

# Climate effect of urbanization in East China

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**Motivation:** The recent Chinese economic boom is accompanied by a massive urbanization in Eastern China, to the detriment of arable lands.

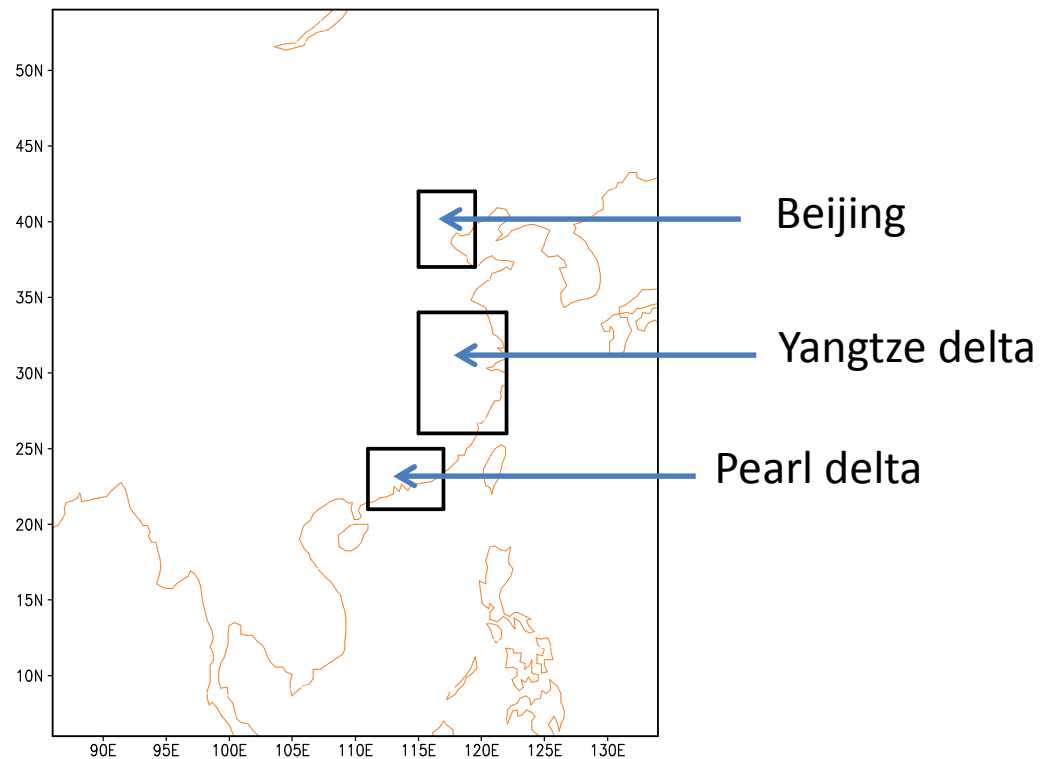
- A) What impacts are expected for climate at local and large scales ?
- B) To mitigate climate change or even to optimise climate, where to put cities?

### Vegetation types in ORCHIDEE:

1. Bare soil
2. Tropical broad-leaved evergreen
3. Tropical broad-leaved rain-green
4. Temperate needle-leaf evergreen
5. Temperate broad-leaved evergreen
6. Temperate broad-leaved summer green
7. Boreal needle leaf evergreen
8. Boreal broad-leaved summer green
9. Boreal needle leaf summer green
10. C3 grass
11. C4 grass
12. C3 agriculture
13. C4 agriculture

Arable land converted to bare soil to mimic urbanisation. SST at the lower boundary is the observed one with interannual variability (21 years: 1989 to 2009, 9 ensemble members)

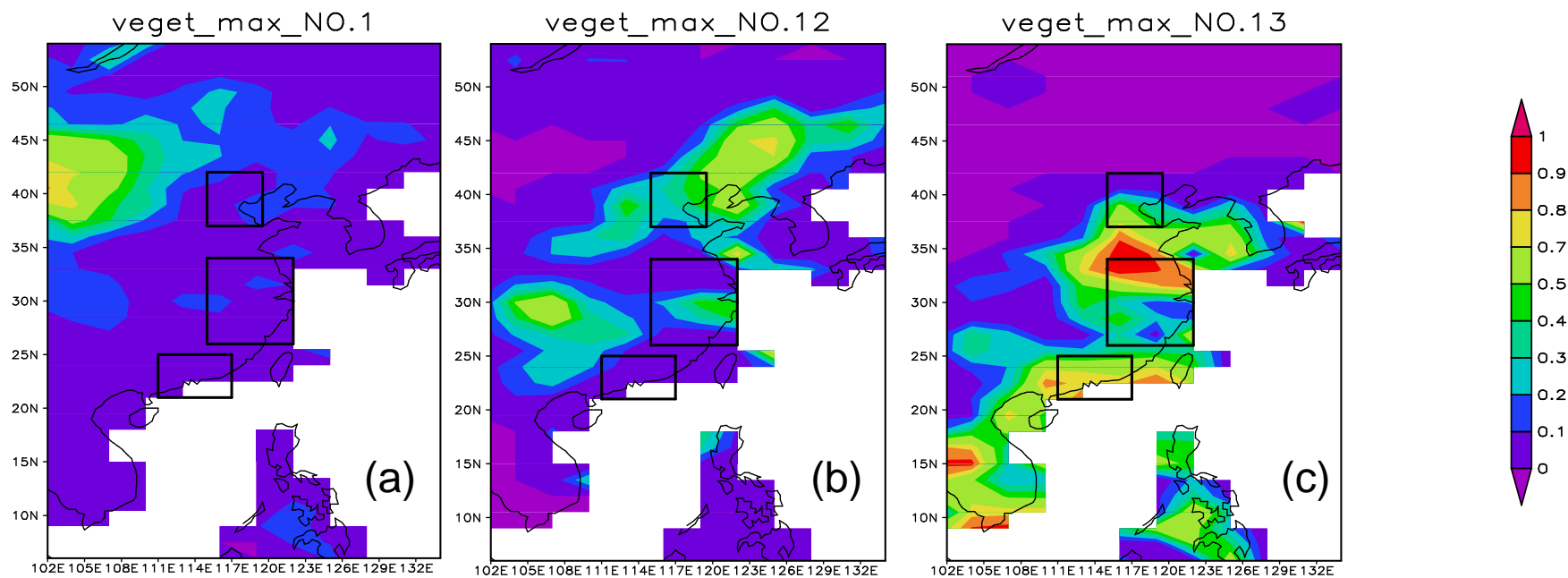
**LMDZ-global: 120(lon) x 120(lat),  
Resolution about 200 km**



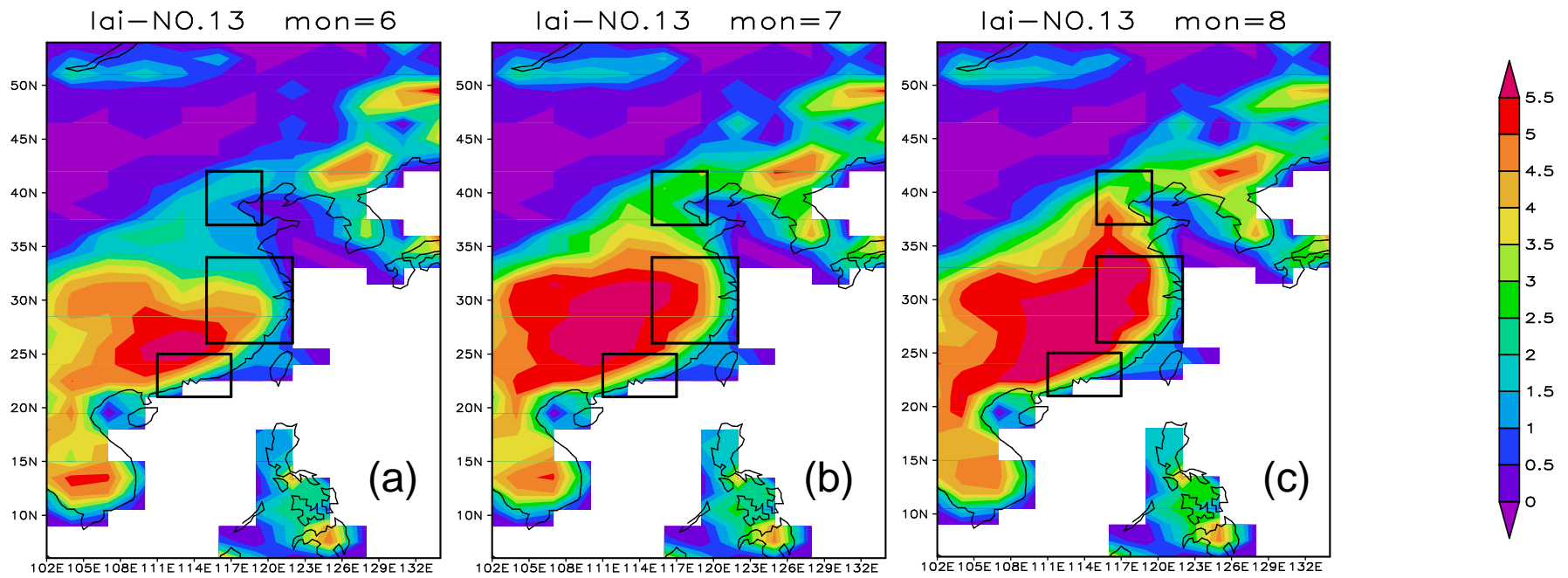
# Numerical experiments design

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	Acronyme	Urbanisation zone	Vegetation types
Controle simulation	CTL		climatological
Sensitivity 1	Yangtze delta	26° -34° N, 115° -122° E	C3 C4 to bare soil
Sensitivity 2	Pearl delta	21° -25° N, 111° -117° E	C3 C4 to bare soil
Sensitivity 3	Beijing area	37° -42° N, 115° -119.5° E	C3 C4 to bare soil
Sensitivity 4	All-three	Combined three areas	C3 C4 to bare soil



Soil vegetation coverage fractions: bare soil, C3 agriculture and C4 agriculture in the control simulation



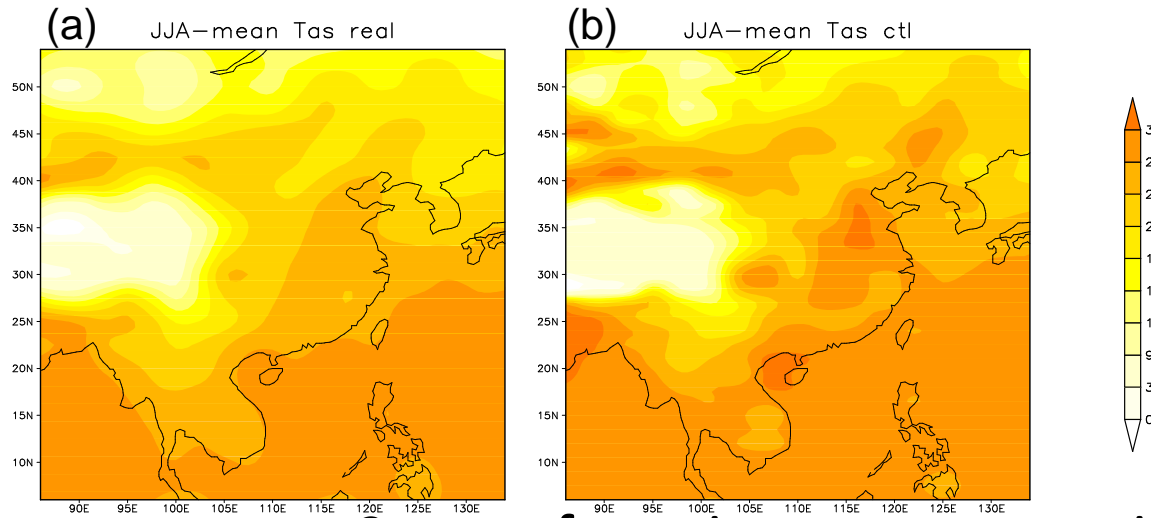
LAI maps of C4 vegetation in summer months

## Changes of surface properties (Surface area units in $10^5$ km<sup>2</sup>)

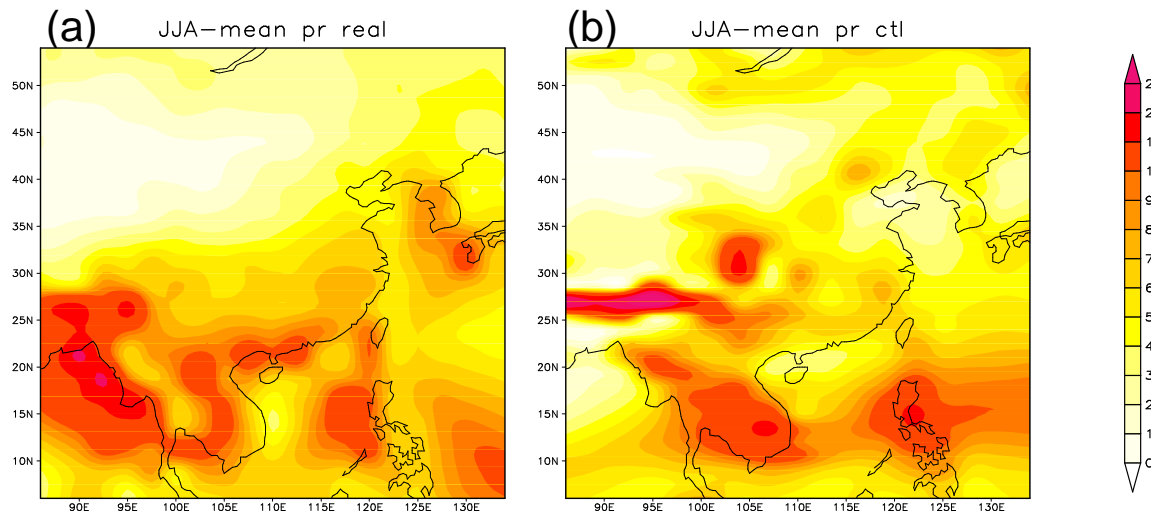
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	Yangtze	Pearl	Beijing
Total land surface	5.49	1.62	1.61
C3 C4 agriculture land	3.39	1.18	1.03
Total Leaf area	14.01	3.89	2.68
C3 C4 mean LAI in summer	4.13	3.31	2.61

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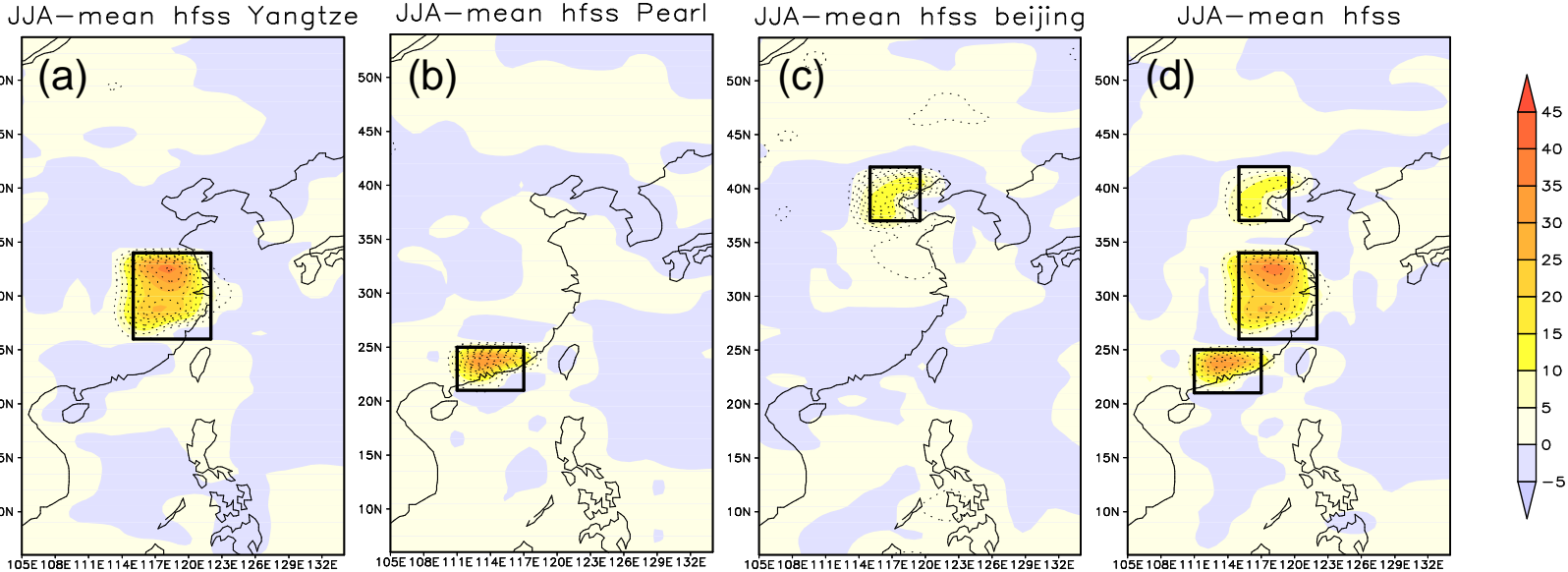


Summer mean 2-m surface air temperature given by NCEP re-analysis and simulated by LMDZ-global



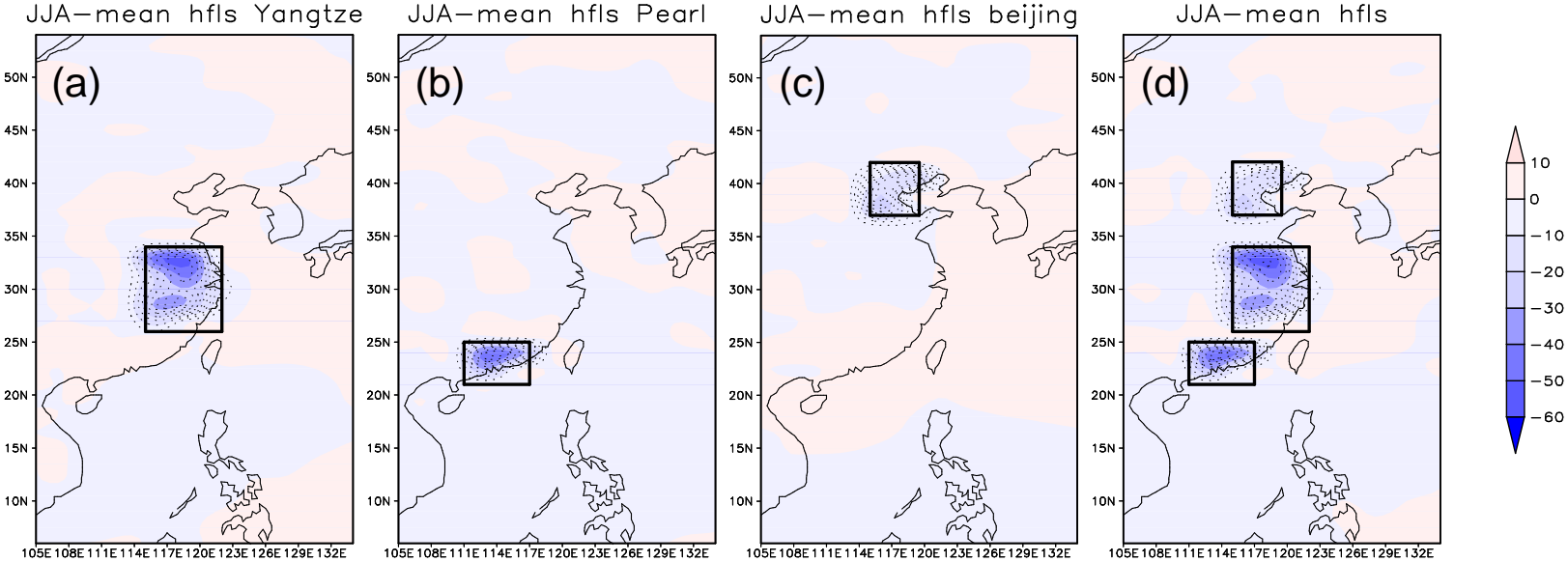
Summer mean precipitation rate (mm/day) given by GPCP and simulated by LMDZ-global

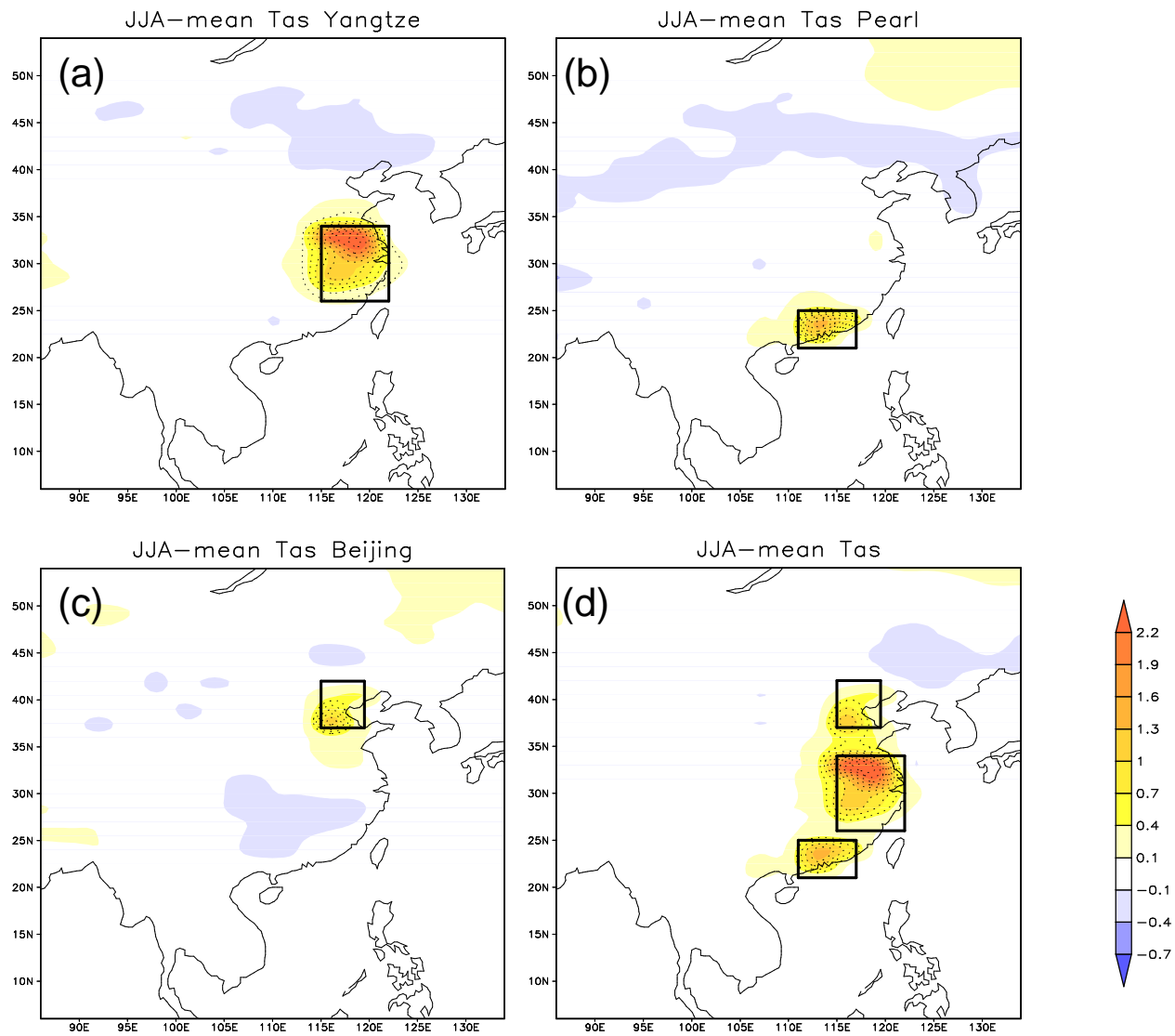
# Changes of sensible heat flux (W/m<sup>2</sup>) in summer



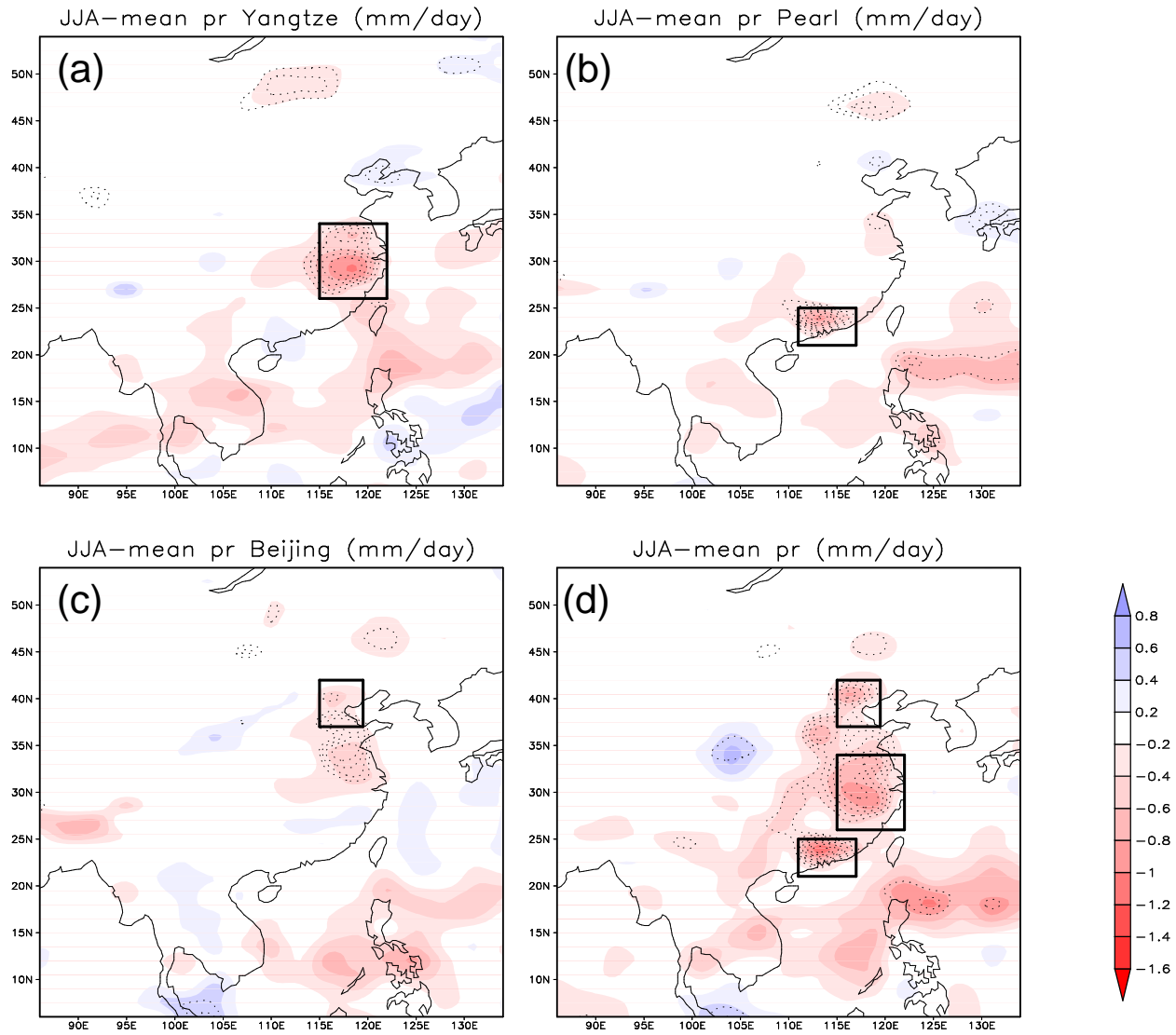


# Changes of latent heat flux (W/m<sup>2</sup>) in summer



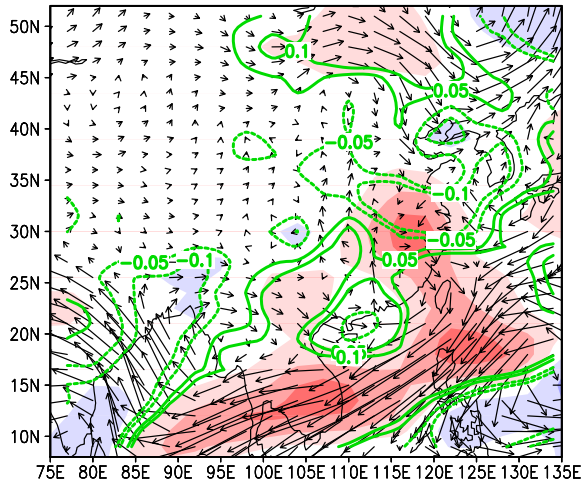


Changes in 2-m surface air temperature

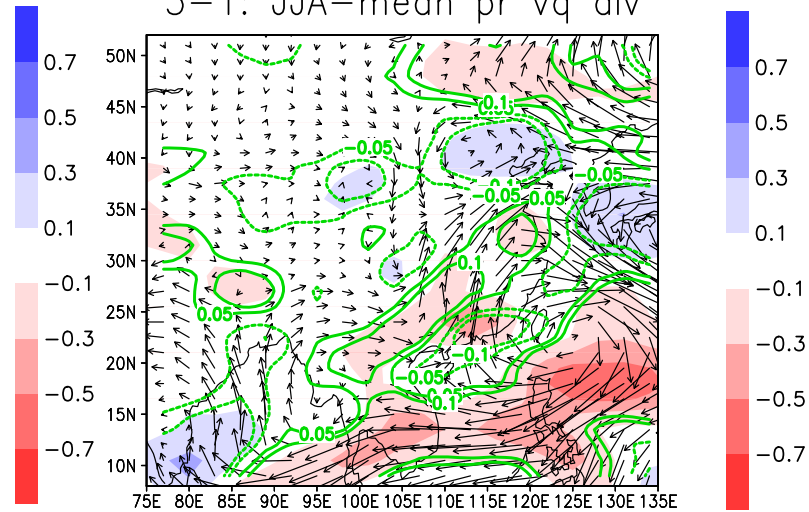


Changes in rainfall rate (mm/day)

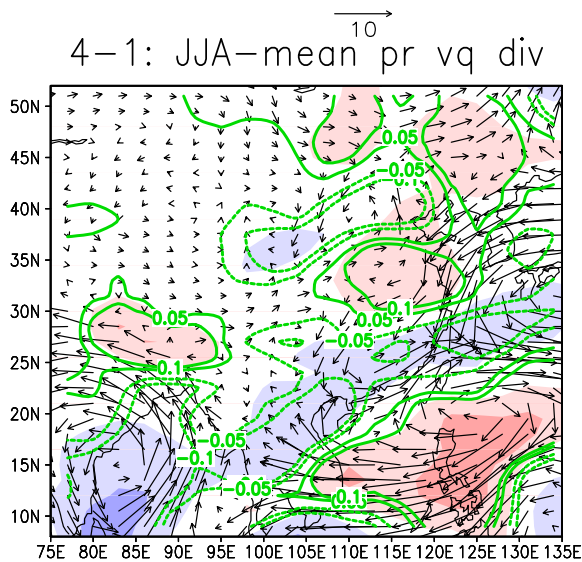
a) Yangtze  
2-1: JJA-mean pr vq div



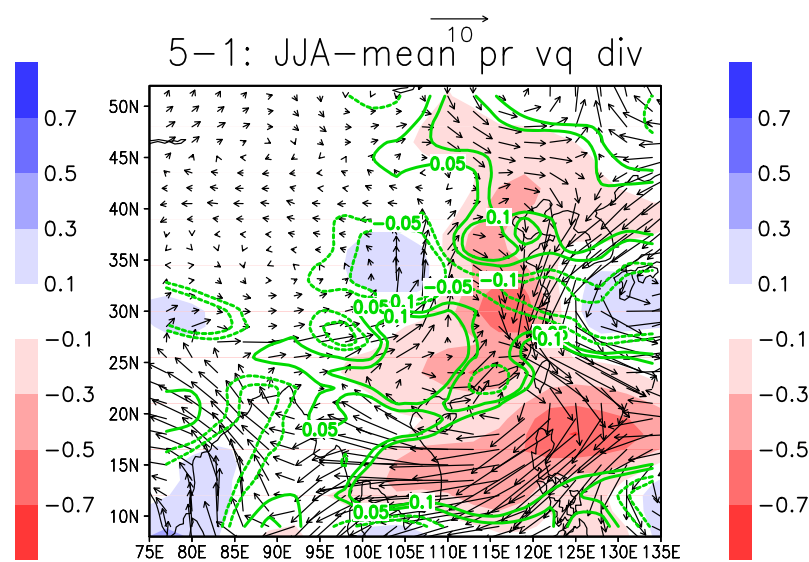
b) Pearl  
3-1: JJA-mean pr vq div



4-1: JJA-mean pr vq div



5-1: JJA-mean pr vq div



c) Beijing

d) All-three

Changes in rainfall (colour, mm/day), water-vapour transport (vector) and divergence (green contour)

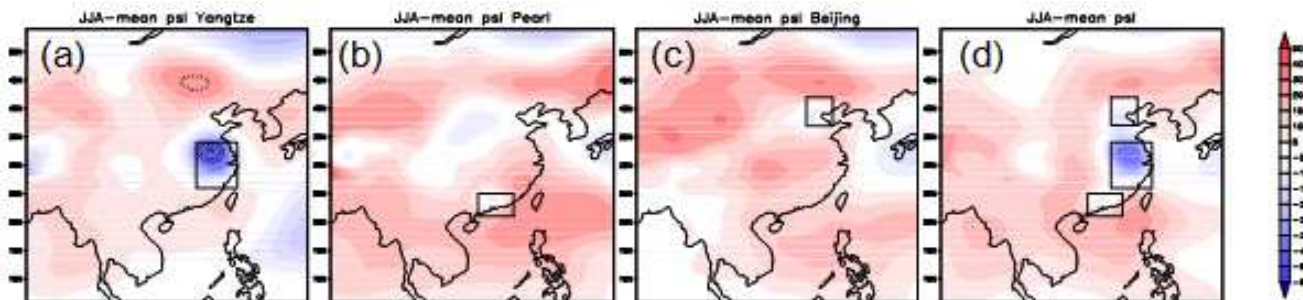
Yangtze

Pearl

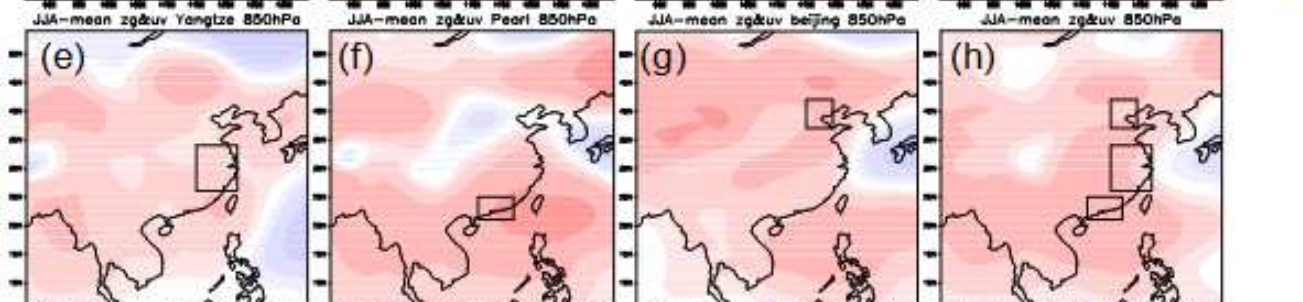
Beijing

All three

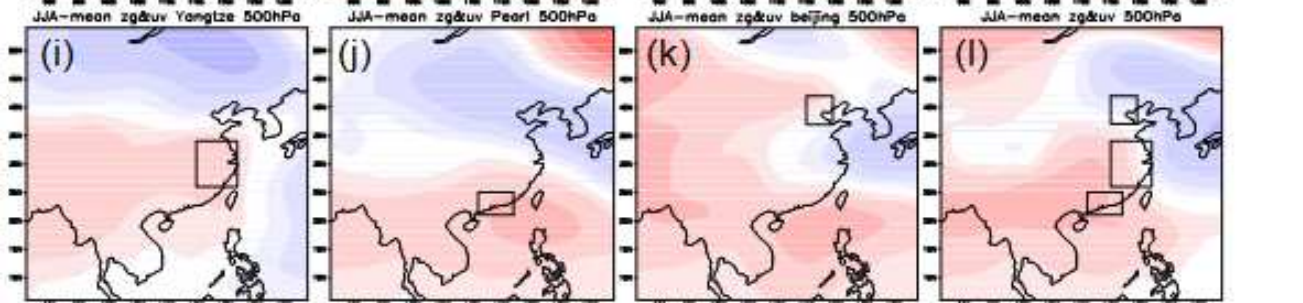
SLP



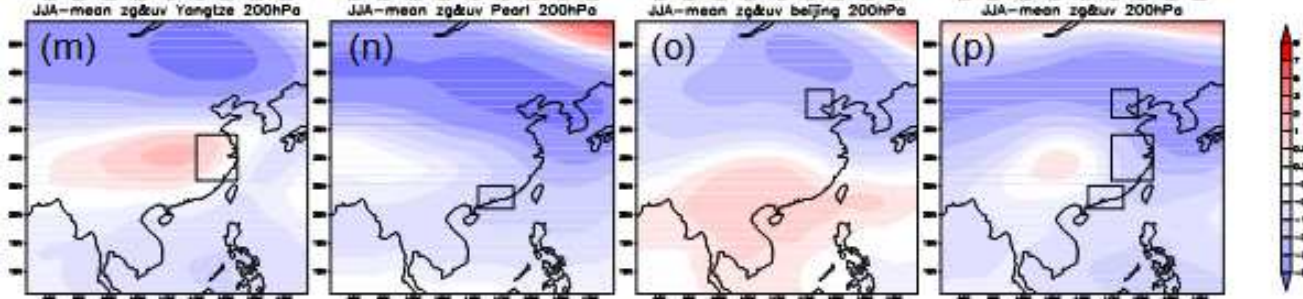
Z850



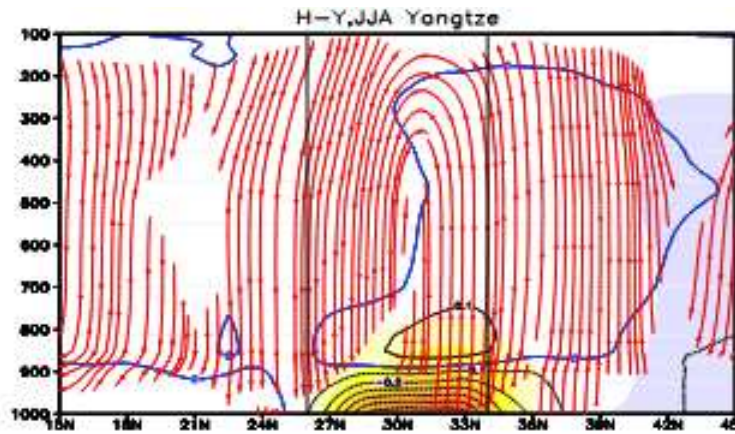
Z500



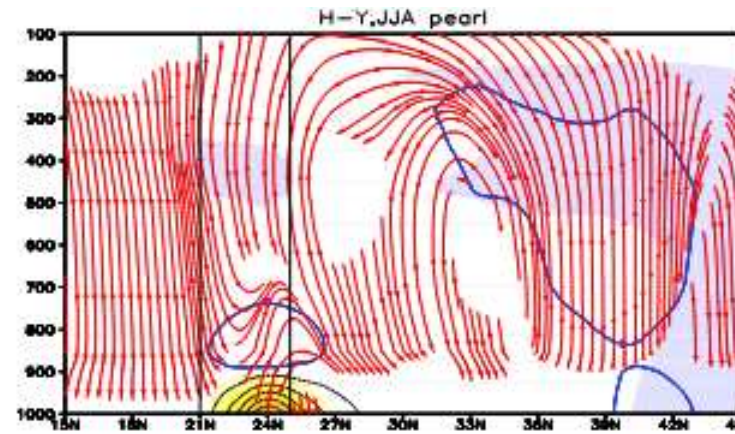
Z200



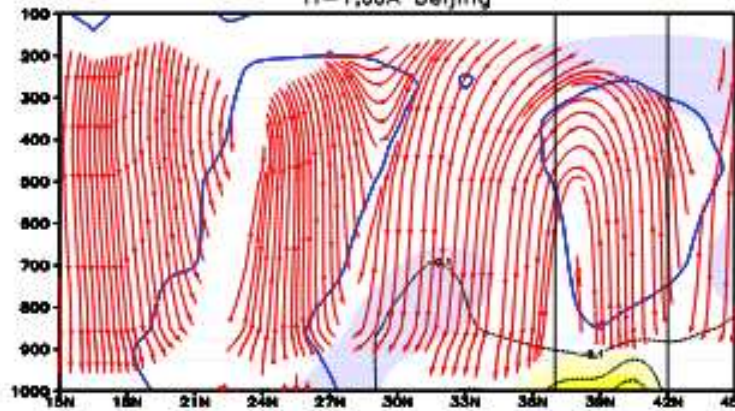
Yangtze



Pearl

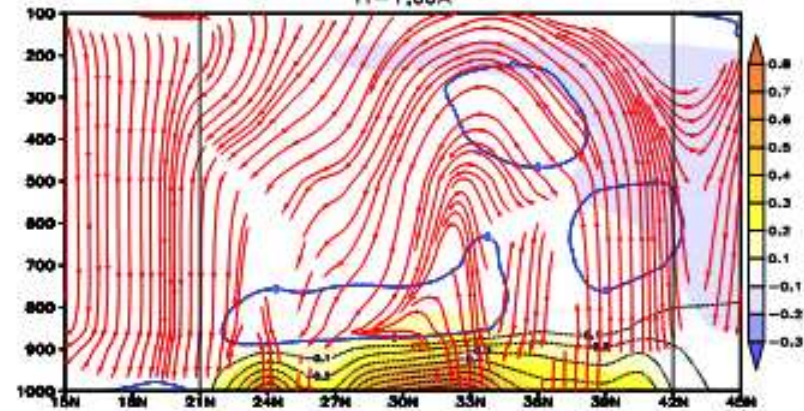


H-Y, JJA beijing



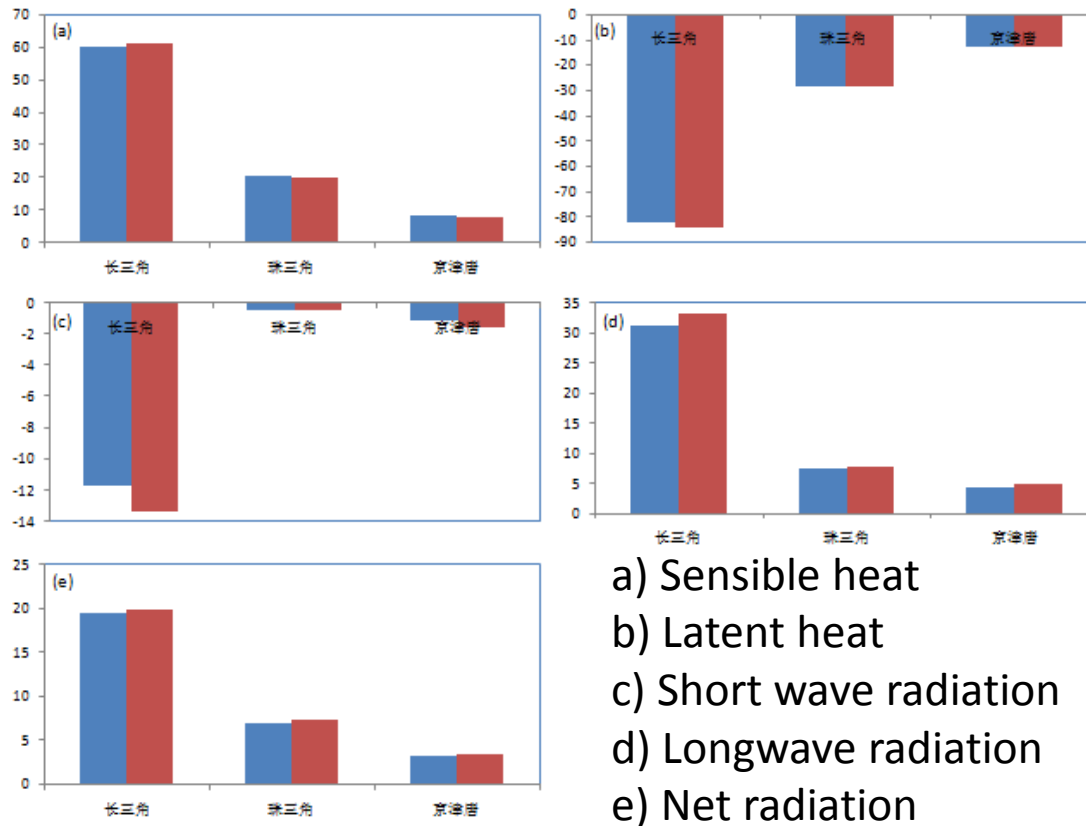
Beijing

H-Y, JJA



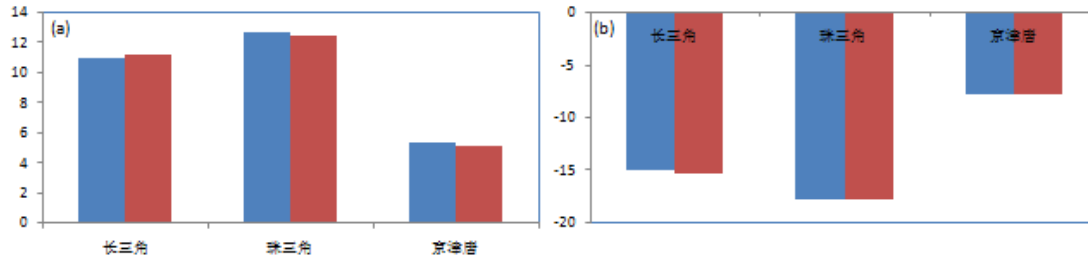
All three

Changes in stream lines, temperature (colour) and specific humidity (contour)



a) Sensible heat  
 b) Latent heat  
 c) Short wave radiation  
 d) Longwave radiation  
 e) Net radiation

Changes of surface energy (units:  $10^{11}$  W, positive leaving the surface) for the three regions (blue for individual experiments and red for combined experiment): Yangtze, Pearl and Beijing.



Energy flux (W/m<sup>2</sup>)  
per unit of changed  
land area

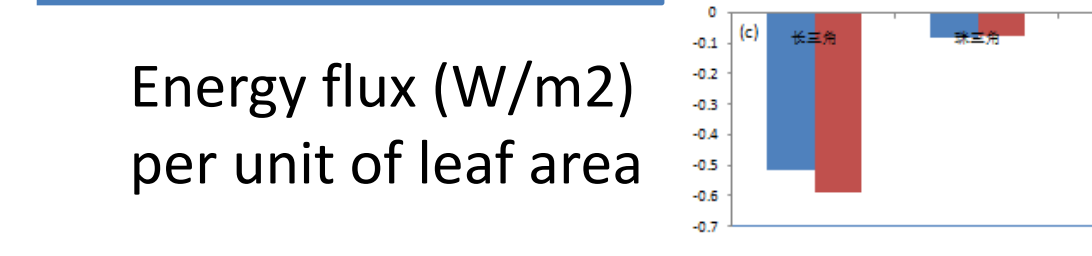
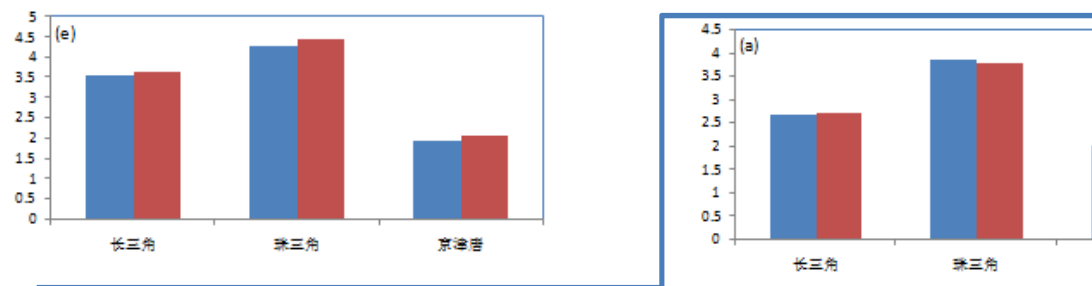
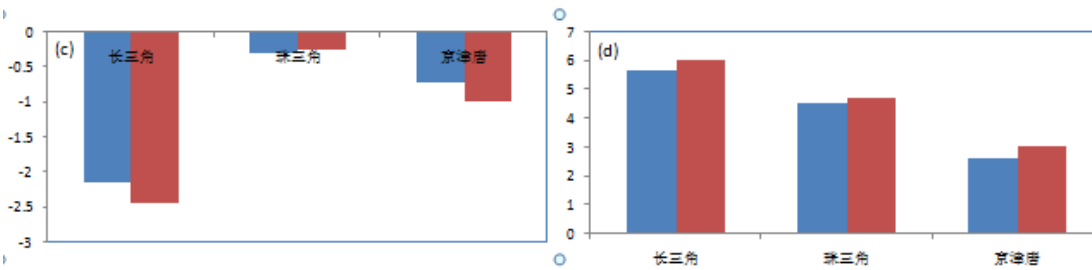
a) Sensible heat

b) Latent heat

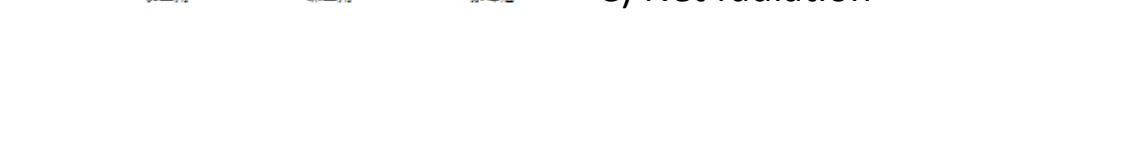
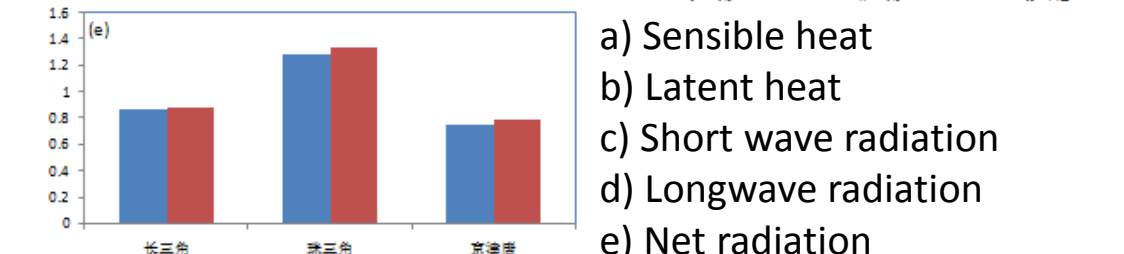
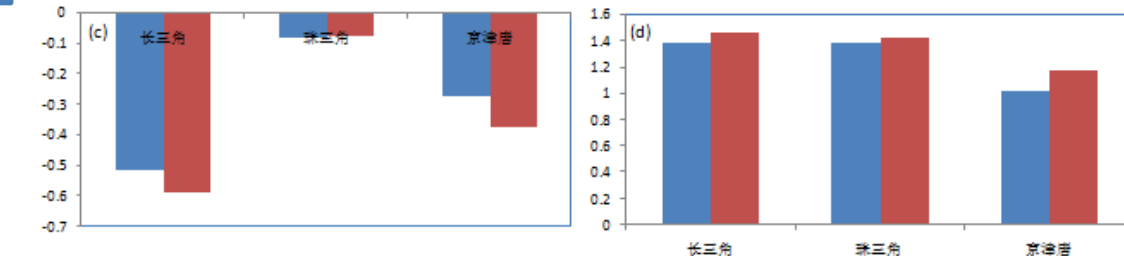
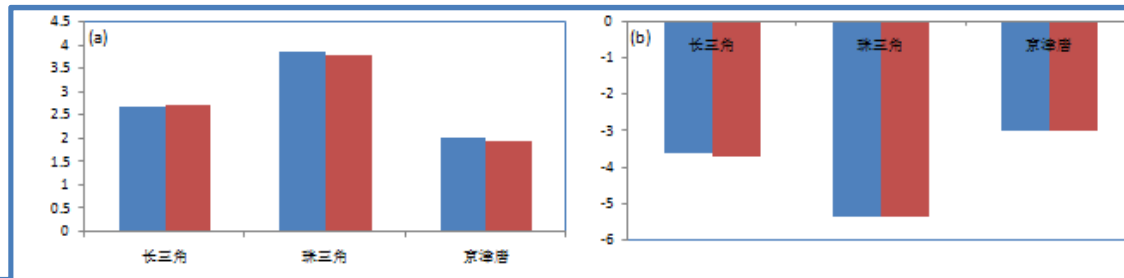
c) Short wave radiation

d) Longwave radiation

e) Net radiation



Energy flux (W/m<sup>2</sup>)  
per unit of leaf area



a) Sensible heat

b) Latent heat

c) Short wave radiation

d) Longwave radiation

e) Net radiation



## Conclusions

- Climate effects of urbanisation are mainly local: with a strong effect of warming and drying
- Combined effects are relatively additional from individual regions
- There is a local thermal low at surface, but a low-in-north and high-in-south structure for geopotentials at upper layers
- There is a tendency for stronger summer monsoon with rainfall belt moving to north
- Changes of heat fluxes (per unit of land area or unit of leaf area) decreases in amplitude from Pearl delta, to Yangtze delta, then to Beijing area., although the most significant changes take place