

Upper Troposphere Cooling and “Southern Flood and Northern Drought” over East Asia

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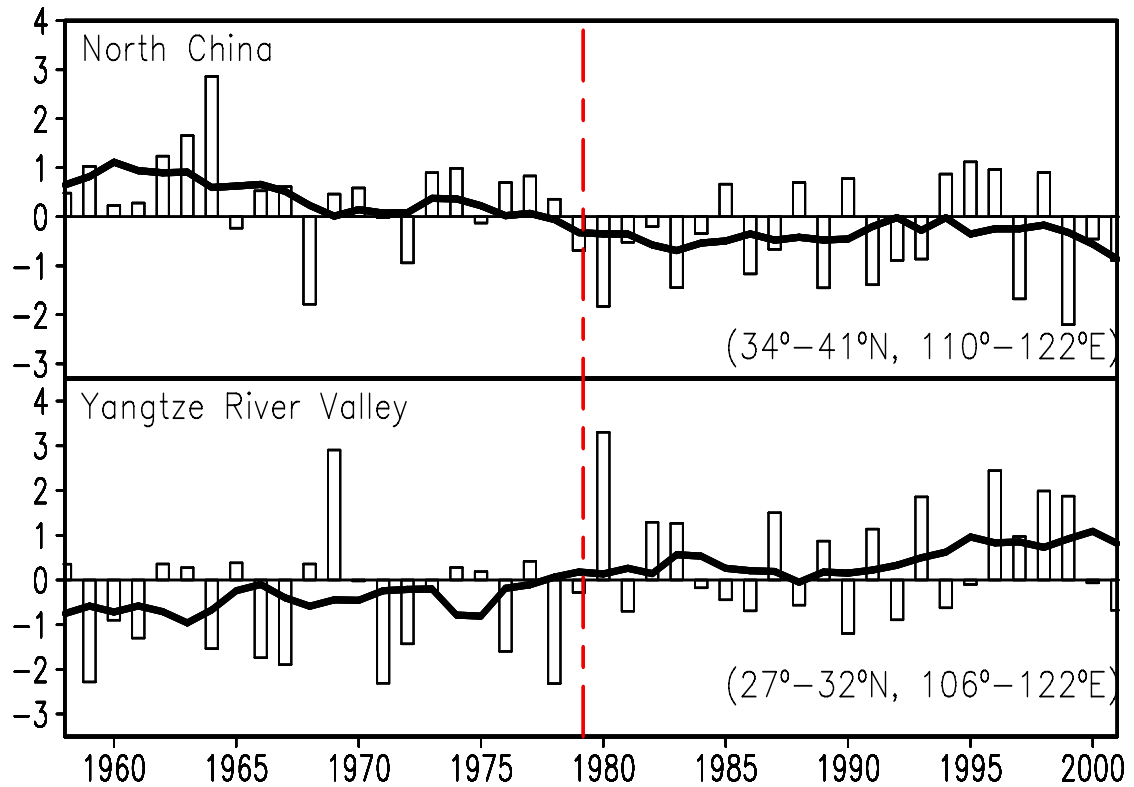
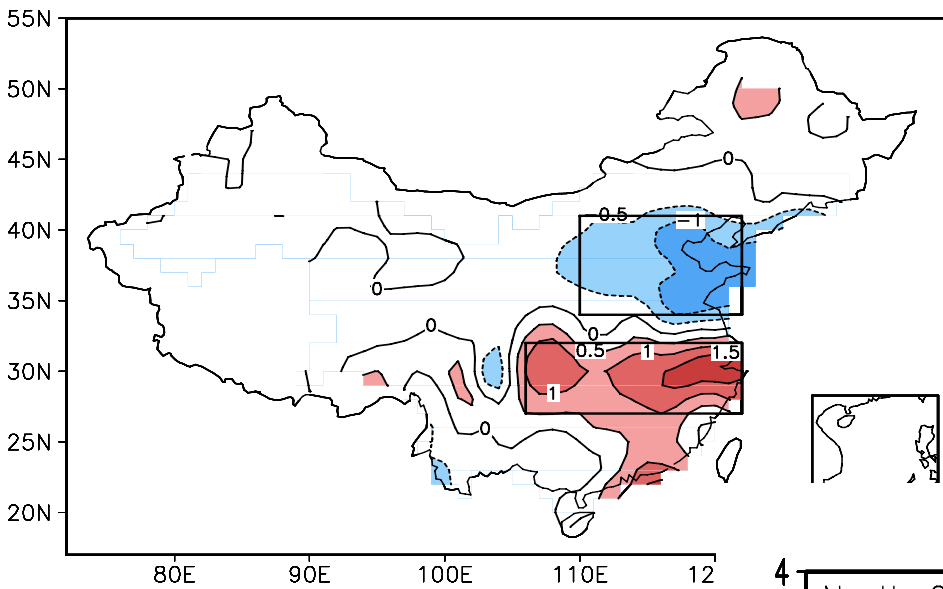
Content

- **South Flood and North Drought**
- **Seasonal Features of SFND**
- **Upper Troposphere Cooling**
- **Why is the Troposphere Cooling?**
- **Conclusions**

South Flood and North Drought

In the past fifty years, summer precipitation has increased in the middle-lower valley of Yangtze River whereas decreased in northern China. This noticeable precipitation trend is called “southern flood and northern drought” in China.

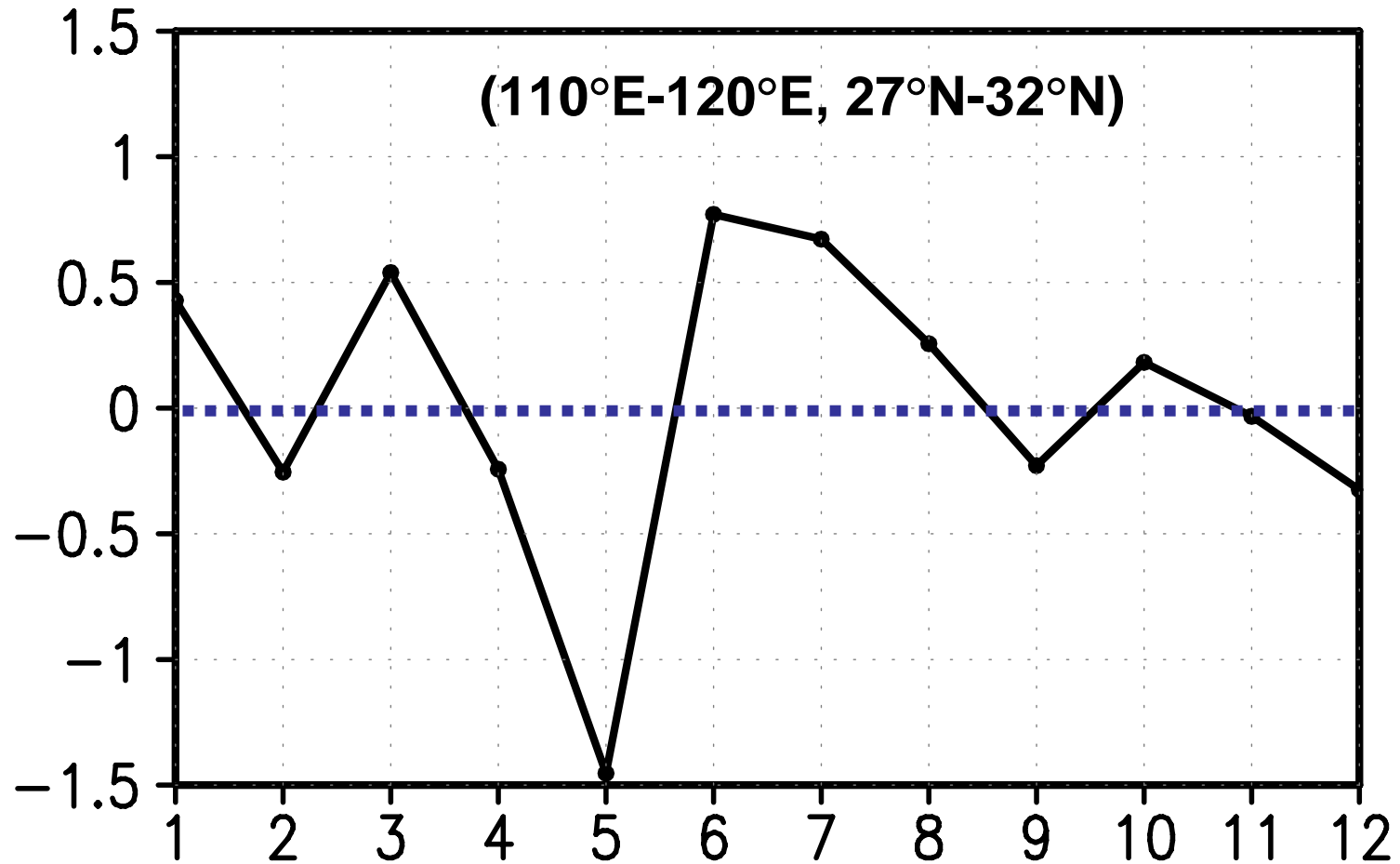
Changes in JA Precipitation (1980-2001 minus 1958-1979)



- **Nitta, T., and Z.-Z. Hu, 1996:**
the intensification and southern location of **the western Pacific subtropical high (WPSH)**
the SST anomaly in the North Pacific and the tropical western Pacific
- **Gong, D.Y., and C.-H. Ho, 2002:**
WPSH has enlarged, intensified, and extended southwestward
the variations of the **SST of the eastern tropical Pacific and tropical Indian Ocean**
- **Hu, Z.-Z., S. Yang and R.-G. Wu, 2003:**
The increased **warming over the Indian Ocean**
- **Xu, Q., 2001:**
The negative radiative forcing of **sulfate aerosols** induces changes in heat equilibrium of the land surface
- **Menon, S., J. Hansen, L. Nazarenko, and Y. Luo, 2002:**
Absorbing **aerosols** heat the air, alter regional atmospheric stability and vertical motions, and affect the large scale circulation and hydrologic cycle with significant regional climate effects.

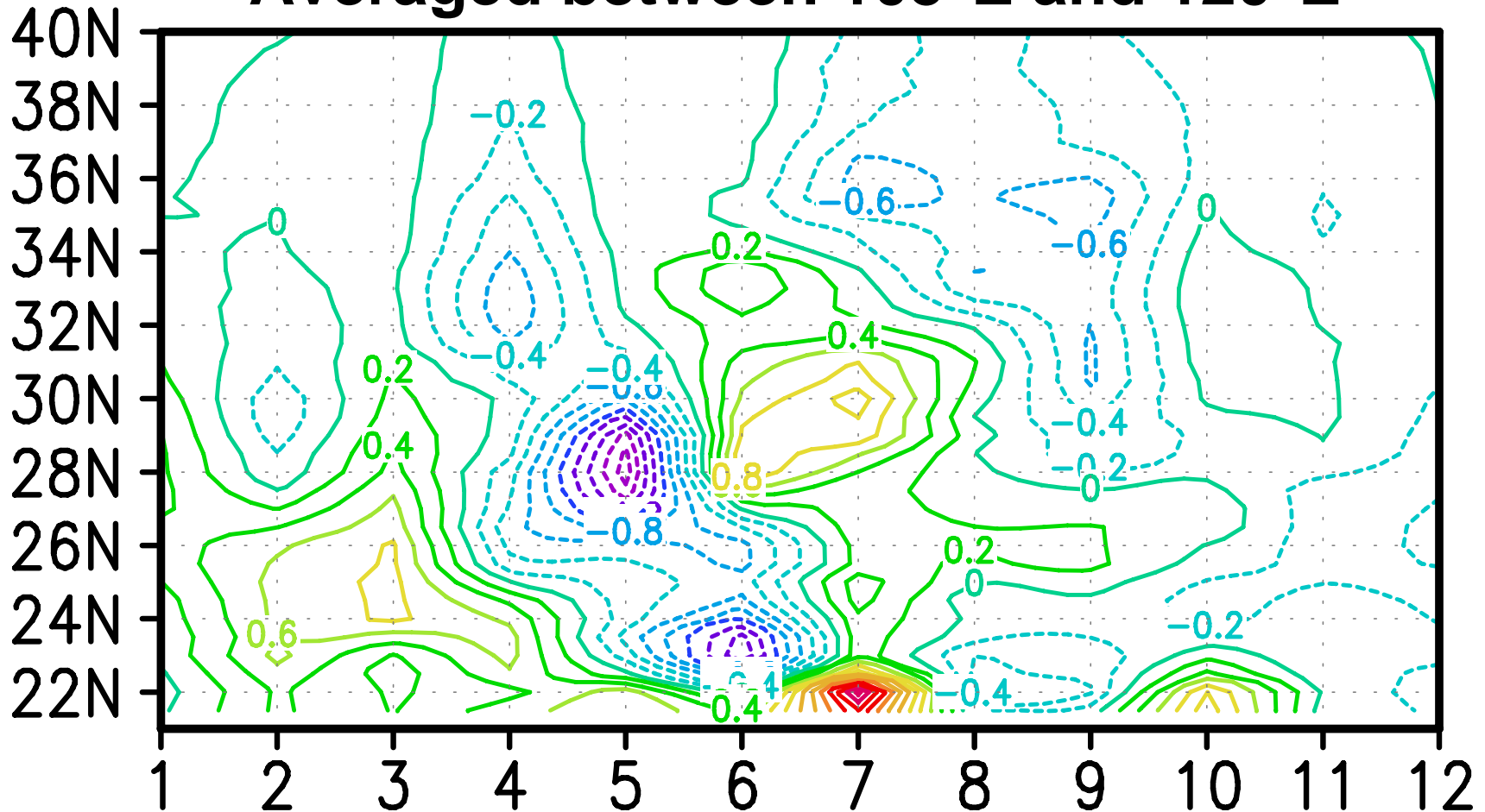
Seasonal Features of SFND

The annual cycle of the regional mean changes in precipitation



Month-meridional cross-section of changes (1980-2001 mean minus 1958-1979 mean) in precipitation

Averaged between 105°E and 120°E

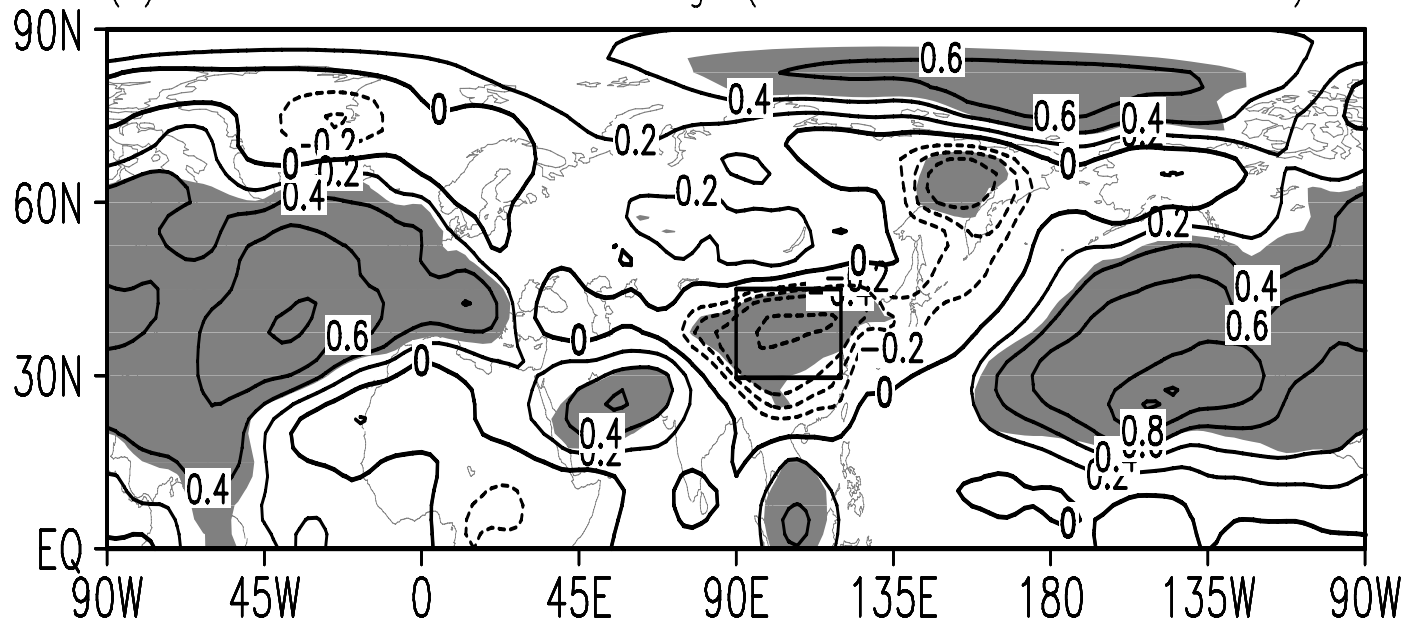


Questions :

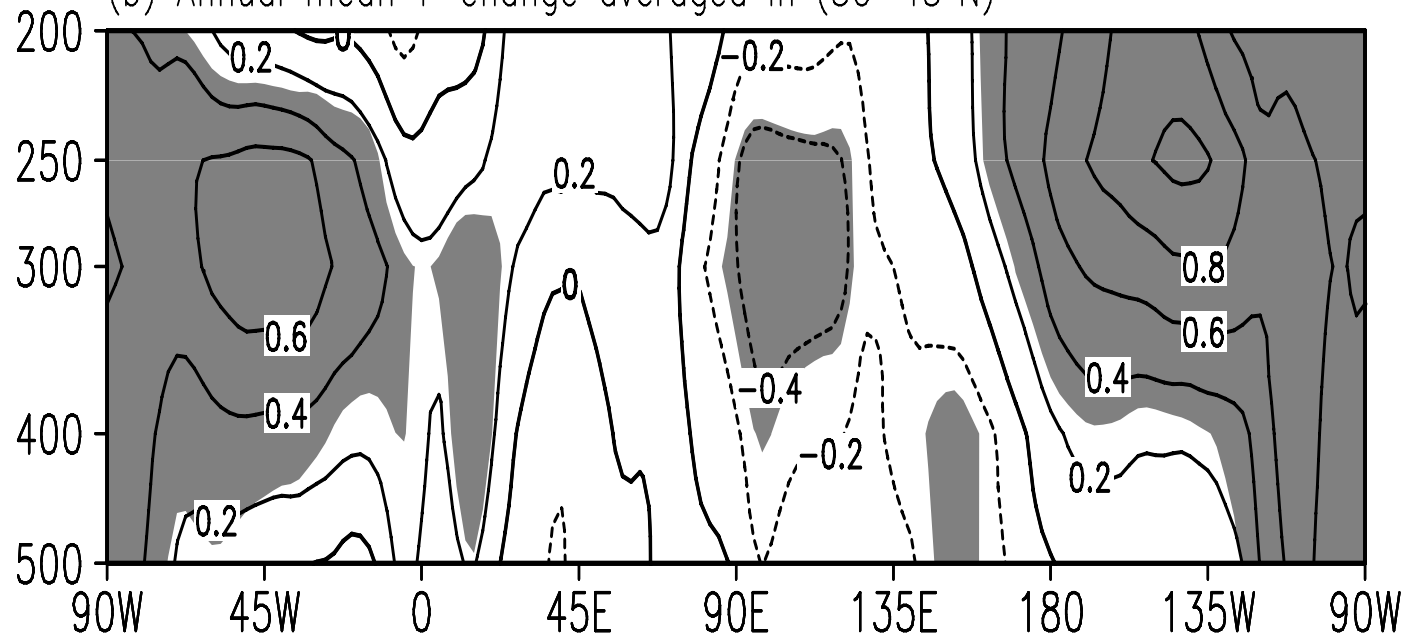
- Do the seasonal features in the rainfall change of East China relate each other ?
- What is an integral part of changes in atmospheric circulation which could account for the rainfall change of East China ?
- How does the local climate variation respond to the global climate change ?
- Could the local Aerosol or air pollution dominate the local climate change ?

Upper Troposphere Cooling

(a) Annual mean 300hPa T-change (1981–2000 minus 1961–1980)

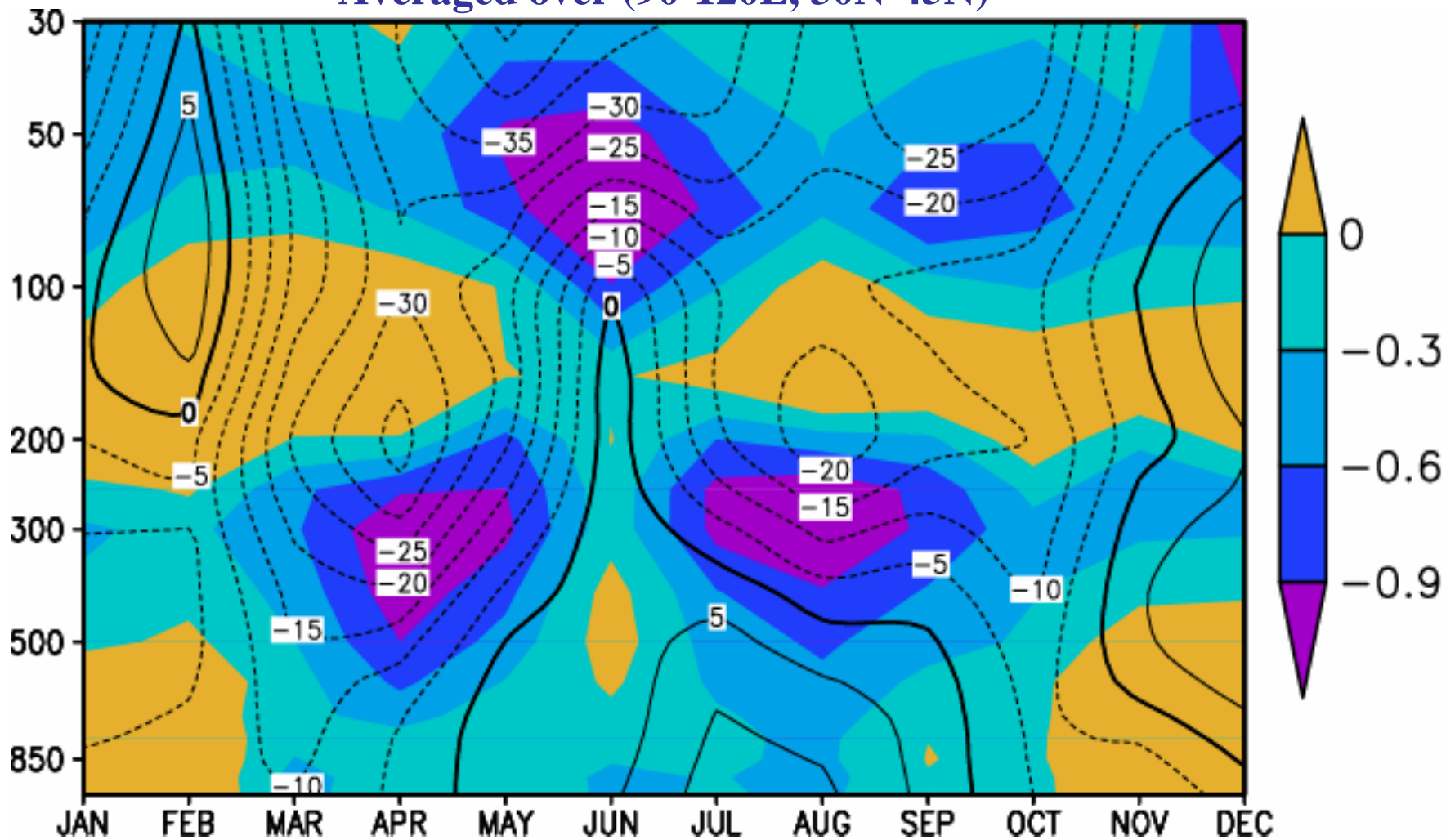


(b) Annual mean T-change averaged in (30–45°N)

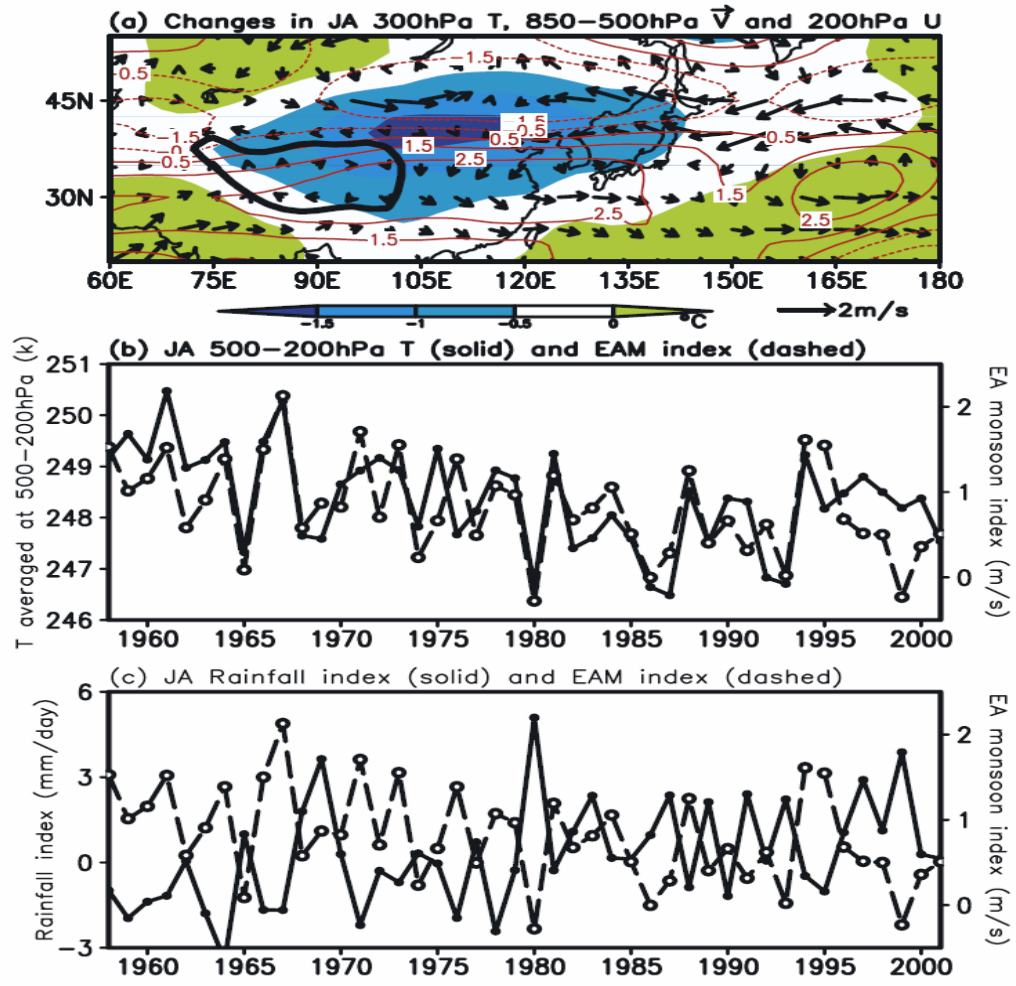


Changes (1980-2001 minus 1958-1979) of geopotential height (contour) and temperature (shaded).

Averaged over (90-120E, 30N-45N)



Connection between the upper tropospheric cooling and the rainfall

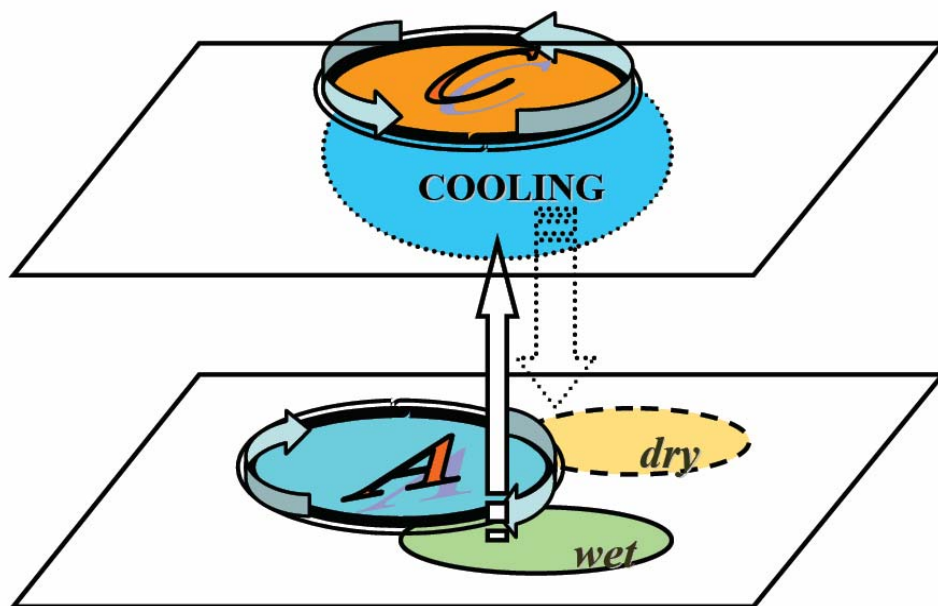


500–200 hPa T: over (100–130E, 35N–45N)

EAM: 850–500 hPa southerlies averaged over (100–120E, 30–40N)

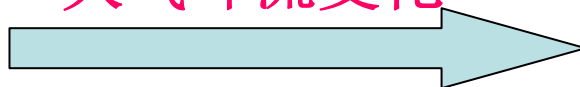
JA rainfall index: July–August mean rainfall rate difference between the Yangtze River valley (107–120E, 27–32N) and the North China (108–120E, 34–40N).

Schematic diagram showing the effect of the upper tropospheric cooling in late spring



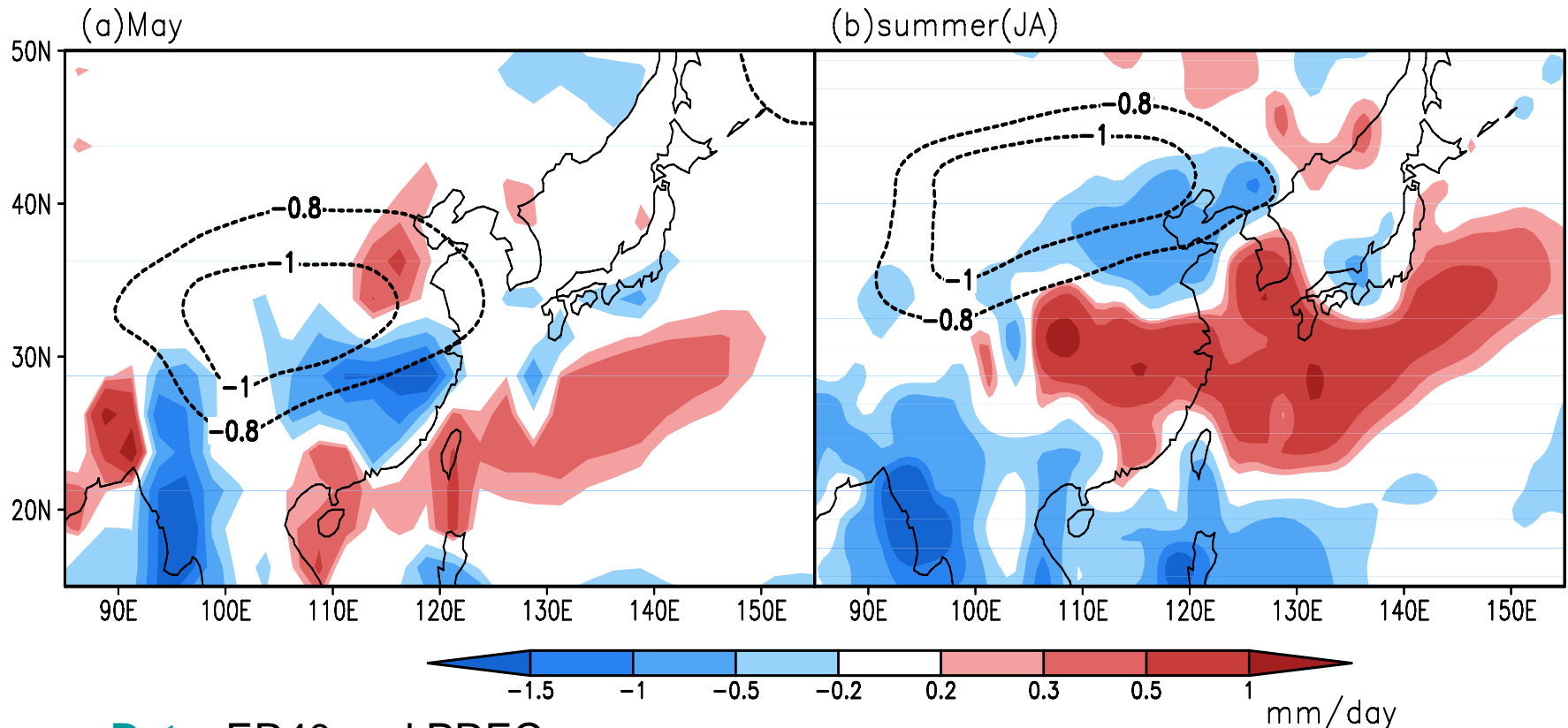
对流层上层变冷

大气环流变化



南涝北旱

Interdecadal changes in 500 - 200 hPa temperature (contour) and the rainfall (shaded) in Spring , and in Summer



Data: ER40 and PREC

Interdecadal change: 1981-2000 minus 1958-1977

Why is the Troposphere Cooling?

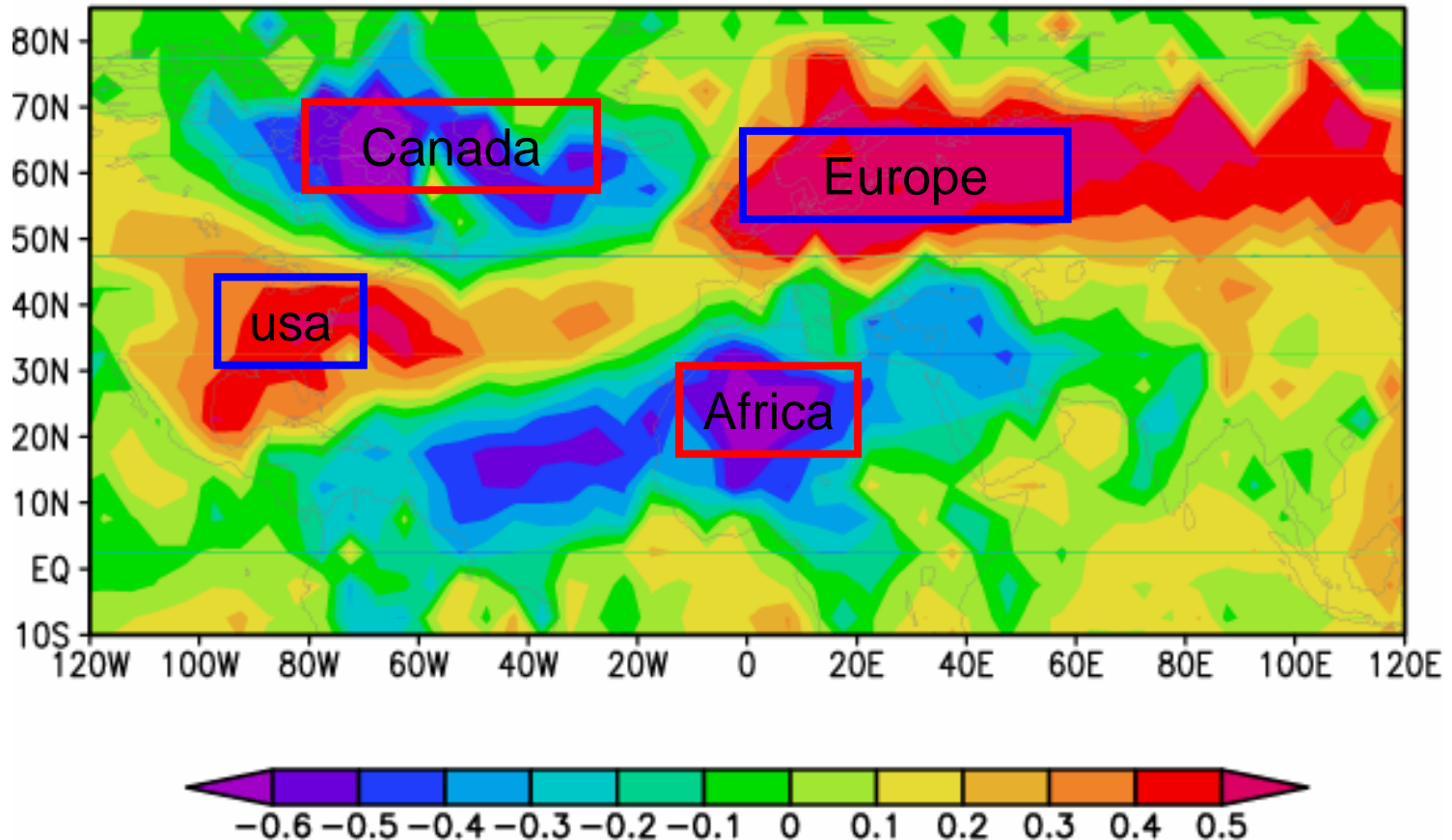
Impacts of winter-NAO

Yu Rucong and Zhou Tianjun, 2004, Impacts of winter-NAO on March cooling trends over subtropical Eurasia continent in the recent half century, *GEOPHYSICAL RESEARCH LETTERS*, VOL. 31, L12204, doi:10.1029/2004GL019814, 2004

WATANABE, MASAHIRO, 2004, Asian Jet Waveguide and a Downstream Extension of the North Atlantic Oscillation, *Journal of Climate*, Vol.17, 4674-4691.

Li Jian, Yu Rucong, Zhou Tianjun, B. Wang, 2005, Why is there an early spring cooling trend downstream of the Tibetan Plateau? *J. Climate* (in Press).

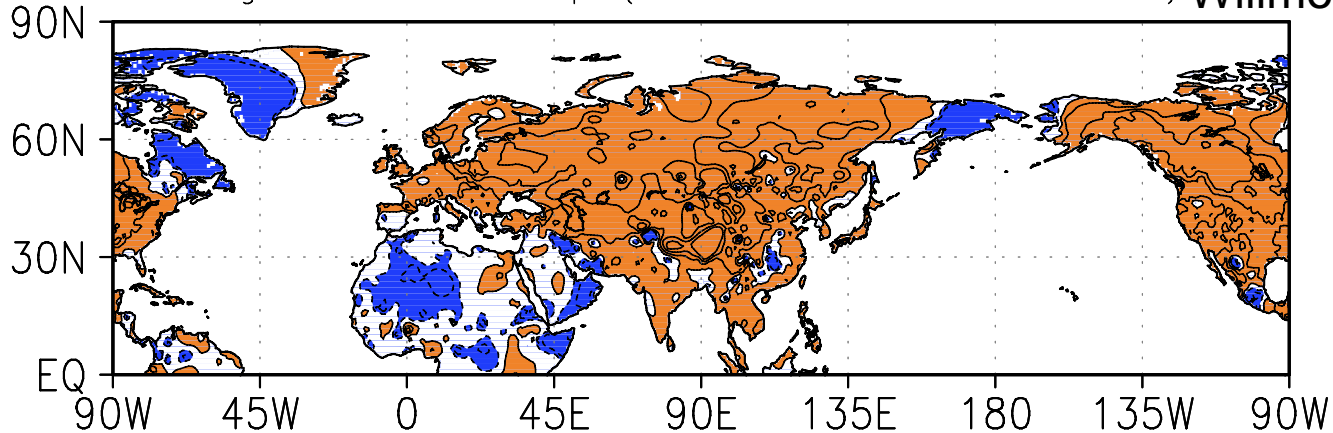
Correlation of surface air temperature with NAO index in DJF



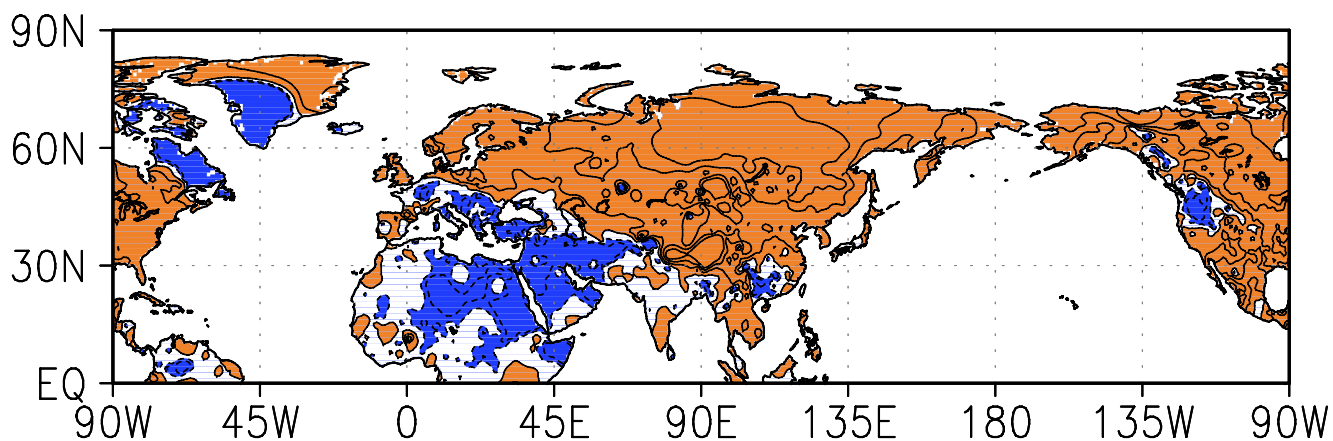
Changes in Surface Temperature

(1980-1999 — 1960-1979)

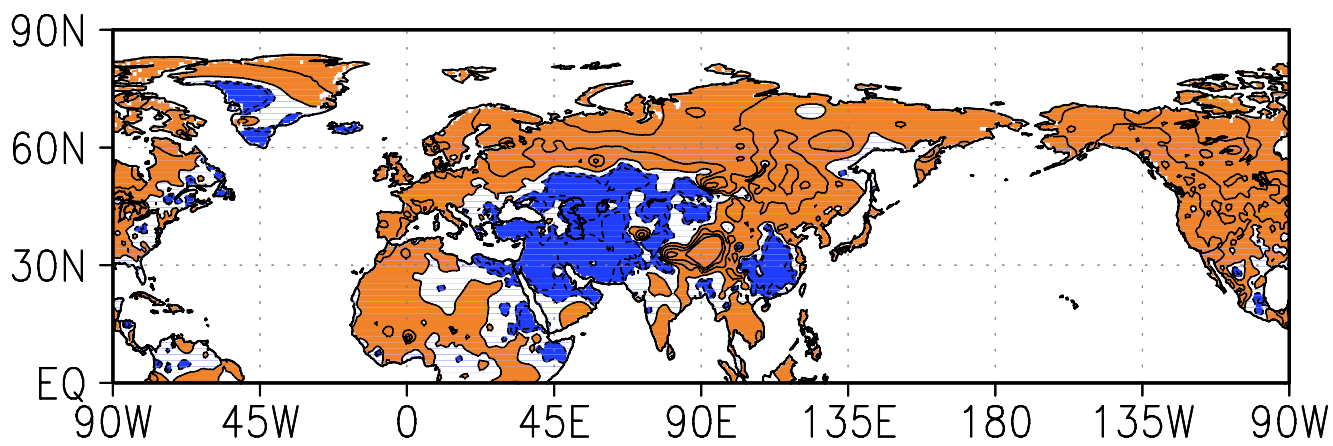
Changes of surface temp. (1980–1999 minus 1960–1979) Willmott et al. 1995



Jan.

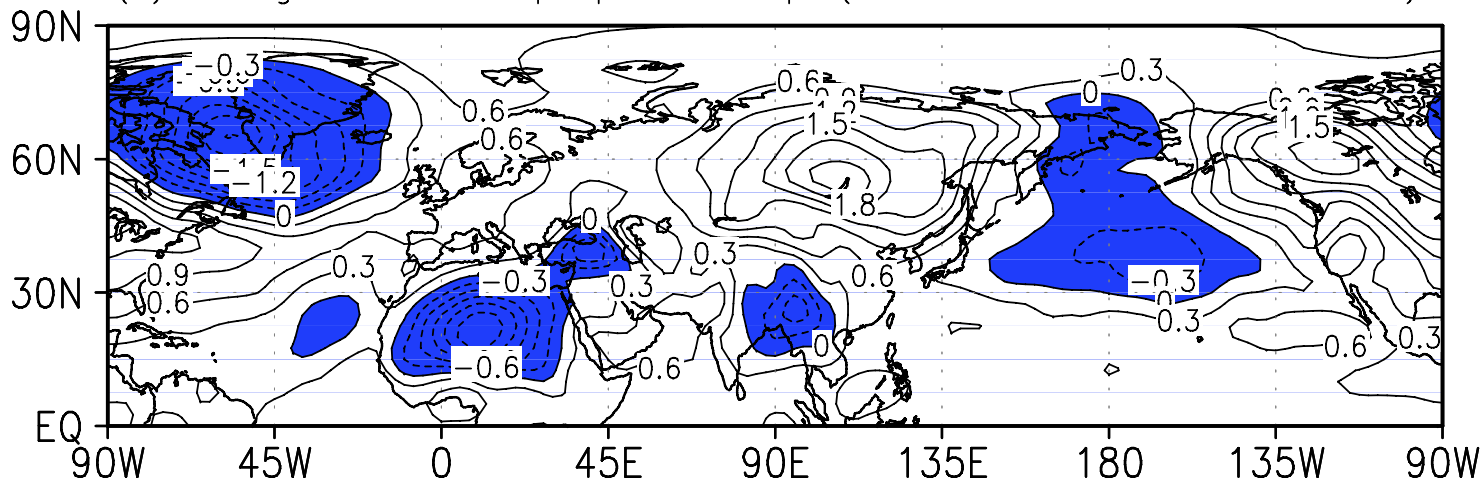


Feb.

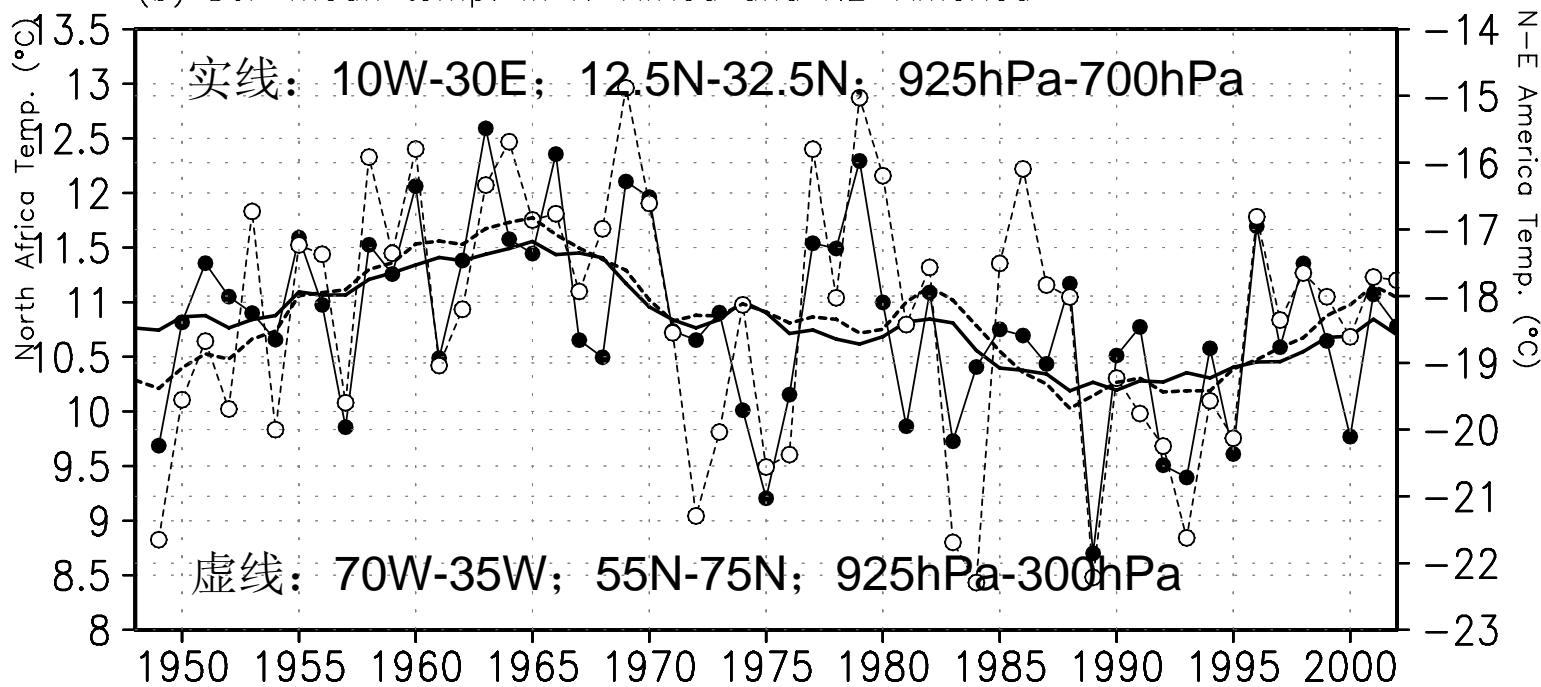


Mar.

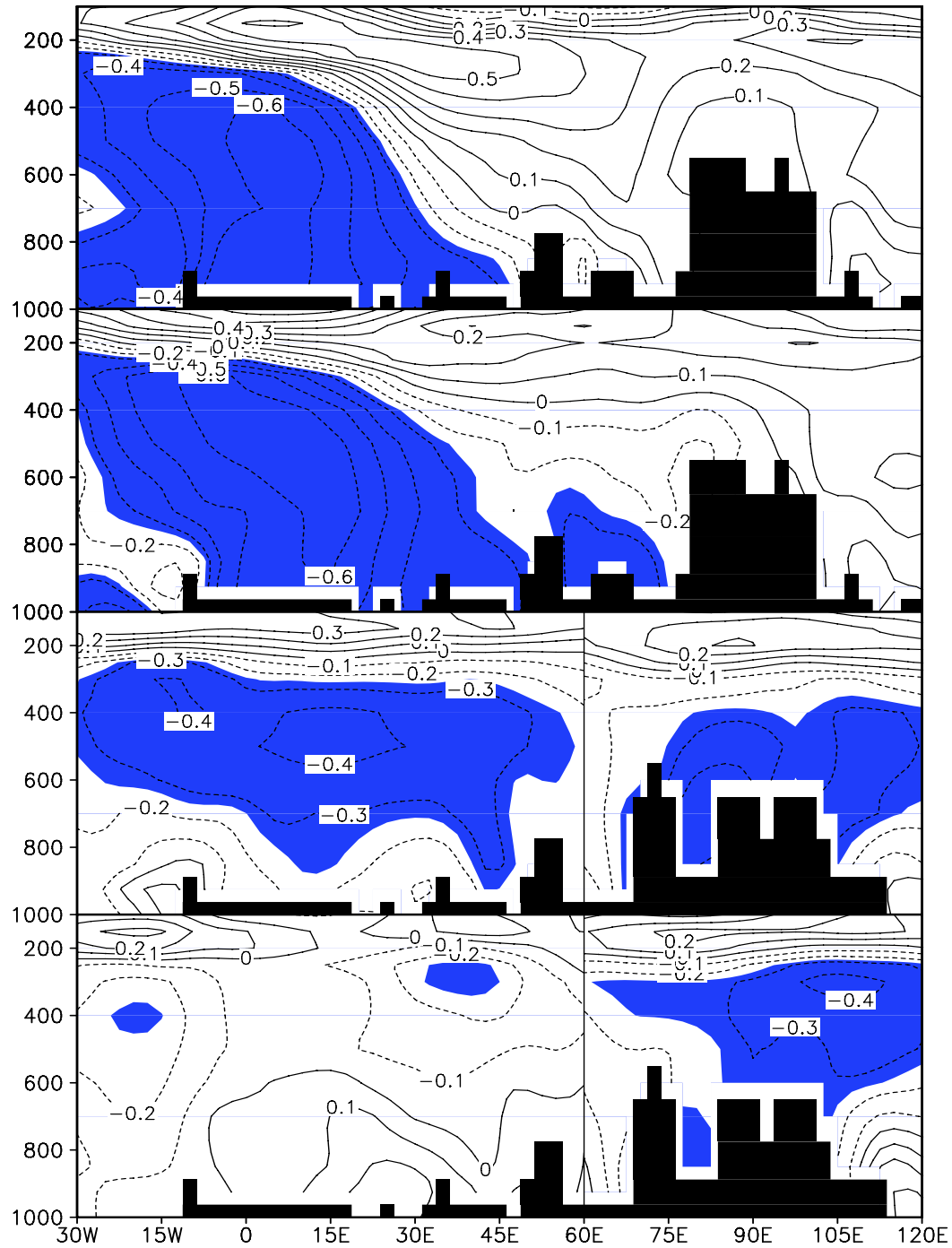
(a) Changes of DJF tropospheric temp. (1981–2000 minus 1961–1980)



(b) DJF mean temp. in N-Africa and NE-America



冬季NAO指数和对流层温度度的相关

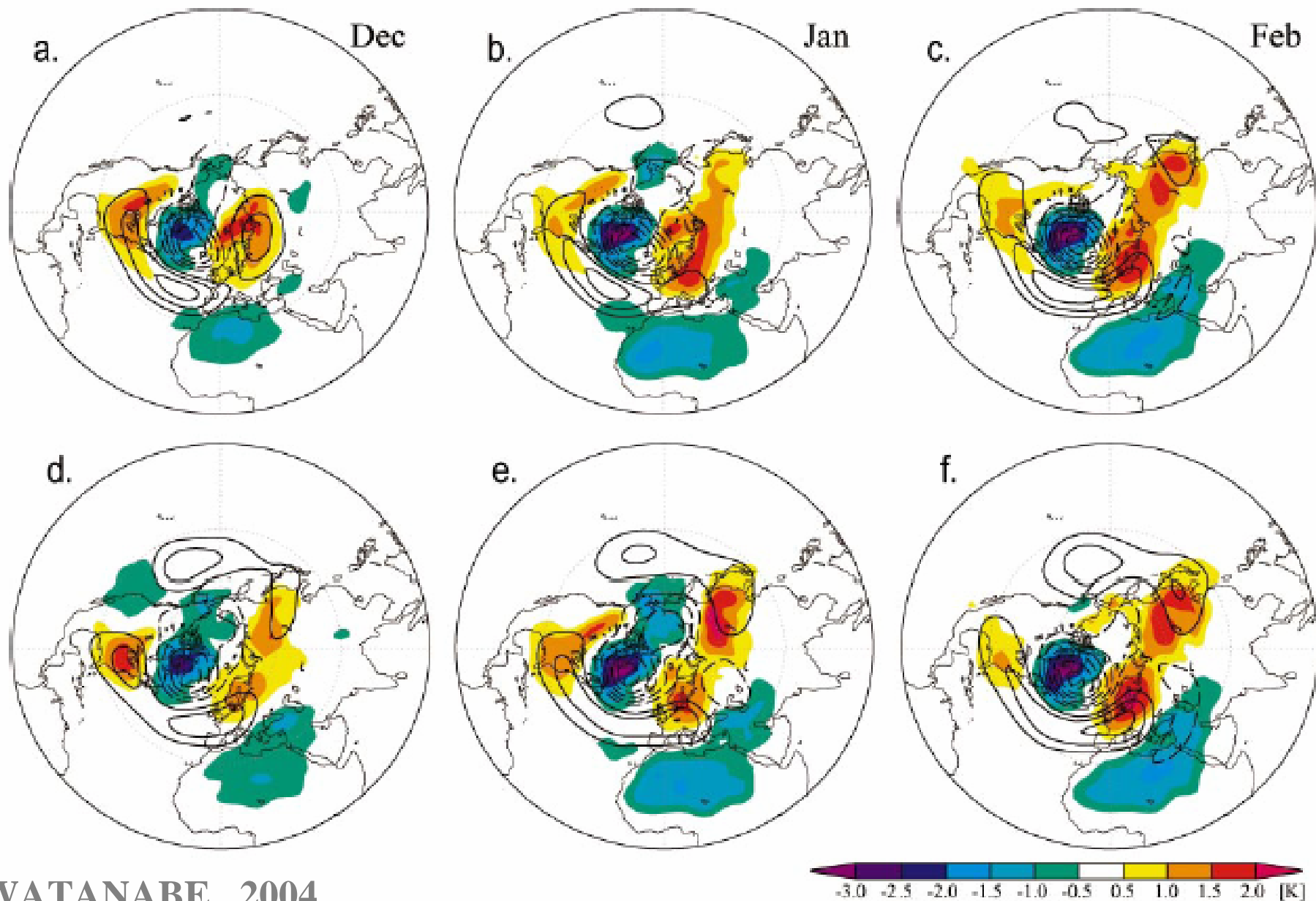


Jan.

Feb.

Mar.

Apr.



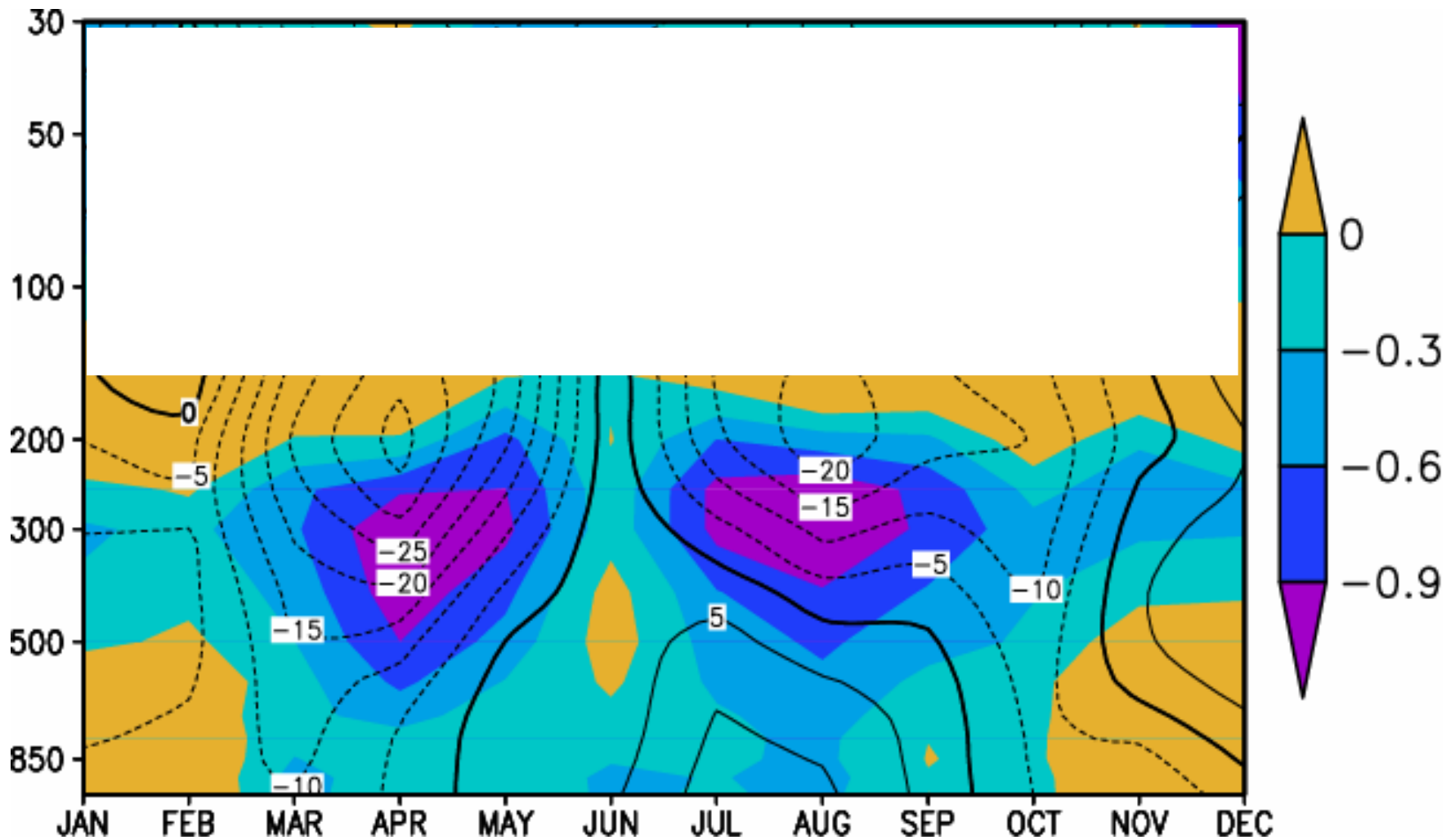
WATANABE, 2004

FIG. 2. (a)–(c) Monthly mean anomalies in 300-hPa geopotential height (contour) and 925-hPa temperature (color) from Dec to Feb, respectively, regressed onto the monthly NAO index. The contour interval is 20 m while negative contours are dashed (the zero contour omitted). (d)–(f) As in (a)–(c) but for regressed anomalies onto the AO index.

What about the cooling in summer?

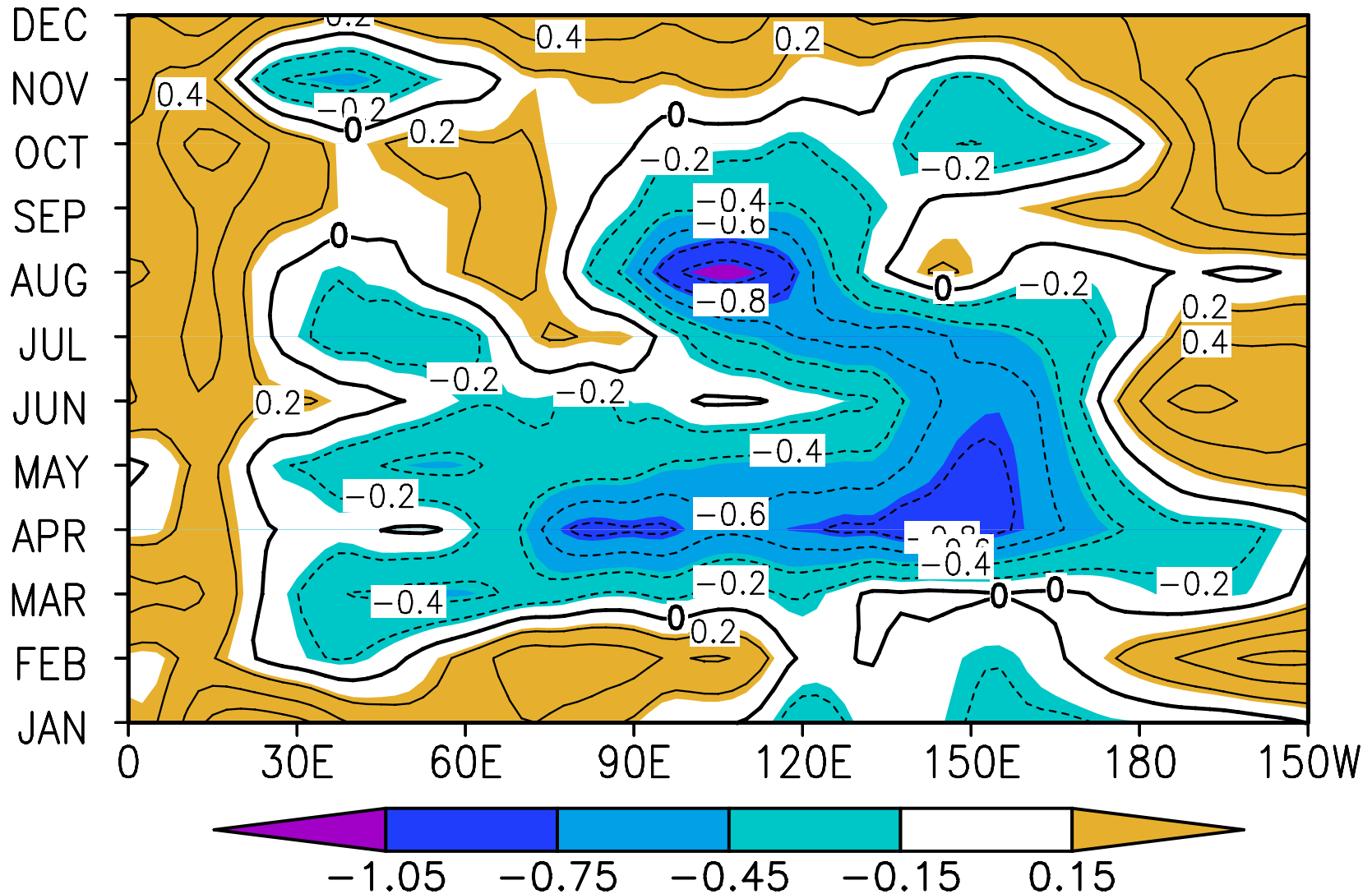
**Related with PDO?
STE?**

Changes (1980-2001 minus 1958-1979) of geopotential height (contour) and temperature (shaded).

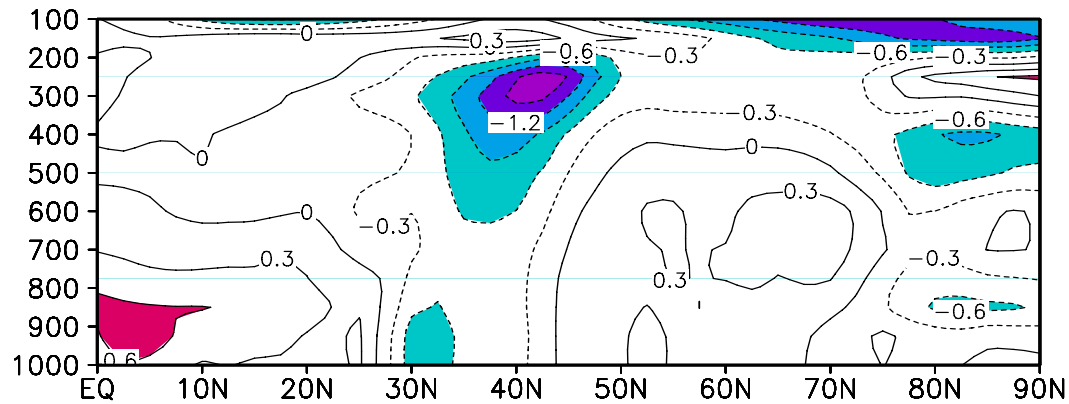


Averaged over (90-120E, 30N-45N)

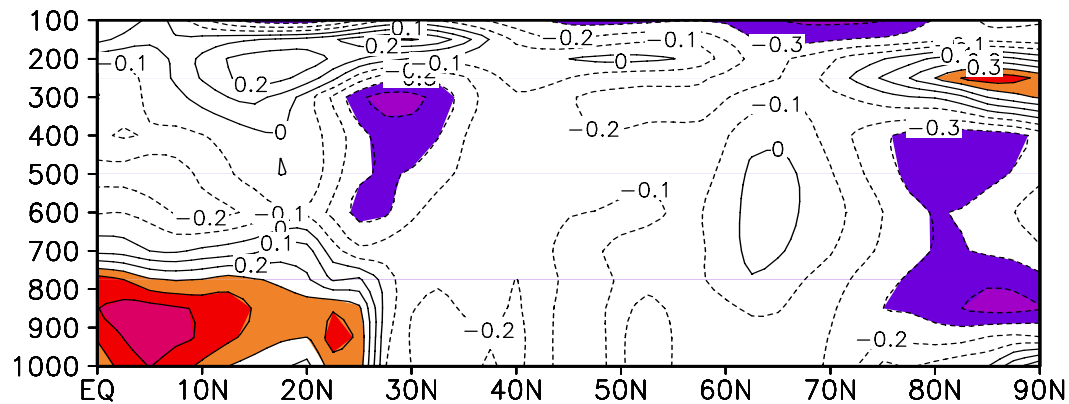
Month-zonal cross-sections of the temperature change (1980-2001 mean minus 1958-1979 mean) averaged over 500-200hPa/40-45°N respectively. Units are °C.



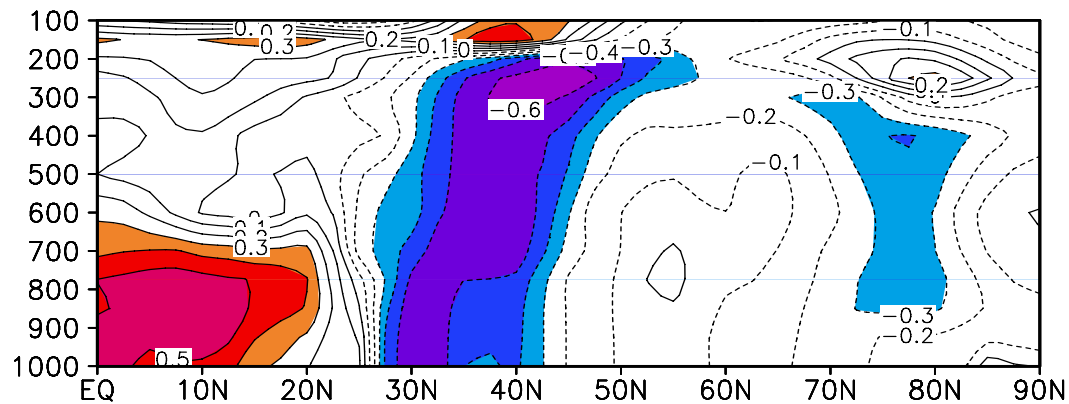
(a) Dif(1981–2000 minus 1958–1977) of JA T500–200 along 100–120E



(b) Cor(JA T500–200 along 100–120E, JFM NAO)

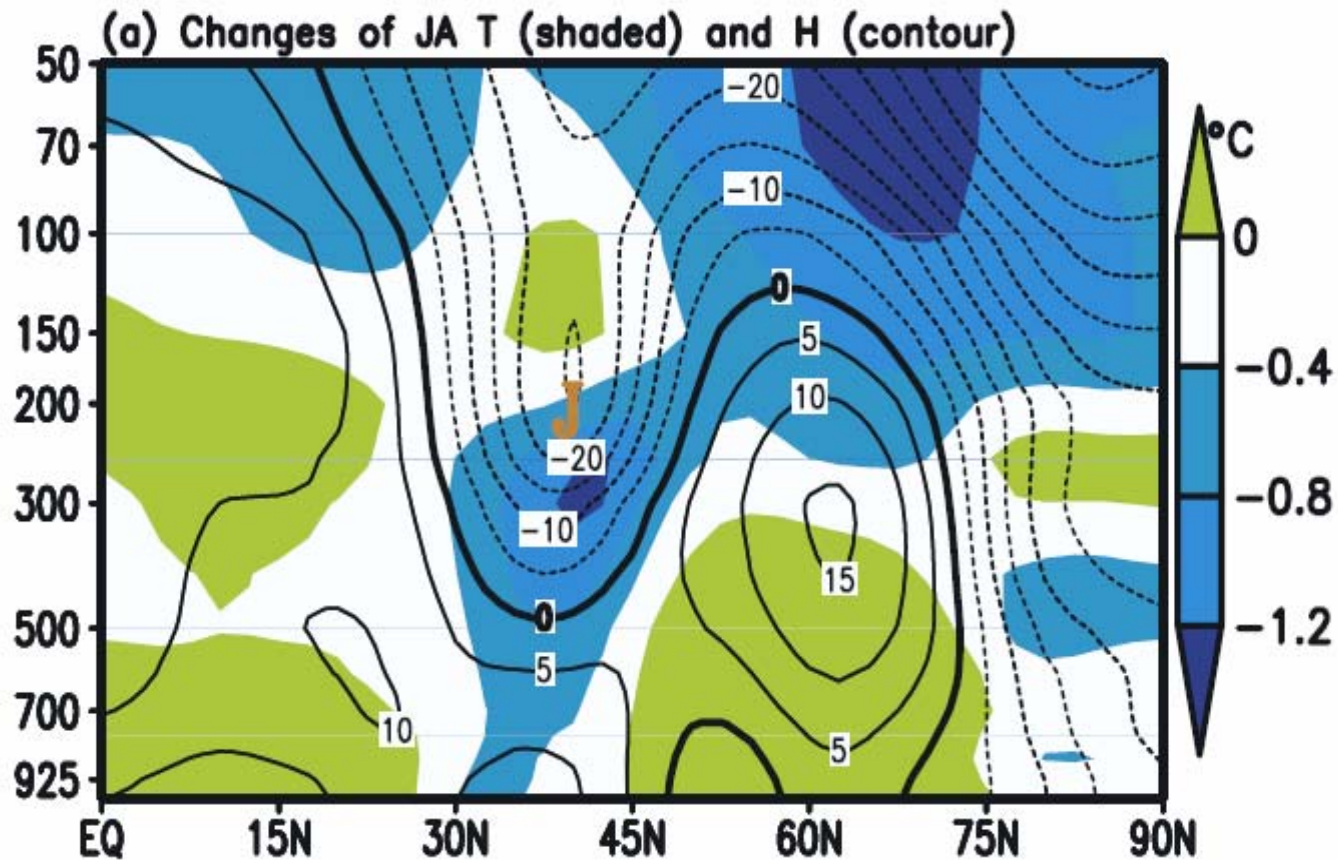


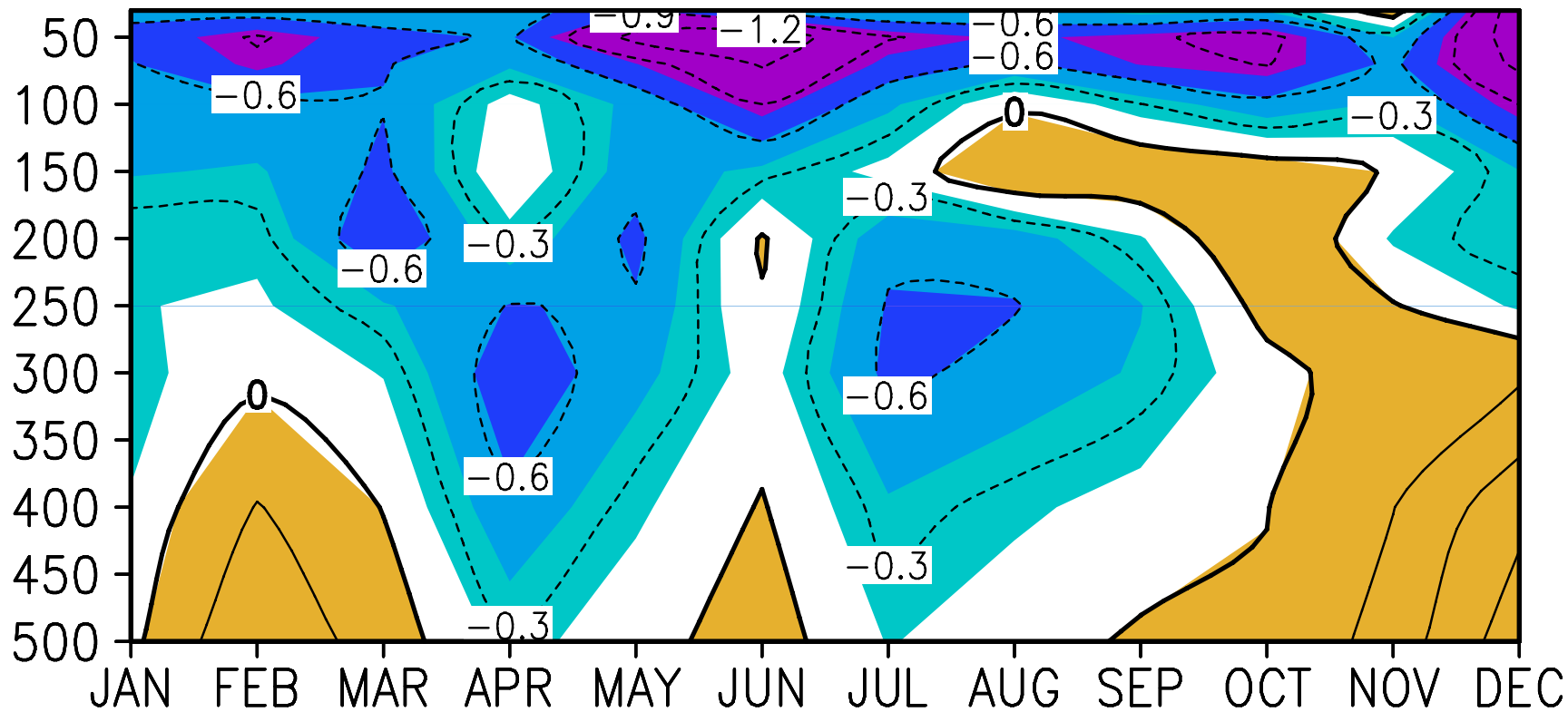
(c) Cor(JA T500–200 along 100–120E, JA PDO)



Stratosphere and Troposphere Exchange?

Upper cooling and the height anomalies





Average in (110-130°E, 35-55°N)

Summary

- The upper troposphere of East Asia has experienced a distinctive cooling change in recent decades. The cooling behaves strong subseasonal variations.
- The atmospheric cooling results in large-scale circulation changes in East Asia.
- The tropospheric cooling could account well for the so called “Southern Flood and Northern Drought” precipitation change in East China or Asia.

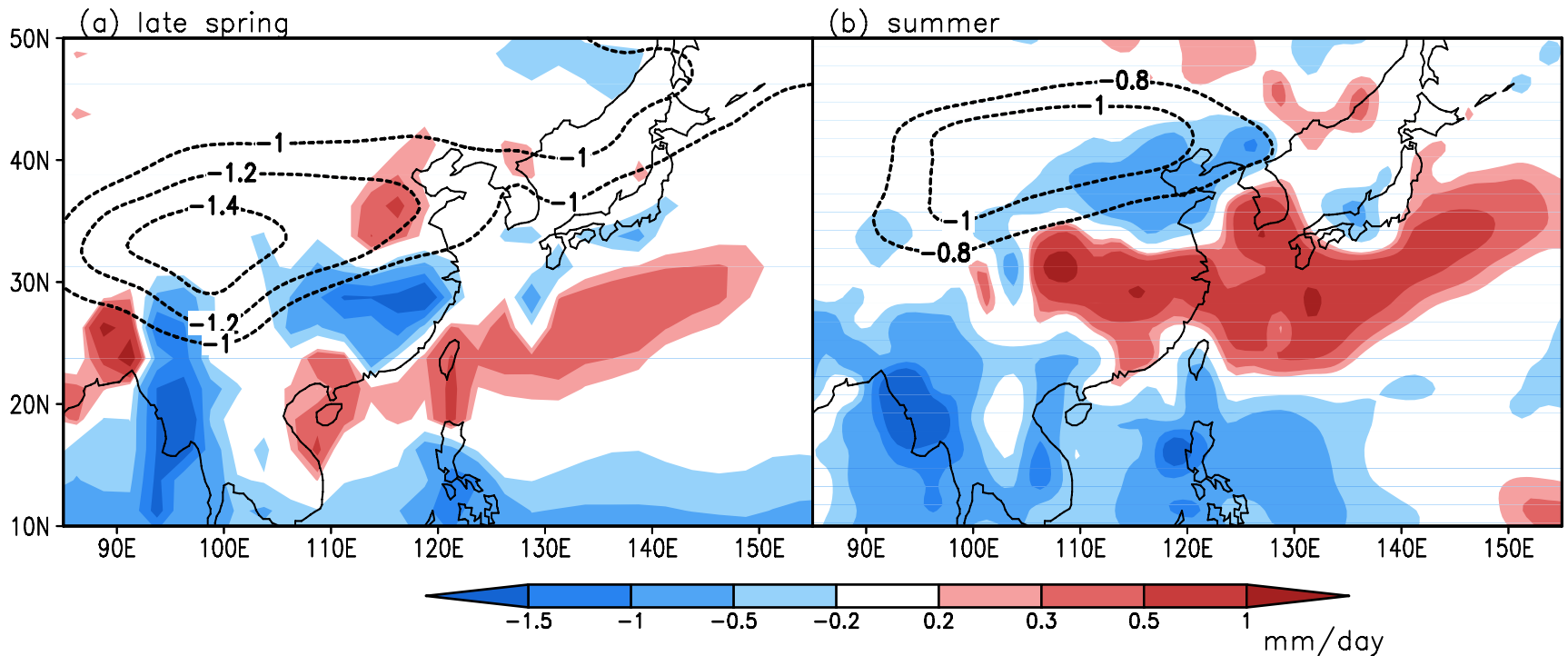
- The winter NAO-related extratropical process can account for the long-term cooling trend over East Asia, especially the spring eastward extension of the cooling signal. The July to August westward retraction of the cooling signal could be affected by the PDO.
- The tropospheric cooling could be attributed much to the Stratosphere and Troposphere Exchange and relate to global climate change.

Answer for Questions :

- Do the seasonal features in the rainfall change of East China relate each other ? **Yes**
- What is an integral part of changes in atmospheric circulation which could results in the rainfall change of East Asia ? **UTC**
- How does the local climate variation respond to the global climate change ? **STE**
SST
- Could the local Aerosol or air pollution dominate the local climate change ? **Remaining**

Thank You !

Upper-level (500-200hPa) cooling (contour) and precipitation changes (1981-2000 minus 1958-1977) (shaded)



NCEP PREC/L data

Temperature changes at four stations from radiosonde

