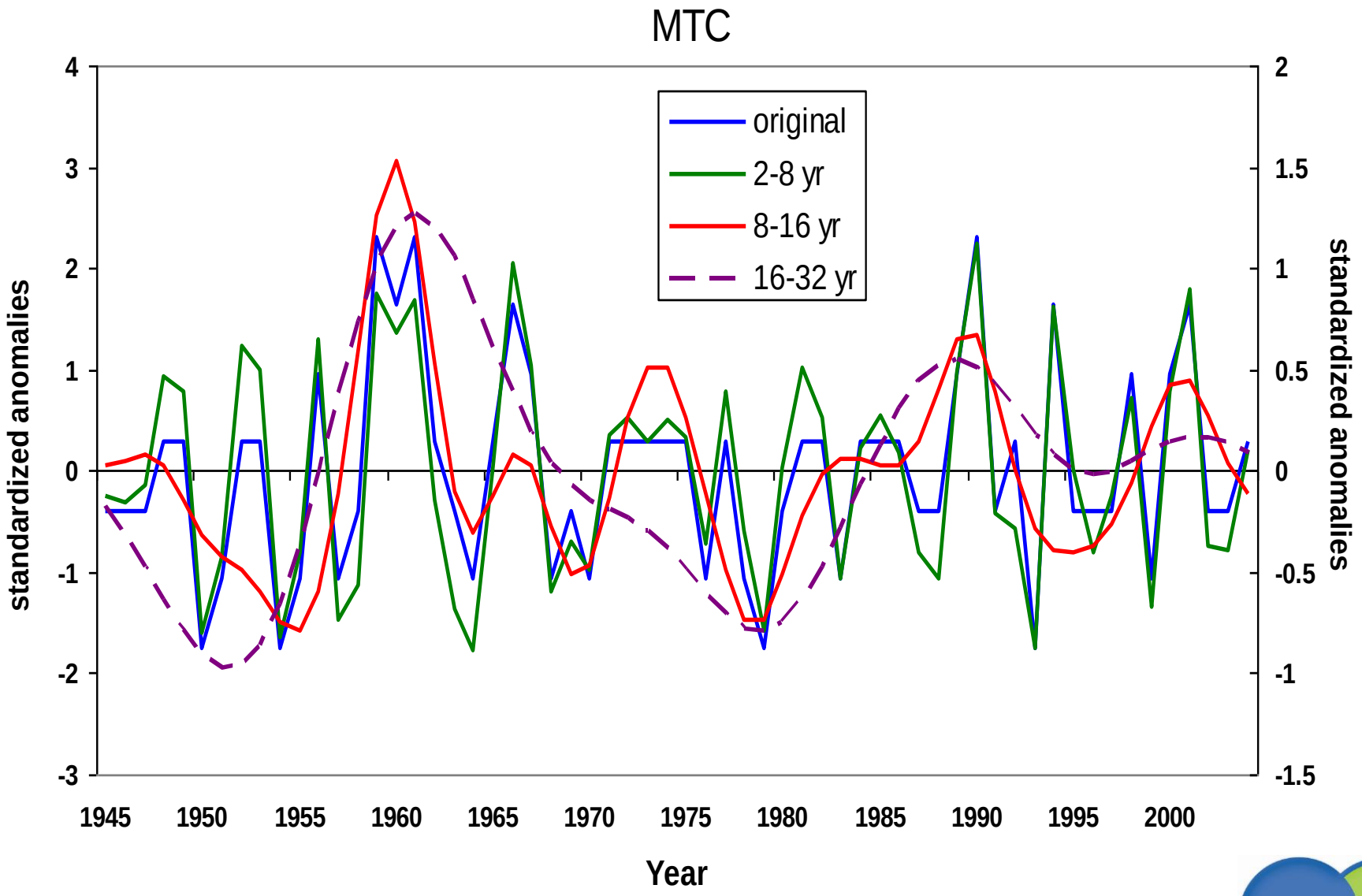
Standardized number of TCs making landfall in Korea and Japan



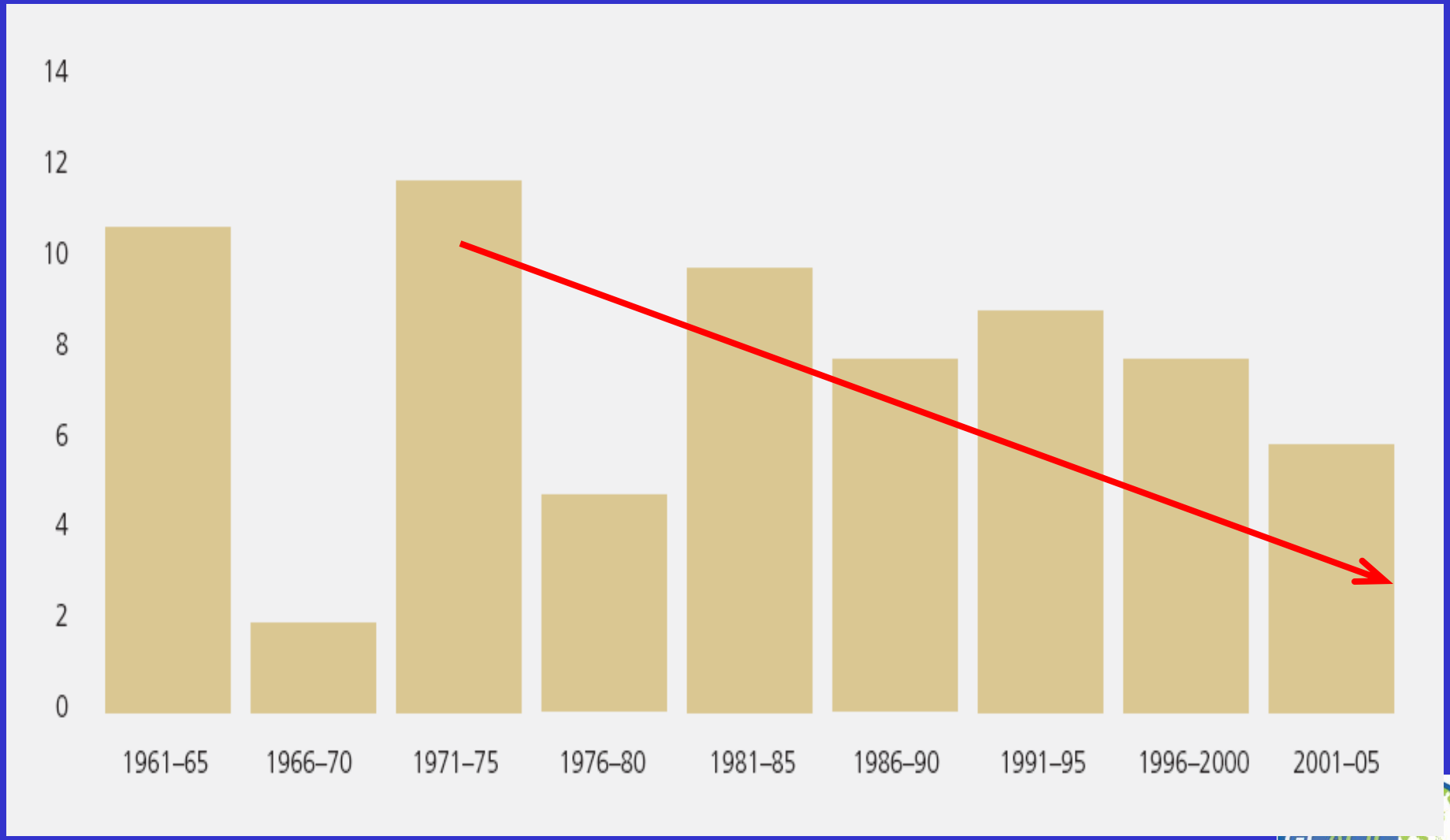
Number of Typhoons Making Landfall in Zhejiang During each 5-year period (1960-2005)



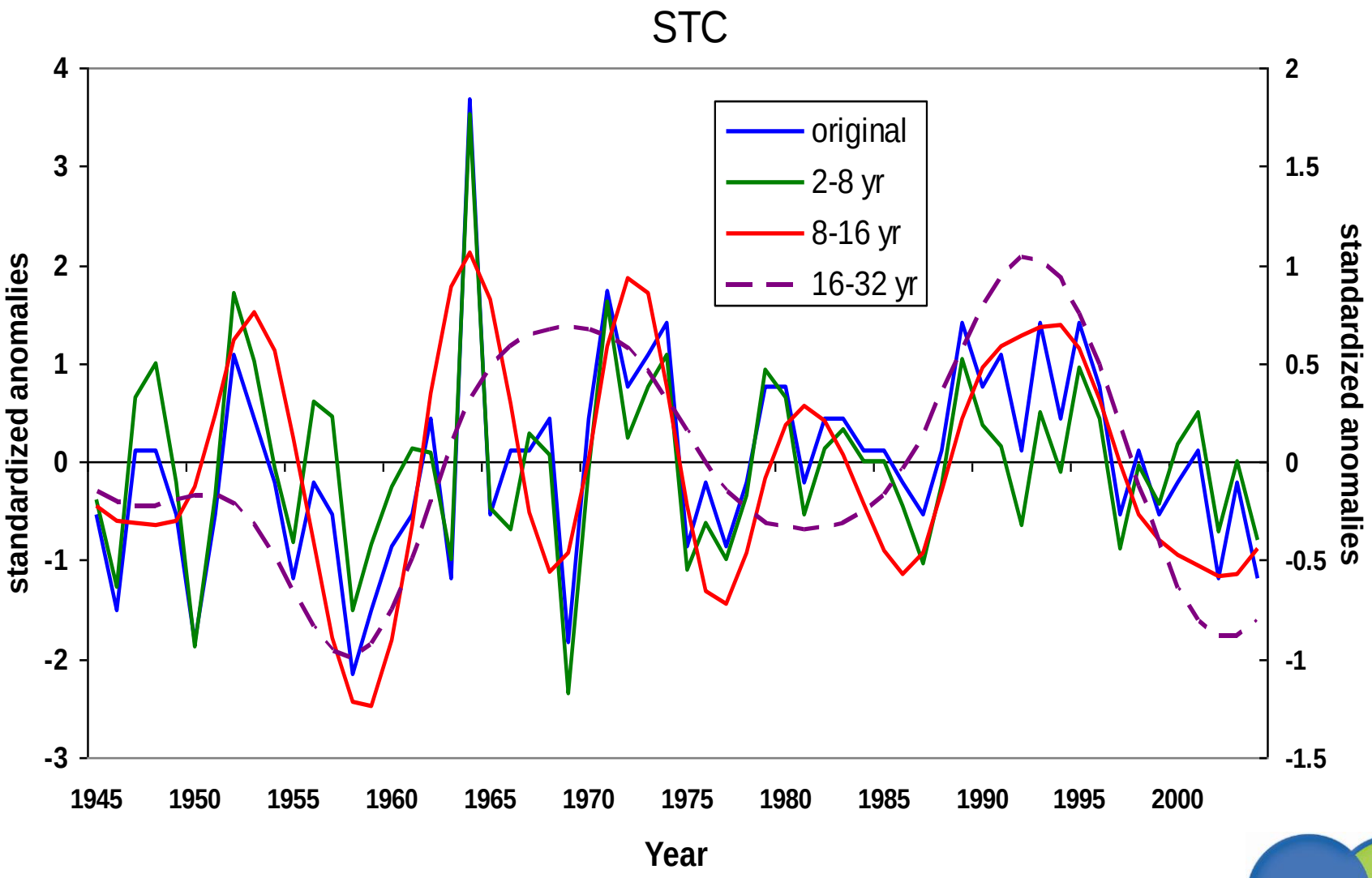
Standardized number of TCs making landfall in East China



Number of Typhoons Making Landfall in Guangdong/Hainan (South China) Every 5-year period (1960-2005)



Standardized number of TCs making landfall in South China, Vietnam and Philippines



Question 3:

Is the number of landfalling tropical cyclones along the Asian coast increasing?

Answer: No

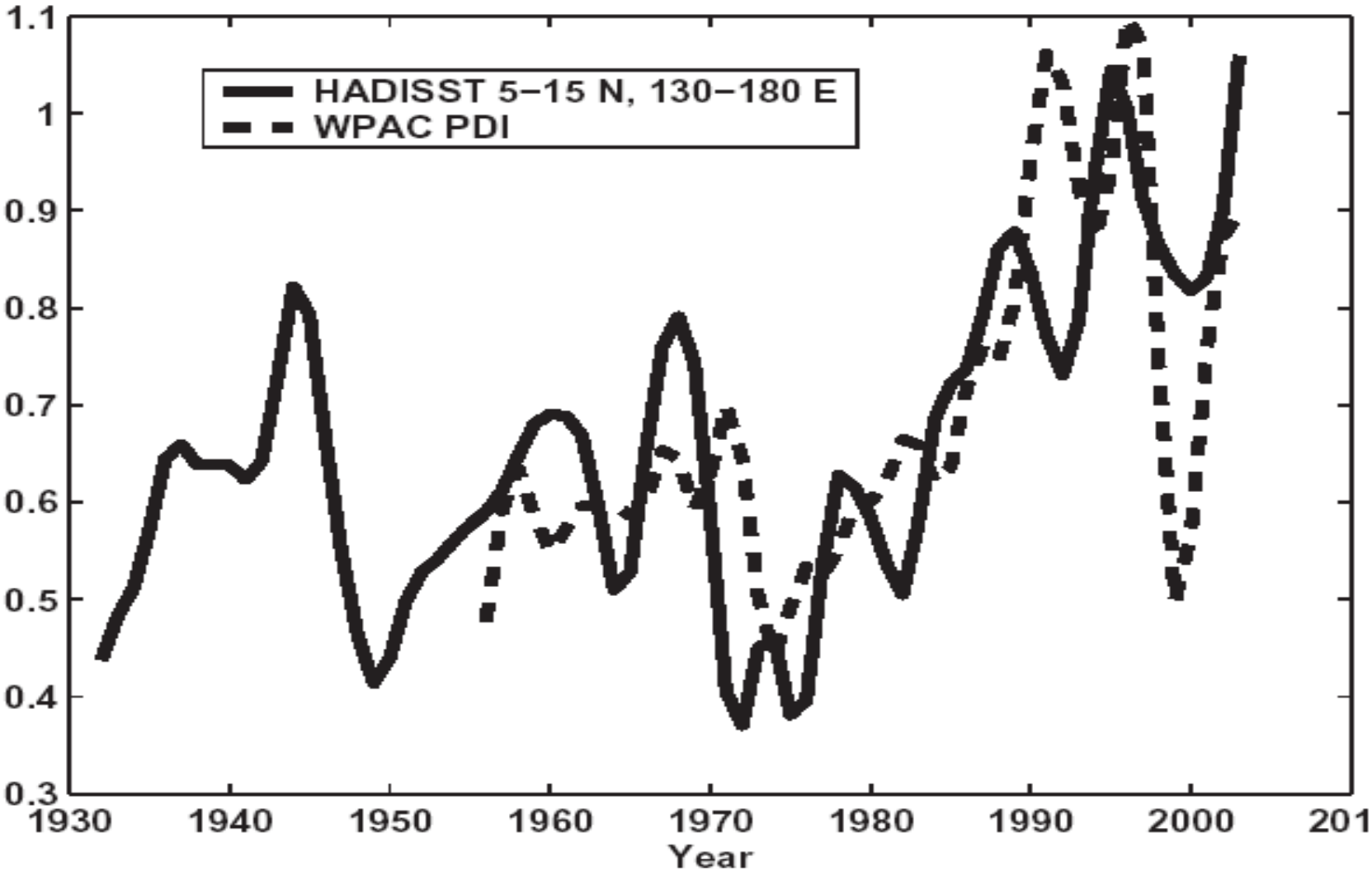
Question 4:

Can changes in such activities be explained by those caused by global warming? If not, can we still explain such changes?

Emanuel's (2005) *Nature* paper

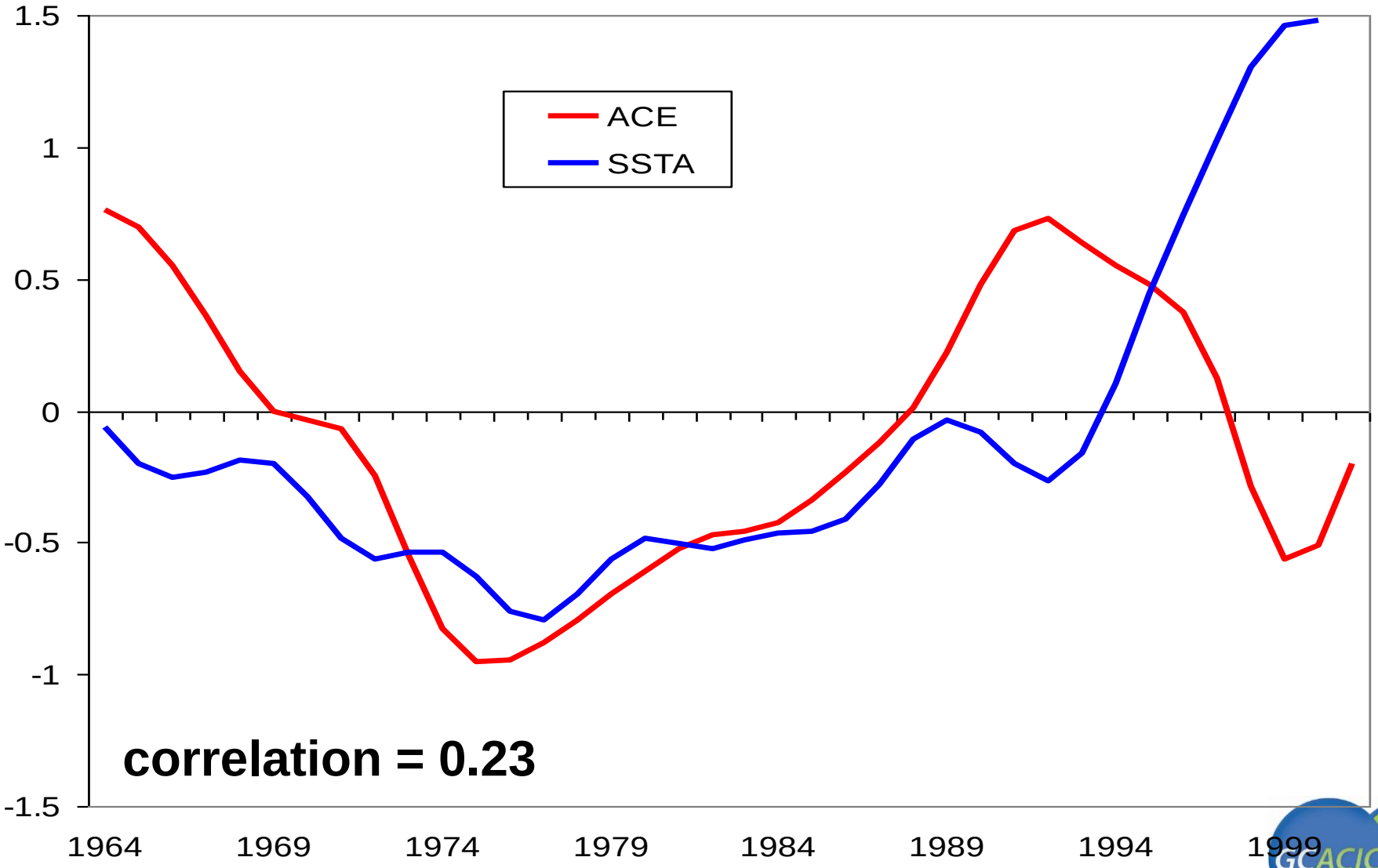
W. North Pacific

PDI: (max wind)^3



Total Cyclone Energy vs. May-Nov SSTA (5-30°N, 120-180°E)

[10-year Gaussian-filtered; standardized]



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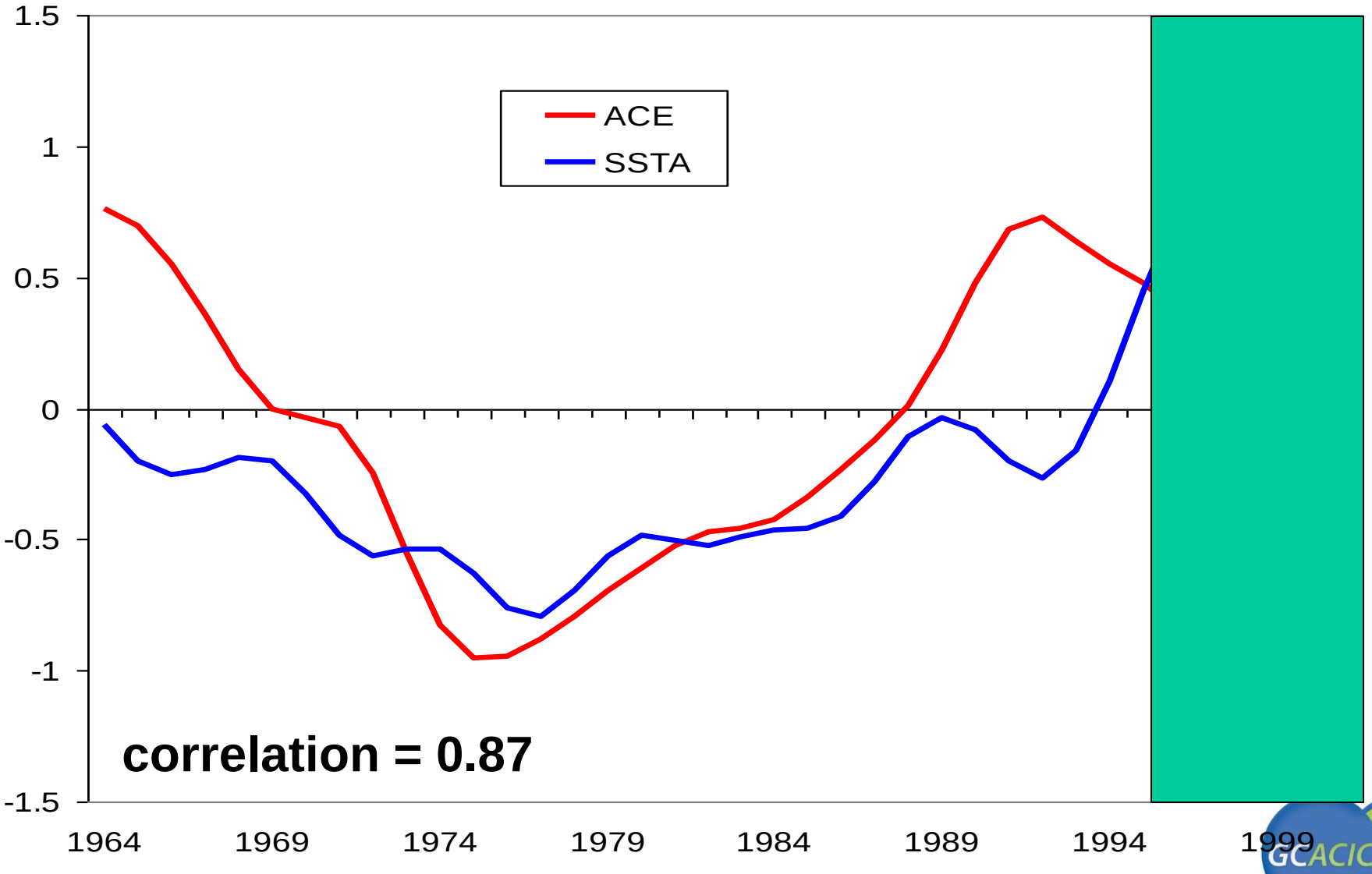

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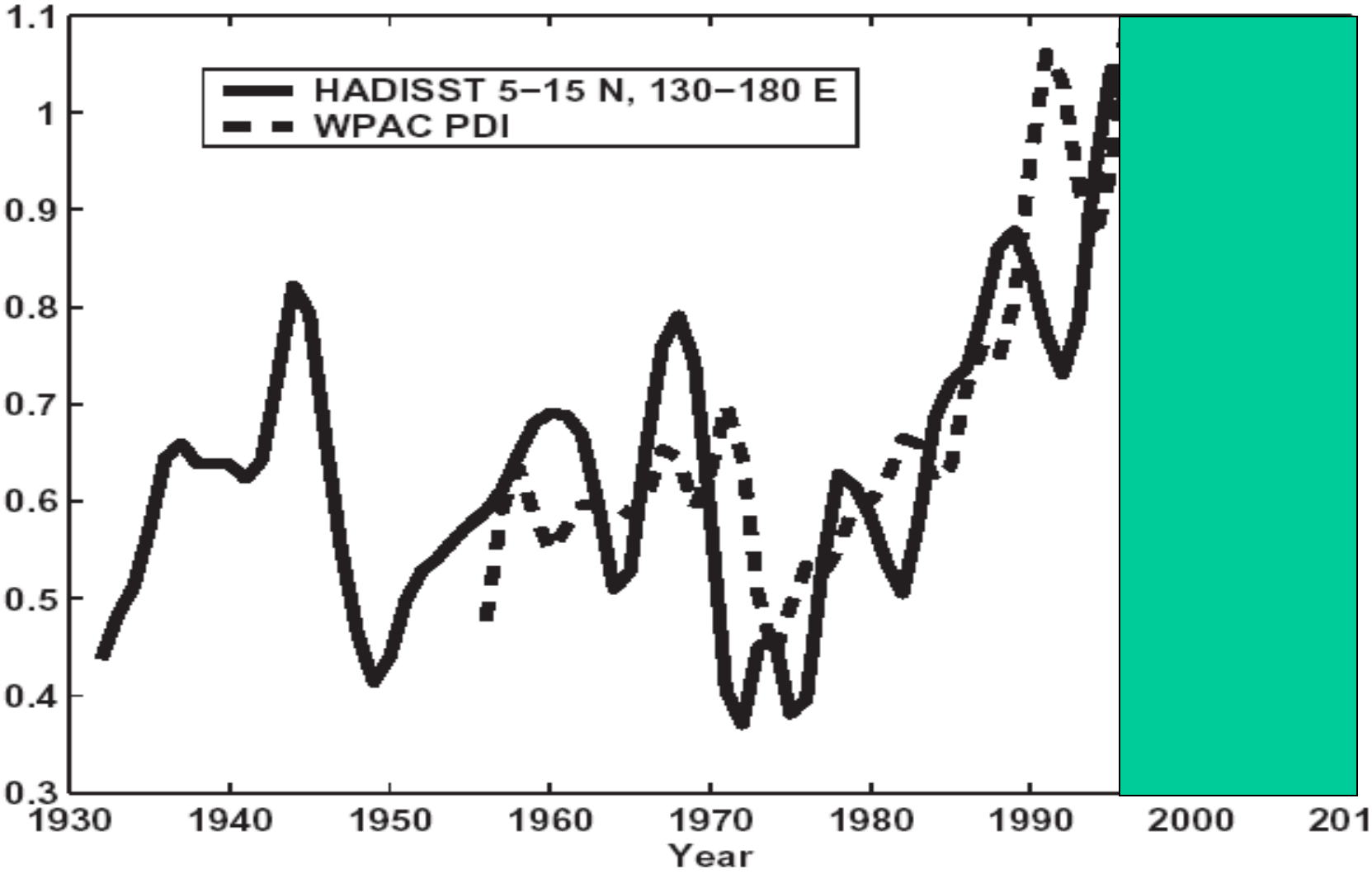


Question 4:

Can changes in such activities be explained by those caused by global warming? If not, can we still explain such changes?

Answer: No

The "Common" Myth

Global Warming

↓

Increase in ocean water temperature

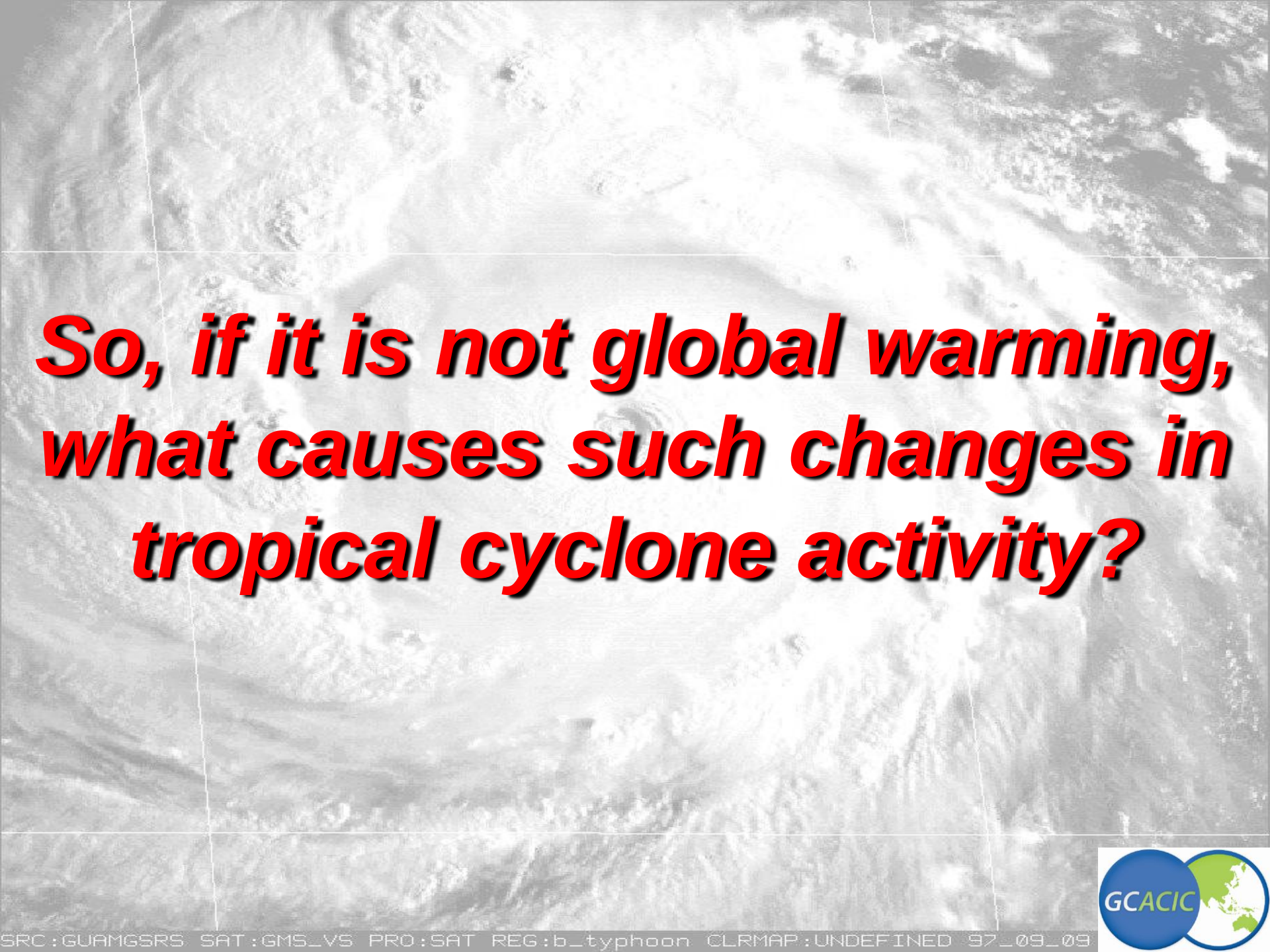
↓

More energy for tropical cyclones to form and to intensify

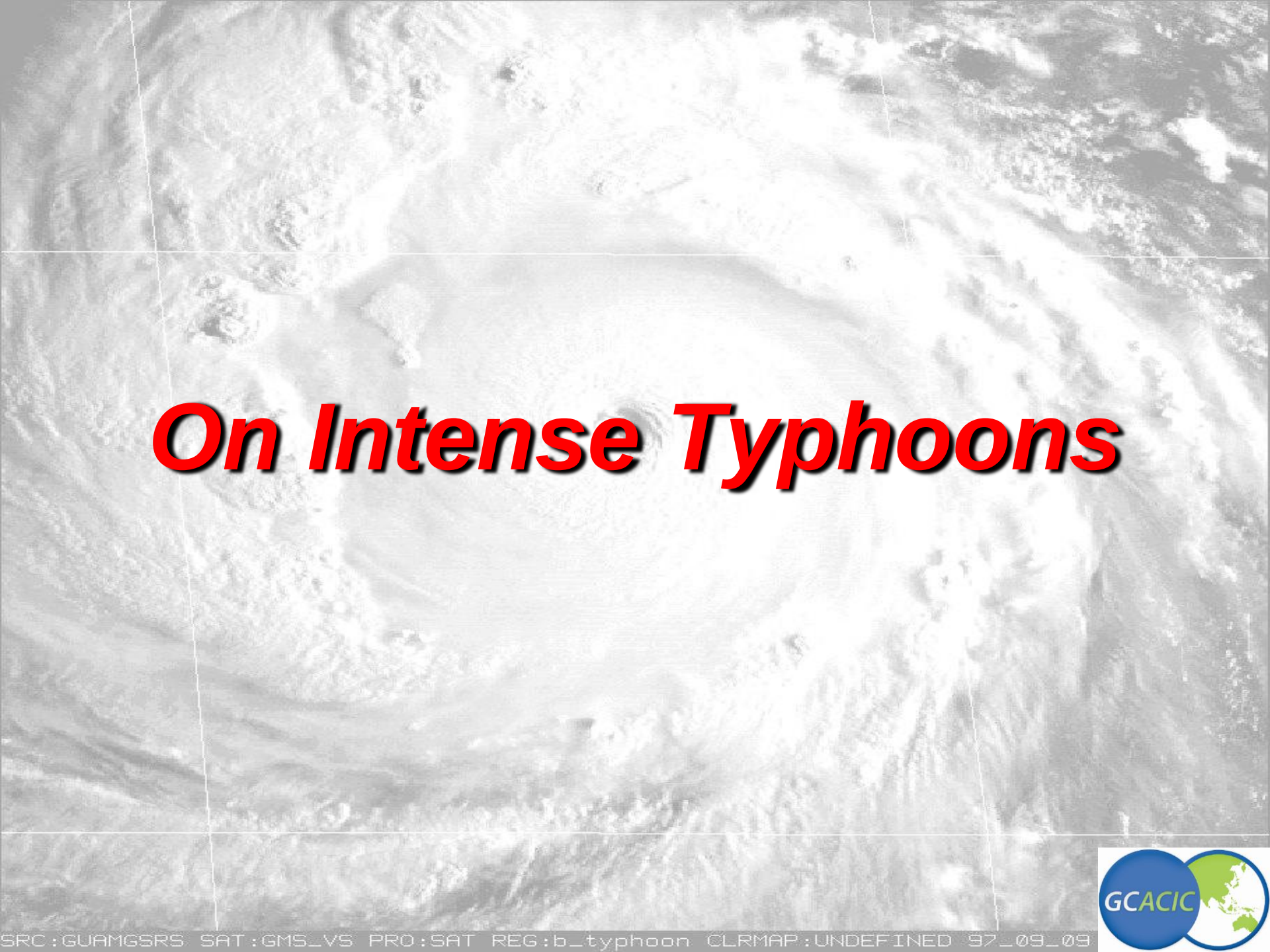
↓

Higher frequency of tropical cyclone formation and more intense tropical cyclones

So, if it is not global warming, what causes such changes in tropical cyclone activity?



On Intense Typhoons



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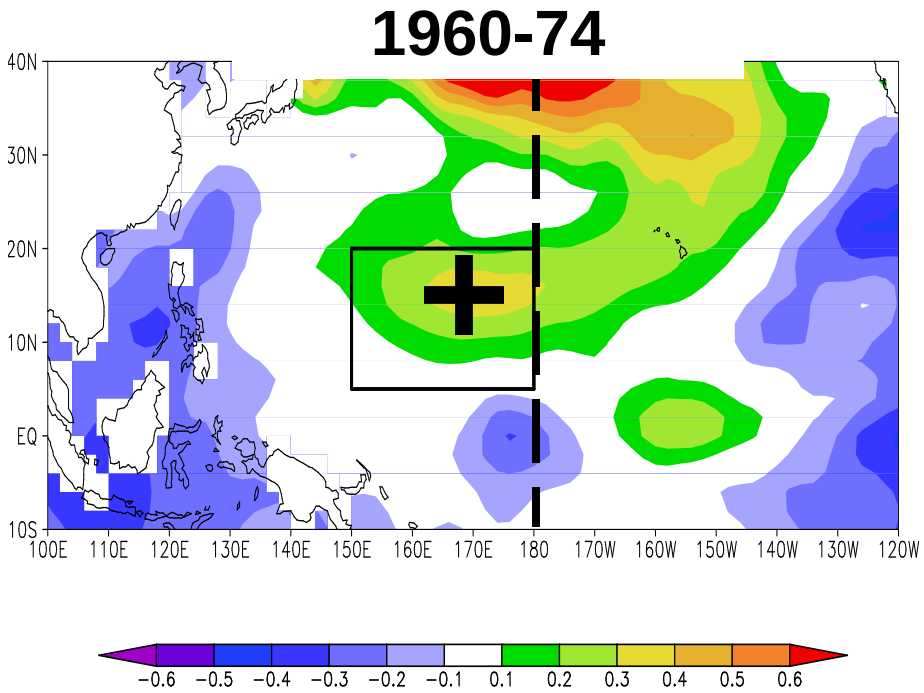

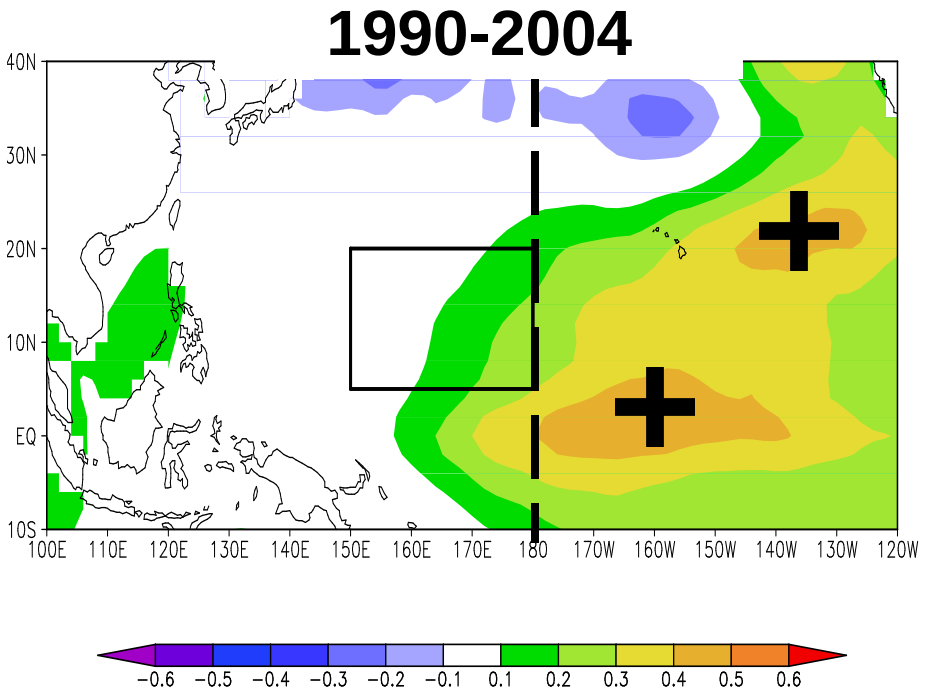

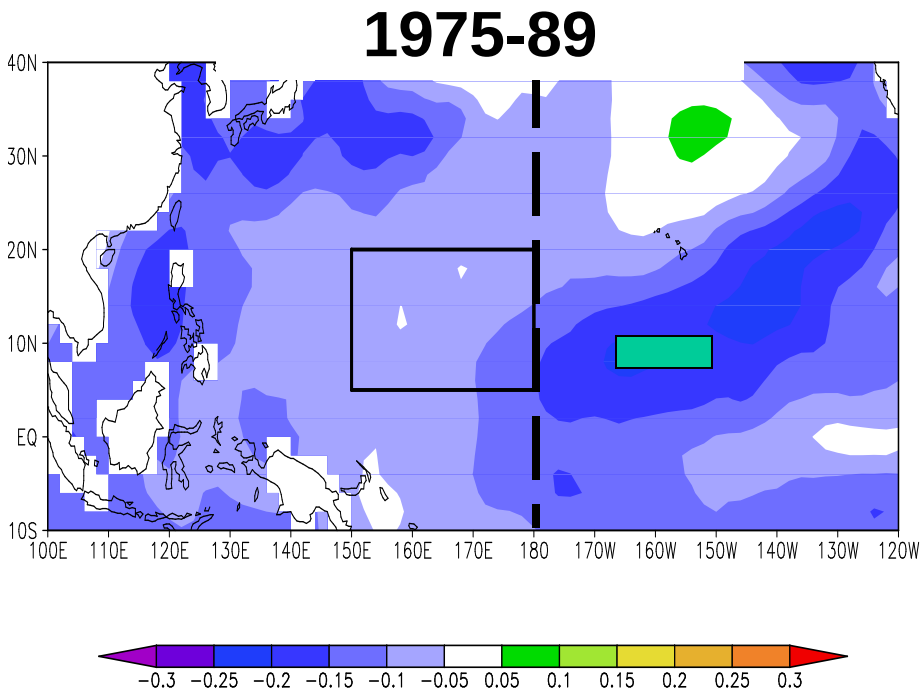

Sea-surface Temperature Anomalies

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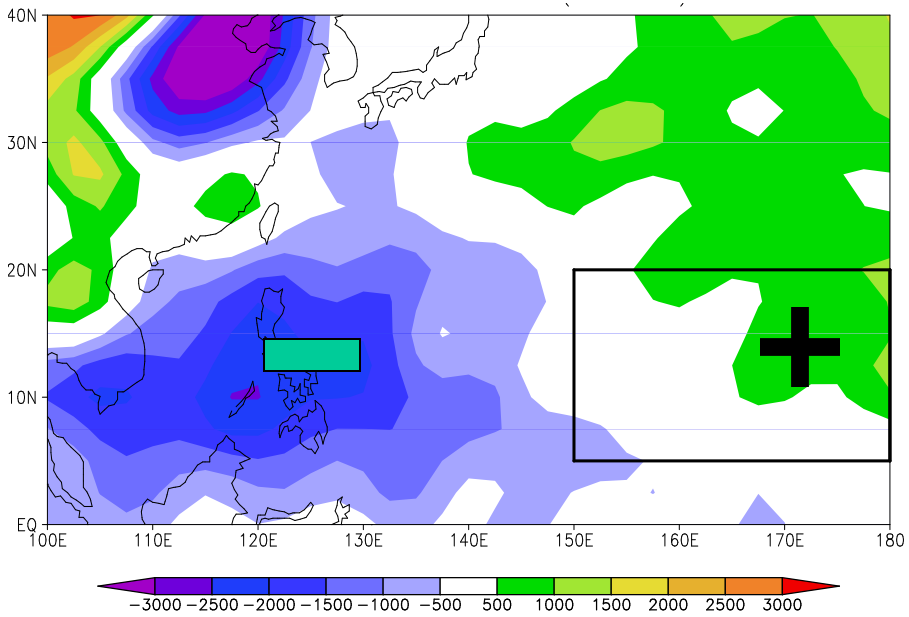
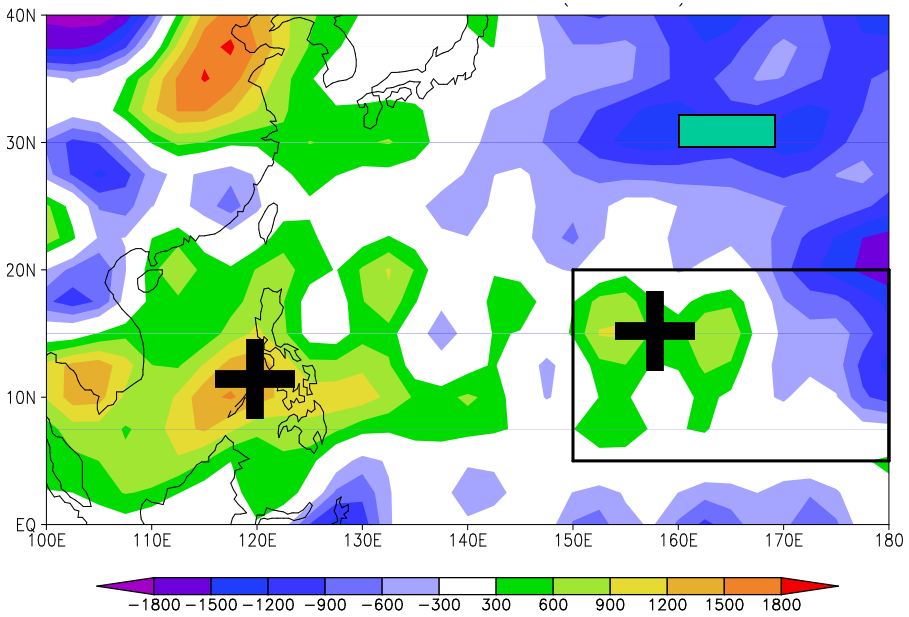
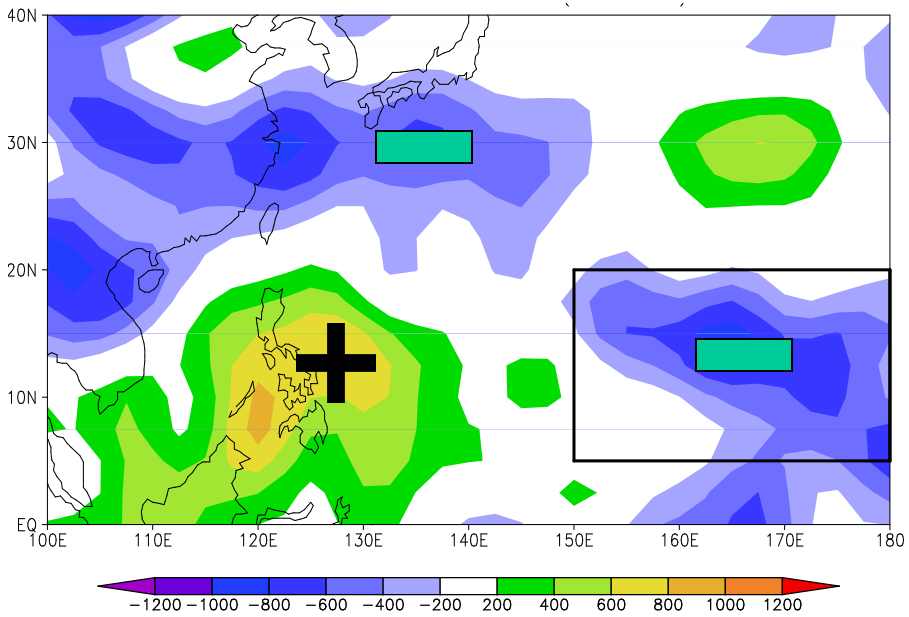
1960-74



1990-2004



1975-89



Potential for the Development of Heavy Convection

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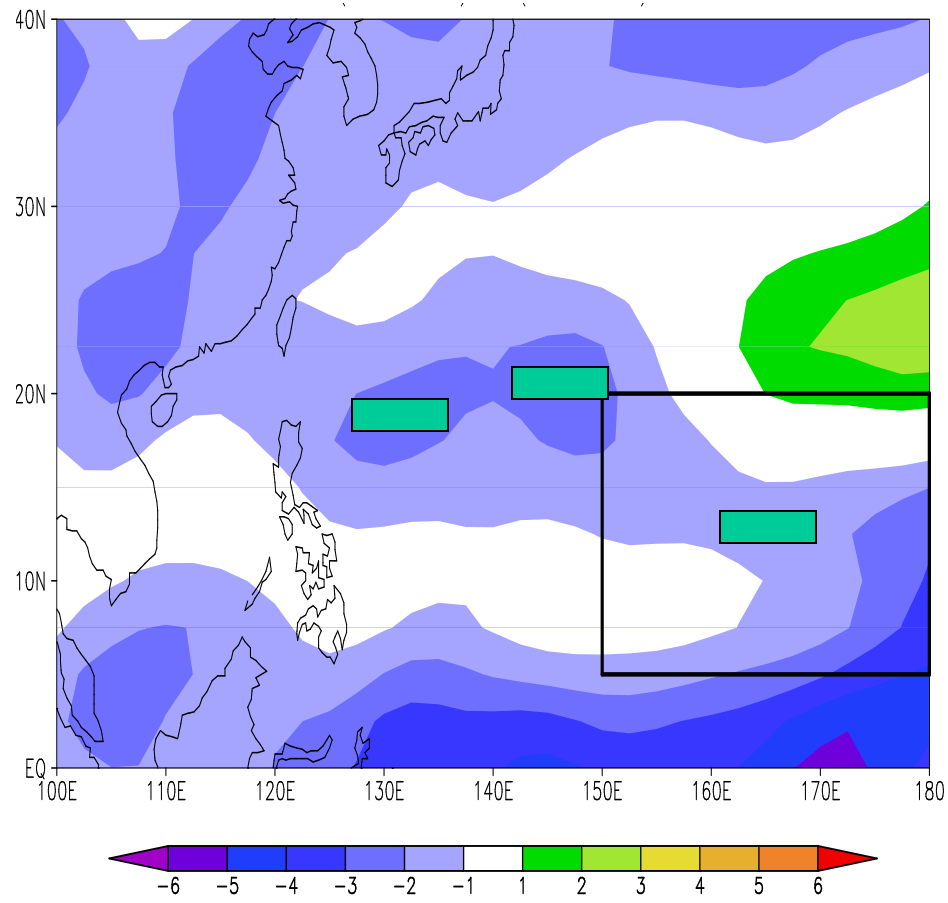
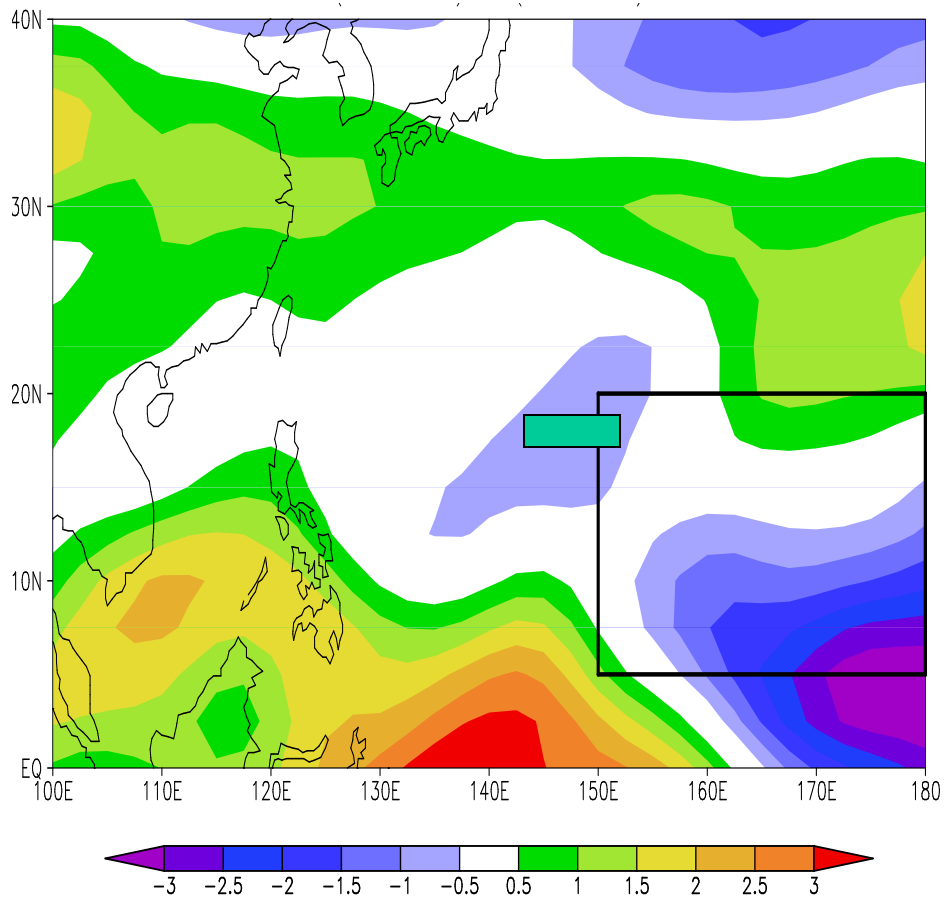
Vertical East-West Wind Shear

(1960-74) minus (1975-89)



(1990-04) minus (1975-89)



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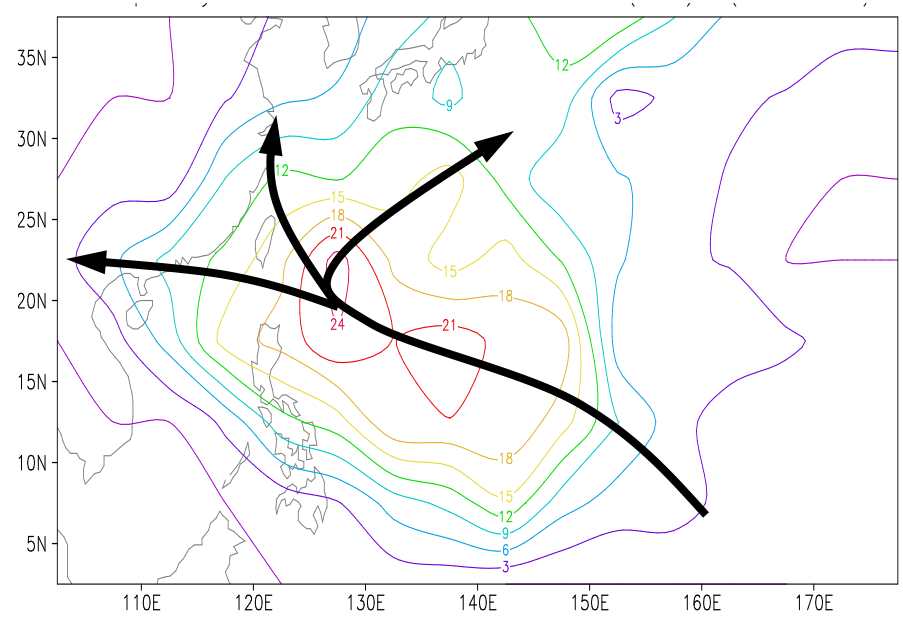
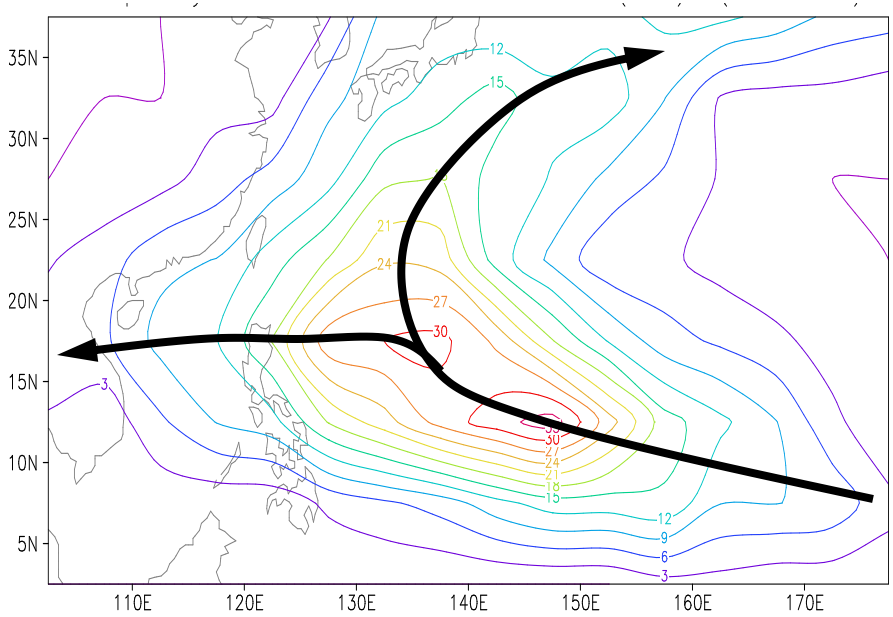
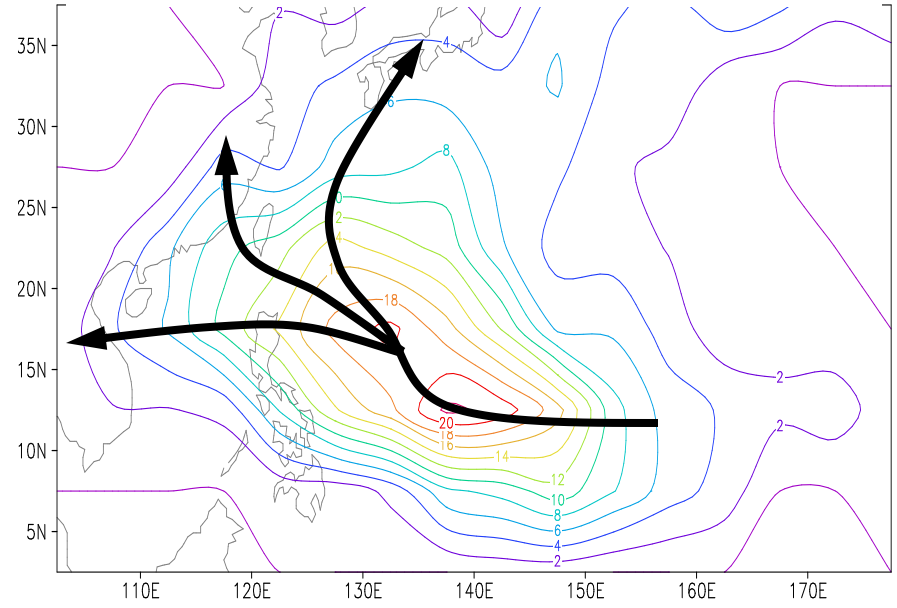
1960-74



1990-2004



1975-89



Frequency of Occurrence of Intense Typhoons

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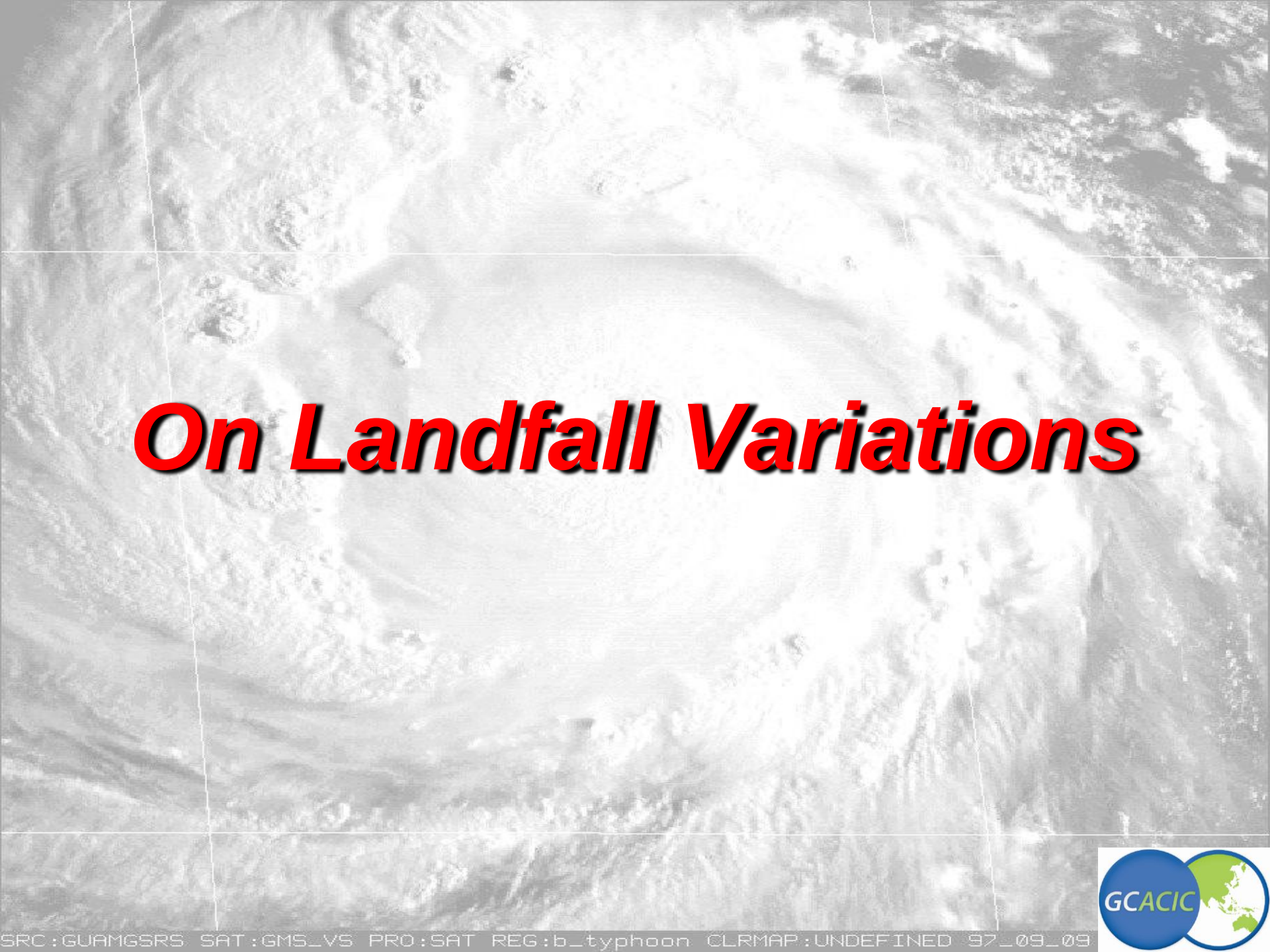
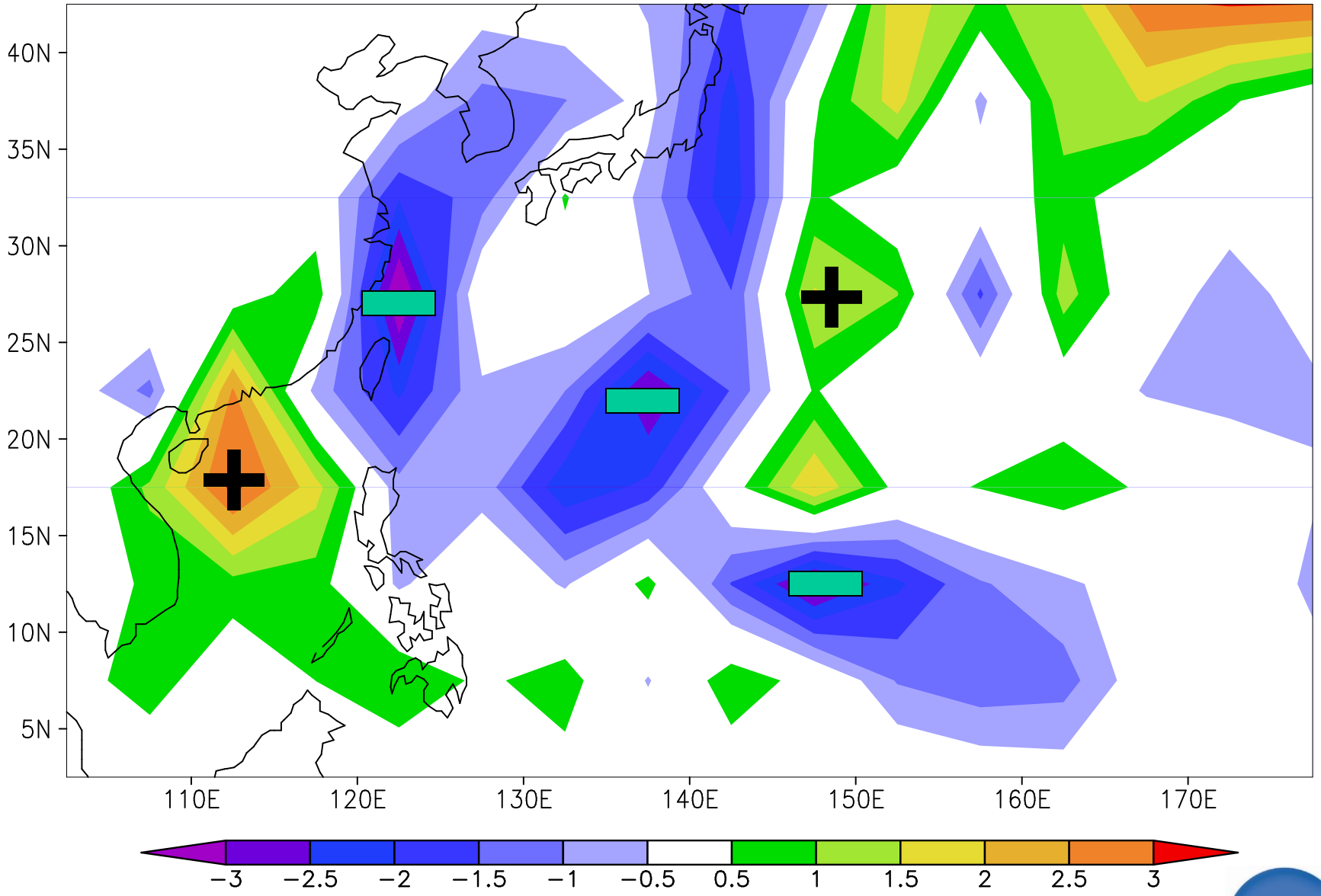
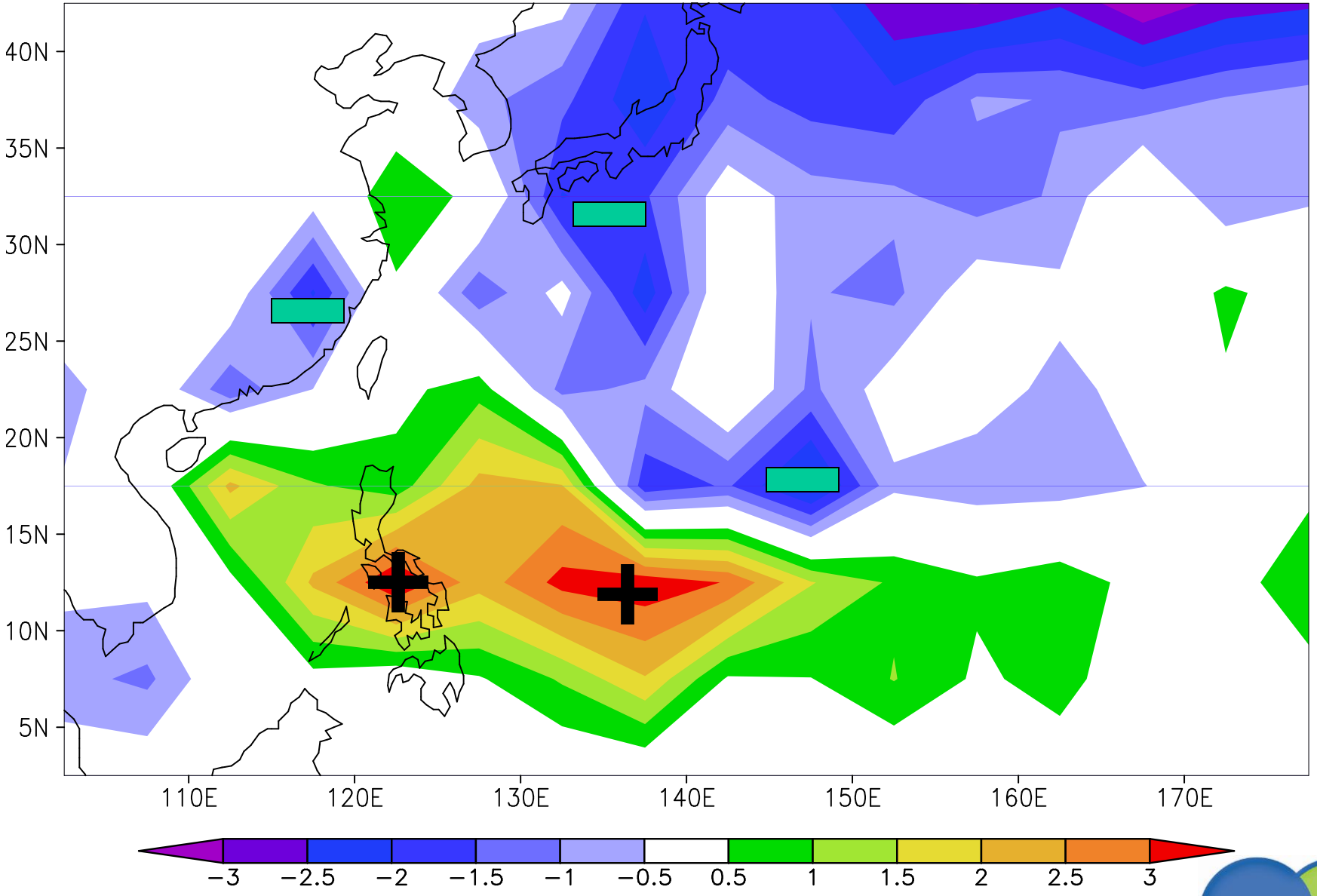
On Landfall Variations



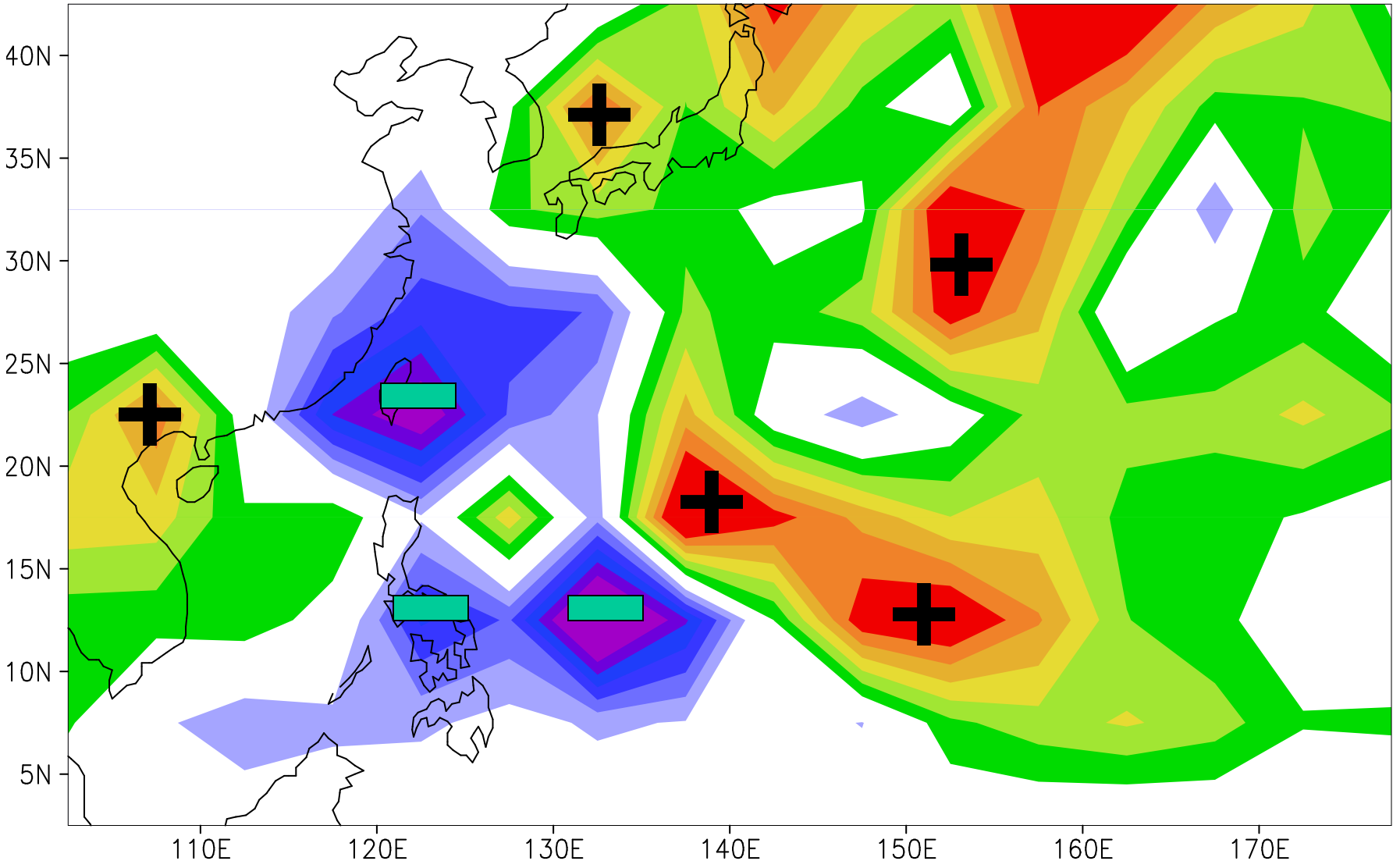
Anomalies of Tropical Cyclone Occurrence 1964-76



Anomalies of Tropical Cyclone Occurrence 1977-88



Anomalies of Tropical Cyclone Occurrence 1989-97



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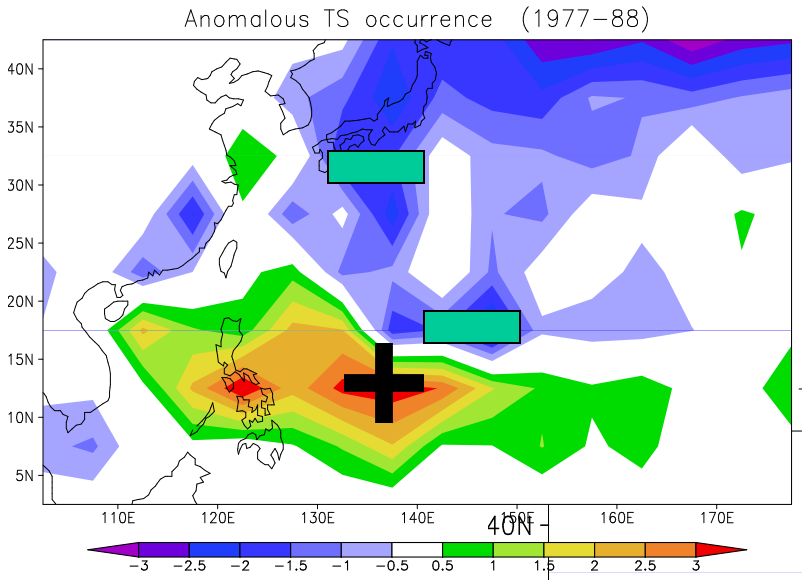
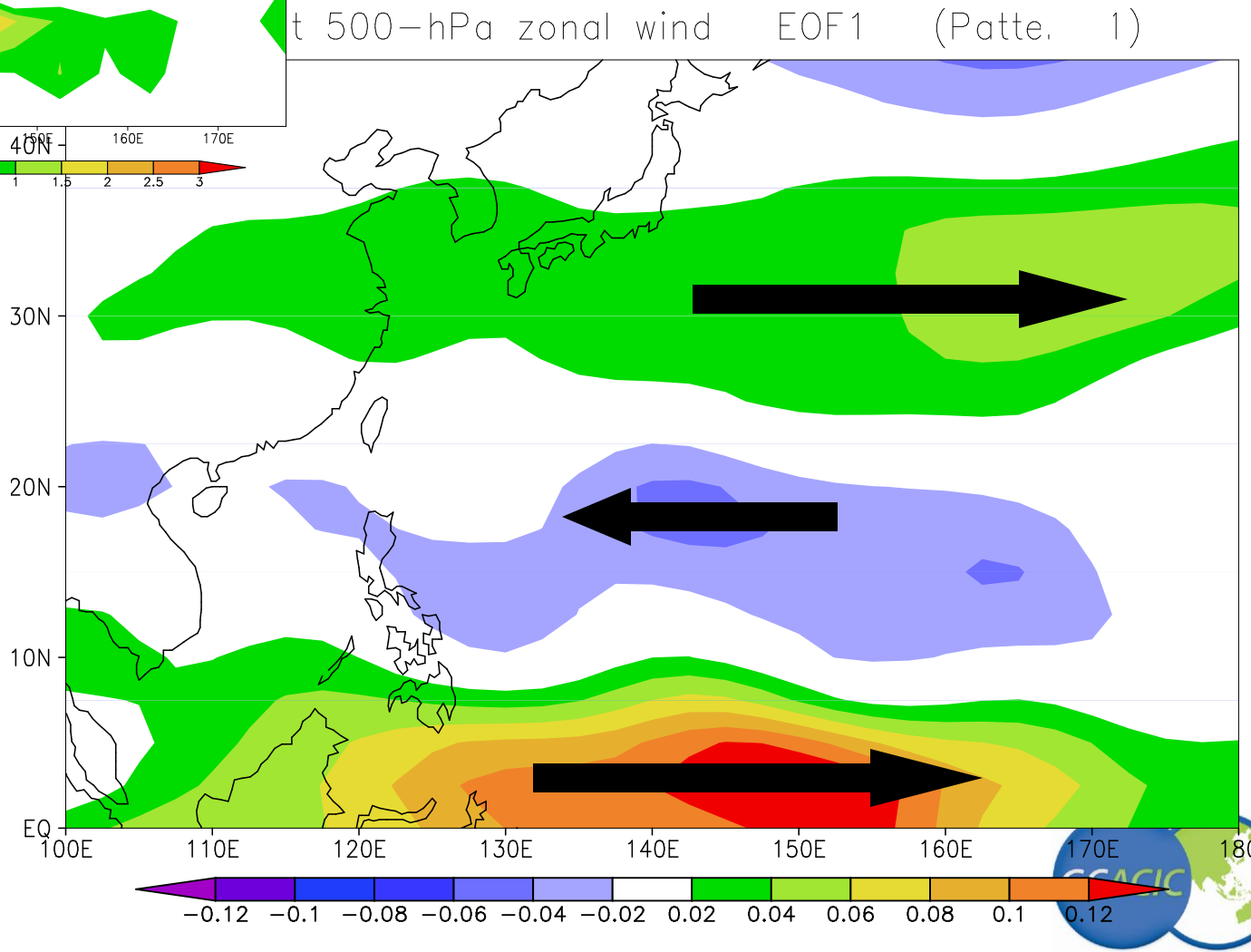
Atmospheric east-west flow pattern (1977-88)





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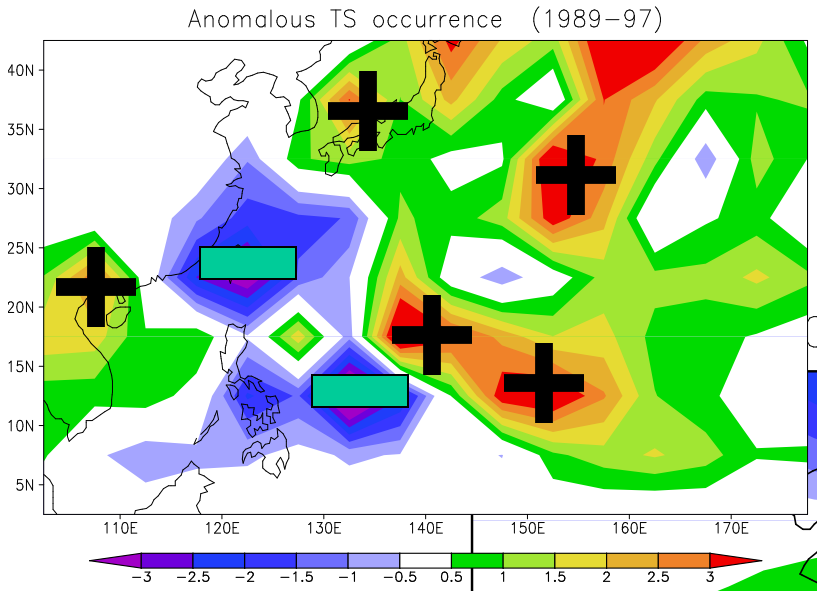
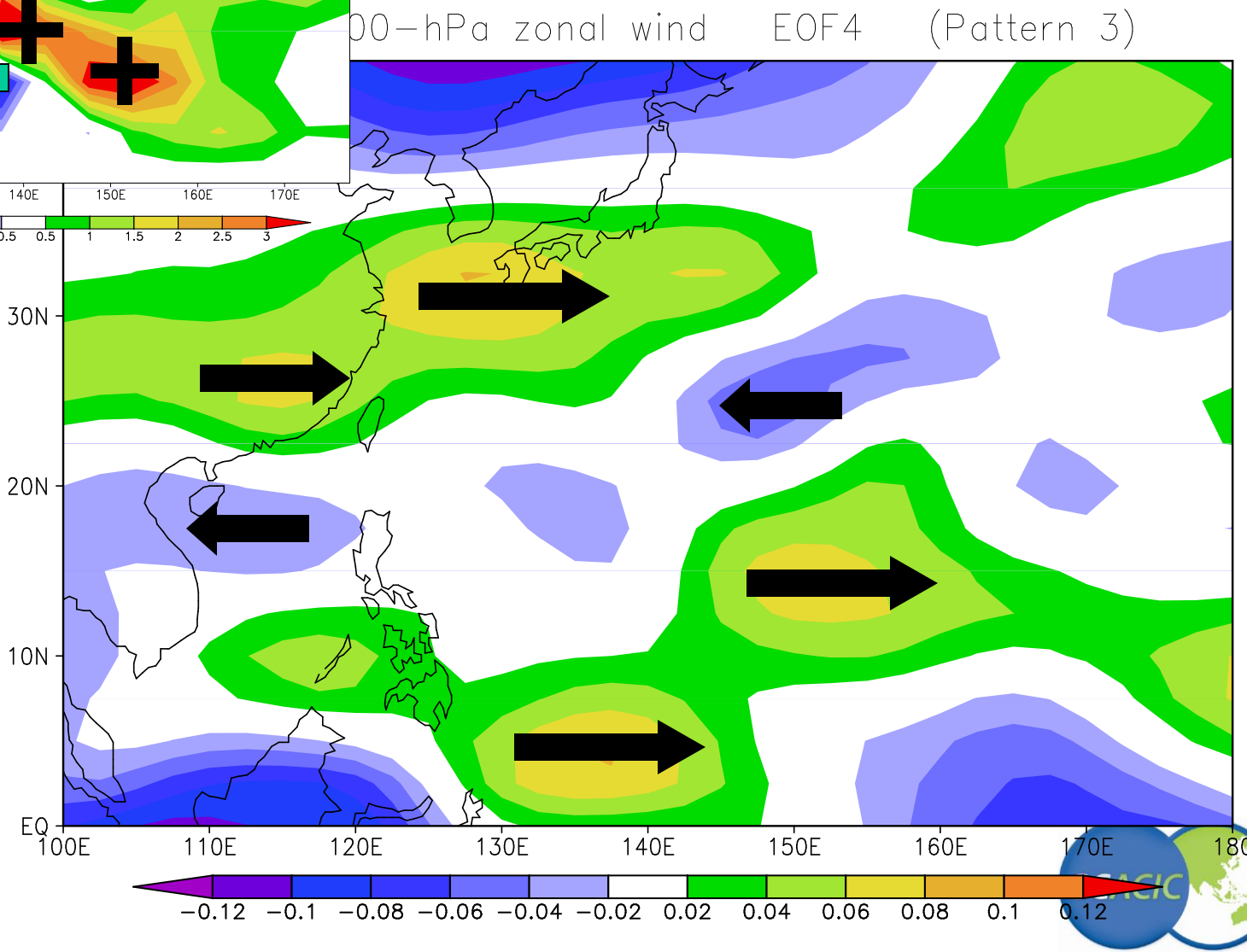




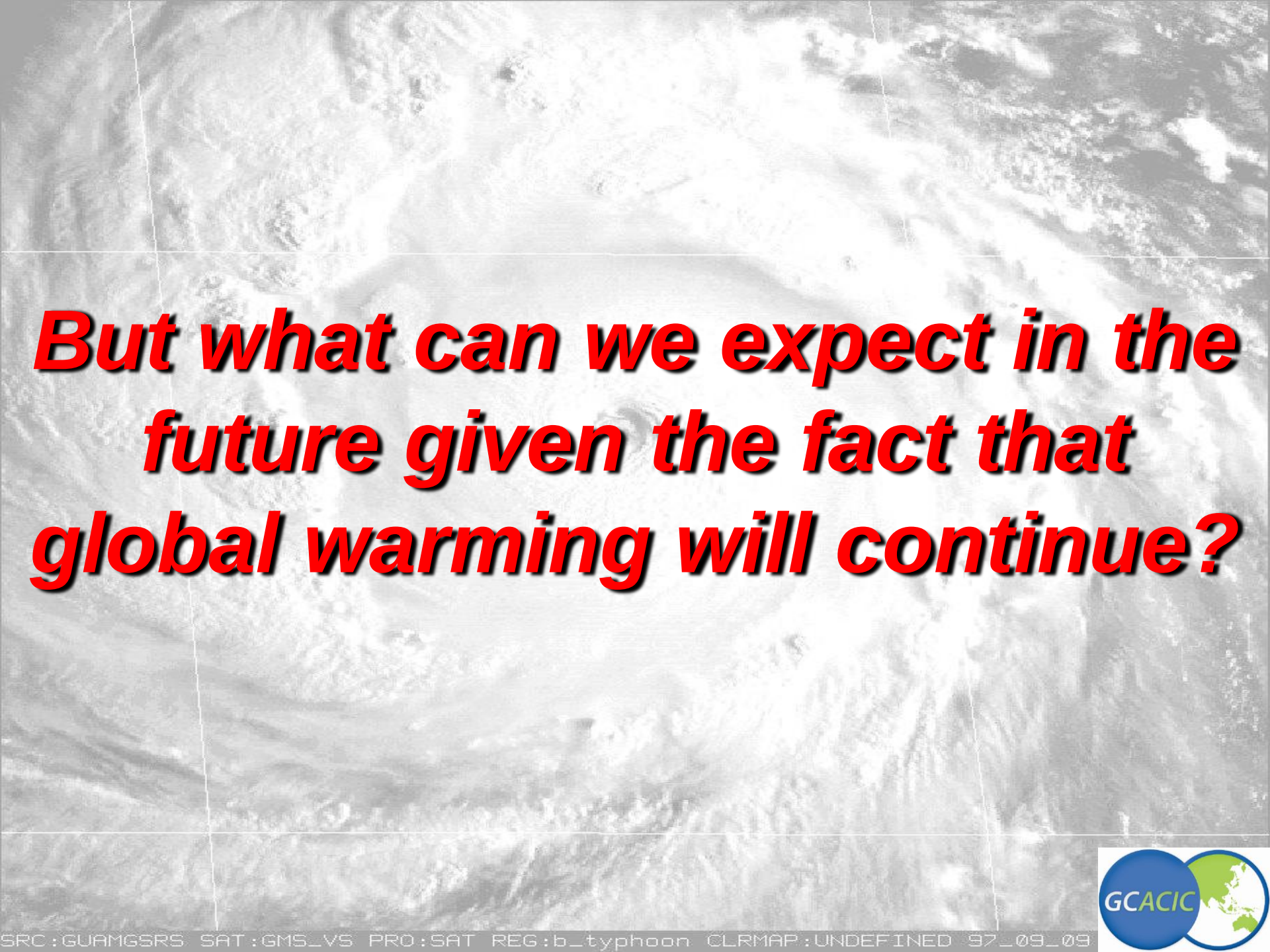
Summary

- Tropical cyclone activities (frequency, intensity and track) in the western North Pacific Ocean ***do not*** follow the trend of global warming.
- Instead, such activities oscillate with periods of one or more decades
- Such variations or oscillations are caused by similar variations in the atmosphere and/or the ocean

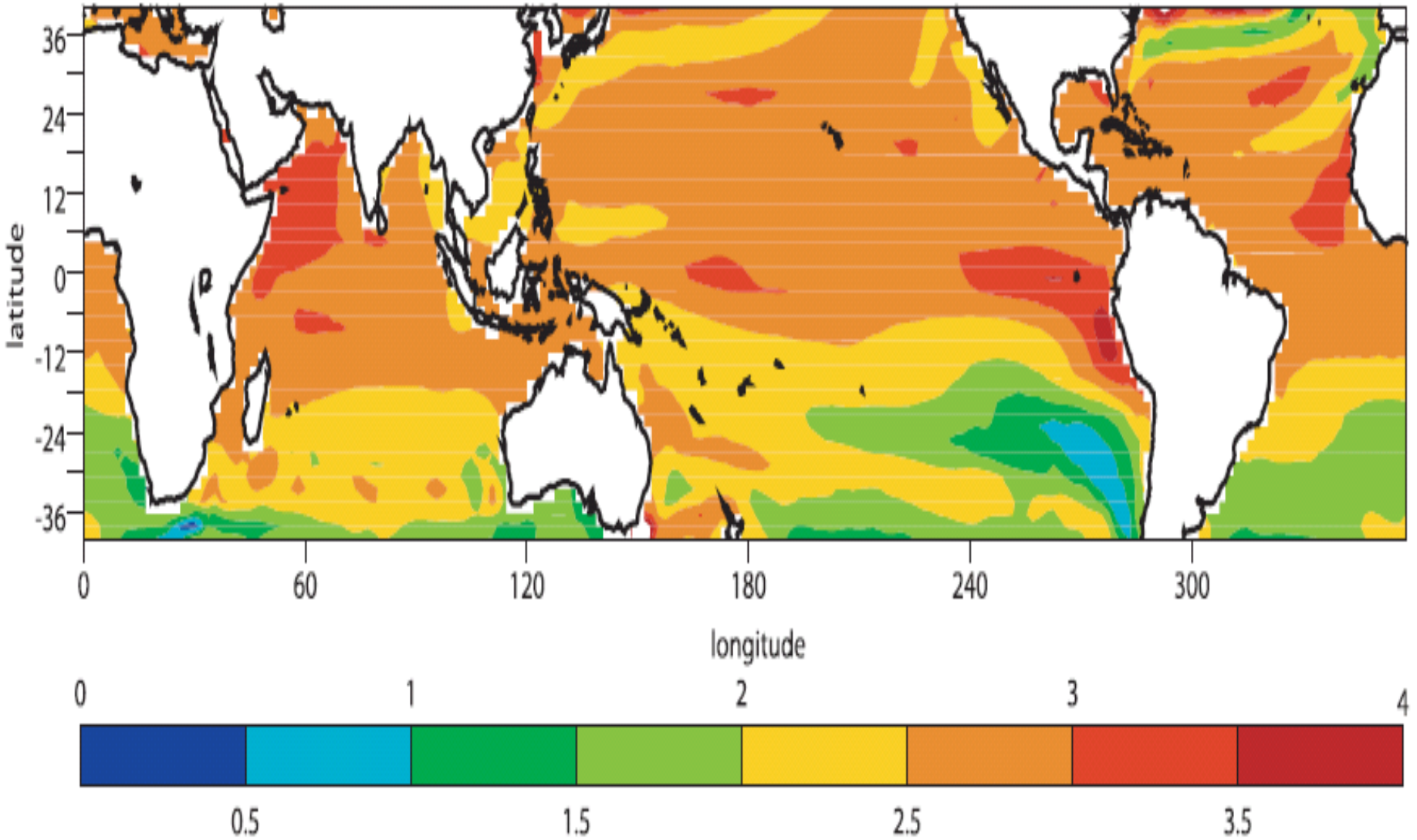
Summary

- Therefore, to cope with changes in tropical cyclone activity requires a thorough understanding of why such variations in the atmospheric and oceanographic conditions occur.
- Improved predictions of seasonal tropical cyclone activity will only come if we can predict such variations.

But what can we expect in the future given the fact that global warming will continue?



Averaged ocean temperatures (2071–2100) minus (1961–1990)



Ratio (%) of number of tropical storms in global warming experiment to number without global warming

Experiment	Blue/red: statistically-significant values								
	Global	NH	SH	Ocean basin					
				N Atl.	WN Pac.	NE Pac.	N Indian	S Indian	SW Pac.
10y 1xCO2, 2xCO2	66	72	61	161	34	33	109	43	69
10y 1xCO2 2xCO2 from 115y CO2 1% pa	102			86	111	91	116	124	99
15y IS95a 2082-2097	94	97	90	75	70	180	142	110	82
10y A1B 2080-2099	70	72	68	134	62	66	48	72	57
2071-2100, A1B		92		92	80	104	74		
2071-2100, A1B		90		87	72	93	49		
A1B, 2180-2200			86	102	106	95	92		

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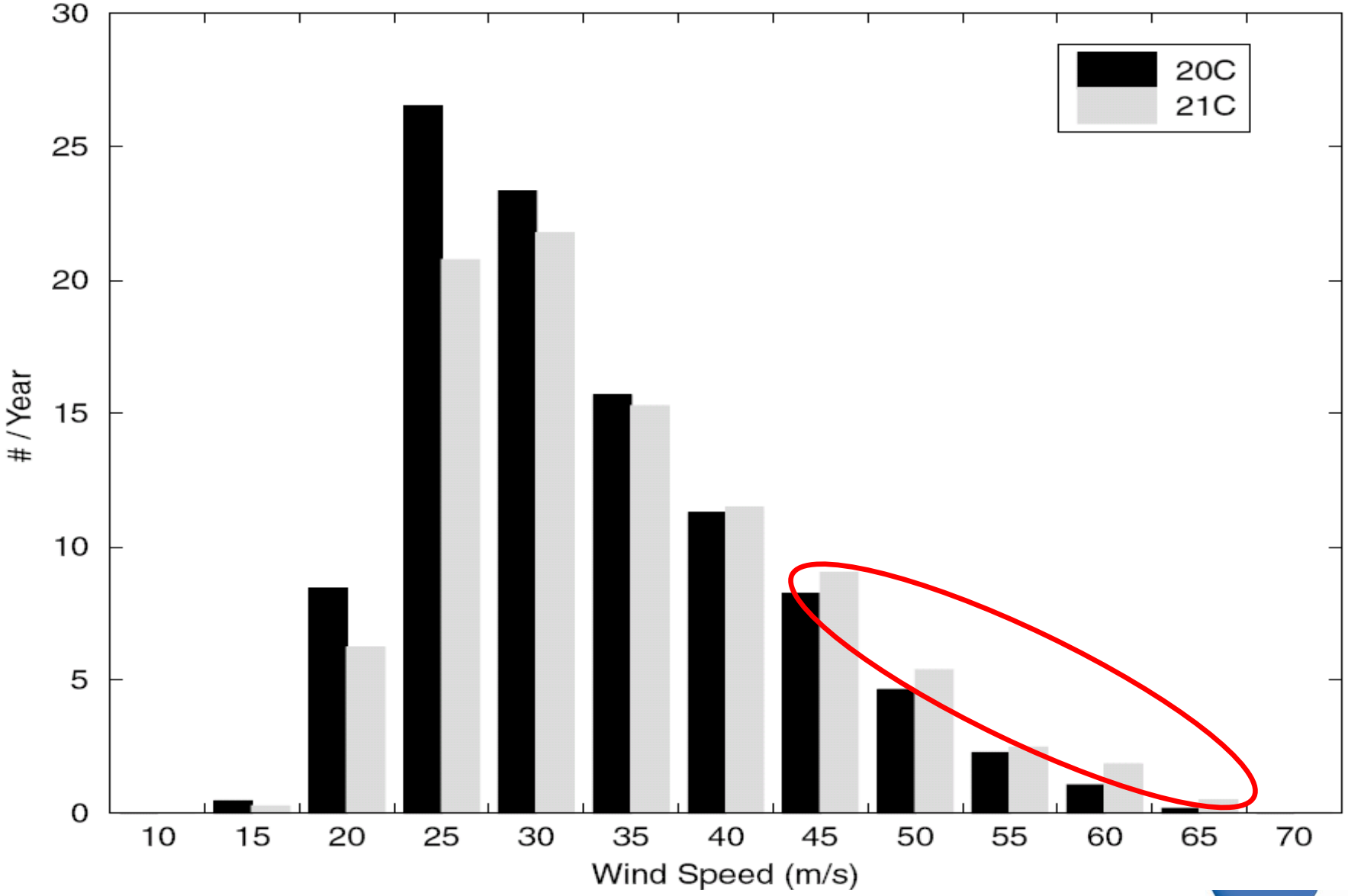
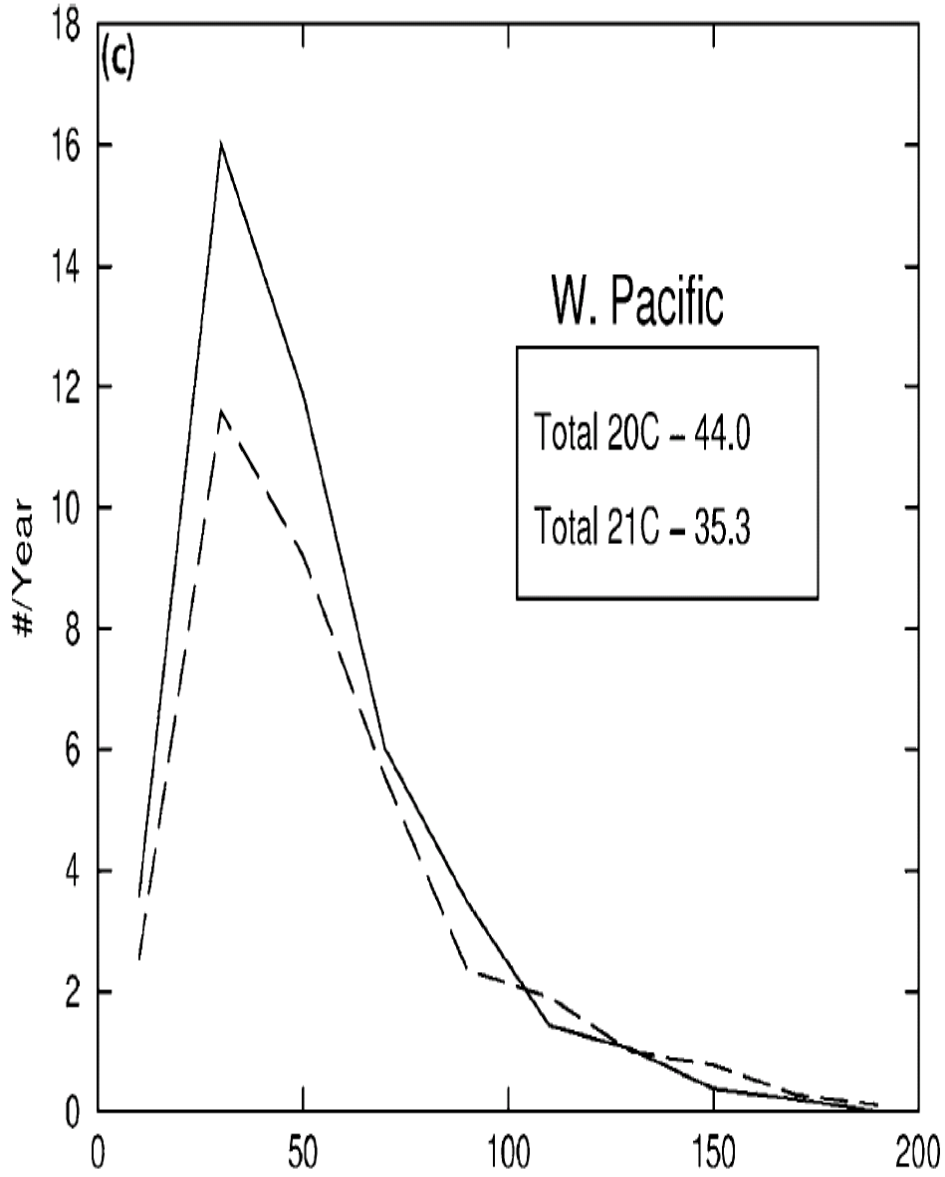
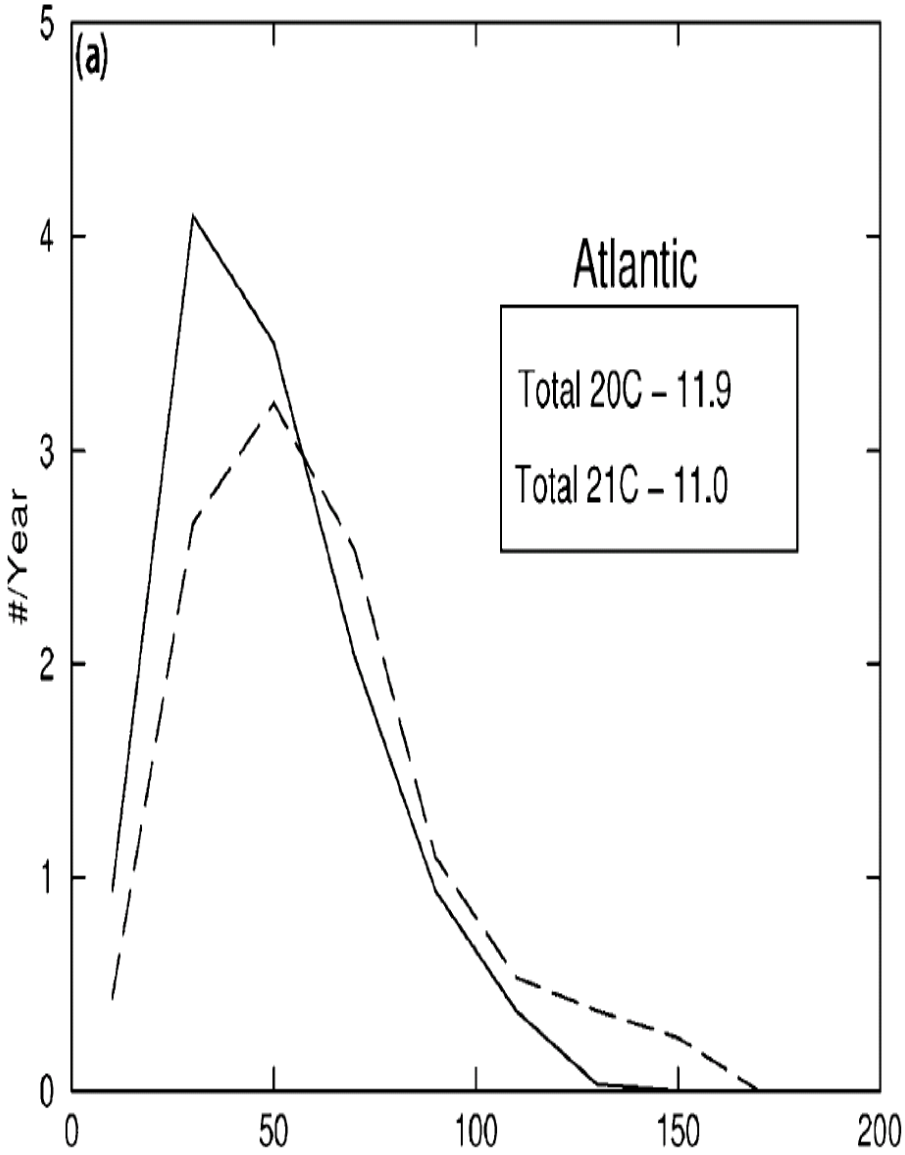
Distribution of Maximum Wind Speeds for 20th and 21st Century Simulations (Northern Hemisphere)



Distribution of Maximum Rotation for 20th and 21st Century Simulations





Summary

- Total tropical cyclone activity is likely to ***decrease*** under a global warming scenario.
- Number of intense tropical cyclones could increase ***but*** the percent will likely be small (at most a few %)
- Variation in tropical cyclone activity will still be largely driven by those in the atmosphere and/or ocean on annual to decadal time scales.