

Application of Button-size Temperature Sensors for Micro-climate Study of the Urban Environment of Hong Kong

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Objective

Study the heat distribution/variations over the Kowloon Peninsula in different weather scenarios for better understanding of the urban climate.



Temperature Sensor (i-Button)



Accuracy: better than $\pm 0.5^{\circ}\text{C}$

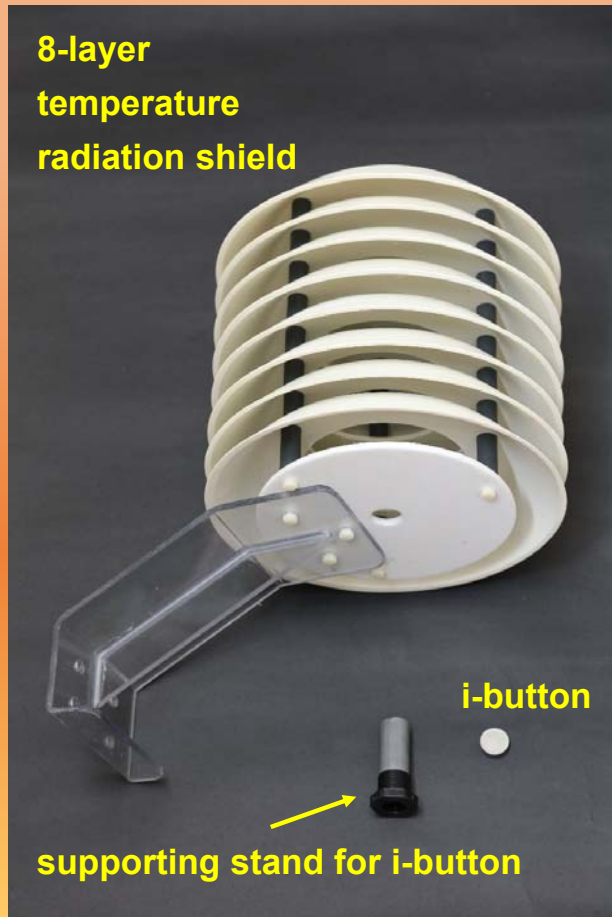
Range: -10°C to $+65^{\circ}\text{C}$

Sampling time: 5 minute

Individually calibrated in a NIST-traceable chamber

No external electric supply needed

Radiation Shield

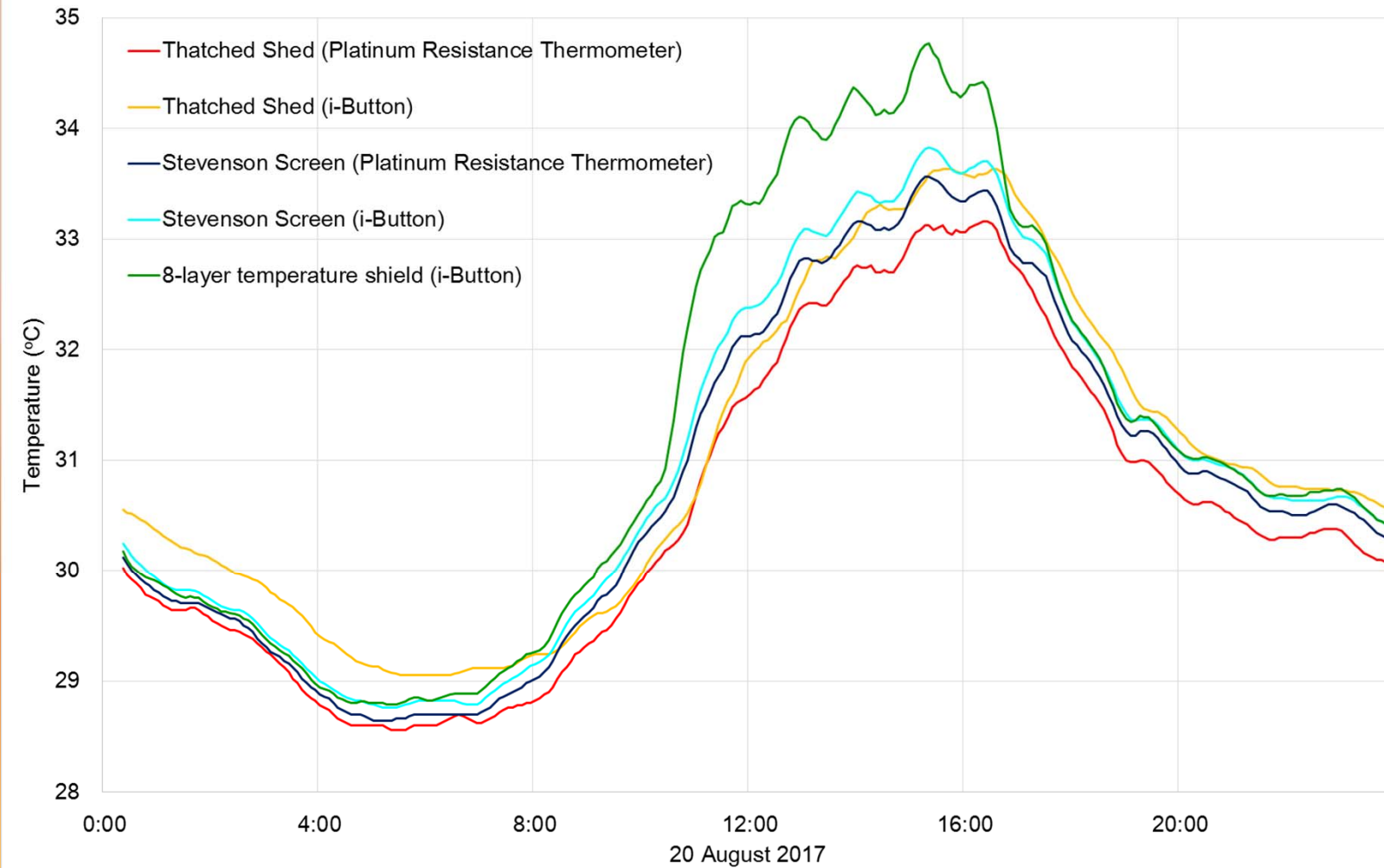


20 August 2017

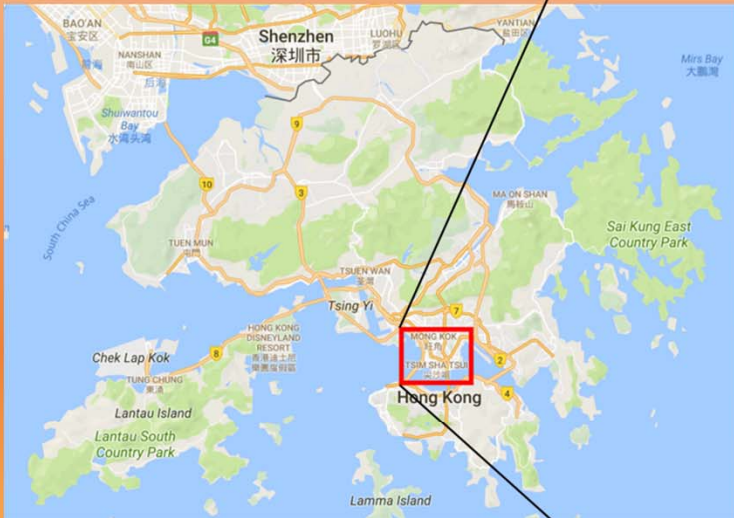
Mean Cloud
amount: 29%

Mean RH: 75%

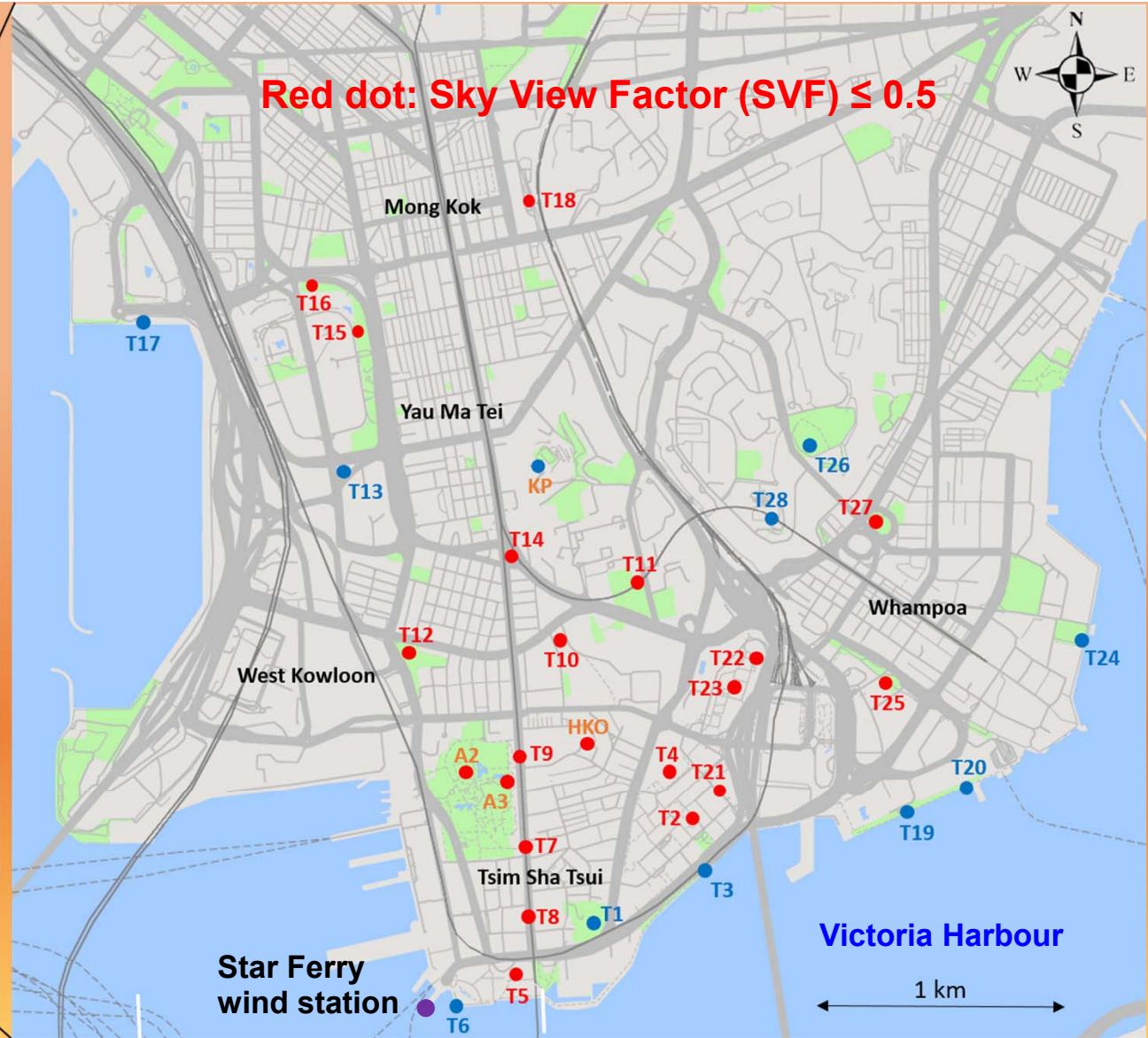
Total Bright
Sunshine:
10.2 hours



Observation Network



Map data ©2017 Google



Measuring Sites (Green Park, East of HKO)



Science Museum (T4)

Measuring Sites (Green Park, West of HKO)



Kowloon Park, Park Lane (A3)

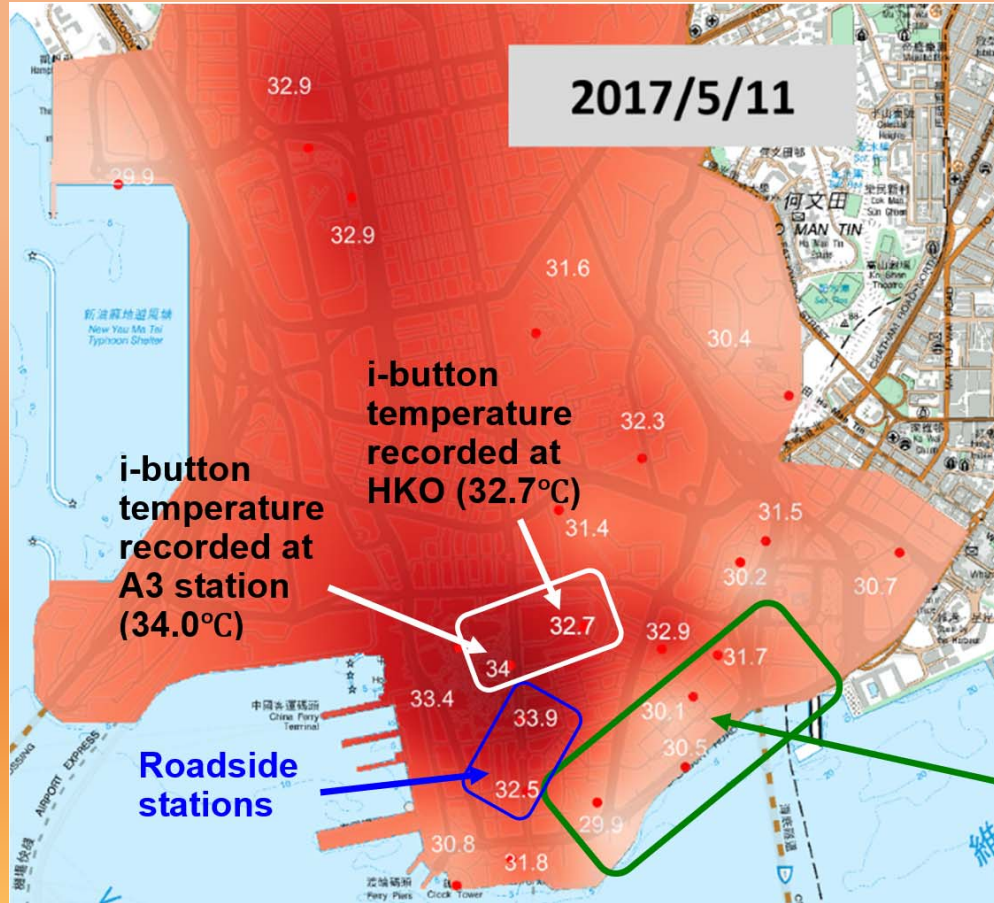
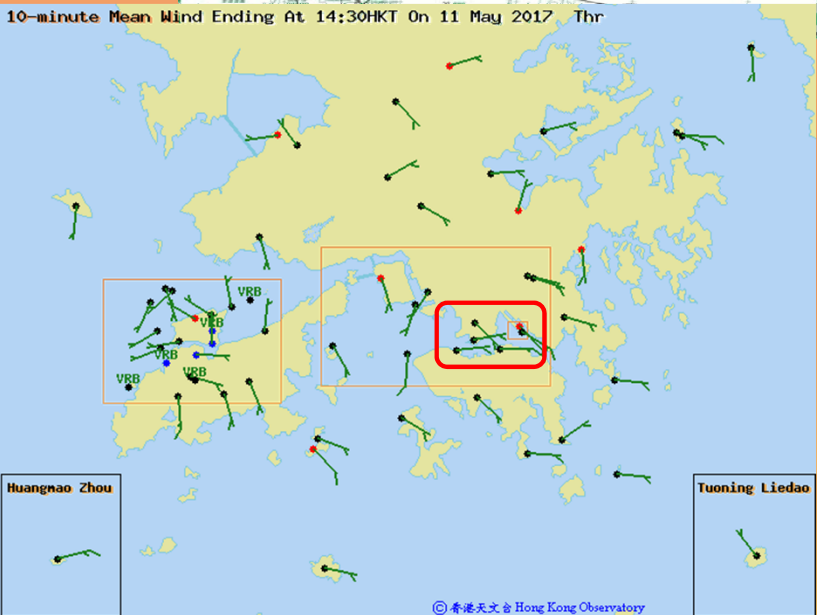
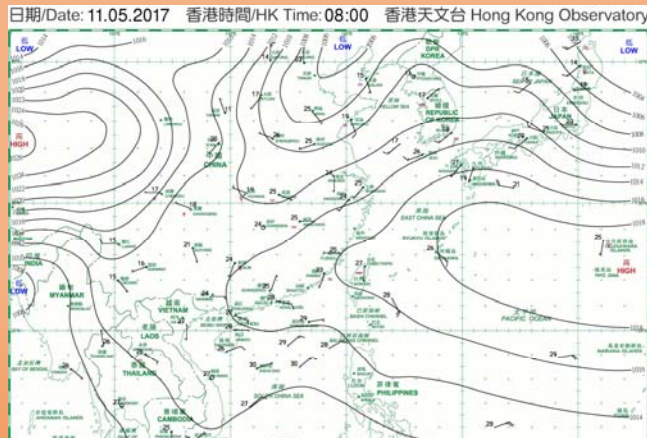
Site Characterization

Station Code	Site Name (latitude and longitude of temperature station)	Altitude	WMO Site Classification		Sky View Factor (SVF)
			Heat Source	Projected Shade	
HKO	HKO Headquarters (22°18'07" 114°10'27")	33.0m	3	5	0.31
KP	King's Park Meteorological Station (22°18'43" 114°10'22")	67.0m	1	1	0.61
A2	Kowloon Park Central (22°18'03" 114°10'11")	26.9m	2	4	0.46
A3	Park Lane, Kowloon Park (22°18'02" 114°10'17")	18.7m	4	5	0.46
T1	Signal Hill Garden (22°17'45" 114°10'29")	36.6m	2	5	0.50
T2	East Tsim Sha Tsui Centenary Garden (22°17'58" 114°10'41")	5.8m	4	5	0.27
T3	East Tsim Sha Tsui Promenade (22°17'49" 114°10'41")	6.1m	3	4	0.58
T4	Science Museum (22°18'03" 114°10'37")	11.0m	4	4	0.45
T5	Space Museum (22°17'38" 114°10'17")	5.6m	5	5	0.34
T6	Viewing Deck of Cultural Centre (22°17'35" 114°10'10")	10.1m	2	4	0.73
T7	Nathan Road near Kowloon Mosque (22°17'53" 114°10'19")	8.7m	5	5	0.27
T8	Nathan Road near Chungking Mansions (22°17'46" 114°10'20")	6.3m	5	5	0.12
T9	Nathan Road near Park Lane (22°18'05" 114°10'18")	11.1m	5	5	0.38
T10	Kowloon Cricket Club (22°18'20" 114°10'24")	9.9m	2	4	0.38
T11	Club de Recreio (22°18'27" 114°10'35")	10.8m	3	4	0.49
T12	Koon Chung King George V Memorial Park (22°18'19" 114°10'03")	8.1m	2	4	0.33

Site Characterization

Station Code	Site Name (latitude and longitude of temperature station)	Altitude	WMO Site Classification		Sky View Factor (SVF)
			Heat Source	Projected Shade	
T13	Junction Road (22°18'41" 114°09'54")	5.7m	3	2	0.58
T14	Gascoigne Road (22°18'31" 114°10'17")	8.6m	4	5	0.32
T15	Cherry Street Park (22°18'58" 114°09'57")	7.2m	3	4	0.48
T16	Cherry Street Park North (22°19'05" 114°09'50")	6.1m	3	4	0.39
T17	Olympic Hoi Fai Road Promenade (22°19'00" 114°09'26")	5.9m	2	2	0.56
T18	Mong Kok East Station (22°19'16" 114°10'19")	14.2m	5	5	0.39
T19	Hung Hom Promenade (22°17'59" 114°11'11")	5.9m	2	4	0.63
T20	Hung Hom Pier Promenade (22°18'02" 114°11'19")	5.7m	3	4	0.51
T21	Hong Tat Path Garden (22°18'03" 114°10'45")	7.3m	4	5	0.23
T22	Podium of Polytechnic University(22°18'17" 114°10'51")	14.6m	5	5	0.47
T23	Lawn Polytechnic University (22°18'14" 114°10'48")	6.0m	4	5	0.17
T24	Tai Wan Shan (22°18'20" 114°11'35")	5.3m	4	4	0.56
T25	Hung Lai Road (22°18'15" 114°11'09")	5.2m	5	5	0.27
T26	Ho Man Tin East Service Reservoir (22°18'44" 114°10'57")	70.9m	2	4	0.60
T27	Fat Kwong Street Garden No.1 (22°18'35" 114°11'07")	20.1m	2	3	0.35
T28	Ho Man Tin High Level Service Reservoir Playground (22°18'35" 114°10'54")	75.9m	1	2	0.77

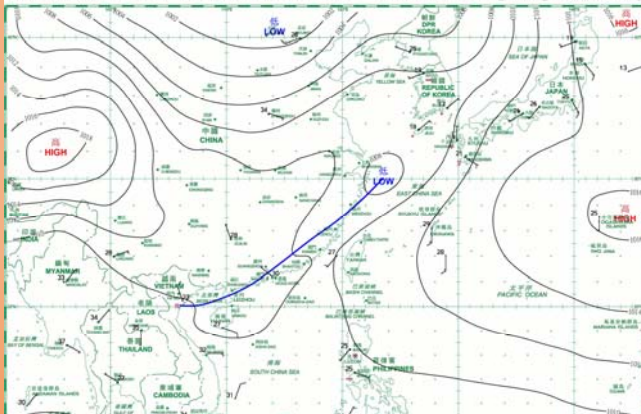
Scenario 1 – Easterly and westerly wind regimes



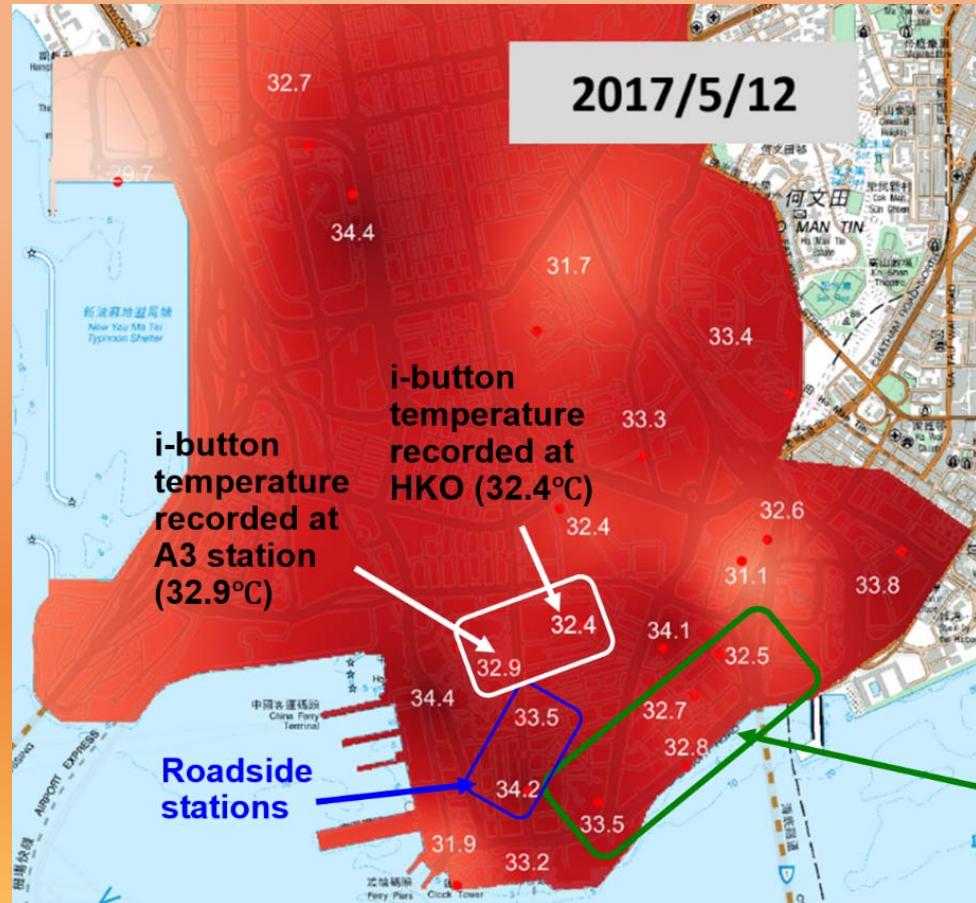
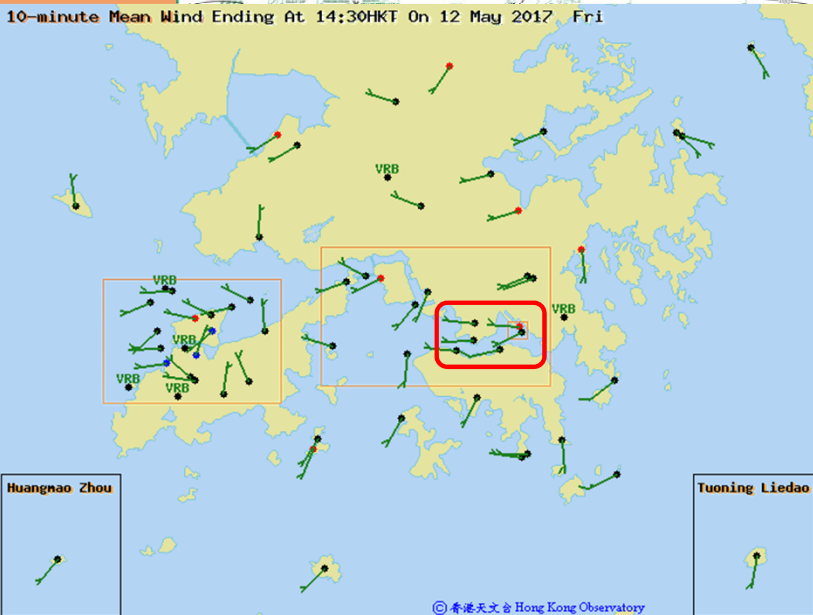
Lower temperatures on the eastern side

Scenario 1 – Easterly and westerly wind regimes

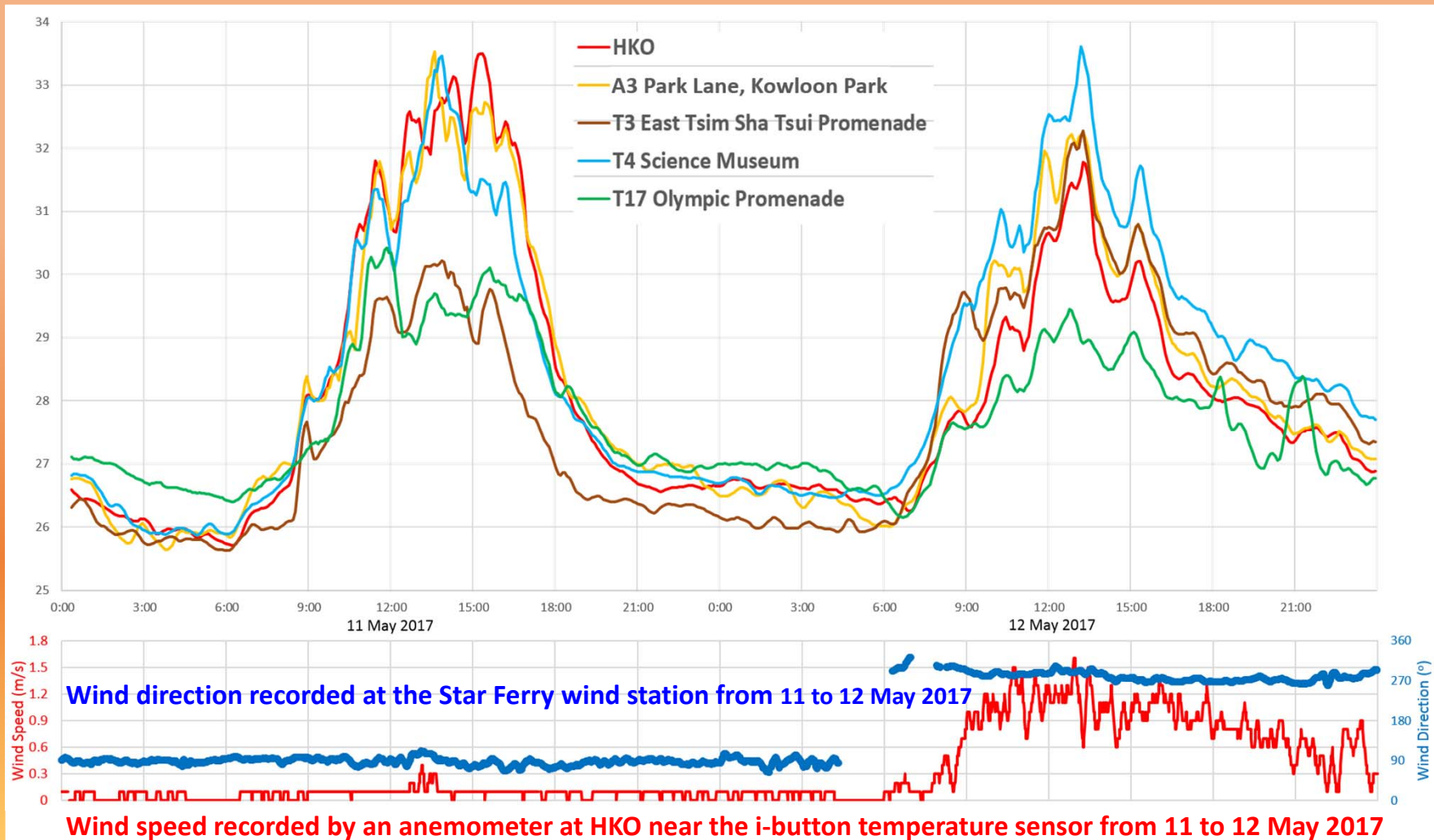
日期/Date: 12.05.2017 香港時間/HK Time: 14:00 香港天文台 Hong Kong Observatory



10-minute Mean Wind Ending At 14:30HKT On 12 May 2017 Fri



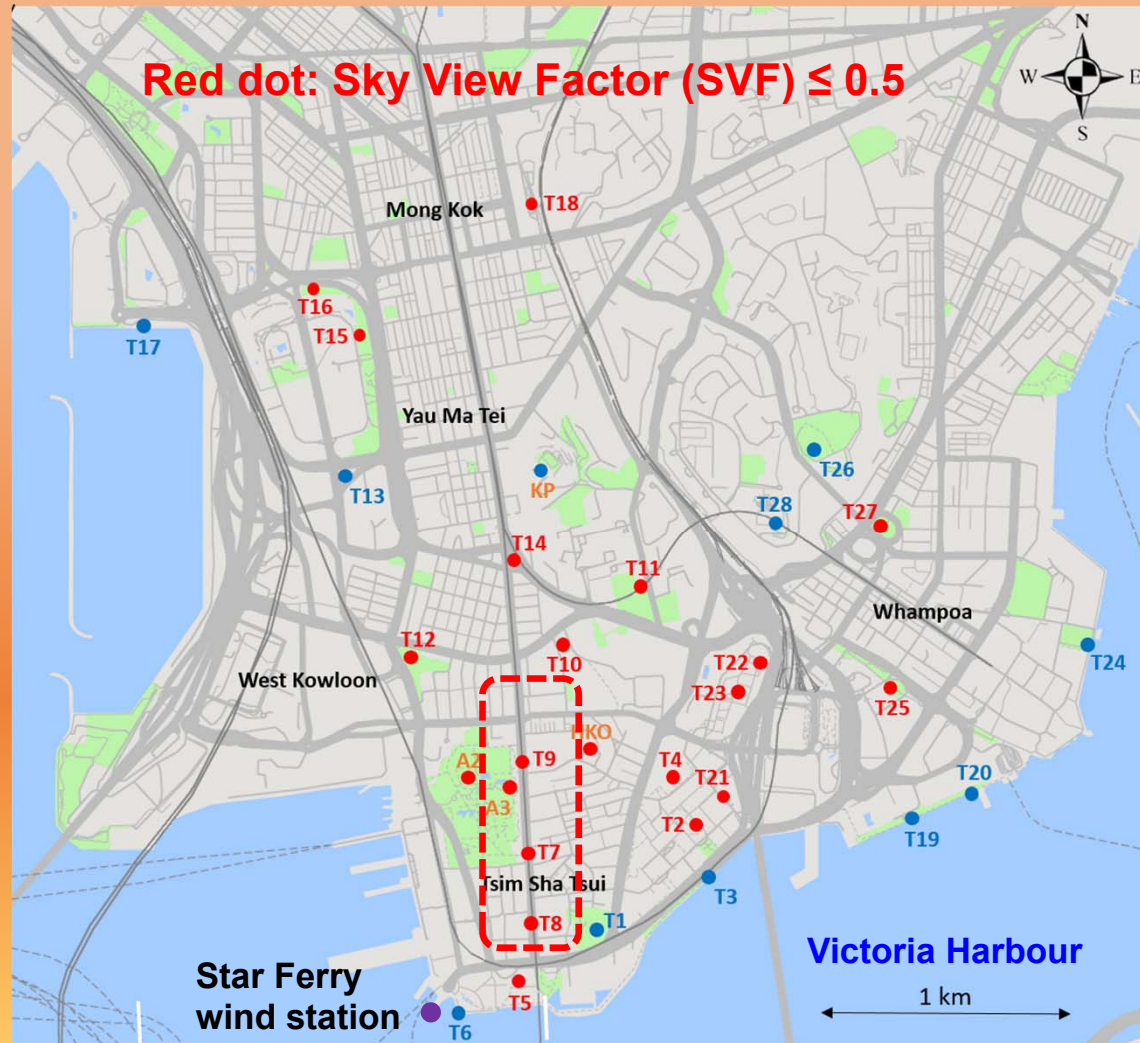
Scenario 1 – Easterly and westerly wind regimes



Scenario 1 – Easterly and westerly wind regimes



Scenario 2 – Roadside stations



Measuring Sites (Roadside)



Nathan Road near Park Lane (T9)

Measuring Sites (Roadside)



Nathan Road near Kowloon Mosque (T7)

Measuring Sites (Roadside)

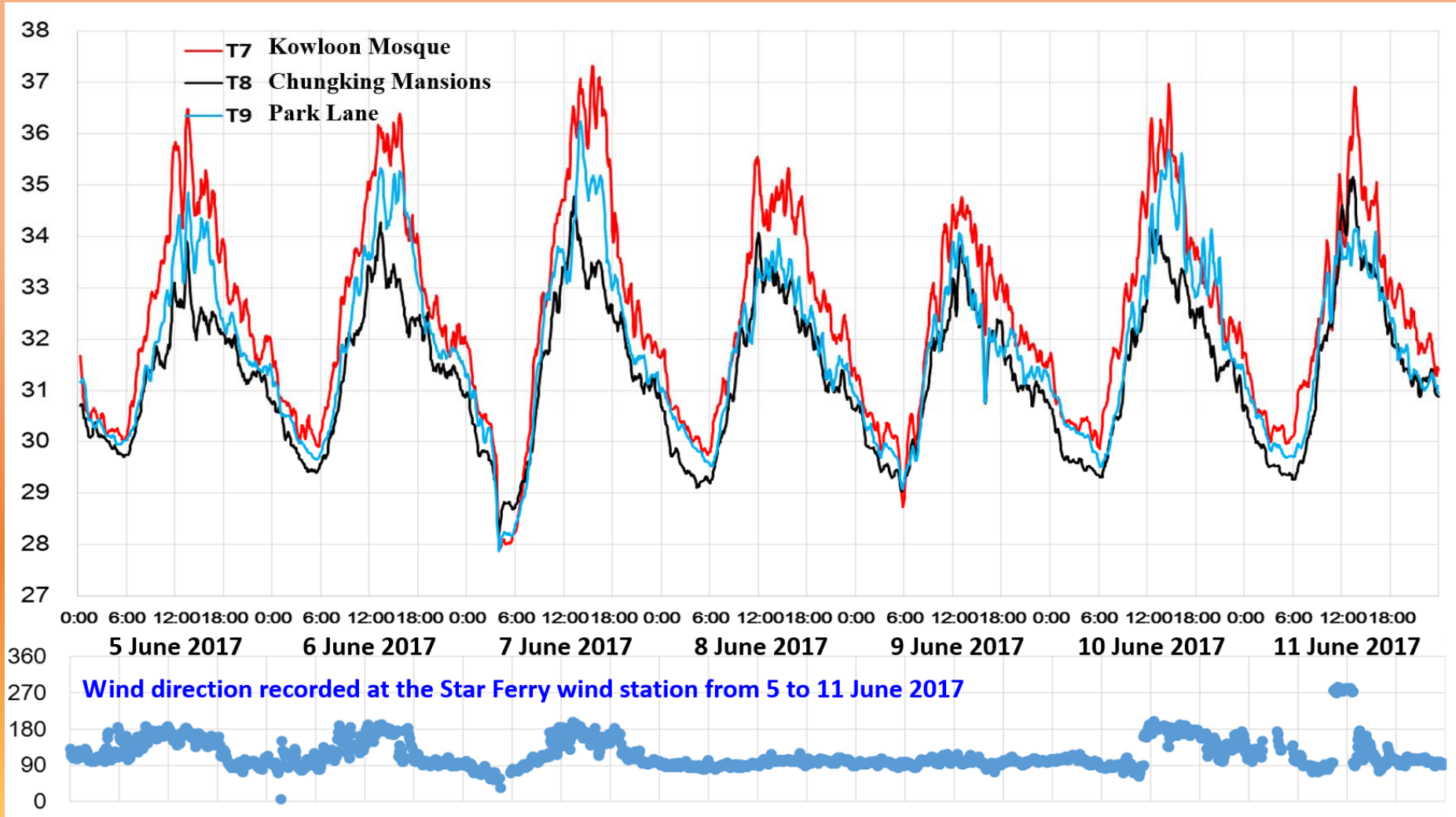


Nathan Road near Chungking Mansions (T8)

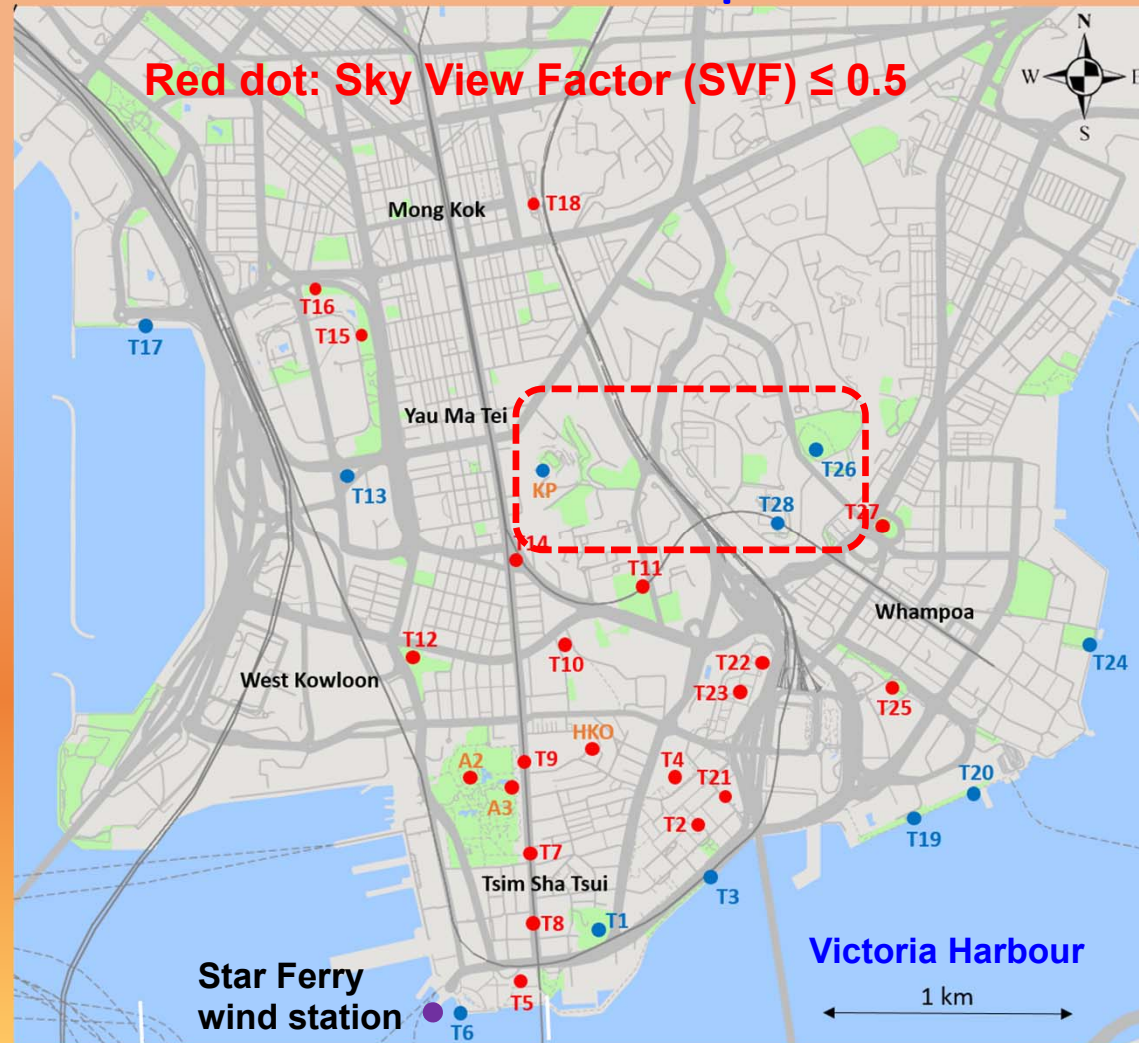
Scenario 2 – Roadside stations



Scenario 2 – Roadside stations



Scenario 3 – Hilltop stations



Measuring Sites (Hilltop)



King's Park Meteorological Station (KP) - 67m above the ground

Measuring Sites (Hilltop)



Ho Man Tin High Level Service Reservoir Playground (T28)
76m above the ground

Measuring Sites (Hilltop)

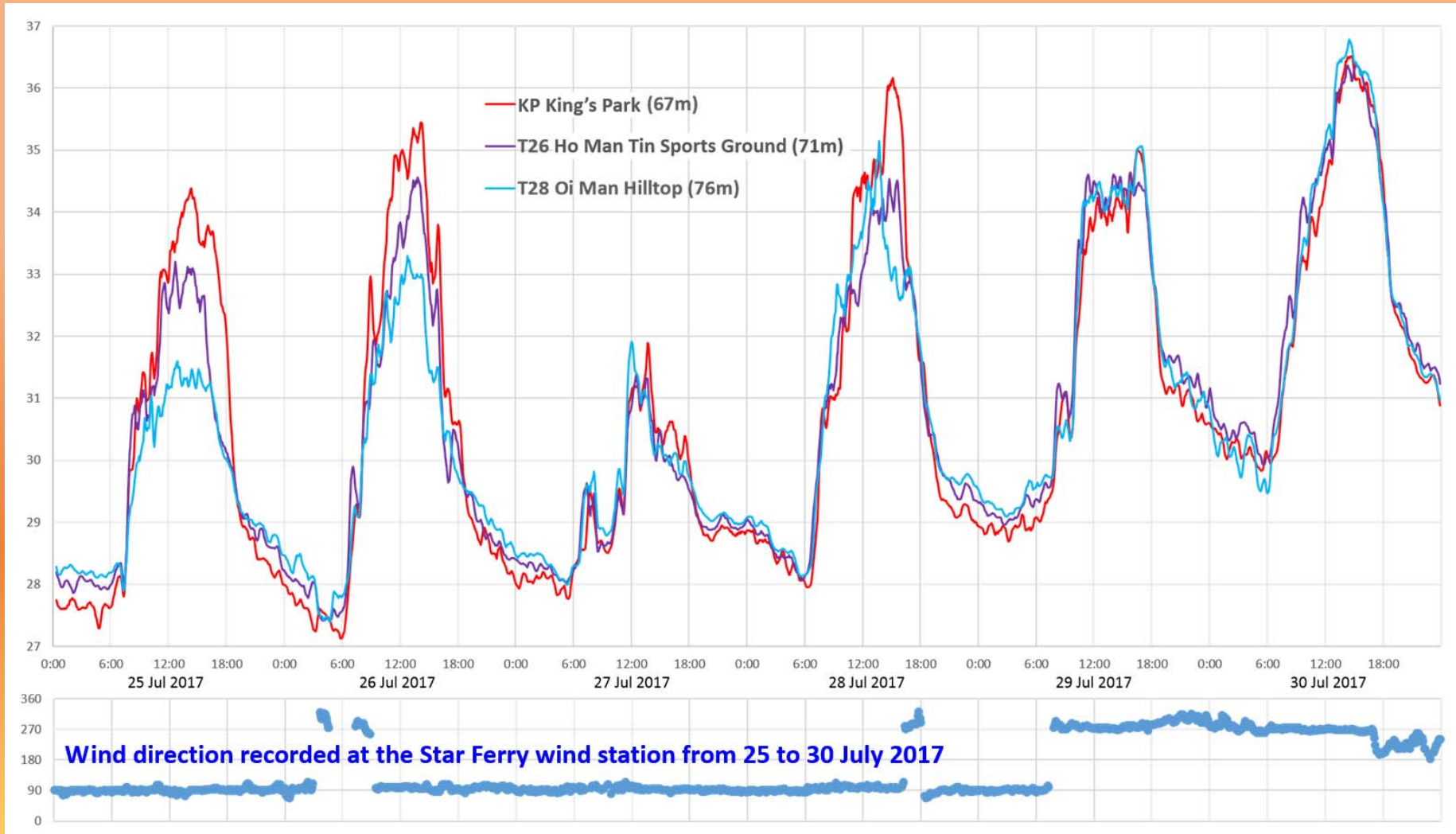


Ho Man Tin East Service Reservoir Playground (T26)
71m above the ground

Scenario 3 – Hilltop stations

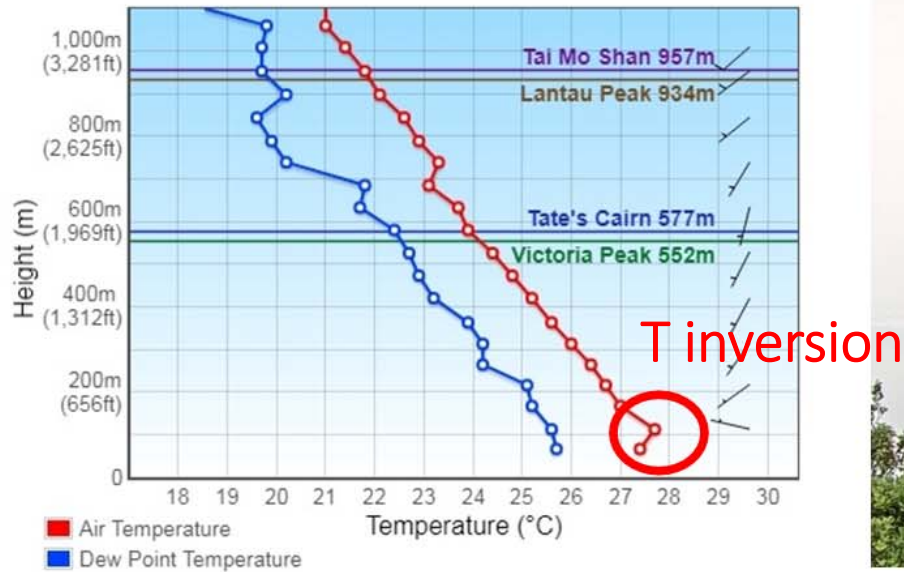


Scenario 3 – Hilltop stations



Scenario 3 – Hilltop stations

Vertical Variation of Air Temperature, Dew Point Temperature, Wind Speed and Wind Direction (0 - 1,000m)



Vertical variation of air temperature, dew point temperature and winds in the lower atmosphere on 29 July 2017. Hazy conditions over the Kowloon peninsula at 2:30 p.m. on 29 July 2017.

Preliminary Observation Summary

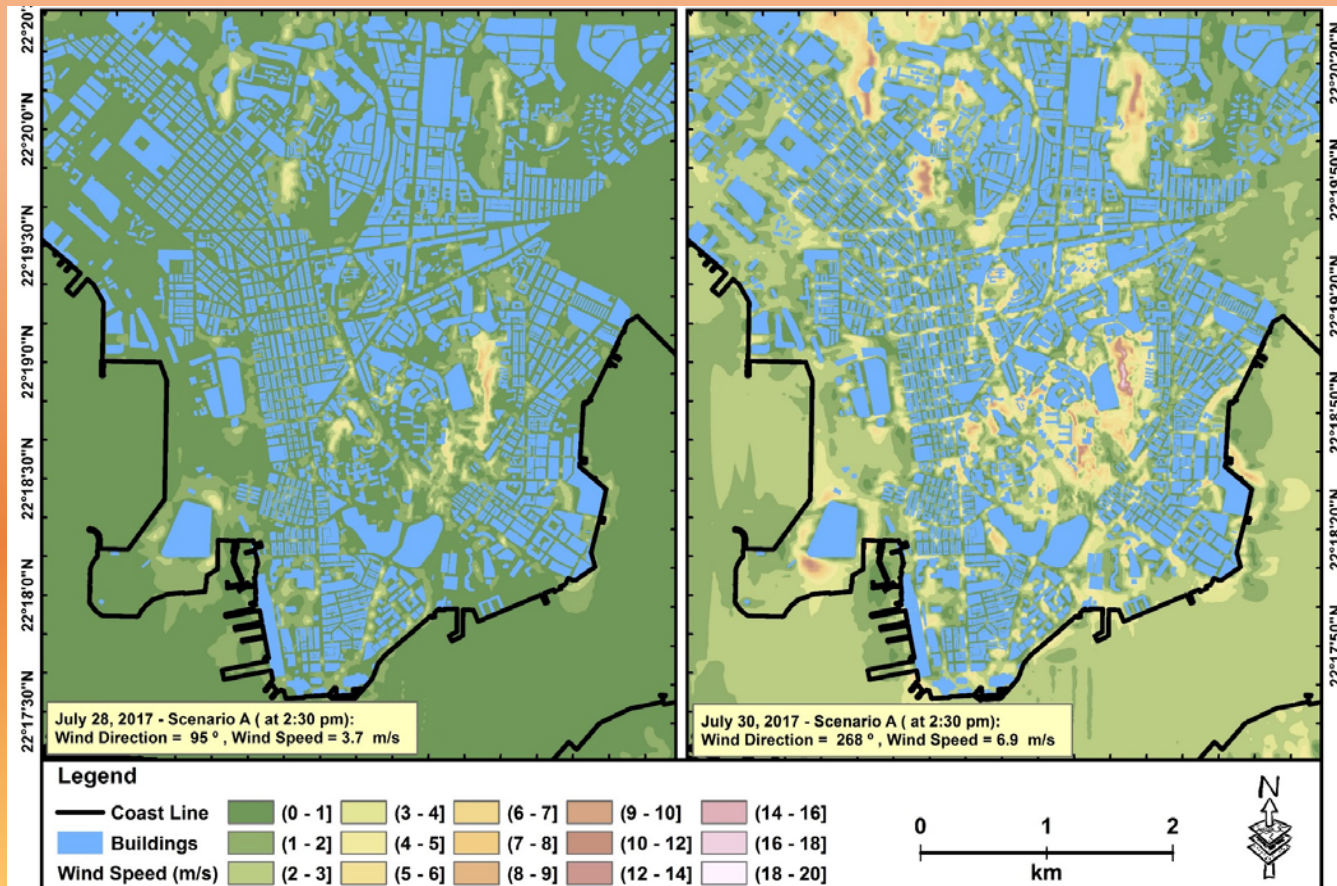
- For easterlies, T at HKO and stations to the west of HKO were relatively higher. For westerlies, those stations had lower T because of less influence of urban heat sources upstream and probably better ventilation.
- For roadside stations, heat sources from nearby vehicles might be an important factor.
- For hilltop stations, higher T was recorded at downstream station, more susceptible to the influence of urban heat sources and probably poor ventilation.

Future work

- Computational Fluid Dynamics (CFD) modelling may be utilized to study the ventilation conditions over the Kowloon peninsula.
- Thermal weather camera can be applied to acquire a finer resolution of the heat distribution over the domain.

Future work

CFD modelling - The Hong Kong Polytechnic University (PolyU)



CFD modelling - The Hong Kong Polytechnic University (PolyU)

28/7 Easterlies

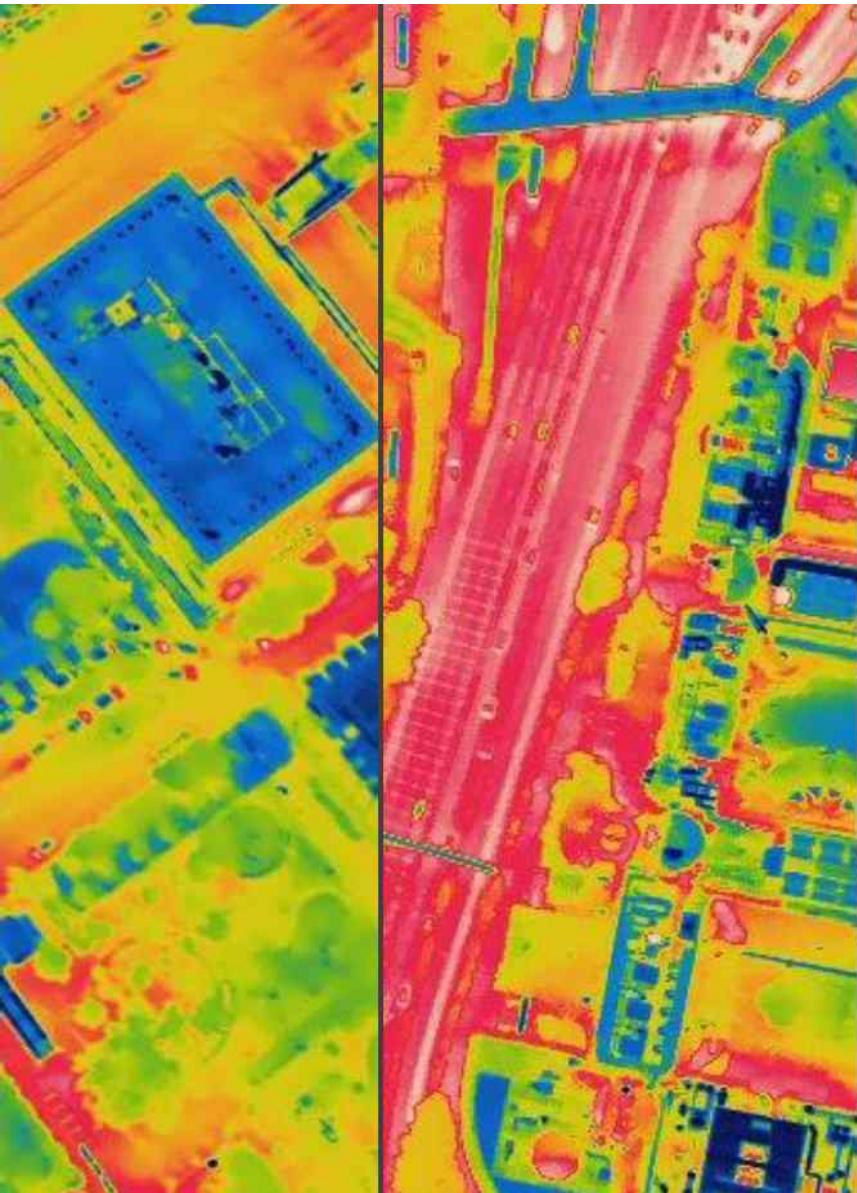
30/7 Westerly



0-1 m/s



2-3 m/s



Thermal Image
Acquisition

Western Harbour Crossing



Jordan Area



Thermal Images on 16 Dec 2015

Application of Button-size Temperature Sensors for
Micro-climate Study of the Urban Environment of Hong Kong

Thank You!

Measuring Sites (Green Area, North of HKO)



Club de Recreio (T11)

Measuring Sites (Green Area, North of HKO)



Kowloon Cricket Club (T10)

Measuring Sites (Seaside, East of HKO)



East Tsim Sha Tsui Promenade (T3)

Measuring Sites (Seaside, East of HKO)



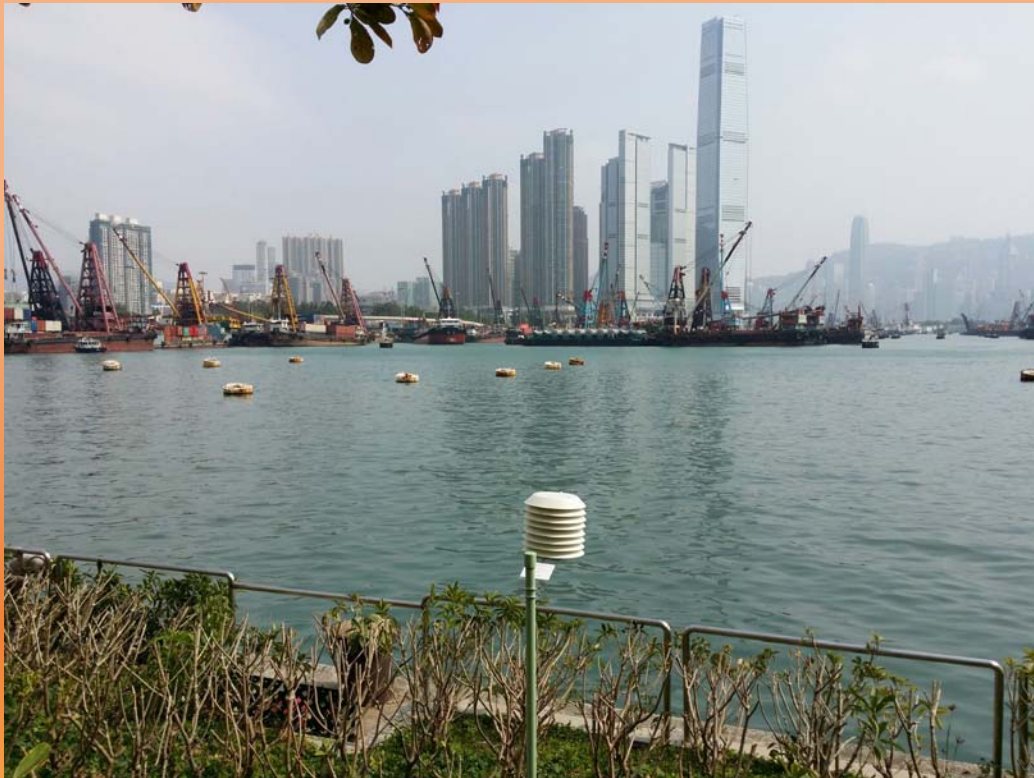
Hung Hom Promenade (T19)

Measuring Sites (Seaside, South of HKO)



Viewing Deck of Cultural Centre (T6)

Measuring Sites (Seaside, Northwest of HKO)

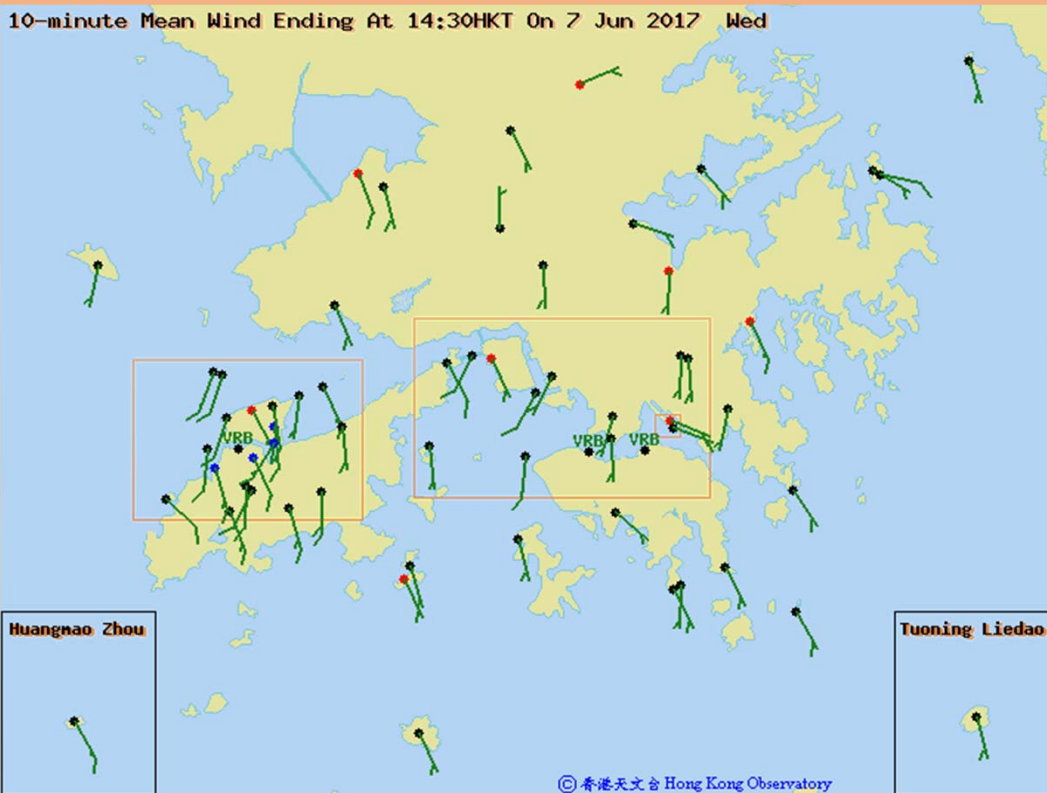


Olympic Hoi Fai Road Promenade (T17)

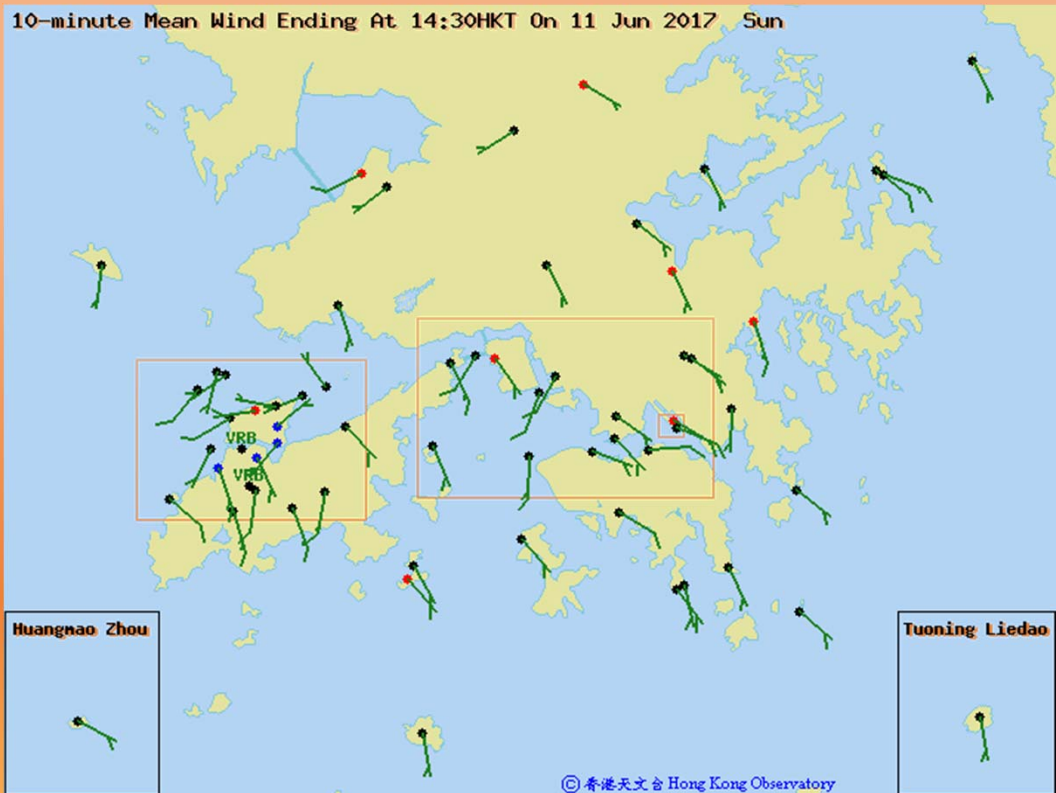
Case in June

Hot Episode 5/6-11/6

10-minute Mean Wind Ending At 14:30HKT On 7 Jun 2017 Wed

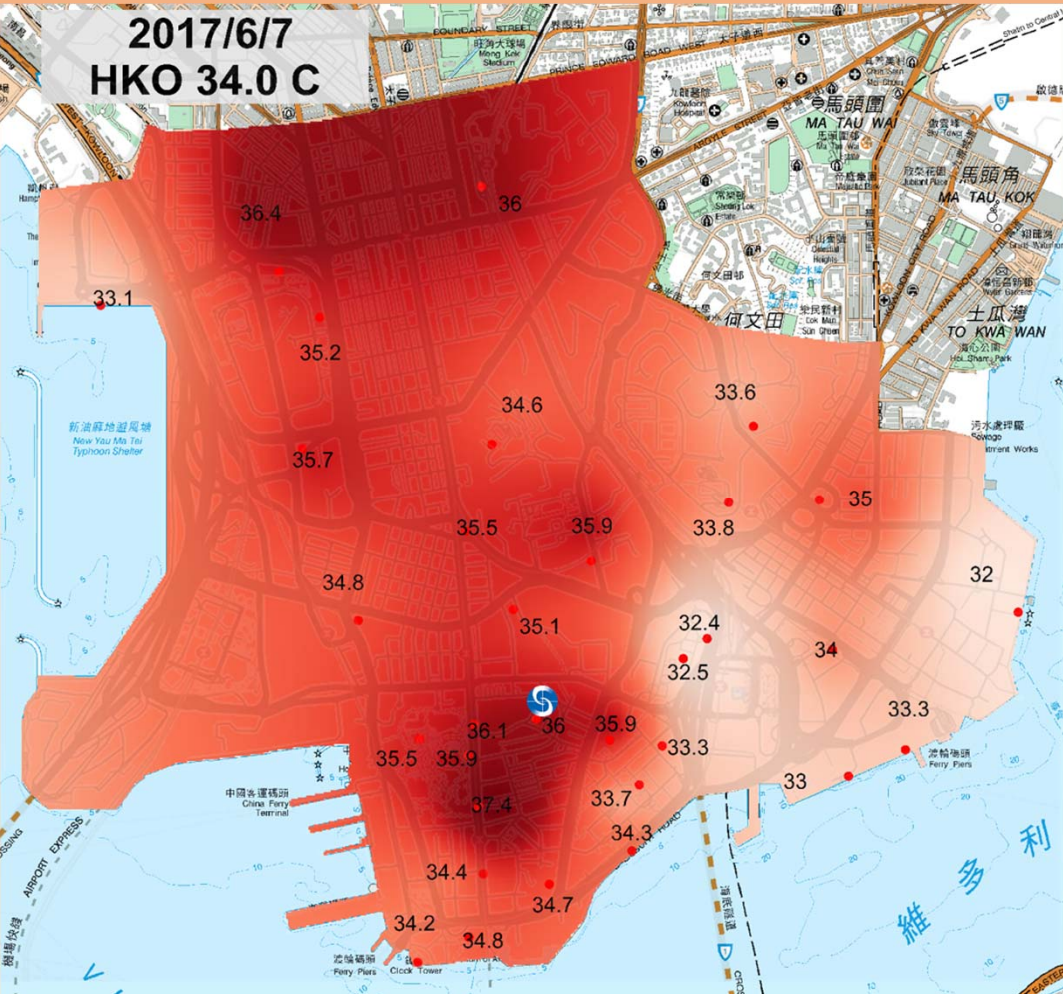


10-minute Mean Wind Ending At 14:30HKT On 11 Jun 2017 Sun

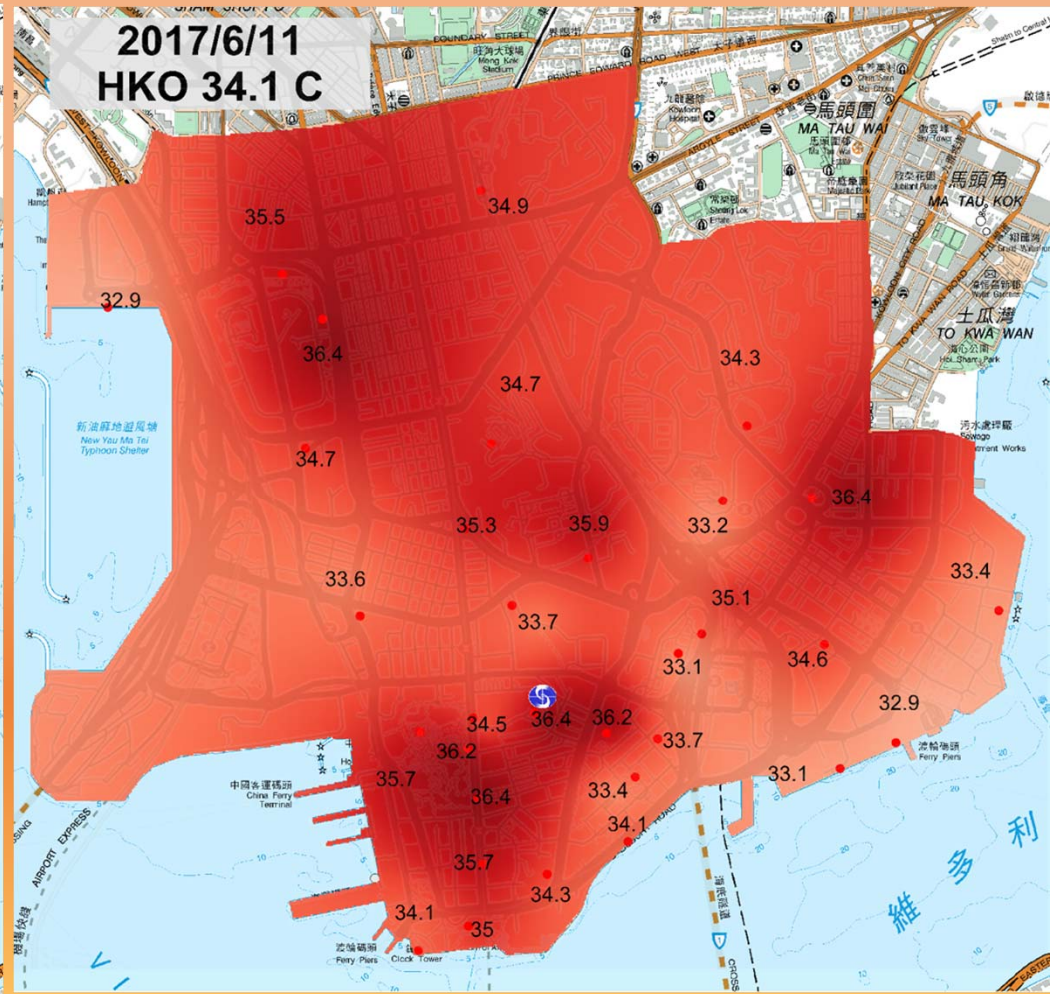


Generally SE'lies

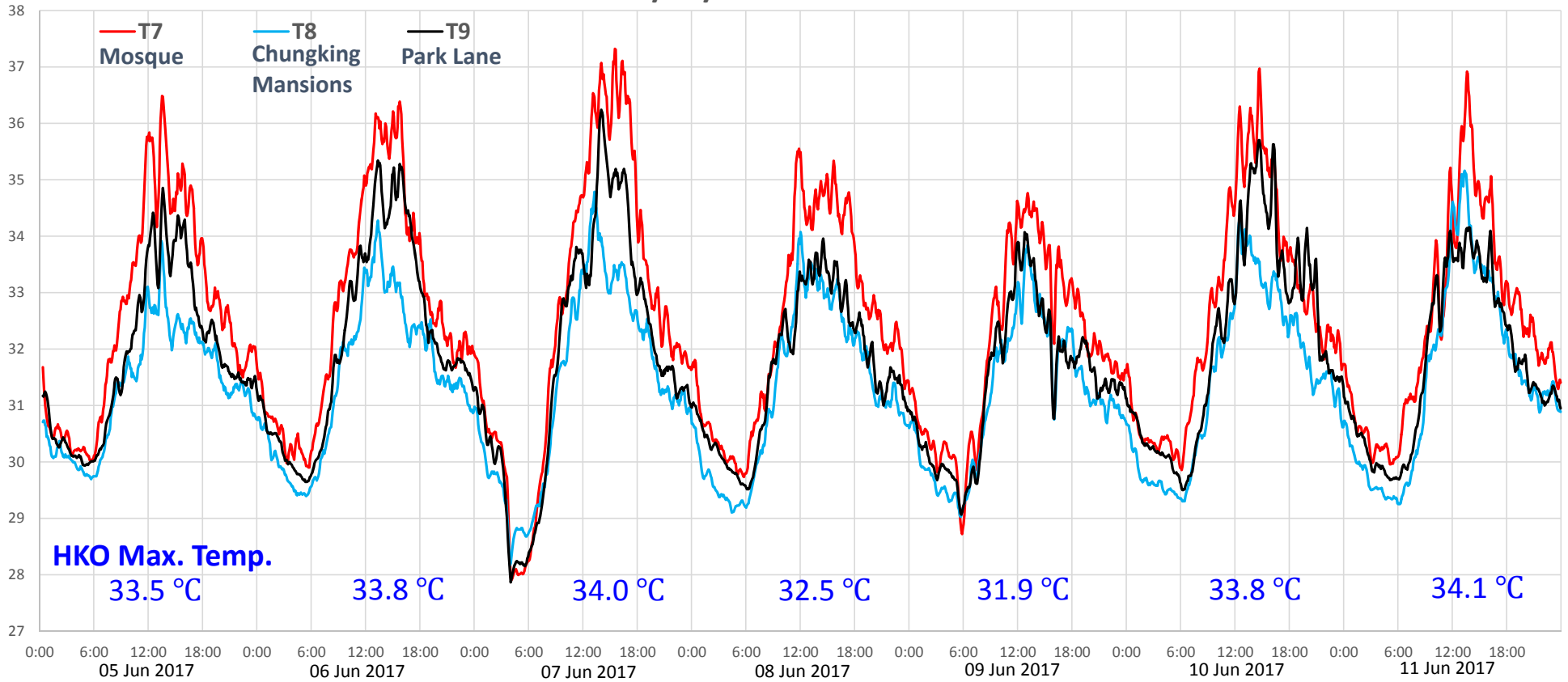
2017/6/7
HKO 34.0 C



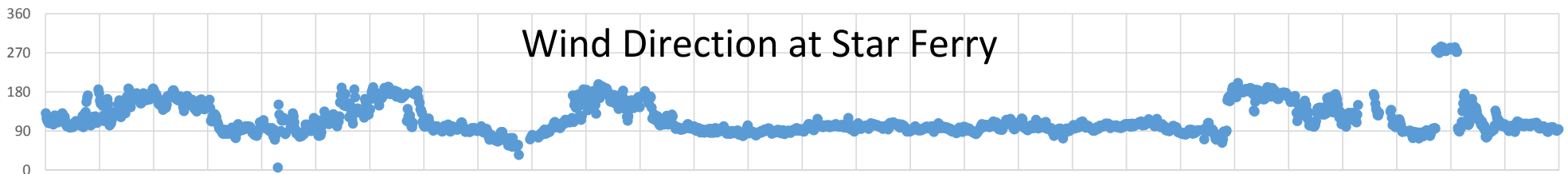
2017/6/11
HKO 34.1 C



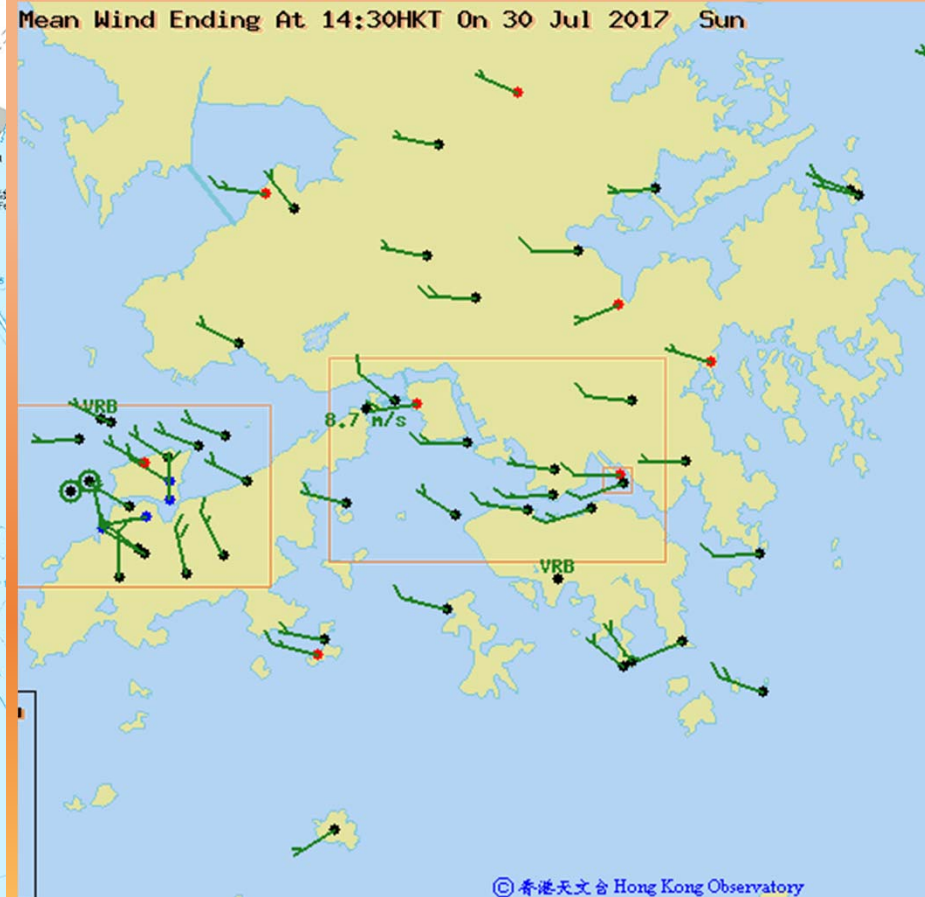
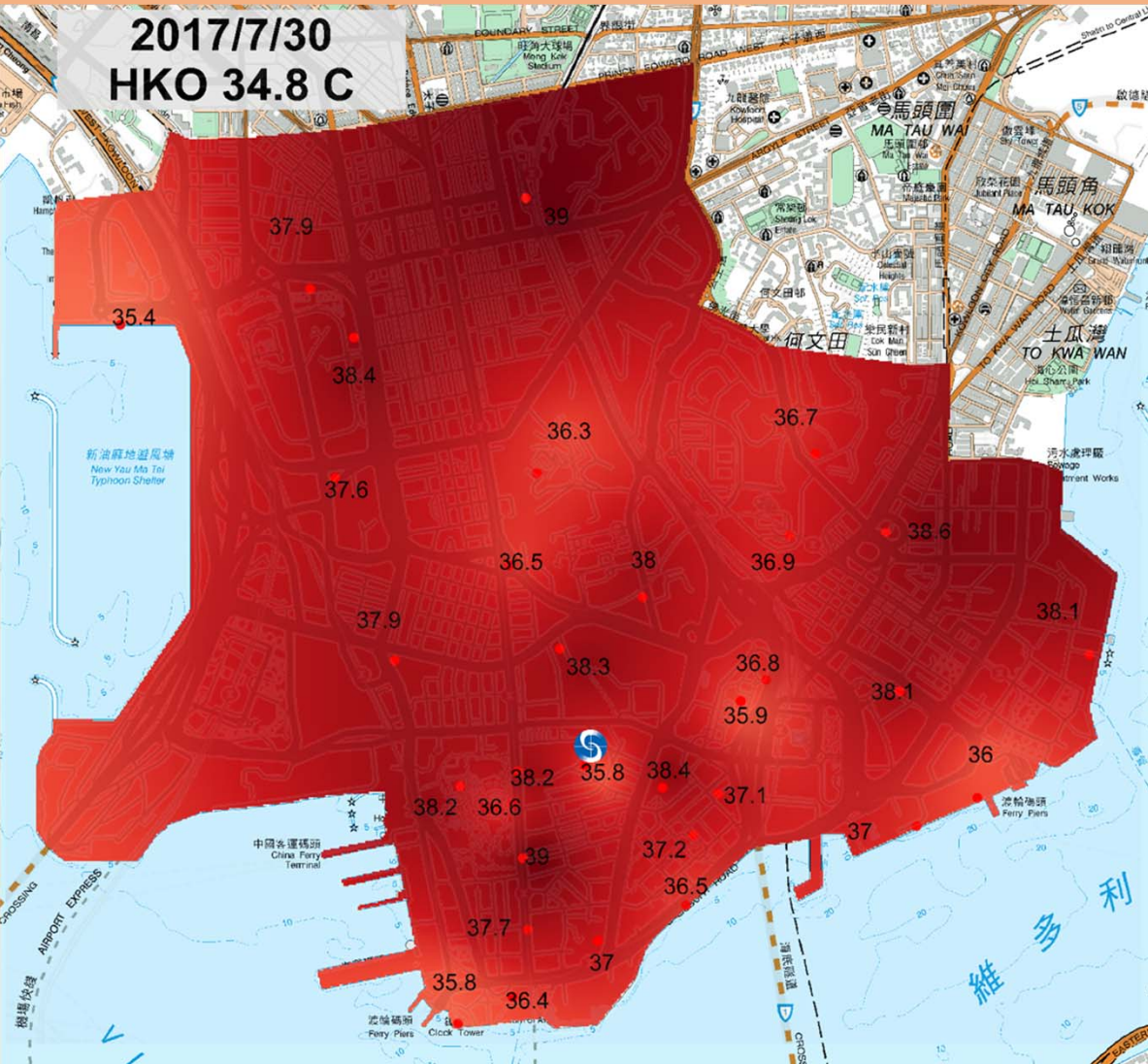
2017/06/05-11 Nathan Road

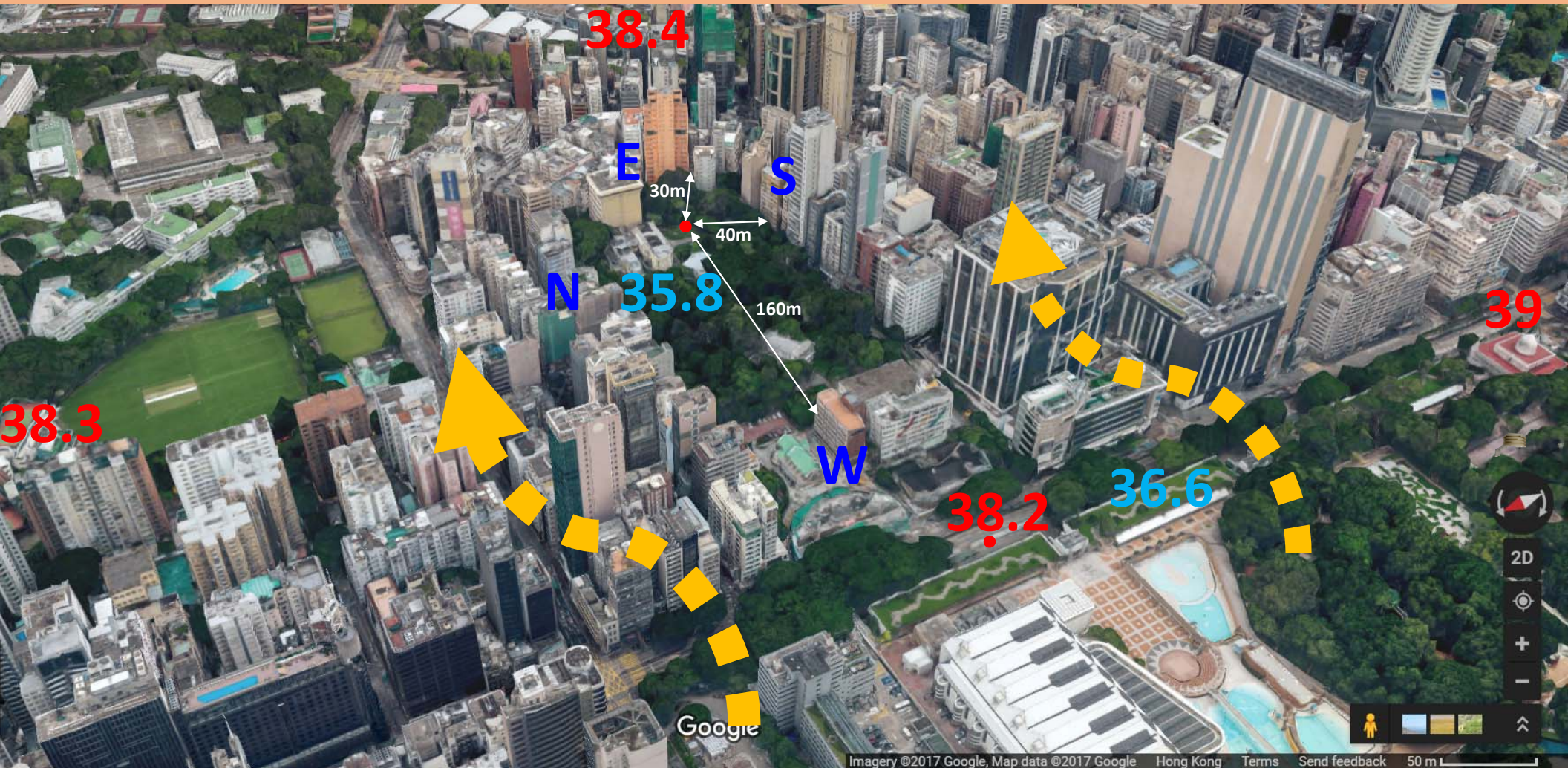


Wind Direction at Star Ferry

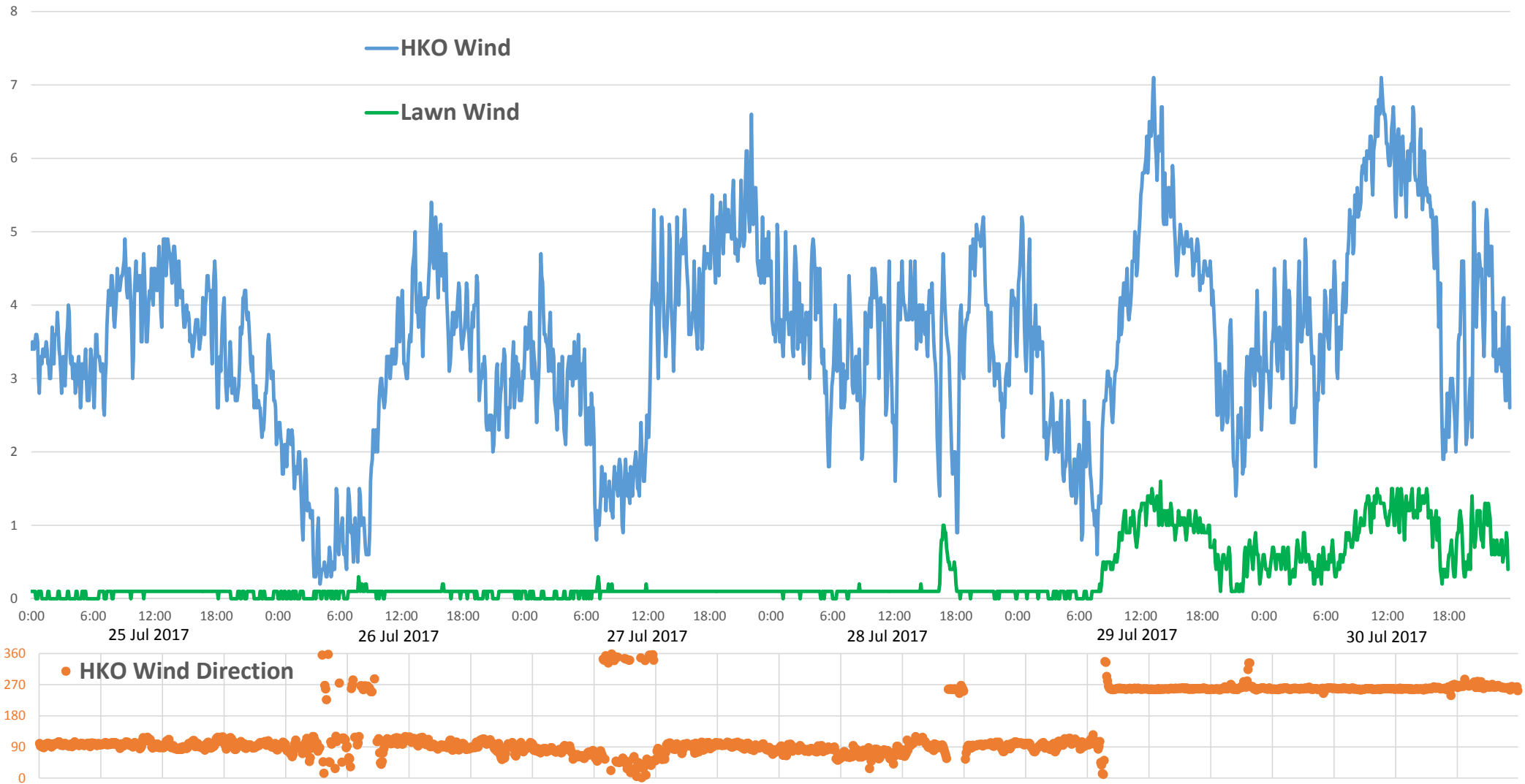


Westerly Case 30/7/2017

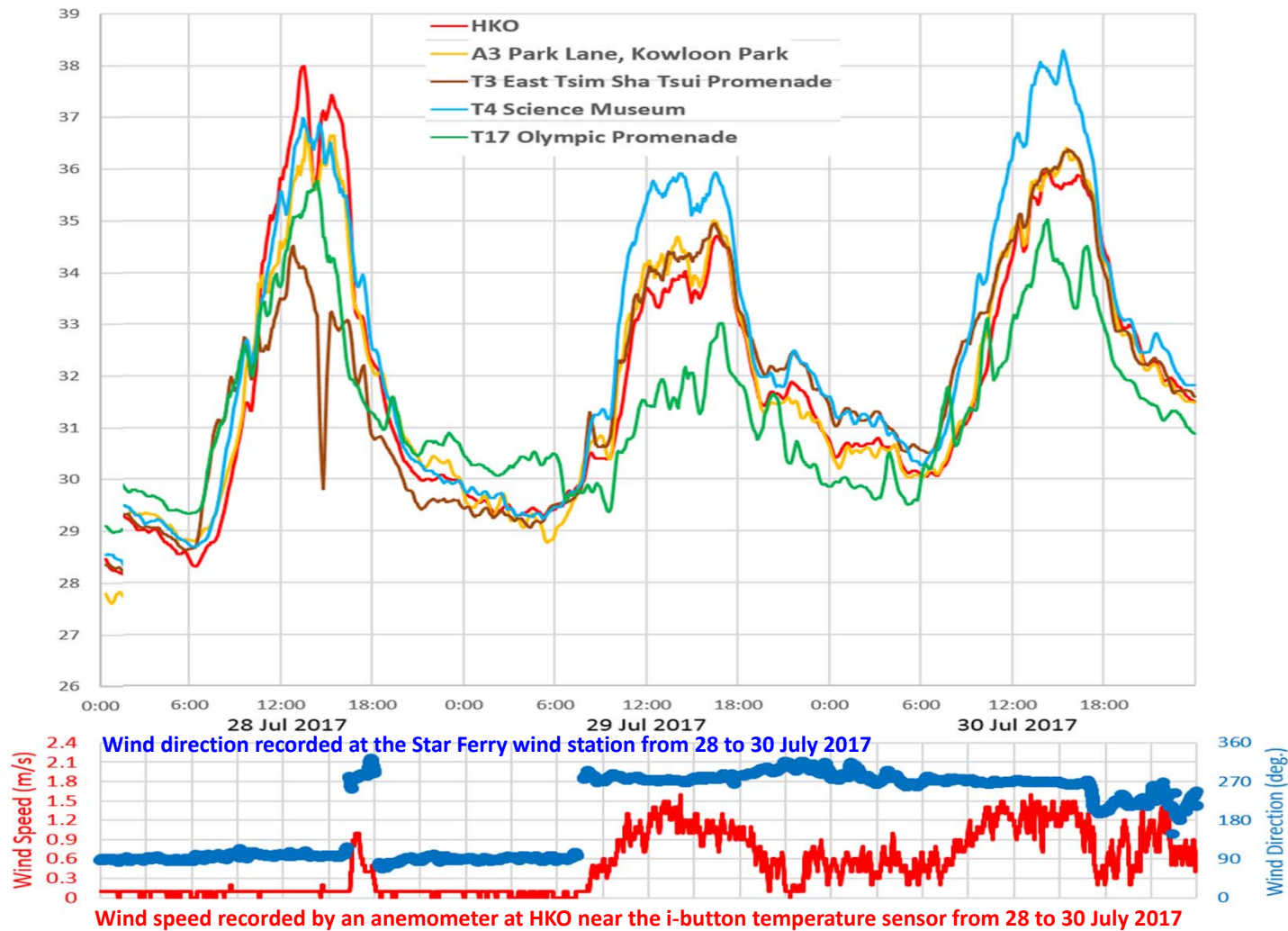




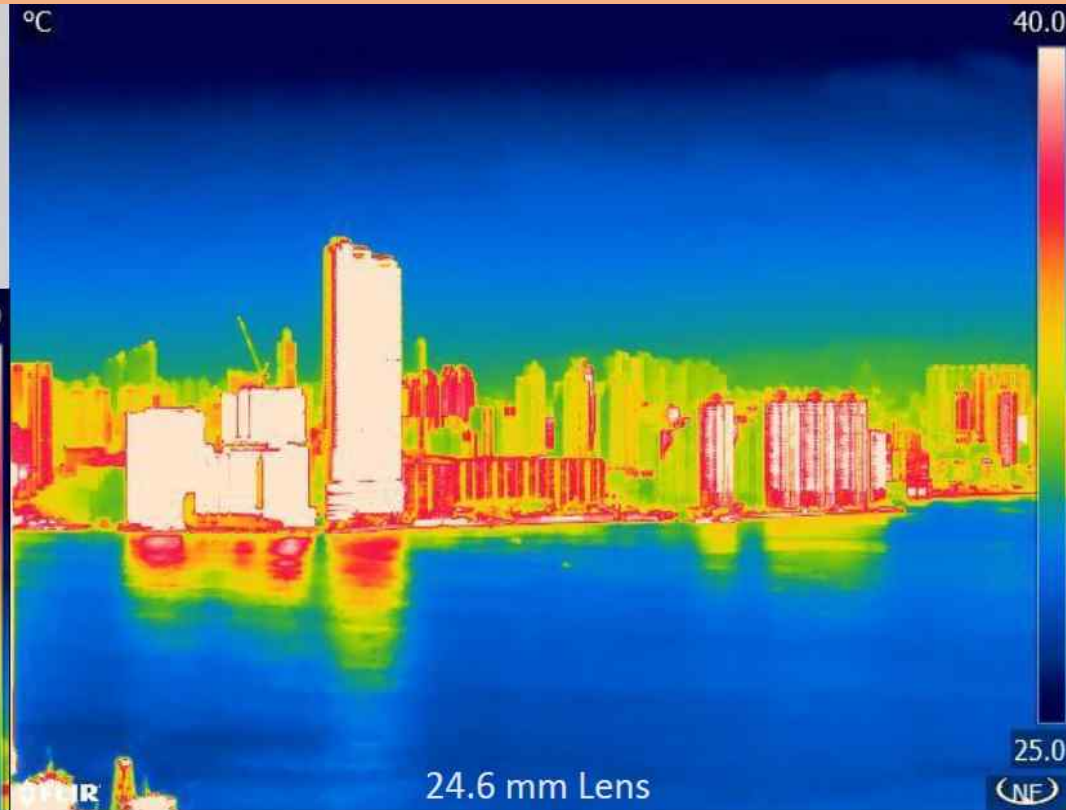
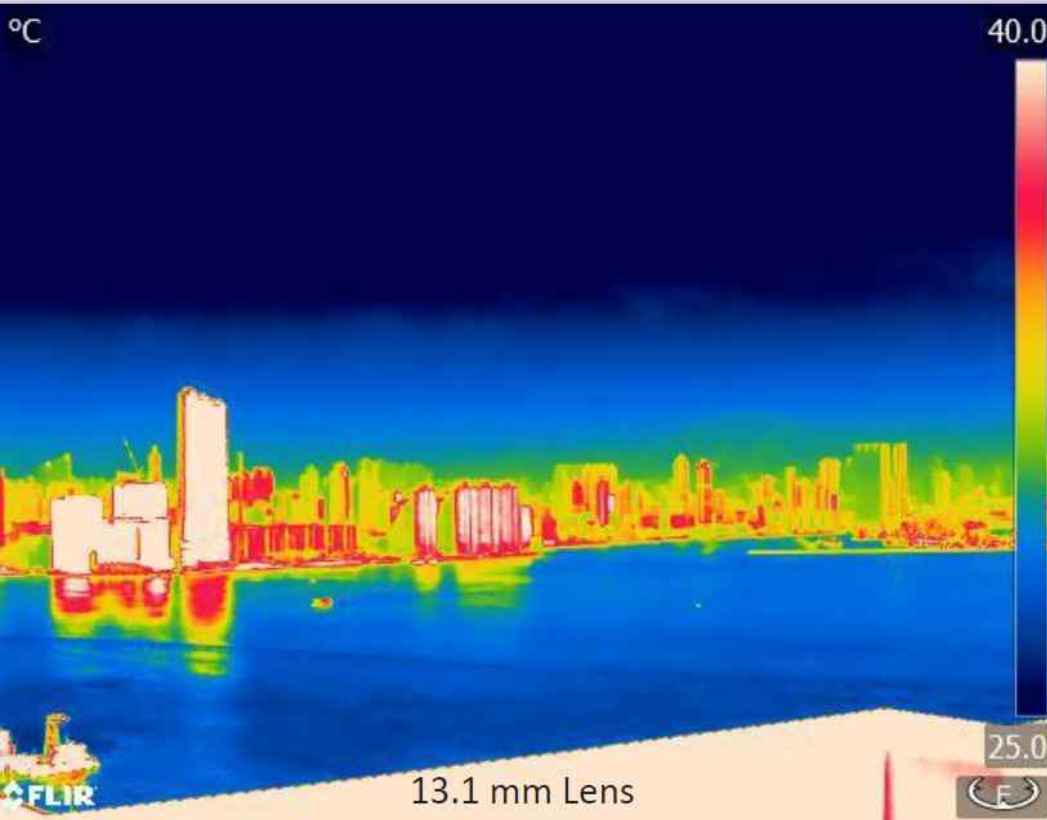
Wind at HKO



Scenario 1 – Easterly and westerly wind regimes(supp.)



THE LENSES



Focal Length (mm)	Sampling Distance on Ground ¹ (m)	Footprint of the imagery ¹ (m)
13.1	0.79	506.3 x 379.7
24.6	0.42	269.6 x 202.2

¹ 2000 ft flying height is assumed

Measurement at HKO

