

## **Supplementary Notes on the Climate Change Powerpoint for Secondary Schools**

### Slide 1

Climate change has been a focused research topics of the international scientific community for decades. In recent years it has become a hot discussion topic among members of the public. This PowerPoint presentation is intended to introduce to students the basic knowledge of climate change; the status of climate change globally and in Hong Kong; its impact and actions we as individuals may take to mitigate climate change.

### Slide 2

The main compositions of air are nitrogen (78%) and oxygen (21%). The residual consisted of trace gases, such as carbon dioxide, argon, helium and a variable amount of water vapour. Although the amount of carbon dioxide is relatively small (about 0.04%), being a greenhouse gas, it plays a significant role in climate change.

### Slide 3

Why greenhouse gases can affect the climate of the earth? The heat content at the surface of the earth is mainly derived from the sun. When solar radiation (visible light) reached the earth, it heats up the earth. The surface temperature of the sun is about 6000°C but the surface temperature of the earth is only about 15°C. In spite of the large temperature difference, the earth also emits radiation. As the surface temperature of the earth is lower, the radiation emitted has a longer wave length (infra-red) which is not visible to the eye. Nevertheless, it is still capable of scattering heat back to the outer space which in term cools the earth. If the heating and cooling of the earth is comparable, the long-term mean temperature of the earth will remain more or less unchanged.

### Slide 4

The greenhouse gases in the air, such as carbon dioxide, will hinder the emission of heat from the earth to outer space. The greenhouse gases absorb part of the infra-red radiation emitted from the earth and then re-emitted in all directions also in the form of infra-red radiation. Consequently, part of the heat will go into the outer space but part of it will return to the earth. This is what is known as the greenhouse effect. As such, if the greenhouse gases in the atmosphere increases, the earth surface will receive more radiation energy than before, the air temperature of the earth will rise. Apart from carbon dioxide which is familiar to most people, greenhouse gases also include nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), chlorofluorocarbons (CFC), ozone (O<sub>3</sub>) and water vapour (H<sub>2</sub>O).

### Slide 5

Apart from water vapour, all other greenhouse gases are associated with human activities. Carbon dioxide is mainly produced by human beings in the course of energy usage and industrial processes. Nitrous oxide is produced in waste landfills; agriculture and animal husbandry produce methane; air-conditioning and uses of aerosol spray produce CFCs; vehicle exhausts produce ozone.

### Slide 6

Since the Industrial Revolution in 1750, human activities such as burning of fossil fuel like coal, petroleum and natural gas has caused the concentration of carbon dioxide to increase rapidly by about 40%. Furthermore, human activities also caused the concentration of methane and nitrous oxide to rise sharply.

### Slide 7

The figure shows the global mean temperatures since instrumental records began. The first decade of the 21st century has been the warmest since instrumental record began.

### Slide 8

Apart from very few areas over the ocean, temperatures over almost all regions are rising. In general, the rising rate is higher over the higher latitudes than the lower latitudes. In land, the rising rate is higher than ocean.

### Slide 9

The temperature record of the Hong Kong Observatory Headquarters (HKOHQ) at Tsim Sha Tsui has become available since 1885. Hong Kong was not spared from the effect of global warming, also because of the high density urban development, the temperature at the HKOHQ has risen 1.2°C in the last century. This is considerably greater than the global rate for the same period. The average temperature rising rate at the HKOHQ was 0.18°C per decade in the recent 30 years (1988-2017).

### Slide 10

We may all be familiar with the water cycle: Water on land and of the ocean becomes water vapour in the atmosphere through the processes of evaporation and evapotranspiration. When the vapour rises to a certain height, it cools down, condenses as cloud and then falls back to ground as rain. Global warming will enhance the water cycle, causing the mean global precipitation to increase. Precipitation here includes rain and snow.

### Slide 11

Unlike temperature, although the mean global precipitation is expected to rise, not all regions would experience a precipitation rise. The figure shows that the variation of regional precipitation could be great. Some regions will increase but some will decrease.

### Slide 12

The annual total rainfall at the Hong Kong Observatory Headquarters rose at an average rate of 40 mm/decade from 1947 to 2017, though statistically insignificant at 5% level. The annual rainfall trend is small when compared to the year-to-year fluctuations. Annual rainfall ranges from a minimum of 901 mm to a maximum of 3343 mm.

### Slide 13

Global warming will lead to a rise in sea level. Reasons for the rise are thermal expansion of sea water and the melting of snow and ice on land.

### Slide 14

As shown by the experiment in the figure, when the temperature of sea water rises, the sea water will expand and the sea level will rise.

### Slide 15

Global temperature increases will cause glaciers on high mountains and polar land to melt into water and flow into the oceans. Consequently, the sea level will rise.

### Slide 16

The graph shows the global mean sea level measured by tide gauge and satellite. The global mean sea level height rose at a rate of 1.7 mm per year during the period 1901-2010. The rising rate is higher at 3.2 mm per year during the period 1993-2010.

### Slide 17

Global warming is not simply a temperature rising phenomenon. The atmospheric circulation and chemical composition will change too. There will be increase in occurrence of extreme weather and climate events. Heat wave, drought, flooding will become more frequent and tropical cyclone over the Atlantic Ocean is expected to strengthen.

### Slide 18

The annual number of days with heavy rain in Hong Kong is on the rise. According to the data recorded at the Hong Kong Observatory Headquarters, the annual number of days with heavy rain rose at an average rate of 0.3 days per decade after the World War II. Heavy rain day refers to the day with an occurrence of 30 mm or more of hourly rainfall. In general, hourly rainfall of 30 mm is the general reference criterion for the issuance of the amber rainstorm warning in Hong Kong.

### Slide 19

With temperature rising in Hong Kong, the number of cold days in winter is falling rapidly at a rate of 2.1 days per decade. Cold day refers to the day with a daily minimum temperature of 12°C or below. Temperature of 12°C or below is the general reference criterion for the issuance of cold warning in Hong Kong. As regards to the number of very hot days (day with maximum temperature of 33°C or above, a general reference criterion for the issuance of very hot warning in Hong Kong) in summer, the change is not significant. This is related to the reduction of solar radiation reaching Hong Kong.

### Slide 20

The sea level change of a location is influenced by the prevailing wind and atmospheric pressure at the time. High winds could help to pile up sea water near the shore leading to a sea level rise. At lower atmospheric pressure, the sea water beneath receive less force compared with the waters under normal pressure further away. This acts like a vacuum pump sucking the sea surface up, leading to a higher sea surface level. A tropical cyclone having much stronger winds and a rather low central pressure is capable of bringing about a substantial sea level rise. This phenomenon is known as storm surge.

### Slide 21

As shown in the figure, with a rise in sea level, flooding of the coastal region will be much easier during typhoon approaches and heavy rain.

### Slide 22

Extreme weather such as heavy rain will trigger landslides and flooding. An increase in the number of heavy rain events will pose a greater threat to life and properties.

### Slide 23

The rise in sea level will submerge regions with height close to sea level. It will also increase the risk of flooding of the coastal regions.

### Slide 24

Both temperature and rainfall are important parameters affecting the growth of plants. Global warming causes a change in temperature and rainfall, and hence will have a direct effect on the growth of the plants. Some areas will have a reduction in food production. Warming will also affect the natural food chain, alter the flowering and fruit bearing seasons of plants, and subsequently the time for reproduction and feeding of birds.

### Slide 25

Mosquitoes thrive better in a hot environment. More mosquitoes could be found in Hong Kong in the summer rather than in winter. When temperature rises, the number of mosquitoes will rise too. This will make the spreading of infectious diseases, e.g. Dengue fever and Malaria easier. Moreover, fleas will proliferate helping infectious diseases to spread effectively.

### Slide 26

For future climate projections, a new set of four scenarios referred to as the Representative Concentration Pathways (RCP) was designed in the Fifth Assessment Report of Intergovernmental Panel on Climate Change to consider different atmospheric greenhouse gas concentration trajectories in the 21st century. In the high greenhouse gas concentration scenario, global mean surface temperature and global mean sea level for 2081-2100 will likely be in the range 2.6 - 4.8 °C and 0.45 - 0.82 m, respectively, above the 1986-2005 average.

### Slide 27

Under the high greenhouse gas concentration scenario ([RCP8.5](#)), the temperature is expected to rise by 1.5-3°C and 3-6°C in the mid-21st century (2051-2060) and late 21st century (2091-2100) respectively, when compared to the 1986-2005 average of 23.3°C.

Under the medium-low greenhouse gas concentration scenario ([RCP4.5](#)), the temperature is expected to rise by 1-2°C and 1.5-3°C in the mid-21st century and late 21st century respectively, when compared to the 1986-2005 average.

As for extreme weather, the study shows that the annual number of hot nights (days with a minimum temperature of 28°C or above) and very hot days (days with a maximum temperature of 33°C or above) in summer will increase. On the other hand, the annual number of cold days in winter (days with a minimum temperature of 12°C or below) will continue to drop.

### Slide 28

The annual rainfall in late 21st century is expected to rise by about 180 mm when compared to the 1986-2005 average.

### Slide 29

Under the high greenhouse gas concentration scenario ([RCP8.5](#)), the number of extremely wet years is expected to increase from 3 in 1885-2005 to about 12 in 2006-2100. The number of extremely dry years would remain about the same.

### Slide 30

Climate change is of great concern to us. How can we mitigate the greenhouse effect? We can do it through conserving energy, reduce the use of electricity; promote the use of renewable energy such as wind energy and solar power to generate electricity; use mass transit vehicles for transportation whenever possible. (At this point, students may be encouraged to discuss which types of renewable energy are suitable for Hong Kong).

### Slide 31

Other mitigation measures include: cut down the generation of waste, hence reduce the need for more landfills, use less paper, plant more trees and prevent hill fire.

### Slide 32

Reduce consumption is also a viable measure. Since the production processes of all commercial goods required the use of a large amount of energy, hence producing carbon dioxide. (At this point, students may be encouraged to give examples of other viable mitigation measures).

### Slide 33

“Reduce global warming with a simple life style”. The main cause of global warming lies in the excessive consumption of energy and resources of the earth by human beings. It is now time for us to take some real steps to mitigate climate change. A simple life style is the key to success. Let us all contribute our effort for the goodness of the earth.

(updated in March 2018)