

2014年2月19日 CCS外部評価  
13時30～14時00分(発表30分)

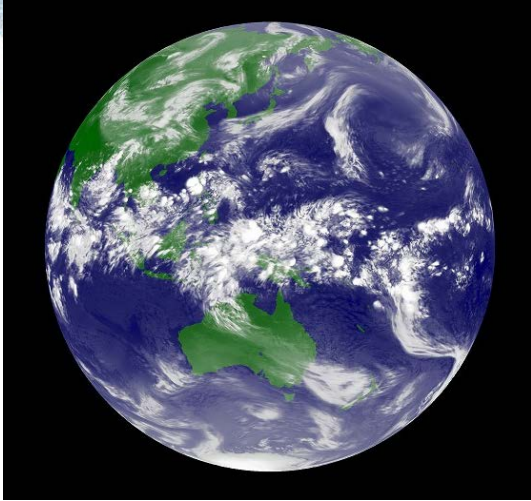
# Overview for Regional-Scale Meteorology and Climatology

Associate Prof. of CCS  
Hiroyuki Kusaka



# Modeling, Simulation and Observation

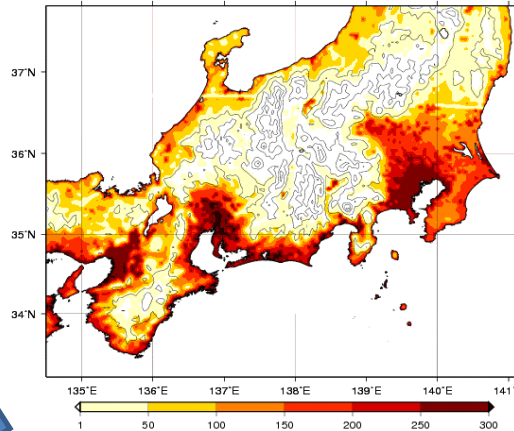
NICAM  
2004



## Urban Climate, Developing LES



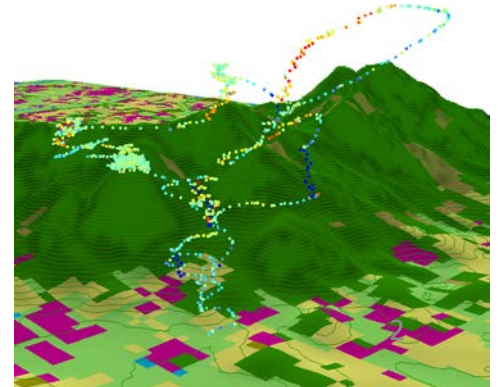
## Regional Climate (Projection, DDS) Improving WRF



## Applied Meteorology (Renewable Energy, Biometeorology)



## Local Climate (Wind, Rainfall, Cloud) Developing LWM





# Research Theme

## Regional Climate Projection (Dynamical Downscaling)

[Hiroyuki Kusaka](#), Asuka Suzuki-Parker, Doan Quang Van

## Local Climate (Urban Heat Island, Local Wind, Precipitation Climatology)

[Hiroyuki Kusaka](#), Maki Okada, Akifumi Nishi, Takayuki Kato

## Developing Numerical Models (LWM, UCM and LES)

[Ryosaku Ikeda](#), Yuko Akimoto



# Research Theme

## Regional Climate Projection (Dynamical Downscaling)

Hiroyuki Kusaka, Asuka Suzuki-Parker

## Local Climate (Urban Heat Island, Local Wind, Precipitation Climatology)

Hiroyuki Kusaka, Akifumi Nishi, Takayuki Kato

## Developing Numerical Models (LM, UCM and LES)

Ryosaku Ikeda, Yuko Akimoto, Van Doan Quang, Akifumi Nishi

# Improving the WRF model

WRF is a regional model used in the world wide

2001

Kusaka-Model (one of the 1st UCM)

2004 WRFV2

Coupling WRF with UCM

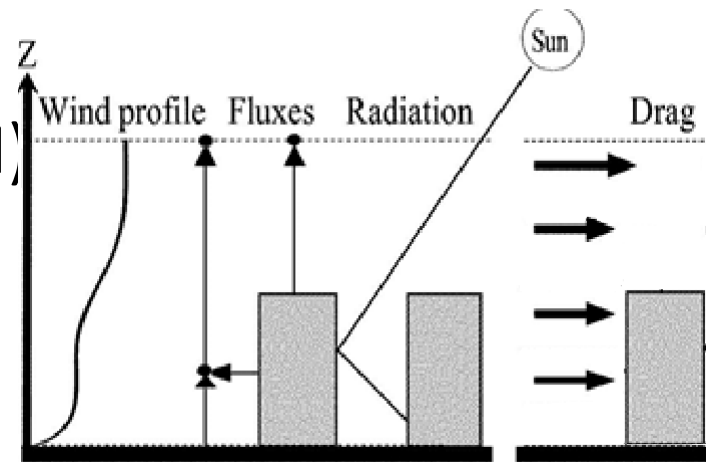
2006 WRFV2.2

Official Release WRF with UCM from NCAR

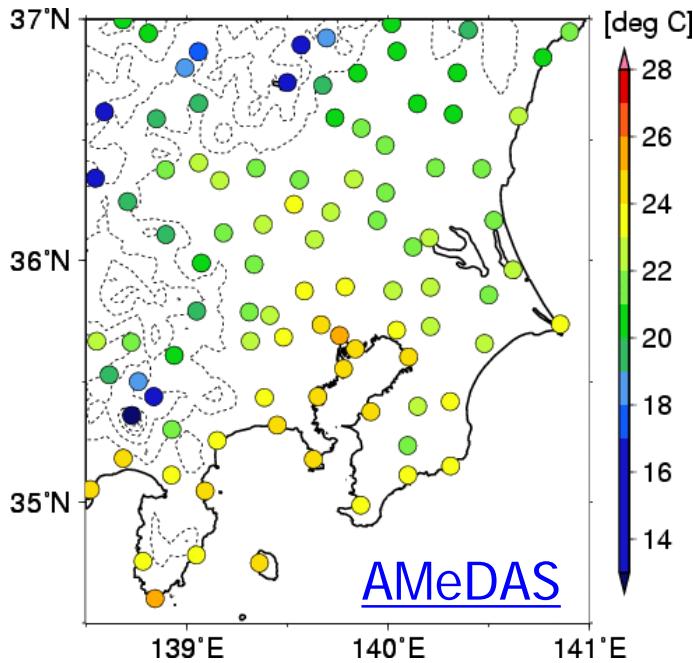
2008 WRFV3.0

Many researchers use WRF for Regional Climate Projection

Kusaka Model is a standard UCM in the world and the number of citation of Kusaka (2001, BLM) is 361 times(google) and 161 (ISI).

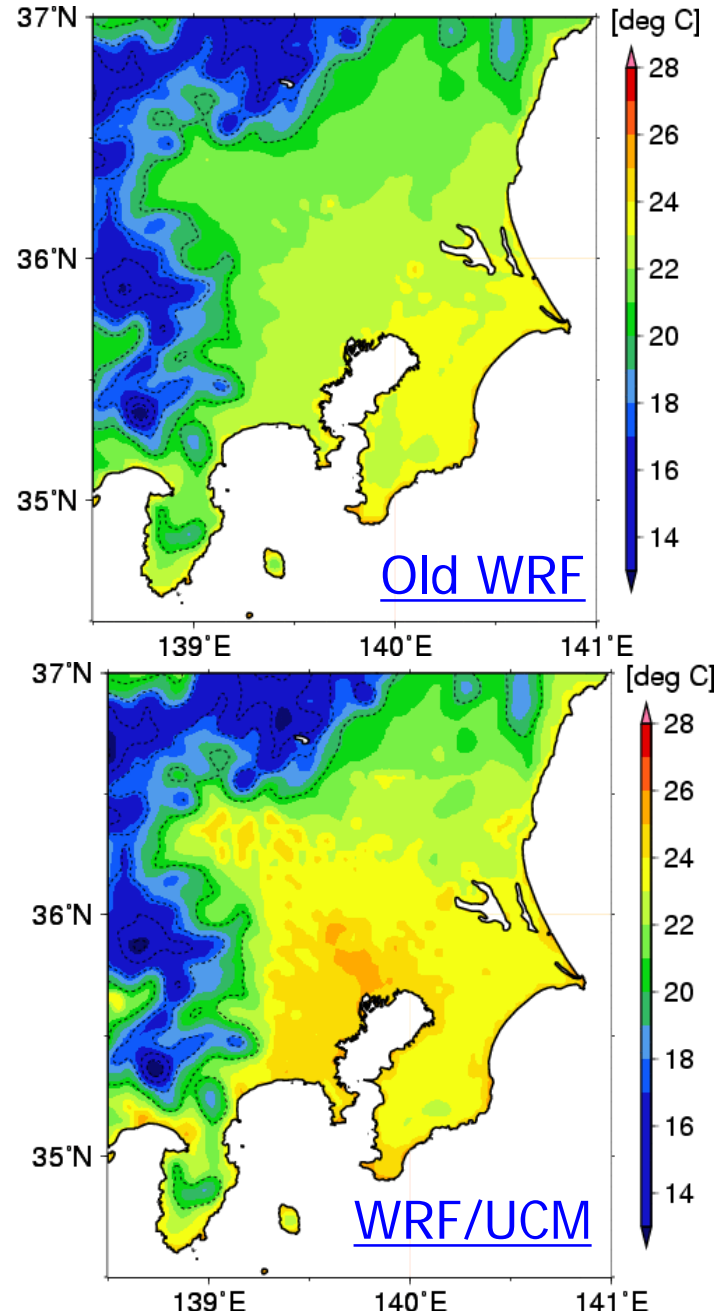


# Impact of Coupling WRF and UCM



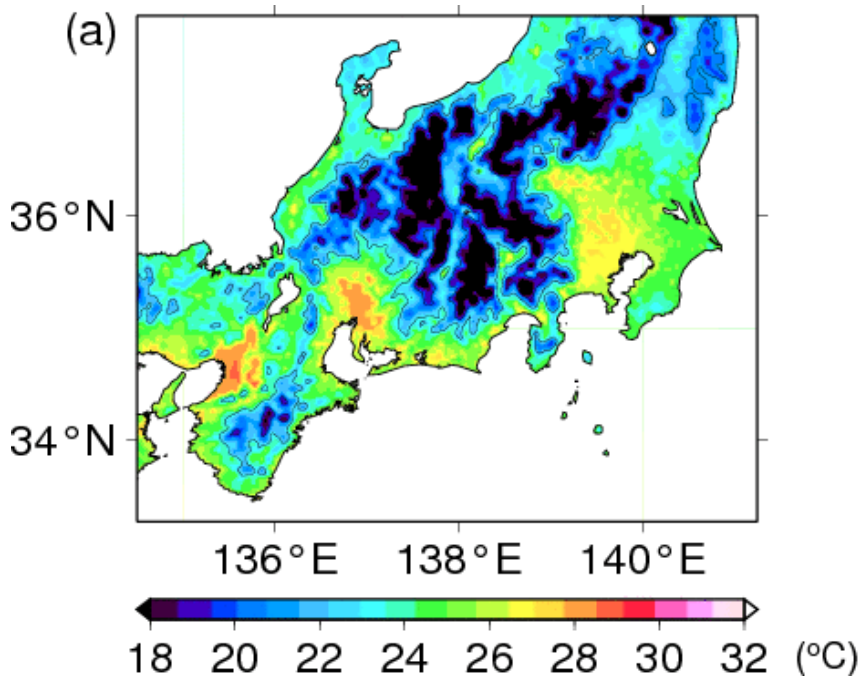
Temperature at 05  
JST (August mean)

Kusaka et al. (2012a, JMSJ)

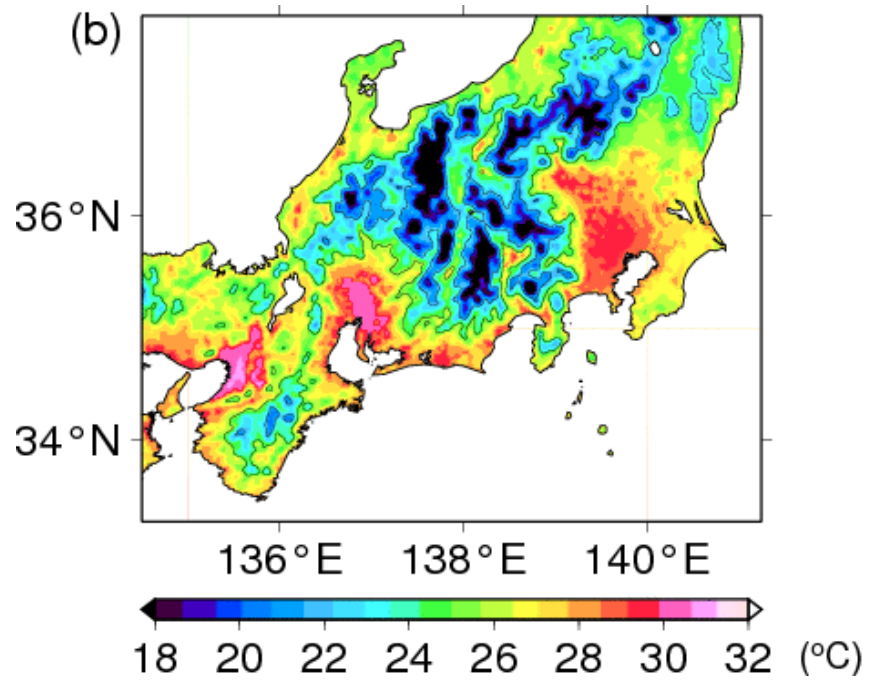


# Regional Climate Projection by WRF/UCM

2000s

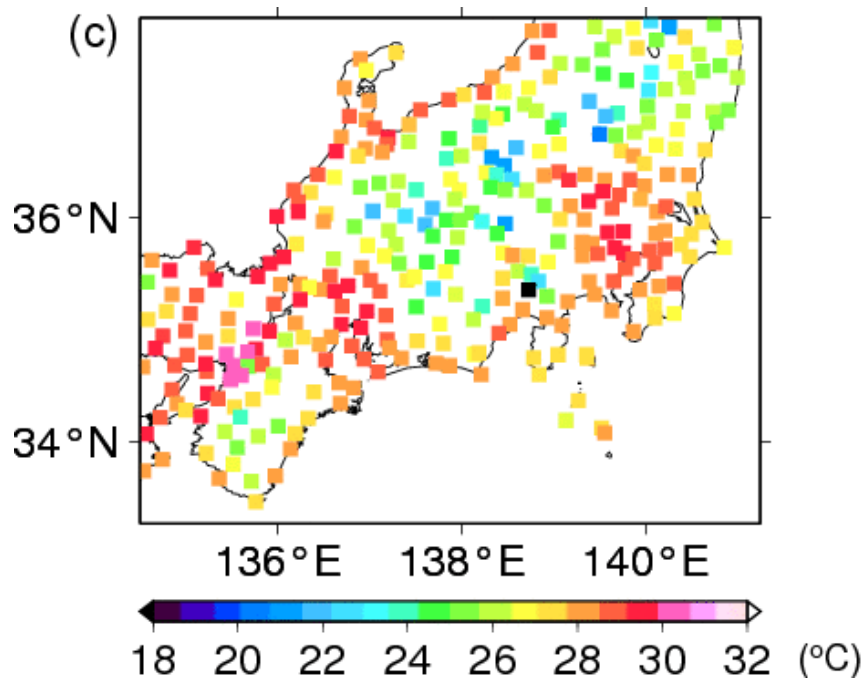


2070s

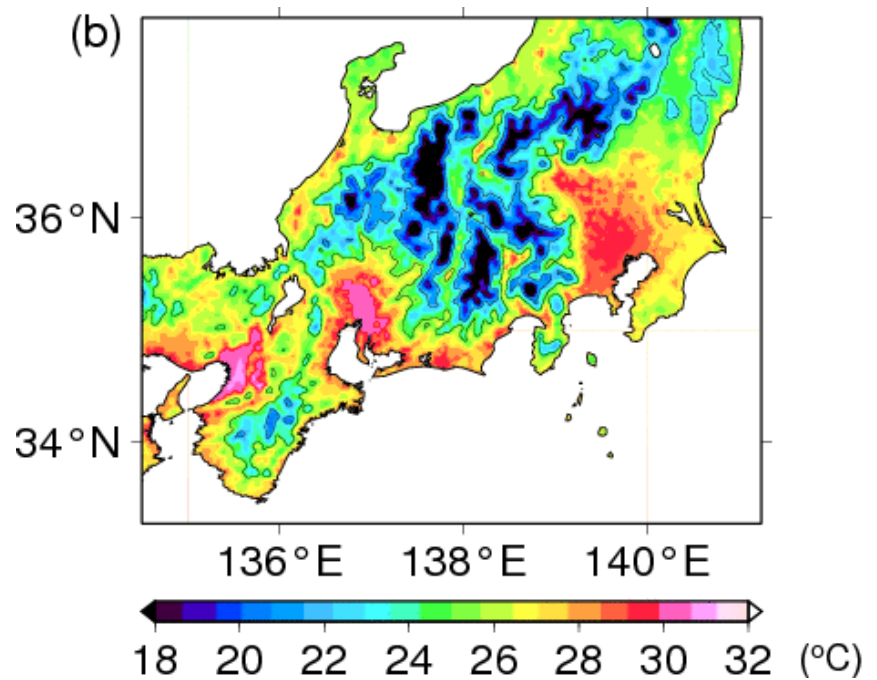


Kusaka et al. (2012b, JMSJ)

## 2010 Record-breaking extreme hot summer



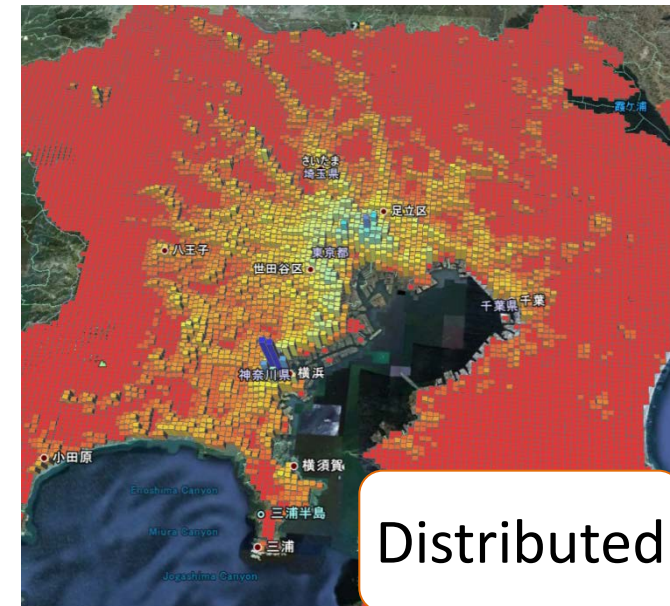
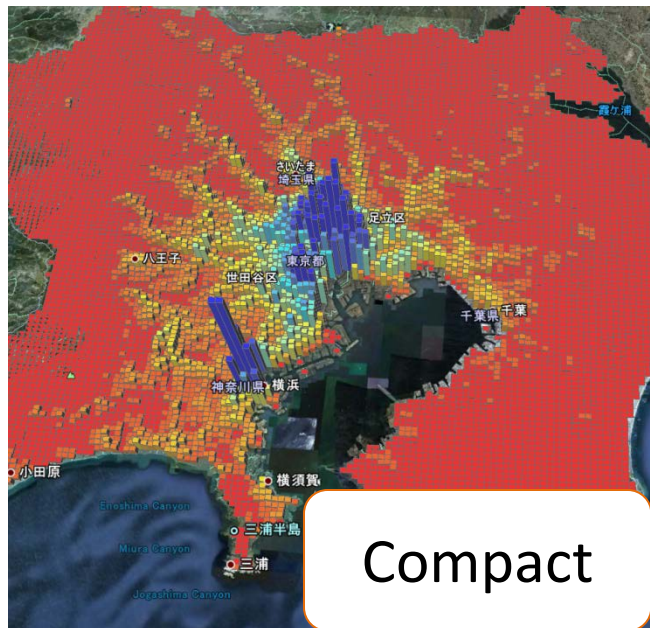
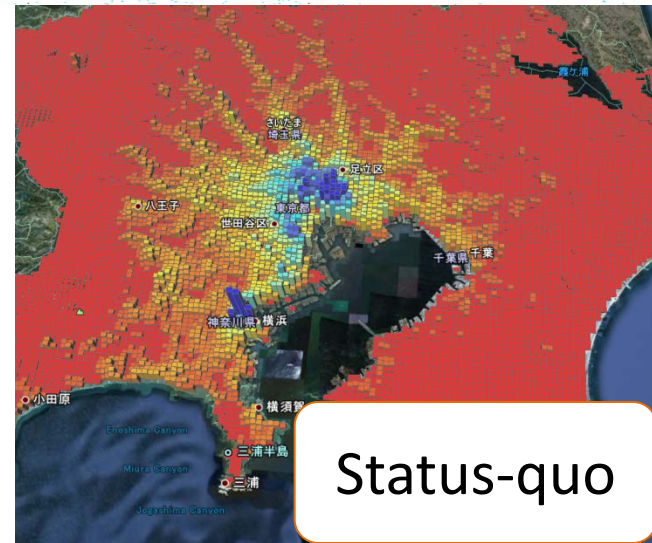
## 2070s



Kusaka et al. (2012b, JMSJ)

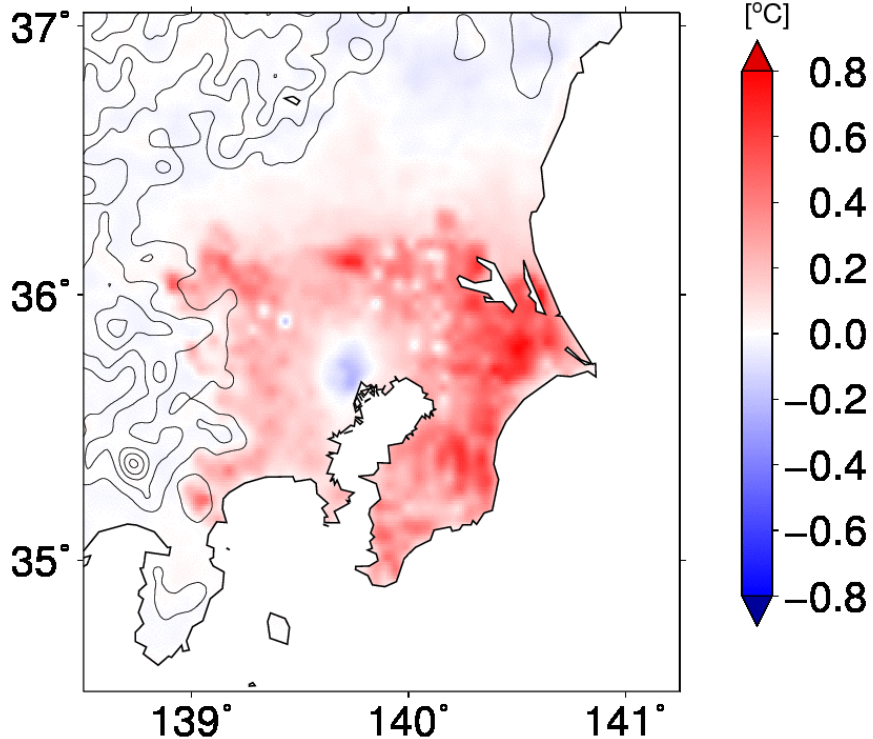


Our life style could mitigate future uncomfortable urban thermal environment.

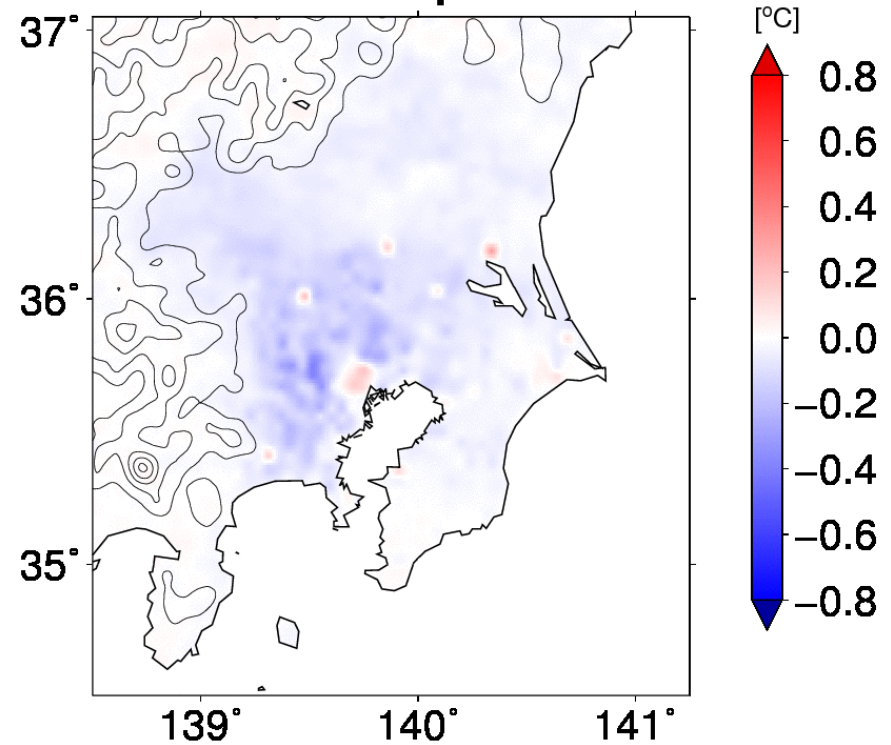


# Which will you select, distributed or compact city?

- Impact of distributed city on the temperature



- Impact of compact city on the temperature



Energy Saving of 1.6 Billion [W h] ~ Nuclear-generated electric power



# Research Theme

## Regional Climate Projection (Dynamical Downscaling)

Hiroyuki Kusaka, Asuka Suzuki-Parker

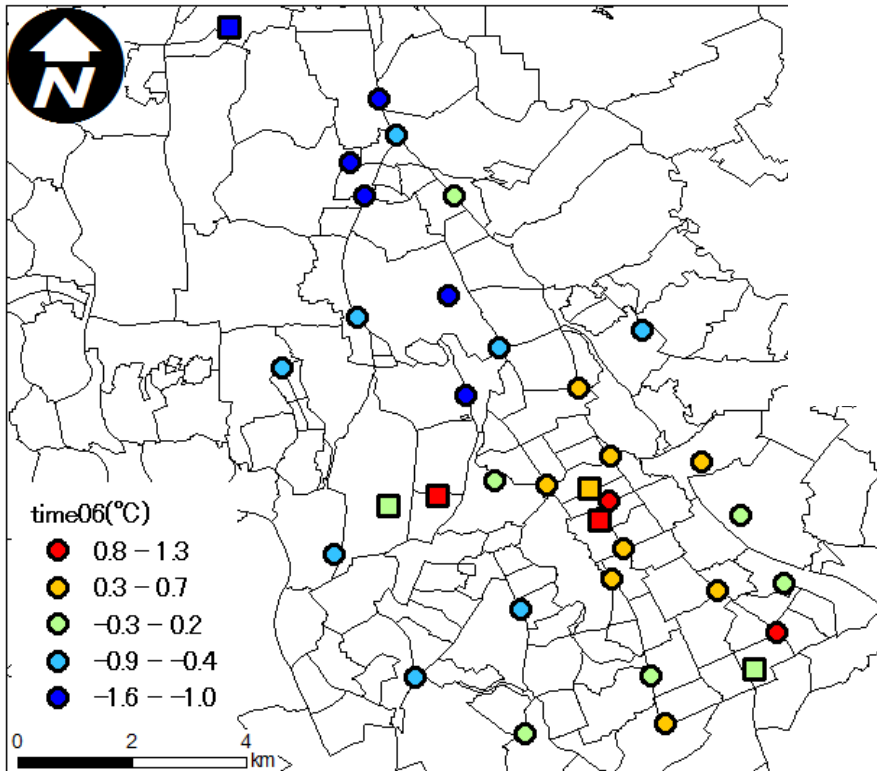
## Local Climate (Urban Heat Island, Local Wind, Precipitation Climatology)

Hiroyuki Kusaka, Akifumi Nishi, Takayuki Kato

## Developing Numerical Models (LM, UCM and LES)

Ryosaku Ikeda, Yuko Akimoto, Van Doan Quang, Akifumi Nishi

# Urban Heat Island Measurement



1981年



1977年

UHI is  $1^{\circ}\text{C}$  and  $0.5^{\circ}\text{C}$  in Jan and Aug, respectively. Annual mean is  $0.7^{\circ}\text{C}$  that  $\sim$  GW.

# Impact of Urbanization on Precipitation Climatology in Tokyo

Many people concern urban impact on precipitation.

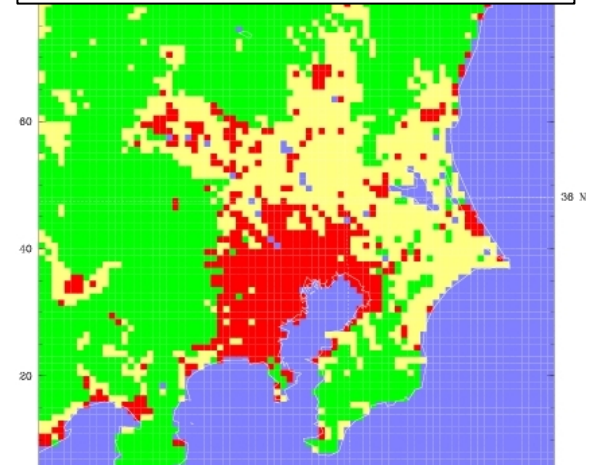
Observational study says

Yes (Fujibe et al. 2009, SOLA)

No (Kanae et al. 1999, JMSJ)

Note: Non-linearity (Chaos nature) in precipitation simulation brings large uncertainty in conclusion from a standard sensitivity experiment. Thus, there are still under discussion on this issue.

CTRL experiment



No Urban experiment



Fig.6: Urban impacts on the monthly precipitation amount in August during the 8-year period (2001-2008). (a) Residential city scenario case. (b) Commercial city scenario case. (c) Commercial city with double anthropogenic heat scenario case. Red and blue indicate the increase and decreased precipitation amount by existence of the urban areas, respectively. All results are an ensemble mean from the four WRF members.

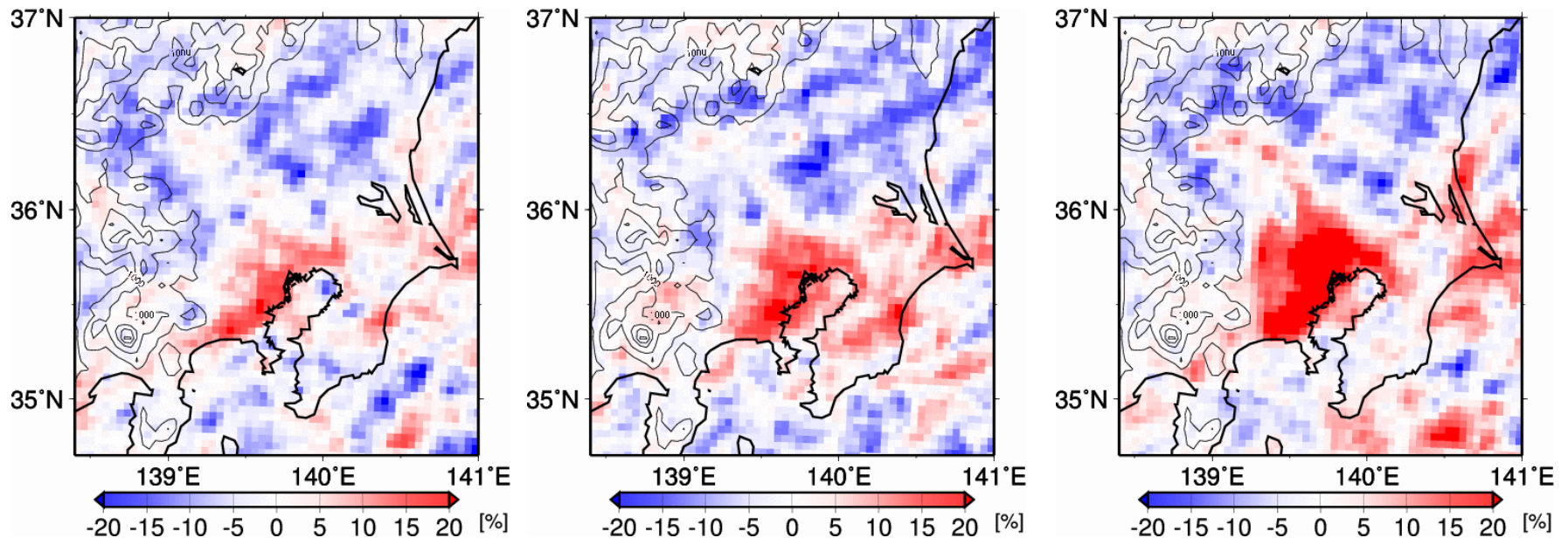
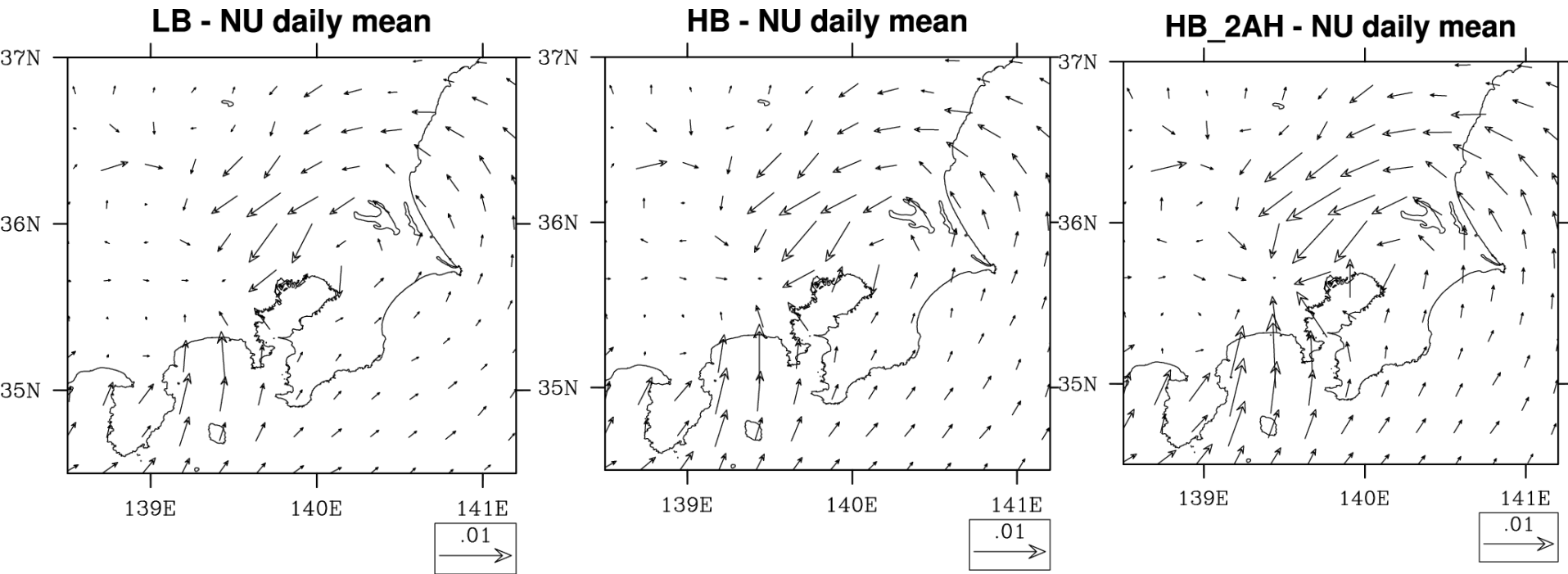


Fig.14: Urban impacts on the horizontal moisture flux at 200 m level in August during the 8-year period (2001-2008). (a) Residential city scenario case. (b) Commercial city scenario case. (c) Commercial city with double anthropogenic heat scenario case.





# Research Theme

## Regional Climate Projection (Dynamical Downscaling)

Hiroyuki Kusaka, Asuka Suzuki-Parker

## Local Climate (Urban Heat Island, Local Wind, Precipitation Climatology)

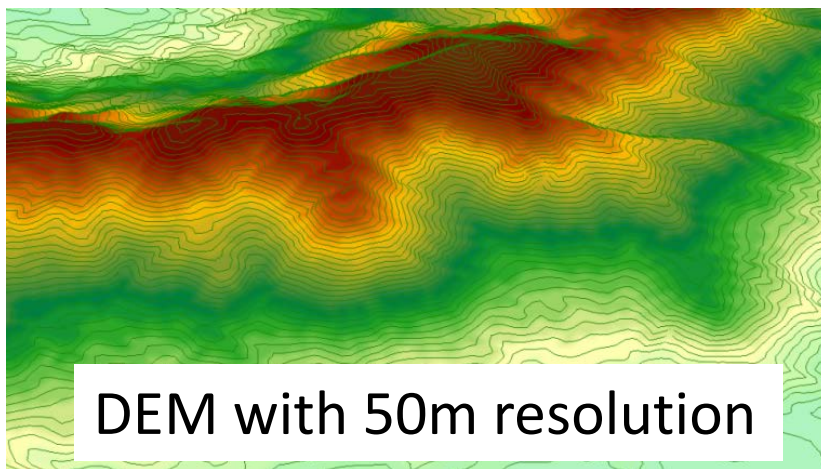
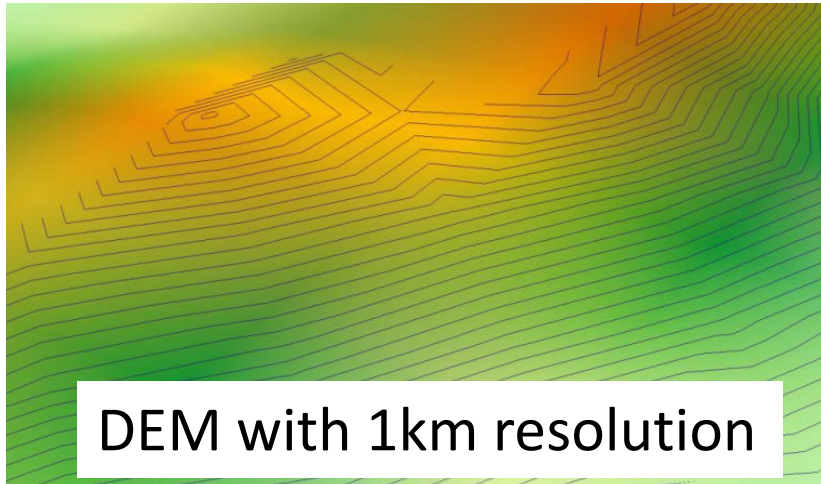
Hiroyuki Kusaka, Akifumi Nishi, Takayuki Kato

## Developing Numerical Models (LM, UCM and LES)

Ryosaku Ikeda, Yuko Akimoto, Van Doan Quang, Akifumi Nishi



# Developing LES-based Local Wind Model for the Complex Terrain



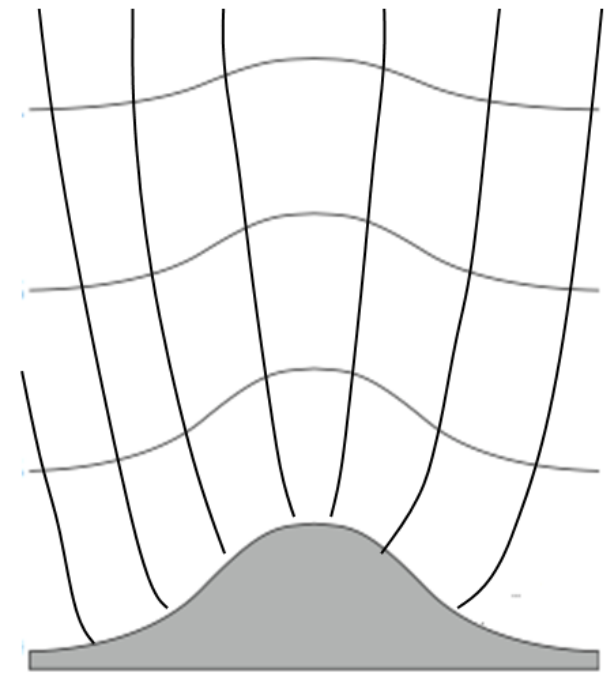
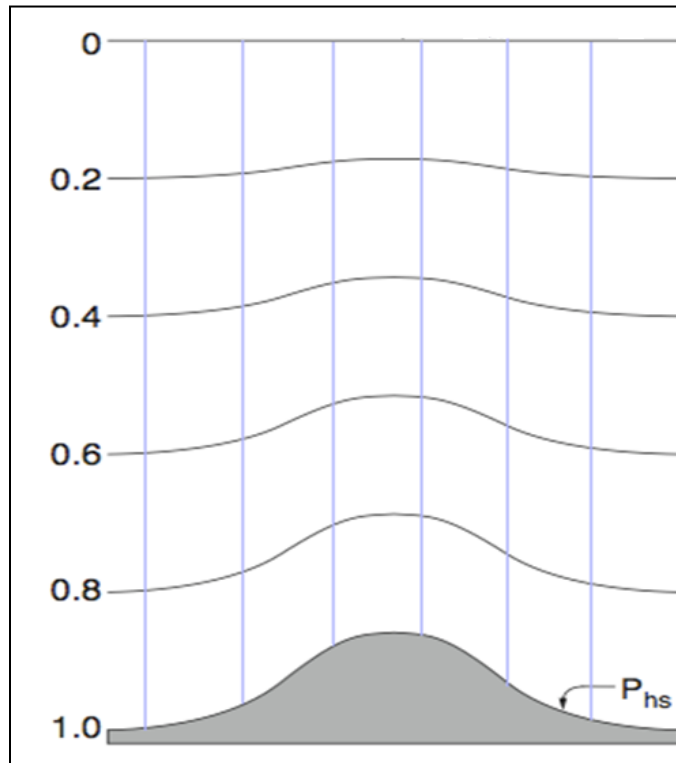
- 1) Higher and higher spatial resolution of Meteorological model.
- 2) Users need information of rapid change of wind (RAMP)



Grid-system and turbulence parameterization are recently significant issues.

RANS model can be used for lower than 500 m resolution

LES model can be used for higher than 100 m resolution

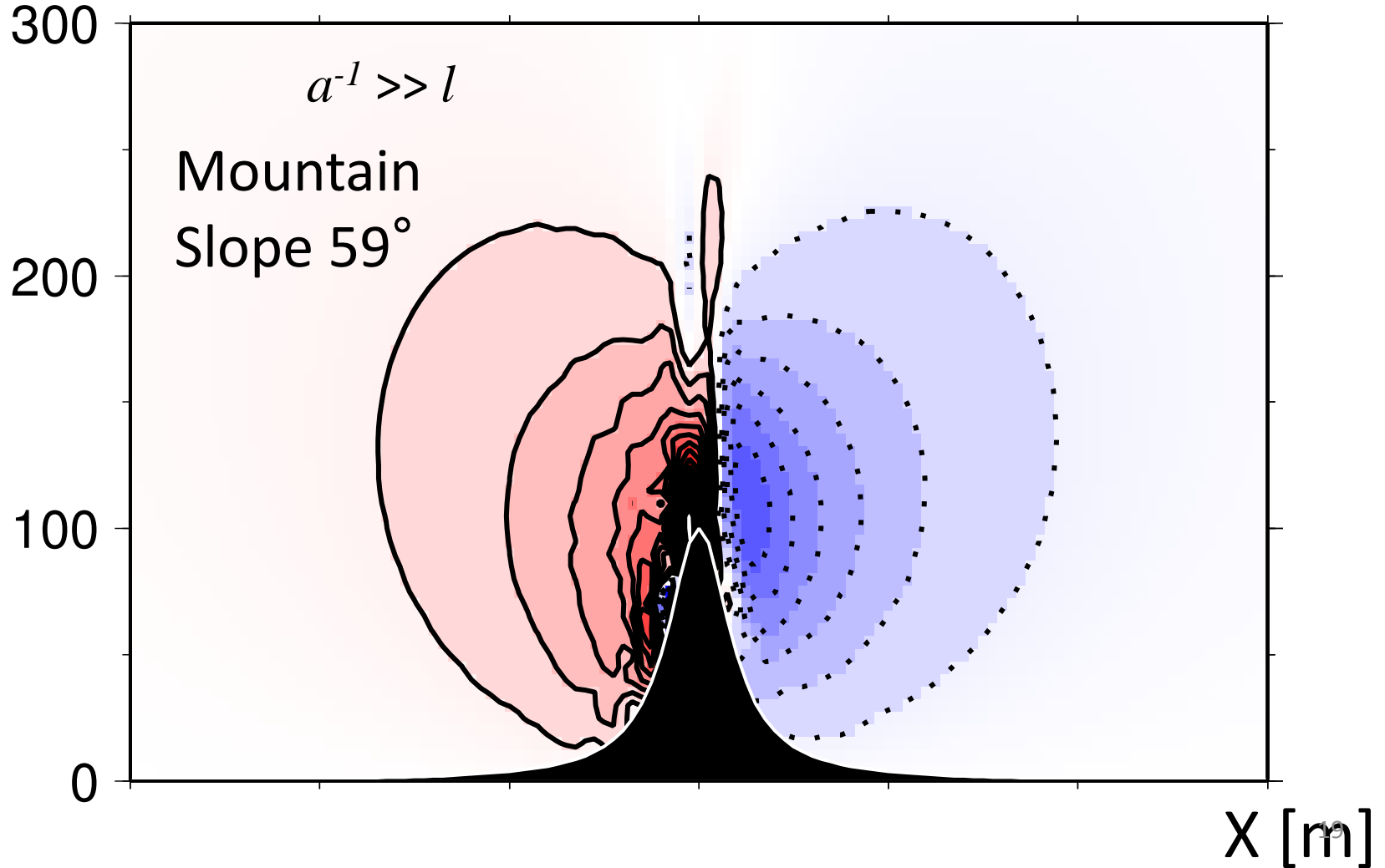


RANS with terrain-following coordinate  
(NHM, WRF, RAMS, many RCMs and GCMs)

LES with generalized curvilinear coordinate  
(our Local Wind model)

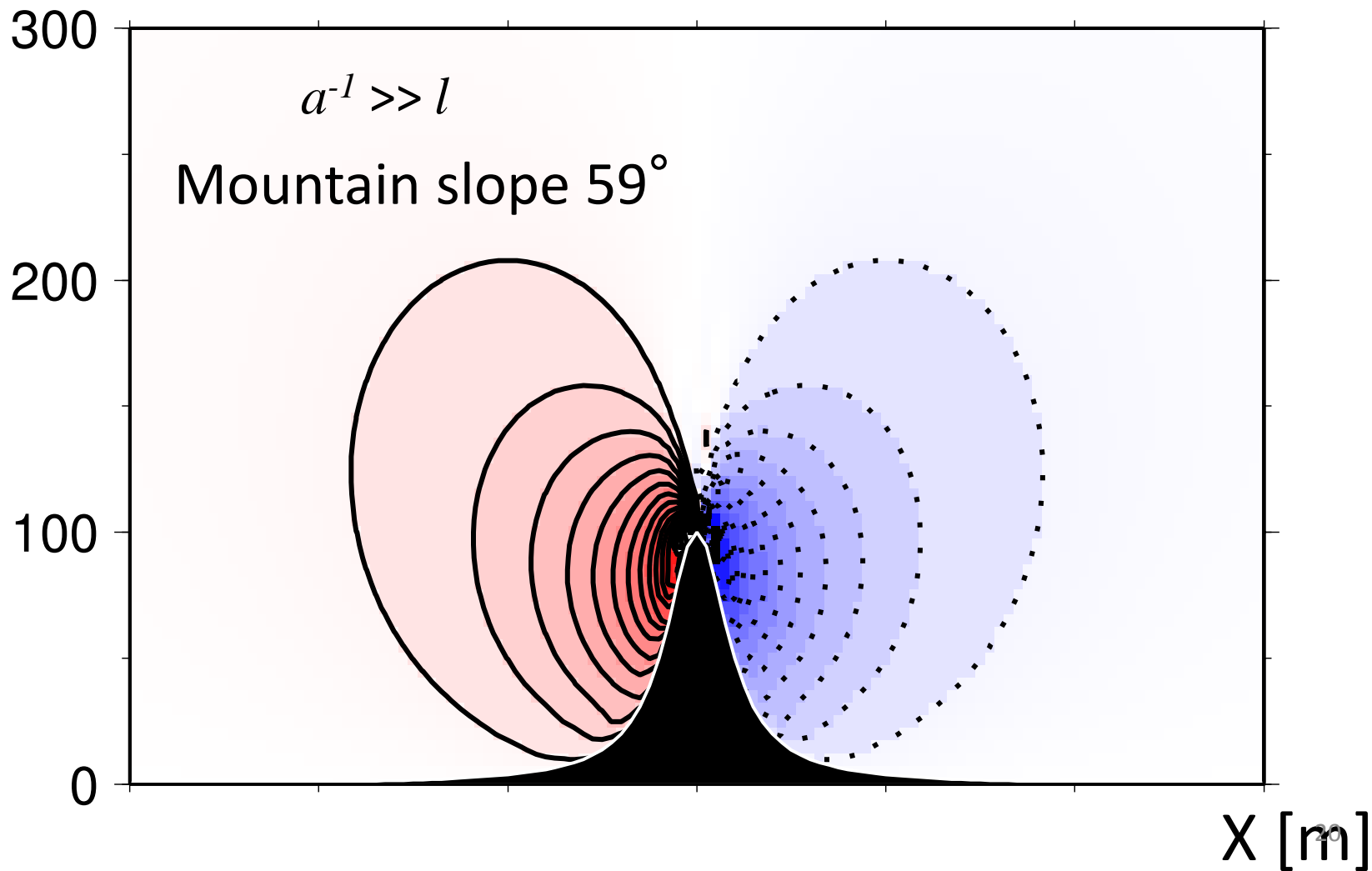
Simulated w from our model  
with terrain-following coordinate

Height [m]



Simulated w from our model with  
Generalized curvilinear coordinate

Height [m]






A new building-resolving LES will be introduced by Mr. Ryosaku Ikeda



# Research Activity



# Social Action Work

## (1) Mt. Tsukuba OBS.



Mt. Tsukuba Observatory:

1893-2001 JMA

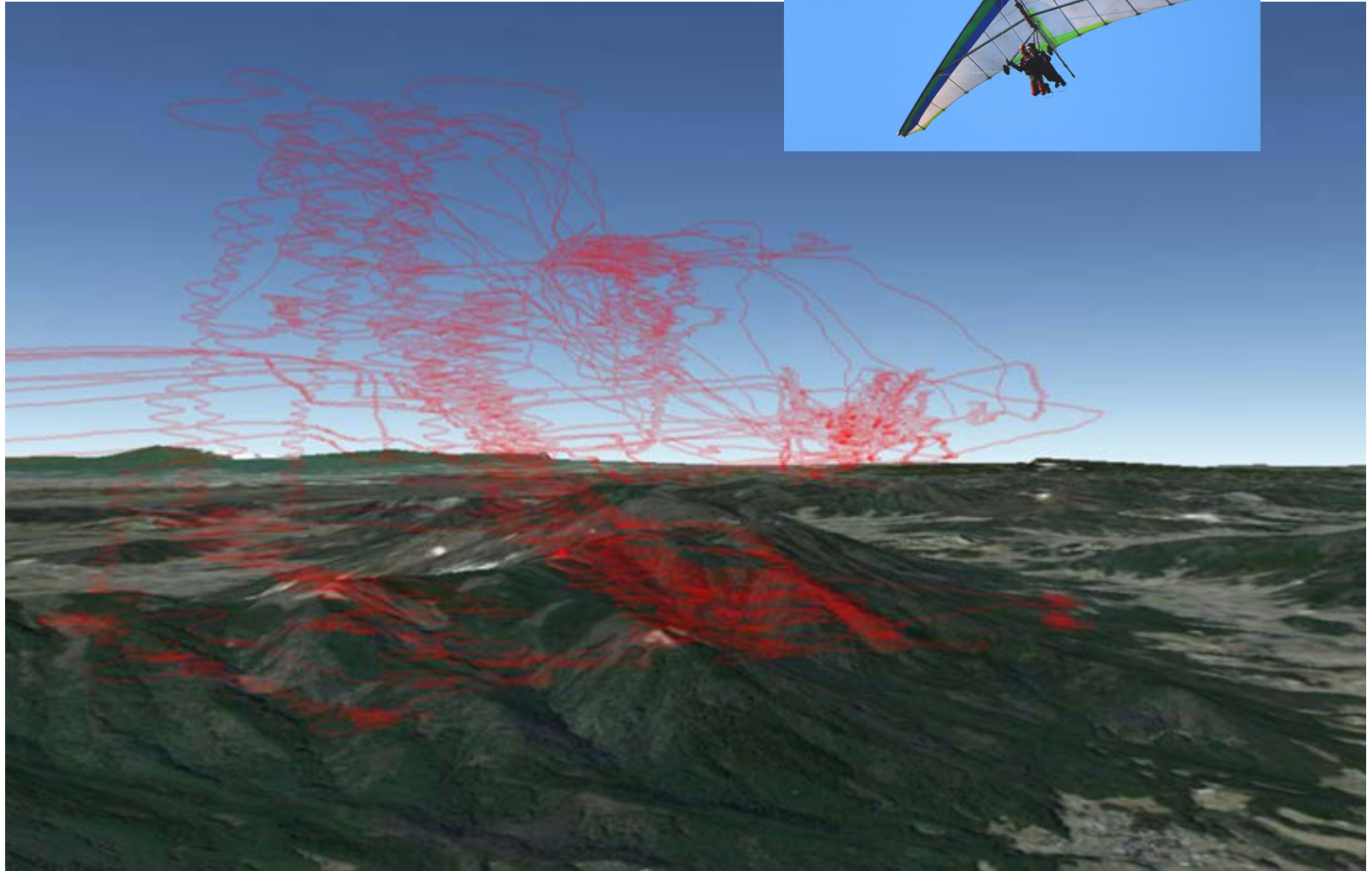
2001-2006 ....

2006-2012 TERC, Univ. of Tsukuba

2012- CCS, Univ. of Tsukuba

Open Data at the top of Mt. Tsukuba (831m), Every 10 min:  
Temperature, Humidity, Wind, Radiation, Pressure, Precipitation, etc

This project will contribute to  
Daily weather forecast,  
Monitoring of climate change without urban effect,  
Mountain climber, Sky sports pilot





# Social Action Work

## (2) Mitigation of uncomfortable thermal environment in Tajimi city



Mayor of Tajimi city and Prof. Sato of our dean ( 2010 )



Temperature measurement



Finding better mitigation policy for our health



Dry mist point



# Collaboration with International Institute

2013-	Badan Meteorologi, Klimatologi dan Geofisika (BMKG), Indonesia	Developing the GUI-based dynamical downscaling system
2012-	台灣中央研究院 (Academia Sinica), Taiwan	Dynamical downscaling for Taipei
2007-	National Center for Atmospheric Research (NCAR), USA	Improving the WRF model



# S8 Project

To support the impact assessment researchers, we have been developing a new DDS system called “**Global Warming Downscaler**”.

A web application with GUI system to perform the DDS with the WRF/UCM

Internet browser (Internet Explorer, Google Chrome) of Windows-PC.

- (1) User can select the domain, period, season, emissions scenarios (SRES, RCP), and GCM (CMIP3, CMIP5).
- (2) User can modify the land-use and anthropogenic heat emission to consider urbanization, land cover change, and energy conservation policies of the future.
- (3) User can perform DDS using only Mouse.



# Summary: Research Activity for 2009-2013 (1) Performance

Peer-Reviewed Journal Paper	51 papers
Non-reviewed Article	20 articles
Textbook	6 books (1 <sup>st</sup> author: 1 book)
International conference	44 times
Domestic conference, etc	134 times
Grant (government and non-profit)	190,000,000 Yen (1,900,000 USD)
Grant (private company)	8,000,000 Yen (80,000 USD)
Social Action Work	Tsukuba and Tajimi cities

# Summary: Research Activity for 2009-2013 (2) 5 Selected Papers

**Kusaka, H.**, Nawata, K., Suzuki-Parker, A., Takane, Y. and Furuhashi, N., **2014**: Mechanism of precipitation increase with urbanization in Tokyo as revealed by ensemble climate simulations, *J. Appl. Meteor. Clim.*, (in press) . Urban Impact on precipitation climatology

**Kusaka, H.**, Hara, M., Takane, Y., **2012**: Urban climate projection by the WRF model at 3-km horizontal grid increment: Dynamical downscaling and predicting heat stress in the 2070's August for Tokyo, Osaka, and Nagoya metropolies. *J. Meteor. Soc. Japan.*, 90B, 47-63.

Regional climate projection (urban-scale)

**Kusaka, H.**, Miya, Y., Ikeda, R., **2011**: Effects of solar radiation amount and synoptic-scale wind on the local wind "Karakkaze" over the Kanto plain in Japan. *J. Meteor. Soc. Japan.*, 89, 327-340.

Local wind

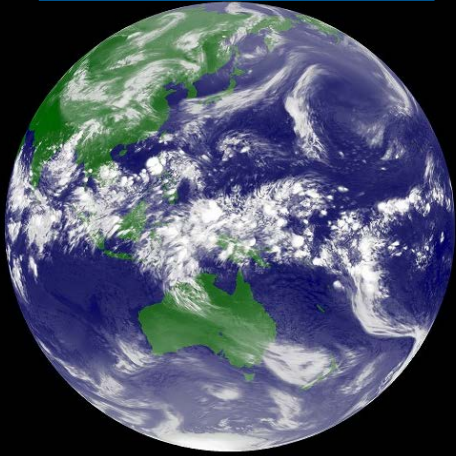
**Takane, Y. and Kusaka, H.**, **2011**: Formation mechanism of the extreme surface air temperature of 40.9 C observed in the Tokyo metropolitan area: Considerations of dynamic foehn and foehn-like wind. *J. Appl. Meteor. Clim.*, 50, 1827-1841.

Local wind, Extreme high temperature

**Ikeda, R. and Kusaka, H.**, **2010**: Proposing the simplification of the multilayer urban canopy model: Intercomparison study of four models. *J. Appl. Meteor. Clim.*, 49, 902-919.

Urban climate modeling

NICAM  
(Prof. Tanaka)

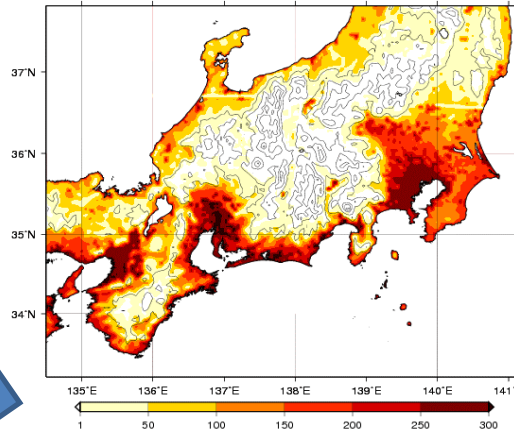


# Future Plan

LES  
(Mitigation of UHI)  
(GW vs UHI?)



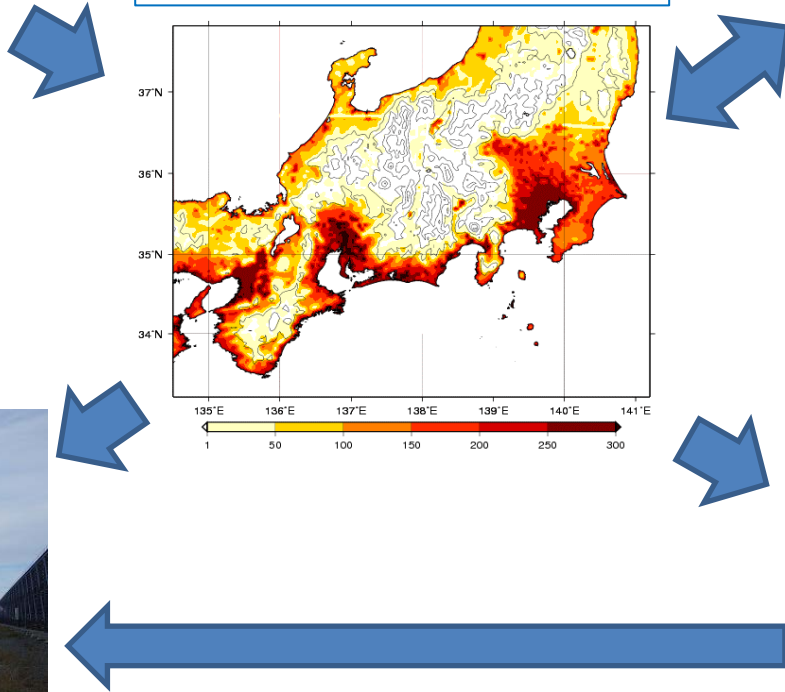
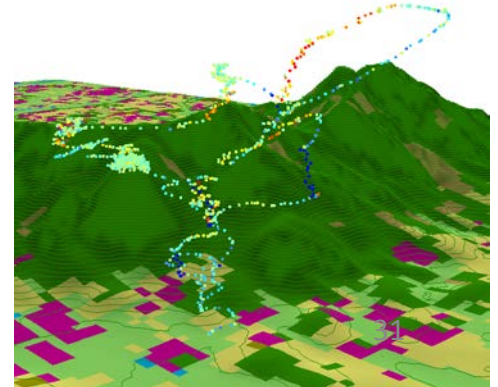
WRF/UCM  
(DDS to Asian  
Countries and JPN)



Local Wind  
(Wind Power)



Local Wind  
(Basic Study)



# Thank you for your attention

