Urban climate projection technology using multi-down scaling

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Why am I here ?

(1) Background

The risks of global warming in cities (AR5)

(2) Motivation

Urban climate projection technology in the context of Global warming studies

(3) Introduction

How to use the technology and

what is necessary

What is Urban Climatology ?

Urban Climate is one of Interdisciplinary study fields

Climatology

Energy (Anthropogenic Heat Emission)

Civil Engineering (Land use : Urban planning)

Architecture Engineering (Building topography)

Biometeorology (Thermal sensation)

Conventional down scaling is not enough ?

(1) Urban Heat Island can be more significant than global warming in mega-cities

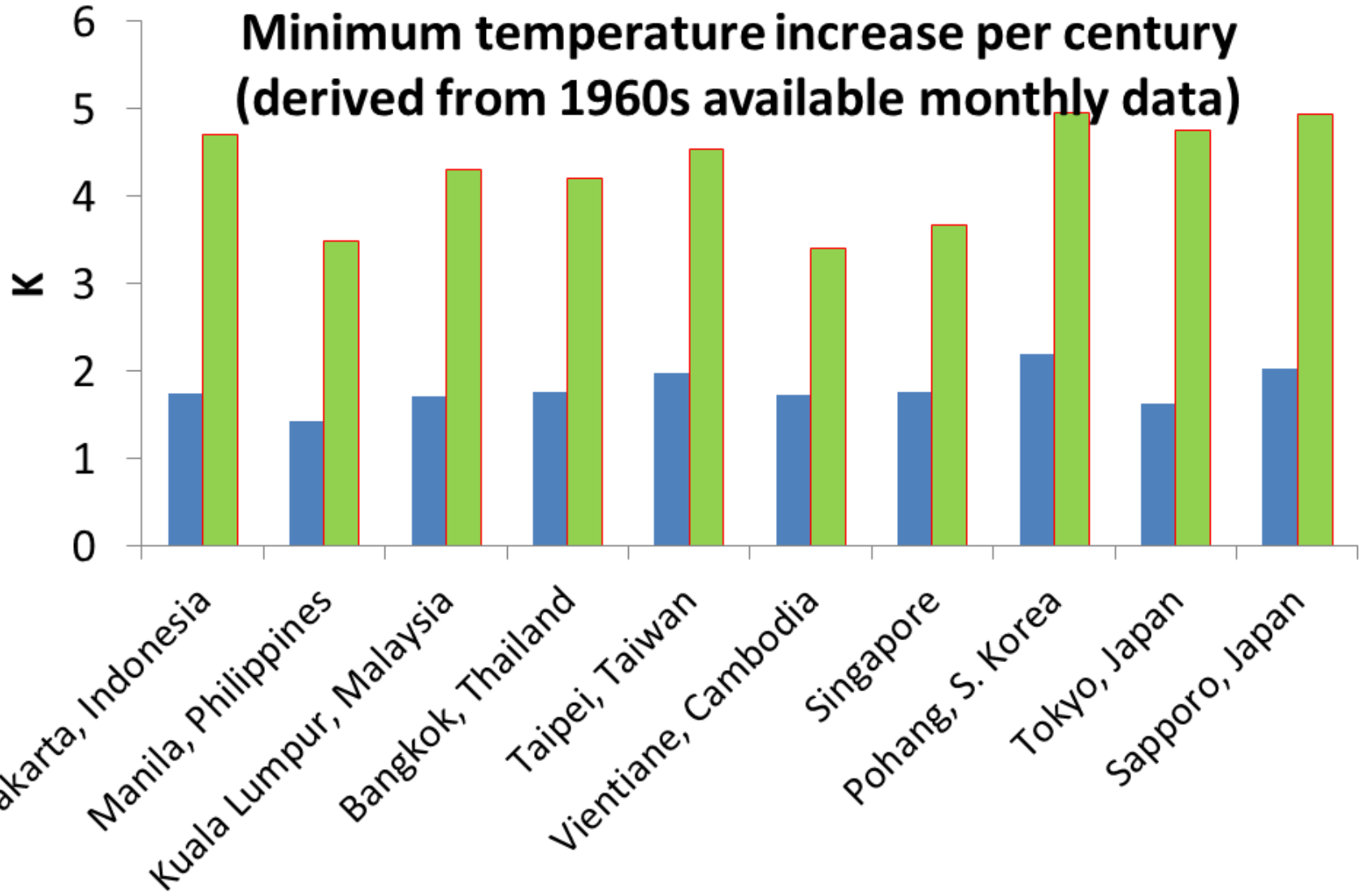
(2) In Global warming studies, urban effect is carefully excluded.

(3) Anthropogenic heat and Building effect

(Large heat capacity and large drag)

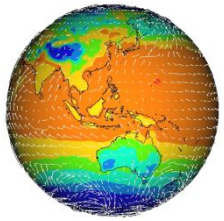
Global Urban Climatology

Heat Island > Global warming



Urban Climate Projection: Multi Down Scaling Technology

Global scale

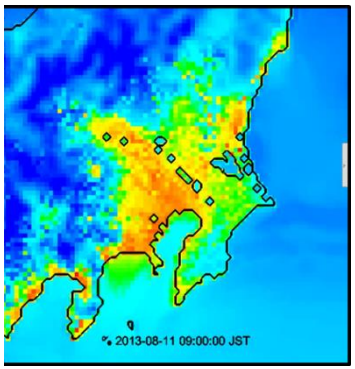


input

Global Scenario of CO2 and GHGs

1km resolution

Urban scale



input

Urban Scenario

・Land use category, energy use (industrial, commercial, transportation)

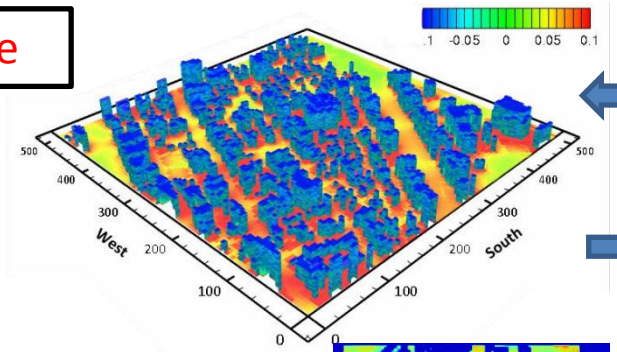
output

Urban Climate Projection

・Rainfall (flood), temperature

2 m resolution

District scale



input

Building and Transport Scenario

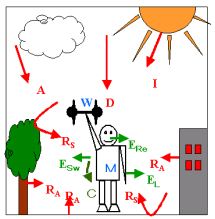
・Green building, 3D morphology, Traffic Model

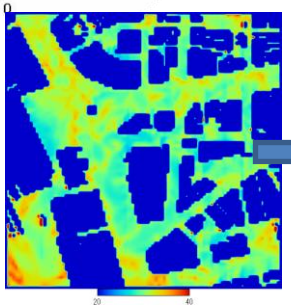
output

District Climate Projection

・Temperature, wind velocity

Human scale



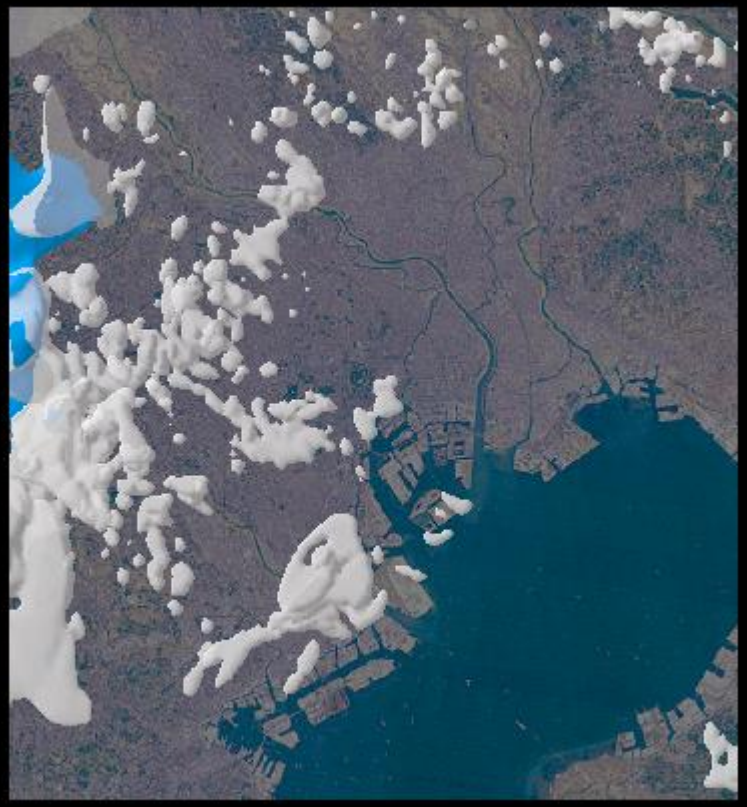


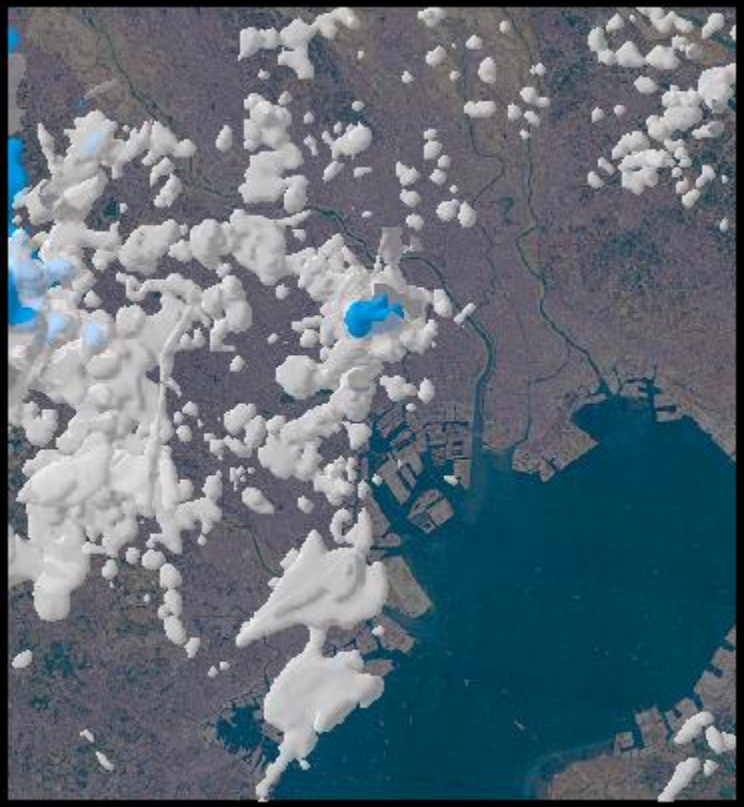
output

Health Impact (Heat stress), energy reduction potential

Conventional Rainfall prediction

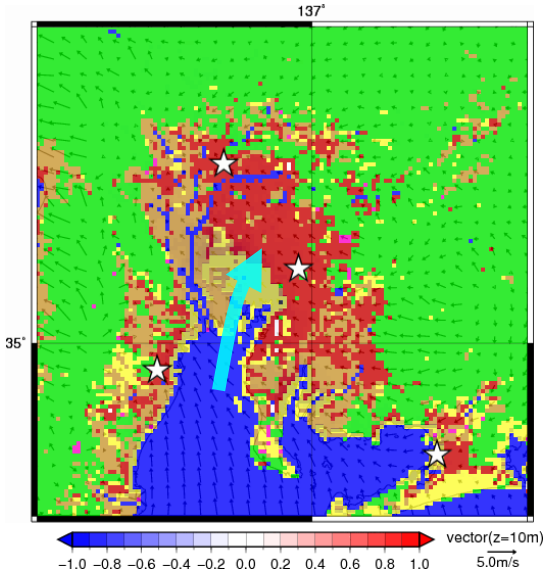
Rainfall prediction with urban effect



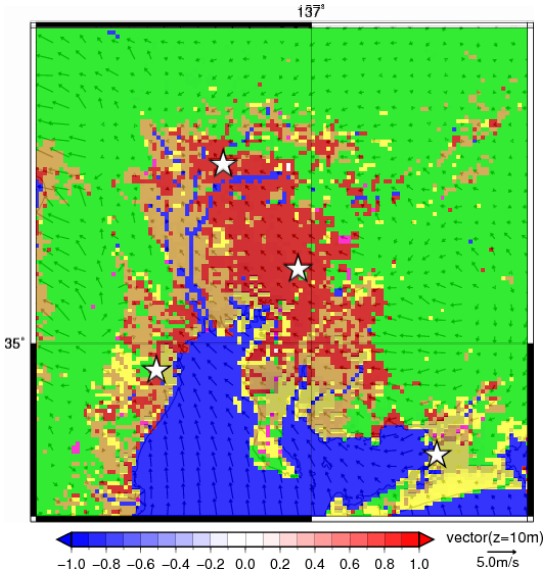


2050 Urban climate projection (Nagoya city) with different urban planning scenario 1km resolution

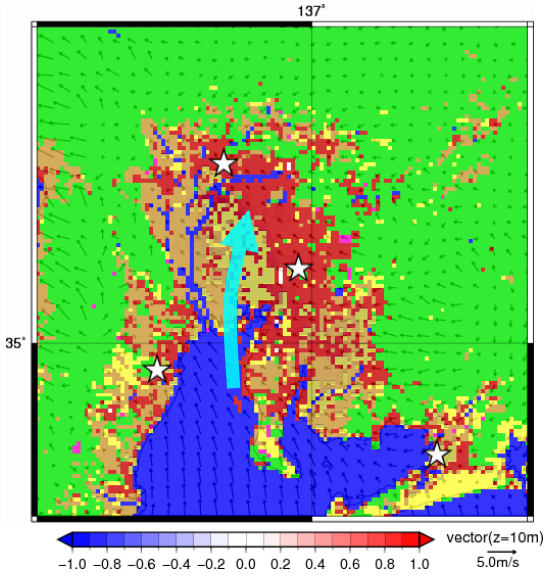
(1) Adapting Tsunami



(2) Adapting Earthquake



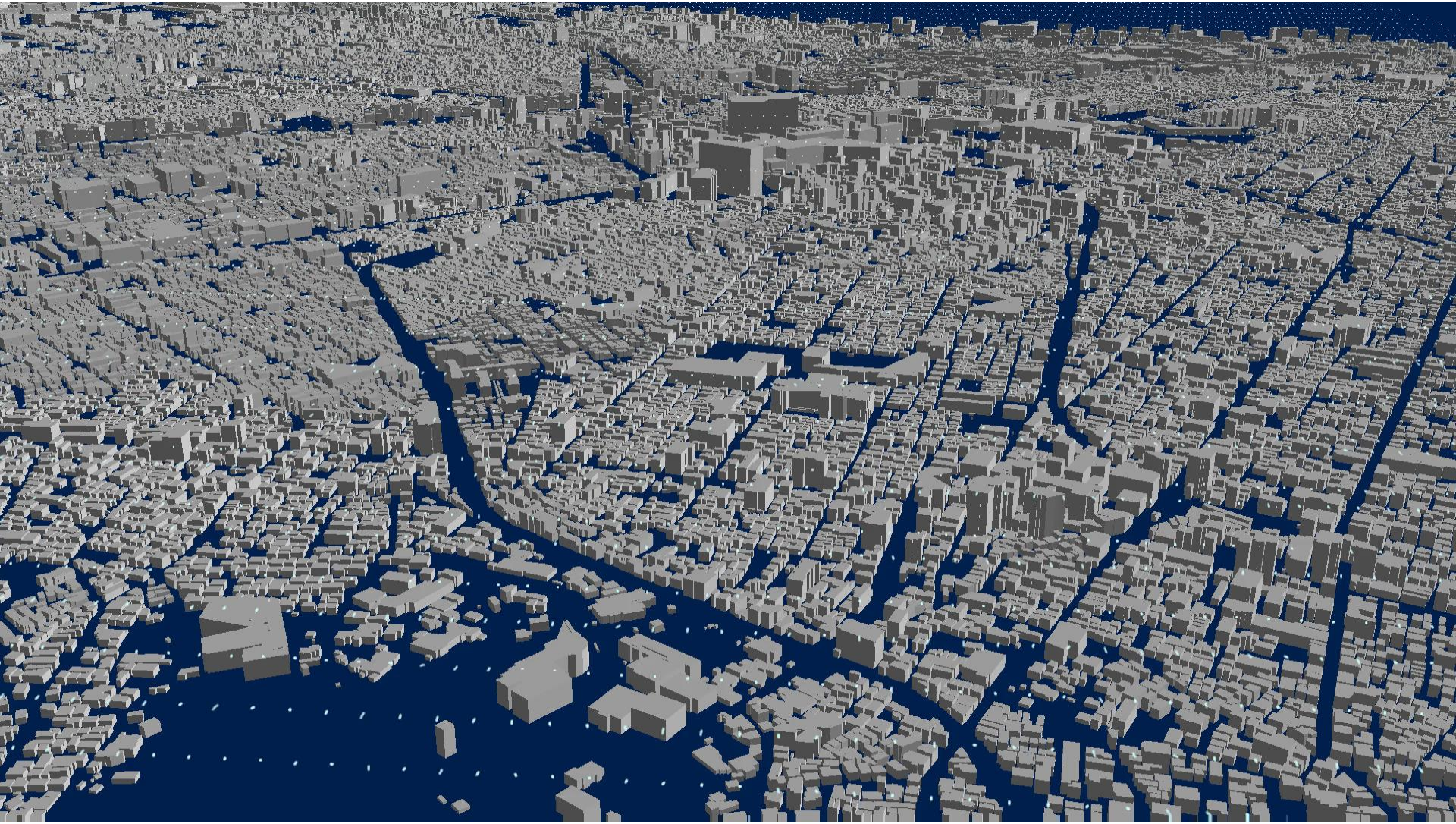
(3) Adapting Quick-sand



Color : **Temperature decrease** of each scenario from that of no counter measure

Vector : **wind velocity** for each scenario

District scale wind field projection 2m resolution



Model Application: Tajimi City (main railway station)

Kinematic Sensible Heat Flux Over 24 Hours (All Effects)

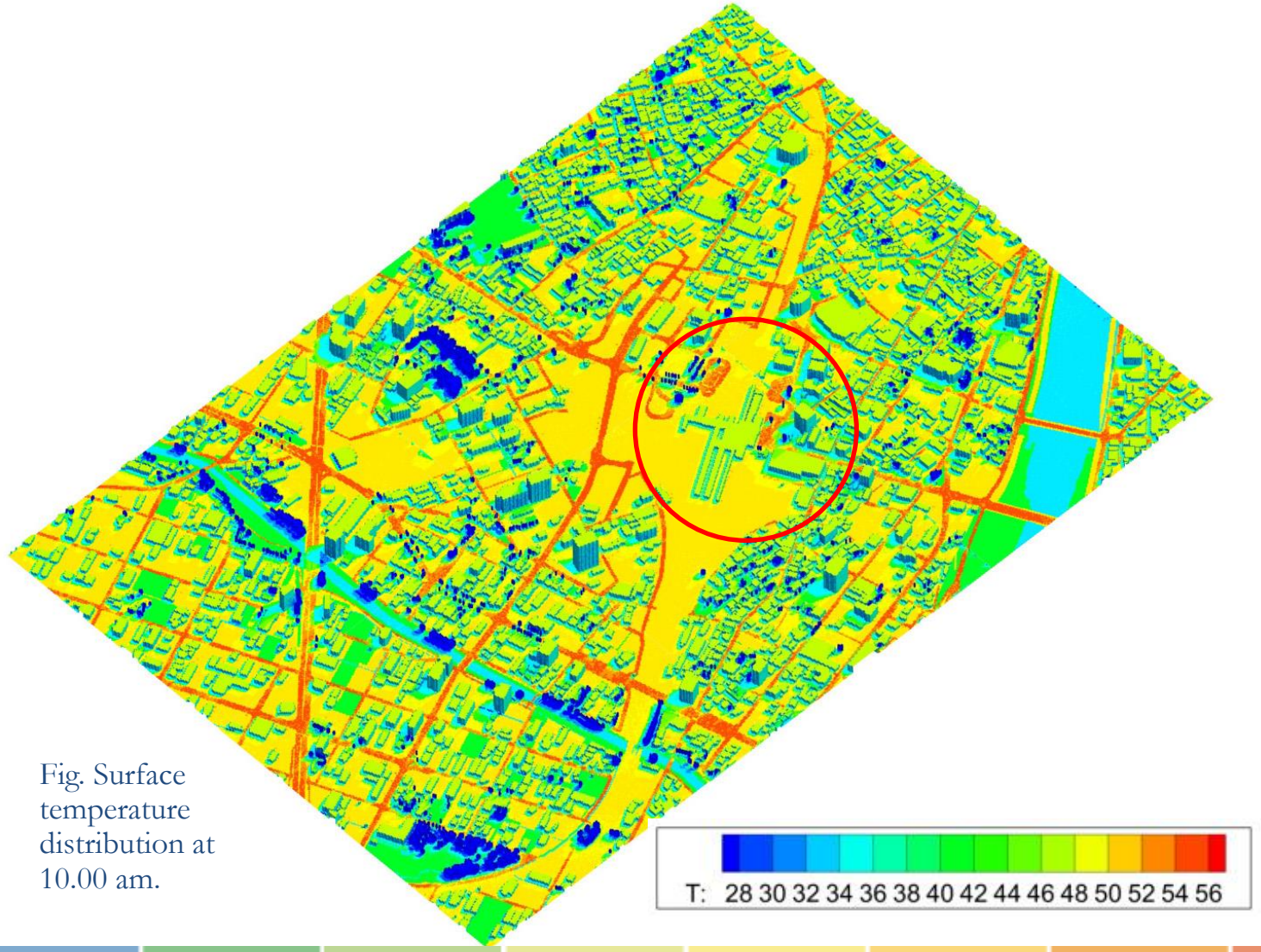


Fig. Surface temperature distribution at 10.00 am.

What data is necessary ?

(1) Land use

Landsat 8 (30m resolution)

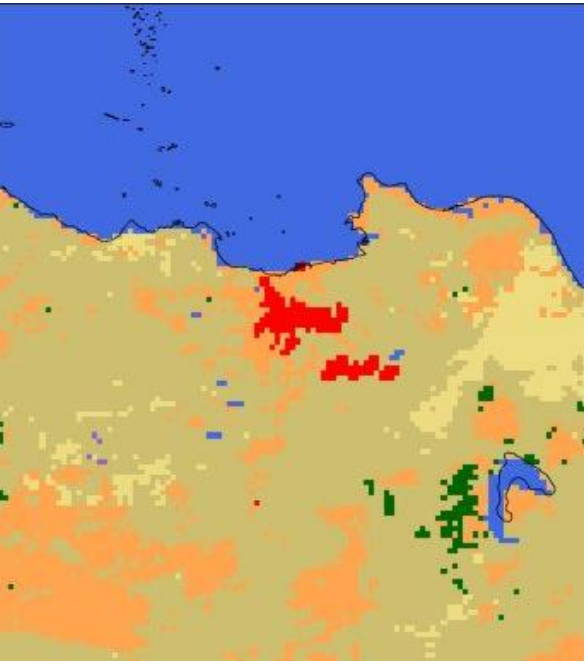
(2) Anthropogenic Heat

LUCY (4km resolution)

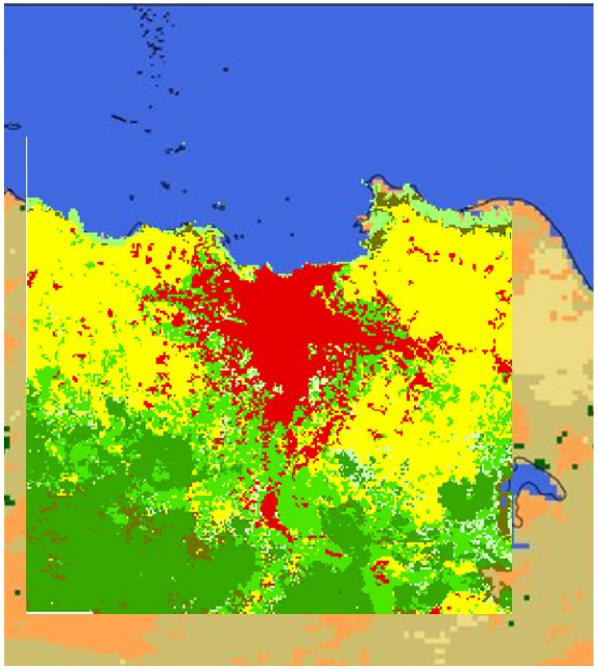
(3) 3D building dataset

Land use Landsat 8

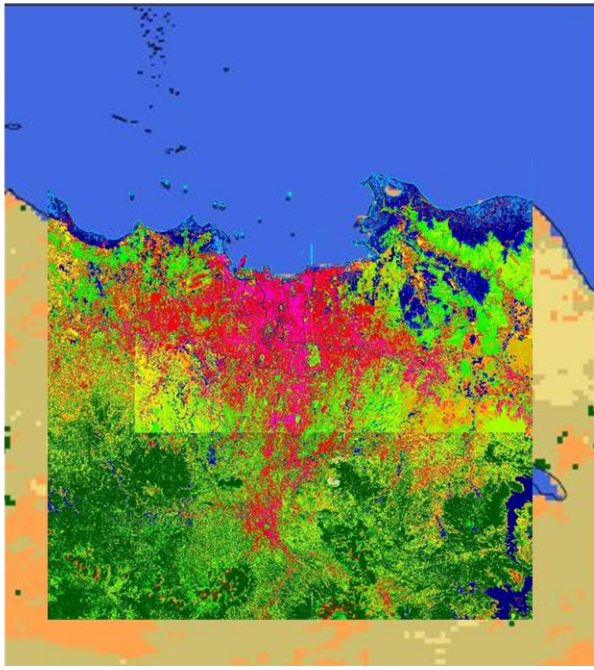
USGS 1km



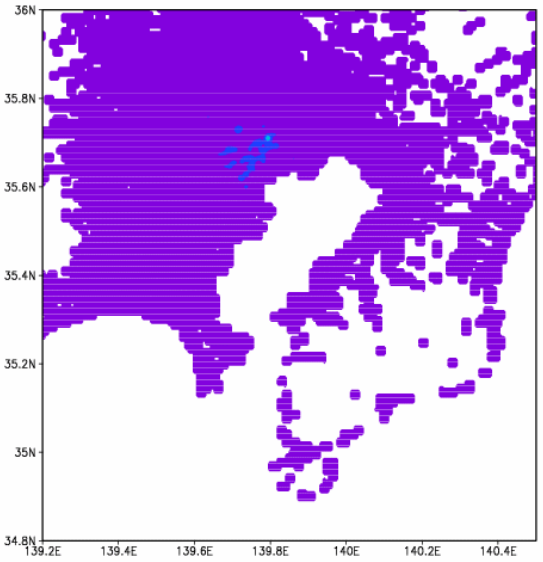
MODIS 500m



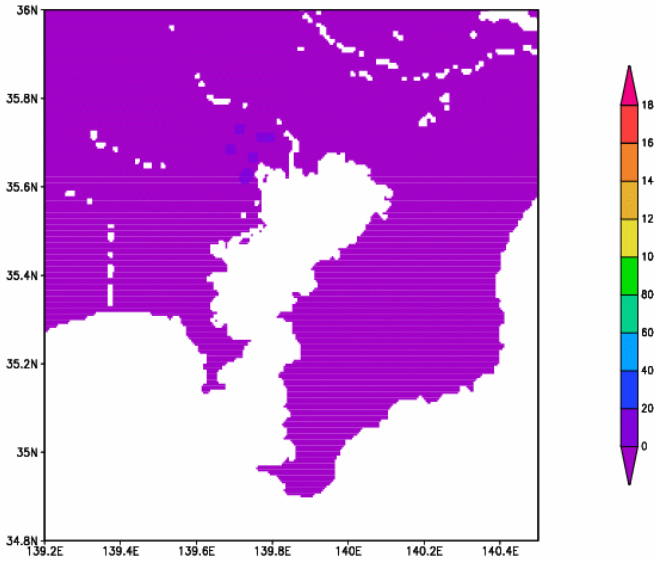
Landsat 30 m



Anthropogenic Heat Emission Data (Tokyo)



Sensible Heat



latent heat

Global data of AHE with 4km resolution is available (4km) (data name: Lucy)

3D building data is important

(1) All cities (Japan)
(2) Metro Manila (Philippines)
(3) Istanbul (Turkey)
(4) Hong Kong
etc..

New project (S14) for mitigation & adaptation strategy in Jakarta will start since the next April

Jakarta (Indonesia)

- Collaborators (University, Government)
- 3D building data
- Urban planning (Master plan)

Conclusion

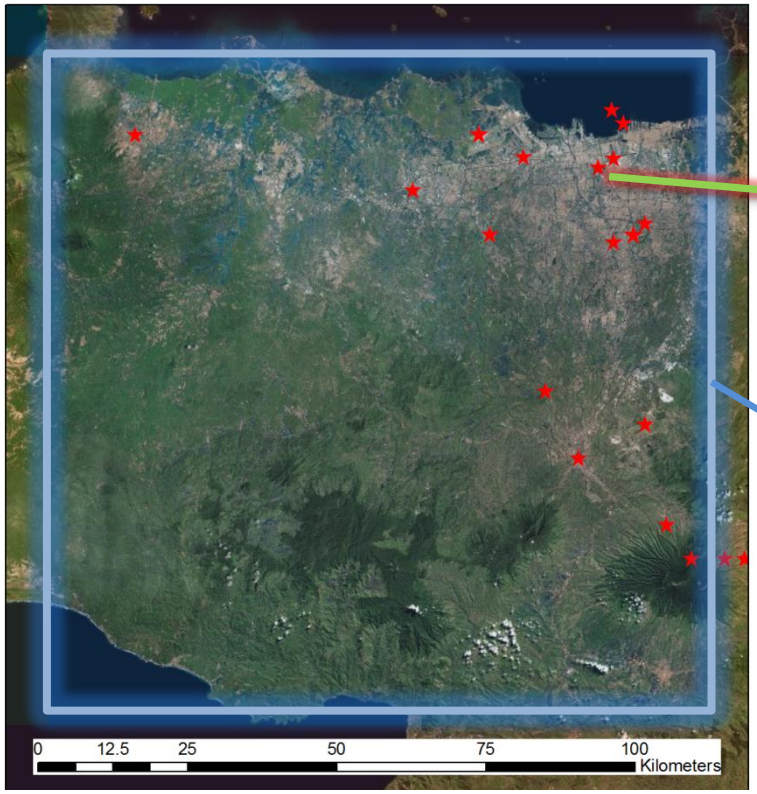
(1) Urban climate projection technology using multi-down scaling

(2) Possibility to be used for the mitigation and adaptation strategies in Mega-cities (Jakarta)

(3) Urban GIS data (3D building data)

(4) Collaboration with government and universities

Methodology



Urban Temperature Trend Estimation

Observation Station of Highly Urbanized Area

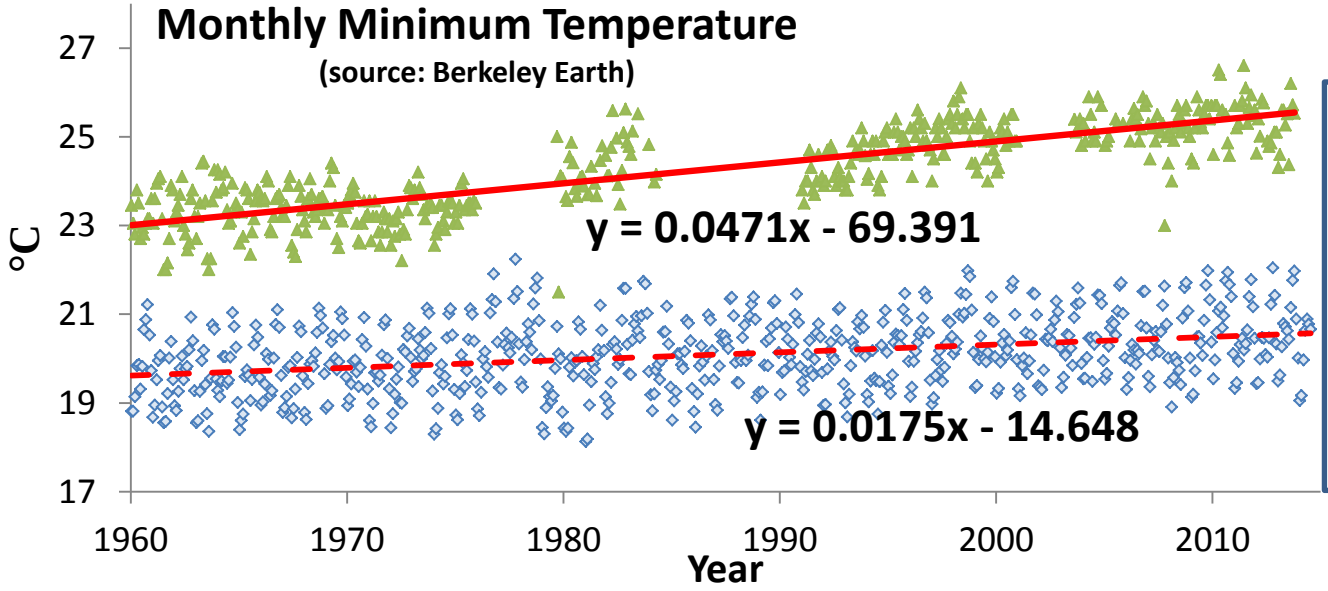
Observation database compiled by the Berkeley Earth (Rohde et al., 2013)

Regional Temperature Trend Estimation

Global Surface Temperature 1.0°× 1.0 ° Gridded Data

BEST Berkeley Earth Surface Temperature (BEST)

Compare the rate of increase of Station and Region

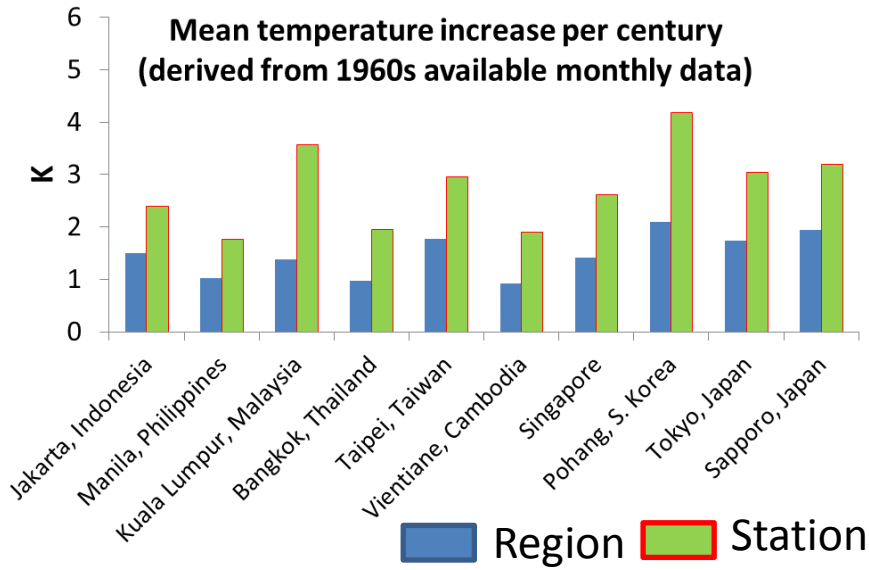


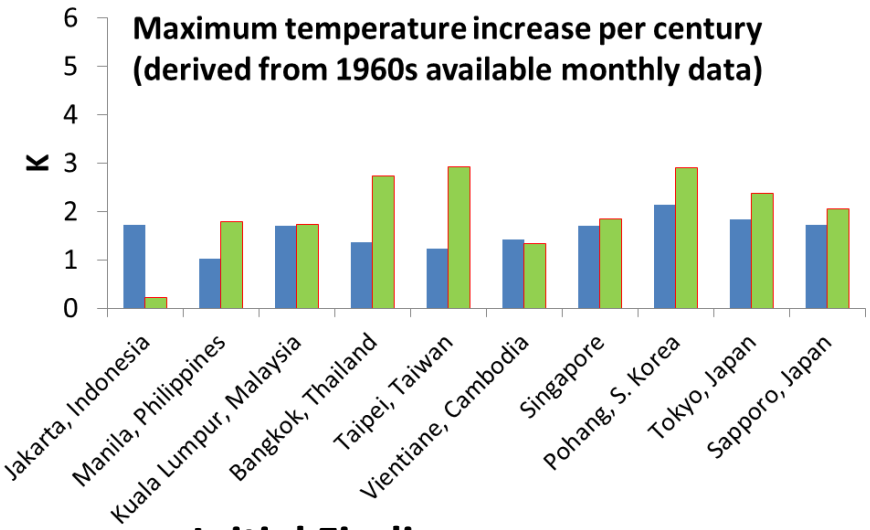
Output

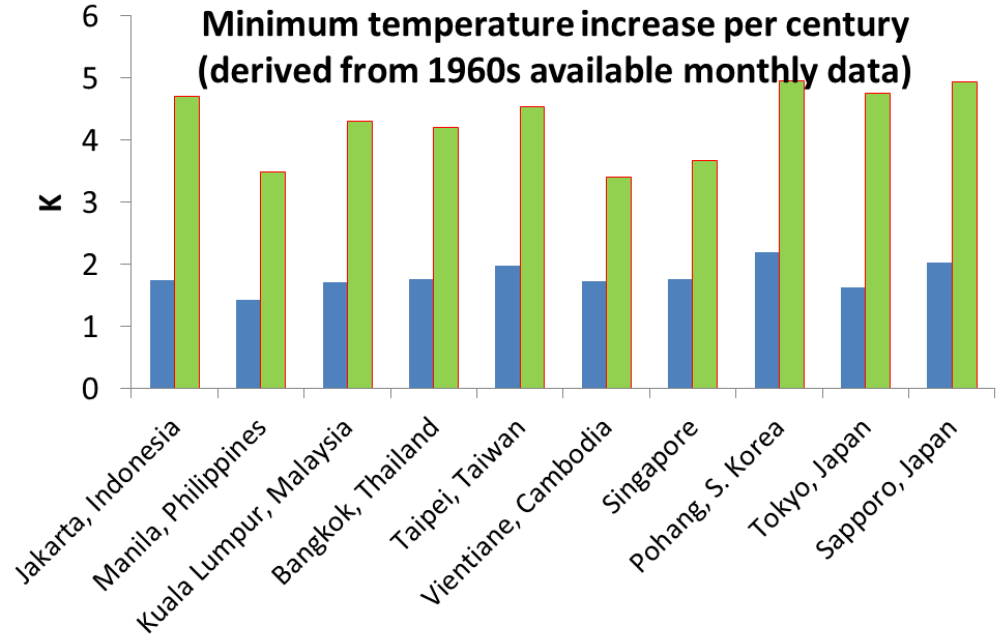
Simplified estimate of Temperature increase per 100 years:

y=mx+b

Trend=m*100







Initial Findings:

1. **Most rapid rise in minimum temperature at cities compared to surroundings (>2°C).**
2. **Significant rise in average temperature than the region.**
3. **Maximum temperature highly dependent on station environment.**

Reference for Berkeley Earth Surface Temperature

Rohde R, Muller RA, Jacobsen R, Muller E, Perlmutter S, et al. (2013) A New Estimate of the Average Earth Surface Land Temperature Spanning 1753 to 2011. Geoinfor Geostat: An Overview 1:1