



# **A study of the teleconnection in the Asian Pacific monsoon region and their impact on precipitation in China**

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# Outline

- 1、 Introduction
- 2、 Teleconnection between onset of the Indian summer monsoon and the Meiyu season in the Yangtze River basin in China
- 3、 Teleconnection between the Indian summer monsoon and precipitation in North China
- 4、 Conclusions





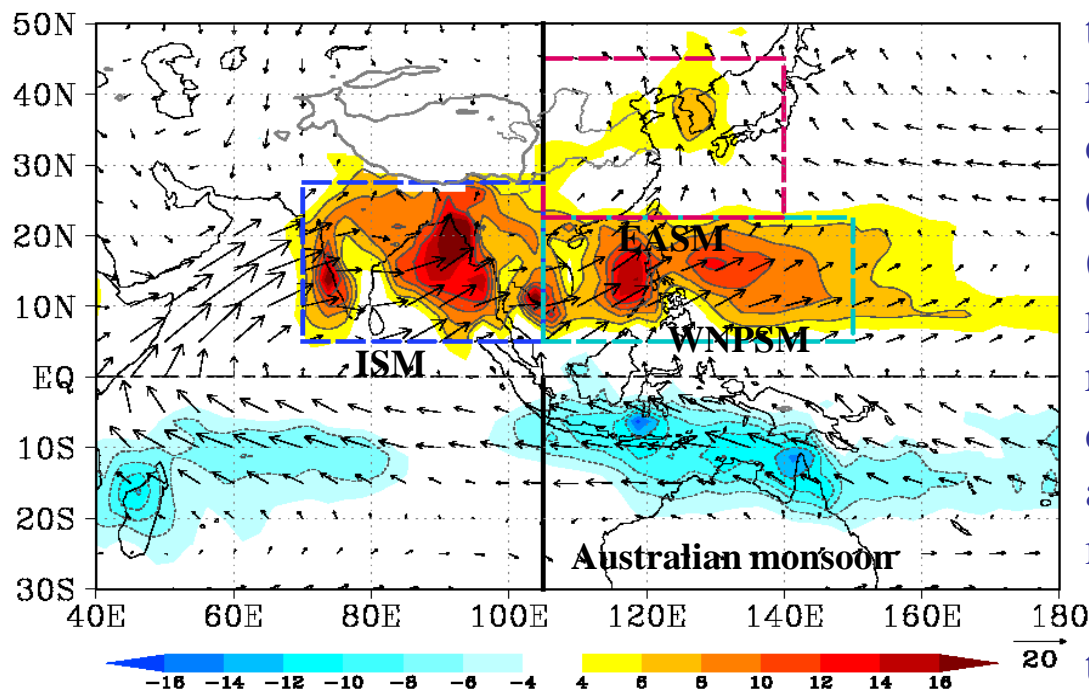
# 1、 Introduction





# 亚洲太平洋季风区

## Asian -Pacific Monsoon Region



(a)

Figure 1 (a) Climatological July-August mean precipitation rates (color shading in mm/day) and 925 hPa wind vectors (arrow) in the Asian-Australian monsoon region. The precipitation and wind climatology are derived from CMAP (Xie and Arkin 1997) (1979-2000) and NCEP/NCAR reanalysis (1951-2000), respectively. The three boxes define major summer precipitation areas of the Indian tropical monsoon ( $5^{\circ}$  N- $27.5^{\circ}$  N,  $65^{\circ}$  E- $105^{\circ}$  E), western North Pacific tropical monsoon ( $5^{\circ}$  N- $22.5^{\circ}$  N,  $105^{\circ}$  E- $150^{\circ}$  E), and the East Asian subtropical monsoon (Wang et al., 2005).

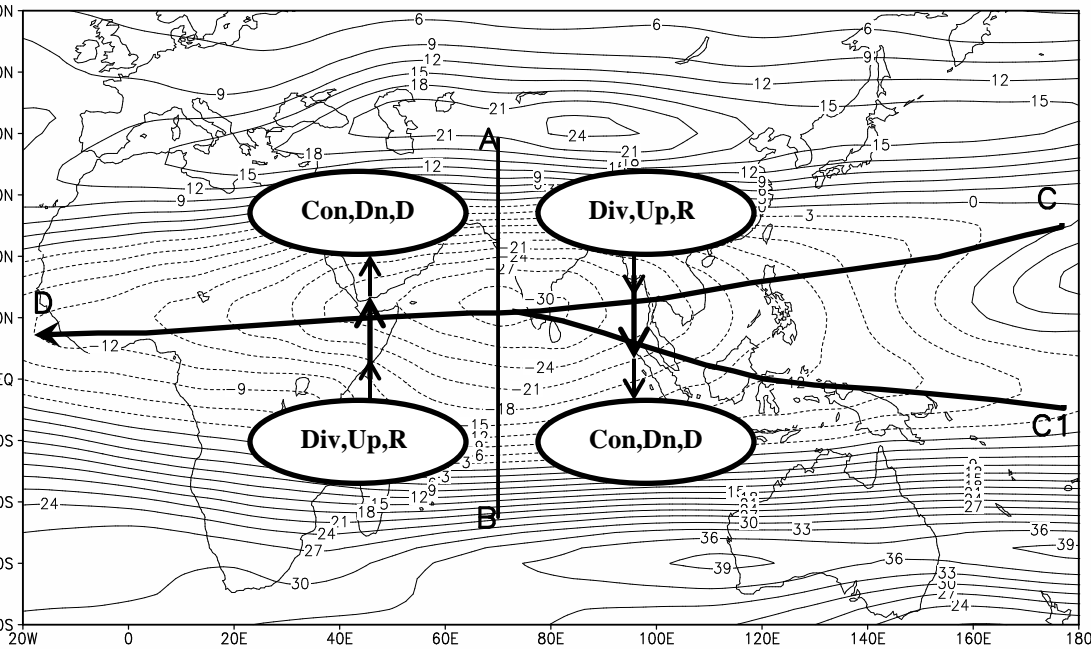




# 热带东风急流

## Tropical Easterly Jet

(b) Climatological mean tropical easterly jet (150-100 hPa layer) over the Asian-African monsoon region averaged for summer (JJA) of 1958-2002. Isolines (Dashed: easterly; and solid: westerly wind) denote mean wind speed for 150-100 hPa layer. CD and C1D are jet axis. AB is the demarcation line of entrance (right) and exit (left) zone. Div: divergence, Con: convergence, Up: upward motion, Dn: downward motion, R: rainfall region, and D: dry region. Unit: ms<sup>-1</sup>.



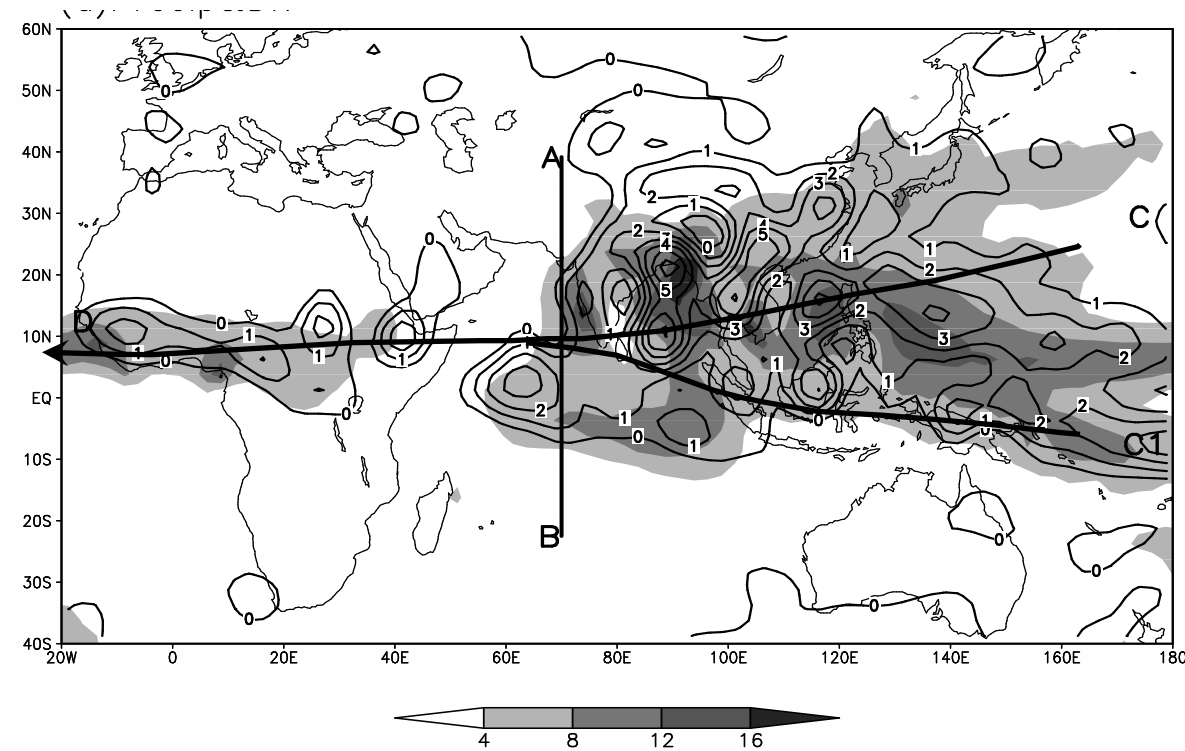
(b)





# 季风区夏季降水

## Summer (JJA) Precipitation for Asian Monsoon Region



(c)

(c) Same as (b),  
but for rainfall and  
divergence (Unit:  
 $10^{-6} \text{s}^{-1}$ ). Shaded  
areas:  $>4 \text{mm day}^{-1}$   
(Chen et al., 2006)

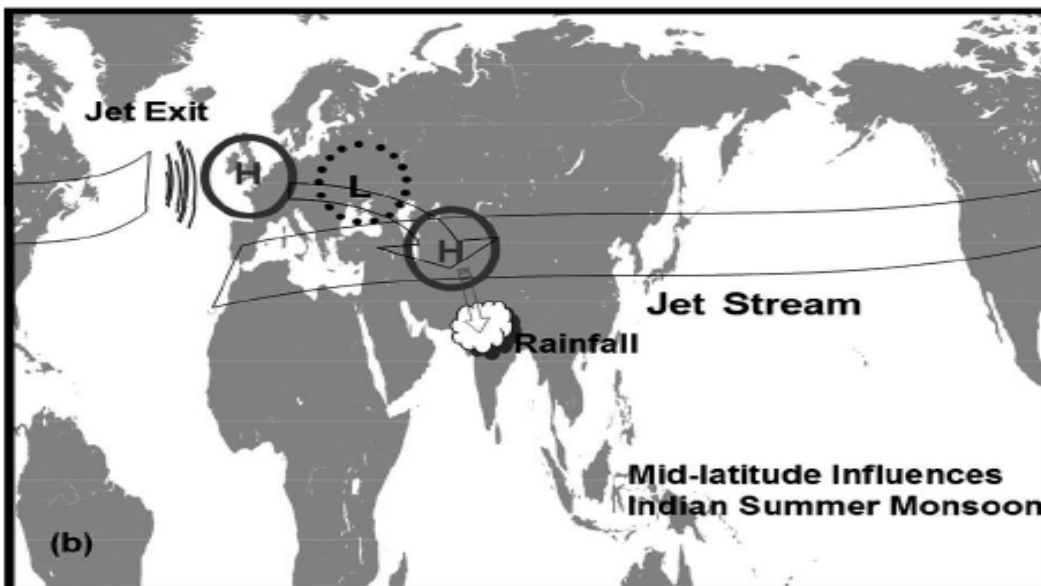
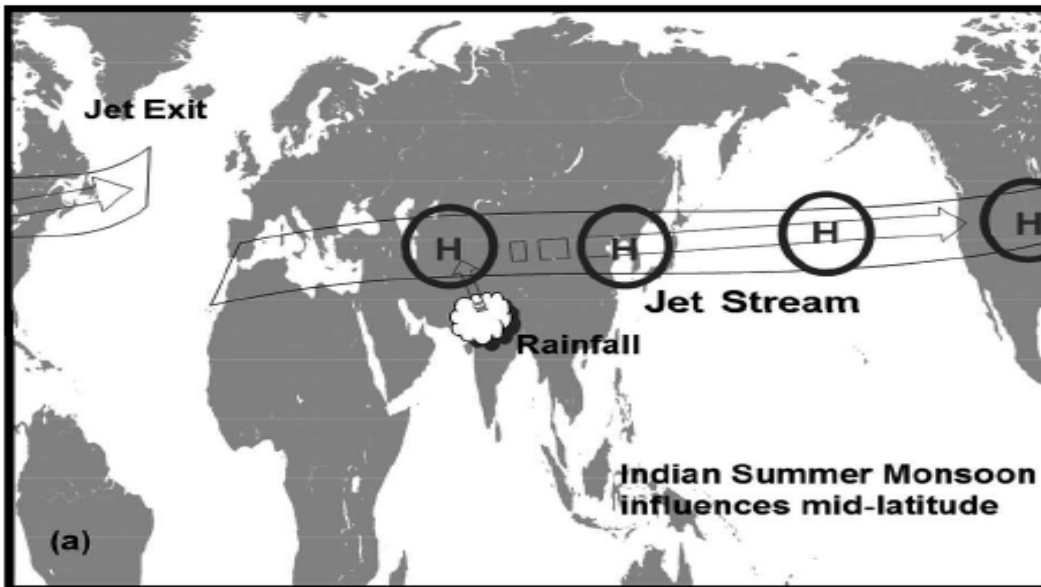




## A summary of teleconnection patterns in the Asian monsoon region



Investigators	Names	Origin regions and propagating routes
Nitta (1987) Huang and Wu (1989)	Japan-Pacific pattern (JP) or East Asia/Pacific pattern (EAP)	Anomalous convective activities over tropical western North Pacific From Philippine Sea across East Asia to Japan
Wang et al. (2000)	Pacific-East Asia teleconnection pattern (PEA)	ENSO events have a delayed impacts on the East Asian summer monsoon via development of anticyclonic anomaly over Philippine Sea.
Wang et al. (2001) Li and Zhang (1999)	WNP-North America Teleconnection pattern	Strong summer monsoon over Western North Pacific (WNP) From WNP crossing North Pacific to North America
Lau and Weng (2002) Lau et al. (2004)	Tokyo-Chicago Express	Rainfall anomalies over Japan and northeastern China From Japan and Northeast China, crossing North Pacific, to Western Canada, the northern Great Plains and Mid-west of US
Lau et al. (2004)	Shanghai-Kansas Express	Fluctuations of heat sources and sinks in the Indo-Pacific monsoon region. Emanating from central East Asia across North Pacific to North America
Guo and Wang (1988); Kripalani and Kulkarni (1997; 2001)	India-North China pattern	Summer precipitation over Indian Peninsula From Indian Peninsula across the Tibetan Plateau to North China and further to Japan
Ding and Wang (2005)	Circumglobal teleconnection pattern	The heat source produced by abnormal Indian summer monsoon and the jet exit region of the North Atlantic From Northwest India/Pakistan, crossing East Asia and North Pacific to North America or From Western Europe, across European Russia, India and East Asia, to North America



## Global Teleconnection





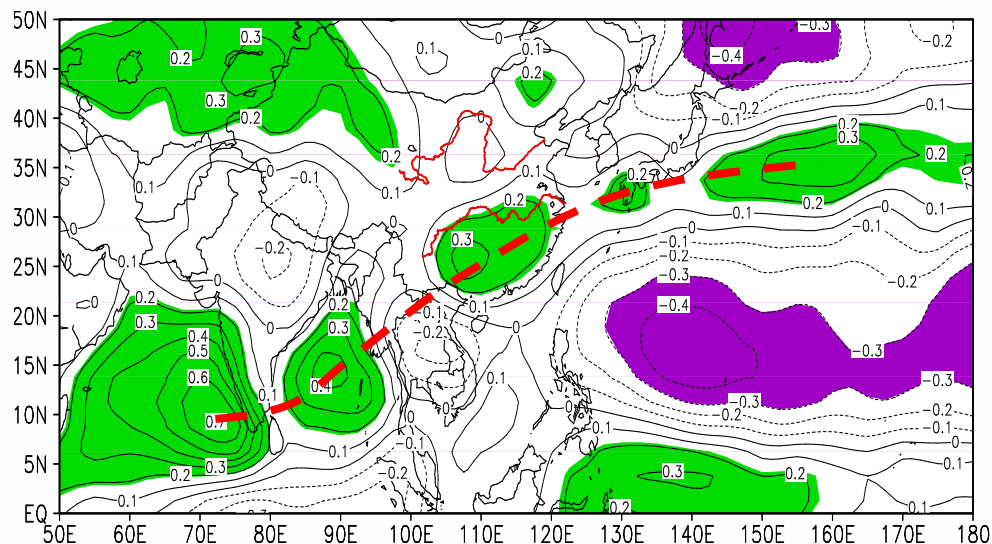
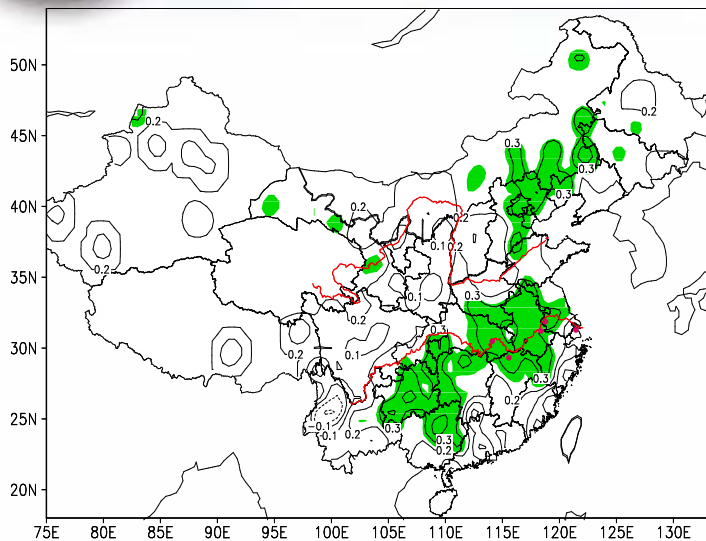
## **2、 Teleconnection between onset of the Indian summer monsoon and the Meiyu season in the Yangtze River basin in China**





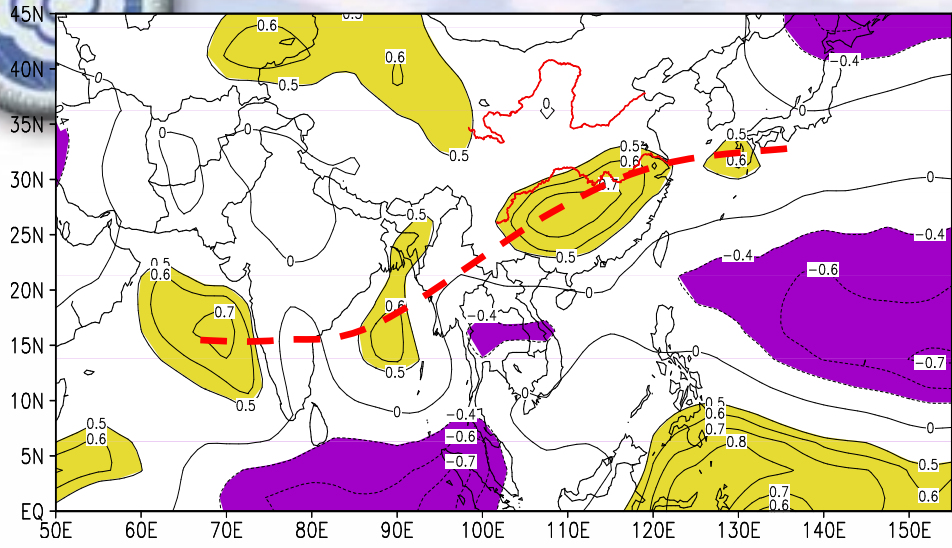
# 克拉拉邦季风降水与中国及亚洲季风区降水的相关

**Correlation between summer precipitation in Kerala and that over the Asian monsoon region (right panel) and China (left panel)**



克拉拉邦 (Kerala) 季风降水与同期中国160站降水 (左图) 及亚洲季风区降水 (右图) 的相关分布





克拉拉邦侯平均降水与滞后3侯的亚洲季风区降水的相关分布（阴影区为通过99%信度检验的显著相关区）

Same as the above slide, but for lag-correlation by 3 pentads

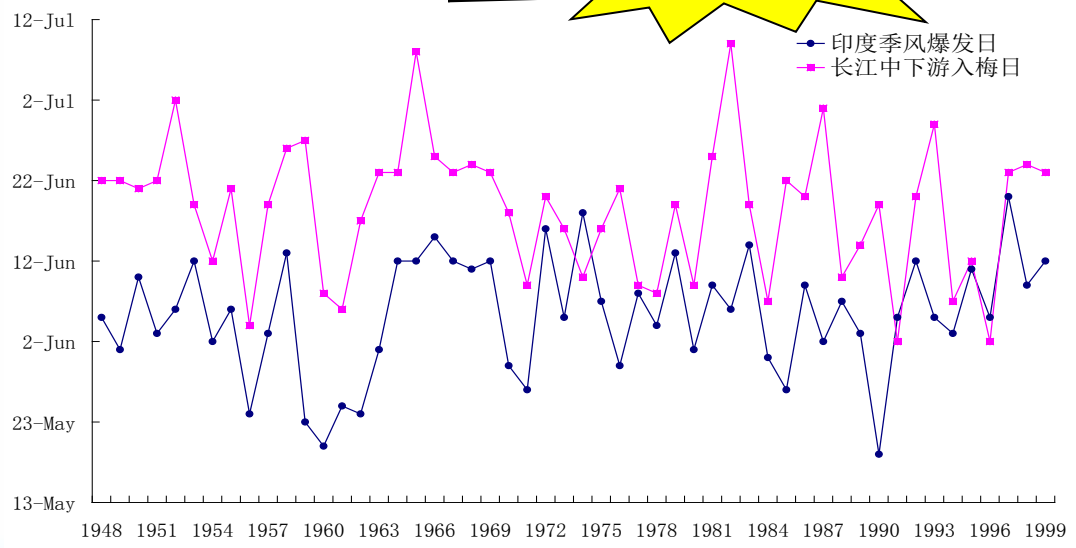
**相关系数：0.3**

印度夏季风爆发日与中国长江流域入梅日的时间序列

印度季风平均爆发日：**6月5日**

长江流域平均入梅日：**6月18日**

**Time series of onset dates for India and Yangtze River basin Meiyu**

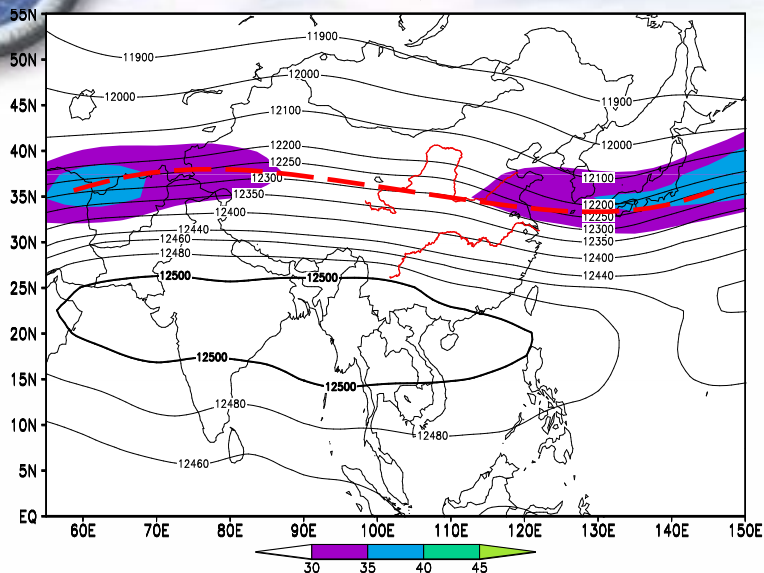




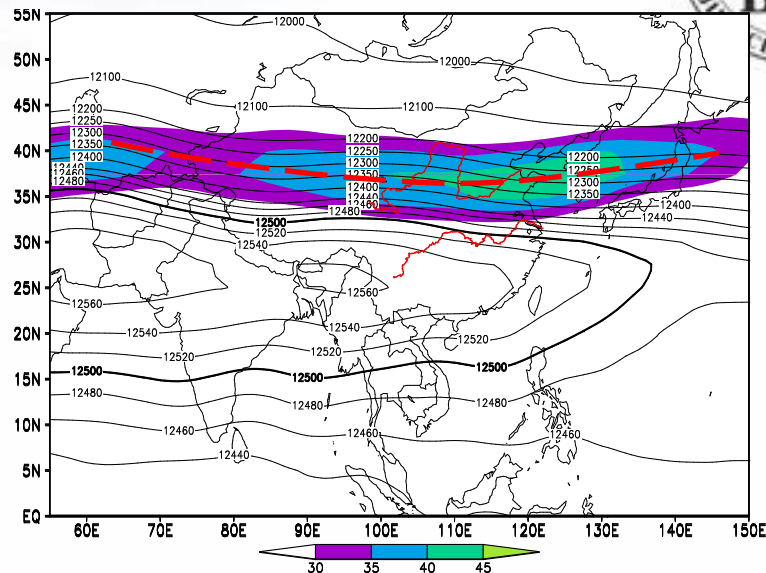
# 200hPa高度场的变化



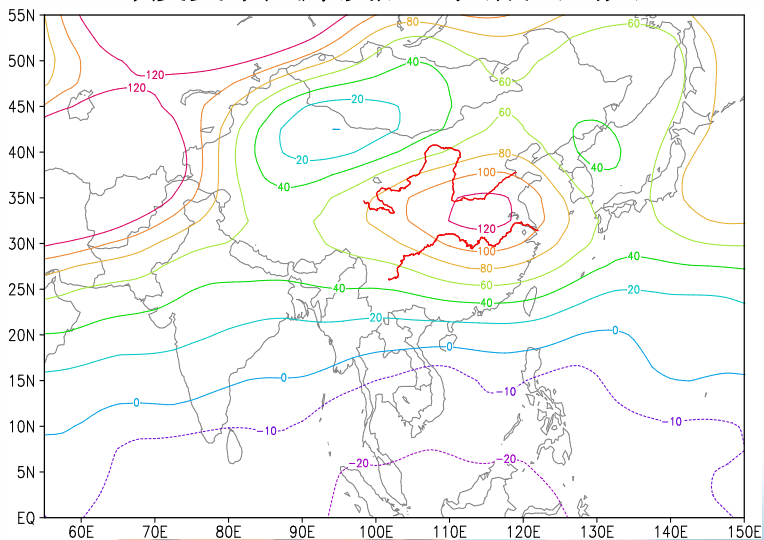
### 印度夏季风爆发当天



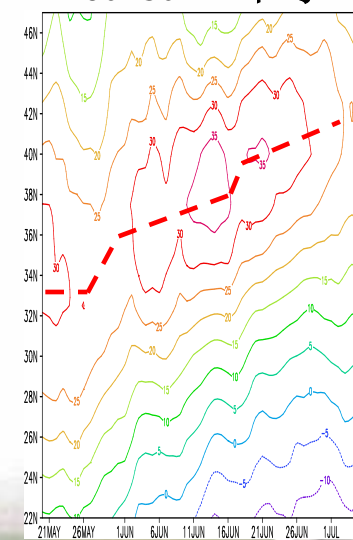
### 印度夏季风爆发后13天



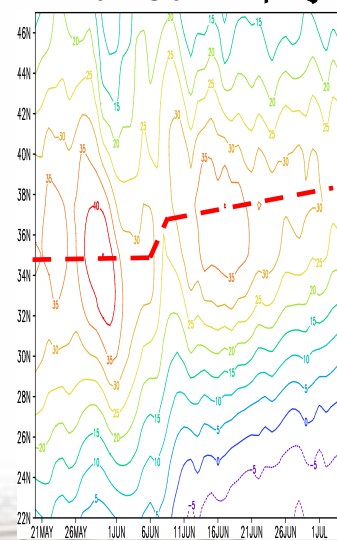
### 印度夏季风爆发后13天减去当天



### 60~80° E平均



### 110~130° E平均

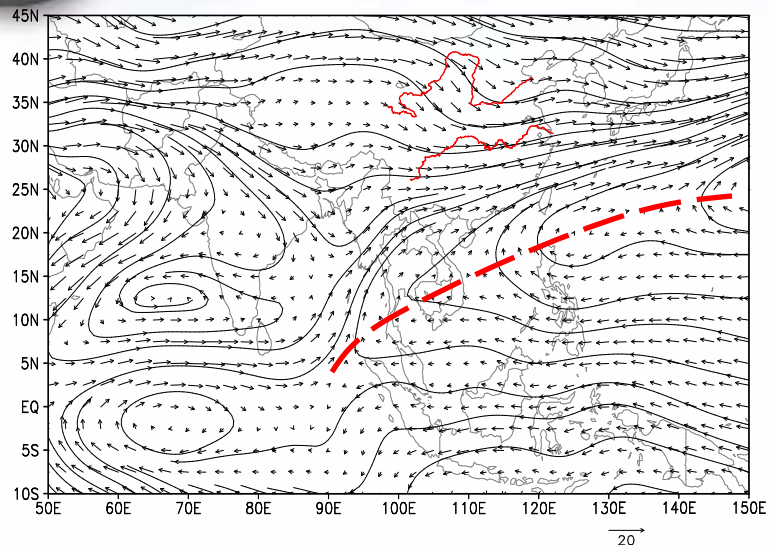




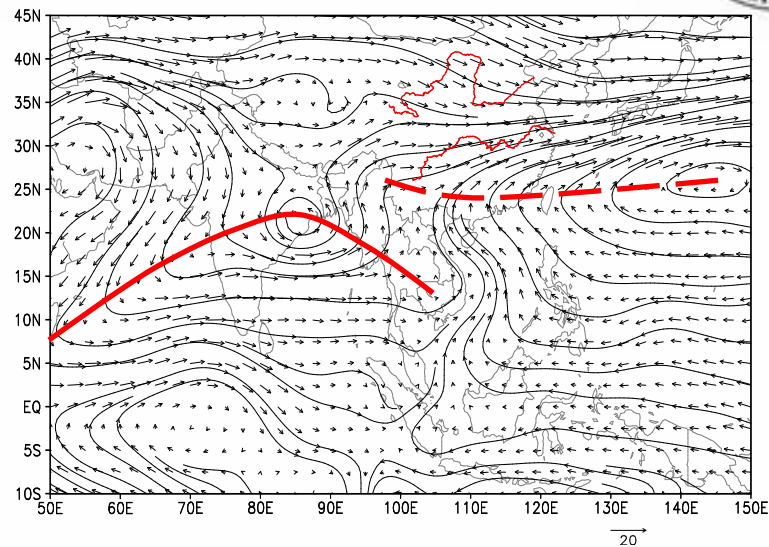
# 500hPa风场的变化



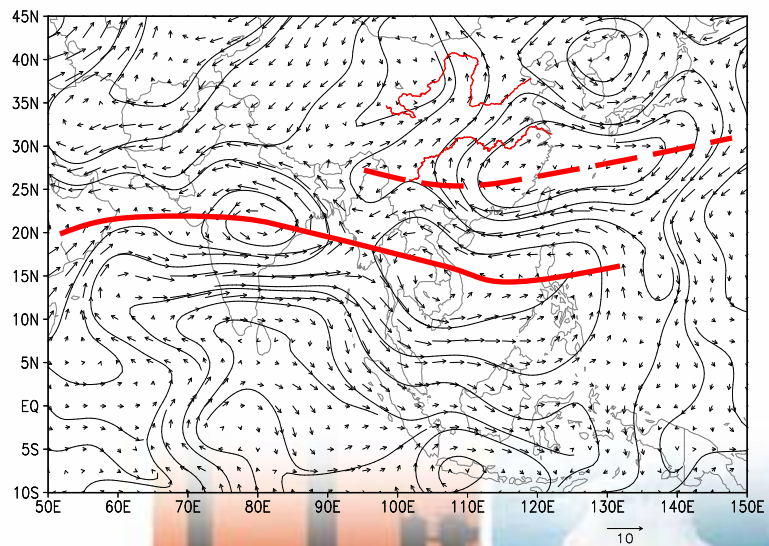
### 印度夏季风爆发当天



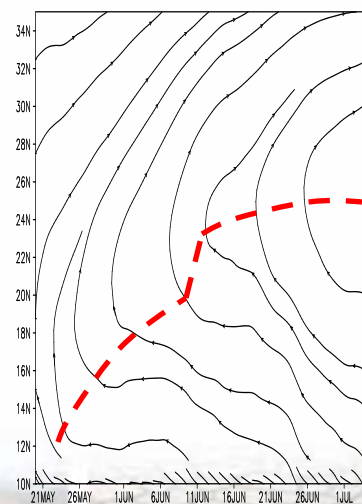
### 印度夏季风爆发后13天



### 印度夏季风爆发后13天减去当天



### 120~150° E平均

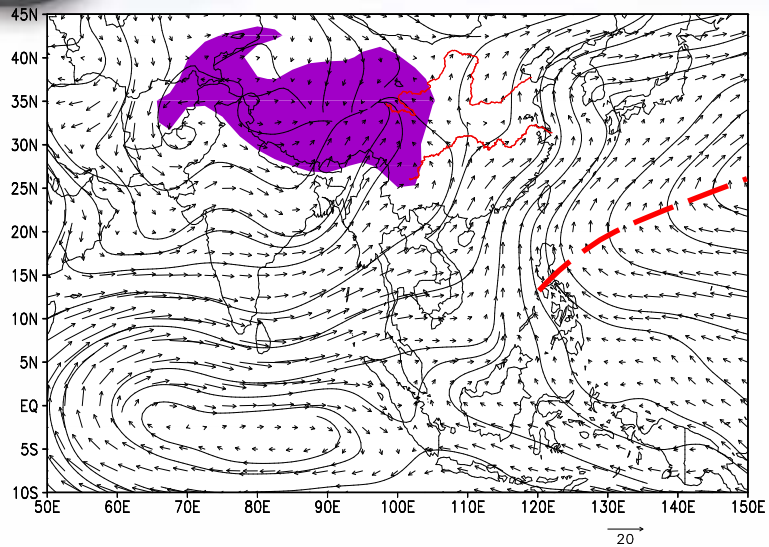




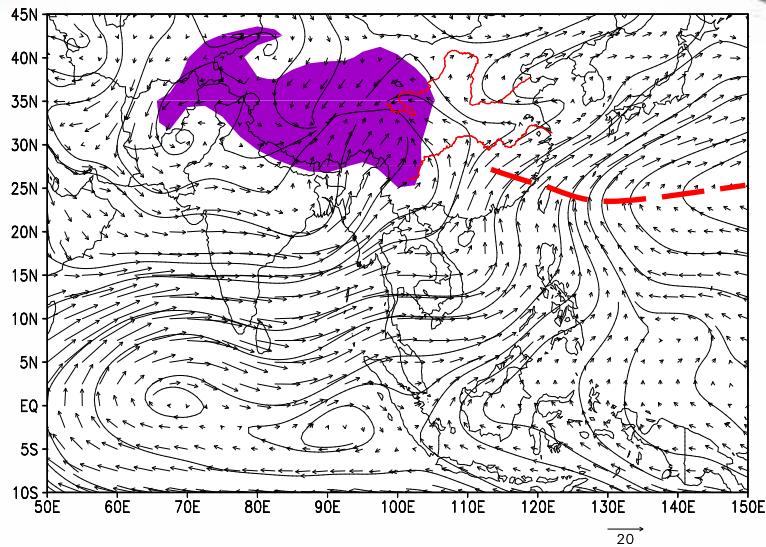
# 850hPa风场的变化



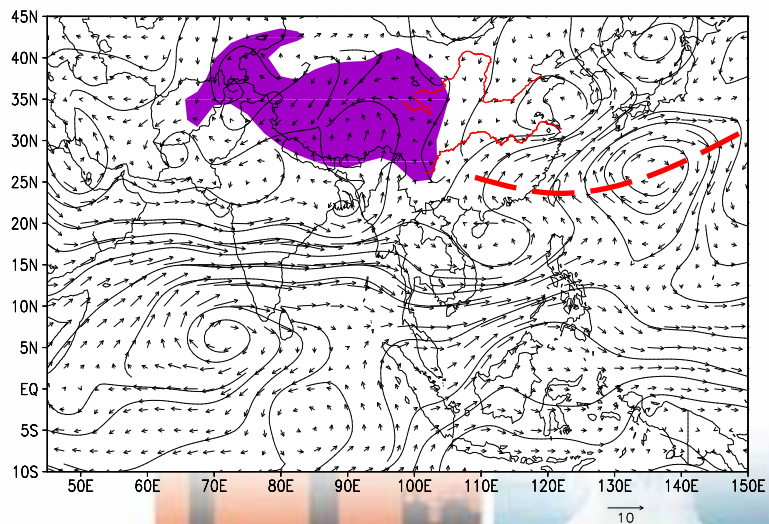
### 印度夏季风爆发当天



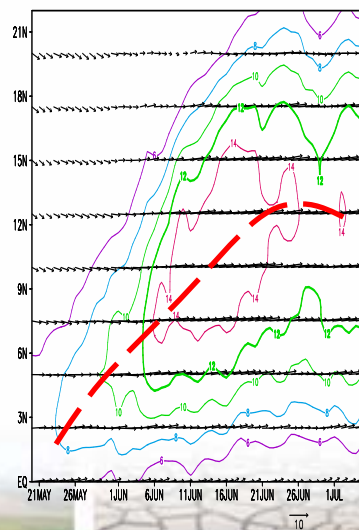
### 印度夏季风爆发后13天

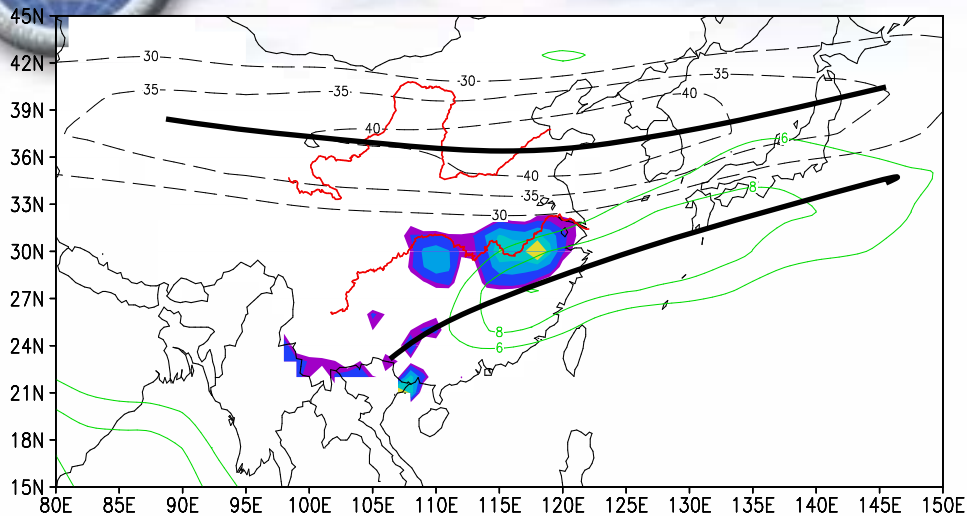


### 印度夏季风爆发后13天减去当天



### 60~90° E平均





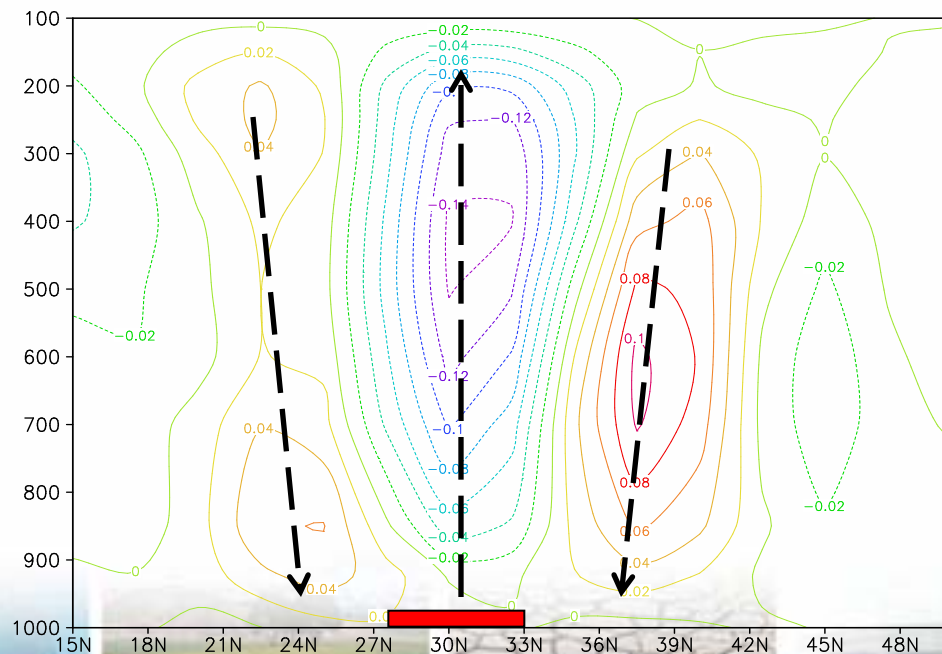
## 印度夏季风爆发13天后长江流域 高空西风急流和低空急流分布

(虚线表示200hPa等风速线, 实线表示850hPa等风速线, 粗实线代表急流轴位置, 阴影代表梅雨总量大于200mm的区域)

### Coupling Pattern of upper westerly jet and LLJ on the 13th day after onset of Indian summer monsoon

## 印度夏季风爆发后13天沿 120° E的垂直速度的分布

(箭头代表大气运动方向, 红色阴影代表梅雨区)





# 小结

- 印度西南部的克拉拉邦地区夏季风爆发后两周左右，中国长江流域梅雨开始。
- 印度夏季风爆发后通过从印度西海岸经孟加拉湾到达我国长江流域及日本南部地区的遥相关型影响中国长江流域梅雨。
- 在这两周时间里，亚洲季风环流发生了一系列重要变化，印度夏季风爆发、南亚高压北进、中层爆发性涡旋出现、低层热带西风带不断加强东传及西太平洋副高北跳东退。大约两周左右，东亚地区上空形成相互耦合的高、低空西风急流，从而触发了长江流域梅雨的发生。



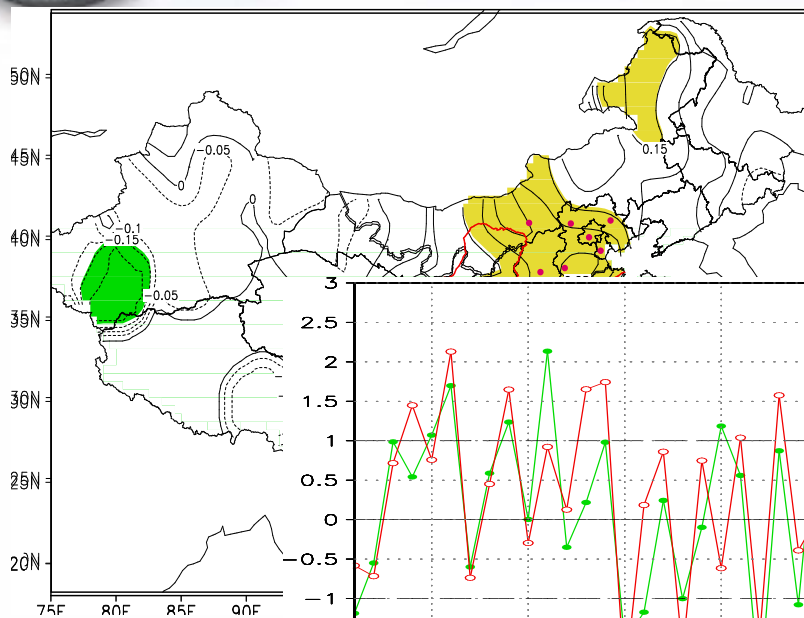


# 3、 Teleconnection between the Indian summer monsoon and precipitation in North China

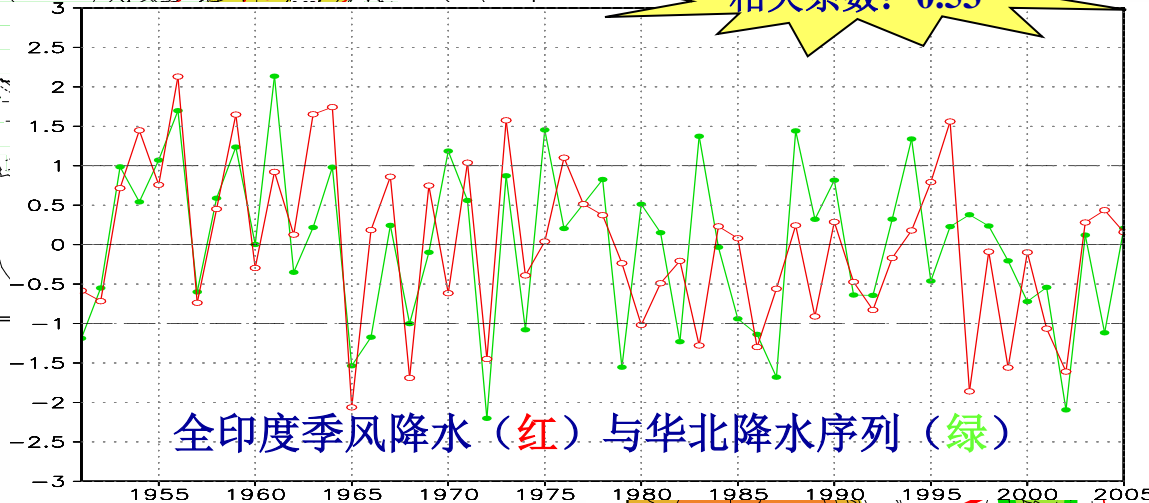


# 印度夏季风与中国及亚洲季风区降水的相关

## Correlation of all-India summer (JJAS) precipitation and that over North China

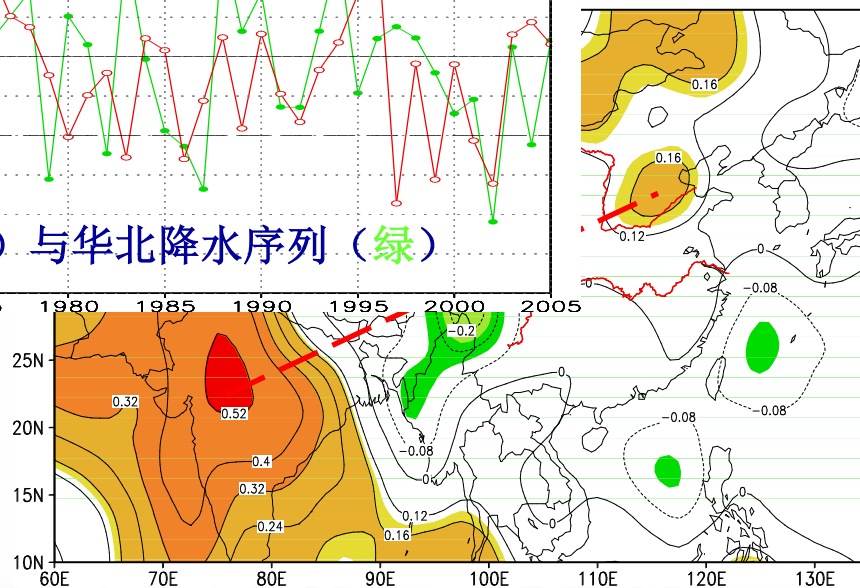


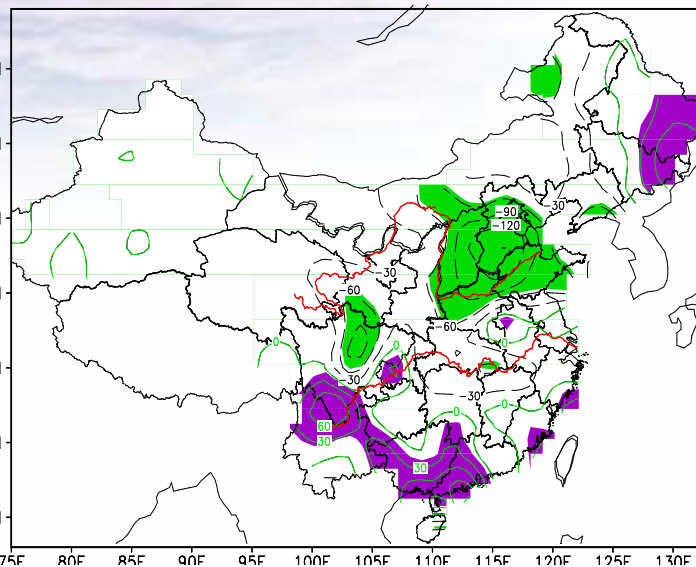
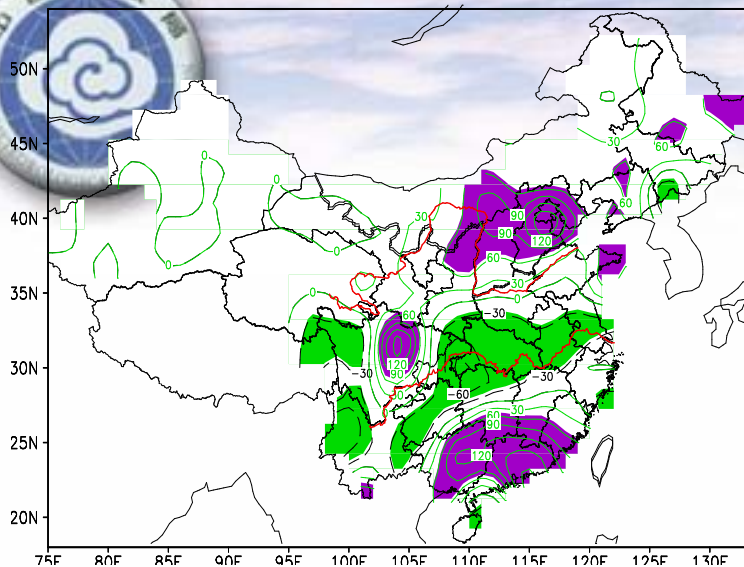
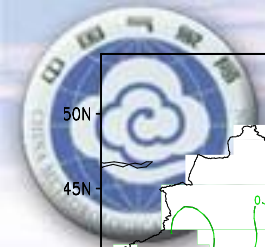
相关系数: 0.53



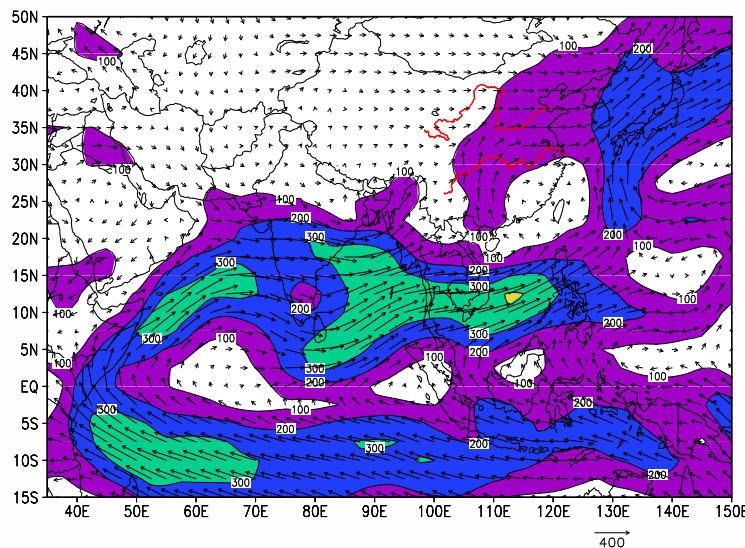
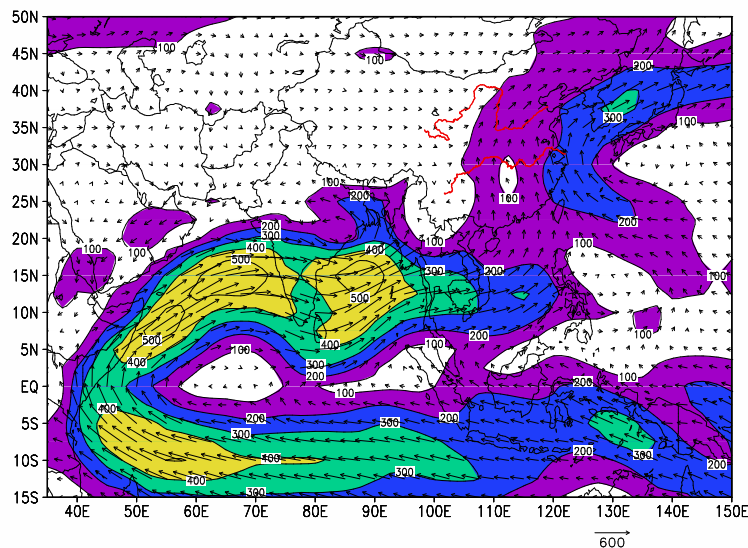
全印度季风降水 (红) 与华北降水序列 (绿)

全印度6~9月降水与中国 (左图) 及亚洲季风区降水 (右图) 的相关分布





降水异常场  
Precipitation anomaly

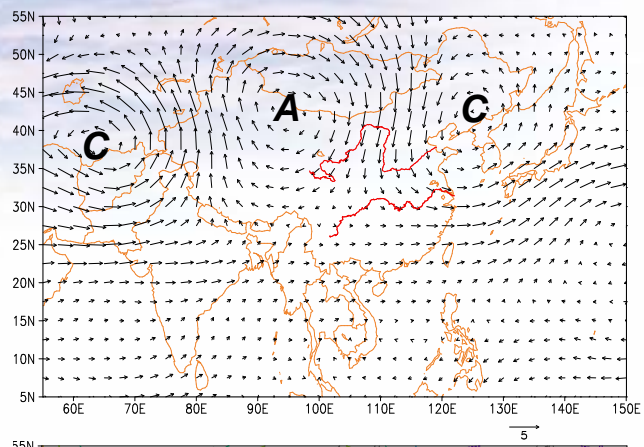
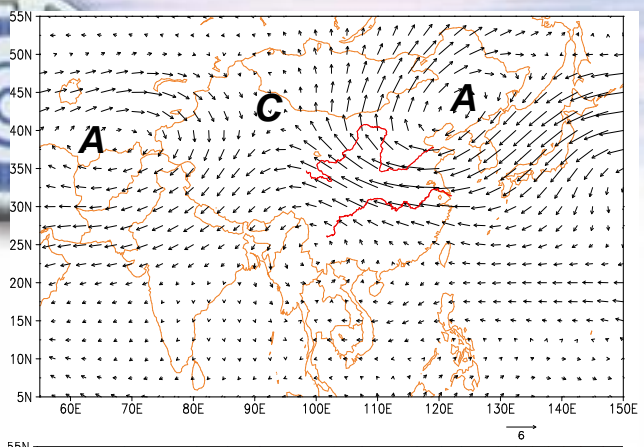
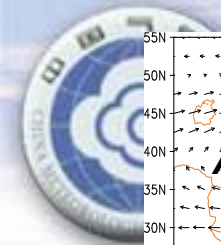


水汽输送场  
Moisture transport

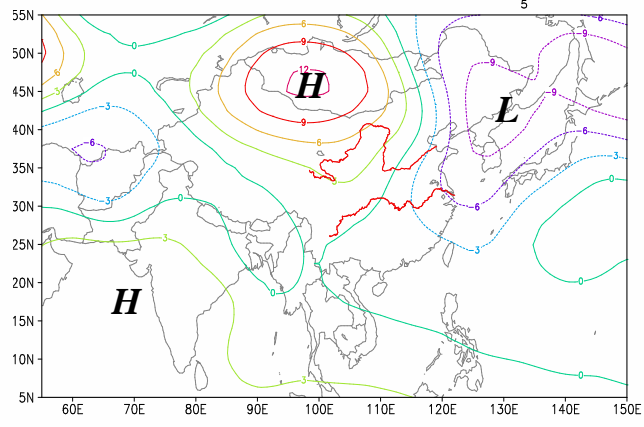
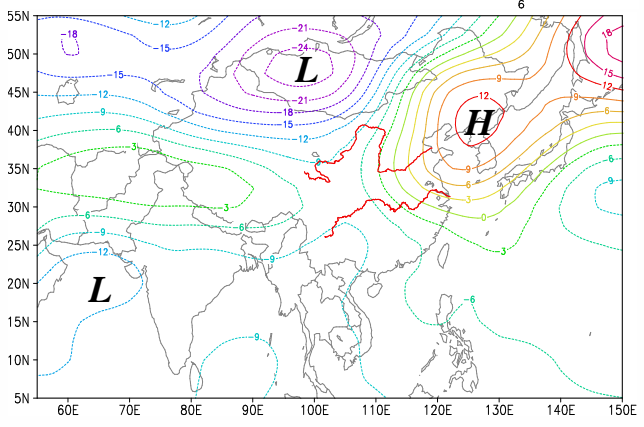
强、弱印度夏季风年我国夏季平均降水及水汽输送的合成场

(左: 强季风年Strong monsoon year ; 右: 弱季风年Weak monsoon year )

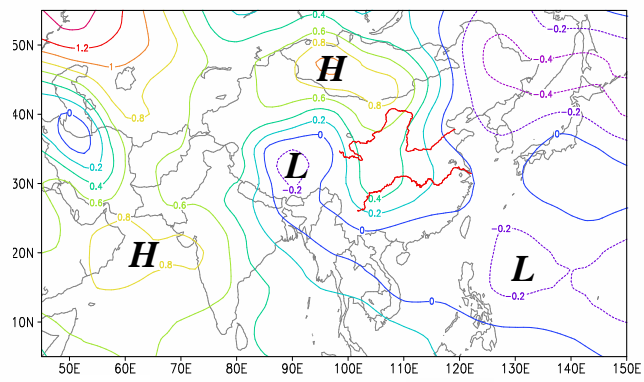
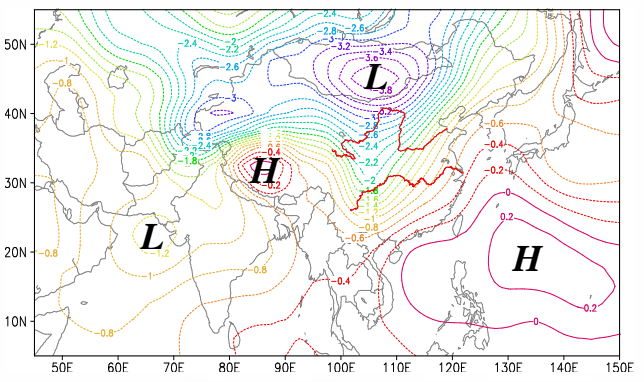




200hPa风场



500hPa高度场



海平面气压场

强、弱印度夏季风年各层环流异常场分布  
(左: 强季风年; 右: 弱季风年)





# 小结

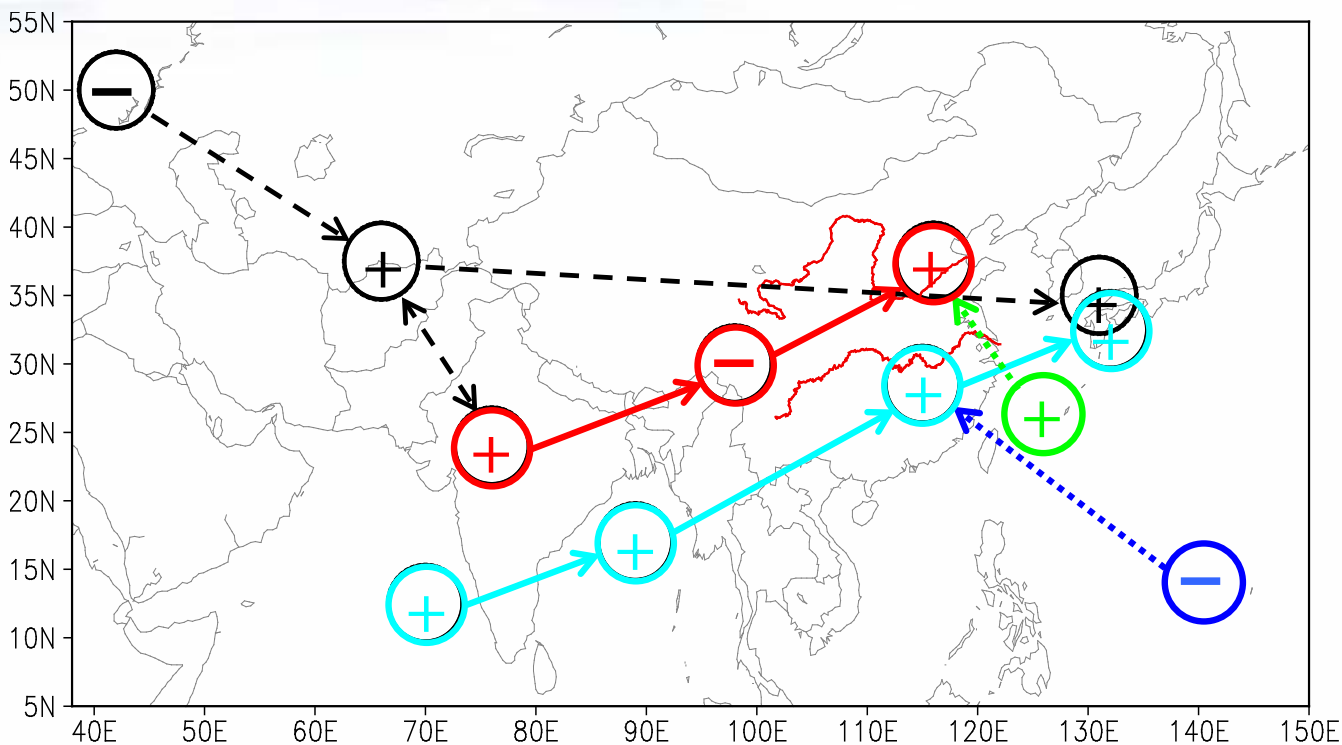
- 印度夏季风和华北夏季降水存在显著的正相关关系，和青藏高原东部降水呈反相关，形成从印度西北部经青藏高原到我国华北的呈西南-东北走向的遥相关型。
- 印度夏季风对华北地区夏季降水有很大影响。当印度季风槽加深的同时，中高纬的低压槽也加深发展，这时西太平洋高压脊西伸，来自低纬的西南风水汽输送和源于西太平洋副高南侧的东南风水汽输送共同作用，有利于华北地区的降水偏多。





# 4. Conclusions





- 夏季风爆发初期，ISM通过“南支”遥相关型影响长江流域梅雨；
- 夏季风盛行期间，ISM通过“北支”遥相关型影响华北地区降水；
- WNPSM主要通过经30~60天滤波的CISO影响中国夏季降水。





**The interactions among the Asian-Pacific monsoon subsystems have significant impacts on the climatic regimes in the monsoon region and even the whole world. Based on the domestic and foreign related research, an analysis is made of four different teleconnection modes found in the Asian-Pacific monsoon region, which reveal clearly the interactions among the Indian summer monsoon (ISM), the East Asian summer monsoon (EASM), and the western North Pacific Summer monsoon (WNPSM). The results show that: (1) In the period of the Asian monsoon onset, the date of ISM onset is two weeks earlier than the beginning of the Meiyu over the Yangtze River Basin, and a teleconnection mode is set up from the southwestern India via the Bay of Bengal (BOB) to the Yangtze River Basin and southern Japan, i.e., the “southern” teleconnection of the Asian summer monsoon. (2) In the Asian monsoon culmination period, the precipitation of the Yangtze River Basin is influenced significantly by the WNPSM through their teleconnection relationship, and is negatively related to the WNPSM rainfall, that is, when the WNPSM is weaker than normal, the precipitation of the Yangtze River Basin is more than normal.**





**(3) In contrast to the rainfall over the Yangtze River Basin, the precipitation of northern China (from the 4th pentad of July to the 3rd pentad of August) is positively related to the WNPSM. When the WNPSM is stronger than normal, the position of the western Pacific subtropical high (WPSH) becomes farther northeast than normal, the anomalous northeastward water vapor transport along the southwestern flank of WPSH is converged over northern China, providing adequate moisture for more rainfalls than normal there.**

**(4) The summer rainfall in northern China has also a positive correlation with the ISM. During the peak period of ISM, a teleconnection pattern is formed from Northwest India via the Tibetan Plateau to northern China, i.e., the “northern” teleconnection of the Asian summer monsoon. The above four kinds of teleconnections reflect the links among the Asian monsoon subsystems of ISM, EASM, and WNPSM during the northward advancing march of the Asian summer monsoons.**





**Thank you!**