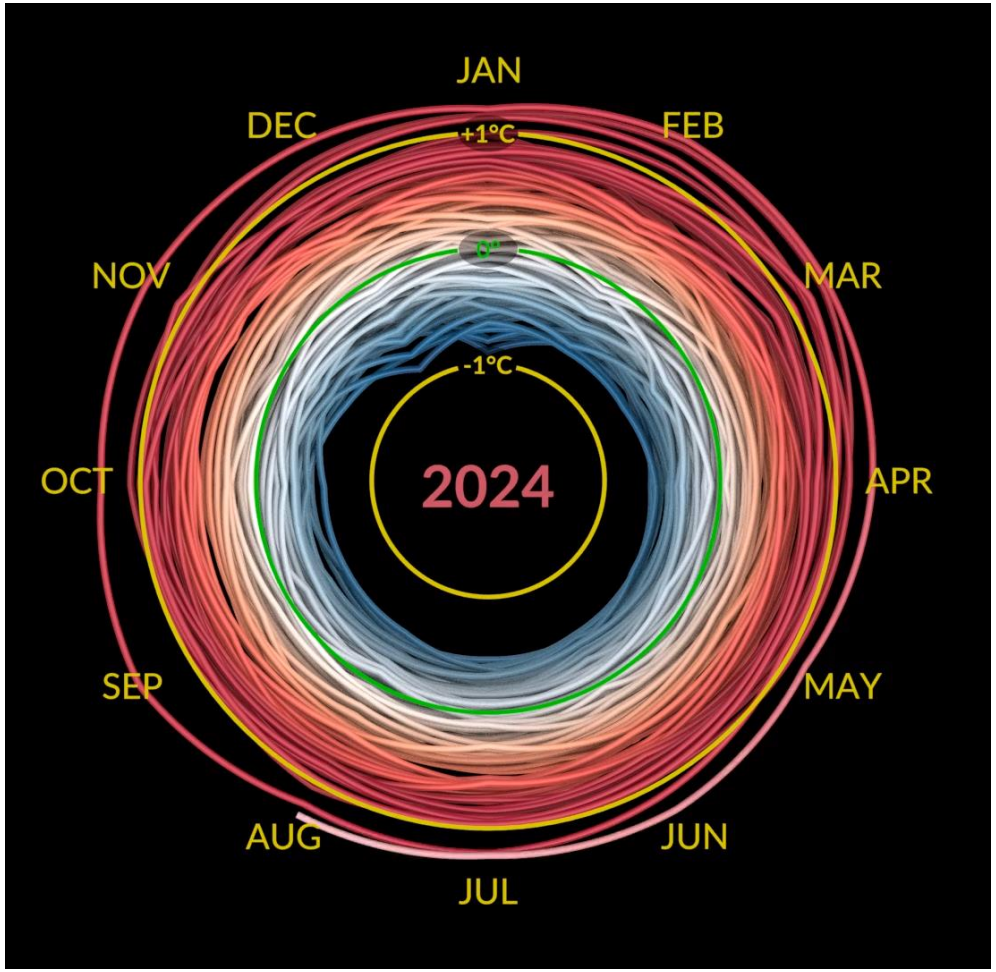
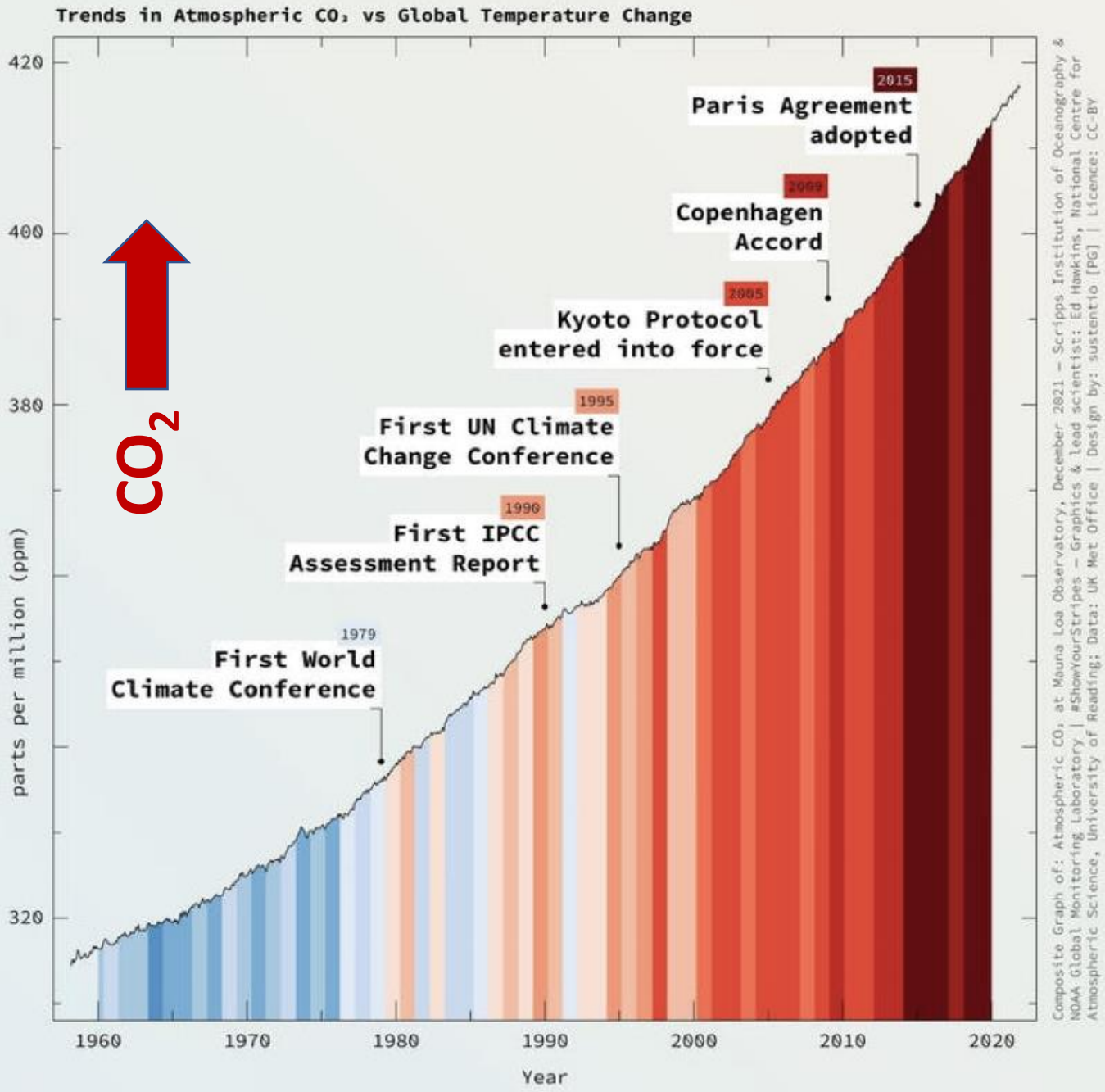
Extreme Heat in Hong Kong - 2024 Update

CM Shun, HKUST (with inputs from the Hong Kong Observatory)



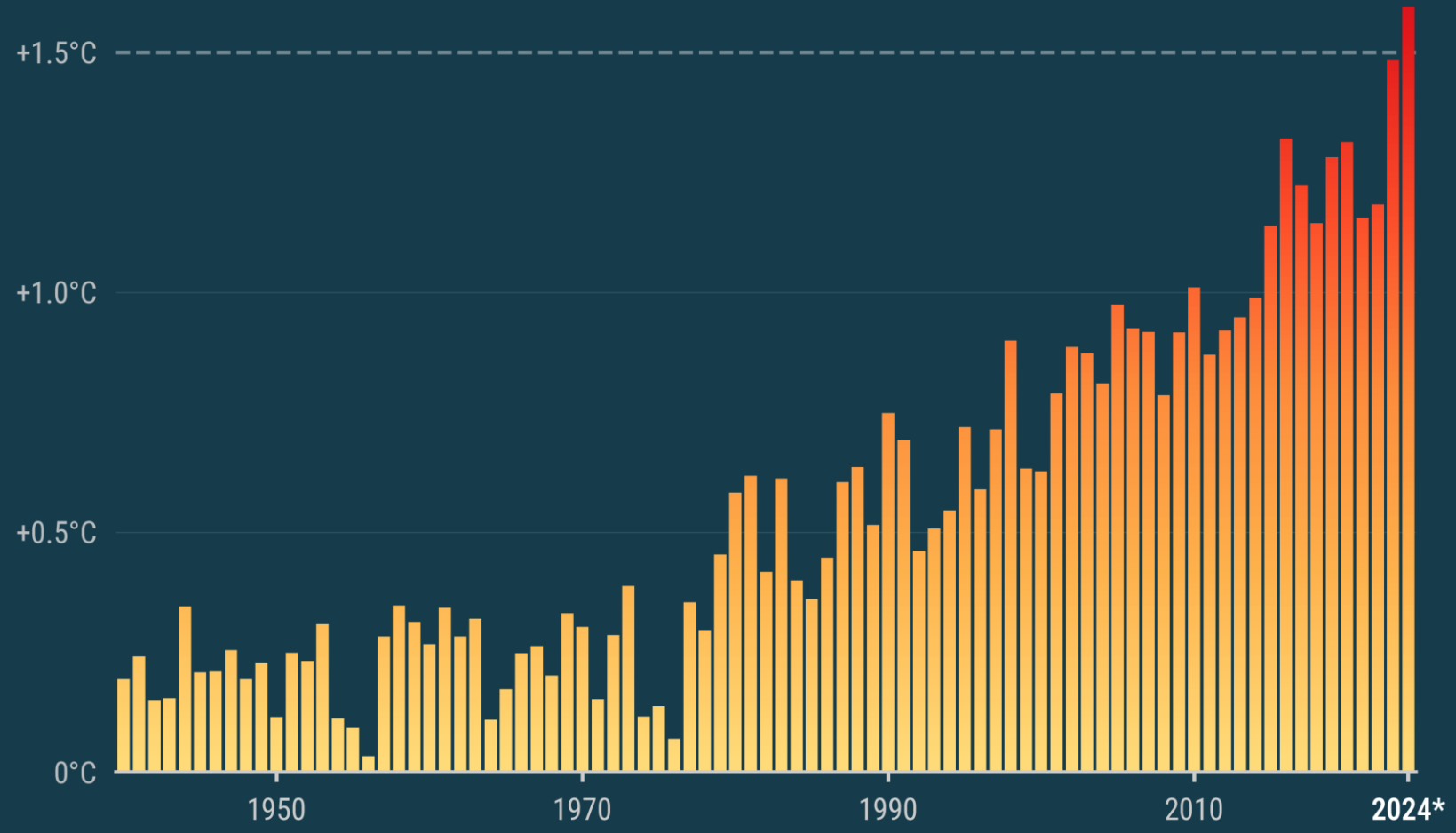
October 2024 was 1.65˚C above the pre-industrial level and was the 15th month in a 16-month period for which the global-average surface air temperature exceeded 1.5˚C above pre-industrial levels



2024 on track to be warmest year and first year above 1.5°C

Annual global temperature anomalies relative to pre-industrial (1850–1900)

Data: ERA5 (1940–2024) • Credit: C3S/ECMWF



* Provisional estimate for 2024 based on 10 months (January to October)

PROGRAMME OF THE EUROPEAN UNION

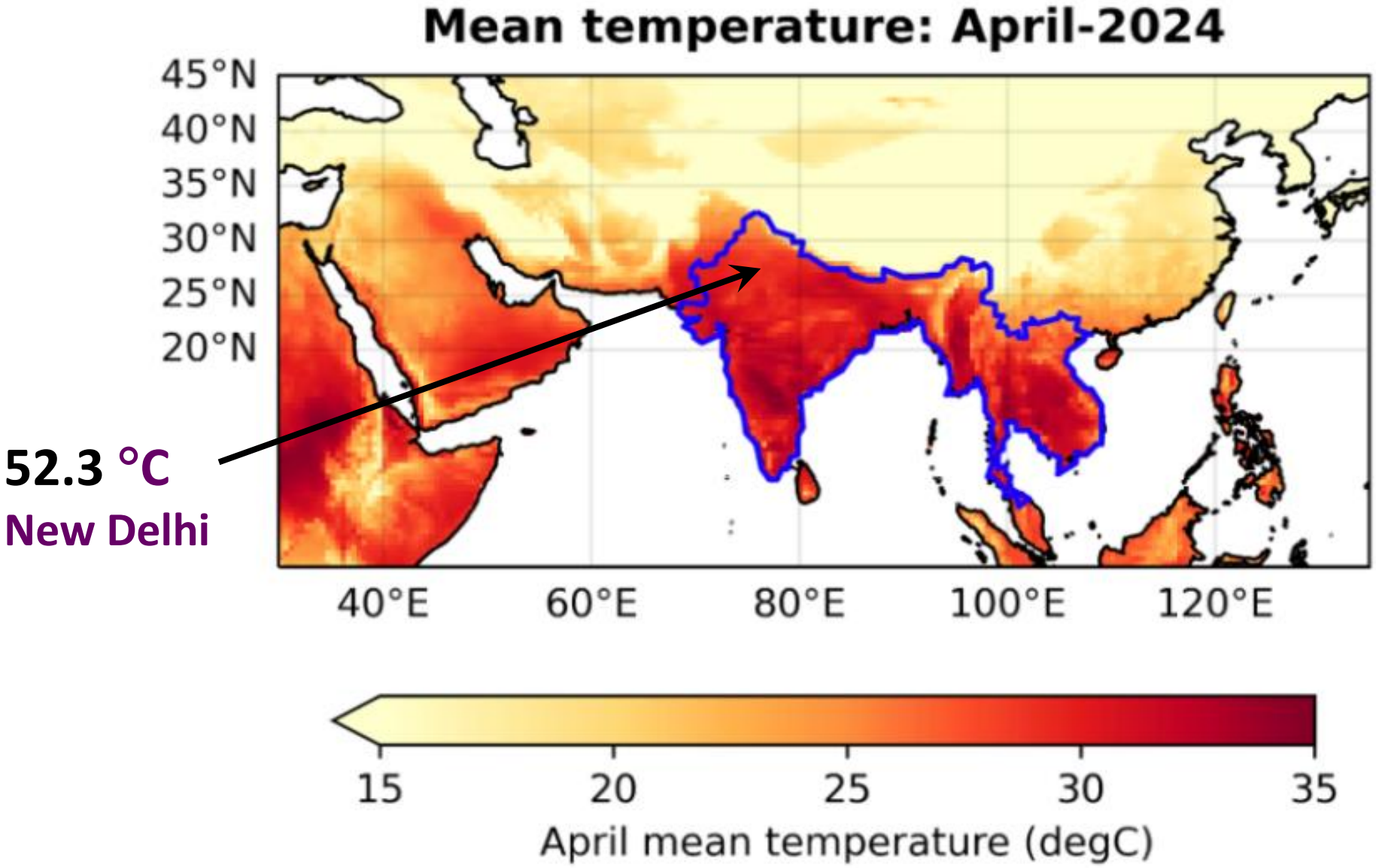
Copernicus Europe's eyes on Earth

IMPLEMENTED BY ECMWF

Climate Change Service

climate.copernicus.eu

Asian Heat 2024



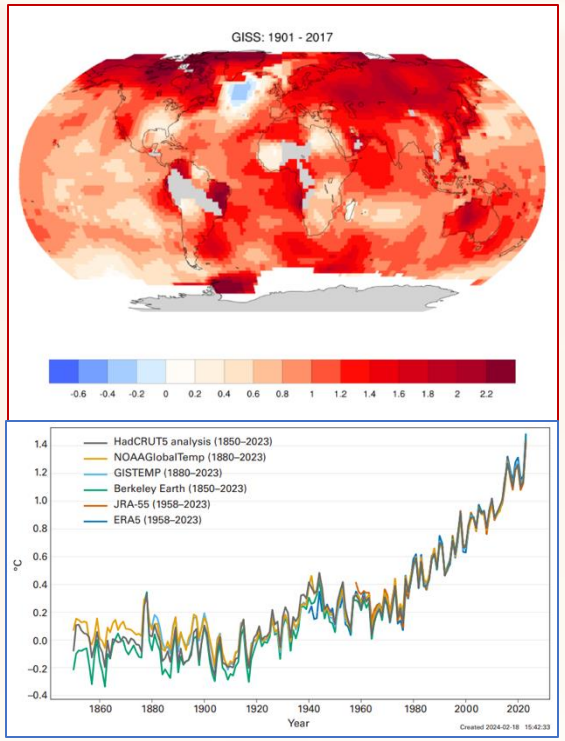
52.3 °C

New Delhi

Warming in Hong Kong

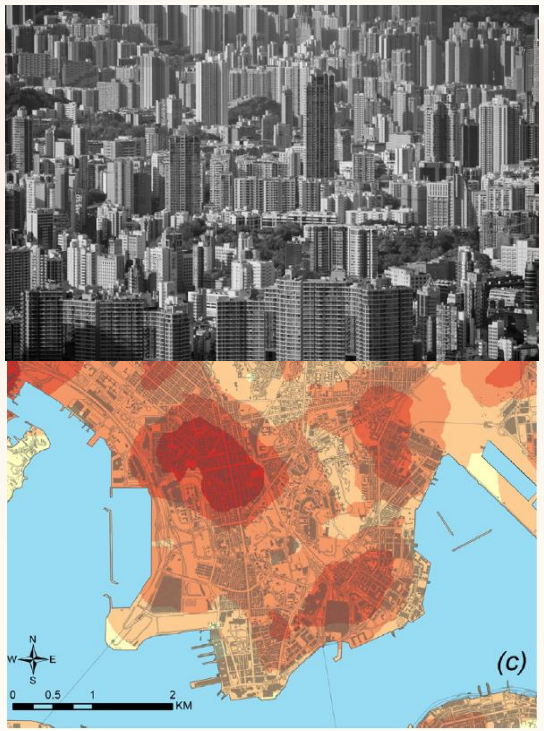
Attributing to global warming and local urbanization, there is a significant warming trend over the last century.

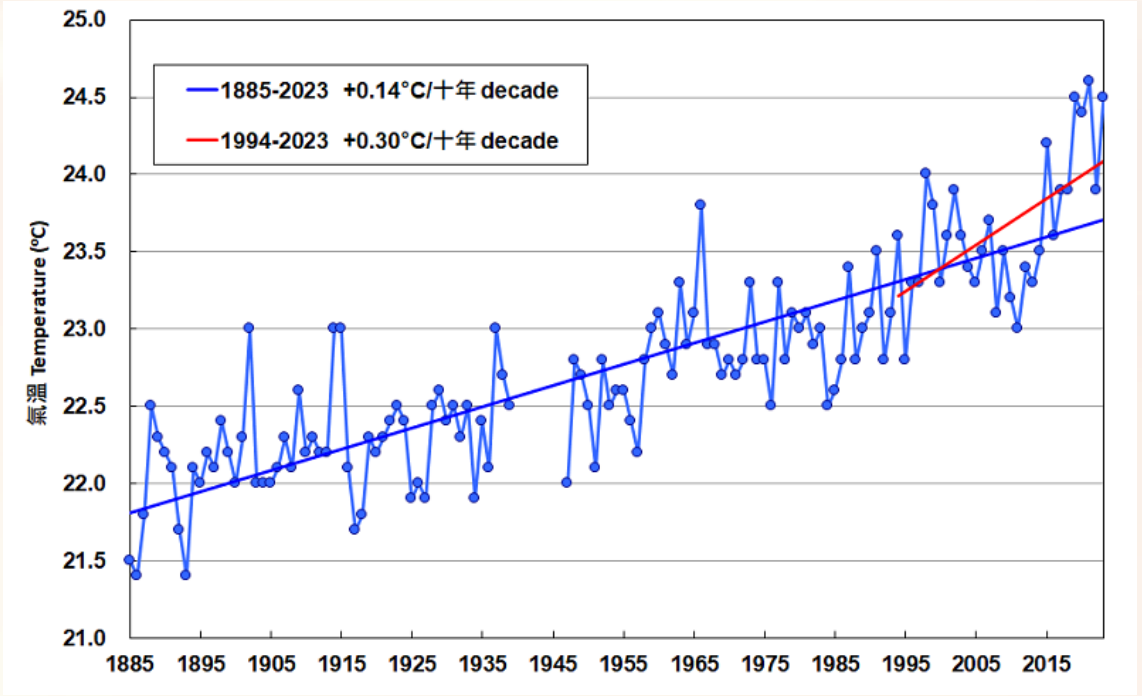
Global warming



+

Local urbanization





Annual mean temperature recorded at the Hong Kong Observatory Headquarters (1885-2023).

(Ref : Yuan et al., 2019 : Assessing spatial variability of extreme hot weather conditions in Hong Kong: A land use regression approach, Environmental Research, Volume 171, Pages 403-415 and WMO Statement on the state of the global climate in 2023)

香港天文台
HONG KONG OBSERVATORY

Hottest days in Hong Kong

Date	HKOHq Max. Temperature (°C)	Remark
22 Aug 2017	36.6	Super Typhoon Hato
8 Aug 2015	36.3	Severe typhoon Soudelor
27 July 2023	36.1	Super Typhoon Doksuri
24 July 2022	36.1	Subtropical ridge
23 May 2021	36.1	Subtropical ridge
18 Aug 1990	36.1	Typhoon Yancy
19 Aug 1900	36.1	Tropical cyclone to the SE of Hong Kong
.....		
17 Sep 2024	35.7	Tropical cyclone to the SE of Hong Kong

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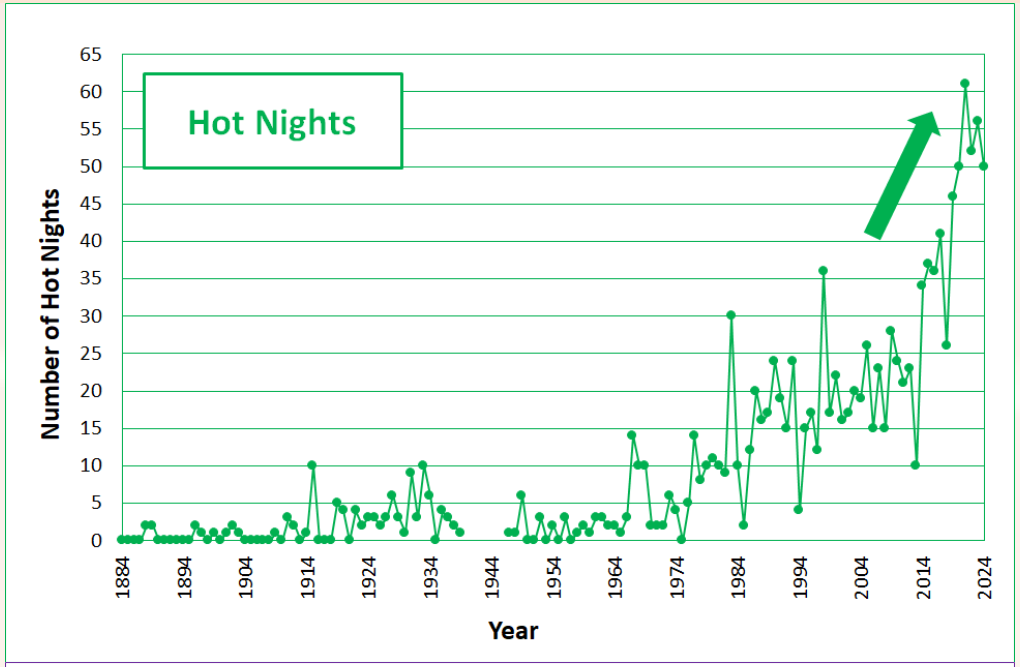
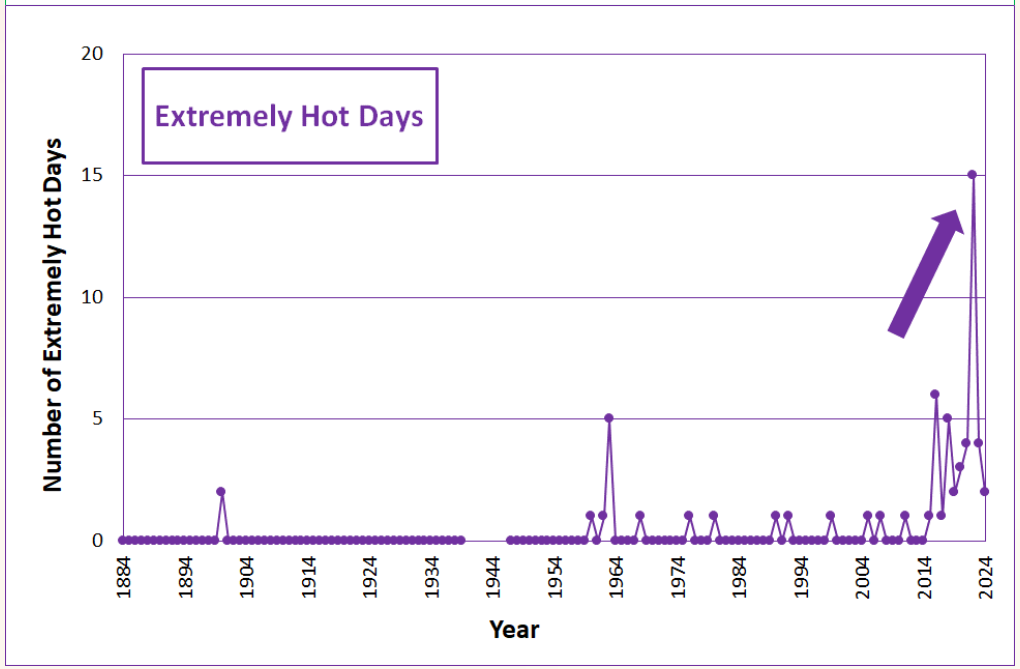
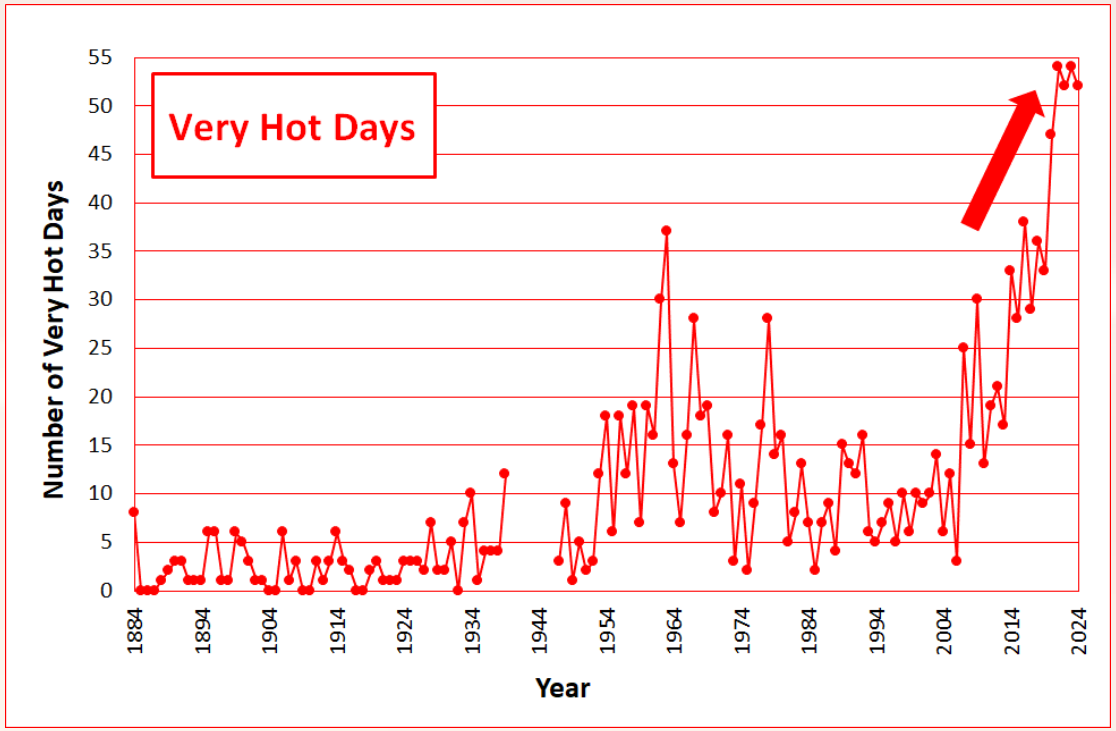
Extremely High Temperatures in Hong Kong







	Hot Nights	Very Hot Days	Extremely Hot Days
1885-1914 (30-year average)	0.6	2.2	0.07
1995-2024 (30-year average)	28.8 (⬆ 48 times)	23.2 (⬆ 11 times)	1.6 (⬆ 23 times)

In 2022, there were 15 extremely hot days (daily maximum temperature at HKOHq >= 35.0 °C), the highest since records began in 1884.

Hot nights - days with a minimum temperature of 28°C or above
Very hot days - days with a maximum temperature of 33°C or above
Cold days - days with a minimum temperature of 12°C or below

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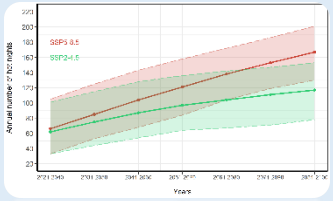
Climate projections for Hong Kong

IPCC AR6 Shared Socioeconomic Pathways

Global Climate Models from CMIP6

Statistical Downscaling
Ongoing



Including changes in annual rainfall, annual maximum daily rainfall, mean sea level, annual mean temperature, number of hot days, hot nights and cold days.

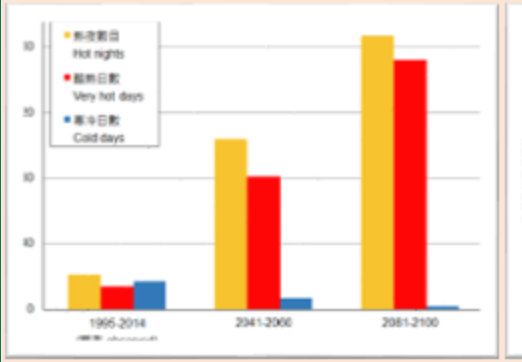
Dynamical Downscaling
(under development)

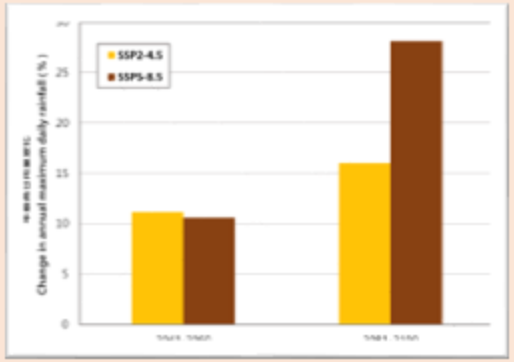
WCRP CORDEX
Coordinated Regional Climate Downscaling Experiment

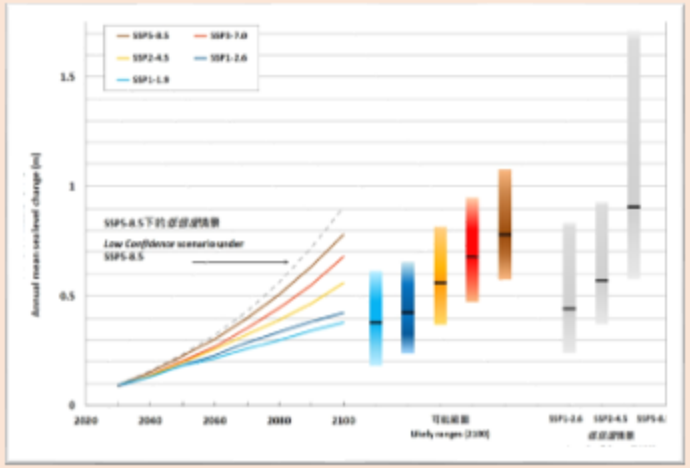
Compute sub-daily rainfall and other elements such as solar radiation over HK and nearby region by adopting regional climate models, such as RegCM from ICTP, co-work with WCRP CORDEX project.

Key Projected Trends

- Increases in mean temperatures and annual rainfall
- More extreme temperature and rainfall events
- Mean sea level continues to rise







IPCC AR6: Intergovernmental Panel on Climate Change Sixth Assessment Report
CMIP6: Coupled Model Intercomparison Project Phase 6
CORDEX: Coordinated Regional Climate Downscaling Experiment
WCRP: World Climate Research Programme
ICTP: International Centre for Theoretical Physics
RegCM: Regional Climate Model

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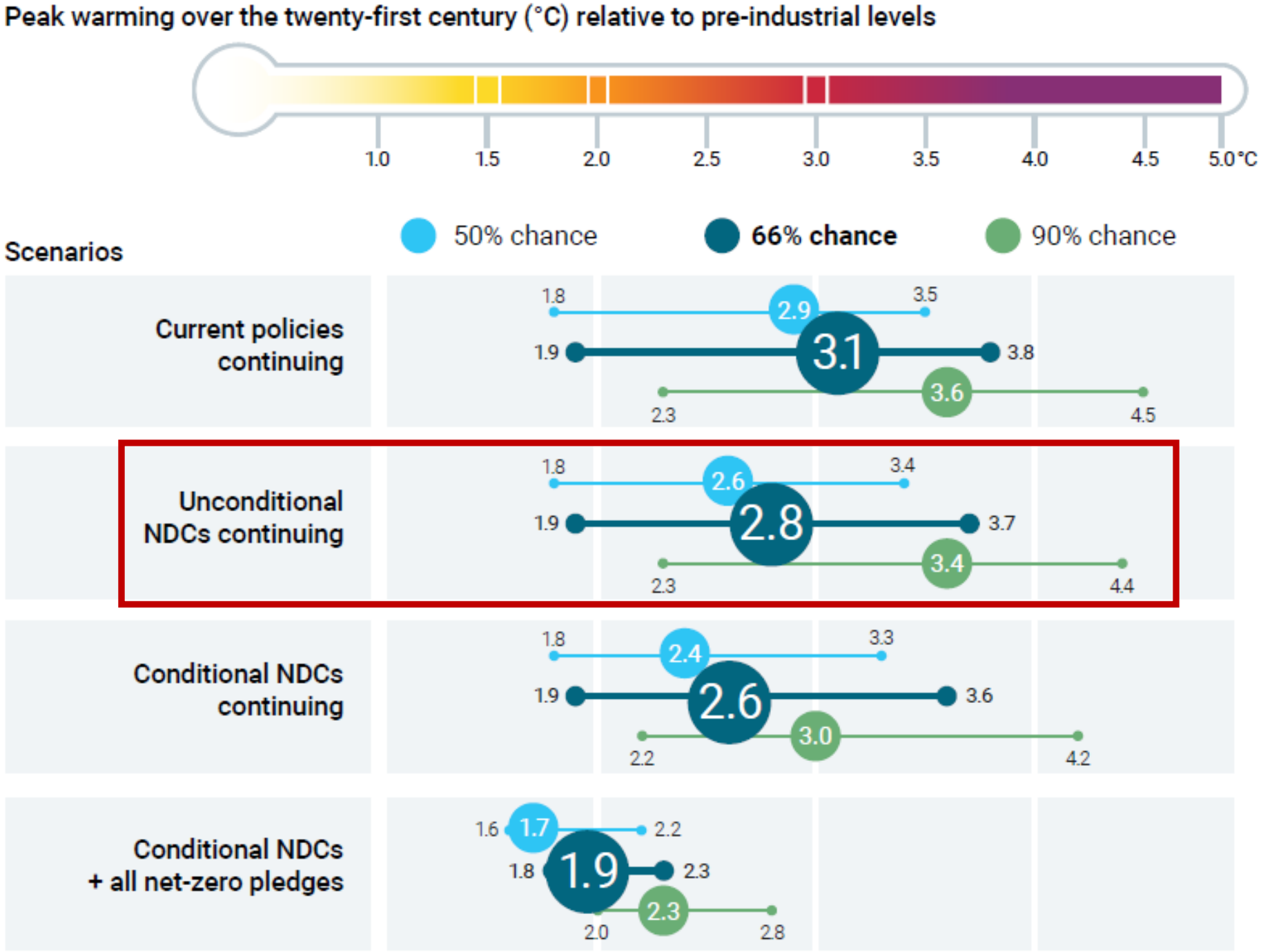
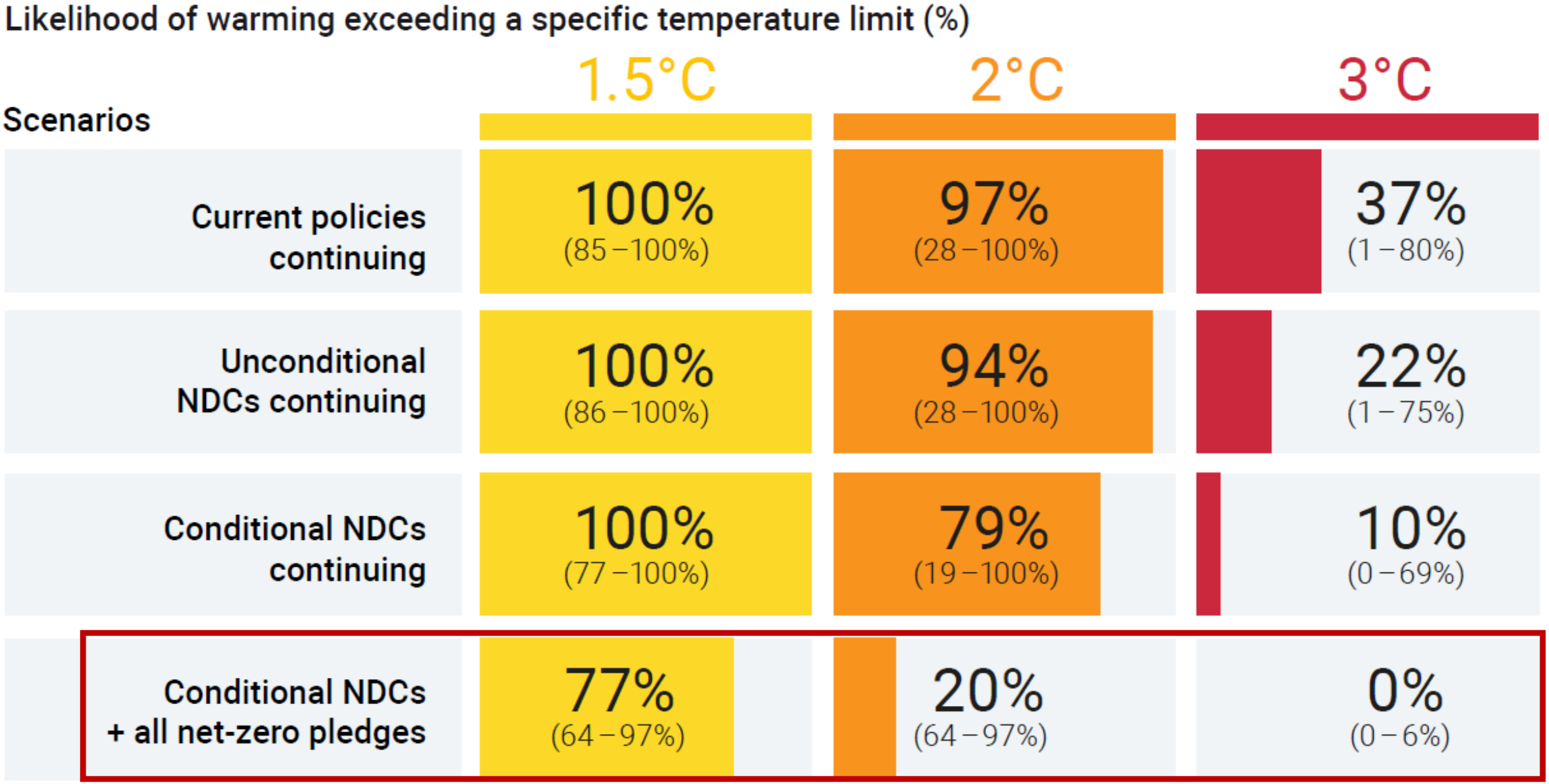
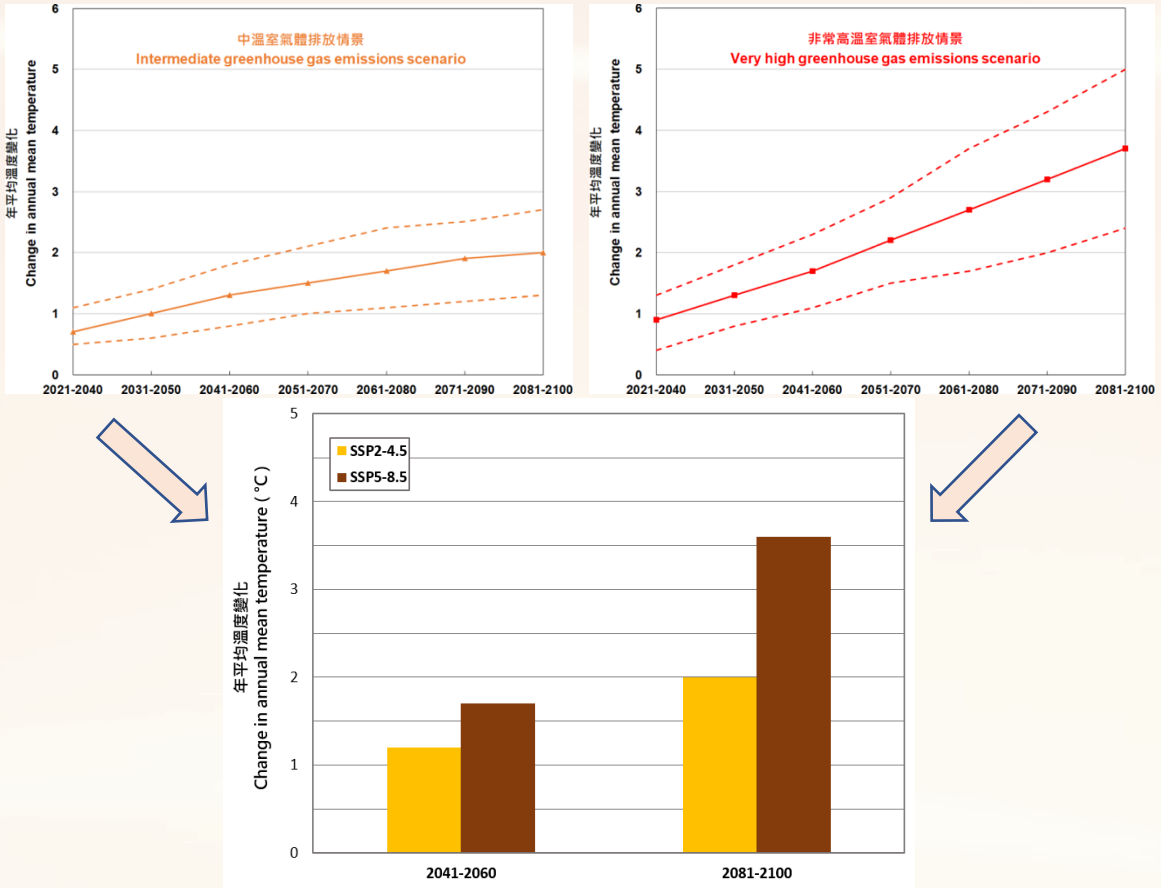

Peak warming over the twenty-first century (°C) relative to pre-industrial levels
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0°C
Scenarios
50% chance
66% chance
90% chance
Current policies continuing
1.8
2.9
3.5
1.9
3.1
3.8
2.3
3.6
4.5
Unconditional NDCs continuing
1.8
2.6
3.4
1.9
2.8
3.7
2.3
3.4
4.4
Conditional NDCs continuing
1.8
2.4
3.3
1.9
2.6
3.6
2.2
3.0
4.2
Conditional NDCs + all net-zero pledges
1.6
1.7
2.2
1.8
1.9
2.3
2.0
2.3
2.8


Likelihood of warming exceeding a specific temperature limit (%)
1.5°C
2°C
3°C
Scenarios
Current policies continuing
100% (85–100%)
97% (28–100%)
37% (1–80%)
Unconditional NDCs continuing
100% (86–100%)
94% (28–100%)
22% (1–75%)
Conditional NDCs continuing
100% (77–100%)
79% (19–100%)
10% (0–69%)
Conditional NDCs + all net-zero pledges
77% (64–97%)
20% (64–97%)
0% (0–6%)

Climate Projections of Hong Kong (IPCC AR6)

Increase in Annual Mean Temperature

Relative to 1995-2014 (23.4°C, at HKO), the annual mean temperature in Hong Kong in 2081-2100 is projected to increase by about 2.0°C and 3.6°C respectively under the intermediate (SSP2-4.5) and very high (SSP5-8.5) emissions scenarios.

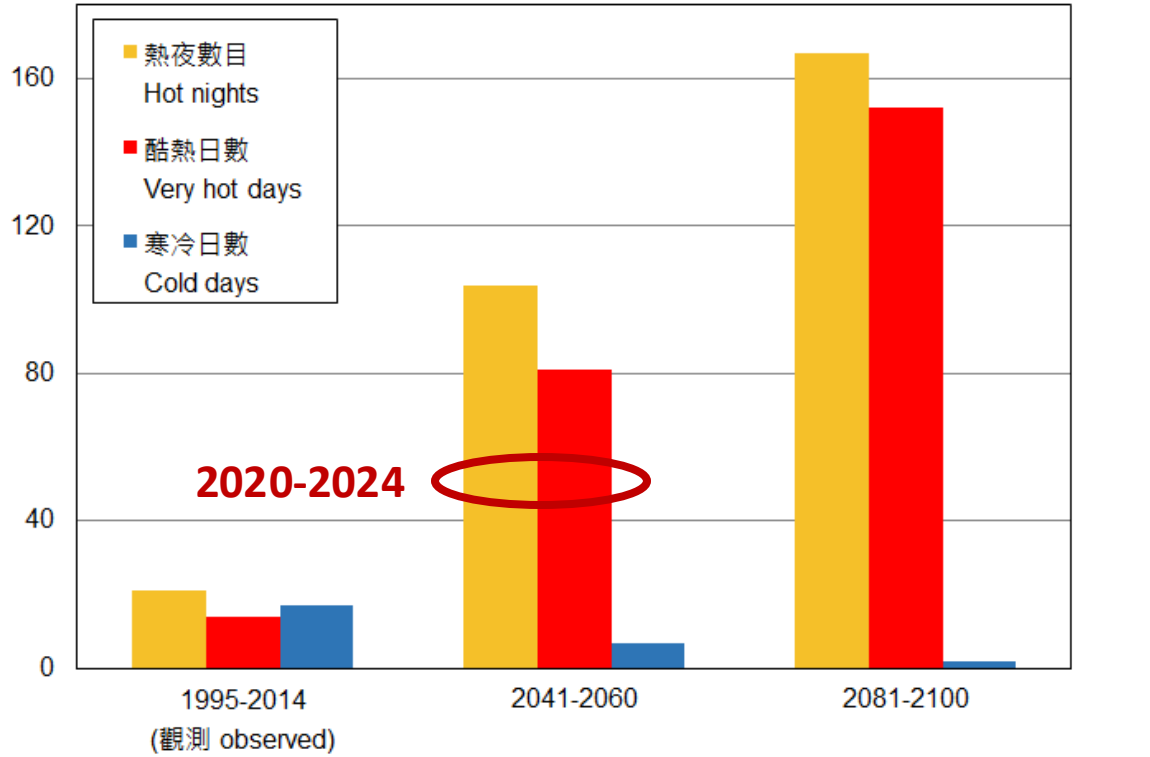


Annual mean temperature of Hong Kong relative to the average of 1995-2014 under the intermediate (SSP2-4.5) and very high (SSP5-8.5) emissions scenarios

https://www.hko.gov.hk/en/climate_change/proj_hk_temp_mean.htm

More Extreme Temperatures

The annual number of hot nights and very hot days in Hong Kong are expected to increase significantly in the 21st century, while the annual number of cold days is expected to drop.



在非常高溫室氣體排放情景（SSP5-8.5）下，香港每年熱夜數目、酷熱日數和寒冷日數的未來推算

Projected annual number of hot nights, very hot days and cold days in Hong Kong under very high greenhouse gas emissions scenario (SSP5-8.5)

香港天文台
HONG KONG OBSERVATORY

Research collaborations with academia and stakeholders

Climate x Health for climate resilience and adaptation

ELSEVIER

Building and Environment
Volume 205, November 2021, 108274

The synergistic effect of urban heat and moisture islands in a compact high-rise city

Xinjie Huang [a], Jiyun Song [a b], Chenghao Wang [c], Ting Fong May Chui [d], Pak Wai Chan [e]

ELSEVIER

Environmental Research
Volume 212, Part C, September 2022, 113351

Projecting future temperature-related mortality using annual time series data: An example from Hong Kong

Pin Wang [a b], Hang Wai Tong [c], Tsz Cheung Lee [c], William B. Goggins [b]

ELSEVIER

Urban Climate
Volume 51, September 2023, 101669

Spatial-temporal changes of compound temperature-humidity extremes in humid subtropical high-density cities: An observational study in Hong Kong from 1961 to 2020

Yueyang He [a b], Zixuan Wang [c], Hau Man Wong [a], Guangzhao Chen [d], Chao Ren [d], Ming Luo [e], Yuguo Li [c], Tsz-cheung Lee [f], Pak Wai Chan [f], Janice Ying-en Ho [d], Edward Ng [a b g]

ELSEVIER

Sustainable Cities and Society
Volume 64, January 2021, 102507

Spatiotemporal assessment of extreme heat risk for high-density cities: A case study of Hong Kong from 2006 to 2016

Junyi Hua [a], Yuyi Zhang [a], Chao Ren [a], [o], Yuan Shi [b], Tsz-Cheung Lee [c]

ELSEVIER

Environmental Research
Volume 171, April 2019, Pages 403-415

Assessing spatial variability of extreme hot weather conditions in Hong Kong: A land use regression approach

Yuan Shi [a], Chao Ren [a b c], Meng Cai [a], Kevin Ka-Lun Lau [b c d], Tsz-Cheung Lee [e], Wai-Kin Wong [e]

ELSEVIER

Building and Environment
Volume 138, 15 June 2018, Pages 207-220

Wind weakening in a dense high-rise city due to over nearly five decades of urbanization

Lei Peng [a], Jia-Ping Liu [b], Yi Wang [c], Pak-wai Chan [d], Tsz-cheung Lee [d], Fen Peng [e], Man-sing Wong [f], Yuguo Li [a]

ELSEVIER

Science of The Total Environment
Volume 690, 10 November 2019, Pages 923-931

The impact of extremely hot weather events on all-cause mortality in a highly urbanized and densely populated subtropical city: A 10-year time-series study (2006–2015)

Dan Wang [a b], Kevin Ka-Lun Lau [b c], Chao Ren [c d], William Bernard III Goggins [a], Yuan Shi [e], Hung Chak Ho [f], Tsz-Cheung Lee [g], Lap-Shun Lee [g], Jean Woo [b h], Edward Ng [c e]

ENVIRONMENTAL RESEARCH
LETTERS

LETTER • OPEN ACCESS

Effects of anthropogenic heat due to air-conditioning systems on an extreme high temperature event in Hong Kong

Y Wang[1,5], Y Li[1], S Di Sabatino[2], A Martilli[3] and P W Chan[4]

Published 22 February 2018 • © 2018 The Author(s). Published by IOP Publishing Ltd

Environmental Research Letters, Volume 13, Number 3

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International Journal of Climatology | RMetS

RESEARCH ARTICLE

Investigating the urban heat and cool island effects during extreme heat events in high-density cities: A case study of Hong Kong from 2000 to 2018

Chao Ren, Kai Wang, Yuan Shi, Yu Ting Kwok, Tobi Eniolu Morakinyo, Tsz-cheung Lee, Yuguo Li

Home > International Journal of Biometeorology > Article

The development of the Hong Kong Heat Index for enhancing the heat stress information service of the Hong Kong Observatory

Original Paper | Published: 06 November 2015

Volume 60, pages 1029–1039, (2016) Cite this article

International Journal of Biometeorology

Aims and scope →

Submit manuscript →

K. L. Lee, Y. H. Chan, T. C. Lee, William B. Goggins & Emily Y. Y. Chan

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ELSEVIER

Renewable Energy
Volume 142, November 2019, Pages 73-84

Estimates of the impact of extreme heat events on cooling energy demand in Hong Kong

Tobi Eniolu Morakinyo [a], Chao Ren [b], Yuan Shi [c], Kevin Ka-Lun Lau [a], Hang-Wai Tong [d], Chun-Wing Choy [d], Edward Ng [a c]

ELSEVIER

Journal of Environmental Psychology
Volume 94, March 2024, 102251

Climate change scepticism and its impacts on individuals' engagement with climate change mitigation and adaptation to heat in Hong Kong: A two-wave population-based study

Qiuyan Liao [a], Jiehu Yuan [a], Wendy Wing Tak Lam [a], Tsz-cheung Lee [c], Lin Yang [b], Linwei Tian [a], Richard Fielding [a]

香港天文台
HONG KONG OBSERVATORY

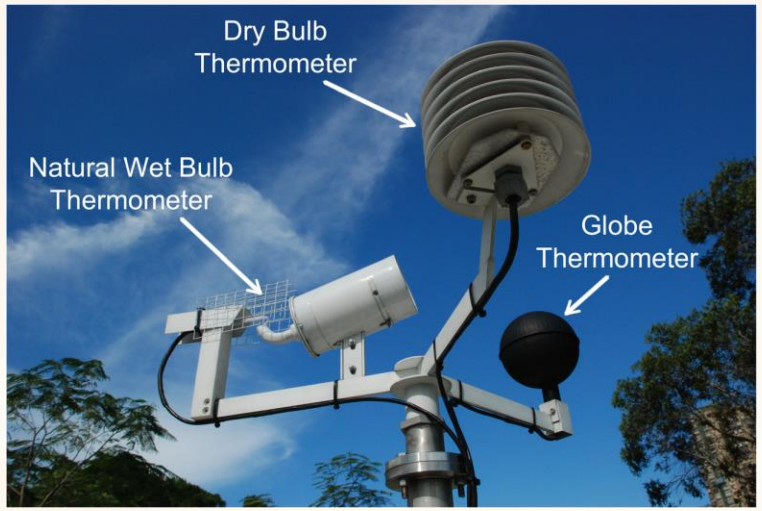
Hong Kong Heat Index (HKHI)

HKO and the Chinese University of Hong Kong (CUHK) jointly developed the Hong Kong Heat Index (HKHI) for use in the hot and humid sub-tropical climate in Hong Kong to enhance the heat stress information services using the hospitalization data and different measurement data from the HKO in-house developed "Heat Stress Monitoring System".

Hong Kong Heat Index (HKHI) :

HKHI = 0.8 Tnw + 0.05 Tg + 0.15 Ta

- Natural Wet-Bulb Temperature (Tnw)
- Globe Temperature (Tg)
- Air Temperature (Ta)

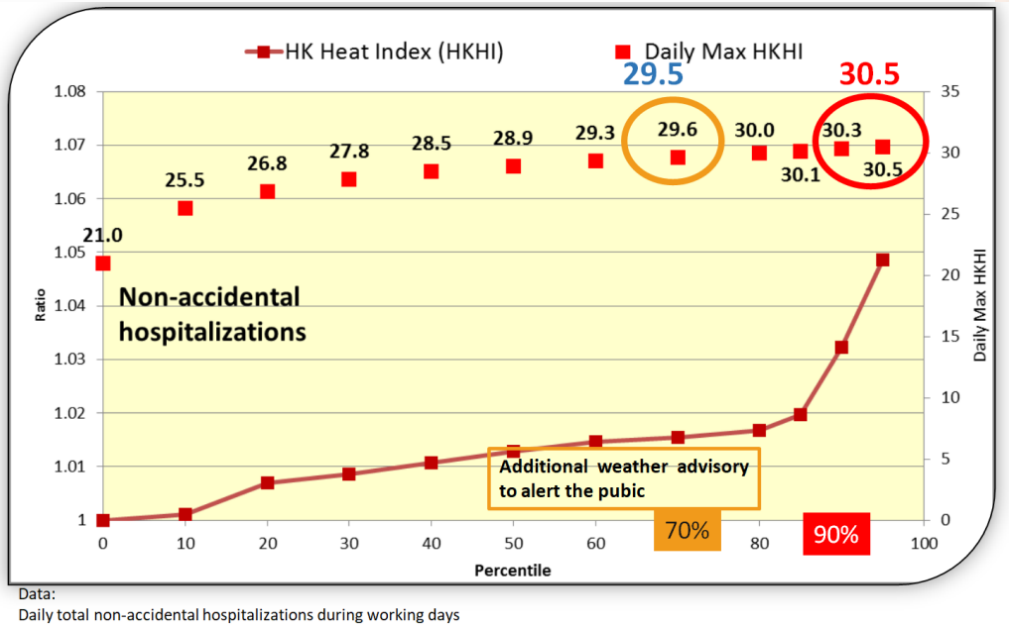


International Journal of Biometeorology
July 2016, Volume 60, Issue 7, pp 1029–1039 | Cite as

The development of the Hong Kong Heat Index for enhancing the heat stress information service of the Hong Kong Observatory

Authors | Authors and affiliations

K. L. Lee, Y. H. Chan, T. C. Lee, William B. Goggins, Emily Y. Y. Chan



Excess hospitalization ratio with different percentiles of daily maximum HKHI

香港天文台 HONG KONG OBSERVATORY

Heat related advisory, alerts and warning issued by HKO

- Since 2000, the HKO has been issuing the Very Hot Weather Warning (VHWW) to alert the public to the risk of heat stroke and sunburn in very hot weather, and to advise the public on relevant precautionary measures. It is also adopted as a criterion for opening of temporary heat shelters for needed people and exemption of motor vehicle idling with engine on.
- Over the years, based on collaborative heat health studies with partners, the VHWW and related advisory services/precautions have been enhanced in phases to cope with the public needs and the increasingly hot climate, including prolonged heat and extremely hot conditions.

Consultation with partners

Heat Health Research

Hot Weather Special Advisory (2014)

"Hot" : Temperatures between 28 and 32 degrees, especially when risk of heat stroke is higher, e.g. high humidity, sunny or weak winds

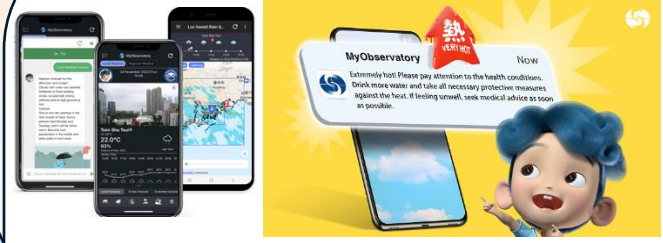
Very Hot Weather Warning (2000)

"Very Hot" — Temperatures generally reaching **33 degrees**

"Prolonged Heat" Special Alert as additional push notification (2021/2022) — A few days of very hot weather or hot nights*

*Hot night : daily minimum temperature at least 28 degrees

"Extremely Hot" Special Alert as additional push notification (2023) — Temperatures generally reaching **35 degrees**



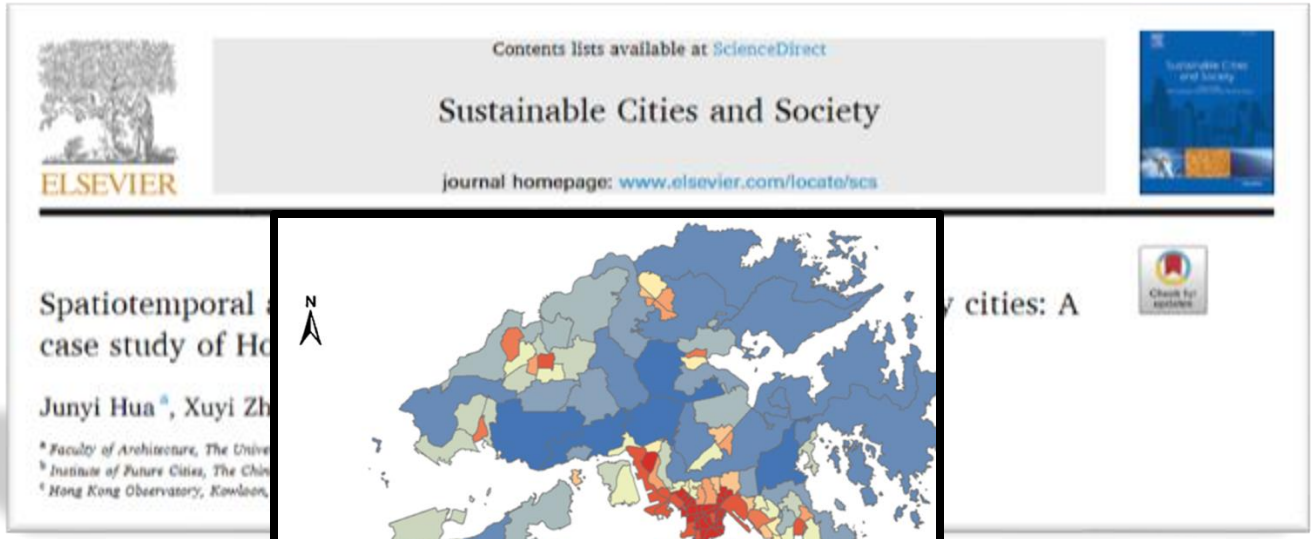
The VHWW and related advisory/alert will be disseminated through the Observatory's website, the "MyObservatory" mobile application and TV and radio broadcasts. App users can also choose to receive push notifications.

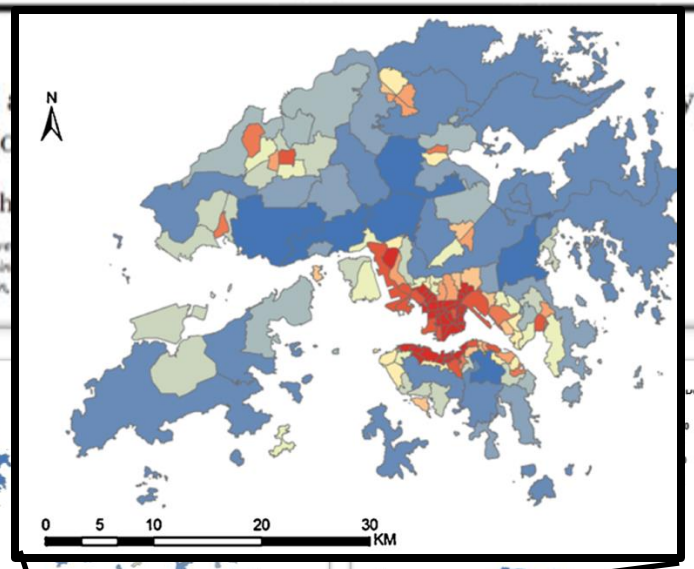
https://www.weather.gov.hk/en/education/weather/hot-and-cold-weather/00706-Beware-of-Health-Effects-of-Extremely-Hot-Weather.html
https://www.weather.gov.hk/en/whatsnew/f1_HotWxSpecialAdvisory.htm
https://www.weather.gov.hk/en/Whats-New/107173/Latest-Service-Enhancement-by-the-Observatory-%E2%80%94-Special-Alert-on-Prolonged-Heat
https://www.weather.gov.hk/en/Press-Releases/108056/The-Observatory-enhances-Very-Hot-Weather-Warning-service

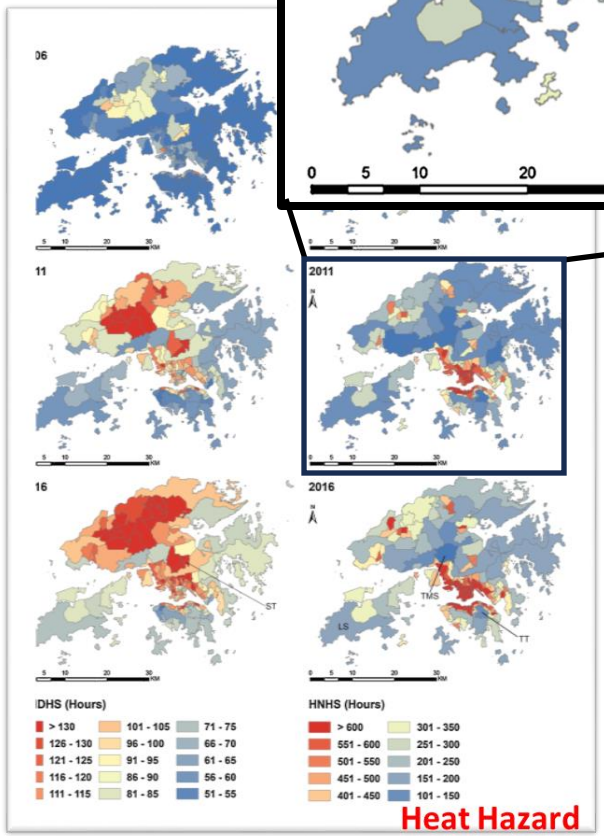
香港天文台 HONG KONG OBSERVATORY

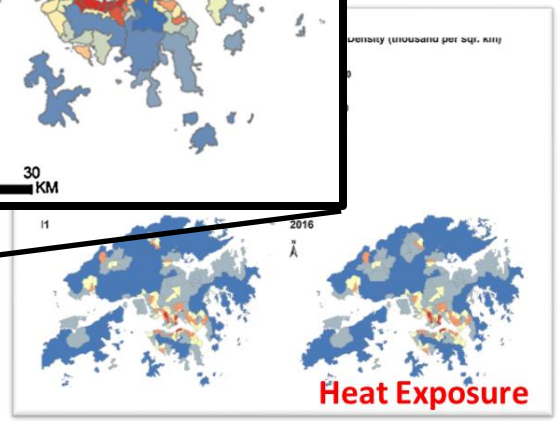
Hong Kong Heat Index	Heat Stress at Work Warning	Warning Signs
#30 to <32	Amber	
	Amber Heat Stress at Work Warning indicates the level of heat stress in certain work environments is high.	
32 to <34	Red	
	Red Heat Stress at Work Warning indicates the level of heat stress in certain work environments is very high.	
≥34	Black	
	Black Heat Stress at Work Warning indicates the level of heat stress in certain work environments is extremely high.	

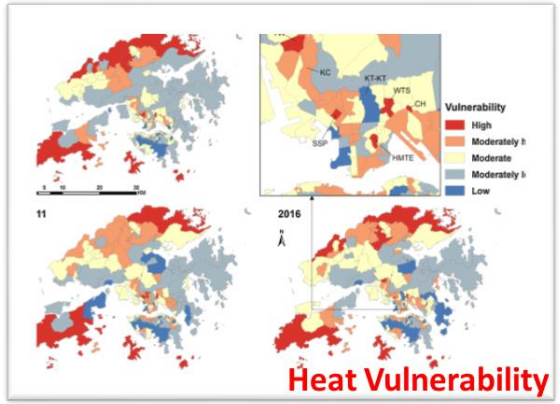
When the Hong Kong Observatory issues "Extremely Hot" Special Alert, the Labour Department issues "Amber" Heat Stress at Work Warning even if the HKHI has not reached 30.

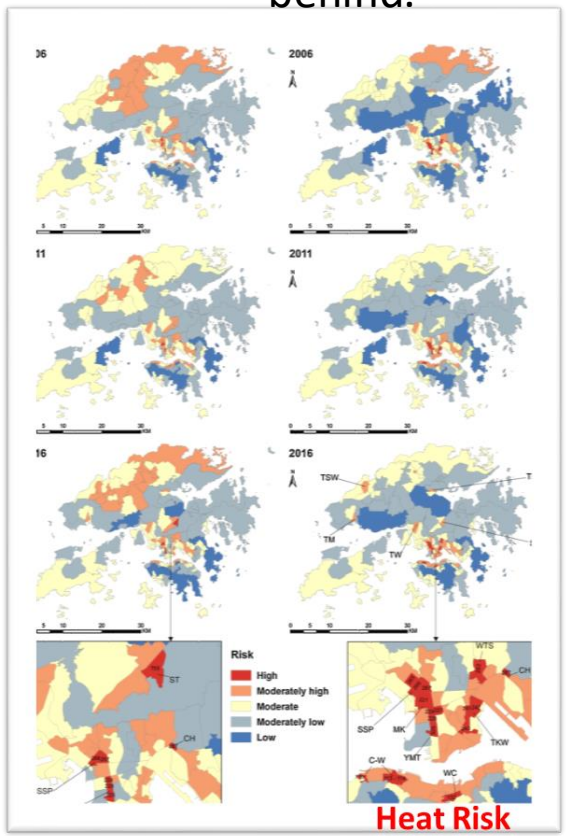












- This study developed **a spatiotemporal hazard-exposure-vulnerability assessment of the extreme heat risk in Hong Kong** integrating cumulative very hot day hours and hot night hours in summer, population density and a principal component analysis (PCA) of demo-socioeconomic characteristics.
- The risk was found **spatially variant**, and high-risk spots were identified at the community scale for both daytime and nighttime with underlying determinants behind.

- In both the daytime and the nighttime, high risk mainly occurred in the **core urban areas**.

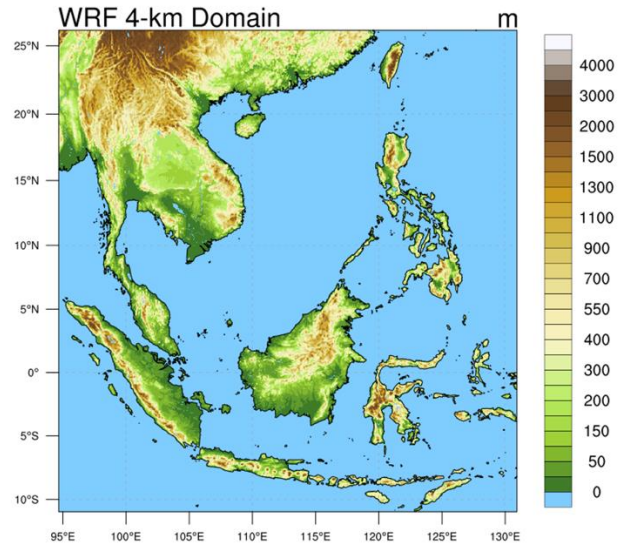
- This study would be a useful reference for community-scale heat risk assessment and mitigation for the development of healthy and sustainable high-density cities.

HKUST cross-scale human-nature integrated modeling framework

For historical reanalysis, future projections,

and Minute-to-season multi-hazard warning systems

Global Scale
100 km resolution



Continental scales
4-km resolution

City Scales

Farm Scales

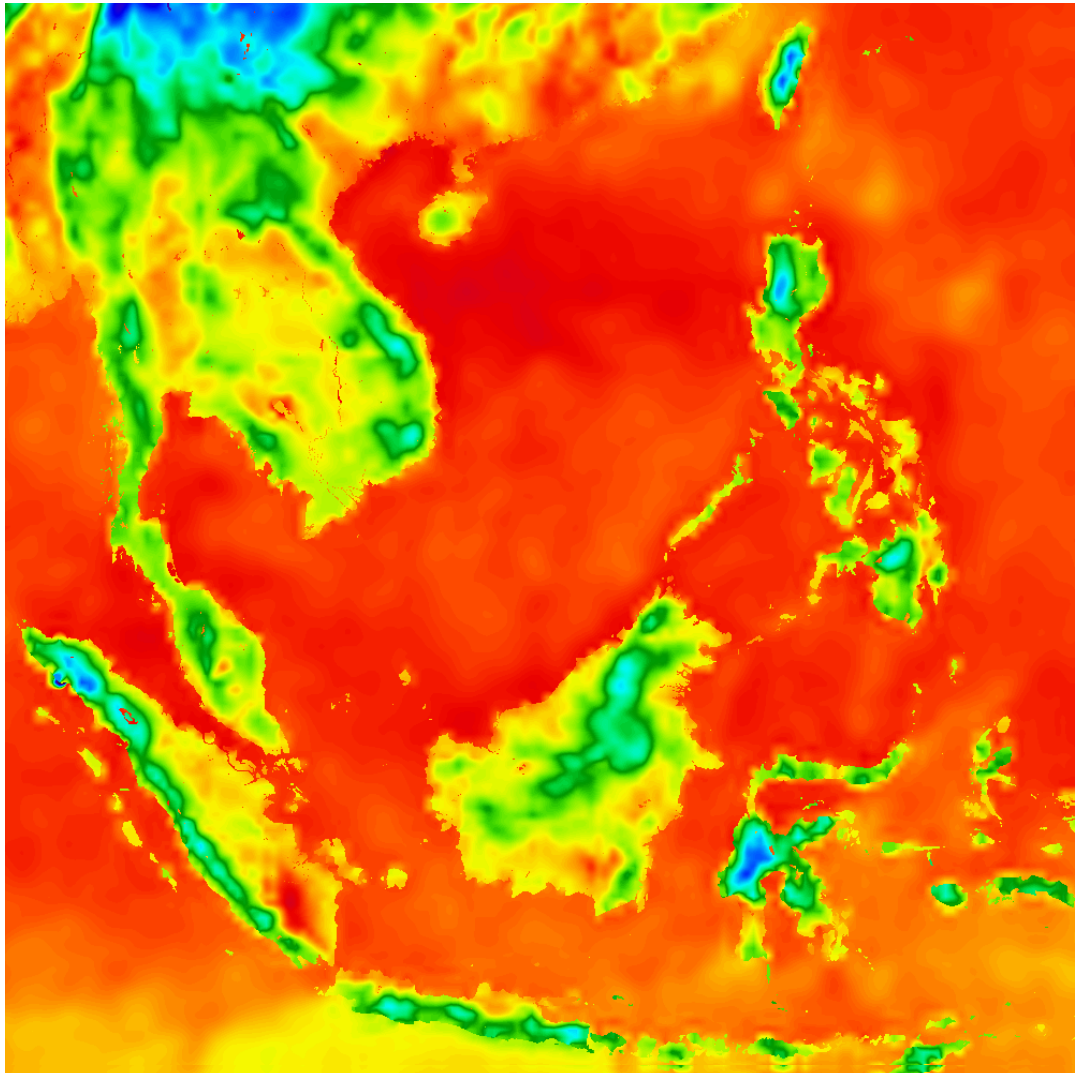
Neighborhood and
Building Scales
< 100-meter resolution

Science challenge
- Tropics
- Urban physics
- Observations

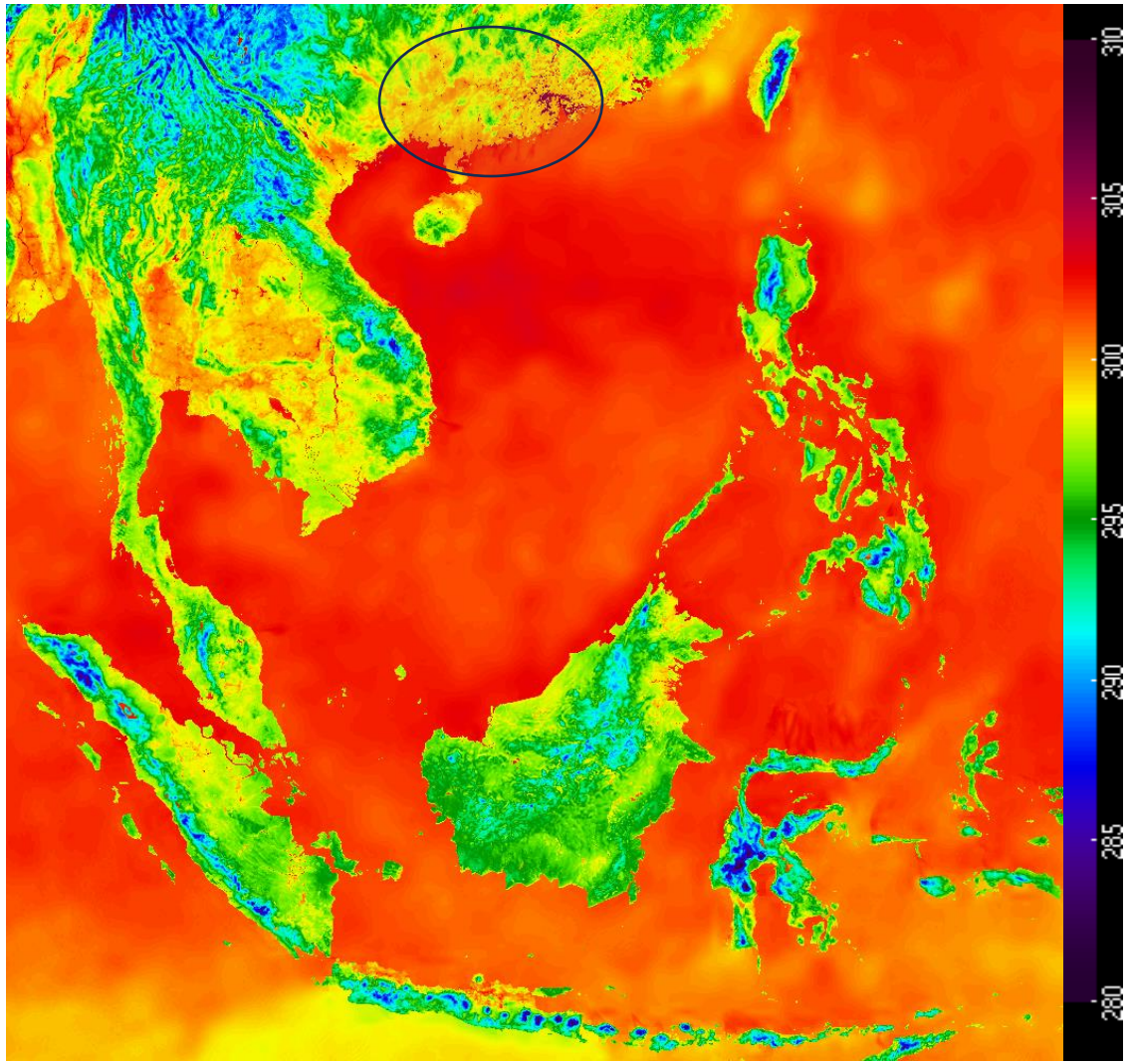
Logistic and infrastructure challenge

Getting the trustful information to vulnerable groups – last mile problem

4-km WRF-SEA simulated surface skin temperature



ERA5



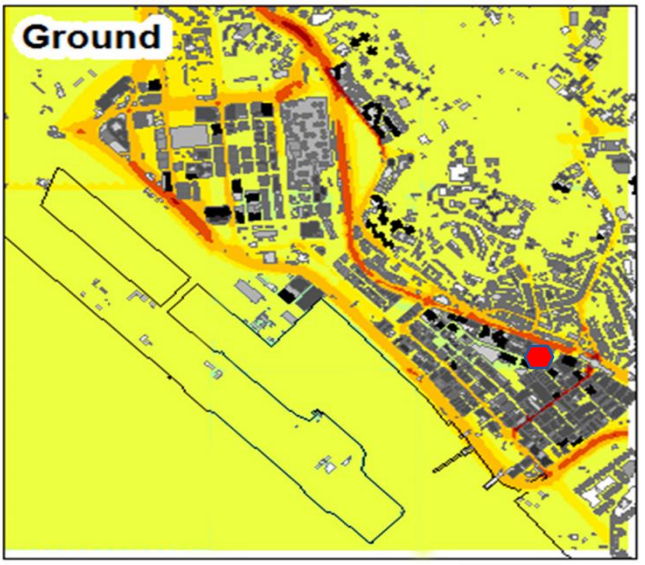
4-km WRF

PRAISE HK | Empower the Public with Personalised Air Quality Information

Technical Integration

Engagement & User Experience design

App Interface and Server Development



ADMS-Urban Modelling
for air quality management and giving predictions of pollutant concentrations

Regional Emission Inventory

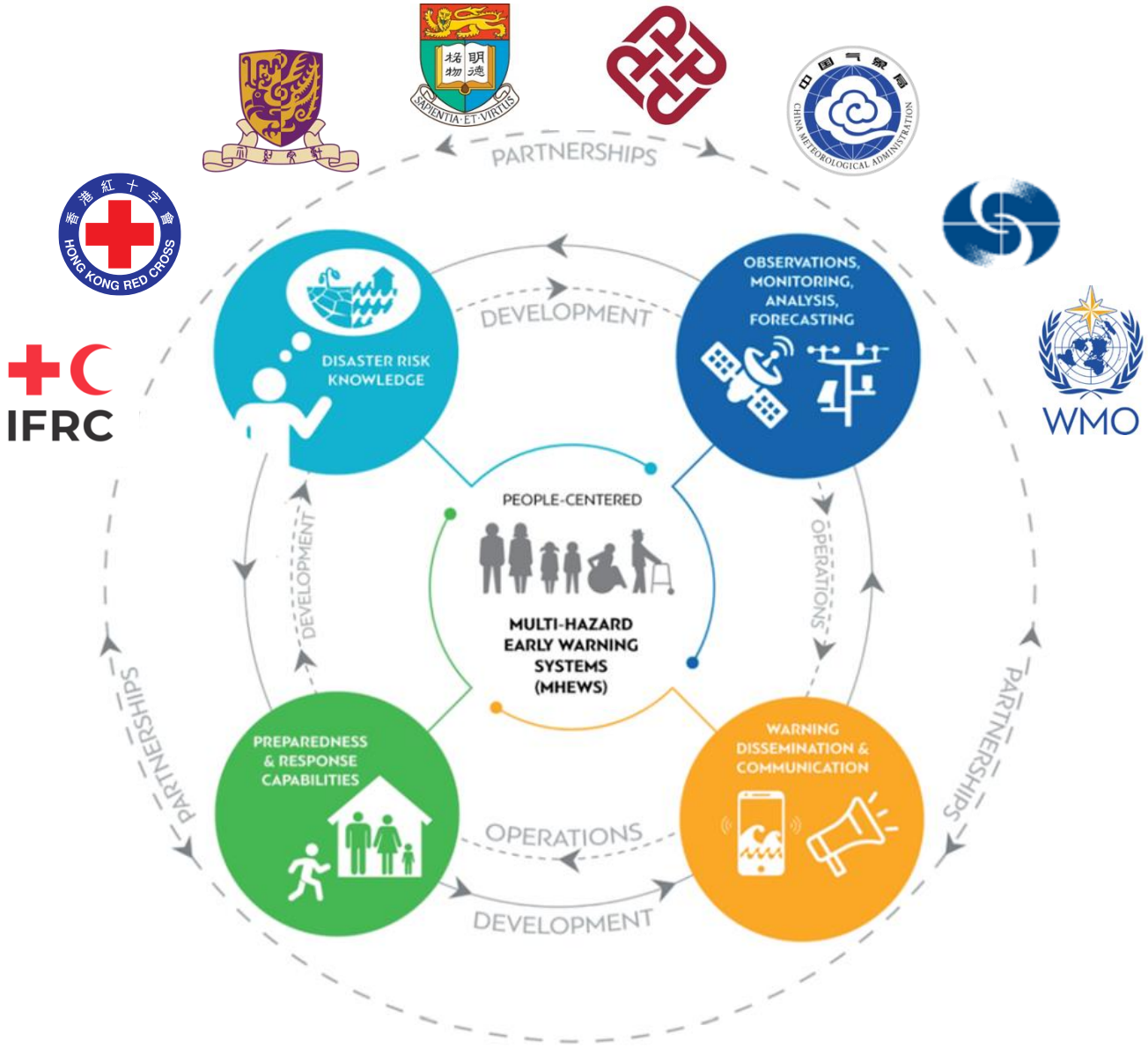
Regional Meteorological Projection
taking into account wind speed & direction, temp., relative humidity etc.

Urban Morphology & Traffic Statistic
including traffic volume and traffic speed

Big Data Informatics
to generate real-time traffic model filling up the missing information from urban informatics

Street resolving, ultra-high resolution, outdoor air quality distribution map
With real-time AI, index of agreements (IOAs) ~ 0.94, much higher than earlier IOAs ~ 0.80

China announces major boost to Early Warnings for All @ COP 29



Thank You !