

# **The tropospheric biennial oscillation (TBO) and the summer precipitation in China**

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# Main topics

- Significant TBO of summer rainfalls in China
- The dominant modes of TBO of summer rainfalls in China
- Large-scale aspects related to the TBO of summer rainfalls in China
- The possible mechanism of TBO of summer rainfalls in China





# Datasets

- (1) The NCEP / NCAR reanalysis datasets from 1951 to 2004,  $2.5^\circ \times 2.5^\circ$  .
- (2) The EXRSST monthly global sea surface temperature dataset from January 1985 to December 2004,  $2^\circ \times 2^\circ$  .
- (3) 740 stations daily rainfall data in China from 1961 to 2004, compiled by CMA.
- (4) The outgoing longwave radiation (OLR) datasets from January 1979 to December 2004.

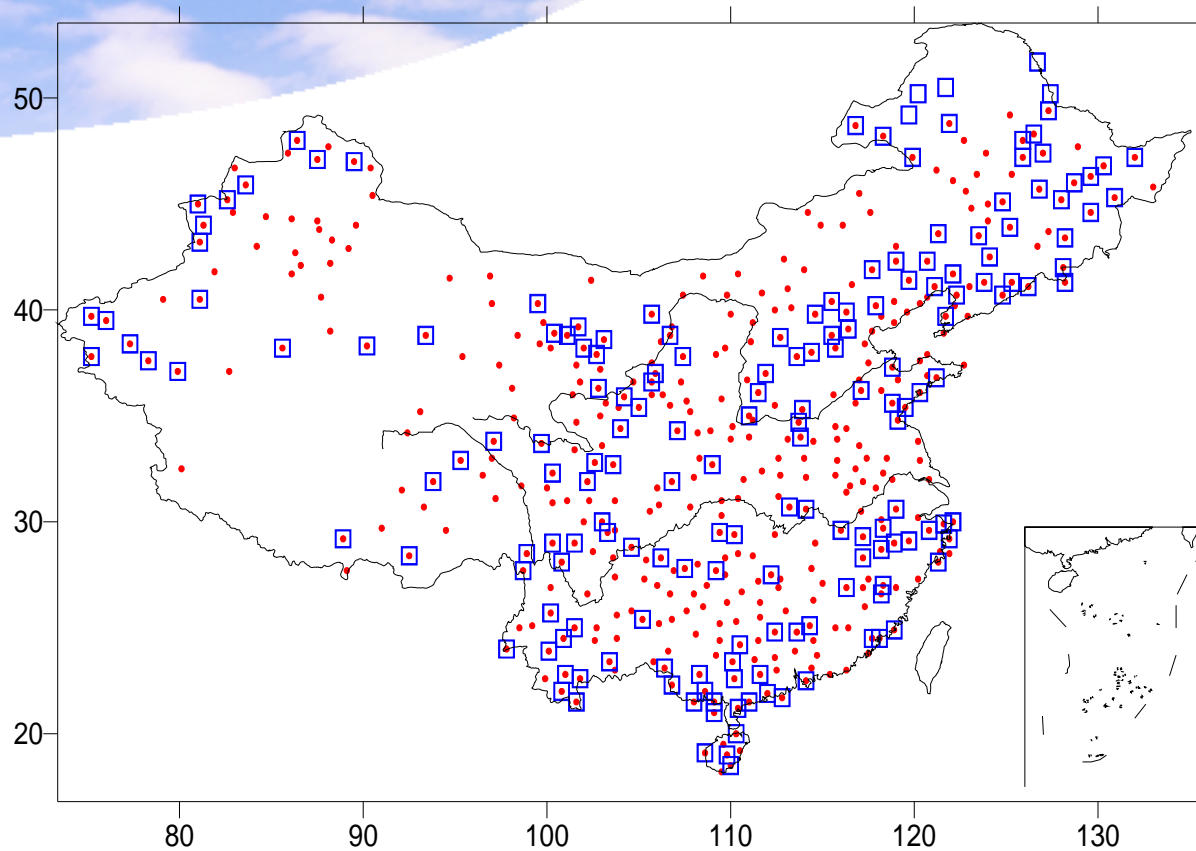


# Significant TBO of summer rainfalls in China

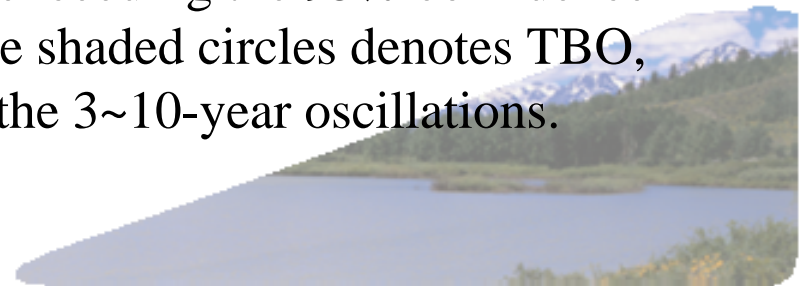
Spatial modes and the corresponding dominate periods  
of the interannual component of summer rainfalls in China

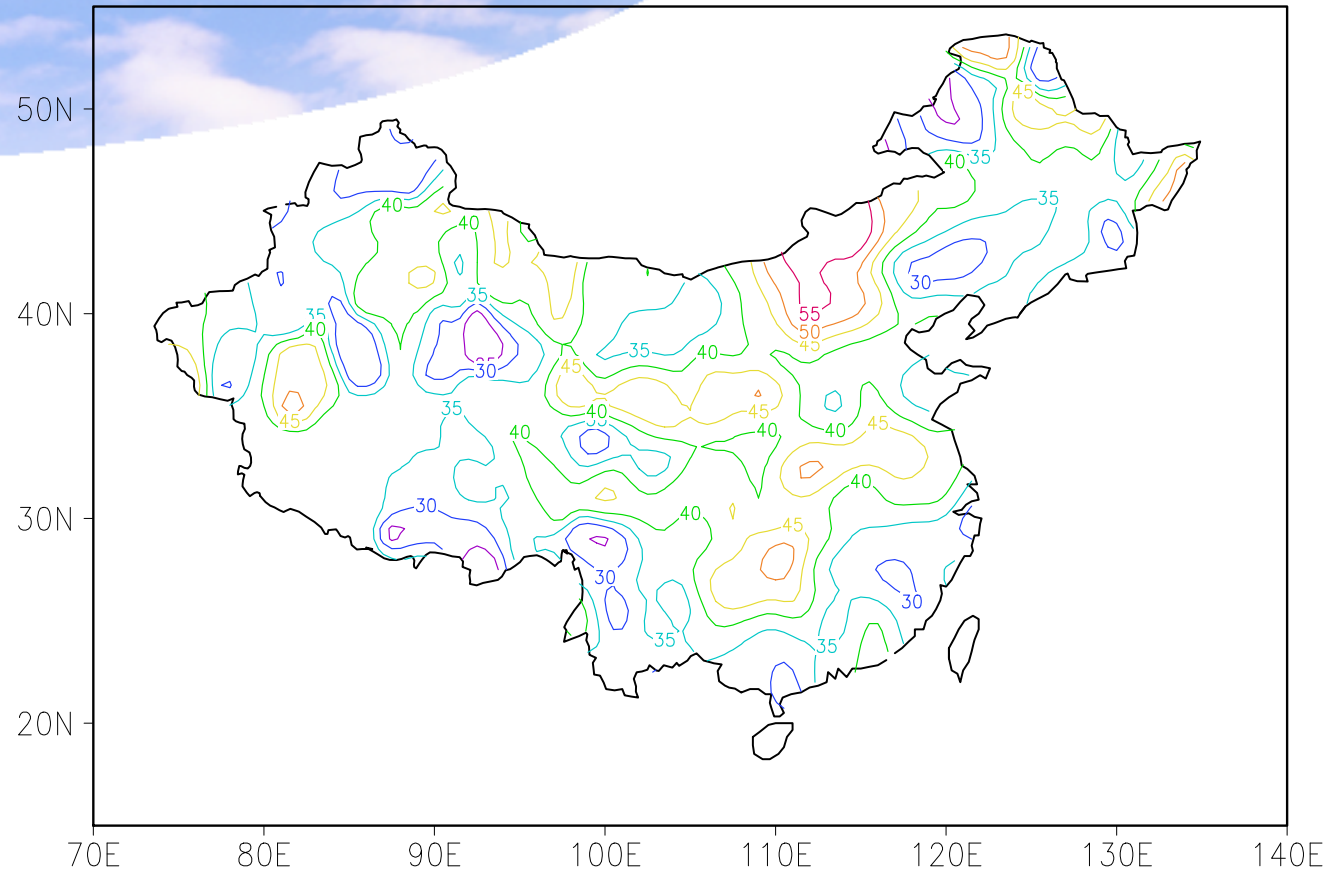
Mode	Pattern	Explained variation	Period (Year)
1	“+ - +” (“- + -”) pattern	10.1%	2~3*, 4~7*
2	More (less) rainfalls in most China	9.2%	2~3*
3	Opposite anomalous rainfall patterns in the northern and the southern part of China	7.4%	2~4*, 5~7





Distributions of the dominant periods exceeding the 95% confidence level in summer rainfalls in China. The shaded circles denotes TBO, while the hollow squares denotes the 3~10-year oscillations.

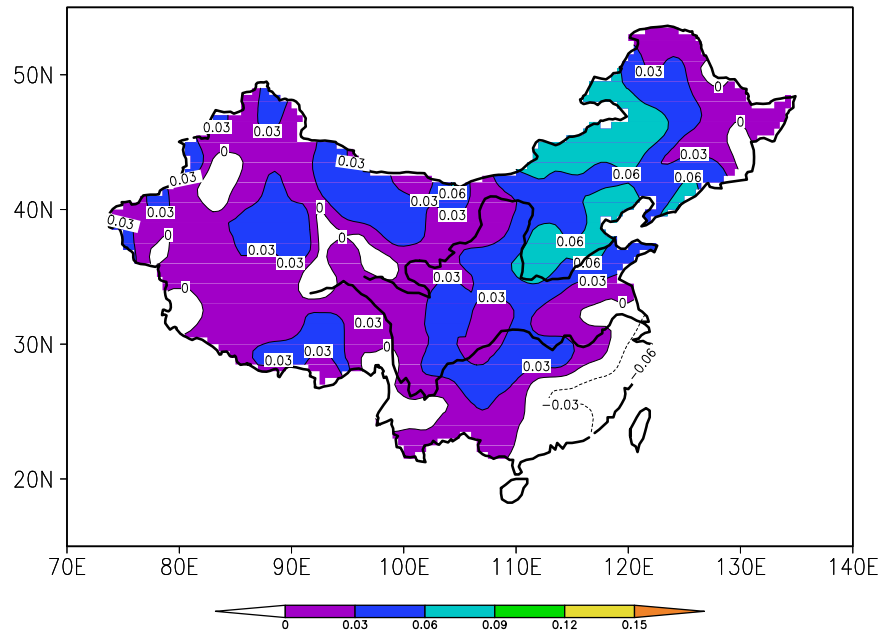




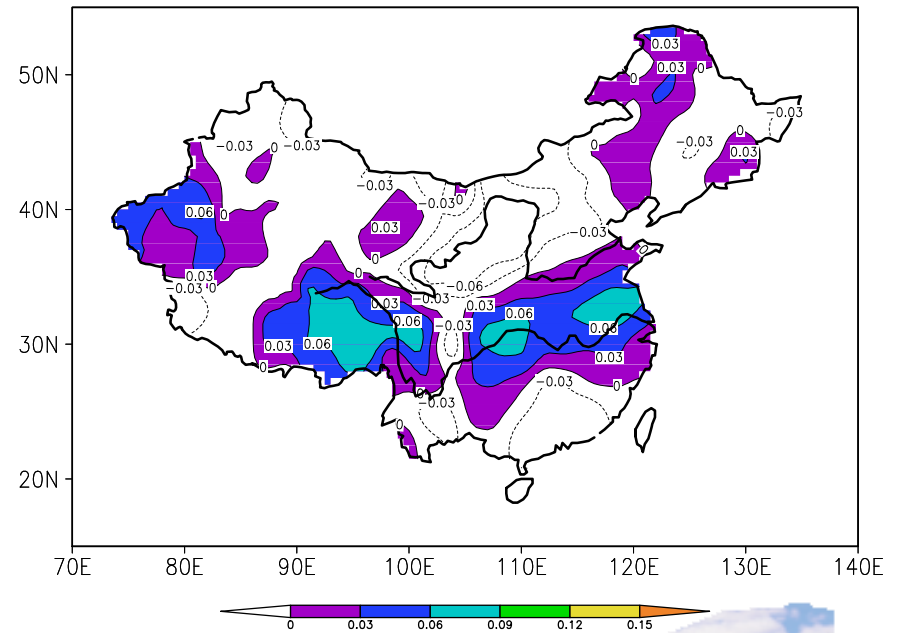
Percentages of variations of TBO to those of the interannual component of summer rainfalls in China



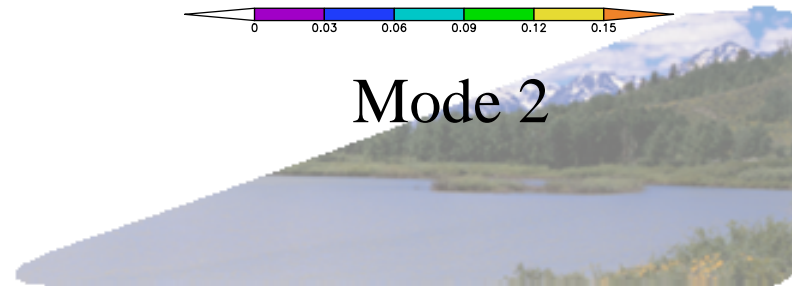
# The dominant modes of TBO of summer rainfalls in China

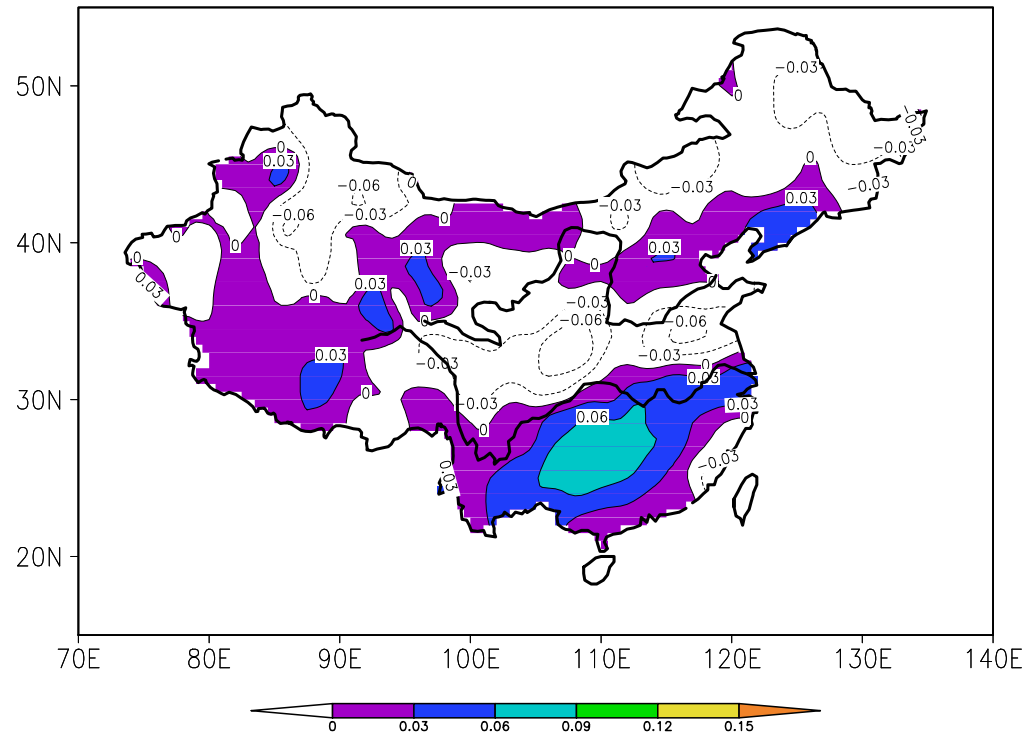


Mode 1



Mode 2



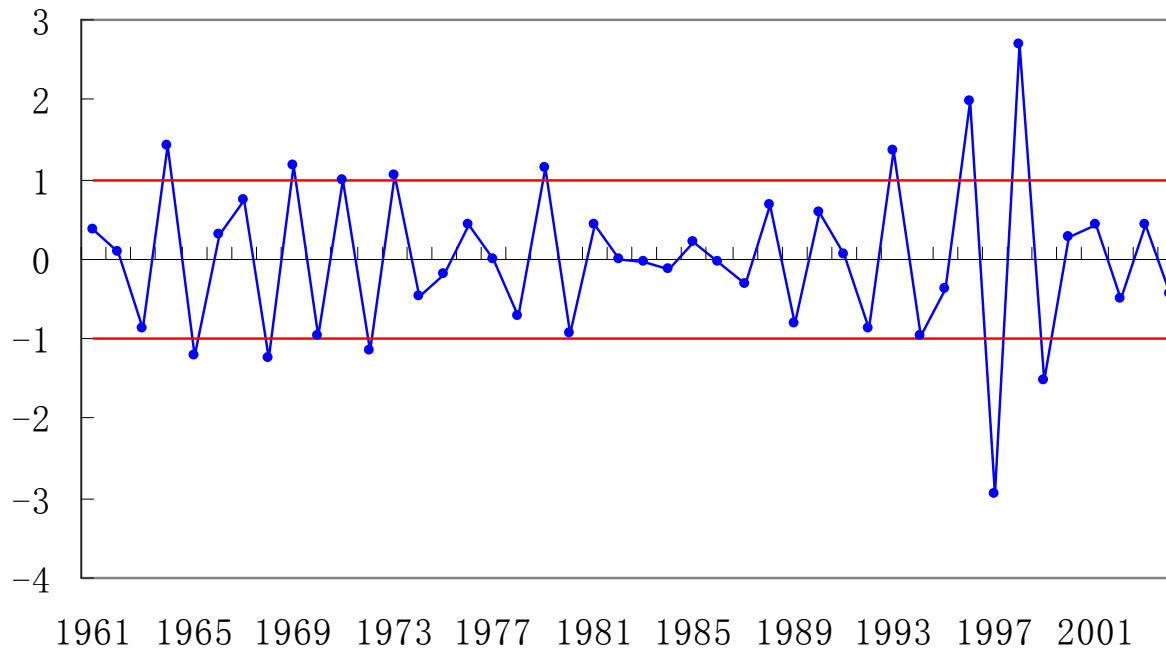


Spatial distributions of three leading modes of TBO of summer rainfalls in China. (a) to (c) denotes the first to the third mode, respectively.

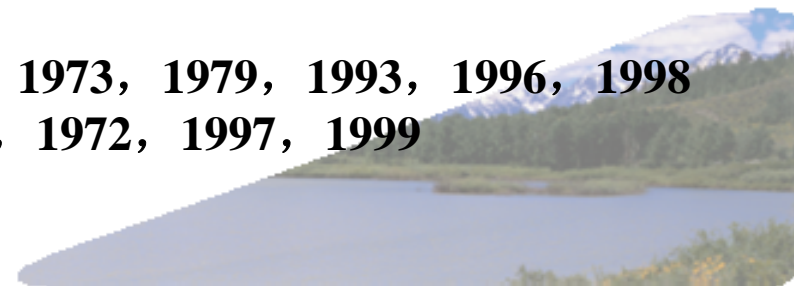
### Mode 3



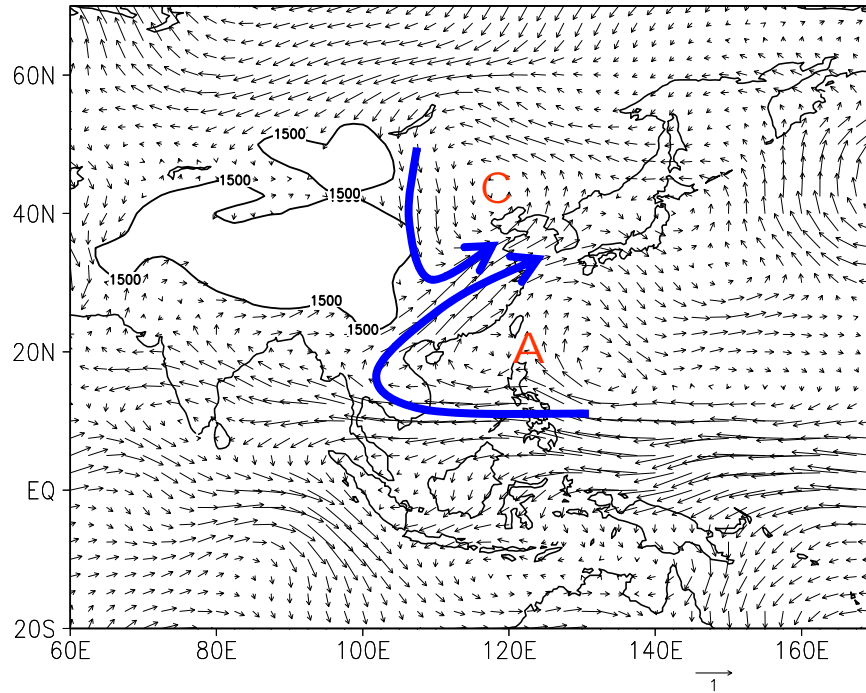
# Large-scale aspects related to the TBO of summer rainfalls in China



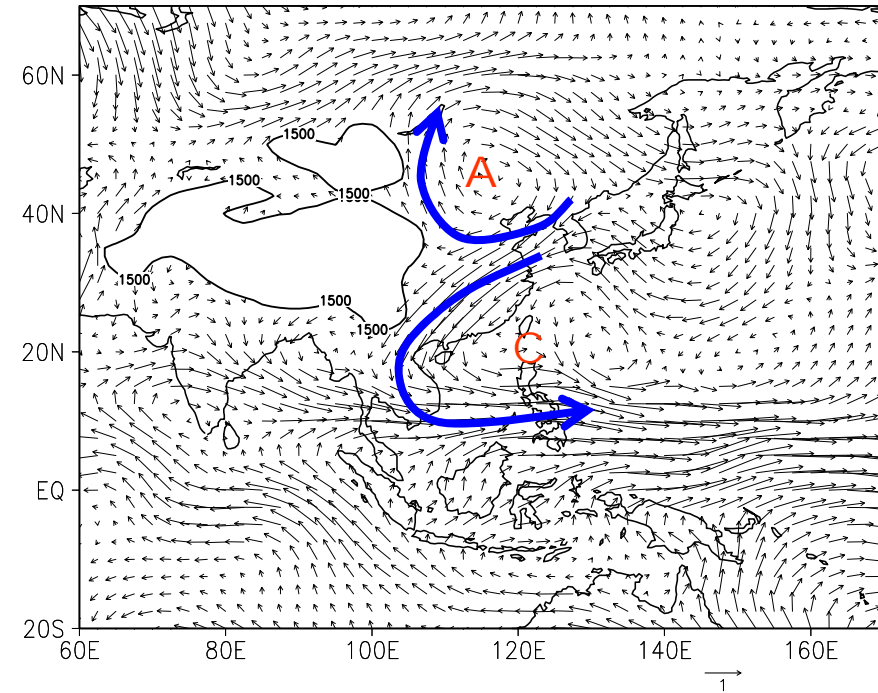
**Positive anomalous years :1964, 1969, 1973, 1979, 1993, 1996, 1998**  
**Negative anomalous years: 1965, 1968, 1972, 1997, 1999**



- **Wind circulations**

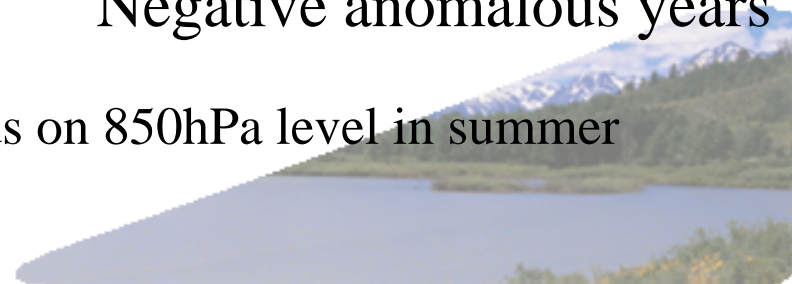


Positive anomalous years

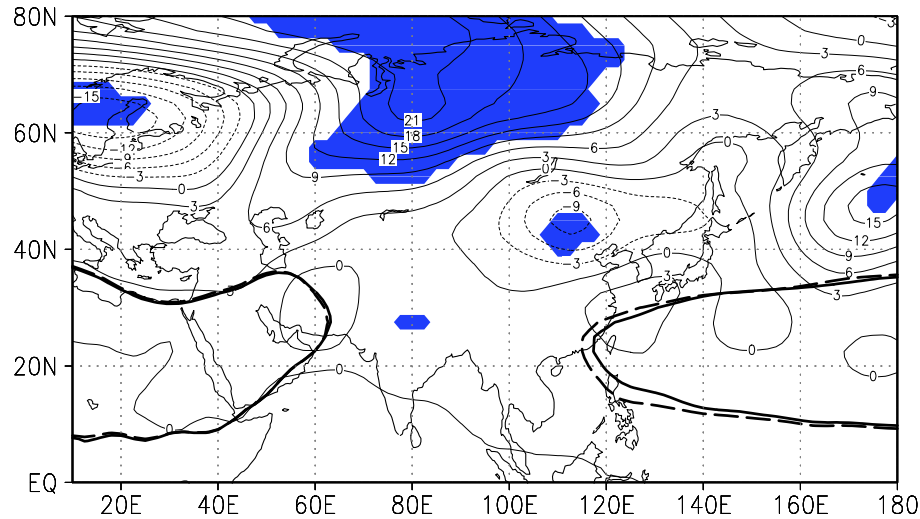


Negative anomalous years

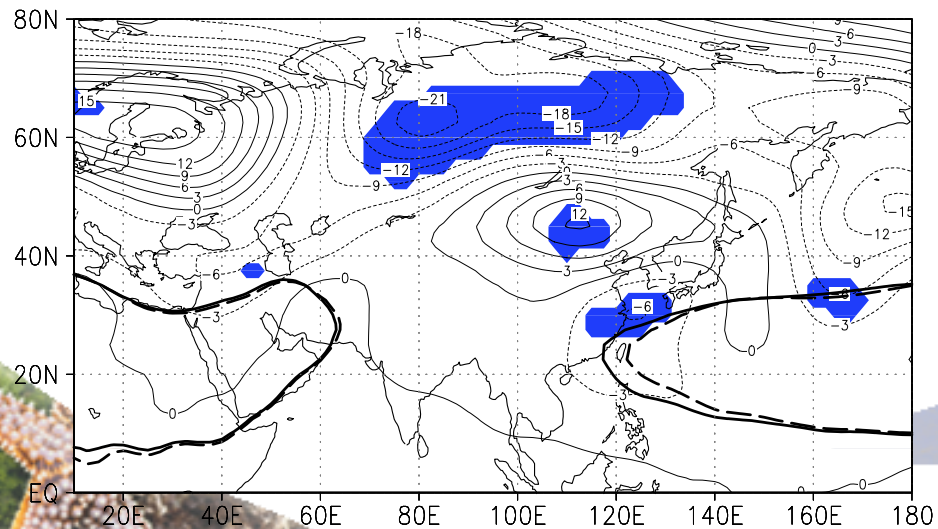
Composite anomalous wind fields on 850hPa level in summer



- **Height fields**

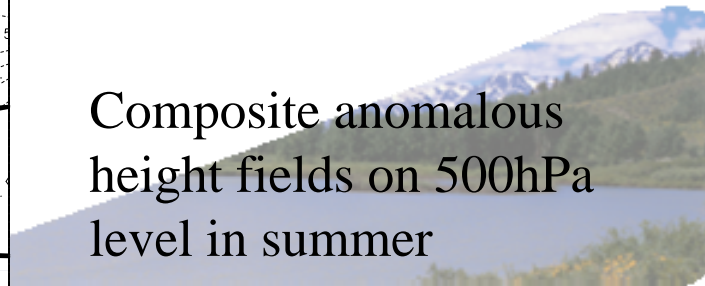
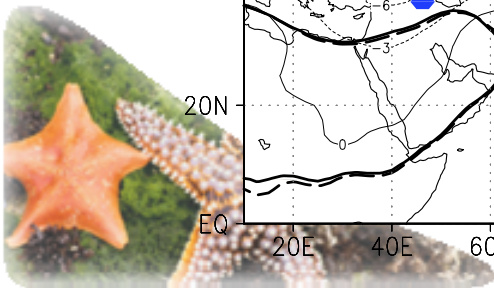


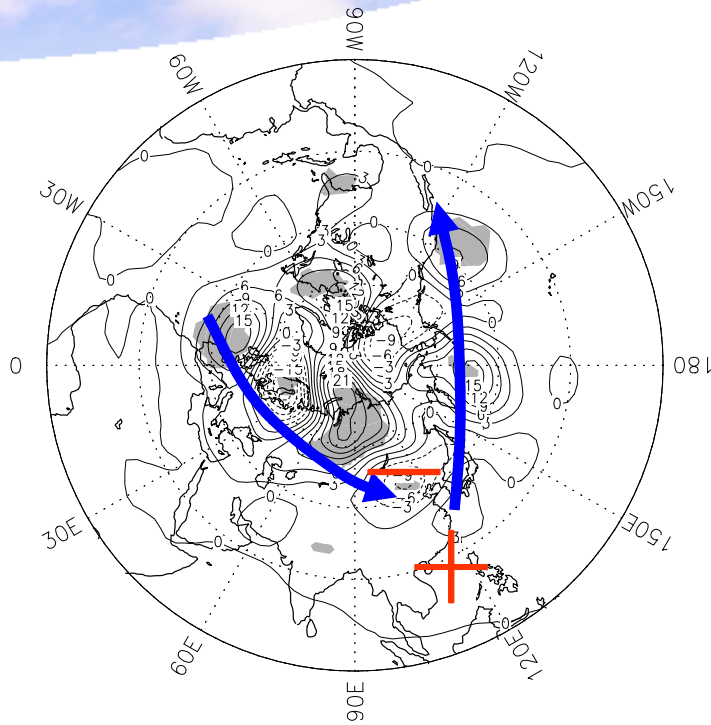
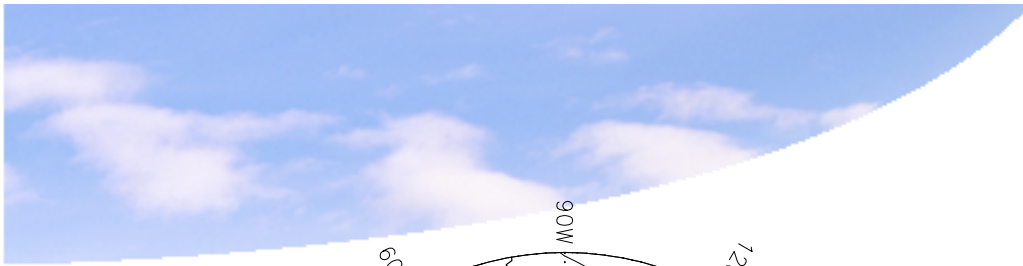
Positive anomalous years



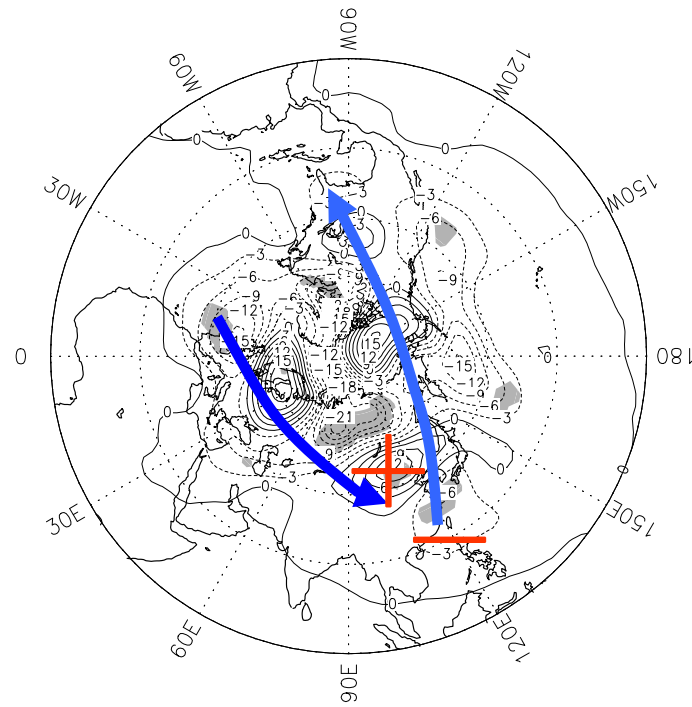
Negative anomalous years

Composite anomalous  
height fields on 500hPa  
level in summer





Positive anomalous years

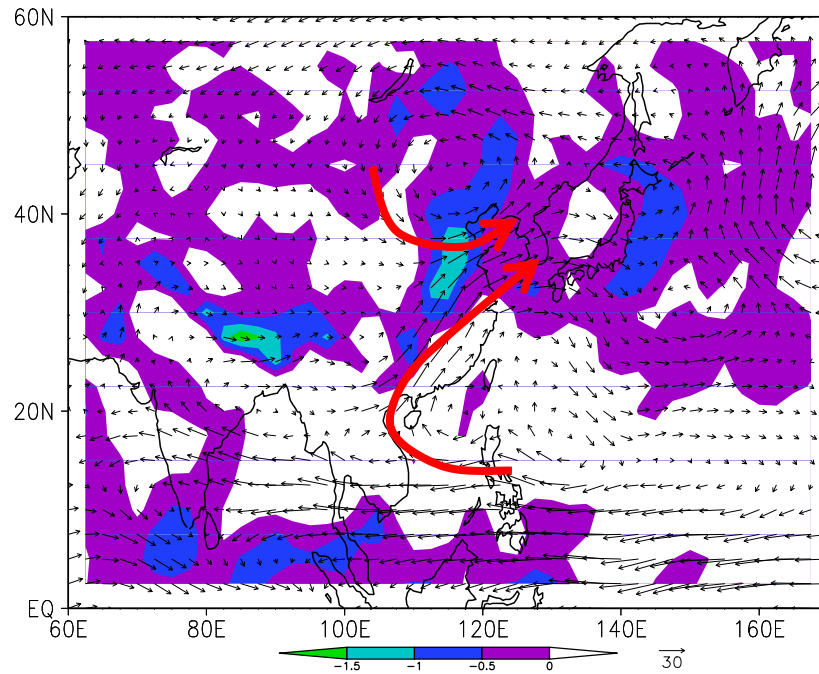


Negative anomalous years

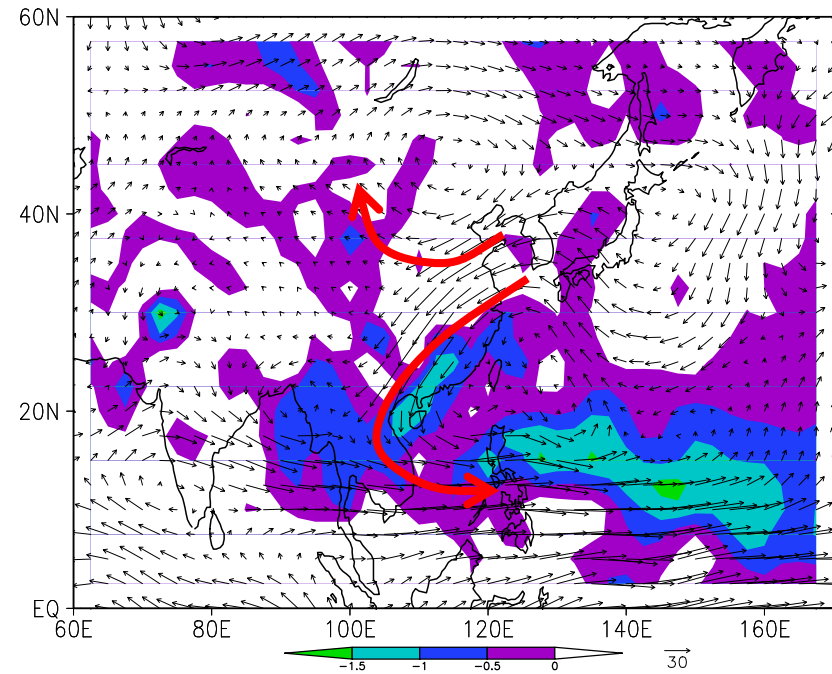
Composite anomalous height fields on 500hPa level in summer



- **Water vapor transport**

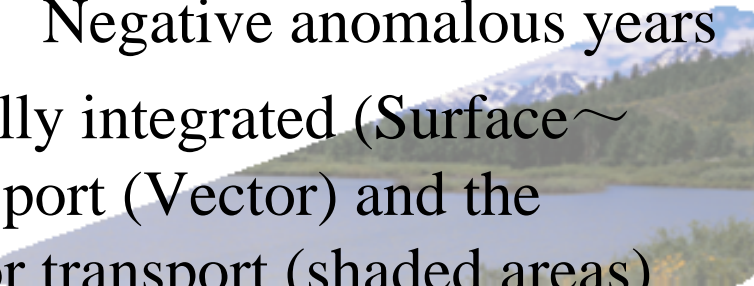


Positive anomalous years

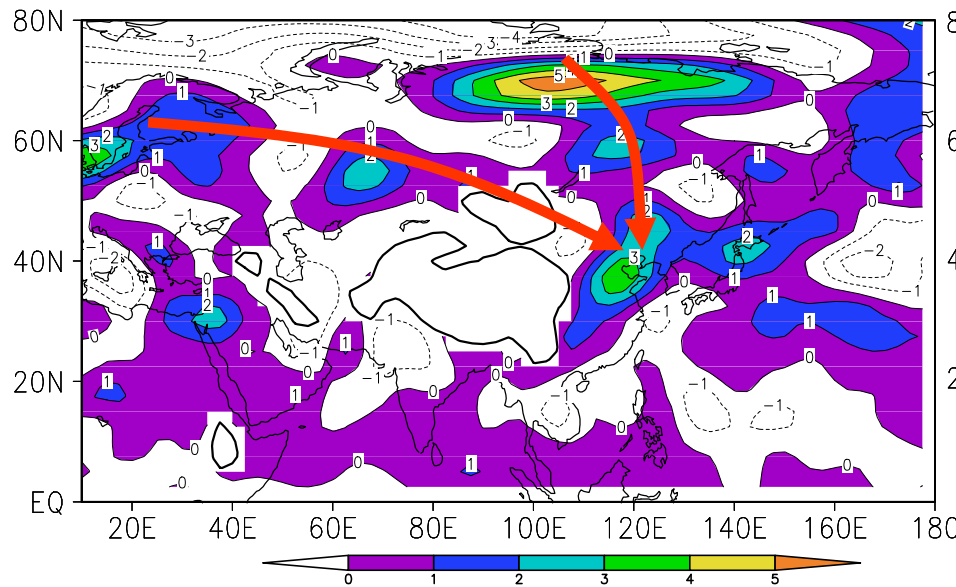


Negative anomalous years

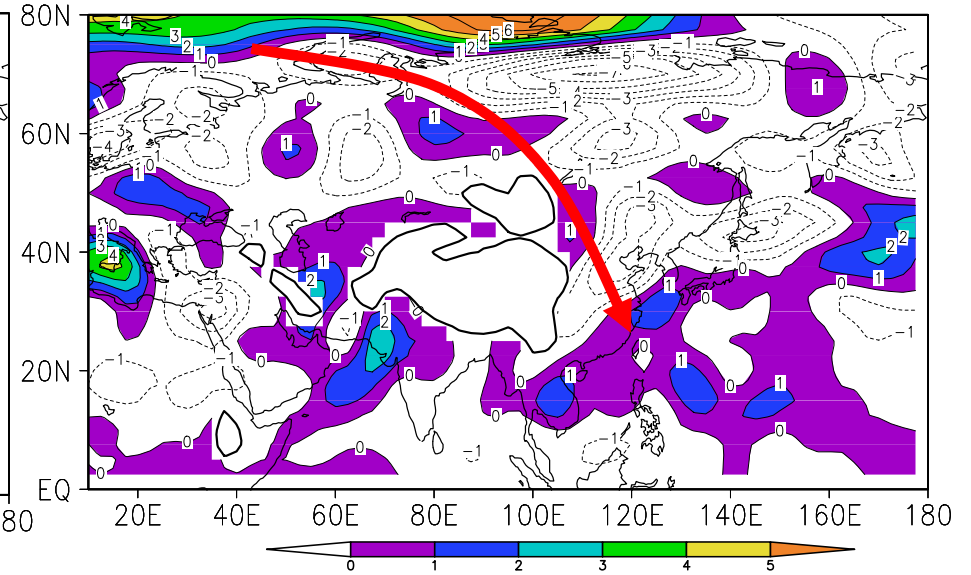
Composite anomalous vertically integrated (Surface ~ 300hPa) water vapor transport (Vector) and the convergence of the water vapor transport (shaded areas)



- **Cold airs' activity**



Positive anomalous years

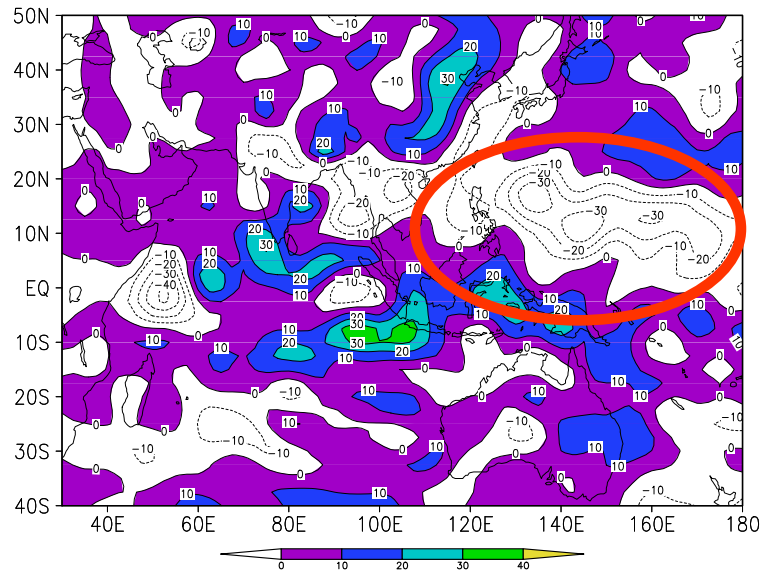


Negative anomalous years

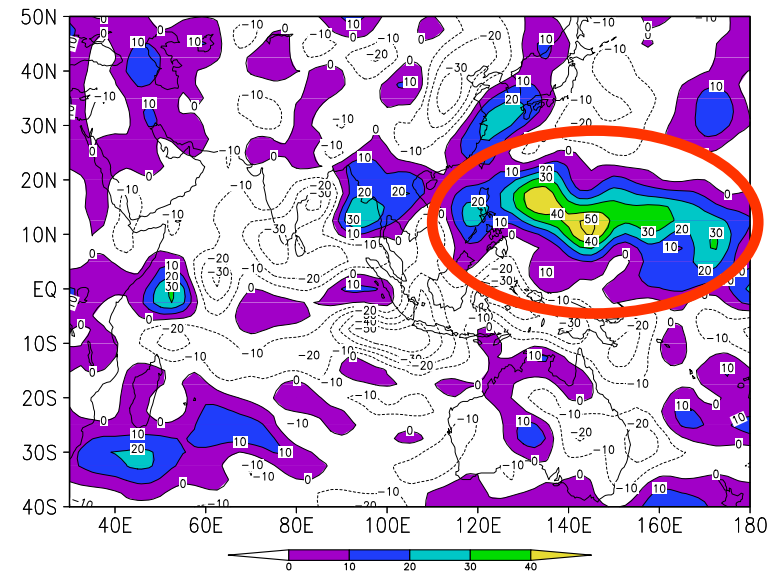
Composite anomalous potential vorticity on 850hPa level



- **Anomalous apparent heat sources**



Positive anomalous years

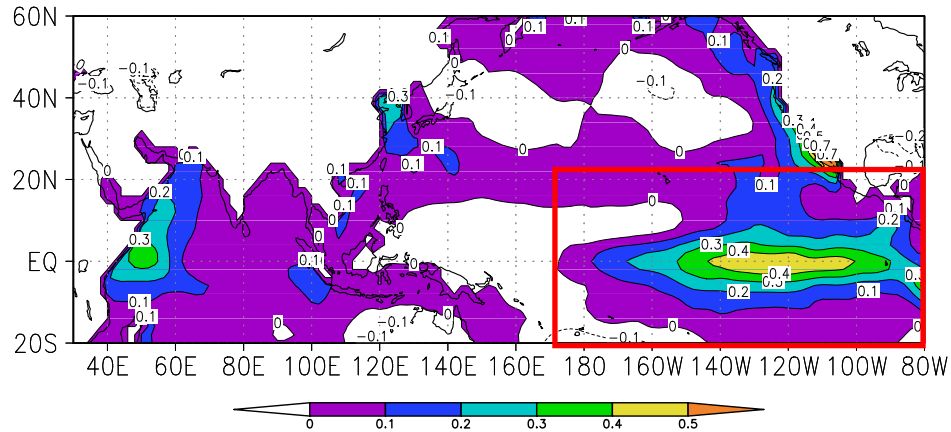


Negative anomalous years

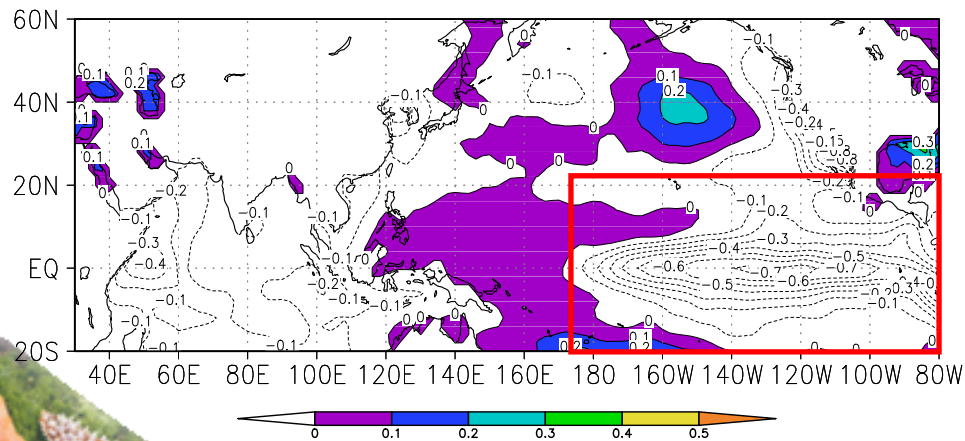
Composite anomalous vertically integrated apparent heat source ( $Q_1$ )



# • Sea surface temperature

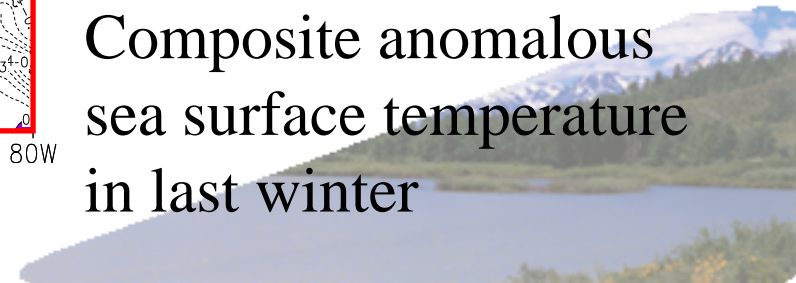
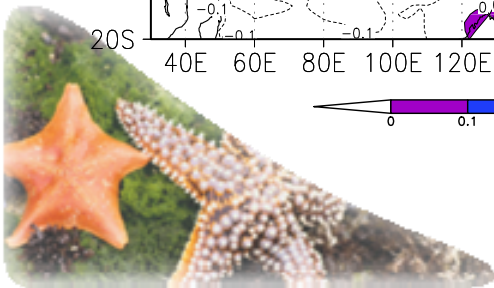


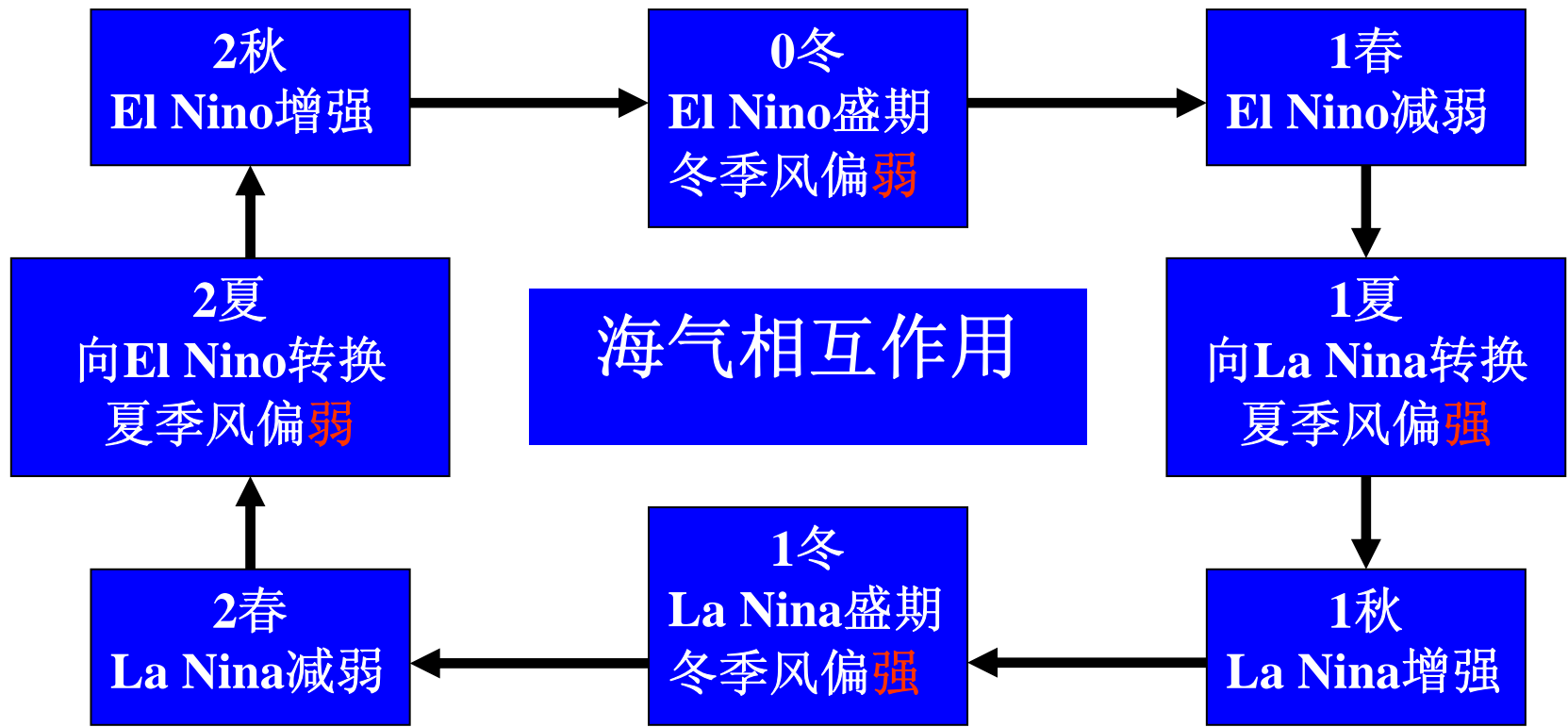
Positive anomalous years



Negative anomalous years

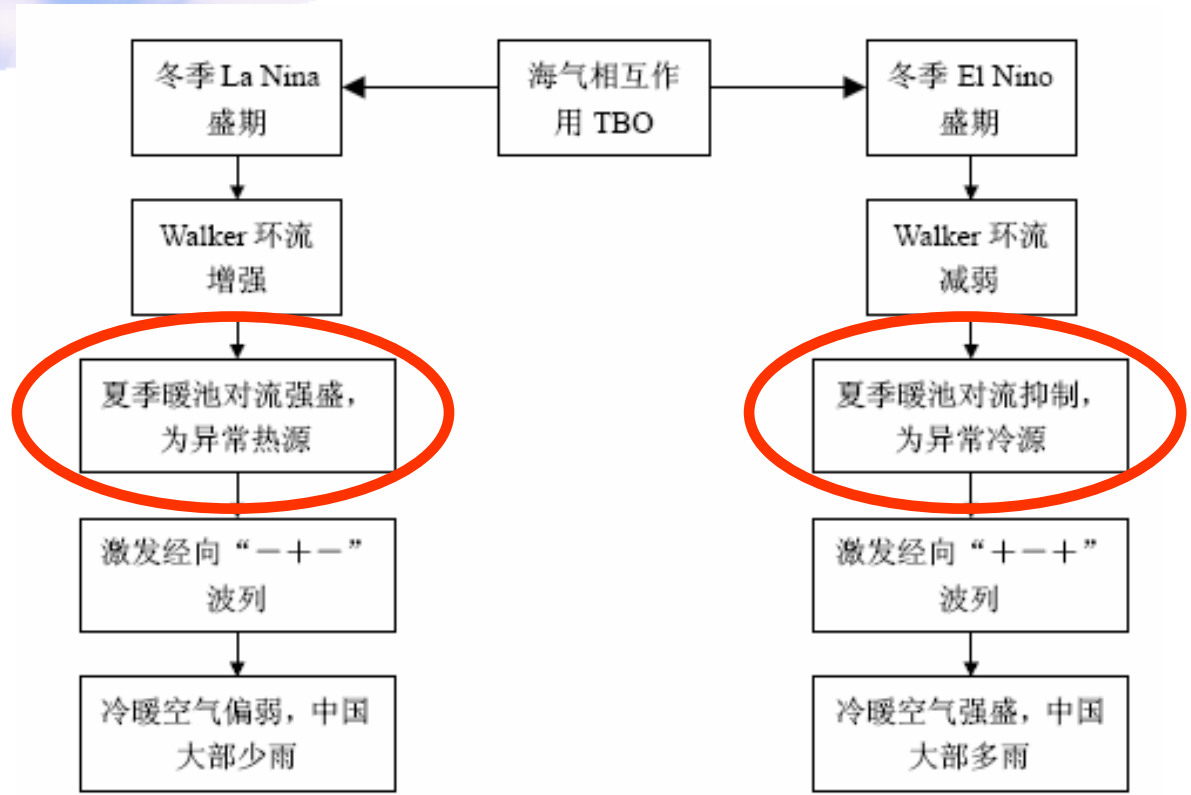
Composite anomalous  
sea surface temperature  
in last winter



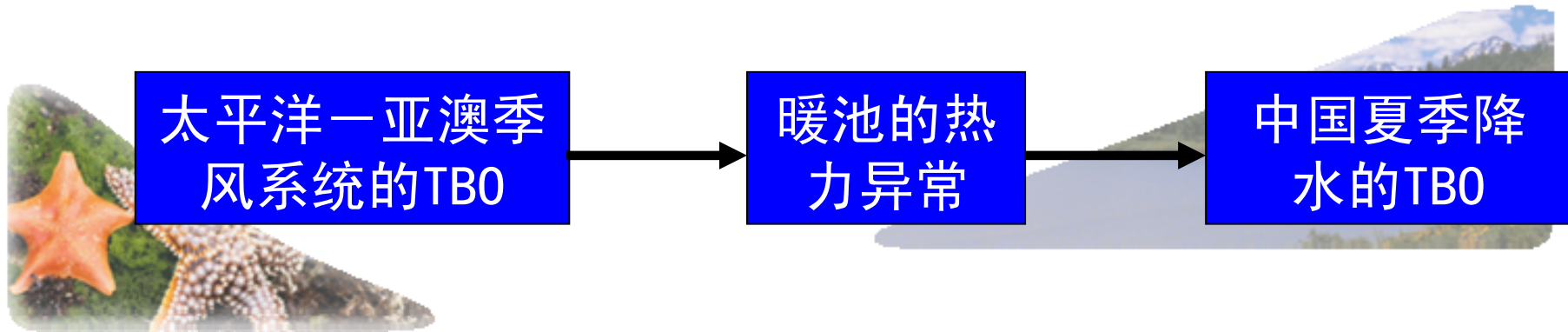


东亚季风、ENSO和TBO的关系示意图



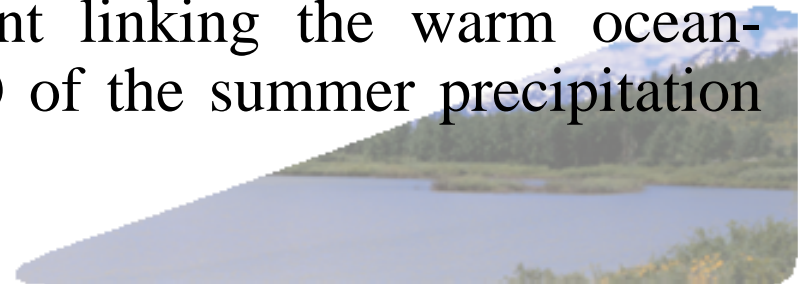


中国夏季降水TBO的可能机制示意图



# Conclusions

- Out of all stations used in this study, 75% demonstrate the existence of the TBO. The regions of the strongest TBO mode are located in the middle Inner Mongolia, the eastern part of West China, the Huaihe River basin and the middle and lower basins of the Yangtze River.
- The three leading modes of the TBO of the summer precipitation in China have been identified.
- A possible mechanism to interpret the TBO of the summer precipitation in China is suggested. This precipitation TBO is a part of the TBO of warm ocean-Asian monsoon system, with the anomalous thermal condition (SST) of the warm pool being a key component linking the warm ocean-monsoon system to the TBO of the summer precipitation in China.





Thank you!

