Interannual & Interdecadal Variations of the Frequency of Landfalling Typhoons

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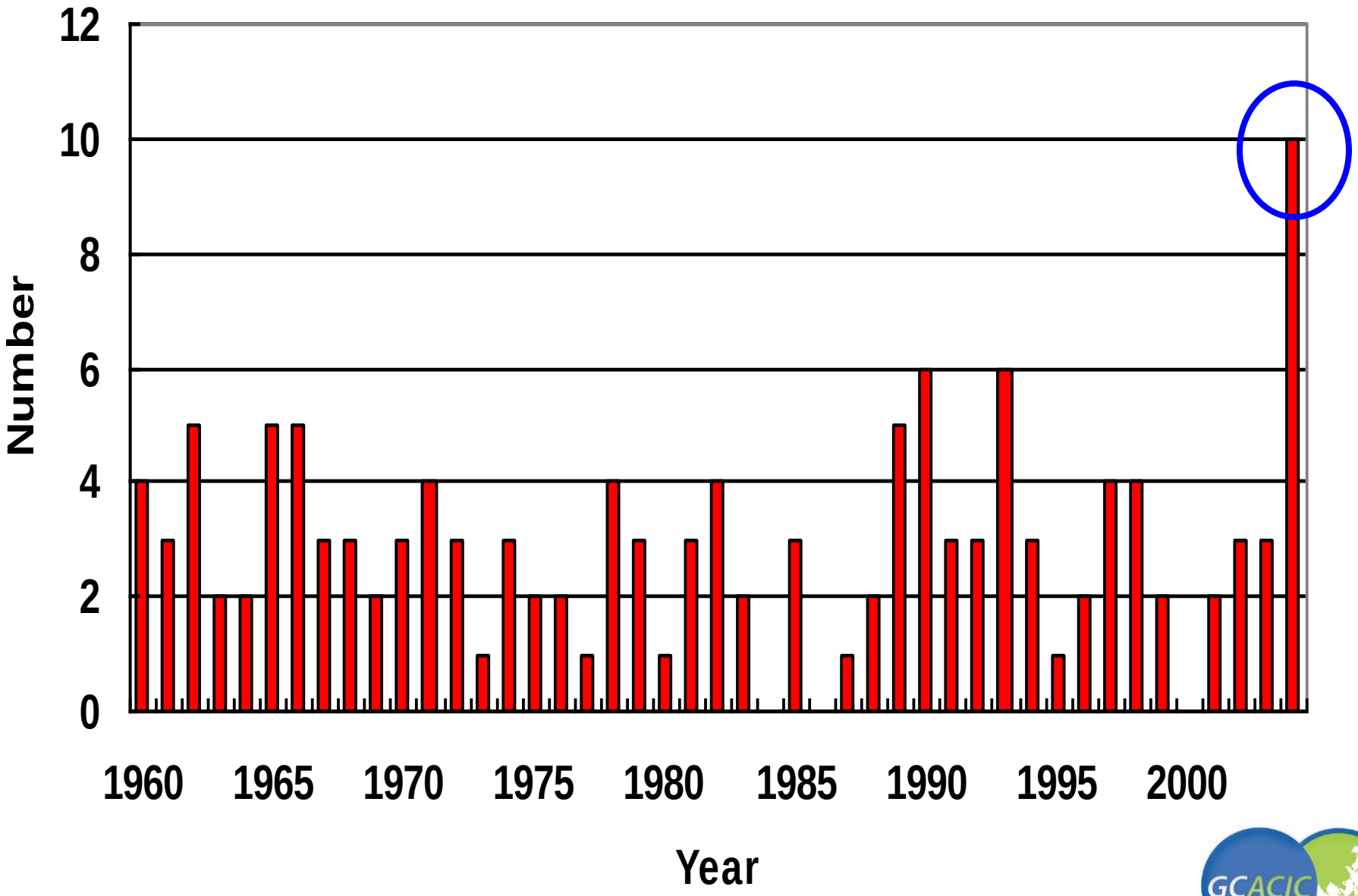
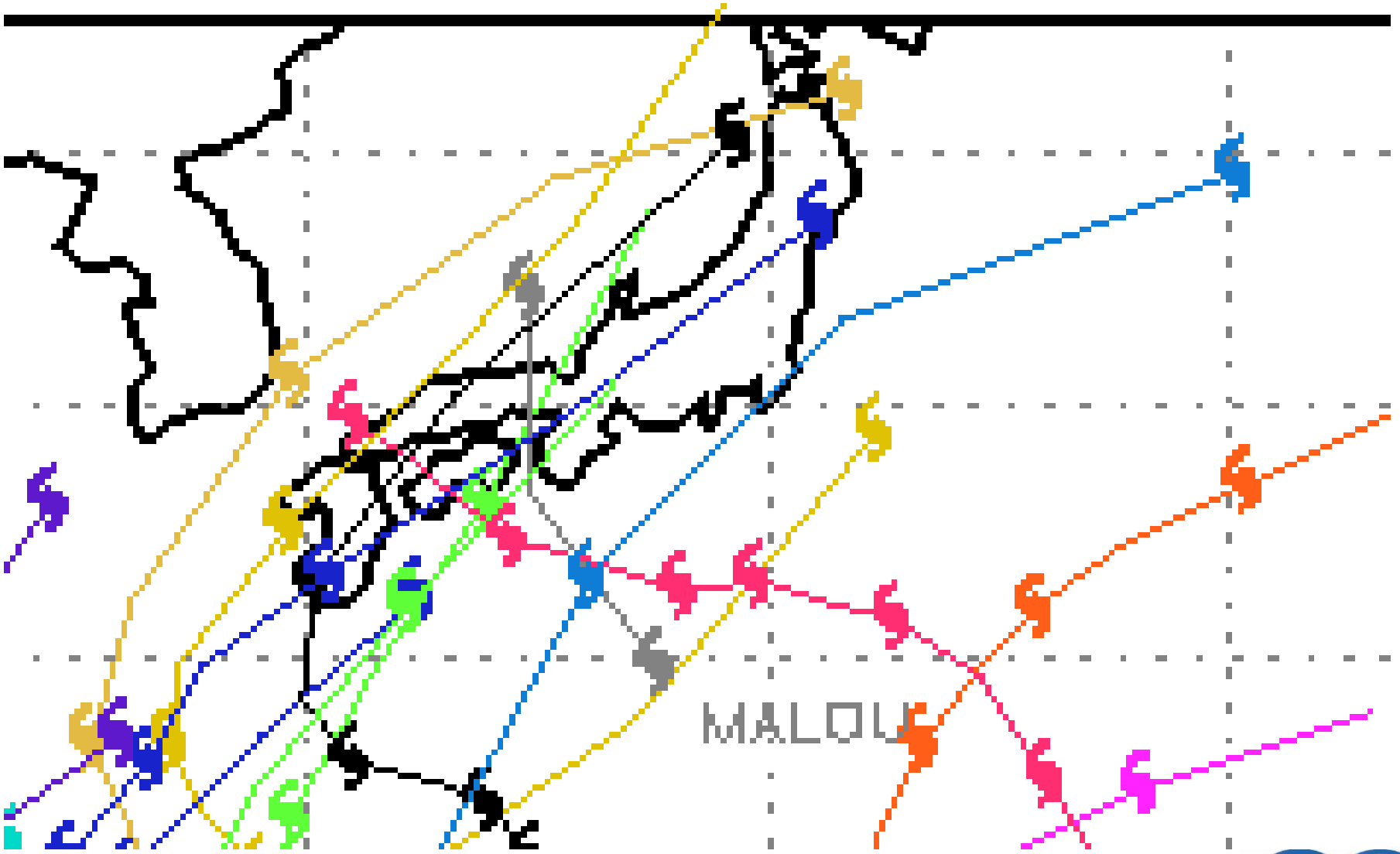
Outline

- Motivation
- Grouping of landfalling TCs
- Interannual and interdecadal variations in each group
- Possible reasons for such variations

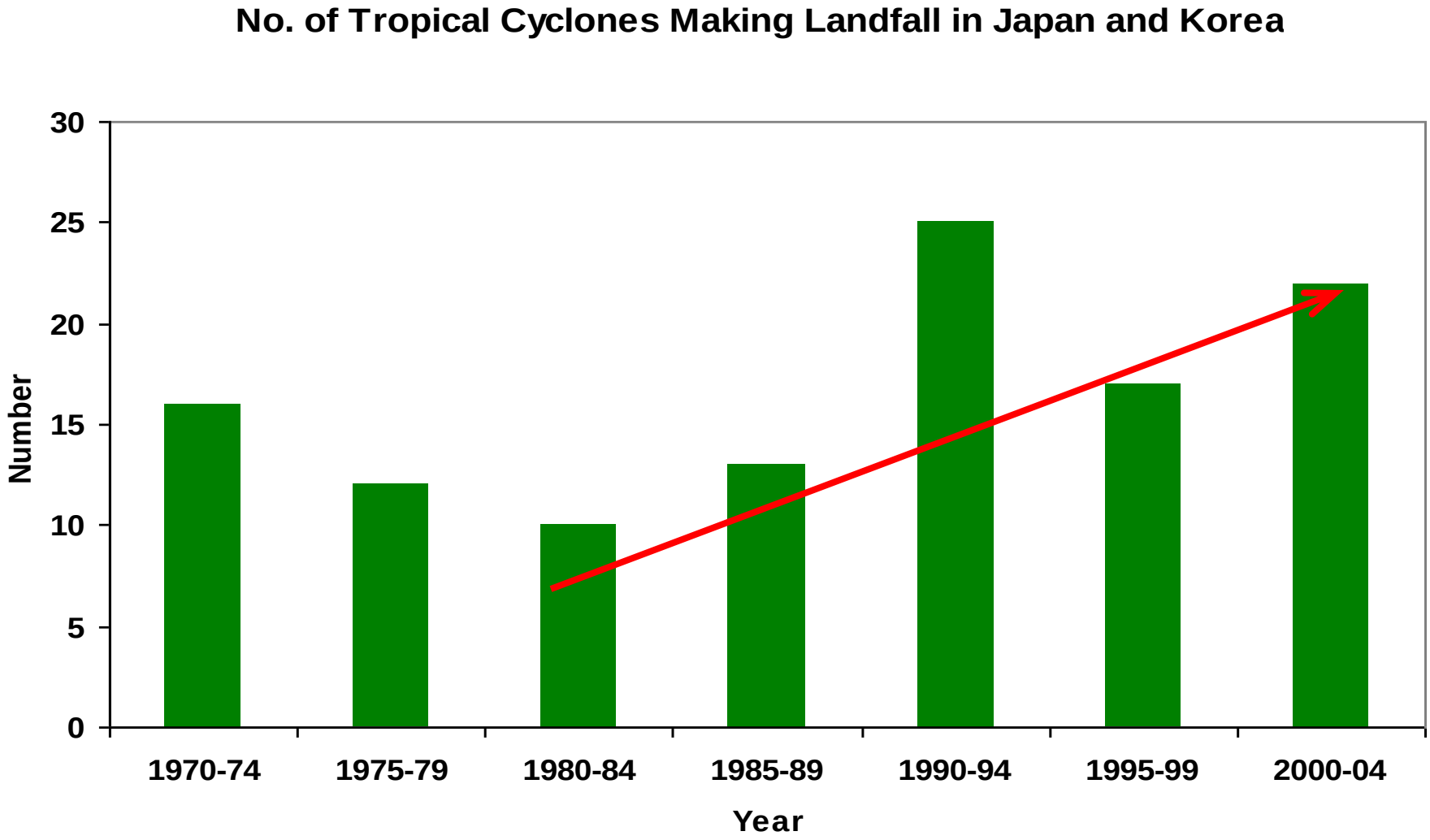
Number of Tropical Cyclones Making Landfall in Japan



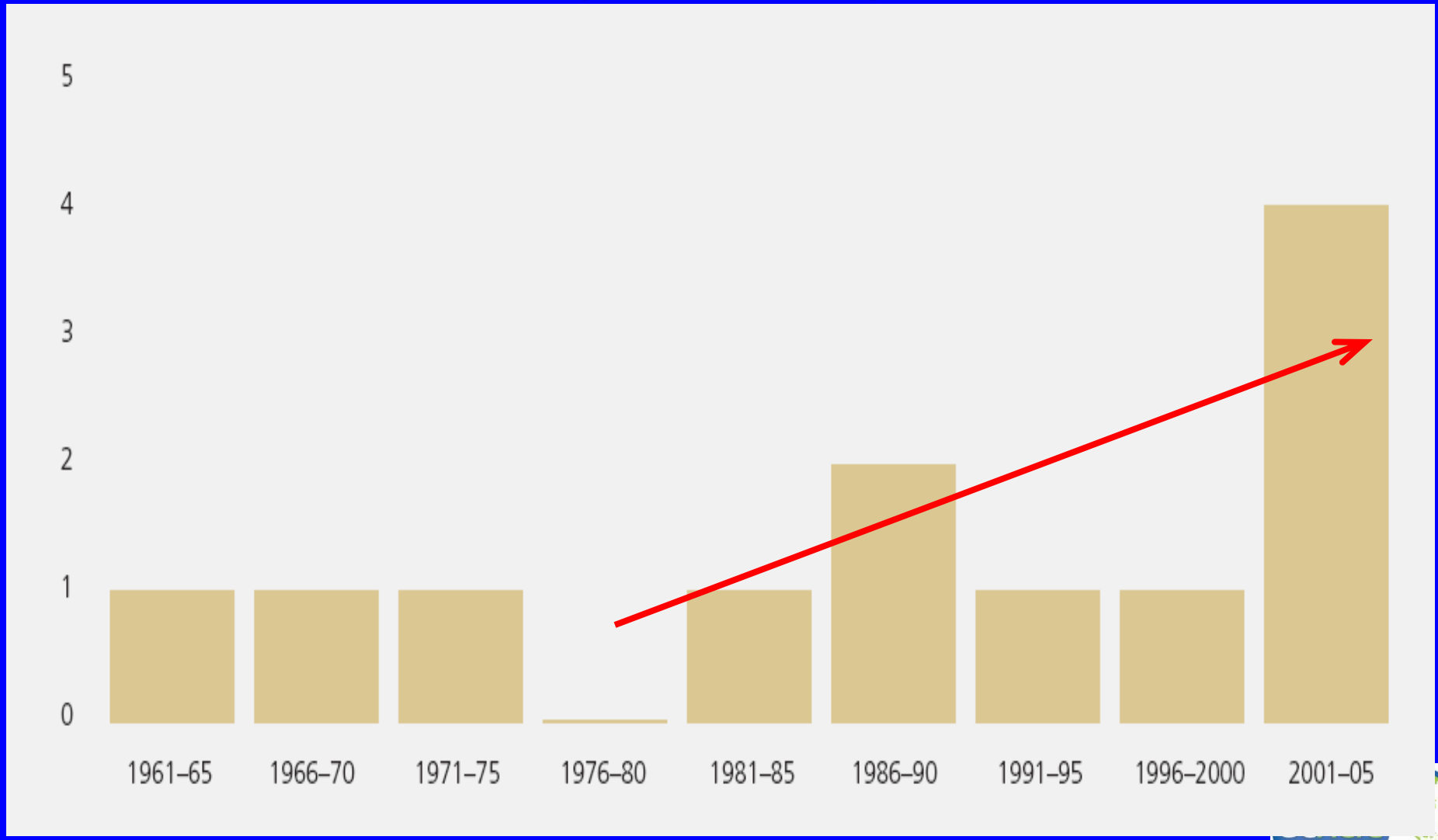
Tropical Cyclones Affecting Japan in 2004



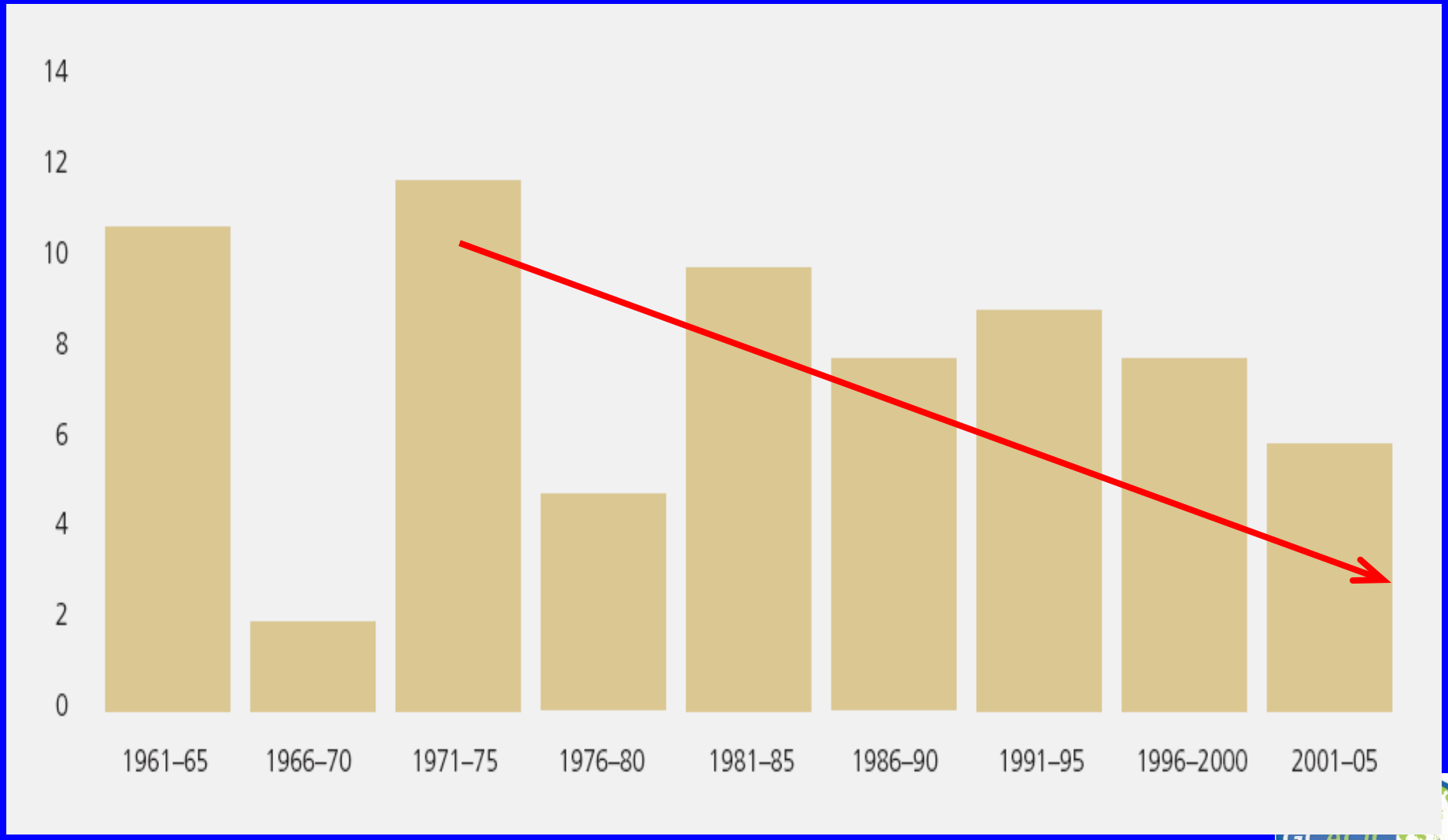
Number of Tropical Cyclones Making Landfall in Japan and Korea Every 5-year period (1970-2004)



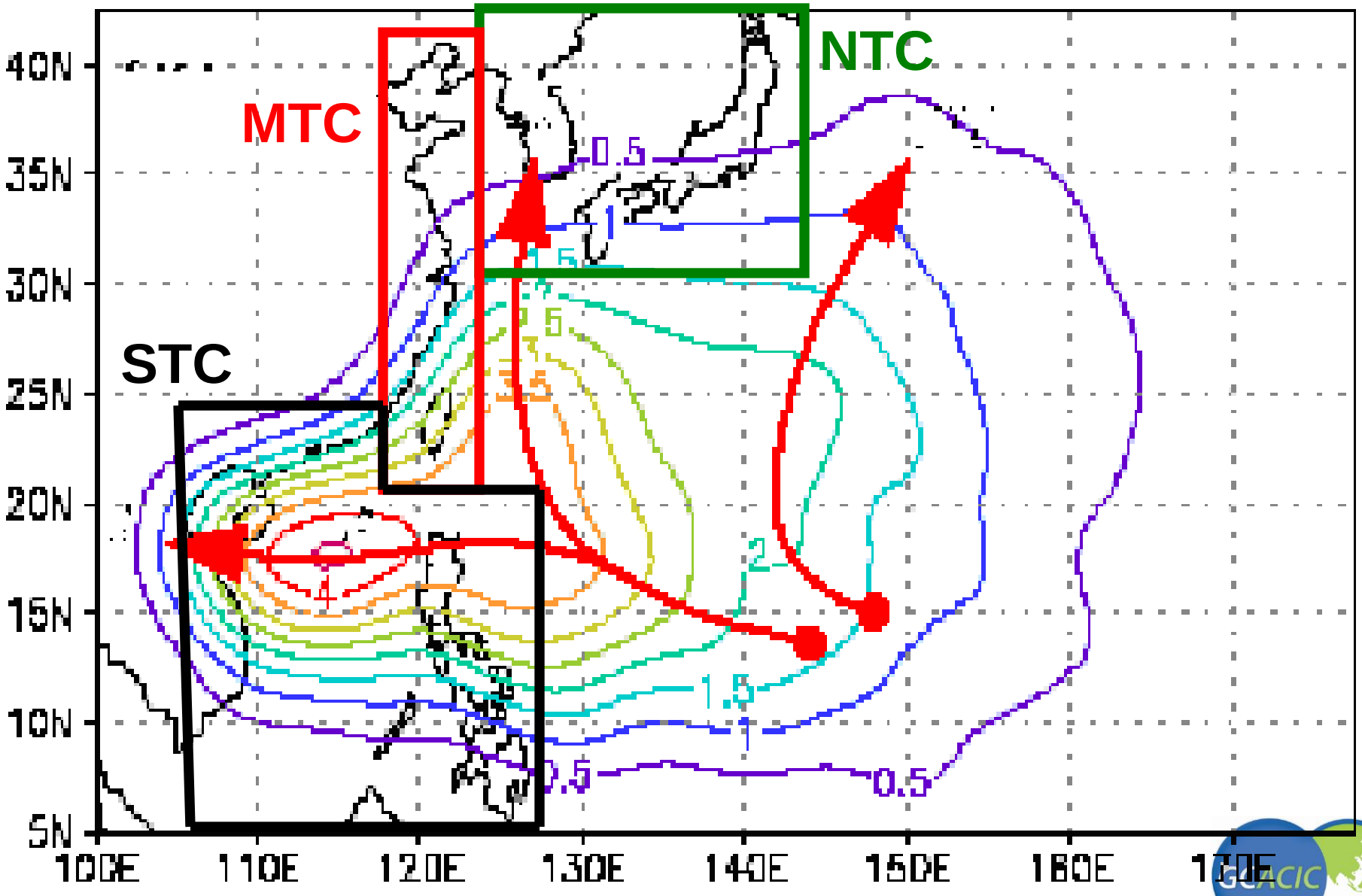
Number of Typhoons Making Landfall in Zhejiang Province of China (East China) Every 5-year period (1960-2005)



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



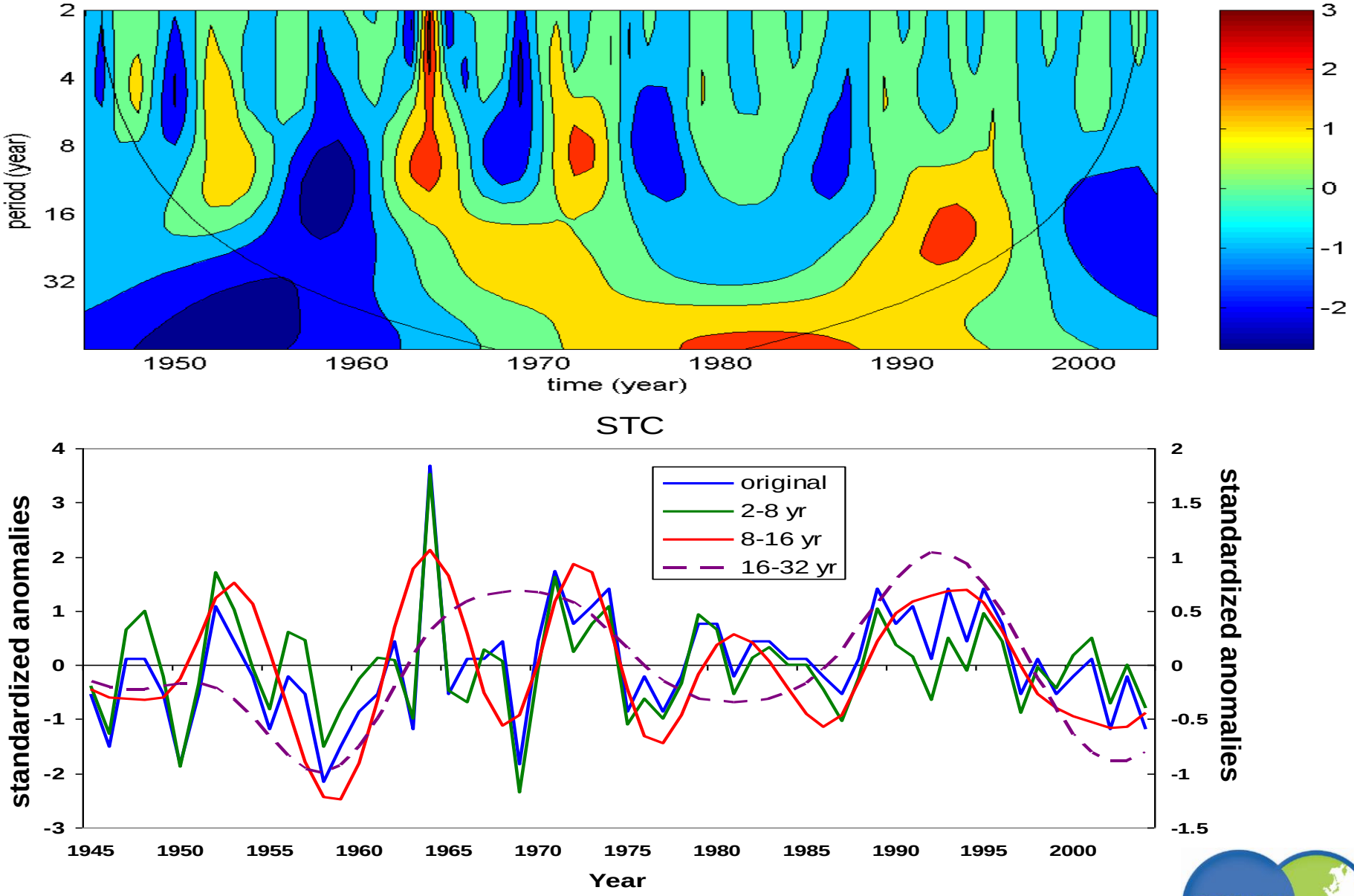
Frequency of Tropical Cyclone Occurrence



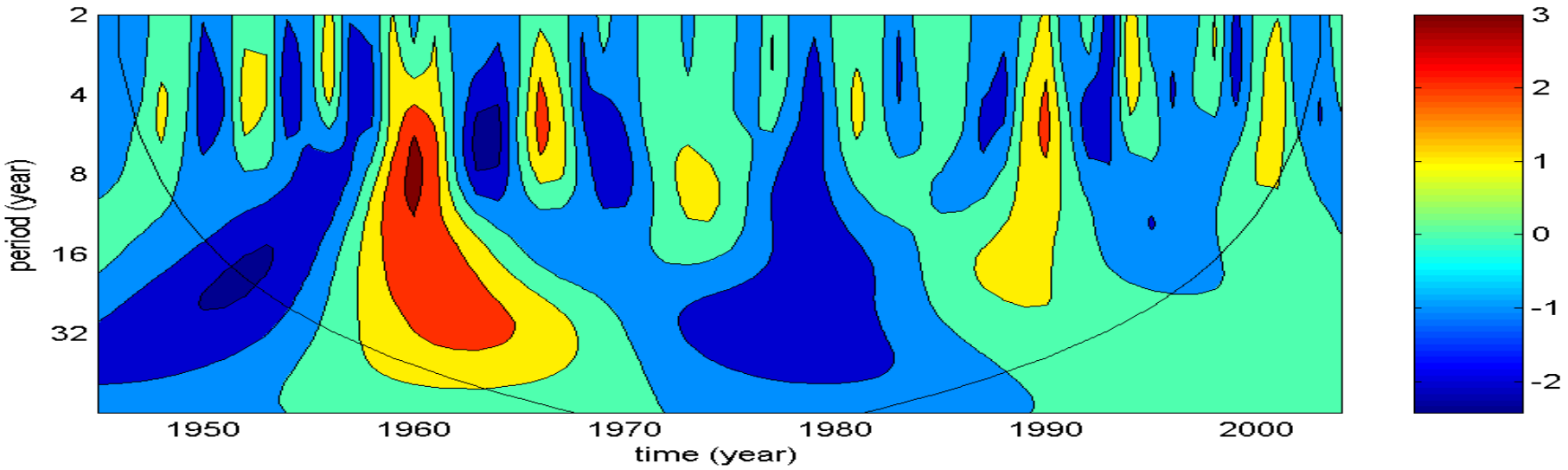
Landfall Groupings [all tropical cyclones (TCs) with maximum winds at landfall > 17 m s^{-1}]

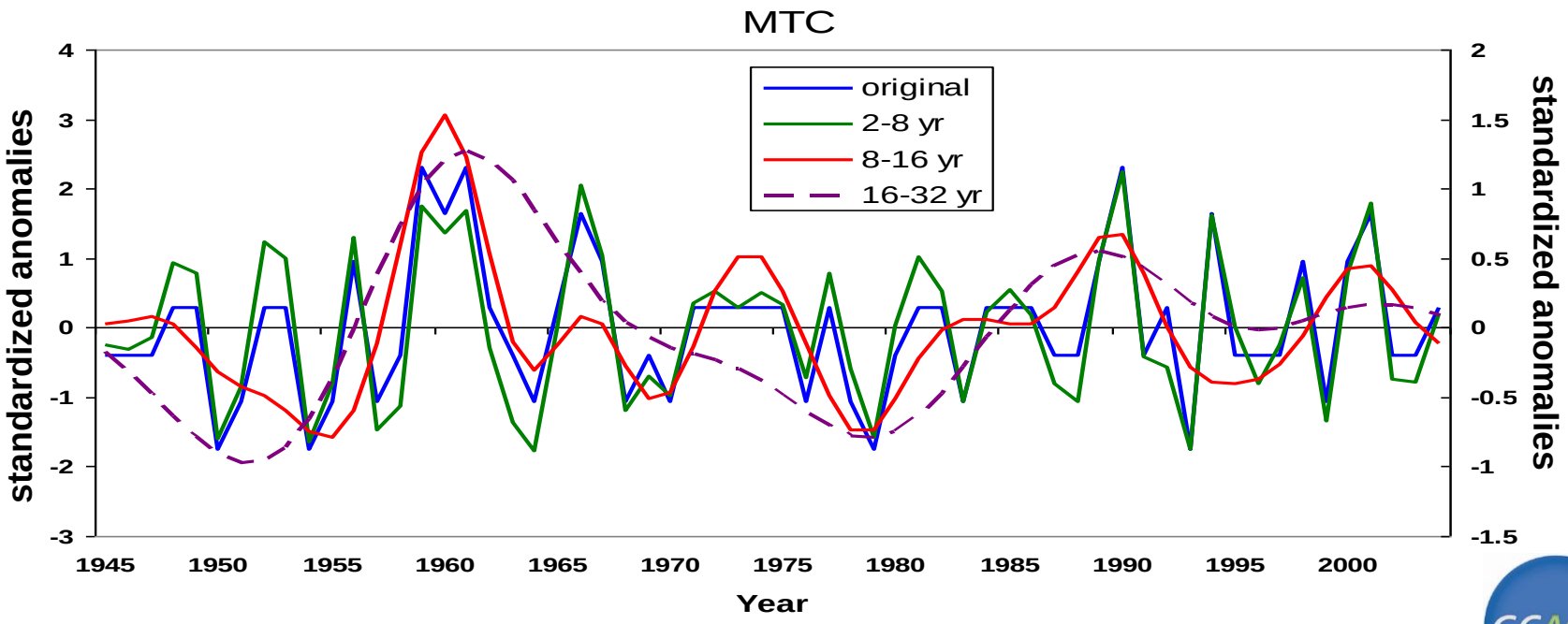
south Asia TCs (STC)	TCs making landfall in south China, Vietnam and the Philippines
middle Asia TCs (MTC)	TCs making landfall in East China (Taiwan, Fujian, Zhejiang and Jiangsu provinces, and City of Shanghai)
north Asia TCs (NTC)	TCs making landfall in the Korean Peninsula and Japan
Asian TCs (ATC)	All TCs making landfall anywhere in East Asia

Wavelet Analysis of STC Occurrence Frequency

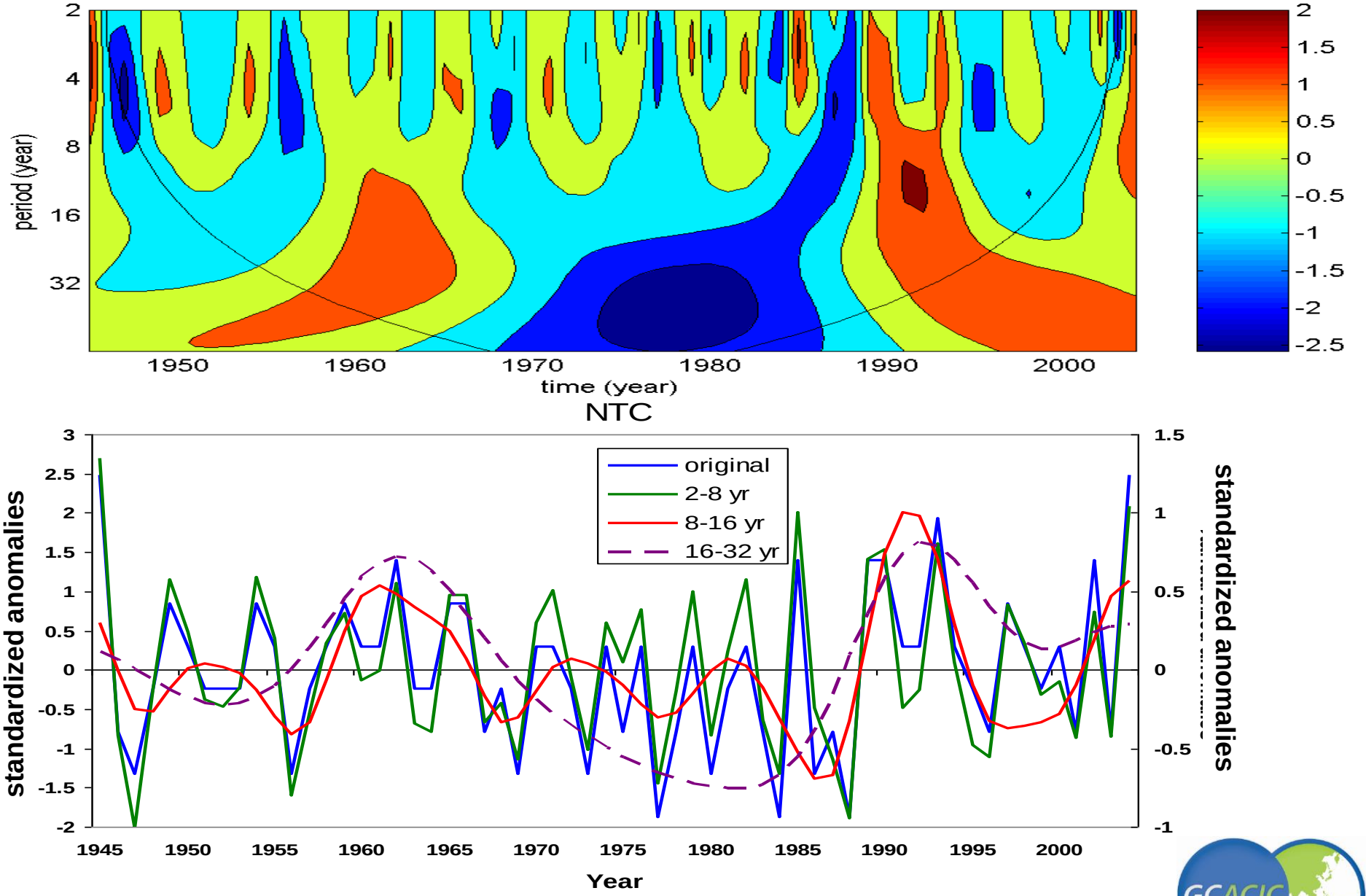


Wavelet Analysis of MTC Occurrence Frequency

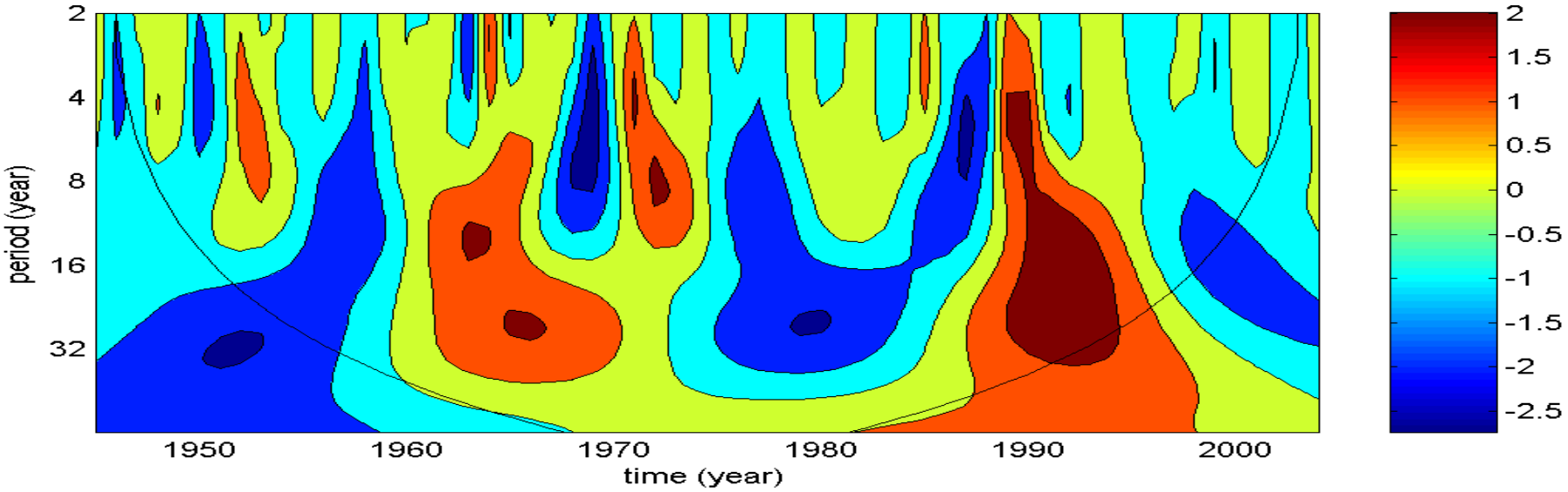


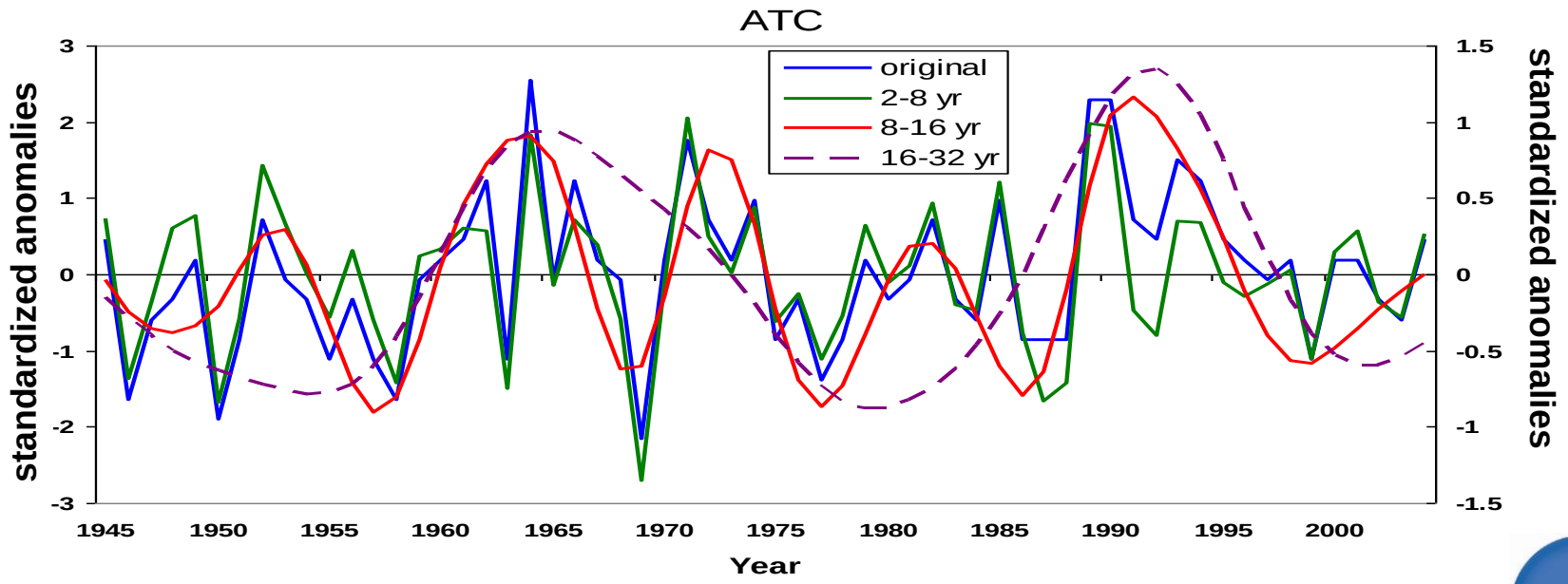


Wavelet Analysis of NTC Occurrence Frequency

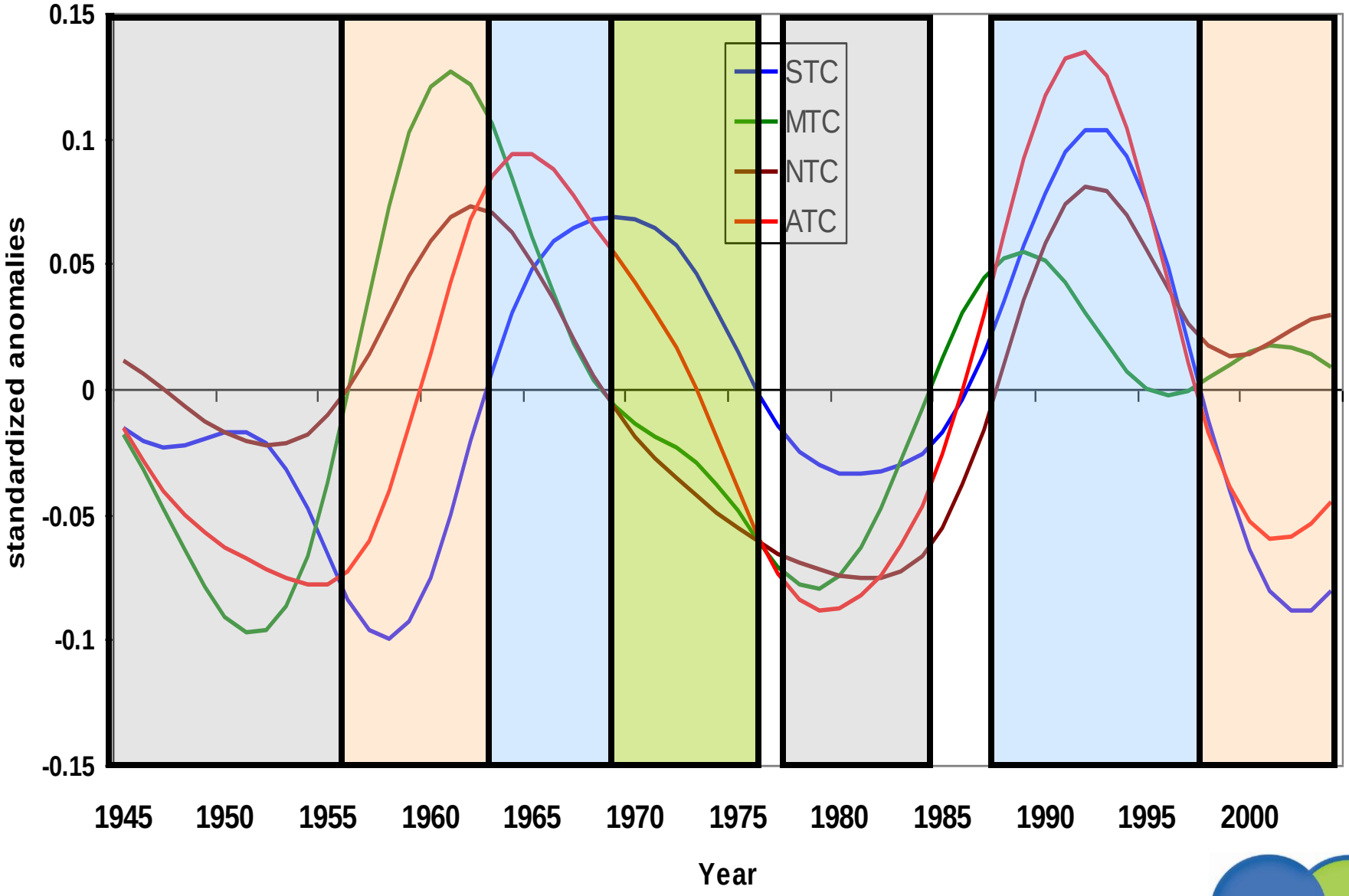


Wavelet Analysis of ATC Occurrence Frequency

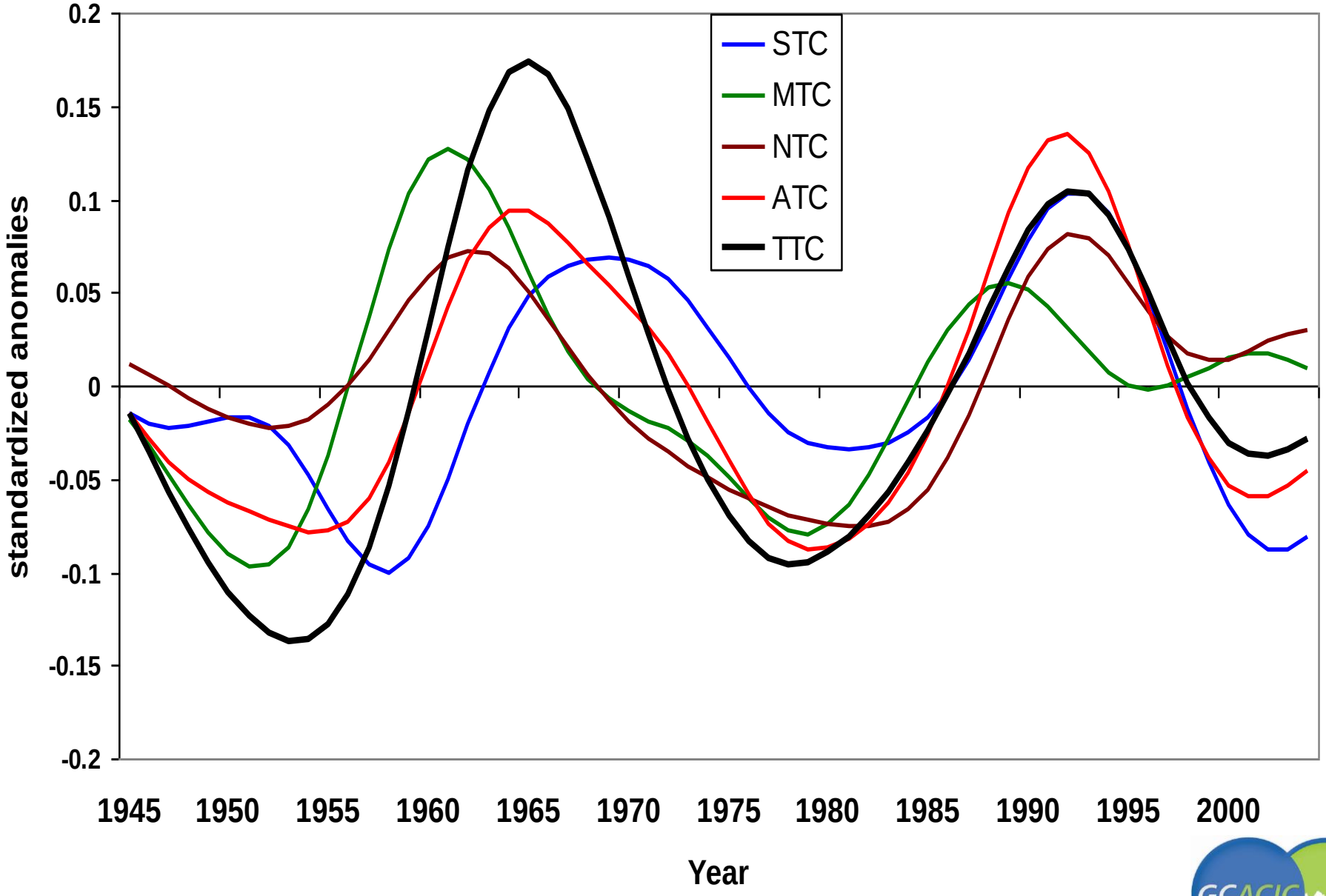




TC Landfalling Frequency (16-32 year period)



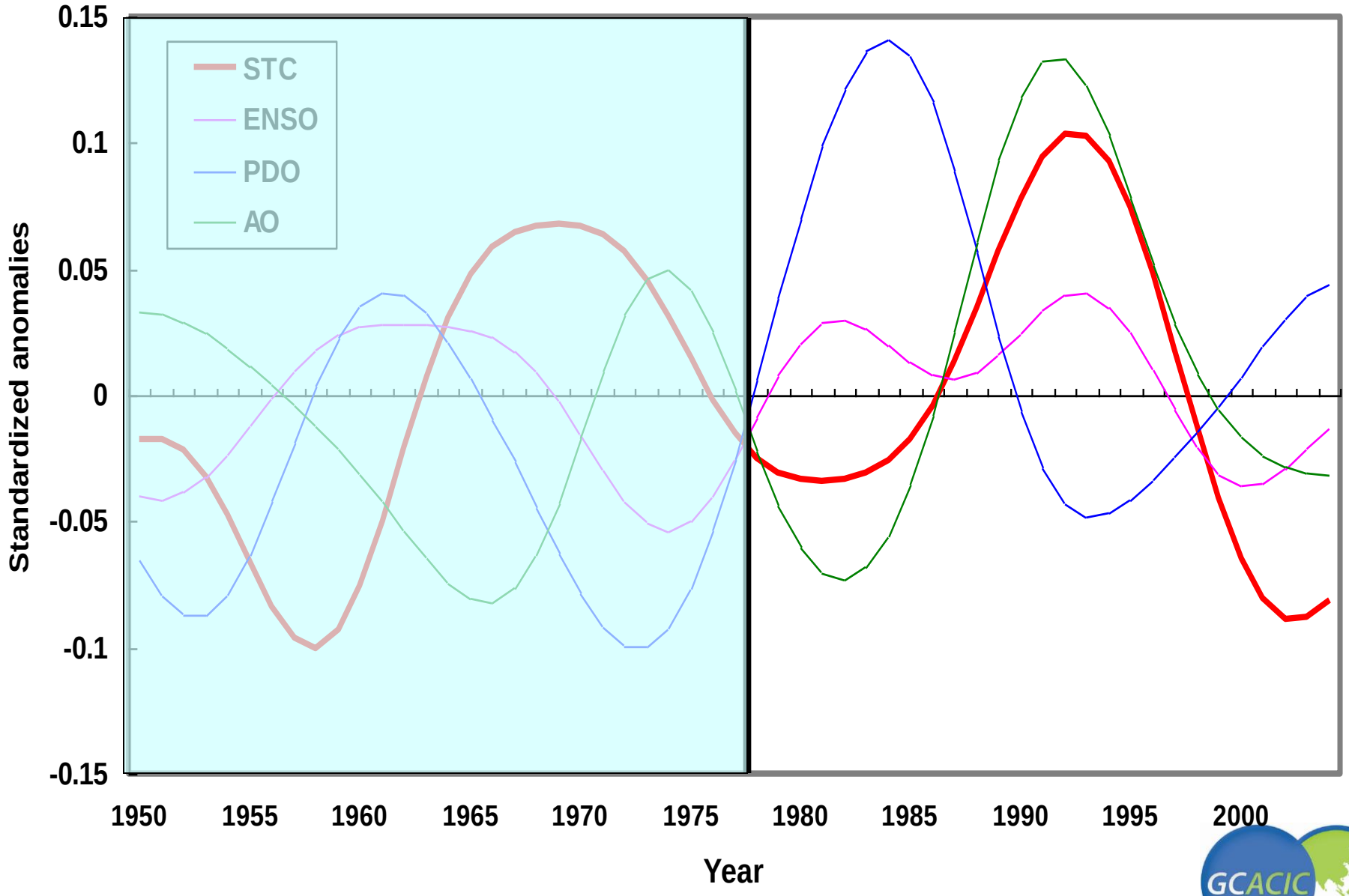
Landfall in East Asia vs. TC Activity over the Western North Pacific at the 16-32-year Oscillation Period



Correlations between STC and various oscillation indices at the 16-32-year Oscillation Period

Oscillation	Entire period (1950-2004)
ENSO	0.22
PDO	*-0.35*
AO	*0.46*
ENSO+PDO+AO	*0.64*
ENSO+PDO	*0.59*
ENSO+AO	*0.54*
PDO+AO	*0.49*

Variations of STC and various oscillation indices at the 16-32-year Oscillation Period



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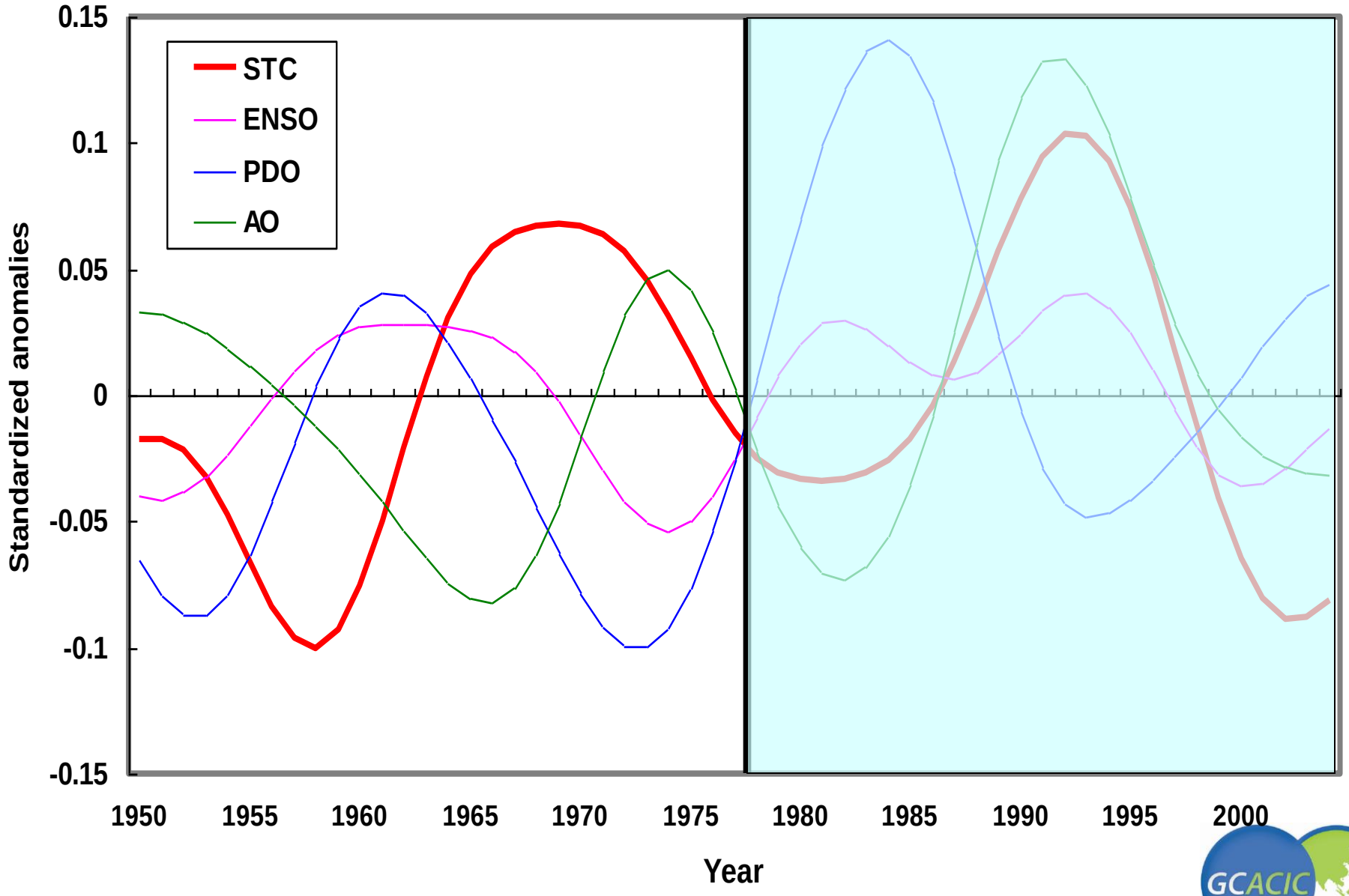
Variations of STC and various oscillation indices at the 16-32-year Oscillation Period



Correlations between STC and various oscillation indices at the 16-32-year Oscillation Period

Oscillation	Entire period (1950-2004)	1950-1977	1978-2004
ENSO	0.22	-0.20	*0.72*
PDO	*-0.35*	-0.35	*-0.52*
AO	*0.46*	-0.22	*0.89*
ENSO+PDO+AO	*0.64*	*0.93*	*0.98*
ENSO+PDO	*0.59*	0.43	*0.91*
ENSO+AO	*0.54*	*0.93*	*0.97*
PDO+AO	*0.49*	*0.79*	*0.91*

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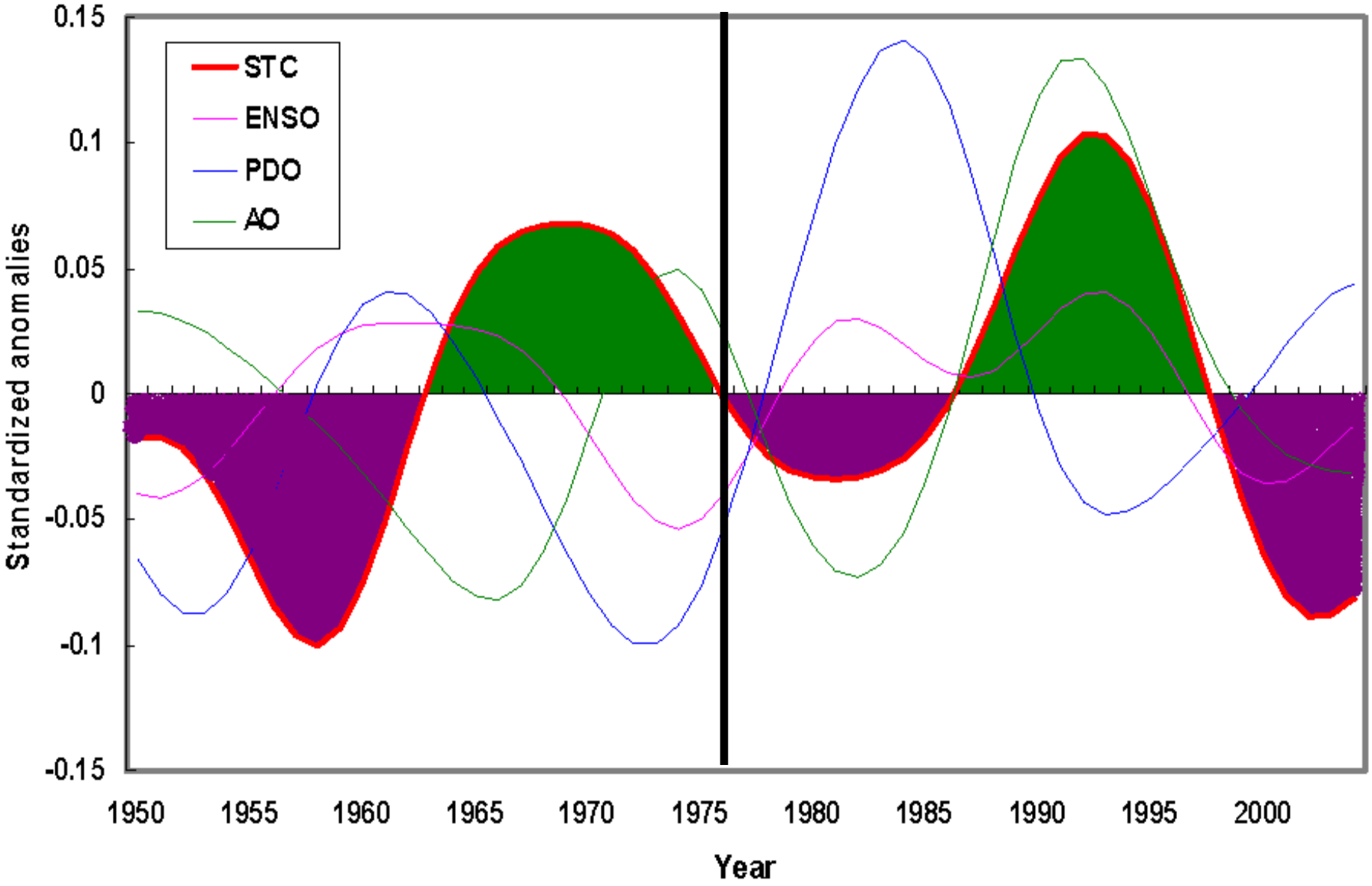
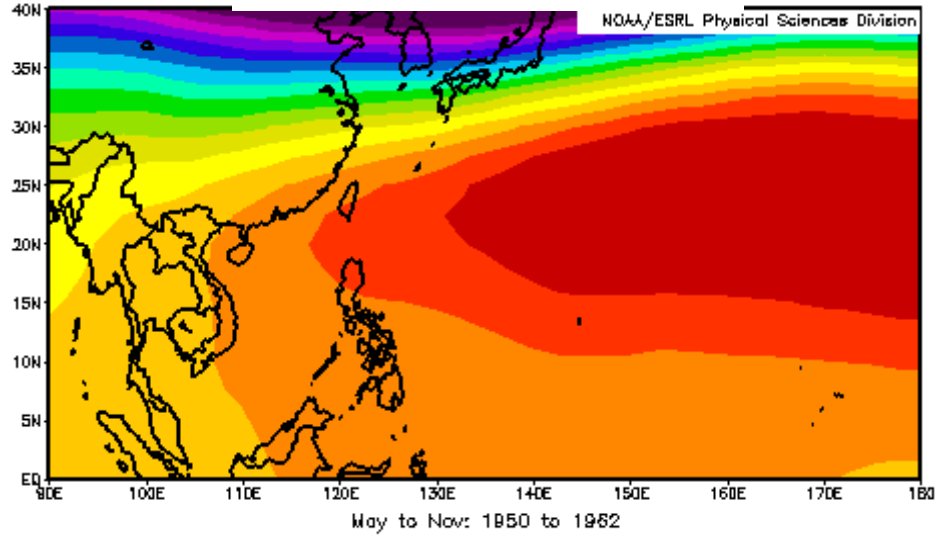
Variations of STC and various oscillation indices at the 16-32-year Oscillation Period



less STC (1950-62)



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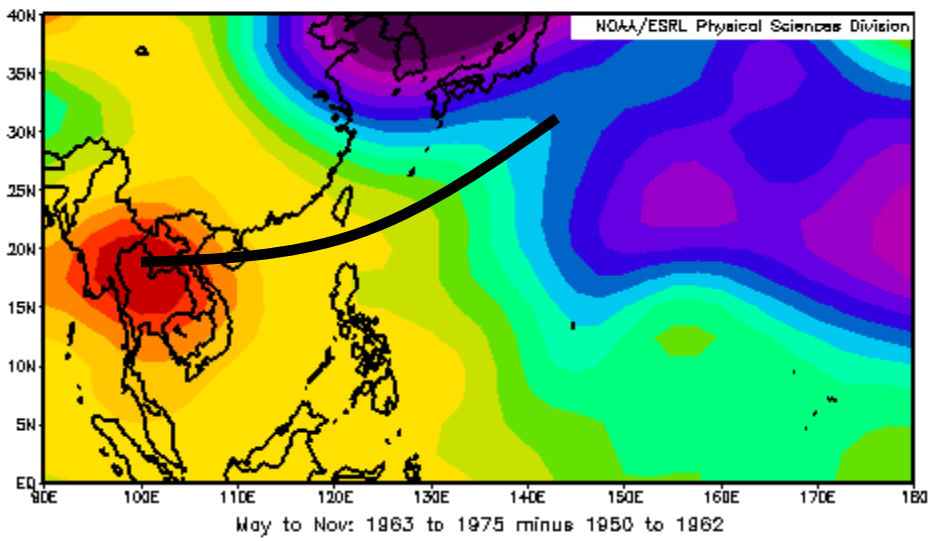
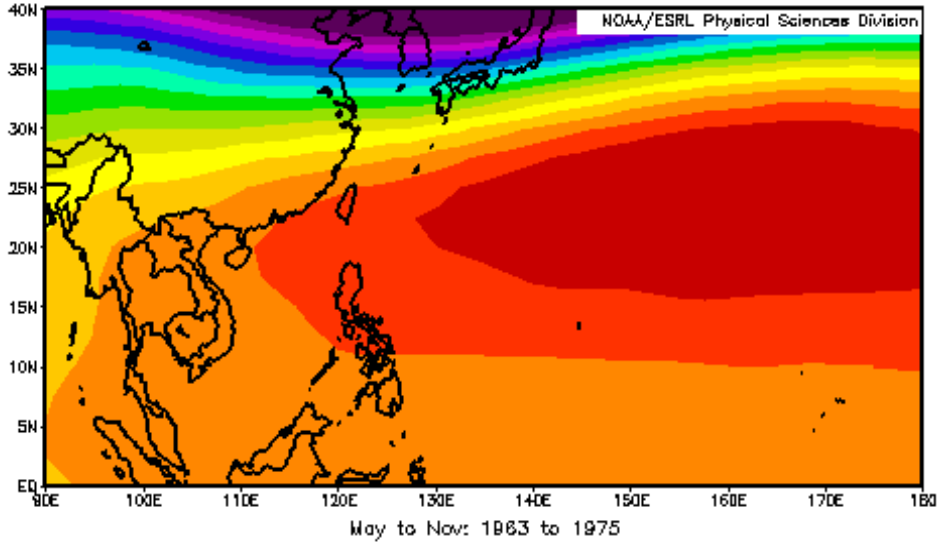


more STC (1963-75)



500-hPa Geopotential Heights

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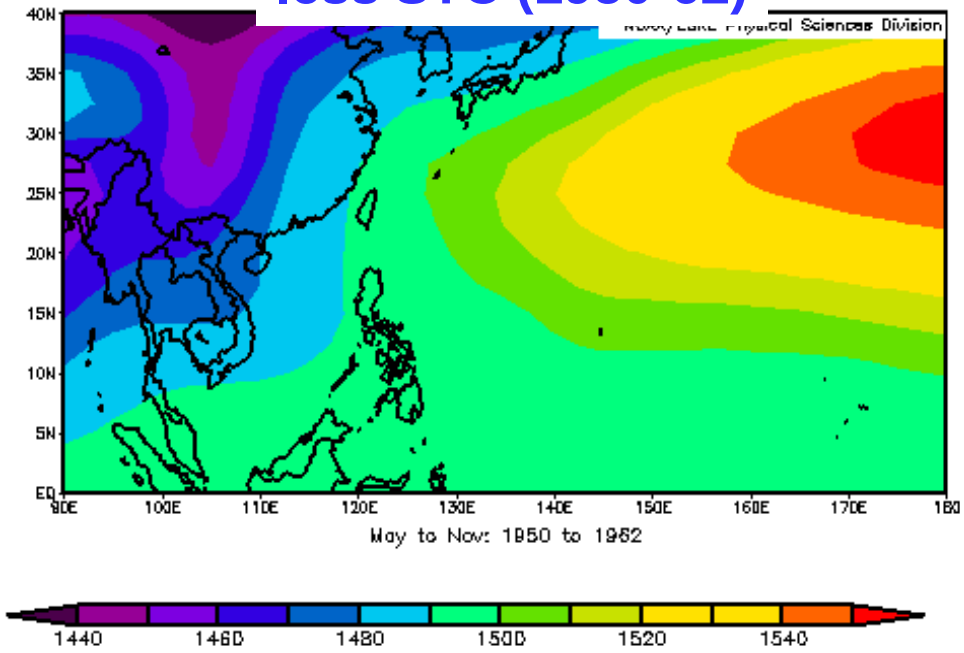
less STC (1950-62)



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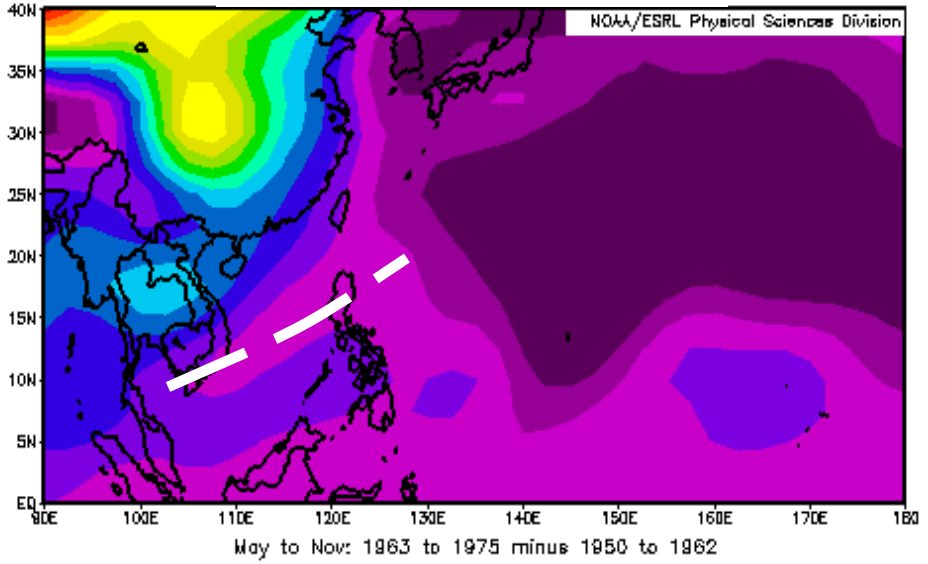
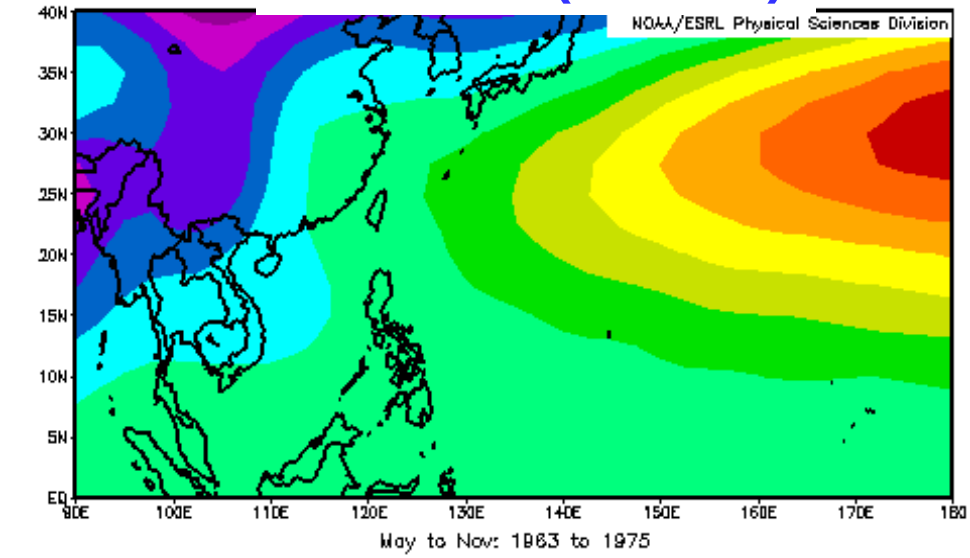
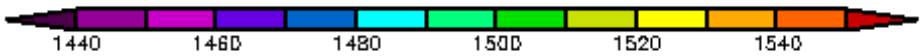


more STC (1963-75)





850-hPa Geopotential Heights

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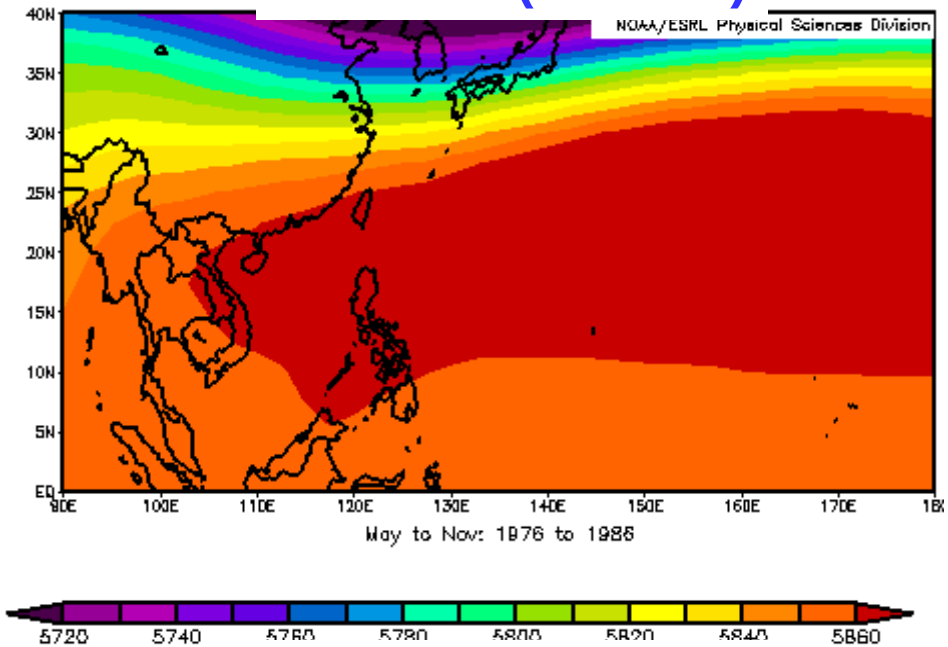
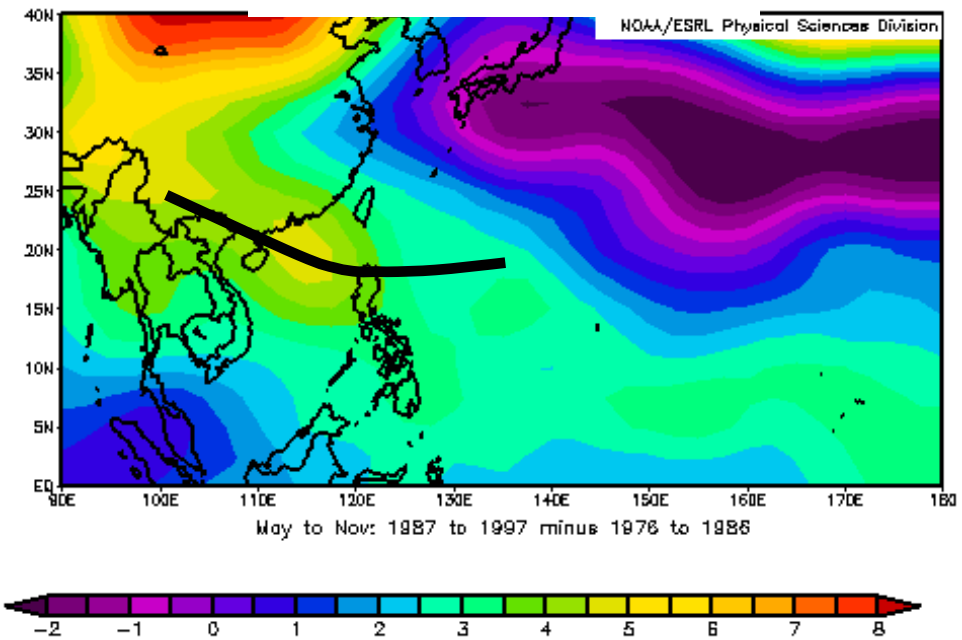
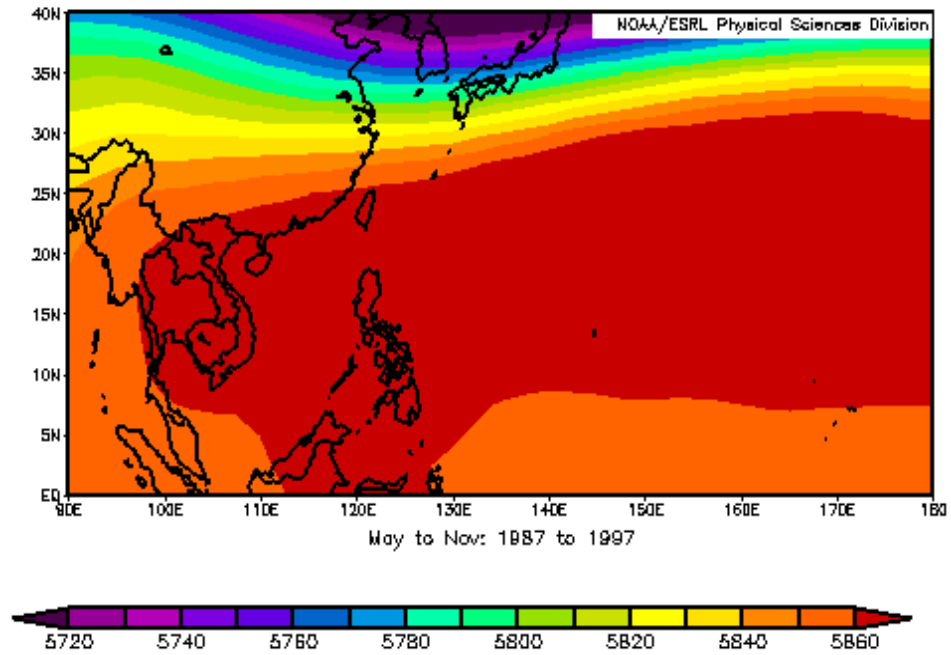
less STC (1976-86)



more minus less



more STC (1997-97)



500-hPa Geopotential Heights

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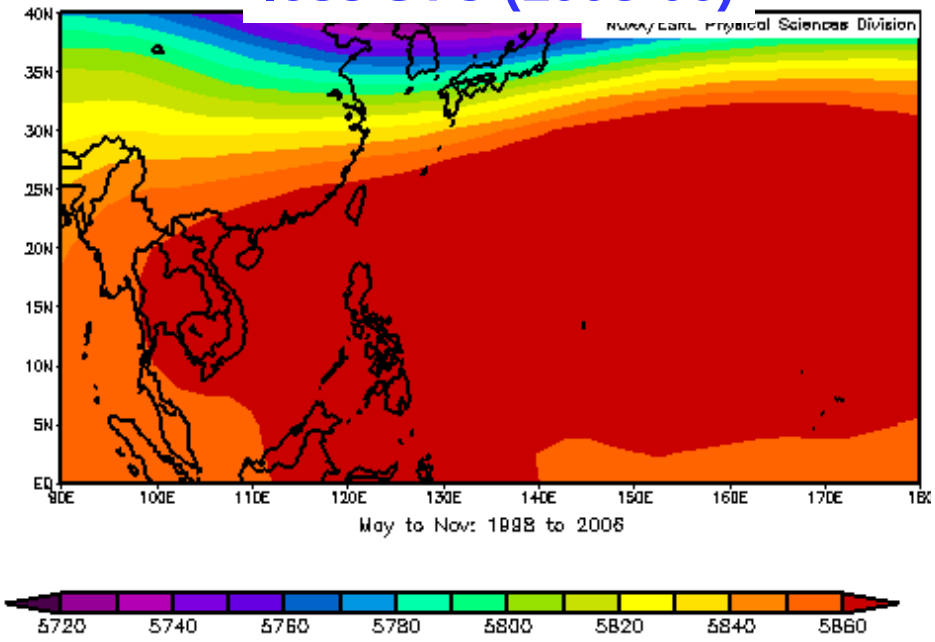
less STC (1998-06)



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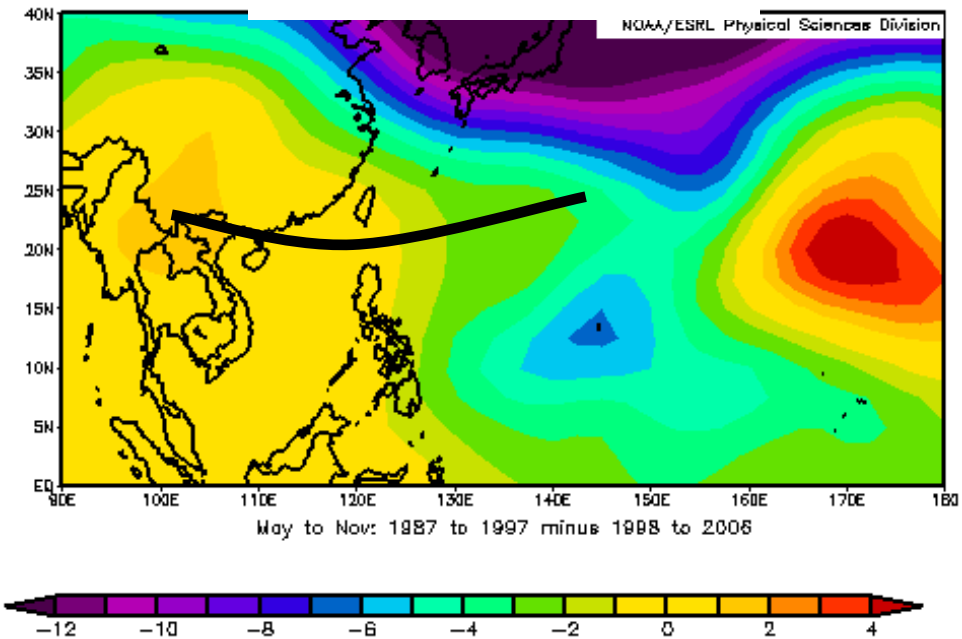
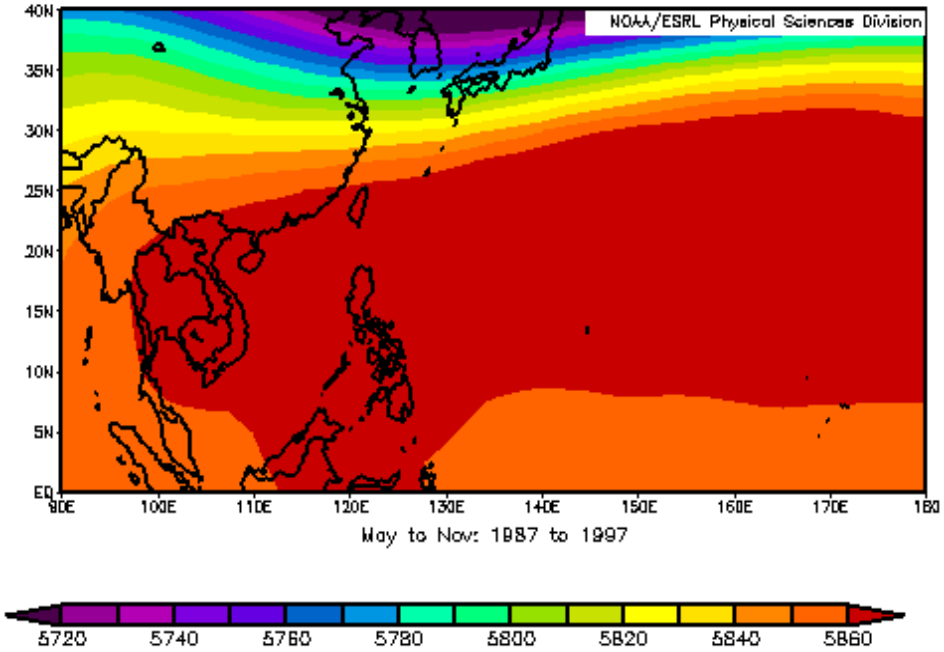


more STC (1997-97)



500-hPa Geopotential Heights

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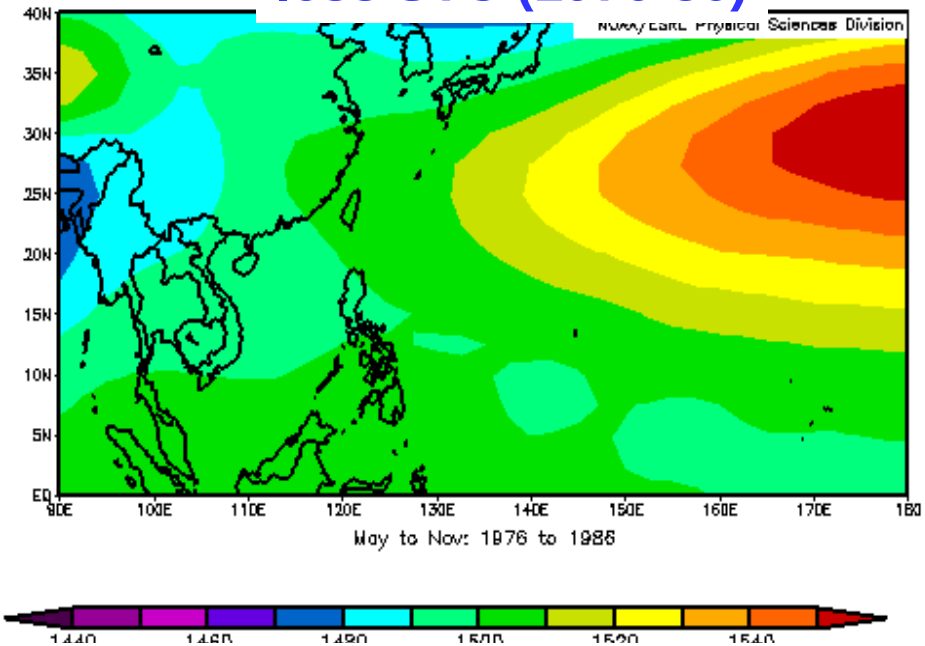
less STC (1976-86)



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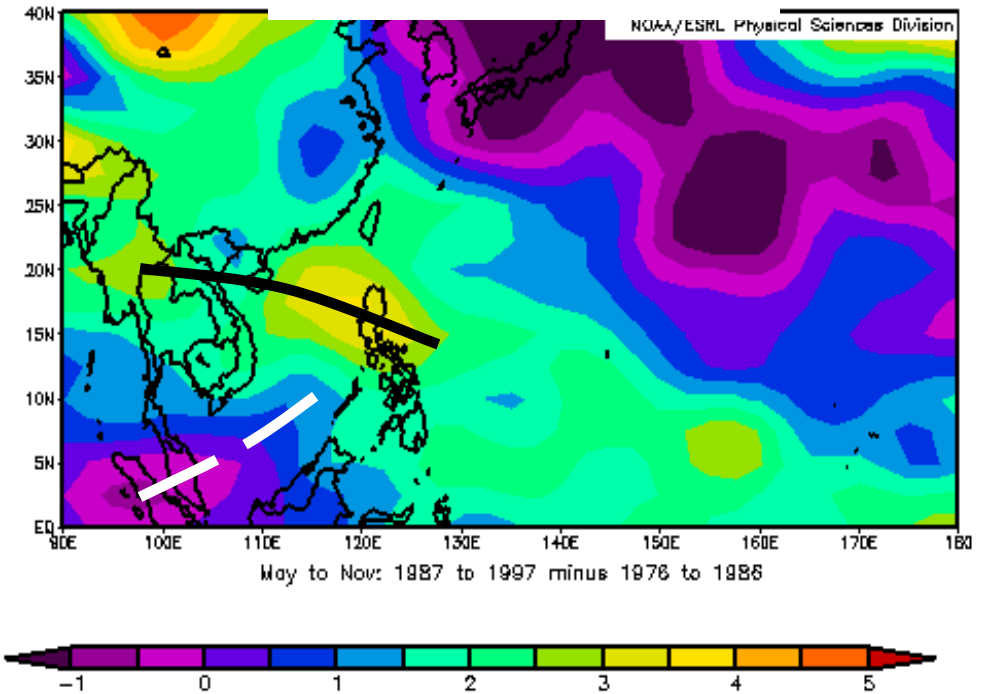
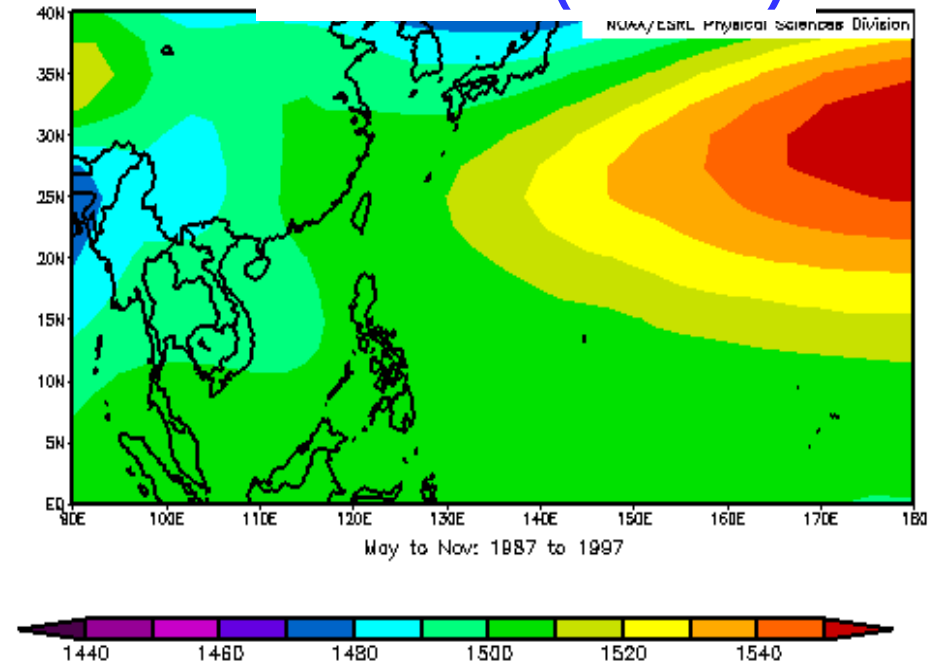


more STC (1997-97)



850-hPa Geopotential Heights

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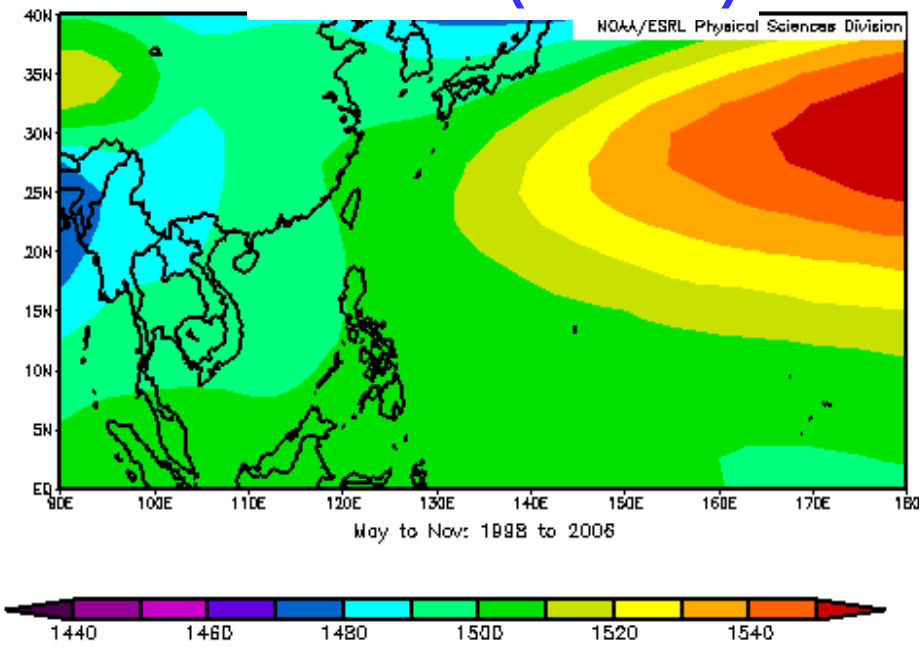
less STC (1998-06)



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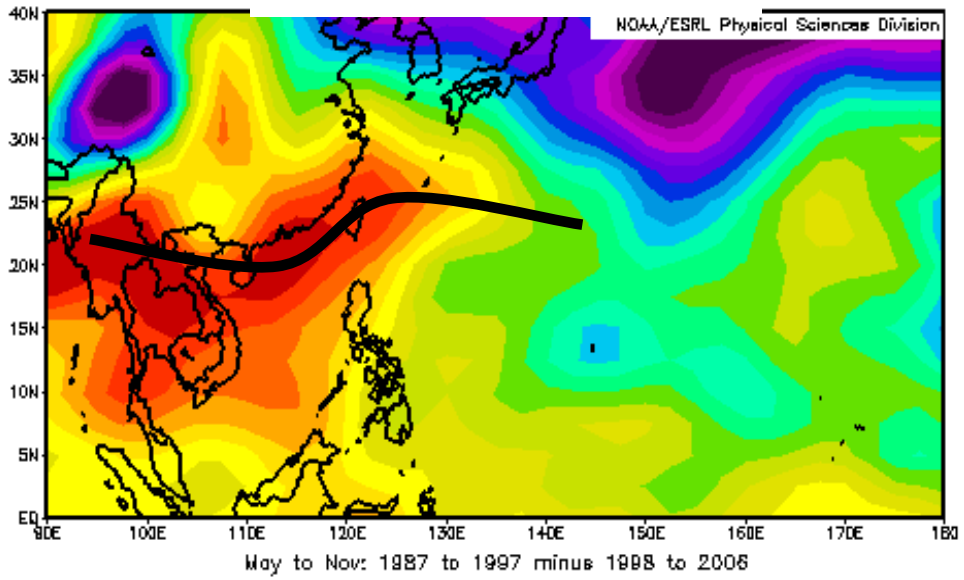
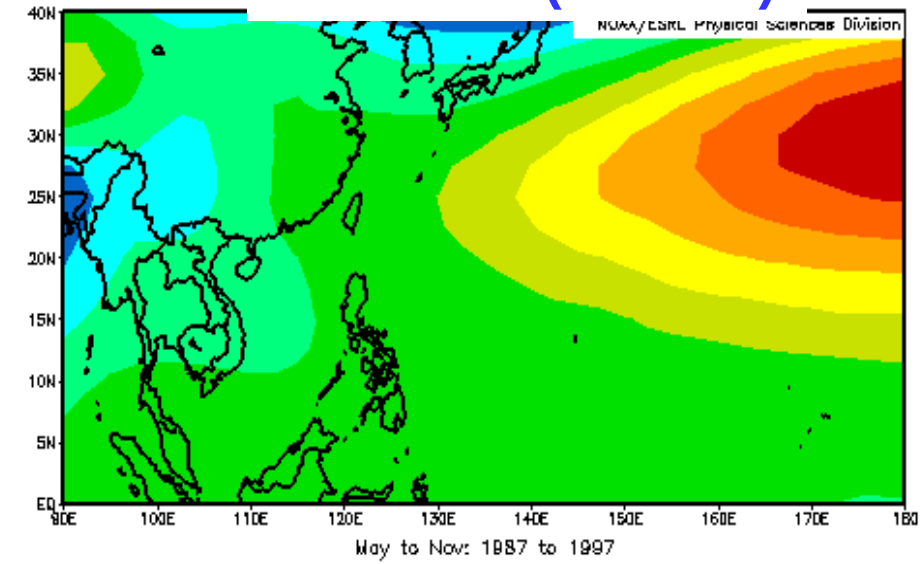
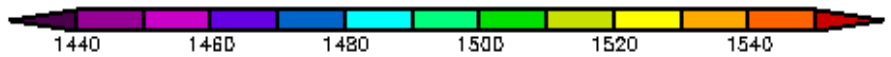


more STC (1997-97)





850-hPa Geopotential Heights

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Summary

- No significant trend in the frequency of tropical cyclone landfall in any region in Asia is observed.
- Frequency of tropical cyclone landfall in a given region in Asia goes through large interannual and interdecadal variations.
- The decadal variations can be the same for all regions during some periods but may be opposite in other periods
- These decadal variations of landfall frequency are consistent with those of TC activity over the western North Pacific

Summary

- Interdecadal variations of landfall are apparently caused by similar variations in the planetary-scale atmospheric and oceanographic features
- Changes in either one dominant feature or in a combination of two or more features modify the flow patterns associated with TC landfall in a particular region, and hence change the frequency of landfall