7.1 Is the climate changing?

7.1 The unquestionable truth – Is the climate changing?

Summary

To know more about climate change, first we need to understand the difference between weather and climate. Weather describes the conditions of the atmosphere within a short period of time, while climate describes the average meteorological conditions over a long period of time.

Weather and climate vary from region to region. After a brief discussion of the global climate, this chapter goes on to introduce the climates in China and Hong Kong specifically.

To better understand the ongoing climate change, we need to examine the scientific evidence such as the increasing global surface temperature, increasing ocean heat content, shrinking sea ice, retreating glaciers and ice sheets as well as rising sea level.

7.1.1 Weather and climate

Weather describes the conditions of the atmosphere in a place within a short period of time (e.g. several hours, a few days). Climate on the other hand describes the average meteorological conditions in a place over a long period of time. Therefore, climate can be interpreted as the "average weather". According to the definition given by the World Meteorological Organization (WMO), the reference period for compiling climate statistics should be at least 30 years.

What is climate?

More information

What are conditions of the atmosphere?

Conditions of the atmosphere refer to the meteorological elements such as temperature, relative humidity, precipitation, air pressure, wind direction and wind speed.

Example of weather

Fig1.1a shows the regional temperatures of Hong Kong in the afternoon on 26 November 2018. Fig1.1b shows that the temperature of Tsuen Wan Ho Koon station was 19°C and the relative humidity was 90%. Fig 1.1c is the image of radar echoes showing that there was rain around Hong Kong.

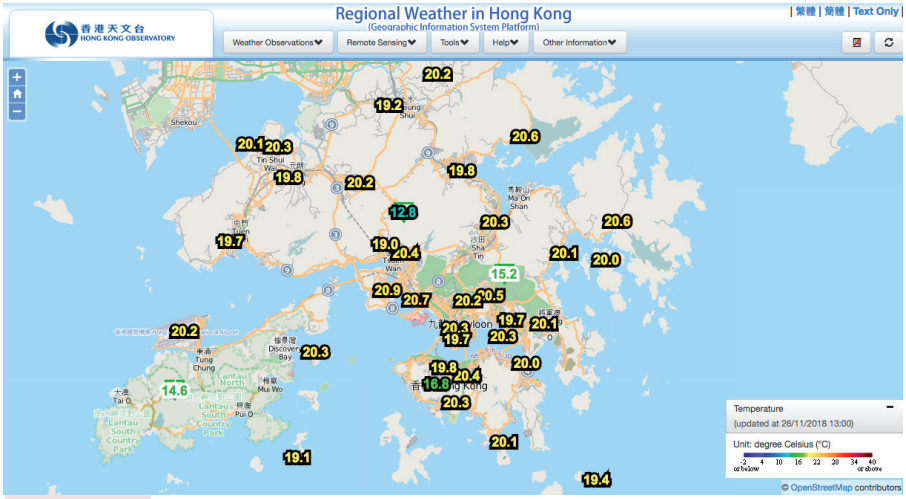


Fig 1.1a **Regional temperatures of Hong Kong**

Source: Hong Kong Observatory (HKO)

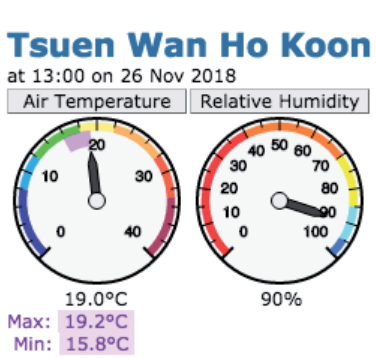


Fig 1.1b **Weather conditions at Tsuen Wan Ho Koon station**

Source: HKO

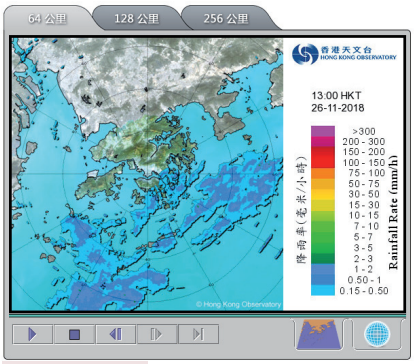


Fig 1.1c **Image of radar echoes**

Source: HKO

Current weather conditions

More information

The ABC's of Climate

More information

Educational Resources (climate and climate change)

More information

Example of climate

Using long records of meteorological data, we can calculate the climatological values.

Monthly mean of temperature and atmospheric pressure recorded at the Observatory (1981 to 2010)

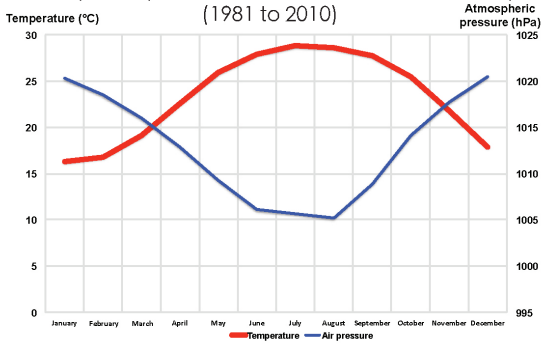


Fig 1.1d **Monthly mean temperature and monthly mean atmospheric pressure of Hong Kong**

Data source: HKO

Monthly mean of rainfall in Hong Kong (1981 to 2010)

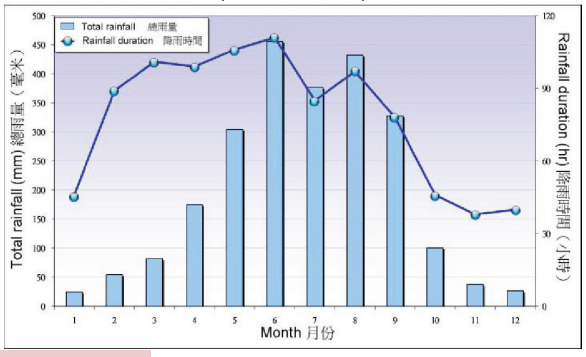
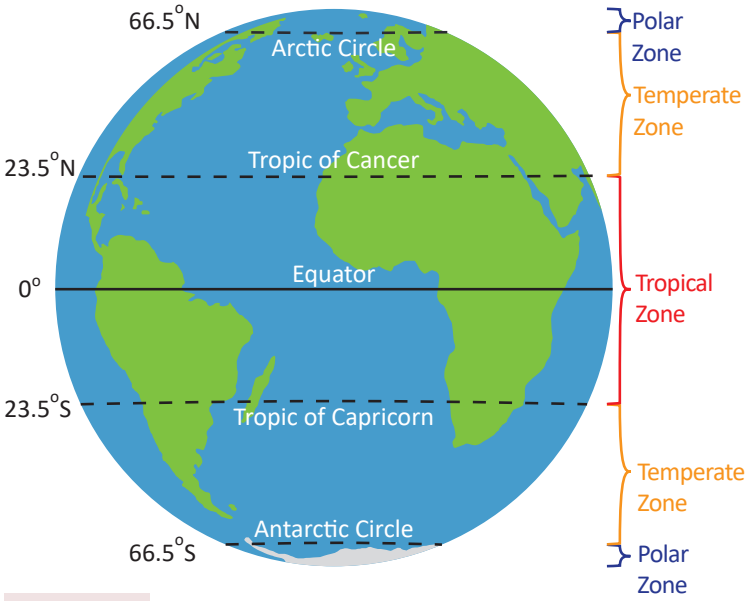


Fig 1.1e **Monthly mean of rainfall in Hong Kong**

Source: HKO

7.1.2 How is the global climate?

One of the most important factors affecting regional climate is the solar radiation, known as insolation, received. A simple climate classification divides the Earth into climatic zones by the Arctic Circle, the Tropic of Cancer, the Tropic of Capricorn and the Antarctic Circle. **Tropical zone** refers to the region between the Tropic of Cancer and the Tropic of Capricorn; **temperate zone** refers to the region between the Arctic Circle (the Antarctic Circle) and the Tropic of Cancer (the Tropic of Capricorn); **polar zone** fills the areas within the Arctic and Antarctic Circles. Among the three climatic zones, tropical zone receives the greatest amount of insolation, and polar zones receive the least.



Climatic zones (Köppen climatic classification)

More information

Fig 1.2 **Climatic zones classified by the Tropic of Capricorn, the Tropic of Cancer, the Antarctic Circle and the Arctic Circle**

Other climate classifications may take into account parameters such as temperature, precipitation, duration of precipitation and types of vegetation. Regions with similar parameters will be grouped into a climatic zone. For example, Köppen's climatic classification divides the world into 6 major climatic zones based on 3 factors: growth of vegetation, temperature and precipitation.

In addition to latitude, there are other factors such as geographical location, altitude, distance from the sea, ocean currents and prevailing wind, which affect the regional climate.

7.1.3 How are the climates in China and Hong Kong?

Climate in China

Located in the southeast of the Eurasian continent, China is vast in size with complex terrain. It has the Pacific Ocean in the east and Qing Zang Gaoyuan in the west. The interactions among the ocean, continent and terrain give rise to typical monsoon climates. Fig 1.3 shows the major climatic features in China.

What is monsoon?

Monsoon refers to the seasonal reversal of wind direction.

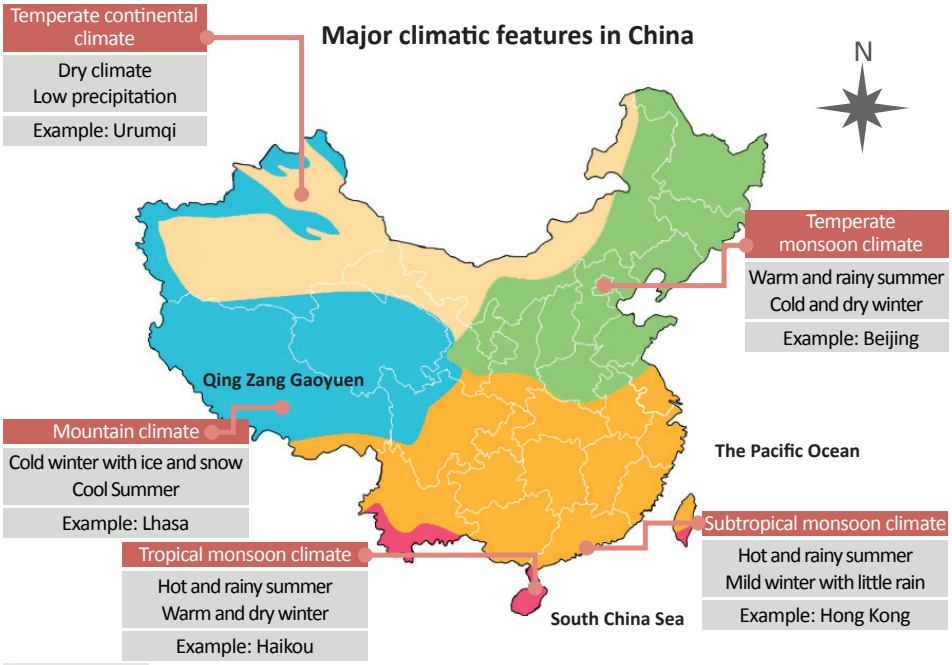


Fig 1.3 **Major climatic features in China**

Source: China Meteorological Administration

In winter, China is affected by the Asian high pressure system, with cold and dry prevailing northerly offshore winds. In summer, China is affected by the subtropical ridge of high pressure over the western North Pacific. The prevailing southerly airstreams generally bring warm, humid and rainy weather.

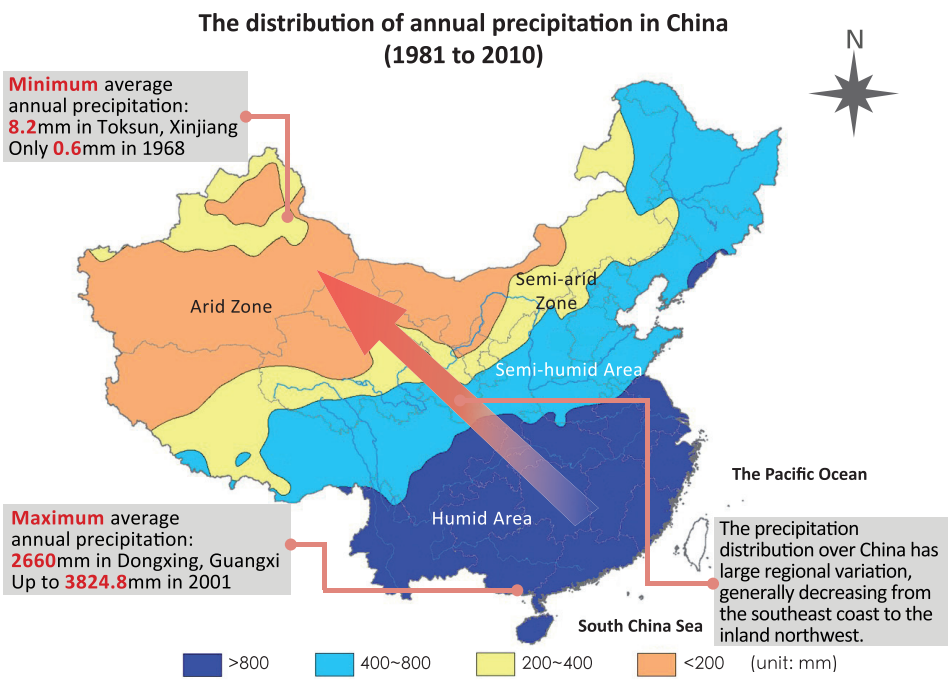


Fig 1.4 **The distribution of annual precipitation in China**

Source: China Meteorological Administration

What are the major climatic features in China?

More information

Climate in Hong Kong

Hong Kong's climate is sub-tropical, tending towards temperate for nearly half the year. During November and December there are pleasant breezes, plenty of sunshine and comfortable temperatures. Many people regard these as the best months of the year. January and February are cloudier, with occasional cold fronts followed by dry northerly winds. It is not uncommon for temperatures to drop below 10°C in urban areas. March and April are milder although there are occasional spells of high humidity, with fog and drizzle bringing about low visibilities. May to August are hot and humid with occasional showers and thunderstorms, particularly common during the mornings. There is usually a fine dry spell in July which may possibly last for one to two weeks, or even longer in some years. July and September are the months during which Hong Kong is most likely to be affected by tropical cyclones, although tropical cyclones are not unusual at any time between May and November.

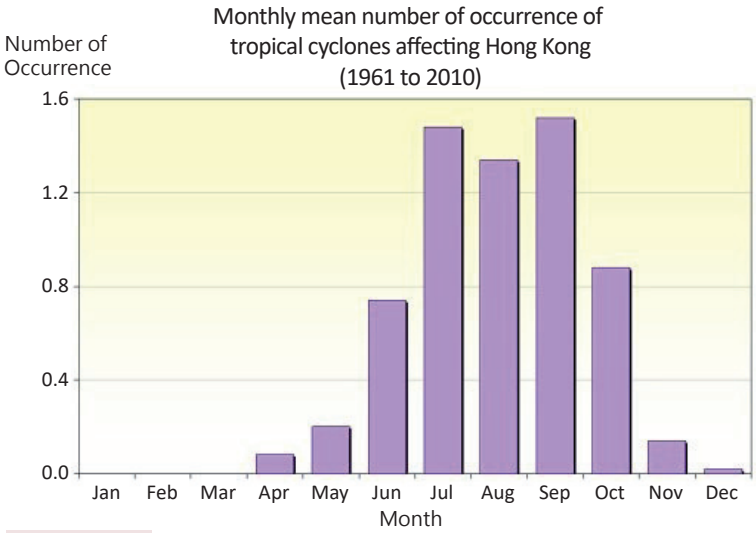


Fig 1.5 **Monthly mean number of occurrence of tropical cyclones affecting Hong Kong**

Source: HKO

The mean annual rainfall ranges from about 1,400mm at Ping Chau to more than 3,000mm in the vicinity of Tai Mo Shan. About 80% of the rain falls between May and September.

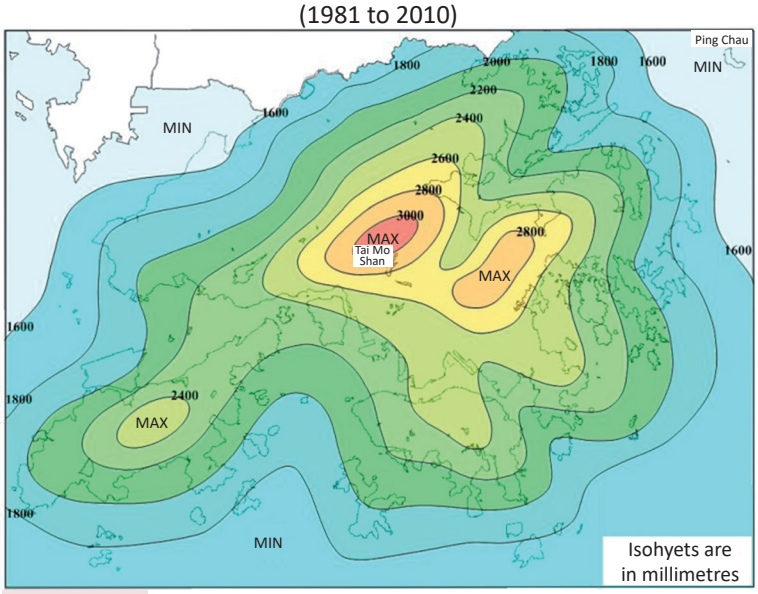


Fig 1.6 **Distribution of mean annual rainfall in Hong Kong**

Source: HKO

Climate in Hong Kong

More information

Monthly Weather Summary

More information

Climate Statistics

More information

7.1.4 The scientific evidence of climate change

A large number of studies have shown that the scientific evidence of climate change is overwhelming, and there is a clear scientific consensus among climate scientists. The scientific evidence of climate change is set out in the following.

(a) Increasing global surface temperature

The analyses of global temperature data from various meteorological institutions and research centres have reached the same conclusion that the average global temperature has been increasing significantly over the past hundred years. According to the WMO Statement on the State of the Global Climate in 2017[i], global mean temperature in 2017 was about 1.1°C above pre-industrial levels (Fig 1.7). Fig 1.8 shows almost every corner of the globe has experienced a warming trend over the past hundred years.

The latest global temperature trend

More information

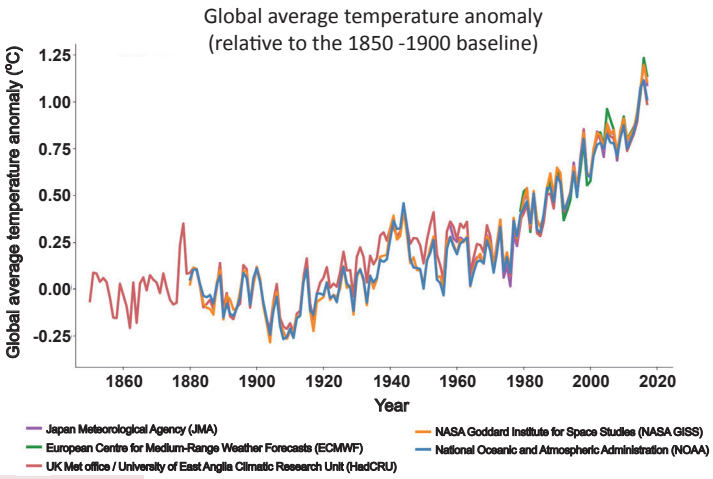


Fig 1.7 Global average temperature anomaly

Source:The WMO Statement on the State of the Global Climate in 2017

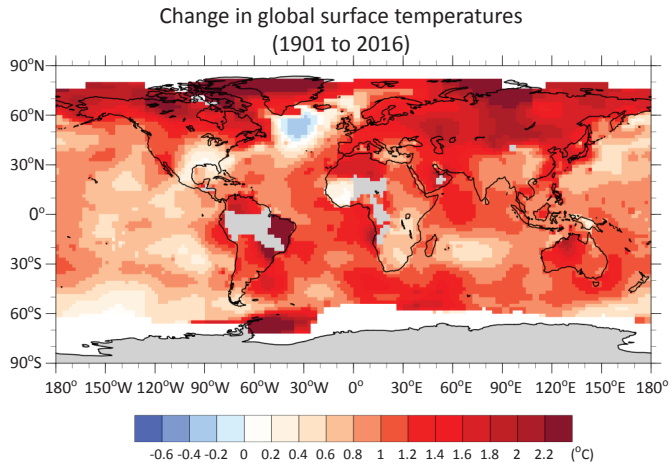


Fig 1.8 Change in global surface temperatures

Data source: NASA

How long has the global surface temperature been persistently higher than the 20th century average?

The reality of the inconvenient truth

More information

Why snowstorms and extremely cold weather still occur in some regions under global warming?

Cold events in a certain place at a certain time are just weather, and say nothing about climate. Against the backdrop of natural climate variability, global warming refers to the increase in global average temperature since the 20th century as a result of human activities. Snowstorms and extremely cold weather are parts of the natural climate variability and are not precluded by global warming. However, global warming has reduced the frequency of extremely cold events over the last few decades. The frequency of extremely cold events is expected to decrease further if global temperature keeps rising in the future.

Is global warming really at work?

More information

(b) Increase in sea surface temperature and ocean heat content

The ocean covers more than 70% of the Earth's surface. The heat capacity of ocean is much higher than that of land. Fig 1.9a and Fig 1.9b clearly show the long-term increasing trend of sea surface temperature and ocean heat content.

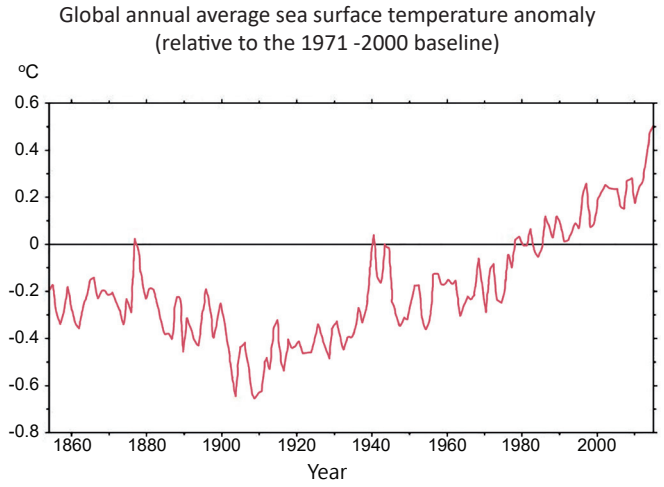


Fig 1.9a **Global annual average sea surface temperature anomaly[ii]**

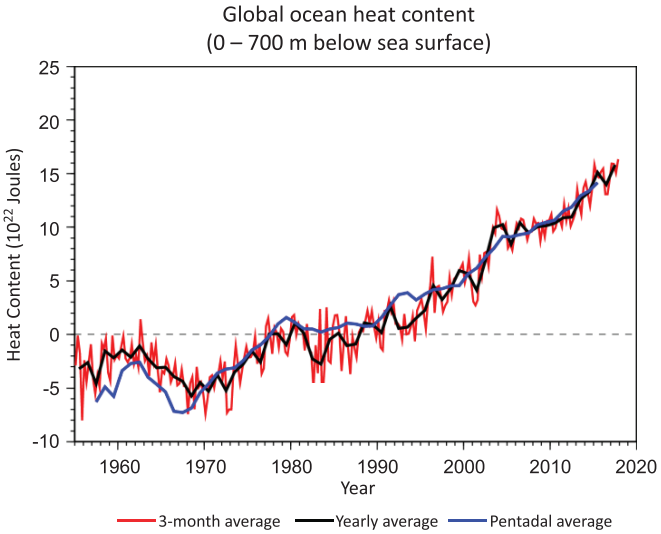


Fig 1.9b **Global ocean heat content[iii] (0 - 700m below sea surface)**

Source: US National Oceanic and Atmospheric Administration (NOAA)

Climate change: Ocean heat content

The ocean absorbs and stores energy from the Sun. If the ocean absorbs more heat than it releases, the heat content increases.

The latest ocean heat content

More information

Ocean heat as 'fuel' for tropical cyclones

More information

(c) Shrinking sea ice

Arctic sea ice is decreasing in all seasons. The decrease is particularly more prominent in summer. Studies have shown that the loss of Arctic summer sea ice over the past 30 years was unprecedented in the last 1,450 years.

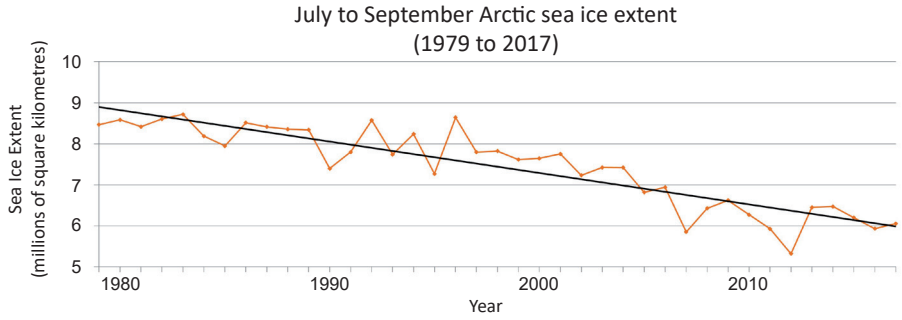


Fig 1.10 **July to September Arctic sea ice extent**

Data source: US National Snow and Ice Data Center (NSIDC)

The latest Arctic sea ice extent

More information

Although Antarctic sea ice extent has increased slightly over the past few decades, the overall global sea ice extent is on the decline. Antarctic sea ice extent exhibits large fluctuations in recent years and hit its lowest value ever recorded by satellites in early 2017.

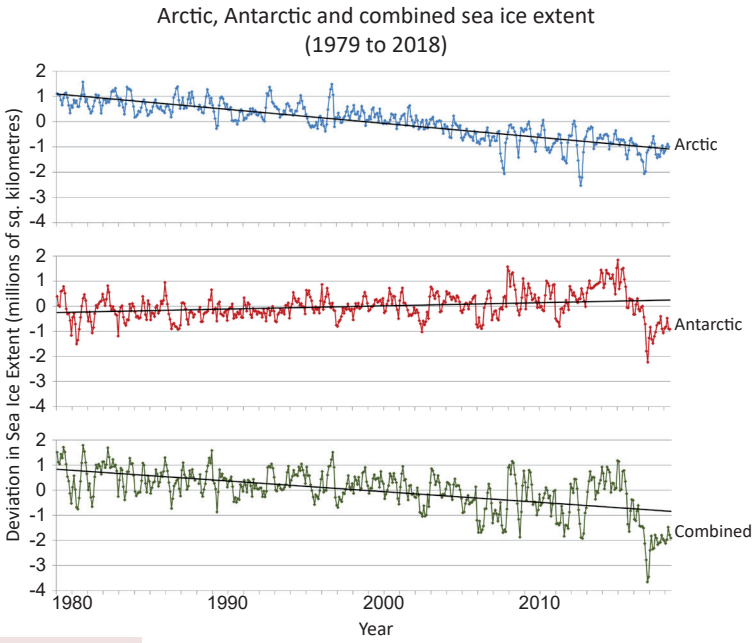


Fig 1.11 **Arctic, Antarctic and combined sea ice extent**

Data source: NSIDC

Disappearing Ice

More information

Changes of Antarctic sea ice extent from 31 August 2016 to 3 March 2017

More information

Fig 1.12 **Antarctic sea ice (2007)**

Source: Acaro[iv]

(d) Decrease in the Northern Hemisphere snow cover extent

Snow cover extent has decreased in the Northern Hemisphere, especially in spring.

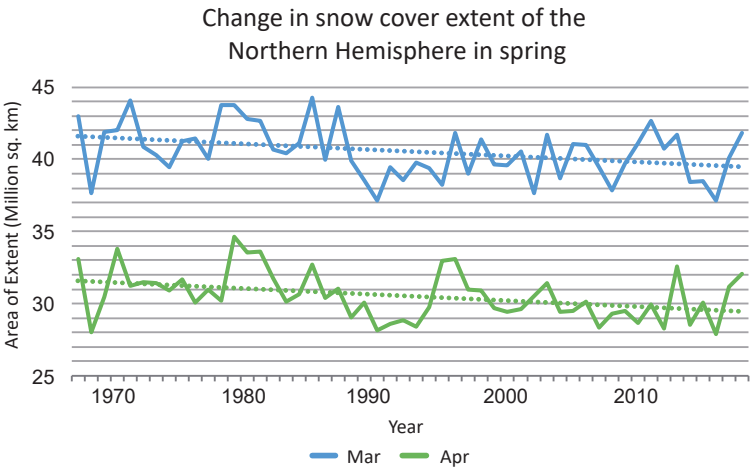


Fig 1.13 **Change in snow cover extent of the Northern Hemisphere in spring[v]**

Data source: Rutgers University

(e) Mass loss of ice sheets

The Greenland and Antarctic ice sheets are the two largest ice sheets on Earth. In recent years, scientists measure the ice mass variation of Antarctica and Greenland by tracking gravity changes on Earth with satellites. Mass loss of the Greenland ice sheet has accelerated since 1992. The average rate of ice loss has increased from 34 billion tonnes per year over the period of 1992 - 2001 to 215 billion tonnes per year over the period of 2002 - 2011.

The average rate of ice loss from the Antarctic ice sheet has increased from 30 billion tonnes per year over the period of 1992 - 2001 to 147 billion tonnes per year over the period of 2002 - 2011. The losses are mainly from the northern Antarctic Peninsula and the Amundsen Sea sector of West Antarctica.

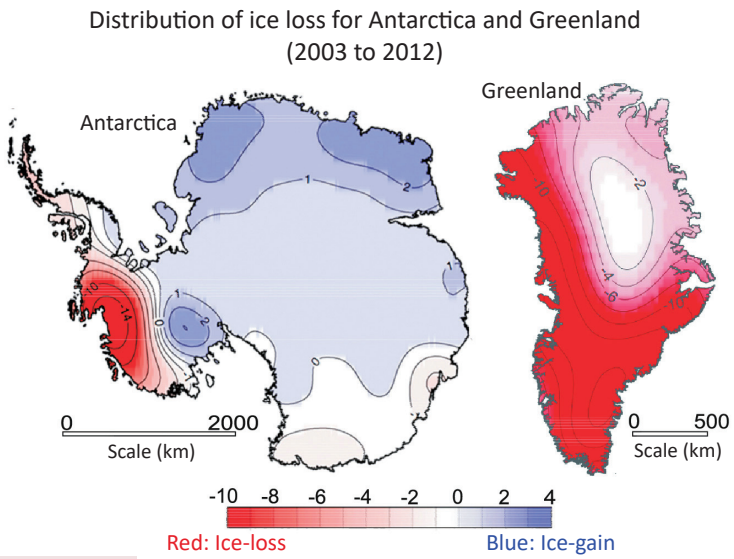


Fig 1.14 **Distribution of ice loss for Antarctica and Greenland**

Source: The Fifth Assessment Report of IPCC

The latest mass variation of Antarctic and Greenland ice sheets

More information

Ice losses from Antarctica have tripled since 2012, accelerating global sea level rise

More information

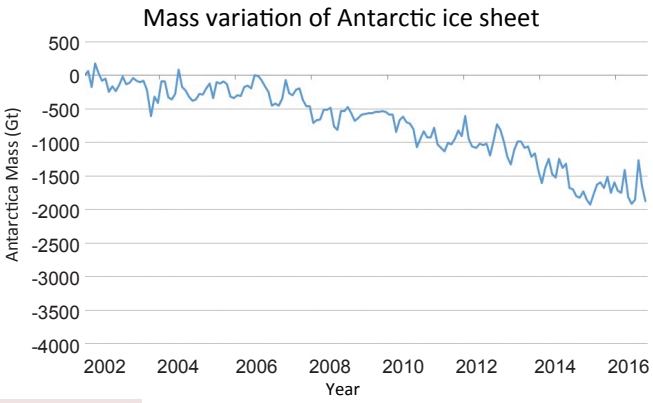


Fig 1.15a **Mass variation of Antarctic ice sheet**

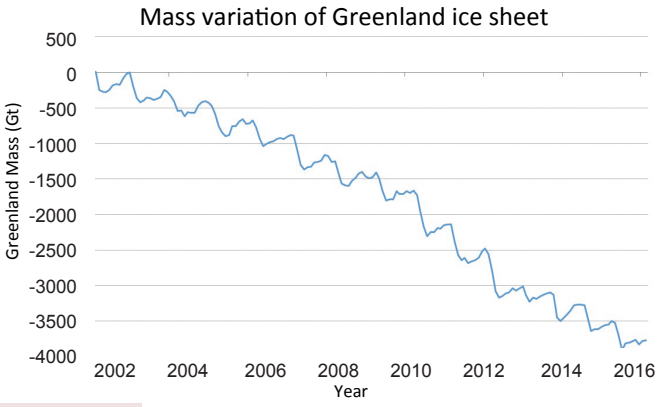


Fig 1.15b **Mass variation of Greenland ice sheet**

Data source: NASA

(f) Retreating glaciers

Report of World Glacier Monitoring Service (WGMS) indicates that the overall mass balance of glaciers in the world has continued to shrink for about 40 years. The mean annual mass balance of global glaciers has been persistently negative since 1980[vi].

Latest glacier mass balance

More information

The film "Chasing Ice" captured the largest glacier calving event in Greenland

More information

Fig 1.16 Columbia Glacier, Alaska (upper photo: 2009, lower photo: 2015)

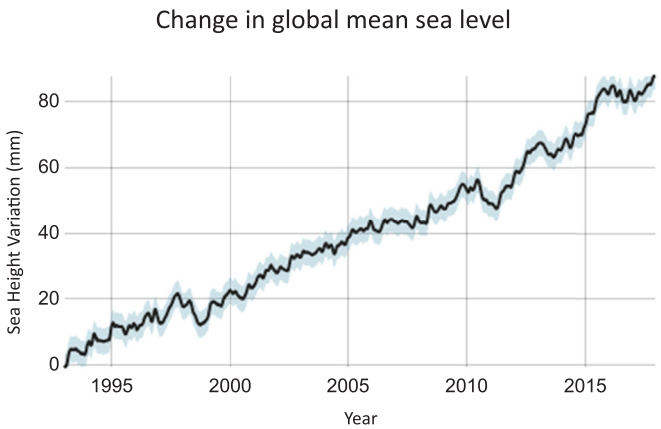
Source: James Balog and the Extreme Ice Survey

(g) Sea level rise

Seawater expands when it warms and melting land-based ice and snow adds water to the oceans, resulting in global sea level rise. As shown in Fig 1.17a, satellite data clearly shows the rise of global sea level over the past 20 years. Fig 1.17b, extracted from the Fifth Assessment Report of IPCC, shows that the rate of global sea level rise during the satellite altimetry era is nearly twice the average rate over the 20th century, which, in turn, is much higher than the average rate over the last two millennia.

Latest sea level

More information



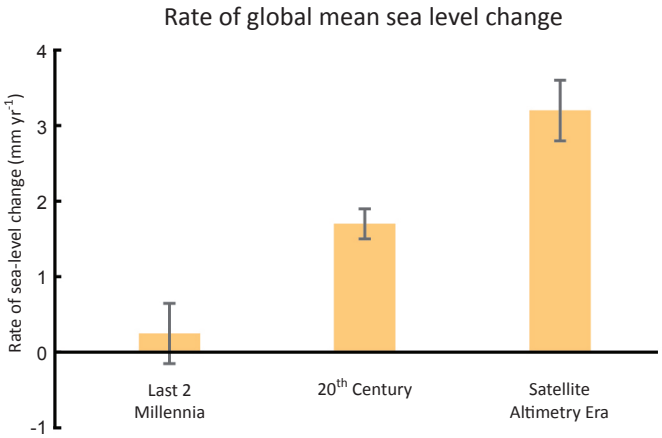


Fig 1.17a Change in global mean sea level[vii]

Source: NASA

Fig 1.17b Rate of global mean sea level change[viii]

Source: The Fifth Assessment Report of IPCC

(h) More frequent extreme weather events

Climate change leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather events. According to the Fifth Assessment Report of IPCC, the numbers of warm days and nights have increased globally since 1950 while the numbers of cold days and nights have decreased. Most land areas have experienced more heat waves since the middle of the 20th century. More land regions experience increase in heavy precipitation events.

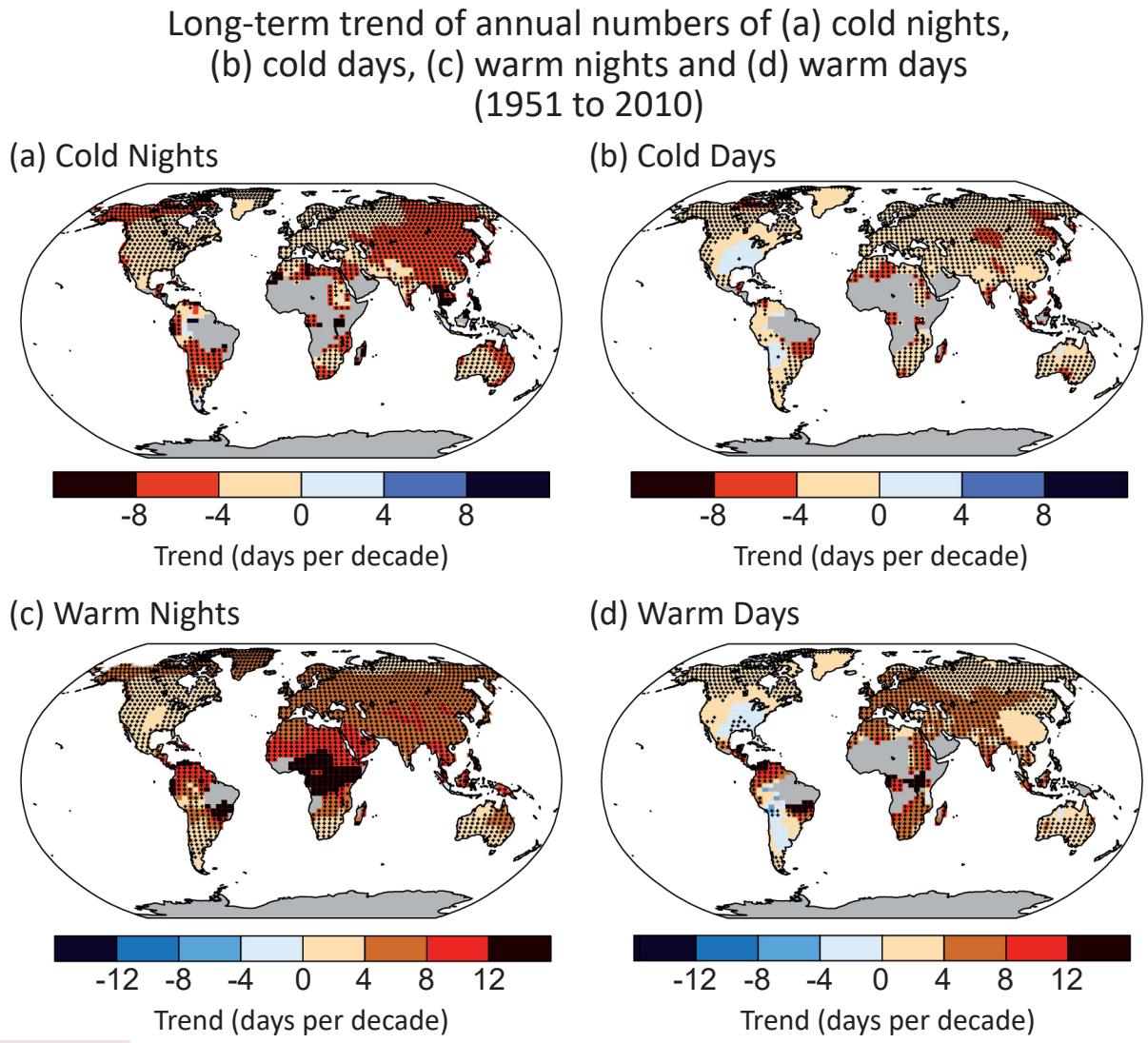


Fig 1.18 **Long-term trend of annual numbers of (a) cold nights, (b) cold days, (c) warm nights and (d) warm days[ix]**

Source: The Fifth Assessment Report of IPCC

Both the Fourth and Fifth Assessment Reports of IPCC confirmed that warming of the climate system was unequivocal.

What is IPCC?

The Intergovernmental Panel on Climate Change (IPCC), established under the auspices of the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), is a scientific body tasked to evaluate the risk of climate change caused by human activities.

Climate change is a very complex issue. Policymakers need an objective source of information about the causes of climate change, its potential environmental and socio-economic consequences, and the adaptation and mitigation options to respond to its impacts. This is the key motivation behind the establishment of IPCC in 1988 as the authority on climate change.

The main activity of IPCC is the compilation of assessment reports on a regular basis. The First Assessment Report in 1990 played a decisive role in the establishment of the United Nations Framework Convention on Climate Change (UNFCCC). The Second Assessment Report in 1995 provided key input to the negotiations of the Kyoto Protocol. The Third Assessment Report in 2001 and a number of special reports provided relevant information for the development of the UNFCCC and the Kyoto Protocol. The Fourth Assessment Report in 2007 confirmed that warming of the climate system was unequivocal. The Fifth Assessment Report in 2013 reaffirmed this finding and concluded that it was extremely likely that human influence had been the dominant cause behind the observed warming since the mid-20th century.