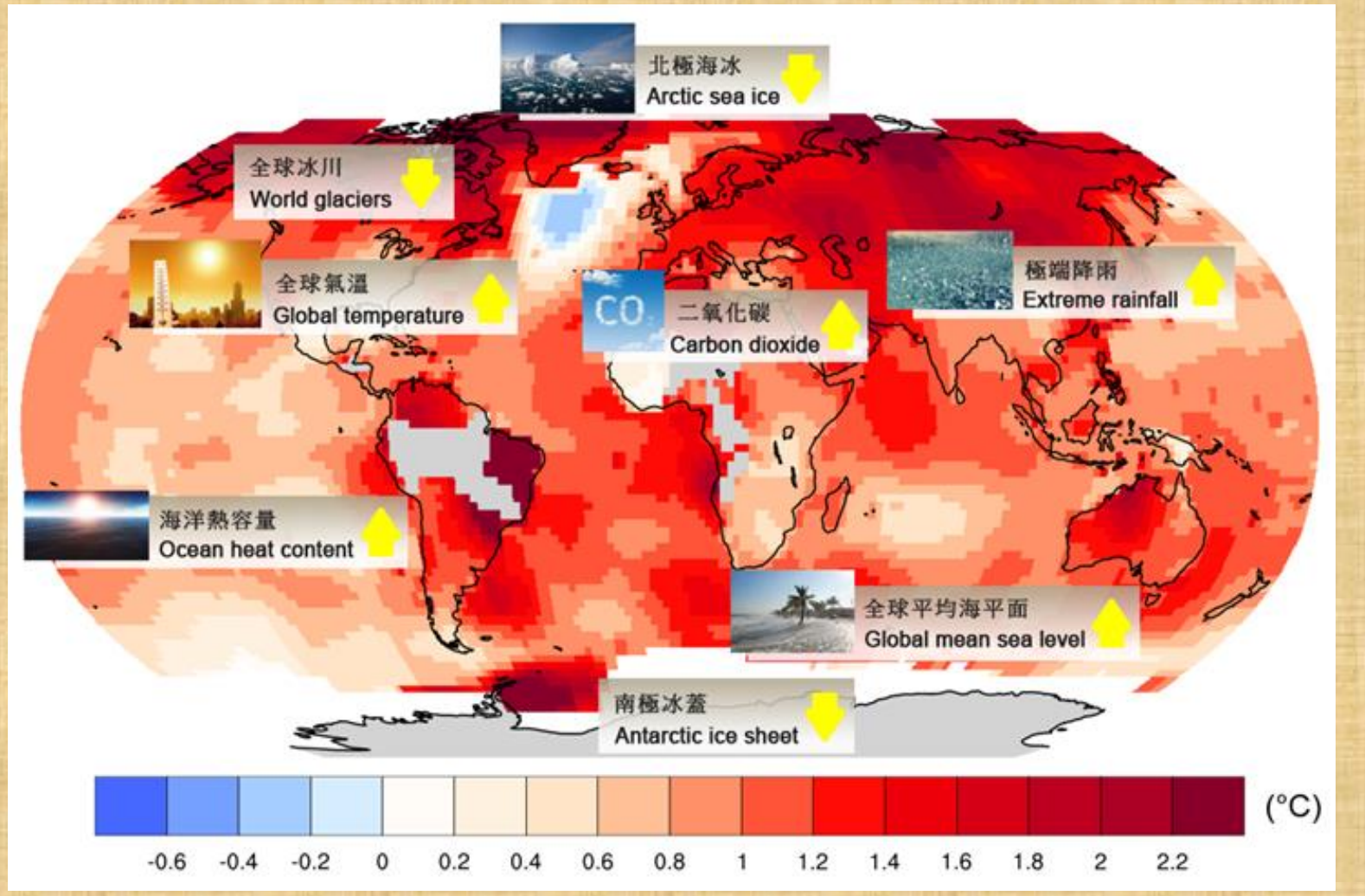
香港天文台
HONG KONG OBSERVATORY

Impact of Climate Change in Hong Kong

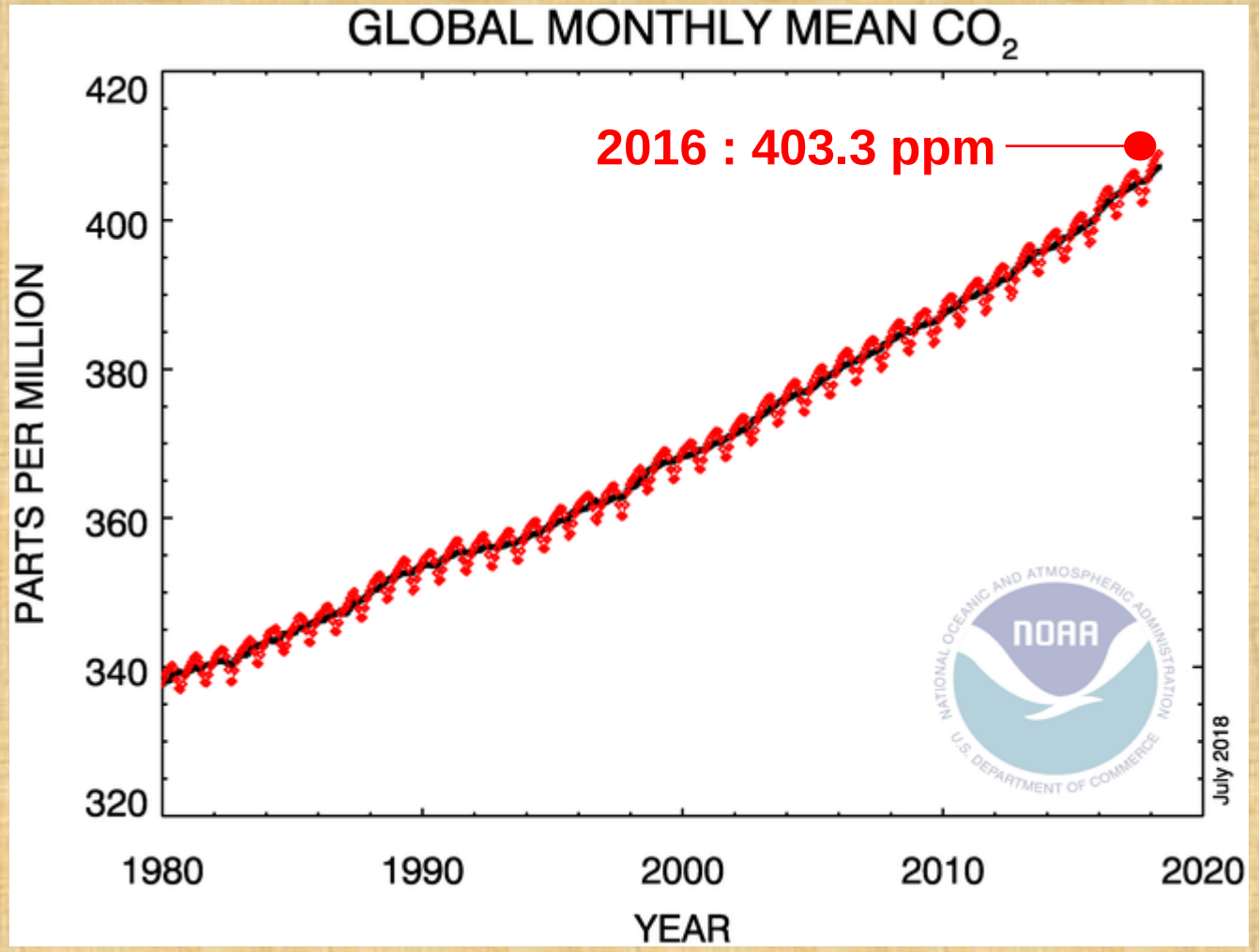
FC Sham
Chief Experimental Officer

Evidence of a warming world



Change in surface temperature 1901-2016

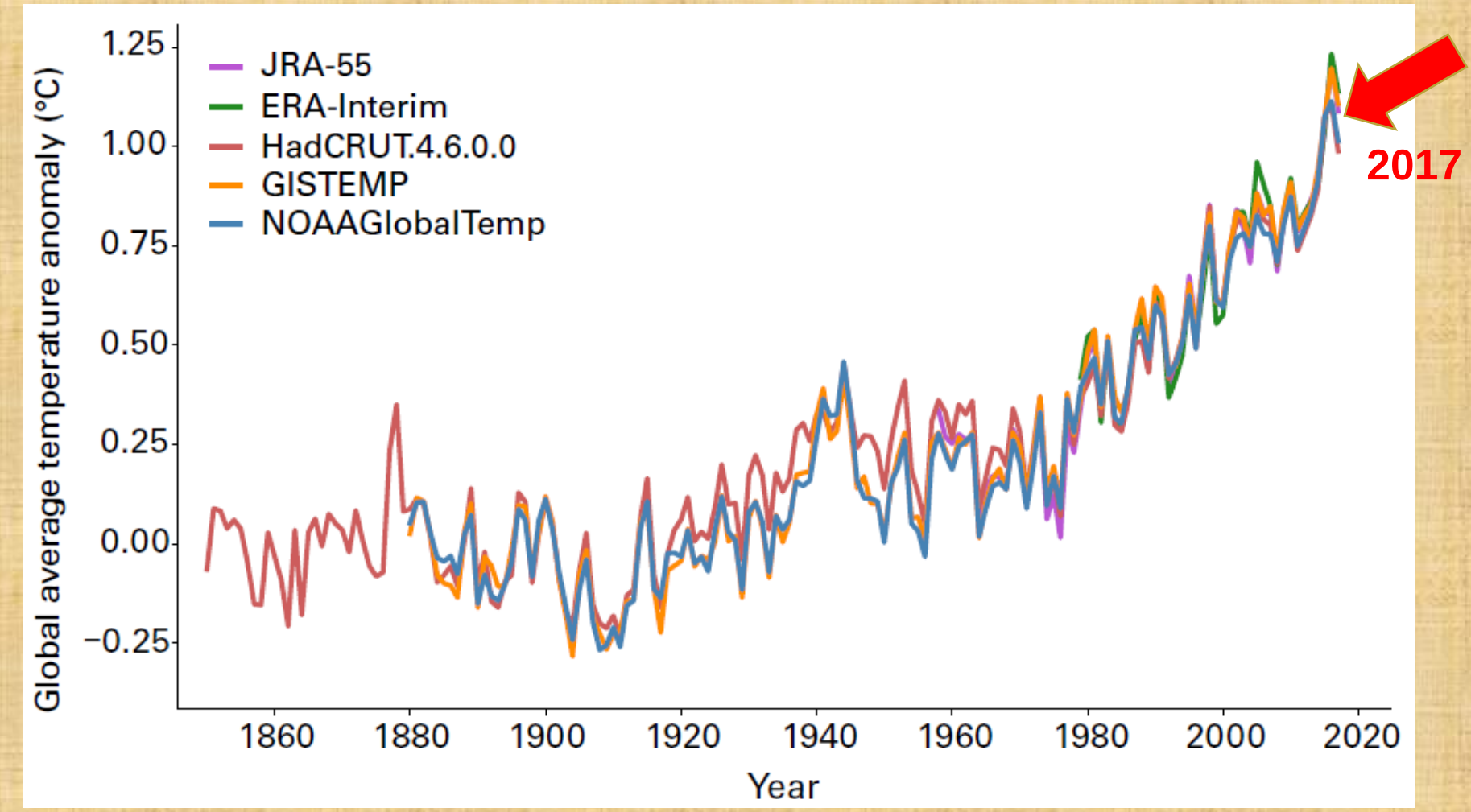
Atmospheric CO_2 concentration



Unprecedented in at least the last 800,000 years. The annual increase from 2015 to 2016 was 3.3 ppm, marking the largest increase on instrumental record.

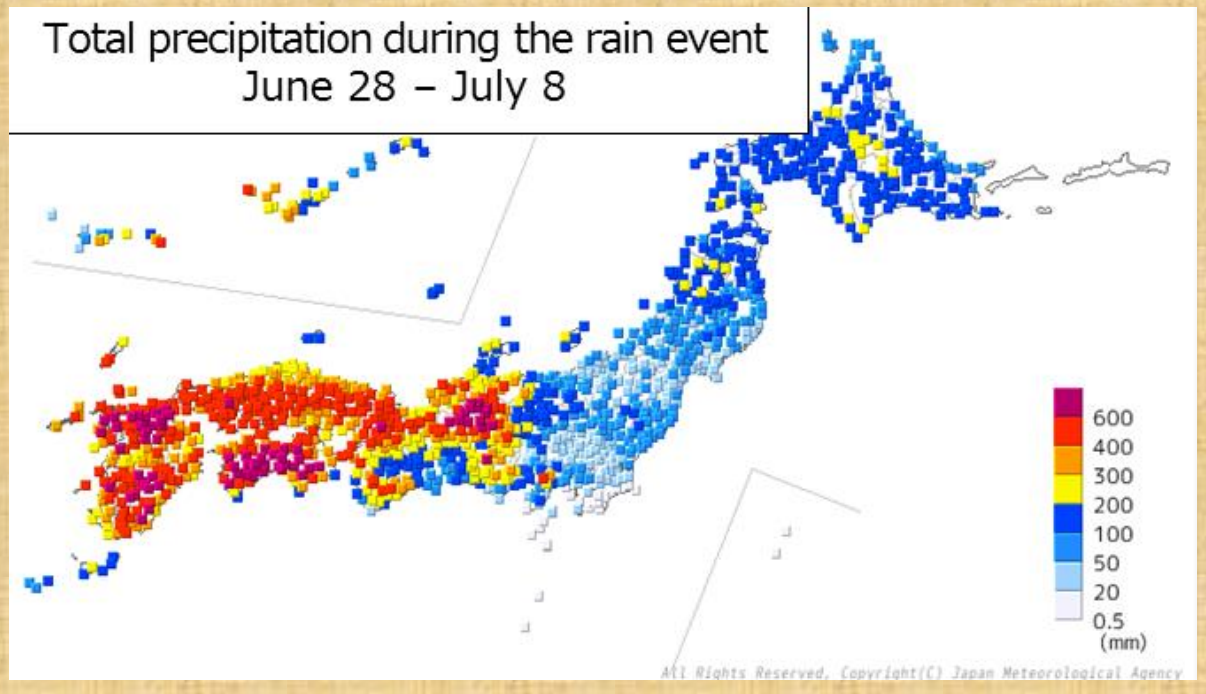
Global warming is unequivocal

2015, 2016 and 2017 were the three warmest years on record.
Global mean temperature in 2017 was about 1.1 ˚C above pre-industrial levels.

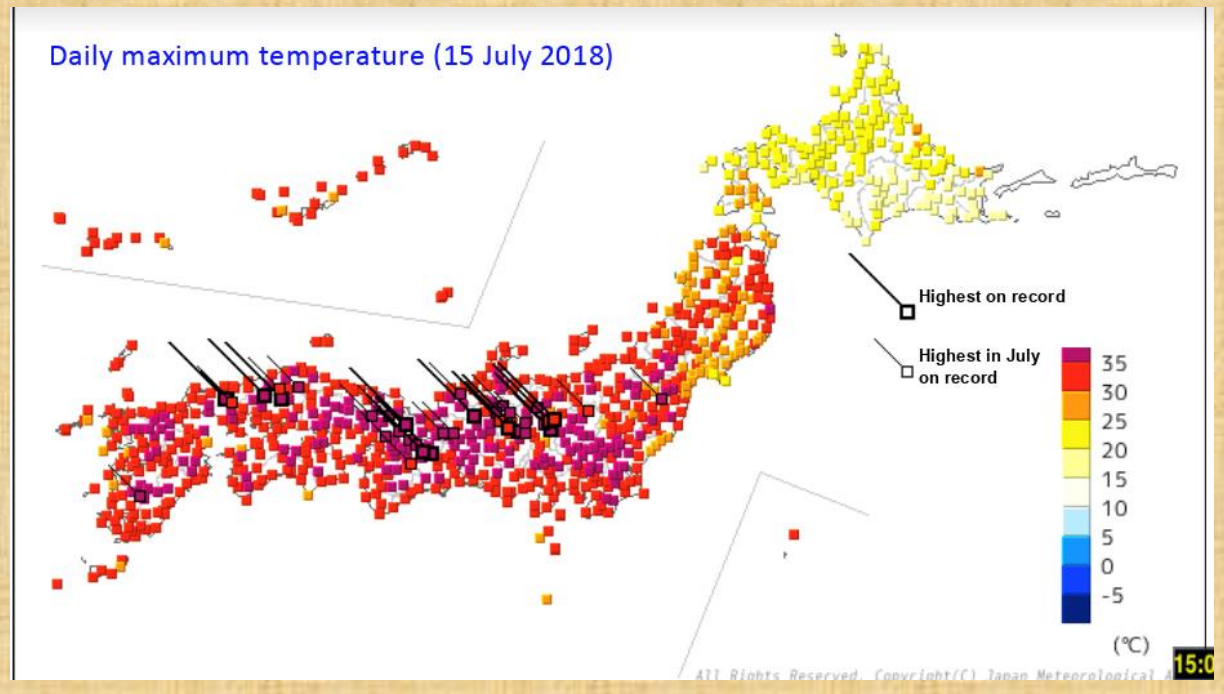


Record-breaking extreme weather

Extreme weather in early summer 2018

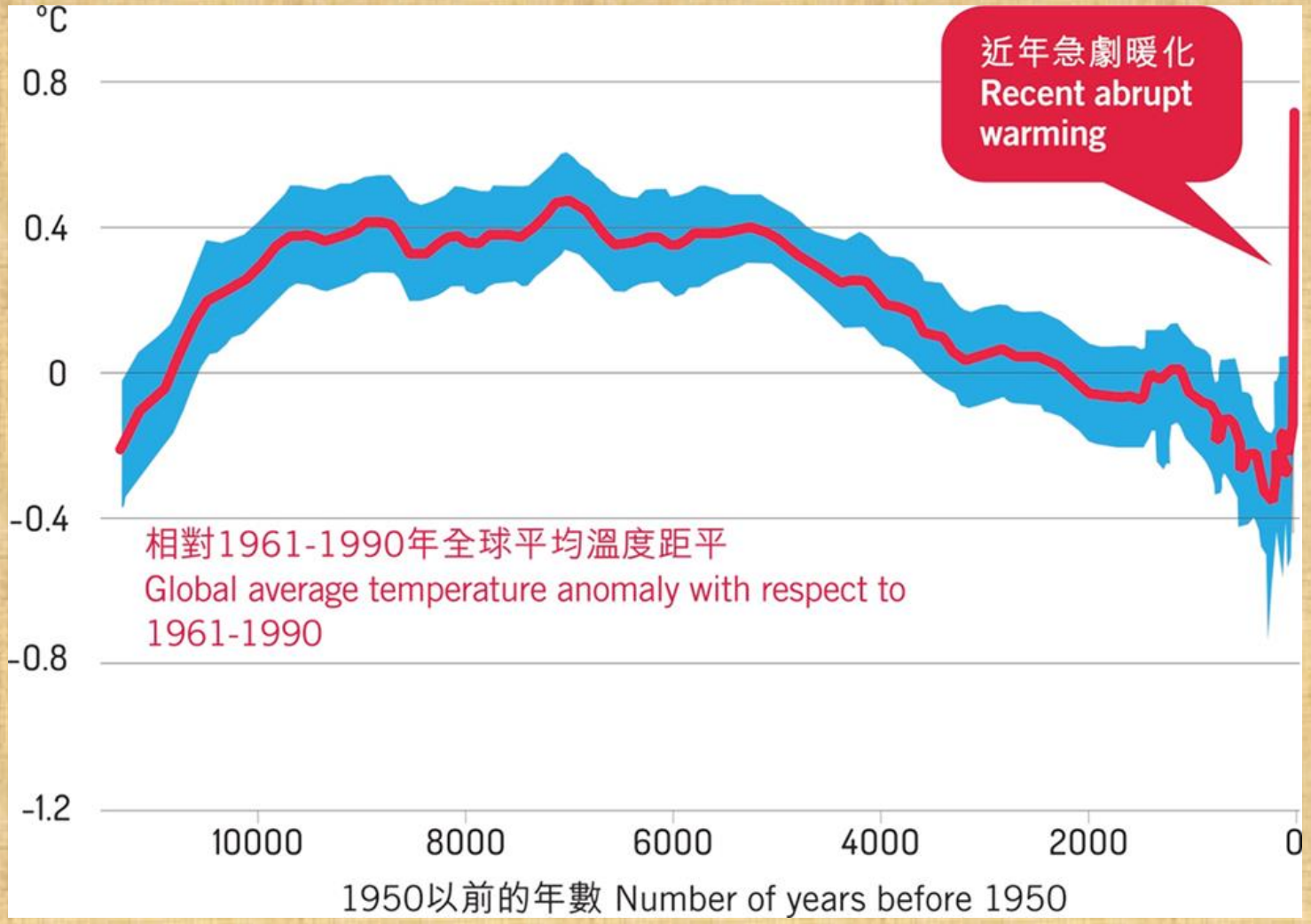


Japan suffered the worst flooding and landslide in decades. More than 200 people lost their lives.

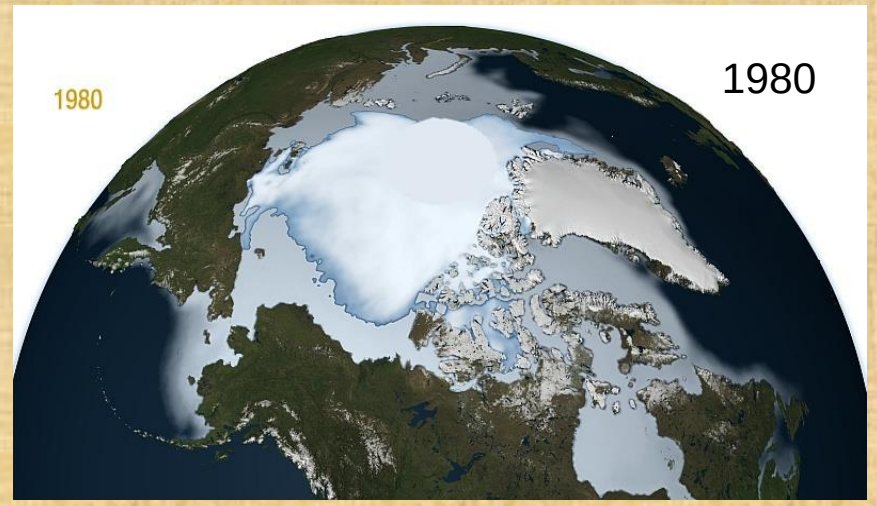


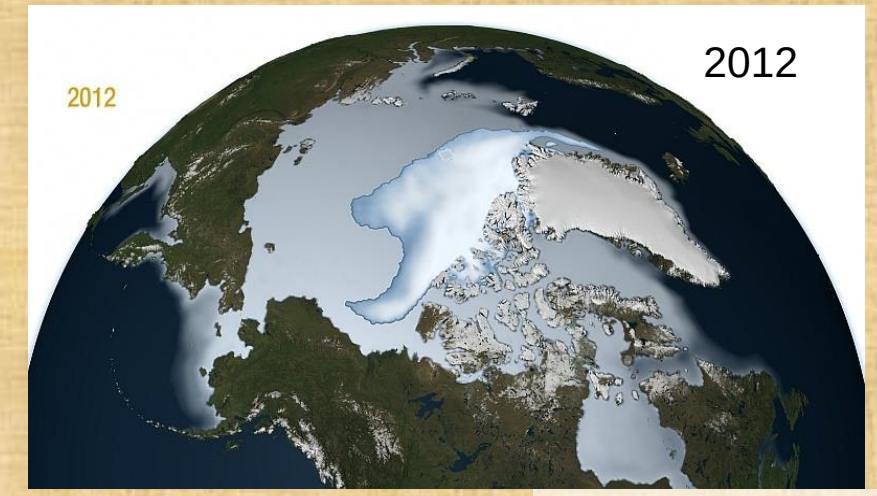
Daily temperature record of 41.1˚C at Kumagaya (near Tokyo) on 23 July

Recent abrupt warming has reversed the long-term cooling trend of past 5,000 years

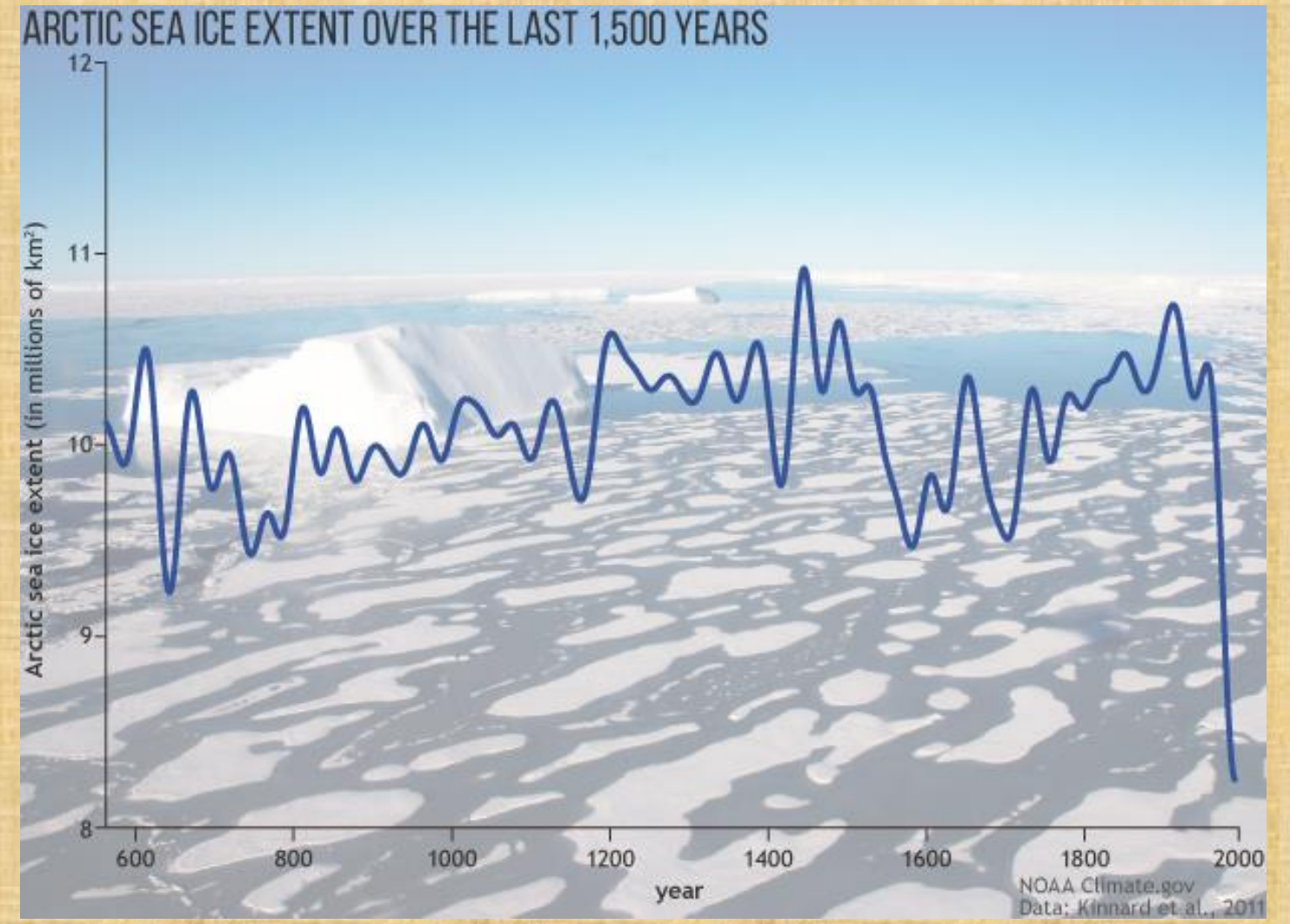


Decrease in summer Arctic sea ice in the past 3 decades is unprecedented in the last 1450 years

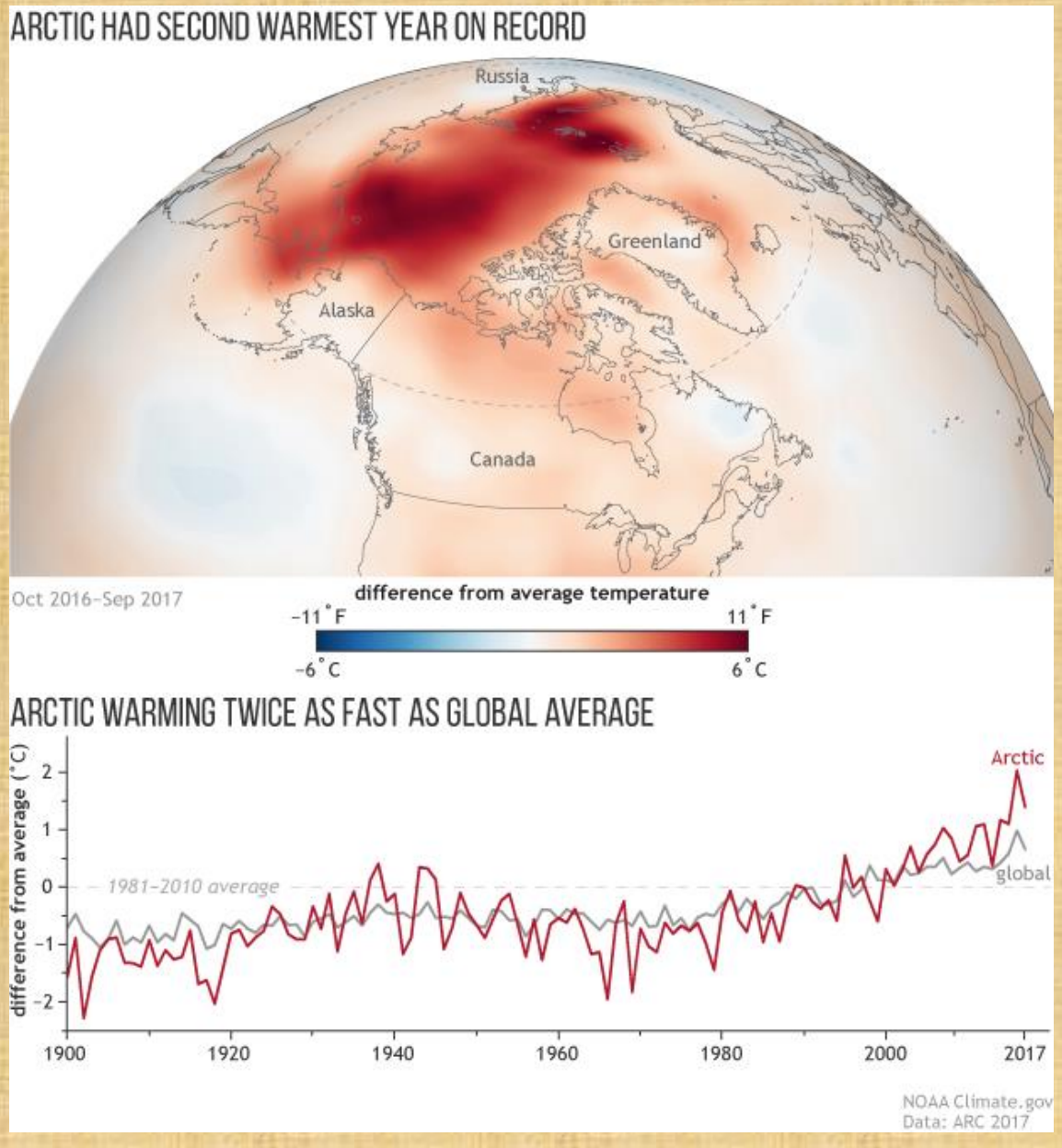




Source: NASA



Arctic warming twice as fast as global average



Retreat of the Columbia Glacier, Alaska

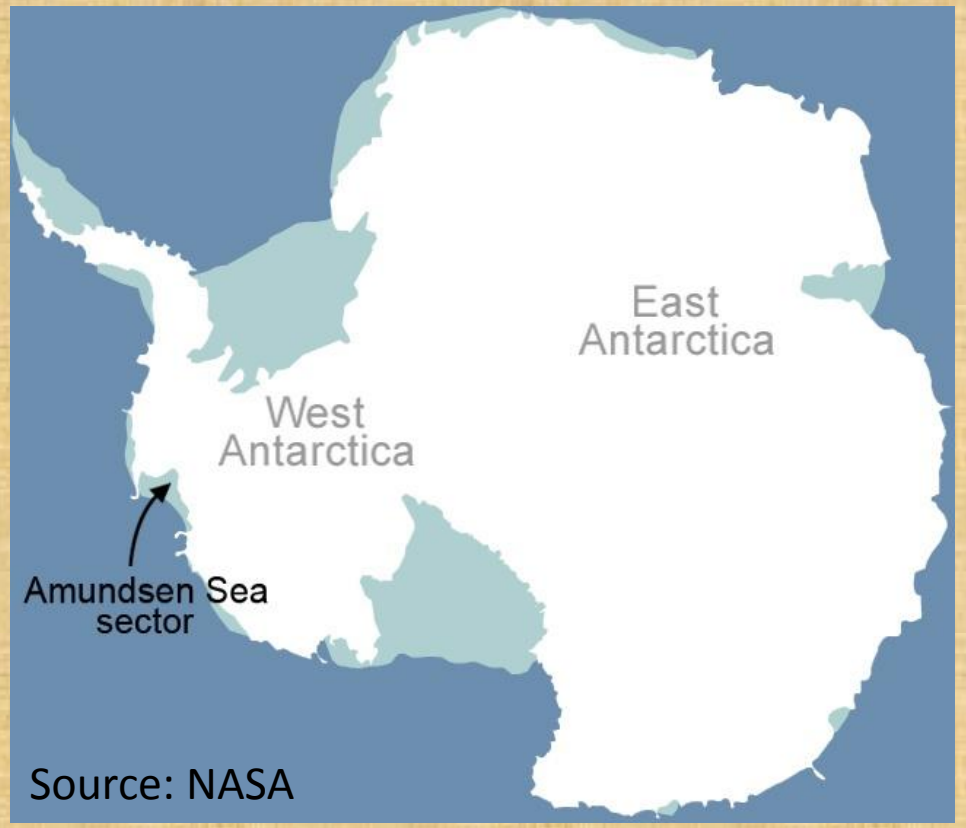
2009

2015

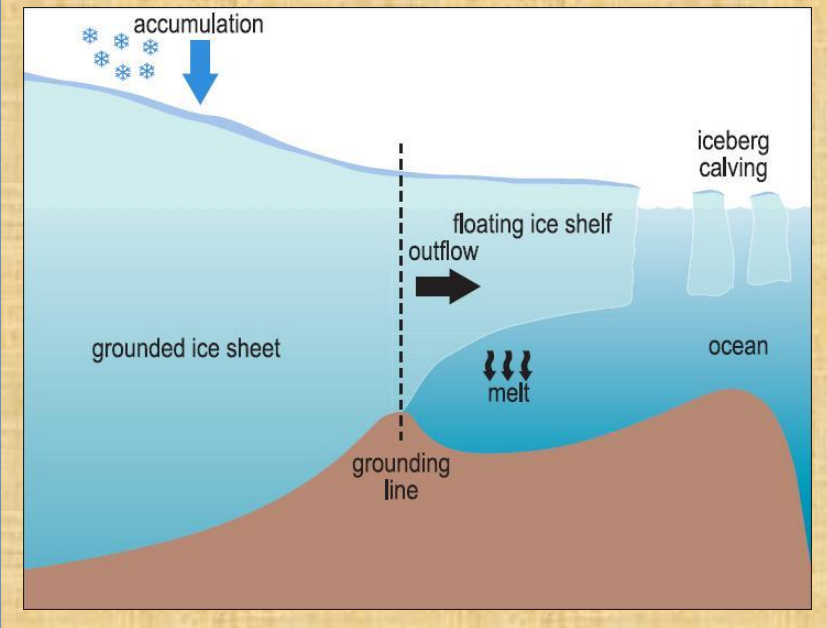
Accelerated glacier retreat

Largest Greenland glaciers calving ever filmed

Melting of glacier unstoppable in the Amundsen Sea sector



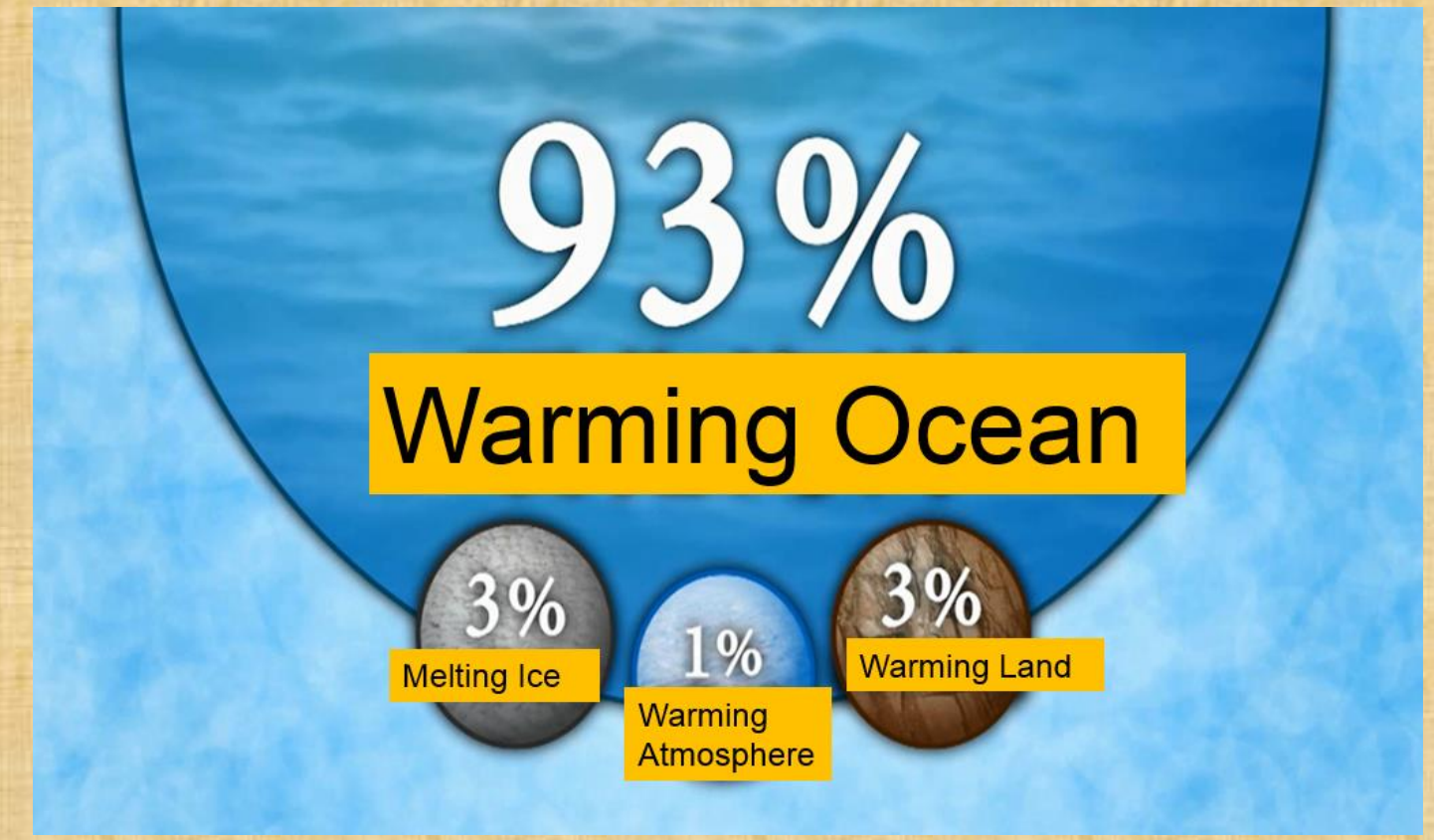
Source: NASA



Source: IPCC AR5

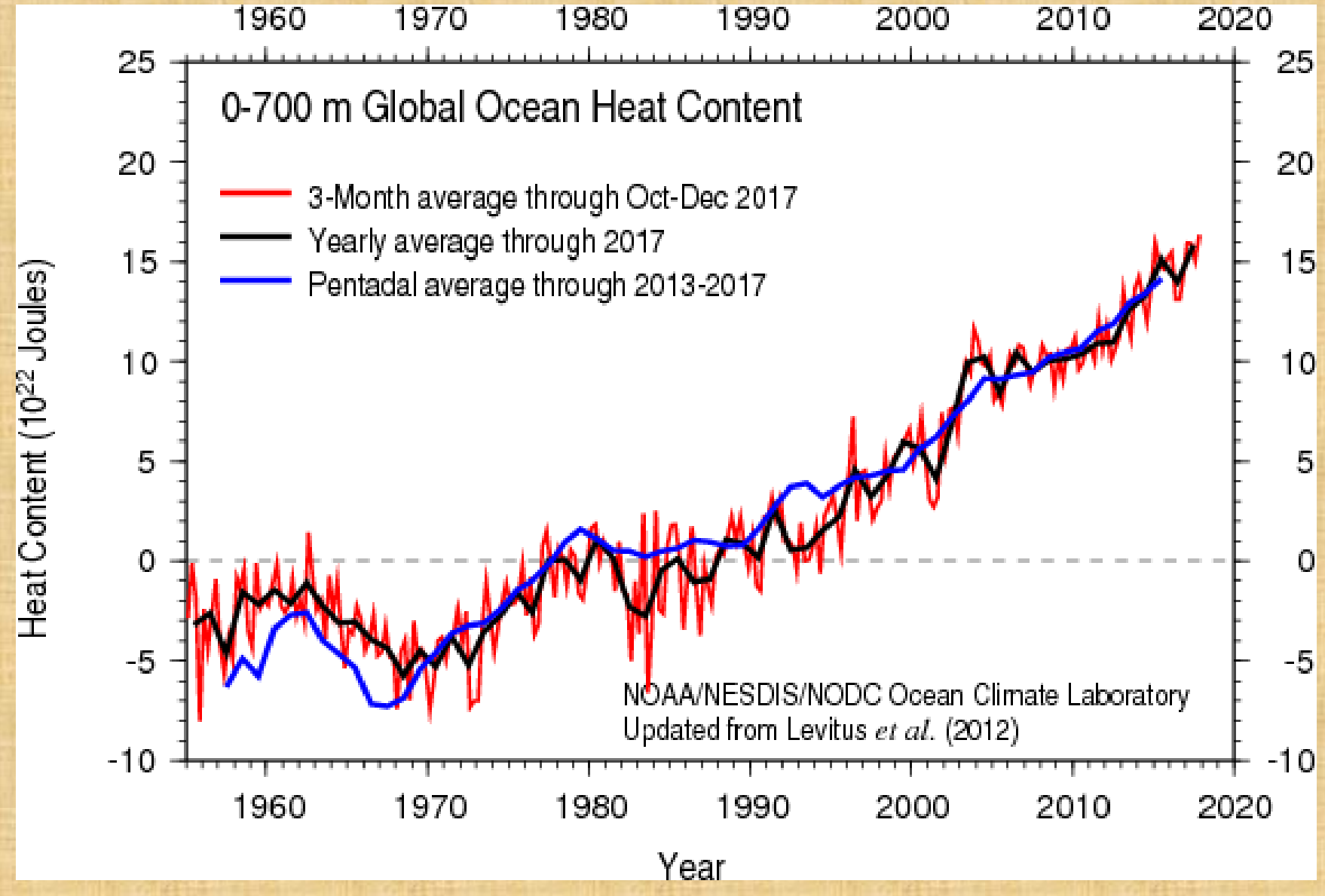
May cause significant global sea level rise of around 1.2 metres if glaciers in West Antarctic melt away

Ocean warming accounts for about 93% of total heating rate

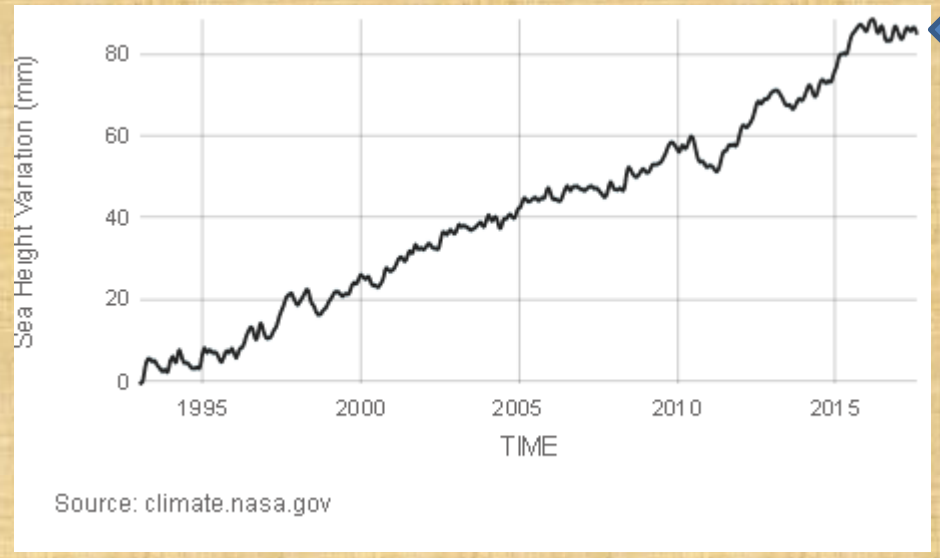


- Only a tiny portion (1%) of energy trapped by GHG goes to heating up the atmosphere

Global ocean heat content

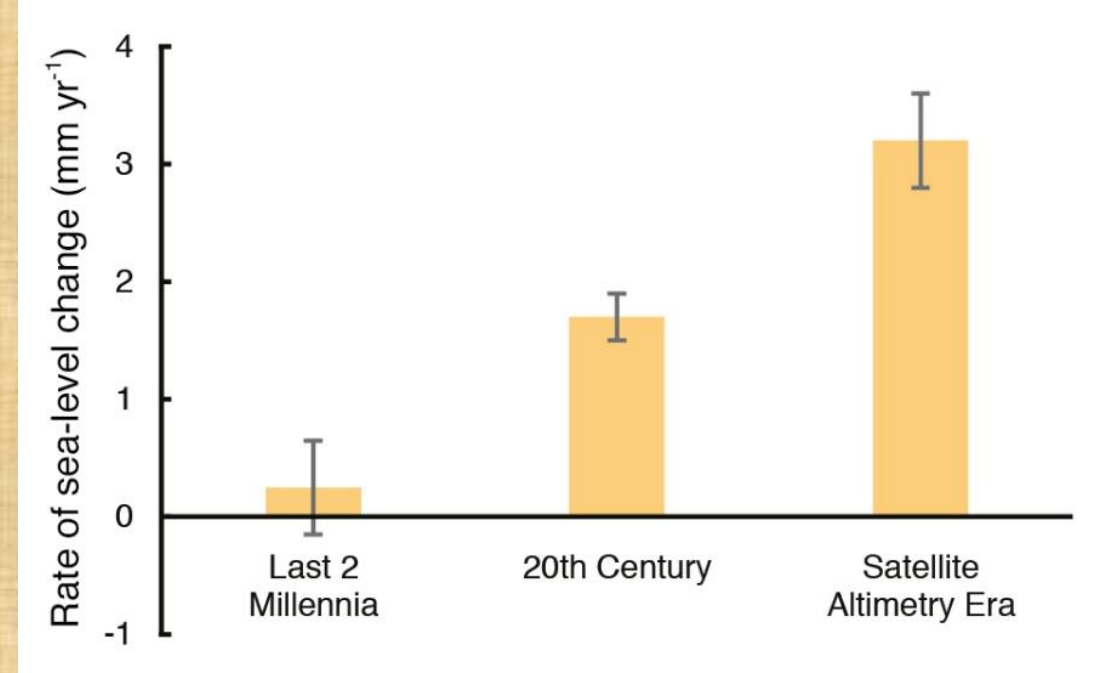


Sea level rising

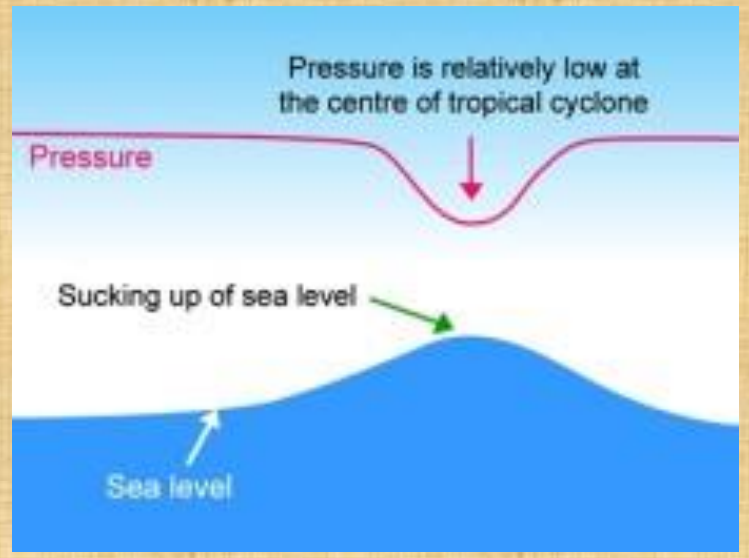


2016: highest global mean sea level in the satellite record

Rate: 3.2 mm/year (1993-present)



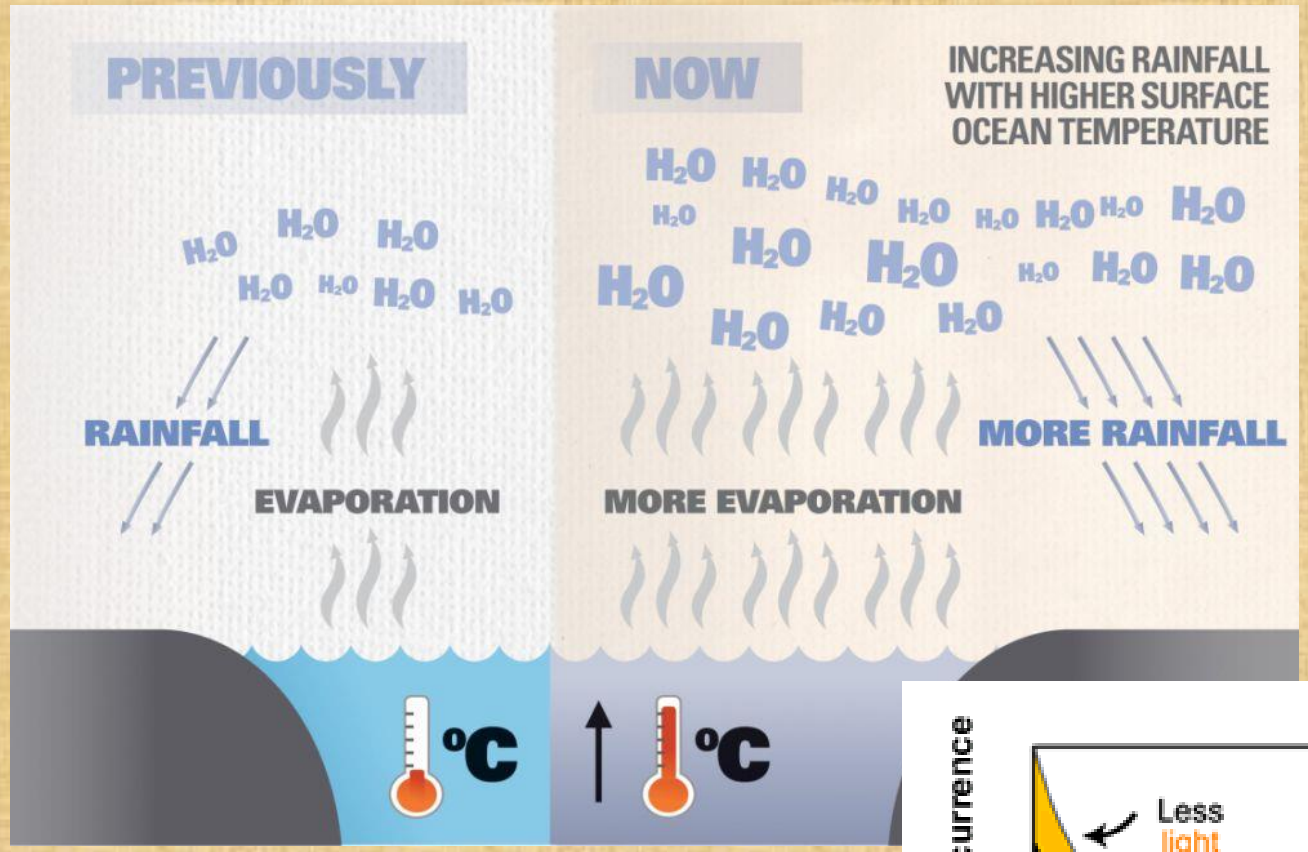
Threat of storm surge increases with rising sea level



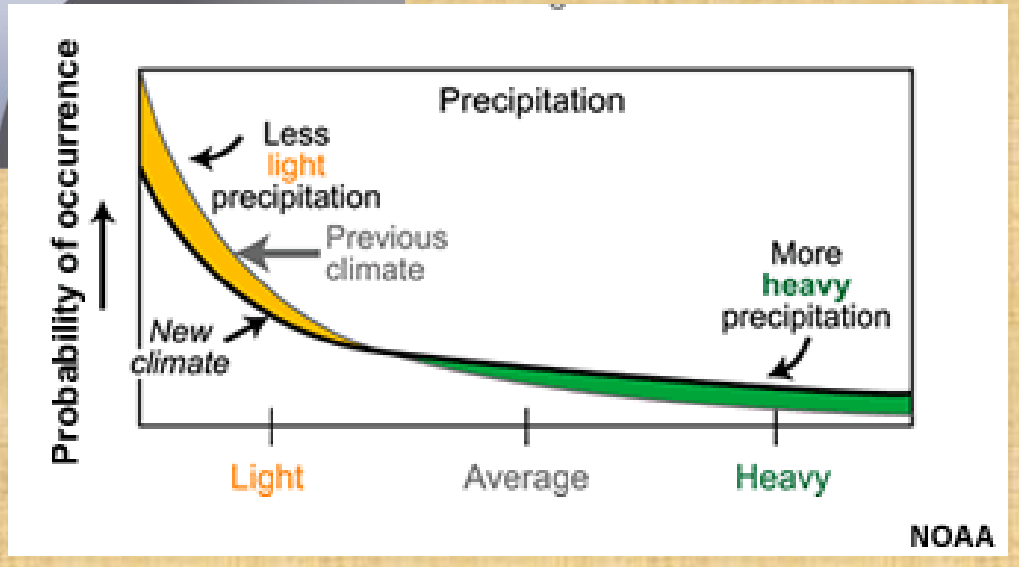
Storm surge during the passage of Hurricane Sandy

2013 Super Typhoon Haiyan

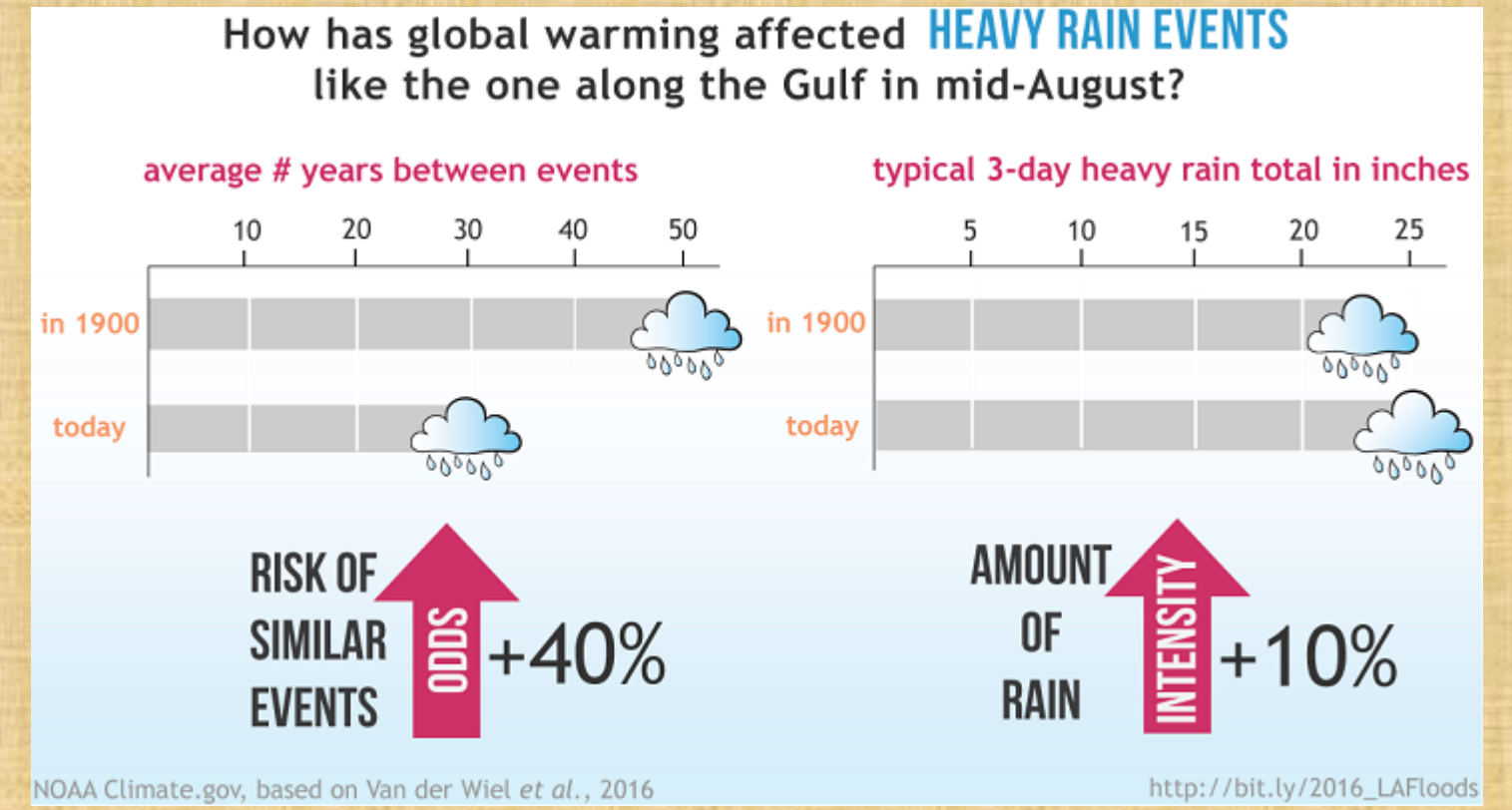
Enhanced hydrological cycle



Source: Climate Commission, Australia



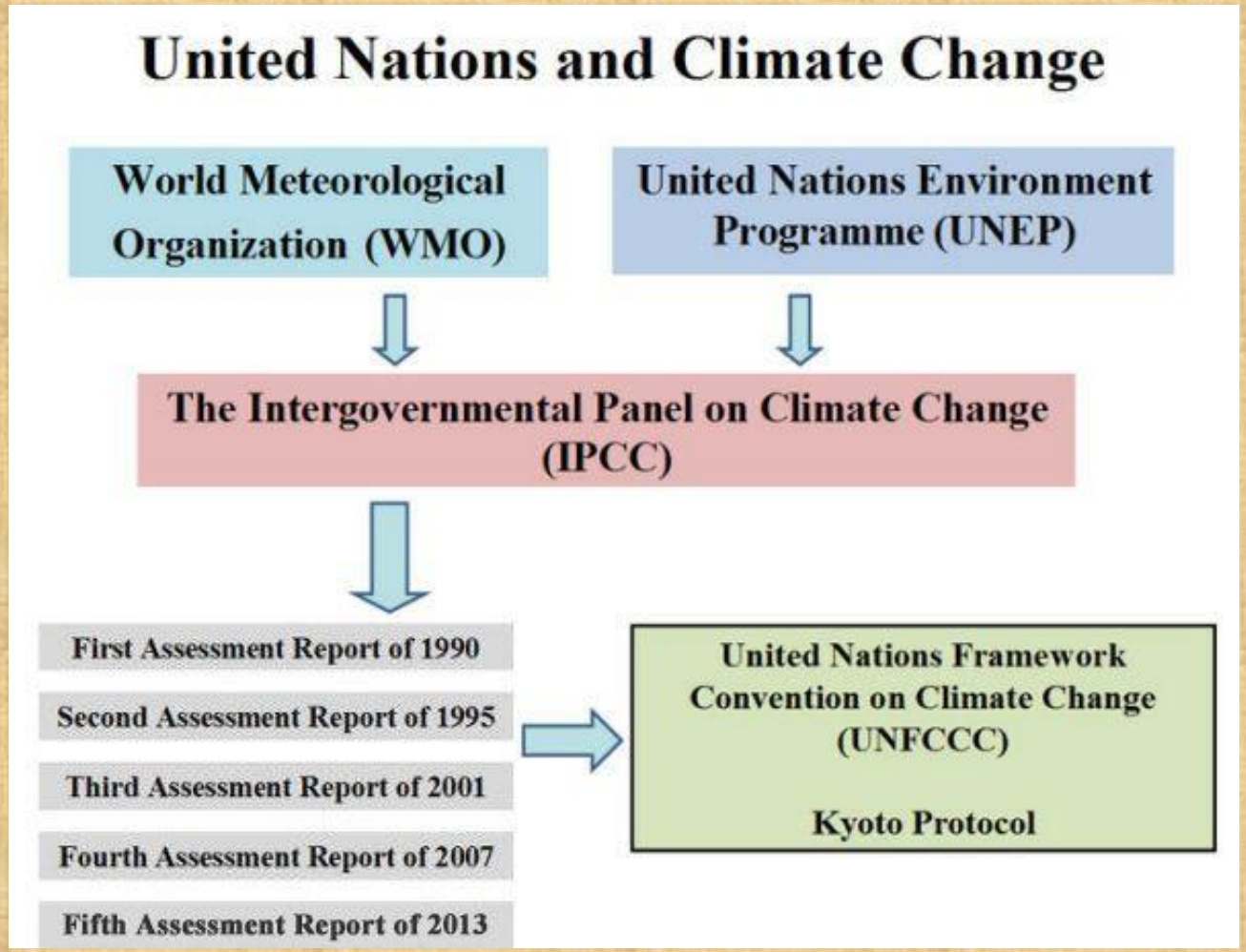
South Louisiana (US) flooding 2016



Myth 1 – No consensus of scientists?

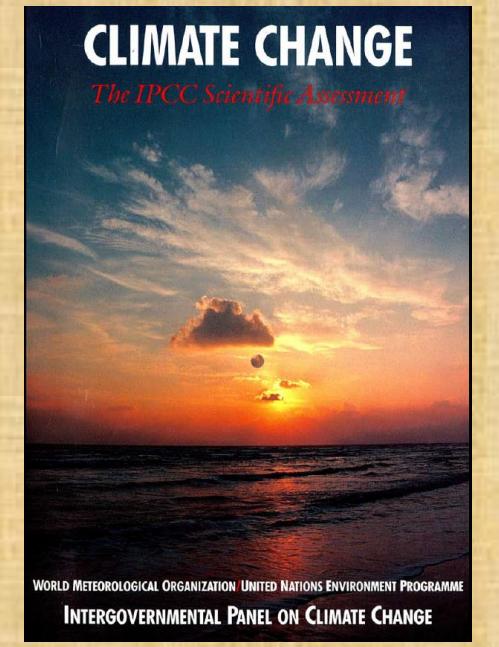
Scientific consensus

IPCC:
政府間氣候變化
專門委員會

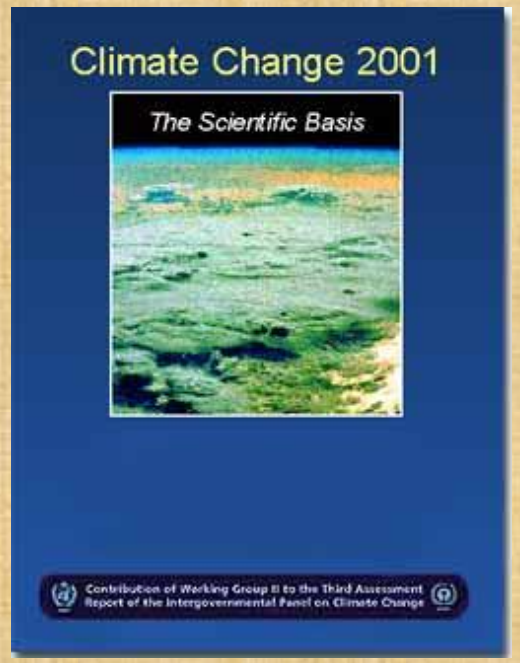


IPCC – alarmist or conservative?

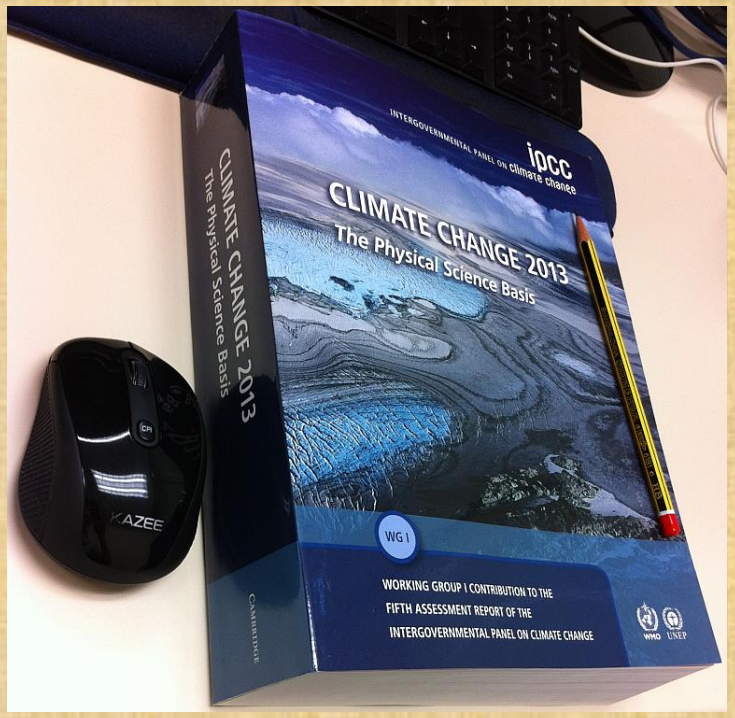
1990



Not sure whether
it is natural or not

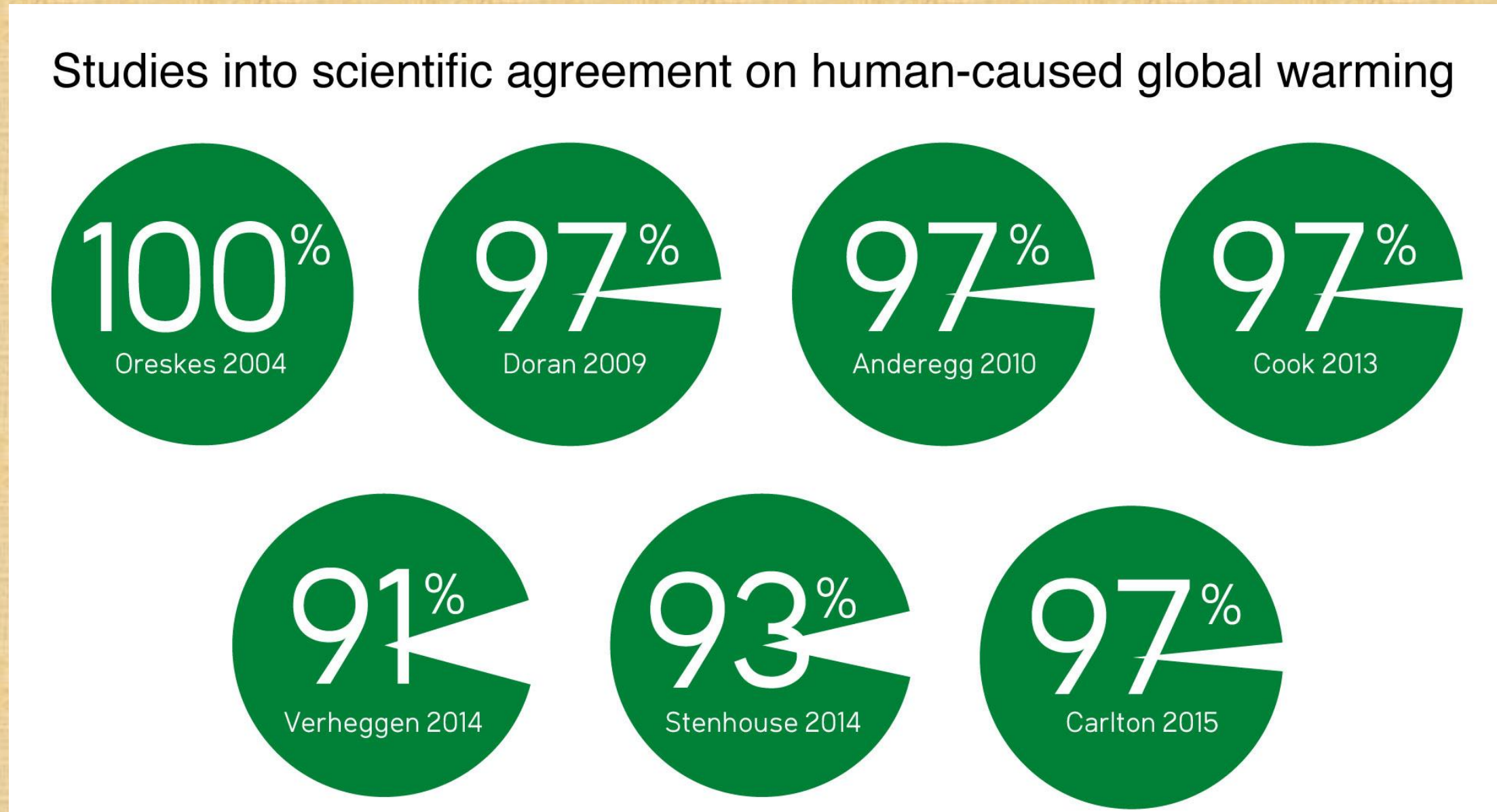


very unlikely to be
natural variation alone



Human influence on
the climate is clear.

Almost ¼ of a century!

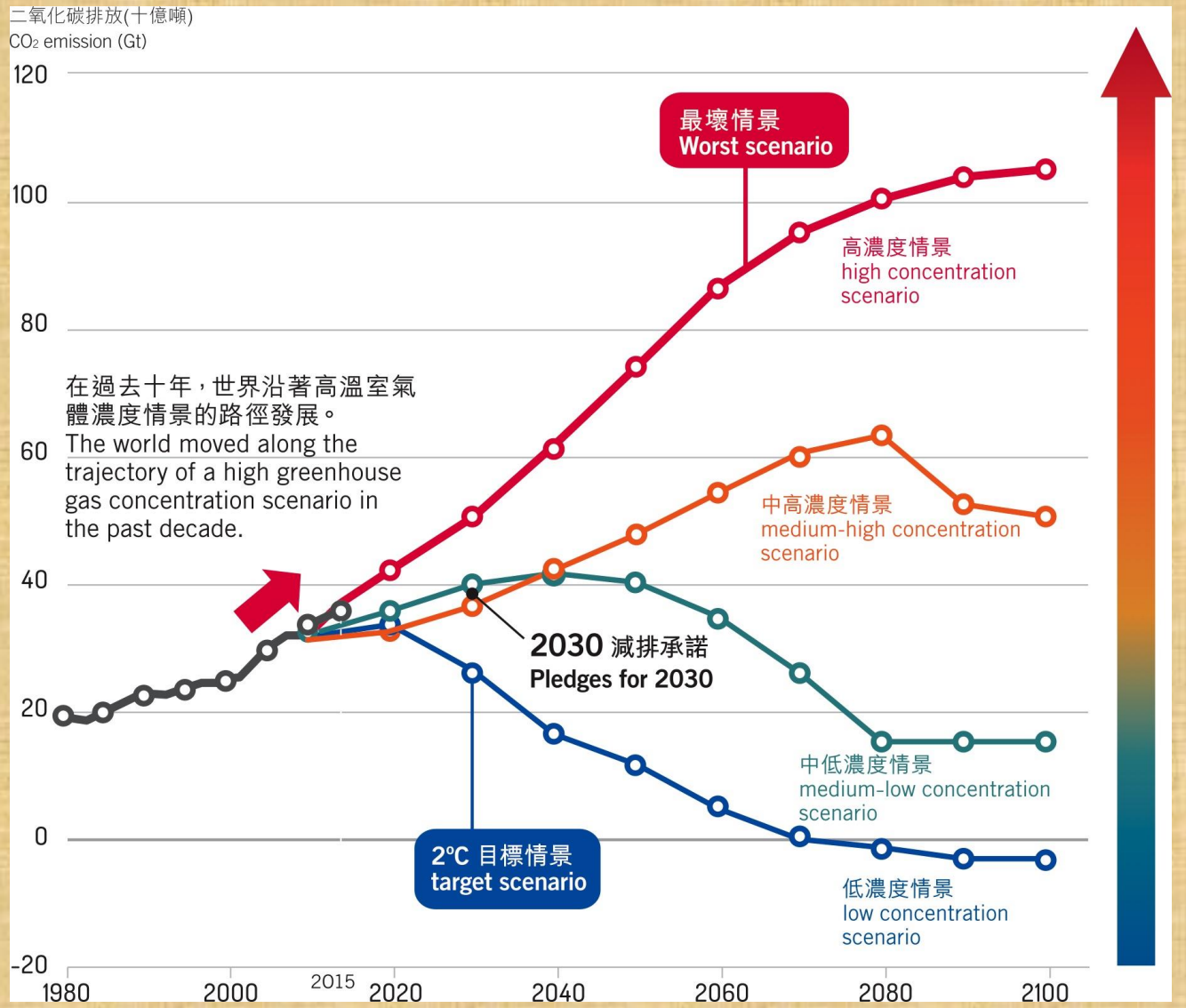


Source: http://www.skepticalscience.com

COP21

Paris Agreement put in force on 4 November 2016

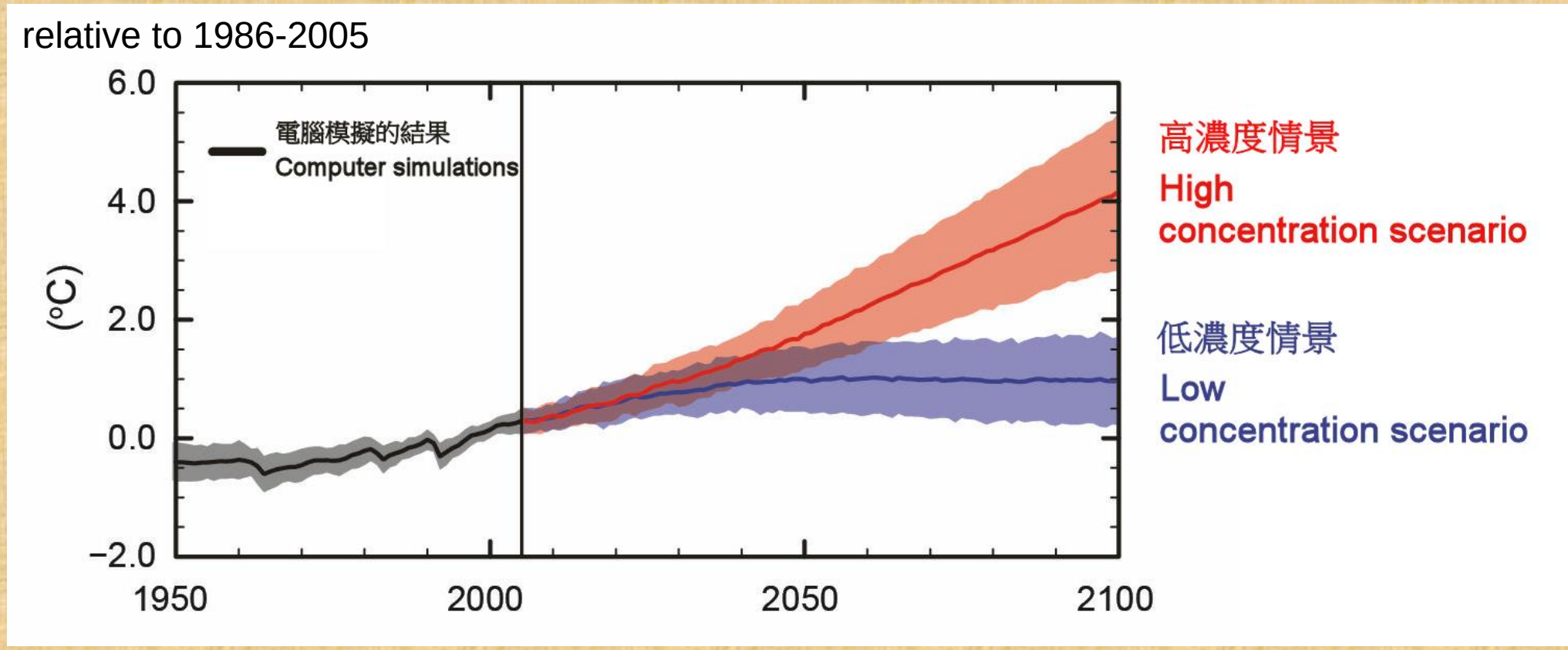
Where is the world heading to after COP21?



Given the COP21 pledges, a rise of 3 ^{o}C (above pre-industrial levels) by end of century is likely.

Much more mitigation effort is required to keep temperature rise below 2 ^{o}C by end of this century

Global average temperature change



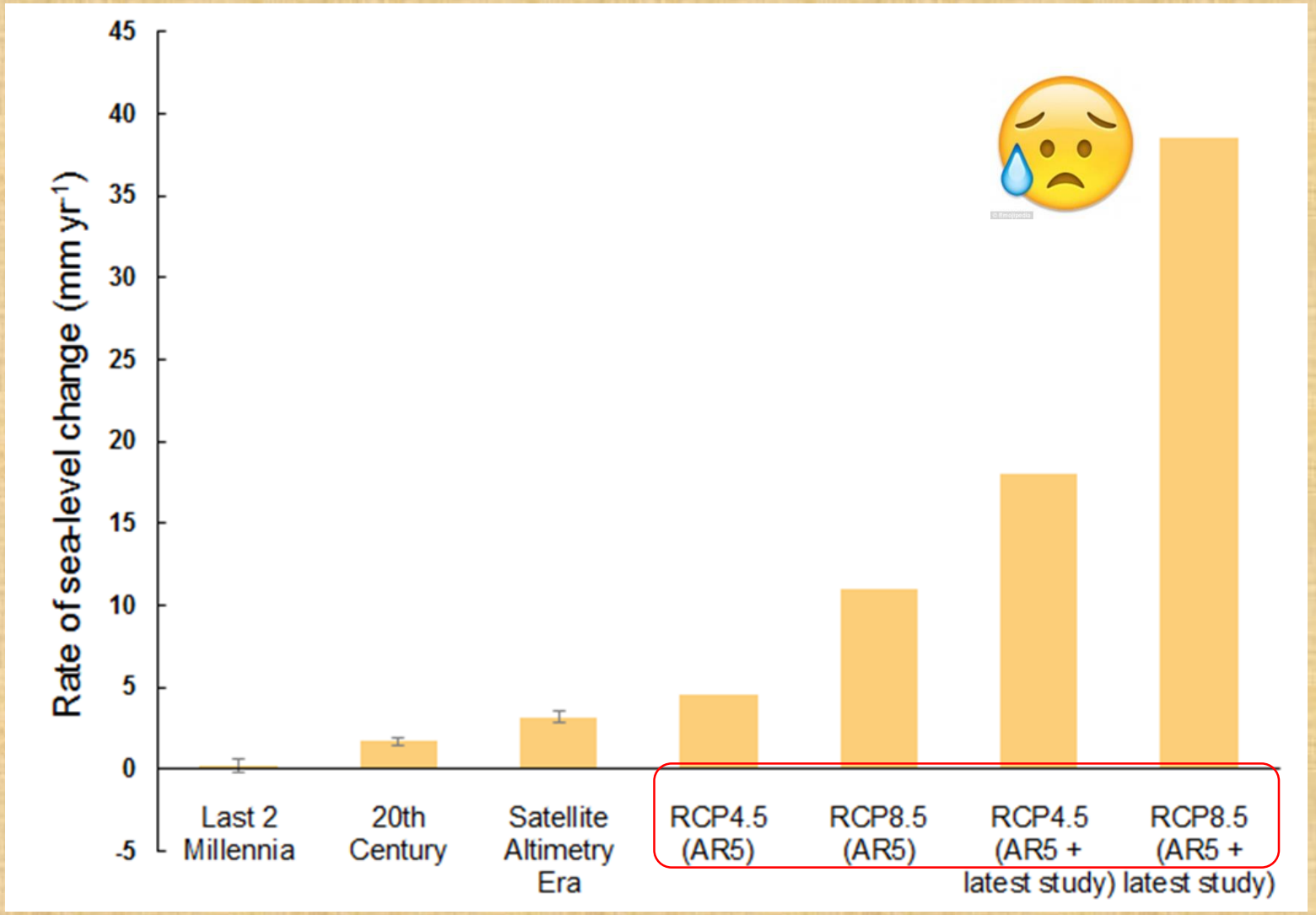
- For RCP8.5, temperature rise could reach 4 °C by 2100
- Temperature rise below 2 °C is only possible for RCP2.6

More heat waves

More land areas experience an increase in heavy precipitation

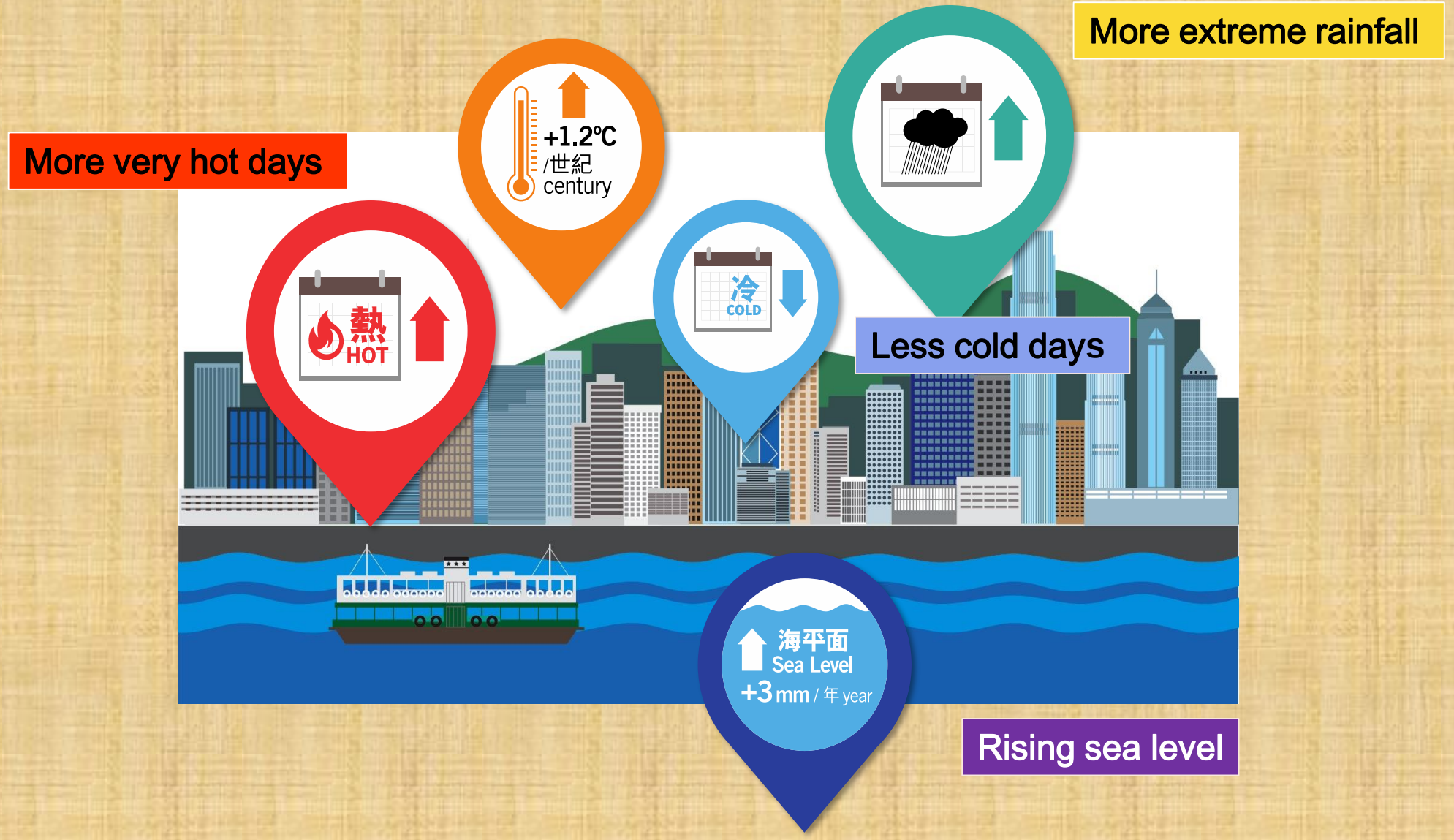
Longer and more intense droughts in some regions

Sea level rises faster than expected

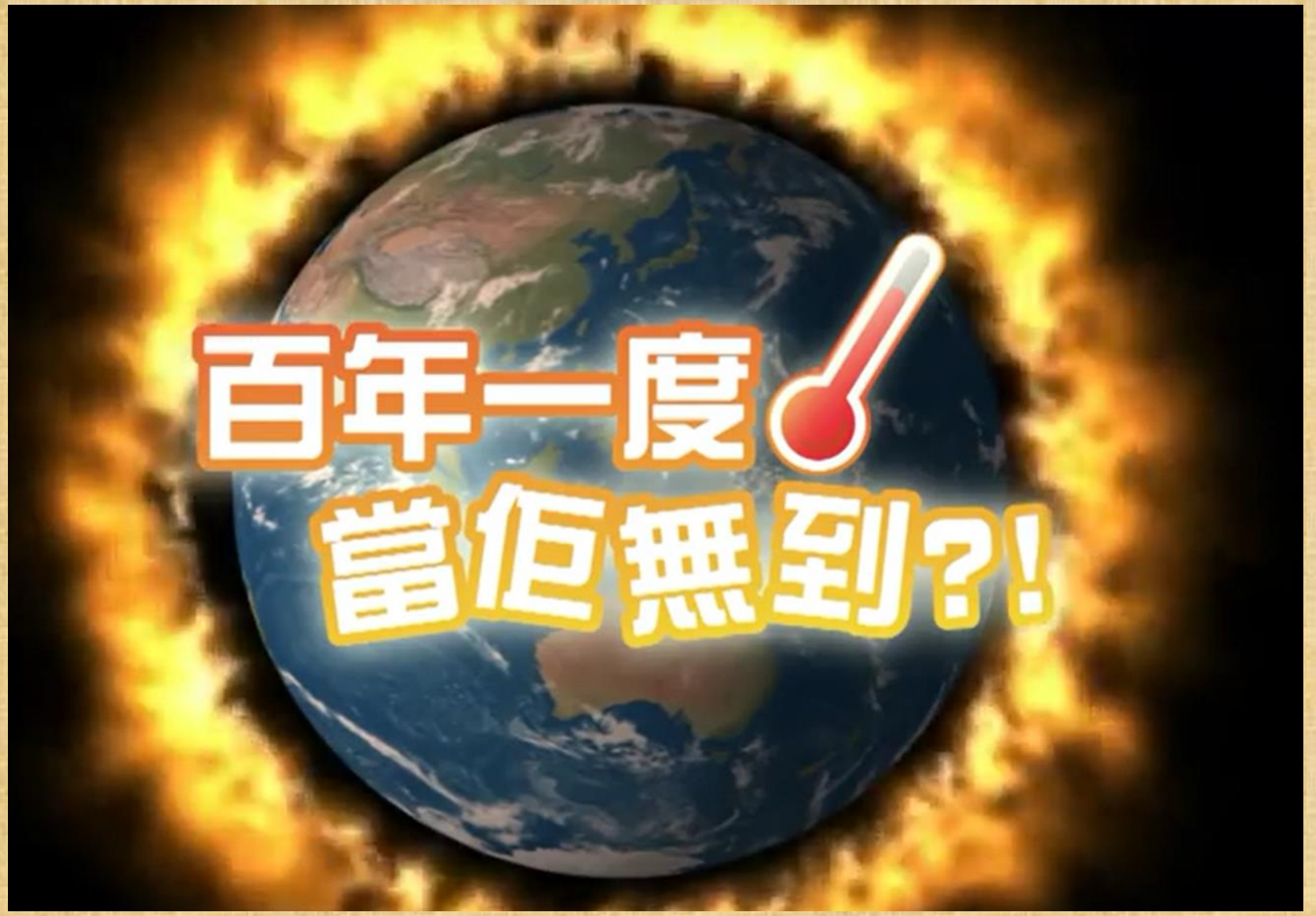


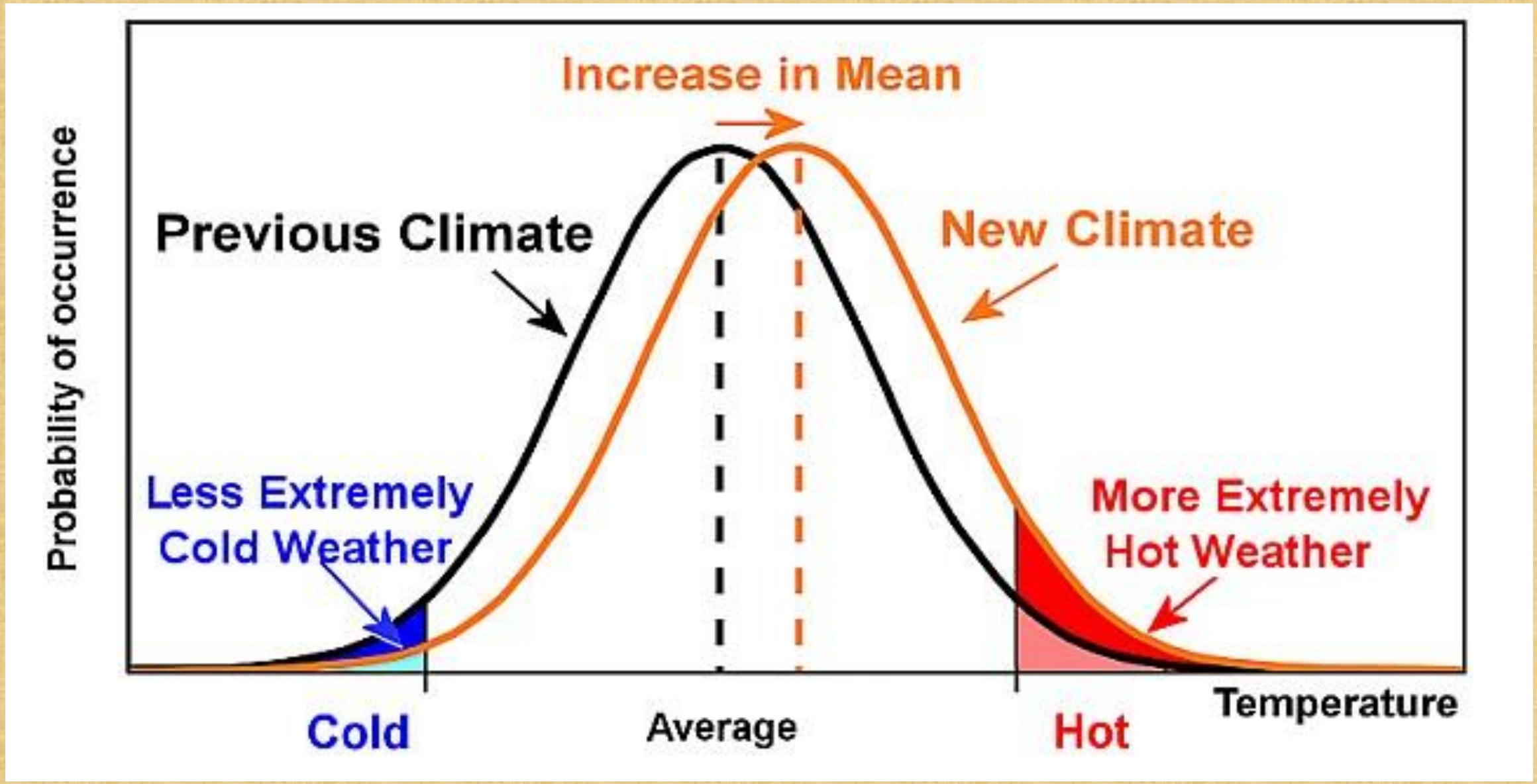
Rising sea level will accentuate the threat of storm surges

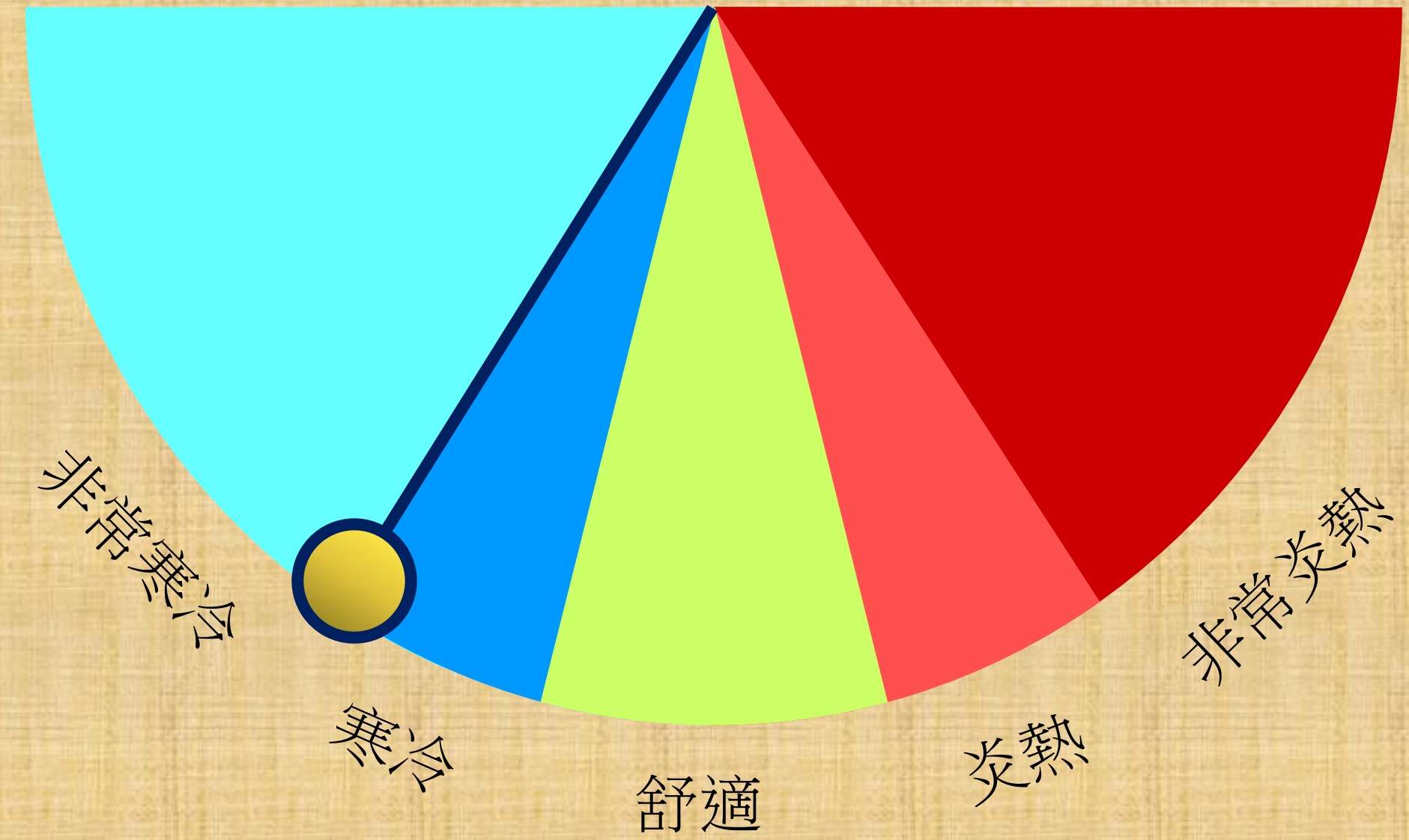
Impact on Hong Kong



Myth 2 - One degree in one hundred years!

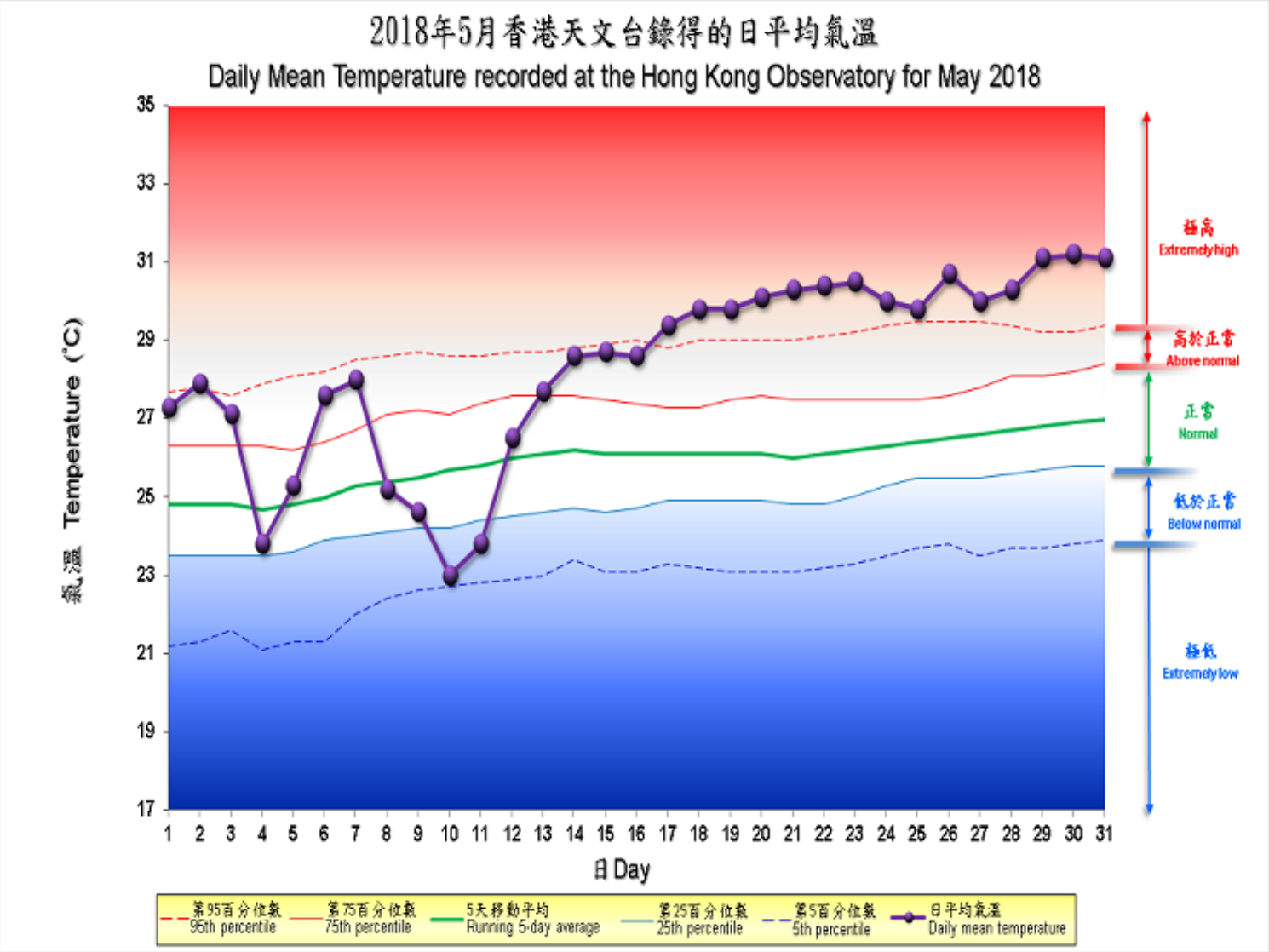



Increase in Mean
Previous Climate
New Climate
Probability of occurrence
Less Extremely
Cold Weather
More Extremely
Hot Weather
Temperature
Cold
Average
Hot


非常寒冷
寒冷
舒適
炎熱
非常炎熱

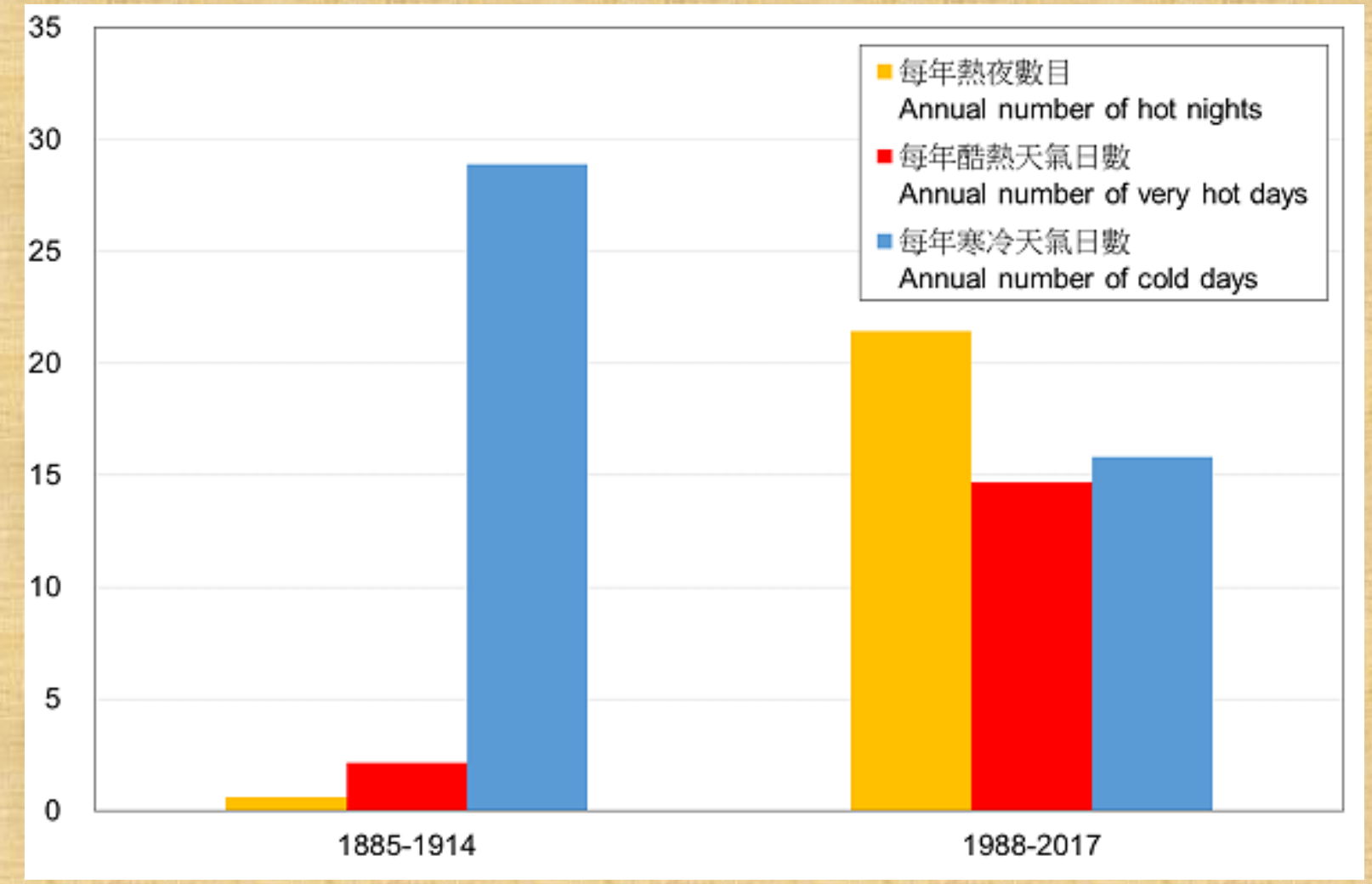

非常寒冷
寒冷
舒適
炎熱
非常炎熱

May 2018



- Total 16 very hot days
- 6 hot nights
- Breaking the records for May

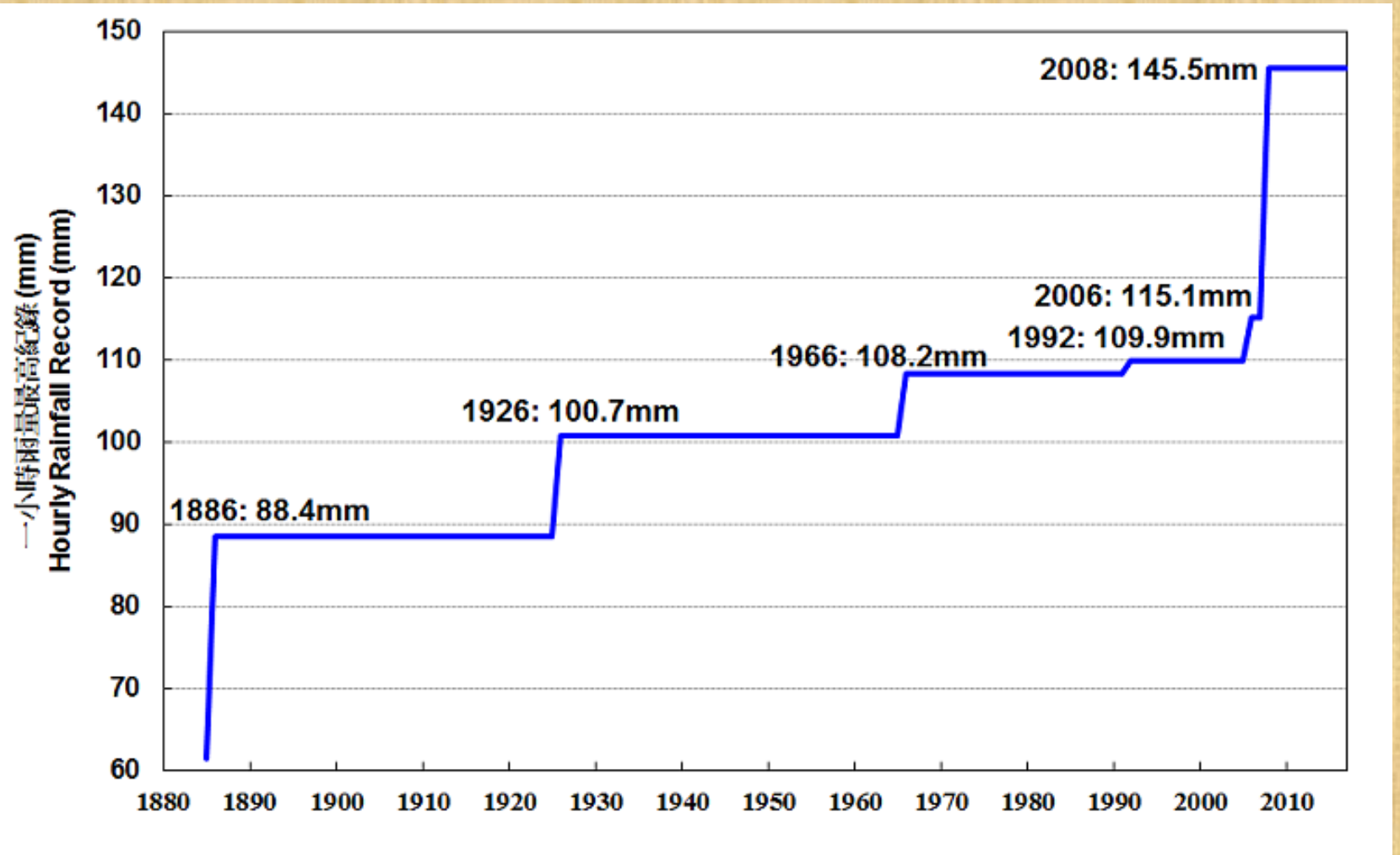
Increase in very hot days & hot nights
Decrease in cold days



Hot nights
35X / 100 years

Very hot days
6X / 100 years

More frequent extreme rainfall



Hourly rainfall records at HKO

Typhoons with extreme sea level in Hong Kong

Measured at Victoria Harbour

Rank *	Year/Month	Name of tropical cyclone	Maximum sea level above Chart Datum (m)	Maximum storm surge (m)
1	Sep 1937**	--	4.05	1.98
2	Sep 1962	Wanda	3.96	1.77
3	Aug 1936**	--	3.81	1.92
4	**Aug 2017**	**Hato**	**3.57**	**1.18**
5	Sep 2008	Hagupit	3.53	1.43

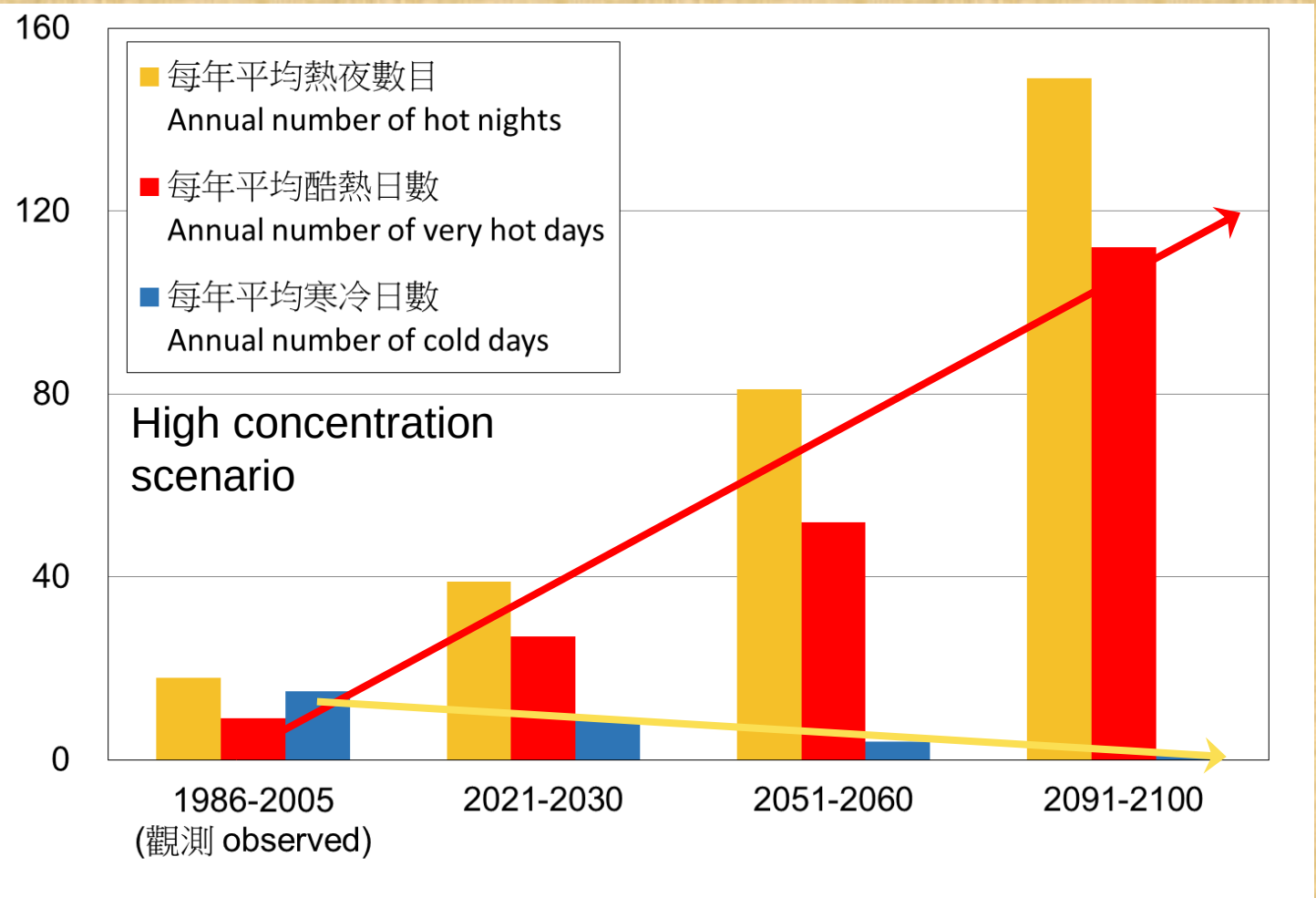
Measured at Tai Po Kau

Rank *	Year/Month	Name of tropical cyclone	Maximum sea level above Chart Datum (m)	Maximum storm surge (m)
1	Sep 1937**	--	6.25	3.81
2	Sep 1962	Wanda	5.03	3.20
3	Aug 1979	Hope	4.33	3.20
4	**Aug 2017**	**Hato**	**4.09**	**1.66**
5	Sep 2008	Hagupit	3.77	1.77

* Ranking based on the maximum sea level

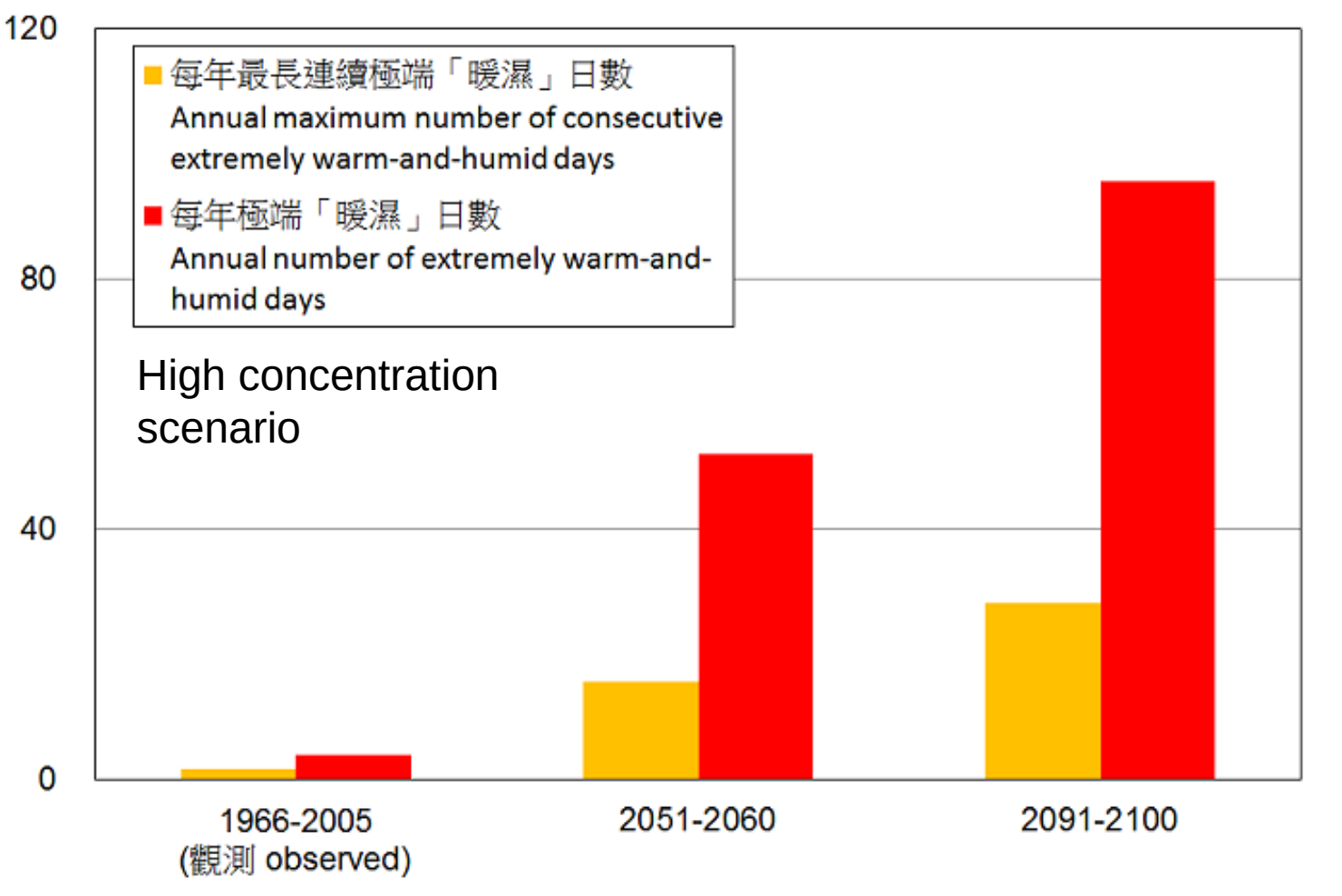
** By observing tide poles (before 1951)

More very hot days, more hot nights, fewer cold days



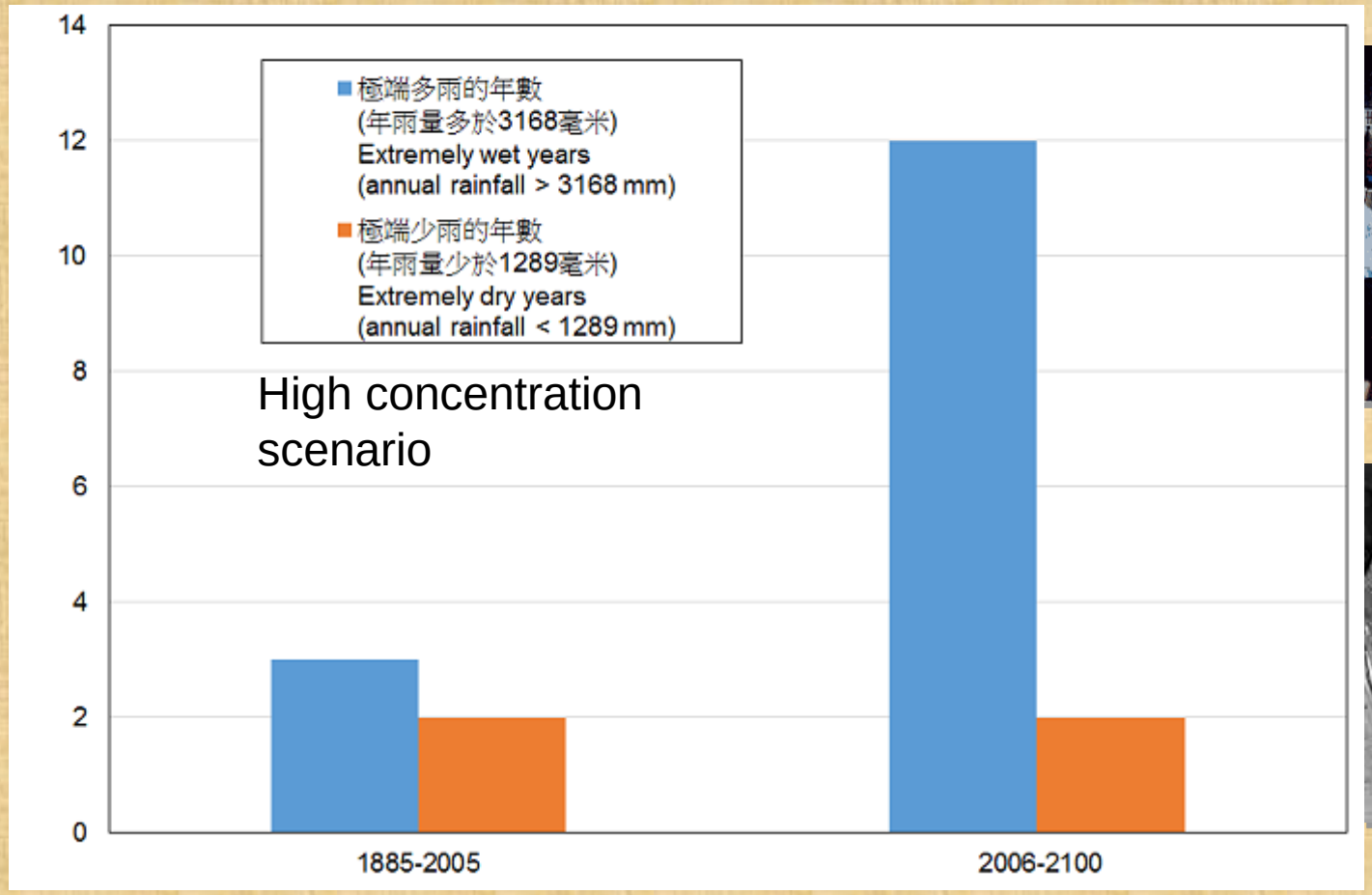
If emission reductions in the Paris Agreement fail to materialize, the world may follow the high greenhouse gas concentration scenario.

Number of extremely warm-and-humid days will increase



Duration of high heat stress is also projected to increase.

More extremely wet years

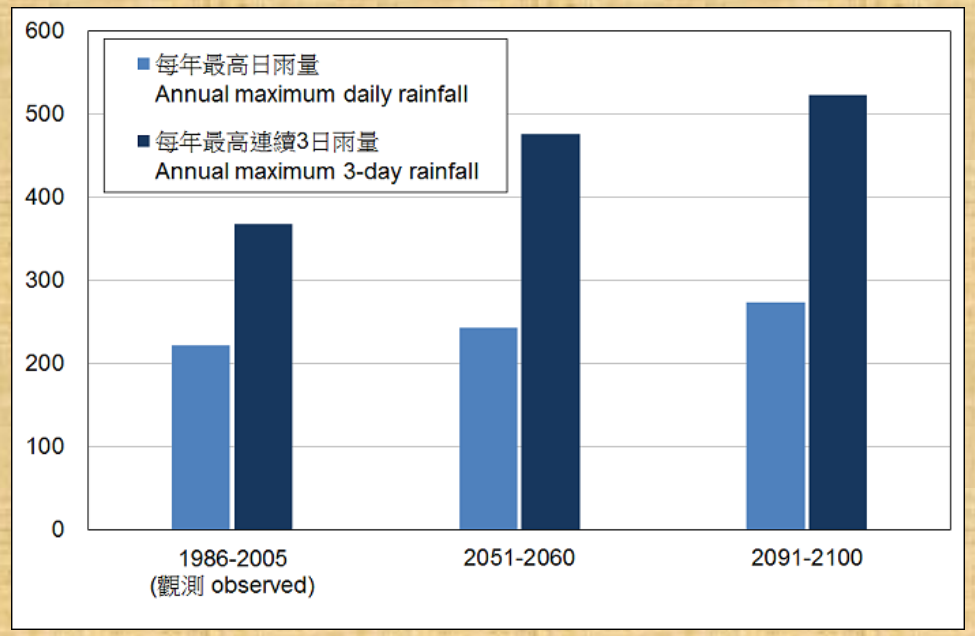


(source：DSD)

(source：WSD)

Significant increase in number of extremely wet years under the high concentration scenario

More extreme rainfall



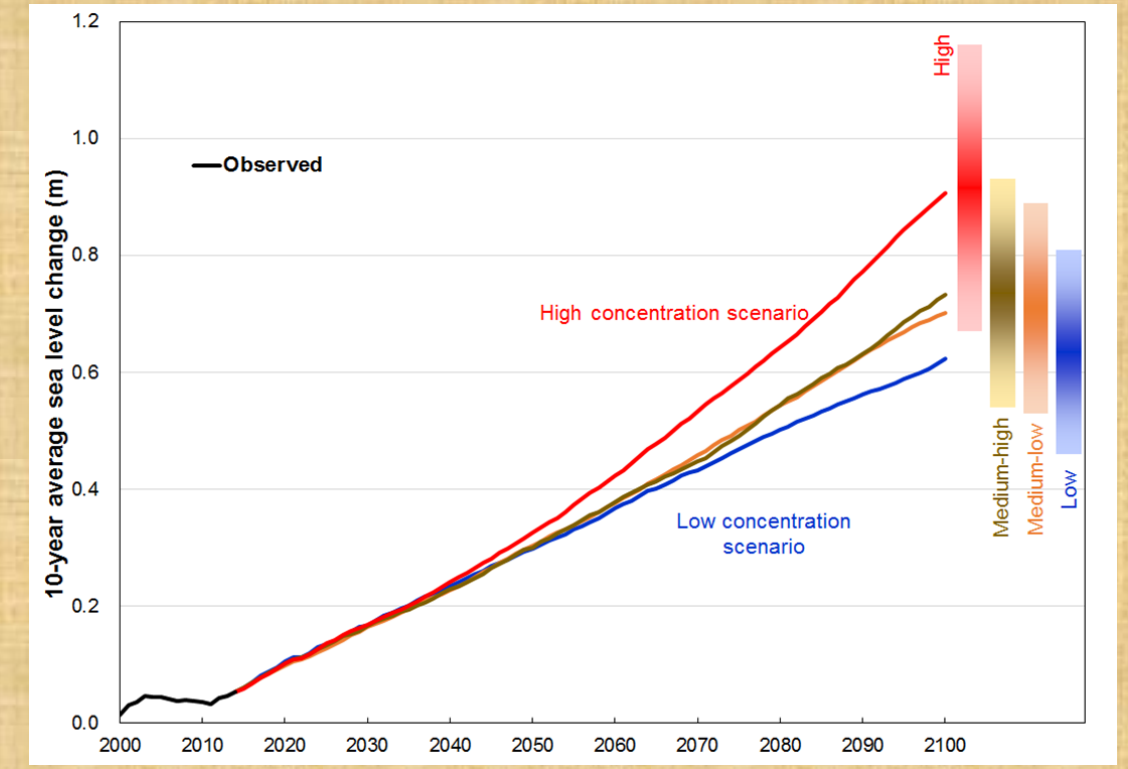
Annual max. 3-day rainfall could reach 500 mm under the high concentration scenario

	1986-2005 Actual	2051-2060 Projection	2091-2100 Projection	2051-2060 Projection	2091-2100 Projection
Greenhouse gas concentration scenario	--	Medium-low	Medium-low	High	High
Annual number of extreme rainfall days	4.2	4.5	4.4	5.0	5.1
Average rainfall intensity (mm/day)	23.4	25.0	24.0	25.4	26.7
Annual maximum number of consecutive dry days	46	49	52	54	59
Annual number of rain days	102	103	102	100	97

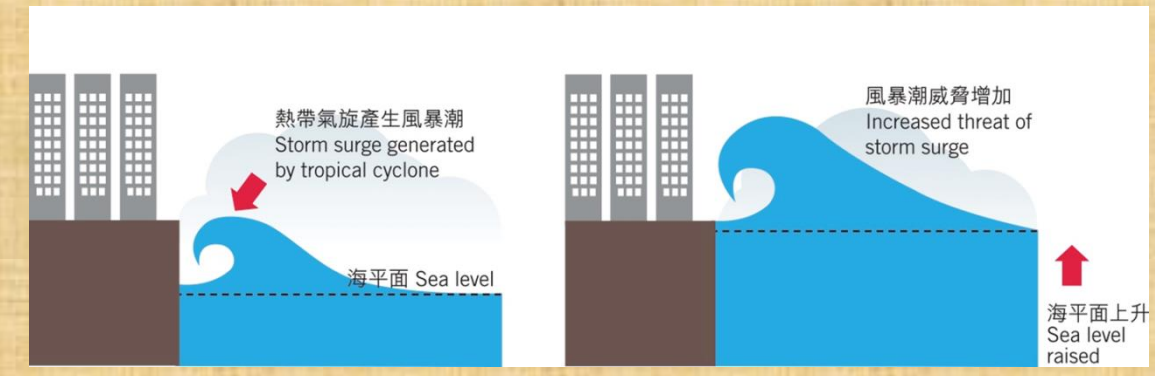
Average rainfall intensity will increase

Number of rain days will decrease

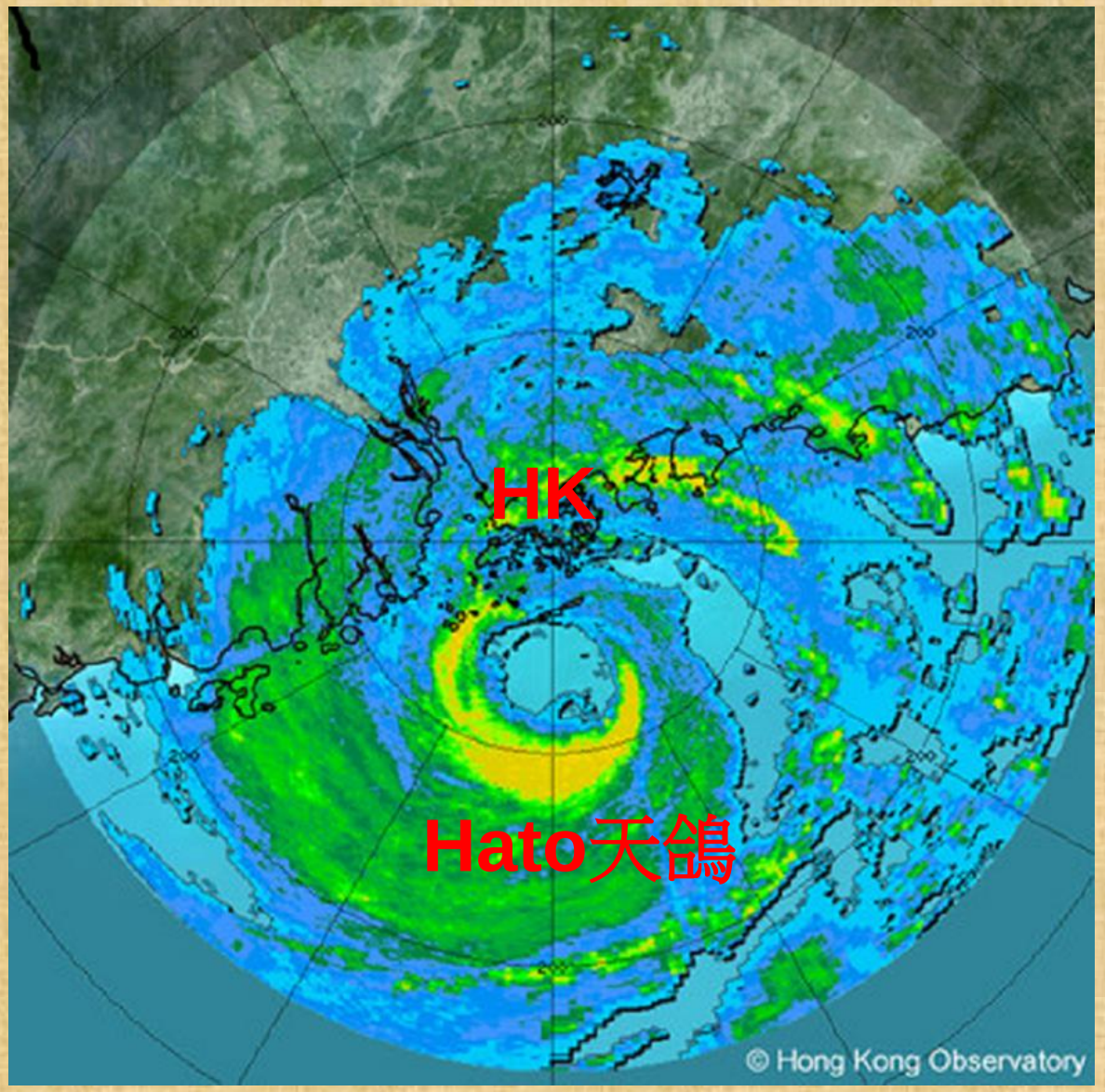
Sea level will rise in all scenarios

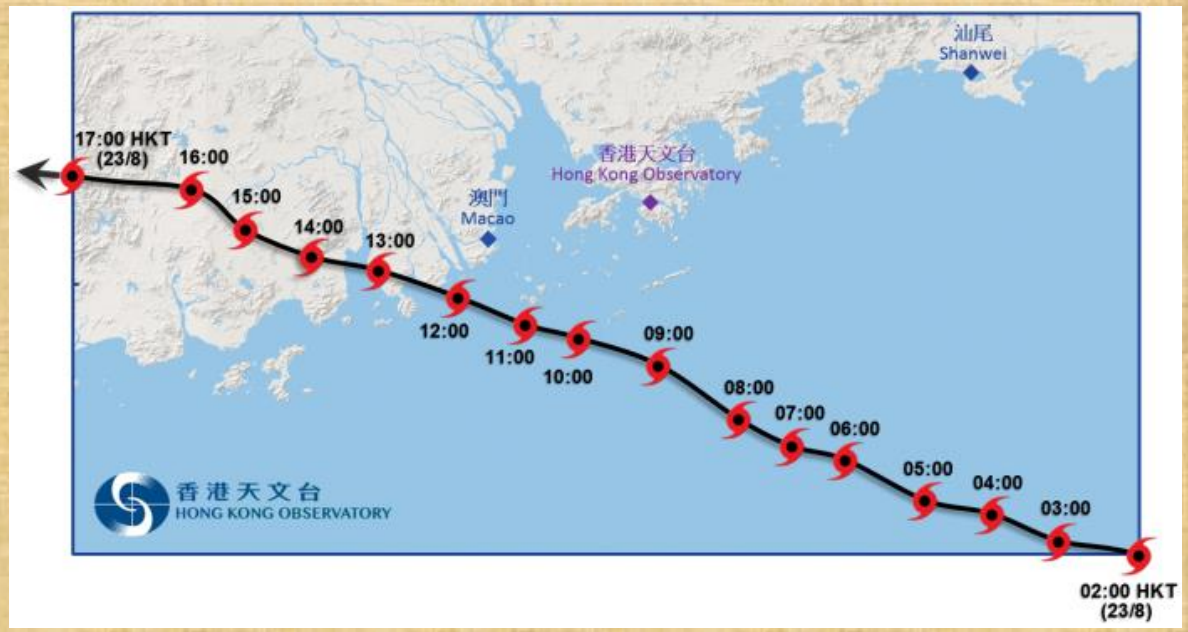


Sea level rise increases the threat of storm surge



2017 Super Typhoon Hato

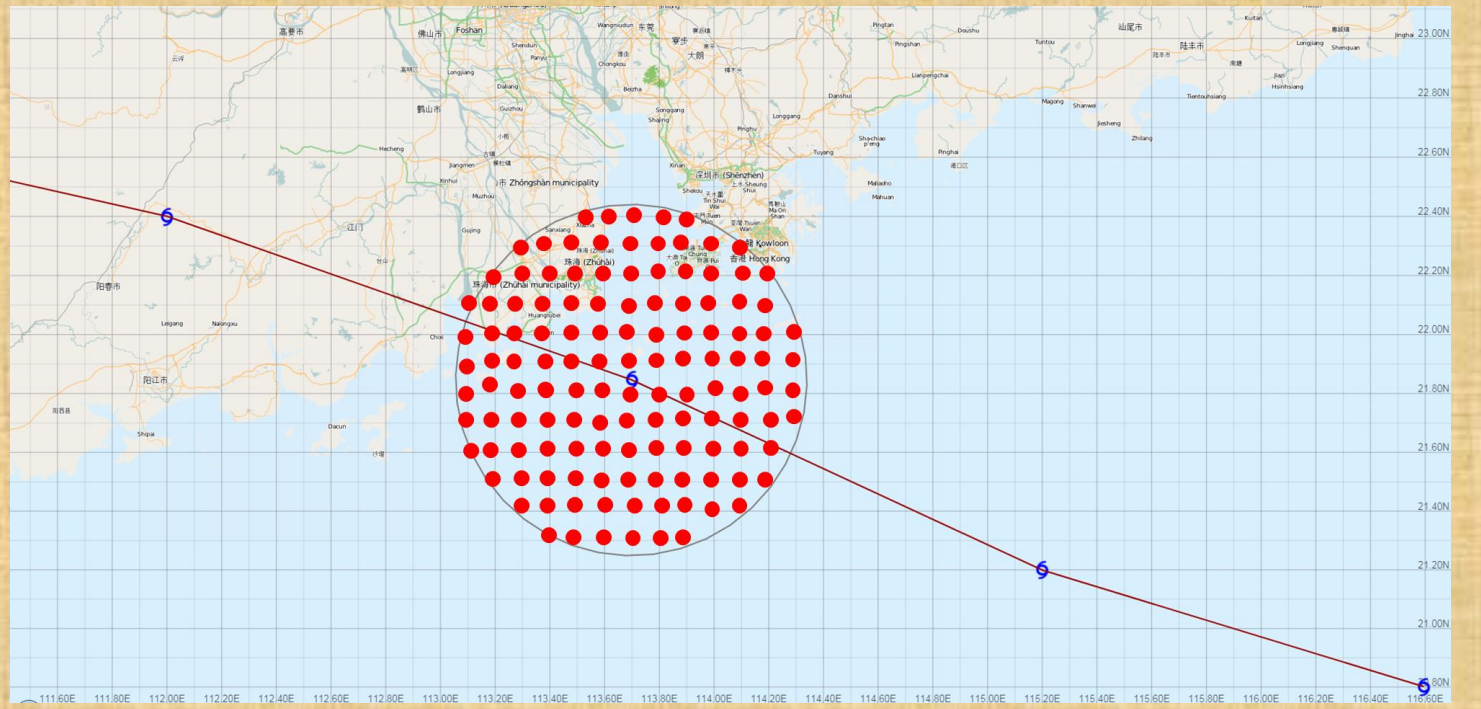




Measured at Victoria Harbour

Maximum sea level above Chart Datum 3.57 m

What to expect for the worst track scenario of Hato



- Perturbing the track of Hato, the tide level at Quarry Bay could reach a maximum of over **4.5 m** in the worst case scenario (Lau & Chan, 2017)
- Under climate change, mean sea level in HK is projected to increase by ~ 1 m by the end of this century (high GHG concentration scenario) -> Hato at the end of century could also bring tide heights of over **4.5 m**!

天文台熱帶氣旋災害短片

風暴潮

Risks for buildings and infrastructure

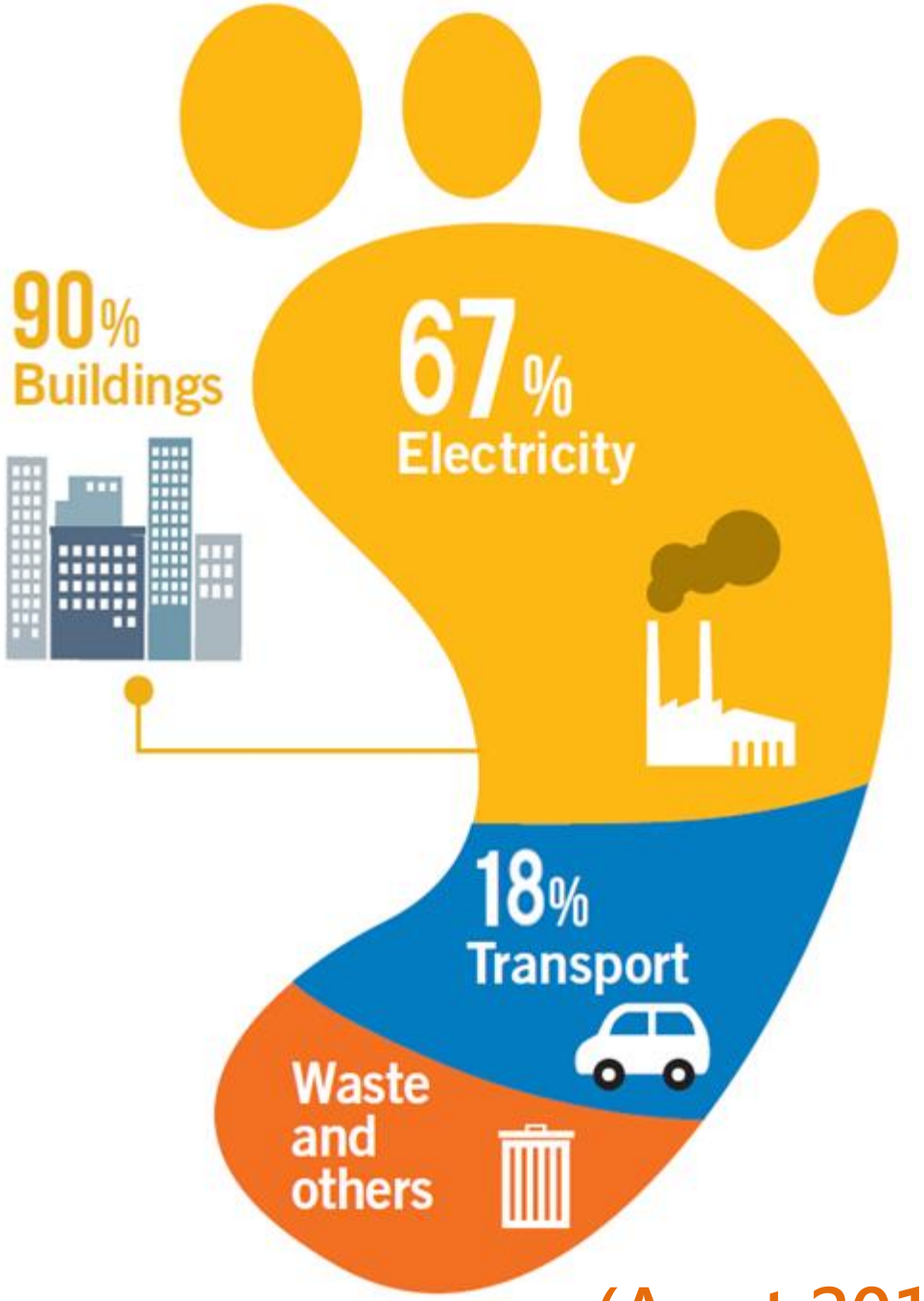
Extreme events	Risks
Precipitation extremes	• Landslides • Flooding (both inside and outside of the building!)
Increase in extremely hot days	• Increase in cooling demand
Mean sea level rise and storm surge	• Coastal flooding • Flooding in basements • Power outage
Increased intensity of tropical cyclones	• Damage to glass curtain walls

Combating Climate Change

- Mitigation – public education and outreach activities
- Adaptation – climate projection and information services for stakeholders
- Resilience – forecast and warning of extreme weather; promote public awareness of disaster prevention

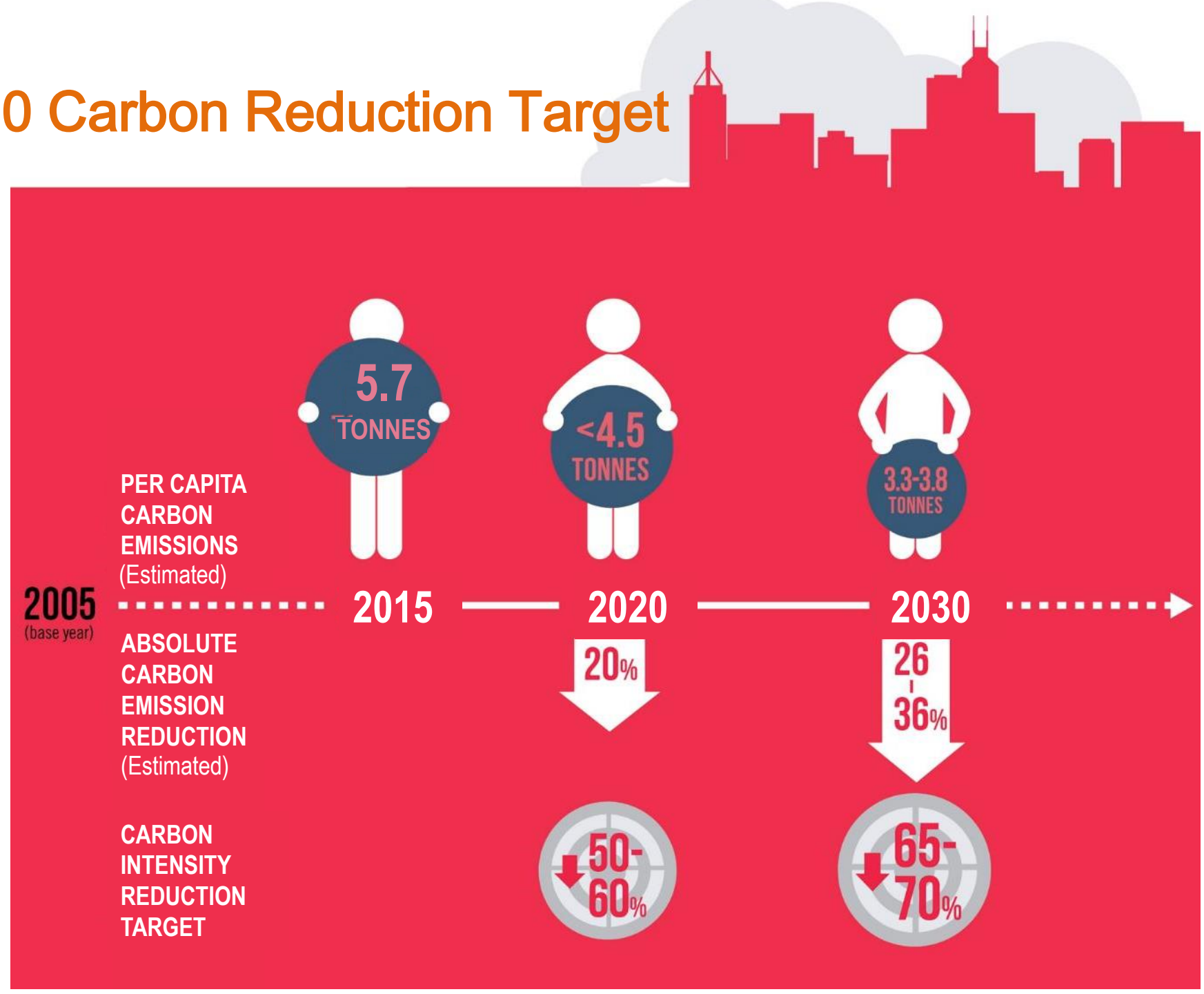
香港
溫室氣體
排放源

Local Sources of HK's Carbon Emissions



(As at 2015)

2030 Carbon Reduction Target



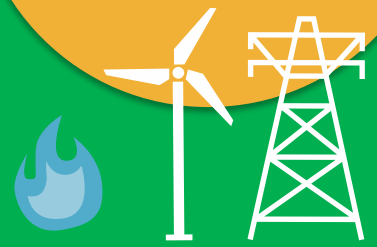
Low Carbon Living

城市的主要減緩措施

City's Main Mitigation Measures

減少燃煤發電

Phrasing down coal for electricity generation



推廣節能建築

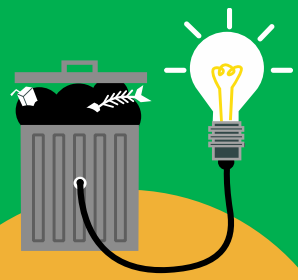
Promote energy saving building

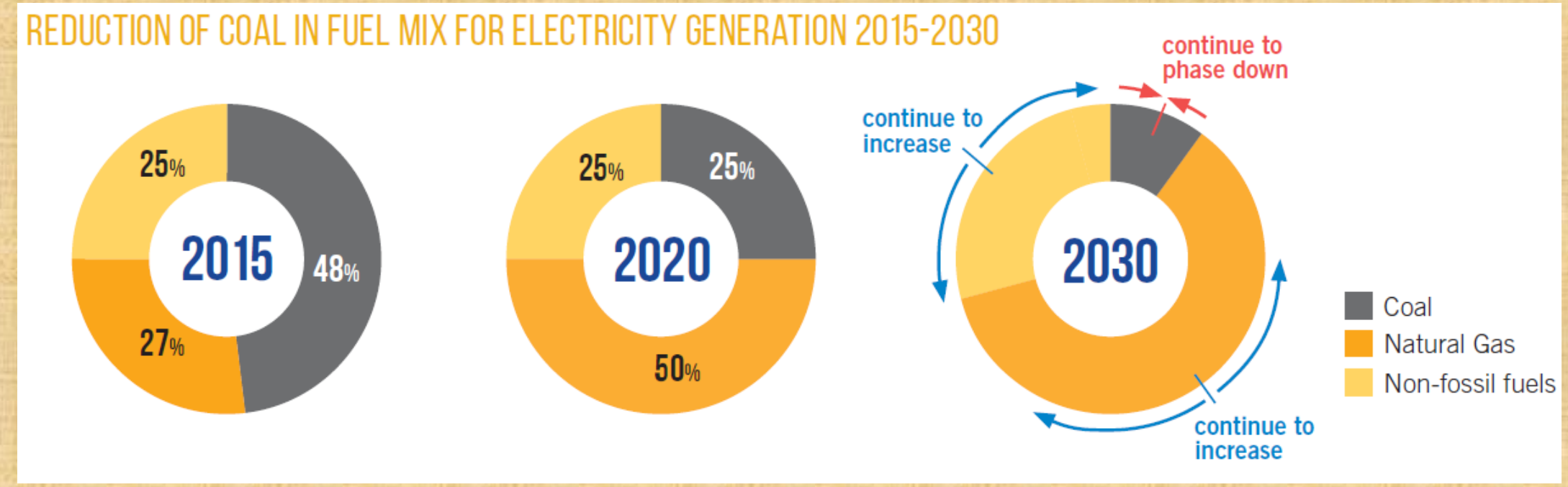
減少交通運輸的排放

Reduce emission from transportation

減少廢物及轉廢為能

Reduce waste and convert waste to energy





減燃煤發電
Phasing Down Coal for Electricity Generation

適應氣候變化

Adapting to Climate Change

強化氣候應變能力Climate Resilience

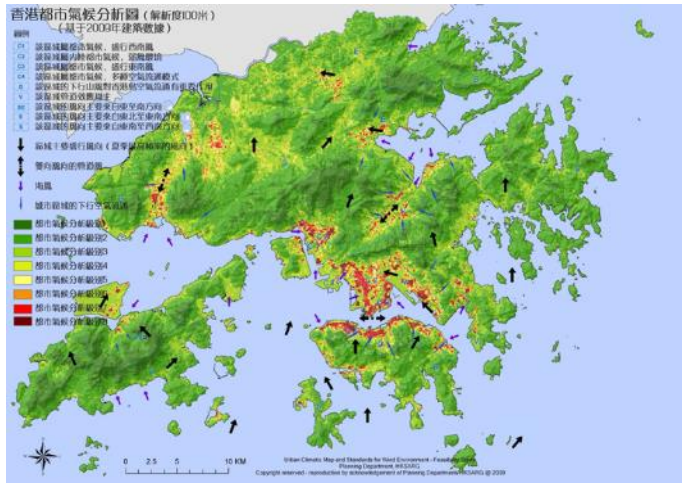
Strengthening

強化城市結構及斜坡安全
提升排水及洪水管理計劃
深入應對海平面上升挑戰 .....

Strengthen the urban fabric and slope safety
Upgrade drainage and flood management
Tackle the challenge of sea level rise .....

Climate Ready@HK 氣候變化香港行動

Adapting to climate change



Integrating thermal load and wind information in urban planning

Building infrastructure to reduce urban flood risk during heavy rain events

Resilience


PATH TO STRENGTHEN RESILIENCE
Conduct studies on information gaps and monitor changes
1
Strengthen institutional capacity and policy focus
2
Carry out drills
3
Update disaster and emergency planning from time to time
4
UPDATE
EMERGENCY PLAN
Improve dialogue and coordination with private sector
5
Raise community awareness
6

Lesson sharing in Tai O

Installing flood barrier to cope with storm surges


香港
氣候
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Thank you