The impacts of thermal anomalies in the East China Sea and its adjacent seas on East Asian atmospheric circulation and climate change in East China

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Outline

1. Background

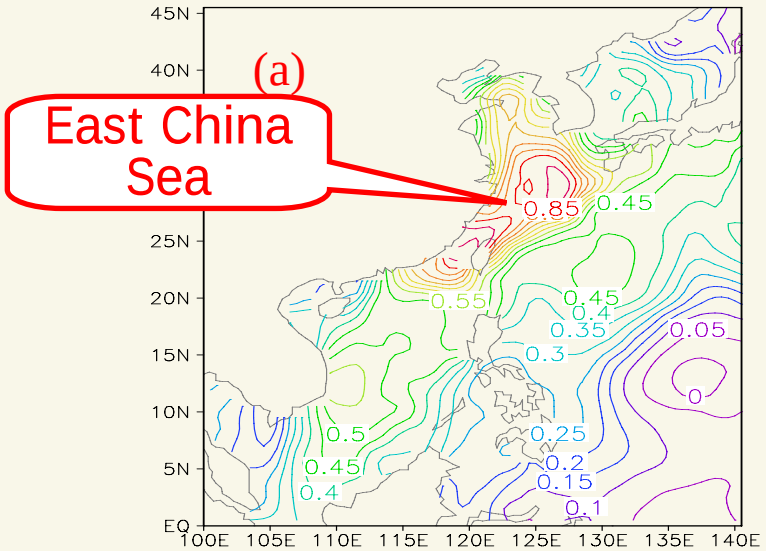
2. Numerical Experiments

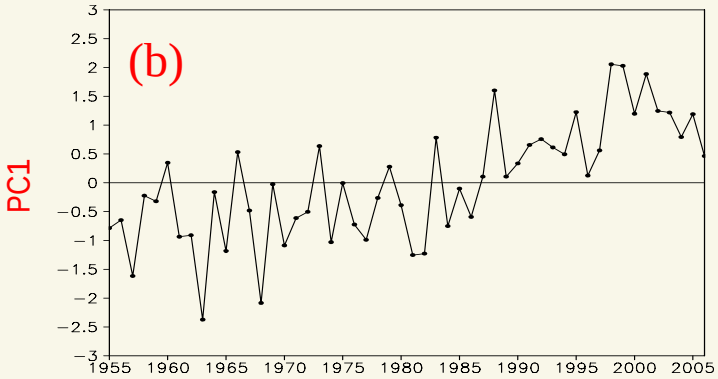
3. Observations

4. Conclusion

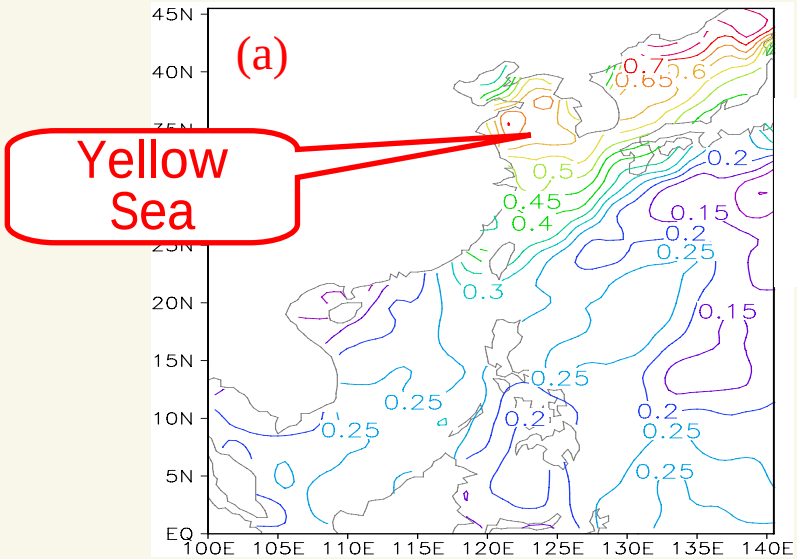
1. Background

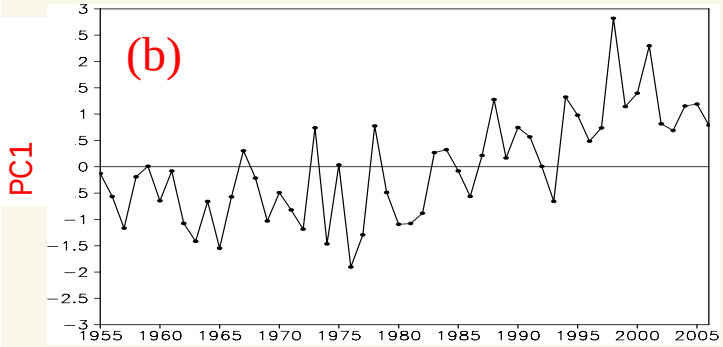
★ East Asian marginal seas have been warming in the past decades.





EOF1（51.9％）for SSTA in Winter





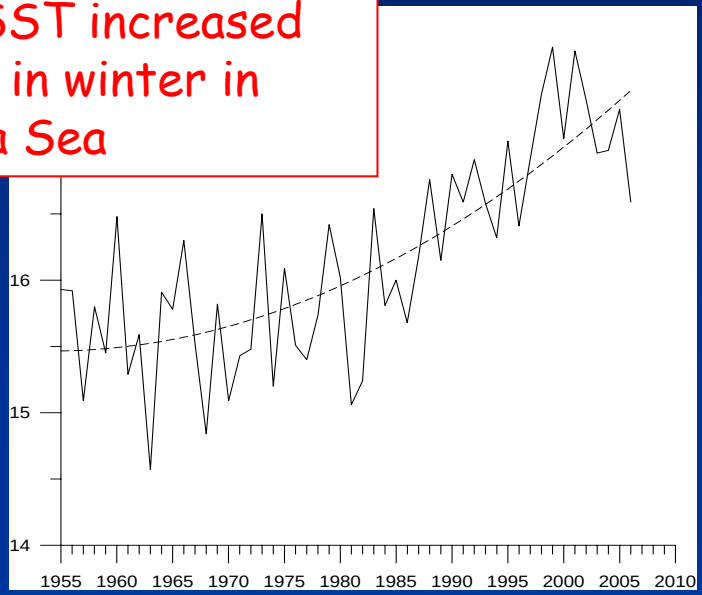
EOF1（43.6％） for SSTA in Summer

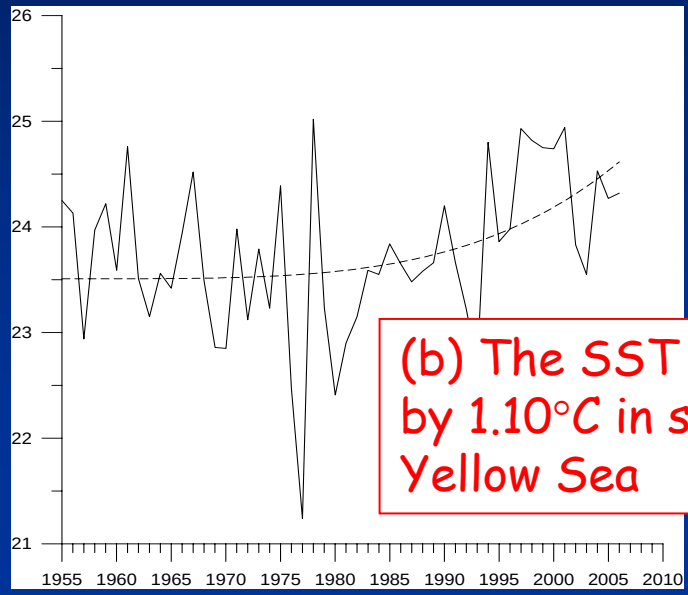
$$y(t)=c_0+c_1t+c_2t^2+c_3t^3+c_4t^4+c_5t^{1/2}+c_6t^{-1}+c_7t^{-1/2}+c_8t^{-2}+c_9e^{-t}+c_{10}\ln t$$

$$y=15.46525+7.2749966\times10^{-4}t^2$$

$$y=23.50874+1.5130692\times10^{-7}t^4$$

(a) The SST increased by 1.96°C in winter in East China Sea



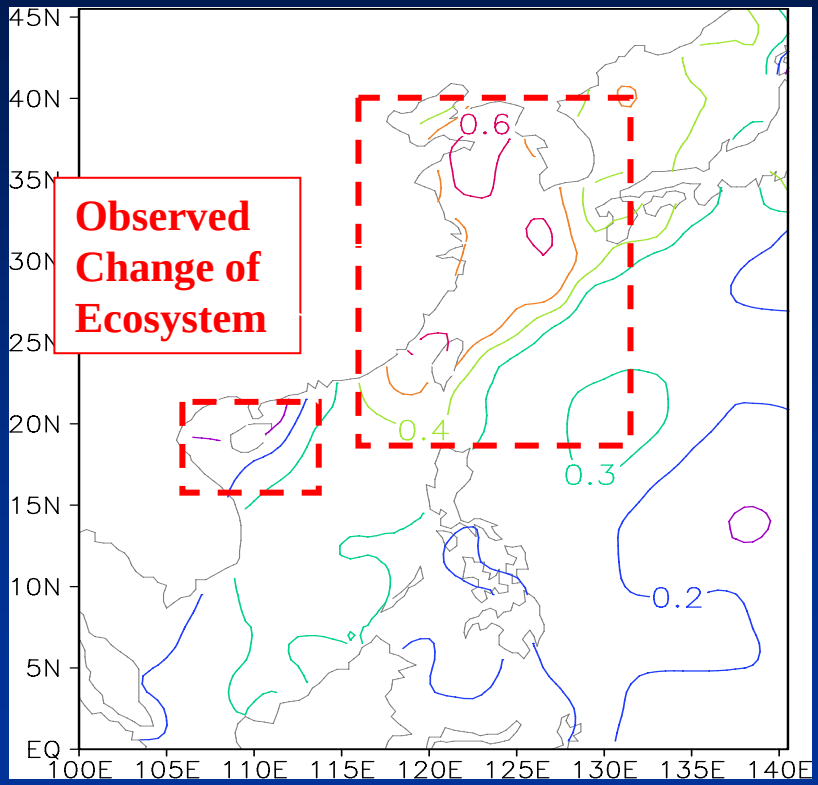


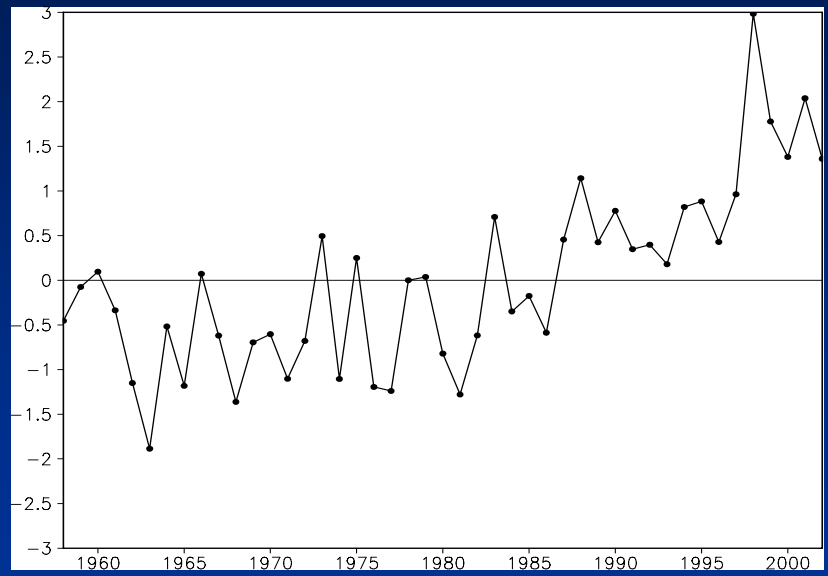
(b) The SST increased by 1.10°C in summer in Yellow Sea

Long-term trend of SST of the strongest signal areas in winter (a) and summer (b).

The SST increased by 1.96°C in winter for the period of 1955-2005 and 1.10°C in summer for the period of 1971-2006

★ Warming Water in ECS impacts on East Asian seas marine ecosystem



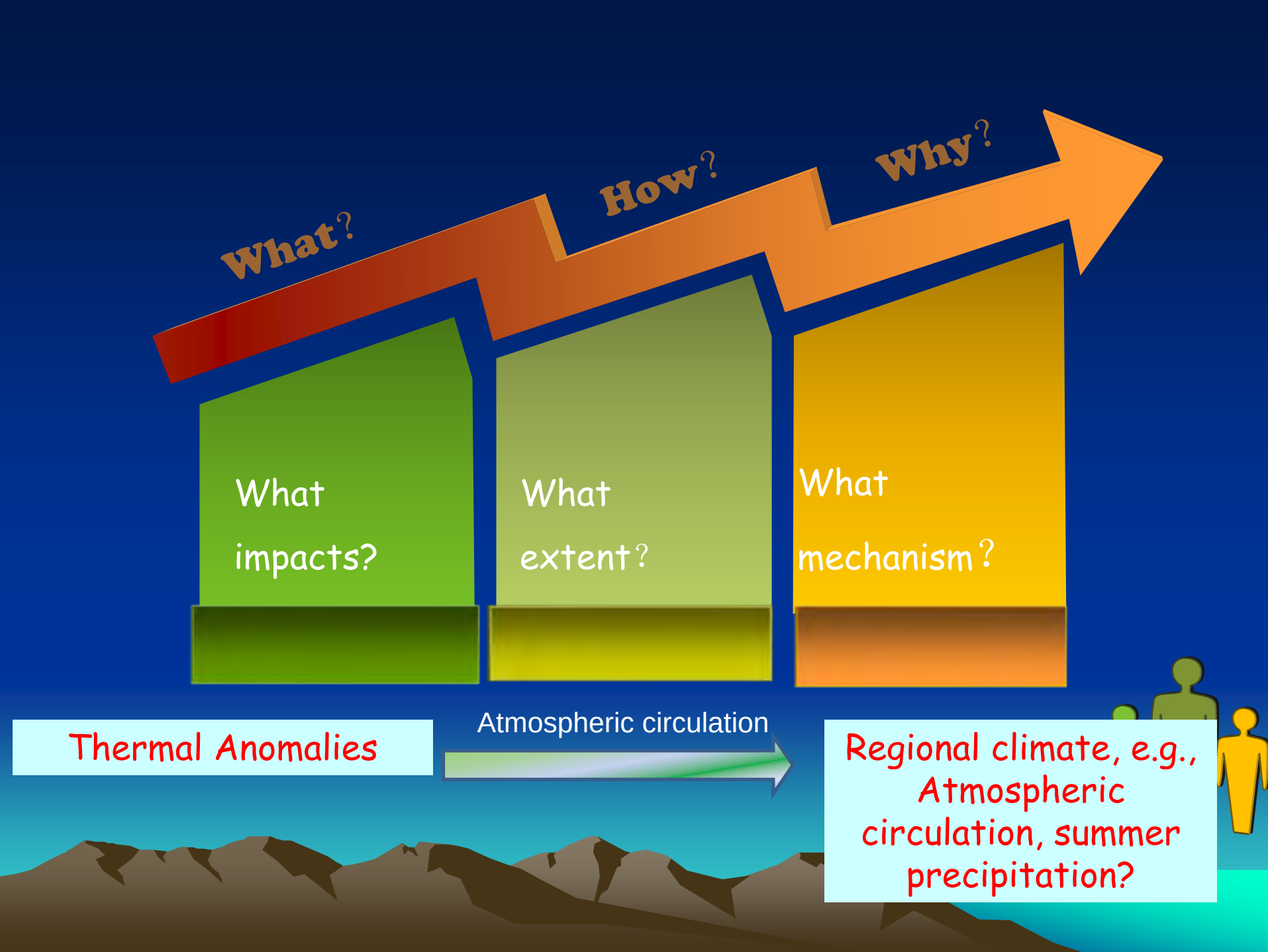


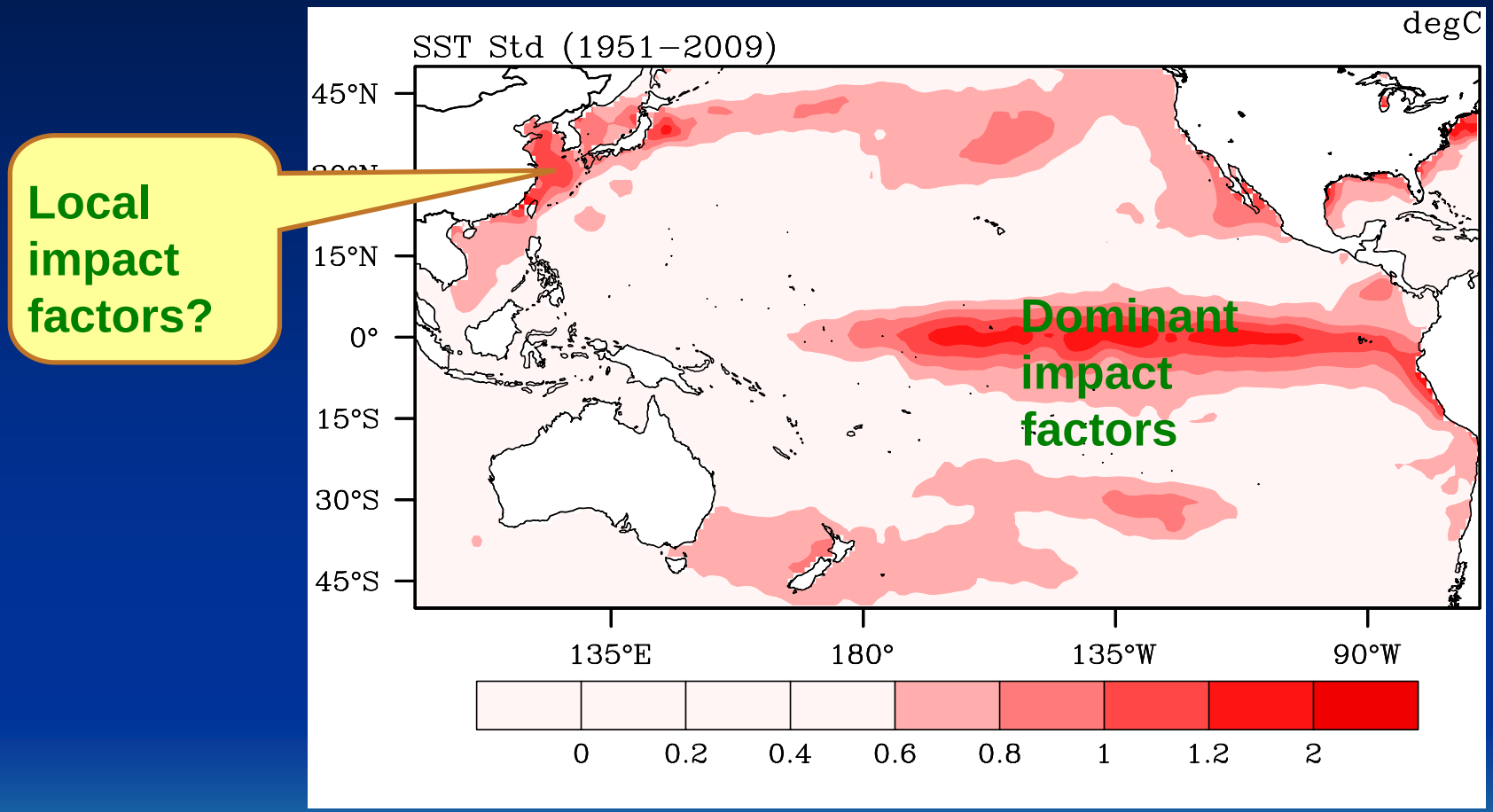
For example,

1) HABs (Harmful Algal Blooms) frequently happens in East China Sea;

2) Marine bio-geographic distributions have been greatly changing, including warm water species increasing, temperate water species decreasing, tropical fish expanding their range northward into the subtropical area etc., in the past decades.

- ★ Inter-decadal weakening trend of East Asian Monsoon in winter might greatly contribute to the rise in SST of the offshore area of China, particularly in ECS.
- ★ Variations of SST in ECS are closely related with the increasing heat transport of the source area of Kuroshio on inter-annual and inter-decadal timescales.
- Weakening East Asian Monsoon and increasing heat transport of Kuroshio may cause East Asian Marginal Seas rapidly warming.
- Q: We are still wondering if the thermal (SST) anomalies in ECS play an important role in regional climate change?


What?
How?
Why?
What impacts?
What extent?
What mechanism?
Thermal Anomalies
Atmospheric circulation
Regional climate, e.g., Atmospheric circulation, summer precipitation?



Standard deviation of Pacific SST in winter

2. Numerical Experiments: Simulation of Sensibitity of Summer Precipitation to Thermal (SST) Anomalies of ESC

1) Model：RegCM3

2) Domain：center position（29.5ºN，119ºE），resolution 20kmx20km，Grids points 104x112，Vertical levels 18，Pressure of model top 5hPa

3) Initial and boundary conditions： NNRP1（NCEP/NCAR），SST： OISST（NOAA）

4) Convective Precipitation Schemes：Fritsch-Chappell

5) Simulation Time ： 1989.1-2010.1

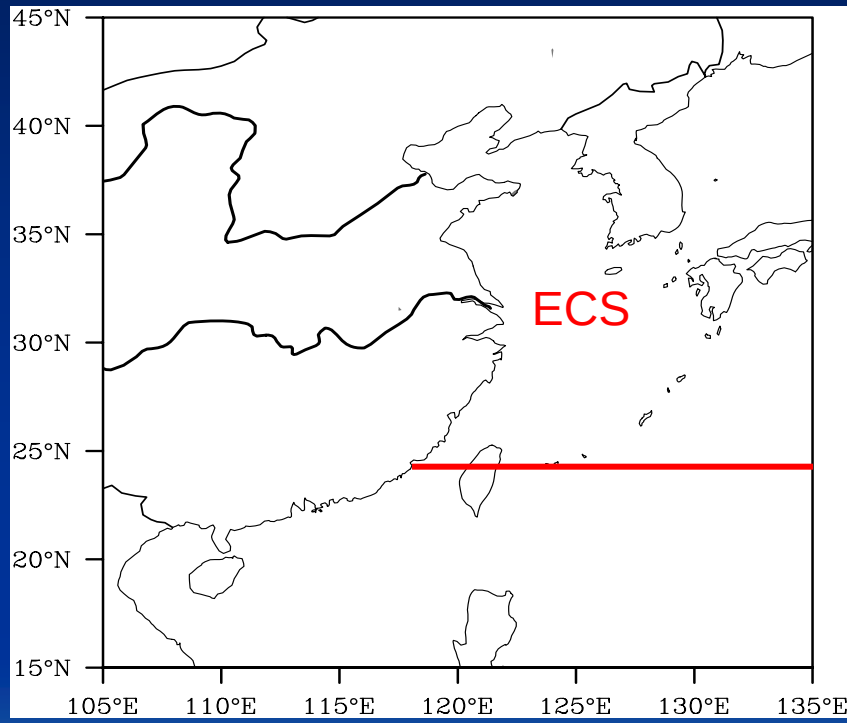
1Control Test: climatological SST（annual mean 1982~2009）

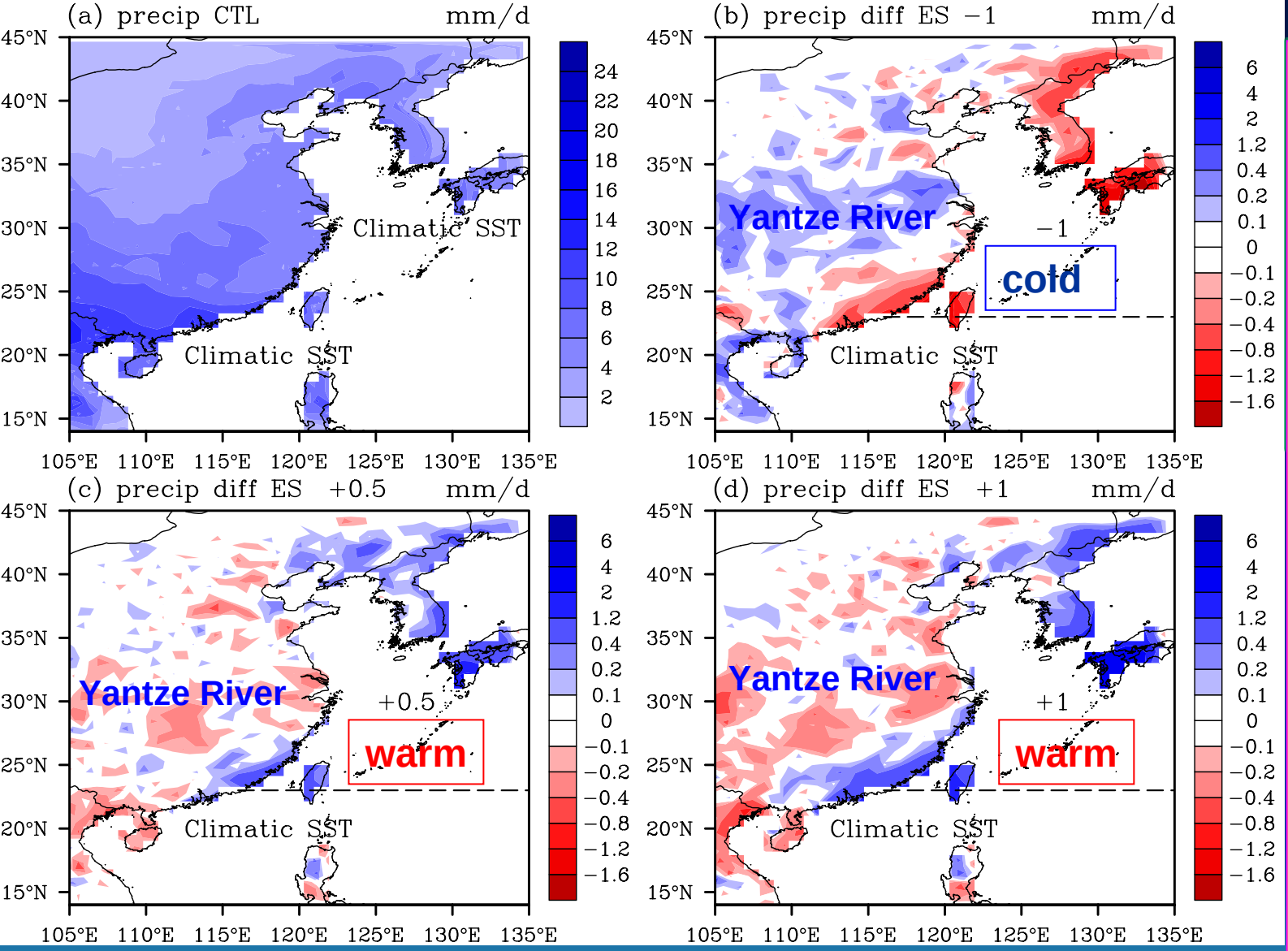
3 Sensitive Test ： change SST in ESC and other areas remain unchanged

Experimental scheme

	Control Test (CTL)	Sensitization Test		
		ECS-1	ECS+0.5	ECS+1
Domain	(13 ~48°N, west of 138°E)	(22~45°N, west of 135°E）	Same as ECS-1	Same as ECS-1
SST	Climatological SST	Climatic SST -1℃	Climatic SST +0.5℃	Climatic SST +1℃
Simulation Time	1989.1-2010.1	Same as CTL	Same as CTL	Same as CTL

Model experimental Area



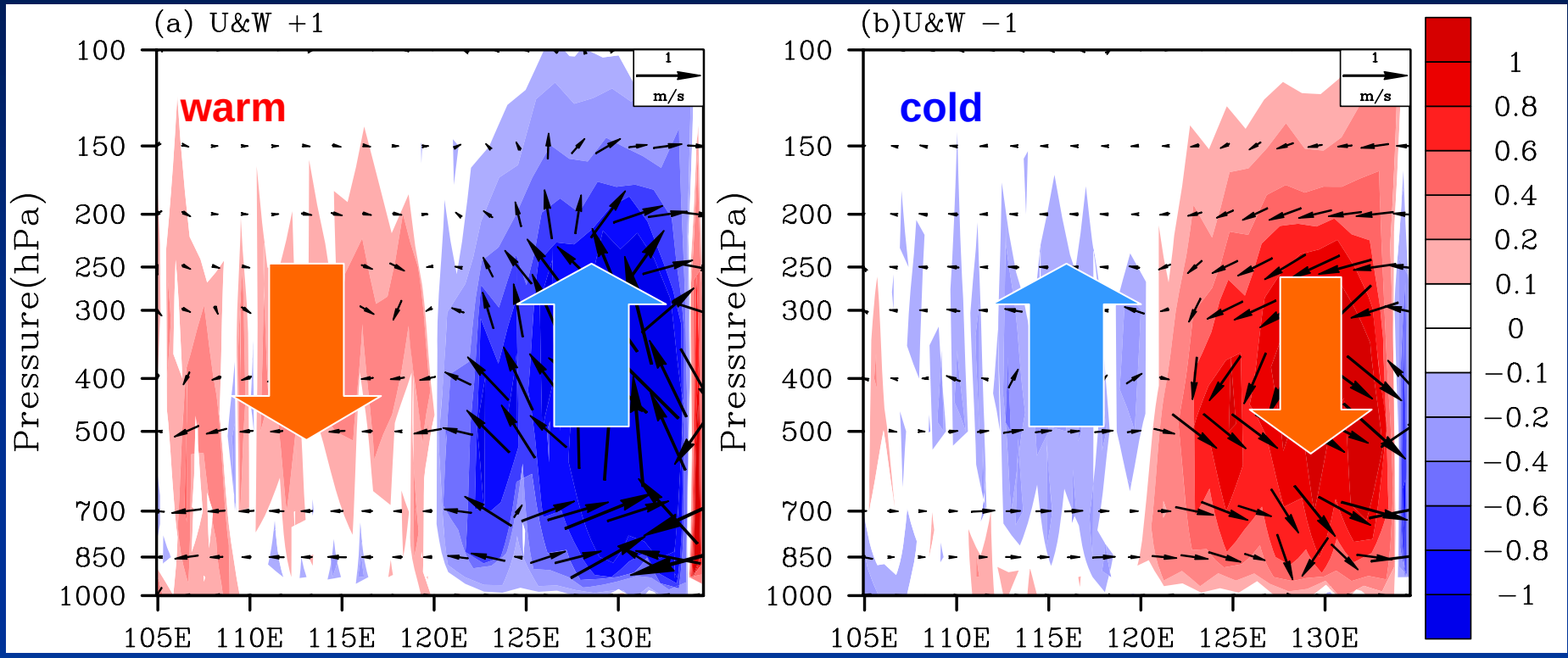


Simulated summer rainfall anomalies in eastern China responding to different SST conditions in ESC. (a) climatological mean SST; (b) -1, (c)+0.5 and (d)+1℃ SST anomalies to climatological mean SST, respectively.

The **warm** (**cold**) anomalies in ECS can contribute to the **less** (**more**) rainfall in the middle and lower reaches of the **Yangtze River, JiangHuai valley and most of North China** and **more** (**less**) precipitation in **South China, southeast part of Northeast China and Korean Peninsula.**

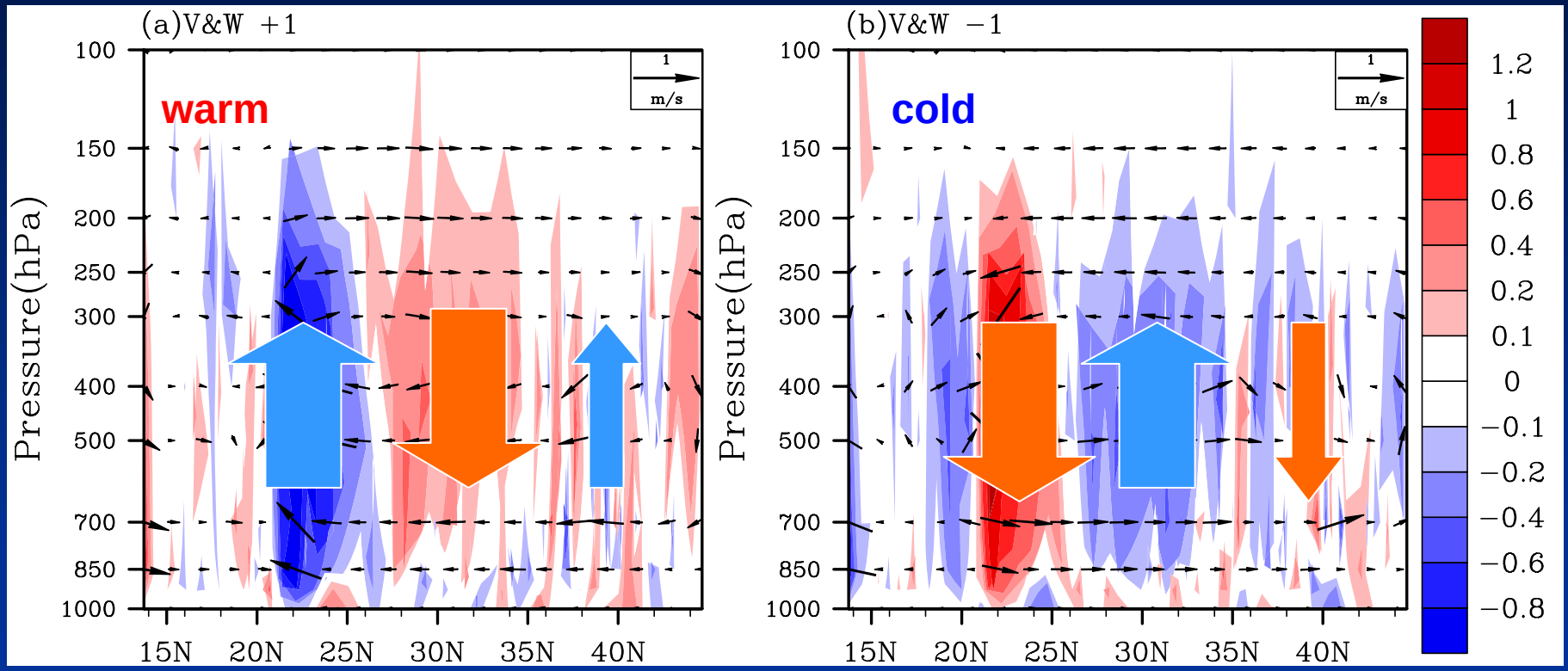
East Asian Zonal Circulation

Altitude-longitude cross sections of the simulated zonal circulation anomalies averaged for 25~35°N responding to the +1℃ (a) and -1℃ (b) SST anomalies of ECS .



When SST in ECS is above normal in summer, an anomalous downward motion can appear over *the middle and lower reaches of the Yangtze River and the Yangtze River/Huaihe River valley (105-120E) in East China*, which contributes to the decrease in summer rainfall in these areas, in addition to an upward motion over the region to the east of these seas, and vice versa.

East Asian Meridional Circulation



When SST in ECS is above normal in summer, an anomalous upward motion occurs in *South China (22-25N), the southern part of Northeast China (35-40N) and the Korean Peninsula (35-40N)*. Thus, there is an obvious increase in summer precipitation in these regions, and vice versa

3. Observations

DATA

1) SST Data：HadISST，resolution 1°×1°

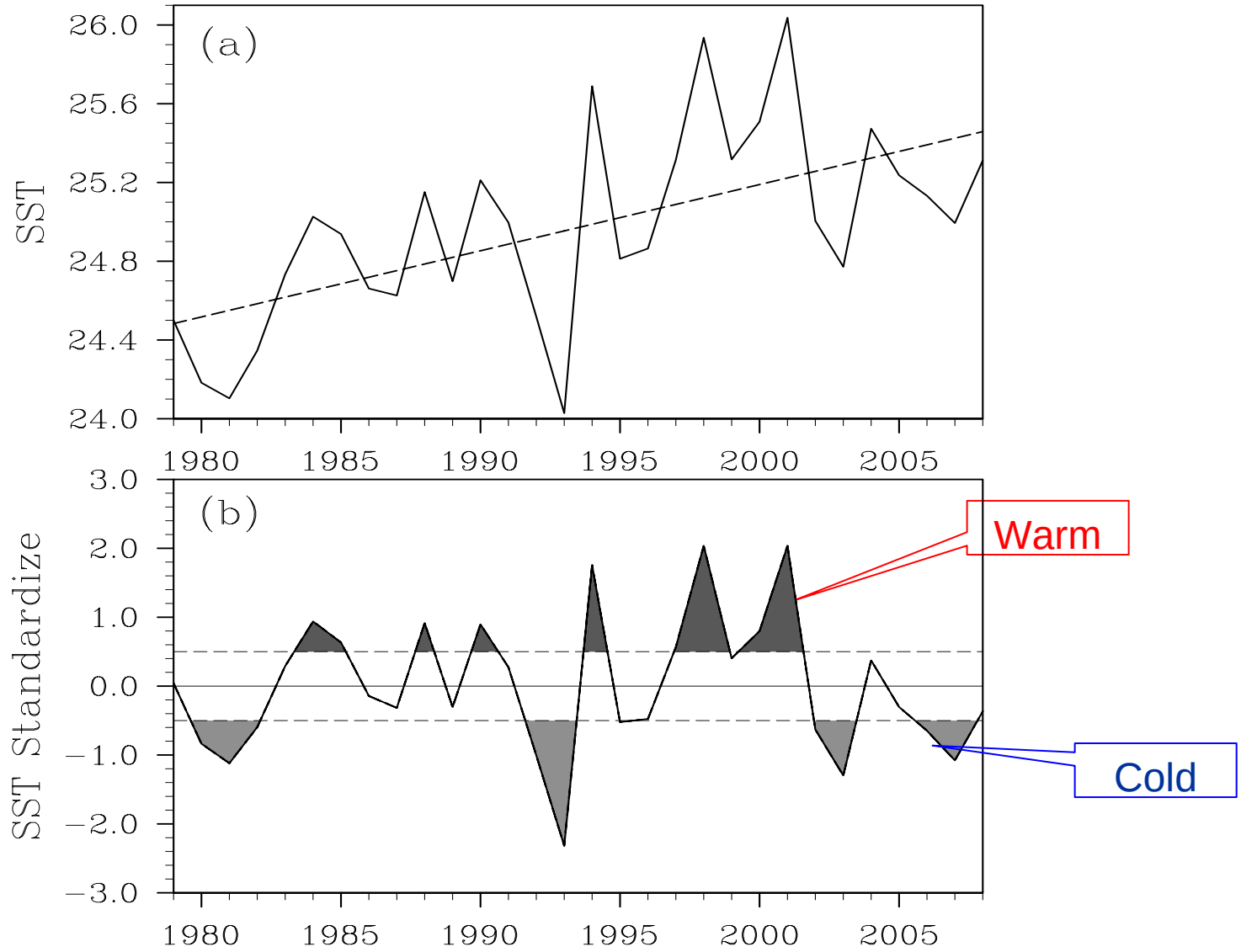
2) Atmosphere Data：Reanalysis data from NCEP/NCAR

3) Rainfall Data：

752 observational stations from China Meteorological Administration

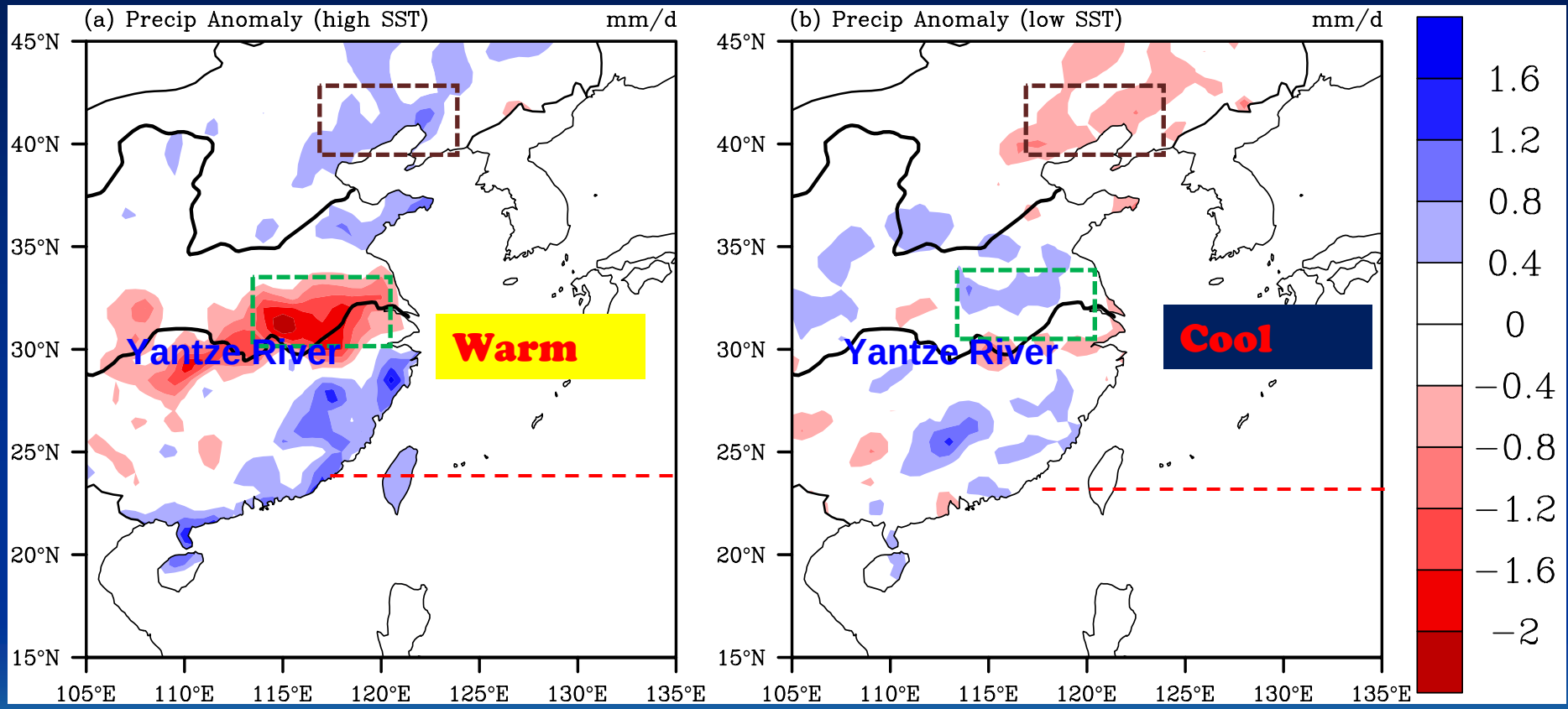
GPCP2.1(Global Precipitation Climatology Project) monthly Reanalysis data

Time Range：Summer (June~August) in 1979~2008



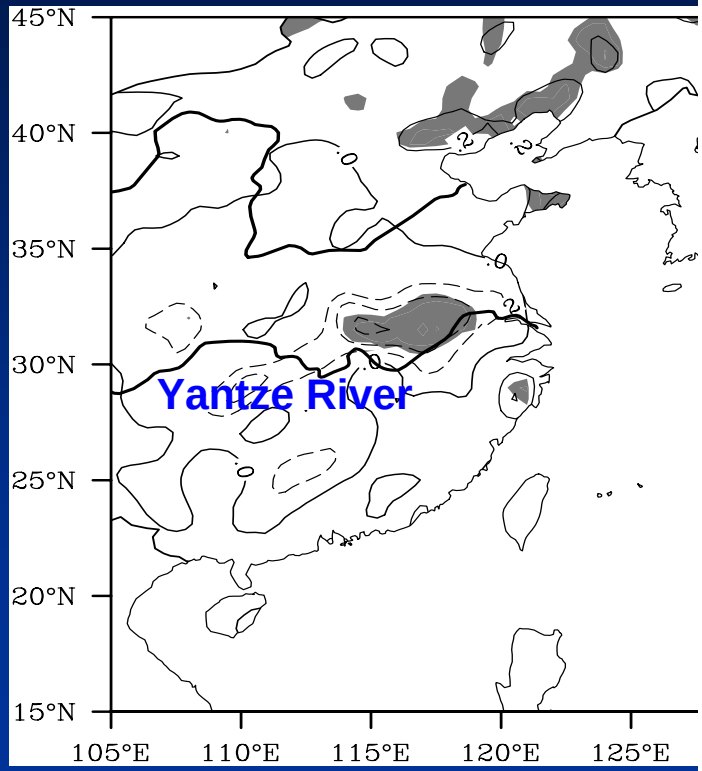
(a) East China Sea SST index (ECSI) and (b) detrended and standardized ECSI index (b). The warm (above) and cold (below) years are shaded.

Composite summer rainfall anomalies during SST in East China Seas and its adjacent waters is warm(a) and cool(b) anomalous; (units: mm/d)

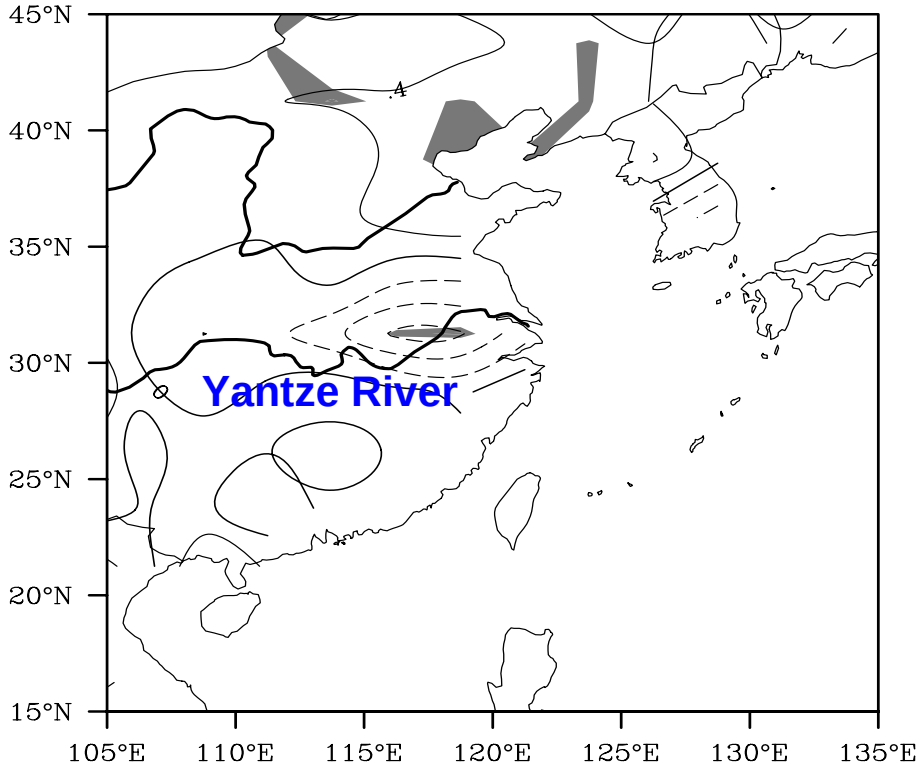


When SST in ECS is in warm (cold) anomalies, there are less (more) rainfall in middle and lower reaches of the Yangtze River and Jianghuai valley and the more (less) rainfall in the southern part of Northeast China

Station data



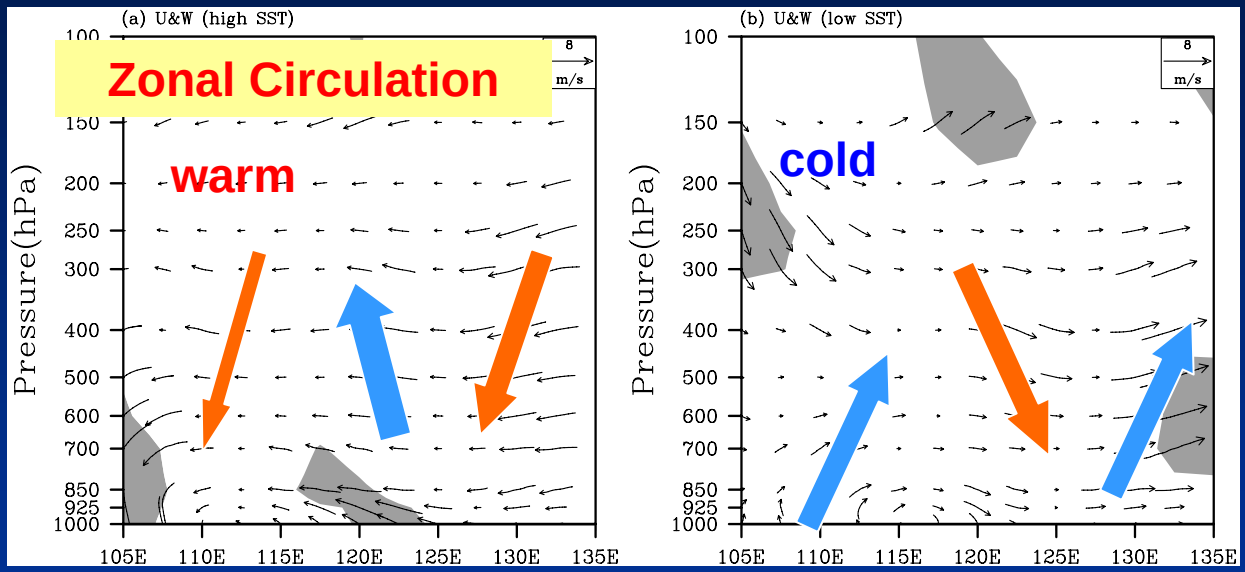
GPCP2.1

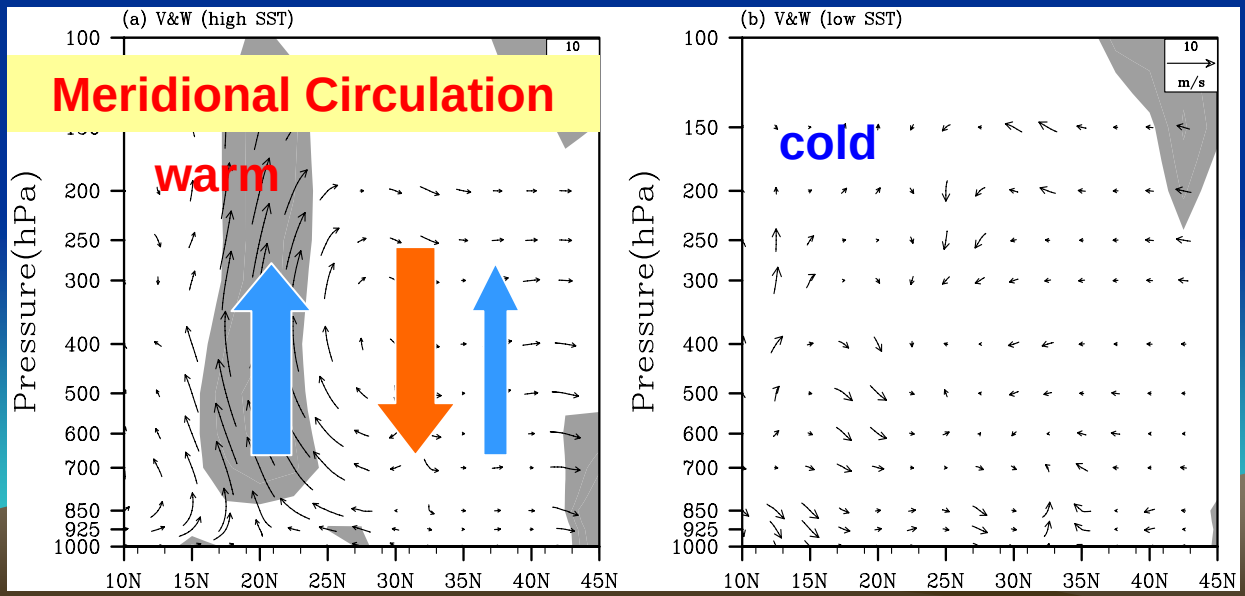


Distributions of correlation coefficients between the summer precipitation in eastern China and the SST index of ECS

The solid (dotted) line denote positive (negative) value; shading indicates 90% significant level.

Relationships between SSTs in ECS and East Asian Zonal and Meridional Circulation





Altitude-longitude cross sections of the simulated zonal for 25-35° N and meridional circulation anomalies averaged corresponding to (a) warm and (b) cold anomalies in ECS.

4. Conclusion

1) The experimental result and observations show that warm (cold) state in the ECS has remarkable effects on zonal and meridional atmospheric circulations over East Asia.

2) The East Asian zonal and meridional atmospheric circulations which could be modified by thermal variations in ECS affect regional climate, e.g., summer precipitation in East China and some other places in East Asia.

It is suggested that the thermal state of ECS has obvious impacts on East Asian atmospheric circulation and regional climate change in East China.

3) The regional climate in East Asia is actually comprehensively affected by various impact factors, thermal variations of ECS plays a non-neglected role in the regional climate.

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Thanks!