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Characteristics analysis and simulation of energy budget over urban

Sun Shiqiang 2012 -09- 21

Outline

- 1. Analysis of observed data
- 2. Urban Canopy Model
- 3. Preliminary conclusion of simulation
- 4. On-going work

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1. **Analysis of observed data**

- The land use status undergone great changes, thermodynamic property of surface changes, the energy exchange process changes.

- So it is in urban. We need to do much deeper research work on radiation and energy budget in urban.

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Recent research progress

- Since *1999* ,Oke and Grimmond conducted a series of research activities about heat storage of urban in Mexico、LosAngeles and Vancouver .
- Eliassona (*2006*) analysised characteristics of radiation and energy budget in Goteborg.
- Stephanie (*2009*) made a detailed comparison about characteristics of radiation and energy budget on different kinds of roofs in Vancouver.

- In china, Department of Atmospheric Science in Nanjing University conducted a research activity about radiation and energy budget of urban in *2005* summer vacation and in *2006* winter vacation .

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Our urban experimental campaign

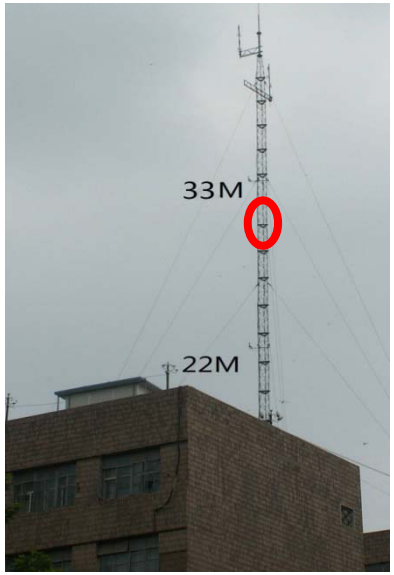
Data： July 27 to August 4 ,2010.

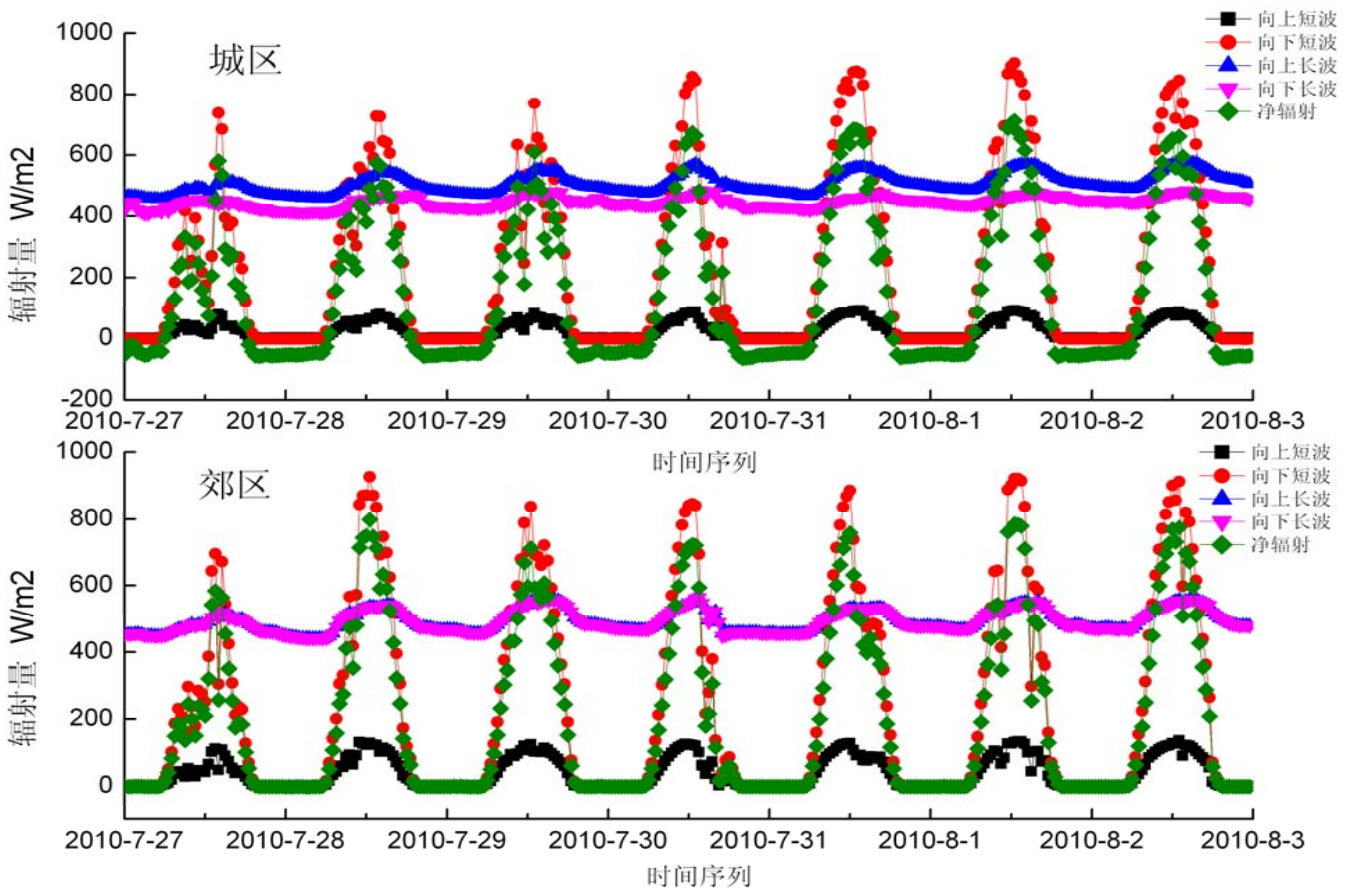
Sites：

A）11m over the roof of NO.6 Middle school in Nanjing. (Urban)

B）2m over the grass of meteorological observation field in NUIST. (Suburban)

Weather condition: hot and partly cloudy, little and calm wind.





◆Fig1.The diurnal variation of the radiation budget in urban and suburban

Radiation trap effect in urban canopy

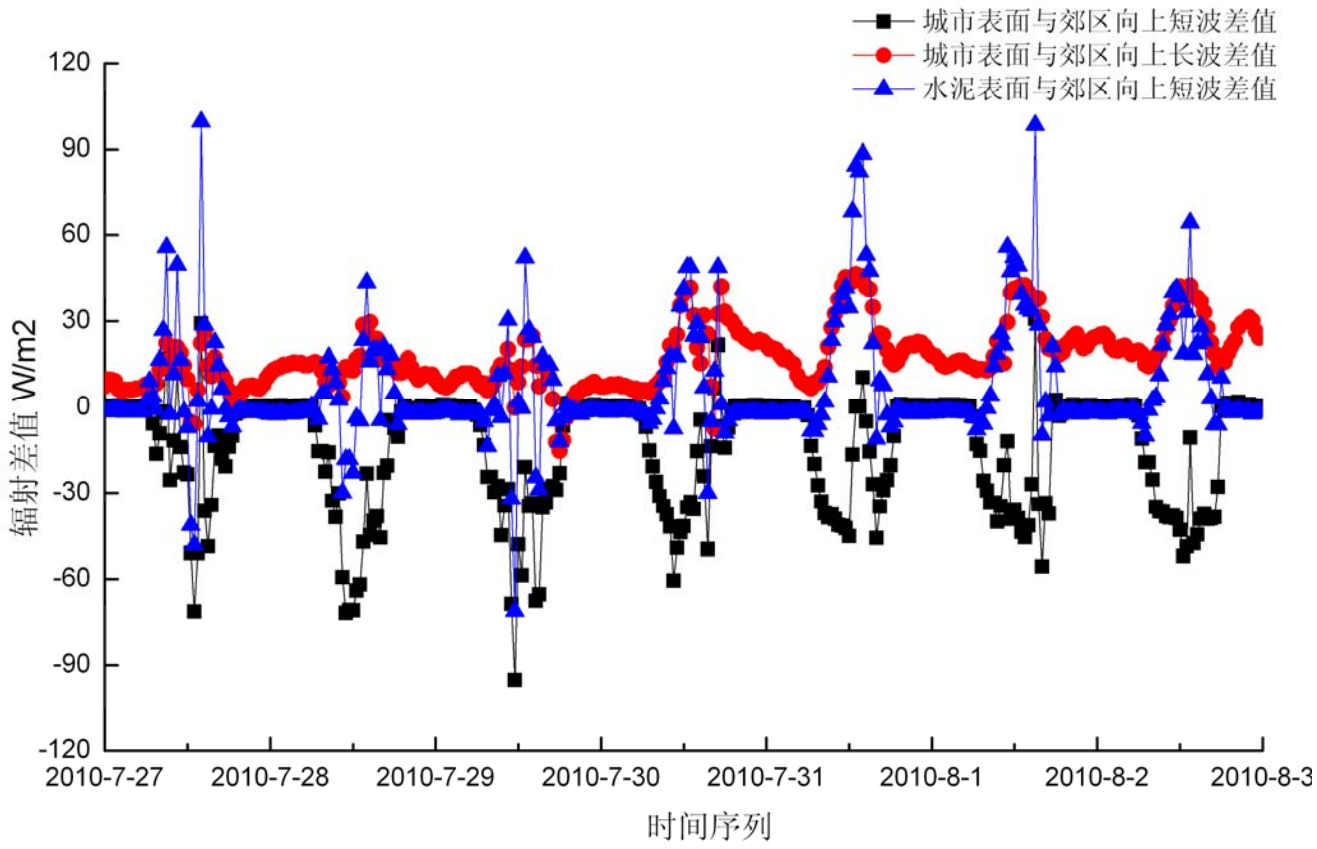


Fig2. The diurnal variation of the value of the radiation budget in urban and suburban

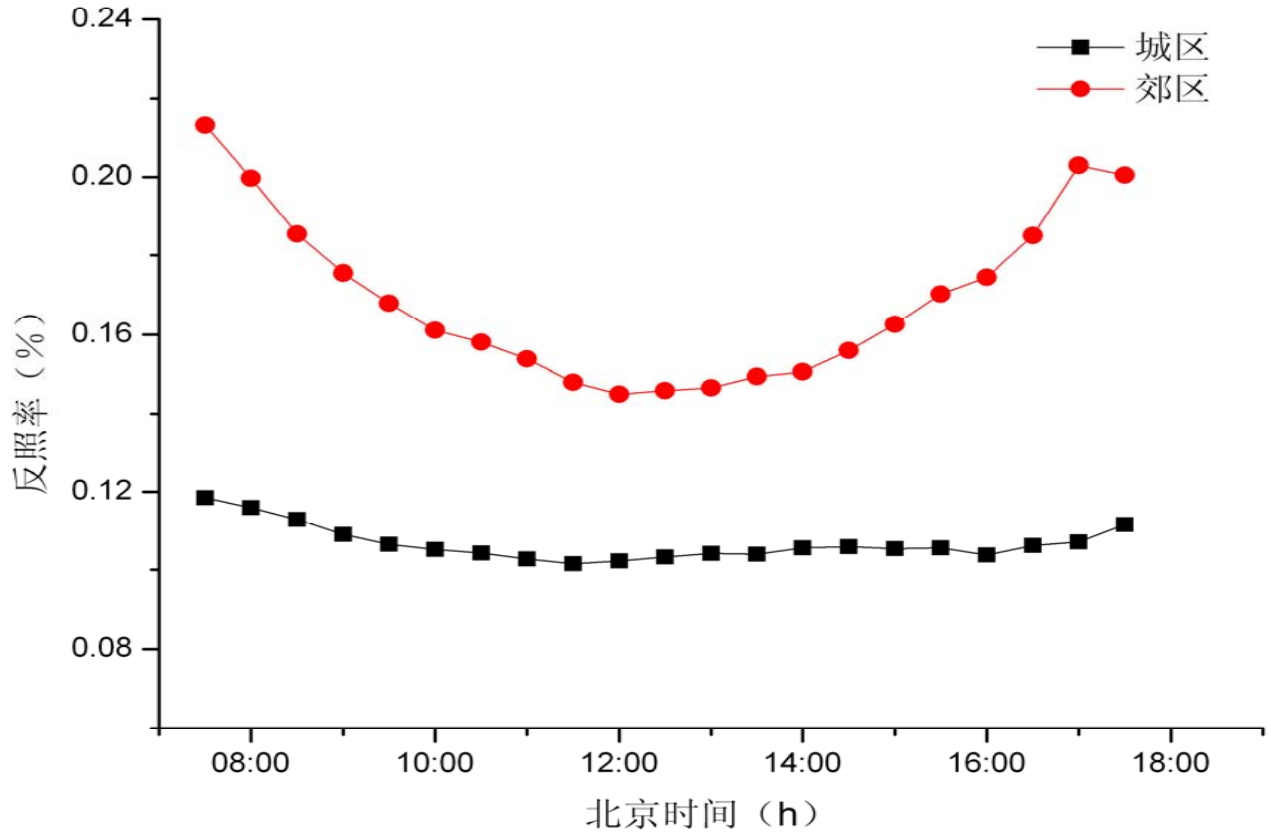


Fig3.The average diurnal variation of the albedo on clear day in urban and suburban

Add the albedo of concrete surface in urban

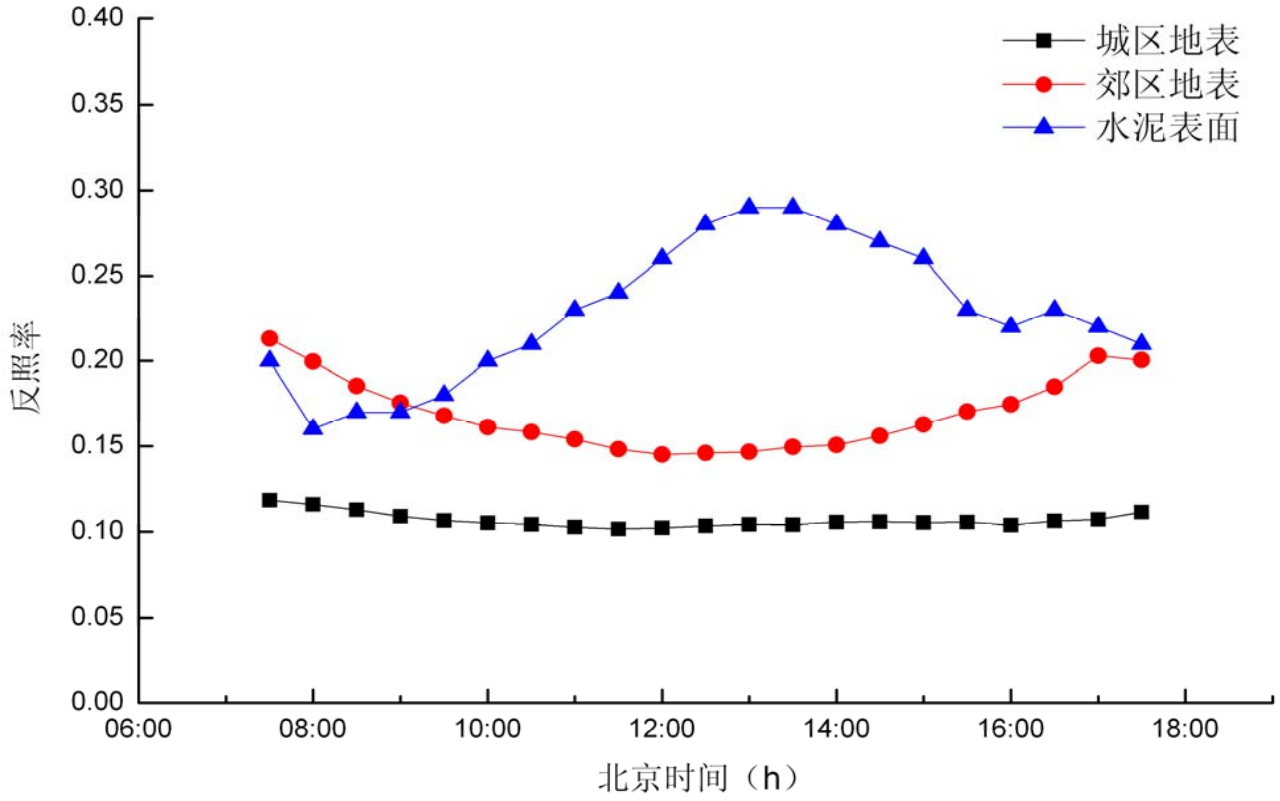


Fig4.The average diurnal variation of the albedo on clear day in urban and suburban

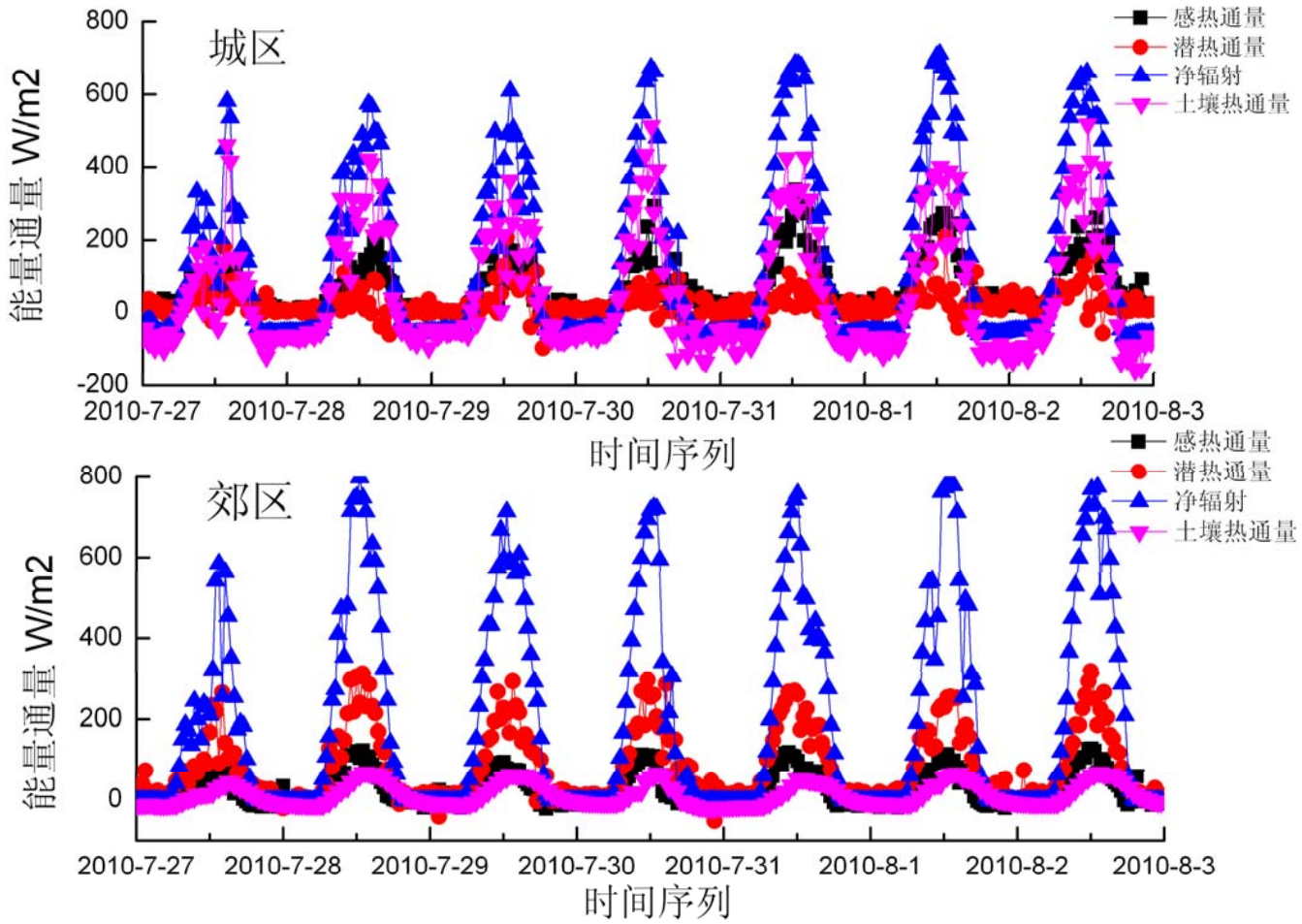
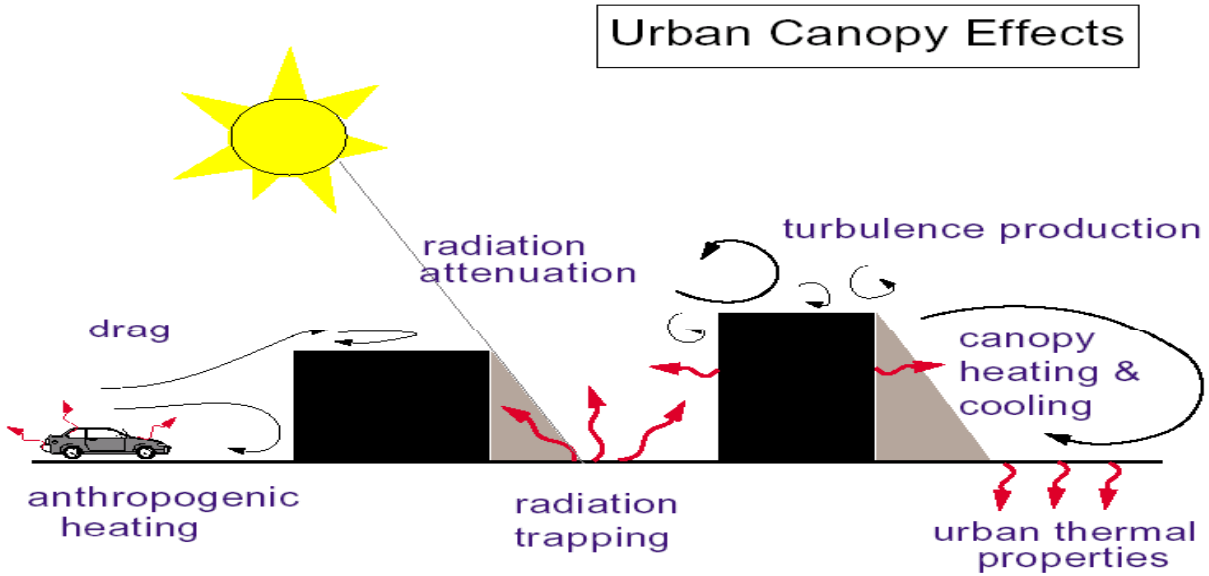


Fig5.The diurnal variation of the energy balance in urban and suburban

2. Urban Canopy Model

- Oke（1987）first proposed the concept of urban canopy layer.
- Kusaka (2001) proposed single-layer urban canopy model (UCM) .
- Martilli (2002) proposed multilayer urban canopy model (BEP).
- Francisco(2010）based on BEP， proposed multilayer urban canopy model and building energy model (BEP+BEM).√



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Two numerical cases

WRFV3.2.1/Three domains /9 km*3 km*1 km/2010.8.1-2010.8. 3 48h

Simulated 1 : BEP+BEM, In this case we choose the default parameters of urban scheme.

Simulated 2: BEP+BEM, In this case we choose the default. Except, we gave street direction the ture value-45° .

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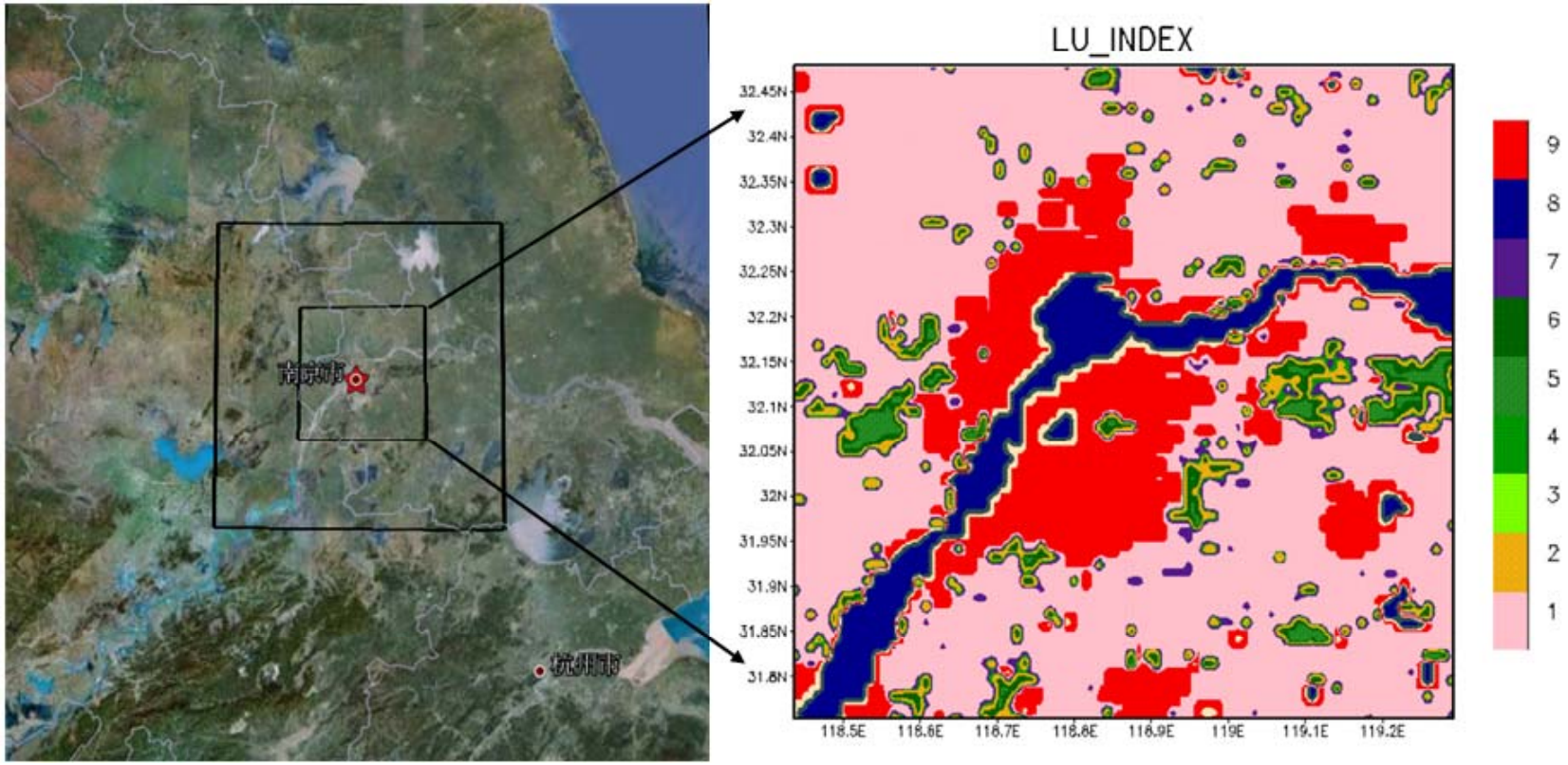
Simulated domain



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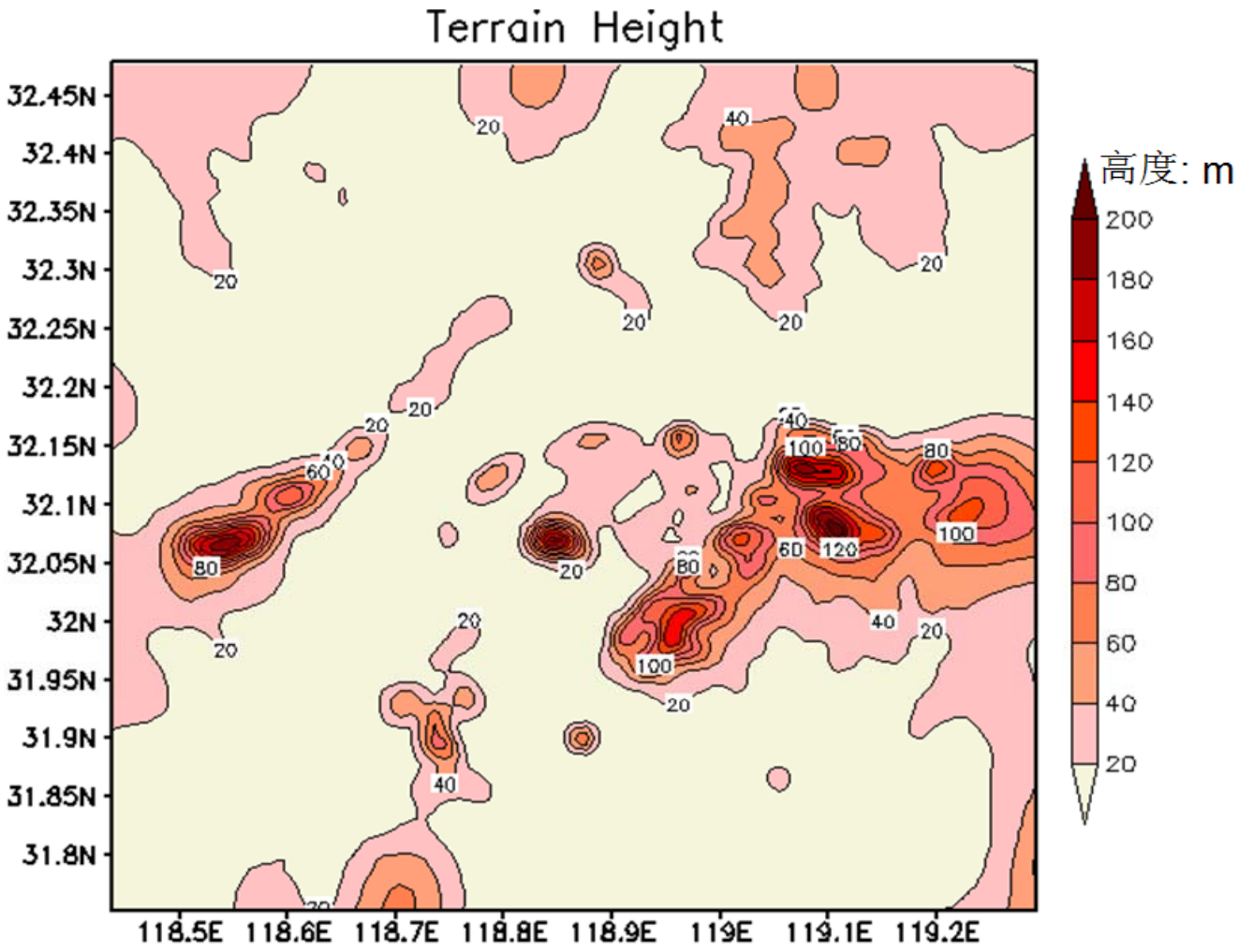

Fig6. Domain Terrain Height show us flat topography

Sf _urban_physics=1,2,3 √

- Fraction of the urban landscape which does not have natural vegetation=0.865 0.429 0.429 (physics=1,2,3)
- Coefficient of performance of the a/c systems =3.5 3.5 3.5 (physics=3)
- Air condition switch ,1=ON，=1 1 1(physics=3)
- Initial local time of A/C systems——End local time of A/C systems =0 0 0 24 24 24 (physics=3)
- Target temperature of A/C systems =297 298 298 (physics=3)
- Comfort range of the indoor temperature=0.5 0.5 0.5(physics=3)

Type: Commercial, Hi-dens Res, Low-dens Res

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Street parameters 街道参数(physics=2,3)

Urban category street direction street width building width

1 0.0 20 20
1 90.0 20 20
2 0.0 25 10
2 90.0 25 10
3 0.0 90 10
3 90.0 90 10

Just Street direction
90° changed 45°

Peak number of occupants per unit floor area =0.02 0.01 0.01(physics=3)

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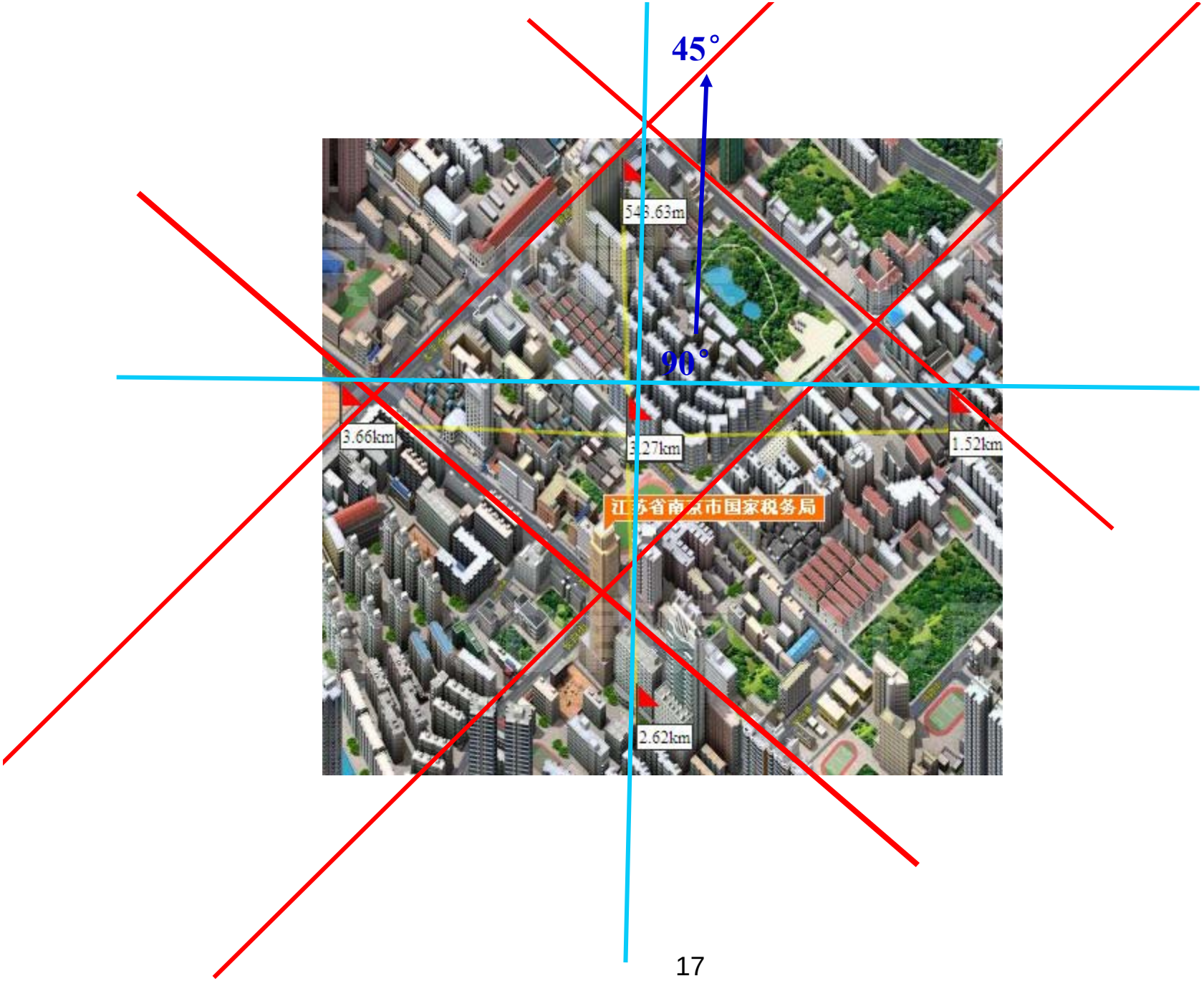
45°
90°
3.66km
1.52km
2.62km

3.Preliminary conclusion of simulated

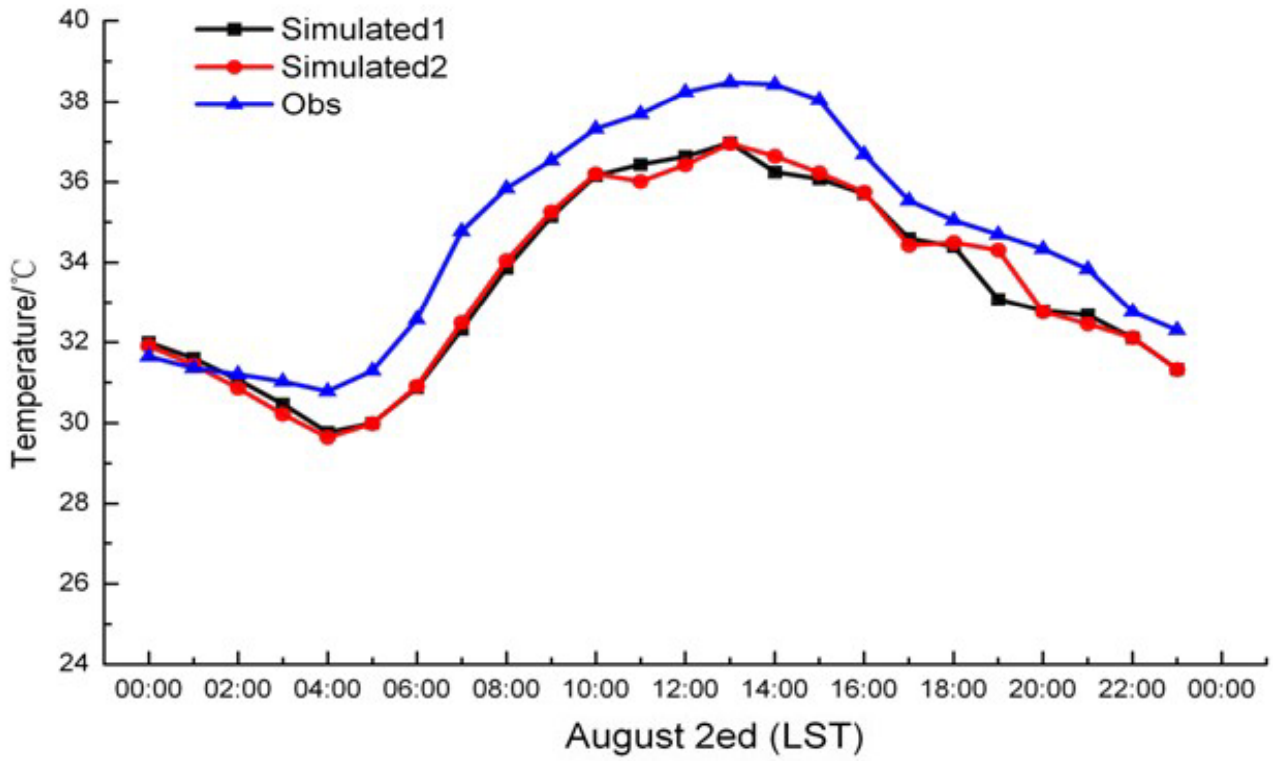

Fig7. Contrast between simulated 2m Air temperatures and observed data in urban observation site

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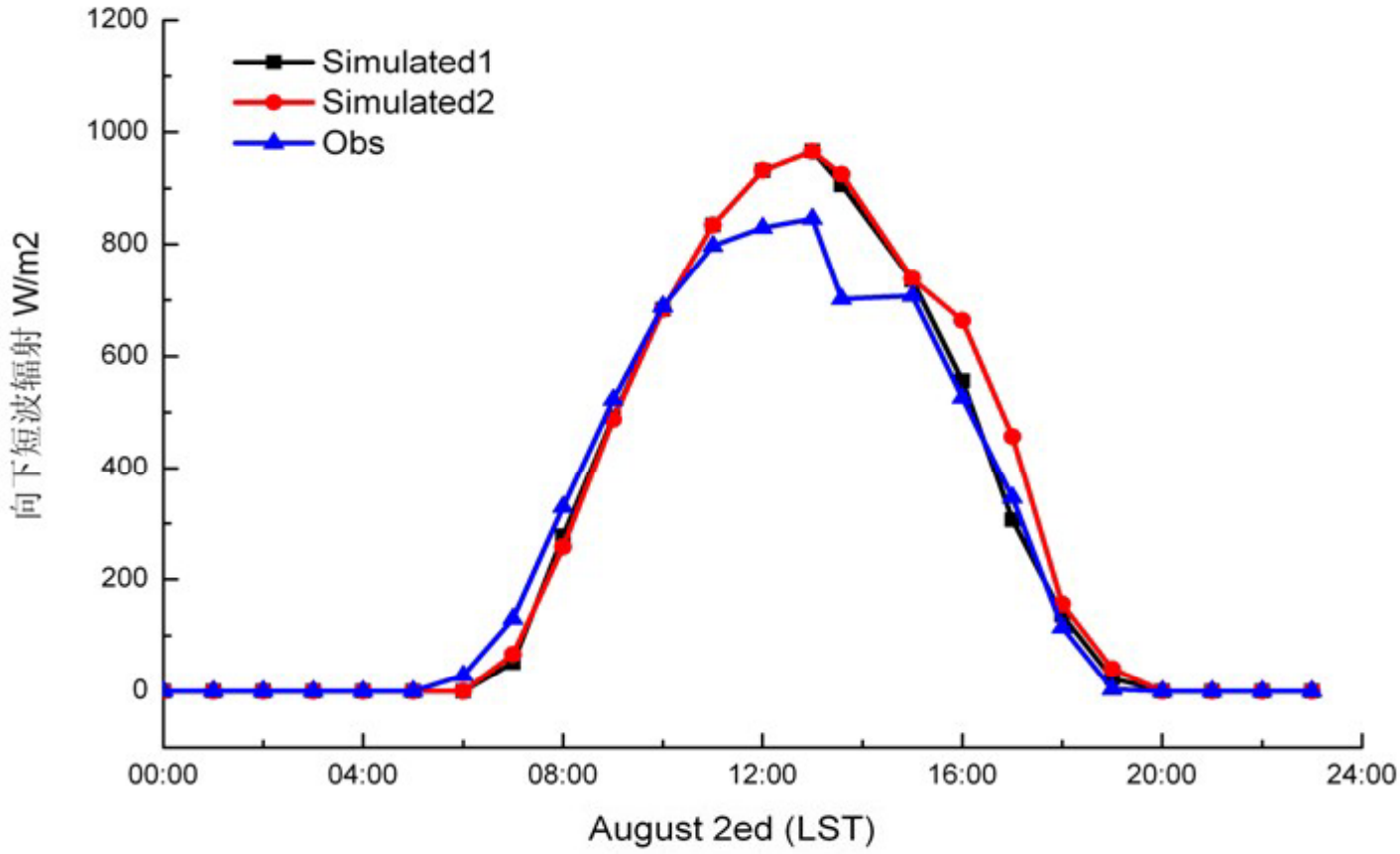
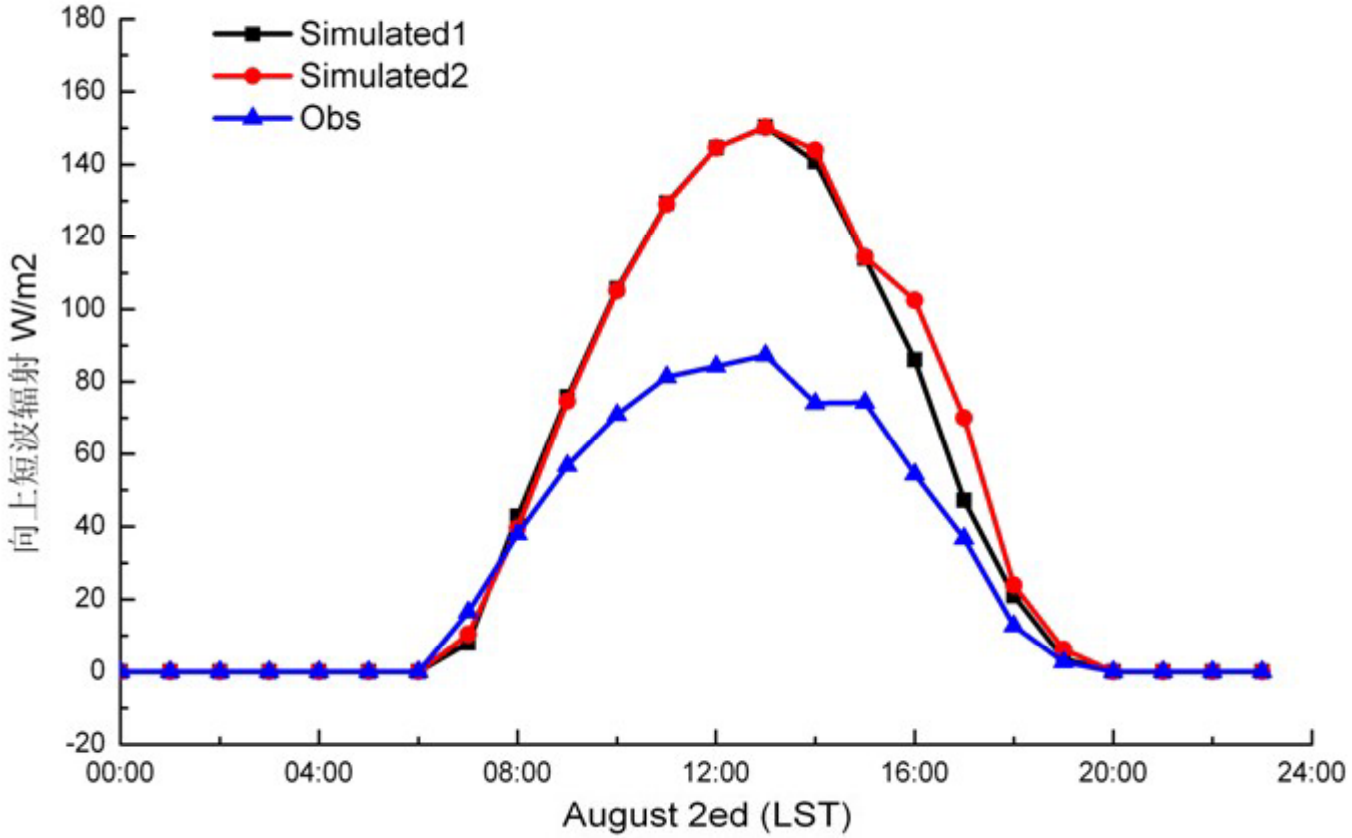


Fig8. Contrast between simulated downward shortwave radiation fluxes and observed data in urban observation site



◆Fig9. Contrast between simulated upward shortwave radiation fluxes and observed data in urban observation site

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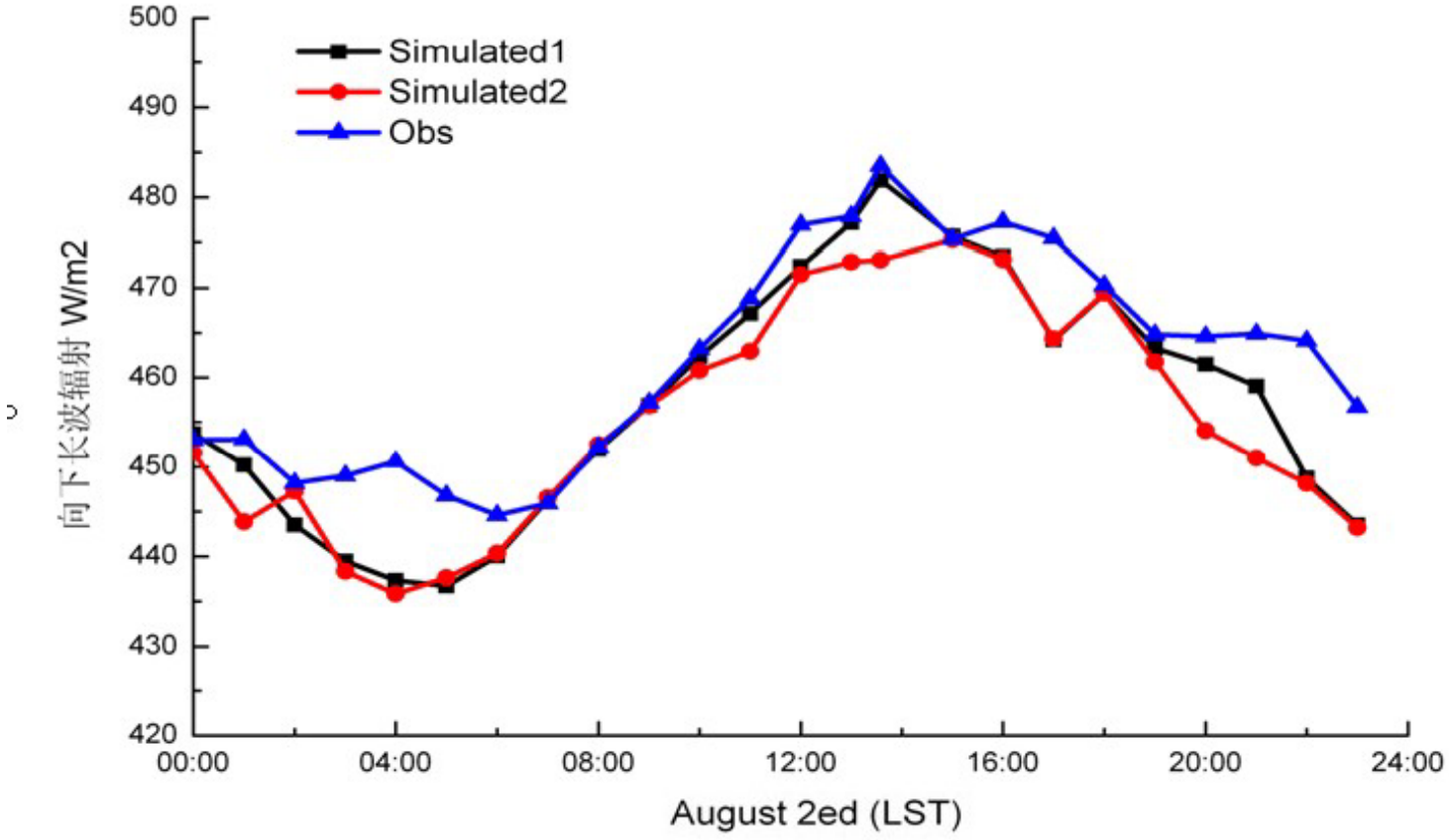

Fig10. Contrast between simulated downward longwave radiation fluxes and observed data in urban observation site

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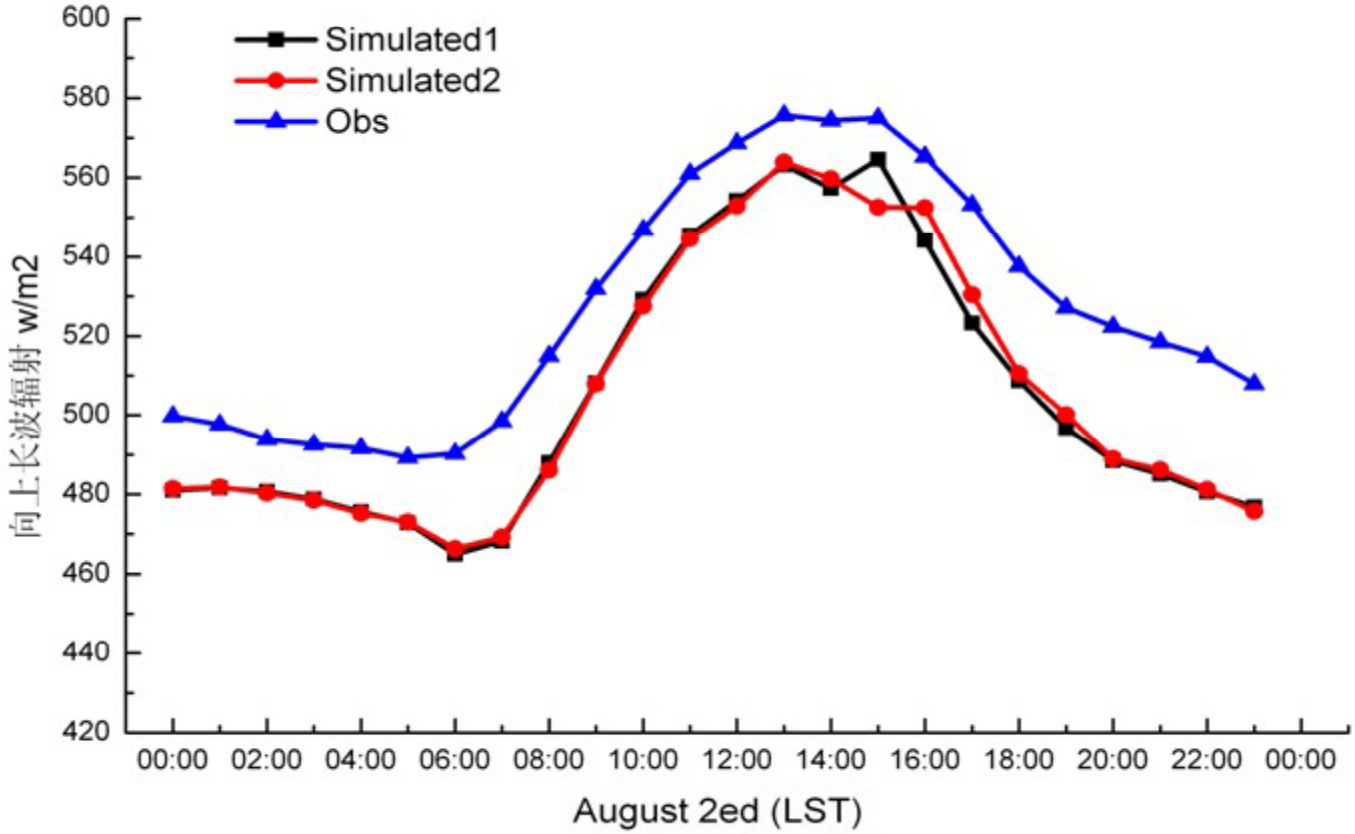

Fig11. Contrast between simulated upward lonwave radiation fluxes and observed data in urban observation site

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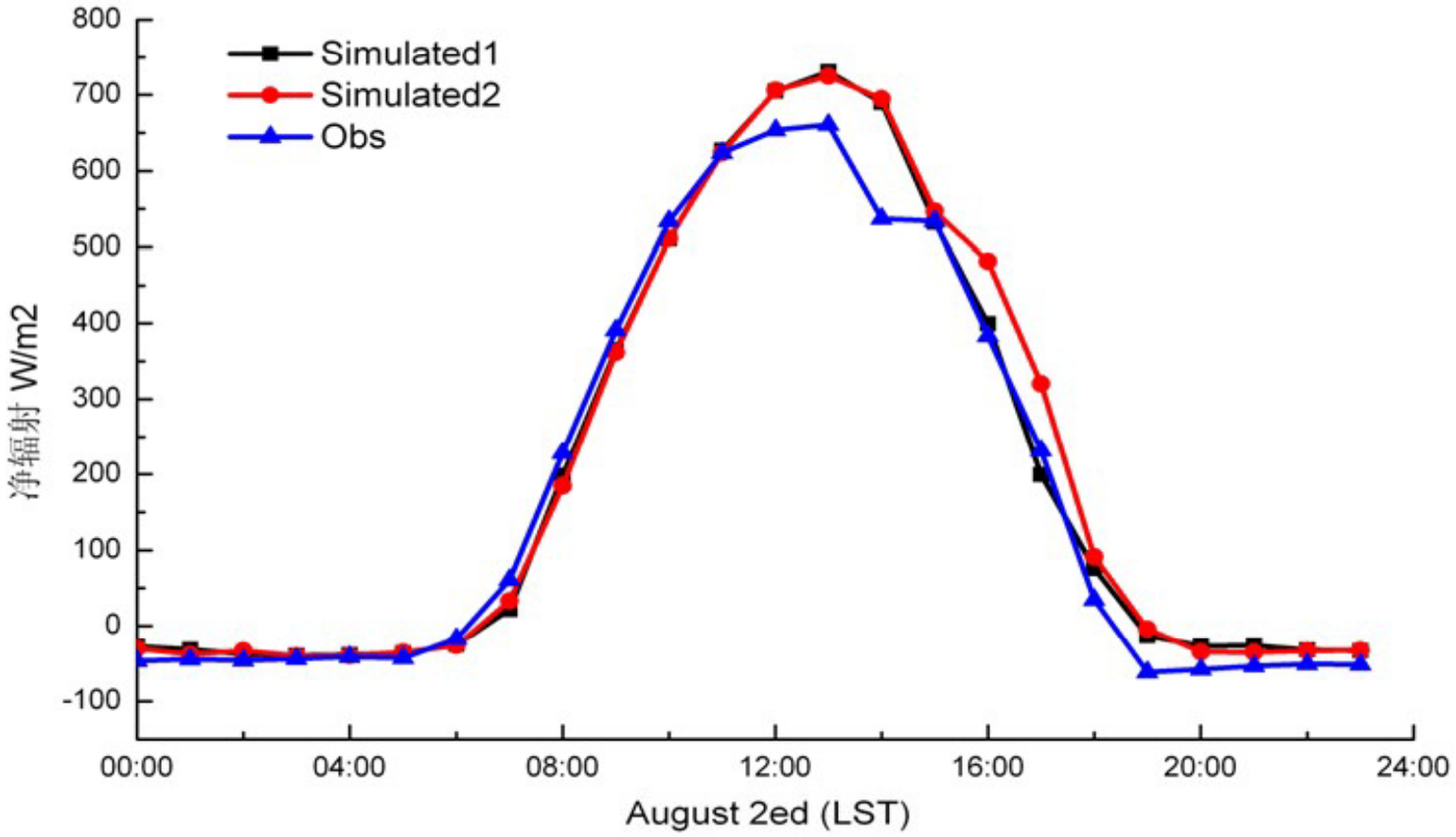

◆**Fig12. Contrast between simulated net radiation fluxes and observed data in urban observation site**

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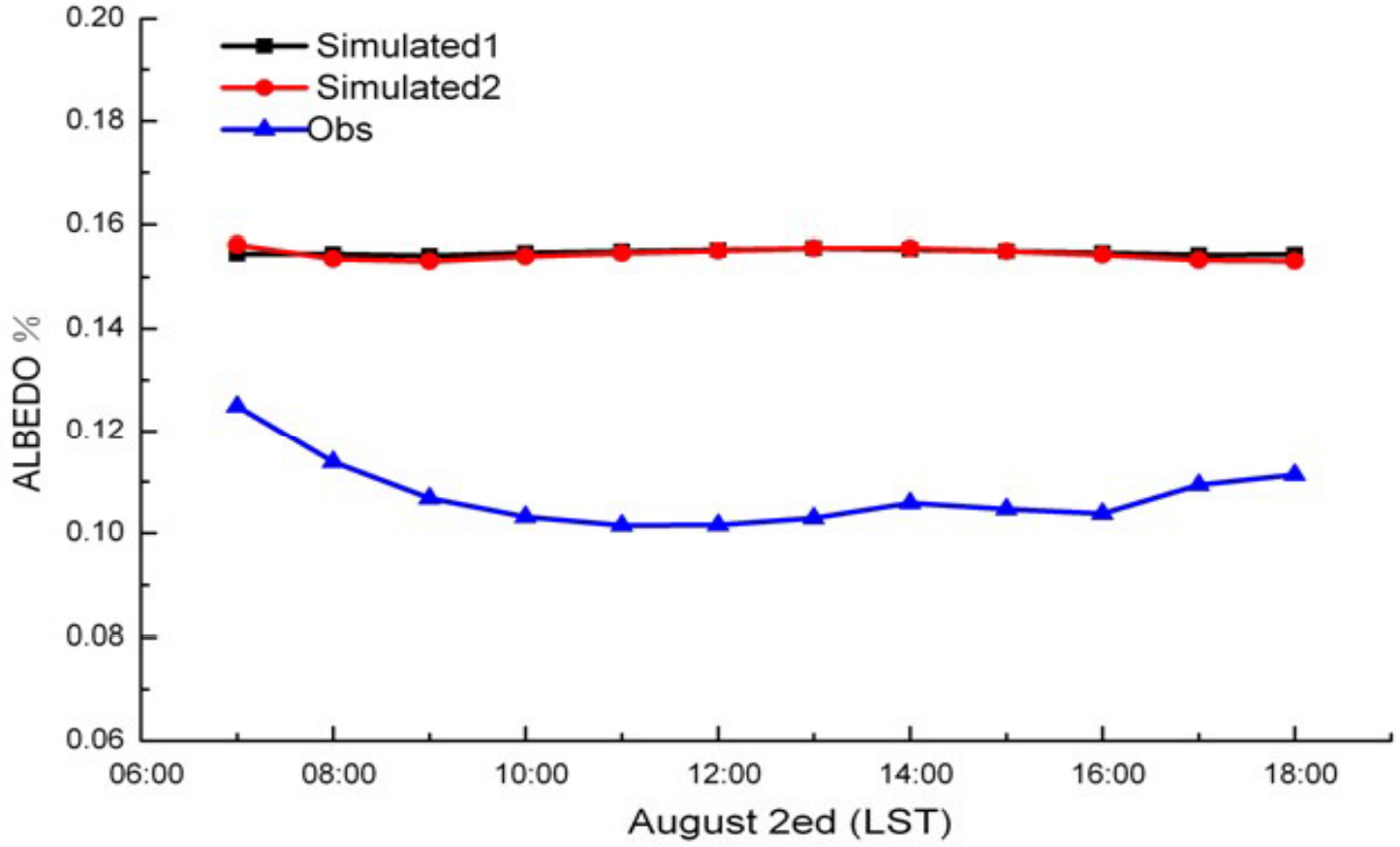

Fig13. Contrast between simulated Albedo and observed data in urban observation site

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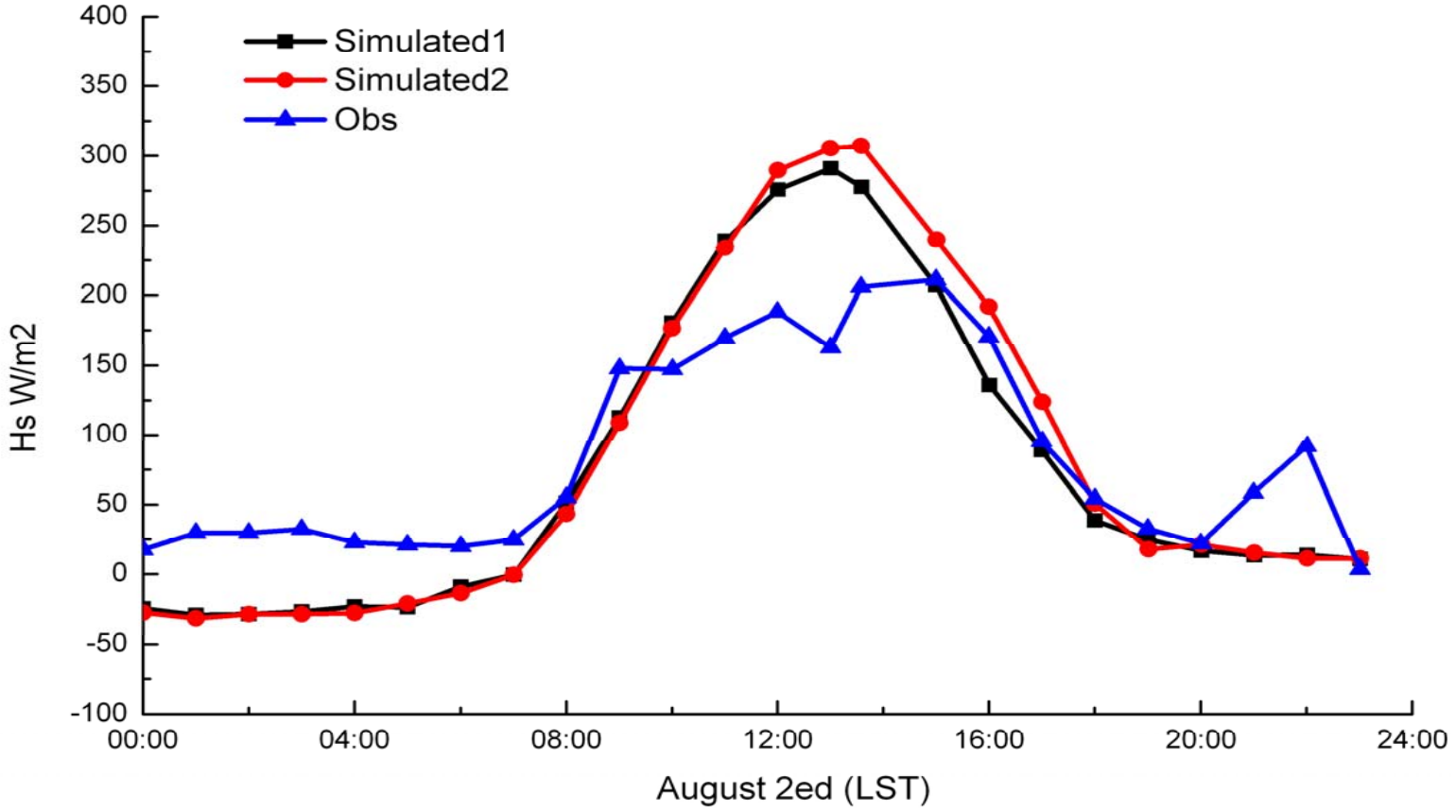

Fig14. Contrast between simulated Hs and observed data in urban observation site

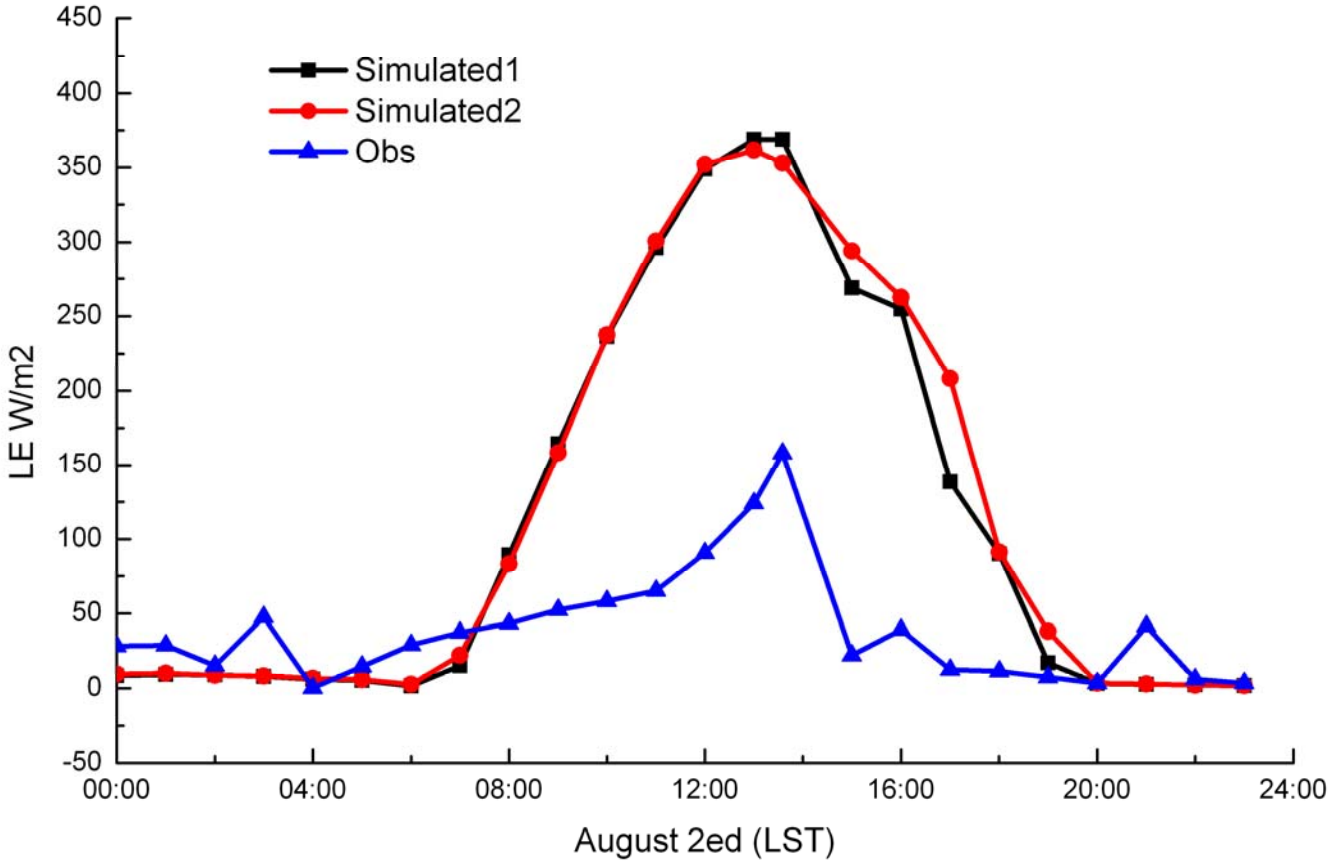

Fig15. Contrast between simulated LE and observed data in urban observation site

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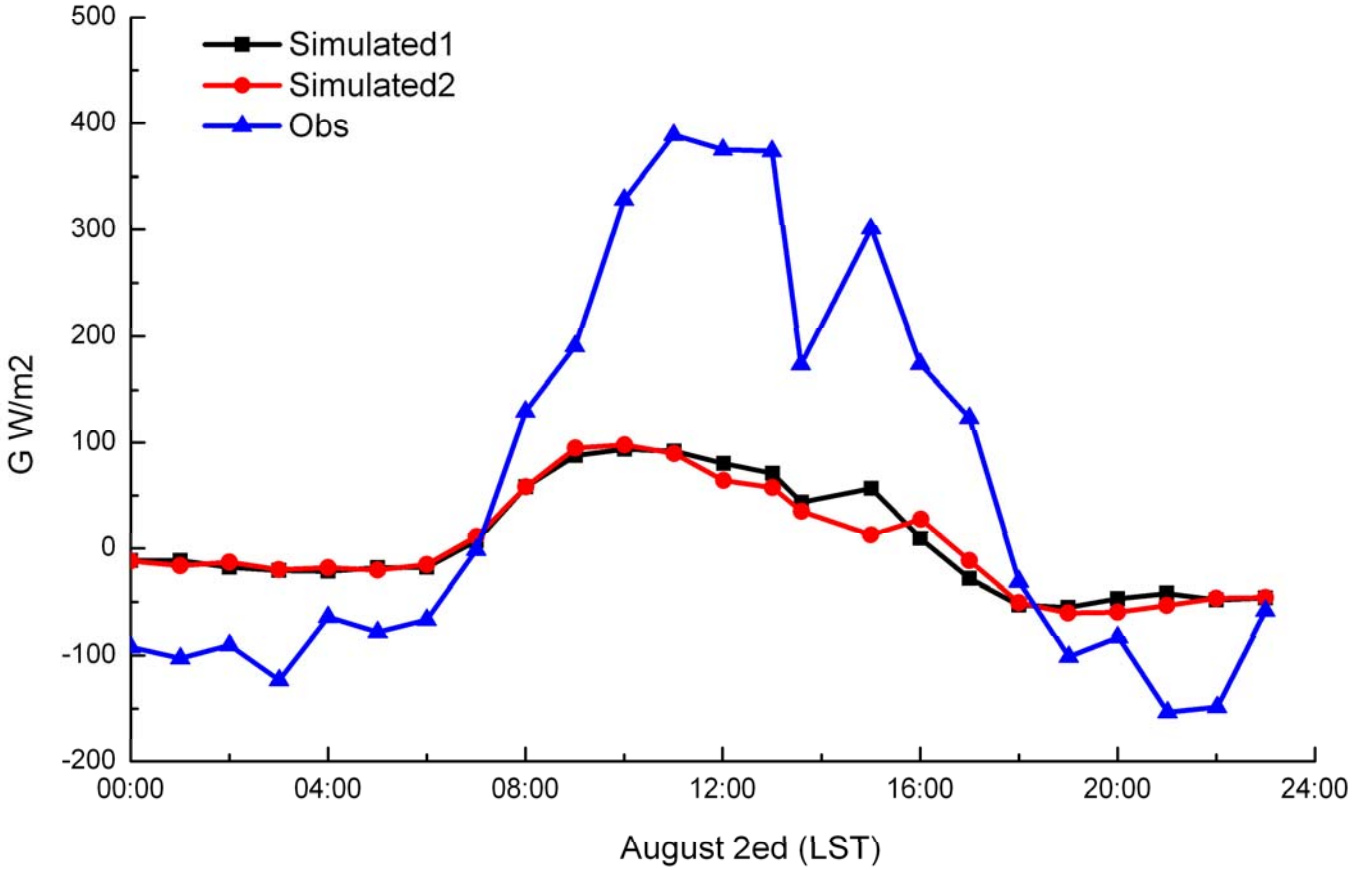

◆**Fig16. Contrast between simulated G and observed data in urban observation site**

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4.On-going Work

- 1. Ready to Simulate more cases.
  (for example, replace 2010_modis surface ）
- 2. Read more papers about urban canopy model .
- 3. Determine the research direction and how to write this paper.

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Thank You!!!

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