# Implementing WUDAPT product into urban development impact analysis by using WRF simulation result - A case study of the Pearl River Delta Region (1980-2010)

Chao REN[1, 2]*, Jimmy Chi-Hung FUNG[3], Jason Wai Po TSE [4], Ran WANG[1], Michael Mau Fung WONG[4], Yong XU[2]

1. School of Architecture, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong
2. The Institute of Future Cities (IoFC), The Chinese University of Hong Kong, Shatin, N.T., Hong Kong
3. Division of Environment, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong
4. Environmental Science Programs, School of Science, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong

* Corresponding Author
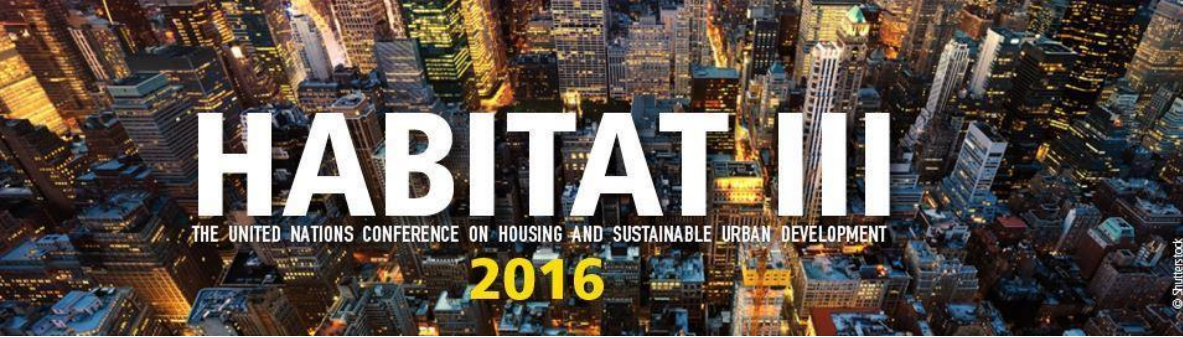
In HABITAT III,
WE DECIDE THE FUTURE
OF CITIES TOGETHER

New Urban Agenda

Quito Declaration on **Sustainable Cities and Human Settlements for All**

Quito implementation plan for the New Urban Agenda

Transformative commitments for sustainable urban development

from: *social, economic and environmental dimensions*

Data Science and Informatics Technology

Applications & Implementations

Policy Change

People's Urban Living Quality Improvement

'Local Climate Zone' Scheme

(Stewart & Oke, 2012)

Built types	Definition	Land cover types	Definition
1. Compact high-rise	Dense mix of tall buildings to tens of stories. Few or no trees. Land cover mostly paved. Concrete, steel, stone, and glass construction materials.	A. Dense trees	Heavily wooded landscape of deciduous and/or evergreen trees. Land cover mostly pervious (low plants). Zone function is natural forest, tree cultivation, or urban park.
2. Compact midrise	Dense mix of midrise buildings (3–9 stories). Few or no trees. Land cover mostly paved. Stone, brick, tile, and concrete construction materials.	B. Scattered trees	Lightly wooded landscape of deciduous and/or evergreen trees. Land cover mostly pervious (low plants). Zone function is natural forest, tree cultivation, or urban park.
3. Compact low-rise	Dense mix of low-rise buildings (1–3 stories). Few or no trees. Land cover mostly paved. Stone, brick, tile, and concrete construction materials.	C. Bush, scrub	Open arrangement of bushes, shrubs, and short, woody trees. Land cover mostly pervious (bare soil or sand). Zone function is natural scrubland or agriculture.
4. Open high-rise	Open arrangement of tall buildings to tens of stories. Abundance of pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.	D. Low plants	Featureless landscape of grass or herbaceous plants/crops. Few or no trees. Zone function is natural grassland, agriculture, or urban park.
5. Open midrise	Open arrangement of midrise buildings (3–9 stories). Abundance of pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.	E. Bare rock or paved	Featureless landscape of rock or paved cover. Few or no trees or plants. Zone function is natural desert (rock) or urban transportation.
6. Open low-rise	Open arrangement of low-rise buildings (1–3 stories). Abundance of pervious land cover (low plants, scattered trees). Wood, brick, stone, tile, and concrete construction materials.	F. Bare soil or sand	Featureless landscape of soil or sand cover. Few or no trees or plants. Zone function is natural desert or agriculture.
7. Lightweight low-rise	Dense mix of single-story buildings. Few or no trees. Land cover mostly hard-packed. Lightweight construction materials (e.g., wood, thatch, corrugated metal).	G. Water	Large, open water bodies such as seas and lakes, or small bodies such as rivers, reservoirs, and lagoons.
8. Large low-rise	Open arrangement of large low-rise buildings (1–3 stories). Few or no trees. Land cover mostly paved. Steel, concrete, metal, and stone construction materials.	**VARIABLE LAND COVER PROPERTIES** Variable or ephemeral land cover properties that change significantly with synoptic weather patterns, agricultural practices, and/or seasonal cycles.	
9. Sparsely built	Sparse arrangement of small or medium-sized buildings in a natural setting. Abundance of pervious land cover (low plants, scattered trees).	b. bare trees	Leafless deciduous trees (e.g., winter). Increased sky view factor. Reduced albedo.
		s. snow cover	Snow cover >10 cm in depth. Low admittance. High albedo.
10. Heavy industry	Low-rise and midrise industrial structures (towers, tanks, stacks). Few or no trees. Land cover mostly paved or hard-packed. Metal, steel, and concrete construction materials.	d. dry ground	Parched soil. Low admittance. Large Bowen ratio. Increased albedo.
		w. wet ground	Waterlogged soil. High admittance. Small Bowen ratio. Reduced albedo.

The World Urban Database and Access Portal Tools (WUDAPT)

The most recent report from the Intergovernmental Panel on Climate Change (IPCC) notes the dearth of information on urban areas. **The goal of the WUDAPT initiative** is to fill this demand.

Create LCZs with Landsat

Use freely available Landsat imagery to create a Local Climate Zone (LCZ) classification of your city

Create LCZ Training Areas

Follow the simple steps outlined here to create LCZ training areas for your city

Classify your City

Follow the step-by-step instructions to create an LCZ classification of your city

View LCZ maps

Access LCZ maps for different cities around the world using Geopedia

2 Objectives

Objective 1

- **Acquire and make accessible** coherent and consistent descriptions and information in the aspects of **FORM** And **FUNCTION** of cities relevant to climate studies on **WORLDWIDE** basis.

MISSISSAUGA   BARCELONA

LONDON   NEW YORK

ROME   SAN FRANCISCO
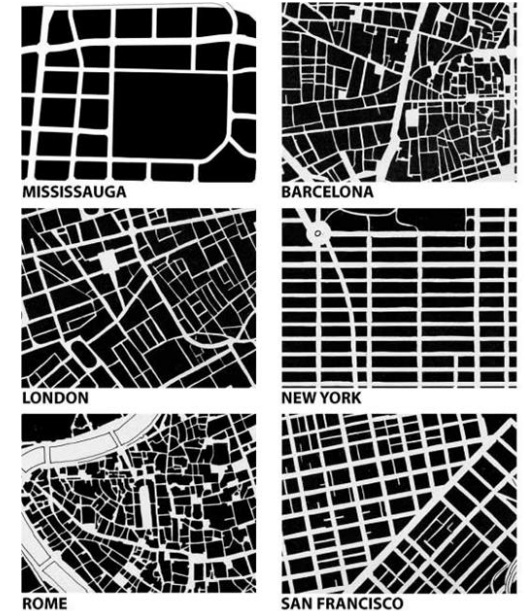
Objective 2

- **Build Portal (tools)** that will **EXTRACT** relevant urban parameters and properties for models and for model **APPLICATIONS** at appropriate scales for various climate, weather, Urban Planning purposes.
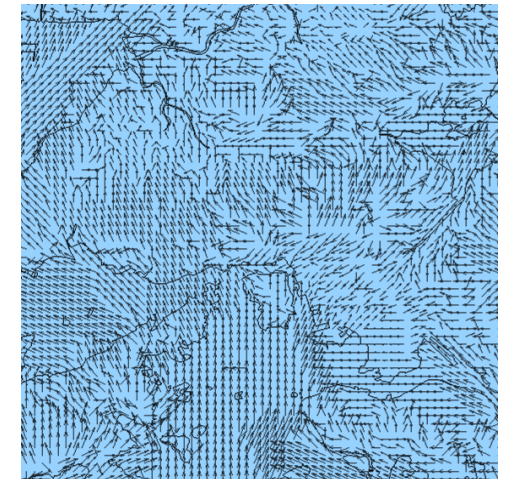
3 Levels of WUDAPT Products
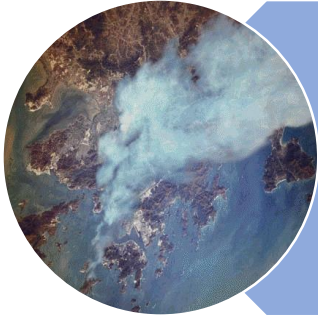
Level 0

- Cities are mapped using the Local Climate Zone (LCZ) scheme (Stewart & Oke, 2012). Each LCZ type is described in terms of the typical appearance of each in ground-based and aerial photographs and is linked to some urban parameter values.

Level 1

- The LCZ maps are used to sample urban landscapes to provide more information on the aspects of form and function in greater details.
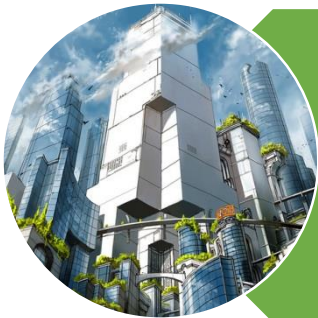
Level 2

- This is the highest level and it refers to urban data gathered at a specified spatial scale (e.g. 250 m) across the entire urban area ('wall-to-wall' coverage).

(Ching, et al., 2016)

WUDAPT: Major Cities in China

Beijing
Shanghai
Wuhan
Guangzhou
Changsha
Dalian
Guangzhou
Hangzhou
Jinan
Nanjing
Qingdao
Shanghai
Shenyang
Tianjing
Xi'an
Xiamen
....

So later when you work on urban climate study in China, you don't need to worry about the initial data.
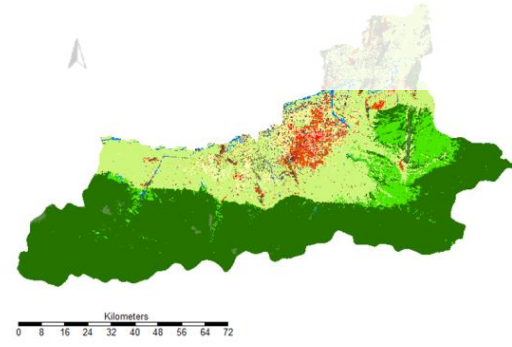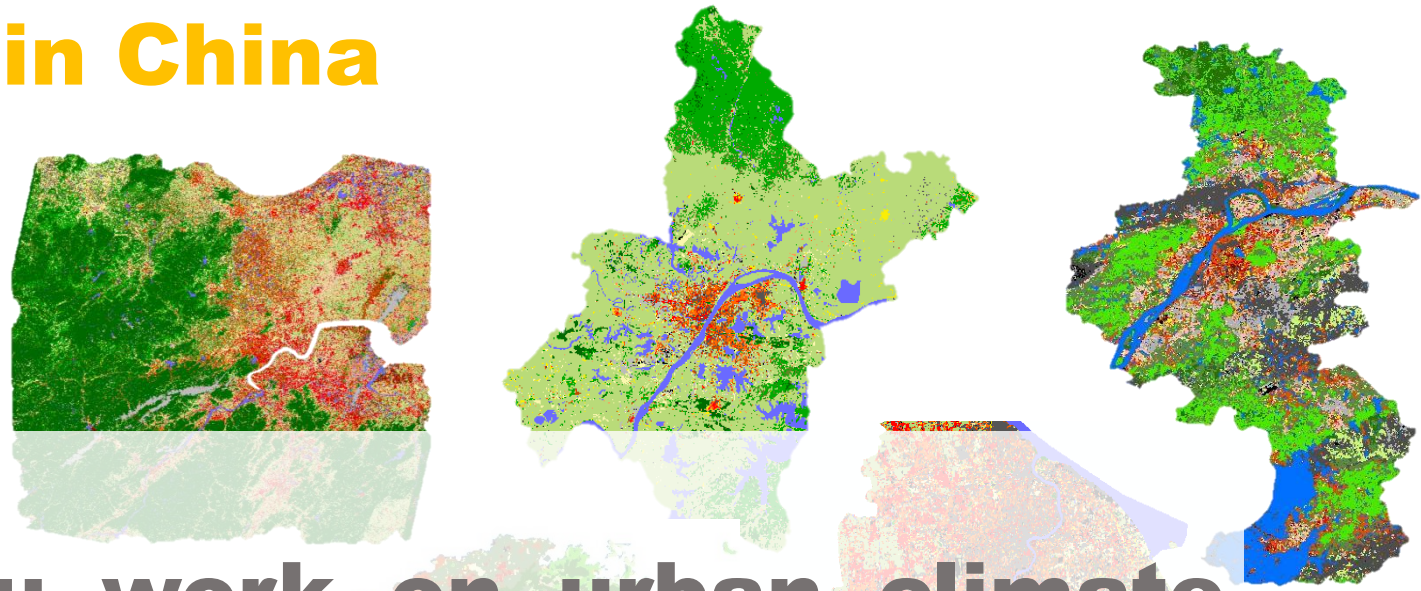
LCZ 1 Compact high-rise
LCZ 2 Compact mid-rise
LCZ 3 Compact low-rise
LCZ 4 Open high-rise
LCZ 5 Open mid-rise
LCZ 6 Open low-rise
LCZ 7 Lightweight low-rise
LCZ 8 Large low-rise
LCZ 9 Sparsely built
LCZ 10 Heavy industry
LCZ A Dense trees
LCZ B Scattered trees
LCZ C Bush, scrub
LCZ D Low plants
LCZ E Bare rock or paved
LCZ F Bare soil or sand
LCZ G Water
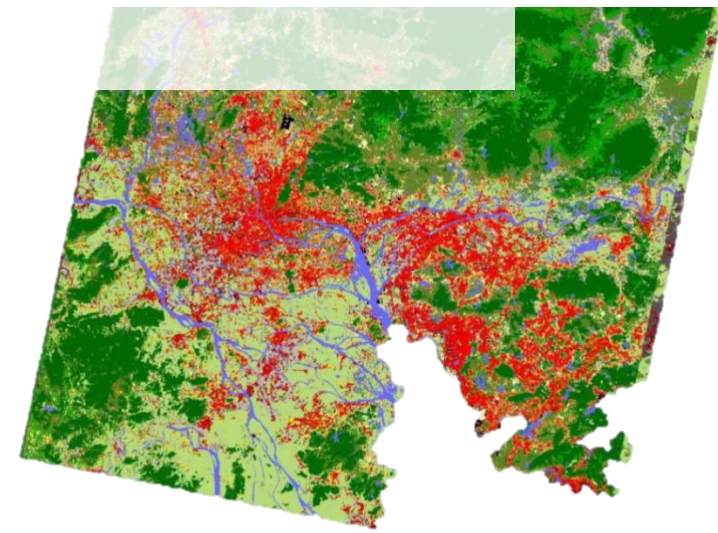
By Jun 2016, we have finished the LCZ mapping work for 57 all provincial capital cities and major economic big regions.

Local Climate Zone Map for the Pearl River Delta Region
(the1980's- the2010's)
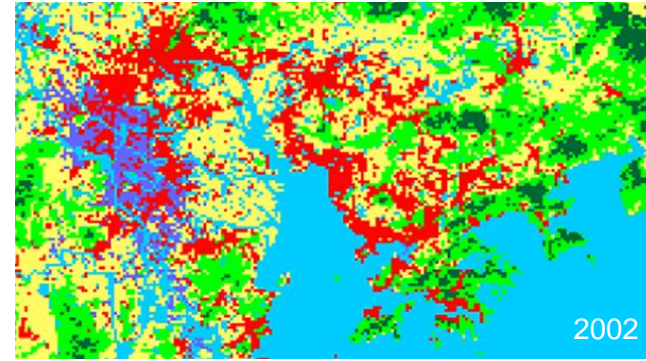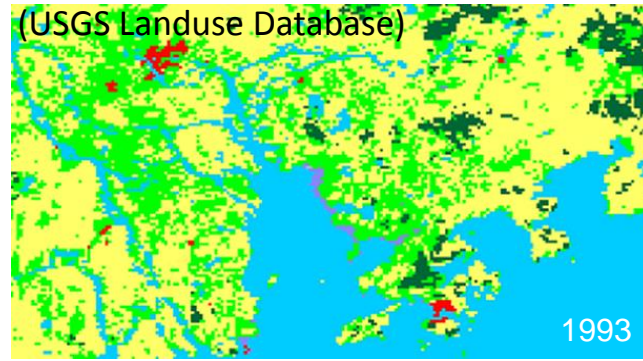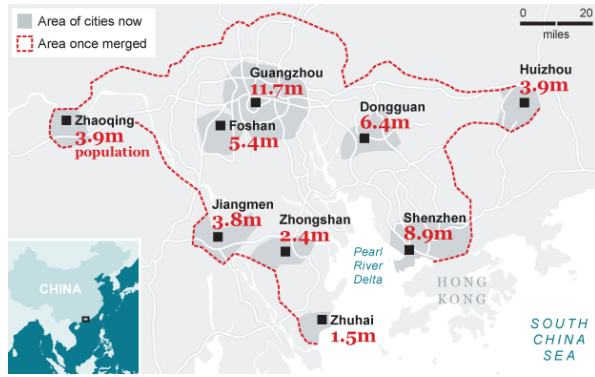
(USGS Landuse Database)

1993

2002

| LCZ 1 Compact high-rise |
| LCZ 2 Compact mid-rise |
| LCZ 3 Compact low-rise |
| LCZ 4 Open high-rise |
| LCZ 5 Open mid-rise |
| LCZ 6 Open low-rise |
| LCZ 7 Lightweight low-rise |
| LCZ 8 Large low-rise |
| LCZ 9 Sparsely built |
| LCZ 10 Heavy industry |
| LCZ A Dense trees |
| LCZ B Scattered trees |
| LCZ C Bush, scrub |
| LCZ D Low plants |
| LCZ E Bare rock or paved |
| LCZ F Bare soil or sand |
| LCZ G Water |

1988

1999

2009

Valid: 2010-06-02_06:00:00
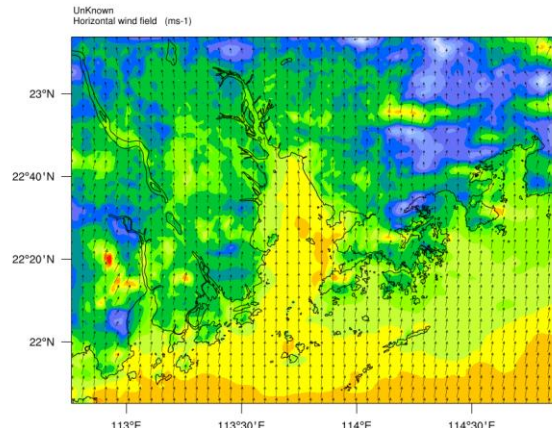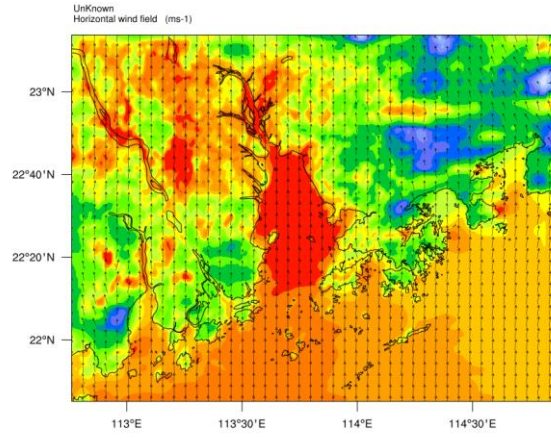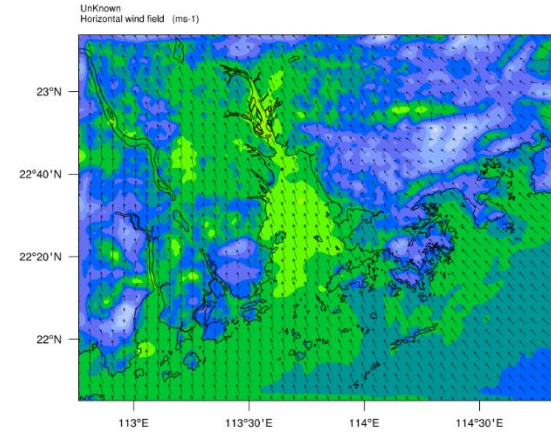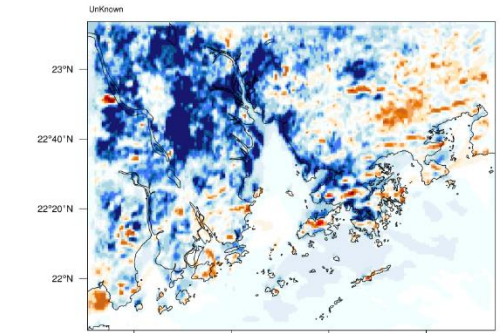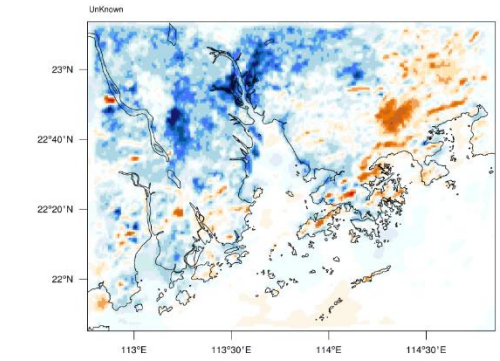
Valid: 2010-07-01_06:00:00

Valid: 2010-06-02_06:00:00
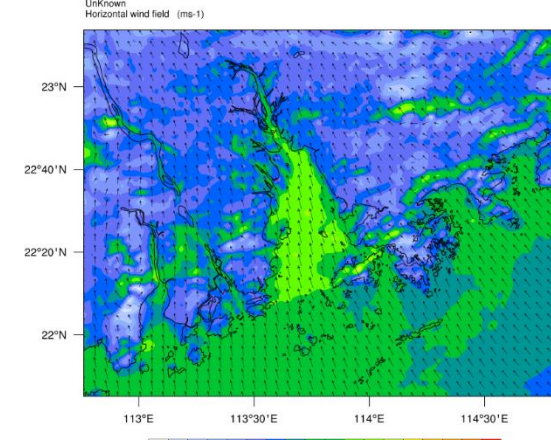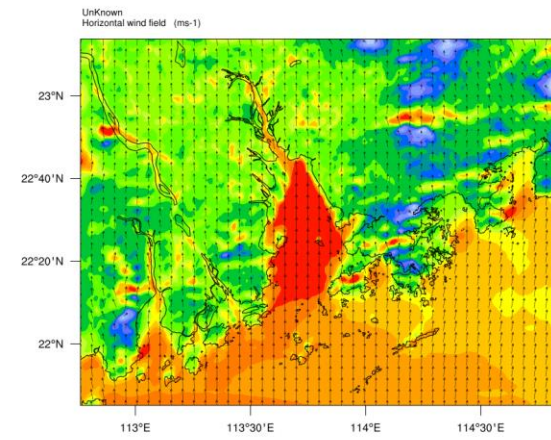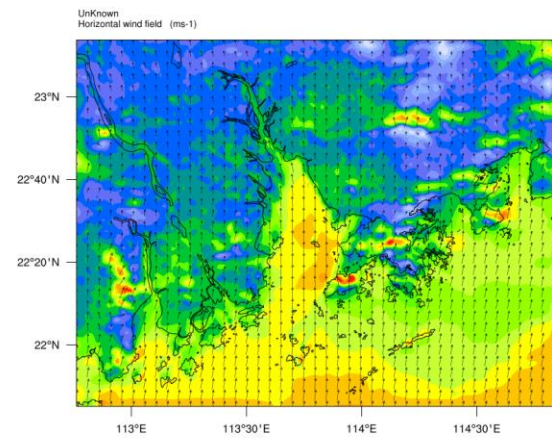
Valid: 2010-06-02_06:00:00

Valid: 2010-07-01_06:00:00

Valid: 2010-07-01_06:00:00

UnKnown

2m temperature difference

20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35

-1.6 -1.2 -.8 -.4 0 .4 .8 1.2 1.6 2

2m temperature difference
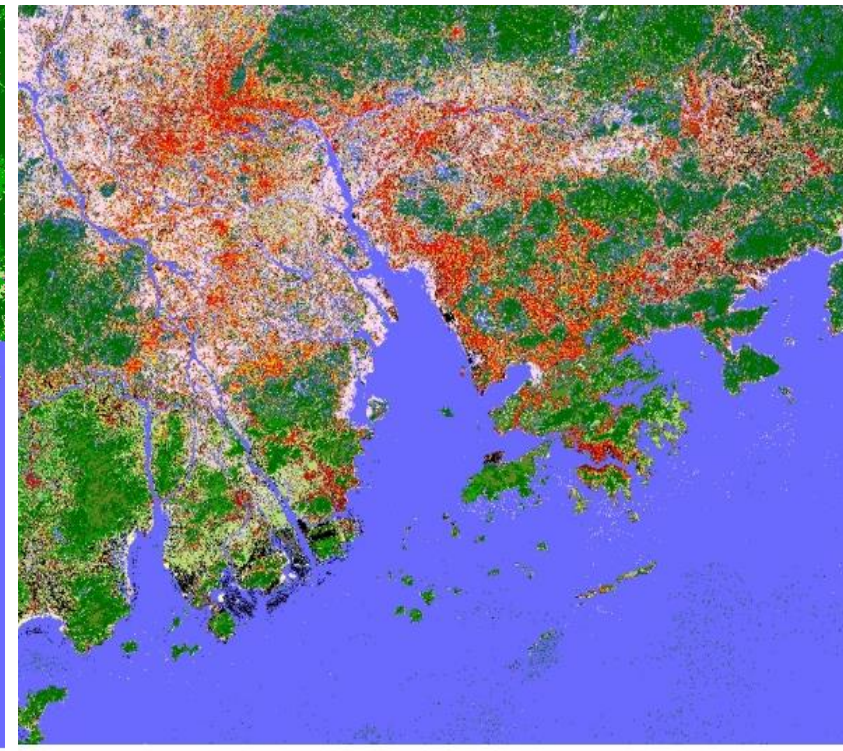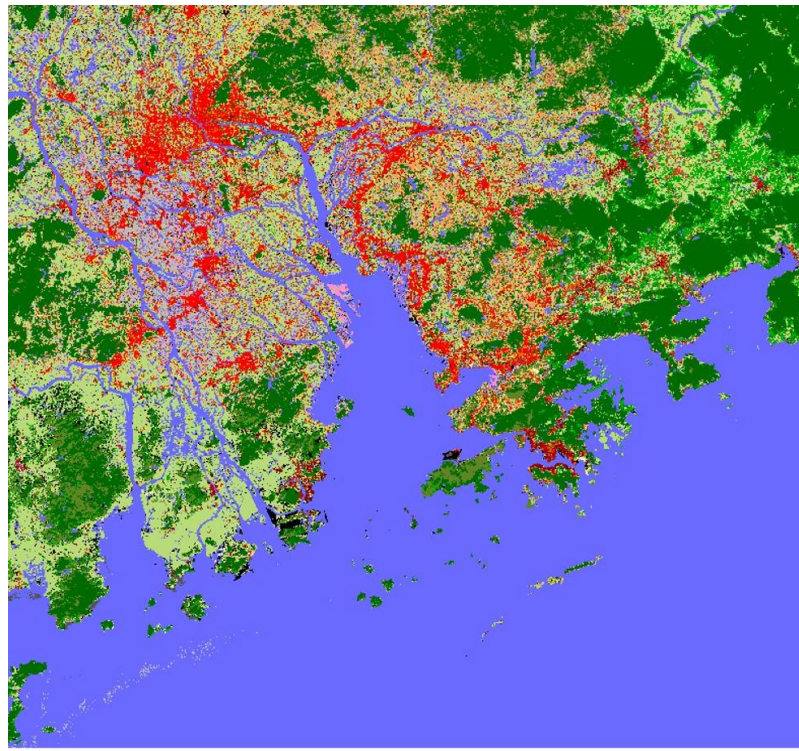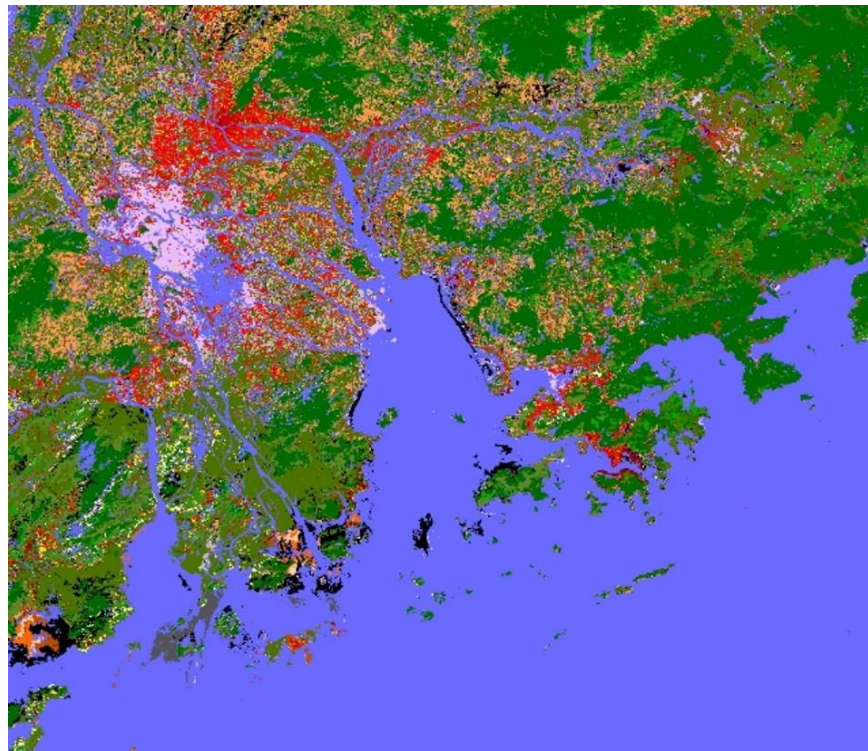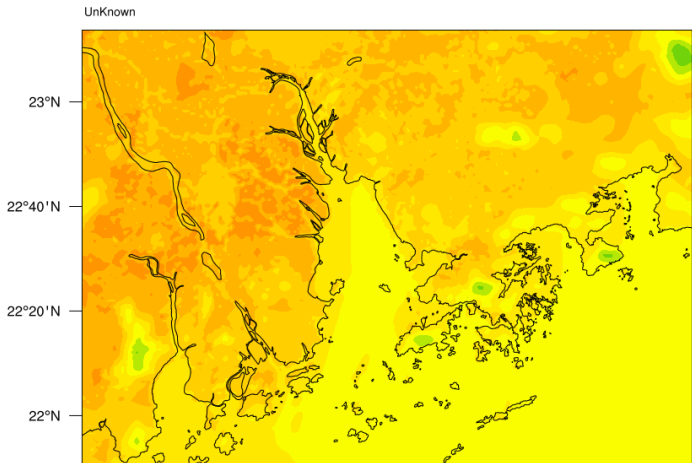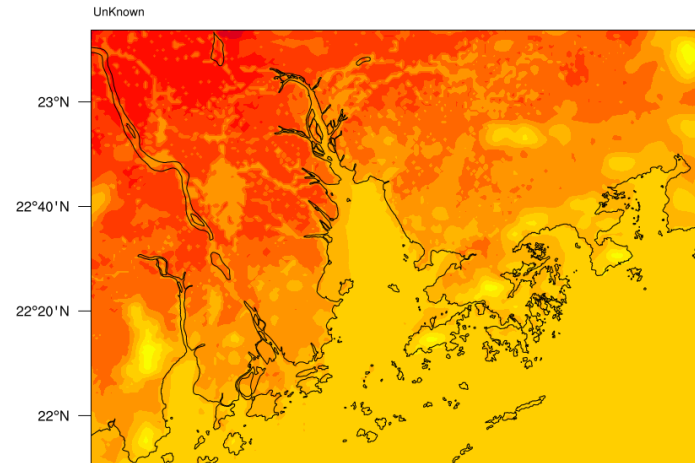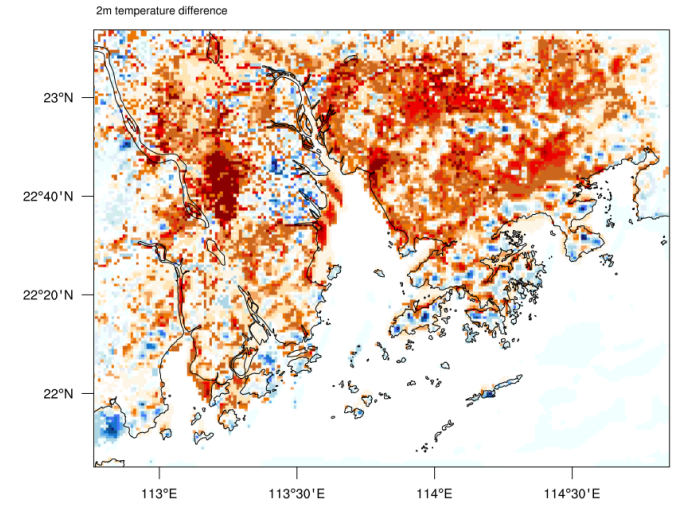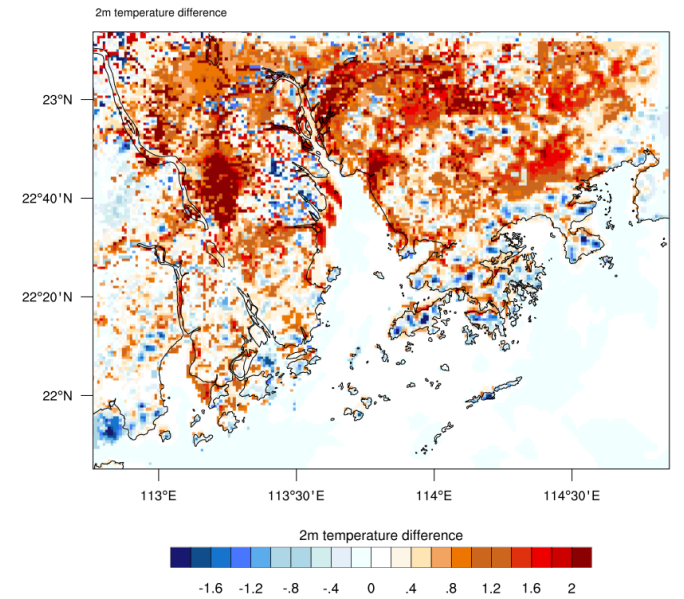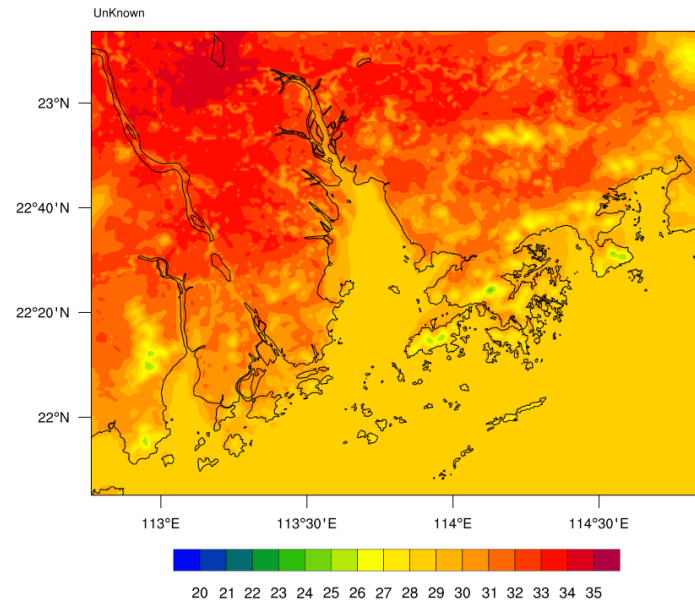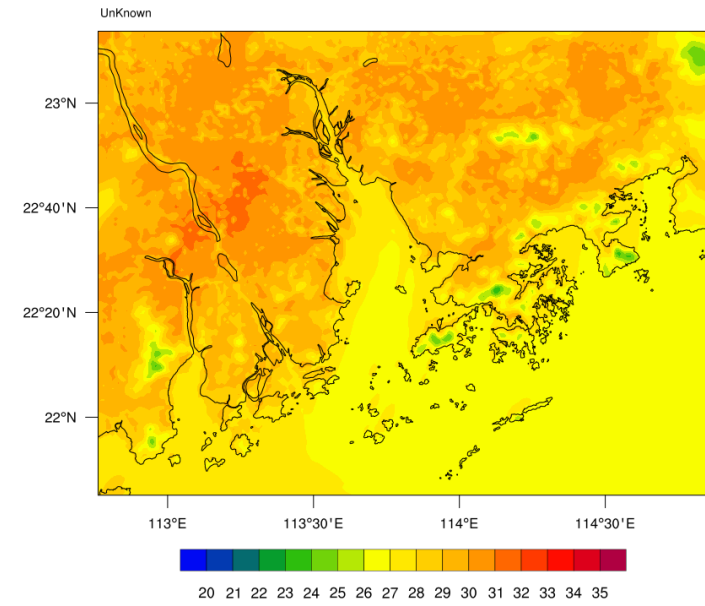
Temperature daytime@2m height above ground

OUTPUT FROM WRF V3.7 MODEL
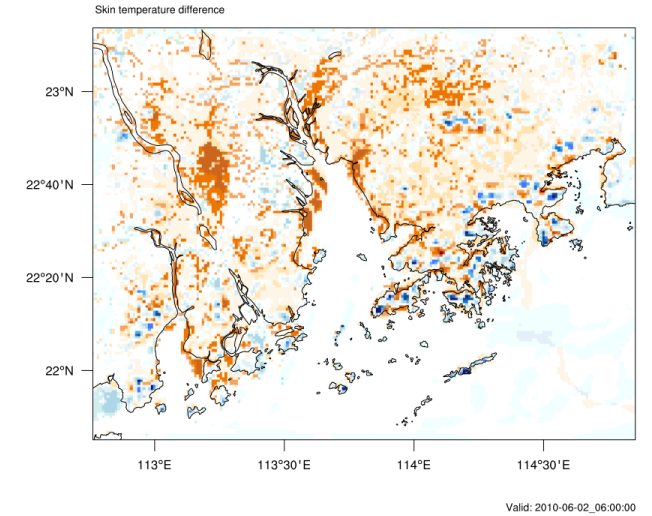WE = 214 ; SN = 163 ; Levels = 48 ; Dis = 1km ; Phys Opt = 3 ; PBL Opt = 7 ; Cu Opt = 0

OUTPUT FROM WRF V3.7 MODEL
WE = 214 ; SN = 163 ; Levels = 48 ; Dis = 1km ; Phys Opt = 3 ; PBL Opt = 7 ; Cu Opt = 0
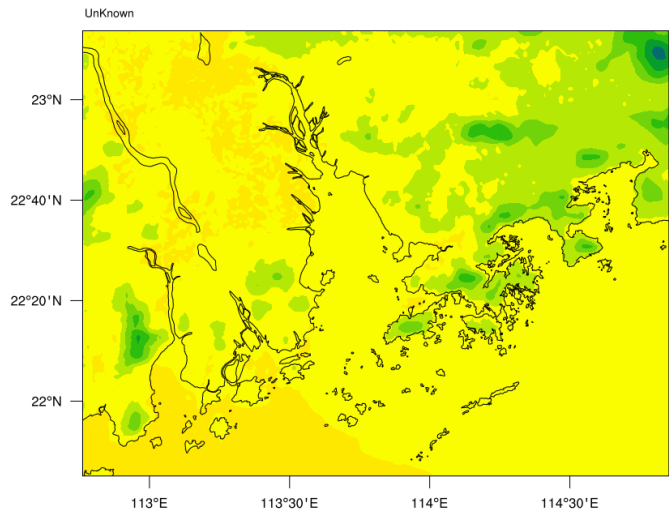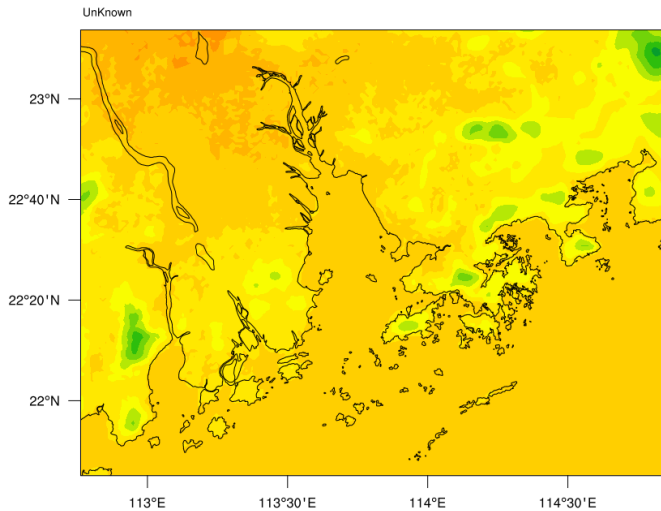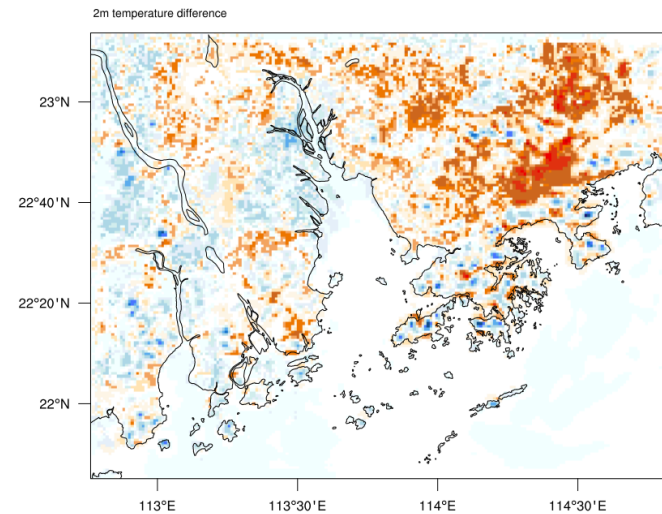
OUTPUT FROM WRF V3.7 MODEL
WE = 214 ; SN = 163 ; Levels = 48 ; Dis = 1km ; Phys Opt = 3 ; PBL Opt = 7 ; Cu Opt = 0
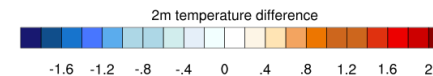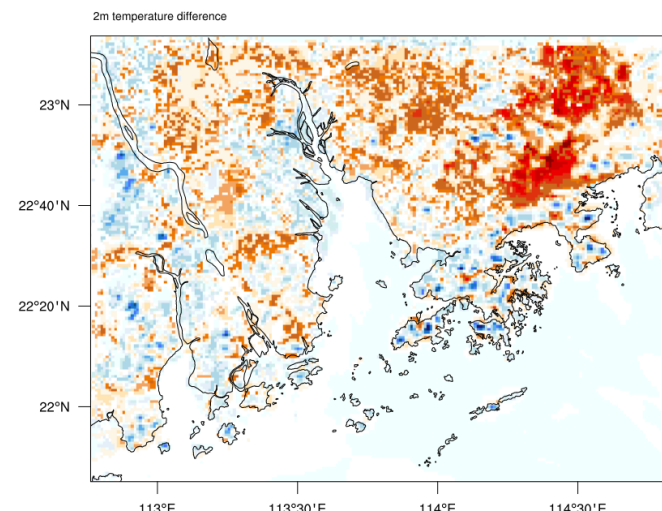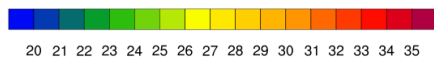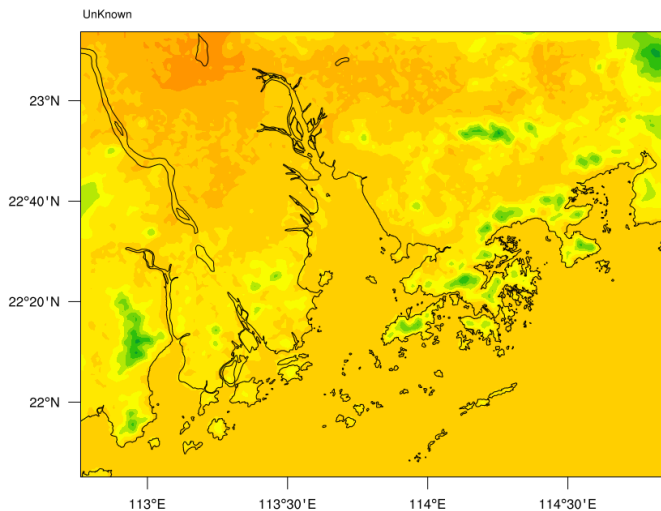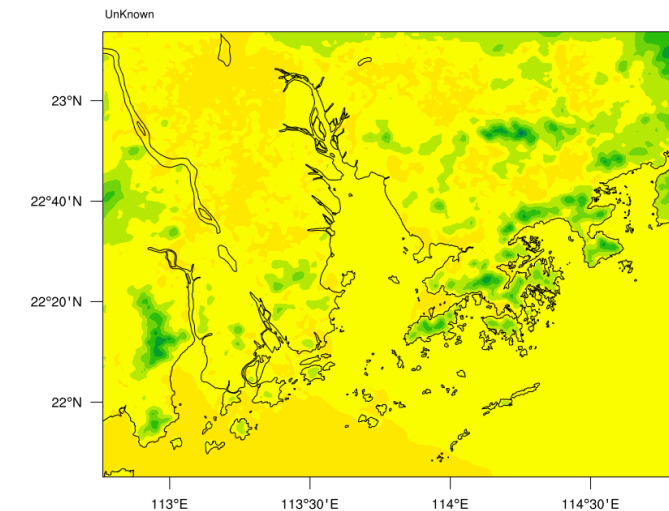
Temperature night time@**2m height above ground**

Wind Simulation Result (daytime)@10m height above ground
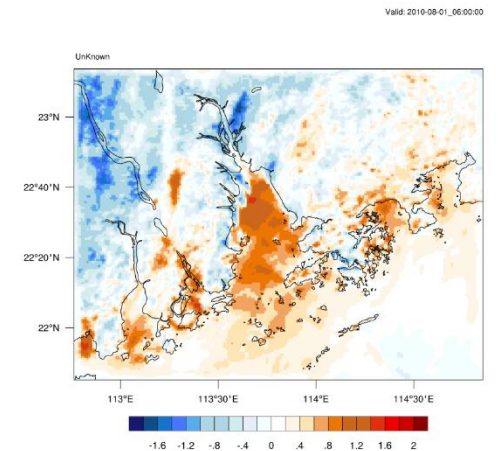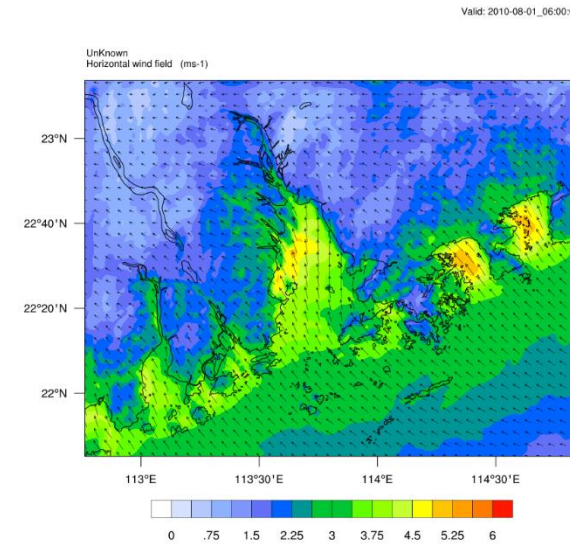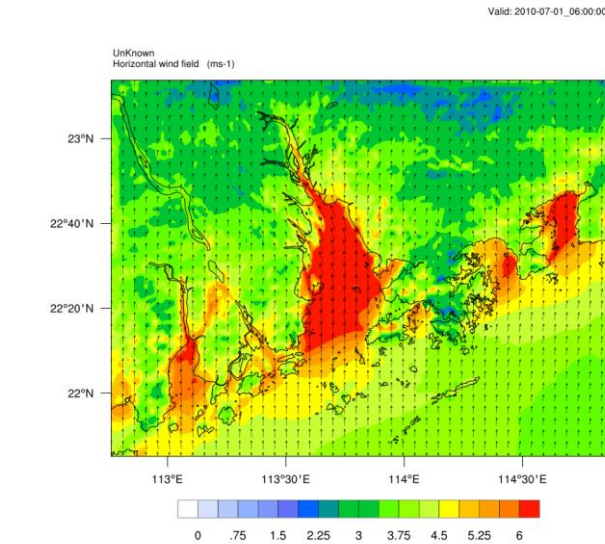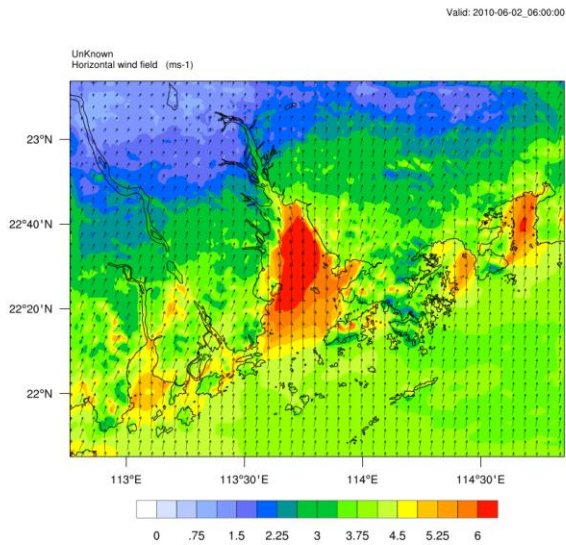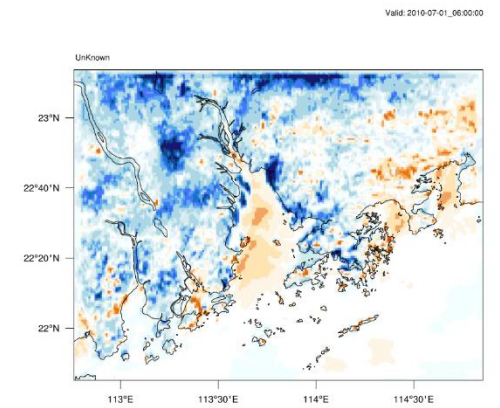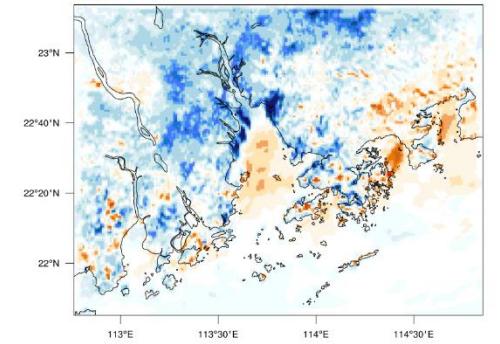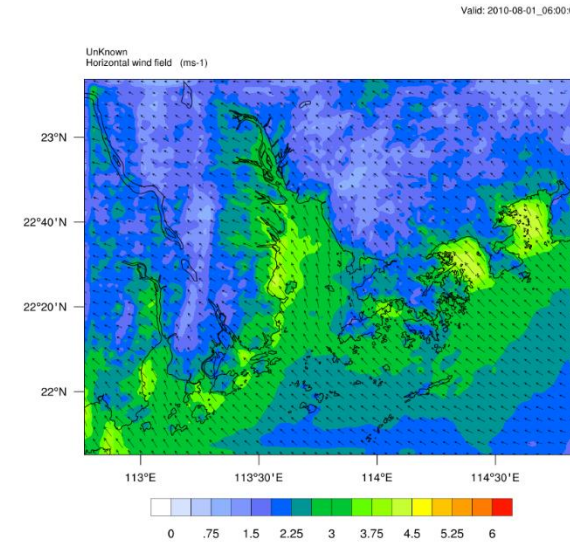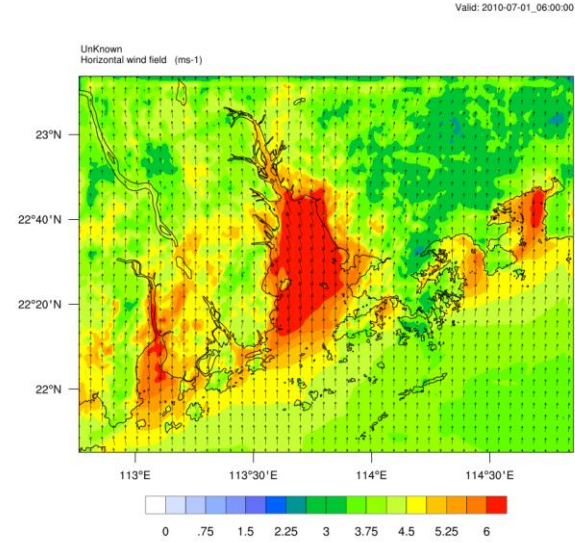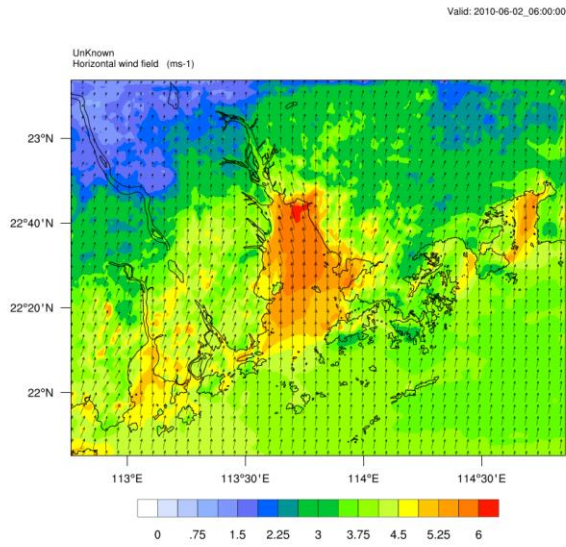
Wind Simulation Result (night time)@10m height above ground

OUTPUT FROM WRF V3.7 MODEL
WE = 214 ; SN = 163 ; Levels = 48 ; Dis = 1km ; Phys Opt = 3 ; PBL Opt = 7 ; Cu Opt = 0

OUTPUT FROM WRF V3.7 MODEL
WE = 214 ; SN = 163 ; Levels = 48 ; Dis = 1km ; Phys Opt = 3 ; PBL Opt = 7 ; Cu Opt = 0

OUTPUT FROM WRF V3.7 MODEL
WE = 214 ; SN = 163 ; Levels = 48 ; Dis = 1km ; Phys Opt = 3 ; PBL Opt = 7 ; Cu Opt = 0
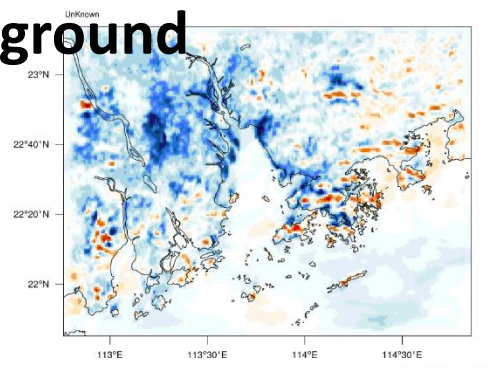
OUTPUT FROM WRF V3.7 MODEL
WE = 214 ; SN = 163 ; Levels = 48 ; Dis = 1km ; Phys Opt = 3 ; PBL Opt = 7 ; Cu Opt = 0

Heat Stress (NWS) daytime
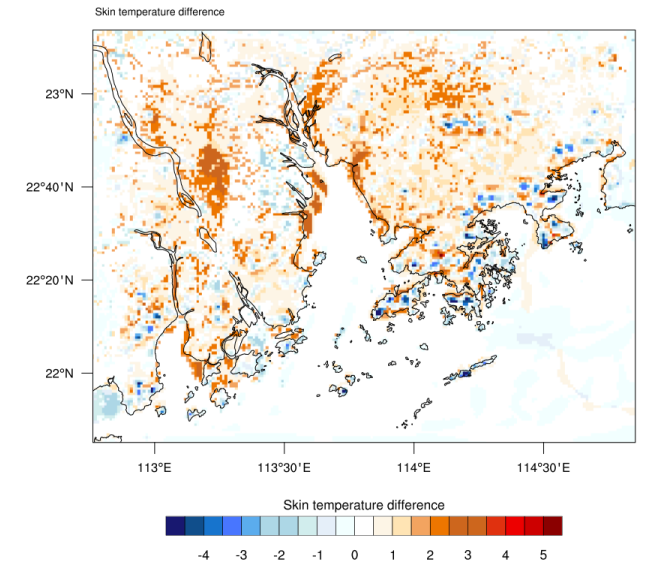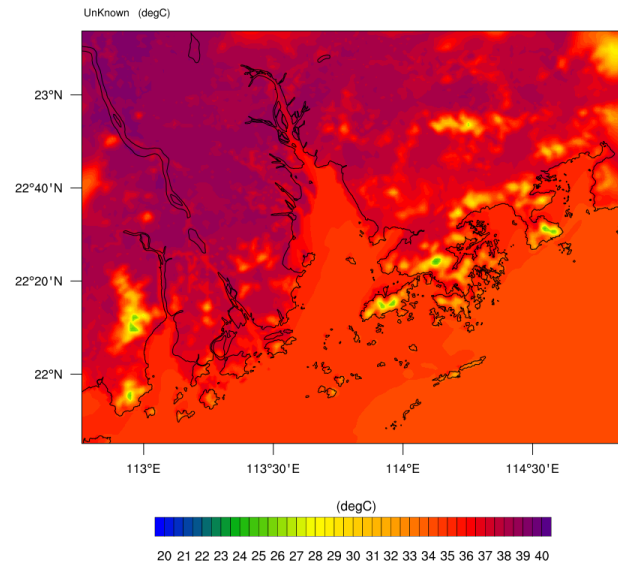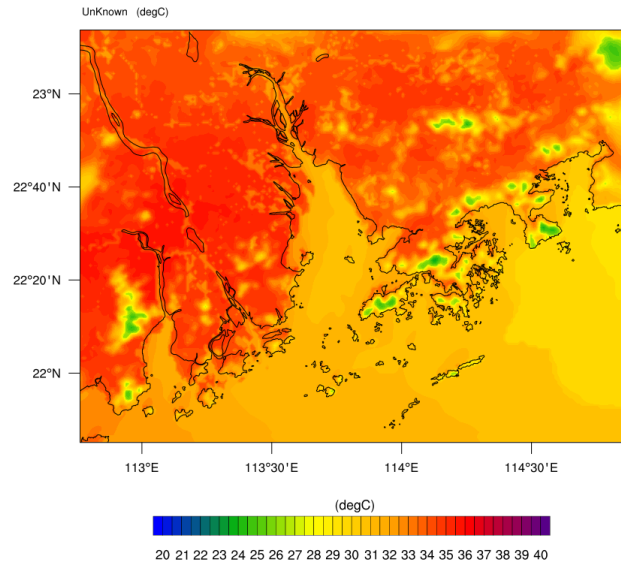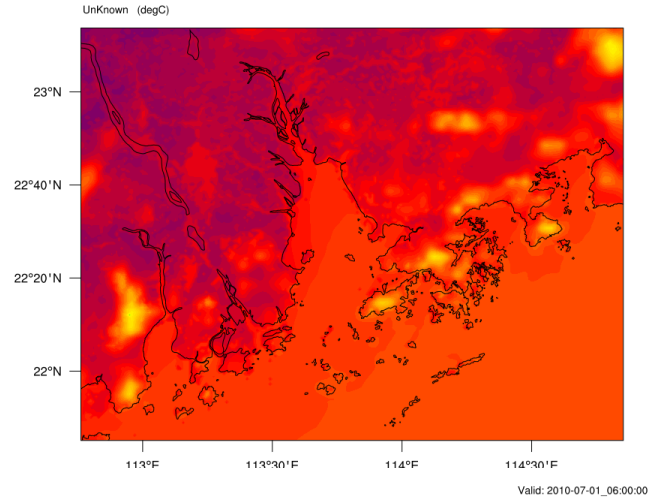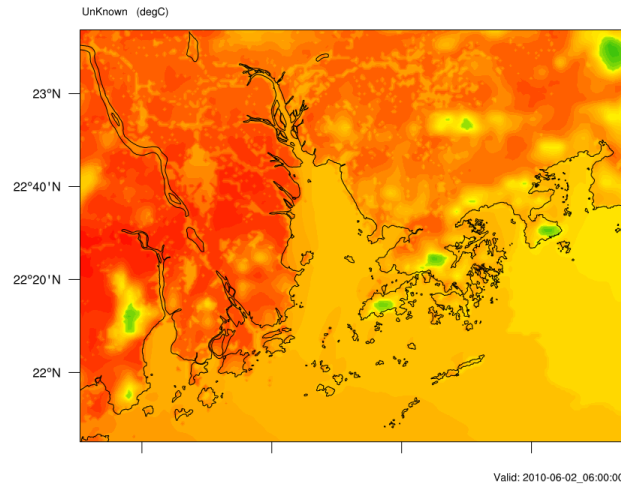
Heat Stress(NWS) nighttime
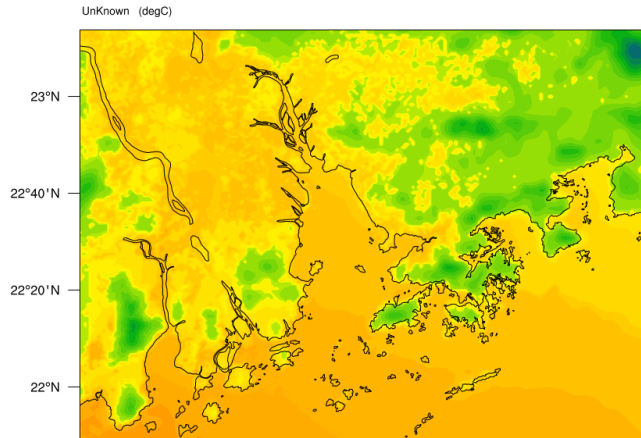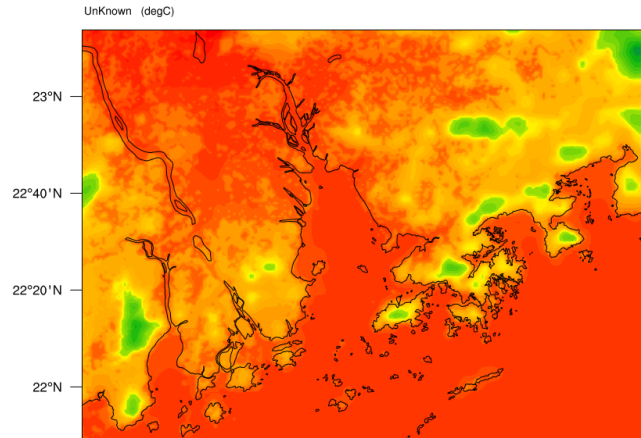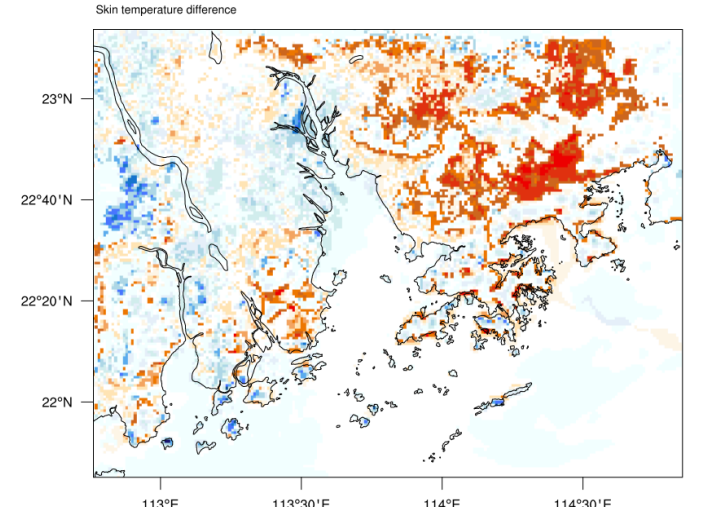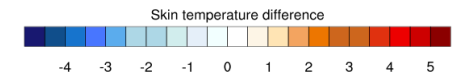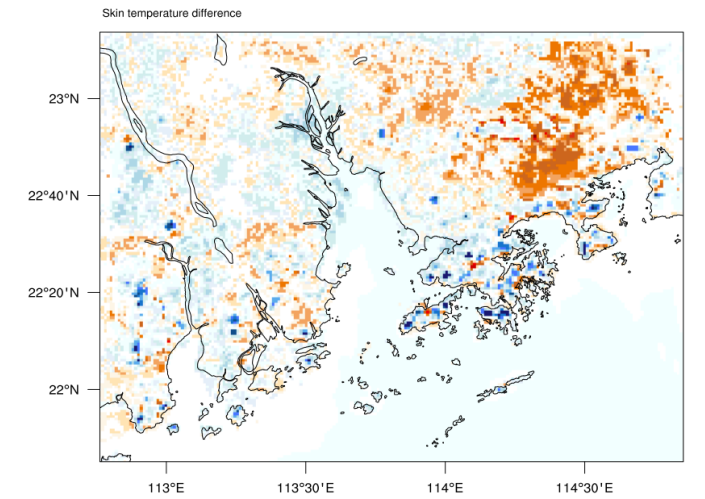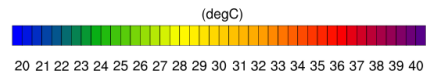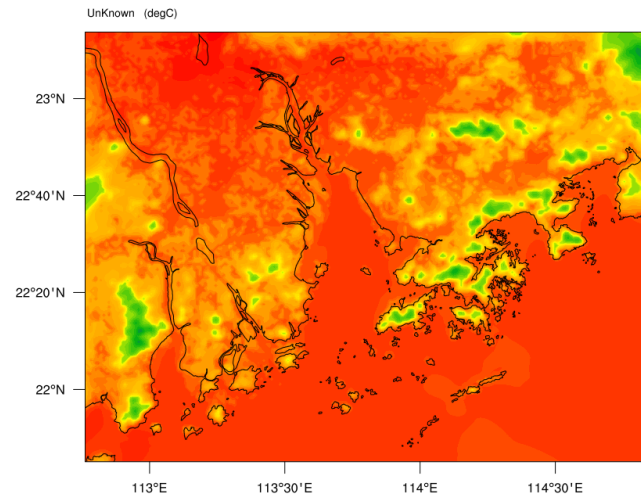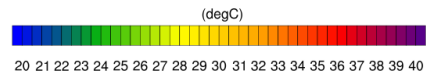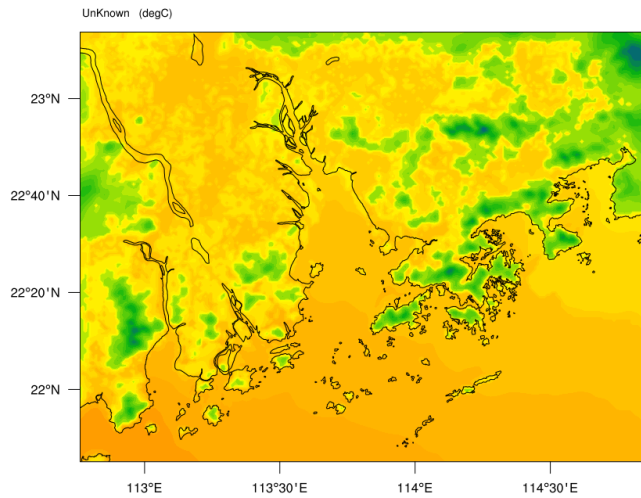
Roadmap of WUDAPT Project

CO2 Emission

Air Pollution

Public Health

WUDAPT Product

Ecology

Climate & Weather

Urban Planning

Energy Cost

Level 0 Data for 57 Major Chinese Cities & Economic Development Regions; and also selected important cities along 1B1R

2016

Level 1 Data for Climate/Weather Modeling Simulations & Energy Balance Study

2018

Level 2 Data for Planning Implementation & Impact Analysis

2020

'Digital Belt & Road' Initative

Collaboration with China Academy of Sciences

Future Work & Collaborations

80 Selected Cities,
20 Countries' Support and Involvement

Yangon, Myanmar
Warsaw, Poland
Karachi, Pakistan
Tehran, Iran
... ...

'Atlas of the Human Planet'

Collaboration with GEO, European Commission

Population Grid in 3D - Asia

Atlas of the Human Planet

Source: Atlas of the Human Planet, GEO

European Commission

IIASA

GEO GROUP ON EARTH OBSERVATIONS

Beijing

Chicago

Milano

Lisboa

Sao Paulo

Khartoom

Hong Kong
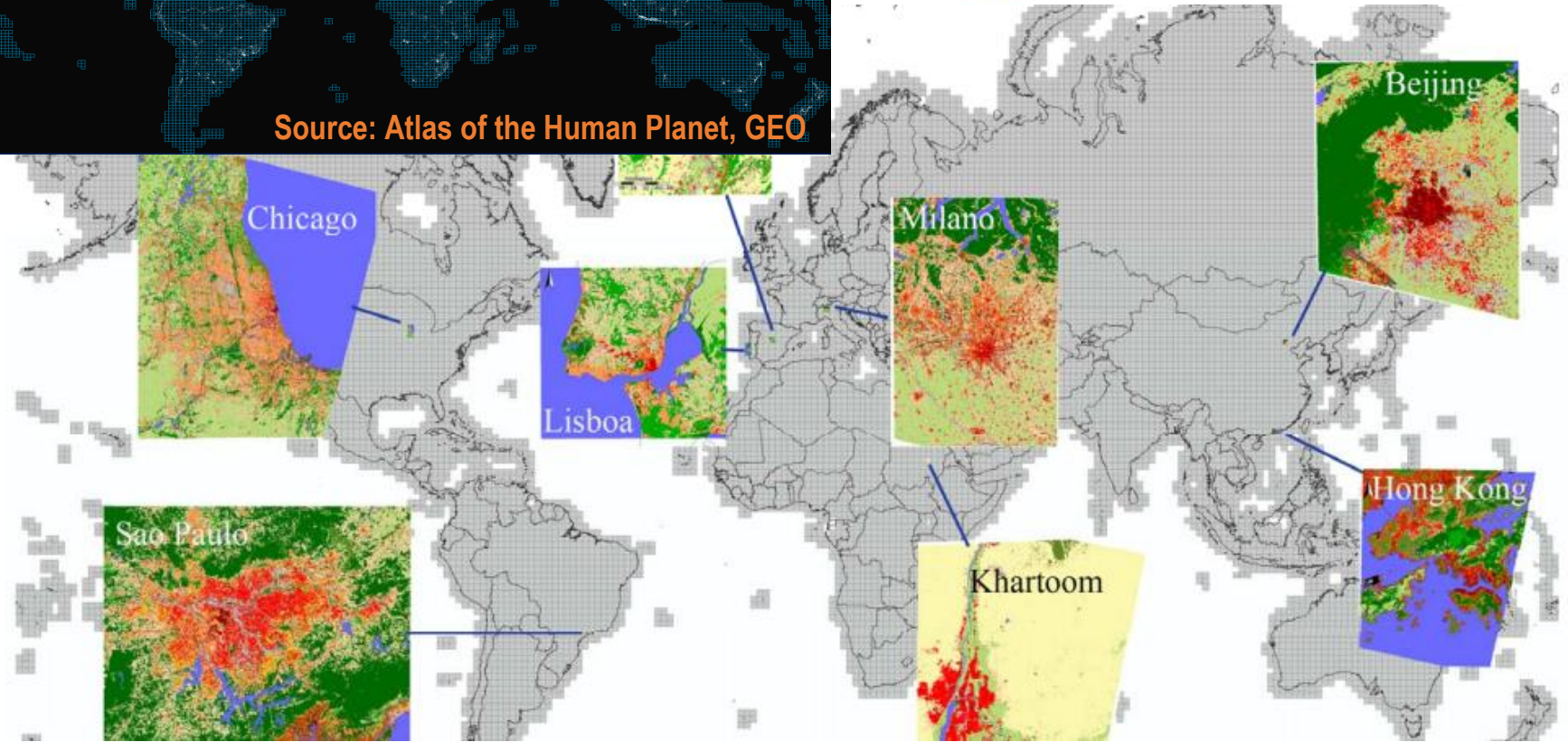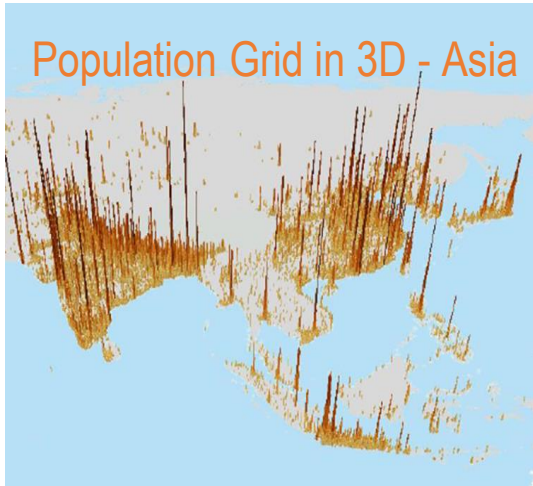
'Shanghai Integrated Urban Weather and Climate Service Demonstration Project'

Supported by World Meteorological Organization

WMO

Weather and climate hazards	Weather and climate related hazard	Other hazards	Emergency Response
Typhoon	Storm Surge	Earthquake	Fire accident
Severe Convective Weather	Urban Inundation,		
Rain storm	Human Health		
Heat wave	Epidemic Diseases,	Other Emergencies	Chemical gas leak
Drought	Air Pollution		
Warning	**Joint Warning**	**Dissemination**	**Specialized Service**

240 280 320 360 400

Welcome to join us! Thanks
WWW.WUDAPT.ORG

Collaboration Partners & Supporters

Core Teams