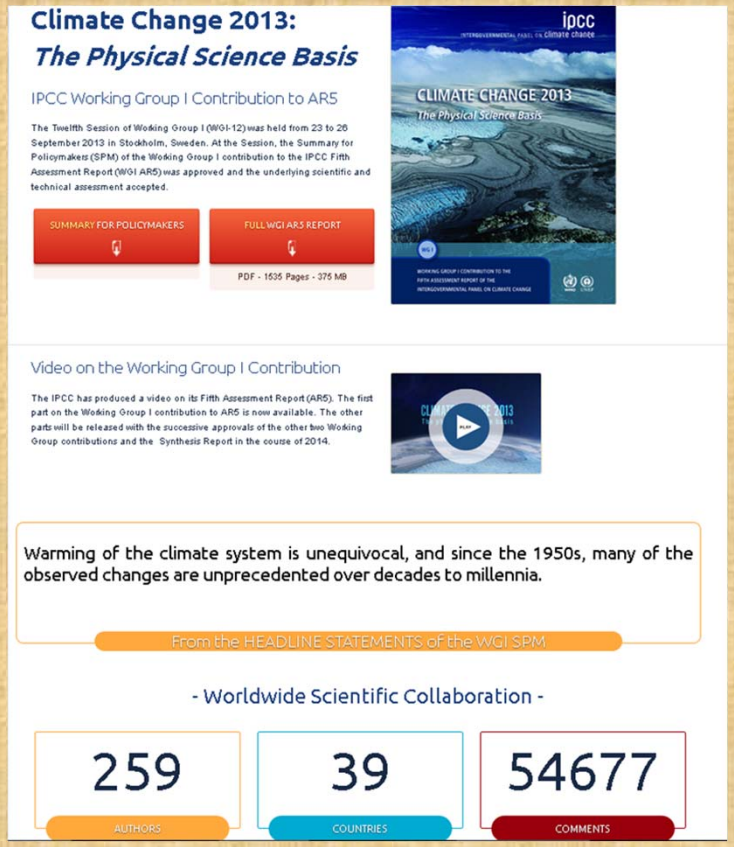
香港天文台
HONG KONG OBSERVATORY

The Science of Climate Change

Consensus among climate scientists



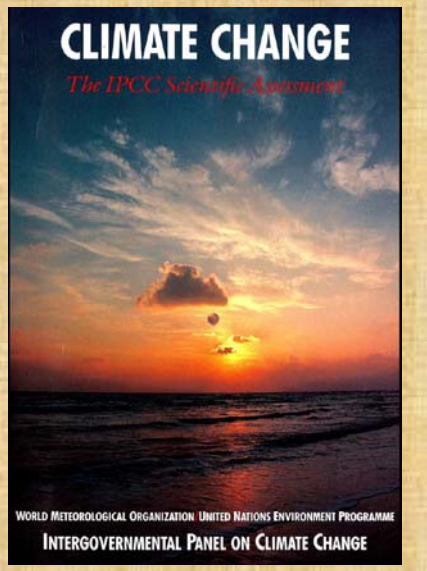
9200 papers

IPCC AR5 reaffirmed:

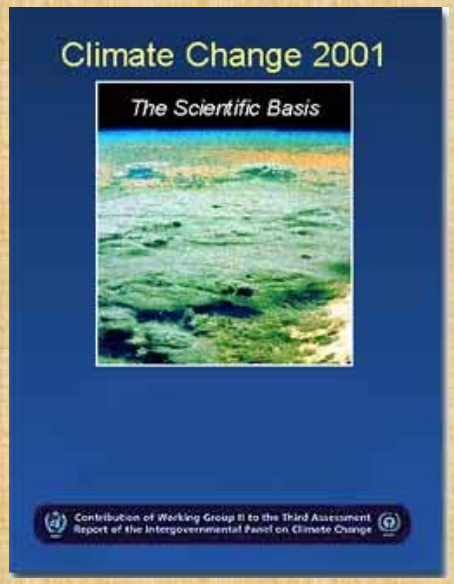
- Warming of the climate system is unequivocal
- Human influence is the dominant cause of the observed warming since the mid-20th century

IPCC – alarmist or conservative?

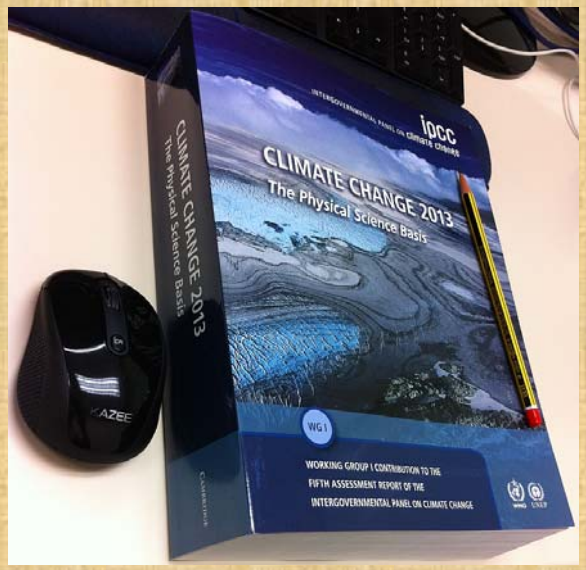
1990



Not sure whether
it is natural or not



very unlikely to be
natural variation alone

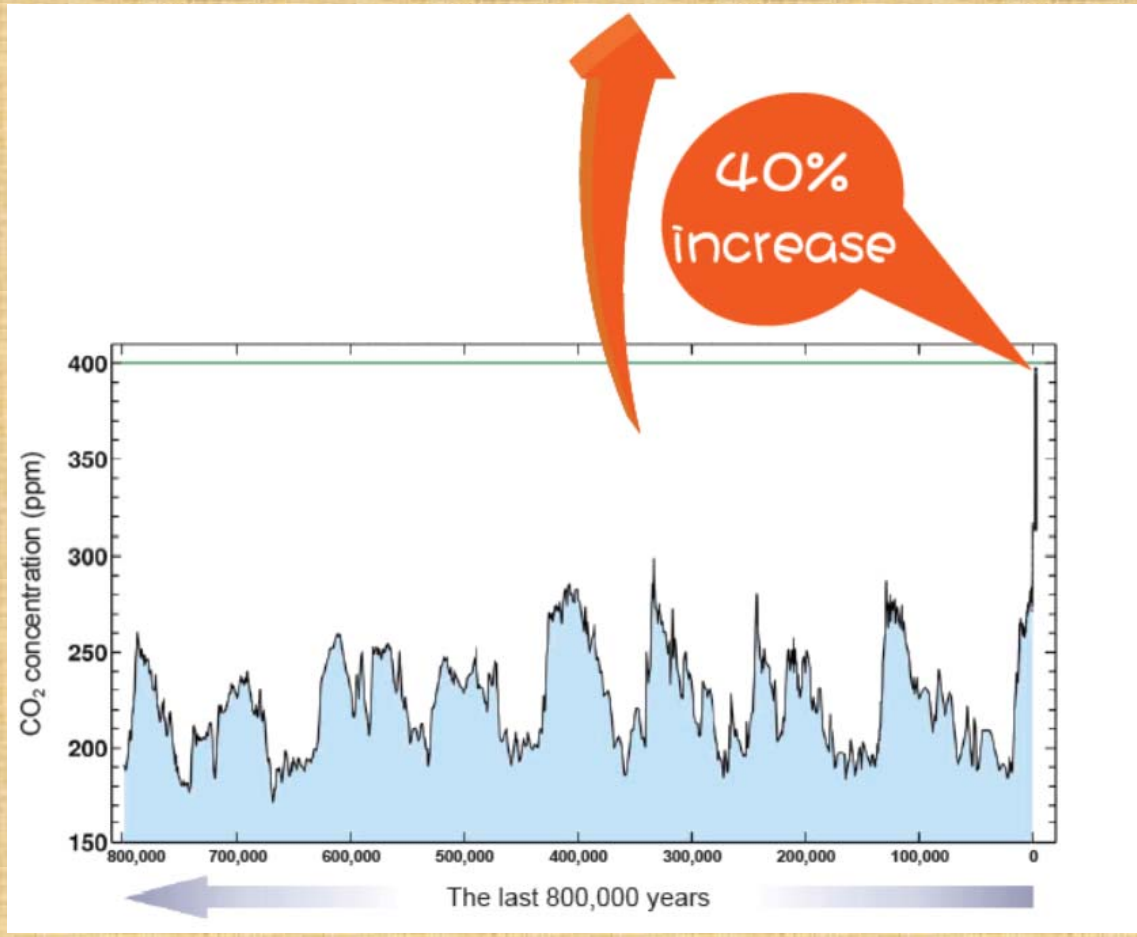


Human influence on
the climate is clear

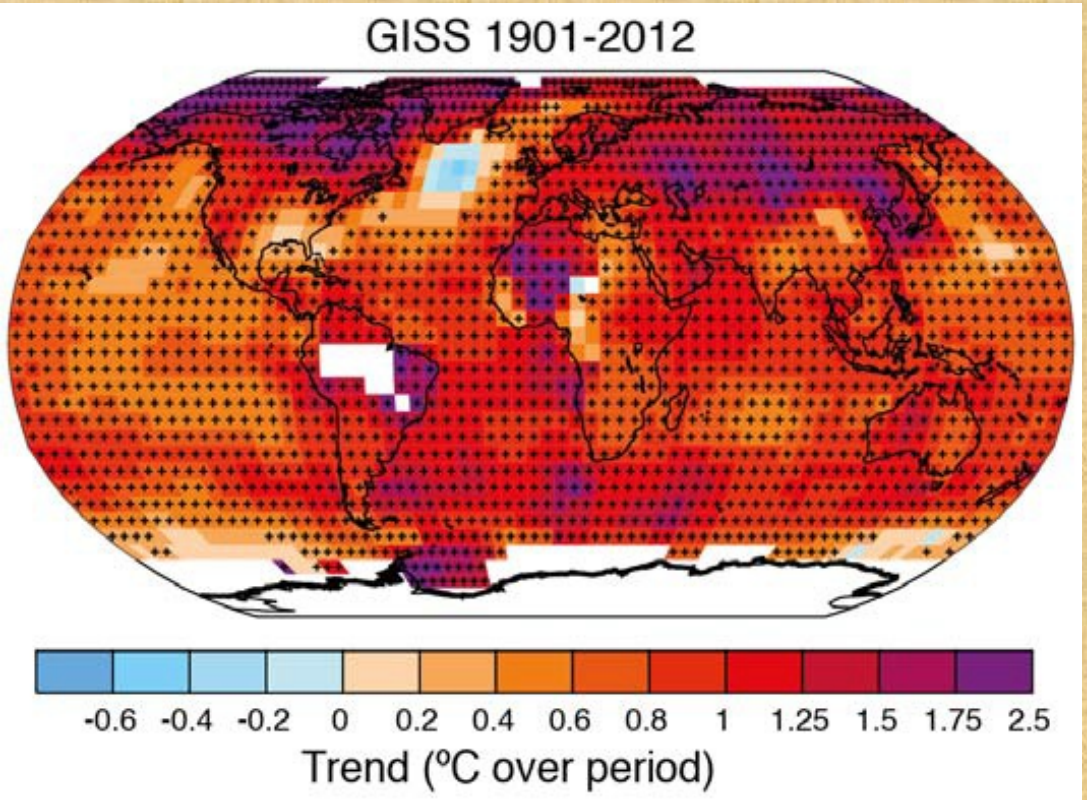
Almost ¼ of a century!

Global climate change

Unprecedented CO_2 concentration

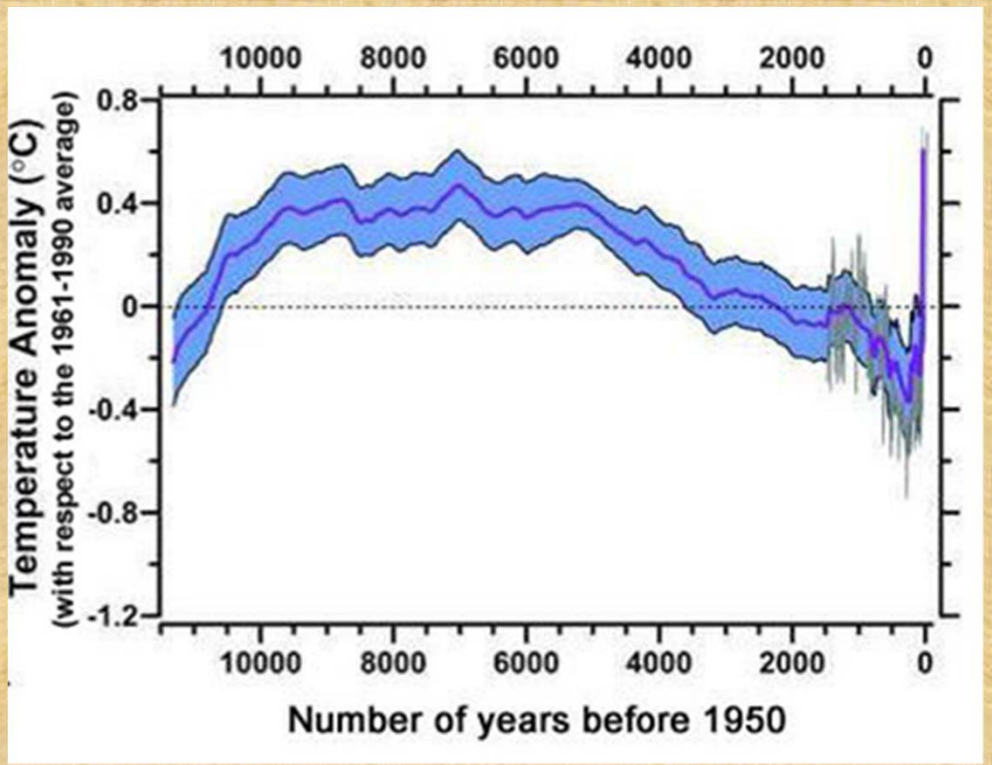


A warming World



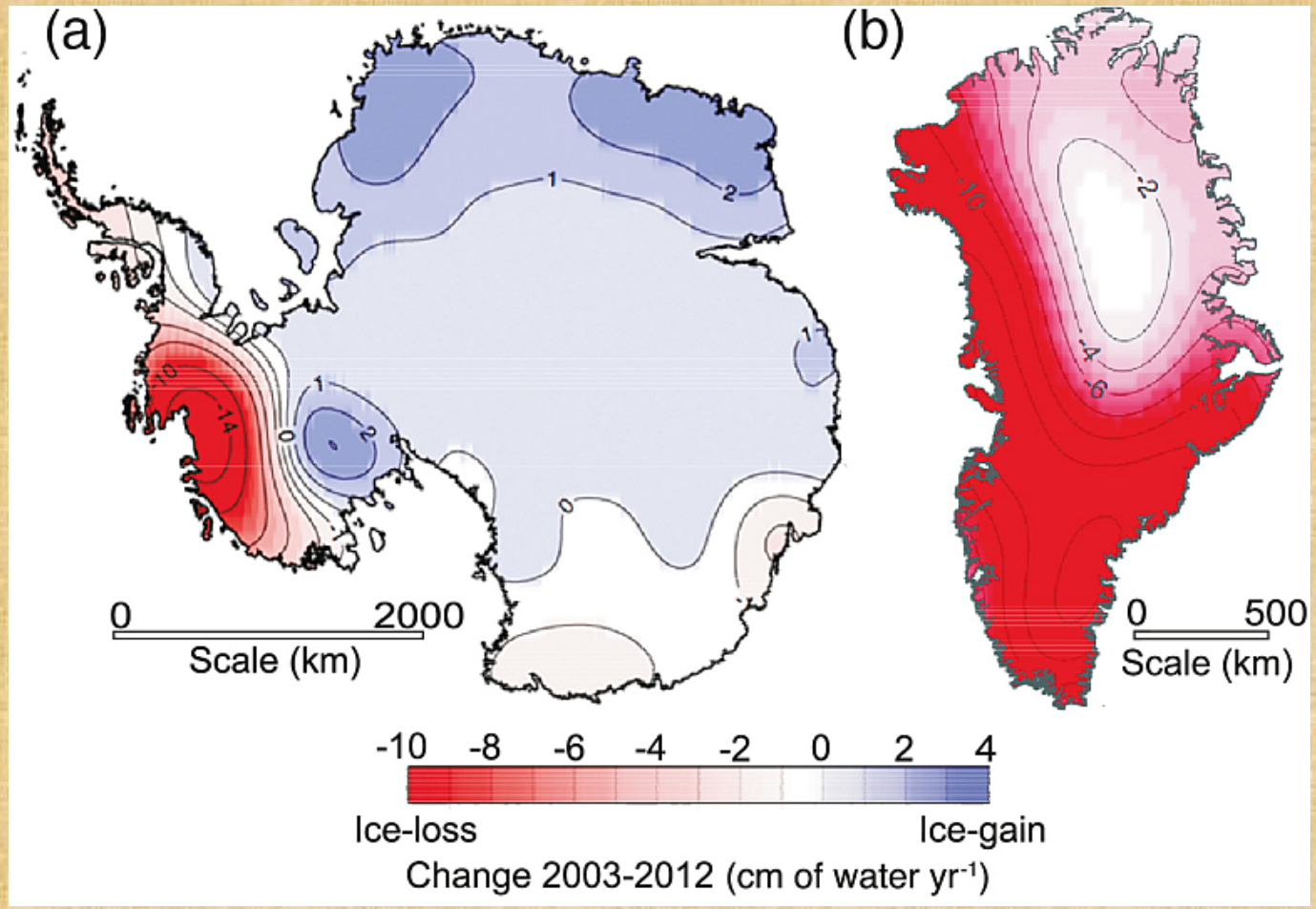
Global mean surface temperature rose by 0.85˚C between 1880 and 2012

Recent warming reversed the long-term cooling trend



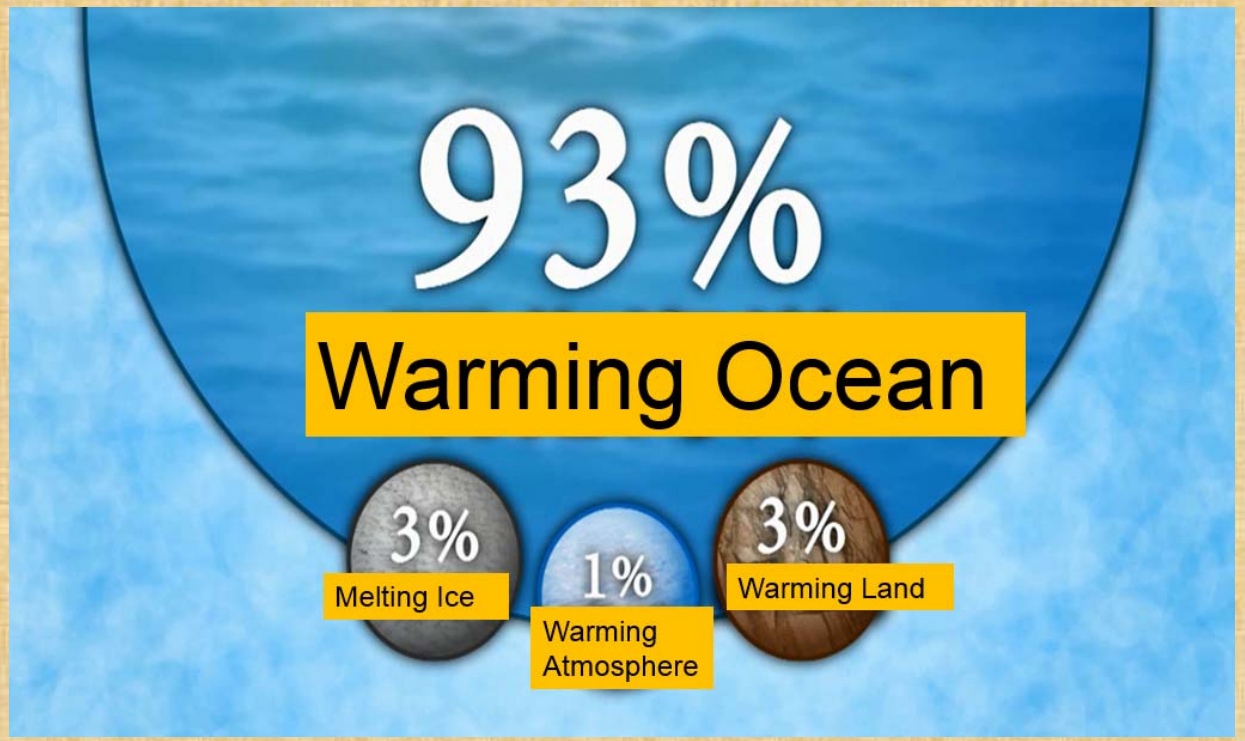
Global temperature anomalies

Ice loss determined from GRACE time-variable gravity



GRACE – Gravity Recovery and Climate Experiment

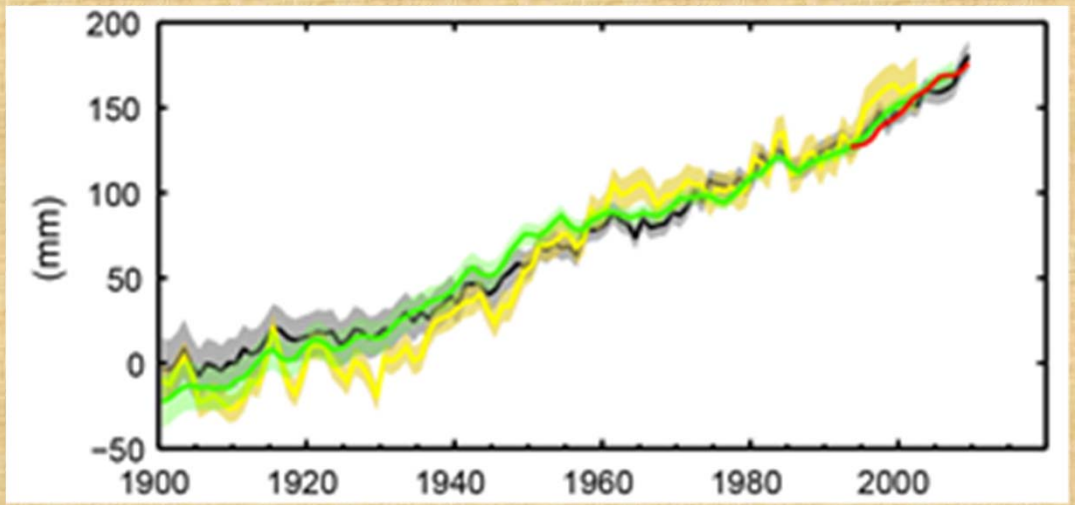
Ocean warming accounts for about 93% of total heating rate



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

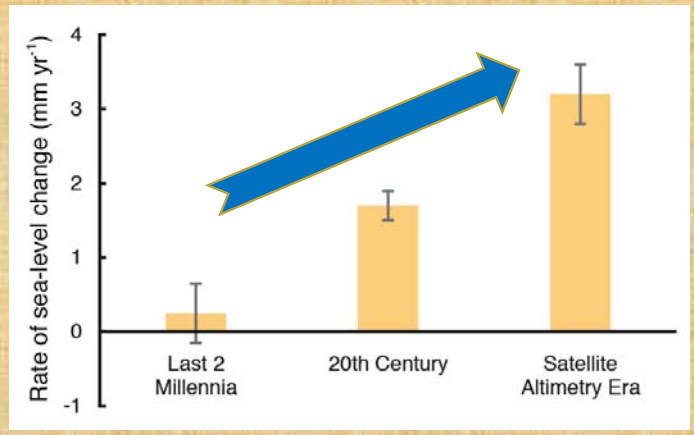
The rate of sea level rise (SLR) since the mid-19th century has been larger than the mean rate during the previous two millennia

Mean sea level rise = thermal expansion of sea water and melting of ice and snow over land



SLR 1.7 mm/yr between 1901 and 2010

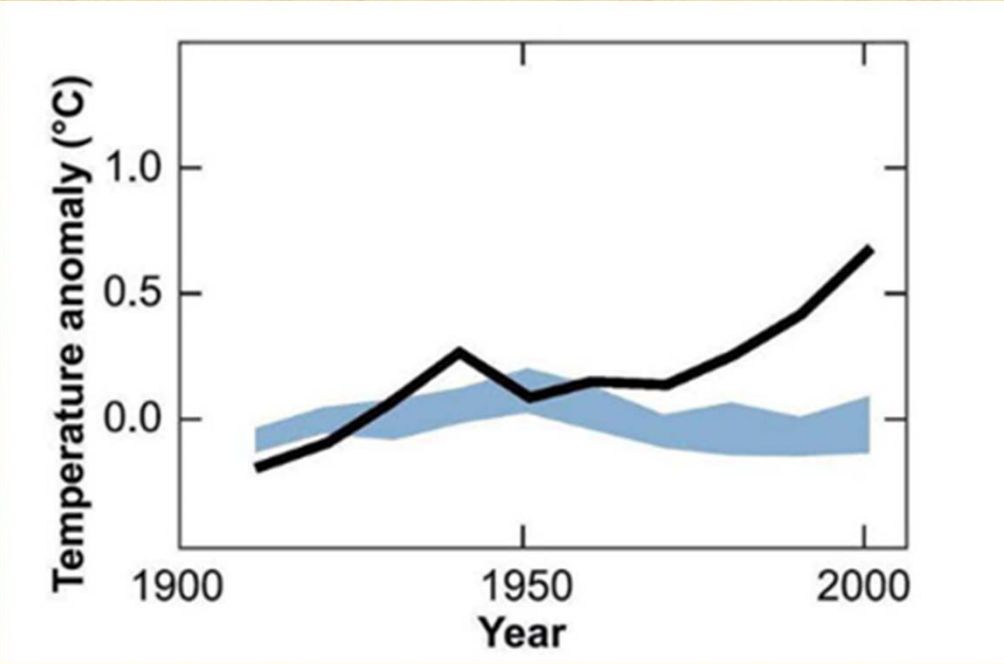
SLR 3.2 mm/yr between 1993 and 2010

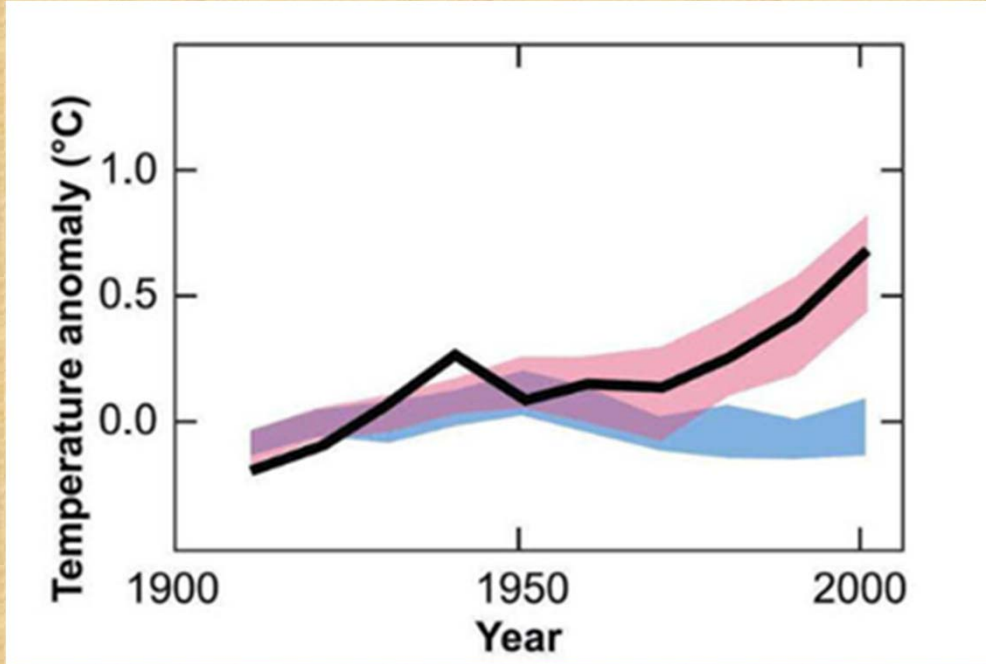


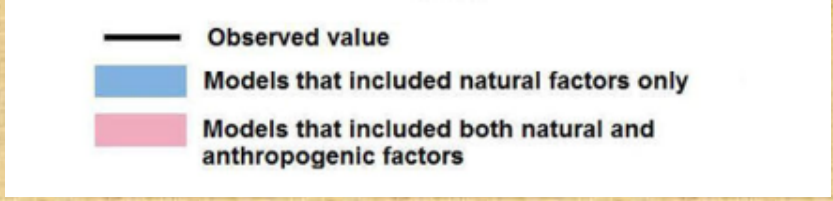
Sea level rise increases the threat of storm surge

Storm surge caused by Hurricane Sandy along the east coast of the United States in 2012

Factors of the World's rising temperature

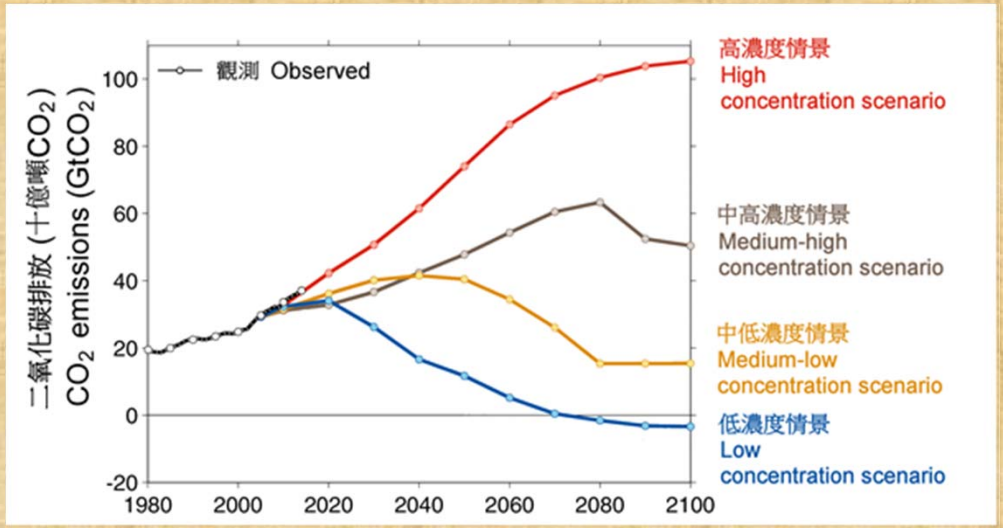






What the future holds

Climate projection

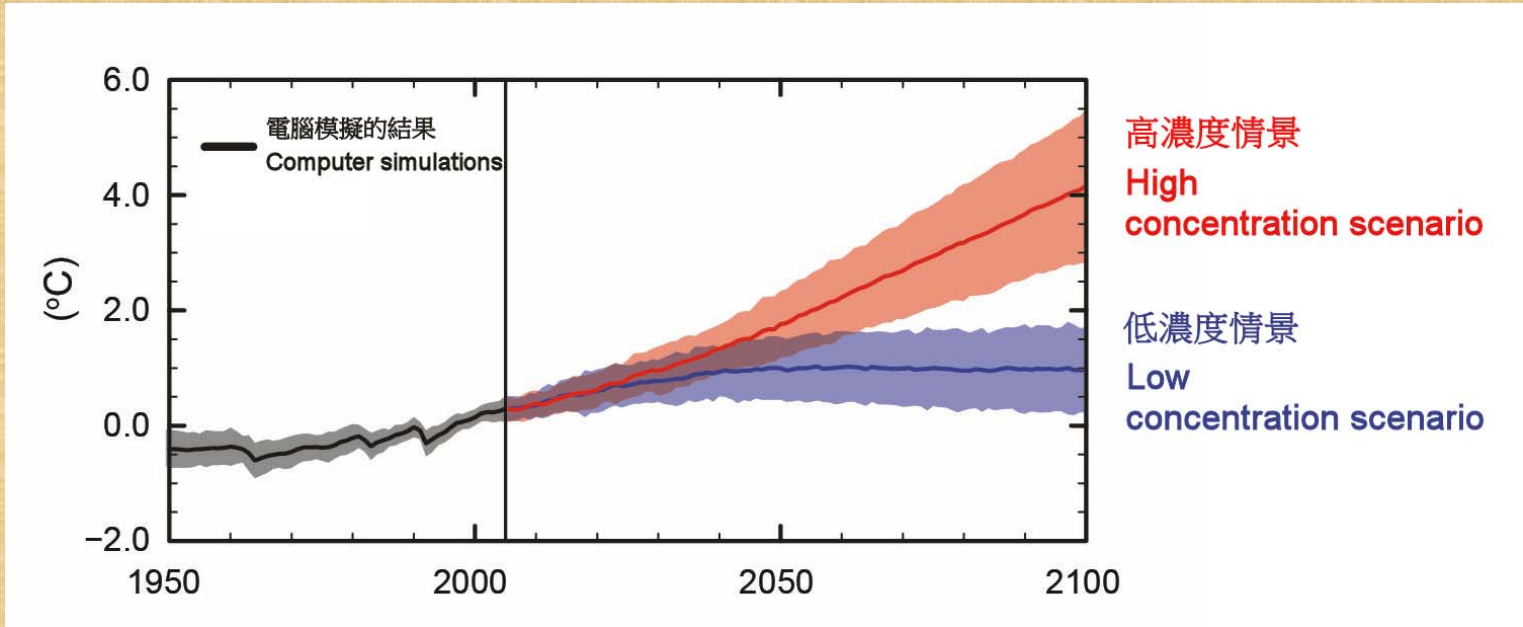


- Four scenarios of GHG conc in AR5:
- RCP2.6 (low), RCP4.5 (medium-low), RCP6.0 (medium-high) and RCP8.5 (high)

- The World is moving along the trajectory of a high GHG conc scenario

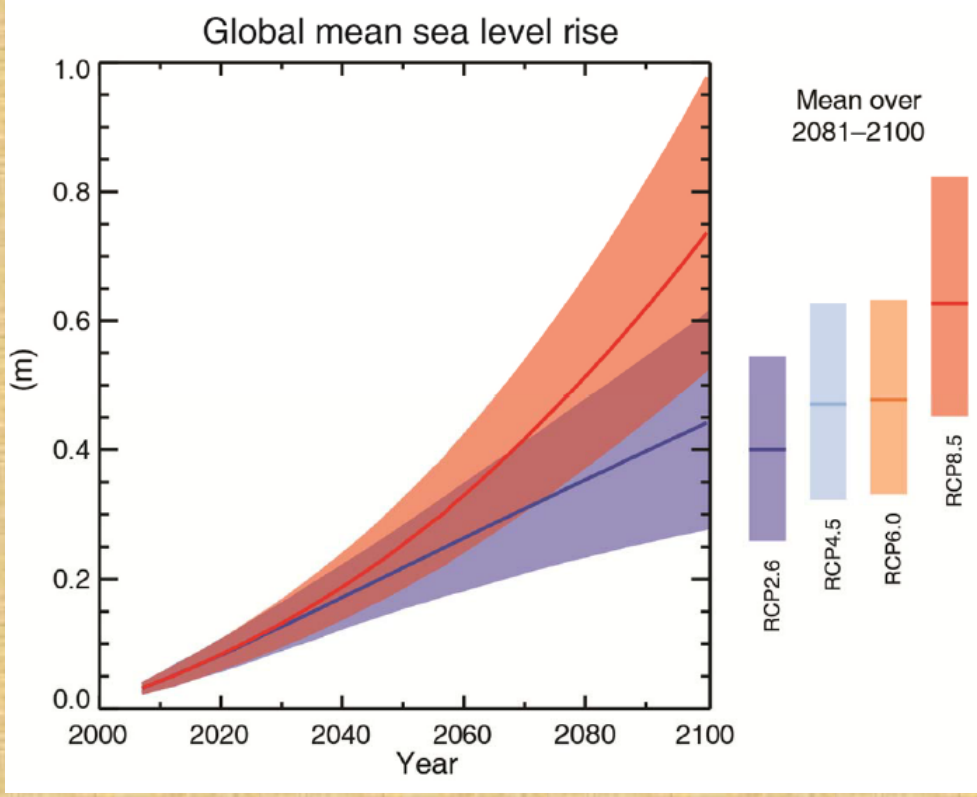
Global average temperature change

relative to 1986-2005



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

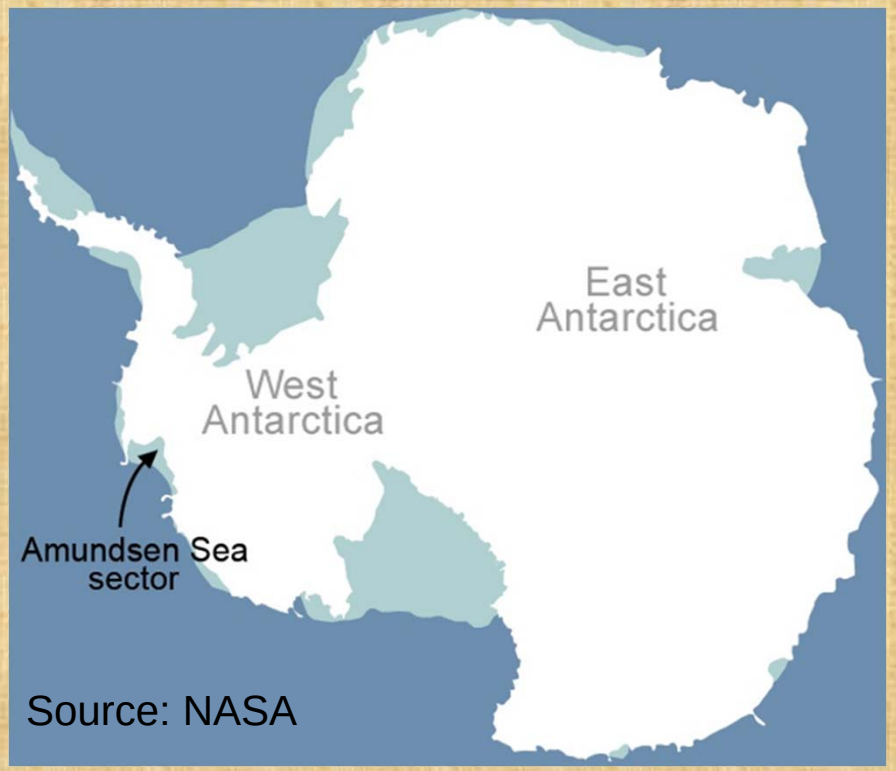
Higher SLR projection than AR4



Scenario	2046-2065	2081-2100
RCP2.6	0.17 - 0.32 m	0.26 - 0.55 m
RCP4.5	0.19 - 0.33 m	0.32 - 0.63 m
RCP6.0	0.18 - 0.32 m	0.33 - 0.63 m
RCP8.5	0.22 - 0.38 m	0.45 - 0.82 m

Global mean sea level rise by 0.45 – 0.82 m under high GHG conc scenario

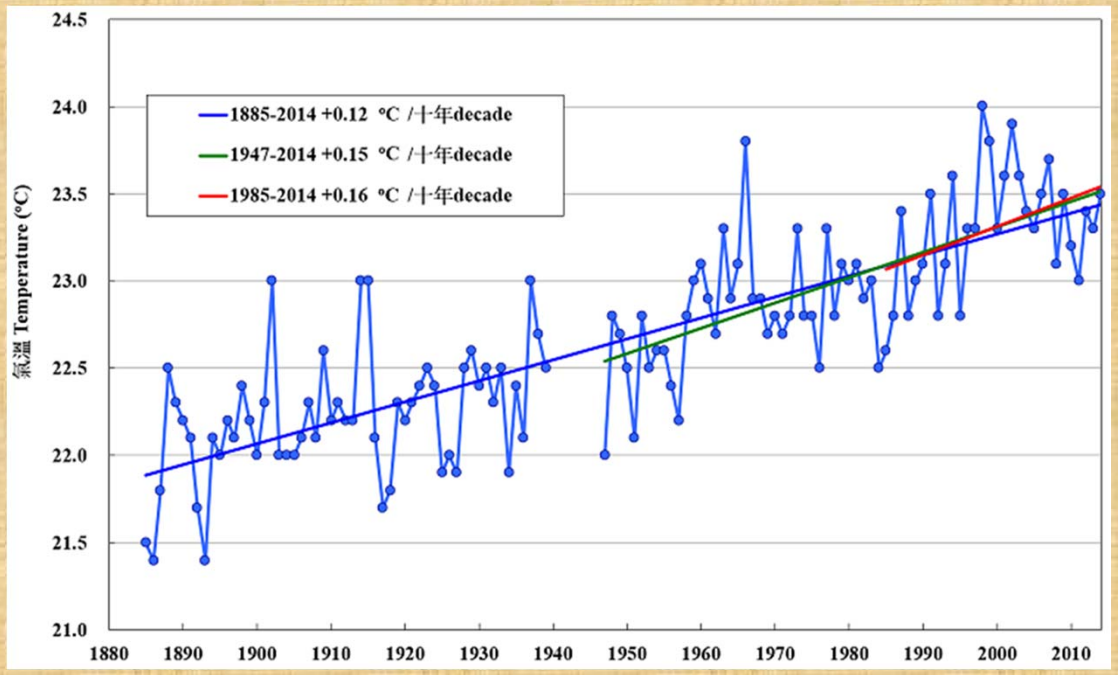
Point of no return – melting of glacier in the Amundsen Sea sector

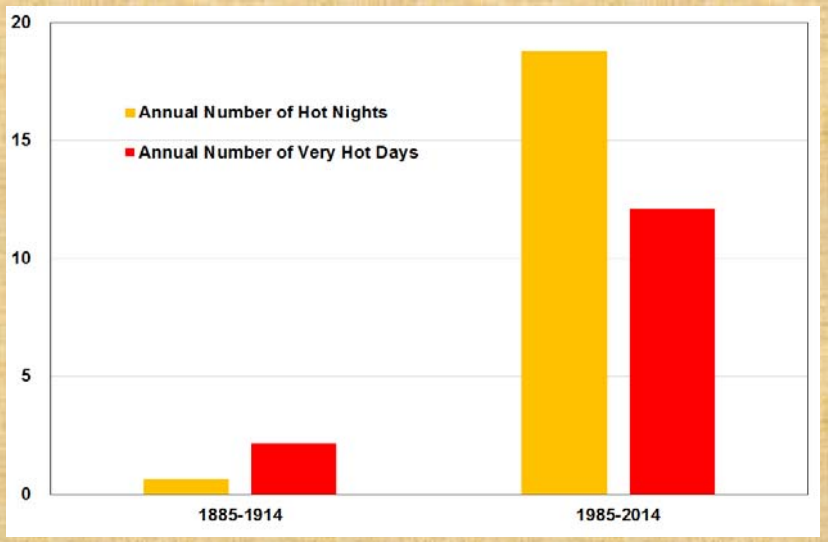


Significant global sea level rise of around 1.2 metres if they all melt away

Observed climate change in Hong Kong

A warming climate with more frequent heat extremes





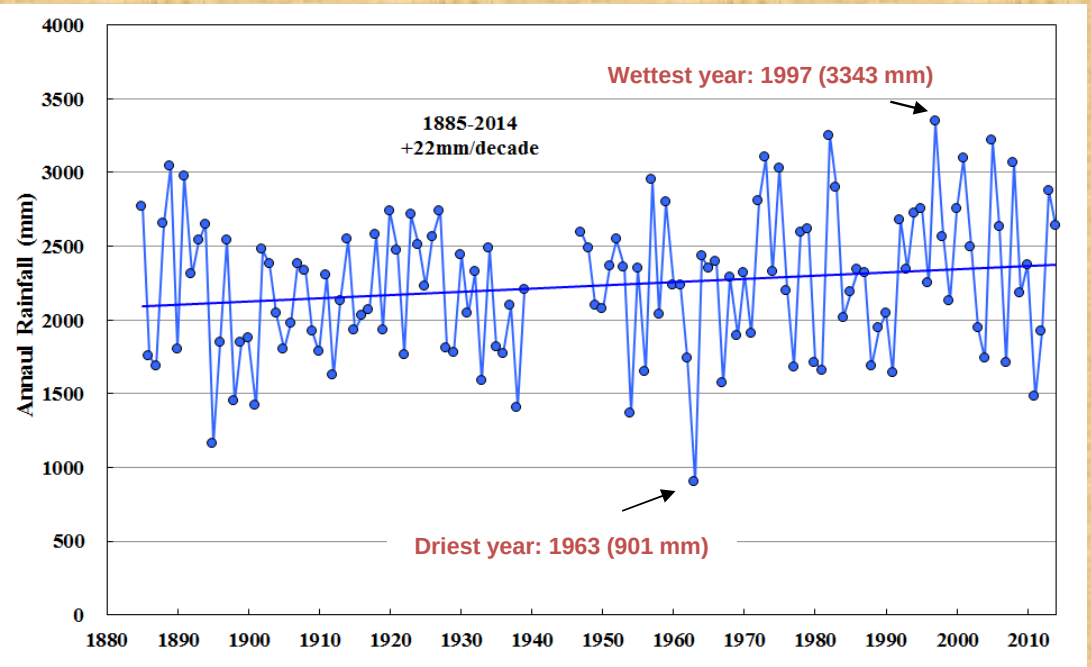
Chance of daily max temperature >= 35˚C

3% in early 20th century

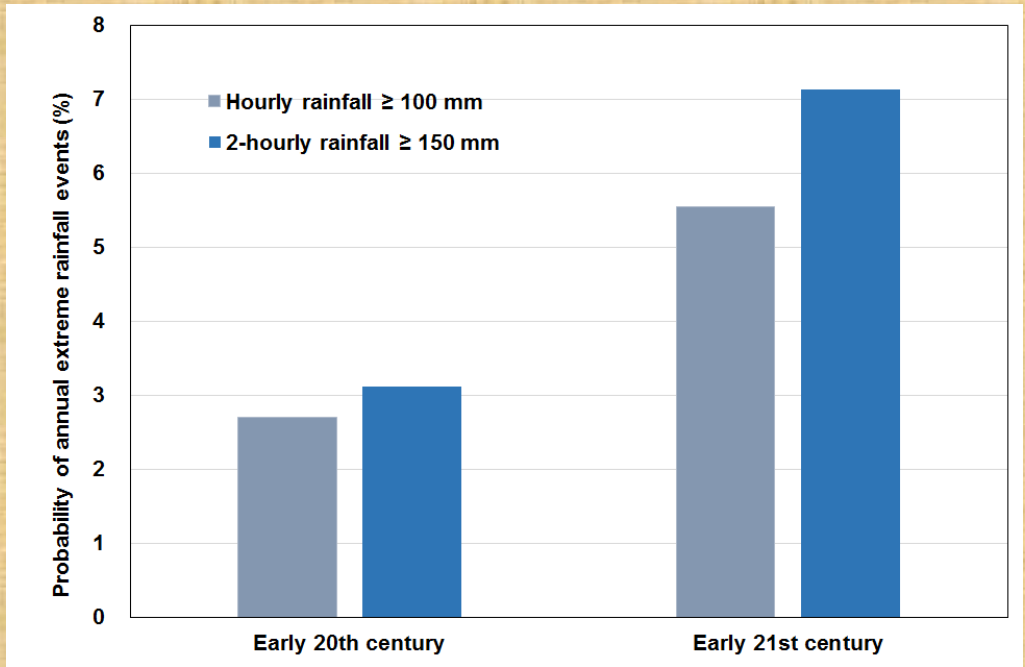
22% in early 21st century

Extreme rainfall events becoming more frequent

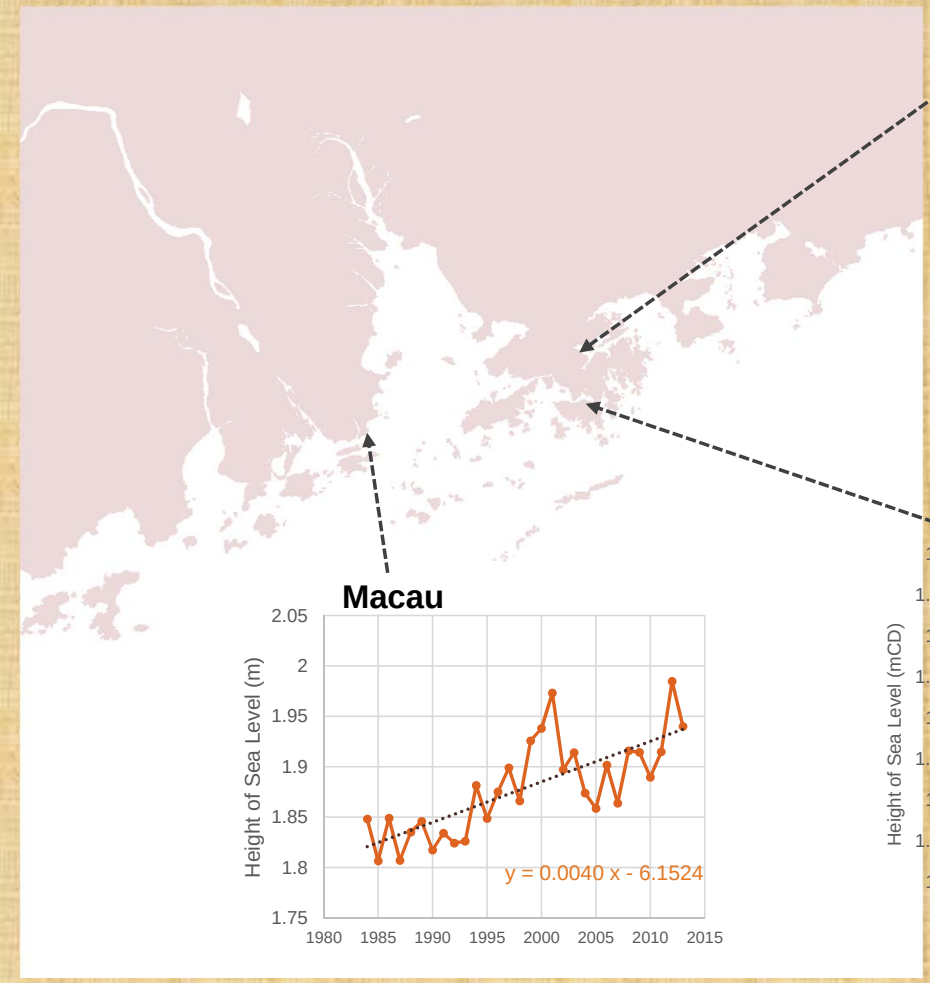
Annual rainfall at the Hong Kong Observatory Headquarters (1885-2014)

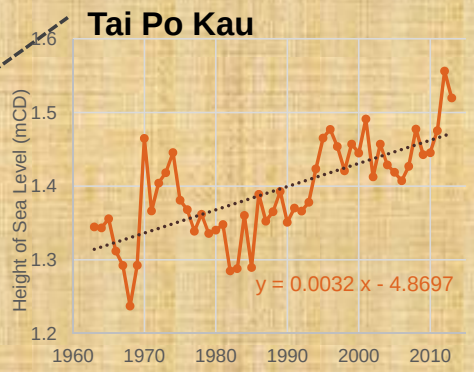


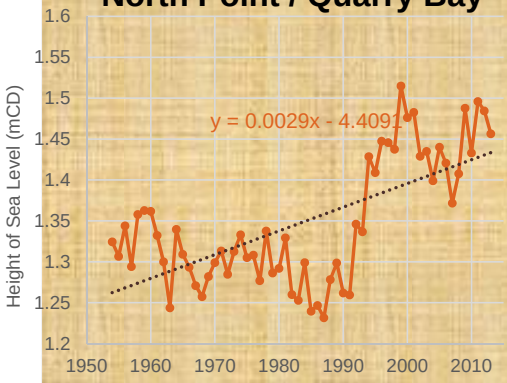
Probability of annual extreme rainfall event



Sea level is rising



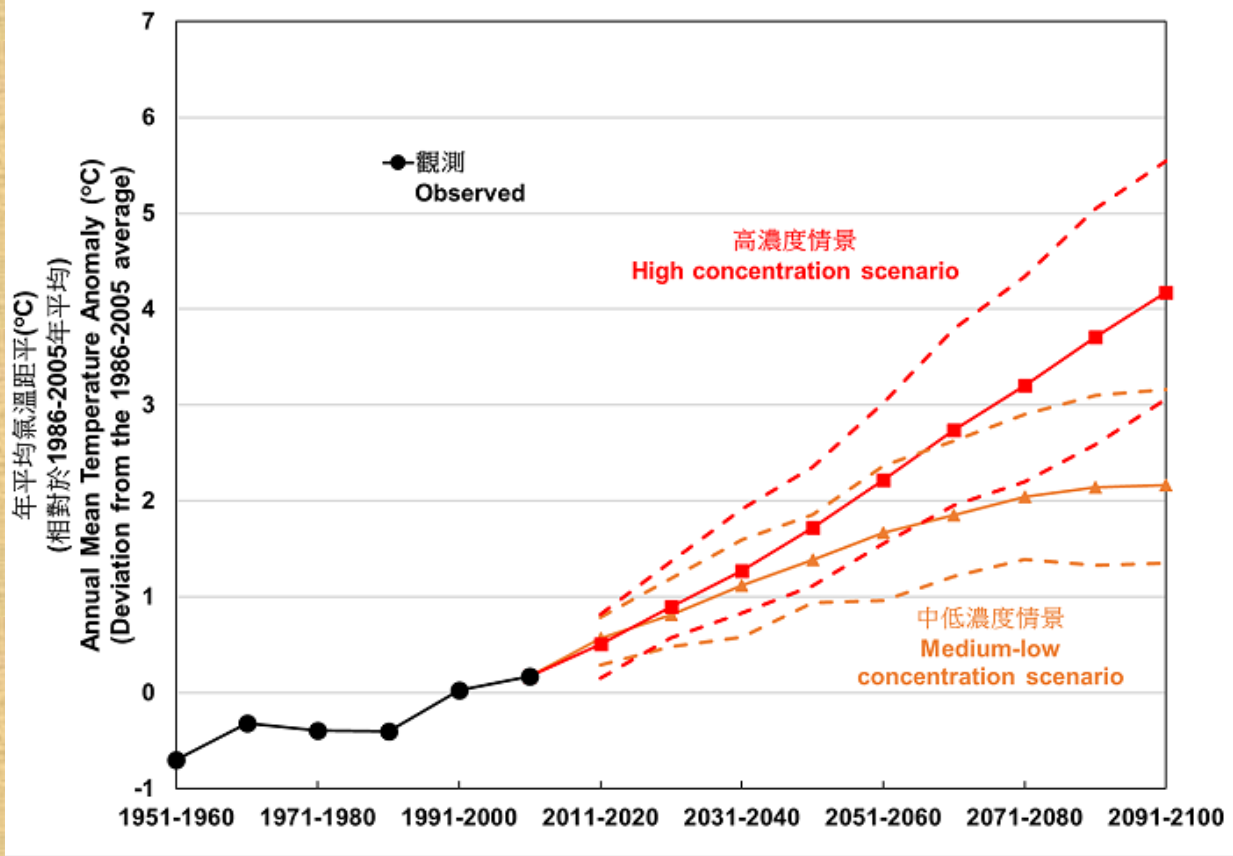




Future Hong Kong in a warming world

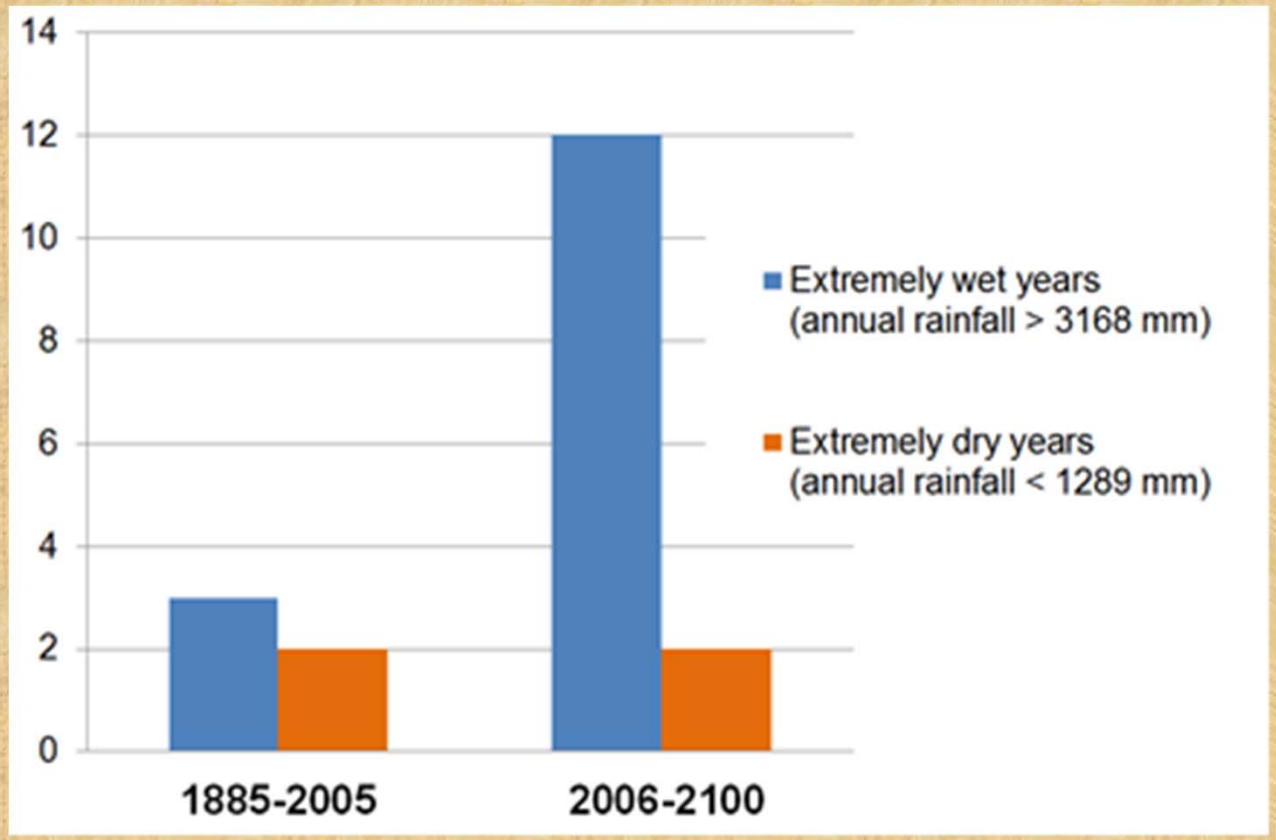
Temperature projection

- 25 global climate models downscaled
- Urbanization effect considered



Average temperature of Hong Kong will rise by 3-6 ˚C (relative to the average of 1986-2005 under the high GHG conc. scenario (RCP8.5)

More extremely wet years



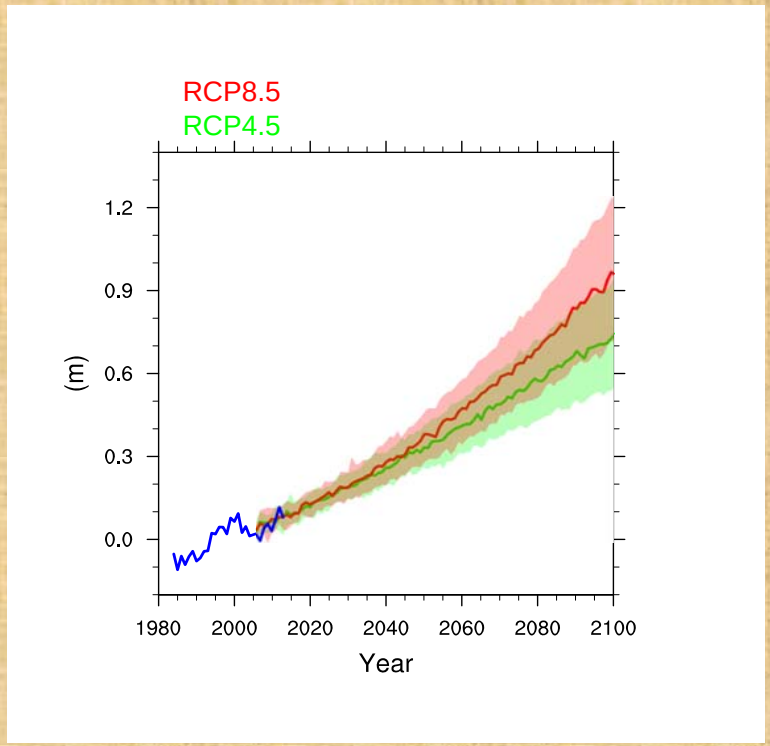
（source：DSD）

（source：WSD）

Significant increase in extremely wet years from three to about 12

Sea level rise in the vicinity of Hong Kong

(relative to the average of 1986-2005)



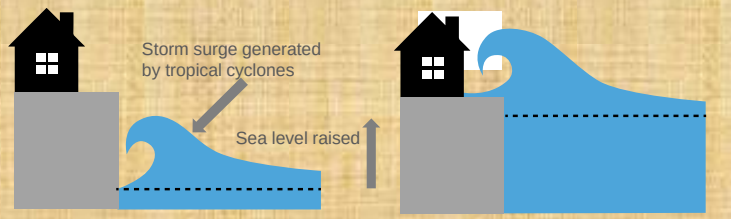
		Sea level rise in Hong Kong and its adjacent waters
RCP4.5	2081-2100	0.67 [0.50 to 0.84]
	2100	0.74 [0.56 to 0.95]
RCP8.5	2081-2100	0.84 [0.63 to 1.07]
	2100	0.96 [0.72 to 1.24]

Summary of Sea Level Rise

Components	2046-2065		2081-2100	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Steric and dynamic effect	0.11 [0.06 to 0.16]	0.14 [0.07 to 0.19]	0.21 [0.13 to 0.27]	0.30 [0.20 to 0.37]
Glaciers + ice-sheet SMB	0.07 [0.02 to 0.13]	0.09 [0.03 to 0.16]	0.13 [0.03 to 0.25]	0.19 [0.05 to 0.38]
Ice-sheet rapid dynamics	0.06 [0.02 to 0.10]	0.06 [0.03 to 0.10]	0.12 [0.03 to 0.21]	0.13 [0.04 to 0.22]
Land water storage	0.01 [0.00 to 0.02]	0.01 [0.00 to 0.02]	0.02 [-0.01 to 0.05]	0.02 [-0.01 to 0.05]
Vertical land movement	0.12 [0.09 to 0.15]	0.12 [0.09 to 0.15]	0.19 [0.14 to 0.24]	0.19 [0.14 to 0.24]
Total (with land movement)	0.38 [0.29 to 0.47]	0.43 [0.32 to 0.53]	0.67 [0.50 to 0.84]	0.84 [0.63 to 1.07]

Impact of Sea Level Rise

Sea level rise makes coastal areas more vulnerable to floods



Return period (year)	Extreme sea level above Chart Datum (m)			Historical Typhoons bringing significant storm surges to Hong Kong (Storm tide levels recorded in the Victoria Harbour)
	Current mean sea level	For a sea level rise reaching 0.53 m	For a sea level rise reaching 1.07 m	
1	2.7	3.2	3.8	T. Hagupit in 2008 (3.53 m)
2	2.9	3.4	4.0	T. Wanda in 1962 (3.96 m)
5	3.1	3.6	4.2	Typhoon in 1937 (4.05 m)
10	3.3	3.8	4.4	
20	3.4	3.9	4.5	
50	3.5	4.0	4.6	

Changes in the return period of extreme sea level event in Victoria Harbour due to mean sea level rise

Severe flooding in Tai O (Source: TVB)

Storm tide level could be even higher (>6 m) over Tolo Harbour

Shatin was the most affected area during the passage of Wanda in 1962. Streets and houses were flooded and destroyed. Boats were used to ferry families and their possessions.

The Kowloon-Canton Railway track at Sha Tin was damaged by storm surge brought by the Typhoon in 1937.

Situation could be worse as global mean tropical cyclone intensity is likely to increase this century

Damages to ships and piers at Central, Hong Kong Island, brought by severe storm surge during the great typhoon of 1874 (might reach 5.2 m as estimated by model stimulation)

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Thank you