2020 EGU General Meeting

A Building-Block Urban Meteorological Observation Experiment (BBMEX) over Seoul City, Korea

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BBMEX Building Block 3-dimensional Urban Meteorological observation EXperiment

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01 BBMEX Background

02 BBMEX Introduction

03 Results

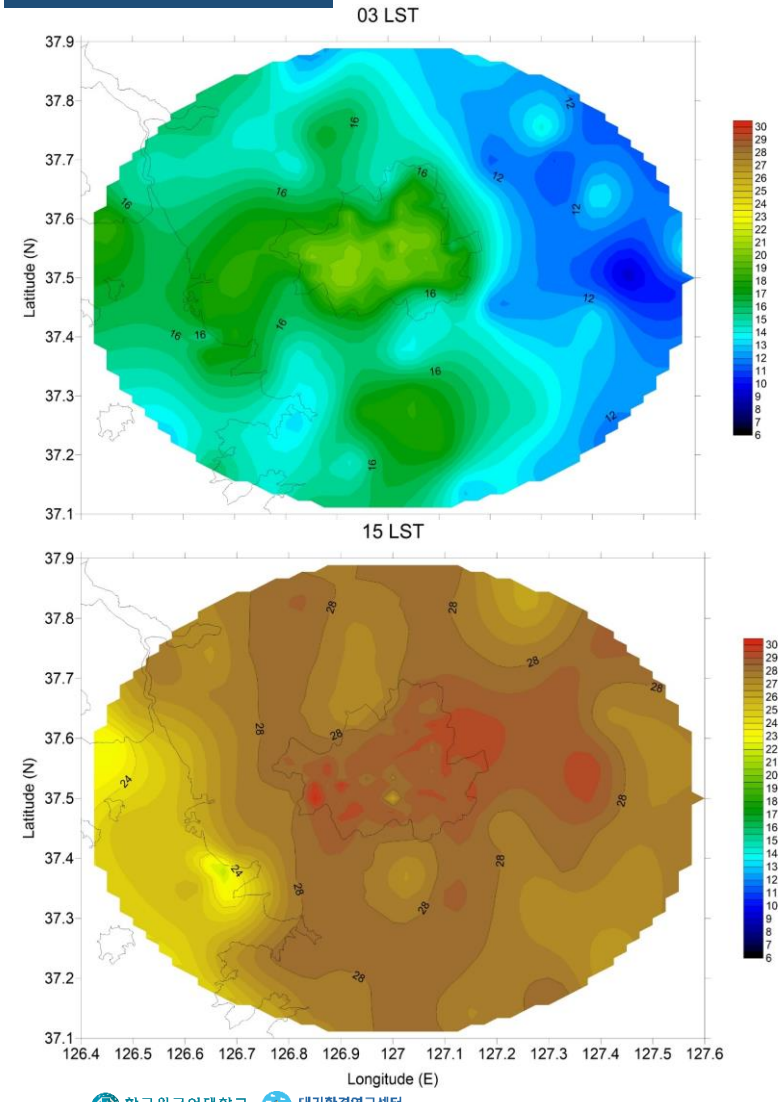
04 Summary

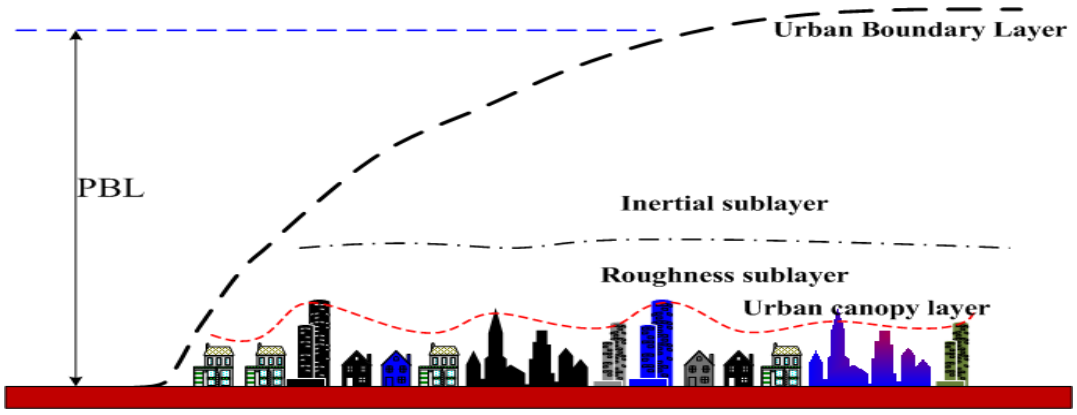
Building
Block 3-dimensional urban
Meteorological Observation
EXperiment

01 BBMEX Background

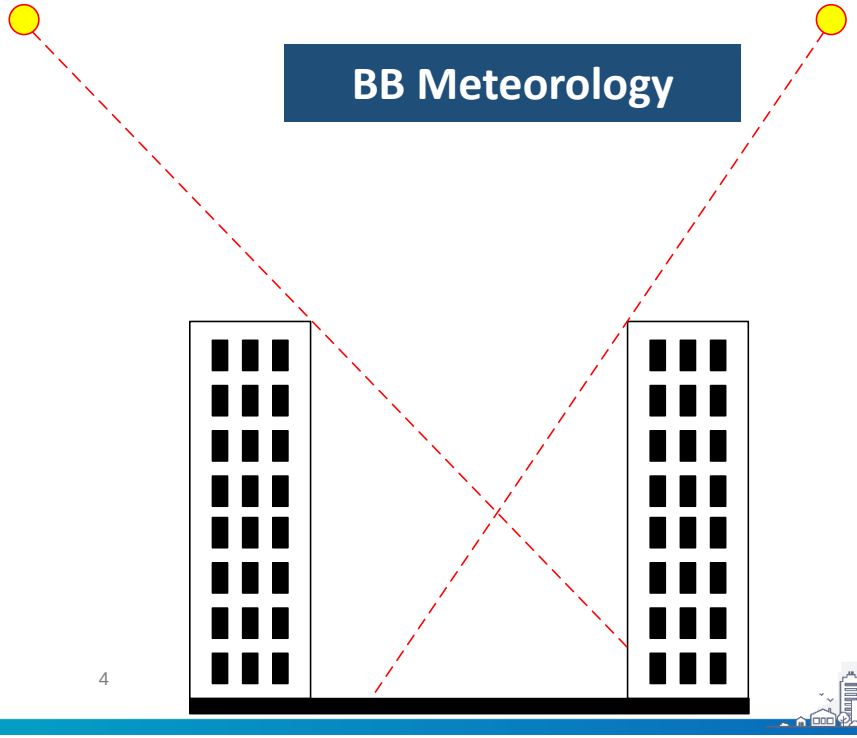
From UHI to Building-Block Meteorology

UHI





BB Meteorology

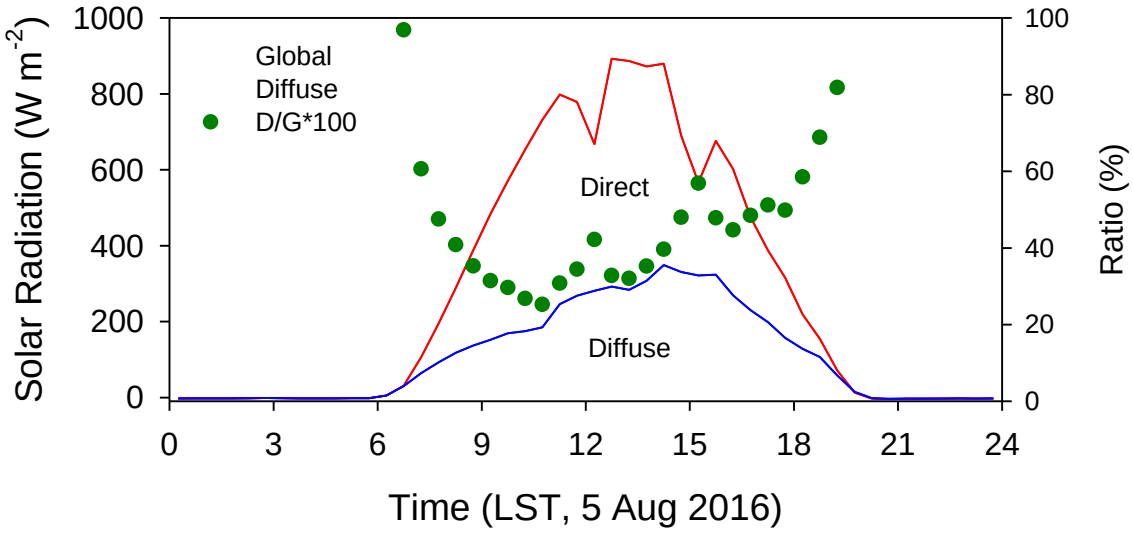


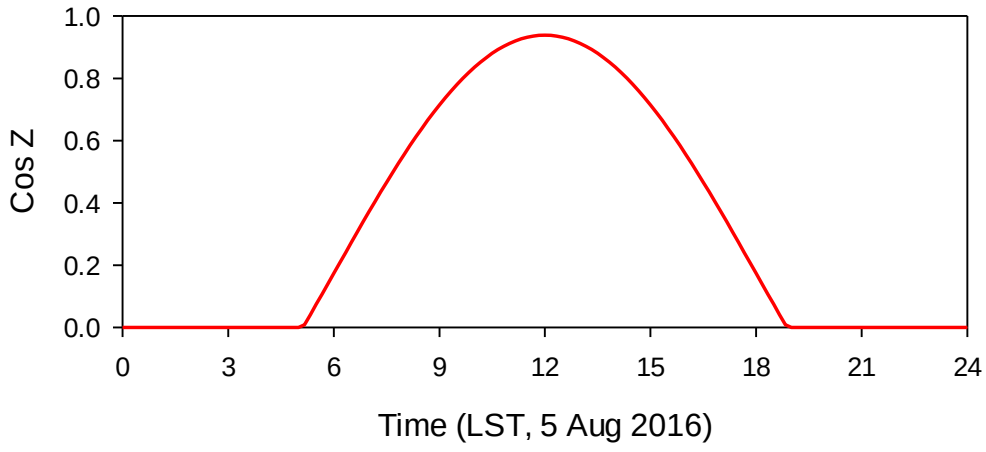
Radiation Balance on surface in a BB

Energy Balance

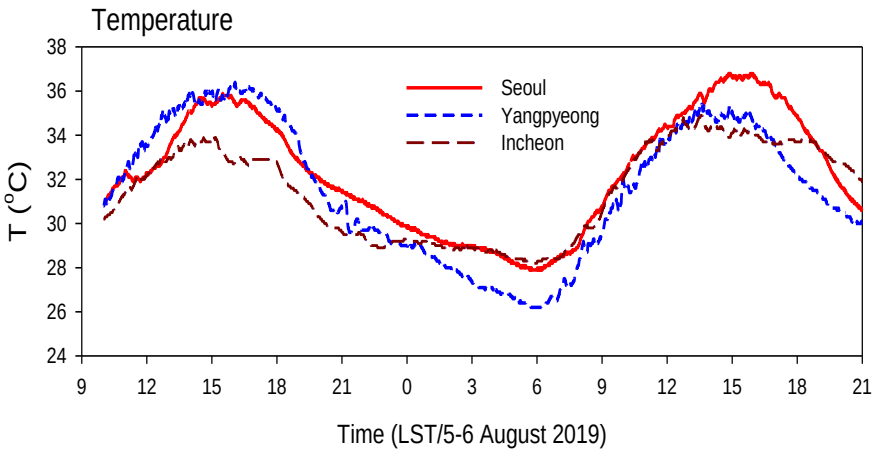
$$S_{Global} = S_{Direct} + S_{Diffuse}$$

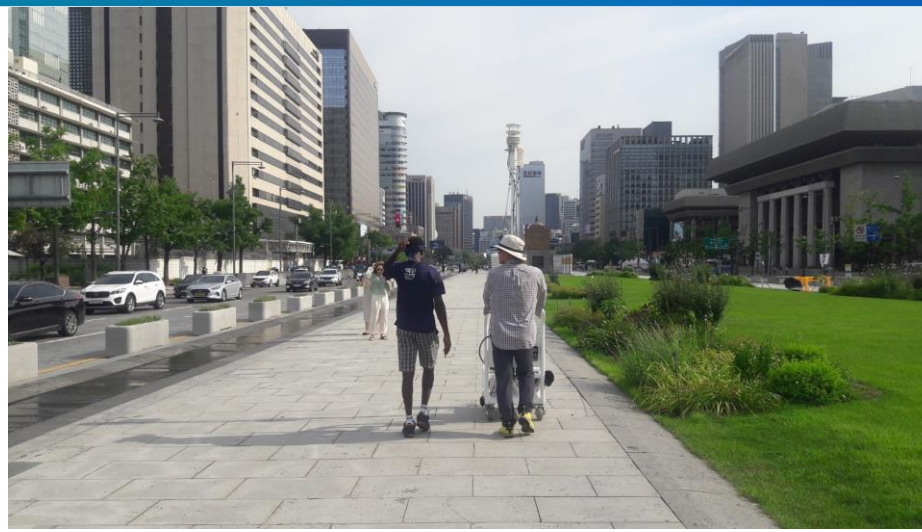
- ✓ Slope angle (W-E)
- ✓ Slope angle (S-N)
- ✓ $S_{Diffuse}$, S_{Direct}
- ✓ Cos Z, Z zenith angle
- ✓ SkyView at each surface





Questions?





Heatwave

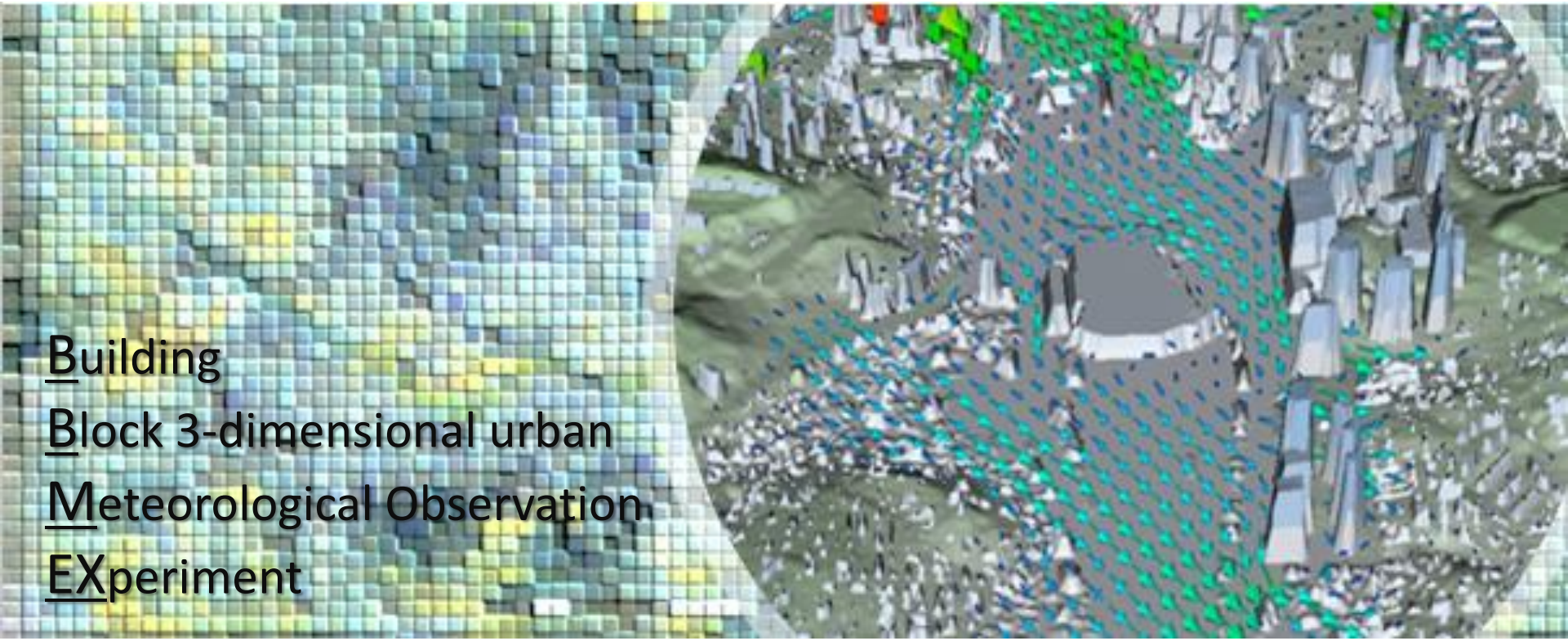
×

- ✓ Synoptic temperature VS BB temperature
- ✓ Vertical profile of temperature in BB
- ✓ Effects of facilities mitigating heat stresses such as grass, surface fountain, waterway

×

BB Meteorology

BBMEX (Building Block 3-dimensional Meteorological Observation EXperiment)



02 BBMEX Introduction

Introduction

Objective

- Acquire the high-resolution temperature fields in a BB
- Effects of facilities mitigating heat stresses

Period/ Place

- **Period:** 5.-6. August 2019 (yearly MaxT records: 40.2℃ on 5 at Anseong, 36.8℃ on 6 at Seoul)
- **Place:** Gwanghwamun

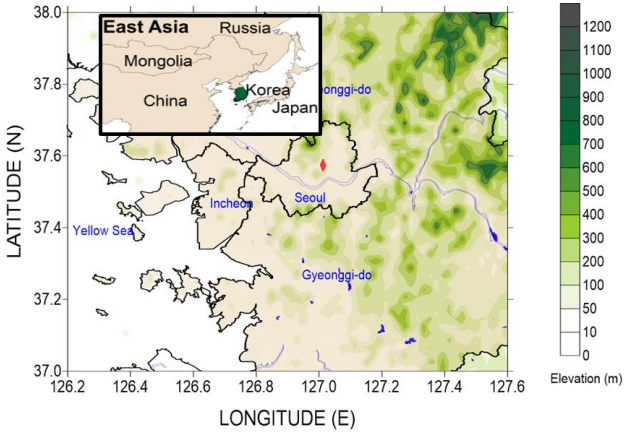
Observation

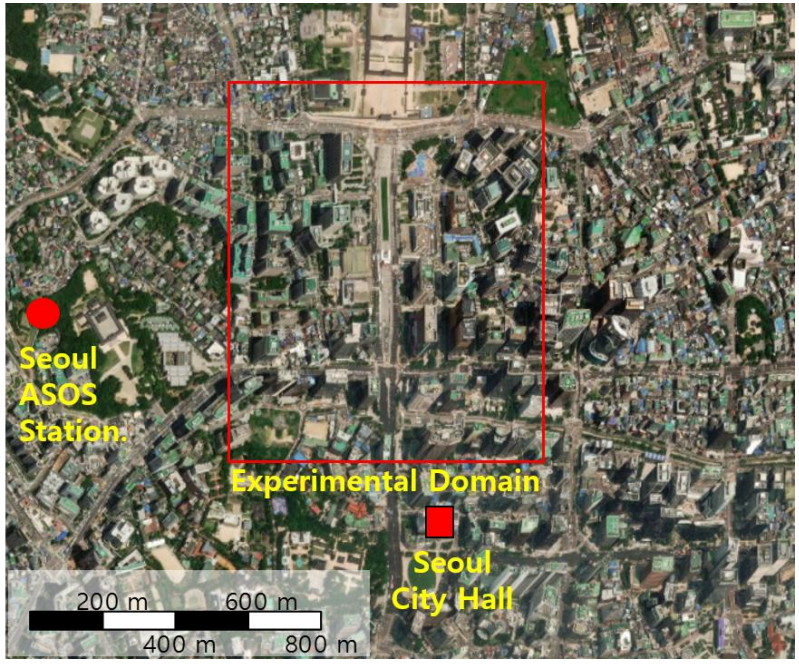
- **Fixed**: TIR, AWS(6 stations), Radiation and Turbulence
  IoT sensors (35 stations)
- **Mobile**: Mobile Vehicle, Mobile Cart
- Effects of Cooling-Fog

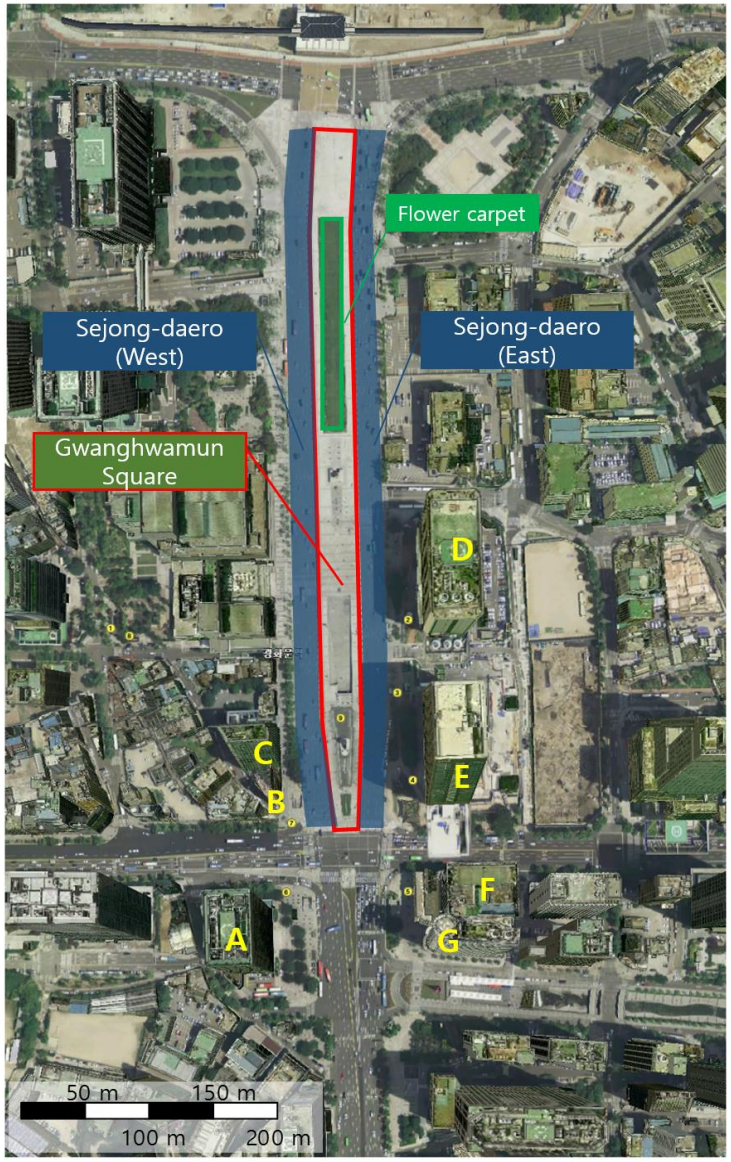
Organize

- **Host:** HUFS, National Institute of Meteorological Sciences
- **Attendants:** STI, Kongju National University, KT, Observer

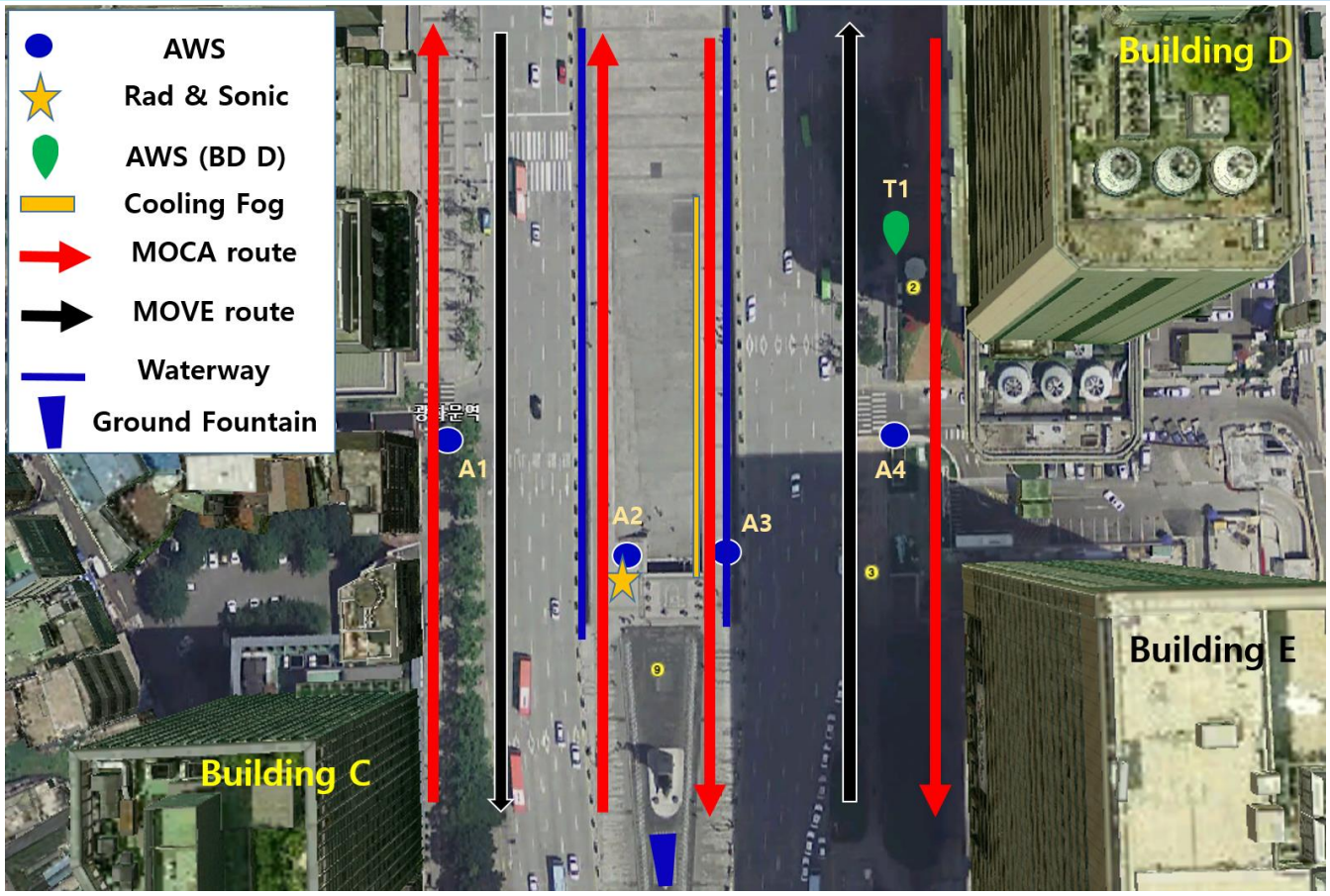
Sites

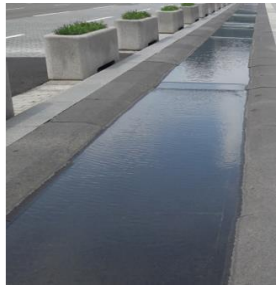

East Asia
Russia
Mongolia
China
Korea
Japan
Seoul
Incheon
Yellow Sea
Gyeonggi-do
LATITUDE (N)
LONGITUDE (E)
Elevation (m)


Seoul ASOS Station
Experimental Domain
Seoul City Hall
200 m
600 m
400 m
800 m


Flower carpet
Sejong-daero (West)
Sejong-daero (East)
Gwanghwamun Square
A
B
C
D
E
F
G
50 m
150 m
100 m
200 m

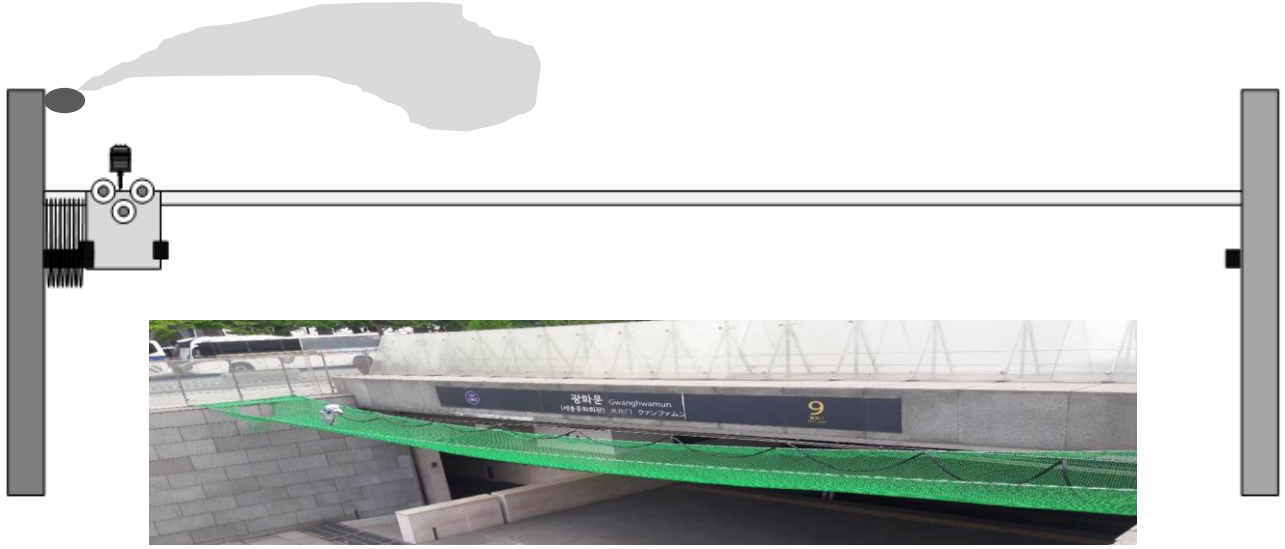
Sites


AWS
Rad & Sonic
AWS (BD D)
Cooling Fog
MOCA route
MOVE route
Waterway
Ground Fountain
Building D
Building E
Building C
T1
A1
A2
A3
A4

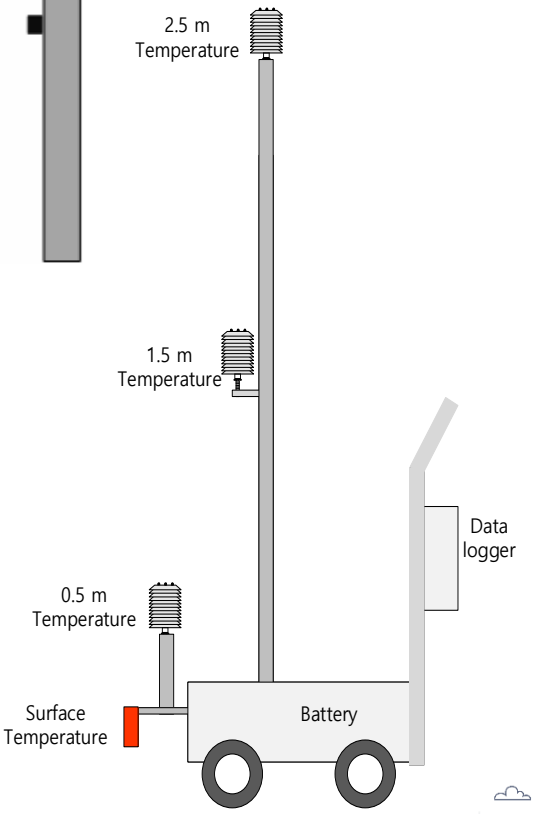


Instruments

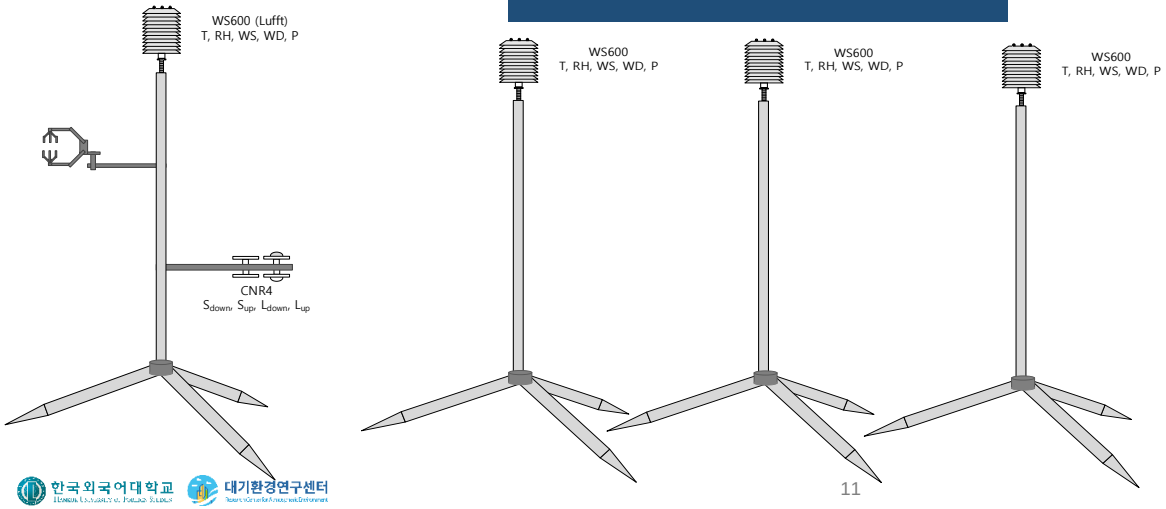
Cooling Fog Effect Monitor



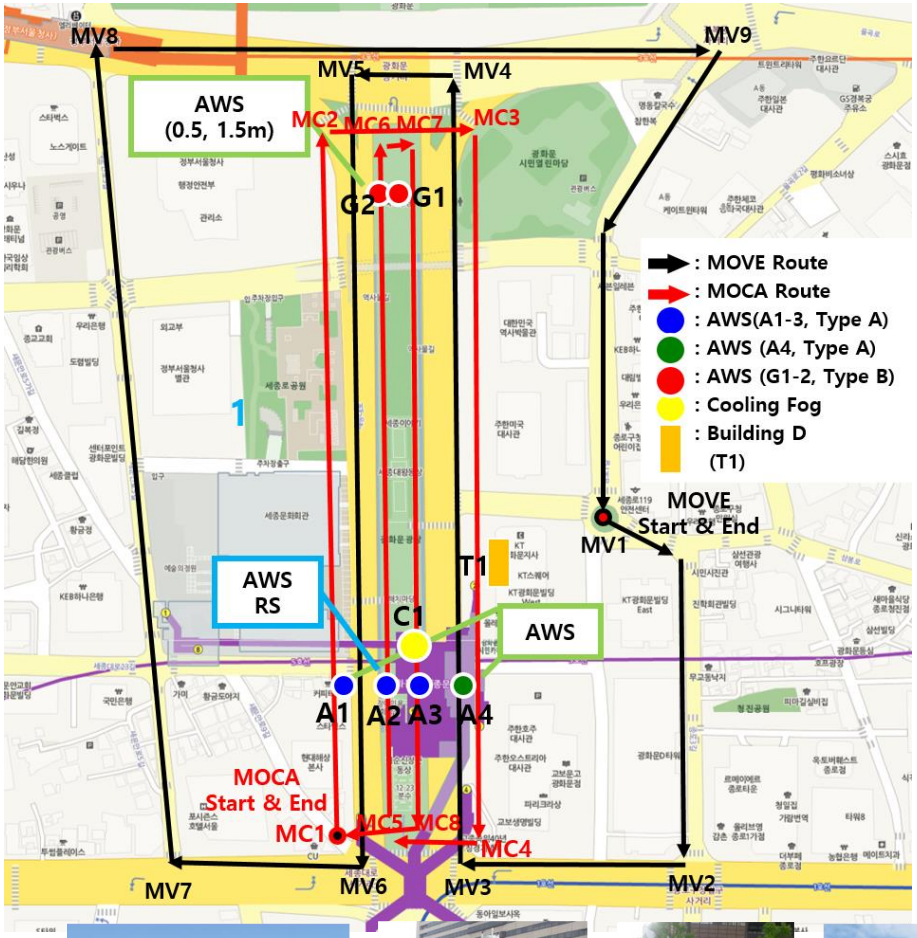
Mobile Cart

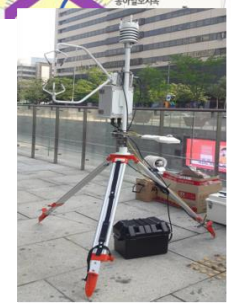


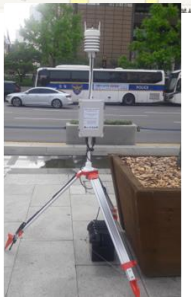
AWS

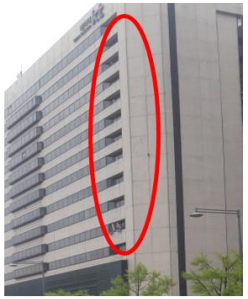


Instrument and Moving Path









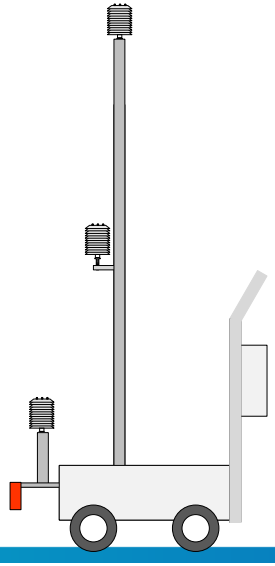
Observation Time

Mobile Vehicle

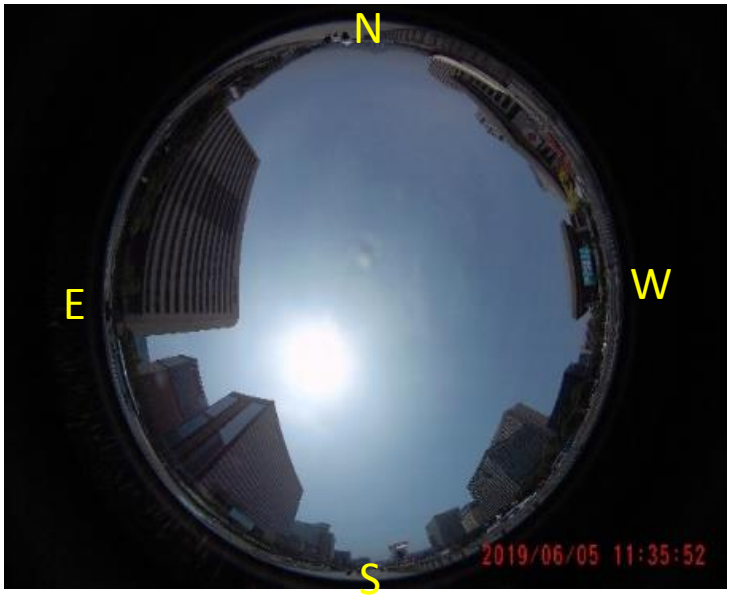
5 Aug		6 Aug	
		6	6:48~7:16
		7	7:54~8:07
		8	08:48~09:19
1	14:51~15:16	9	09:47~10:15
2	15:48~16:18	10	10:48~11:15
3	17:58~18:18	11	11:48~12:20
4	19:48~20:17	12	14:47~15:15
5	20:48~21:15	13	15:47~16:22
		14	16:47~17:05
		15	17:47~18:21
		16	19:47~20:17
		17	20:47~21:14

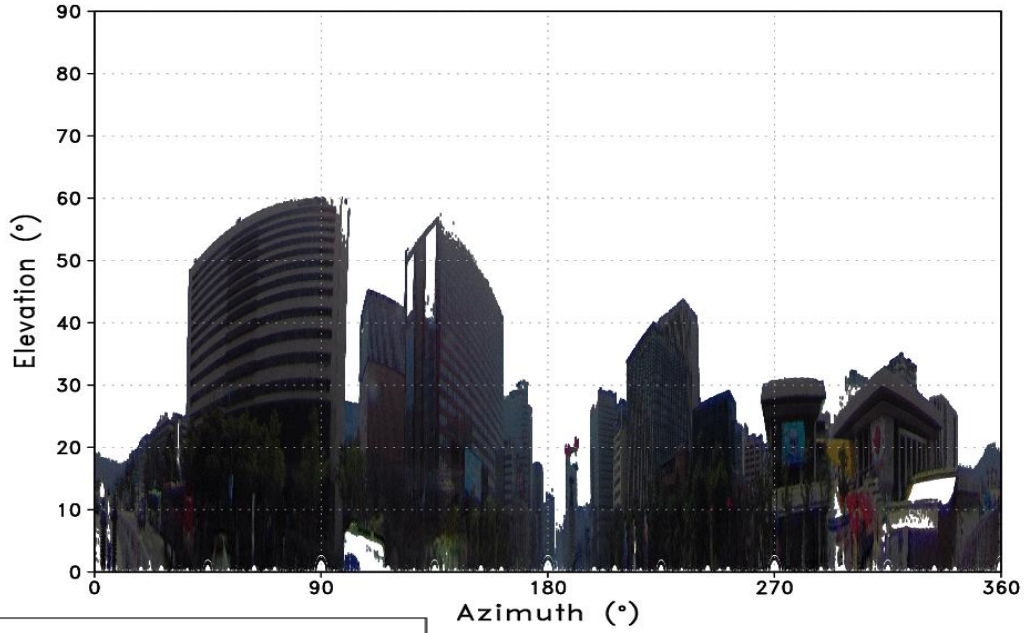
Mobile Cart

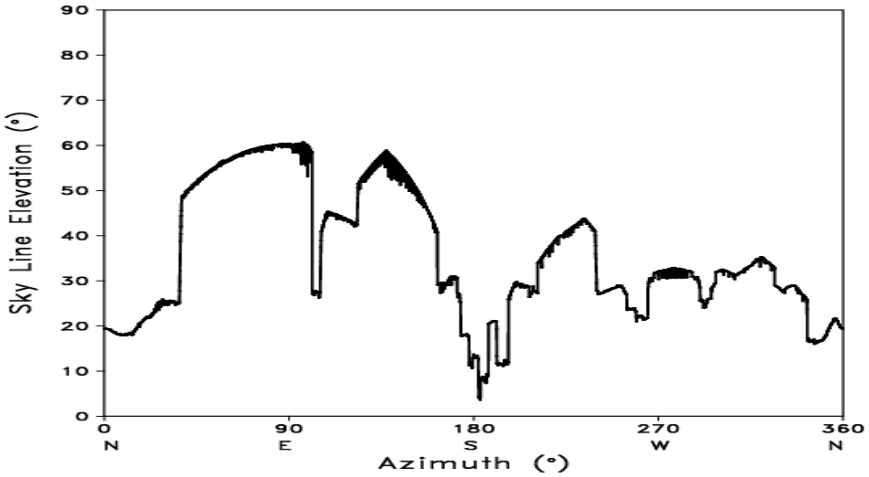
5 Aug		6 Aug	
1	12:00~12:40	9	04:00~04:40
2	13:00~13:40	10	06:00~06:40
3	14:00~14:40	11	07:00~07:40
4	15:00~15:40	12	08:00~08:40
5	16:00~16:40	13	09:00~09:40
6	17:00~17:40	14	10:00~10:40
7	18:00~18:40	15	11:00~11:40
8	21:00~21:40	16	12:00~12:40
		17	13:00~13:40
		18	14:00~14:40
		19	15:00~15:40
		20	16:00~16:40
		21	17:00~17:40
		22	18:00~18:40
		23	21:00~21:40



Sky View


N
E
W
S
2019/06/05 11:35:52


Elevation (°)
0
10
20
30
40
50
60
70
80
90
0
90
180
270
360
Azimuth (°)


Sky Line Elevation (°)
0
10
20
30
40
50
60
70
80
90
0
N
90
E
180
S
270
W
360
N
Azimuth (°)

Skyview

광화문 삼거리
광화문 시민열린마당
북측공장
대한민국 역사박물관
세종로공원
세종이야기
주한미국 대사관
세종대왕동상
광화문광장
KT 광화문지사
세종문화회관
5호선
광화문역(세종문화회관)
현대해상 본사
이순신장군 동상
교보문고 광화문점
교보생명빌딩
노마나무
100년생터
세종대로
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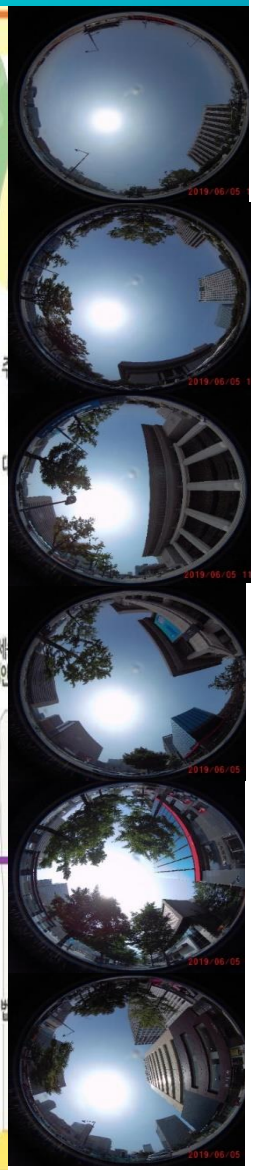
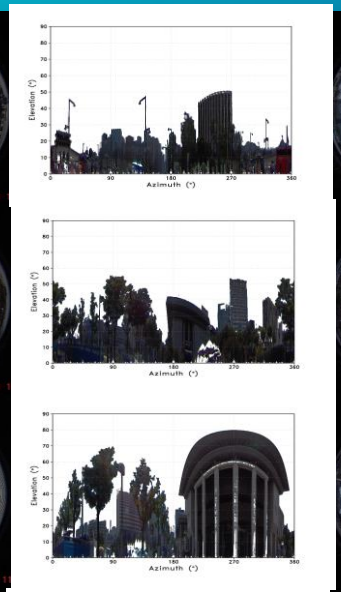
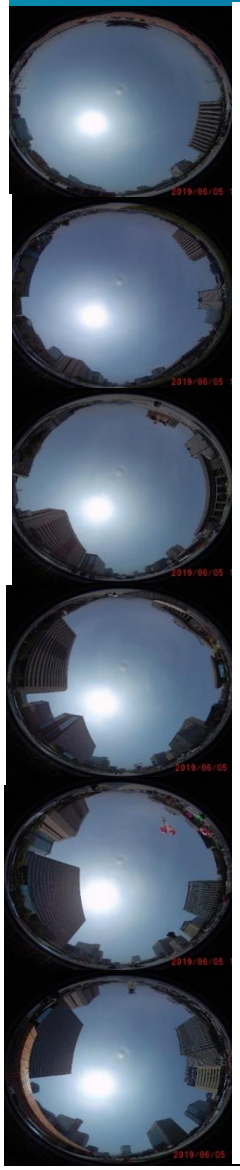
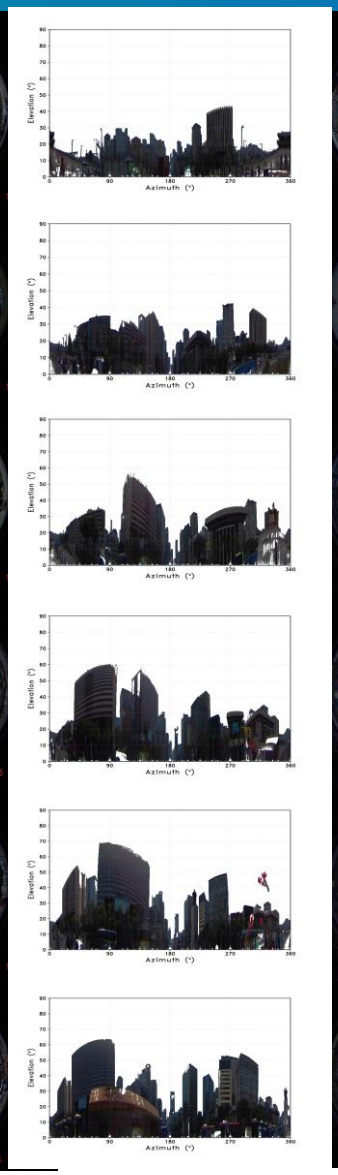
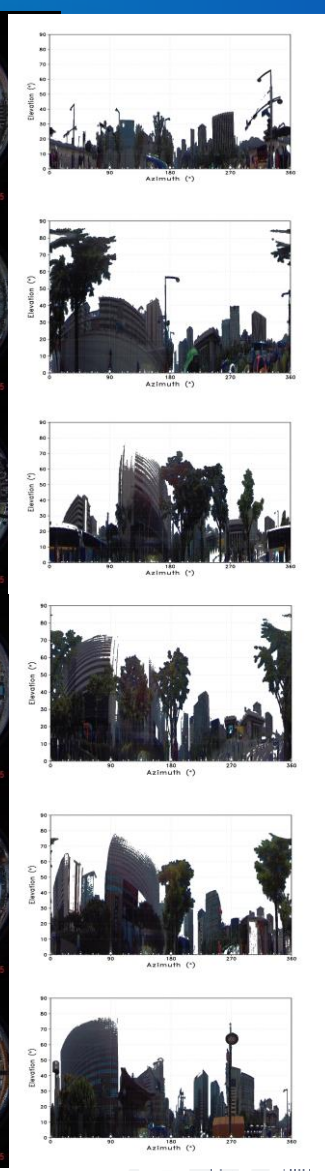


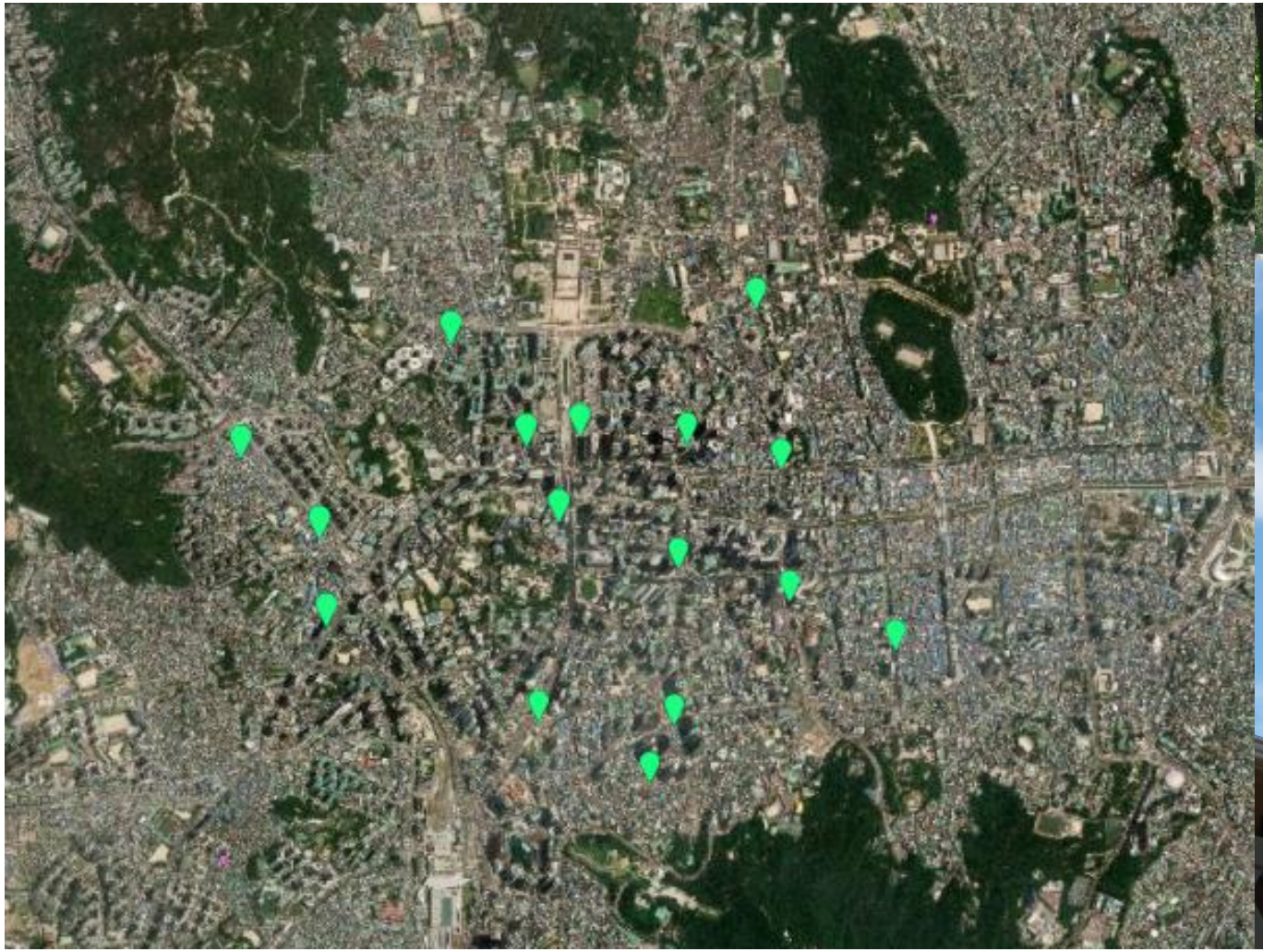

Elevation (°)
Azimuth (°)




Elevation (°)
Azimuth (°)


Elevation (°)
Azimuth (°)

IoT Sensor

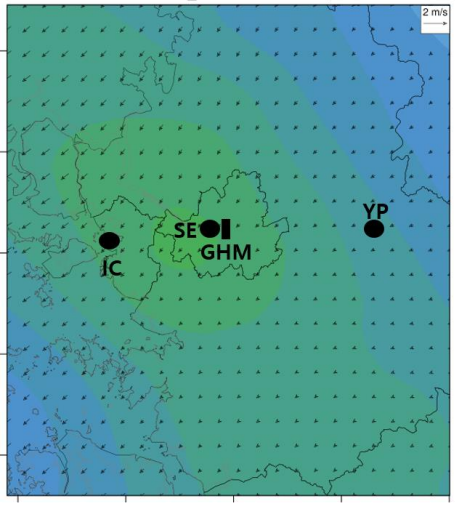


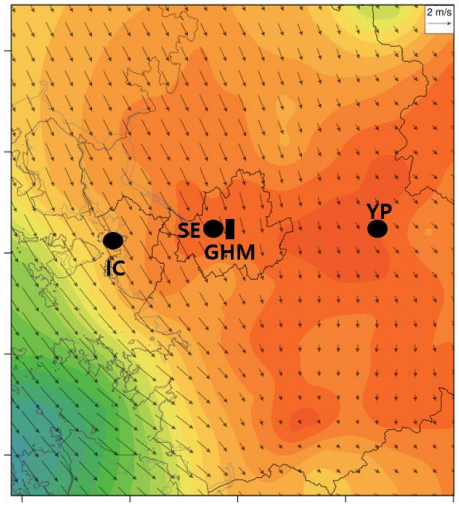
Building
Block 3-dimensional urban
Meteorological Observation
EXperiment

03 Results

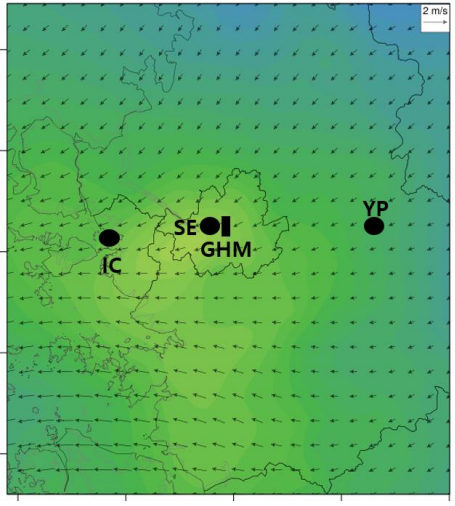
Observation Period (Heat Wave)

06 LST 05 August 2019

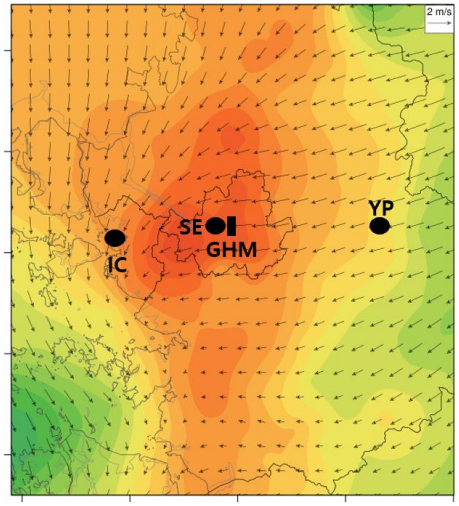


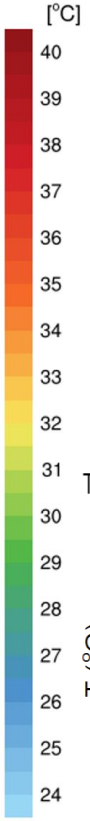


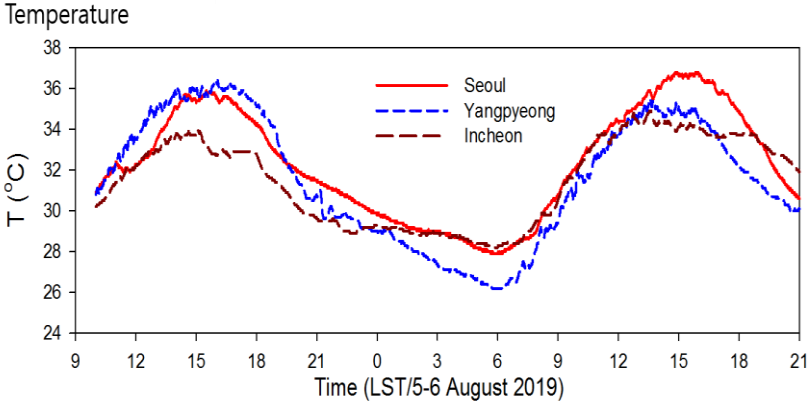
06 LST 06 August 2019



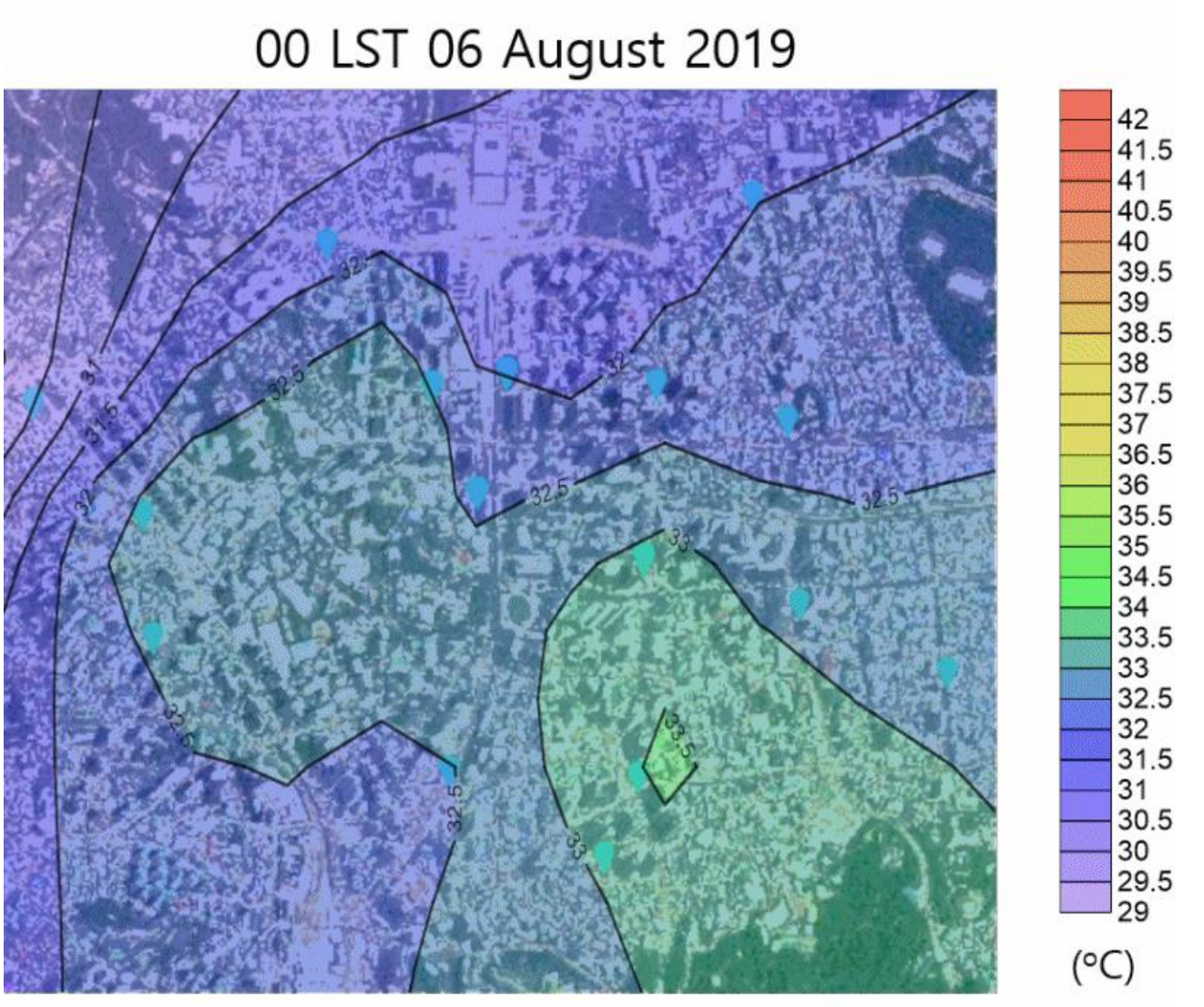
15 LST 06 August 2019



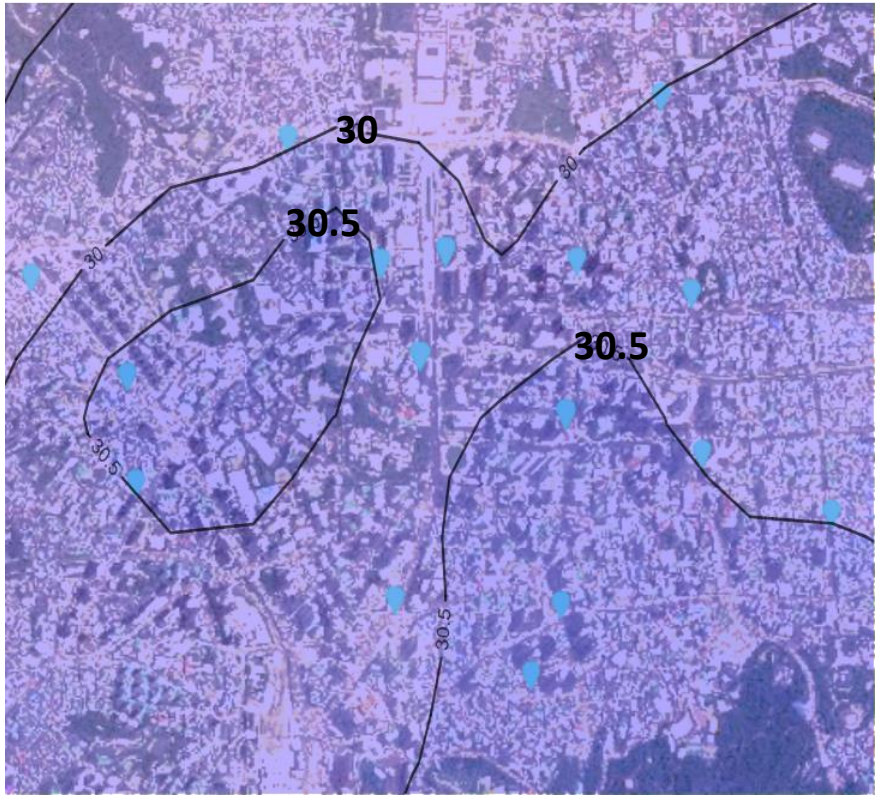




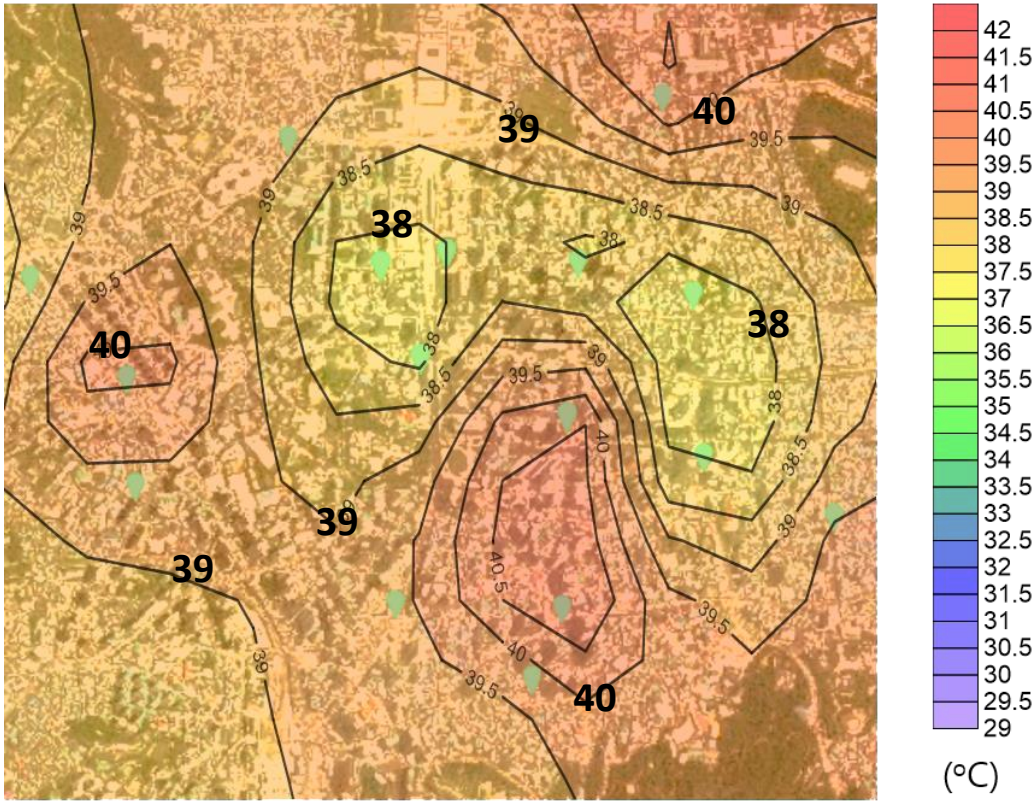
Horizontal distribution



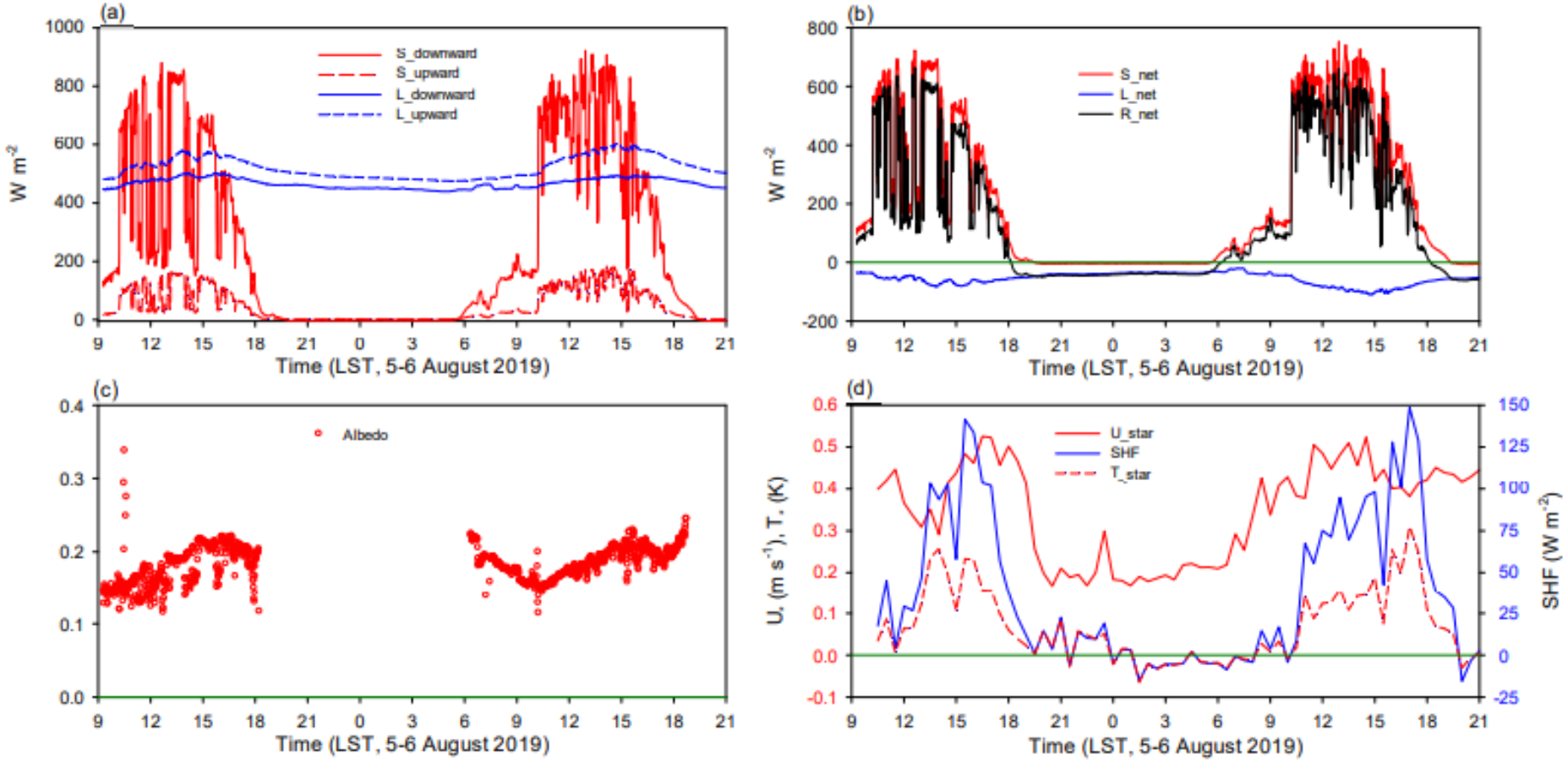
05 LST 06 August 2019



15 LST 06 August 2019

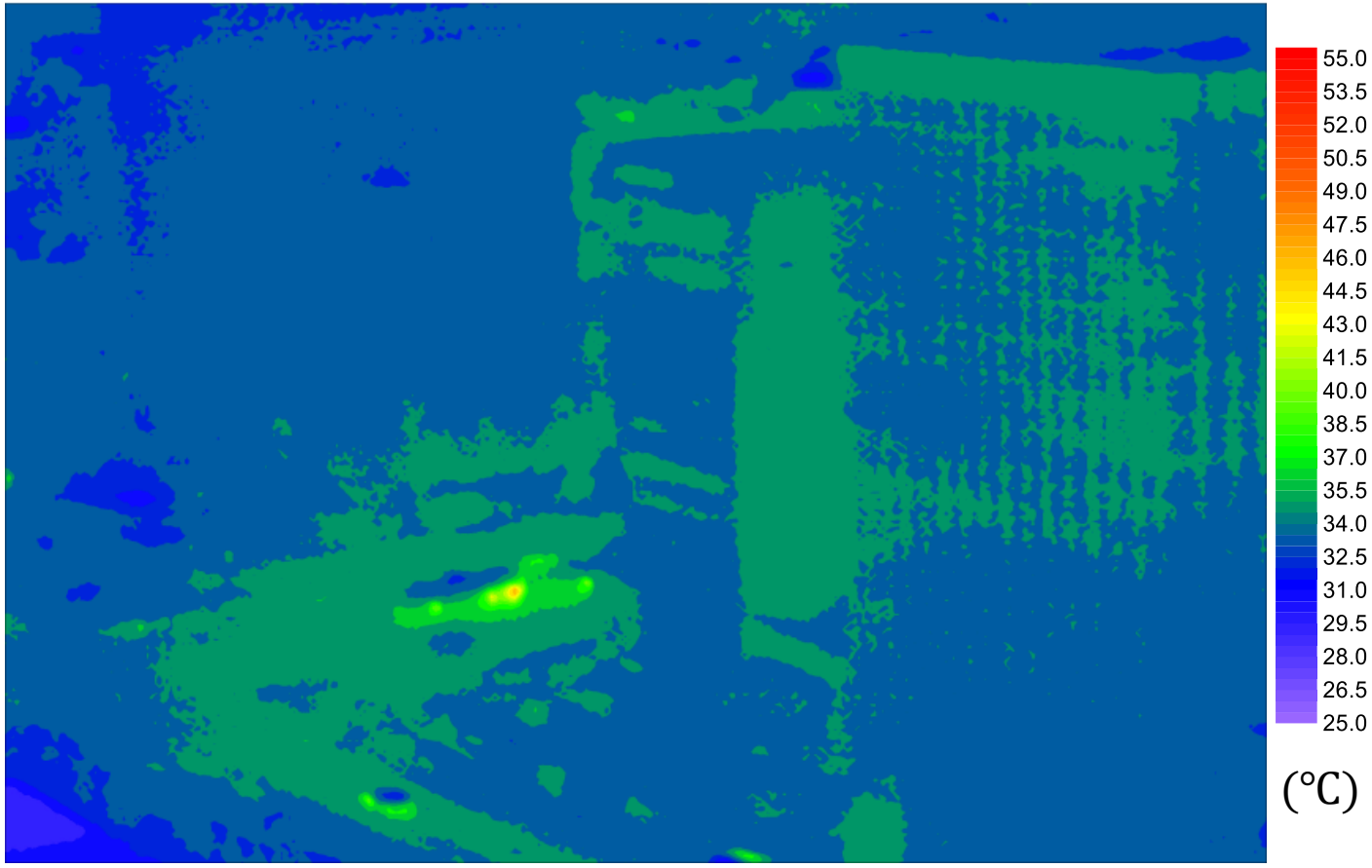


Radiation and Turbulence

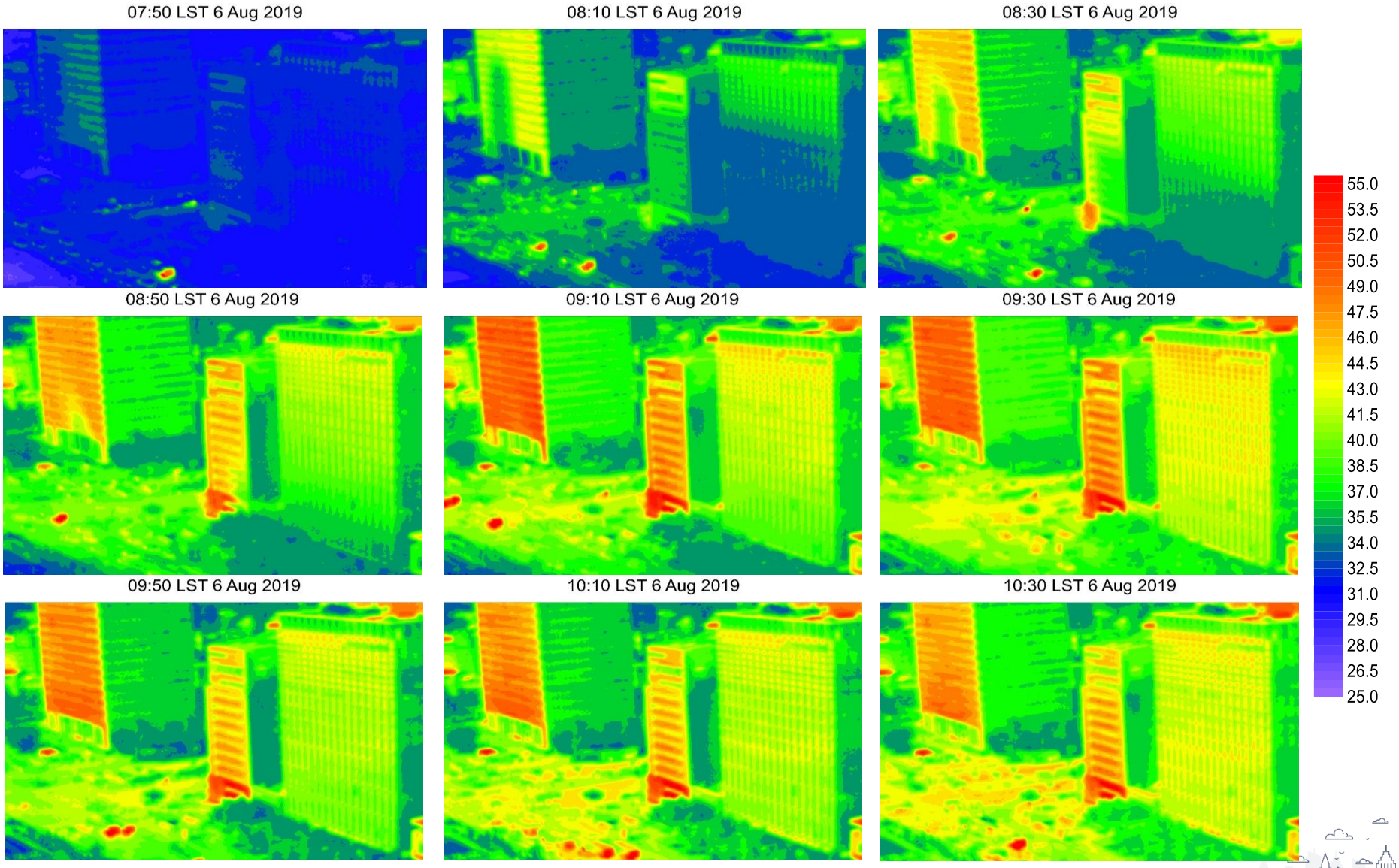


Surface Temperature by Thermal Infrared Imager

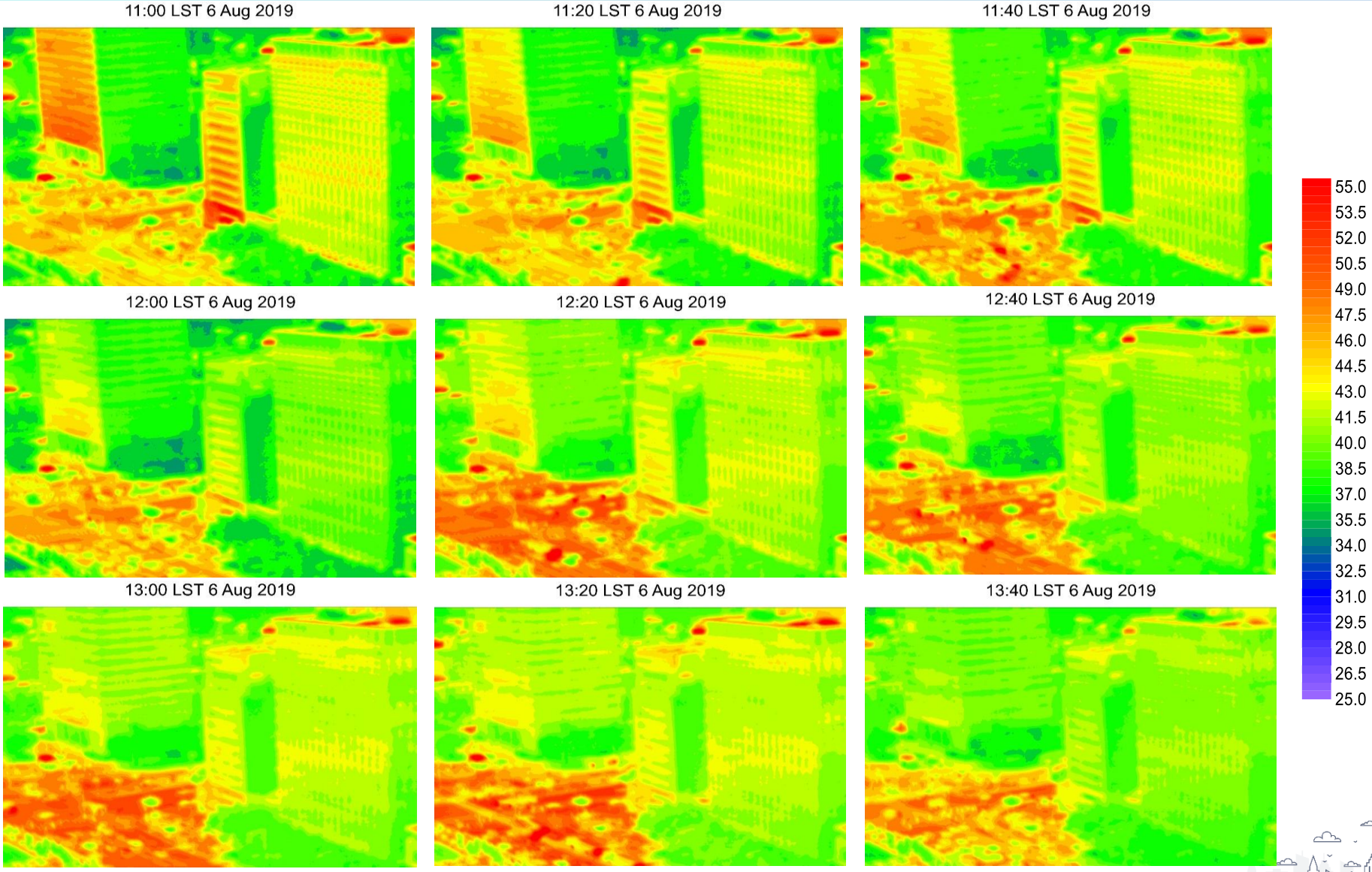
00:00 LST 6 Aug 2019



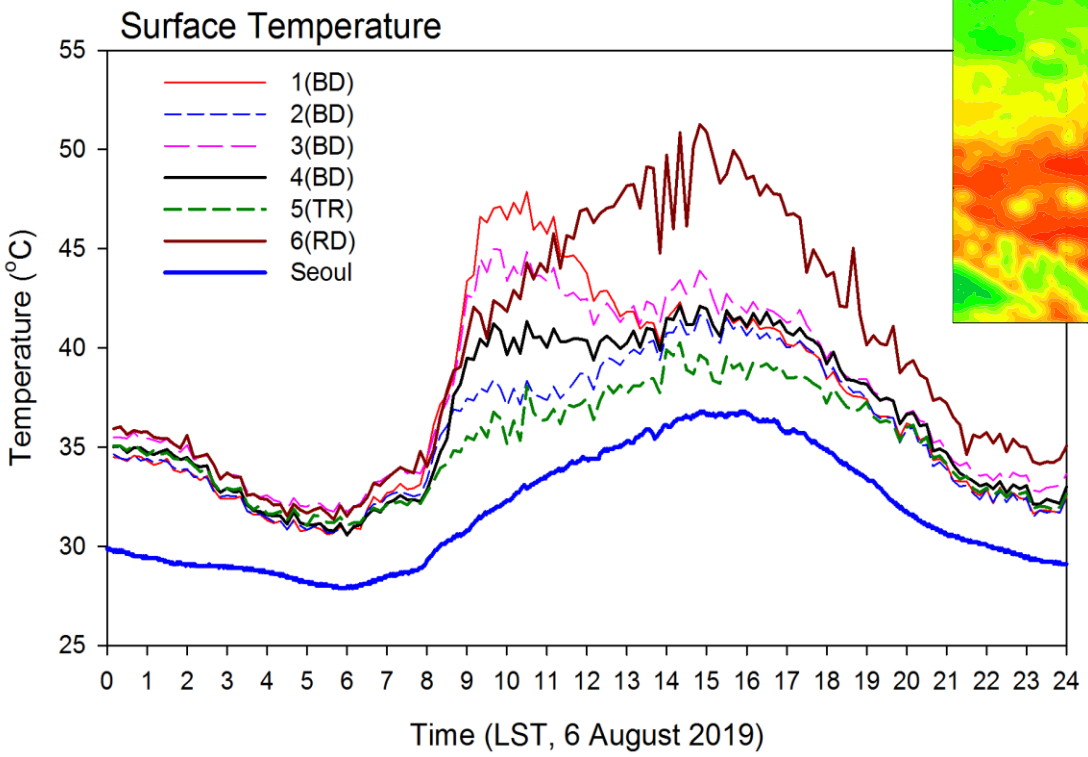
Surface Temperature (morning)

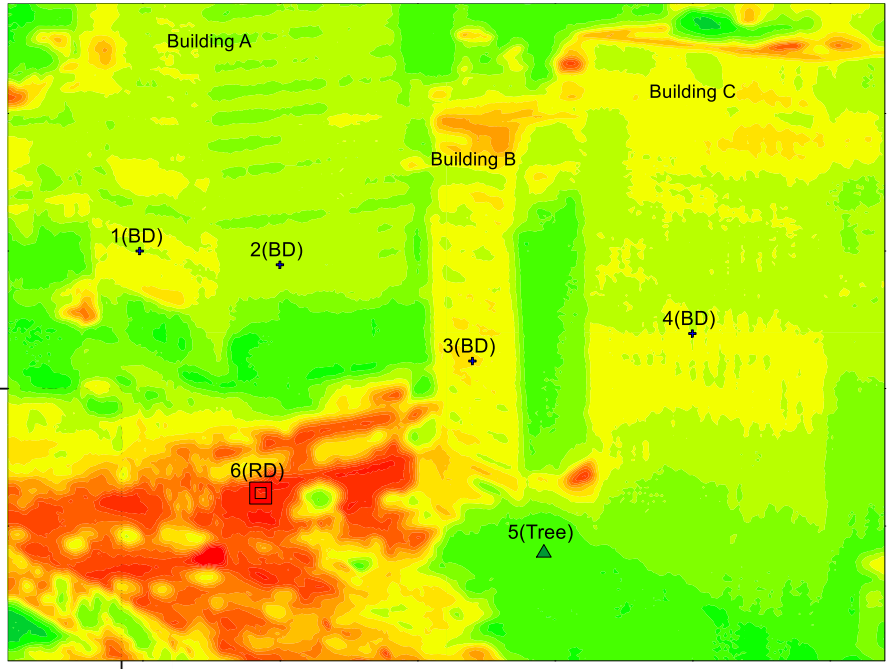


Surface Temperature (near noon)



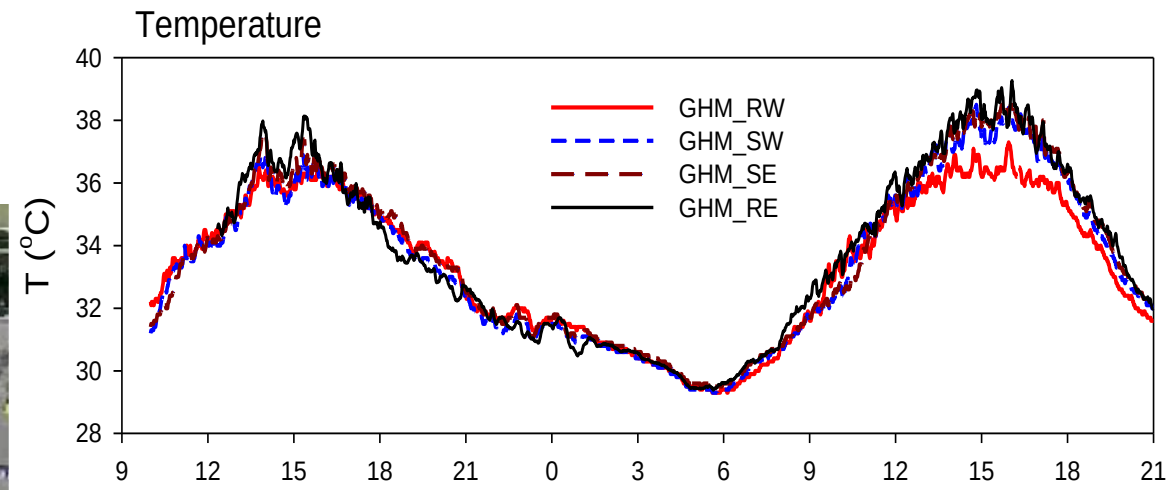
Surface Temperature



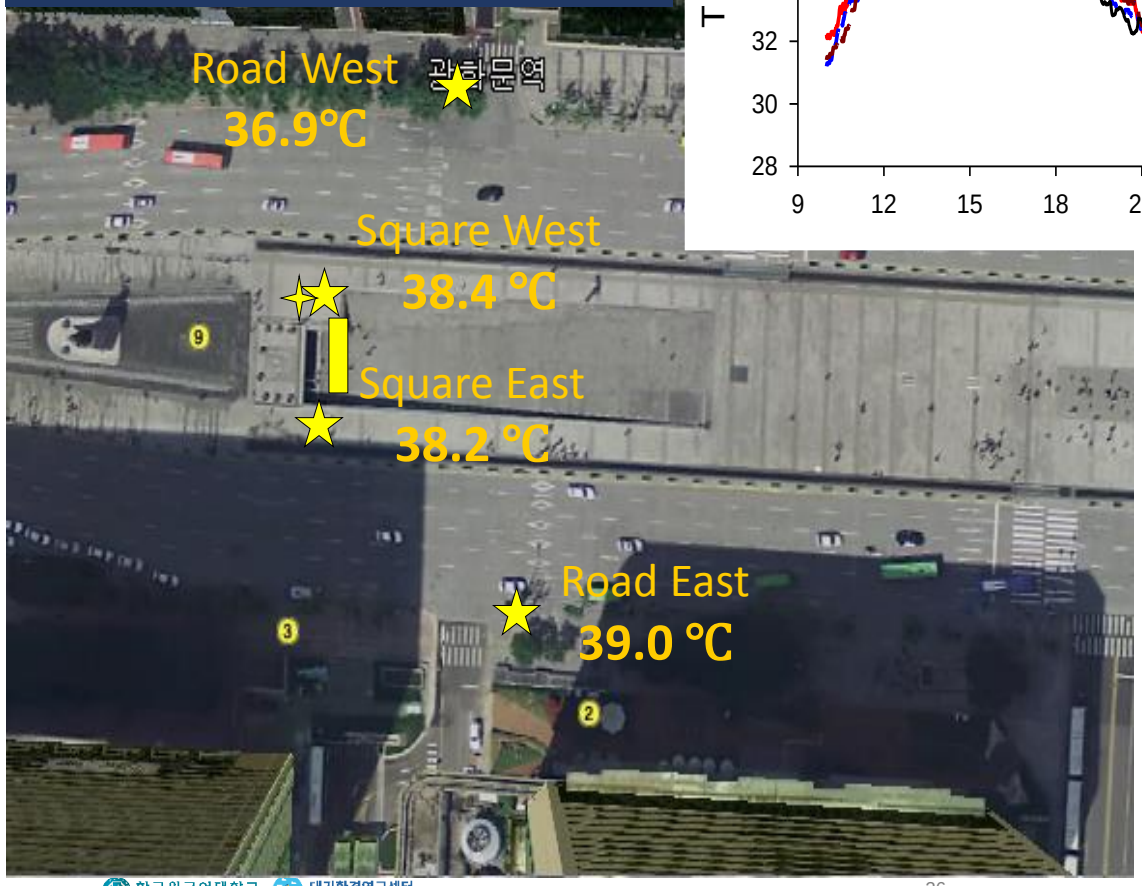


AWS

Seoul ASOS (6 Aug)
- 14:50~15:00 : 36.8 ℃
- 05:40~06:10 : 27.9 ℃



8월 6일 14:50~15:00



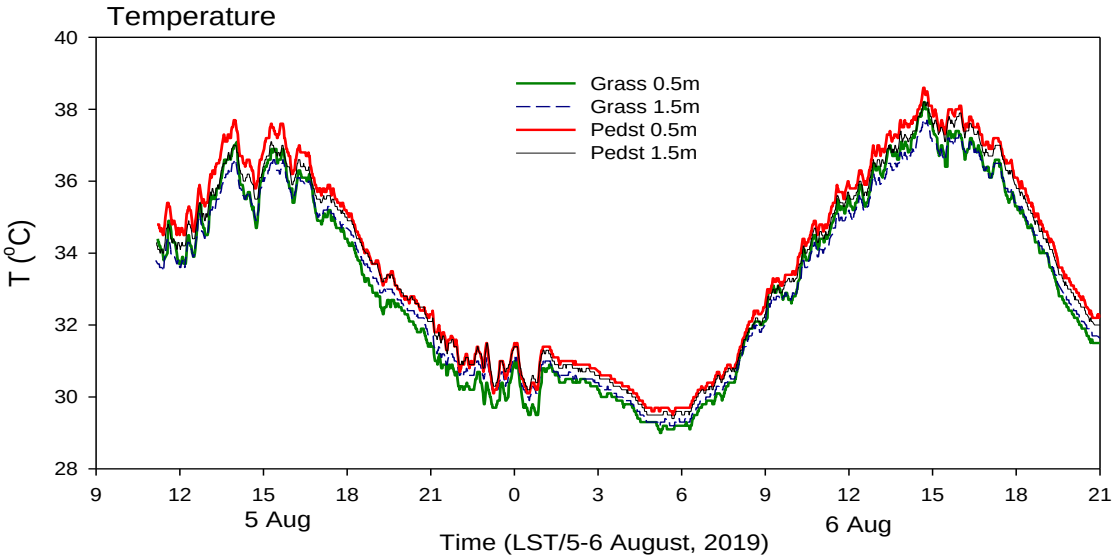
6 Aug 14:50~15:00

RW: 36.9 ℃ (+0.1 ℃)
SW: 38.4 ℃ (+1.6 ℃)
SE: 38.2 ℃ (+1.4 ℃)
RE: 39.0 ℃ (+2.2 ℃)

6 Aug 05:40~06:10

: 29.4~29.6 ℃
(+1.5~1.7 ℃)

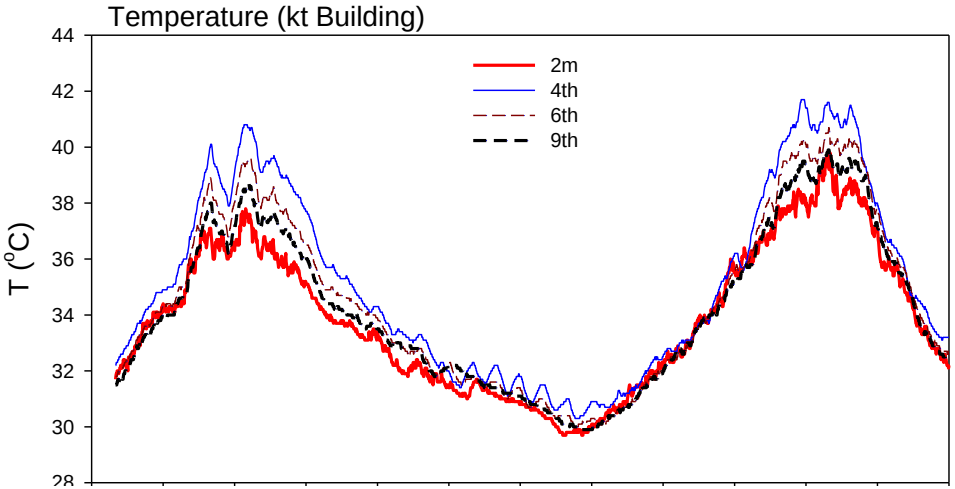
AWS – Grass/Pedestration

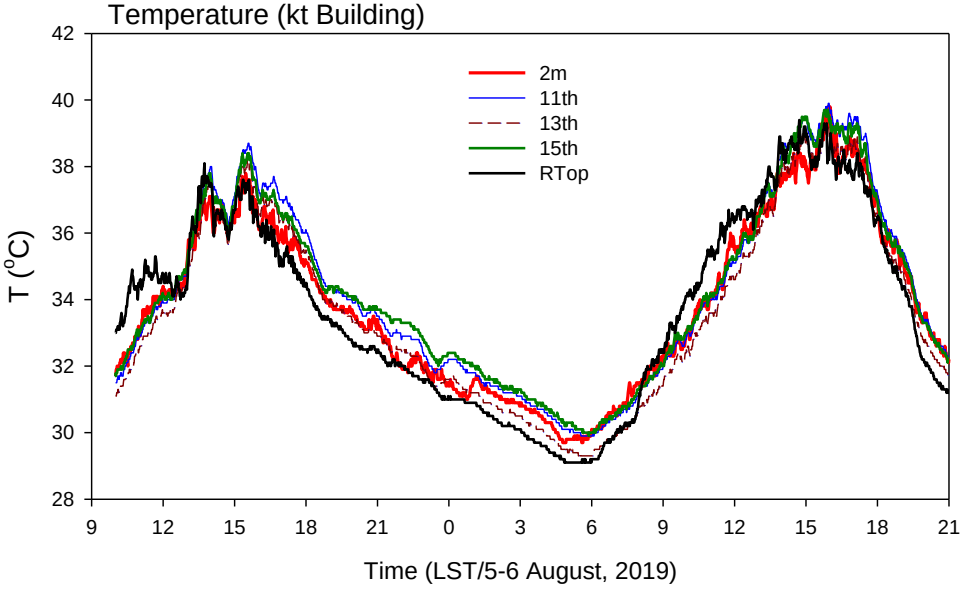


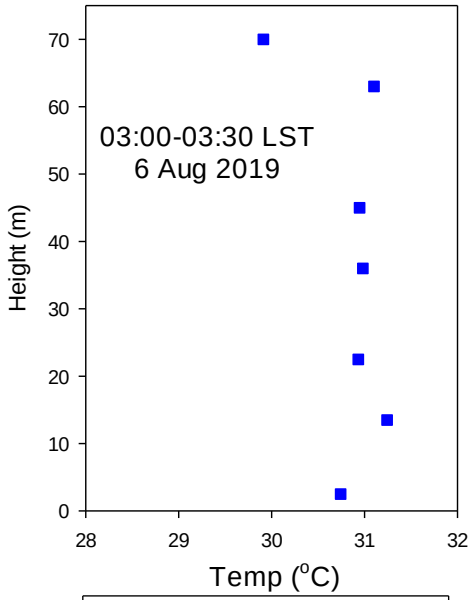
1.5m Ped – Grass Difference

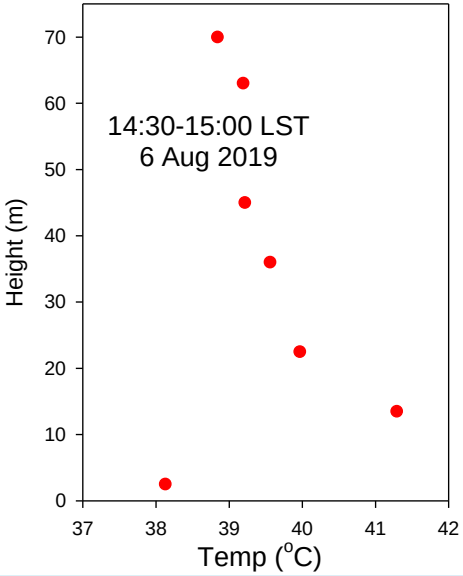
- ✓ Daytime: 0.6 ~ 0.7 ℃
- ✓ Nightime: 0.3 ~ 0.4 ℃

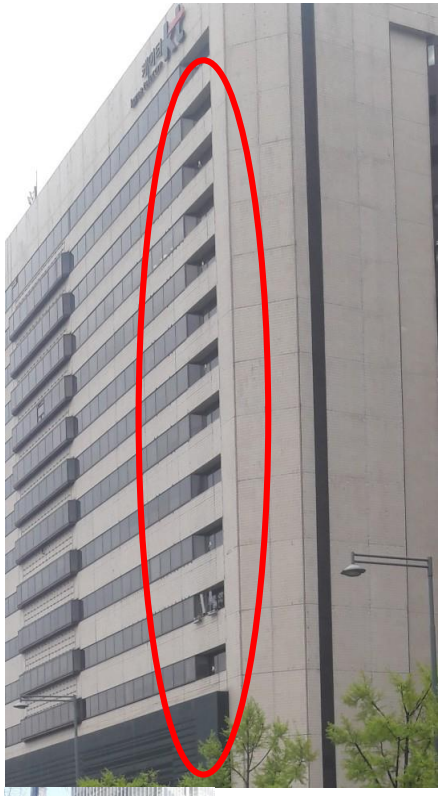
Vertical Profile in a BB



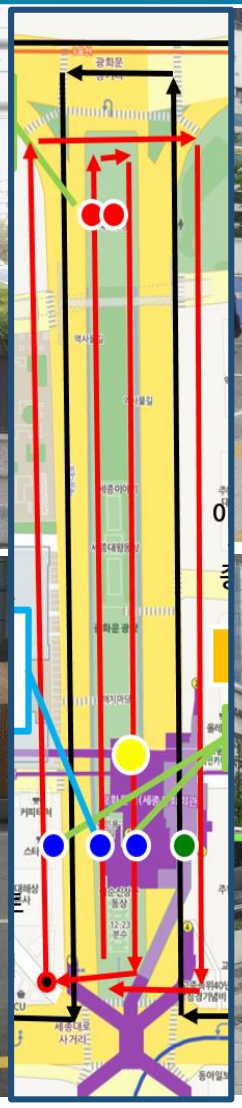




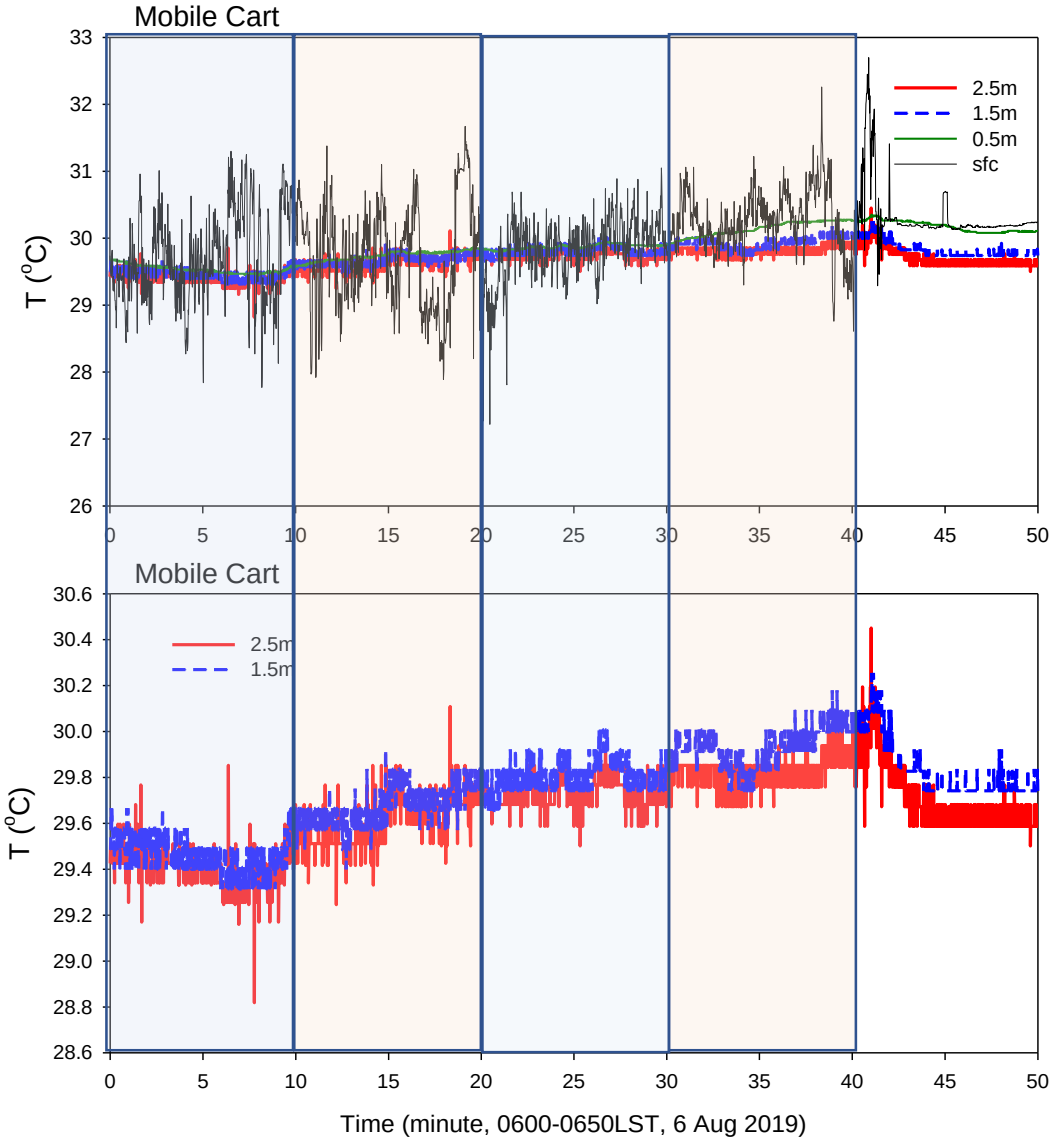




Mobile Cart (View)



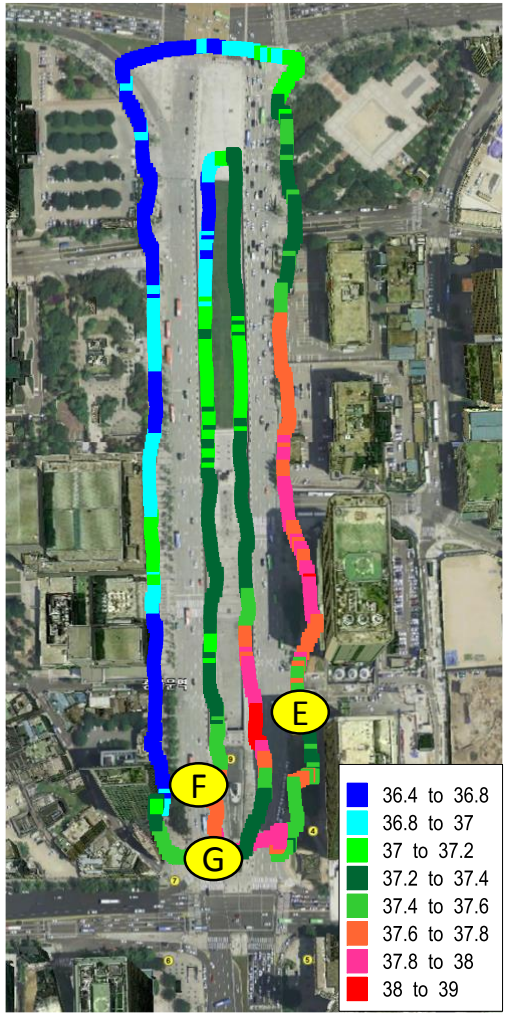
03 Mobile Cart (06 LST)



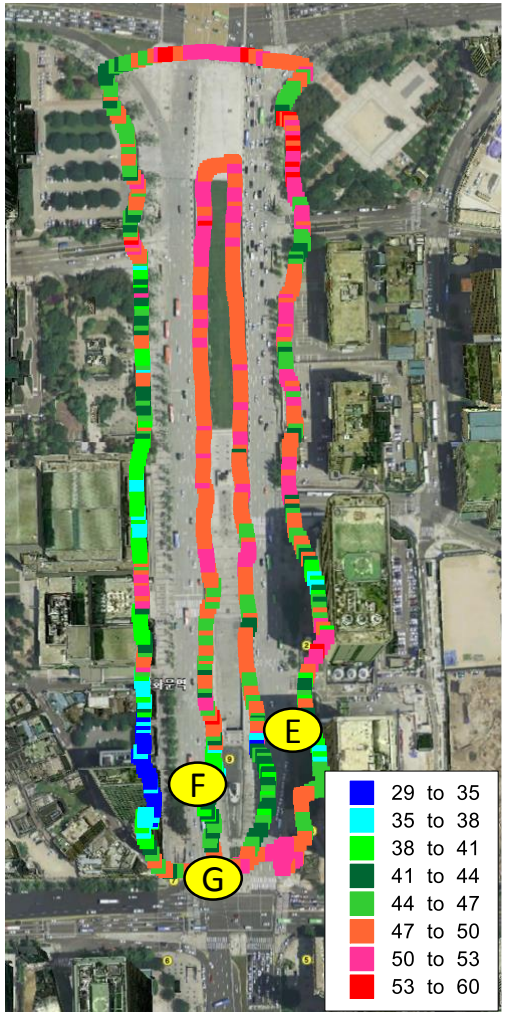
- ✓ 05:40 Sunrise
- ✓ 06:12 Net Rad >0
- ✓ 18:13 Net Rad <0
- ✓ 19:36 Sunset

Mobile Cart (16 LST)

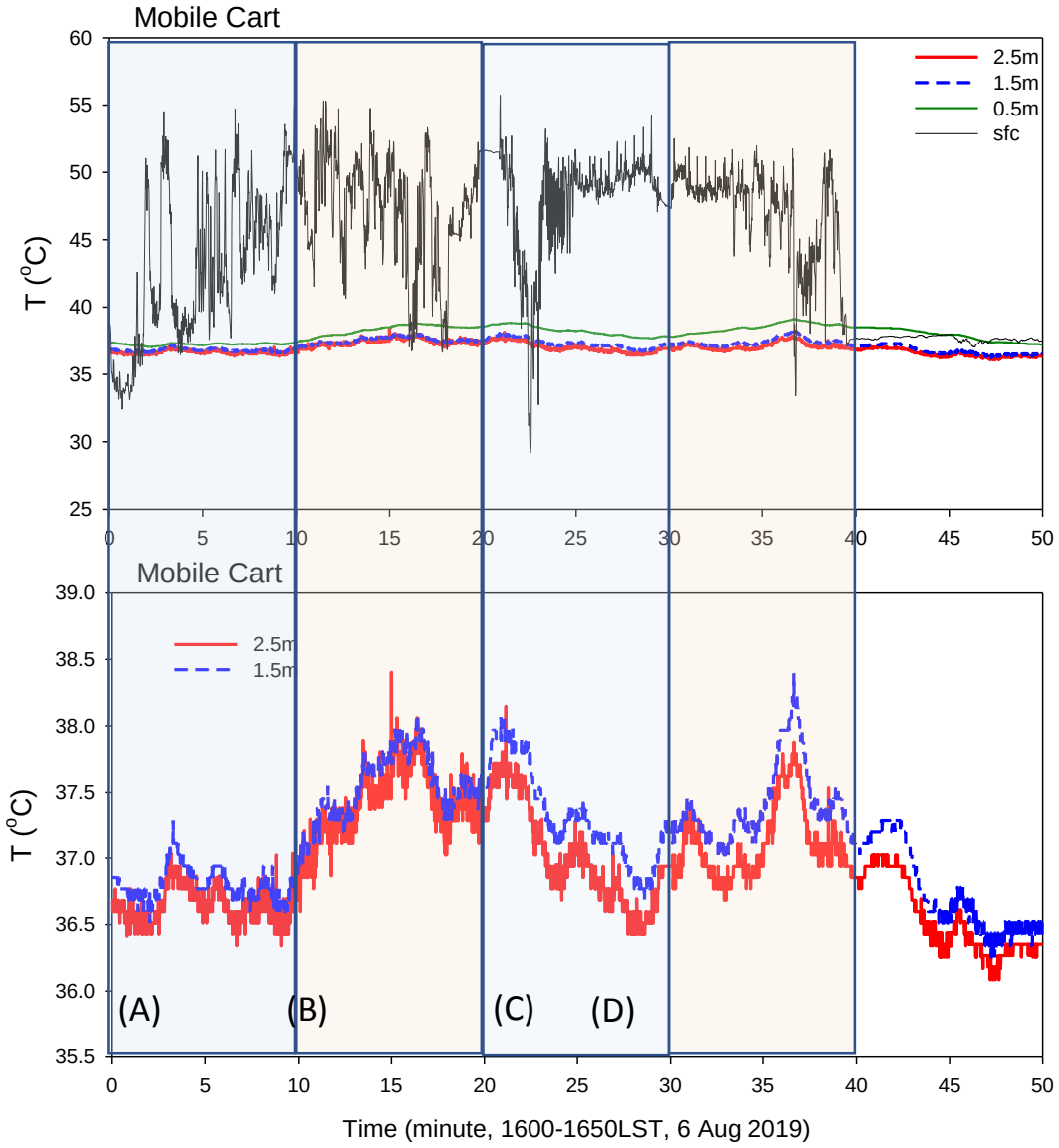
1.5m Temperature



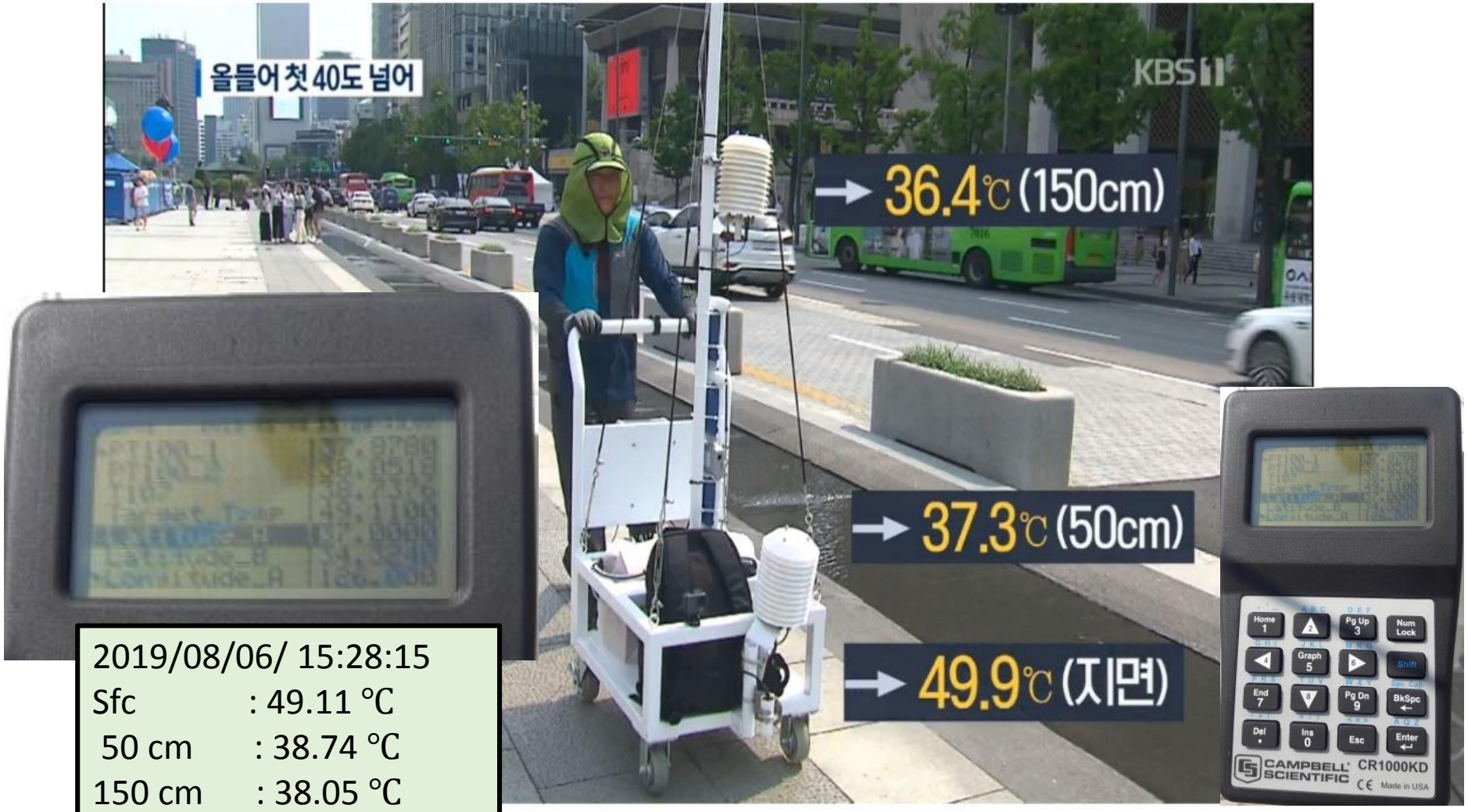
Surface Temperature



Mobile Cart (16 LST)



이동형 카트 관측



2019/08/06/ 15:28:15

Sfc	: 49.11 ℃
50 cm	: 38.74 ℃
150 cm	: 38.05 ℃
250 cm	: 37.87 ℃

Historic Waterway

07:15 LST

09:50 LST

04:30 LST

26.6°C / 29.6 °C

Building
Block 3-dimensional urban
Meteorological Observation
EXperiment

04 Summary

Summary

- ✓ To elucidate high-resolution features of surface and air temperature in high-rise building blocks, 2019 BBMEX (3-dimensional building block meteorological observation experiment) campaign was carried out in a central commercial area (Gwanghwamun area) in Seoul during the heat wave and tropical night period (5-6 August) in 2019.
- ✓ Several types of fixed instruments were deployed, a mobile meteorological observation cart (MOCA) and a vehicle (MOVE) were operated periodically.
- ✓ The surface temperature was determined to be strongly dependent on the facial direction of a building, and sunlit or shade by surrounding obstacles. Considerable increases in surface temperature on the eastern facades of buildings before noon, on horizontal surfaces near noon, and on the western facades in the afternoon could provide more energy in BBs than over a flat surface.
- ✓ The air temperatures in the BB were higher than those at the Seoul ASOS station by 0.1-2.2 °C (1.1-1.9 °C) in daytime (night-time).
- ✓ The MOCA revealed that the surface and air temperature in a BB could be affected by many complex factors, such as the structures of the BBs, shades, as well as the existence of facilities that mitigate heat stresses, such as ground fountain and waterways.

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대기환경연구센터 Research Center for Atmospheric Environment

Thank you!