The Characteristics of North China Drought in Summer 2014 and its Relationship with East Asian Summer Monsoon

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Outline

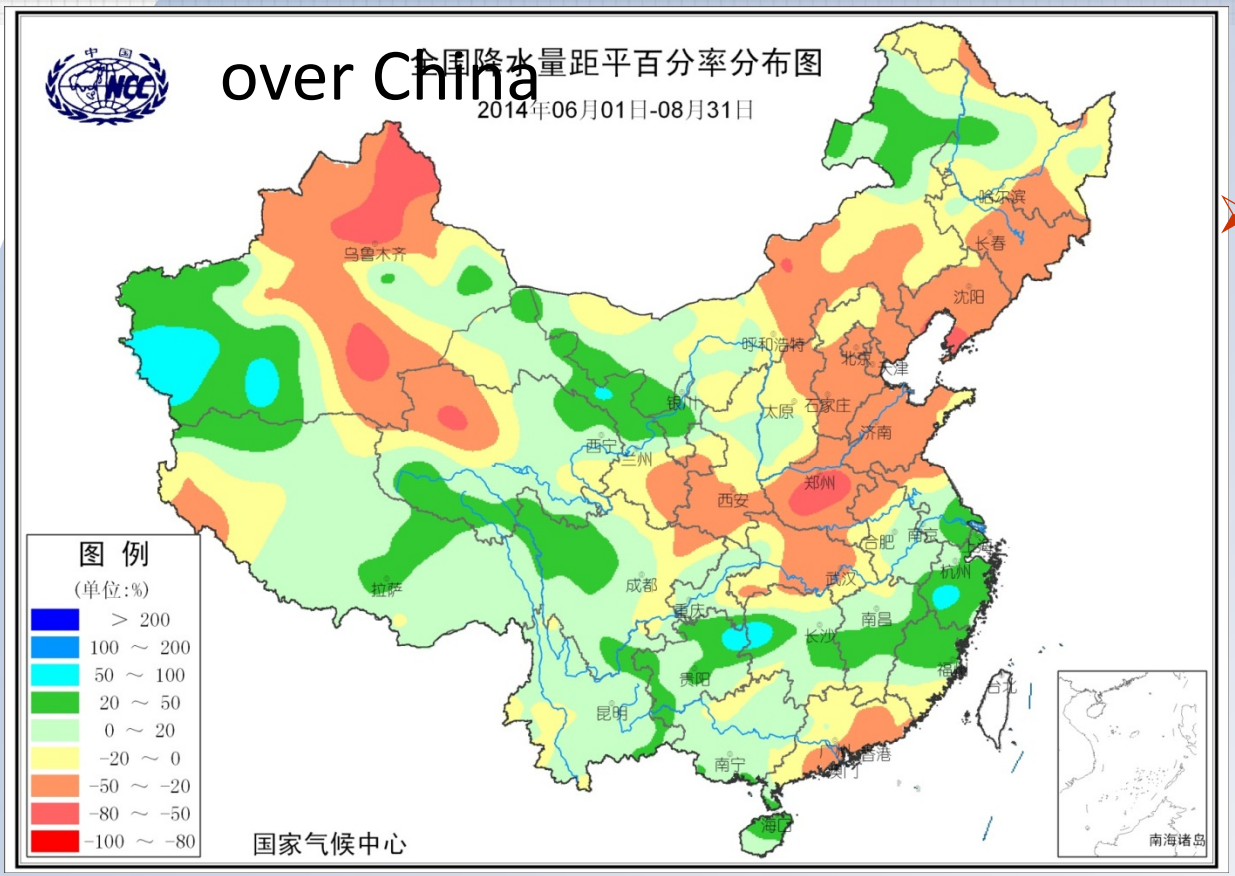
- General Climate in summer 2014 in China
- Drought monitoring, impacts assessment and service in BCC
- The reason analysis of drought in north of China

General Climate in summer 2014 in China

- In the summer 2014, the average rainfall in the nationwide of China is slightly less than normal, and the average air temperature is slightly higher than normal.
- North China had experienced severe drought characterized by long duration, wide coverage and rapid developing, occurring in the key period of crop growth.
- South of the Yangtze River, Southern China, eastern part of Southwest China were ravaged by serious flood disasters. Heavy rainfall led to some regions with torrential rain, flood and landslide and debris flow disasters, which make the people's lives and property losses.
- Southern of China suffered persistent high temperature in July. The Mid-low reaches of Yangtze River experienced the cloudy and rainy weather in August.

c

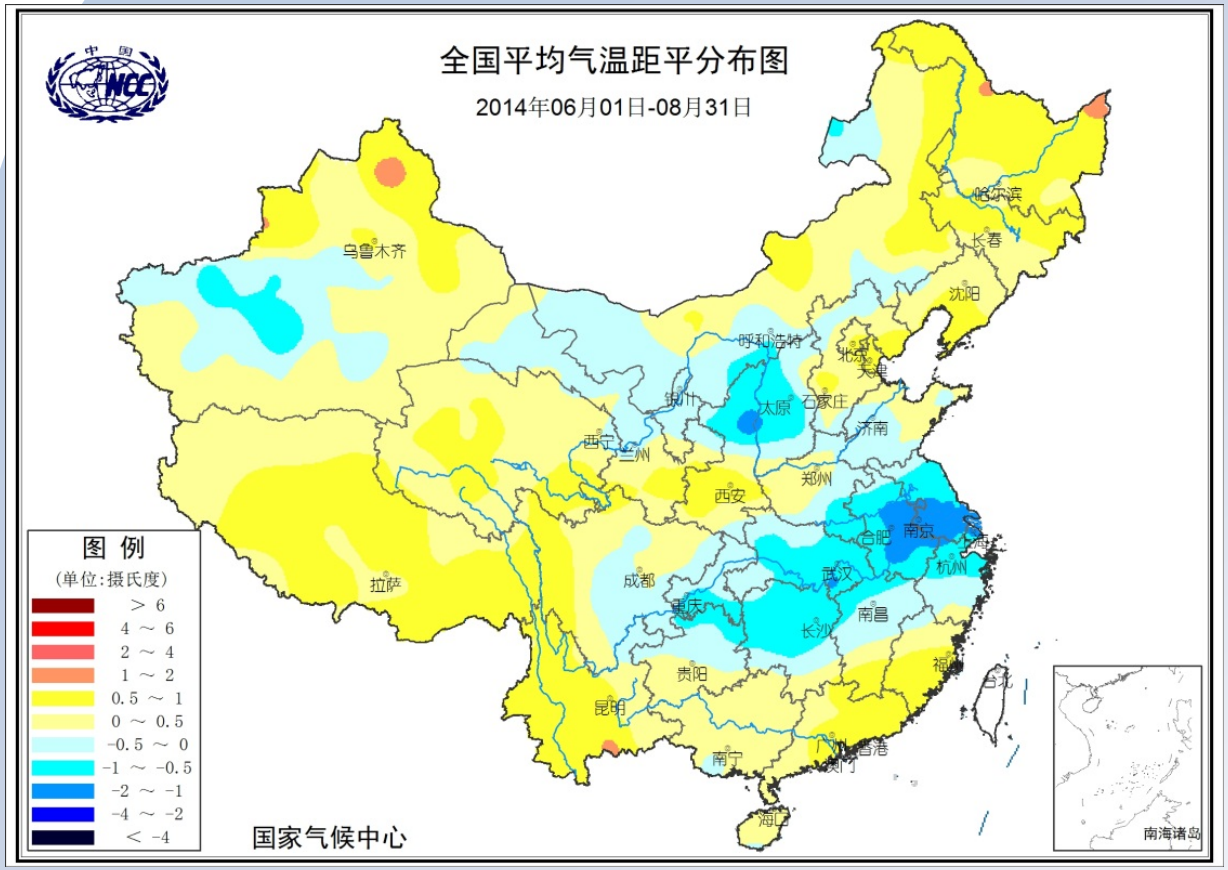
Seasonal mean precipitation in Summer 2014 over China



- North China had experienced severe drought characterized by long duration, wide coverage and rapid developing, occurring in the key period of crop growth.

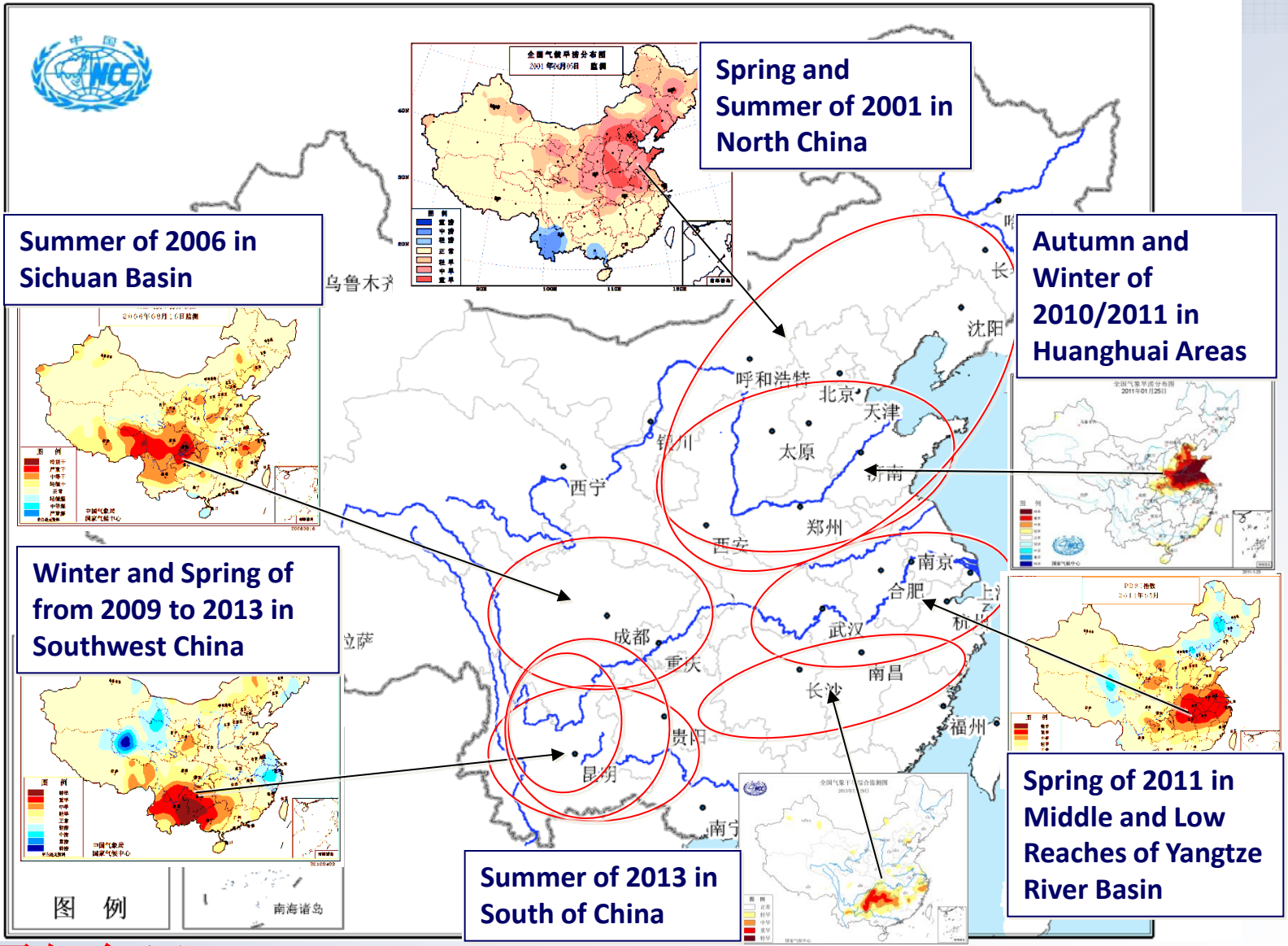
- South of the Yangtze River, Southern China, eastern part of Southwest China were ravaged by serious flood disasters. Heavy rainfall led to some regions with torrential rain, flood and landslide and debris flow disasters, which make the people's lives and property losses.

Seasonal mean temperature anomalies in summer 2014

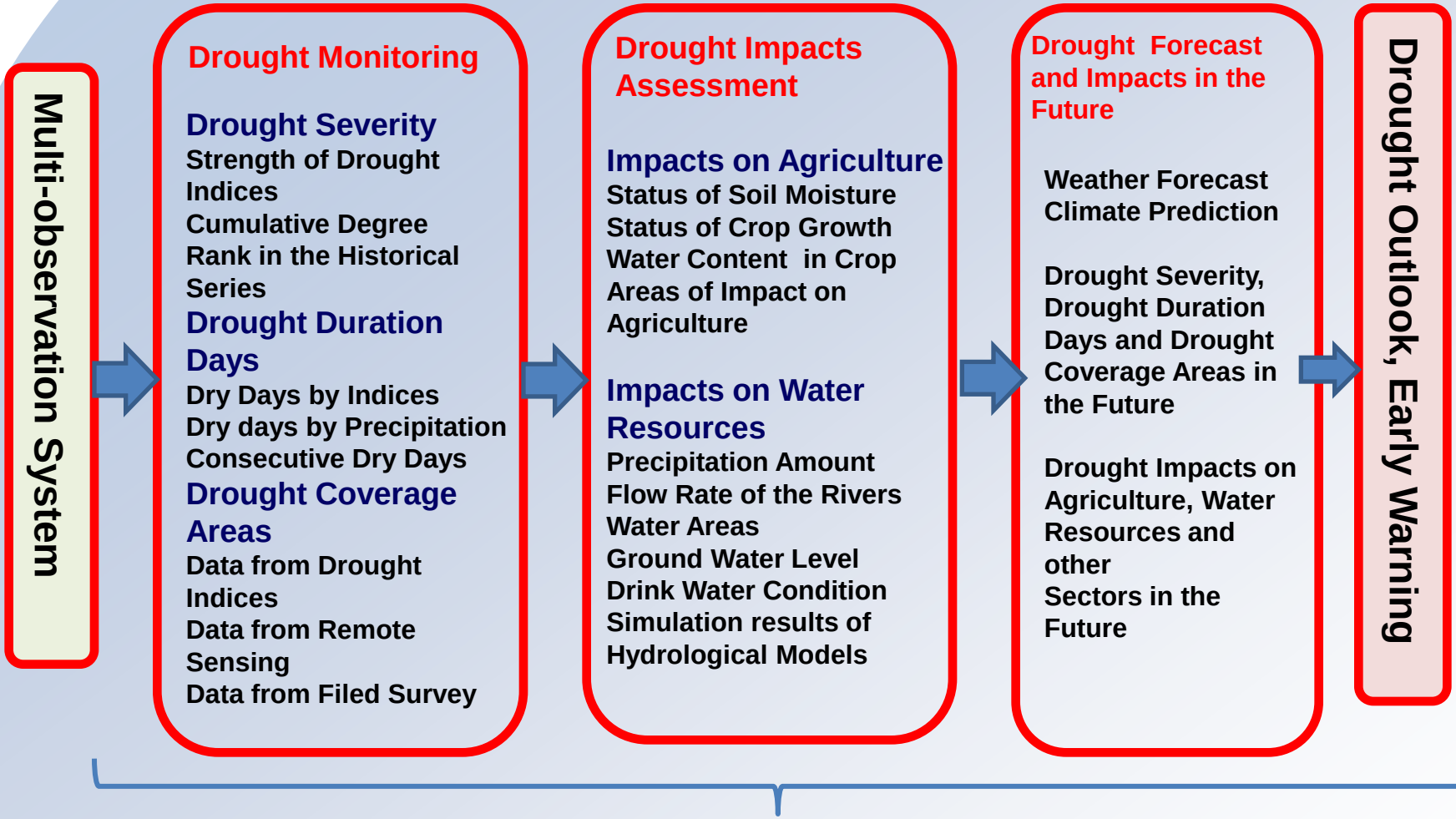


➢**Southern of China suffered persistent high temperature in July. The Mid-low reaches of Yangtze River experienced the cloudy and rainy weather in August.**

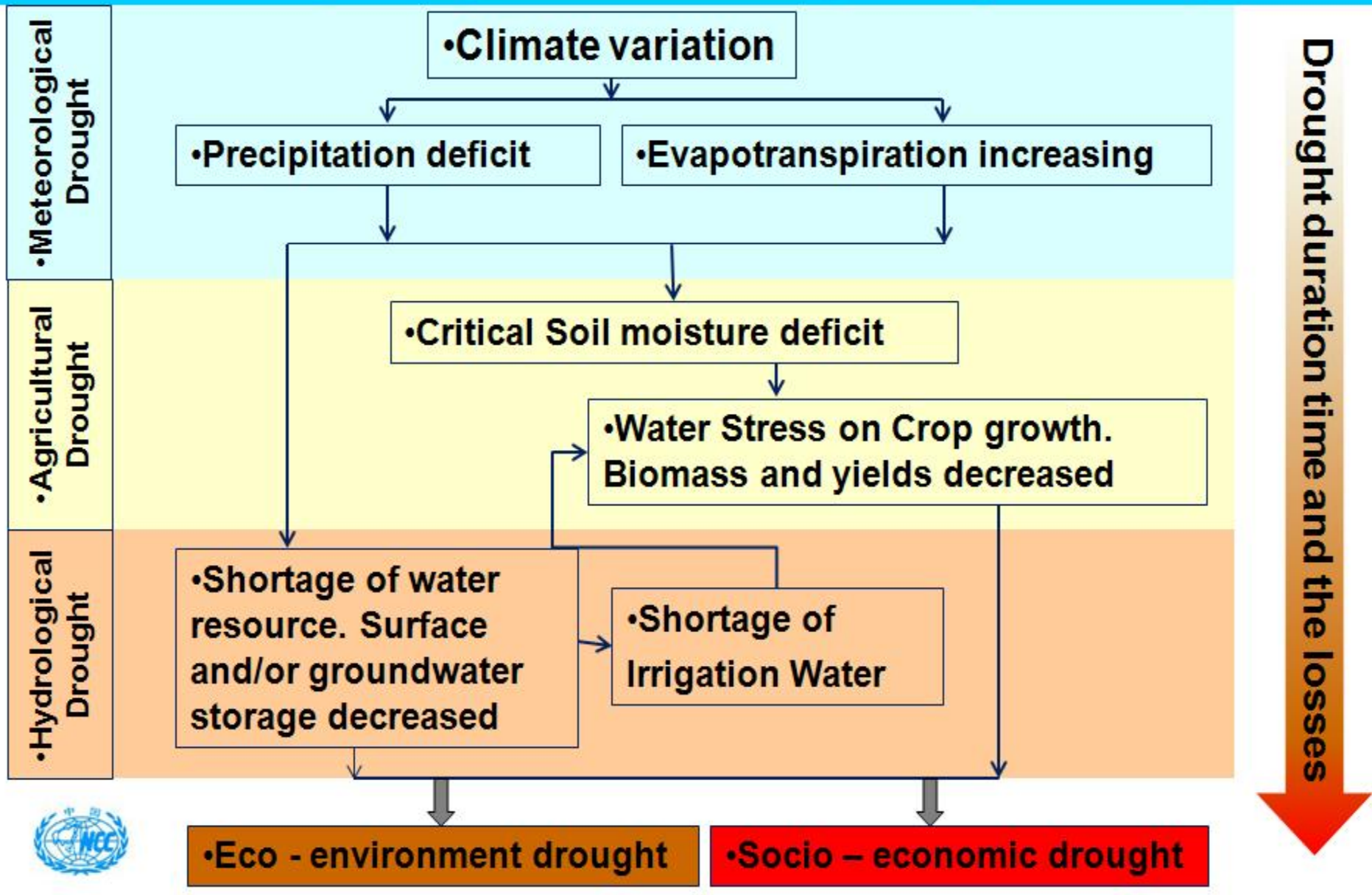
➢ Drought Events Happened in the this Century



Flow Chart of Integrated Drought Monitoring, Assessment and Forecasting



Relationship between Meteorological, Agriculture and Hydrological Drought



Meteorological Comprehensive Index (MCI)

$$MCI = a \times SPIW_{60} + b \times MI_{30} + c \times SPI_{90} + d \times SPI_{150}$$

Short term Impacts of Shortage Precipitation + Long term Impacts of Shortage Precipitation

Ka coefficient

Kw coefficient

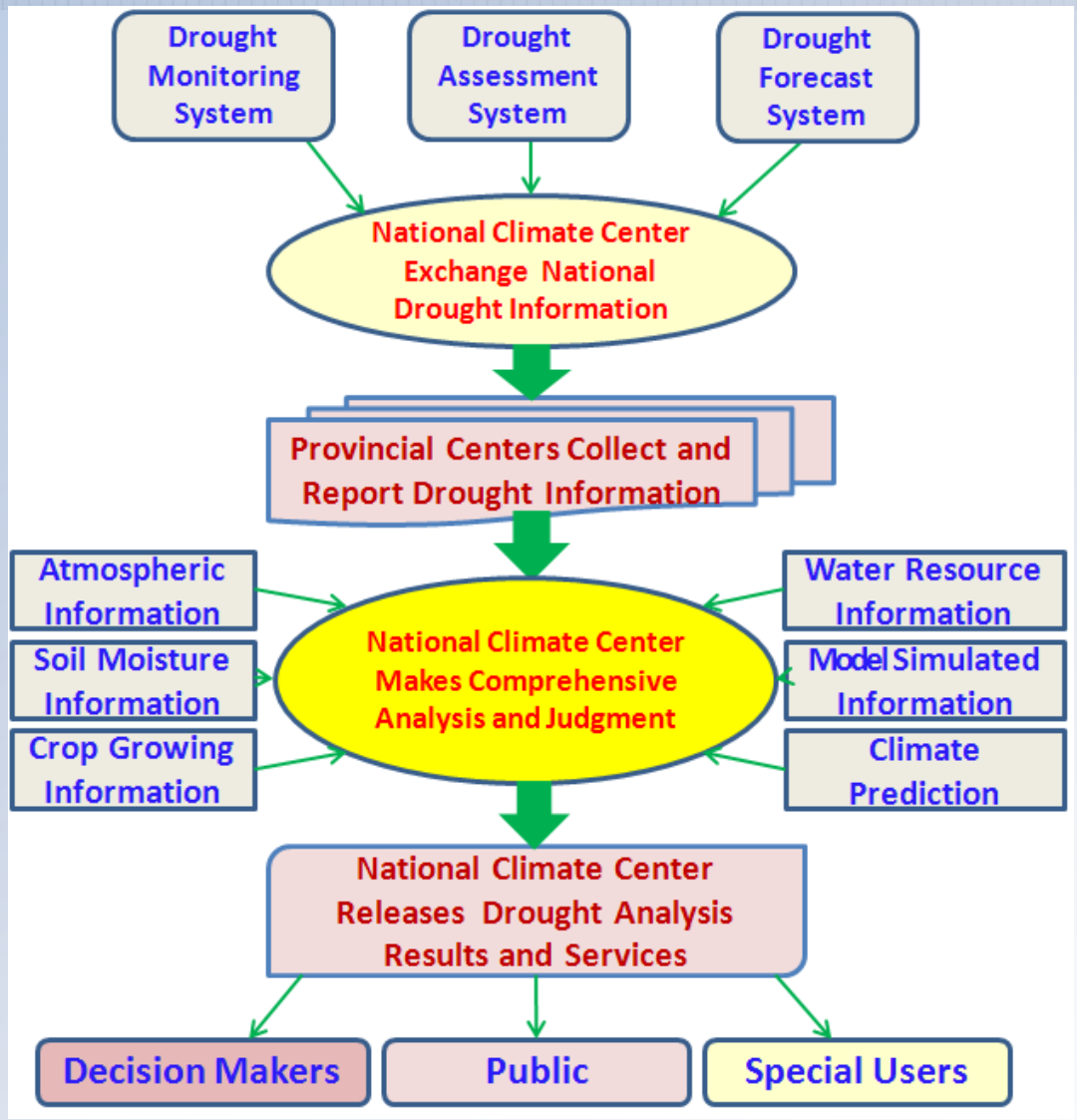
Meteorological Drought Impacts on the Agriculture

Meteorological Drought Impacts on the Hydrology

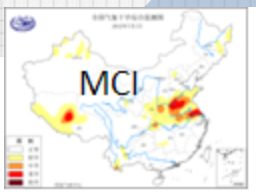
$$MCIA = Ka \times MCI \qquad MCIW = Kw \times MCI$$

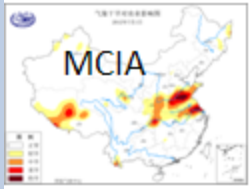
Advantage: (1) Clear Physical Meaning, (2) More Effective, and (3) Easy Apply to Operational System

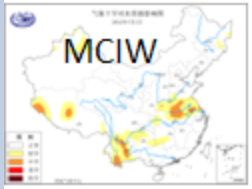
Operation Flow of Severe Drought Monitoring and Impacts Assessment

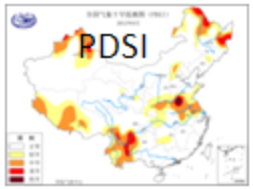


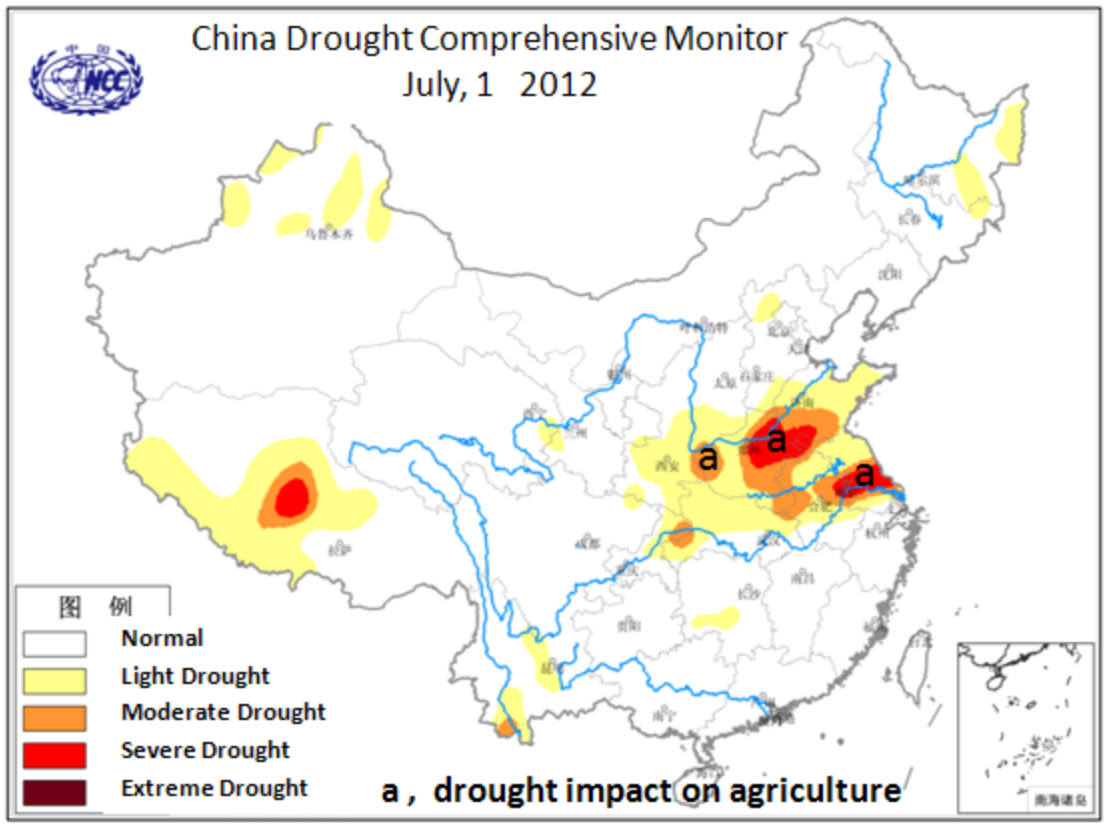
Comprehensive Drought Monitoring Methods

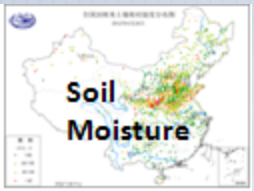


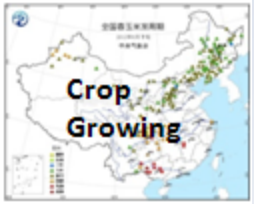


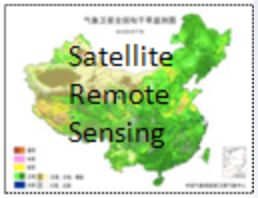


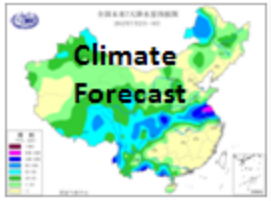


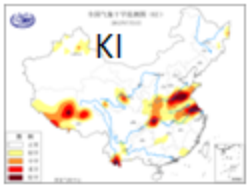


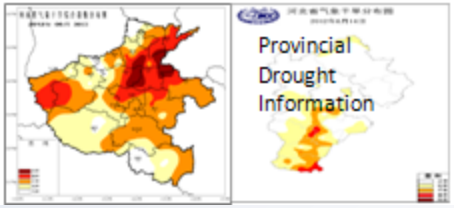




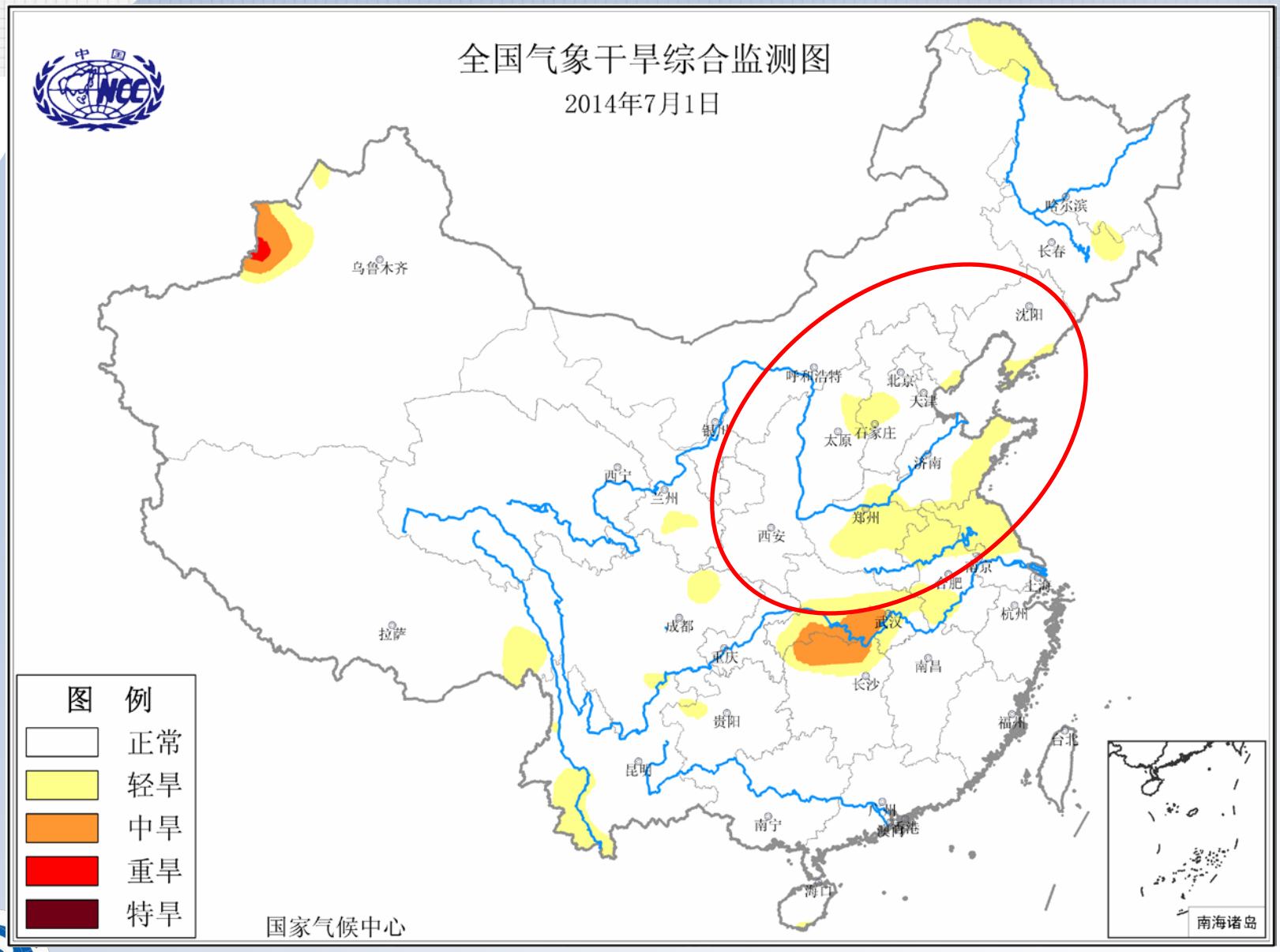




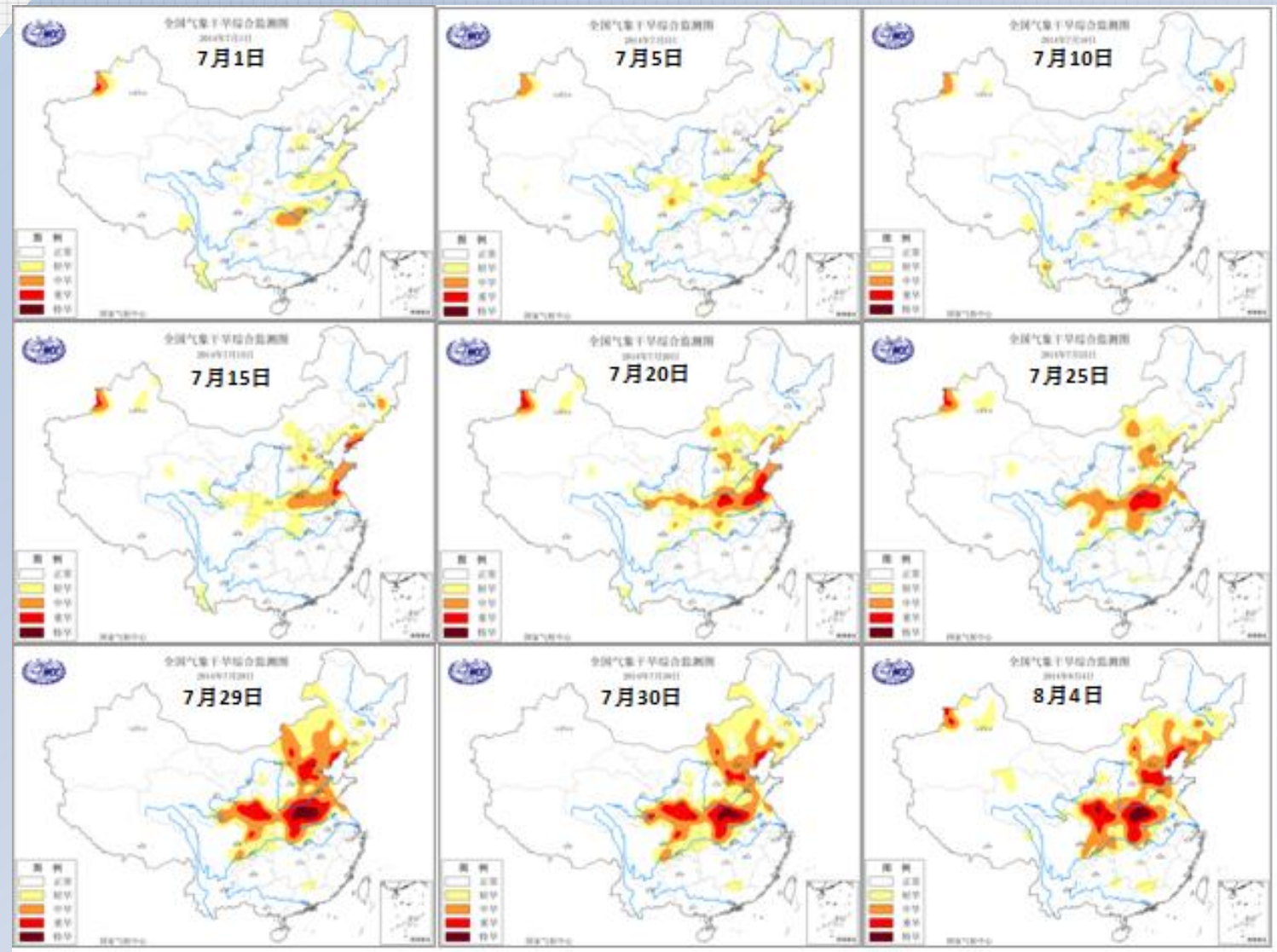


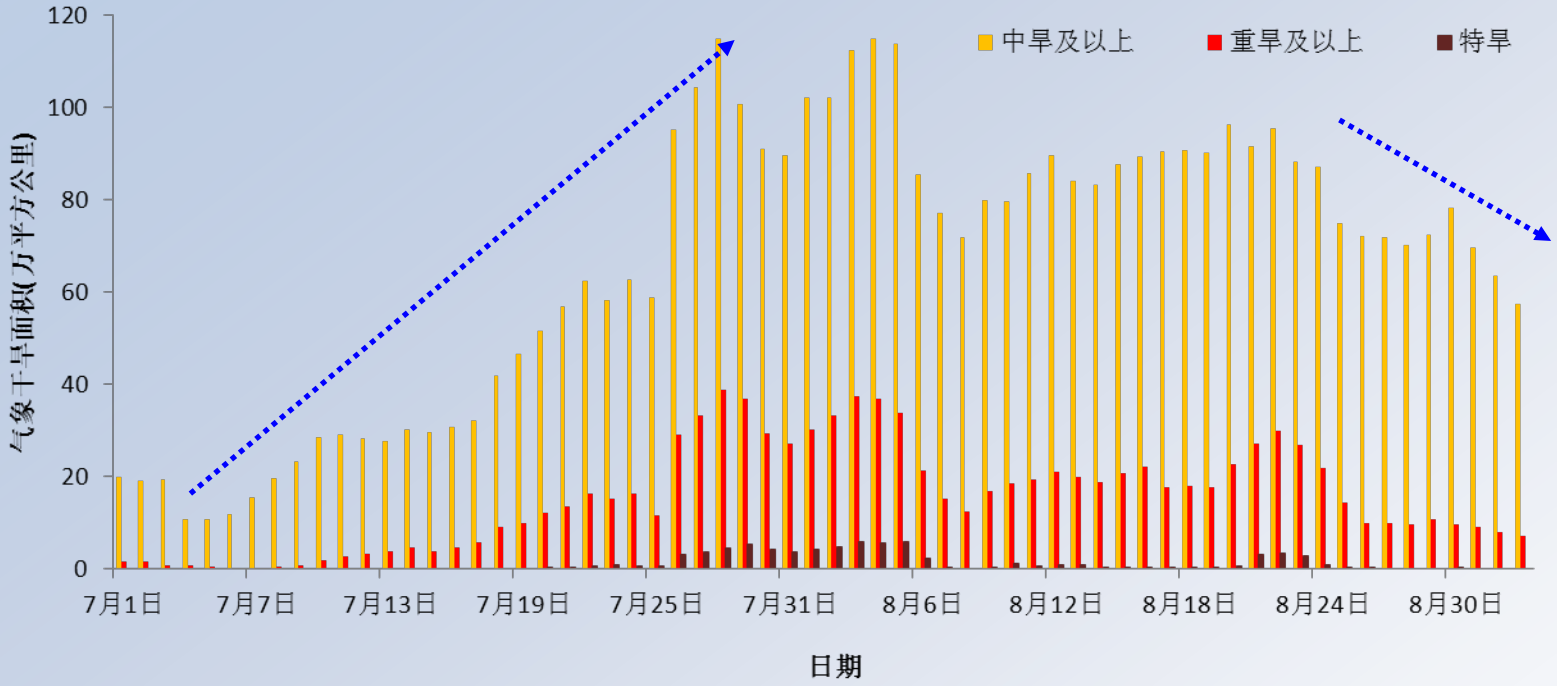


Drought Monitoring and Service in summer 2014



Drought developing in different stages

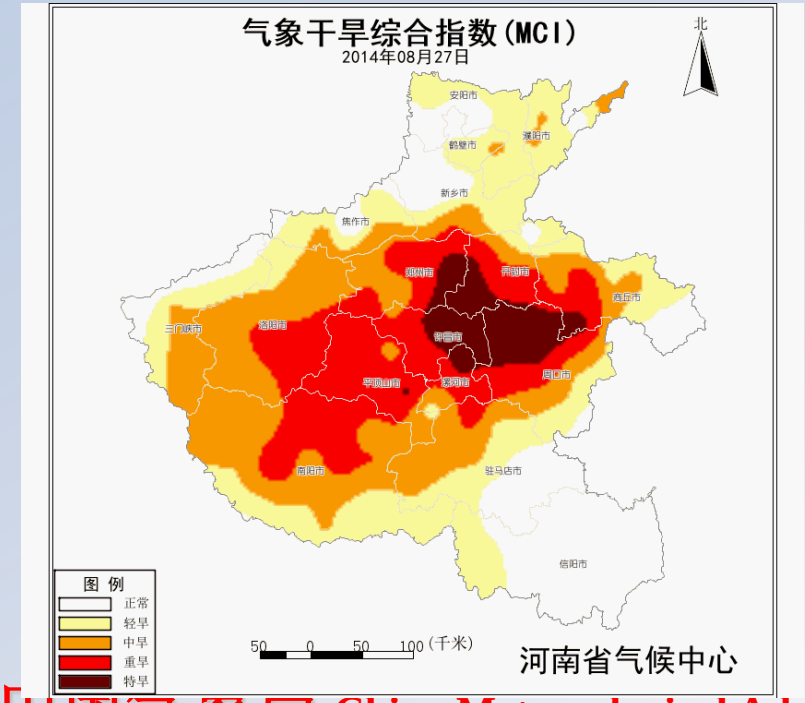


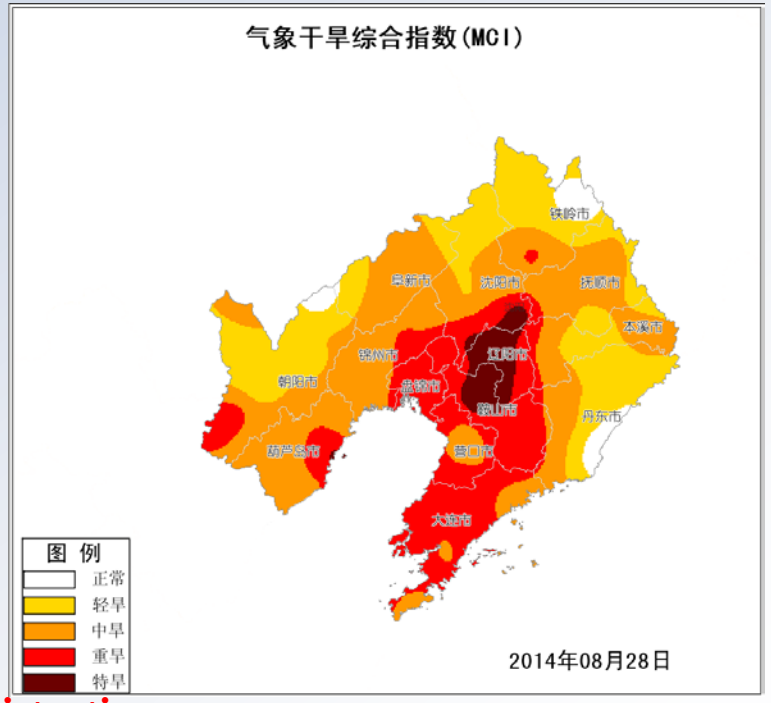


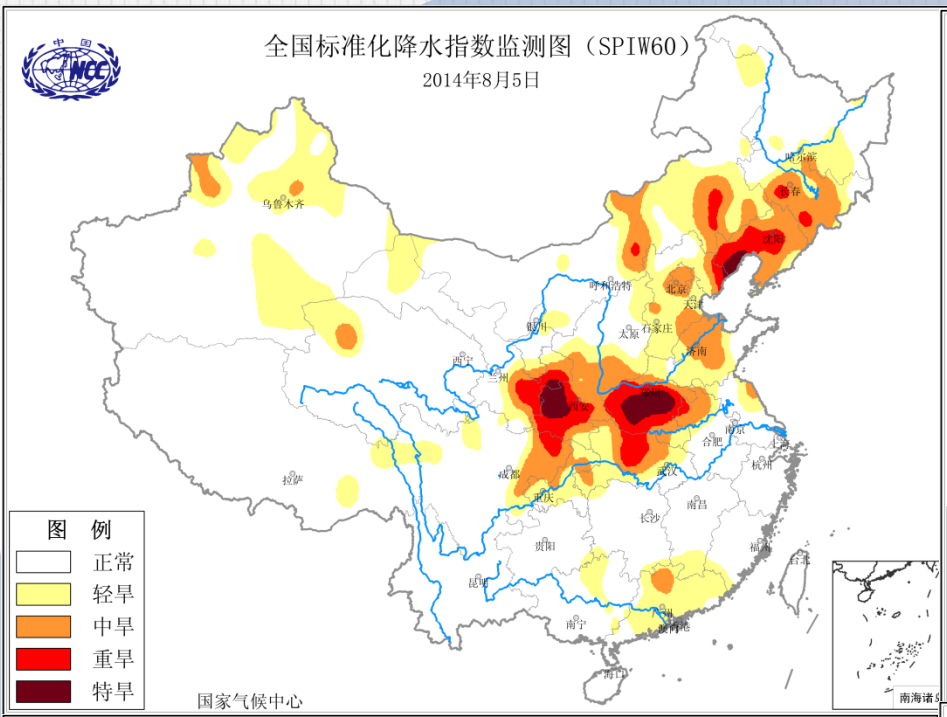
Variation of Daily Meteorological Drought Influence Areas in July and August , 2014

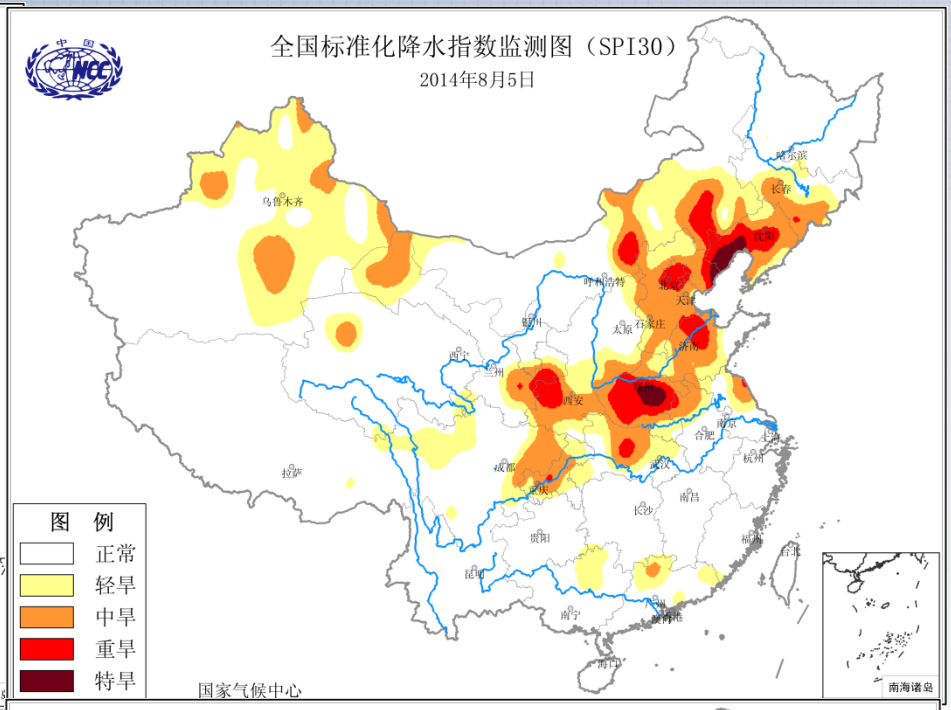
Drought Monitoring and Services in BCC

- Monitor Drought day by day
- Provide the drought influence areas every day
- Provide more than 20 drought index, include MCI, SPI, PDSI, Soil Moisture， Satellite Remote Sensing Pictures, etc.
- Issued the drought early warning in Henan, Shanxi and Liaoning provinces.






全国标准化降水指数监测图（SPIW60）
2014年8月5日
图 例
正常
轻旱
中旱
重旱
特旱
国家气候中心
南海诸岛


全国标准化降水指数监测图（SPI30）
2014年8月5日
图 例
正常
轻旱
中旱
重旱
特旱
国家气候中心
南海诸岛

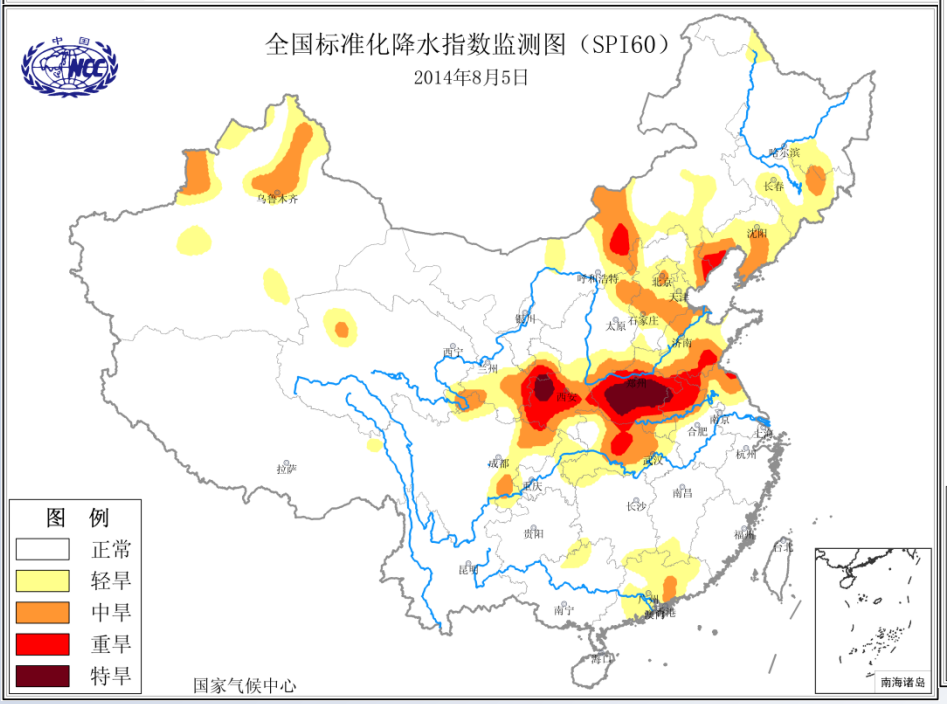

全国标准化降水指数监测图（SPI60）
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图 例
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轻旱
中旱
重旱
特旱
国家气候中心
南海诸岛

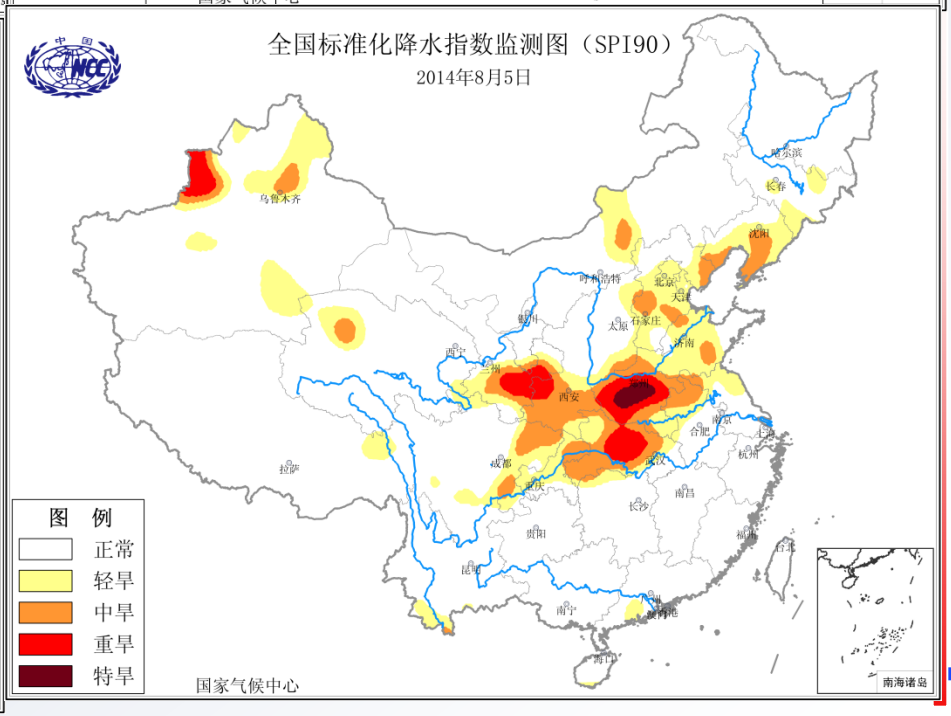
全国标准化降水指数监测图（SPI90）
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图 例
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轻旱
中旱
重旱
特旱
国家气候中心
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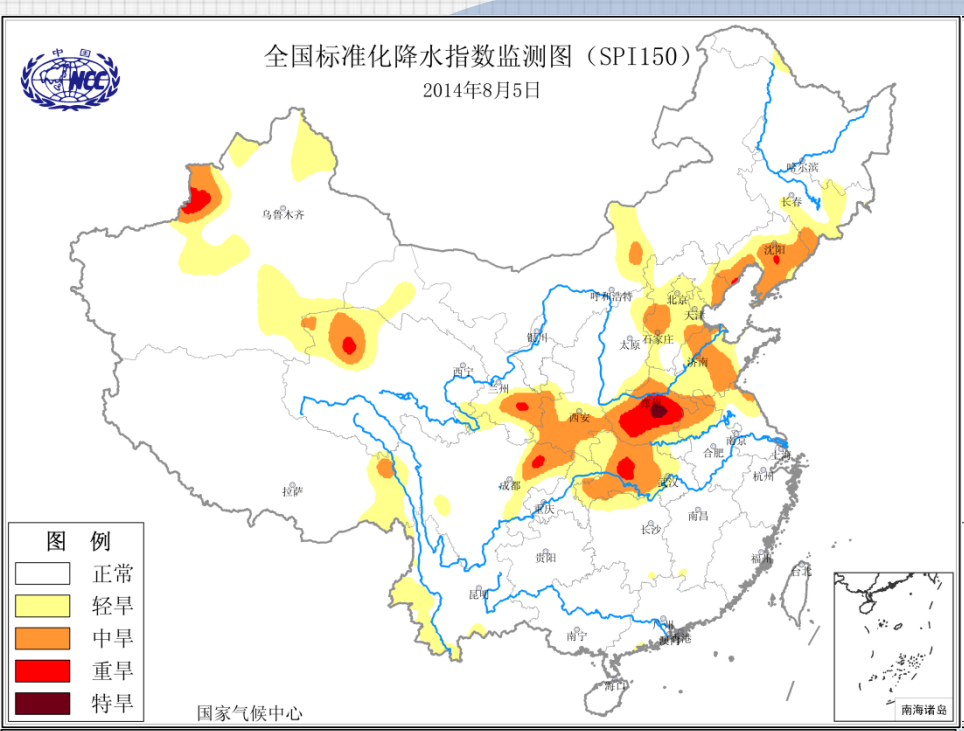
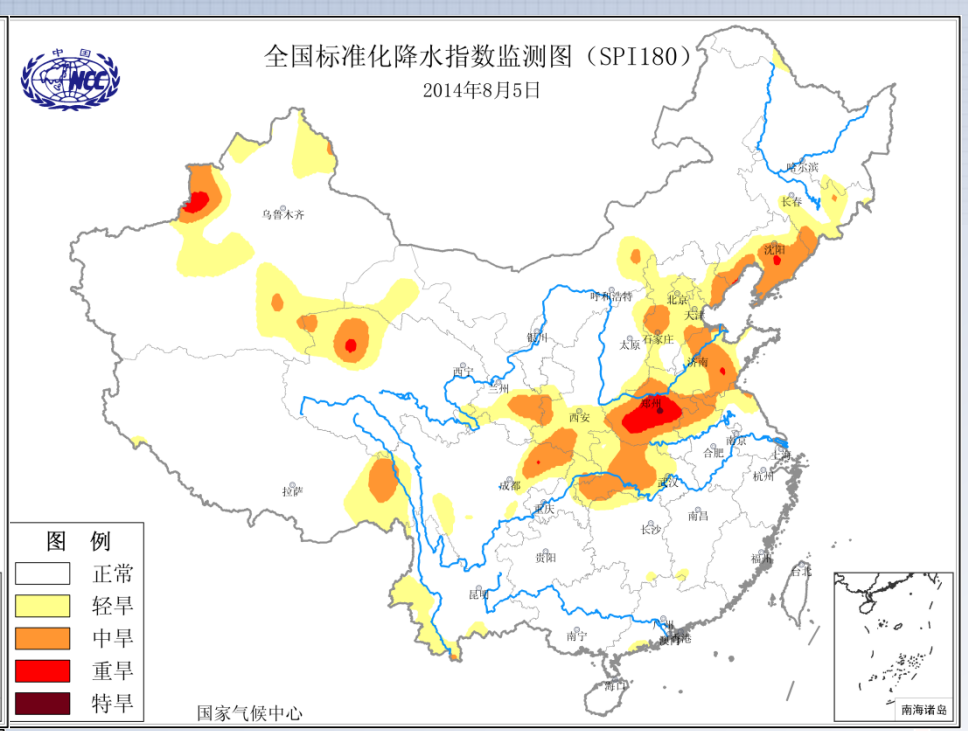
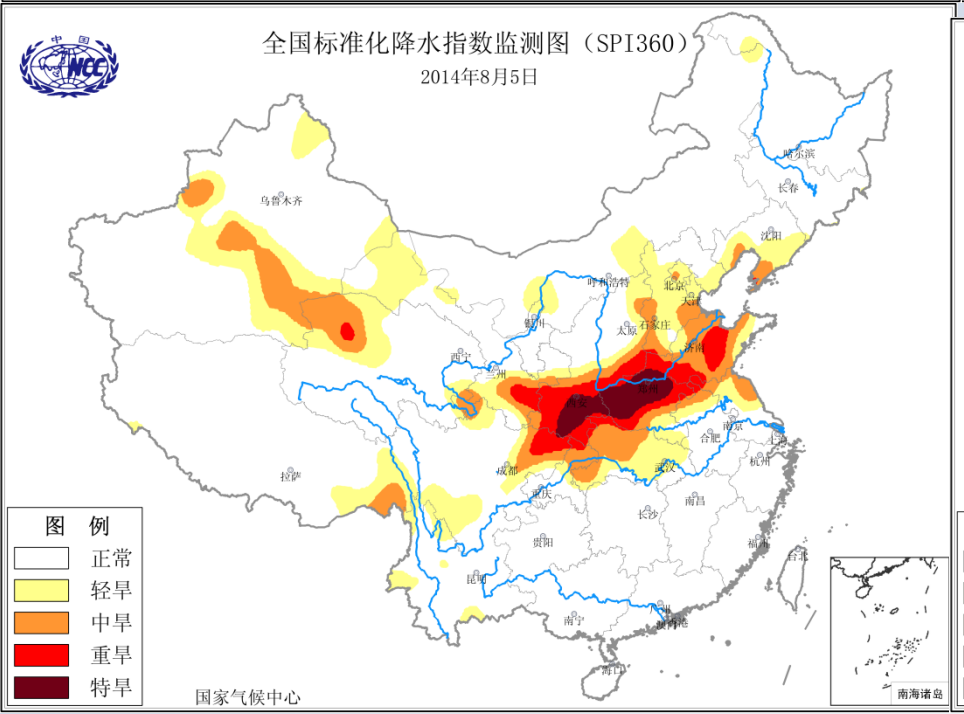
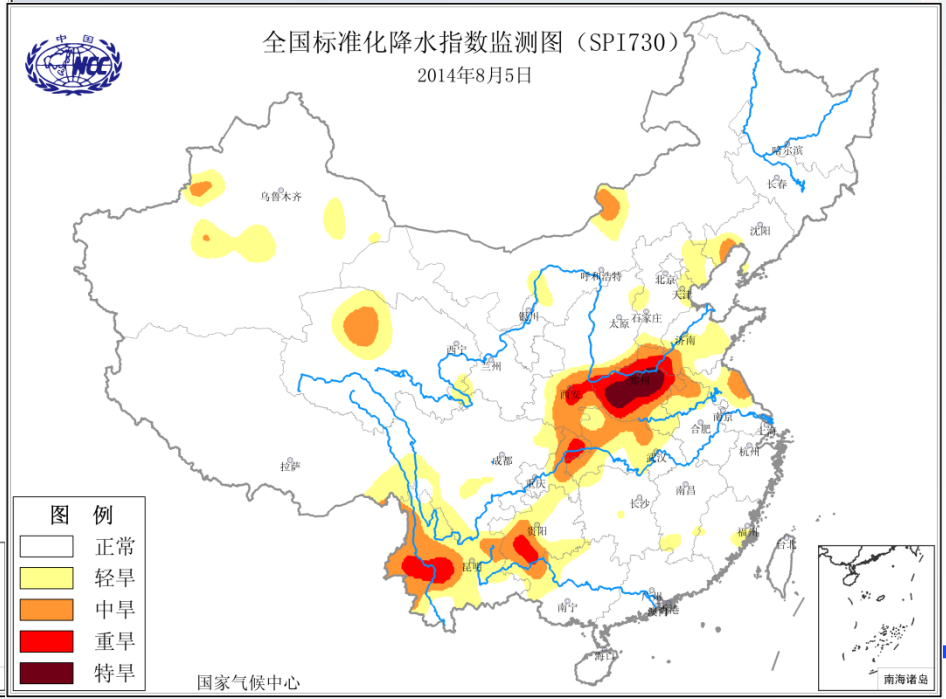

全国标准化降水指数监测图（SPI150）
2014年8月5日
图 例
正常
轻旱
中旱
重旱
特旱
国家气候中心
南海诸岛


全国标准化降水指数监测图（SPI180）
2014年8月5日
图 例
正常
轻旱
中旱
重旱
特旱
国家气候中心
南海诸岛


全国标准化降水指数监测图（SPI360）
2014年8月5日
图 例
正常
轻旱
中旱
重旱
特旱
国家气候中心
南海诸岛


全国标准化降水指数监测图（SPI730）
2014年8月5日
图 例
正常
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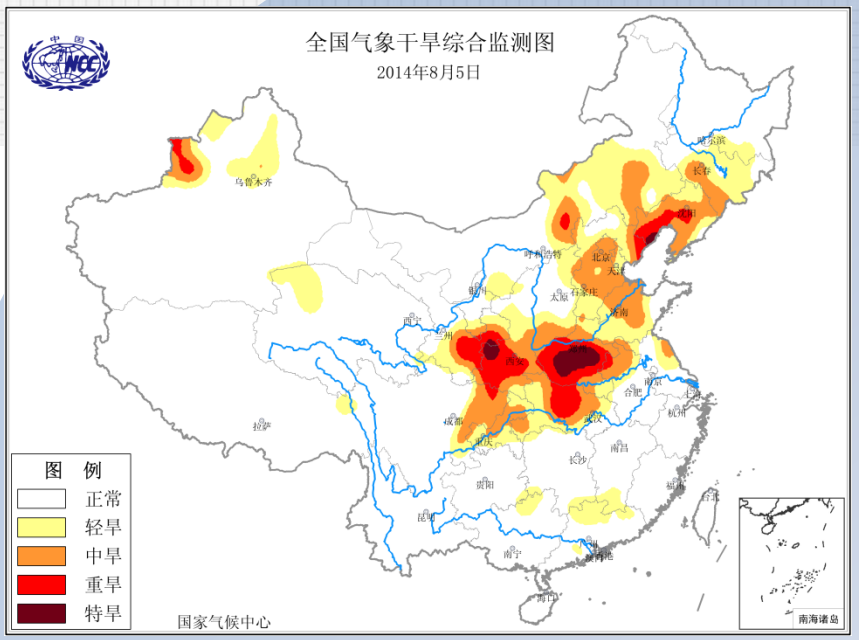
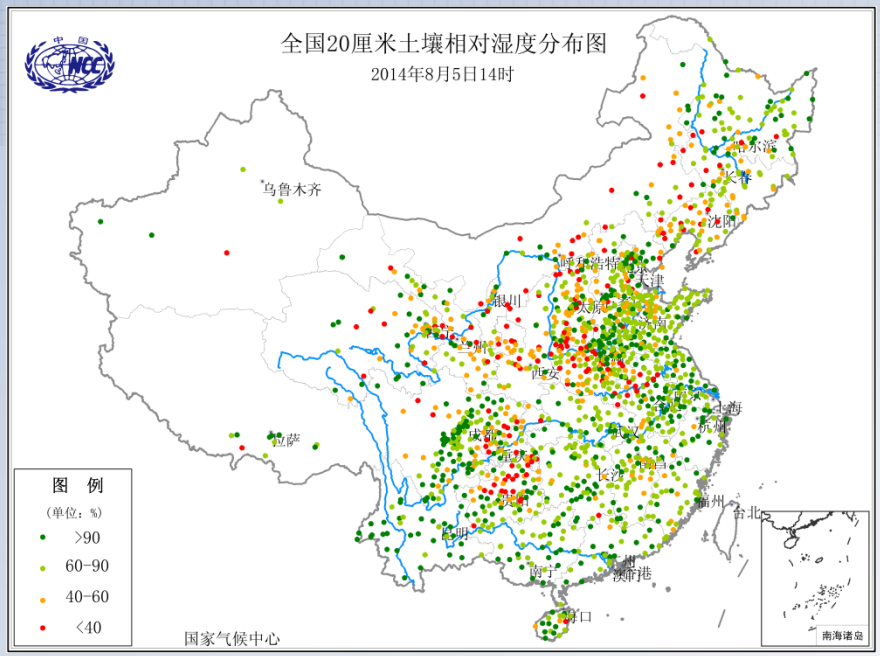
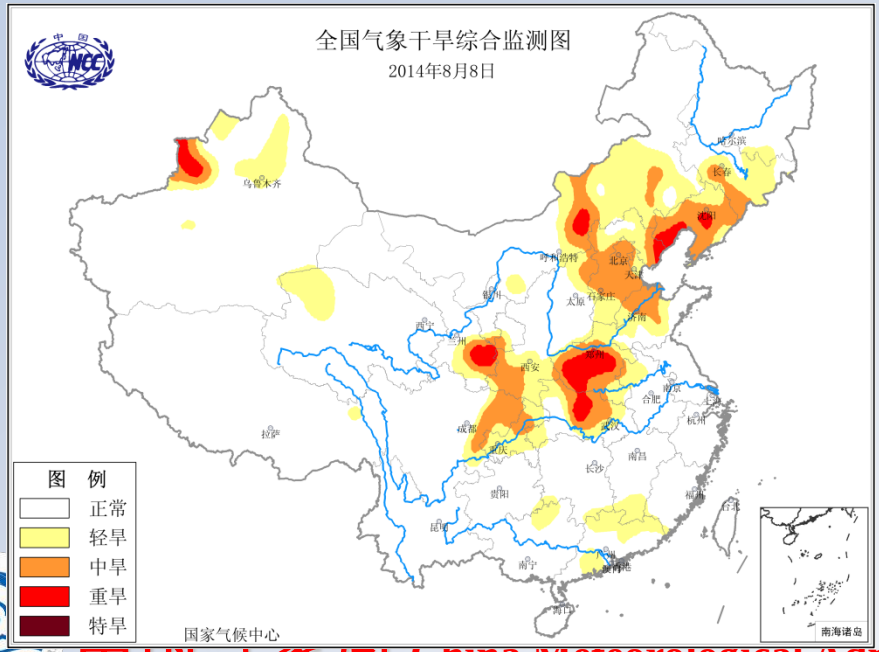
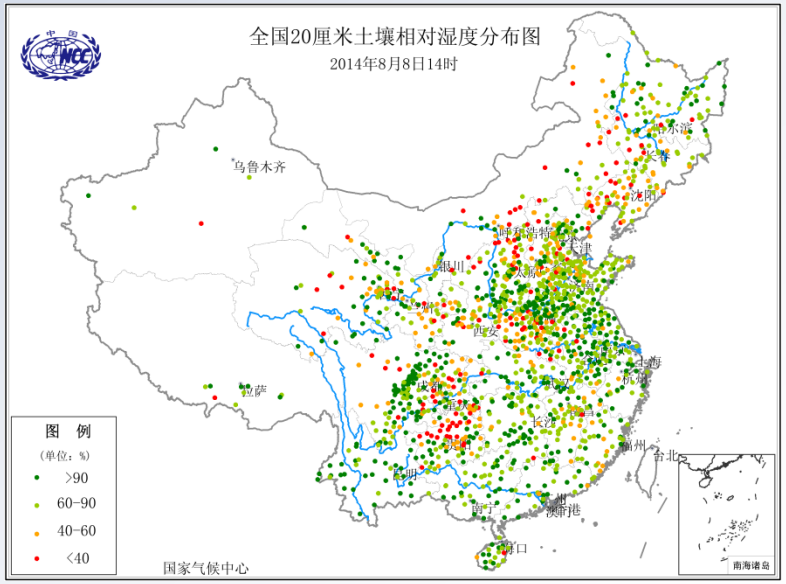
中旱
重旱
特旱
国家气候中心
南海诸岛


全国气象干旱综合监测图
2014年8月5日
图 例
正常
轻旱
中旱
重旱
特旱
国家气候中心
南海诸岛


全国20厘米土壤相对湿度分布图
2014年8月5日14时
图 例
(单位：%)
>90
60-90
40-60
<40
国家气候中心
南海诸岛


全国气象干旱综合监测图
2014年8月8日
图 例
正常
轻旱
中旱
重旱
特旱
国家气候中心
南海诸岛


全国20厘米土壤相对湿度分布图
2014年8月8日14时
图 例
(单位：%)
>90
60-90
40-60
<40
国家气候中心
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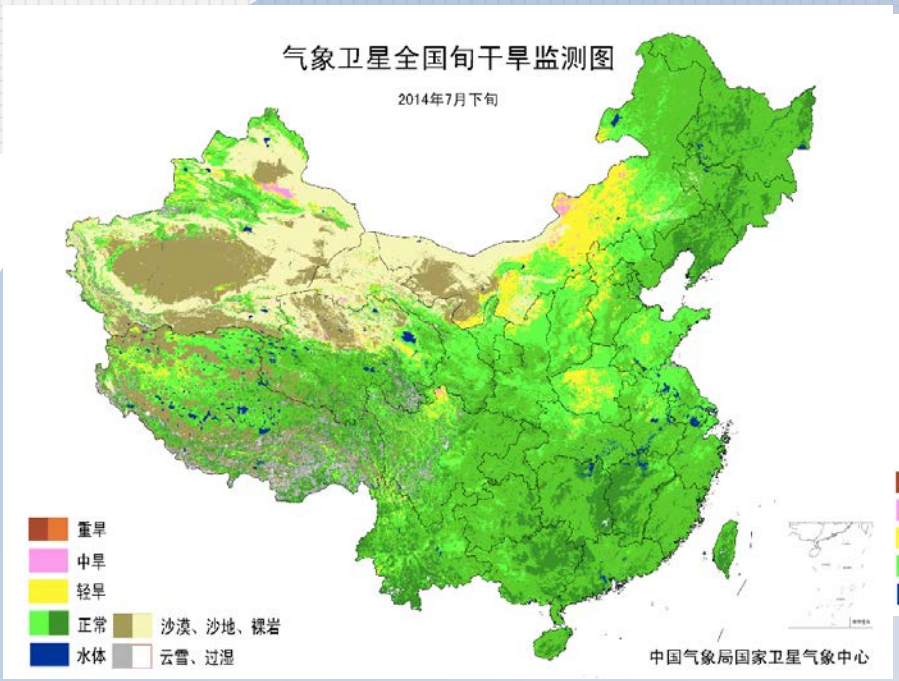
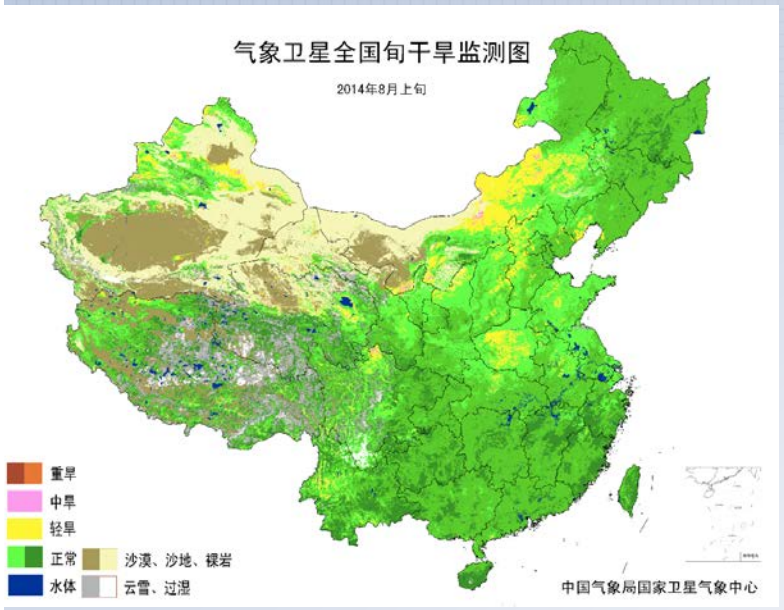
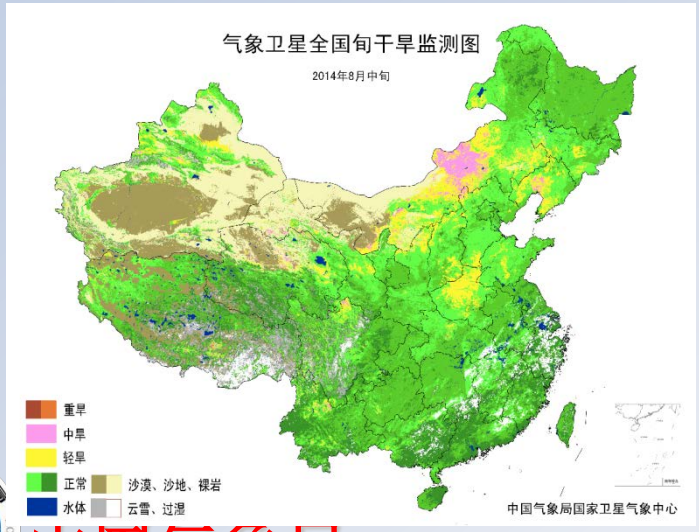
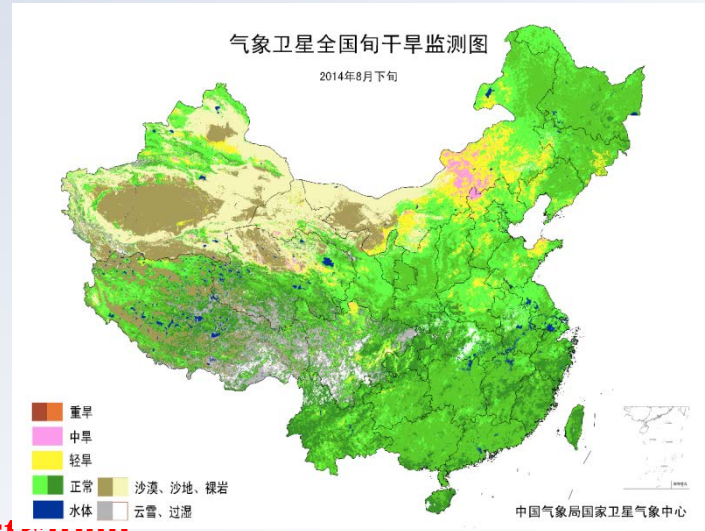

气象卫星全国旬干旱监测图
2014年7月下旬
重旱
中旱
轻旱
正常
沙漠、沙地、裸岩
水体
云雪、过湿
中国气象局国家卫星气象中心

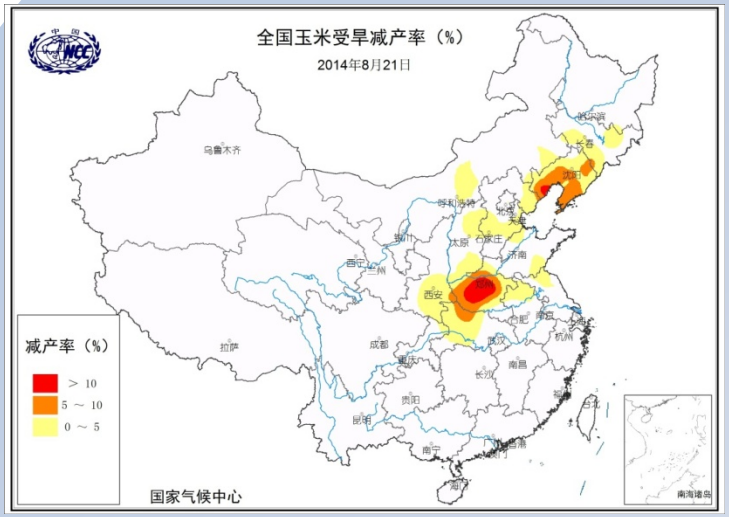

气象卫星全国旬干旱监测图
2014年8月上旬
重旱
中旱
轻旱
正常
沙漠、沙地、裸岩
水体
云雪、过湿
中国气象局国家卫星气象中心


气象卫星全国旬干旱监测图
2014年8月中旬
重旱
中旱
轻旱
正常
沙漠、沙地、裸岩
水体
云雪、过湿
中国气象局国家卫星气象中心


气象卫星全国旬干旱监测图
2014年8月下旬
重旱
中旱
轻旱
正常
沙漠、沙地、裸岩
水体
云雪、过湿
中国气象局国家卫星气象中心

Drought impacts investigation and assessment

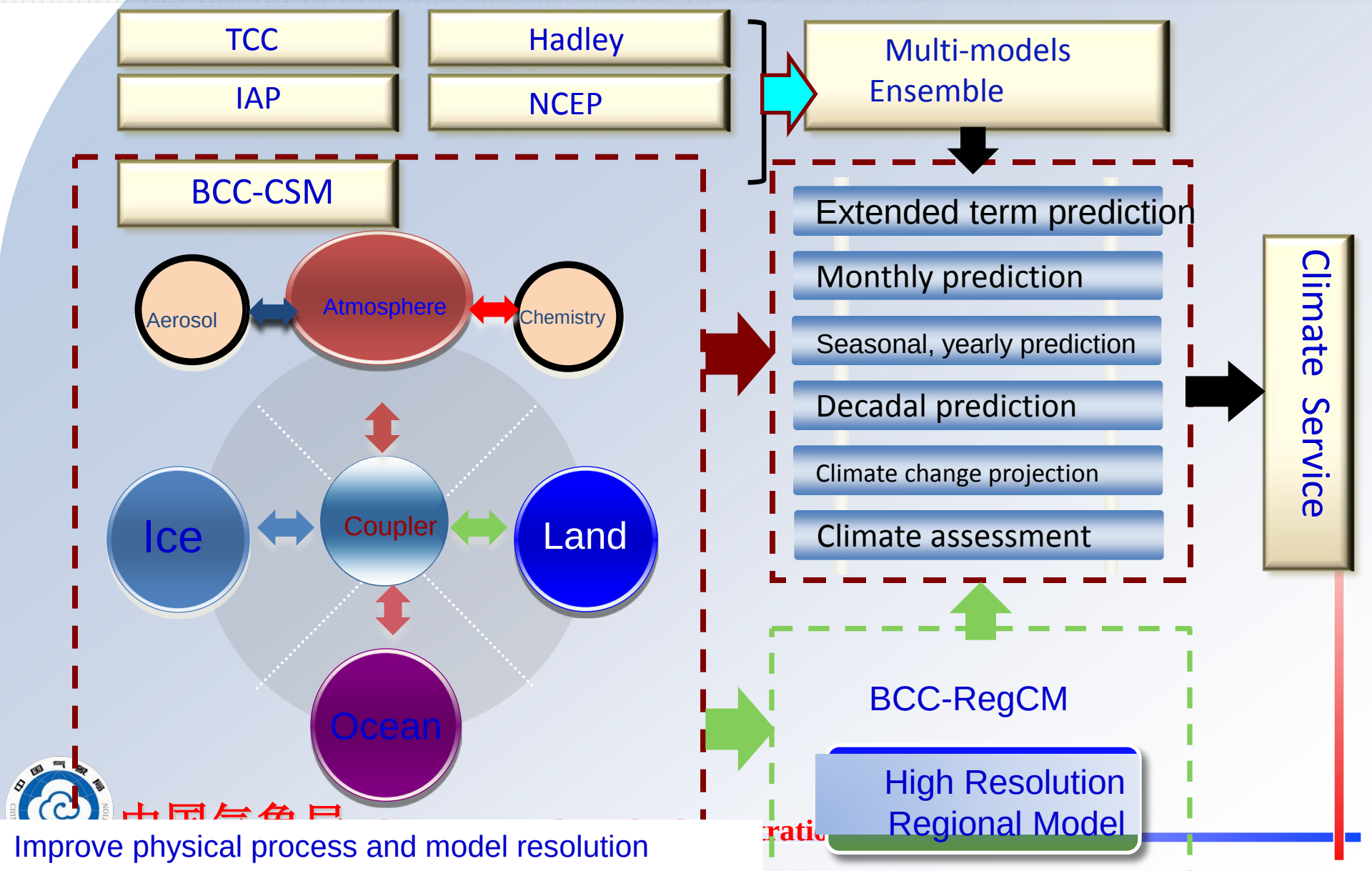
Drought Impact Assessment and Service



- Assessment impact on the Agriculture (Maize yield reduction rate)
- Assessment the influence population , crop drought areas and economic losses
- Assessment the impact on water resources in reservoir and rivers
- Provide services to local governments and public through various media.

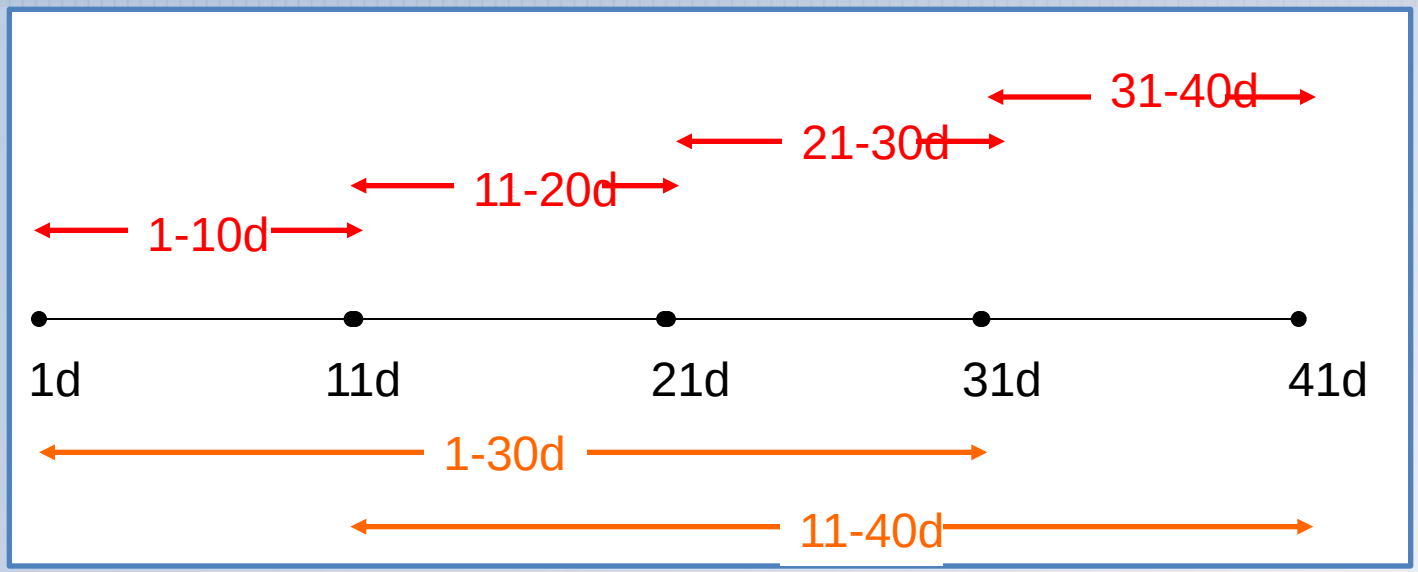
省份	受灾人口（万人）	饮水困难人口（万人）	农作物受灾面积（万公顷）	农作物绝收面积（万公顷）	直接经济损失（亿元）
辽宁	545.9	32.9	188.2	36.7	95.5
河南	1929.9	114.2	216.3	18.6	72.9
吉林	229.3	0.3	94.3	6.2	45
内蒙古	264.8	50.8	124.4	21.9	37.3
山东	542.4	19.5	56.6	7.4	39
陕西	576.2	47.5	53.3	7.3	33.9
湖北	511.9	96.4	73.3	7.6	22
江苏	475.1		35.7	3.4	9.7
四川	362.6	72.3	49.4	4.2	8.8
河北	245.3	0.6	28.8	2.4	8.3
安徽	420.7	8.1	50.4	1.2	7.3
宁夏	75.6	31.1	16.9	1.1	4.7
山西	35.7	0.6	6.6	0.2	1.6
合计	6215.4	474.3	994.2	118.2	386

BCC Climate Prediction System



Improve physical process and model resolution

Output include Six Prediction Periods



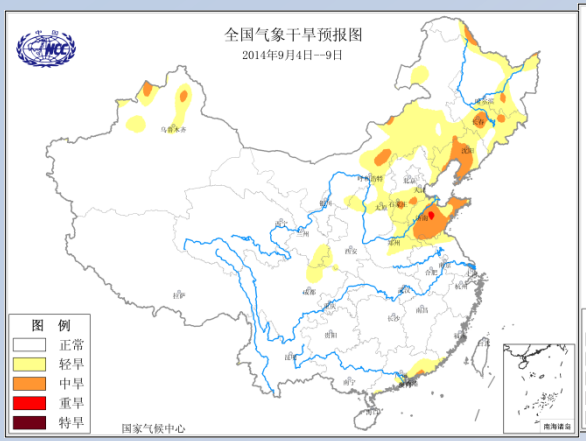
Data Correction

Drought Monitoring Results

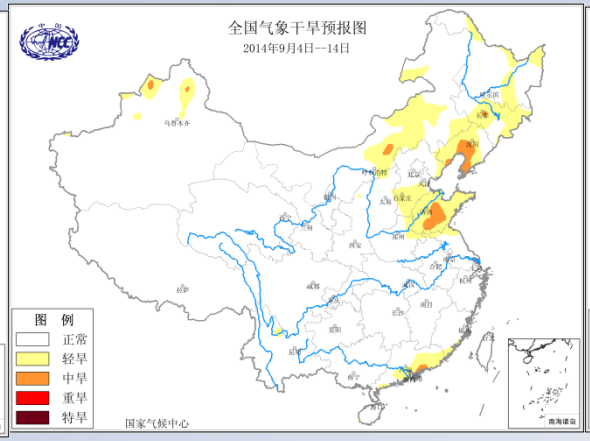
Drought Forecast

Drought Outlook for the next month

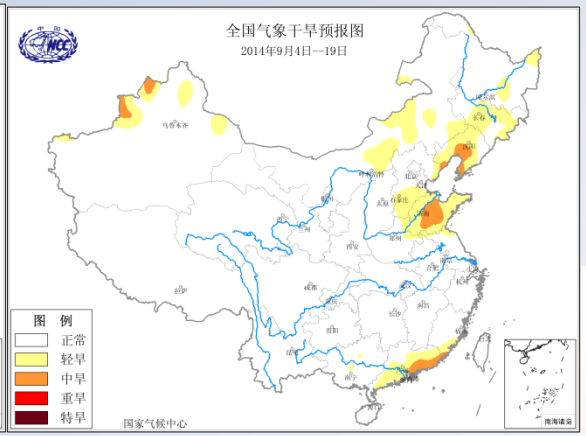
5-day drought forecast



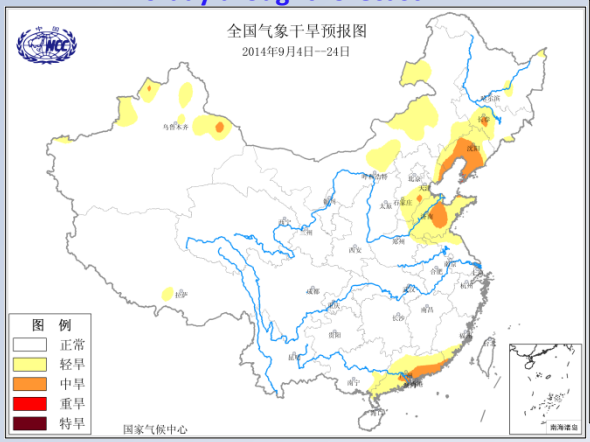
10-day drought forecast



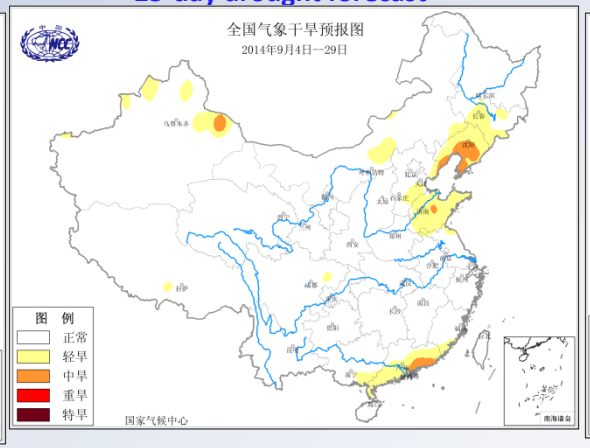
15-day drought forecast



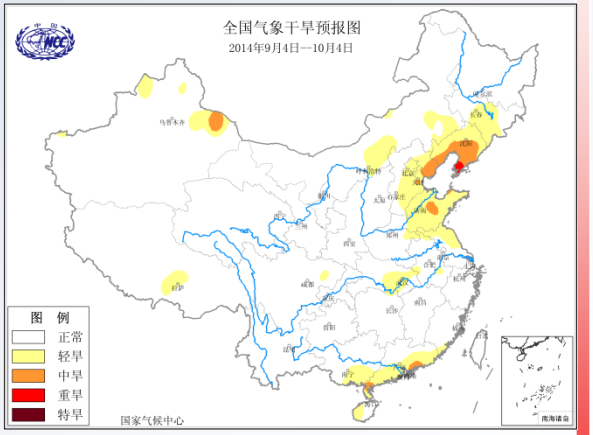
20-day drought forecast



25-day drought forecast



30-day drought forecast



The Reasons Analysis of Drought in Northern China

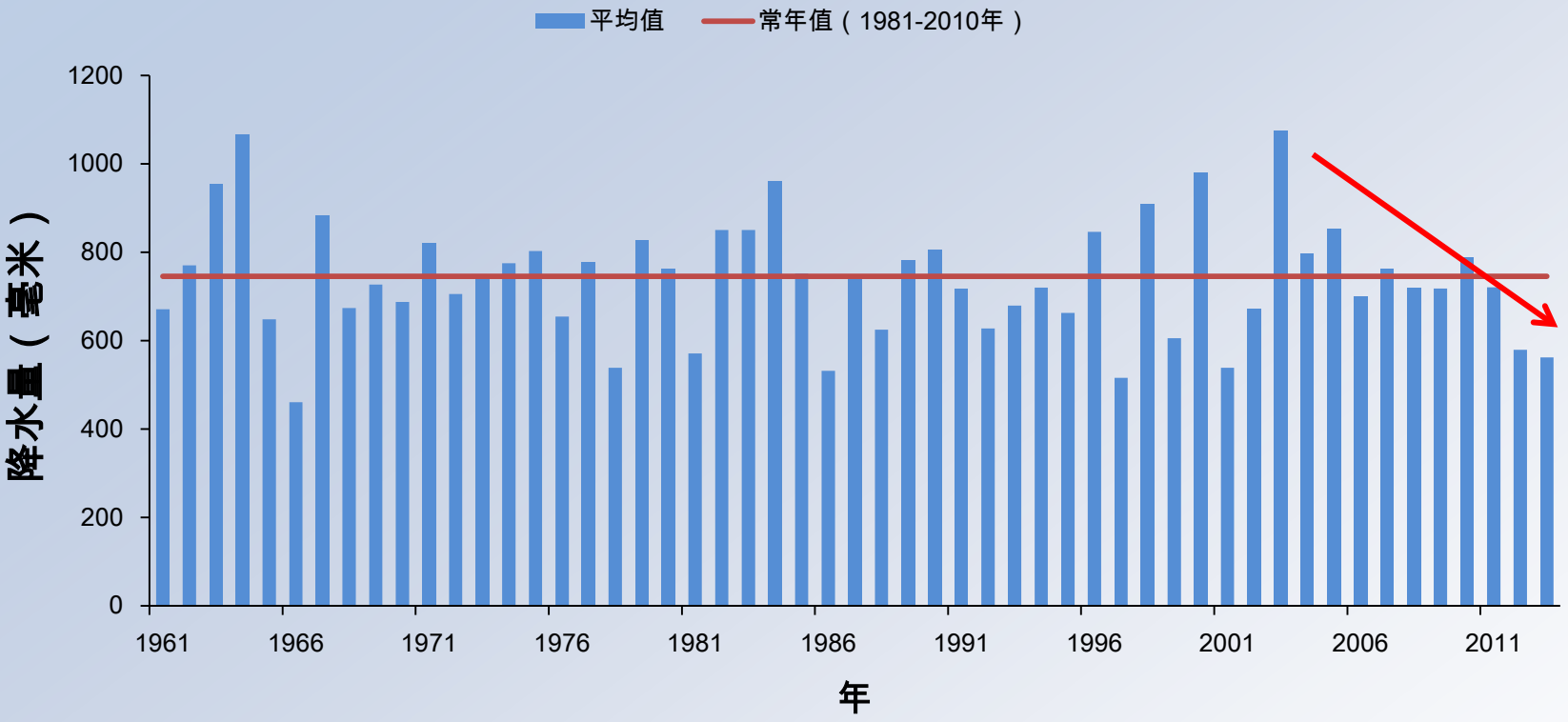
(1) Precipitation

(2) Atmospheric circulation

(3) Summer Monsoon system

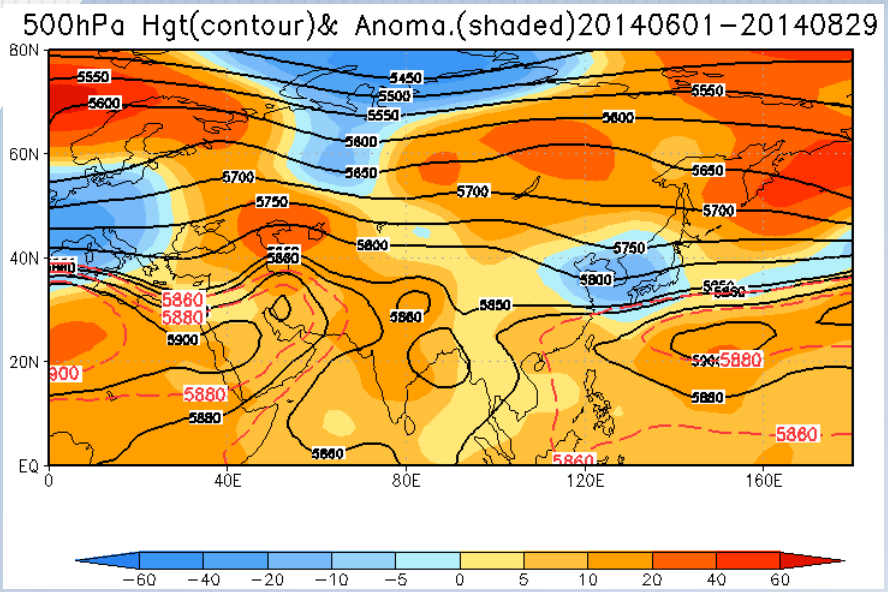
(4) Sea surface temperature

(1) Less Precipitation

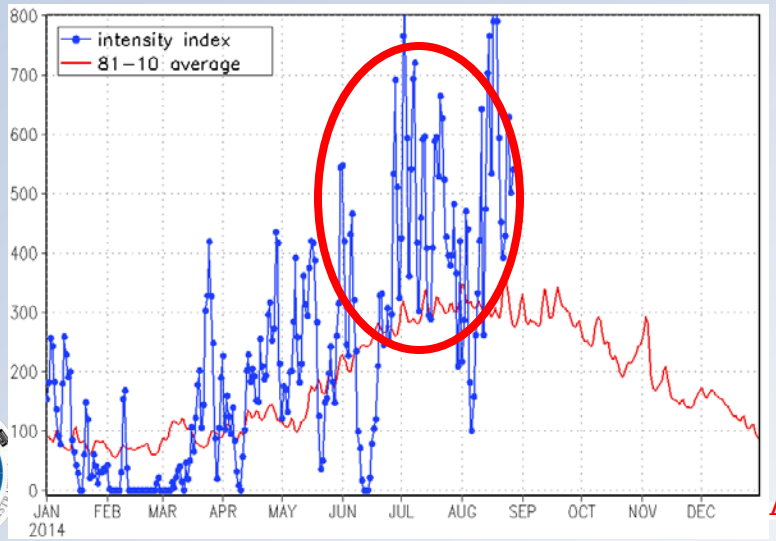


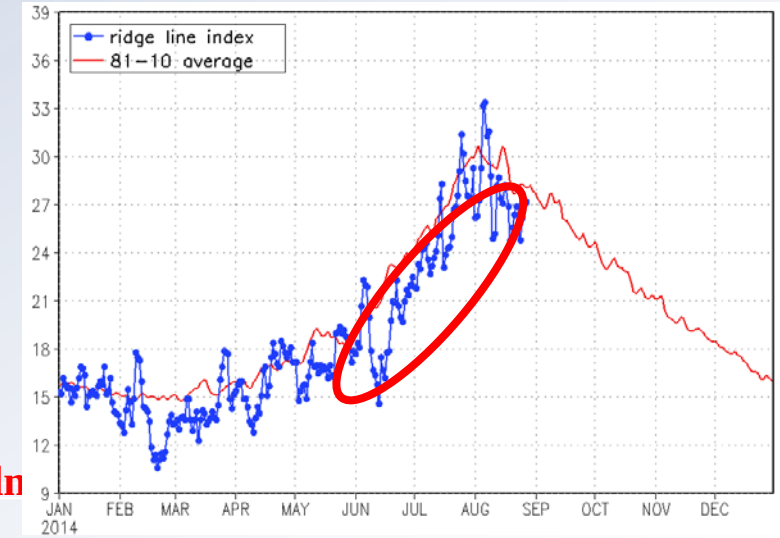
Variations of annual precipitation in Henan province

(2) Atmospheric circulation anomaly over east Asia



From June to August, The western Pacific subtropical high located in the south of the normal position, had higher intensity index than the normal.

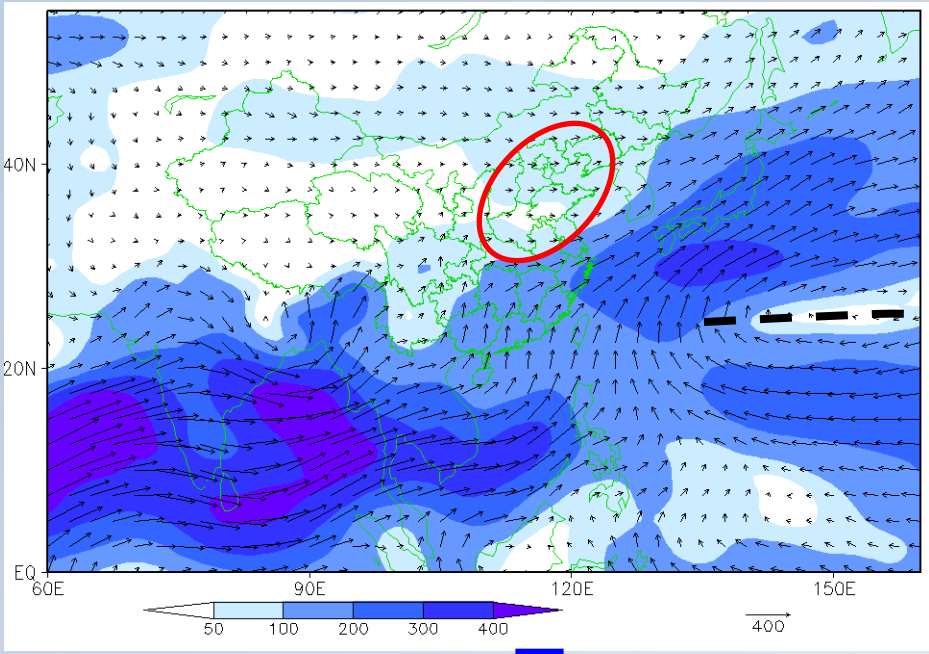


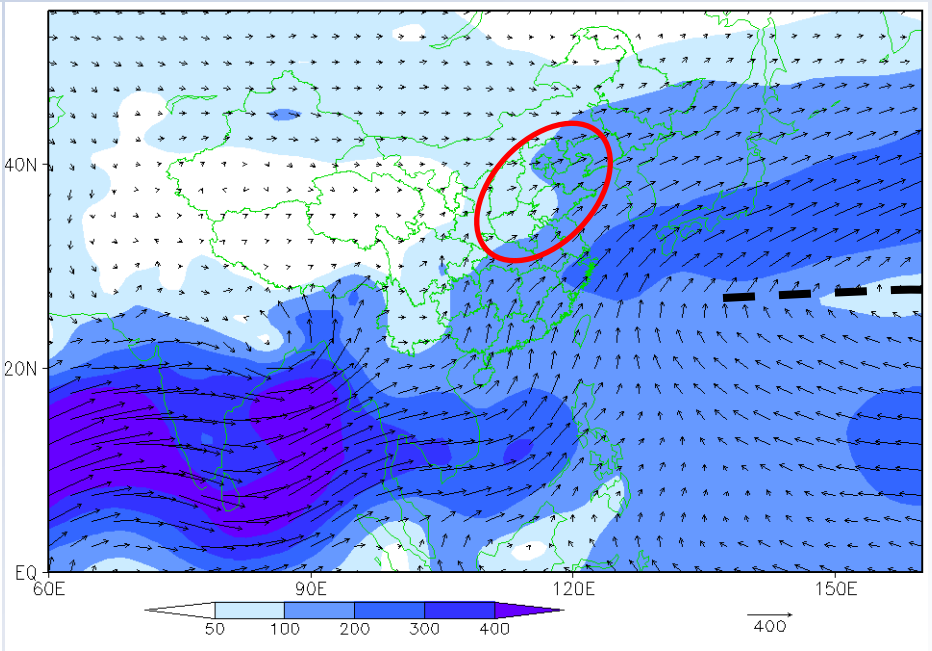


(3) Summer Monsoon system weaker

Water vapor transmission in summer 2014

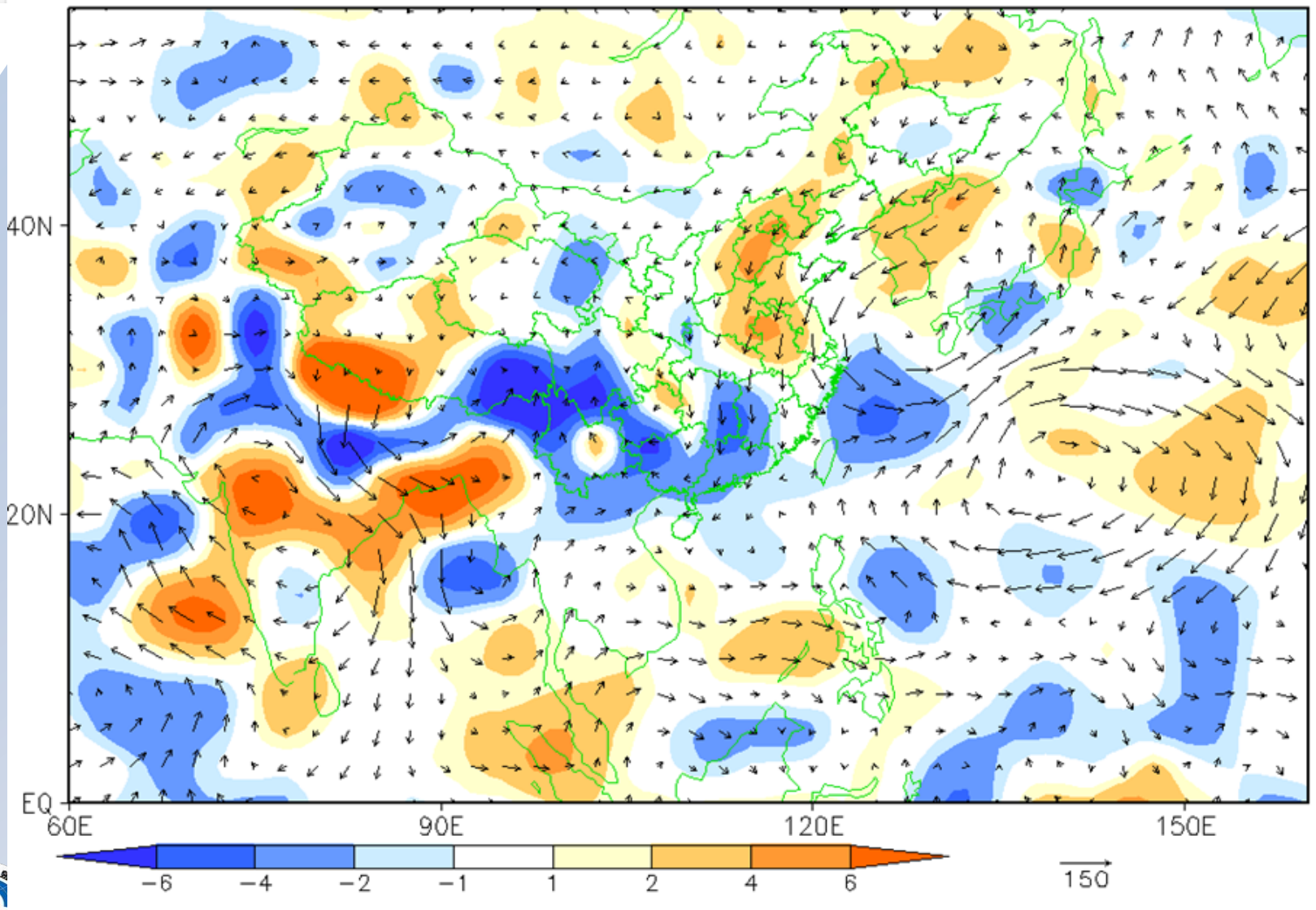
Average of 1981-2010





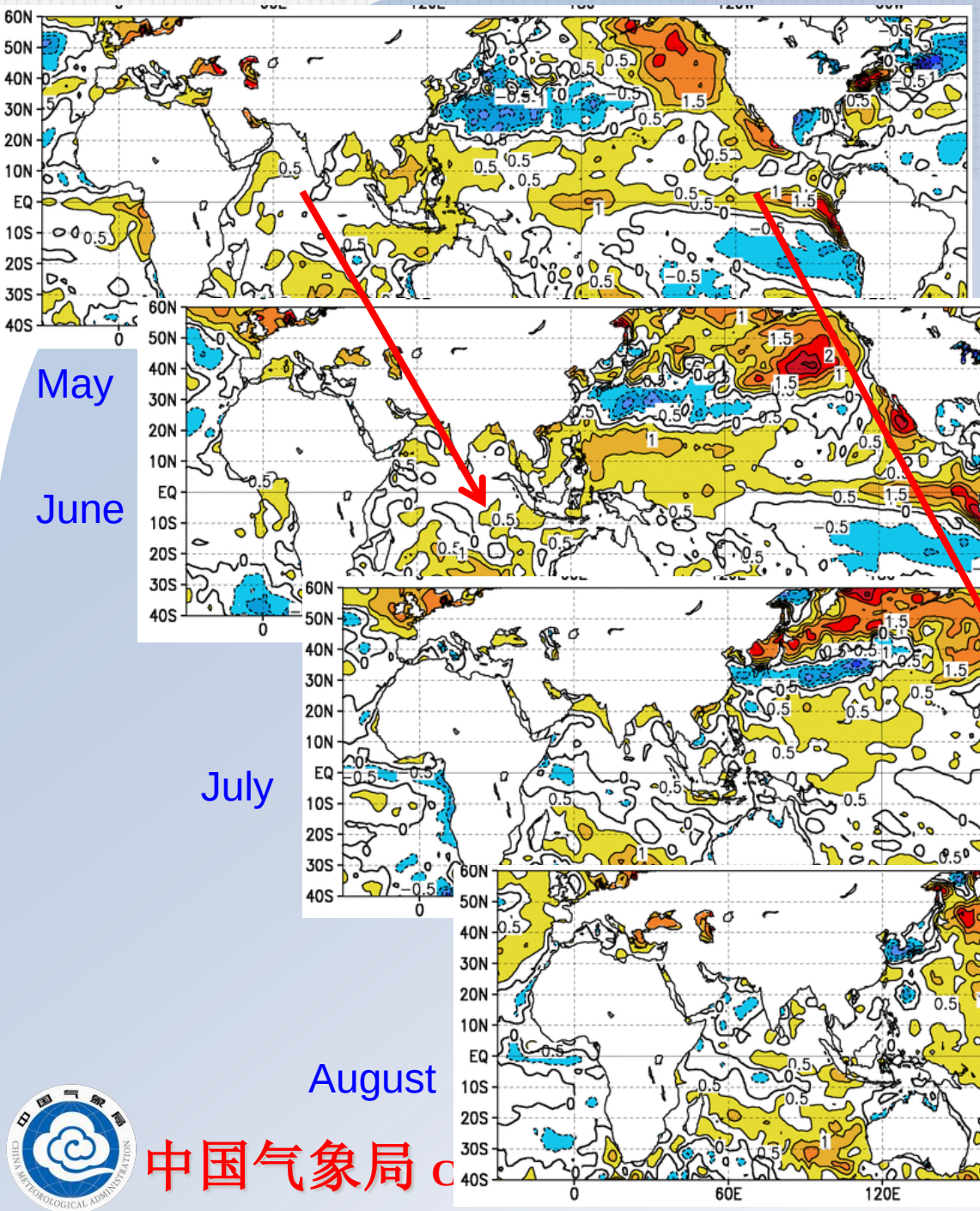
Water vapor transmission path was located in the south of the normal position

The water vapor flux and divergence in 850hPa



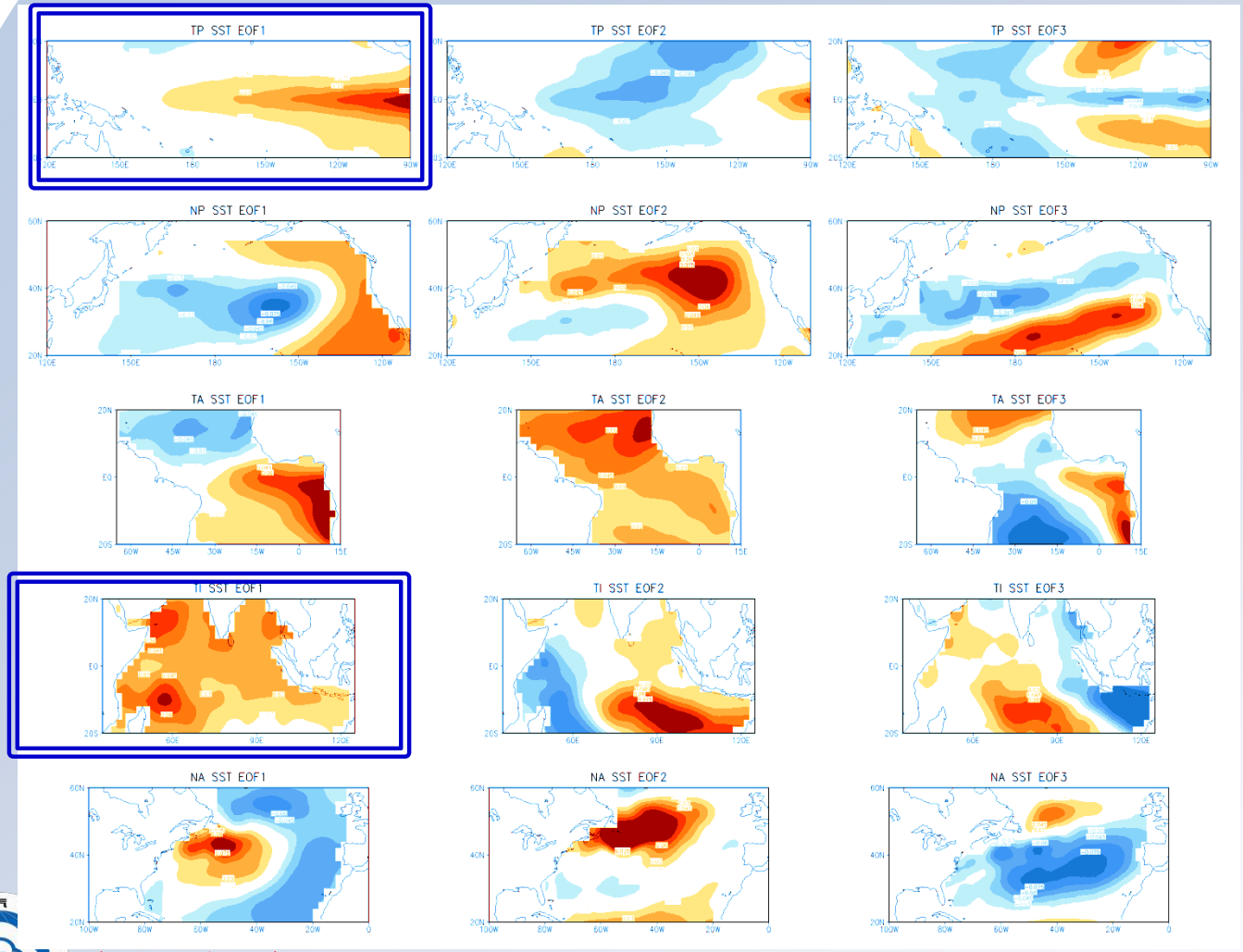
(4) Sea surface temperature anomaly In Pacific Ocean, El Nino conditions continuously developed during last summer.

In addition, positive SST anomalies dominated the most part of Indian Ocean in early summer.



中国气象局 C

Forcing Factors



Tropical Pacific
(20° S–20° N,
100° E–80° W)

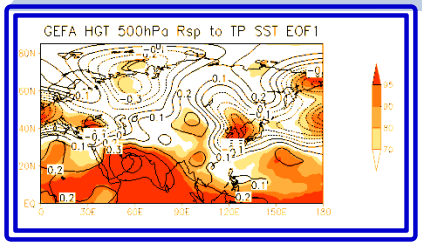
North Pacific
(20° –60° N,
120° E–80° W)

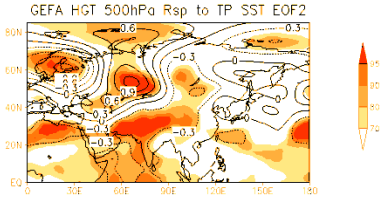
Tropical Atlantic
(20° S–20° N,
70° W–20° E),

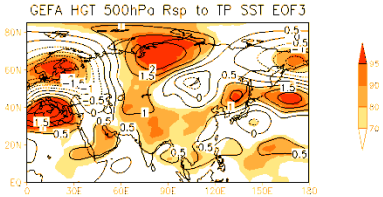
tropical Indian
Ocean
(20° S–20° N,
35° –120° E)

North Atlantic
(20° –60° N,
70° W–20° E)

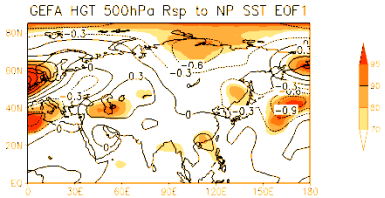
500hPa HGT Response to SST Forcing

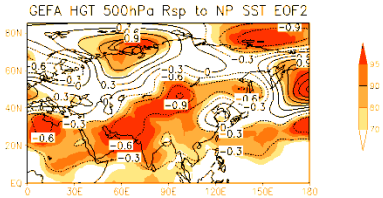


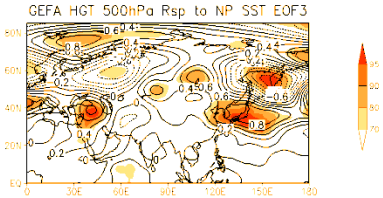




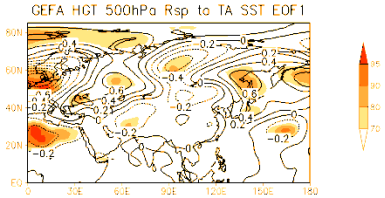
Tropical Pacific

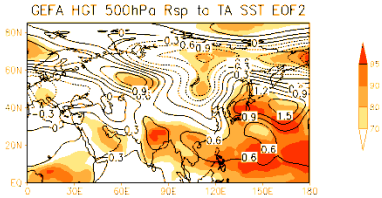


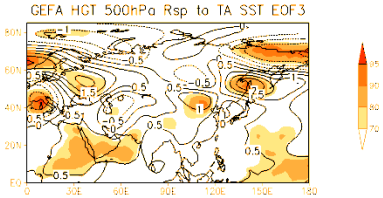




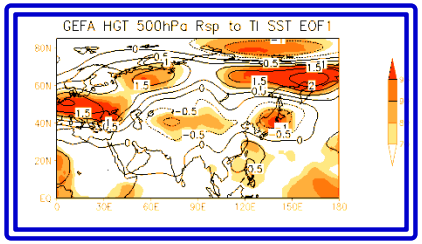
North Pacific

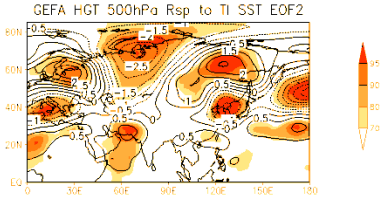


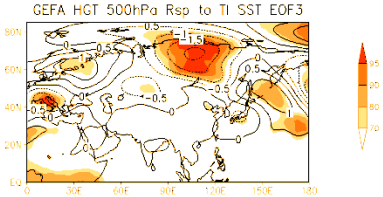




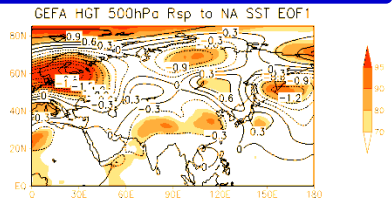
Tropical Atlantic

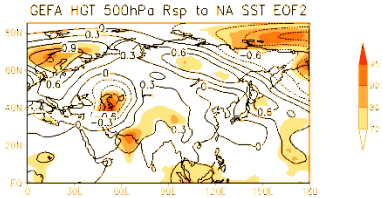


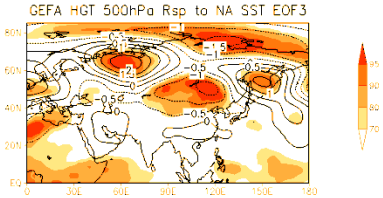




tropical Indian Ocean



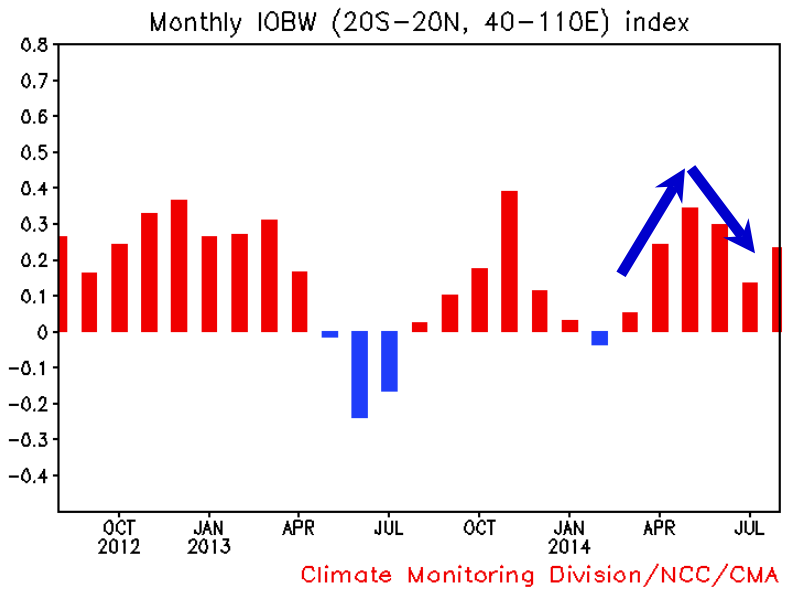




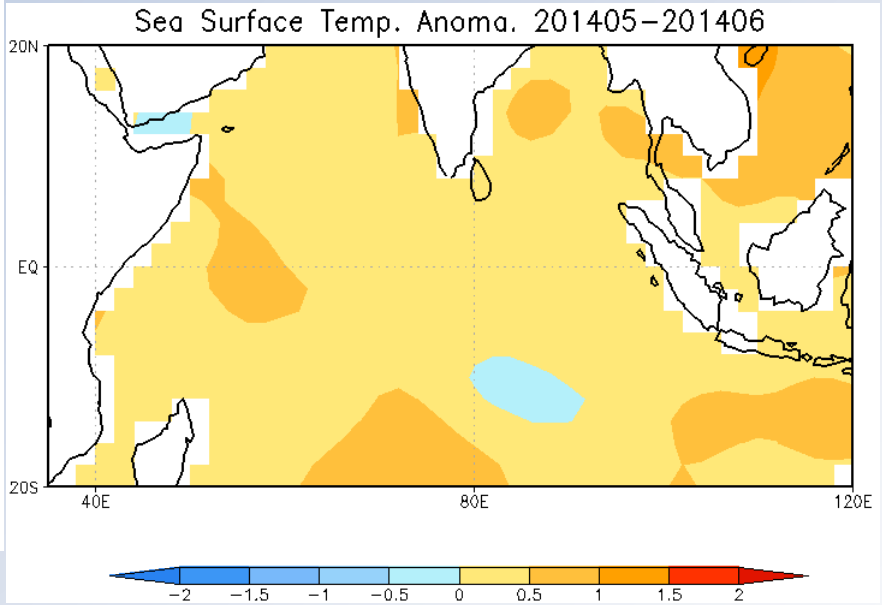
North Atlantic

SST anomaly in Indian Ocean in May and June

IOBW index



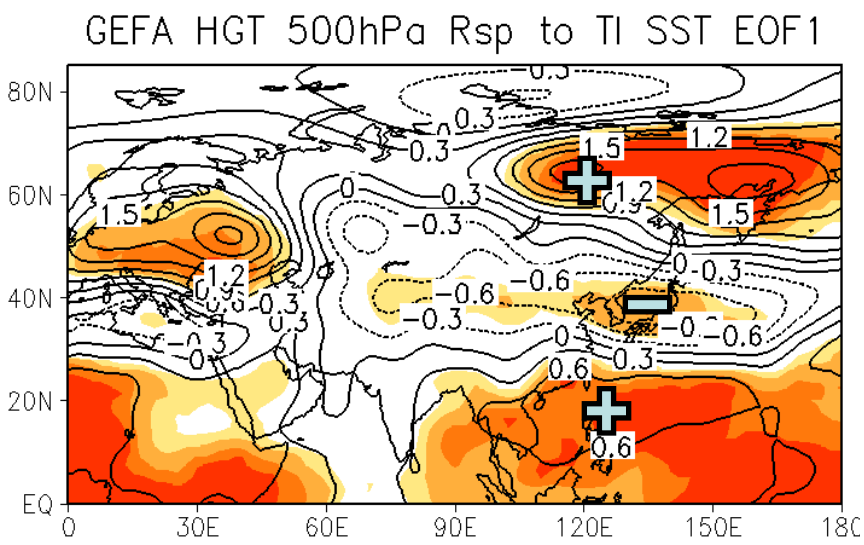
SSTs anomalies (May. And Jun.)



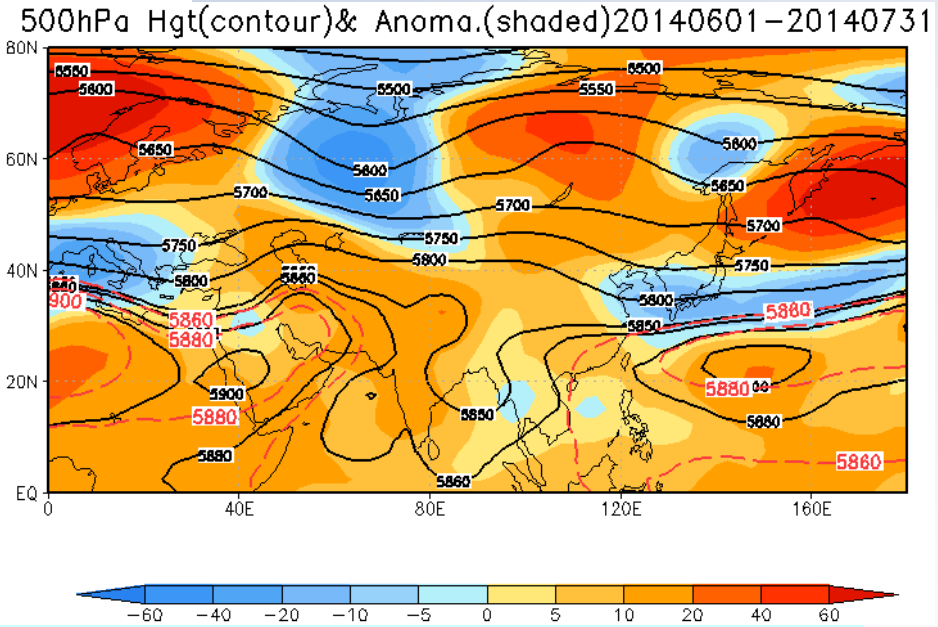
Sea surface temperatures (SSTs) were observed above normal in most I Indian Ocean during May and June. In this period, the positive Indian Ocean basin-wide (IOBW) persisted in May and June, and became weaker in July.

Impact of equatorial Indian Ocean SST IOBW pattern

500hPa HGT response (Jun. and Jul.)

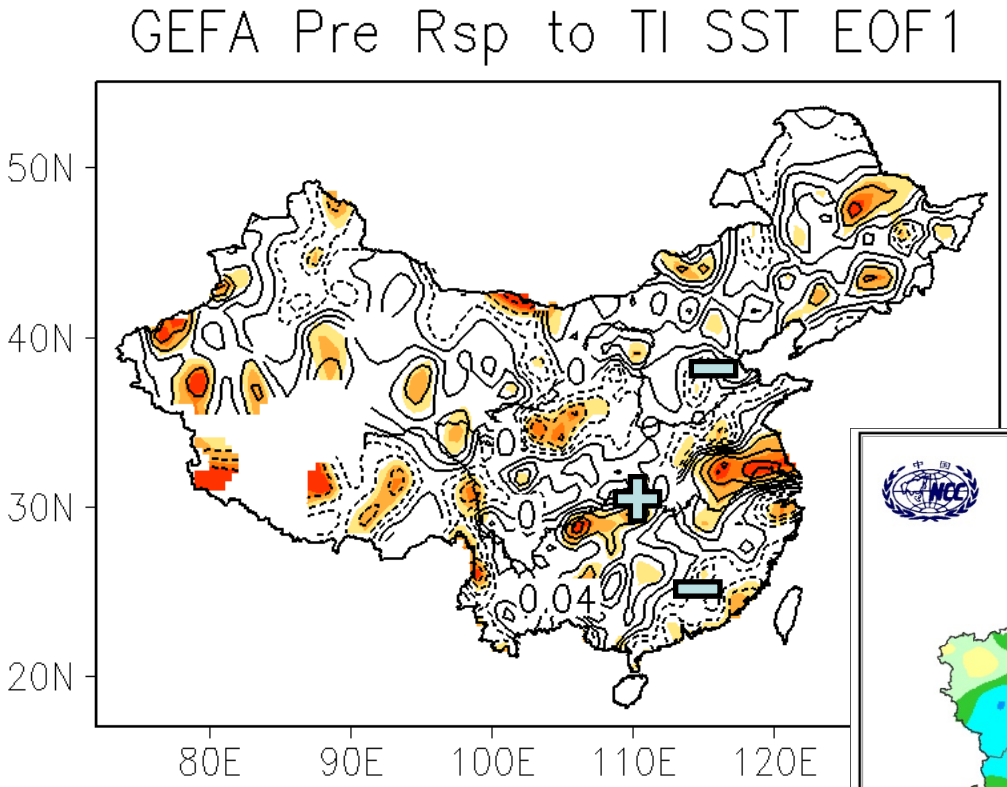


500hPa HGT anomalies (Jun. and Jul.)

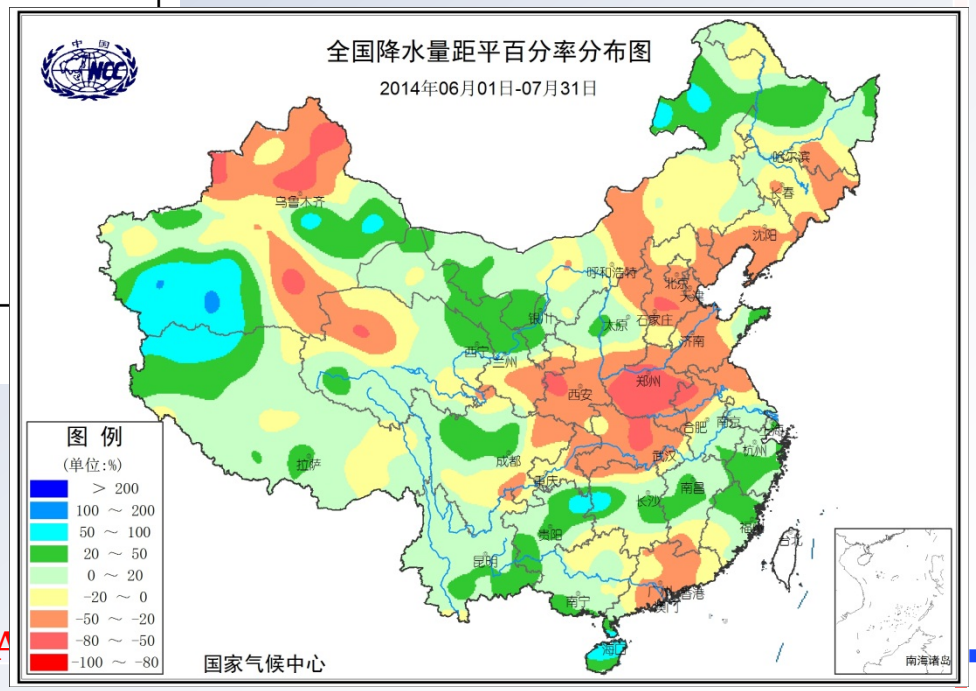


As the response to Indian Ocean SST IOBW pattern forcing, the large-scale circulation anomalies in East Asia region shows a "+-+" pattern, which is favorable to enhance the northwestern Pacific subtropical high and make it located in the south of normal position.

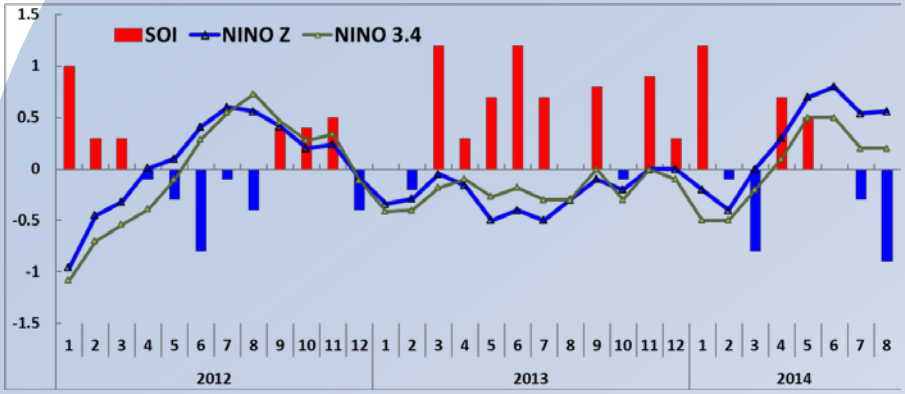
Precipitation response to IOBW

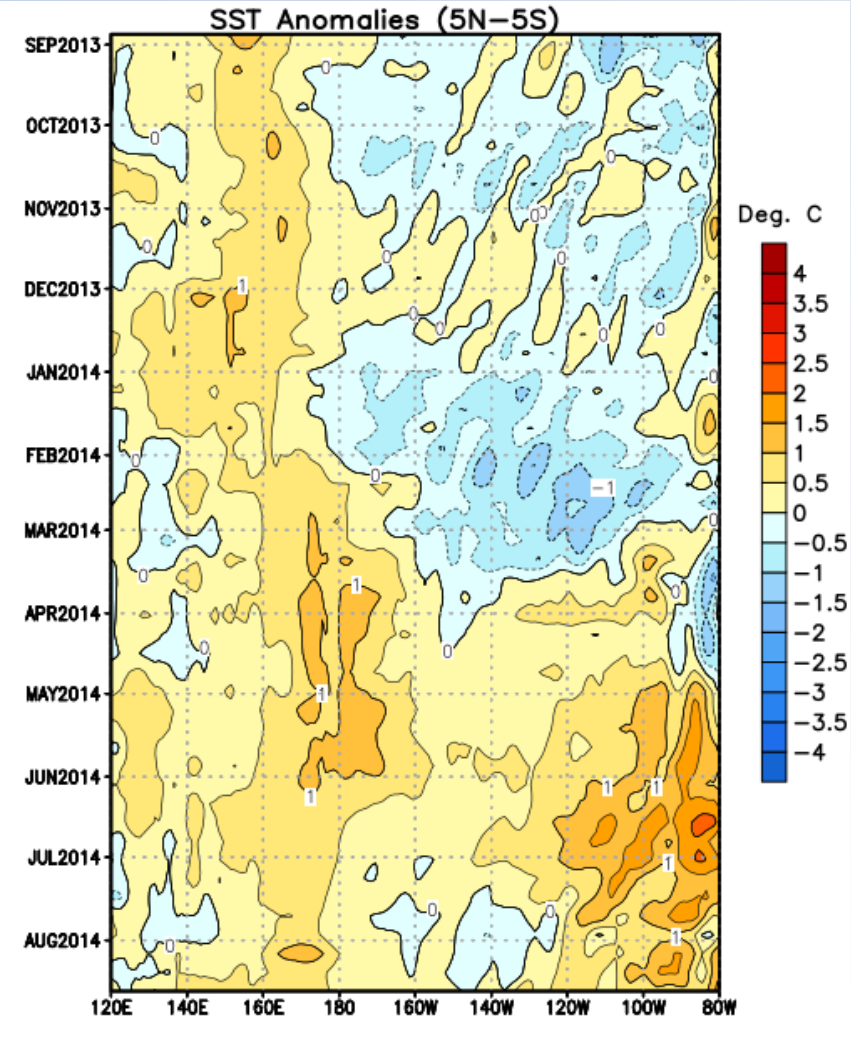


As the response to IOBW pattern forcing, the precipitation anomalies in East China shows a "-+-" pattern, which is similar to the spatial distribution of precipitation anomalies in Jun. and Jul. 2014.



El Nino condition

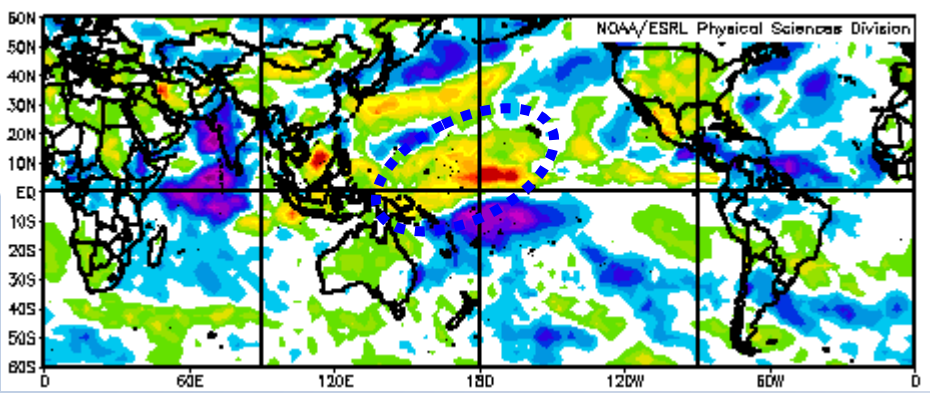




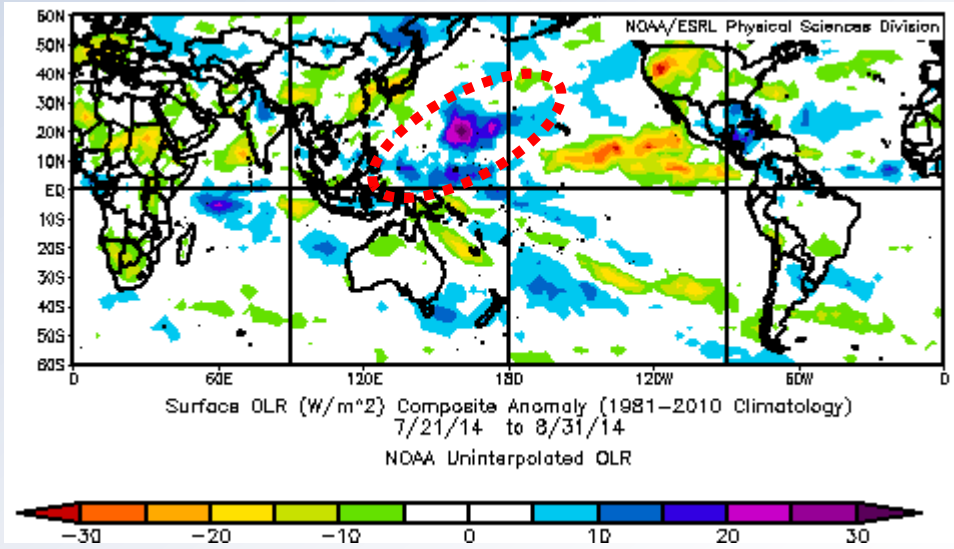
Southern Oscillation Index (SOI) transferred from positive phase to negative phase around July 2014, and reached -0.9 in August, indicating that the response of the tropic atmosphere to the El Niño has established since Aug. 2014.

The response of the tropic atmosphere to the El Niño

June 1st-July 20th mean OLR anomalies



Jul. 21st-Aug. 31st mean OLR anomalies



response to equatorial Pacific El nino conditions

Anom. SST Aug. 2014

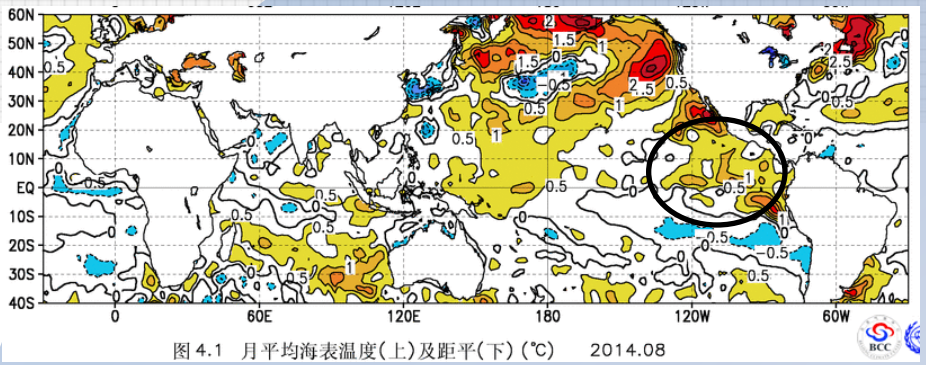
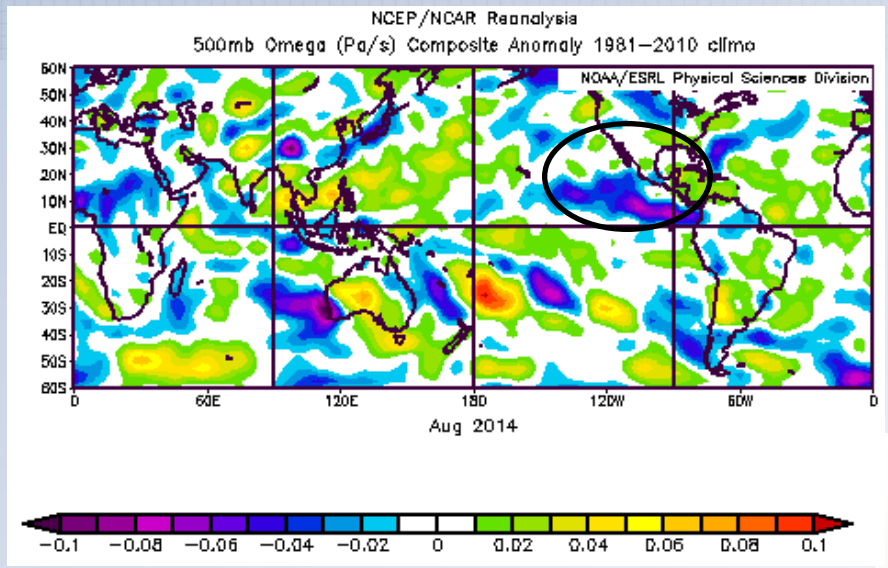
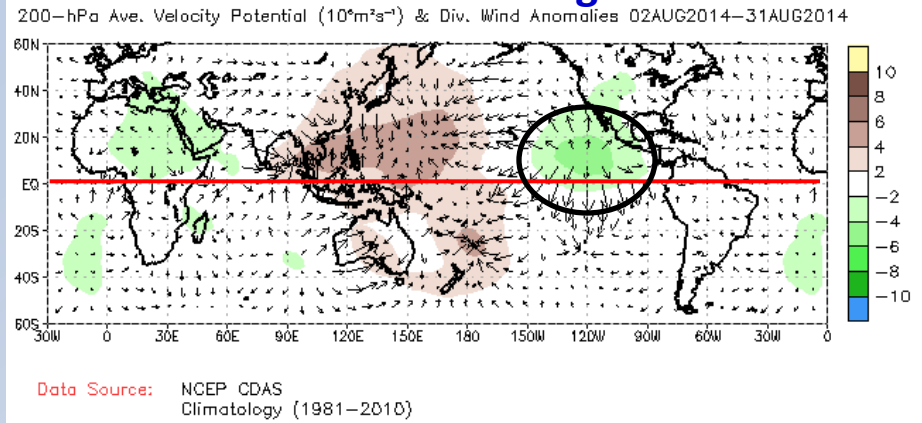


图 4.1 月平均海表温度(上)及距平(下) (℃) 2014.08

Anom. 500hPa Omega Aug. 2014

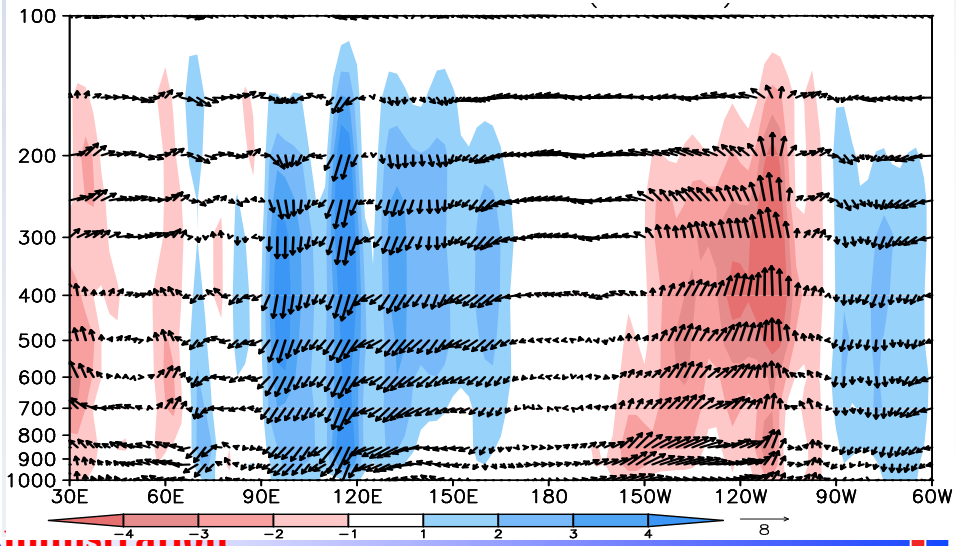


Anom. 200hPa Velocity Potential and Div. Wind Aug. 2014



Data Source: NCEP CDAS
Climatology (1981–2010)

Anom. Vertical Wind(10º-20ºN)Aug. 2014



Anom. OLR Aug.2014

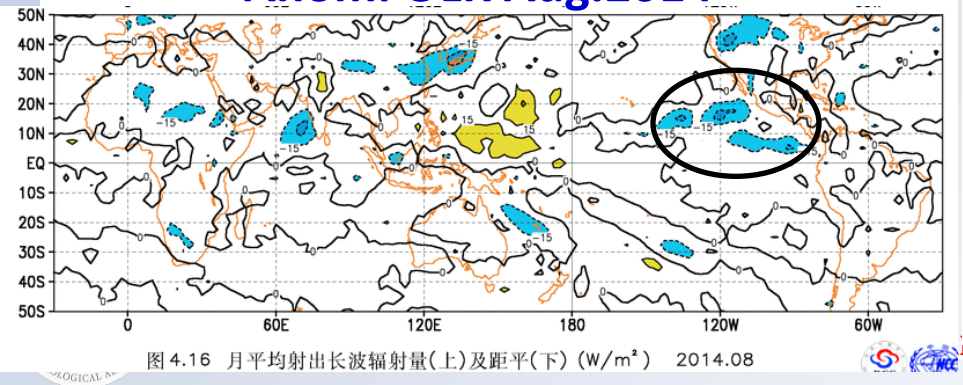
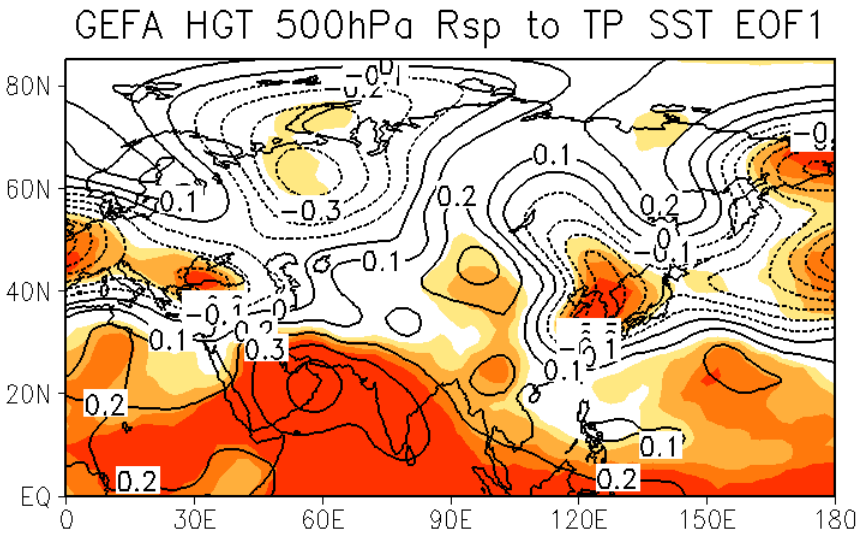
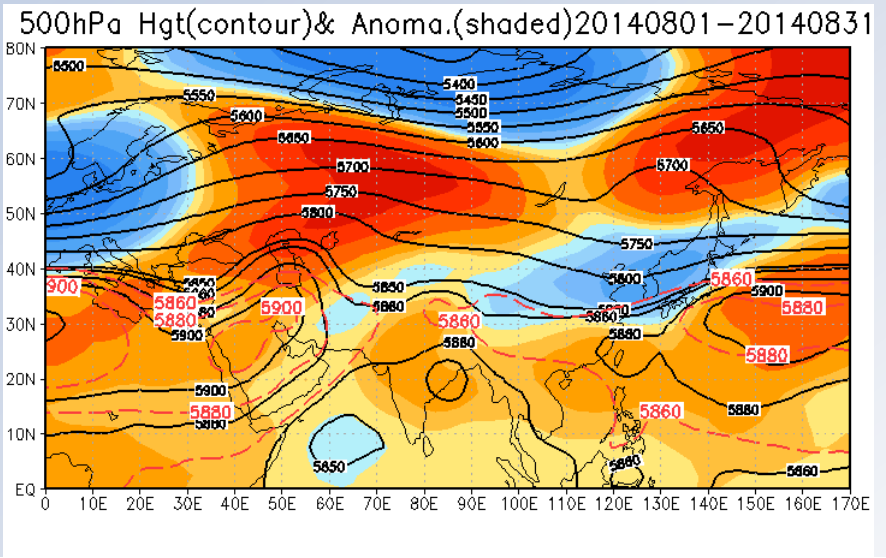


图 4.16 月平均射出长波辐射量(上)及距平(下) (W/m²) 2014.08

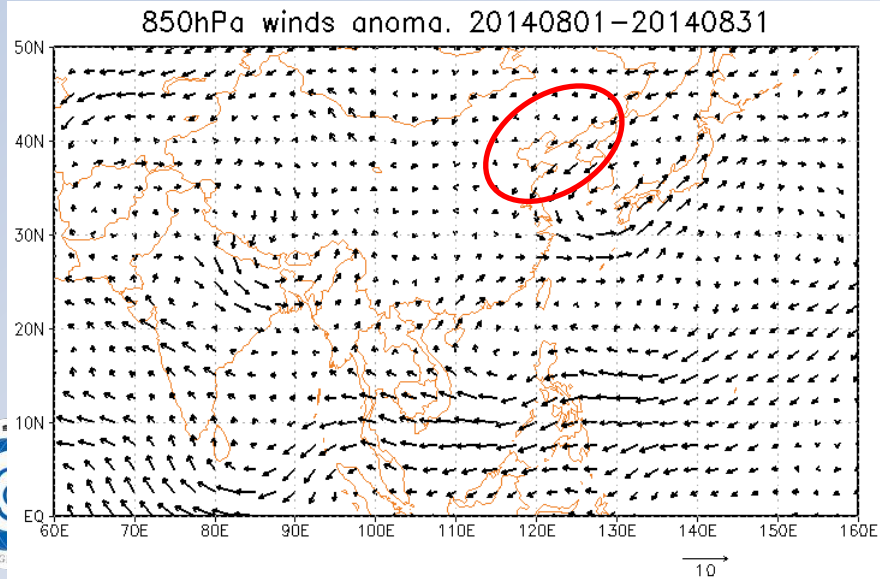
500hPa HGT response (Aug.)



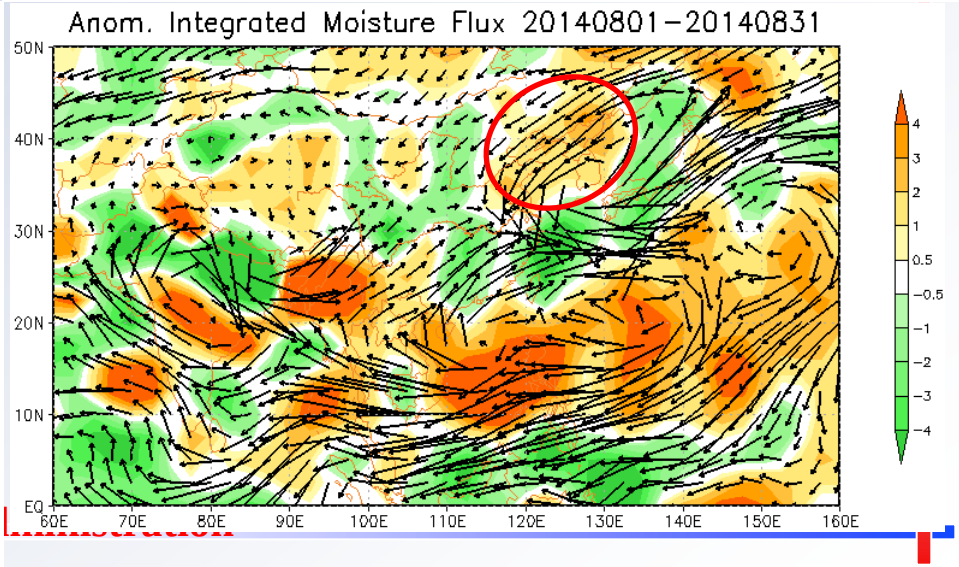
Anom. 500hPa HGT in Aug. 2014



850hPa winds anom. In Aug. 2014



Anom. Integrated Moisture Flux In Aug. 2014



Conclusion

- In the summer 2014, the precipitation distribution has the characteristics of more in the South and less in the North. North China had experienced severe drought.
- Western North Pacific Subtropical High location more south than normal and East Asian summer monsoon was weaker than normal are the direct reasons.
- Warmer SST in tropical India Ocean and El Nino status in Pacific Ocean caused the Northwest Pacific Subtropical High position by south.

Thank you